



Cell 1 Regional Coastal Monitoring Programme Analytical Report 13: 'Full Measures' Survey 2020



Hartlepool Borough Council

February 2021

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

Water Level Parameter	Water Level (m AOD)			
	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.

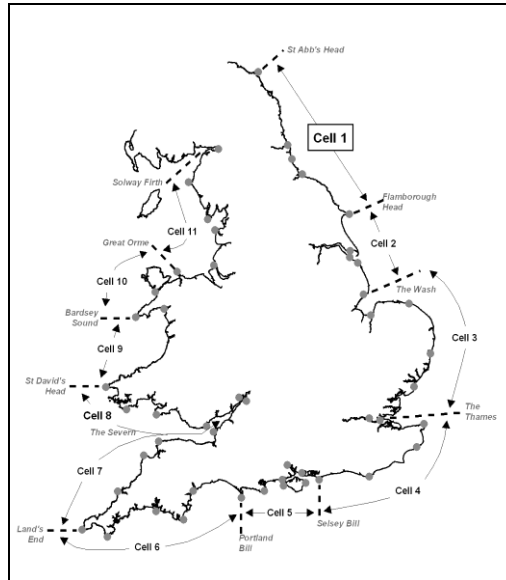


Figure 1 Sediment Cells in England and Wales

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:



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
- LiDAR Surveys
- walk-over cliff and coastal defence asset 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	Feb 19	May 19	
12	2019/20	Sep-Oct 19	Nov 19	May 20	Jul 20	
13	2020/21	Sep-Oct 20	Feb 21(*)			

(*) The present report is **Analytical Report 13** and provides an analysis of the 2020 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, Uppang 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.

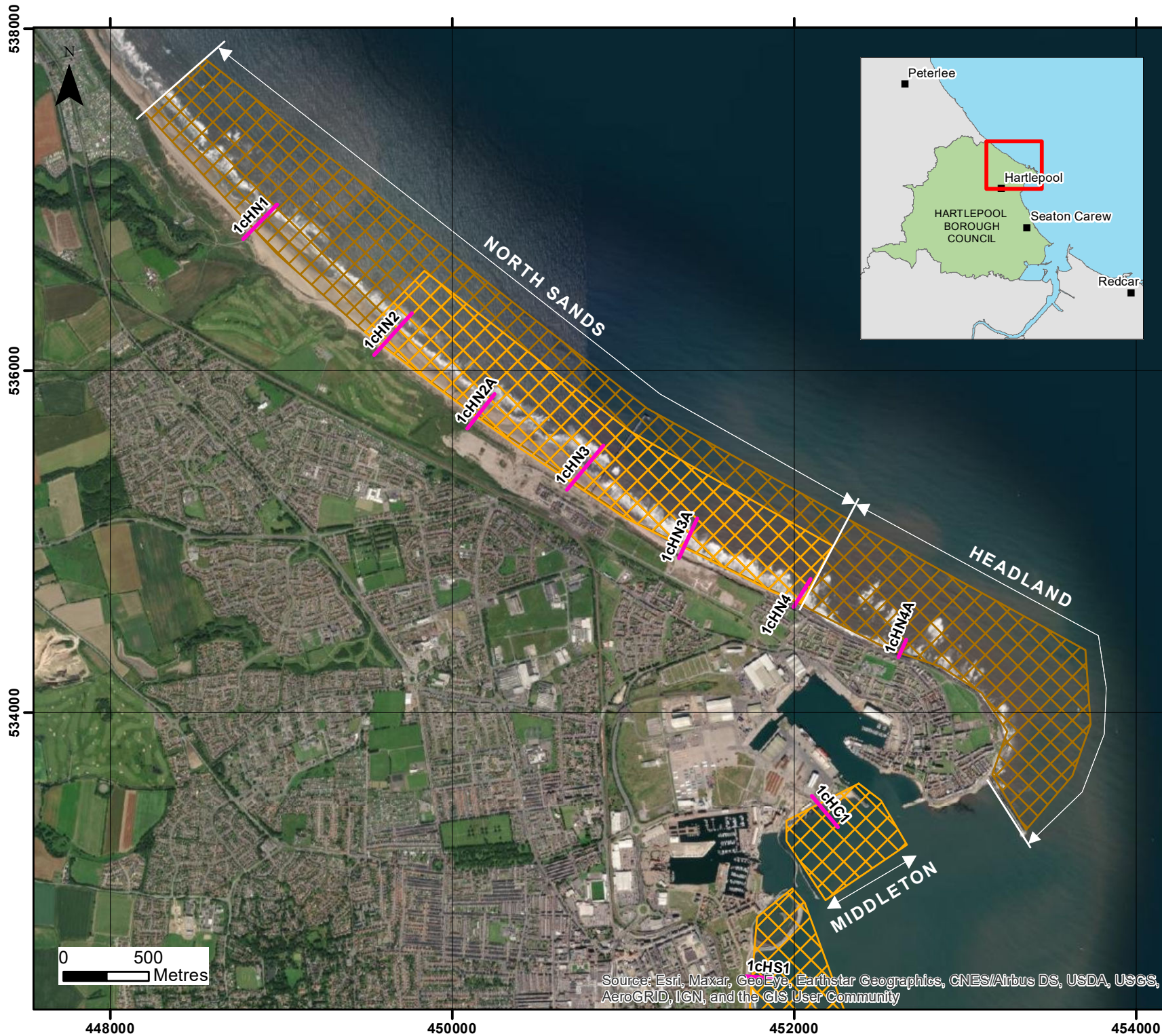
The location of these surveys is shown in Figure 2. The 2020 Full Measures survey was undertaken along this frontage on various dates between 17th September and 19th October 2020. During this time, the weather was generally dry and sunny with force 2 to 6 breezes from variable directions. The sea state 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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Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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
Hartlepool Borough
Council Frontage**

Analytical Report
Topo Surveys

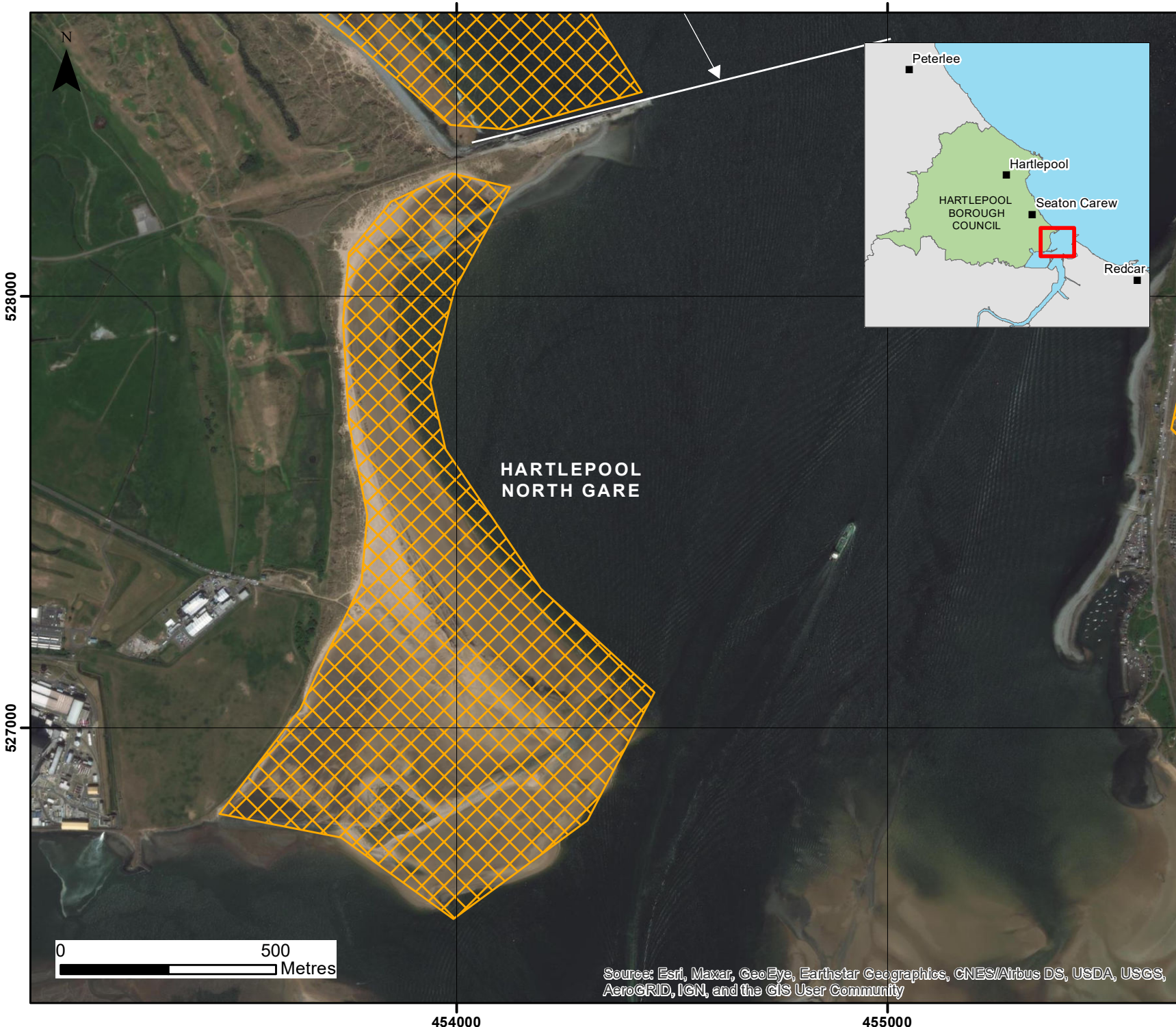
Drawing Scale at A4 1:30,000

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Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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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Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

2. Analysis of Survey Data

2.1 North Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>17th-18th Sep 2020</p>	<p>Beach Profiles:</p> <p>North Sands is covered by four beach profile lines during the Full Measures survey (Appendix A). They were last surveyed in May 2020.</p> <p>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 survey report notes that the northern part of the beach was very uneven and heavily scoured.</p> <p>The beginning of profile 1cHN1, between 0m and 70m chainage, covers dunes and has experienced small sections of accretion of up to 0.1m in level. The crest of the seaward face of the dunes has prograded seaward by up to 2.0m, whilst the dune toe has prograded approximately 0.5m. The upper beach has accreted by up to 0.2m in level to chainage 145m, switching to erosion by up to 0.6m in level to chainage 205m. This has resulted in a steeper middle beach profile. The lower beach between chainages 205m and 265m has accreted by up to 0.6m forming a series of puddles and pools. Seaward of chainage 265, the berm has accreted by up to 0.3m and migrated seaward by up to 15m. The profile is generally at a high level across the dunes compared to previous surveys, particularly at the seaward dune crest which is at its most seaward position recorded. The upper and middle beach are at a relatively medium level compared to previous surveys, whilst the lower beach is at a high level compared to the range recorded from previous surveys, particularly between chainages 270-330m which is at its highest level recorded.</p> <p>At profile 1cHN2, the dunes show very little change, with sections of erosion and accretion limited to ± 0.1m. The toe of the dunes has accreted by up to 0.6m in level. The upper and middle beach to chainage 189m has experienced variable erosion and accretion, limited to ± 0.4m. Seaward of 189m chainage, a berm has formed with the accretion of up to 1.0m of sediment at chainage 210m extending the toe of the beach seaward by 15m. Overall, the upper and middle beach profile is at a medium level compared with previously recorded surveys, whilst the lower beach is at a high level being the highest</p>	<p>The dunes at North Sands have generally remained stable since the previous survey, whilst beach levels have predominantly accreted on the upper beach and lower beach, and eroded across the middle beach. Beach levels range from low to high across the profiles, however they are generally at a medium-low level. Two sections are now at their highest level recorded (between chainages 270-330m at 1cHN1 and between 204-238m at 1cHN2). A small section of the foredune at 1aHN2A is at its most landward position recorded.</p> <p>Longer term trends: The 2020 Full Measures survey is generally in line with the longer term trends which suggest accretion in the west and stability in the middle and east of the survey area.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>on recorded between chainages 204-238m.</p> <p>Profile 1cHN2A was established in October 2011 and runs through the dunes close to North Sands. The foredune has remained mostly stable, however a small section in the central reach of the foredune has eroded by up to 0.4m and is at its most landward position recorded between chainages 69-70m. The toe of the dunes has accreted by up to 0.4m, whilst the upper beach has accreted by up to 0.2m to chainage 112m. The middle beach has mostly eroded by up to 0.2m to chainage 195m, switching to accretion by up to 0.2m between chainages 112-235m. The lower foreshore has eroded by up to 0.4m. Overall, the profile shows a medium level compared with previously recorded surveys, except the small section of the foredune which is at its most landward position since records began.</p> <p>At profile 1cHN3 there has accretion along the dunes by up to 0.2m. The dune toe has accreted by up to 0.3m. The upper beach has accreted by up to 0.2m between the toe of the dunes to chainage 95m, switching to erosion across the middle beach by up to 0.1m to chainage 161m. There has been accretion on the lower beach by up to 0.4m, forming a small berm at chainage 180m. The dunes are at a high level, whilst the rest of the beach profile is at a medium level compared to the range recorded from previous surveys.</p> <p>At profile 1cHN3a there has been relative stability down to the dune face at 20m chainage, with minor sections of change limited to less than ± 0.1m. The dune toe has eroded by 0.1m. There has been accretion across the majority of the upper and middle beach by up to 0.4m to chainage 180m. A shallow lower beach berm seaward of 180m has dropped in level by up to 0.9m. Overall the level is in the mid-to-low range of the previous profiles.</p> <p>At profile 1cHN4 there has been an accretion of sediment across the majority of the beach by up to 0.4m on the upper and lower beach and 0.2m on the middle beach. The rock platform is exposed from chainage 141m seawards, extending to chainage 217m. 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.</p> <p>At profile 1cHN4a, there has been an accumulation of up to 0.6m of sediment on the upper beach between chainages 10-31m, covering up previously exposed rocks. Seaward of this point, there has been little change across the beach profile compared to previous surveys, with minor changes in positions of rocks. Overall, the profile is at a medium level on the upper beach, and a low level on the</p>	

Survey Date	Description of Changes Since Last Survey	Interpretation
	middle and lower beach compared to the previous recorded surveys.	
September 2020	<p>Topographic Survey:</p> <p>North Sands is covered by an annual topographic survey. Data from the 2020 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.</p> <p>The GIS has also been used to calculate the differences between the Autumn 2019 and Autumn 2020 topographic surveys, as shown in Appendix B – Map 4, to identify areas of net erosion and accretion. To the west of the pier, there are alternating bands of erosion and accretion, however accretion dominates with increases in sediment reaching over 1.75m in places. There are small bands of erosion concentrated on the upper-mid beach and on the lower foreshore. To the east of the pier, the same pattern continues, however erosion dominates slightly toward the central-eastern portion of the survey area. 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.</p>	<p>The difference plot at North Sands shows alternating sections of erosion and accretion, with more modest erosion rates west of the pier compared to the east. The plot reflects the seasonal movement of sediment across the beach as sand bars. This is similar to the Autumn 2019 survey which saw the same pattern of movement.</p>

