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

Sunderland City Council

March 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	**Souter Point to Chourdon Point**
HAT	3.18
MHWS	2.48
MLWS	-1.92

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.

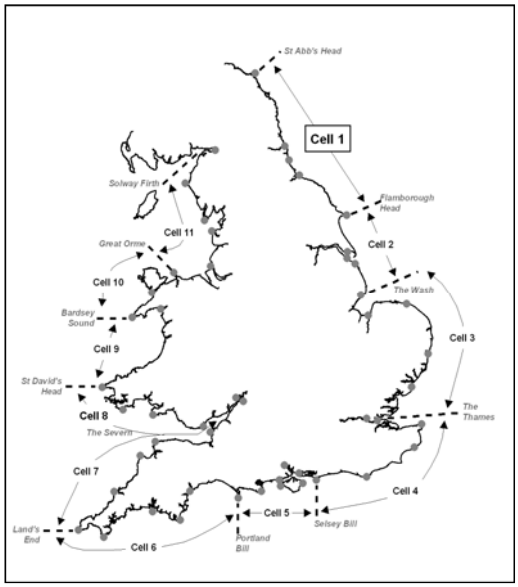


Figure 1 Sediment Cells in England and Wales

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
- 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	Jul 10	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 11	Sep 11
4	2011/12	Oct-Nov 11	Oct 12	Mar-May 12	Oct 12	-
5	2012/13	Sep-Oct 12	Mar 13	Mar 13	Jun 13	-
6	2013/14	Sep-Oct 13	Feb 14	Mar 14	Jul 14	-
7	2014/15	Sep & Nov 14	Feb 15	Mar – Apr 15	Jul 15	
8	2015/16	Sep & Nov 15	Feb 16	Mar 16	Jul 16	Jun 16
9	2016/17	Sep-Nov 16	Feb 17	Apr 17	Jul 17	
10	2017/18	Oct-Nov 17	Mar 18 (*)			

(*) The present report is **Analytical Report 10** and provides an analysis of the 2017 Full Measures survey for Sunderland City Council's frontage.

In addition, separate reports are produced for other elements of the programme as and when specific components are undertaken, such as wave data collection, bathymetric and sea bed sediment data collection, aerial photography, and walk-over visual inspections.

For purposes of analysis, the Cell 1 frontage has been split into the sub-sections listed in the Table 2.

Table 2 Sub-divisions of the Cell 1 Coastline

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

Sunderland City Council's frontage extends from The Bents to Ryhope. For the purposes of this report and for consistency with previous reporting, it has been sub-divided into three areas, namely:

- Whitburn Bay
- Sunderland Harbour and Docks
- Hendon to Ryhope (including Halliwell Banks)

1.2 Methodology

Along Sunderland City Council's frontage, the following surveying is undertaken:

- Full Measures survey annually each autumn comprising:
    - Beach profile surveys along 52 transect lines (commenced 2009)
    - Topographic survey at Whitburn Bay (commenced 2009)
    - Topographic survey at Hendon to Ryhope (including Halliwell Banks) (commenced 2009)
- Partial Measures survey annually each spring comprising:
    - Beach profile surveys along 13 transect lines (commenced 2009)
- Cliff top survey bi-annually at:
    - Hendon to Ryhope (including Halliwell Banks) (commenced 2009)

The location of these surveys is shown in Figure 2. The Full Measures survey was undertaken along this frontage on the 6th and 7th November 2017 (Whitburn Bay), 19th November 2017 (Sunderland Harbour and Docks) and between the 30th October and 4th November 2017 (Hendon to Ryhope (incl. Halliwell Banks)). During this time weather conditions varied considerably. Refer to the survey reports for details of the weather conditions over this survey period.

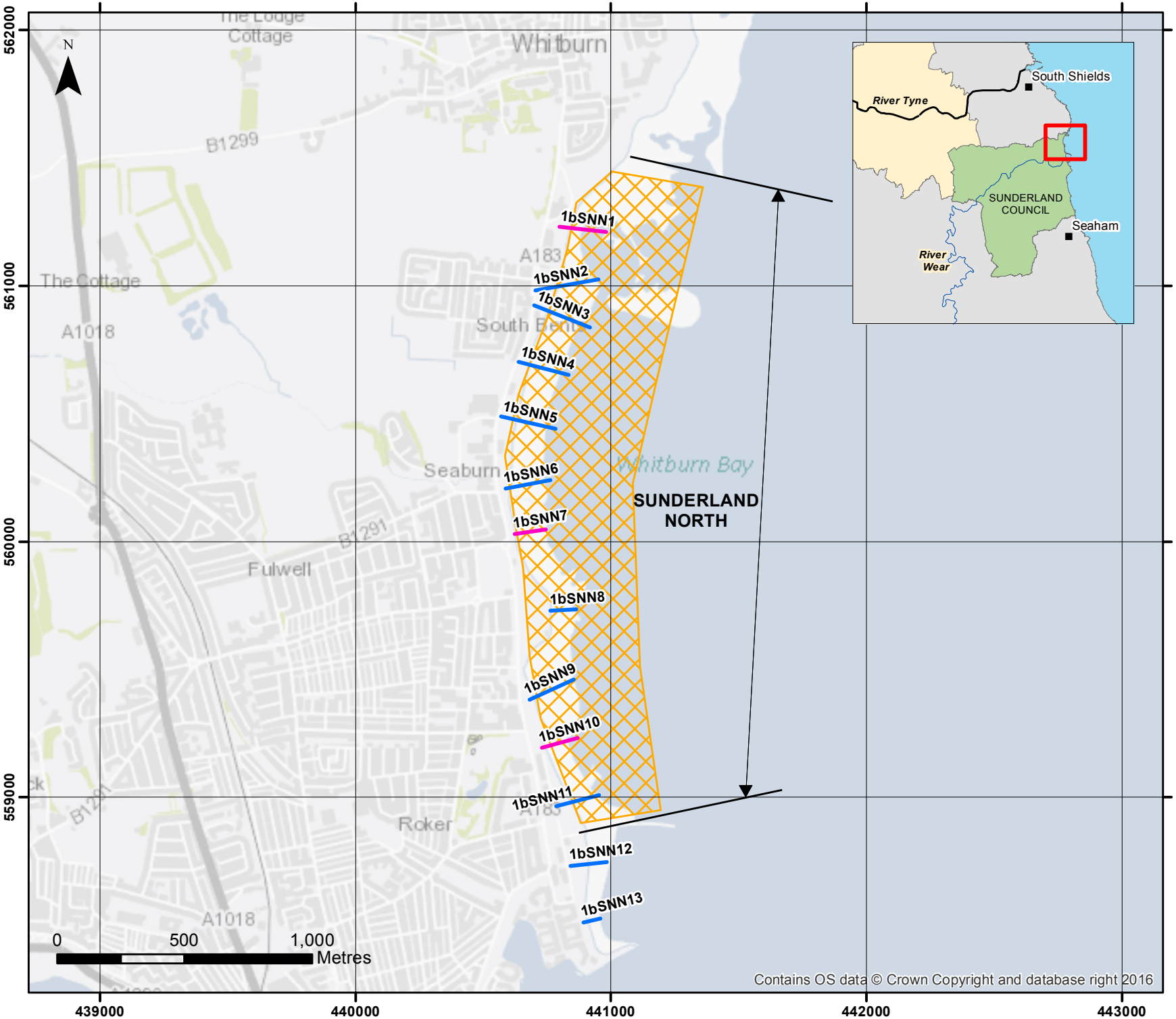
All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data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

Analytical Report
Topo Surveys

Drawing Scale at A4 1:20,000

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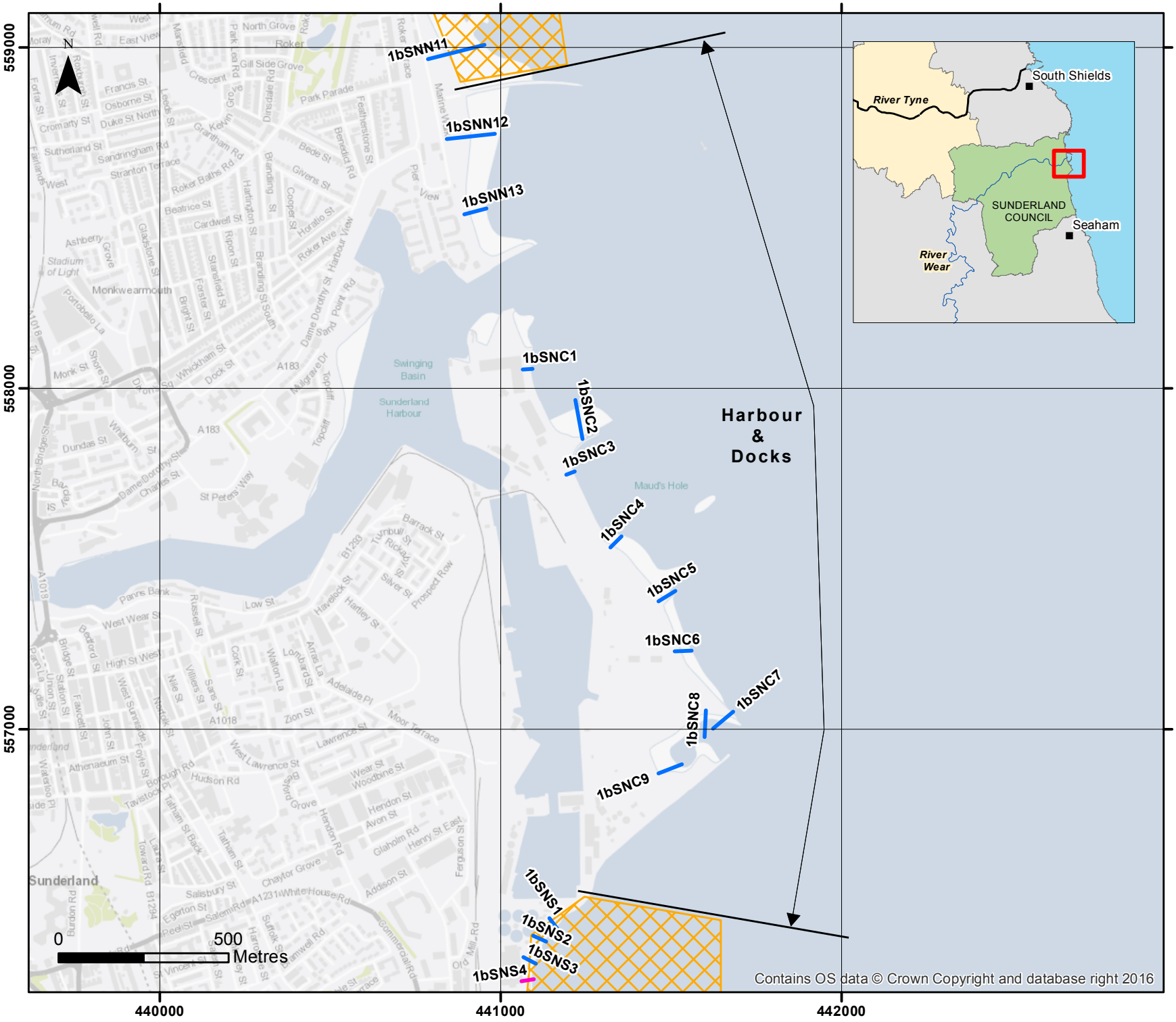

Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 2 Sunderland Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:15,000

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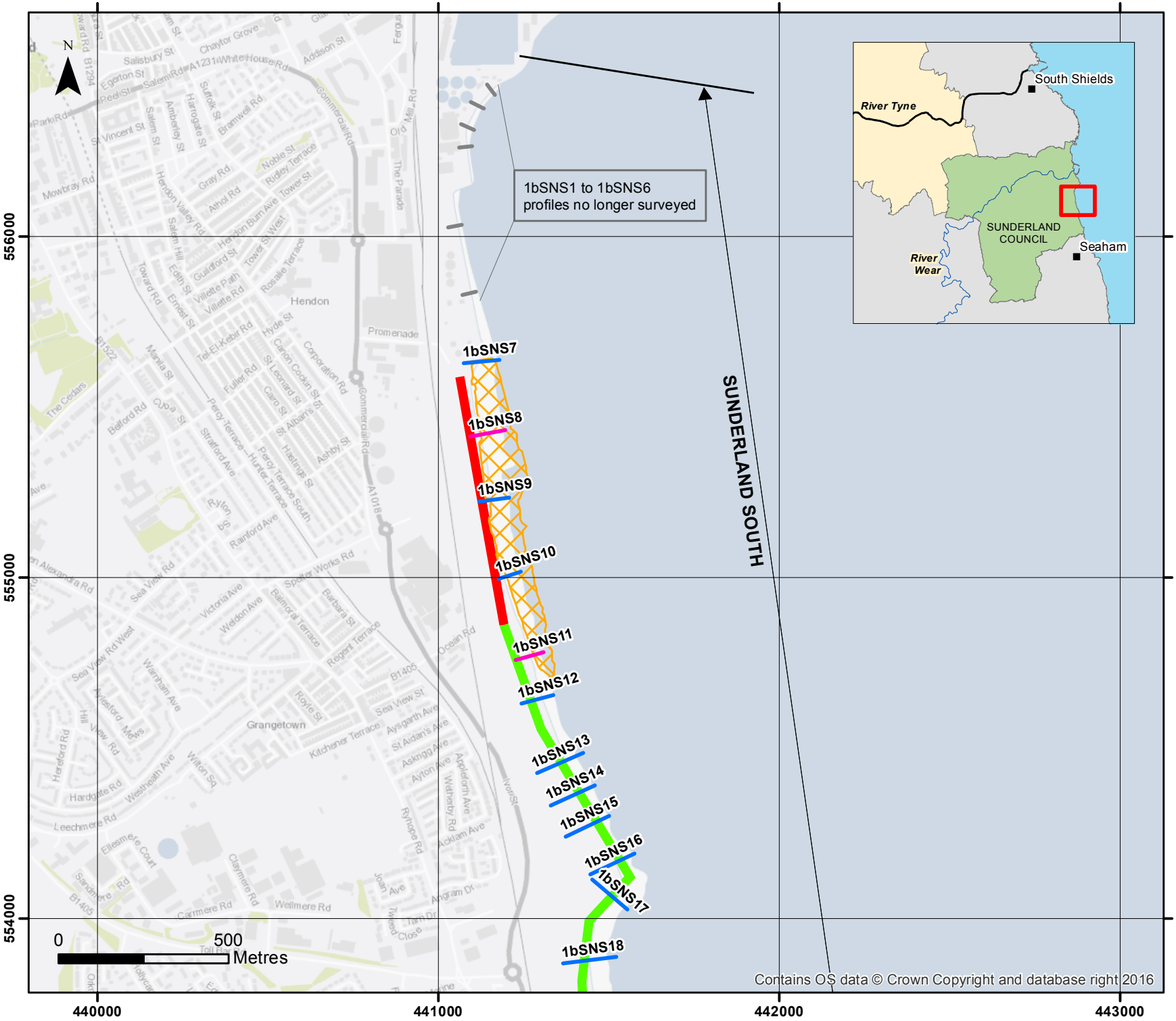

Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual
- Discontinued

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- @ 100
- @ 300

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 3 Sunderland Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:15,000

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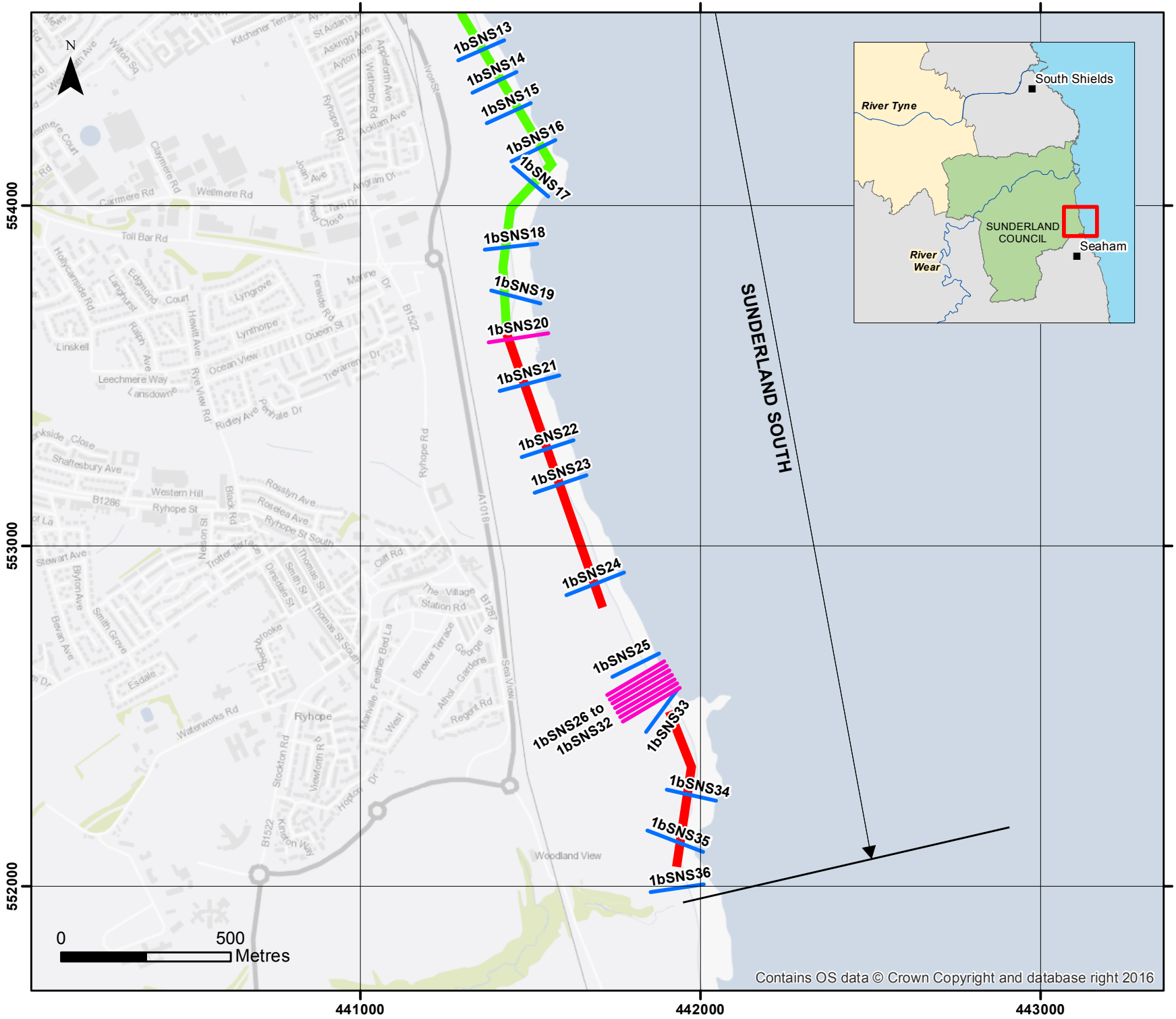

Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Cliff Top Monitoring Pegs

- @ 100
- @ 300

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 4 Sunderland Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:15,000

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2. Analysis of Survey Data

2.1 Whitburn Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
6th & 7th November 2017	**Beach Profiles:** Whitburn Bay is covered by eleven beach profile lines for the Full Measures survey (Appendix A). The previous survey was the Partial Measures survey undertaken in April 2017 and the previous Full Measures survey was undertaken in November 2016. Profiles 1bSNN1, 1bSNN7 and 1bSNN10 were last surveyed during the Partial Measures spring survey, 2017. The remaining profiles were last surveyed during the Full Measures autumn survey, 2016. **1bSNN1** is immediately south of Sunderland City Council's northern boundary. The profile is unchanged above HAT (40m chainage). Between 45m chainage and 100m chainage the level of the beach has accreted by up to 0.6m since April 2017, forming a small berm at chainage 55m,just below HAT. Between 100m and 160m chainage the profile has eroded by 0.2m. Overall, the beach level is at medium-high levels compared to the range recorded from previous surveys. Profiles **1bSNN2** and **1bSNN3** are located towards the north of Whitburn Bay and extend across scrubland before reaching the upper gravel foreshore and then dropping across the lower sandy foreshore towards the rocky outcrop of Whitburn Steel. At profile **1bSSN2**, the dune has remained stable since the last survey. The upper beach has been subject to erosion of up to 0.4m between chainage 75m and 140m. The middle beach between chainage 140m and 230m has seen very little change, limited to ±0.1m. On the lower beach there has been accretion of up to 0.5m between chainage 230m and 270m, with erosion of 0.3m from chainage 270m to 300m removing the berm. The toe of the beach shows accretion of 0.2m. Overall the profile is at a high level compared to the range recorded from previous surveys, with the section between chainage 185m to 245m being the highest on record. At **1bSNN3**, the dunes remain unchanged since the previous survey. The beach profile has changed very little on the upper beach since the November 2016 survey, with the lower beach showing erosion from chainage 170m of up to 0.4m. Overall, the beach is near its highest level on record, except in the	Along the length of Whitburn Bay beaches have been dynamic, generally being dominated by accretion, with some erosion on the lower foreshore. **Longer term trends:** All the profiles in Whitburn Bay are at medium to high levels compared to earlier surveys in the record. The beaches show frequent fluctuation in levels due to sediment being naturally redistributed across the shoreface.

Survey Date	Description of Changes Since Last Survey	Interpretation
	lower foreshore where it is at a relatively low level compared to the range recorded from the previous surveys. Profiles **1bSNN4** to **1bSNN6** are between the shoreline opposite the southern edge of South Bents housing estate and Parsons Rock. Profile **1bSNN4** shows a small 0.2m accumulation of gravelly sands at the toe of the seawall. There has been little change on the upper beach from chainage 25m to 50m. Between chainage 50m and 190m there has been accretion of 0.3m. The lower beach shows erosion of up to 0.3m. The majority of the beach is at its highest recorded level, with the lower beach being at a medium-low level compared to the range recorded from previous surveys. At profile **1bSNN5**, the beach profile has changed very little, with small amounts of accretion of up to 0.2m, making it the highest profile on record. The exception is the toe of the beach which shows erosion of 0.2m from chainage 225m. At profile **1bSNN6**, beach levels have increased by 0.3m across the whole beach, making it the highest on record. **1bSNN7** is at Seaburn, just to the north of Parson's Rocks. Beach levels have increased across the profile compared to the April 2017 survey. Levels have increased at the toe of the seawall by up to 0.5m and across the rest of the profile by 0.2m. Overall, profile is at a high level compared to the range recorded from previous surveys. Profile **1bSNN8** extends across Parsons Rocks. There are no discernible changes across most of the profile since the previous Full Measures survey in 2016, however there has been accretion of sand up to 0.8m on the lower foreshore from chainage 95m. The lower foreshore is relatively high compared to the range recorded from previous surveys. Profile **1bSNN9** drops from the cliff top to the foreshore at Roker. There has been very little change across the profile, limited to ±0.2m. Overall, the profile is at a medium level compared to the range recorded from previous. **1bSNN10** is located approximately mid-way between Parson's Rocks and Roker Pier. There has been erosion of 0.7m at the toe of the seawall. Between chainage 25m and 70m there has been accretion of up to 0.8m. Seawards of chainage 70m the changes are limited to less than ±0.2m. The	

Survey Date	Description of Changes Since Last Survey	Interpretation
	result of the changes is a more consistent gradient, being shallower on the upper beach than in the previous survey. Overall the beach is at a medium level compared to the range recorded in previous surveys. **1bSNN11** is located to the south of Whitburn. There has been small amount of erosion, 0.1m, on the upper beach from the seawall to chainage 25m. The beach level has increased across most of the profile by up to 0.3m, between chainage 25m and 185m. There has been erosion of 0.6m between chainage 185m and 205m, forming a channel-like depression. The toe of the beach seawards of chainage 205m shows accretion of up to 0.4m covering the previously exposed rocks. .Overall the beach is at a relatively high level compared to the range recorded from the previous surveys, except for the depression on the lower foreshore which is relatively low.	
6th & 7th November 2017	**Topographic Survey:** Whitburn Bay, between the Bents and Roker Pier, is covered by an annual topographic survey which commenced in September 2009. Data from the most recent topographic survey (Full Measures, autumn 2017) have been used to create a digital ground model (DGM) (Appendix B – Map 1) using GIS. A difference plot has also been produced using the DGM (Appendix B – Map 2) produced from the last produced topographic survey (Full Measures, autumn 2016) and the present survey. The majority of the beach is dominated by accretion. There are some patchy areas of erosion particularly in the north of the bay.	The topographic survey shows that since the last survey, there has been a mixture of change on the beach though it is predominantly accretion. **Longer term topographic trends Autumn 2009 to Autumn 2017:** The plot shows a general pattern of accretion north of Parson's Rocks and erosion to the south. This pattern of northwards sediment movement may, in part, be due to on-going beach maintenance.

3.2 Sunderland Harbour and Docks

Survey Date	Description of Changes Since Last Survey	Interpretation
7th, 11th, 19th November 2017	**Beach Profiles:** Sunderland Harbour and Docks is covered by eleven beach profile lines (Appendix A), all surveyed annually. The previous survey was the Full Measures survey undertaken in autumn 2016. **1bSNN12** and **1bSNN13** are both located within the shelter of Roker Pier. At profile **1bSNN12**, there has been a variable amount of accretion and erosion throughout the profile, generally less than 0.3m. The upper beach has generally shown very little change. A small 0.3m high step in the beach profile has formed at chainage 60m. The mid beach between chainage 80m and 135m shows accretion of 0.3m. The lower foreshore seawards of chainage 135m shows erosion, bringing MLWS landwards by c.15m. Overall the profile is at a medium-high level compared to the range recorded from previous surveys. At **1bSNN13**, the gradient has steepened. There has been accretion of up to 0.9m on the upper beach, burying the toe the bottom part of the rock armour revetment. The lower foreshore from chainage 62m shows erosion of 0.1m. Overall the profile is at a medium-high level compared to the range recorded from previous surveys. **1bSNC1** and **1bSNC2** are located within the shelter of New South Pier. Profile **1bSNC1** starts at the seaward edge of the dock building and extends across an earth mound before reaching the stepped landward face of the dock wall. The profile then drops from the wall crest directly into deep water. As there is no beach present profile 1bSNC1 has not been analysed. Profile **1bSNC2** starts at the crest of New South Pier and drops several metres to foreshore level. The beach level has fallen between the toe of the seawall and 75m chainage by up to 0.3m.. Seaward of this, there has been accretion of up to 0.4m. The profile is the lowest on record on the upper beach but the highest on record on the lower beach, suggesting drawdown has occurred. **1bSNC3** to **1bSNC6** are on the seaward face of the dock. Profile **1bSNC3** extends from the dockyard across a back flood wall, which has a crest level of around 7.2mOD, and promenade to the main seaward dock wall, which has a crest level of 7.55mOD. The	Within the breakwaters north of the River Wear, beach trends vary with cross-shore movement of material at profile 1bSNN12 and profile steepening at profile 1bSNN13. Between the breakwaters, the level of the upper foreshore has fallen with a corresponding increase in lower foreshore levels indicating drawdown has occurred. Outside of the breakwaters, the beach has shown further losses of material. Within the breakwaters, either side of the former South Outlet of the docks there has been very limited change. **Longer term trends:** Within the breakwaters to the north and south of the River Wear, the beach levels are medium-low compared to earlier surveys but within the bounds of the record. Outside of the harbour breakwaters, the beach levels fluctuate significantly over time. The surveys suggest the redistribution of sediment from the north of the embayment to south of the embayment, with the northerly and central profiles (1bSNC4 and 1bSNC5) being at a low level compared to earlier surveys and the more southerly profile, 1bSNC6, being at a high level. Within the breakwaters either side of the former South Outlet of the docks, long term change is small

Survey Date	Description of Changes Since Last Survey	Interpretation
	profile then extends down the seaward face of the wall into deep water. As there is no beach, profile 1bSNC3 has not been analysed. Profiles **1bSNC4** and **1bSNC5** extend from the rock armoured revetment across the short width of foreshore down to low water. At profile **1bSNC4**, the beach levels show some signs of recovery with accretion of up to 0.6m, however they are still 1.6m lower than 2015 levels. The survey suggests that there may have been some movement of rocks within the revetment, with rock recorded approximately 3m further seaward than in 2016, this is supported by the survey photos. The beach remains at a low level compared to the range recorded from previous surveys. At profile **1bSNC5**, beach levels seaward of the revetment have continued to erode slightly throughout the beach profile, with a loss of up to 0.2m. Again, there is evidence of movement of the revetment, with rock recorded approximately 3m further seawards. The beach is at a low level compared to the range recorded from previous surveys. **1bSNC6** extends across the revetment and seawall. The beach level has dropped by up to 0.6m from the wall to chainage 42m, where there appears to be accretion of 0.1m. The beach levels are at a high level compared to the range recorded from previous surveys. **1bSNC7** to **1bSNC9** are within the shelter of North East Pier and South West Breakwater in the former South Outlet, parts of which have been in-filled with tipped rubble. **1bSNC7** is a section across North East Pier. There has been no discernible change in the overall profile. Small apparent changes will be artefacts of the placement of survey points along the profile. Profile **1bSNC8** crosses the boulders and rubble. There has been no discernible change in the overall profile. Profile **1bSNC9** extends from the dock facilities and crosses a short length of concrete wall and sheetpiling before extending across the sand and gravel backshore, and foreshore to reach and cross a boulder mound that is towards the seaward end of the south west breakwater. The profile shows a small amount (up to 0.5m) of erosion on the landward side of the berm above HAT. The profile remains high relative to earlier surveys.	at 1bSNC7 and 1bSNC8. At profile 1bSNC9, the long-term trend is for increasing beach levels between the concrete wall and the boulder mound with the current levels being at their highest recorded levels since surveys began in October 2009.

3.3 Hendon to Ryhope (incl. Halliwell Banks)

Survey Date	Description of Changes Since Last Survey	Interpretation
4th November 2017	**Beach Profiles:** Hendon to Ryhope is covered by thirty-six beach profile lines (Appendix A). Most profiles are measured annually, but profiles 1bSNS4, 1bSNS8, 1bSNS11, 1bSNS20 and 1bSNS26 to 1bSNS32 are surveyed every 6 months. The previous Full Measures survey was undertaken in autumn 2016 and the previous Partial Measures survey was undertaken in spring 2017. **1bSNS1** to **1bSNS6** are located along the sea wall protecting the Hendon Sewage Treatment Works. The profiles typically include a section along the concrete deck, wall crest (which varies in elevation between around 7.0mOD in the north and 7.6mOD in the south after the dog-leg in the wall position), near-vertical seaward face of the wall, and sloping rock armour revetment. These profiles have now been removed from the survey. **1bSNS7** to **1bSNS10** are located along the defended coastal slopes at south Hendon, which rise in elevation to higher defended cliffs at **1bSNS11**. Profile **1bSNS7** extends across a seawall and concrete revetment, which is fronted by a foreshore comprised of large pebbles and coarse shingle. The beach level at the toe of the seawall has increased by 0.4m (up to chainage 32m), burying the line of sheetpiling exposed in the November 2015 survey. Between chainage 55m and 68m there has been erosion of up to 0.5m. The remainder of the profile shows no discernible changes since the October 2016 survey. Overall, the beach level is at a medium level compared to earlier the range recorded from previous surveys. Profile **1bSNS8** extends across the seawall, rock revetment and beach. There has been accretion of 0.3m at the toe of the revetment between chainage 36m and 47m. Accretion of 0.2m continues across most of the profile, apart from at the toe of the beach (chainage 100m) where there has been minor erosion of 0.1m. Overall, the beach is at a medium-high level compared to the range recorded from previous surveys. At profile **1bSNS9**, there has been an increase of 0.3m at the toe of the revetment. Between chainage 60m and 80m there has been negligible change. Seawards of chainage 80m there has been	Along the length of south Hendon, profiles 1bSNS7 to 1bSNS10 show accretion at the toe of the coastal defence structures. In general, the more northern profiles are dominated by accretion, whilst the more southern profiles are dominated by erosion, this is the same pattern of movement of sediment in the bay as the previous full measures survey. At Grangetown (south Hendon to Salterfen Rocks), many of the profiles show erosion of talus at the cliff toe. Beach level changes are dominated by accretion. Between Salterfen Rocks and the landfill at Halliwell banks (profiles 1bSNS20 to 1bSNS25), the cliff has been largely stable. Beaches show a tendency for sediment to move towards the south, with erosion in the north of the coast and accretion further south, this is the same direction of movement of sediment as the previous full measures survey. There have been variable changes at the toe of the cliffs at the landfill site (1bSNS26 to 1bSNS32), reflecting the ongoing erosion processes. The profiles show erosion in the upper sections, with accretion in the middle and lower beach indicating dynamic sediment movement in response to storms. To the south of Halliwell Banks, around Pincushion, the cliffs have remained largely stable. There has been accretion on the lower foreshore around the south of the headland.

