Cell 1 Regional Coastal Monitoring Programme Analytical Report 11: 'Full Measures' Survey 2018

Hartlepool Borough 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	**River Tyne to Frenchman's Bay**	**Frenchman's Bay to Souter Point**	**Souter Point to Chourdon Point**	**Chourdon Point to Hartlepool Headland**
1 in 200 year	3.41	3.44	3.66	3.91
HAT	2.85	2.88	3.18	3.30
MHWS	2.15	2.18	2.48	2.70
MLWS	-2.15	-2.12	-1.92	-1.90
	Water Level (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

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

Glossary of Terms

Term	Definition
Beach nourishment	Artificial process of replenishing a beach with material from another source.
Berm crest	Ridge of sand or gravel deposited by wave action on the shore just above the normal high water mark.
Breaker zone	Area in the sea where the waves break.
Coastal squeeze	The reduction in habitat area which can arise if the natural landward migration of a habitat under sea level rise is prevented by the fixing of the high water mark, e.g. a sea wall.
Downdrift	Direction of alongshore movement of beach materials.
Ebb-tide	The falling tide, part of the tidal cycle between high water and the next low water.
Fetch	Length of water over which a given wind has blown that determines the size of the waves produced.
Flood-tide	Rising tide, part of the tidal cycle between low water and the next high water.
Foreshore	Zone between the high water and low water marks, also known as the intertidal zone.
Geomorphology	The branch of physical geography/geology which deals with the form of the Earth, the general configuration of its surface, the distribution of the land, water, etc.
Groyne	Shore protection structure built perpendicular to the shore; designed to trap sediment.
Mean High Water (MHW)	The average of all high waters observed over a sufficiently long period.
Mean Low Water (MLW)	The average of all low waters observed over a sufficiently long period.
Mean Sea Level (MSL)	Average height of the sea surface over a 19-year period.
Offshore zone	Extends from the low water mark to a water depth of about 15 m and is permanently covered with water.
Storm surge	A rise in the sea surface on an open coast, resulting from a storm.
Swell	Waves that have travelled out of the area in which they were generated.
Tidal prism	The volume of water within the estuary between the level of high and low tide, typically taken for mean spring tides.
Tide	Periodic rising and falling of large bodies of water resulting from the gravitational attraction of the moon and sun acting on the rotating earth.
Topography	Configuration of a surface including its relief and the position of its natural and man-made features.
Transgression	The landward movement of the shoreline in response to a rise in relative sea level.
Updrift	Direction opposite to the predominant movement of longshore transport.
Wave direction	Direction from which a wave approaches.
Wave refraction	Process by which the direction of approach of a wave changes as it moves into shallow water.

Preamble

The Cell 1 Regional Coastal Monitoring Programme covers approximately 300km of the north east coastline, from the Scottish Border (just south of St. Abb's Head) to Flamborough Head in East Yorkshire. 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.

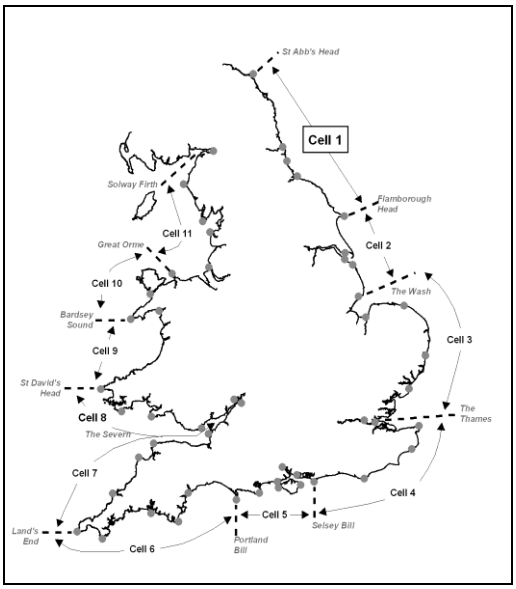


Figure 1 Sediment Cells in England and Wales

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
Northumberland Coast AONB
North Tyneside Council
South Tyneside Council
Sunderland City Council
Durham County Council
Redcar & Cleveland Borough Council
Hartlepool Borough Council
White 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.

Annually, a Cell 1 Overview Report is also produced. This provides a region-wide summary of the main findings relating to trends and interactions along the entire Cell 1 frontage. To date the following reports have been produced:

Table 1 Analytical, Update and Overview Reports Produced to Date

Year		Full Measures		Partial Measures		Cell 1 Overview Report
		Survey	Analytical Report	Survey	Update Report	
1	2008/09	Sep-Dec 08	May 09	Mar-May 09		-
2	2009/10	Sep-Dec 09	Mar 10	Feb-Mar 10	July 10	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-April 11	August 11	Sept 11
4	2011/12	Sep-Oct 11	Oct 12	Mar-May 12	Feb 13	-
5	2012/13	Sep 2012	Feb 13	April 13	May 13	-
6	2013/14	Sep-Oct 13	Feb 14	March 14	July 14	
7	2014/15	Sep-Oct 14	Feb 15	April 15	June 15	
8	2015/16	August 2015	Feb 16	April 16	July 16	Jun 16
9	2016/17	Aug-Sep 2016	Feb 17	Apr 17	Jul 17	
10	2017/18	Sep-Nov 17	Feb 18	Mar 18	May 18	
11	2018/19	Aug-Oct 18	Feb 19 (*)			

(*) The present report is **Analytical Report 11** and provides an analysis of the 2018 Full Measures survey for Hartlepool 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 sections listed in Table 2.

Table 2 Sub-divisions of the Cell 1 Coastline

Authority	Zone
Northumberland County Council	Spittal A
	Spittal B
	Goswick Sands
	Holy Island
	Bamburgh
	Beadnell Village
	Beadnell Bay
	Embelton Bay
	Boulmer
	Alnmouth Bay
	High Hauxley and Druridge Bay
	Lynemouth Bay
	Newbiggin Bay
	Cambois Bay
	Blyth South Beach
North Tyneside Council	Whitley Sands
	Cullercoats Bay
	Tynemouth Long Sands
	King Edward's Bay
South Tyneside Council	Littehaven Beach
	Herd Sands
	Trow Quarry (incl. Frenchman's Bay)
	Marsden Bay
Sunderland Council	Whitburn Bay
	Harbour and Docks
	Hendon to Ryhope (incl. Halliwell Banks)
Durham County Council	Featherbed Rocks
	Seaham
	Blast Beach
	Hawthorn Hive
	Blackhall Colliery
Hartlepool Borough Council	North Sands
	Headland
	Middleton
	Hartlepool Bay
Redcar & Cleveland Borough Council	Coatham Sands
	Redcar Sands
	Marske Sands
	Saltburn Sands
	Cattersty Sands (Skinningrove)
Scarborough Borough Council	Staithes
	Runswick Bay
	Sandsend Beach, Upgang Beach and Whitby Sands
	Robin Hood's Bay
	Scarborough North Bay
	Scarborough South Bay
	Cayton Bay
	Filey Bay

1. Introduction

1.1 Study Area

Hartlepool Borough Council's frontage extends from Crimdon Beck in the north, to the North Gare Breakwater in the south. For the purposes of this report, it has been sub-divided into four areas, namely:

- North Sands
- Hartlepool Headland
- Middleton
- Hartlepool Bay

1.2 Methodology

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

- Full Measures survey annually each autumn/early winter comprising:
    - Beach profile surveys along twelve transect lines
    - Topographic survey along part of North Sands (referred to as Hartlepool North or 'HN')
    - Topographic survey along Middleton (referred to as Hartlepool Central or 'HC')
    - Topographic survey along Hartlepool Bay (referred to as Hartlepool South or 'HS')
- Partial Measures survey annually each spring comprising:
    - Beach profile surveys along twelve transect lines
- Additionally, every five years (starting with 2008 as the baseline year), the Full Measures topographic survey at Hartlepool North is extended to fully cover the whole of North Sands and Hartlepool Headland with a topographic survey. This extends across the boundary of jurisdiction between Hartlepool Borough Council and County Durham Council.

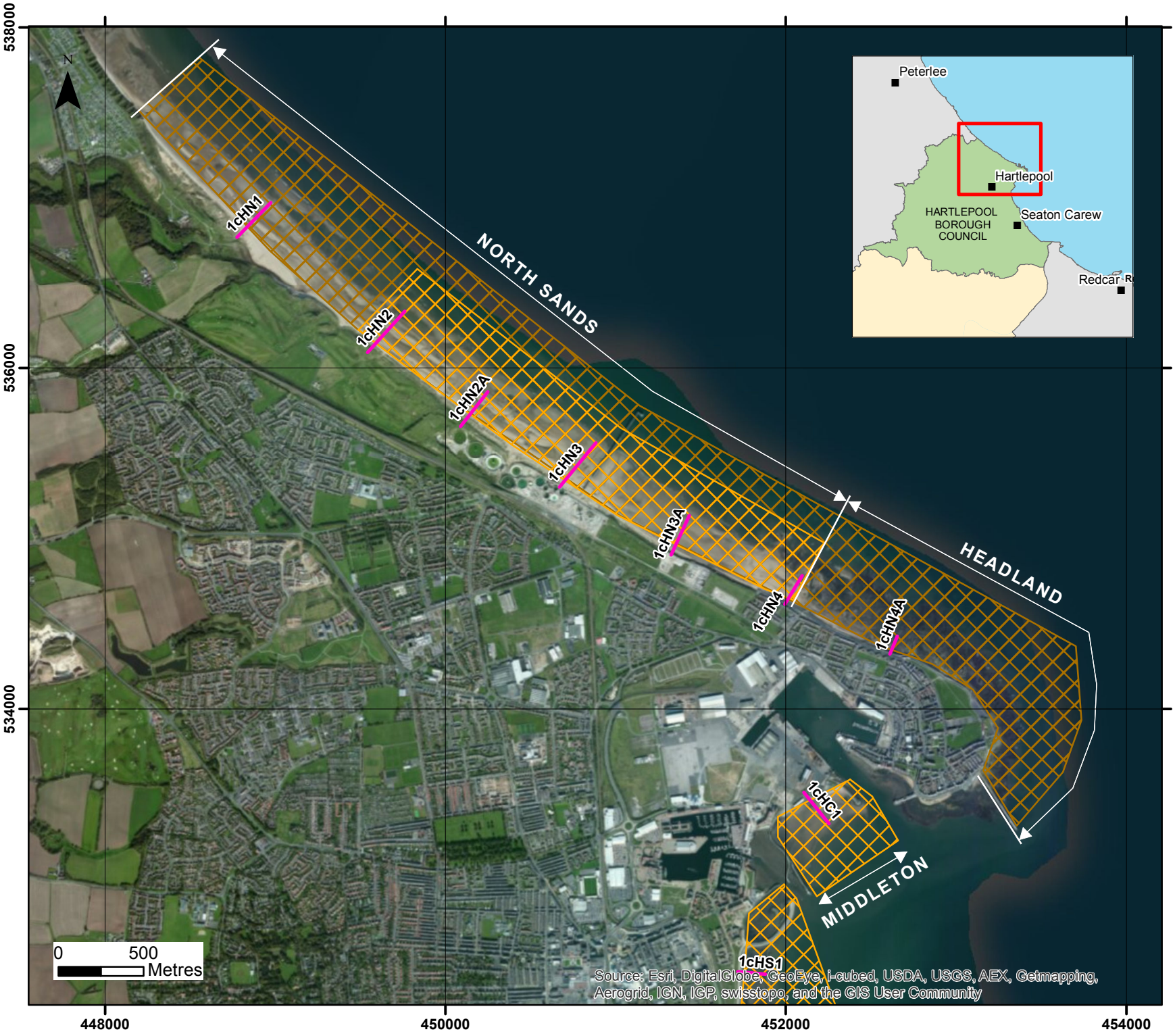
The location of these surveys is shown in Figure 2. The 2018 Full Measures survey was undertaken along this frontage on various dates between 28th August and 24th October 2018. During this time, the weather was generally dry and sunny with force 2 to 4 breezes from variable directions. The sea state at all sites was either calm or moderate. The survey reports from Academy Geomatics document details of the weather conditions over this survey period.

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 Hartlepool Borough Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:30,000

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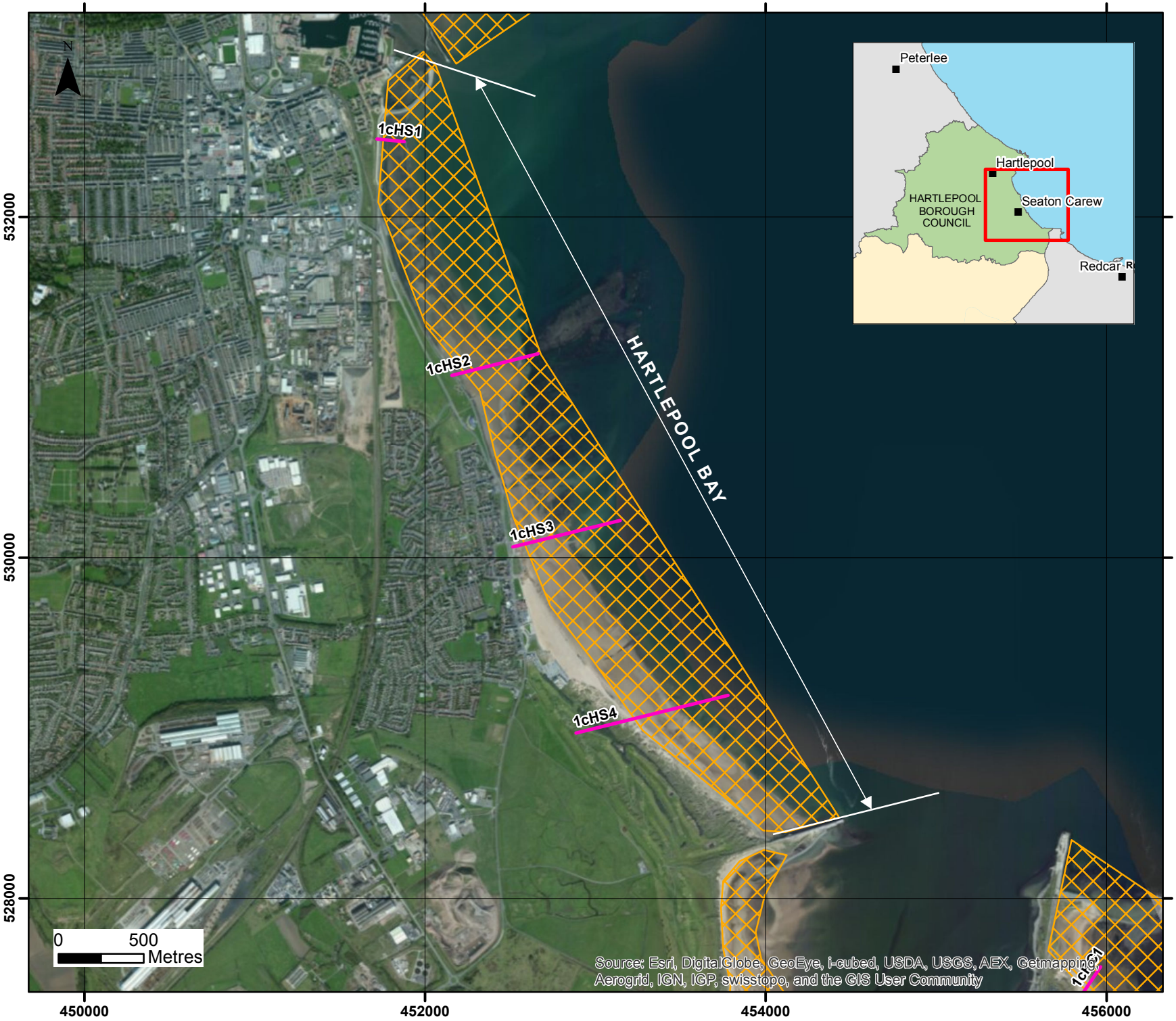

Key

SURVEY LOCATIONS

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- Annual
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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 Hartlepool Borough Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:30,000

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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 3 Hartlepool Borough Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:12,000

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2. Analysis of Survey Data

2.1 North Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
28th – 31st August 2018	**Beach Profiles:** North Sands is covered by four beach profile lines during the Full Measures survey (Appendix A). They were last surveyed in March 2018. Profile **1cHN1** is located within Durham County Council's area of responsibility, about 400m north of the outfall of Crimdon Beck, but is reported here so changes can be interpreted in association with those observed elsewhere along North Sands at HN2, HN3 and HN4. The beginning of profile **1cHN1** between 0m and 70m change covers dunes and has not changed. A small berm has formed at chainage 86m, with an accretion of up to 0.8m. Between 105m chainage and 148m there has generally been erosion of up to 0.35m. From 148m seawards, the profile has increased by up to 1.5m compared to March 2018. The profile is at its highest recorded level at the toe of the dunes, dipping to a low level in the middle beach and moving to a high level at the lower foreshore compared to previous surveys. At Profile **1cHN2,** the profile has not changed on the section with dunes, until chainage 53m where the toe of the dunes has moved landward by c.3m. Between chainage 56m and 180m, two berms have formed at chainages 62m and 130, with the accumulation of 0.8m and 1.6m respectively. Seaward of 180m chainage, the lower foreshore has eroded by up to 0.7m, whilst the toe of the beach has extended 108m seaward. Overall the profile is at a medium level compared with previously recorded surveys, although both berms are at a relatively high level. Profile **1cHN2A** was established in October 2011 and runs through the dunes close to North Sands. The foredune which had started to re-accrete in the September 2015 has continued to accrete marginally. The toe of the dunes has eroded by up to 0.8m to chainage 84m, where there is a small amount of accretion to chainage 93m of 0.2m. Seaward of 93m, beach levels have lowered across the profile, by up to 0.6m in the upper beach, 0.1m in the middle beach and 1.3m in the lower foreshore. Overall, the profile shows low levels, reaching its lowest level recorded between chainages 98-116m and 180-217m. At Profile **1cHN3** there has been little change of the dunes. The toe of the dunes has accreted to	The dunes at North Sands have remained stable since the previous survey, whilst beach levels have predominantly accreted on the upper beach and eroded across the middle and lower beach, except towards the middle and east of the survey area where the middle and lower beach remain relatively stable. Beach levels are at a medium to high level in the western survey area, whilst they are medium to low level across the eastern survey area. **Longer term trends**: The 2018 full measures survey is generally in line with the longer term trends which suggest accretion in the west, stability in the middle of the bay and erosion in the east.