2.2 Middleton

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>19-20th Sept 2020</p>	<p>Beach Profiles:</p> <p>Middleton is covered by one beach profile line during the Full Measures 2020 survey (Appendix A). The survey report notes that there was no access to the upper section of the profile. The beach at profile 1cHC1 between the toe of the seawall at chainage 48m and 58m shows accretion by up to 0.6m. Between chainage 58m and the lower foreshore at chainage 150m, there has been erosion by up to 0.2m. Seawards of 150m there has been an increase in level by 0.1m and an extension seaward of approximately 34m. Overall the beach is at a high level at the toe of the seawall (reaching its highest level recorded between the seawall and chainage 53m) and at a medium level across the middle and lower beach compared to the range from previous surveys.</p>	<p>The beach profile showed an accumulation of material at the toe of the sea wall and on the lower foreshore, however the majority of the rest of the beach profile eroded.</p> <p>Longer term trends: The beach is generally in the middle of the previously recorded levels, however the beach level at the toe of the seawall is at its highest position recorded.</p>
<p>September 2020</p>	<p>Topographic Survey:</p> <p>The frontage is covered by an annual topographic survey between Middleton Jetty and North Pier. Data from the 2020 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 groyne.</p> <p>The GIS has also been used to calculate the differences between the Autumn 2019 and Autumn 2020 topographic surveys, as shown in Appendix B – Map 4, to identify areas of net erosion and accretion. The survey generally shows accretion dominates across the beach profile to the east and west of the survey area, with a large area of erosion across the central portion of the survey area (with a small band of accretion at the toe of the seawall). The changes observed at Middleton beach over the year are modest at $\pm 0.75\text{m}$ and reflect the change seen in profile 1cHC1.</p>	<p>The difference plot for Middleton shows a zone of erosion across the central beach, with accretion to the east and west. This pattern differs from previous Full Measures topographic surveys which exhibited shore parallel changes of erosion and accretion.</p>

2.3 Hartlepool Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
15-16 th October 2020	<p>Beach Profiles:</p> <p>Hartlepool Bay is covered by four beach profile lines during the Full Measures survey (Appendix A). The profiles were last surveyed in May 2020. 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).</p> <p>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, the beach has eroded seaward of the rock armour to the lower foreshore at chainage 116m by between 0.8m (at the toe of the revetment) to less than 0.1m (across the rest of the profile). The beach level is at a high level across the majority of the profile compared to previous recorded surveys, whilst the toe of the seawall is at a medium level.</p> <p>Similar to the previous profile, there has been erosion across the majority of the beach at profile 1cHS2 switching to accretion on the lower foreshore. Erosion is limited to 0.2m between the toe of the revetment and chainage 244m, whilst accretion is limited to less than 0.1m. The profile is generally at a medium level across the beach compared to previously recorded surveys, however the lower foreshore is at a medium-high level.</p> <p>At profile 1cHS3 there has been erosion between the toe of the rock armour and chainage 65m by up to 0.6m. The beach profile between chainages 65-135m have undergone negligible change since the previous survey, with erosion / accretion limited to ± 0.1m. The middle beach between chainages 135-220m has eroded by up to 0.2m, before switching to accretion on the lower beach by up to 0.2m. The beach profile is at a medium-high level compared to the range recorded from previous surveys.</p> <p>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 has varying sections of erosion and accretion limited to ± 0.3m but has generally remained stable since the previous survey. The foredune at 320m chainage has continued to accrete</p>	<p>The northern beach profiles generally show erosion across the upper-lower beach, with accretion and a seaward extension of the lower foreshore. The southern profiles show alternating sections of erosion and accretion, representing sand bar movement across the foreshore. The foredune at 320m chainage at profile 1cHS4 has continued to accrete since March 2009 with an overall accretion of 3.0m. The profiles are generally at a medium-high level across the bay.</p> <p>Longer term trends: The profiles have shown relative stability over 2020, and beach levels are generally medium to high. The foredune continues to develop although footfall may be damaging it and leading to erosion.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>with 0.15m of growth since May 2020, and an overall accretion of 3.0m since March 2009. The seaward face of the foredune has accreted by up to 0.3m at chainage 327m. A small section of erosion has occurred at the toe of the dunes by up to 0.2m to chainage 400m, switching to a small section of accretion by up to 0.2m to chainage 455m. On the middle to lower beach between chainages 455-541m, the beach profile has dropped by up to 0.6m, before switching to accretion on the lower foreshore by up to 0.4m, forming a small berm. The foredune and lower foreshore are at a high level, particularly the foredune which is at its highest level recorded. The rest of the beach has dropped to a medium-low level compared to the range recorded from previous surveys.</p> <p>Topographic Survey:</p> <p>Hartlepool Bay is covered by an annual topographic survey between the South Pier and the North Gare Breakwater. Data from the 2020 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.</p> <p>The GIS has also been used to calculate the differences between the Autumn 2019 and Autumn 2020 topographic surveys, as shown in Appendix B – Map 5, to identify areas of erosion and accretion. The changes recorded over 2020 show the north of the bay has generally undergone little change, with low magnitude of erosion (<0.5m) dominating slightly on the upper-middle beach towards the centre of the bay, and on the upper beach in the north of the bay. The central area has a wide zone of accretion of up to 1.0-1.25m which tapers out towards the south – with bands of erosion present on the middle beach and at the dune toe. The central area of the southern half of the survey extent shows alternating bands of limited change (± 0.1m) and low-magnitude erosion (<0.25-0.5m). The southern area of the survey extent shows a dominance of erosion on the upper beach, with accretion on the middle and lower beach. Change is of higher magnitude in the south of the survey area (± 1.75). Overall, the plot generally shows shore-parallel changes, reflecting the seasonal movement of sediment across the beach in the form of sand bars.</p>	

2.4 North Gare

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>19th October 2020</p>	<p>Topographic Survey:</p> <p>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.</p> <p>Data from the 2020 Full Measures survey have been used to create a DGM (Appendix B – Map 3) using GIS software. The beach contours recorded in 2020 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 shoreline 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.</p> <p>The GIS has also been used to calculate the differences between the Autumn 2019 and Autumn 2020 topographic surveys, as shown in Appendix B – Map 6, to identify areas of net erosion and accretion. The difference plot shows that there are alternating shore parallel bands of accretion and erosion in the north, with erosion dominating on the upper and middle beach. In the southern part of the survey area, to the north and landward of the promontory there is little change. There is generally little change seaward of the promontory, with accretion towards the MHW. Overall, there are more areas of little change / erosion across the survey area, however, change across the survey area is limited in magnitude.</p>	<p>The changes seen in the 2020 Full Measures survey show a pronounced pattern of sand bar movement across the shore face in the north of the survey area and accretion east of the promontory. Changes are low in magnitude.</p> <p>The pattern in 2020 generally mirrors that seen in 2019.</p>

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 North Sands, the survey report notes that the northern part of the beach was very uneven and heavily scoured.

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 and lower beach across the bay, with erosion across the middle beach. The beach is mostly at a medium-low level compared to previous surveys.
- At Middleton, the beach profile shows an accretion at the toe of the sea wall and on the lower foreshore, with a decrease across the rest of the profile since May 2020. The difference plot shows accretion dominating the eastern and western extents of the survey area, whilst erosion dominates in the central portion of the survey area. The continuing erosion of the beach is expected because there are no sources of sediment to the Middleton frontage.
- Profiles in the north of Hartlepool Bay generally show erosion across the upper-lower beach, with accretion in level across the lower foreshore. The southern profiles show alternating bands of erosion and accretion, reflecting the seasonal movement of sediment across the beach as sand bars. The foredune at profile 1cHS4 has continued to accrete, reaching its highest level since records began in 2009. This pattern is also supported by the topographic survey difference plot.
- The topographic plot at North Gare shows a pronounced pattern of sand bar movement across the shore face in the north of the survey area and accretion east of the promontory. Throughout 2020, erosion has generally dominated.
- 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: 1cHN1

Date: 18/09/2020

Inspector: AG

Low Tide:

Low Tide Time:

Wind

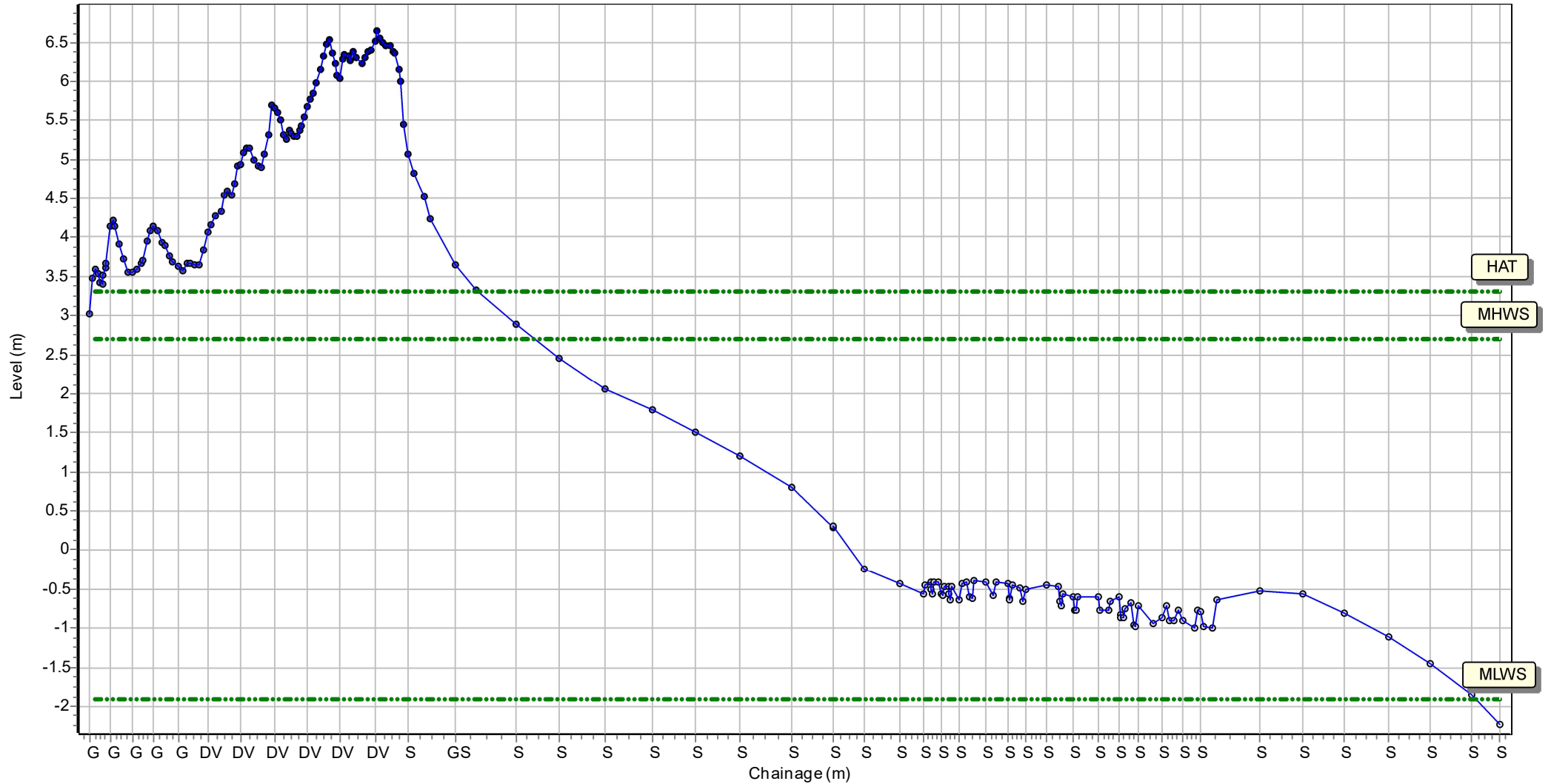
Sea State:

Visibility:

Rain:

Summary: 2020 Full Measures Topo Survey

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



Beach Profile

Location: 1cHN2

Date: 18/09/2020

Inspector: AG

Low Tide:

Low Tide Time:

Wind

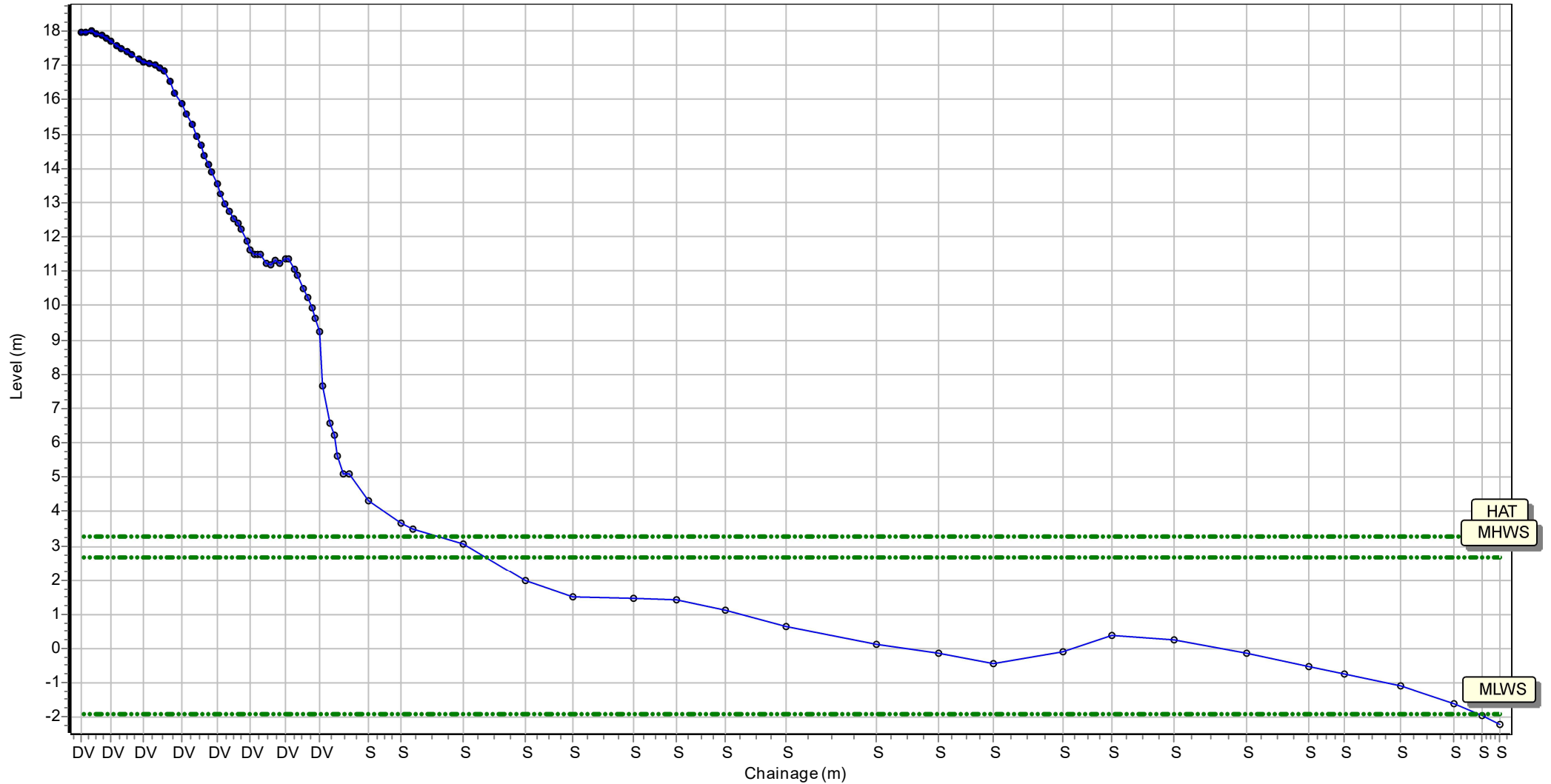
Sea State:

Visibility:

Rain:

Summary: 2020 Full Measures Topo Survey

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



Beach Profile

Location: 1cHN2A

Date: 18/09/2020

Inspector: AG

Low Tide:

Low Tide Time:

Wind

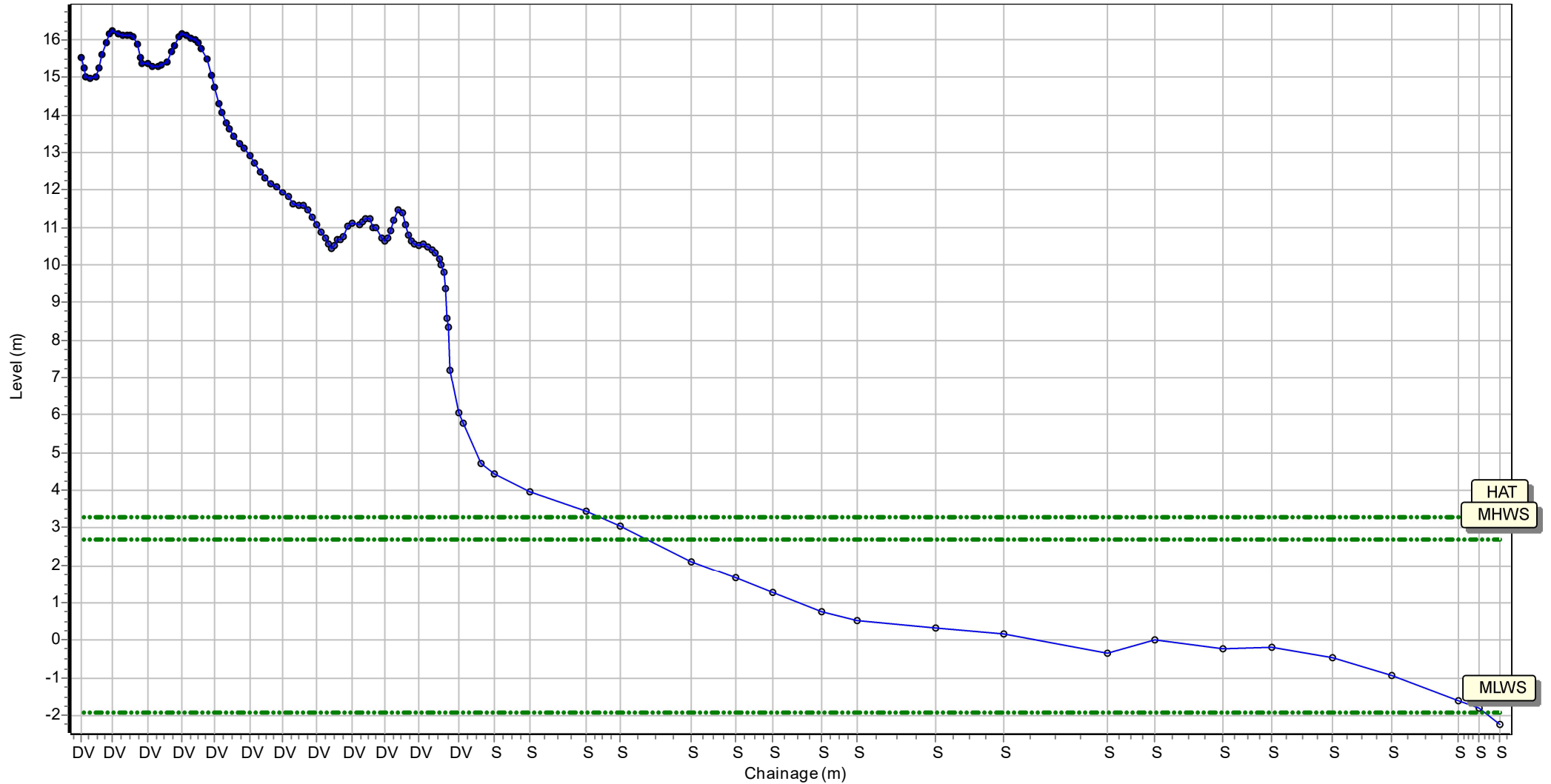
Sea State:

Visibility:

Rain:

Summary: 2020 Full Measures Topo Survey

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



Beach Profile

Location: 1cHN3

Date: 18/09/2020

Inspector: AG

Low Tide:

Low Tide Time:

Wind

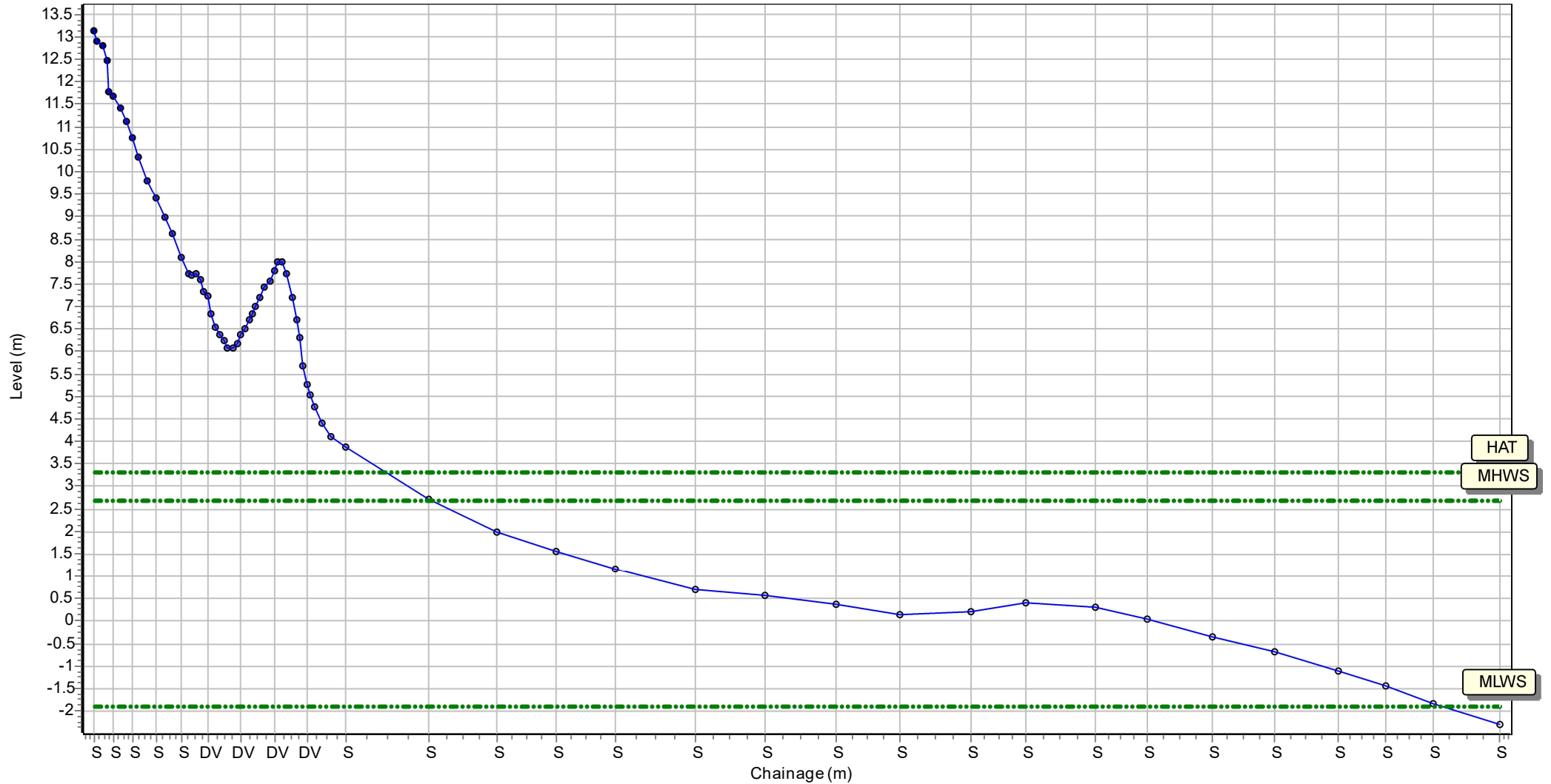
Sea State:

Visibility:

Rain:

Summary: 2020 Full Measures Topo Survey

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



Beach Profile

Location: 1cHN3A

Date: 18/09/2020

Inspector: AG

Low Tide:

Low Tide Time:

Wind

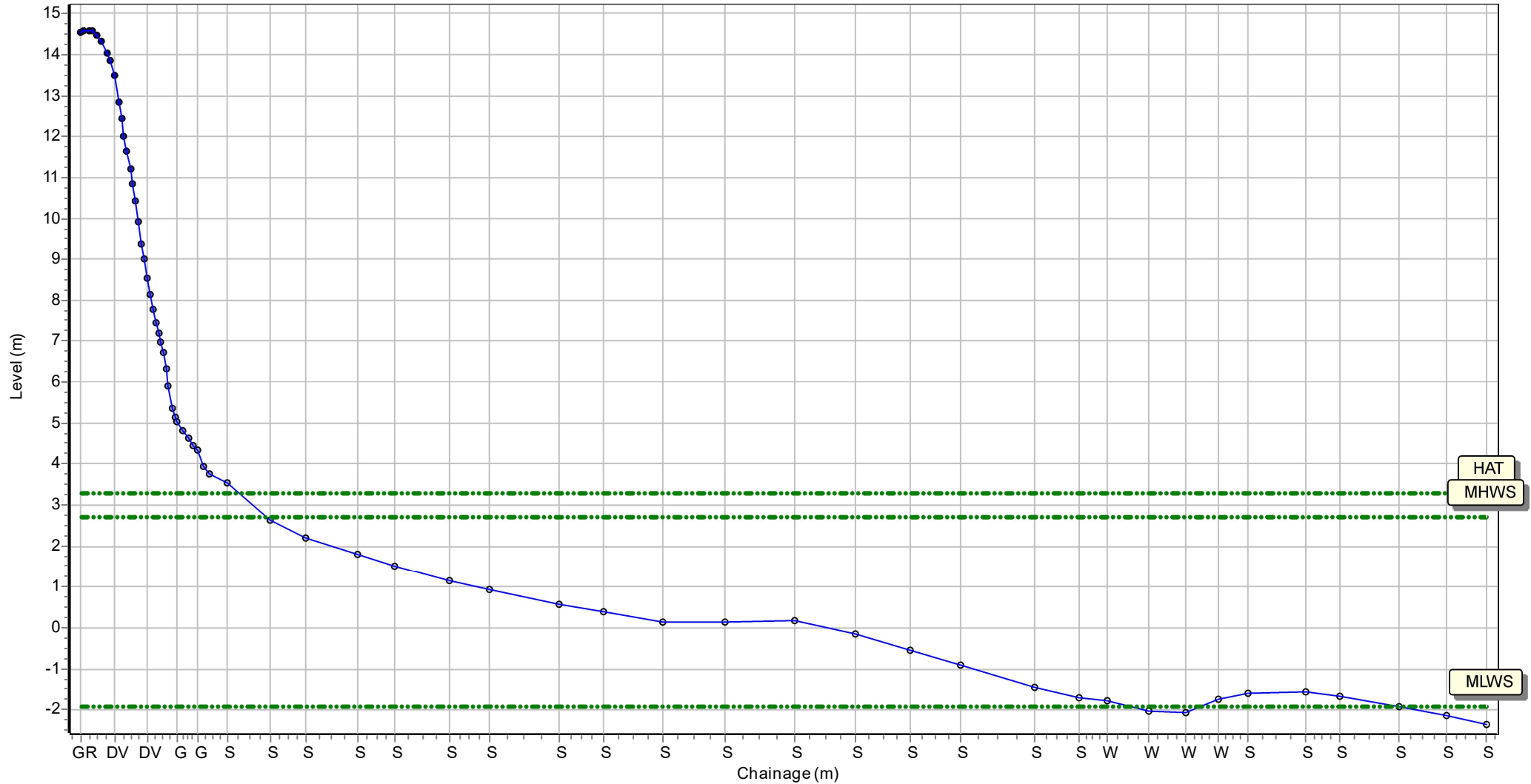
Sea State:

Visibility:

Rain:

Summary: 2020 Full Measures Topo Survey

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



Beach Profile

Location: 1cHC1

Date: 20/10/2020

Inspector: AG

Low Tide:

Low Tide Time:

Wind

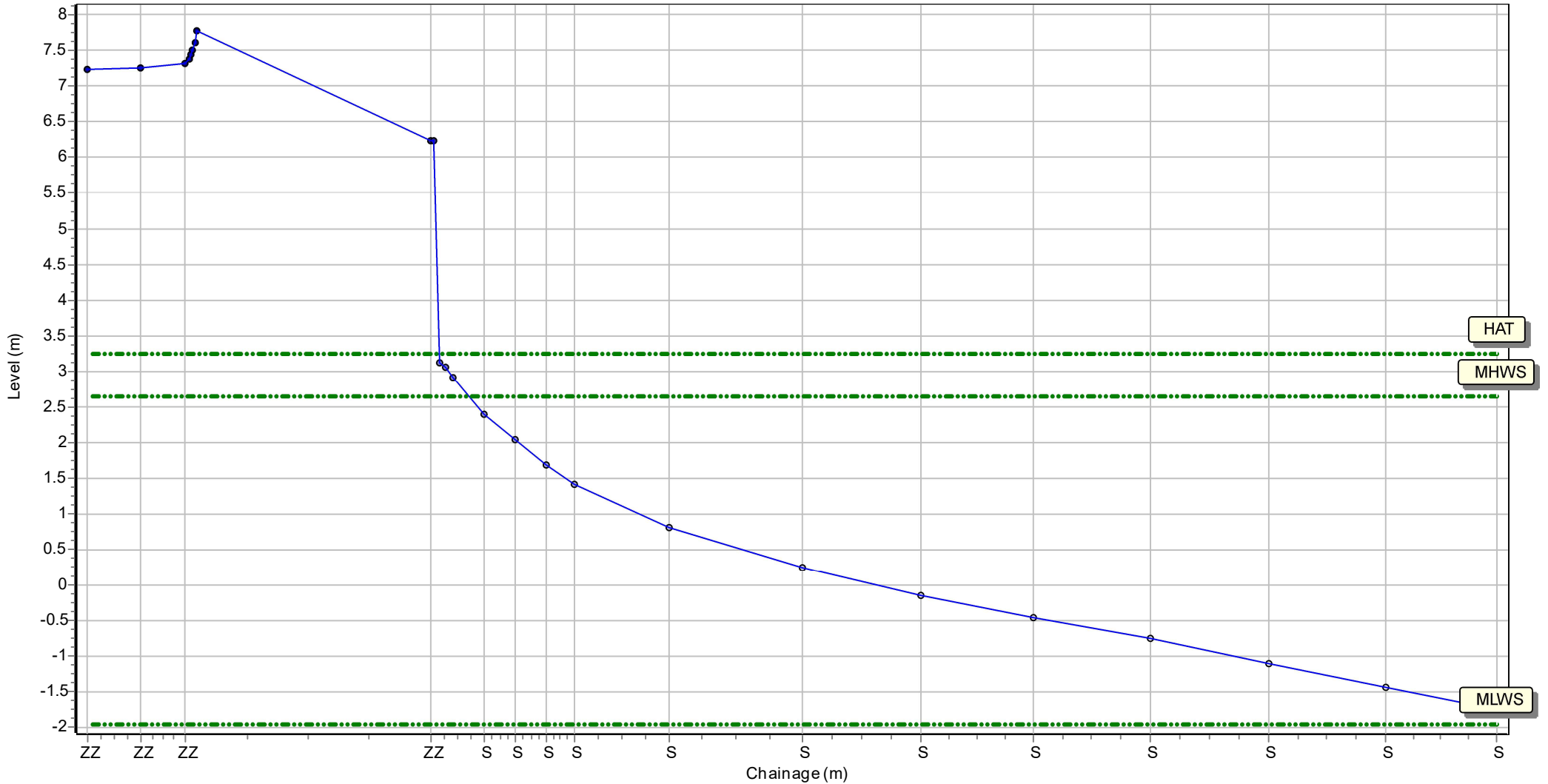
Sea State:

Visibility:

Rain:

Summary: 2020 Full Measures Topo Survey

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



Beach Profile

Location: 1cHS1

Date: 16/10/2020 Inspector: AG

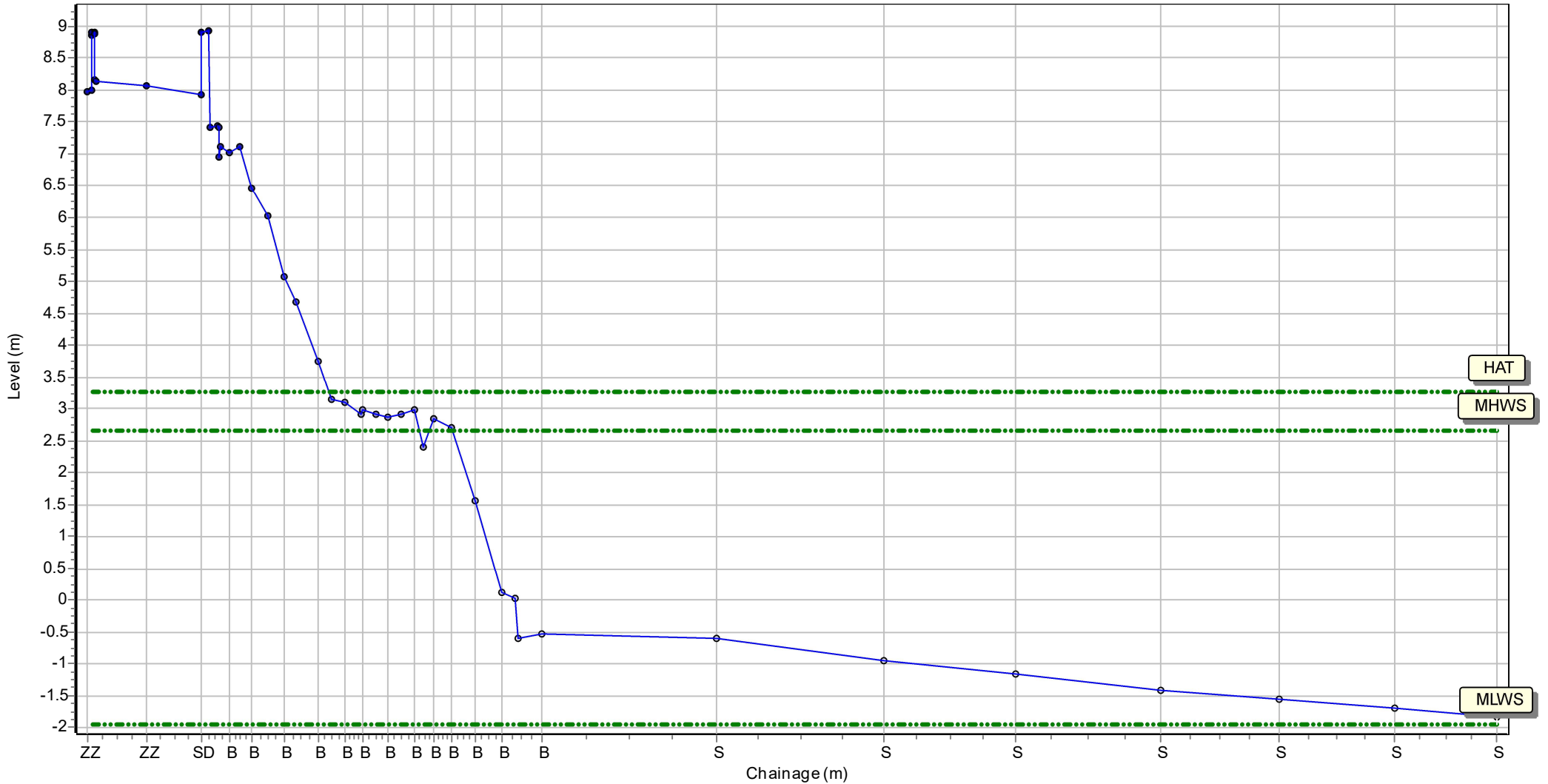
Low Tide: Low Tide Time:

Wind Sea State:

Visibility: Rain:

Summary: 2020 Full Measures Topo Survey

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



Beach Profile

Location: 1cHS2

Date: 16/10/2020

Inspector: AG

Low Tide:

Low Tide Time:

Wind

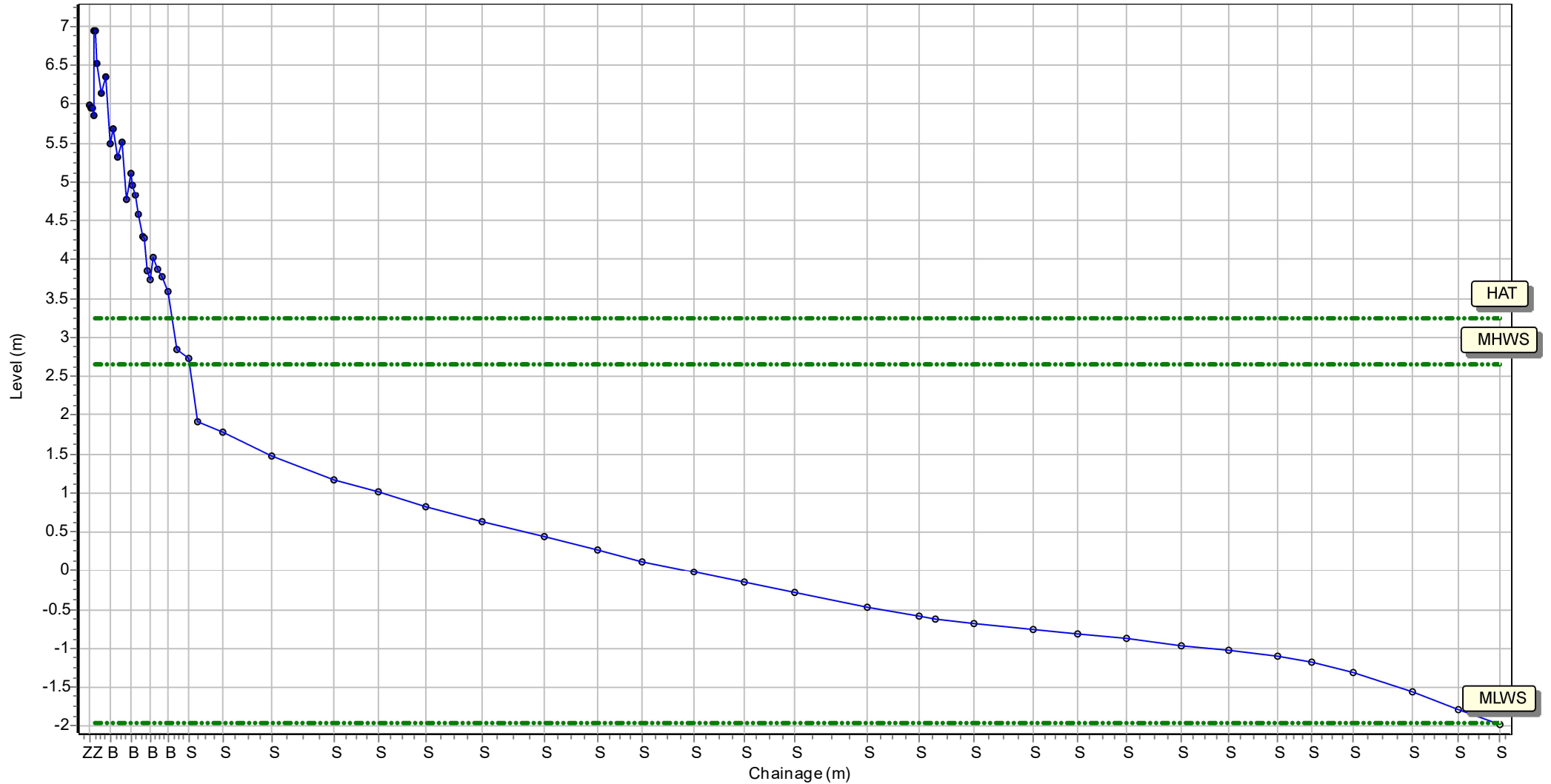
Sea State:

Visibility:

Rain:

Summary: 2020 Full Measures Topo Survey

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



Beach Profile

Location: 1cHS3

Date: 16/10/2020

Inspector: AG

Low Tide:

Low Tide Time:

Wind

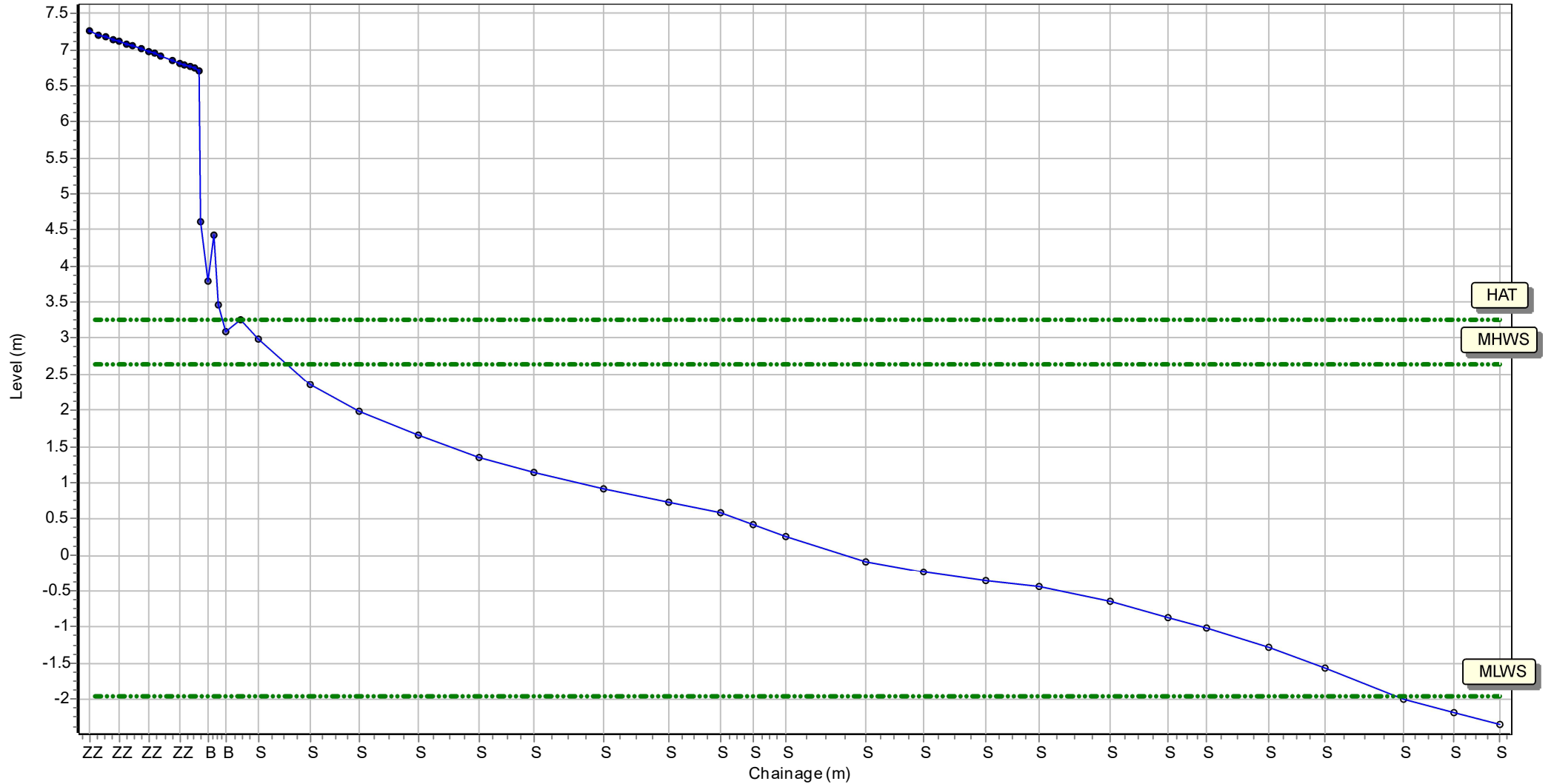
Sea State:

Visibility:

Rain:

Summary: 2020 Full Measures Topo Survey

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



Beach Profile

Location: 1cHS4

Date: 16/10/2020 Inspector: AG

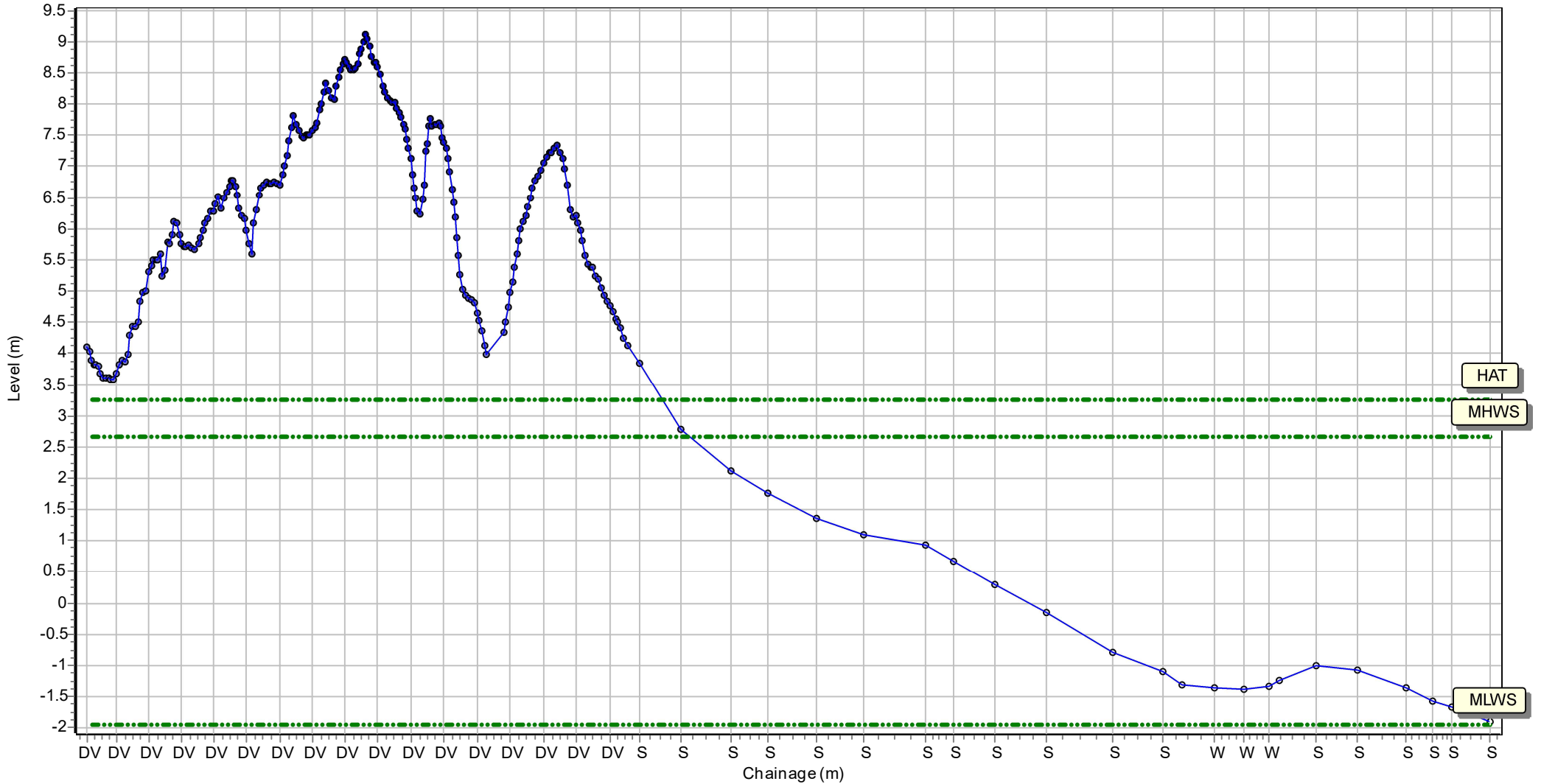
Low Tide: Low Tide Time:

Wind Sea State:

Visibility: Rain:

Summary: 2020 Full Measures Topo Survey

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



Beach Profiles: 1cHN1



Profiles Envelope 10/11/2008 17/09/2019 21/05/2020 18/09/2020

HAT

MHWS

MLWS

SANDS

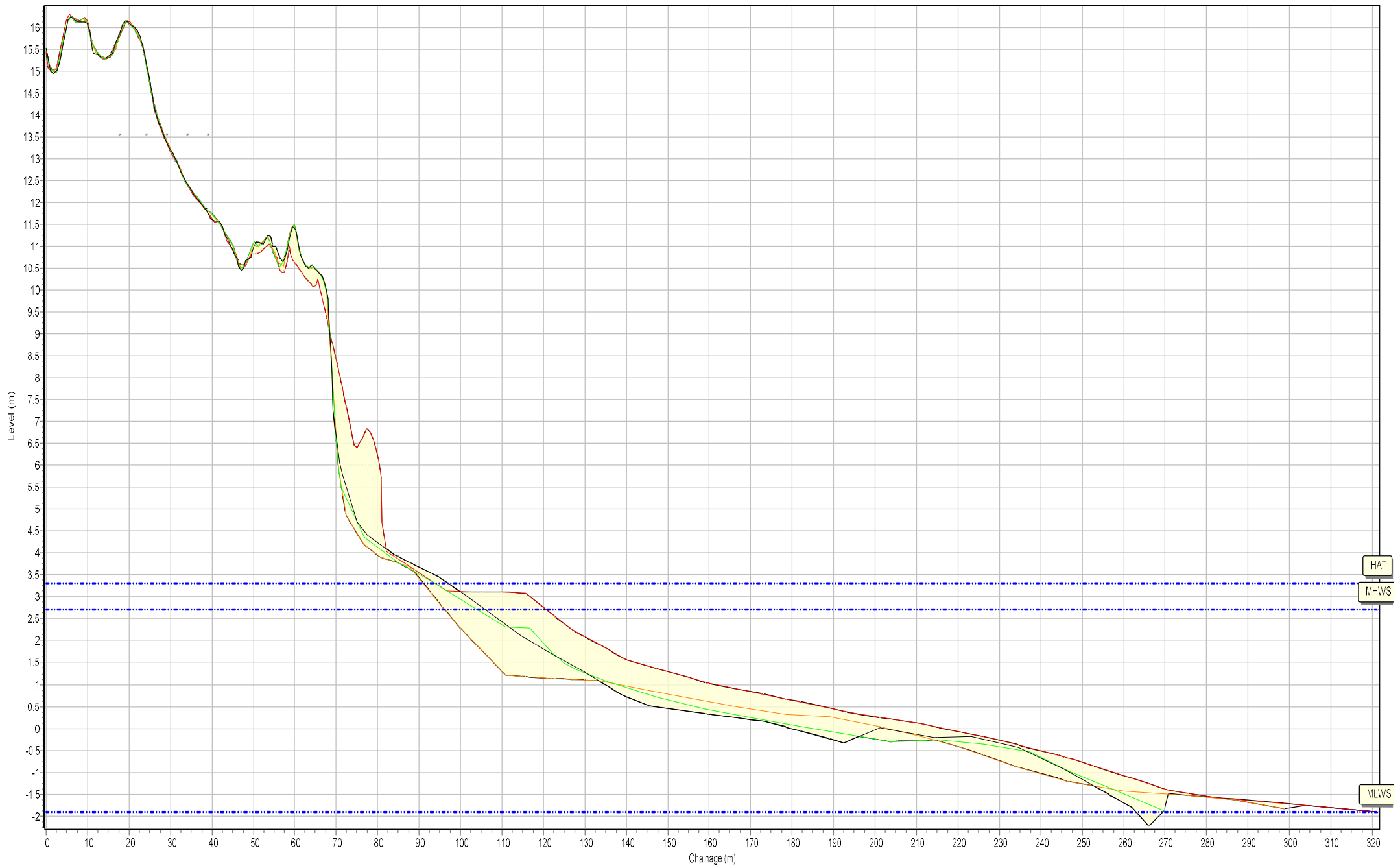
Beach Profiles: 1cHN2



Profiles Envelope 10/11/2008 17/09/2019 21/05/2020 18/09/2020

SANDS

Beach Profiles: 1cHN2A



Profiles Envelope 14/10/2011 17/03/2019 21/05/2020 18/09/2020

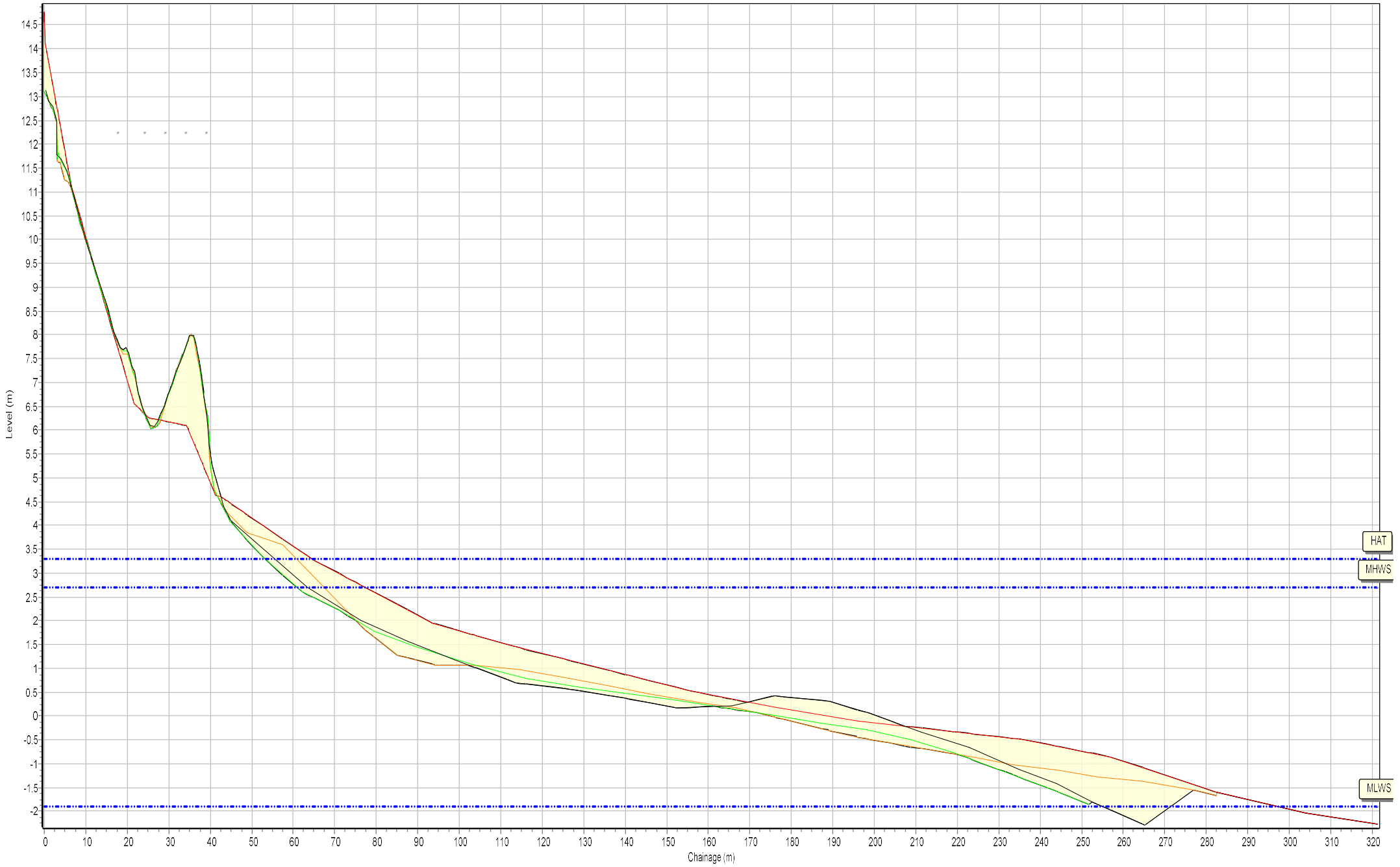
HAT

MHWS

MLWS

SANDS

Beach Profiles: 1cHN3



HAT

MHWs

MLWS

SANDS

Beach Profiles: 1cHN3A



Profiles Envelope 14/10/2011 17/03/2019 21/05/2020 18/09/2020

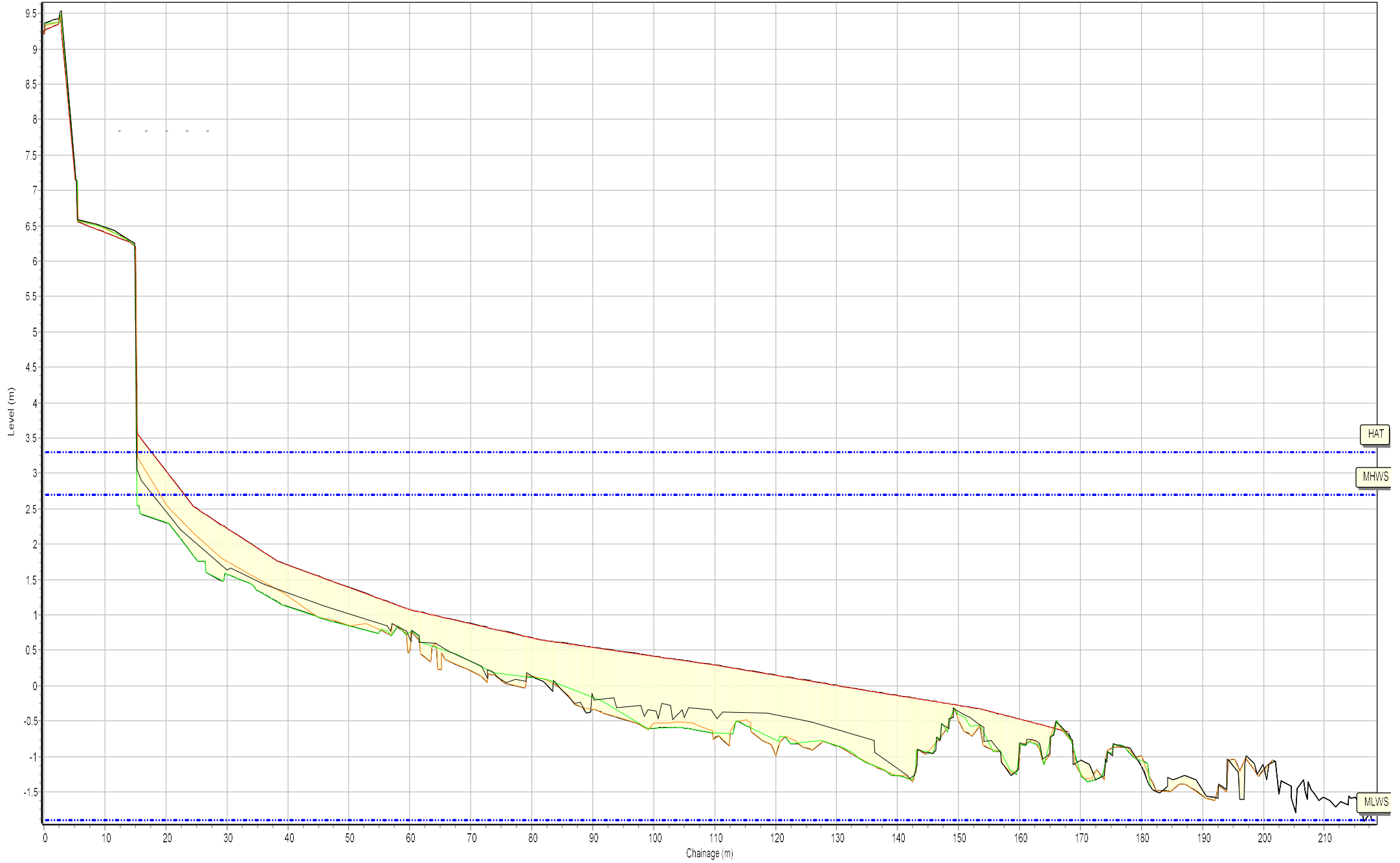
HAT

MHWS

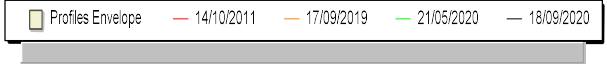
MLWS

SANDS

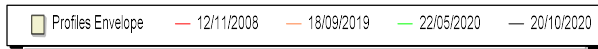
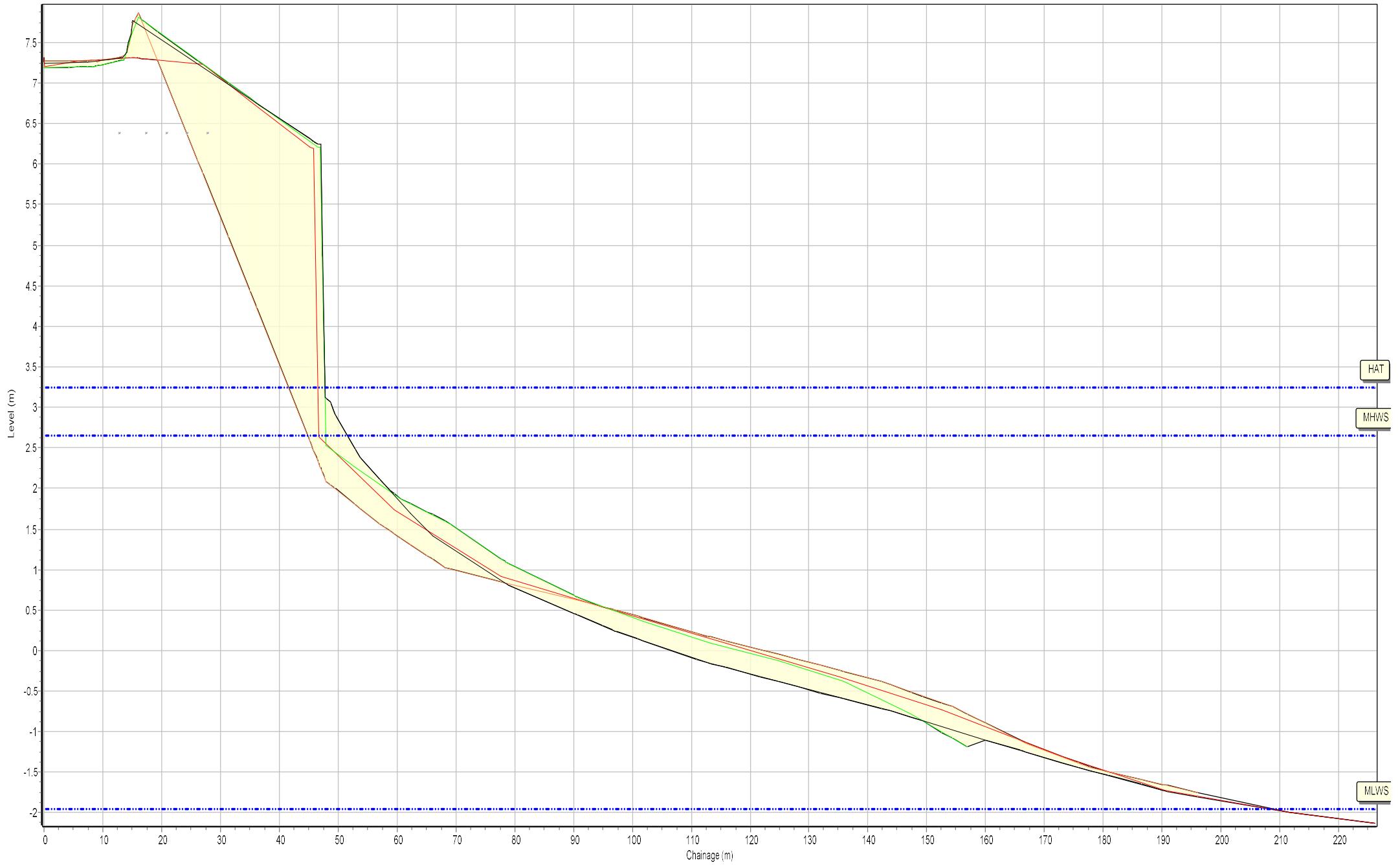
Beach Profiles: 1cHN4



Beach Profiles: 1cHN4A



Beach Profiles: 1cHC1



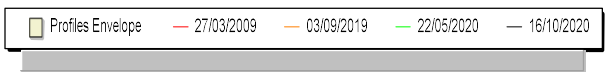
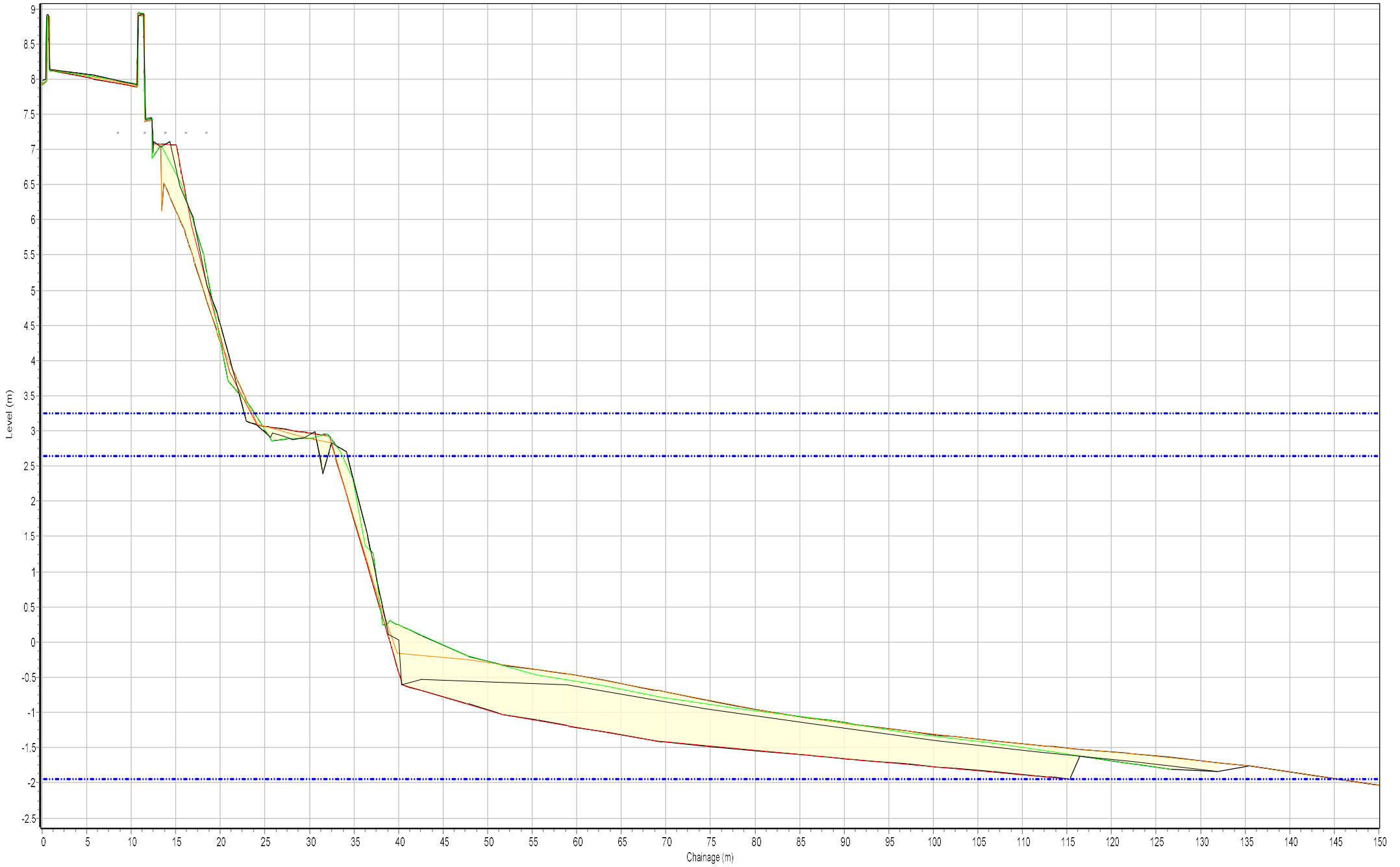
HAT