Survey Date	Description of Changes Since Last Survey	Interpretation
	increasing amounts of accretion of up to 0.5m resulting in a flatter lower beach gradient. The profile is the highest recorded level compared to the range recorded from previous surveys. At profile **1bSNS10**, the berm formed in the 2016 survey at the toe of the revetment has been removed, with erosion of 0.3m to chainage 33m. Between chainage 40m and 92m there has been accretion of 0.2m. The toe of the beach from chainage 92m shows erosion of 0.1m. Whilst the upper beach is at a relatively low level compared to the range recorded from previous surveys, the lower beach is the highest on record. At profile **1bSNS11**, there is apparent change in the cliff profile, but this is likely to be due to limited data points and issues with access to the top of the cliff due to unsafe conditions. Beach levels have decreased across the profile, by up to 0.5m between the toe of the sea defences and 90m chainage. Seawards of chainage 90m the toe of the beach has accreted by 0.4m, burying the previously exposed rocks at chainage 97m to 102m.The upper beach is at a medium level compared to the range recorded from previous surveys, whilst the lower beach is the highest on record. **1bSNS12** to **1bSNS36** are located along the undefended cliffs between Grangetown and Ryhope Dene. Profiles **SNS12** to **SNS19** are between the end of the Hendon sea wall and Salterfen Rocks. Cliff top levels are typically between 20m and 22mOD. They are highest along the profiles further north, dropping in the centre and then increasing again to the south. Profile **1bSNS12** extends from the cliff across the boulder foreshore. There are apparent changes in the cliff in the survey profile, but this is likely to be a data artefact due to interpolation between limited data points and inaccessibility of the cliff toe due to unsafe conditions. There has been accretion of up to 0.4m across the full beach profile, making this the highest profile on record. At profile **1bSNS13**, the majority of the cliff face has not changed in form since the previous survey. There has been accretion across the profile of up to 0.8m, covering up the rock platform previously exposed in the October 2016 survey. The beach profile is the highest on record. At profile **1bSNS14**, the cliff top appears to have retreated by around 2m since the previous survey, which is supported by the survey photos. The cliff top has retreated 5m since 2009.There has been slight accretion on the upper beach of less than 0.2. Between chainage 60m and 85m there has been erosion of up to 0.3m. The rock platform has become exposed from chainage 75m and continues to chainage 102m. Seawards of the exposed rock platform there has been accretion of up to 0.4m,	**Longer term trends:** Along the length of south Hendon, beach levels are generally at a medium level throughout. At Grangetown (south Hendon to Salterfen Rocks), the cliff top position has not changed substantially compared to the last survey, but since 2009 the cliff tops have receded several metres at some locations. Despite the most recent survey periods showing limited change at the cliff top, there has been erosion of the talus deposits at the cliff toe, indicating that the in-situ bedrock will once again be exposed to wave action and therefore more liable to undercutting and subsequent cliff retreat. Between Salterfen Rocks and the landfill at Halliwell banks (profiles 1bSNS20 to 1bSNS25), the cliff has generally remained stable and beach levels are relatively low-medium in the north and medium-high in the south. At the landfill site (profiles 1bSSN26 to 1bSSN32), the cliff position and beach levels are within the bounds of previous surveys. To the south of Halliwell Banks, at profiles 1bSNS33 and 1bSNS35, cliff and beach are within the bounds of previous surveys.

Survey Date	Description of Changes Since Last Survey	Interpretation
	covering up previously exposed rock. The upper beach is at a relatively low level compared to the range recorded from previous surveys, whilst the lower beach is the highest on record. At profile **1bSNS15**, the cliff has remained stable since the previous survey. The cliff top has receded c.6m in total since 2009. Beach levels have increased by up to 0.3m between the cliff toe and chainage 65m. There has been slight erosion of up to 0.2m between chainage 65m and 90m exposing the rock platform approximately 5m further up the beach. Seawards of the rock platform at chainage 130m there has been accretion of up to 0.5m. The beach is at a low-medium level compared to earlier surveys on the upper beach, but a high-level seawards of the rock outcrops. At profile **1bSNS16**, the cliff toe has appeared to recede by approximately 1.5m since the October 2016 survey but there have been no discernible changes to beach levels since the last survey (autumn 2016). The cliff top has receded approximately 6m since 2009 but the cliff toe has only receded around 3m over the same period. Survey photos indicate this may be to do with the variable erosivity of the sandy upper cliff and more clay rich (glacial till) lower cliff. Profiles **1bSNS17** to **1bSNS36** extend between Salterfen Rocks and Ryhope Dean/Pincushion Rocks along Shirley Banks and Halliwell Banks. Profiles between 1bSNS17 and 1bSNS25 typically exhibit a characteristic cliff height of between 23m and 29mOD, with beaches at the toe typically at levels between 3.1m and 4.6mOD. At **1bSNS17**, there are no discernible changes in the profile since the previous October 2016 survey. At **1bSNS18**, the profile shows the beach levels from the toe of the cliff to chainage 54m have dropped by up to 0.4m. The middle beach between chainage 54m and 69m has seen very little change, ±0.1m. Seawards of chainage 69m there has been erosion of up to 0.4m exposing the underlying rocky outcrops. Overall the profile is the lowest on record, compared to the range recorded from previous surveys. There has been no change in the cliff top position since surveys began. At **1bSNS19**, the cliff toe appears to have advanced by around 1m, which may relate to the formation of a talus or access problems. The rocky foreshore remains unchanged. The cliff top has receded 0.5m since 2009. At profile **1bSNS20**, there have been no changes to the cliff since the April 2017 survey. The cliff top has receded around 1m since 2009. The pebble berm between chainage 45m and 55m noted in the March 2016 survey, which was no longer present in the April 2017 survey, has recovered slightly by	

Survey Date	Description of Changes Since Last Survey	Interpretation
	up to 0.3m. Between chainage 52m and 75m there has been slight erosion of less than 0.2m. Overall the changes are minor and within the range of beach levels seen in previous surveys, though the beach is at a low-medium level. At **1bSNS21**, there has been no change in the position of the cliff since the last survey. There has been accretion of 0.2m at the toe of the cliff to chainage 52m.There has been a reduction in beach levels of up to 0.3m between chainage 52m and 72m, exposing boulders which had previously been covered by a veneer of sand in the autumn 2016 survey. There has been accretion of up to 0.5m between chainage 72m and 130m, covering up most of the previously exposed rock platform (except for between chainage 103m to 105m). The toe of the beach seawards of chainage 130m shows minor erosion of 0.1m. Overall the profile is at a medium level compared to the range recorded from previous surveys with the exception of chainage 55m to 72m which is the lowest on record. At profile **1bSNS22**, the cliff has generally remained stable since the last survey. Low points between more prominent parts of the shore platform have lost their sand infills by 0.2m, and there has been an accumulation of 0.3m of sand between chainage 110m and 122m; otherwise, the shore platform remains unchanged. Overall the profile is at a low level compared to the range recorded from previous surveys, except for the sand accumulation in the lower foreshore which is relatively high. At profile **1bSNS23**, there has been no change in cliff position since the last survey. There has been erosion of up to 0.4m between chainage 55m and 85m, exposing around 20m more of the boulders and rock platform. There has been negligible change on the lower beach. The upper beach is the lowest on record, whilst the lower beach is at a high level compared to the earlier surveys. At **1bSNS24**, the cliff top has retreated by around 1m, but the toe has also extended by around 1m since the previous survey. There has been accretion of up to 0.4m across the beach profile. Overall the profile is at a medium-high level compared to the range recorded from previous surveys. At profile **1bSNS25**, there has been no change to the cliff face. There has been minor erosion on the upper beach of up to 0.2m. From chainage 80m seawards the beach has accreted; minor accretion of up to 0.2m to chainage 105m (though the rock remains exposed), with more significant accretion of up to 0.8m from chainage 105m to 135m, reducing to 0.2m over the lower foreshore. The upper beach is at a medium level compared to the range recorded from previous surveys, whilst the lower foreshore is at the highest recorded level.	

Survey Date	Description of Changes Since Last Survey	Interpretation
	Profiles **1bSNS26** to **1bSNS32** are located at Halliwell Banks specifically to assess risks from erosion at a former land fill. Cliff height is between 26m and 27mOD, with beaches at the toe typically at levels between 3.3m and 3.9mODN. Profiles **1bSNS26** to **1bSNS32** have all behaved in a similar way. The top of the cliff shows no movement in all the profiles. However, the cliff toe shows variable movement from receding by around 1m to advancing by around 2m; this reflects the ongoing erosional processes. All of the profiles show erosion of 0.2-0.4m on the upper beach, but accretion of around 0.3m on the mid and lower beach. Overall, the profiles are at a medium level compared to the range recorded from previous surveys, though the lower foreshore tends to be more of a relatively high level. Profiles **1bSNS33** to **1bSNS36** are located around the Pincushion Headland. At profile 1bSNS33, the cliffs have generally retained the same form and position since the last survey. There has been very little change on the upper beach to chainage 80m. Between chainage 80m and 115m there has been erosion of 0.2m. Seawards of chainage 115m there has been accretion of up to 0.4m across the lower foreshore. Overall, the profile is at a medium level compared to the range recorded from previous surveys, although the toe is relatively high. Profiles **1bSNS34** has changed little since the previous survey. Profile **1bSNS35** shows around 0.5m advance of the cliff toe, with an accumulation of up to 0.8m of material at the toe of the cliff. The majority of the beach (chainage 45m to 115m shows no discernible change. However, there has been some sand accumulation of up to 0.4m on the lower foreshore between 115m and 130m, and seawards of chainage 135m, covering the previously exposed rock platform. The upper beach is at a relatively low level compared to the range recorded from previous surveys, whilst the lower beach is at a more medium level. Profile **1bSNS36** also shows around 0.5m advance of the cliff toe, with an accumulation of up to 0.4m of material at the toe of the cliff. The upper beach shows erosion of 0.4m. Between chainage 72m and 150m the exposed rock platform remains unchanged. Seawards of chainage 150m there has been an accumulation of up to 0.4m of sand covering the previously exposed rock platform. The upper and lower beach are at a relatively high level compared to the range recorded from the previous surveys, the exposed rock platform in the middle beach is however at a relatively low level.	

Survey Date	Description of Changes Since Last Survey	Interpretation
November 2017	**Topographic Survey:** Hendon to Ryhope is covered by an annual topographic survey between the Hendon Sea Wall and Ryhope Dene, which commenced in autumn 2009. Data from the most recent topographic survey (Full Measures, autumn 2017) have been used to create a DGM (Appendix B – Map 2) using a GIS. A difference plot has also been produced using the DGM (Appendix B – Map 4) produced from the last produced topographic survey (Full Measures, autumn 2016) and the present survey. The survey is very patchy, with no discernible pattern. There are large areas of no change, and the accretion/erosion which is present is generally of low magnitude (±0.5m). There is roughly equal areas of accretion and erosion, with neither dominating.	The short-term change plot indicates that there has been some cross-shore movement of sediment but change has been limited (±0.5m).
4th November 2017	**Cliff Top Survey:** Cliff top survey data collected between the baseline survey (spring 2009) and the present Full Measures survey (autumn 2017) is documented here. 32 ground control points (numbered 1-32) were established along the cliff top between Hendon and Ryhope in March 2009, with a further three (28A, 28B and 28C) added in September 2009. Note: the numbering of ground control points is not intended to correlate with that of the beach profile lines. Measurements are taken from each ground control point along a fixed bearing to the edge of the cliff top. These cliff top surveys are undertaken bi-annually and are intended to inform on erosion rates of the sea cliffs extending from the defended industrial areas at Hendon southwards along the undefended cliffs to Ryhope Dene. Appendix C – Table C1 provides results from the cliff top survey, showing the position from the ground control point to the edge of the cliff top along a defined bearing. Results show that since the Partial Measures (April 2017) survey apparent erosion greater than the error has only occurred at one location, GCP24, where a loss of 0.35m is recorded. Since surveys began in March 2009 (or September 2009 for 28A, 28B, and 28C) erosion greater than the survey error has occurred at around 74% of the ground control points, where total losses are 11.15m (at location 27) at their greatest, and more typically less than 5m. The long-term erosion rates are up to 1.4m/yr. (location 27), with up to 0.7m/yr. being more typical.	The cliffs have remained stable over the most recent survey period across the majority of the survey points, with the exception of GCP 24 which shows 0.35m of recession. **Longer term trends:** The data indicate that the fastest erosion since 2009 is concentrated in three broad sections; a) the northern part of the developing embayment between the southern extent of the sea defences and Salterfen Rocks, b) throughout the majority of Halliwell Banks and c) to the south of Pincushion rocks. Recession is least, as might be expected, along the defended sections and at the promontories of Salterfen Rocks and Pincushion Rocks.

4. Problems Encountered and Uncertainty in Analysis

Individual Profiles

The survey report notes that the cliff top of profile 1bSNS11 was inaccessible due to slippery and unsafe conditions, and that the cliff base of profile 1bSNS12 was inaccessible due to slippery unsafe rocks and falling debris.

Topographic Survey

The southern part of the beach in Whitburn Bay was being graded at the time of survey on the 7th November 2017.

Cliff Top Surveys

n/a

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

It is recommended that profiles 1bSNC1 and 1bSNC3 are removed from the programme as they do not cover any beach and they are not analysed within the Full Measures reporting.

6. Conclusions and Areas of Concern

- At Whitburn Bay, the recorded profiles and topographic survey present no causes for concern.
- At Sunderland Harbour and Docks, the recorded profiles present no causes for concern.
- At Hendon to Ryhope (incl. Halliwell Banks), the recorded profiles, topographic survey and clifftop survey present no causes for concern. Ongoing cliff erosion is of a similar magnitude to previous surveys.
- At Hendon to Ryhope (incl. Halliwell Banks), the greatest amount of erosion recorded to have taken place between March 2009 and November was 11.15m at Point 27 which is on the northern border of the landfill site. Since the last survey, the greatest erosion has been at Point 24 (three-quarters of the way between Salterfen Rocks and Halliwell Banks), where the cliff edge has receded 0.35m.

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

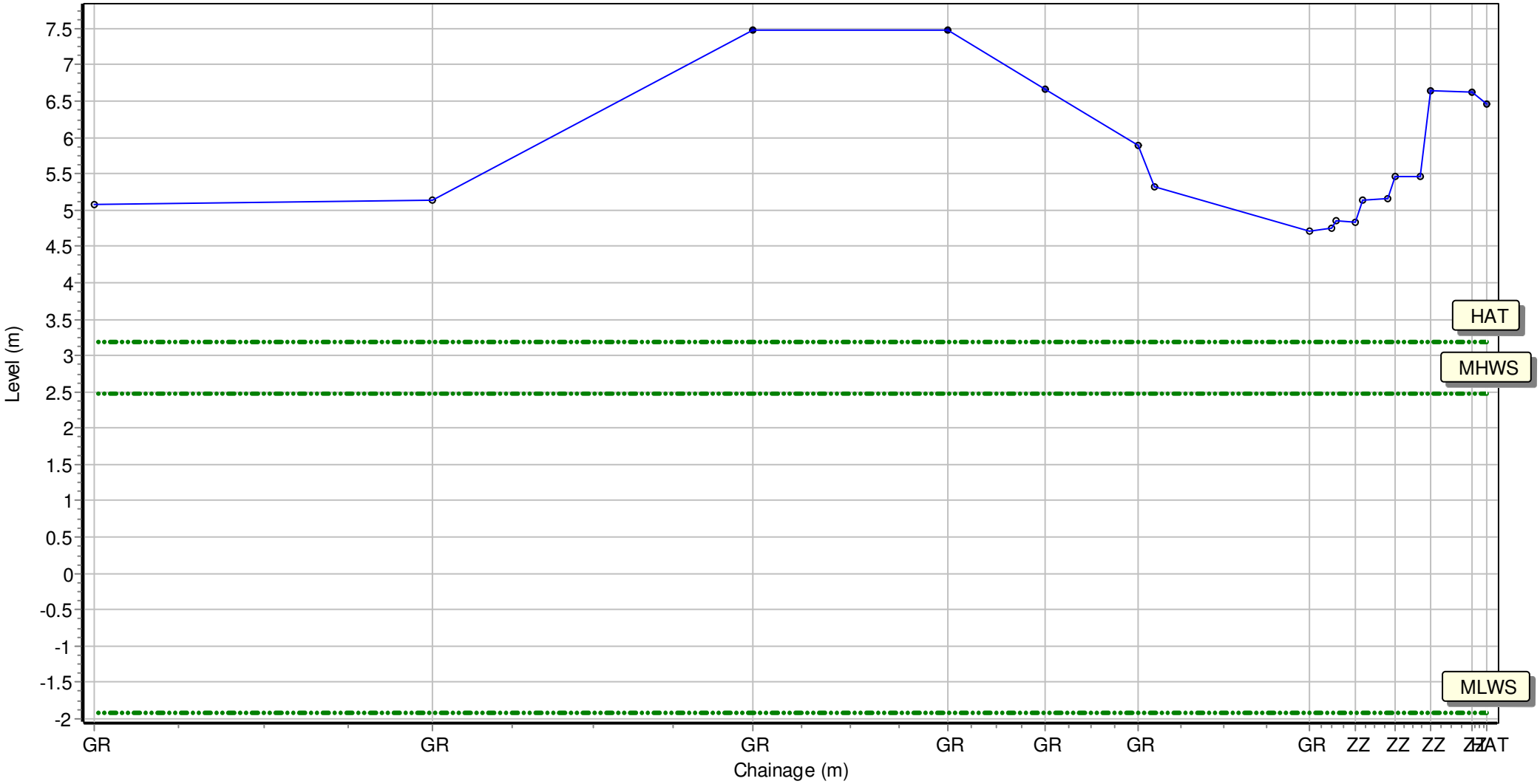
Location: **1bSNC1**

Date: 19/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441063.908 **Northing:** 558055.488 **Profile Bearing:** 87 ° from North