Survey Date	Description of Changes Since Last Survey	Interpretation
	chainage 73m by up to 0.3m. The majority of the beach profile shows erosion with a loss of up to 0.6m between 73m chainage and 262m, moving the toe of the beach landward by 23m. The dunes are at a high level, whilst the rest of the beach profile is at a low level compared to the range recorded from previous surveys, particularly between chainages 73-99m, and 117m-177m which are at their lowest level recorded. At Profile **1cHN3a** there has been relative stability down to the dune face at 20m chainage, with minor sections of change limited to ±0.1m. The drop in beach level at the toe of the dunes recorded in the March 2018 survey has shown some signs of recovery, with levels accreting by 0.8m, back to the November 2017 levels. The remainder of the profile mainly shows varying sections of erosion and accretion of up to 0.2m. Overall the level is in the mid-to-low range of the previous profiles, with the exception of the seaward end (chainage 170m onwards) which is relatively high. At Profile **1cHN4** there has been an accumulation of up to 0.9m high at the toe of the rock protrusion at chainage 15m. The berm between chainage 51m and 111m recorded in March 2018 has been removed with erosion of up to 0.9m. Seaward of chainage 111m there has been relatively no change across the exposed rock platform. Overall the profile is towards the low end of the range recorded from previous surveys. At Profile **1cHN4a**, a new capstone has been established and the existing sea wall amended as part of ongoing promenade refurbishment, resulting in a seaward movement of the sea wall by approximately 1.2m. There has been little change across the beach profile compared to previous surveys, with minor sections of erosion / accretion limited to ±0.1m. Overall the profile is at a medium-low level compared to the previous recorded surveys.	
August 2018	**Topographic Survey:** North Sands is covered by an annual topographic survey. Data from the 2018 Full Measures survey have been used to create a DGM (Appendix B – Map 1) using a GIS package. The majority of the frontage is characterised by shore-parallel contours, except in the vicinity of outfalls, groynes and the pier where contours change direction. The GIS has also been used to calculate the differences between the Autumn 2017 and Autumn 2018 topographic surveys, as shown in Appendix B – Map 3, to identify areas of net erosion and accretion. To the west of the pier, erosion dominates with losses of over 1.5m in places. The beach lowering is	The difference plot at North Sands is dominated by erosion, with more modest erosion rates east of the pier compared to the west. Small bands of accretion are apparent along the middle beach at the western most end of the survey area and on the upper and lower beach east of the pier. This was in contrast to the changes seen in 2017, which was dominated by accretion.

Survey Date	Description of Changes Since Last Survey	Interpretation
	concentrated in the upper-mid beach; however, there are some patches of accretion, with one continuous band of accretion occurring in the middle beach to the very west of the survey. To the east of the pier, erosion continues to dominate, although the changes in beach level are not as severe. Two small bands of accretion are present on the upper and lower foreshore. There is little to no change in beach level at the eastern-most end of the survey, with only minor patches of erosion and accretion limited to ±0.1m.	

2.2 Middleton

Survey Date	Description of Changes Since Last Survey	Interpretation
8th October 2018	**Beach Profiles:** Middleton is covered by one beach profile line during the Full Measures survey (Appendix A). The beach at Profile **1cHC1** between the toe of the seawall at chainage 48m and 59m shows erosion of up to 0.3m. Between chainage 62m and 179m, there has been accretion of up to 0.8m, infilling a depression at chainage 82m and forming a small berm at chainage 155m. Seawards of 179m there has been minor erosion of the beach toe of 0.15m. Overall the beach is at a low level across the upper beach compared to the range from previous surveys, particularly at the toe of the seawall which has reached its lowest level recorded. The middle and lower beach are at a medium to high level, particularly the berm on the lower foreshore which is at its highest level recorded.	The beach profile showed a gain in the upper and middle beach and a loss in the lower beach. **Longer term trends**: The upper beach is in the low range of the previously recorded levels, whilst the middle and lower beach are at a medium-high level.
October 2018	**Topographic Survey:** The frontage is covered by an annual topographic survey between Middleton Jetty and North Pier. Data from the 2018 Full Measures survey have been used to create a DGM (Appendix B – Map 1) using GIS software. Beach contours indicate a steeper beach in the east than the west, with the contours locally affected by pipelines and groynes. In the Autumn 2013 survey, differences between the eastern and western ends of the beach were less marked. Earlier years show a similar topography to 2014 and 2015. The GIS has also been used to calculate the differences between the Autumn 2017 and Autumn 2018 topographic surveys, as shown in Appendix B – Map 3, to identify areas of net erosion and accretion. The beach near the Headland shows a patchy distribution of accretion and erosion, with there generally being little change in the east and erosion in the west. At Middleton erosion dominates in the west with accretion in the east. The changes observed at Middleton beach over the year are modest at less than ±0.75m.	The difference plot for Middleton shows a zone of erosion across the upper beach, and across the beach profile in the west of the survey area. Accretion dominates in the east across the middle and lower beach. Changes are low in magnitude. In front of the headland the difference plots show a patchy distribution of change due to the thin but mobile cover of sand here.

2.3 Hartlepool Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
23rd – 24th October 2018	**Beach Profiles:** Hartlepool Bay is covered by four beach profile lines during the Full Measures survey (Appendix A). The profiles were last surveyed in March 2018. Sea coalers had been banned from driving onto the beach in 2013 but on 28th March 2015 the gates were opened and they were allowed to remove coal from the beach again (Hartlepool Mail). Profile **1cHS1** is located approximately 150m south of the root of the South Pier. The profile starts at the wall to the rear of the promenade and extends across the promenade, over the fronting concrete splash wall and down the sloping face of the rock armour revetment before reaching the beach. Generally, there has been varying sections of erosion and accretion of up to 0.5m between the rock armour. Seaward of the rock armour, the beach has gained up to 0.5m and the toe has extended seaward by 9m. The beach level is at a medium high level on the upper and middle beach, whilst it is at a low level on the lower beach. There has been accretion of up to 0.8m at the toe of the rock revetment at Profile **1cHS2**. Between chainages 63m and 133m there has been erosion of up to 0.25m, switching to accretion across the rest of the profile of up to 0.3m. The October 2018 profile is the highest recorded at the toe of the revetment and seaward of 204m, and is at a relatively medium level through the middle beach. At profile **1cHS3** there has been accretion of up to 1.0m on the upper beach between chainage 30m and 67m. Between chainage 67m and 110m there has been a lowering of up to 0.7m. Between 110m and 225m a berm has formed up to 0.4m high. The lower foreshore seaward of 225m has undergone negligible change in beach level. The upper beach is the highest on record, whilst the middle beach is the lowest on record compared to previous surveys. The lower foreshore is at a high level. The profile **1cHS4** is located further south, around 1km north of the North Gare breakwater in an area of undefended dunes at Seaton Sands. The profile covers approximately 325m of dunes before the beach. The dune section is stable, with a foredune continuing to accrete at around 320m chainage with 0.2m of growth since March 2018. The depression between the main dune and the foredune has migrated seaward by c.4m. The berm developed in the November 2017 survey at chainage 370m has formed once again, reducing in height by 0.2m and migrating seaward by 30m. The rest of the beach has	The upper beach across Hartlepool Bay shows accretion, reaching its highest level in several places. The middle beach has undergone erosion and is at its lowest level recorded in several places, whilst the lower foreshore has undergone generally little change. The profiles reflect seasonal redistribution of material across the beach. **Longer term trends**: The profiles have shown relative stability over 2018. The accretion of the northern three profiles continues and beach levels are generally medium to high on the southern profile HS4, the foredune continues to develop although footfall may be damaging it and leading to erosion.

Survey Date	Description of Changes Since Last Survey	Interpretation
	lowered by up to 0.4m in the middle beach, removing a berm from the March 2018 survey, and up to 0.1m on the lower foreshore. The foredune and upper beach berm are at their highest levels recorded, whilst the depression in the middle beach is at its lowest level recorded. The rest of the beach is at a medium to low level compared to the range recorded from previous surveys.	
	Topographic Survey: Hartlepool Bay is covered by an annual topographic survey between the South Pier and the North Gare Breakwater. Data from the 2018 Full Measures survey have been used to create a DGM (Appendix B – Map 2) using a GIS software package. The plot shows the two smaller bays within the larger Hartlepool Bay frontage. These smaller bays are separated by a slight promontory at Carr House Sands between Hartlepool and Seaton Carew. The beach contours are generally shore parallel, except where linear features (e.g. outfalls) and rock outcrops are present, such as in the northern part of Seaton Sands. Elevations at the rear of the beach are lowest in the north of the survey area near South Pier and higher further south. The GIS has also been used to calculate the differences between the Autumn 2017 and Autumn 2018 topographic surveys, as shown in Appendix B – Map 4, to identify areas of erosion and accretion. The changes recorded over 2018 show a dominance of erosion across the full beach in the north and centre of the bay, with accretion dominating in the southern bay. The changes observed are modest in the north and centre of the bay at less than ±0.75m and are slightly higher in magnitude towards the south of the bay, reaching ±1.0m. The plot generally shows shore-parallel changes, reflecting the seasonal movement of sediment across the beach in the form of sand bars.	

2.4 North Gare

Survey Date	Description of Changes Since Last Survey	Interpretation
October 2018	**Topographic Survey:** North Gare is covered by an annual topographic survey between the North Gare Breakwater and the Seaton on Tees Channel. The area is designated as the Teesmouth National Nature Reserve. Surveys have been carried out since Autumn 2011. Data from the 2018 Full Measures survey have been used to create a DGM (Appendix B – Map 3) using GIS software. The beach contours recorded in 2018 show the promontory and the contours run shore parallel to the beach in the north. In the south of the study area the contours diverge from the shore line and there is an extensive flat area between the shoreline and MHW. However, the lower beach and foreshore are much steeper in the south of the survey area than in the north. The GIS has also been used to calculate the differences between the Autumn 2017 and Autumn 2018 topographic surveys, as shown in Appendix B – Map 6, to identify areas of net erosion and accretion. The difference plot shows that erosion dominates across the beach in the north, with accretion confined to the northern most part of the survey on the middle to lower foreshore. In the southern part of the survey area, to the north and landward of the promontory there is little change, with some patchy small scale accretion. Seaward of the promontory the pattern is also patchy with accretion dominating, especially along the gravel bank from the end of the promontory. However, there is a band of erosion to the east of the promontory running north from the lower foreshore, with erosion up to 1.75m. Overall, erosion dominates along the north of the survey area, whilst accretion dominates on the extensive flat area between the shoreline and MHW. These changes are limited in magnitude, with the greatest change being the patch of erosion in the southern most extent of the survey area.	The changes seen in the north in the 2018 Full Measures survey do not show a pronounced pattern of sand bar movement across the shore face as they did in the 2017 survey, and is instead dominated by erosion across most of the beach (albeit low in magnitude). The pattern in the south in 2018 generally mirrors that seen in 2017, however erosion is slightly more dominant on the lower foreshore than before.

3. Problems Encountered and Uncertainty in Analysis

Beach profile HN1 is located within Durham County Council's area of responsibility but has been reported here so changes can be interpreted in association with those observed elsewhere along North Sands, along HN2, HN3 and HN4.

At Hartlepool North, work was still ongoing between profiles 1aHN4 and 1aHN4A. Section 1HN4A has been completed, with the establishment of a new capstone, resulting in a seaward movement of the sea wall by approximately 1.2m.

At Middleton, there was no access to the upper section of profile 1cHC1.

At North Gare, ground levels within the salt marsh area at the south east corner were taken on foot to avoid disturbing wildlife.

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

No further 'fine-tuning' is recommended at the present time.

5. Conclusions and Areas of Concern

- At North Sands, the beach profiles generally show accretion on the upper beach across the bay, with erosion across the middle and lower foreshore, except towards the centre and eastern survey area where beach levels remain stable. The beach is mostly at a medium-high level on the upper beach and medium-low level on the middle and lower beach.
- At Middleton, the beach profile shows a loss of material at the toe of the sea wall and beach toe, with the formation of berms across the upper and middle beach since March 2018. The difference pot shows erosion dominating the upper beach and central to west side of the beach. The continuing erosion of the beach is expected because there are no sources of sediment to the Middleton frontage. The beach in front of the headland had a patchy distribution of change in 2018.
- The majority of changes through 2018 in Hartlepool Bay were modest. Profiles generally show accretion on the upper beach, erosion on the middle beach and relative stability on the lower beach, reflecting the seasonal movement of sediment across the beach as sand bars. This pattern is also supported by the topographic survey difference plot.
- The topographic plot at North Gare shows a dominance of erosion towards the north compared to the 2017 survey, whilst the pattern seen in the south is a continuation of the elevation changes observed since 2013.Throughout 2018 there was erosion in the north and accretion in the south overall.
- There is no cause for concern at any of these areas.

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

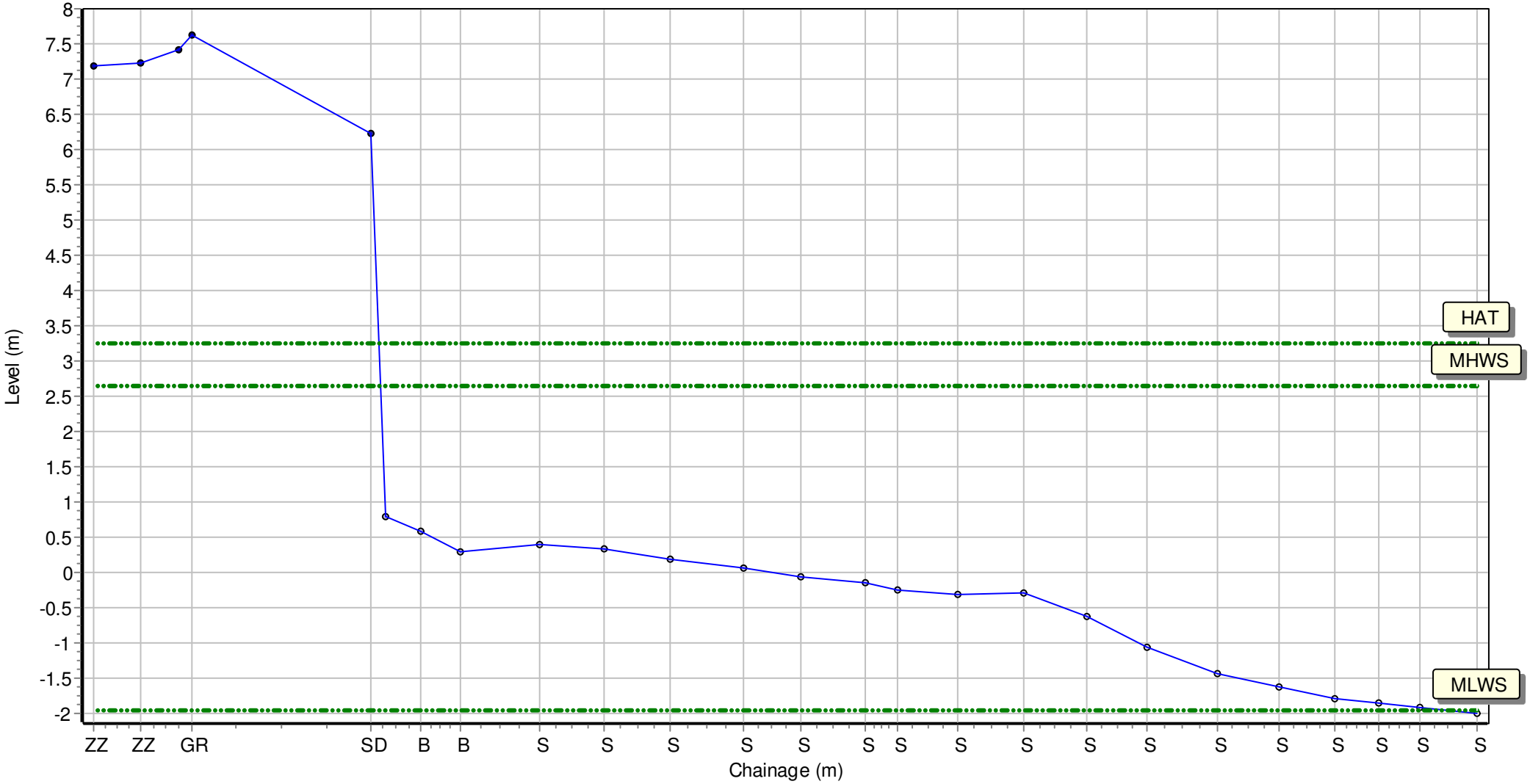
Location: 1cHC1

Date: 08/10/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2018 Full Measures Topo Survey

Easting: 452108.075 **Northing:** 533506.119 **Profile Bearing:** 150 ° from North



Beach Profile

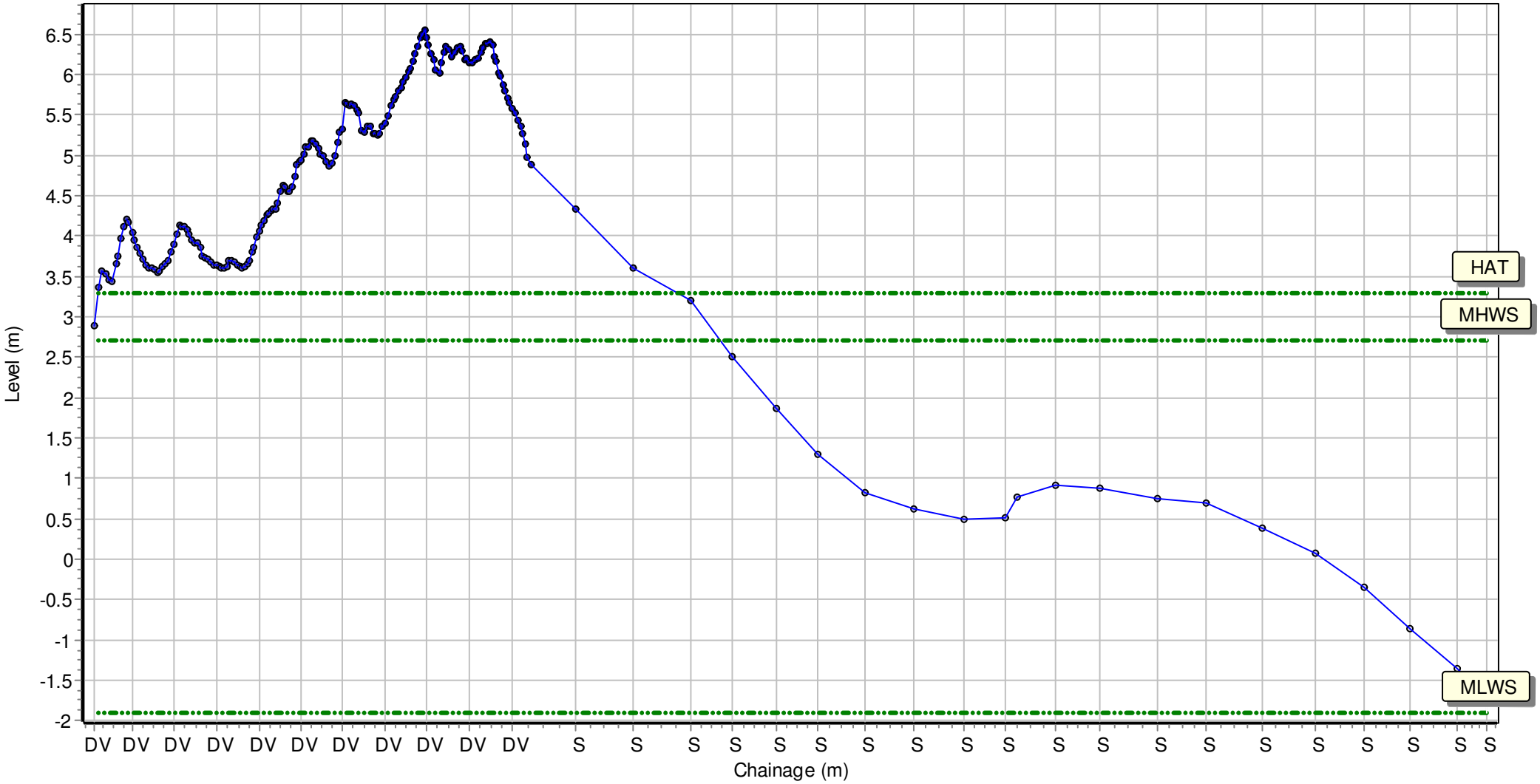
Location: **1cHN1**

Date: 31/08/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2018 Full Measures Topo Survey