MHWS

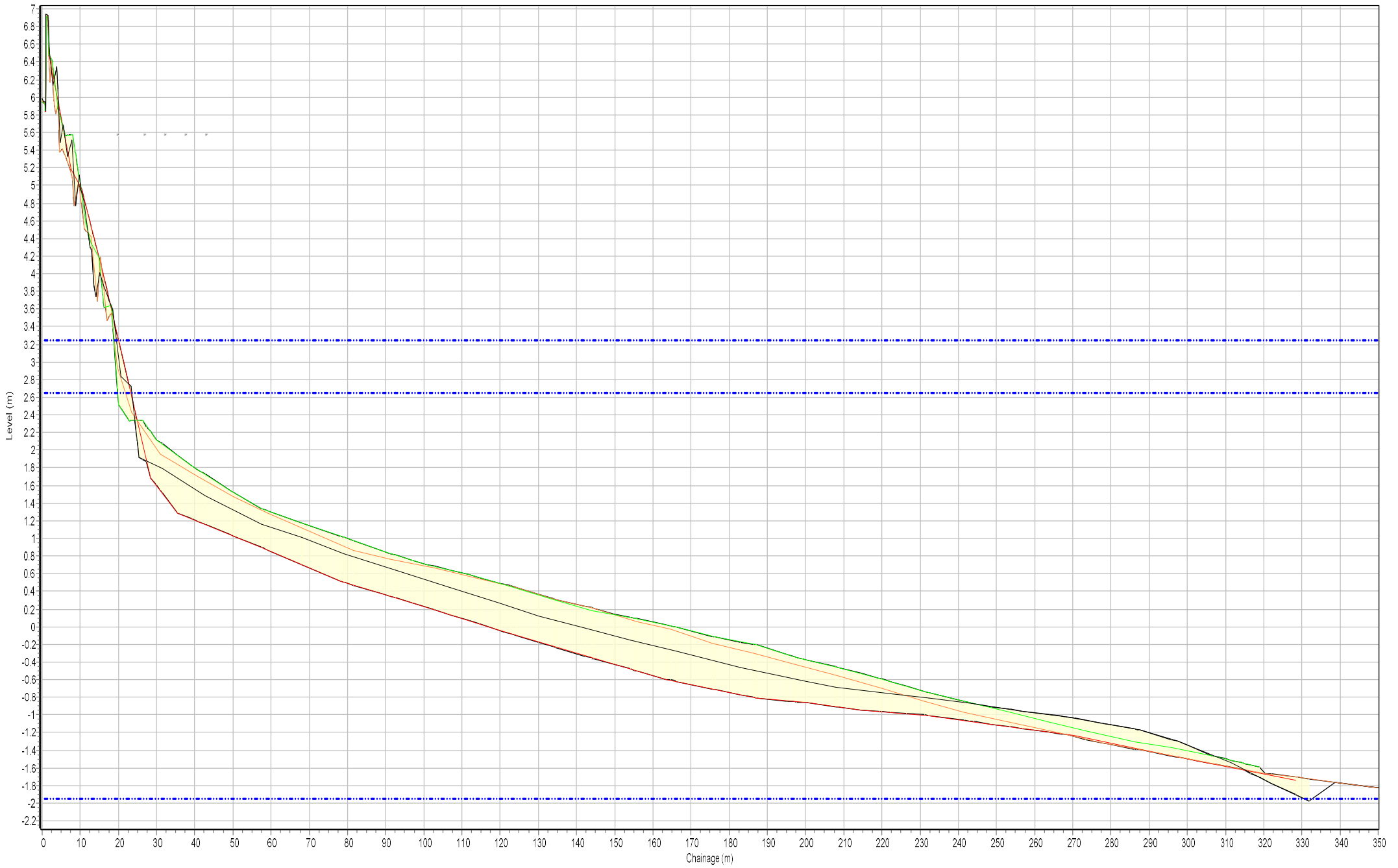
MLWS

SANDS

Beach Profiles: 1cHS1



Beach Profiles: 1cHS2



Beach Profiles: 1cHS3



Profiles Envelope 27/03/2009 03/09/2019 22/05/2020 16/10/2020

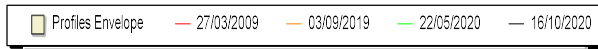
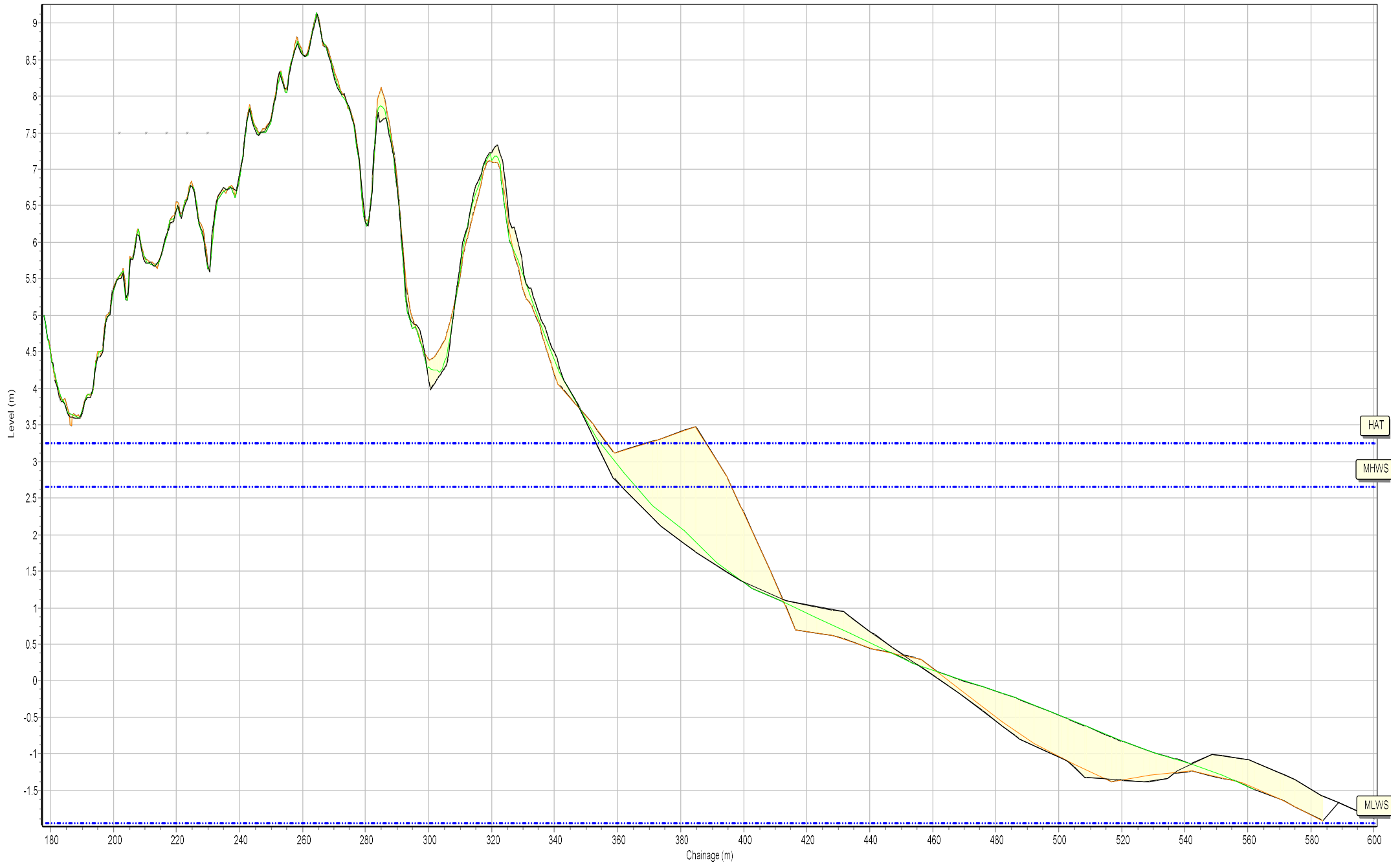
HAT

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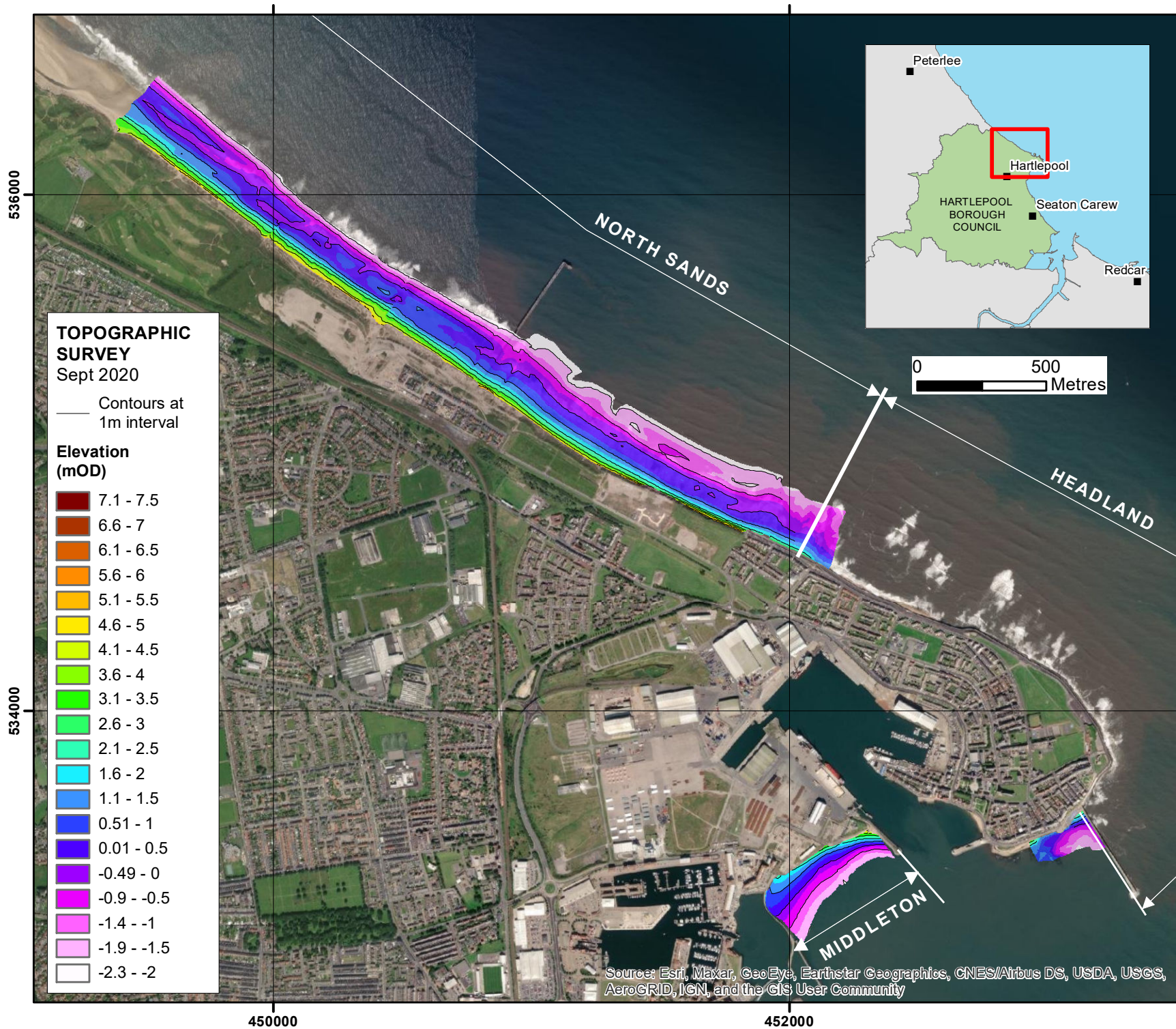
MLWS

SANDS

Beach Profiles: 1cHS4



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

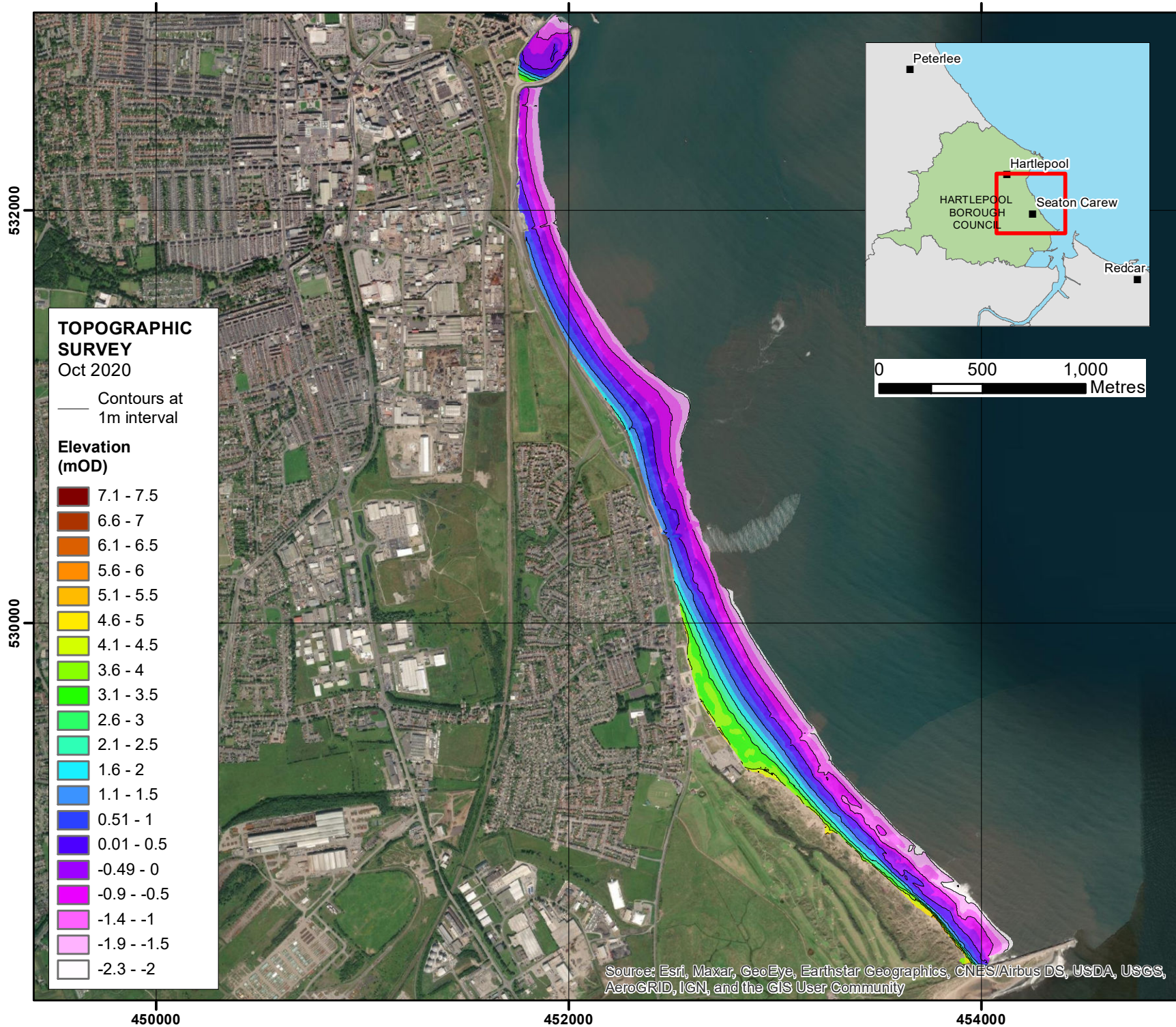
Analytical Report
'Full Measures' Survey 2020

Drawing Scale at A4 1:20,000

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





Key

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

Appendix B - Map 2
HARTLEPOOL SOUTH

Hartlepool Borough Council Frontage

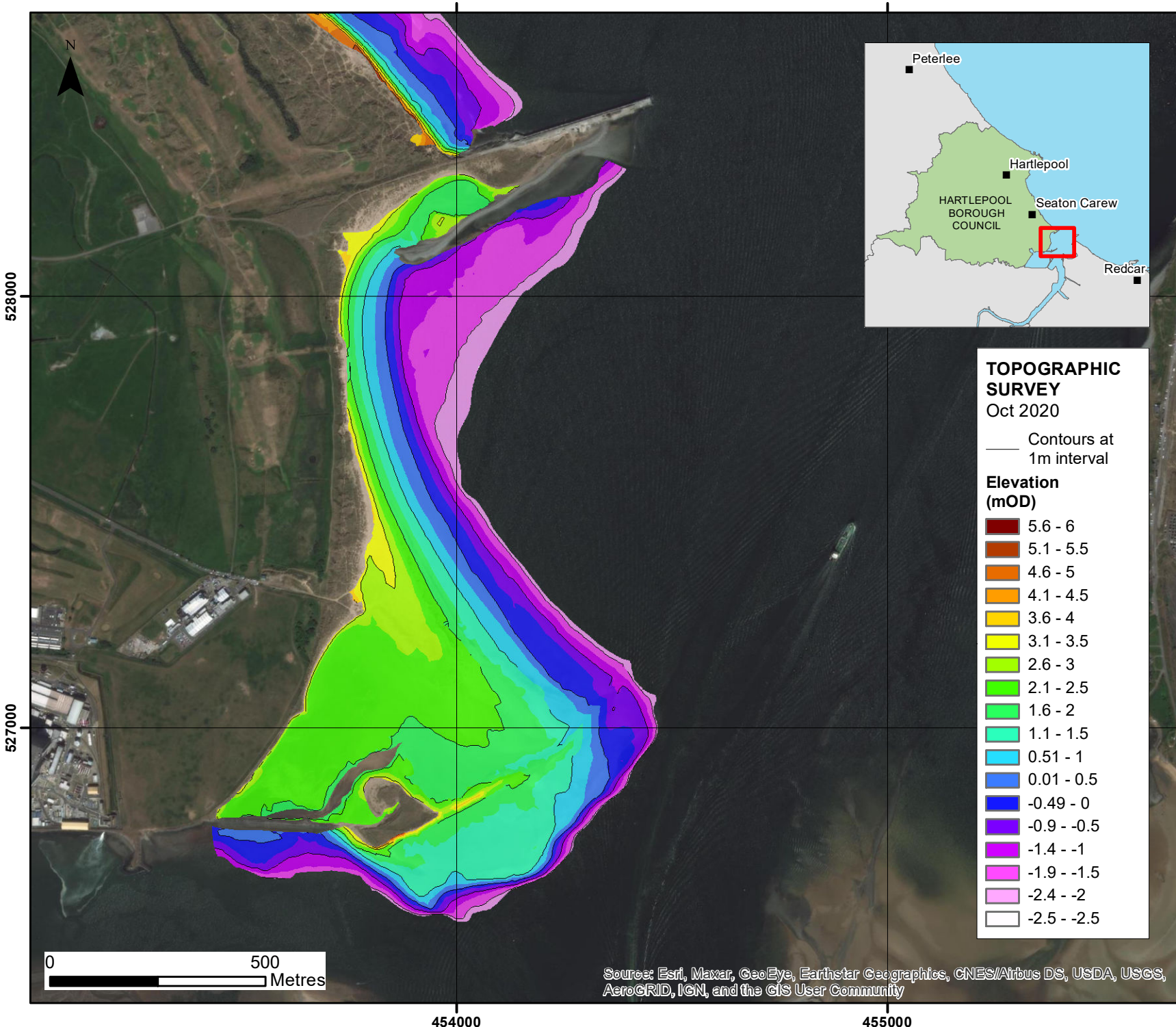
Analytical Report
'Full Measures' Survey 2020