Beach Profile

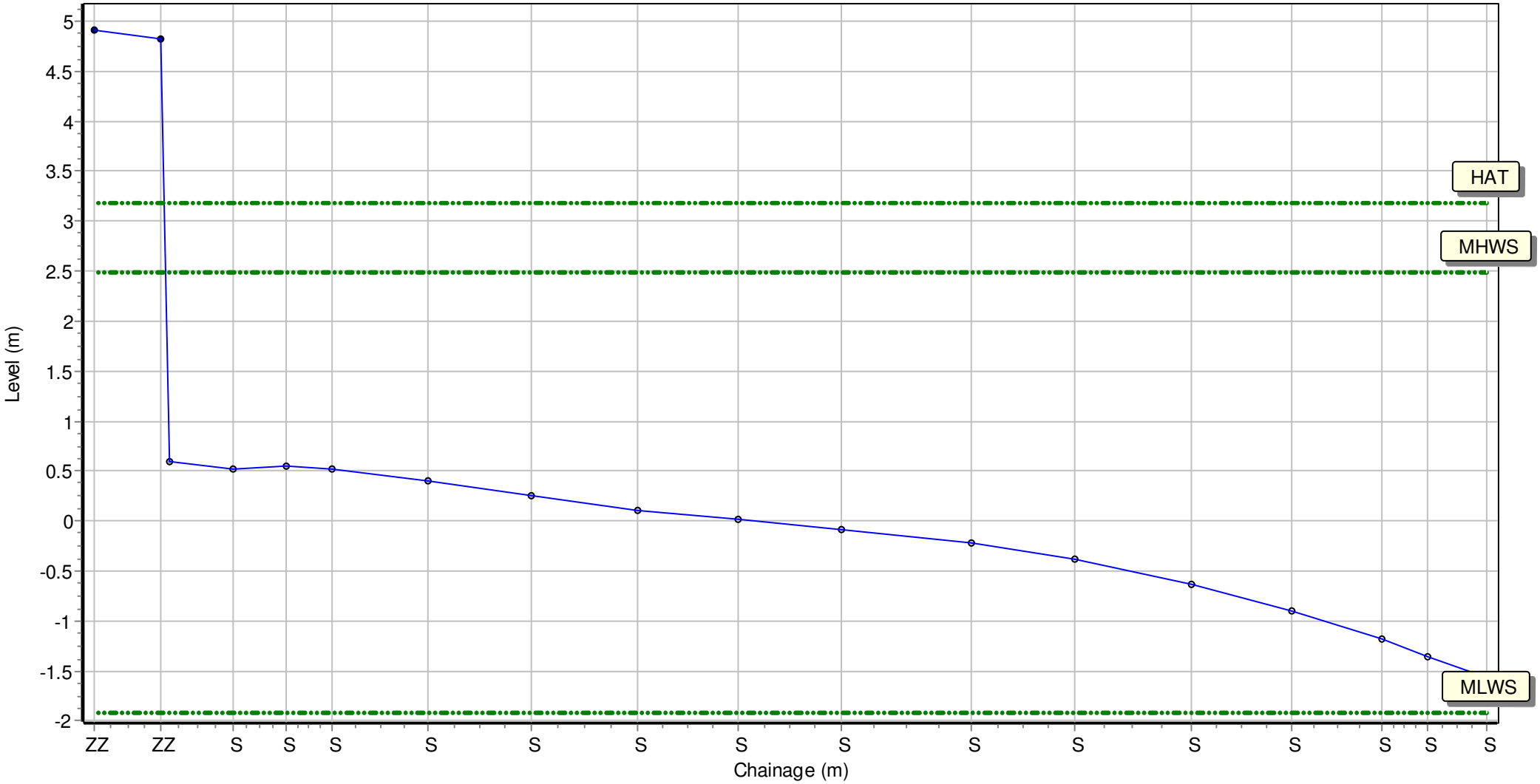
Location: **1bSNC2**

Date: 19/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441240.27 **Northing:** 557850.776 **Profile Bearing:** 349 ° from North



Beach Profile

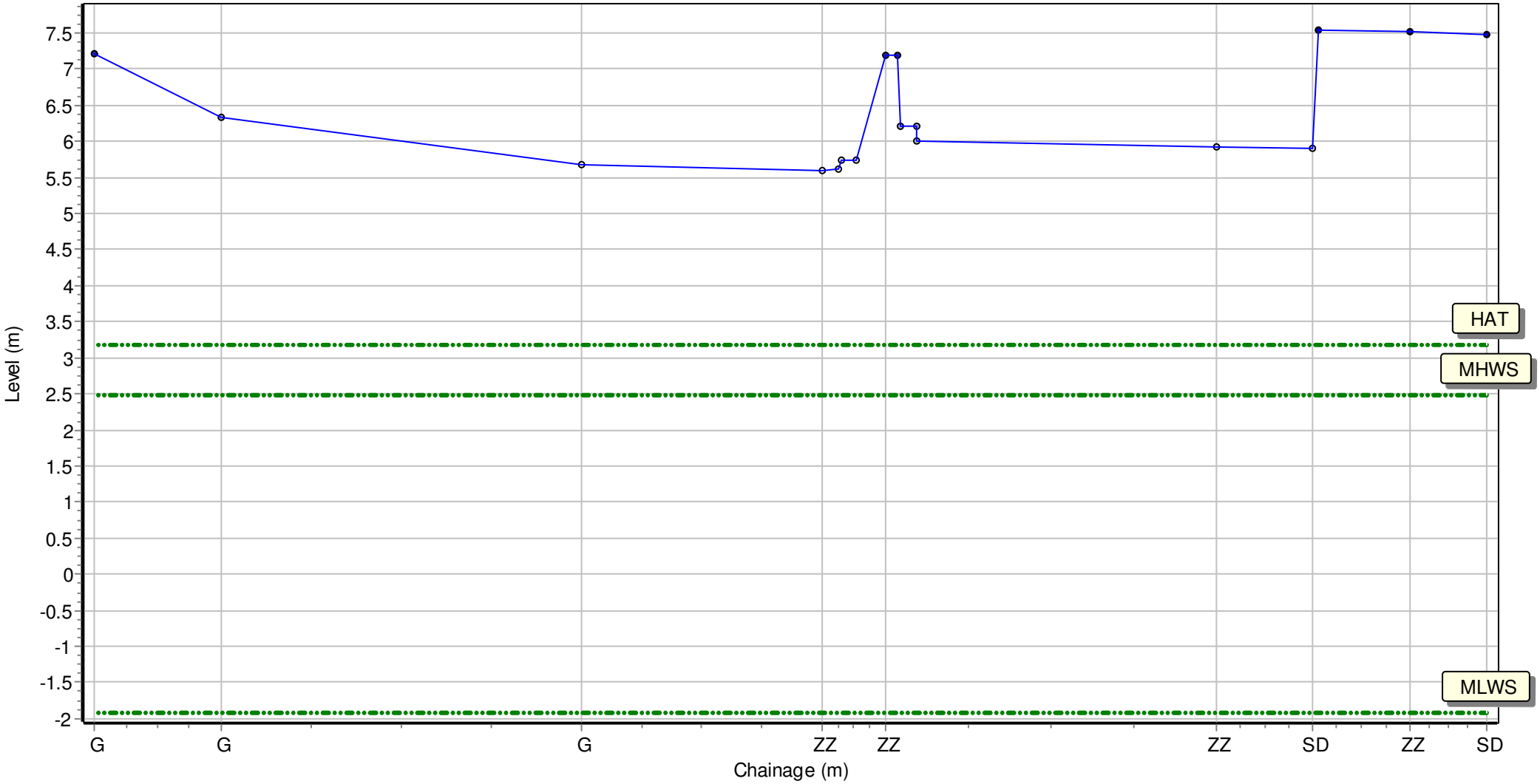
Location: **1bSNC3**

Date: 19/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441192.226 **Northing:** 557747.746 **Profile Bearing:** 70 ° from North



Beach Profile

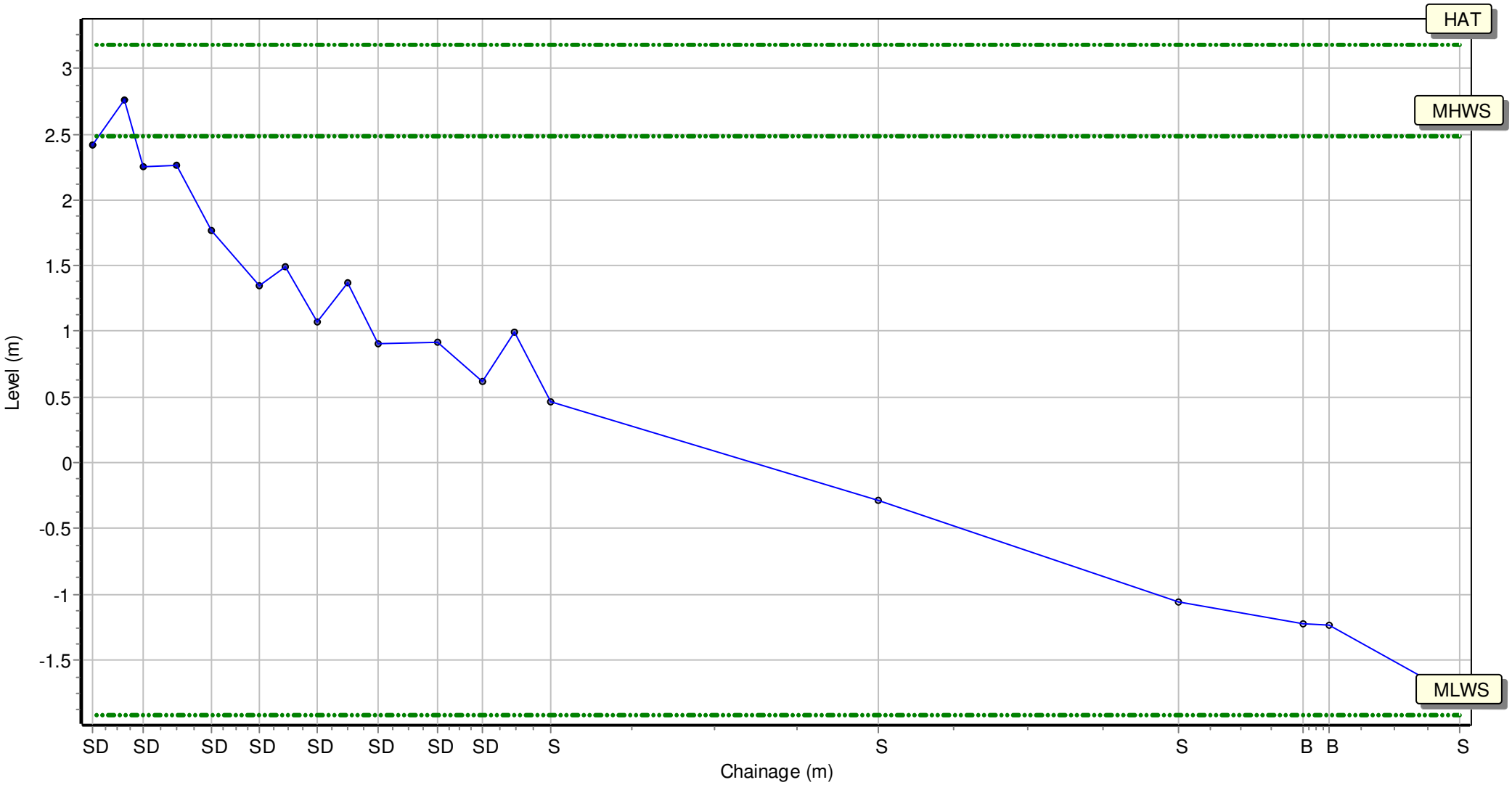
Location: **1bSNC4**

Date: 19/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441321.27 **Northing:** 557533.237 **Profile Bearing:** 45 ° from North



Beach Profile

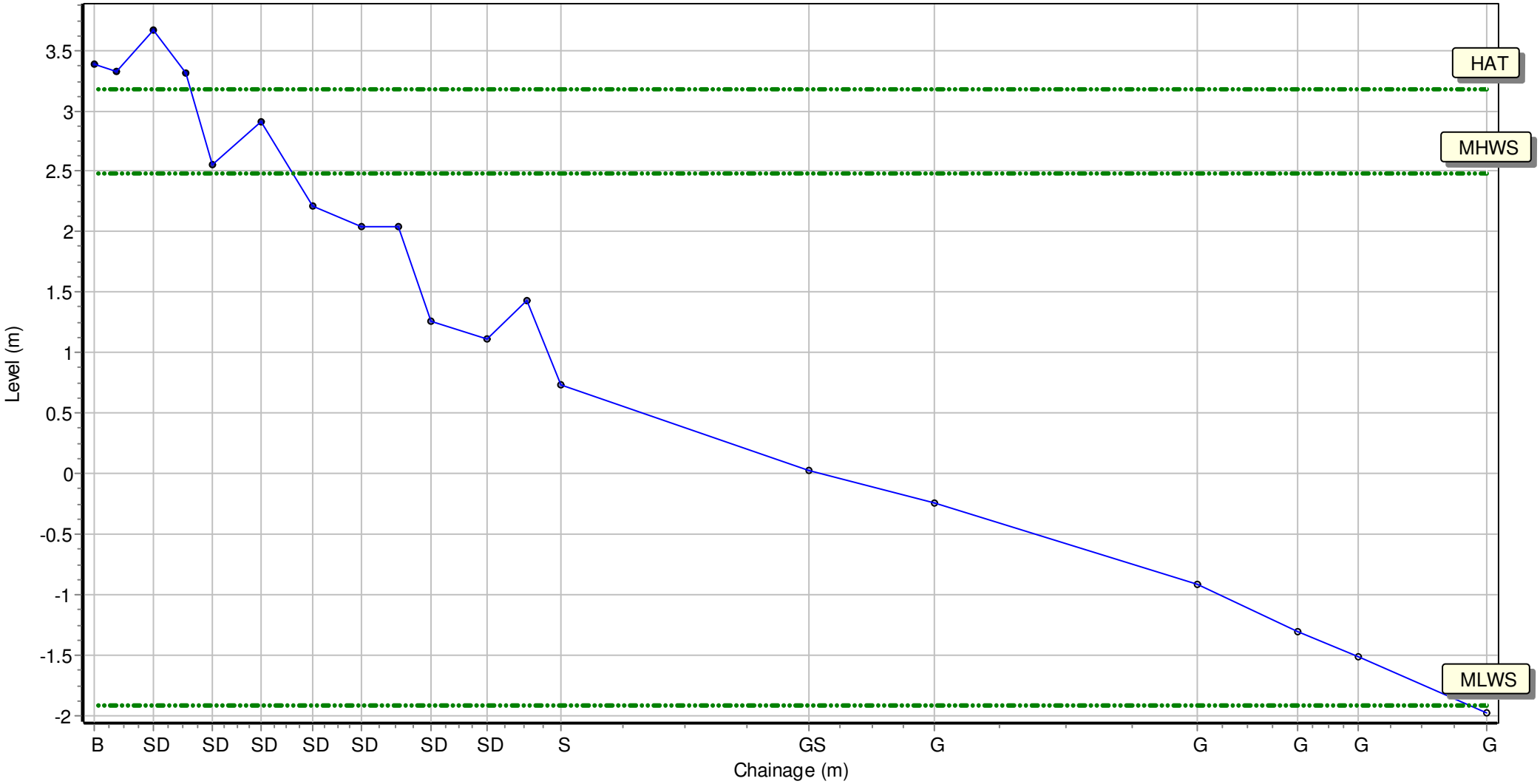
Location: **1bSNC5**

Date: 19/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441463.58 **Northing:** 557376.22 **Profile Bearing:** 58 ° from North



Beach Profile

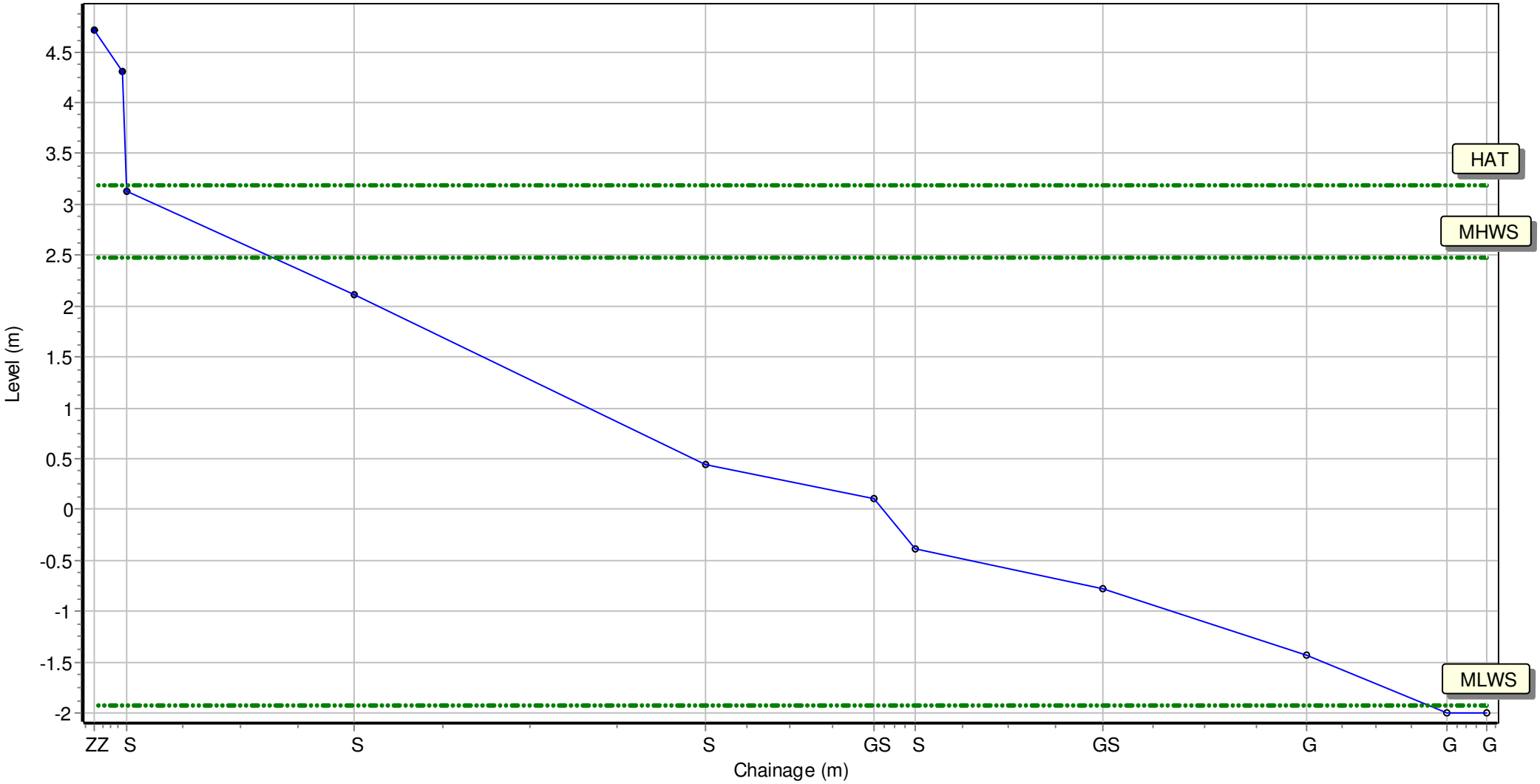
Location: **1bSNC6**

Date: 19/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441511.013 **Northing:** 557229.014 **Profile Bearing:** 88 ° from North