Easting: 448779.624 **Northing:** 536767.42 **Profile Bearing:** 44 ° from North



Beach Profile

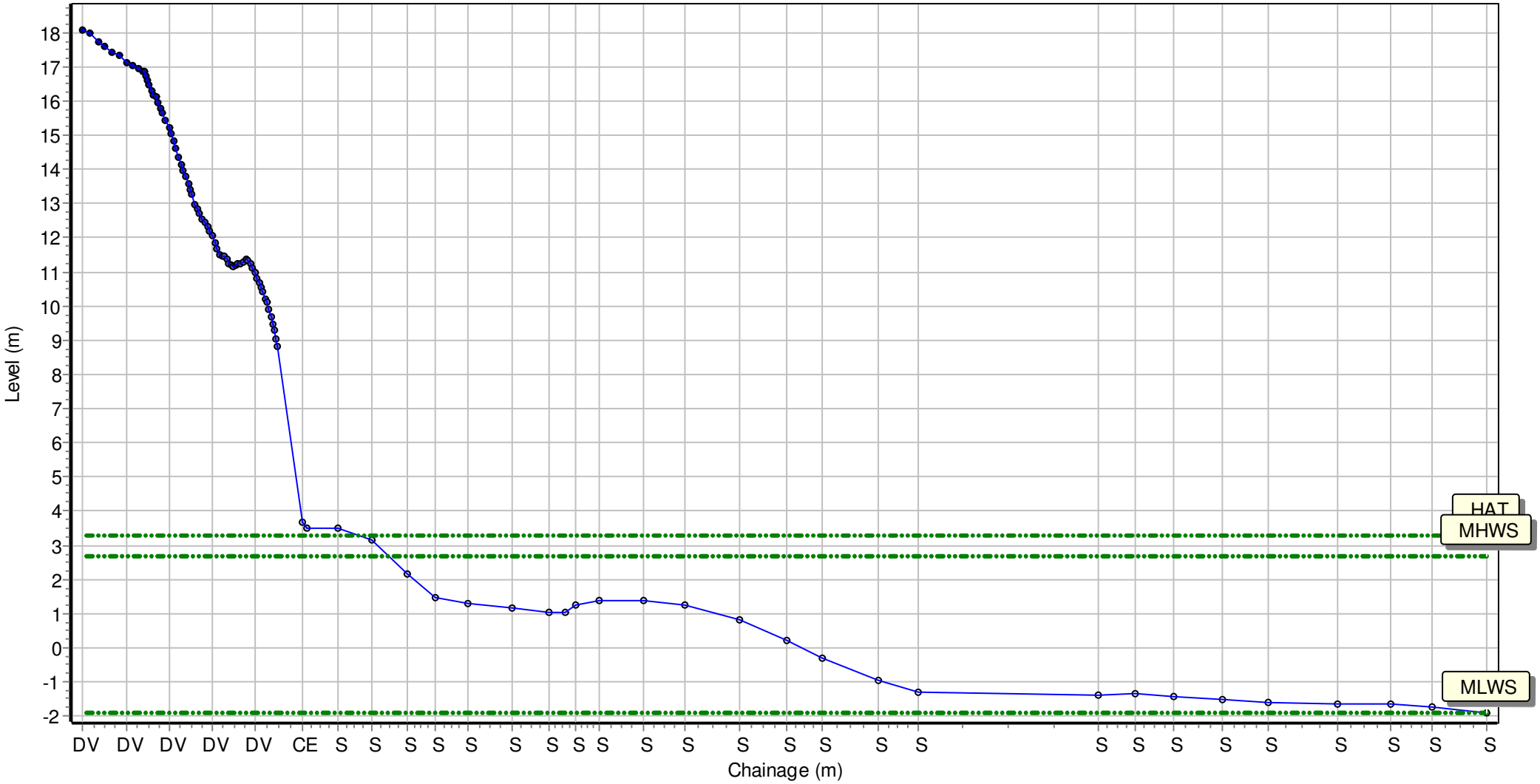
Location: 1cHN2

Date: 31/08/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2018 Full Measures Topo Survey

Easting: 449547.217 **Northing:** 536095.458 **Profile Bearing:** 42 ° from North



Beach Profile

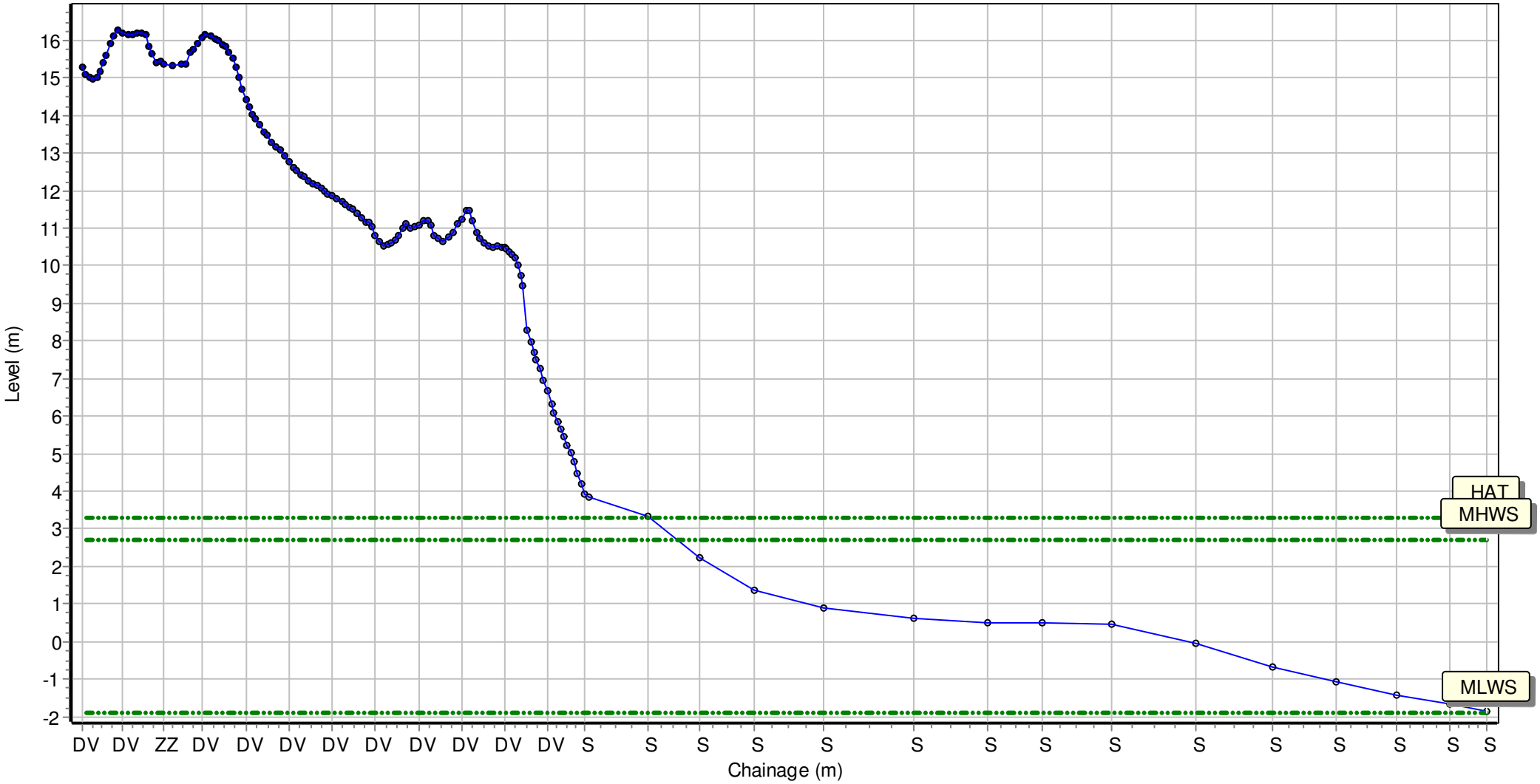
Location: **1cHN2A**

Date: 31/08/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2018 Full Measures Topo Survey

Easting: 450088.047 **Northing:** 535658.212 **Profile Bearing:** 39 ° from North



Beach Profile

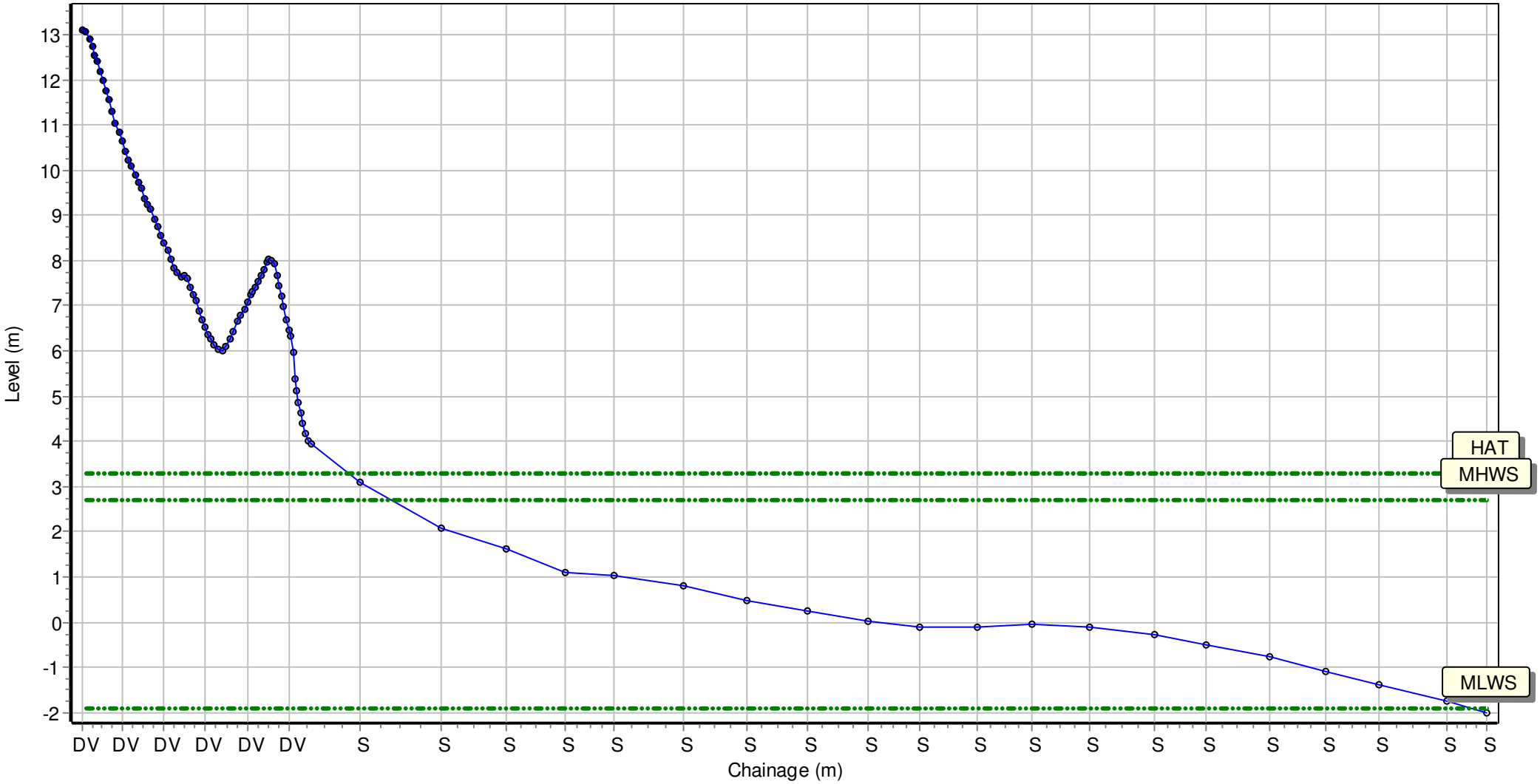
Location: 1cHN3

Date: 31/08/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2018 Full Measures Topo Survey

Easting: 450674.424 **Northing:** 535305.141 **Profile Bearing:** 30 ° from North



Beach Profile

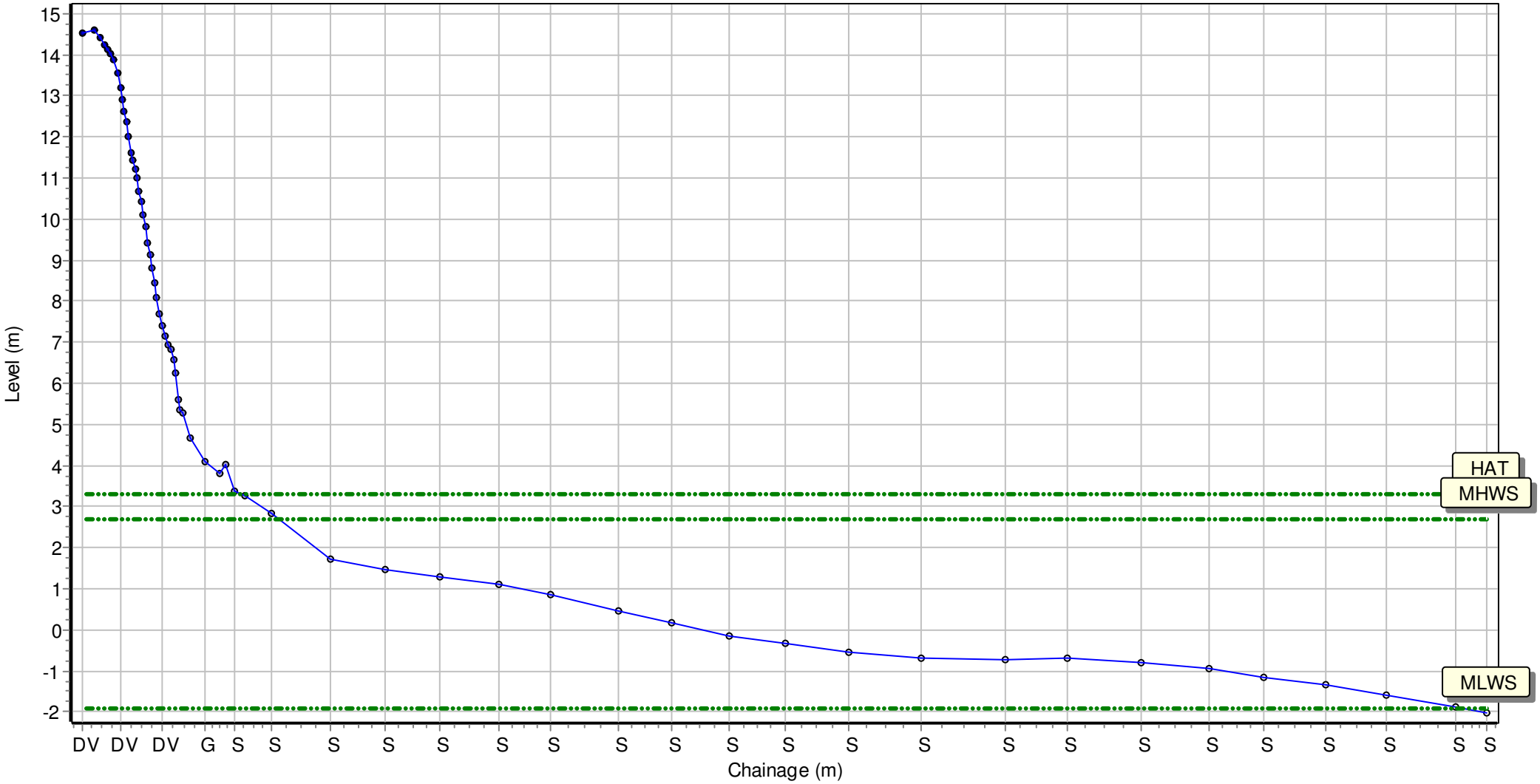
Location: **1cHN3A**

Date: 31/08/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2018 Full Measures Topo Survey