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 3

HARTLEPOOL NORTH GARE

Hartlepool Borough Council Frontage

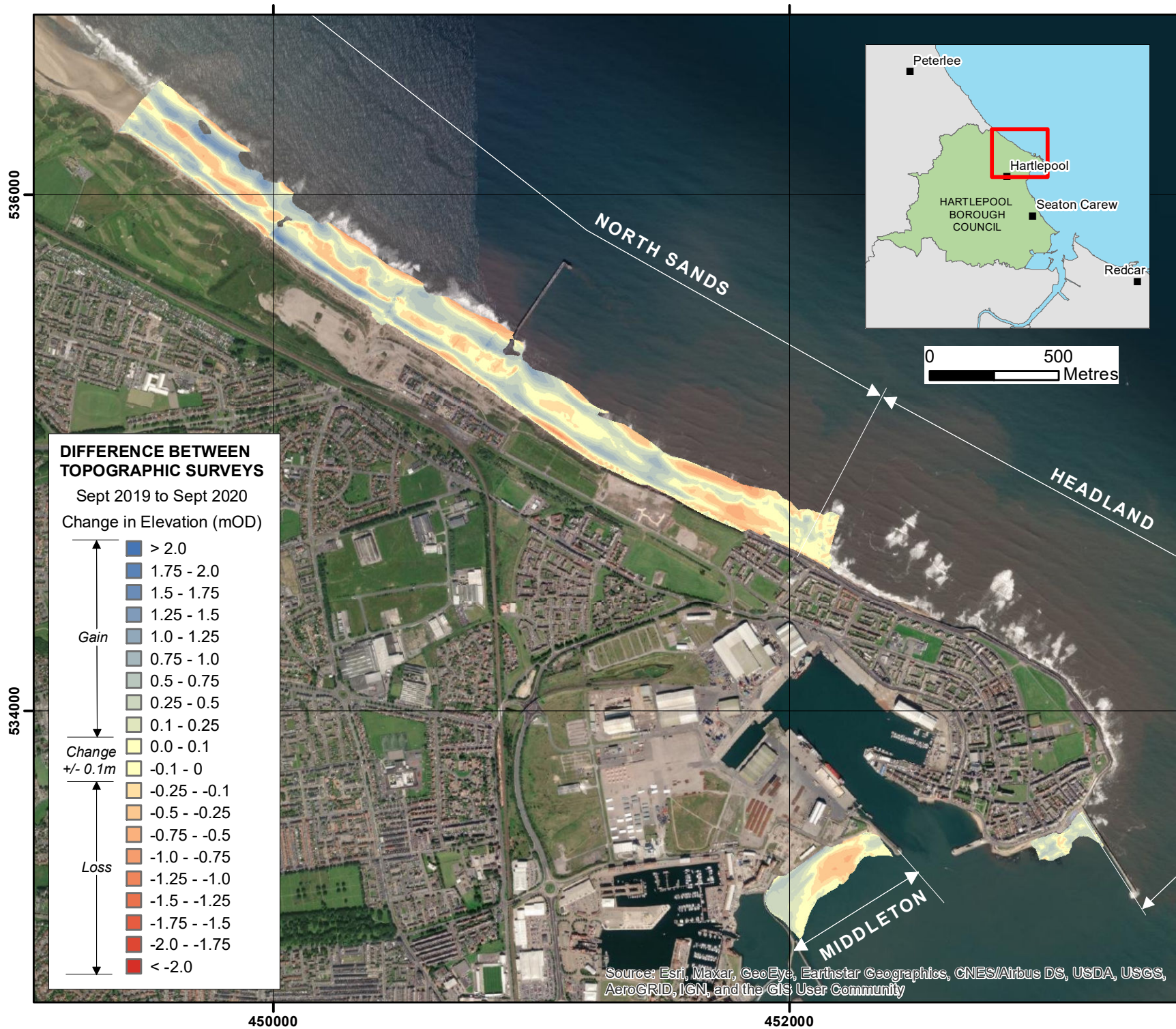
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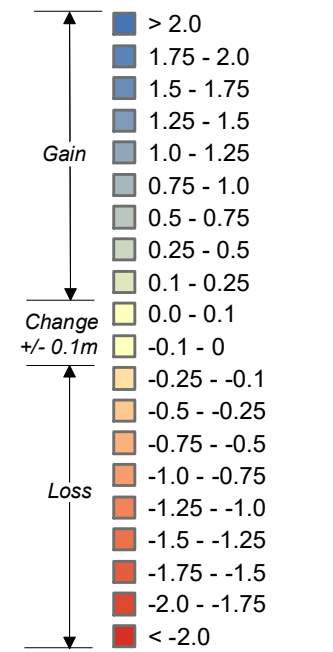
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DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS

Sept 2019 to Sept 2020
Change in Elevation (mOD)



Key

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

Appendix B - Map 3
HARTLEPOOL NORTH

Hartlepool Borough Council Frontage

Analytical Report
'Full Measures' Survey 2020

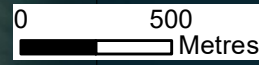
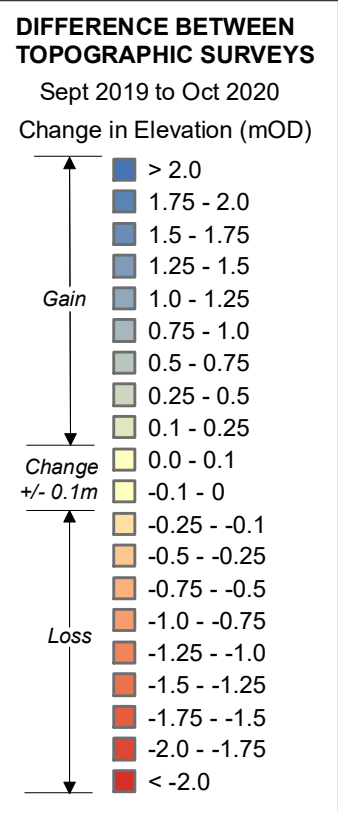
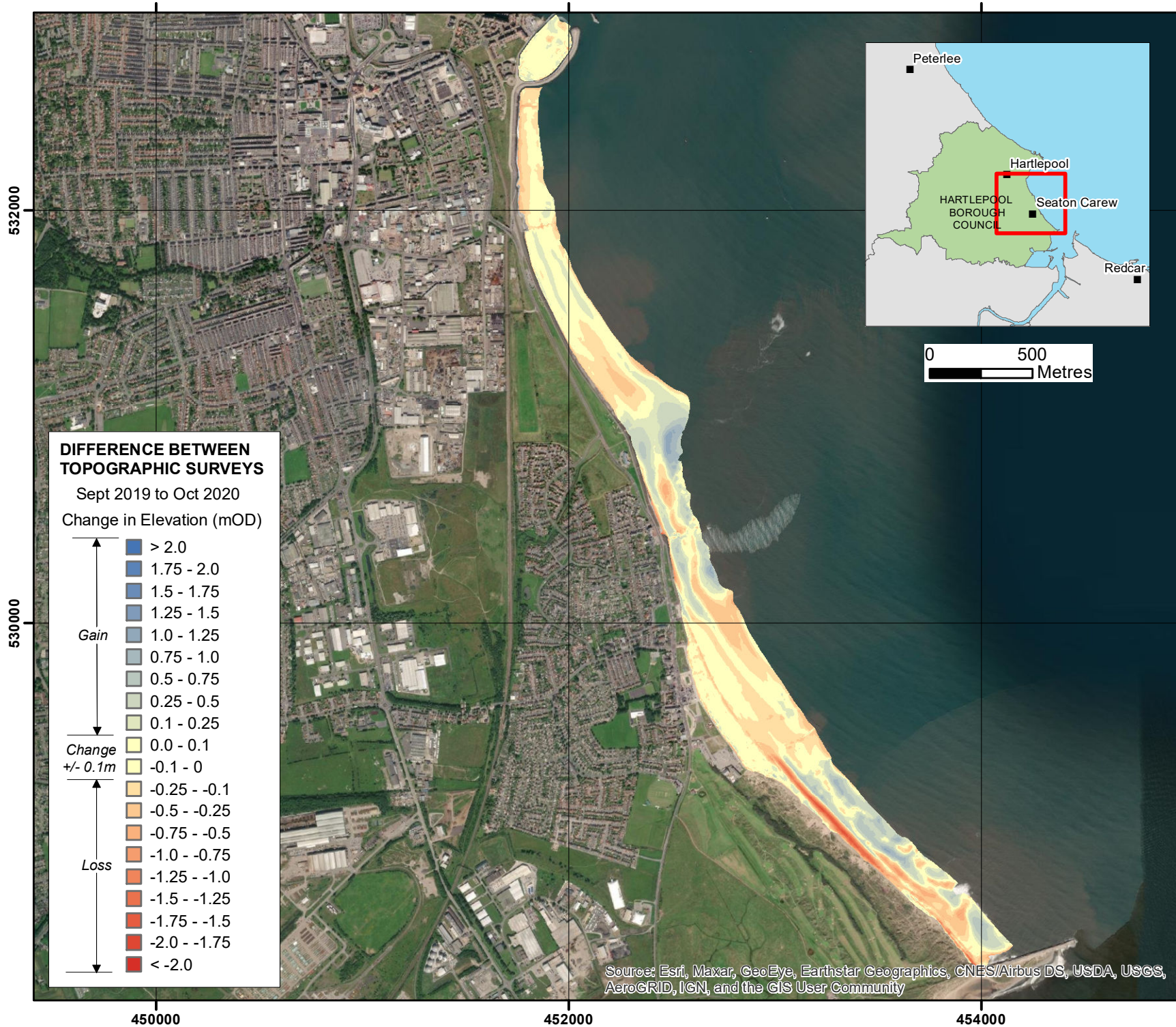
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Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Key

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

Appendix B - Map 5
HARTLEPOOL SOUTH

Hartlepool Borough Council Frontage

Analytical Report
 'Full Measures' Survey 2020

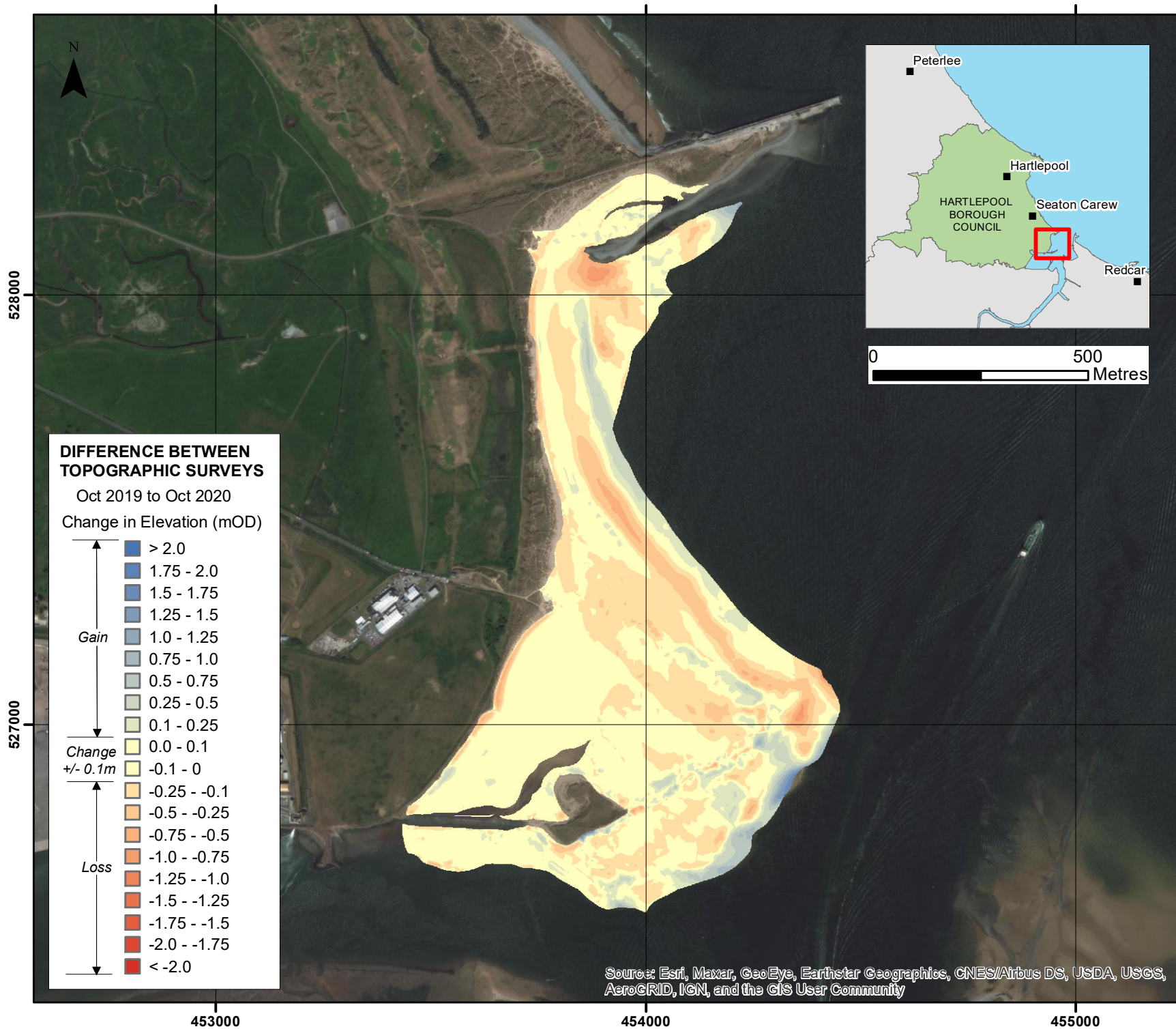
Drawing Scale at A4 1:25,000

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Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Key

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

Appendix B - Map 6
HARTLEPOOL NORTH GARE
Hartlepool Borough Council Frontage
 Analytical Report
 'Full Measures' Survey 2020

Drawing Scale at A4 1:12,000

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