Beach Profile

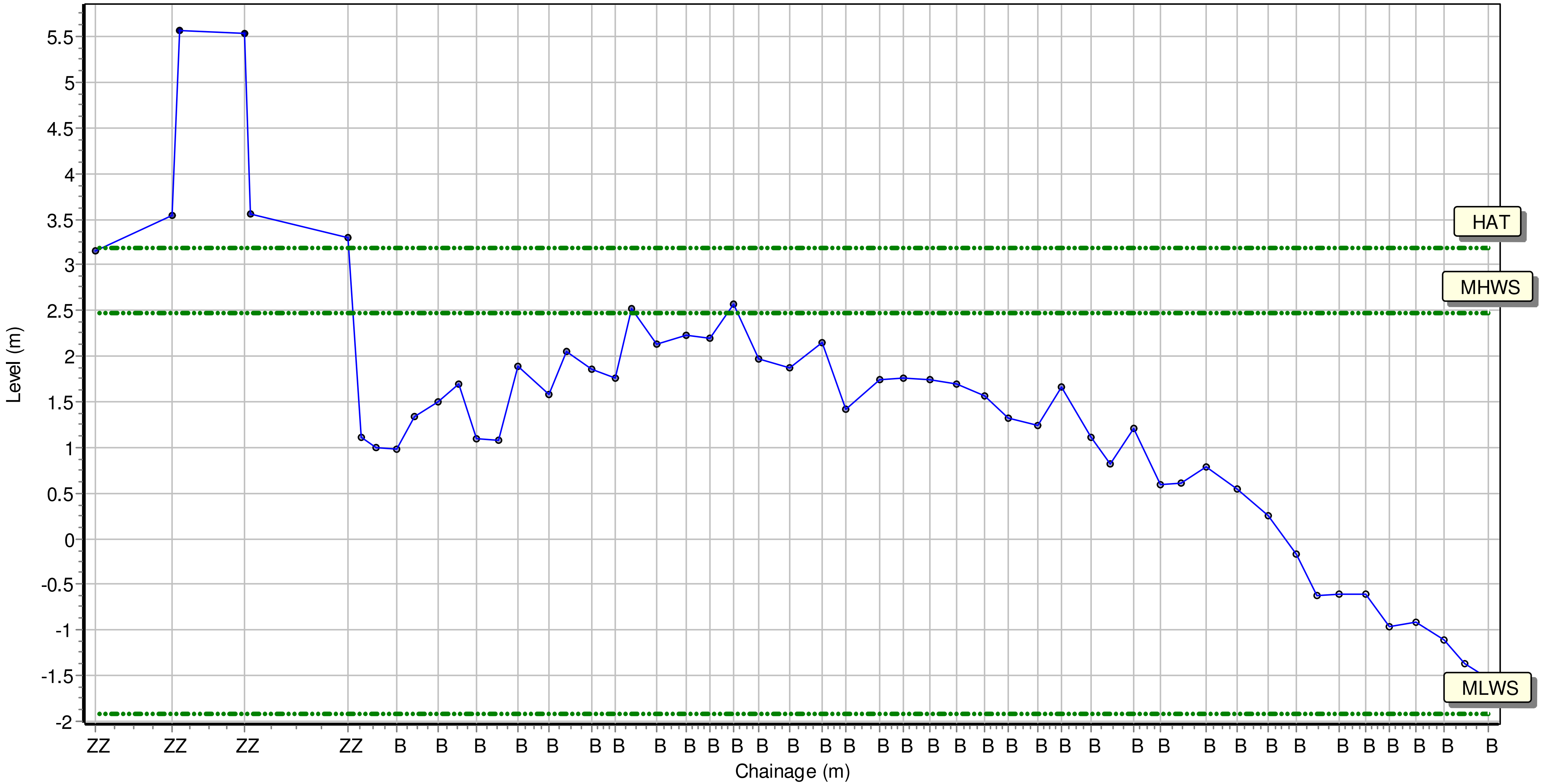
Location: **1bSNC7**

Date: 19/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441682.28 **Northing:** 557051.345 **Profile Bearing:** 230 ° from North



http://www.sandsuser.com

SANDS

Beach Profile

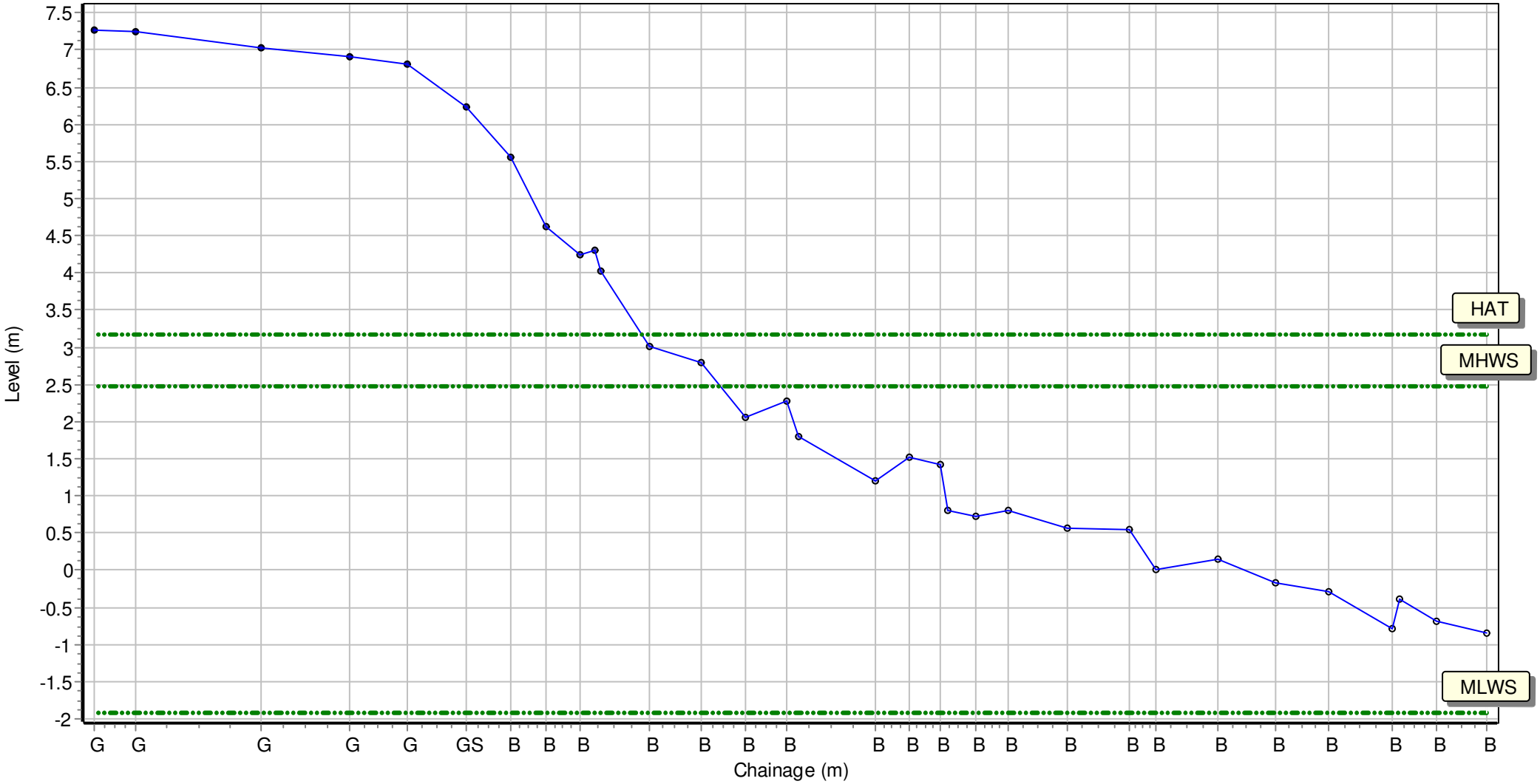
Location: **1bSNC8**

Date: 19/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441601.437 **Northing:** 557055.604 **Profile Bearing:** 183 ° from North



Beach Profile

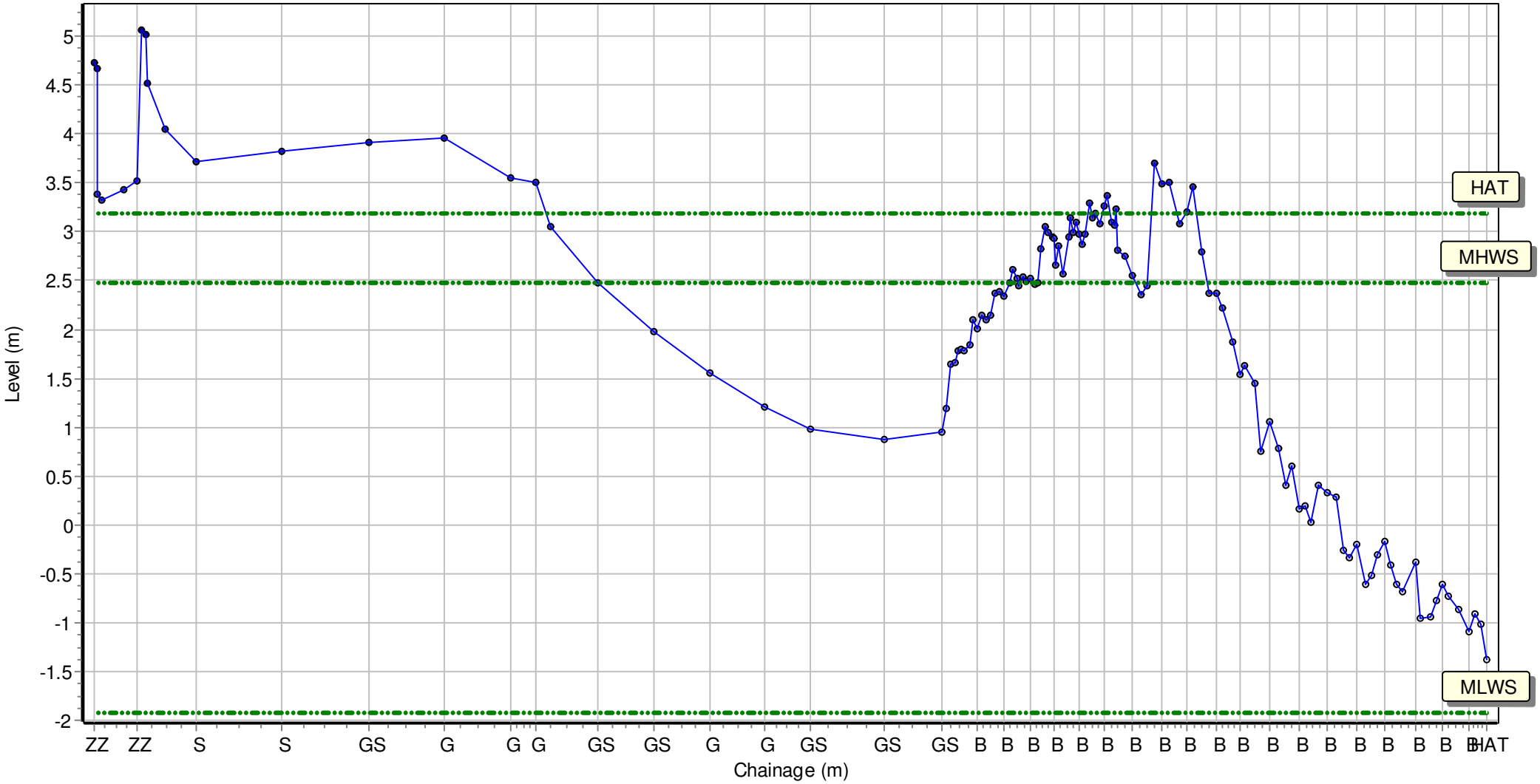
Location: **1bSNC9**

Date: 19/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441461.898 **Northing:** 556870.487 **Profile Bearing:** 70 ° from North



Beach Profile

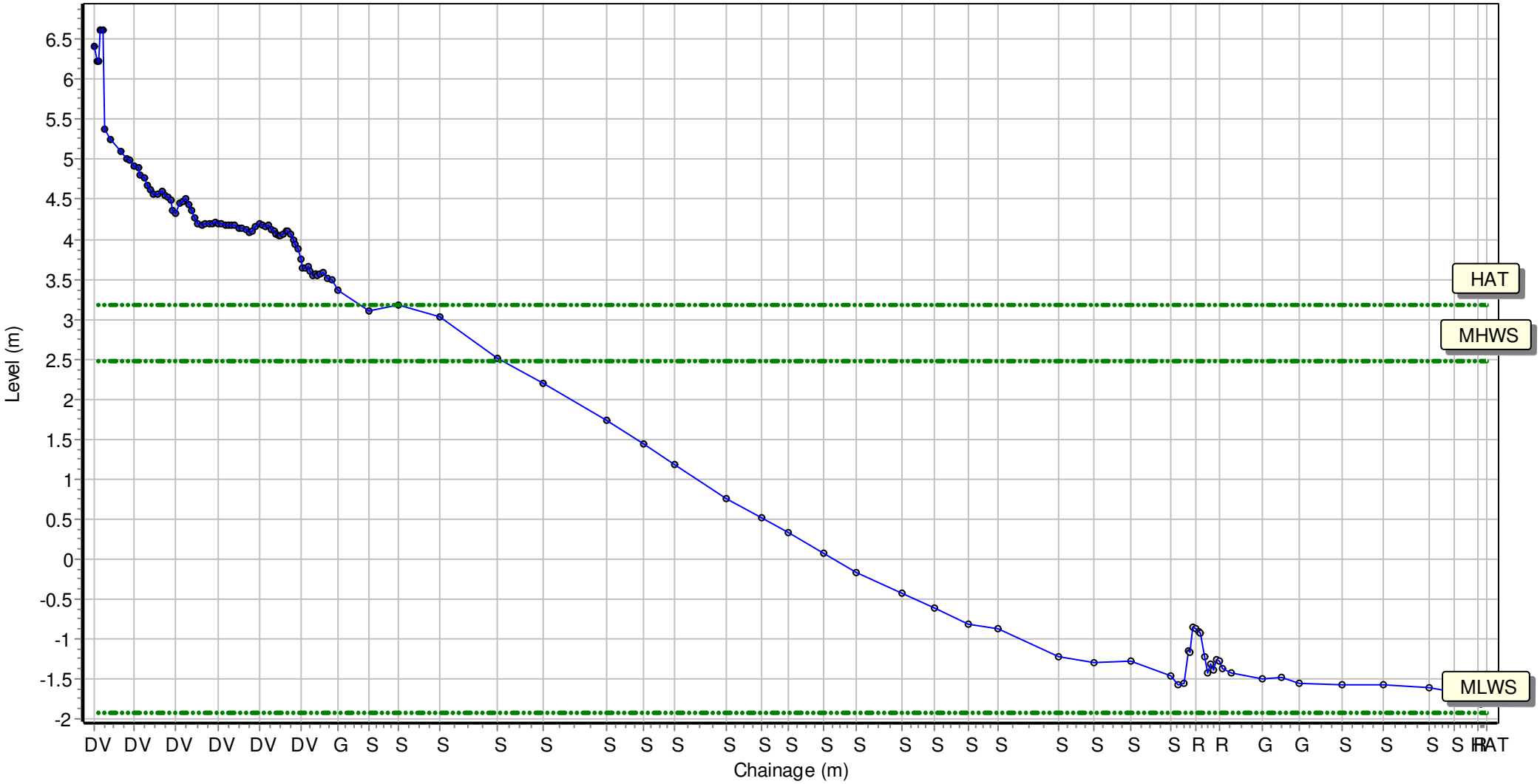
Location: **1bSNN1**

Date: 07/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 440797.428 **Northing:** 561231.249 **Profile Bearing:** 97 ° from North