Easting: 451324.71 **Northing:** 534903.35 **Profile Bearing:** 25 ° from North



Beach Profile

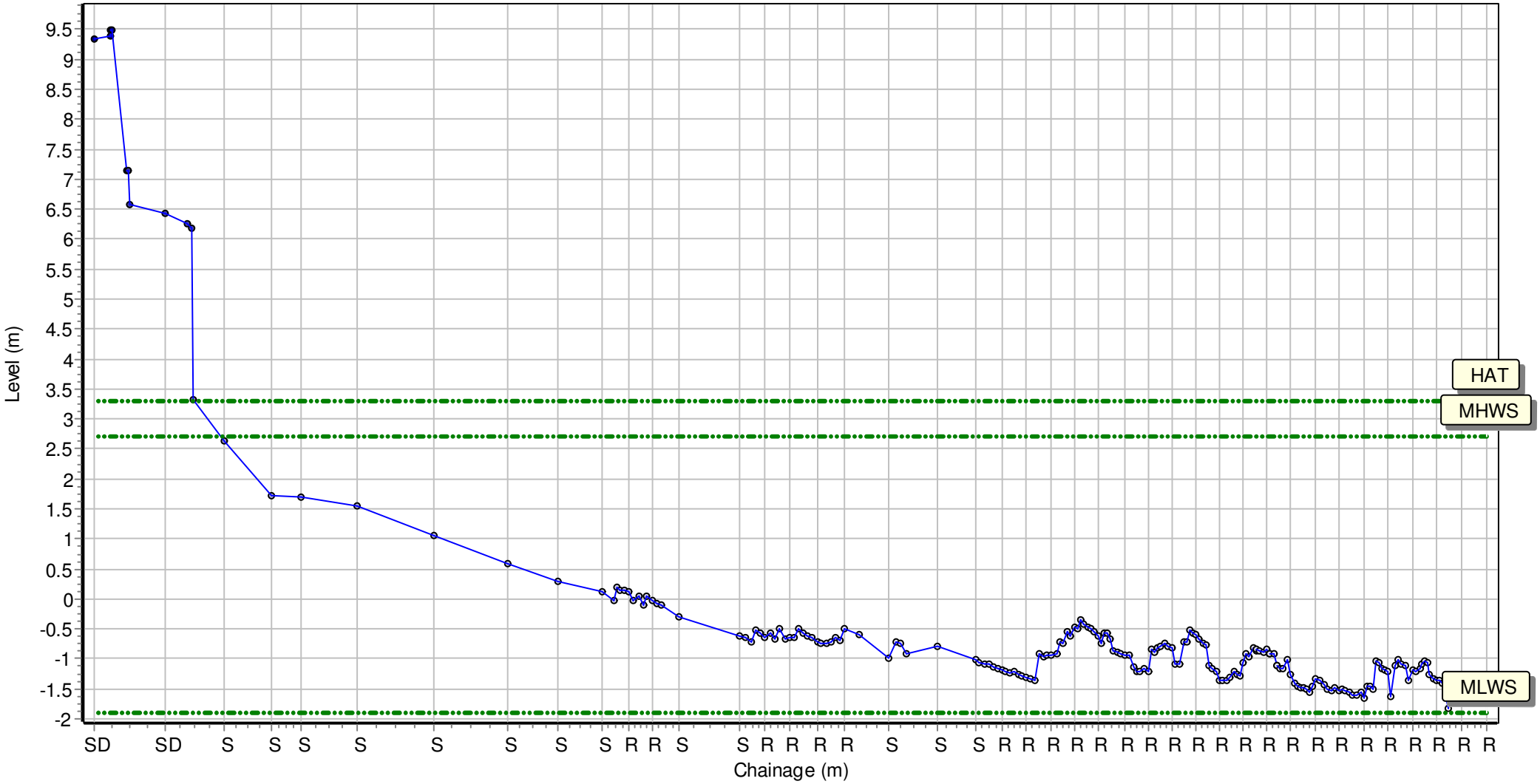
Location: **1cHN4**

Date: 31/08/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2018 Full Measures Topo Survey

Easting: 451997.114 **Northing:** 534616.627 **Profile Bearing:** 25 ° from North



Beach Profile

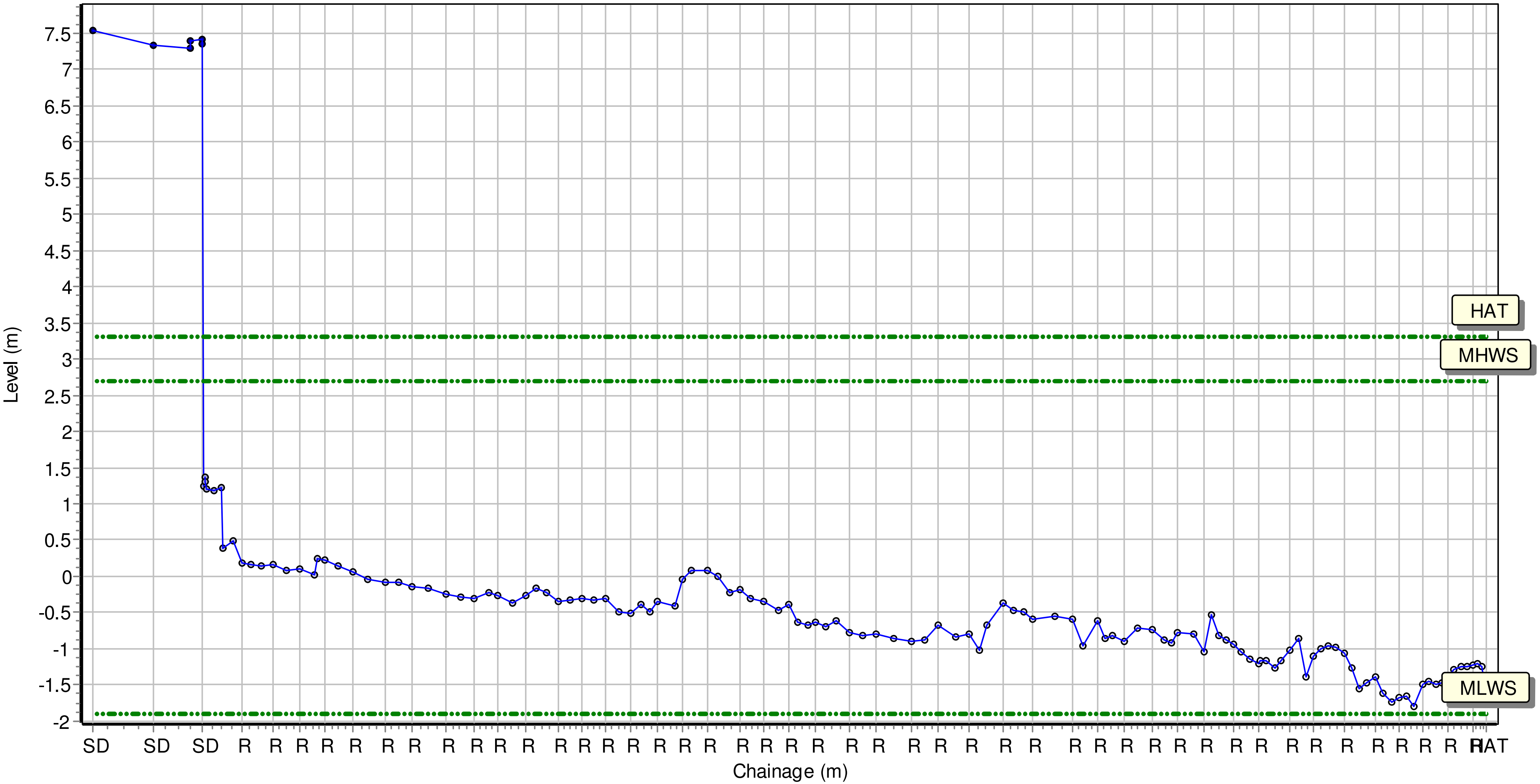
Location: 1cHN4A

Date: 31/08/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2018 Full Measures Topo Survey

Easting: 452610.565 **Northing:** 534321.038 **Profile Bearing:** 23 ° from North



http://www.sandsuser.com

SANDS

Beach Profile

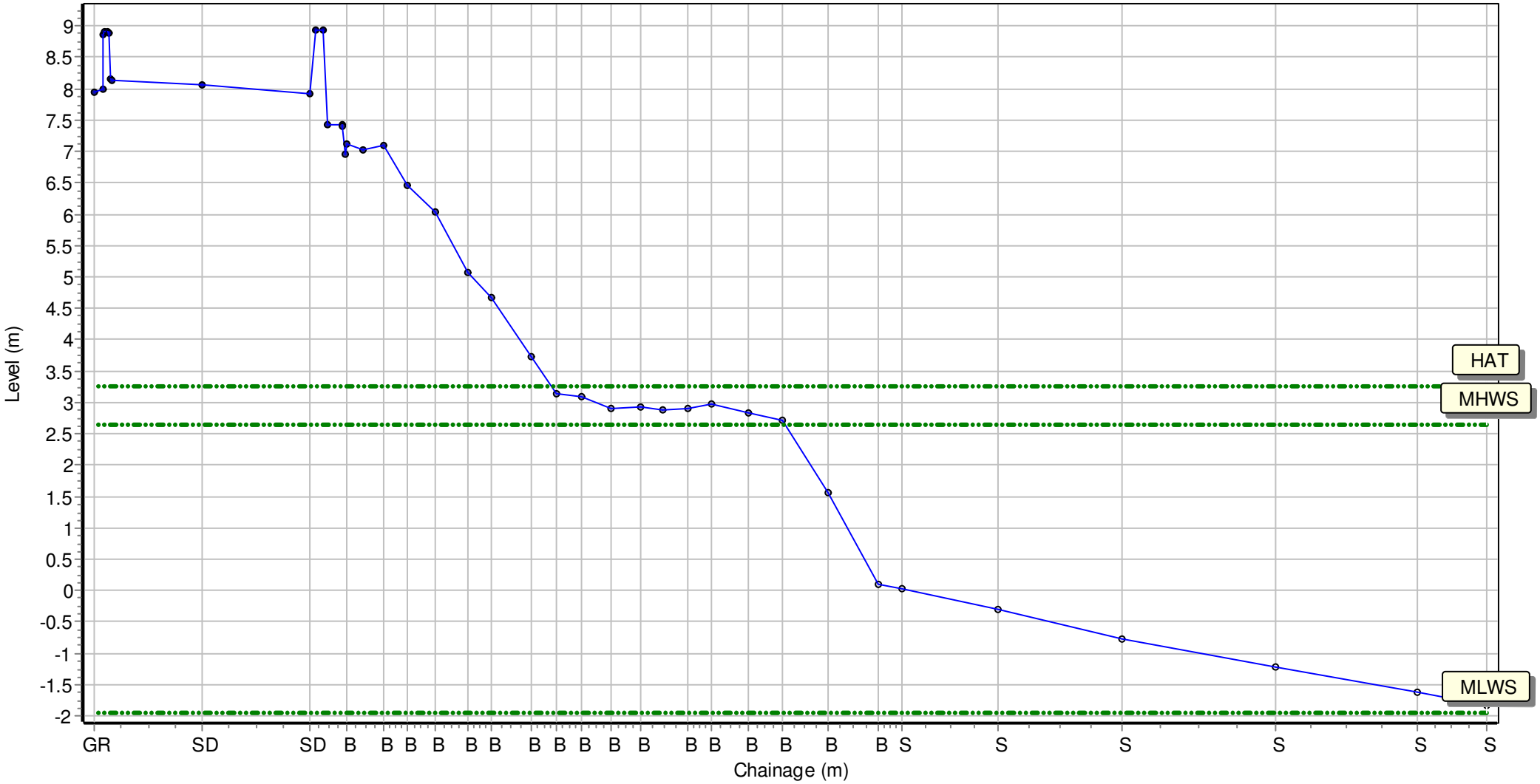
Location: **1cHS1**

Date: 24/10/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2018 Full Measures Topo Survey

Easting: 451718 **Northing:** 532455 **Profile Bearing:** 95 ° from North



Beach Profile

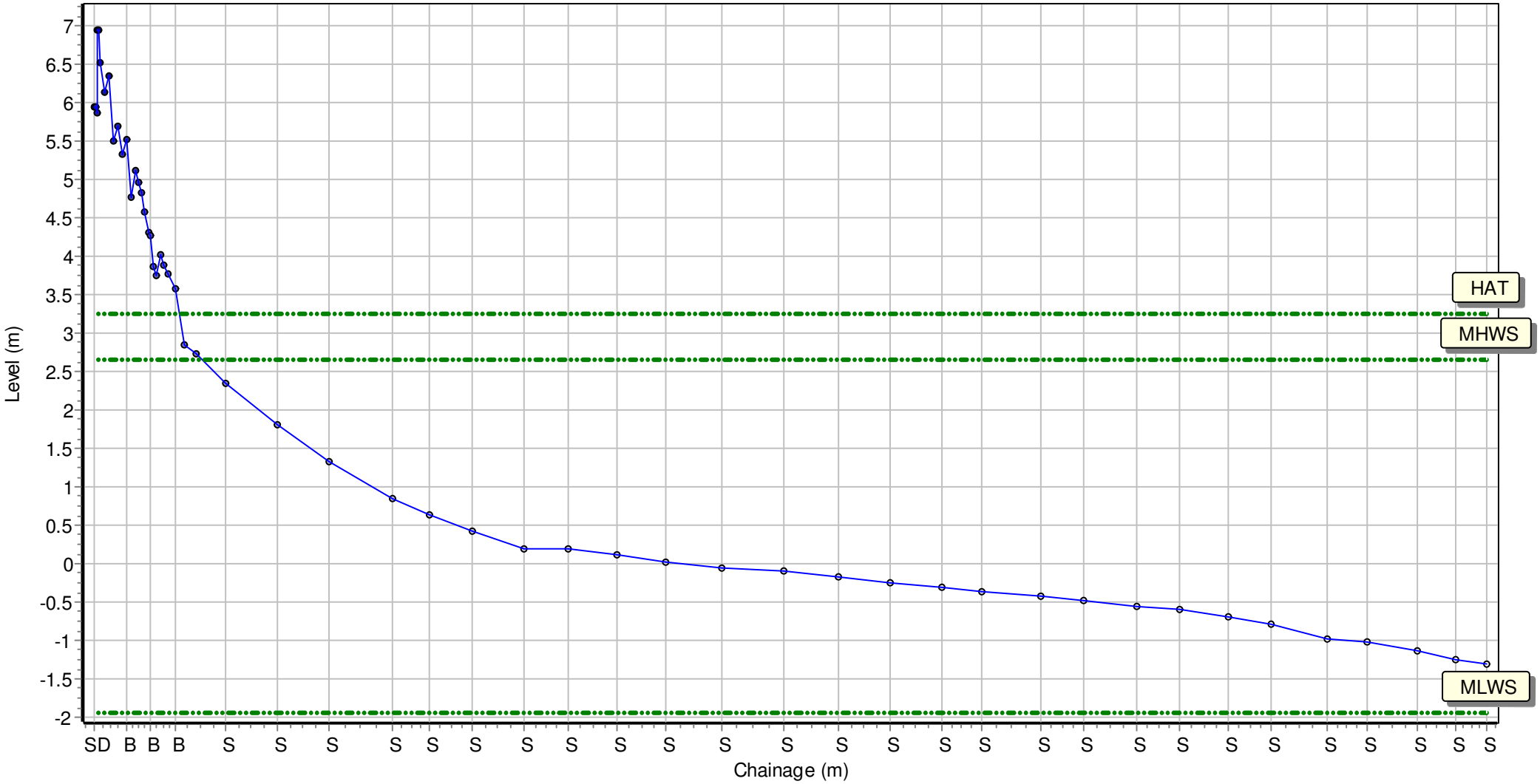
Location: **1cHS2**

Date: 24/10/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2018 Full Measures Topo Survey

Easting: 452160.59 **Northing:** 531071.39 **Profile Bearing:** 77 ° from North



Beach Profile

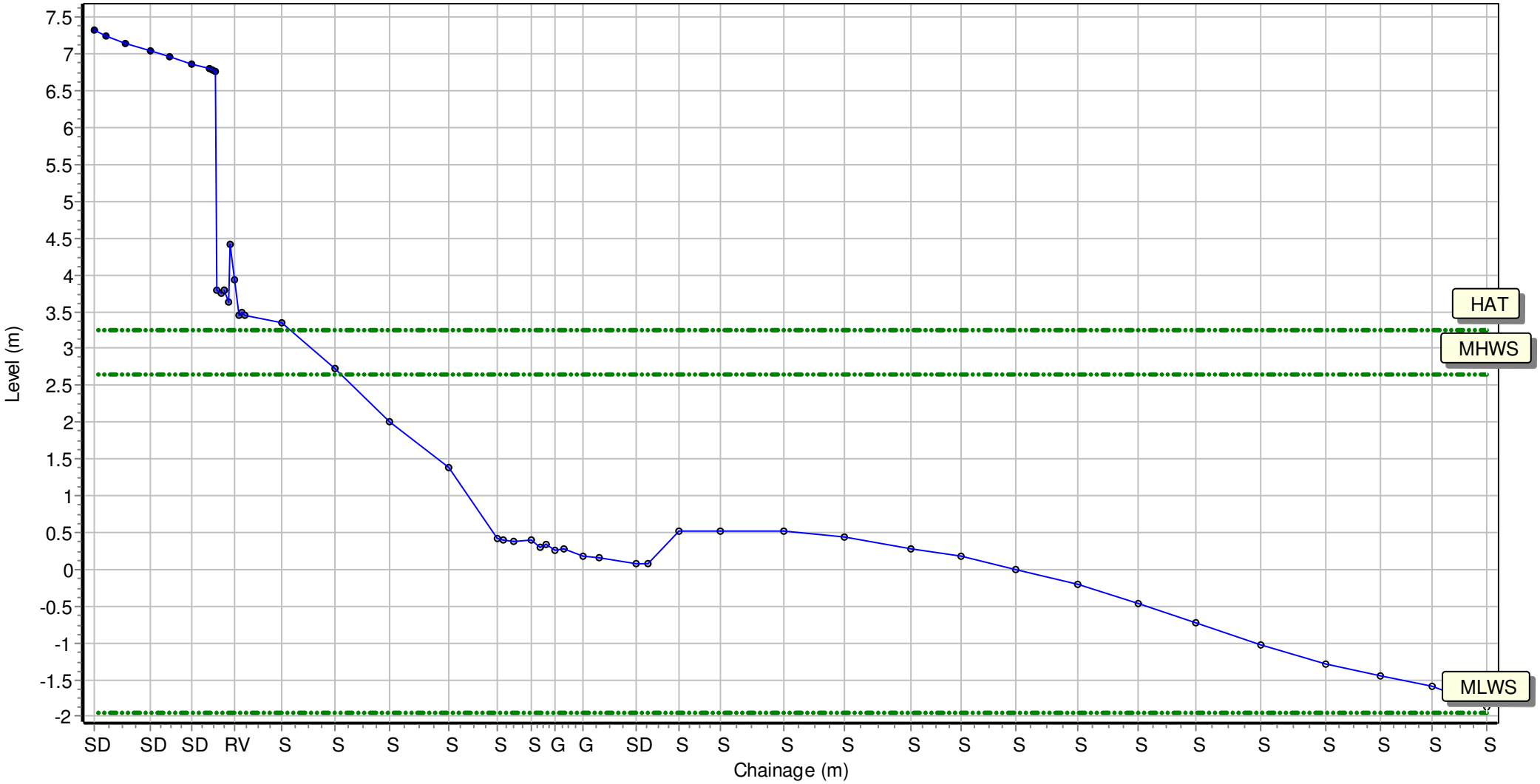
Location: **1cHS3**

Date: 24/10/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2018 Full Measures Topo Survey