Beach Profile

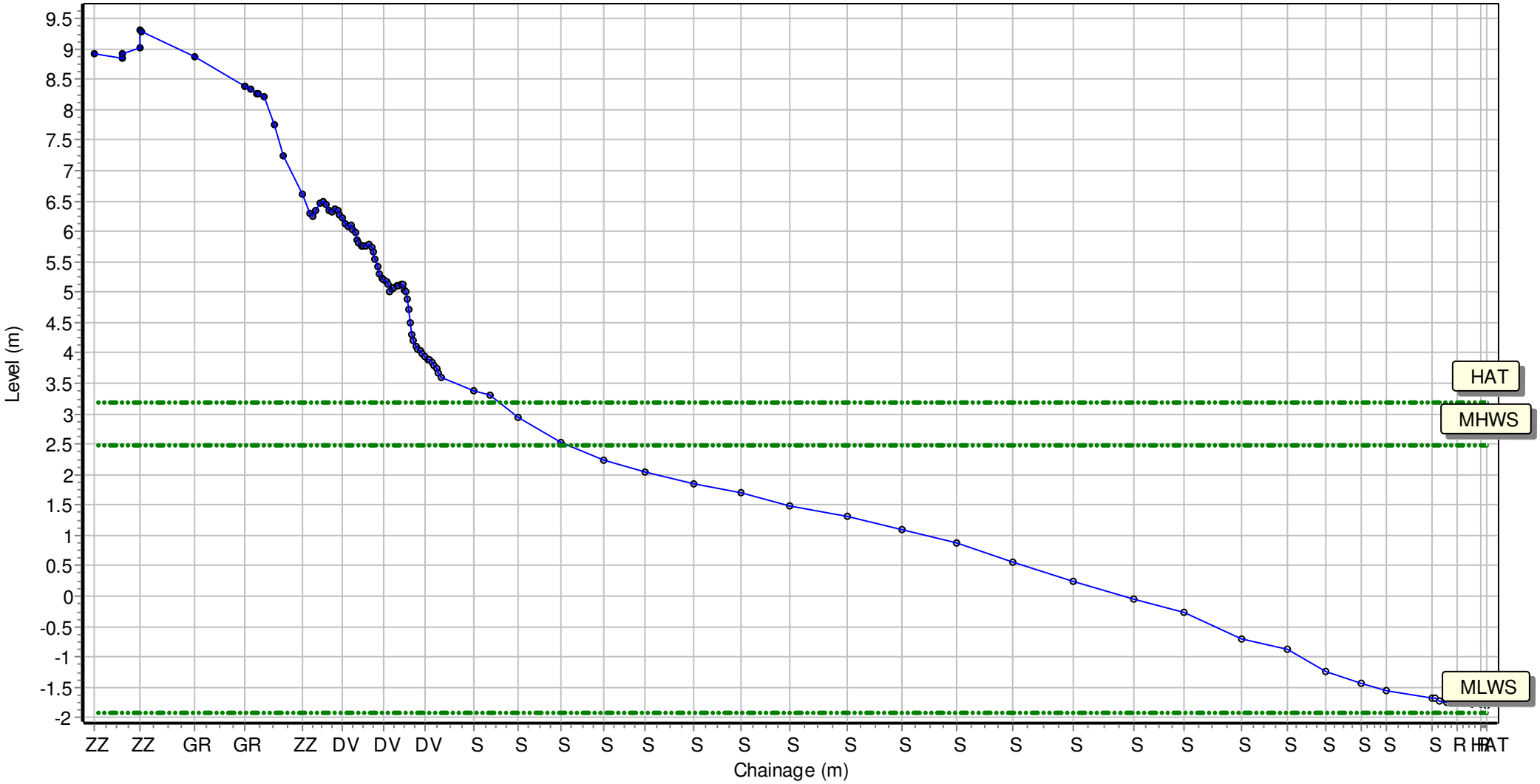
Location: **1bSNN2**

Date: 07/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 440704.168 **Northing:** 560981.14 **Profile Bearing:** 80 ° from North



Beach Profile

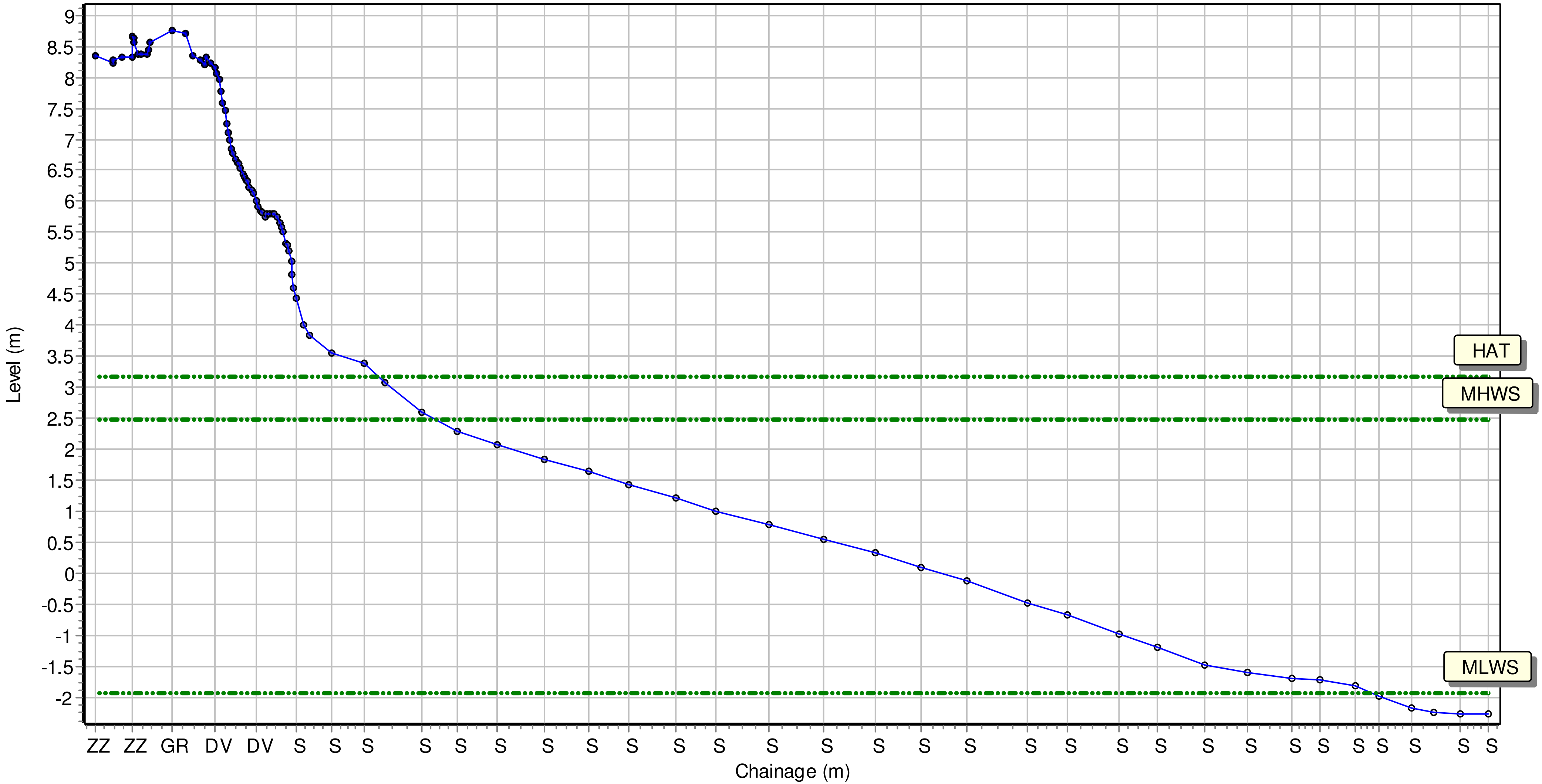
Location: 1bSNN3

Date: 07/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 440698.999 **Northing:** 560923.727 **Profile Bearing:** 112 ° from North



Beach Profile

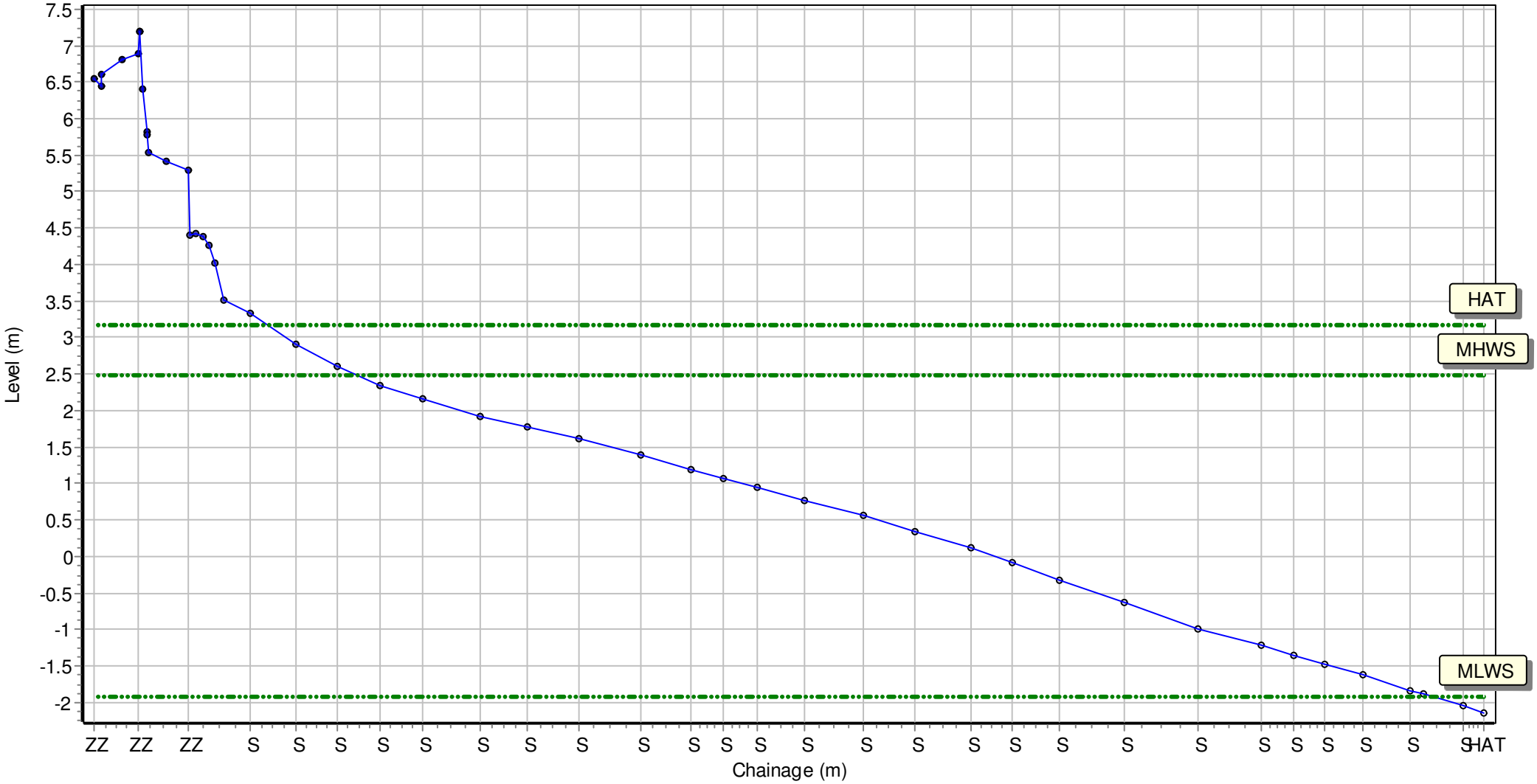
Location: **1bSNN4**

Date: 07/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 440637.004 **Northing:** 560702.72 **Profile Bearing:** 104 ° from North



Beach Profile

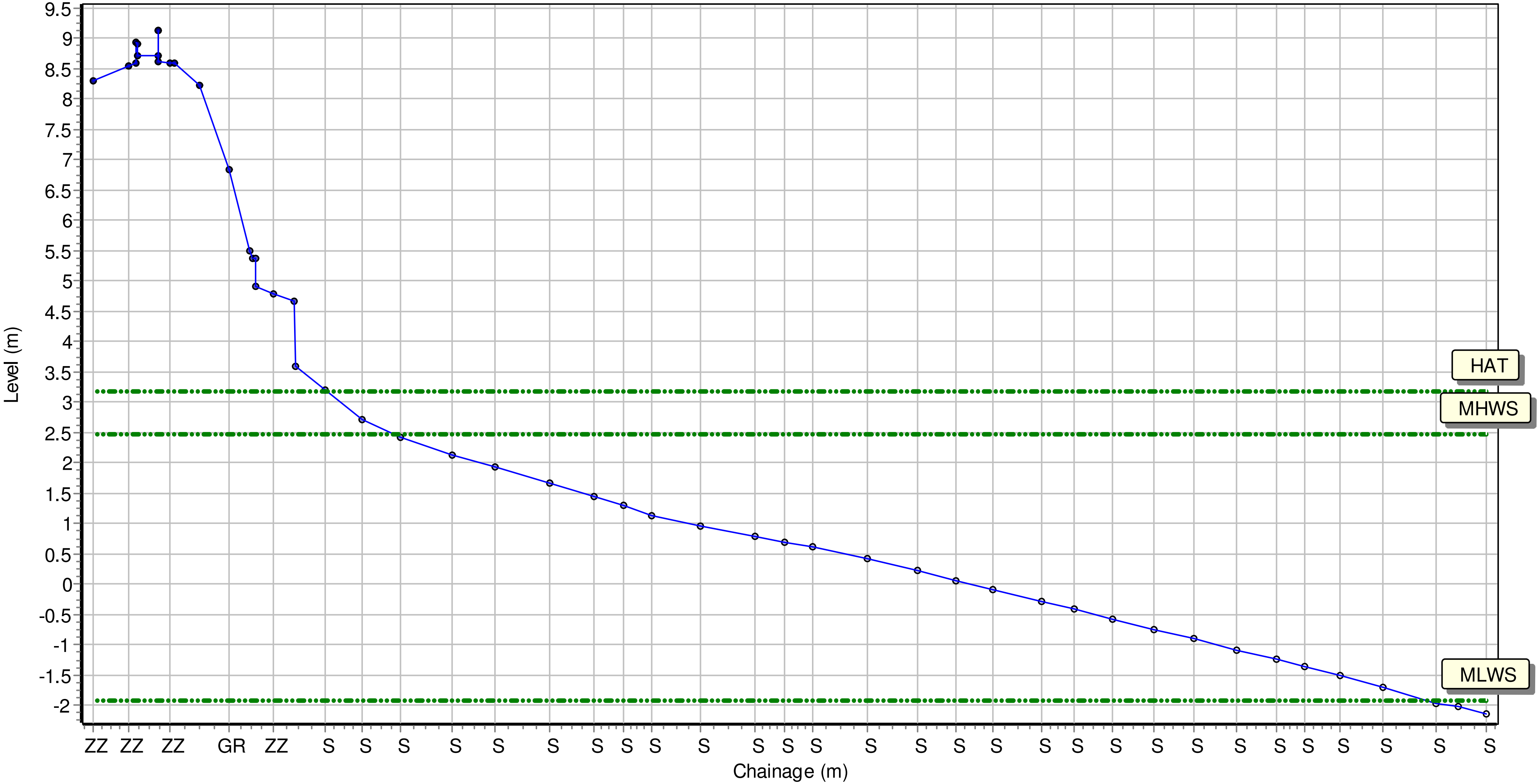
Location: 1bSNN5

Date: 07/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 440568.694 **Northing:** 560490.321 **Profile Bearing:** 103 ° from North



Beach Profile

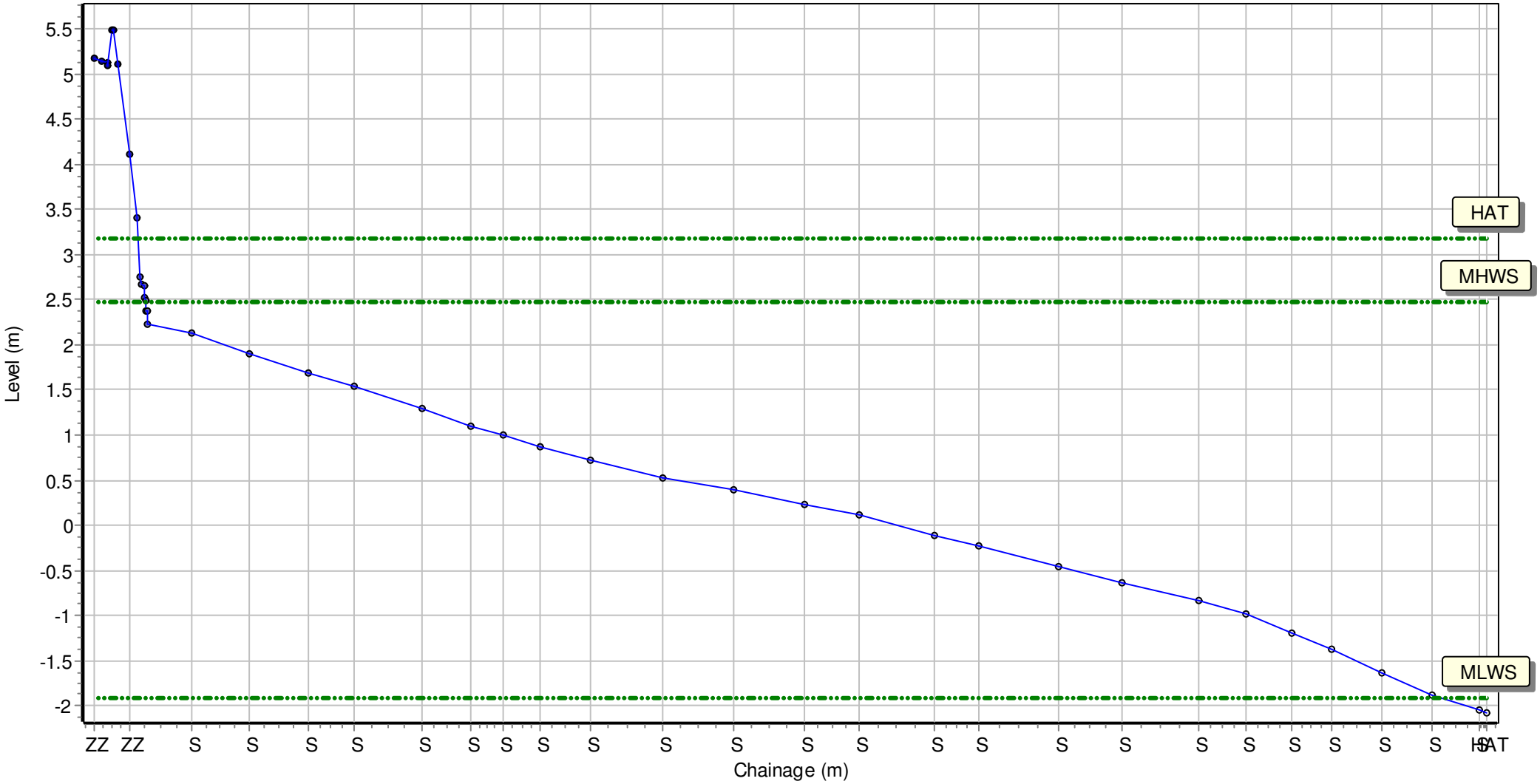
Location: **1bSNN6**

Date: 07/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 440586.486 **Northing:** 560206.172 **Profile Bearing:** 79 ° from North



Beach Profile

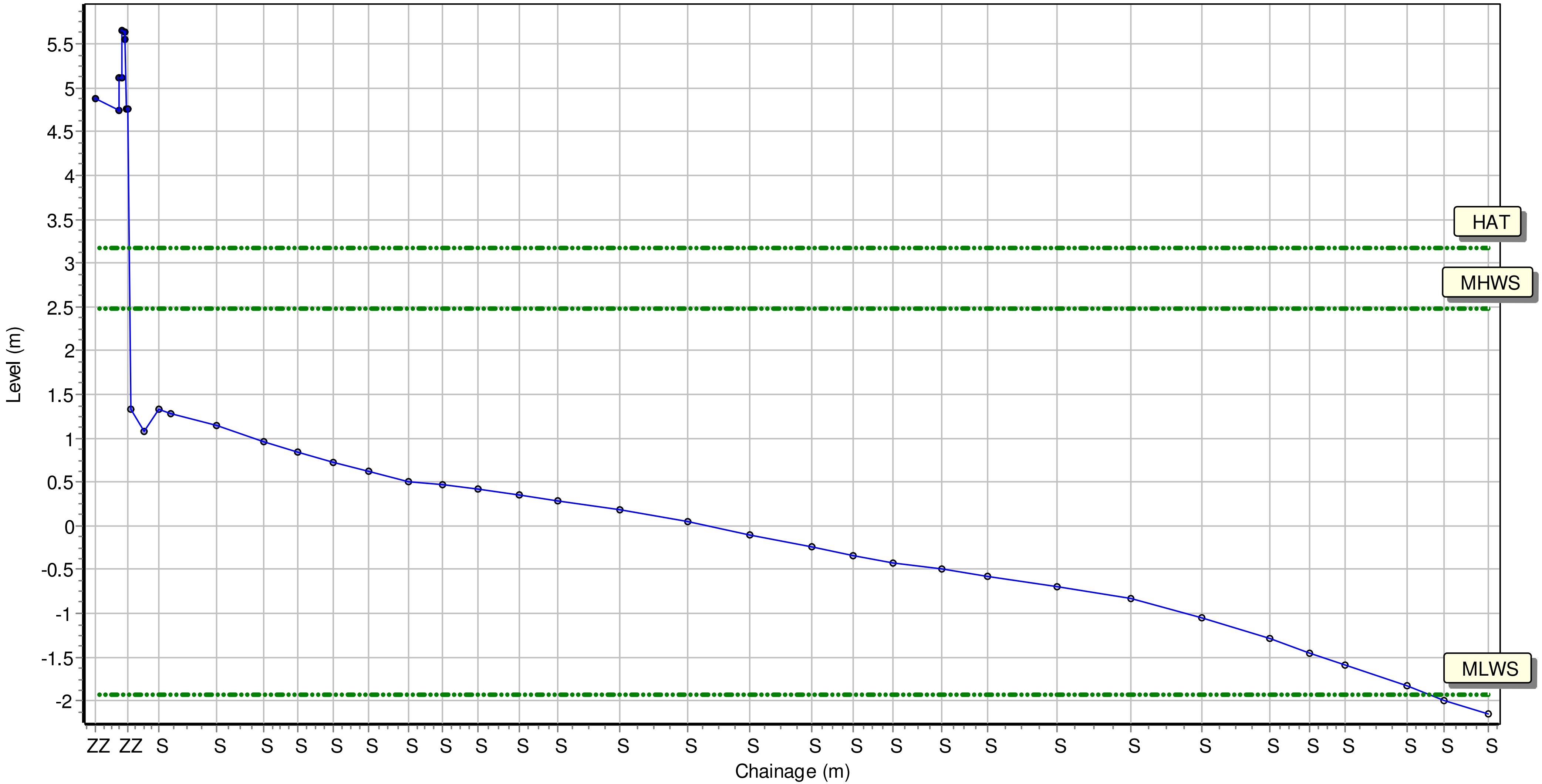
Location: 1bSNN7

Date: 07/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 440623.795 **Northing:** 560029.932 **Profile Bearing:** 81 ° from North



Beach Profile

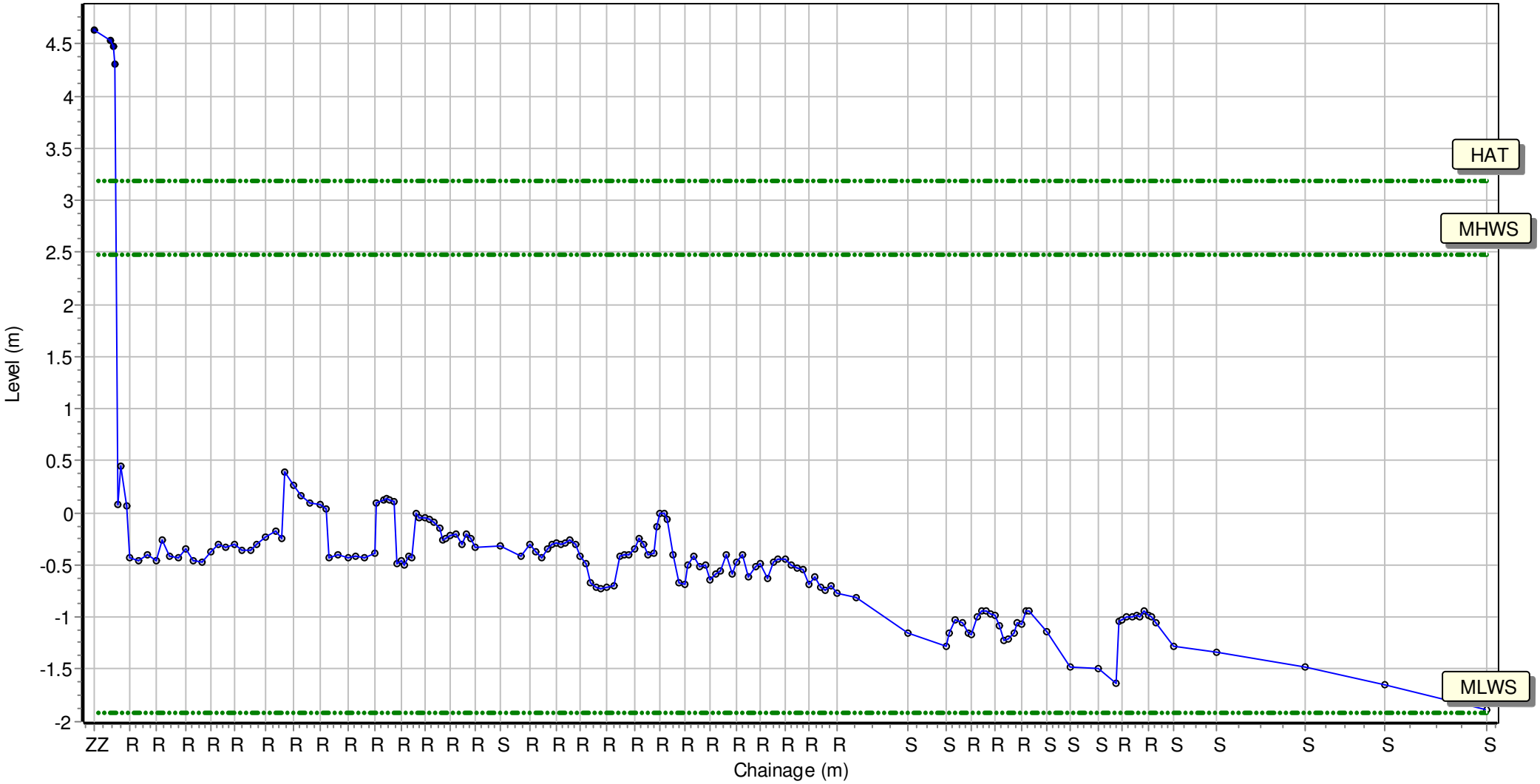
Location: **1bSNN8**

Date: 07/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 440761.57 **Northing:** 559730.278 **Profile Bearing:** 87 ° from North



Beach Profile

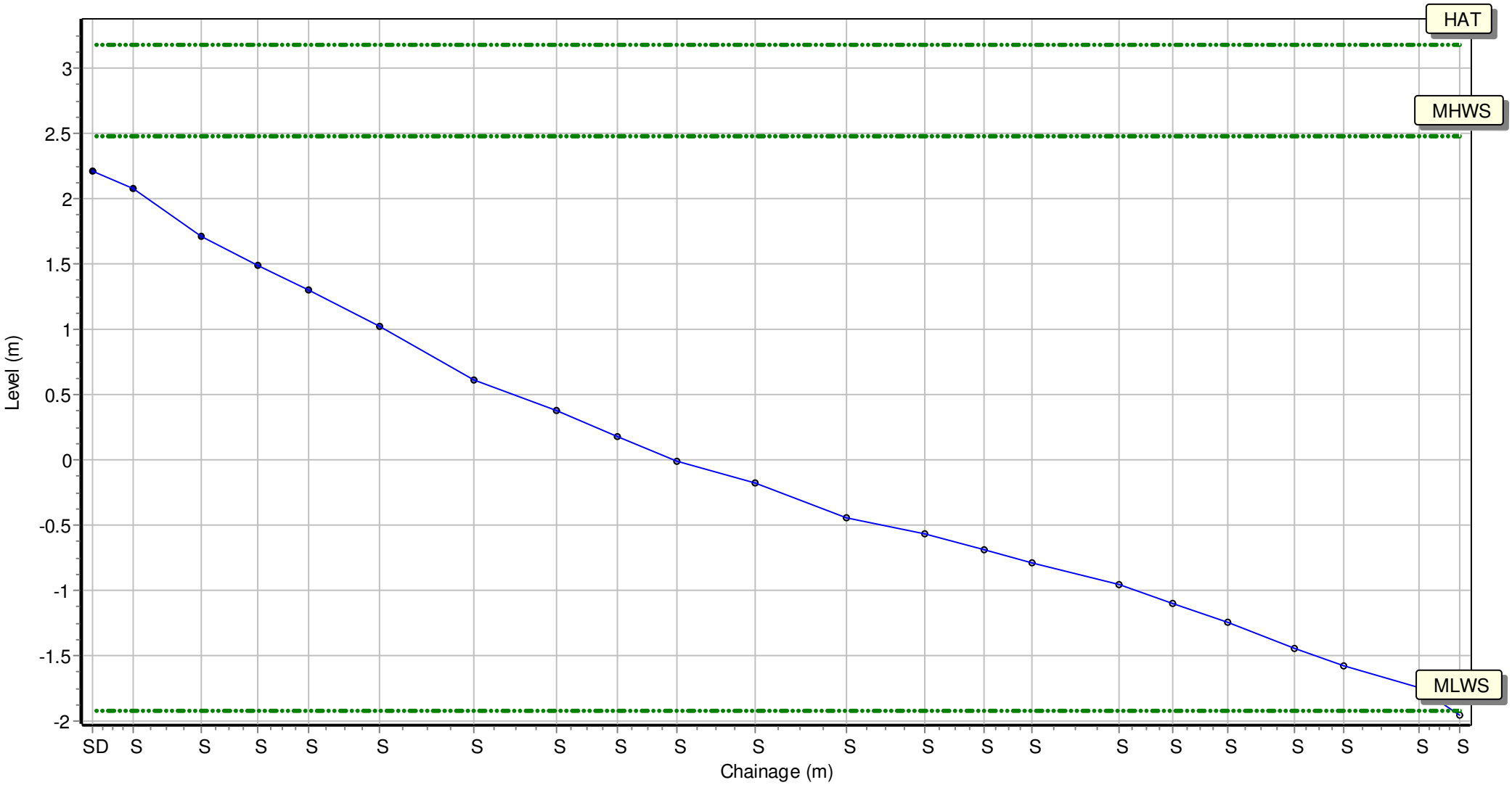
Location: **1bSNN9**

Date: 07/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 440680.051 **Northing:** 559381.258 **Profile Bearing:** 65 ° from North



Beach Profile

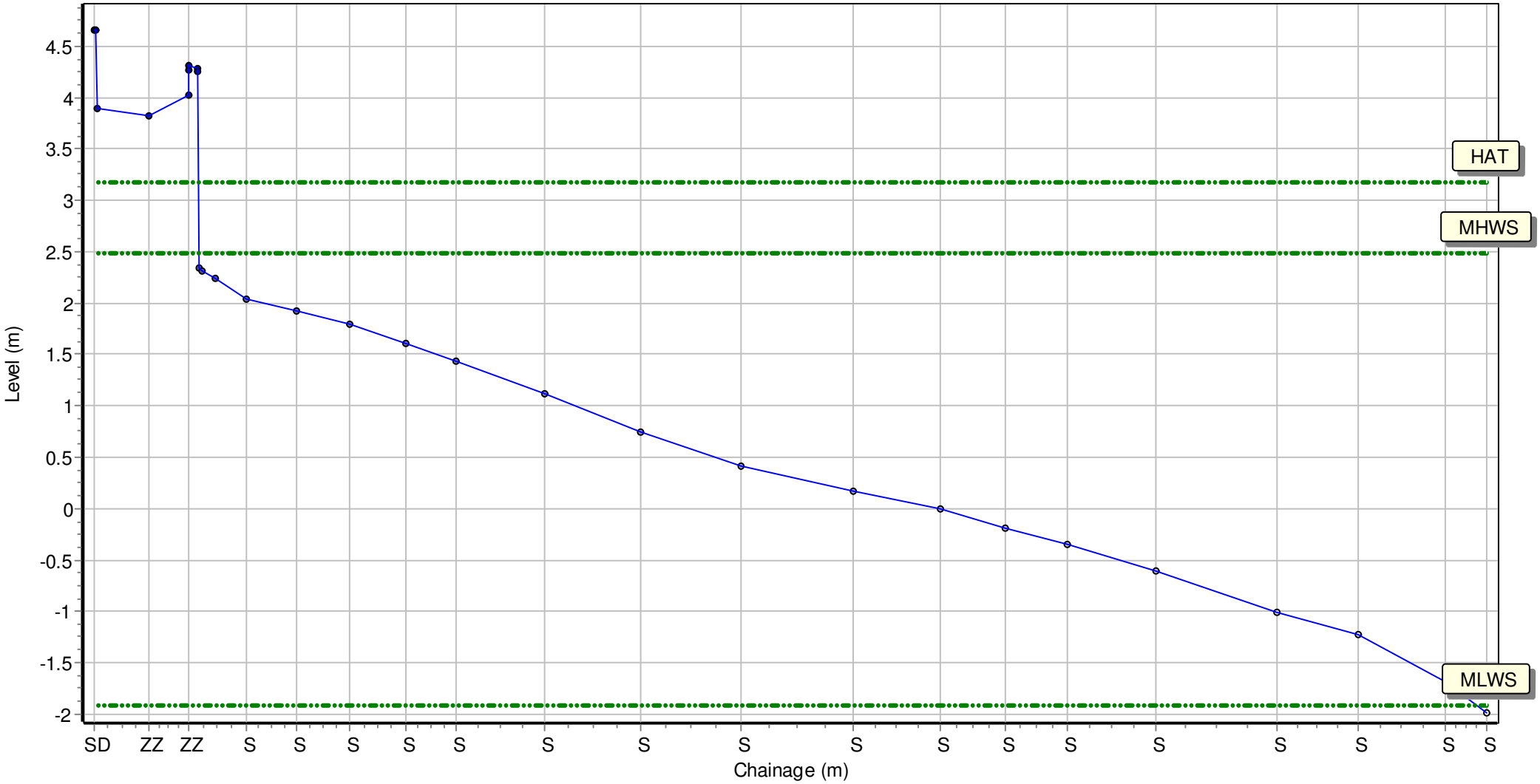
Location: **1bSNN10**

Date: 07/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 440728.714 **Northing:** 559193.372 **Profile Bearing:** 74 ° from North