Easting: 452517.25 **Northing:** 530064.57 **Profile Bearing:** 76 ° from North



Beach Profile

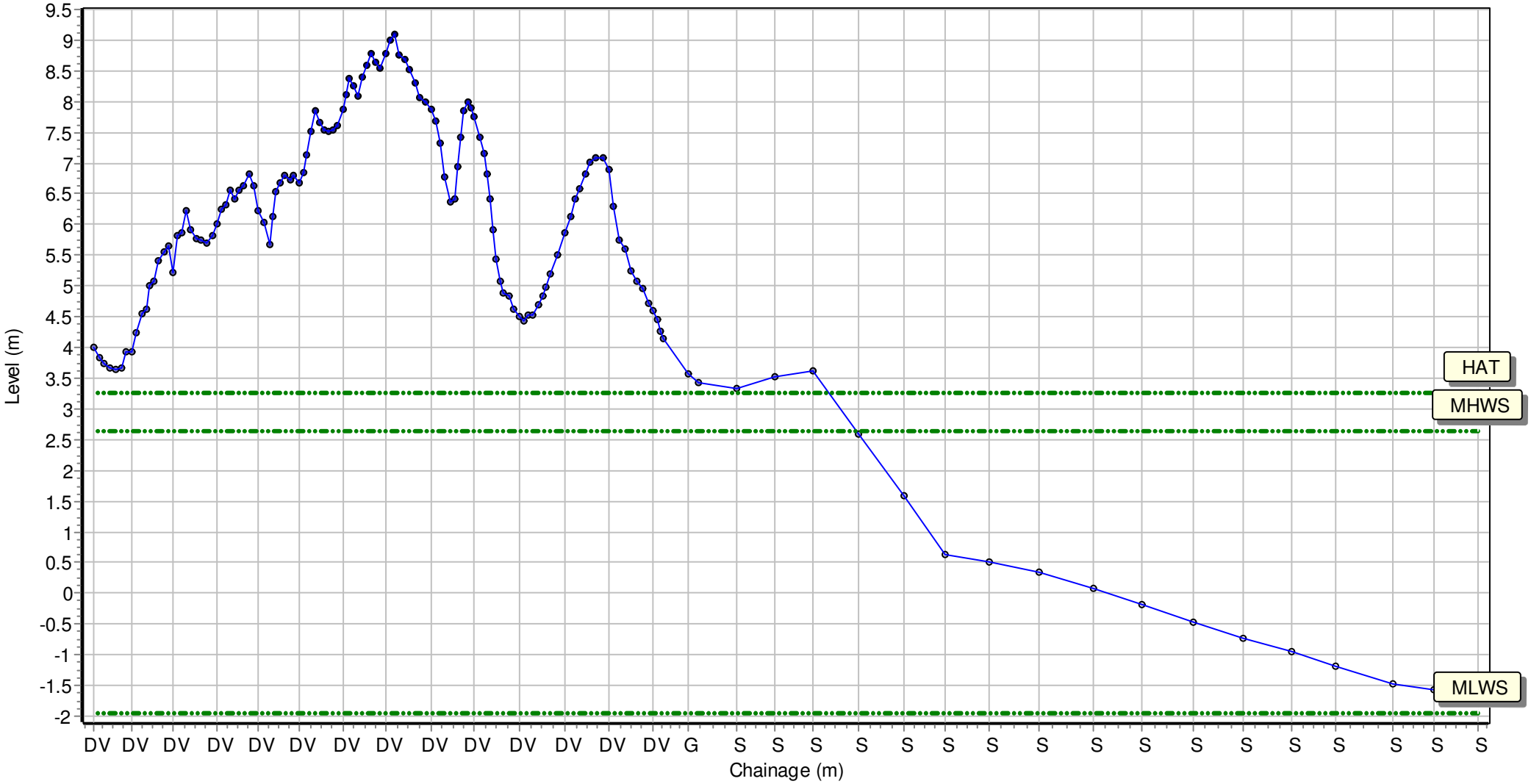
Location: **1cHS4**

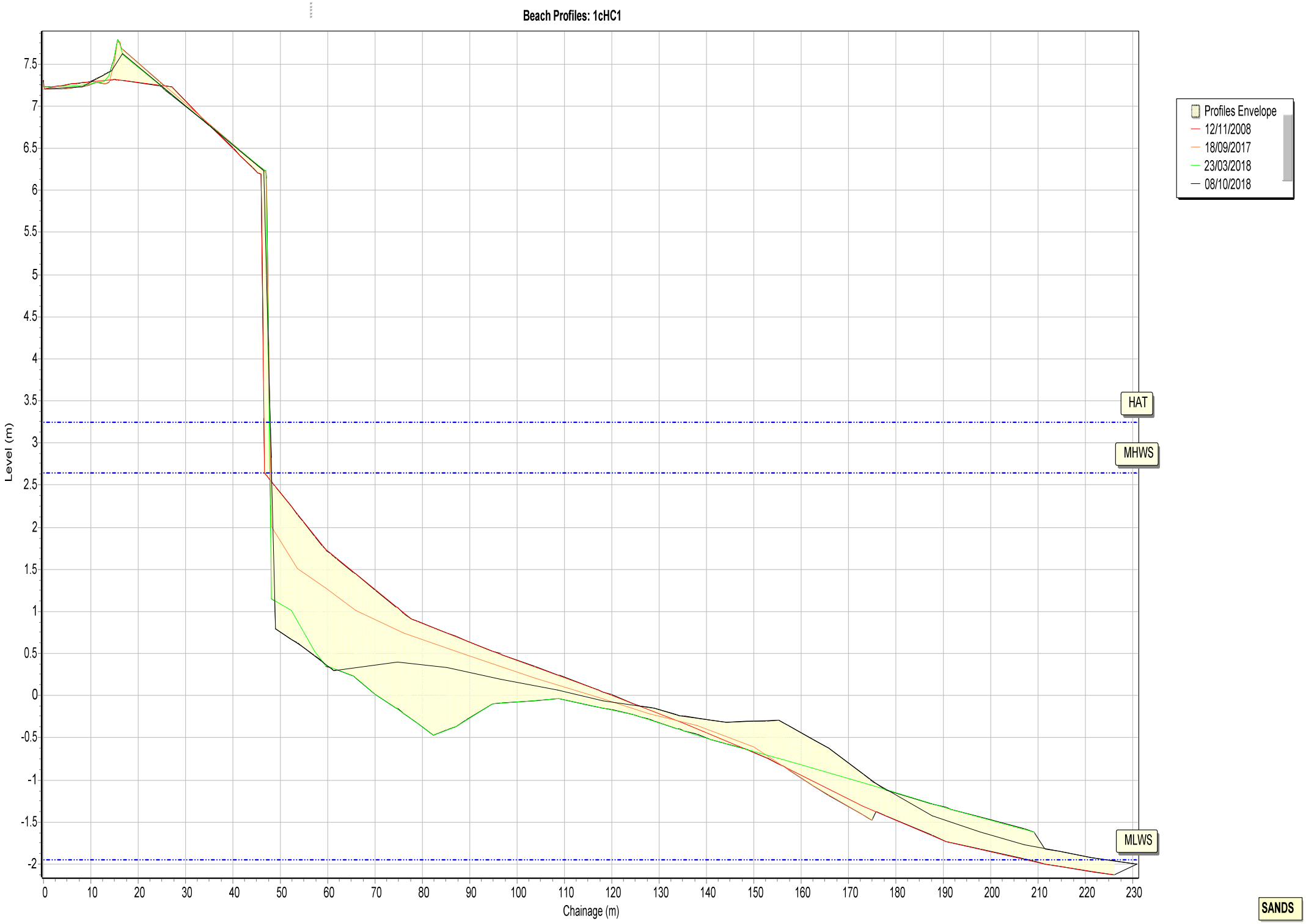
Date: 24/10/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2018 Full Measures Topo Survey

Easting: 452889 **Northing:** 528971 **Profile Bearing:** 76 ° from North

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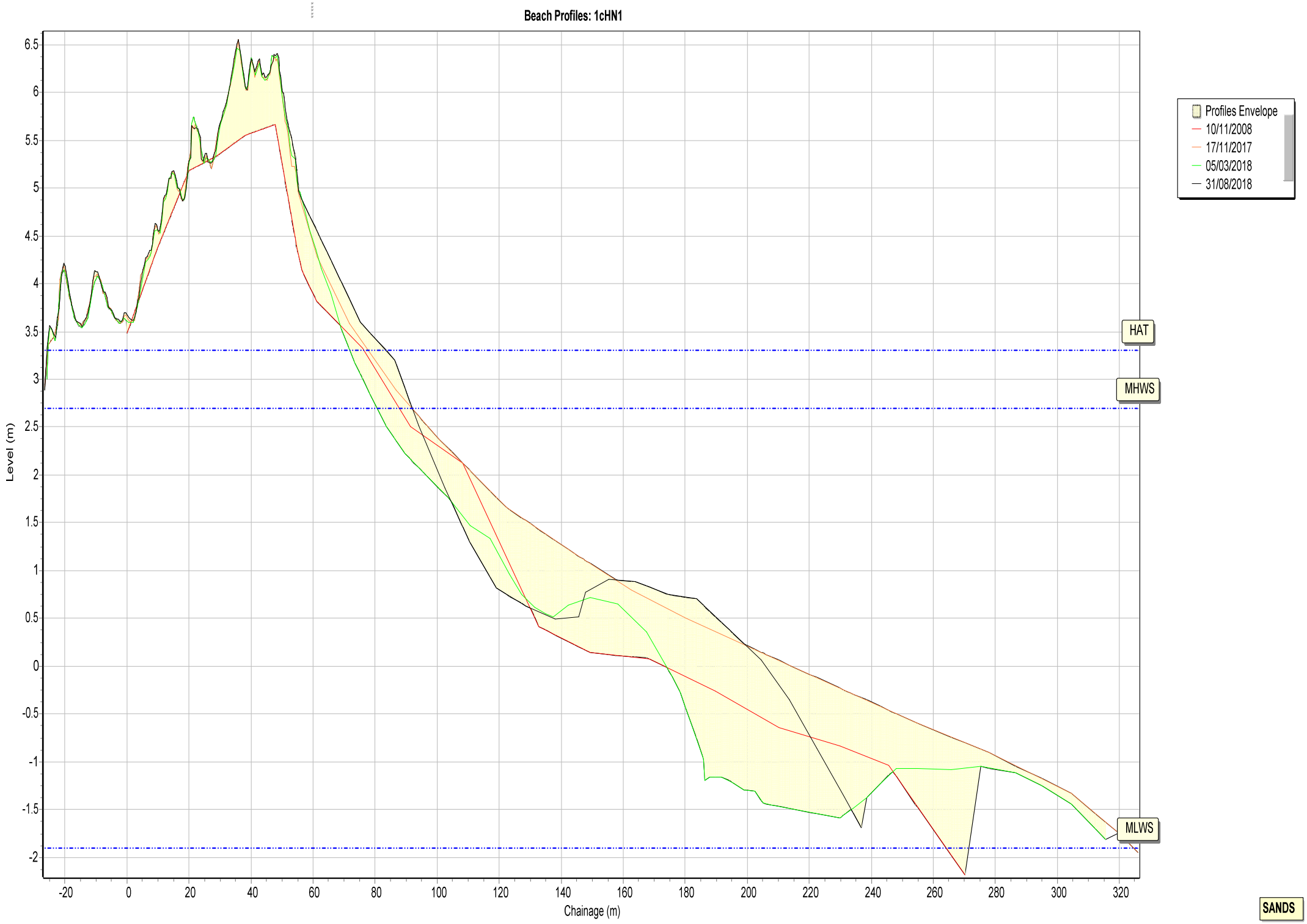
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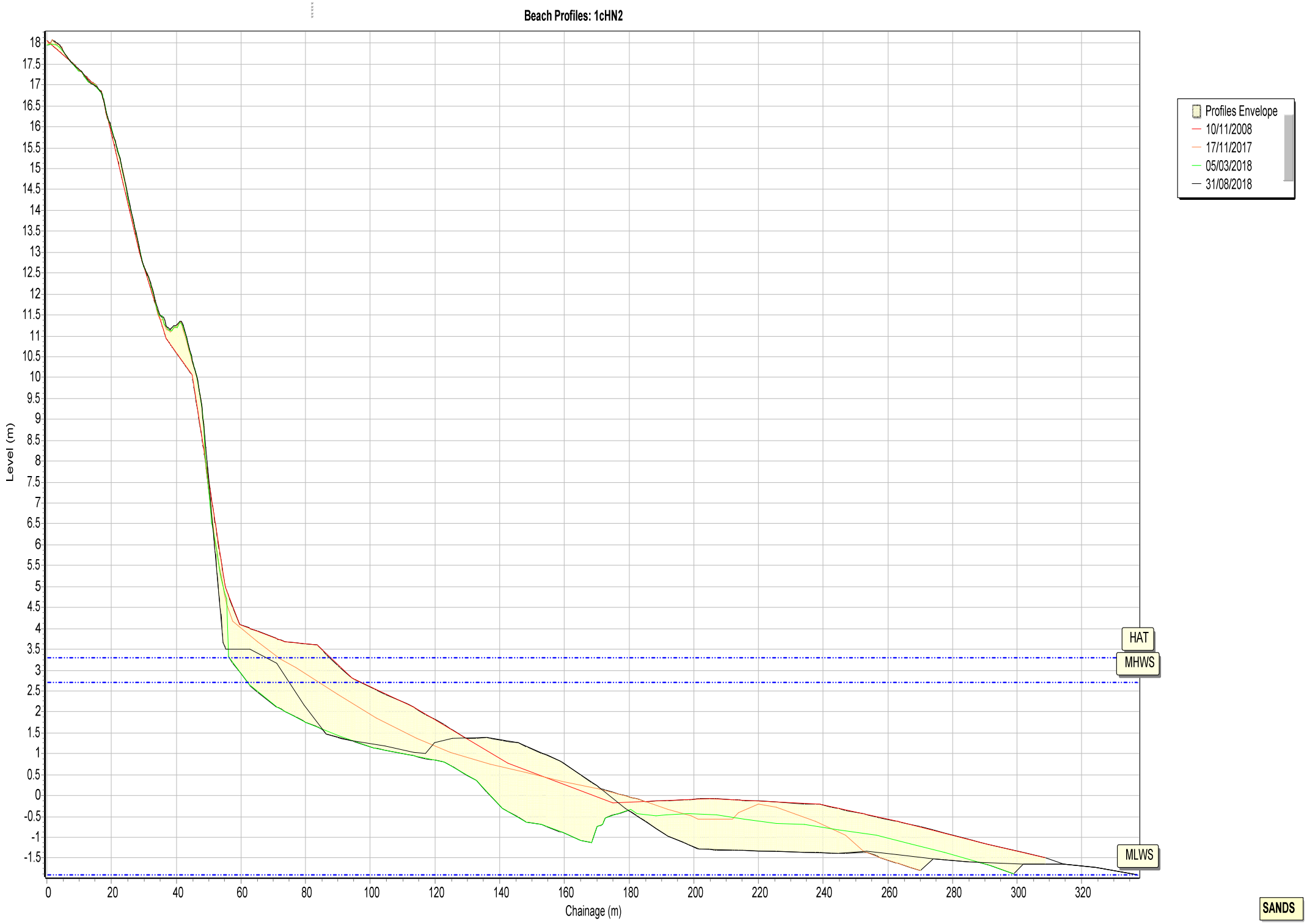
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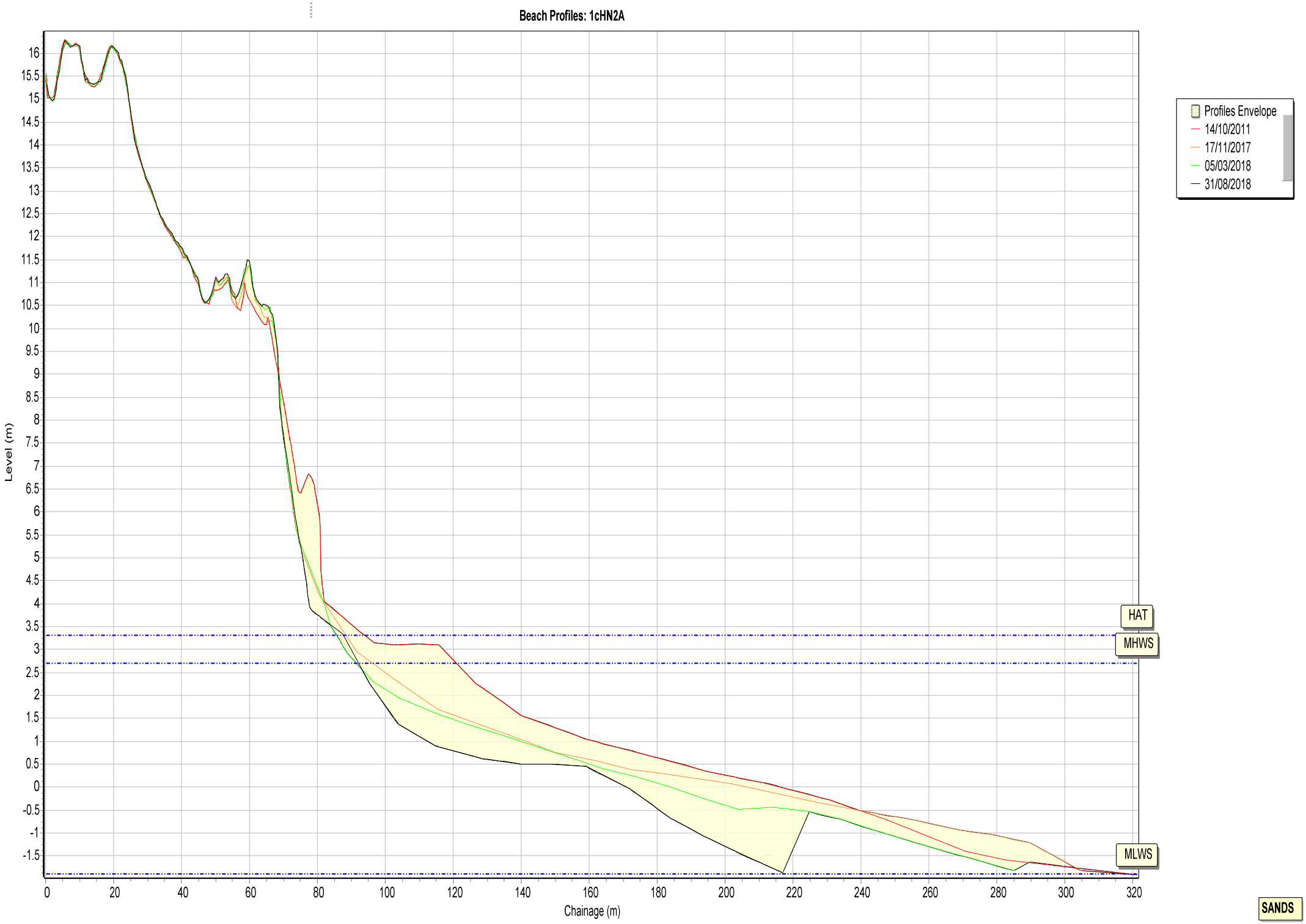
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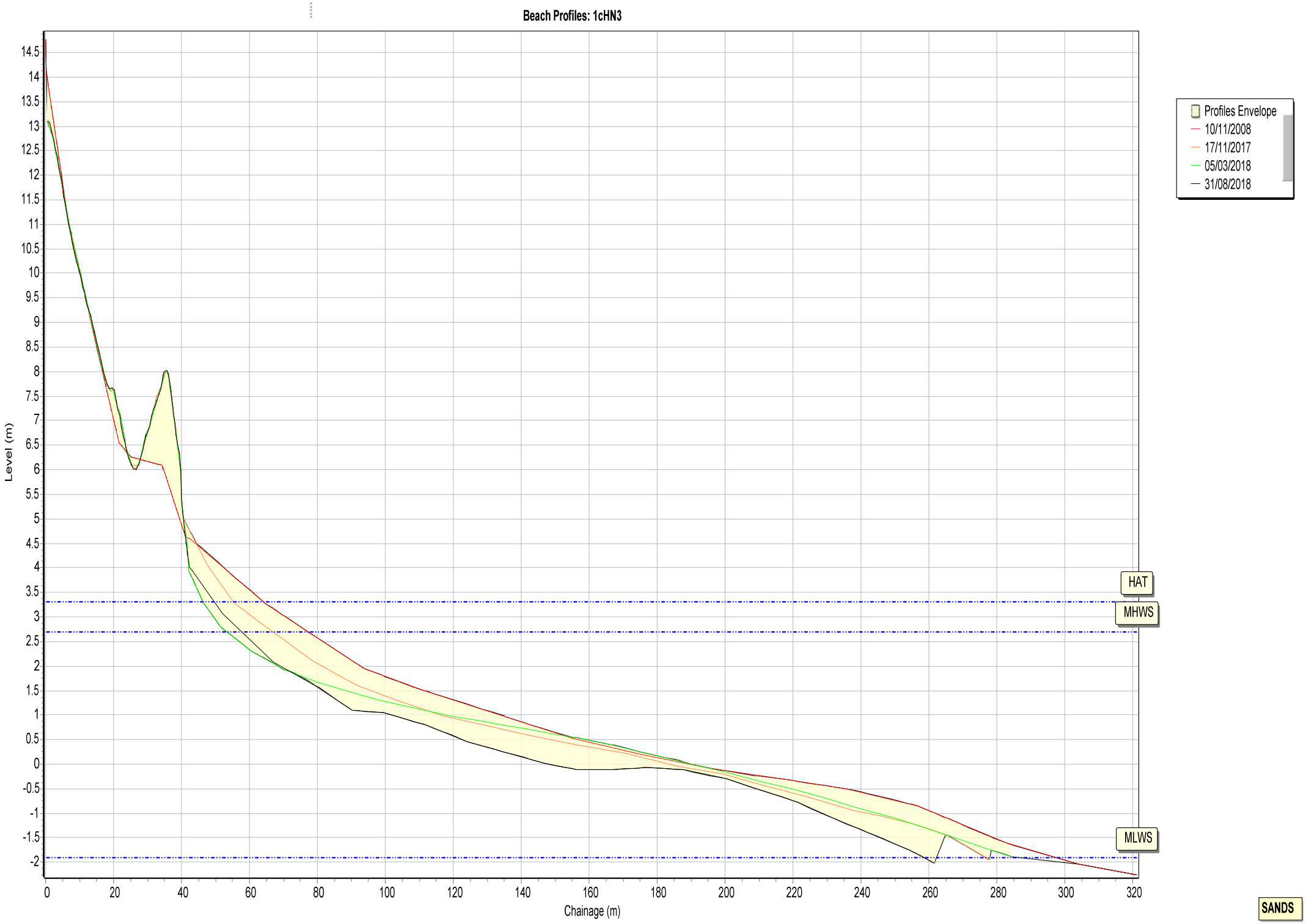
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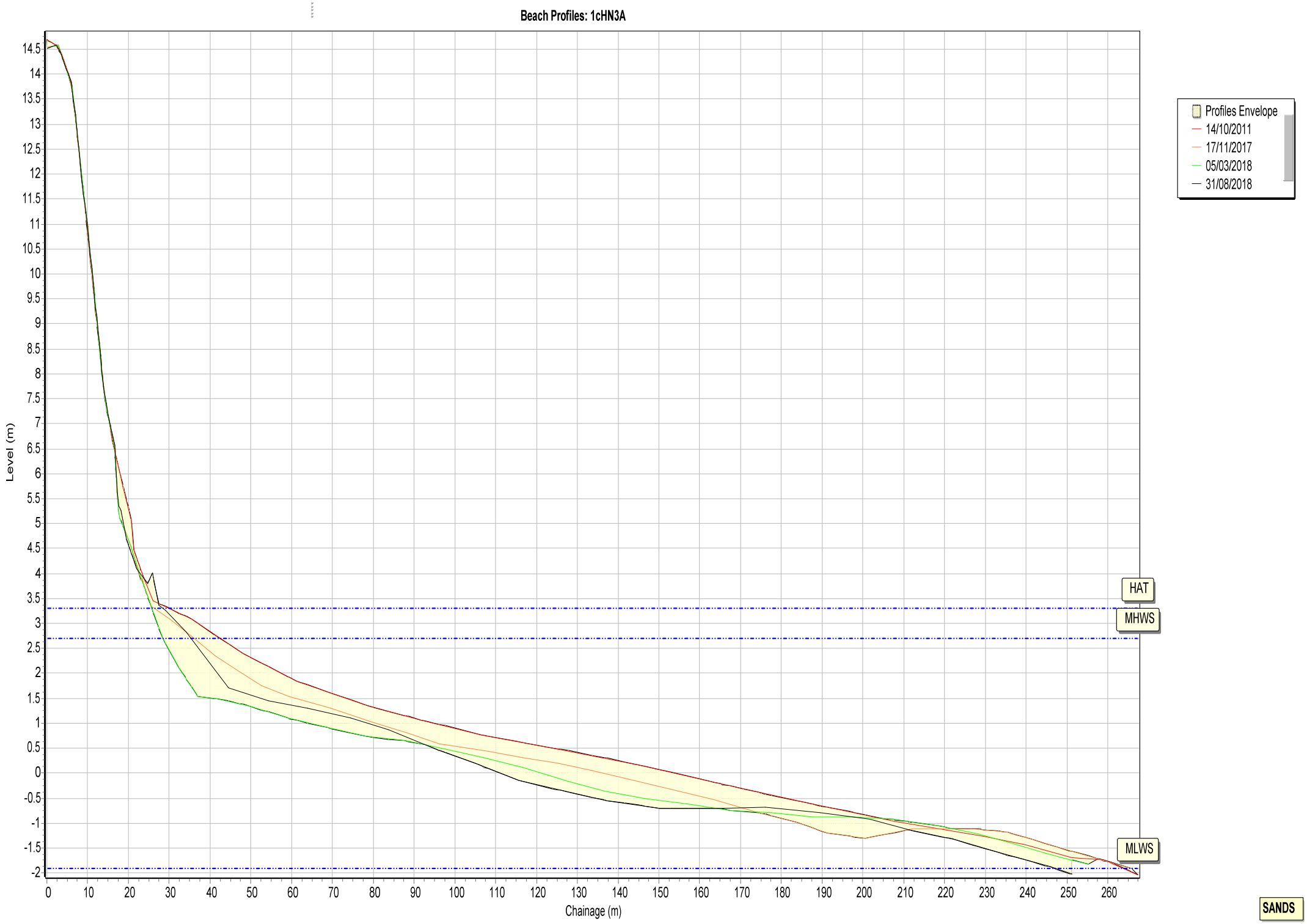
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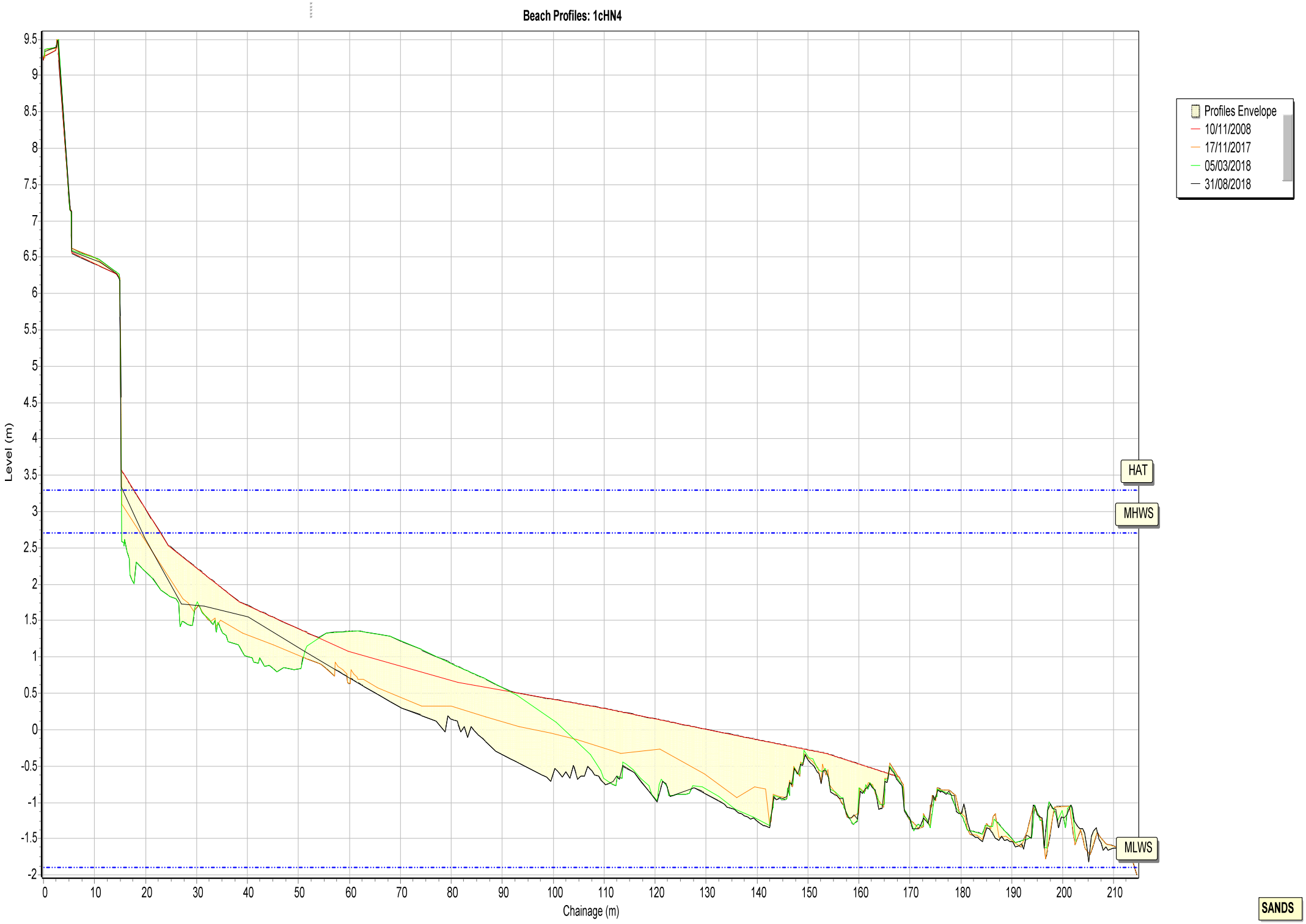
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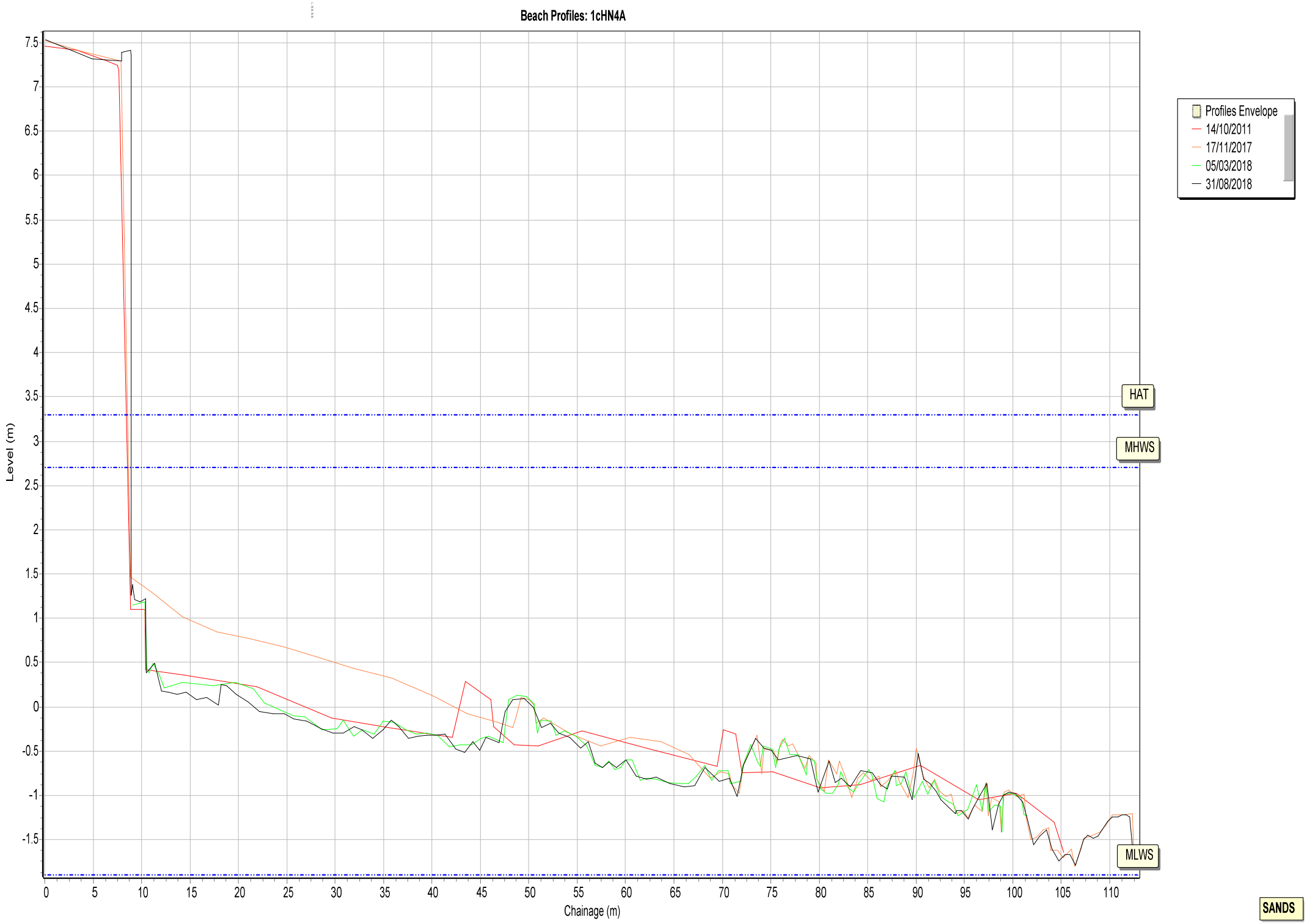
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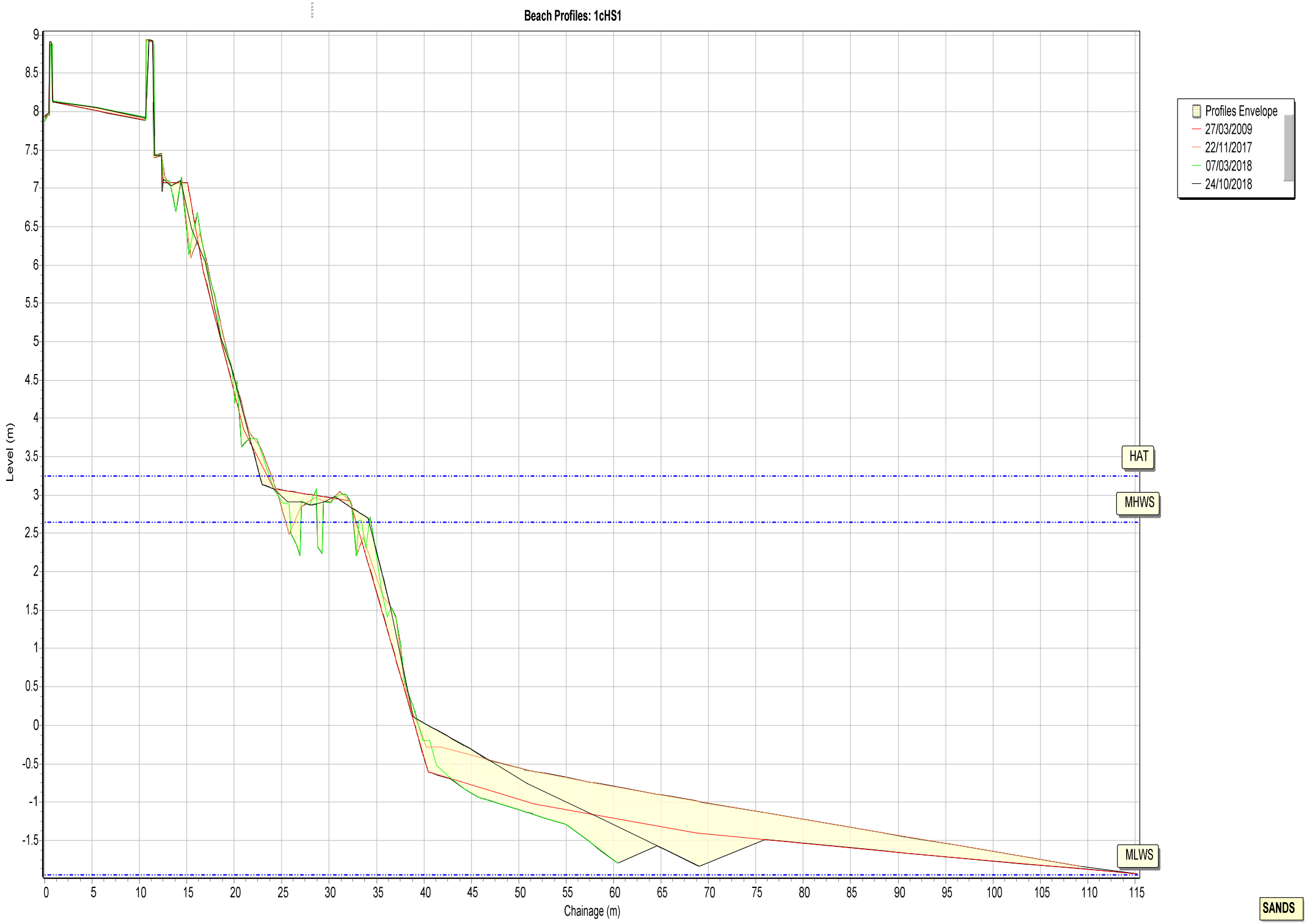
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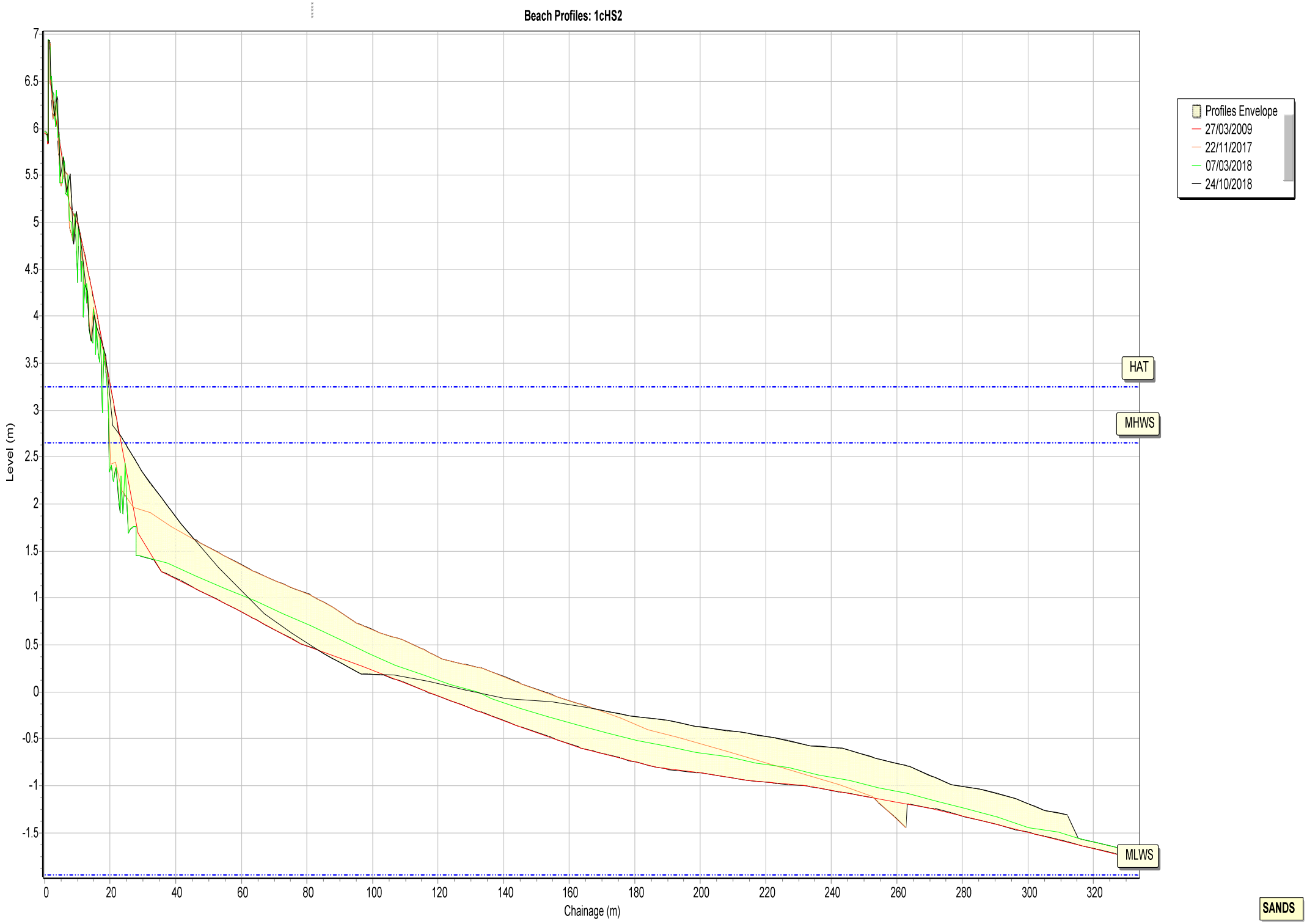
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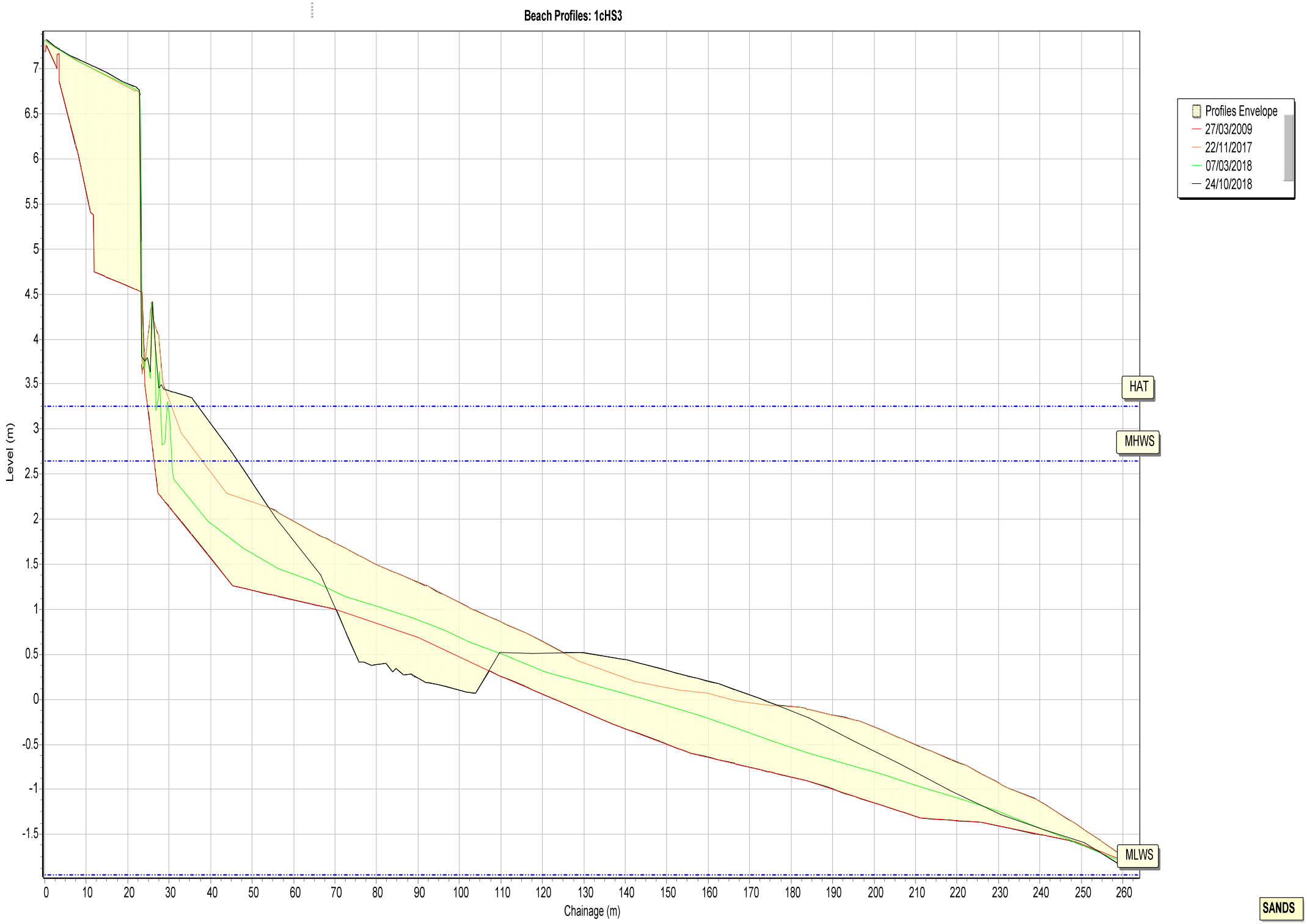
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Chainage (m)
SANDS


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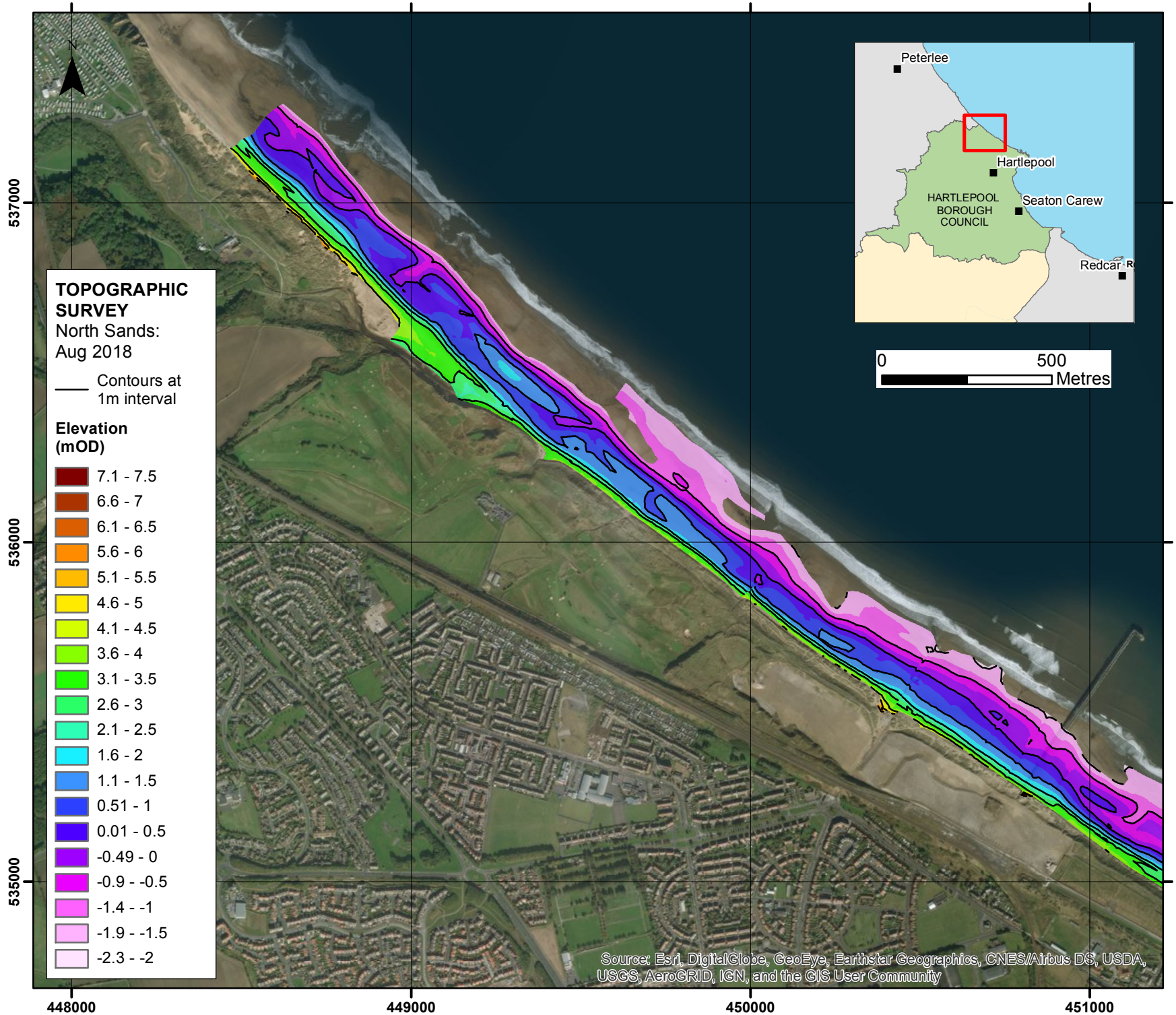
Appendix B

Topographic Survey



Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 1

HARTLEPOOL NORTH

Hartlepool Borough Council Frontage

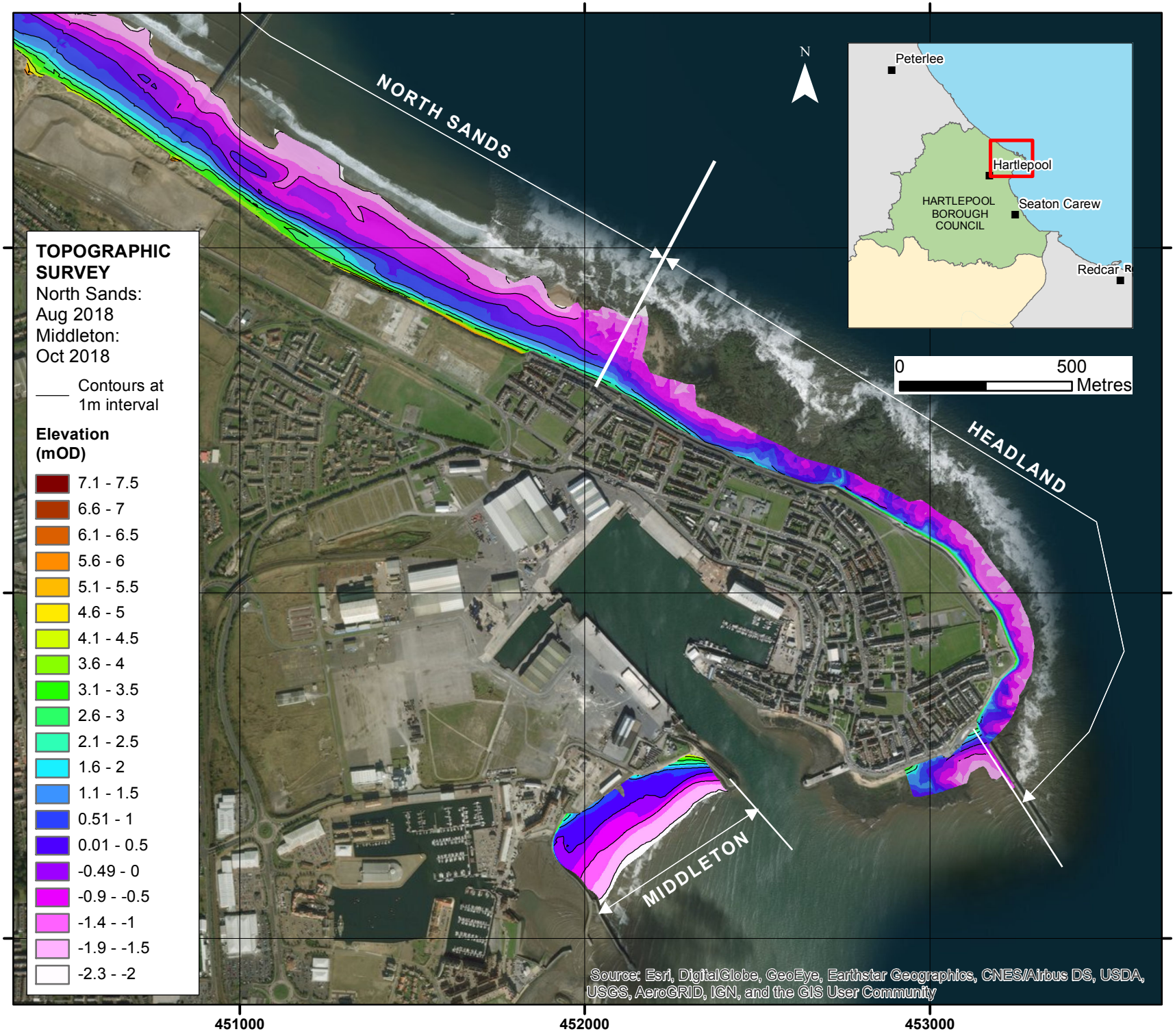
Analytical Report
'Full Measures' Survey 2018

Drawing Scale at A4 1:15,000

WATER
Royal HaskoningDHV
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

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

Royal HaskoningDHV
Enhancing Society Together



Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 2

HARTLEPOOL NORTH TO MIDDLETON

Hartlepool Borough Council Frontage

Analytical Report
'Full Measures' Survey 2018

Drawing Scale at A4 1:15,000

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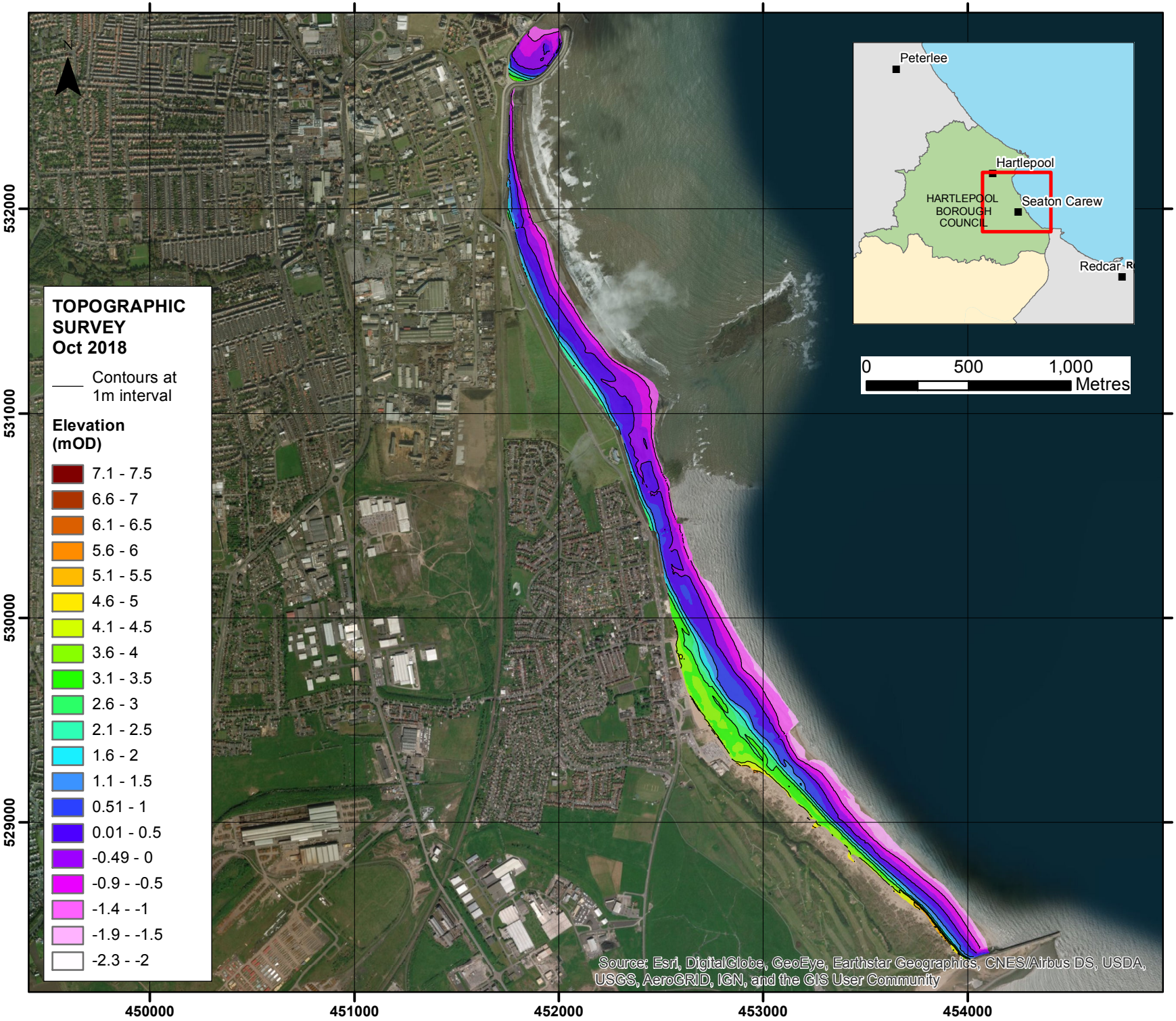

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 3

HARTLEPOOL SOUTH

Hartlepool Borough Council Frontage

Analytical Report
'Full Measures' Survey 2018

Drawing Scale at A4 1:25,000

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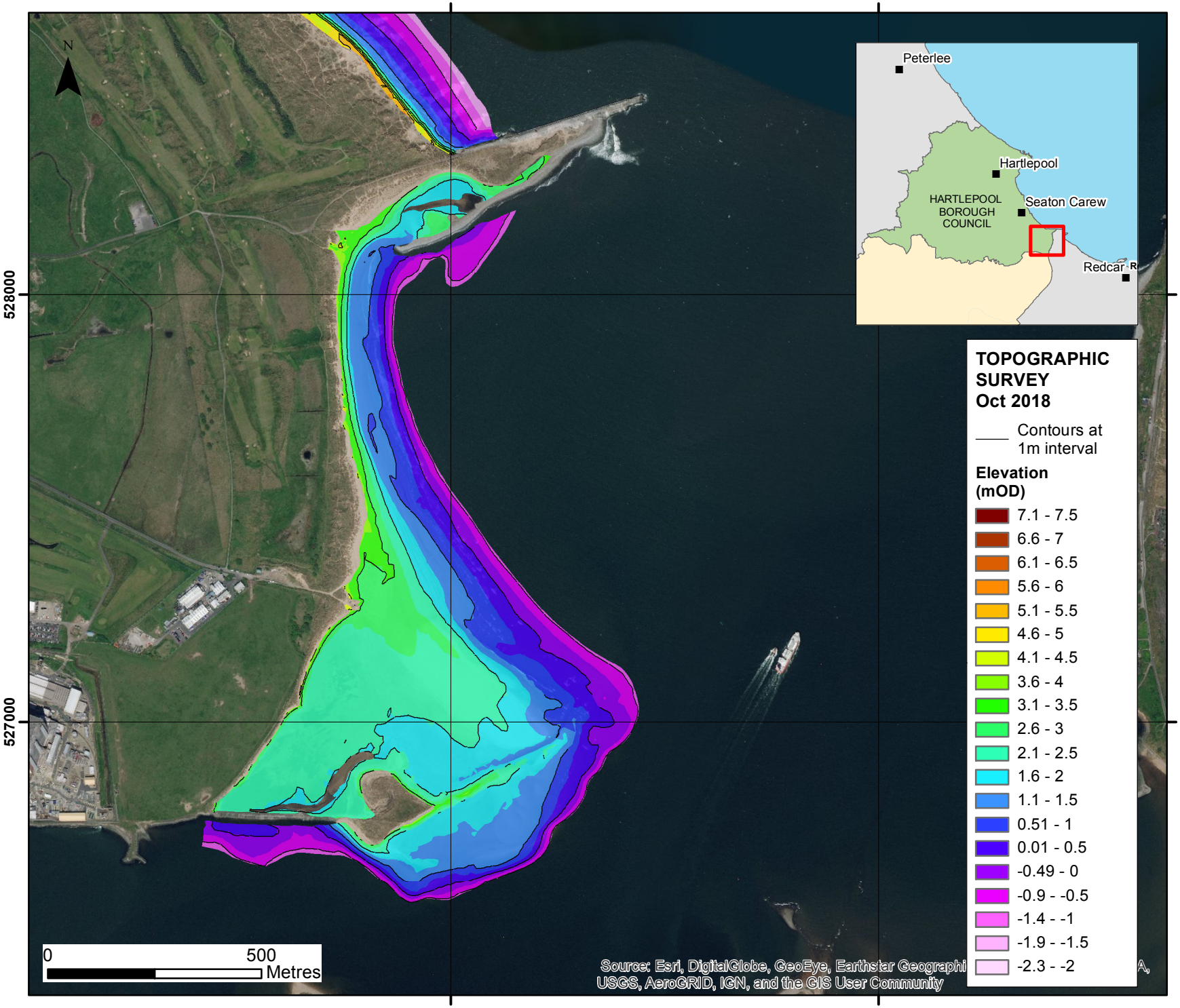

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 4

HARTLEPOOL NORTH GARE

Hartlepool Borough Council Frontage

Analytical Report
'Full Measures' Survey 2018

Drawing Scale at A4 1:12,000

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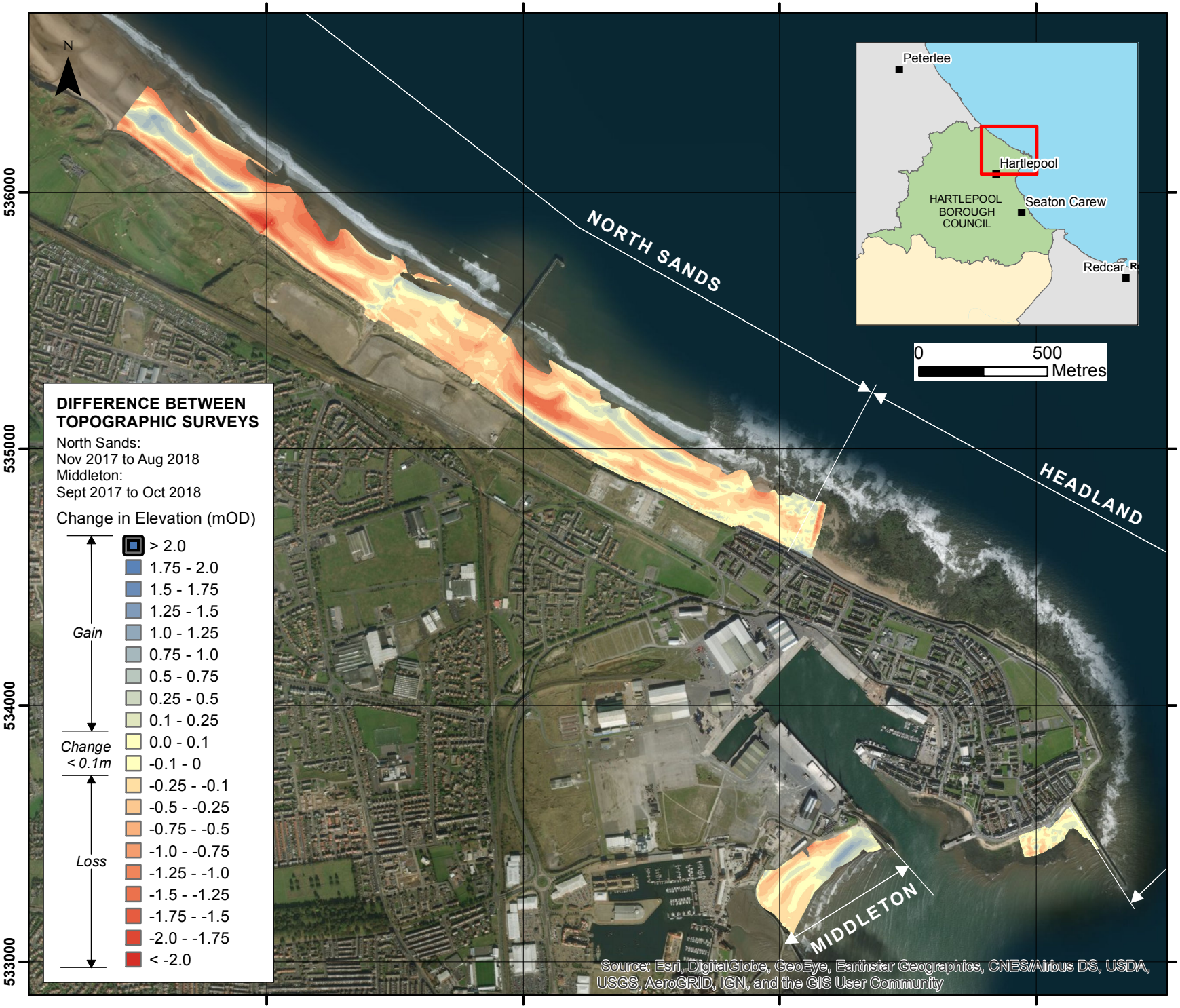

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 5

HARTLEPOOL NORTH

Hartlepool Borough Council Frontage

Analytical Report
'Full Measures' Survey 2018

Drawing Scale at A4 1:20,000

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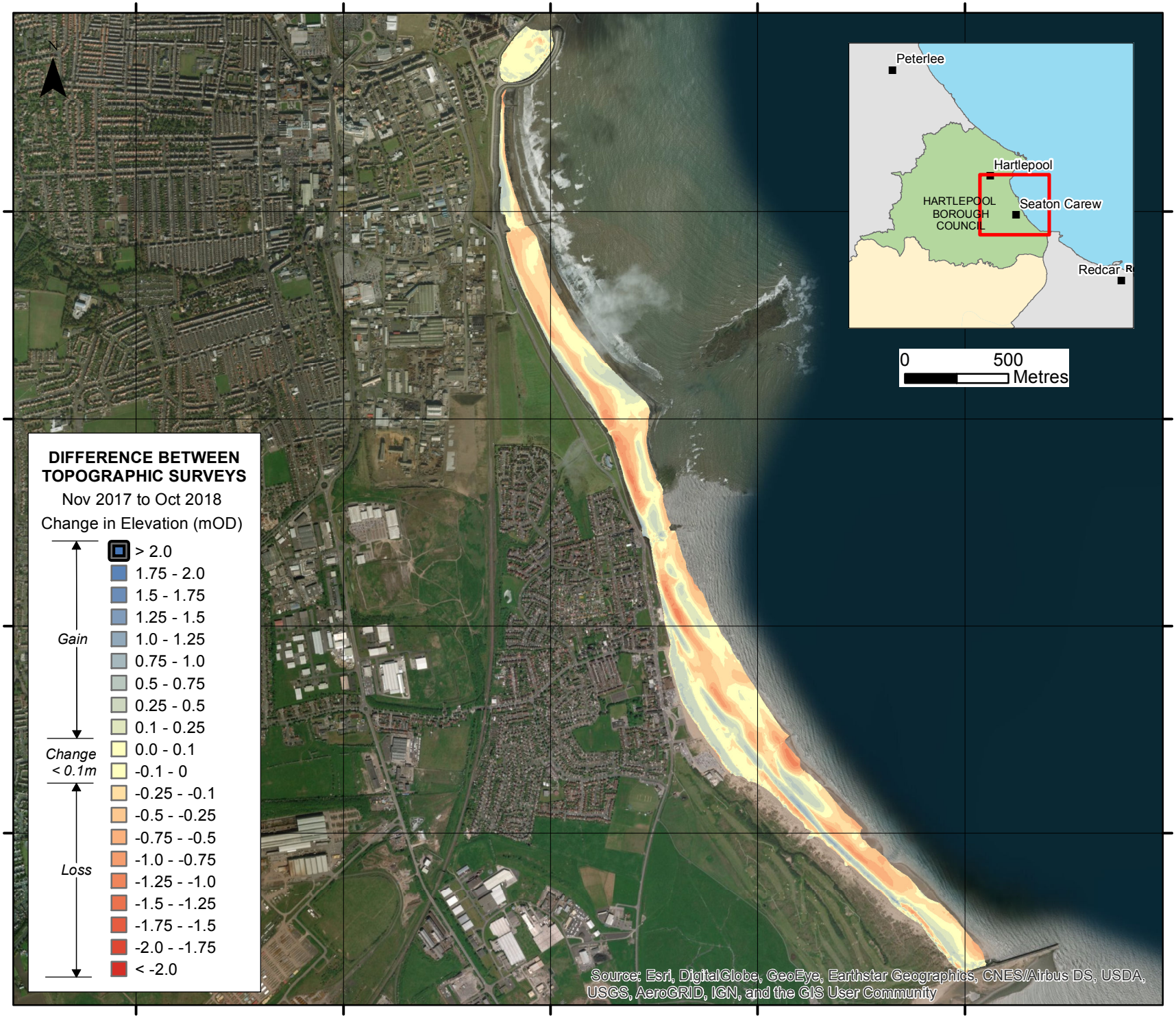

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 6

HARTLEPOOL SOUTH

Hartlepool Borough Council Frontage

Analytical Report
'Full Measures' Survey 2018

Drawing Scale at A4 1:25,000

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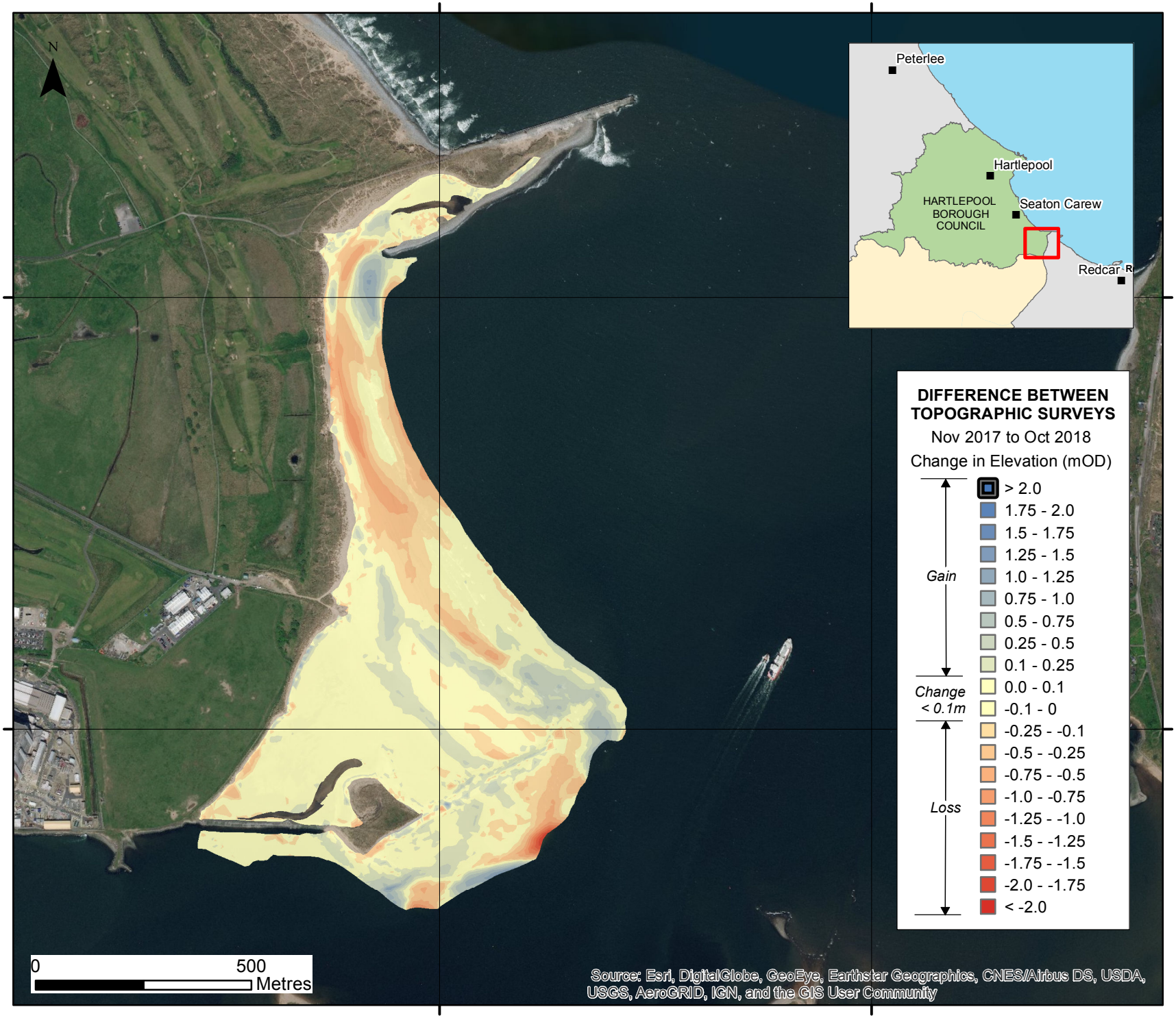

Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 7

HARTLEPOOL NORTH GARE

Hartlepool Borough Council Frontage

Analytical Report
'Full Measures' Survey 2018

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