Beach Profile

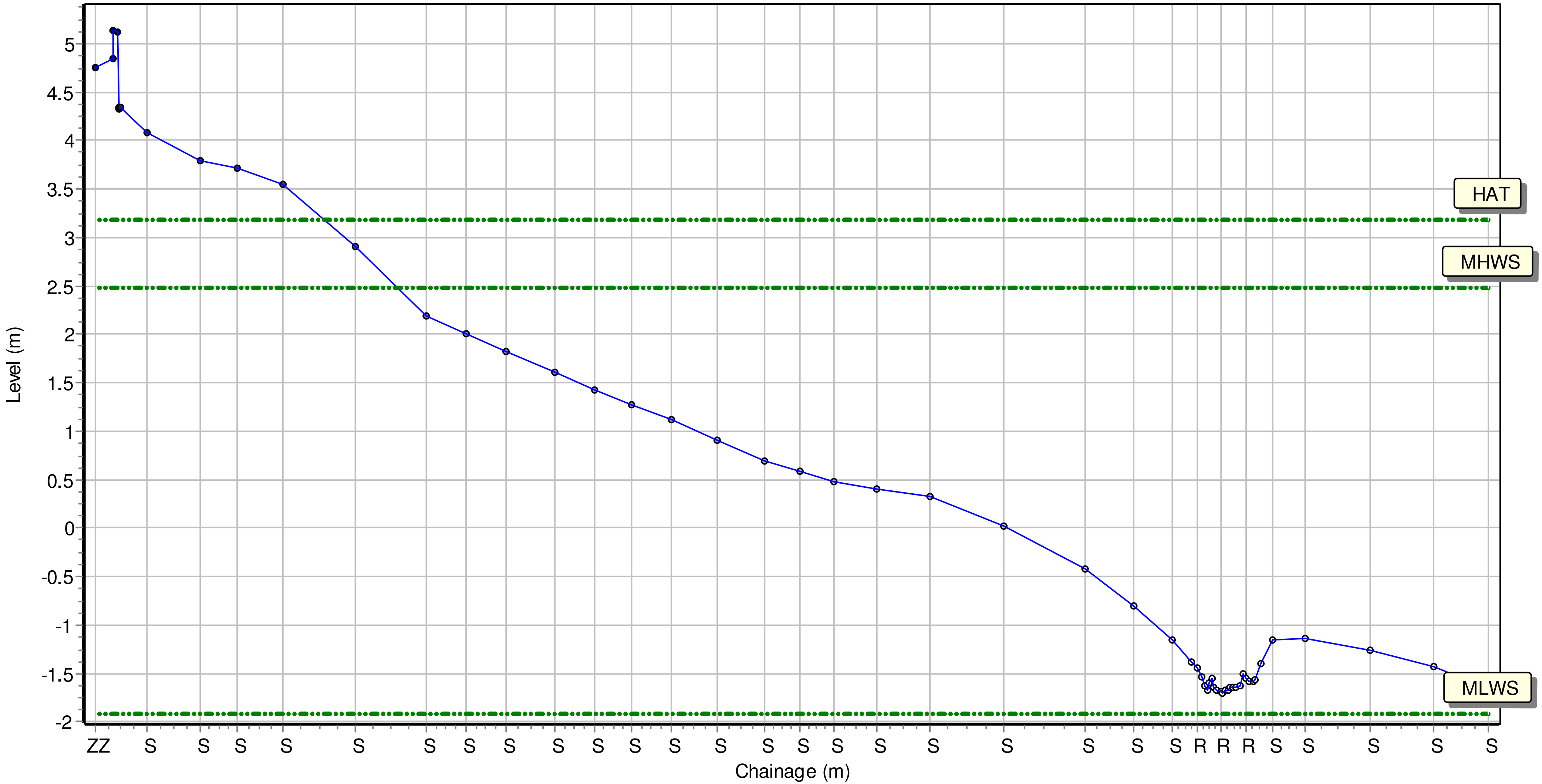
Location: **1bSNN11**

Date: 07/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 440785.596 **Northing:** 558966.827 **Profile Bearing:** 76 ° from North



Beach Profile

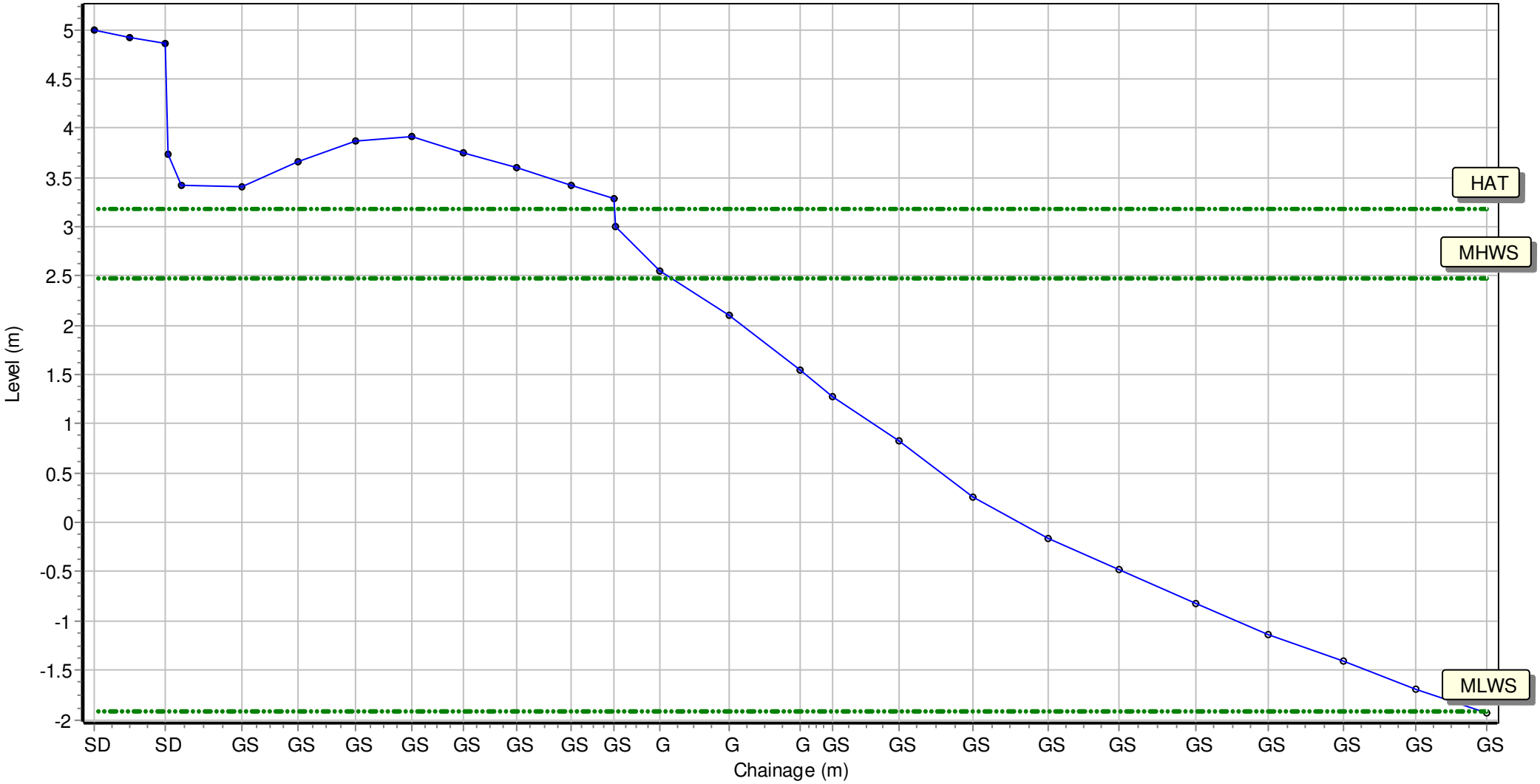
Location: **1bSNN12**

Date: 07/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 440842.281 **Northing:** 558732.094 **Profile Bearing:** 84 ° from North



Beach Profile

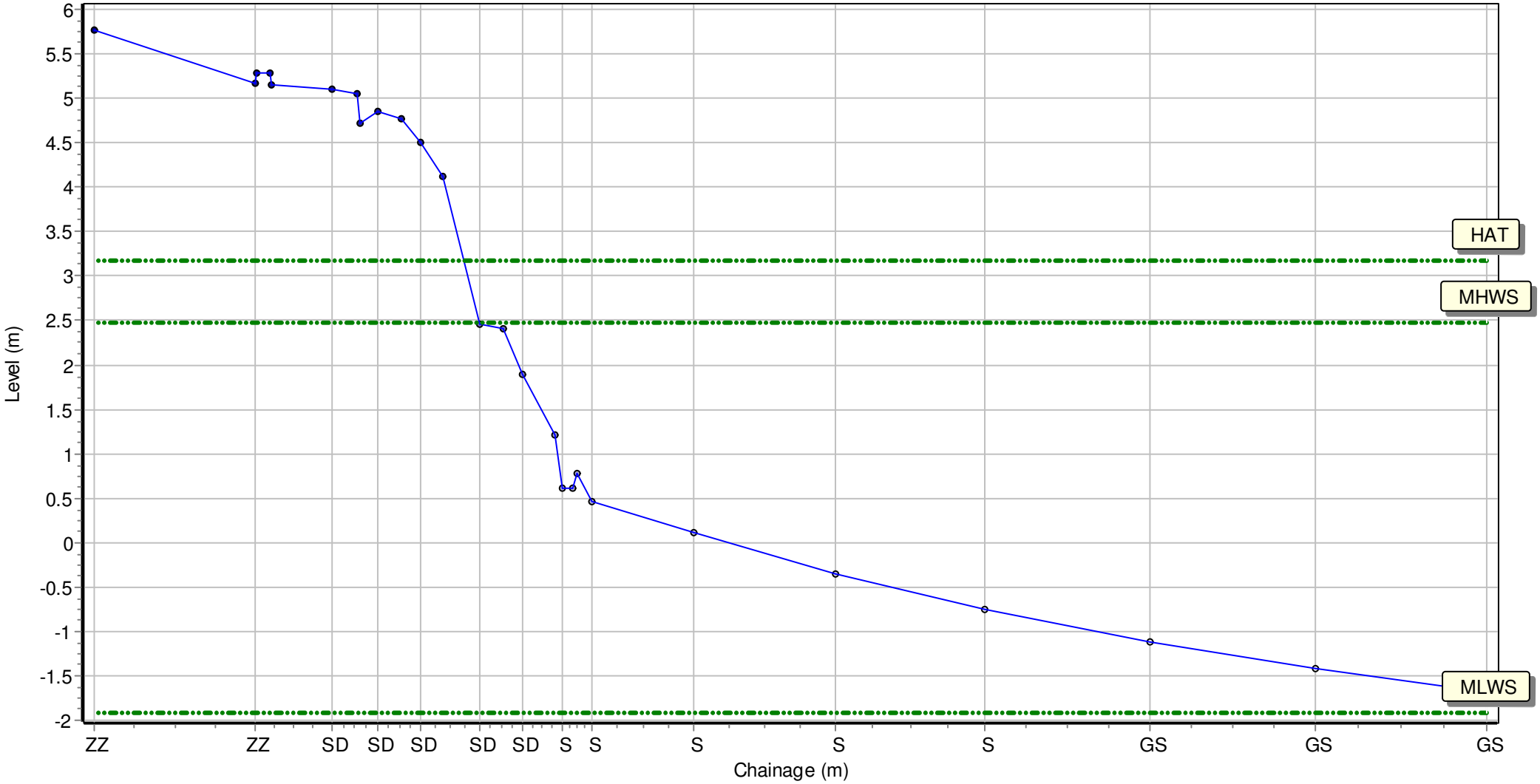
Location: **1bSNN13**

Date: 07/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 440892.257 **Northing:** 558511.587 **Profile Bearing:** 76 ° from North



Beach Profile

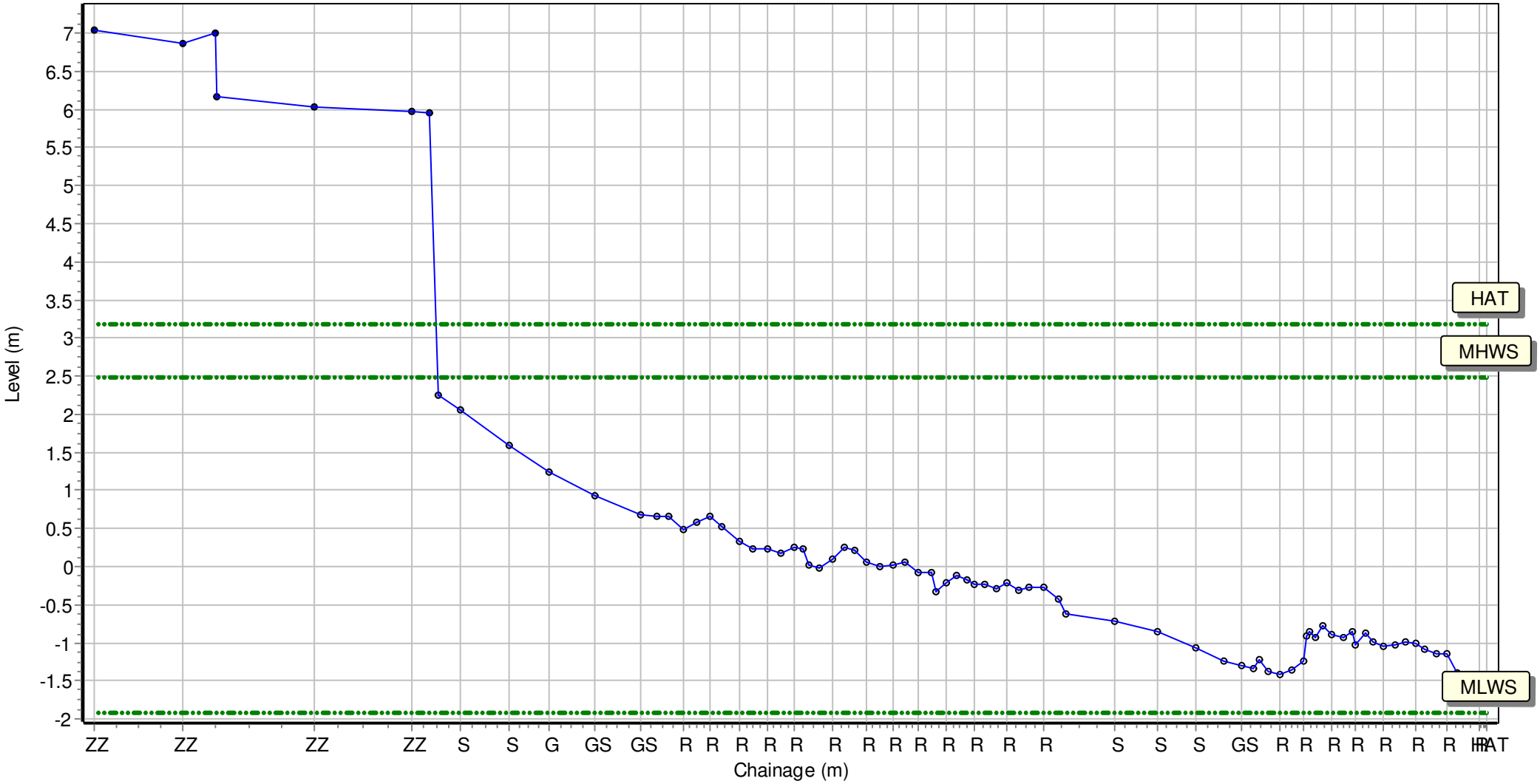
Location: **1bSNS7**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441073.036 **Northing:** 555629.712 **Profile Bearing:** 85 ° from North



Beach Profile

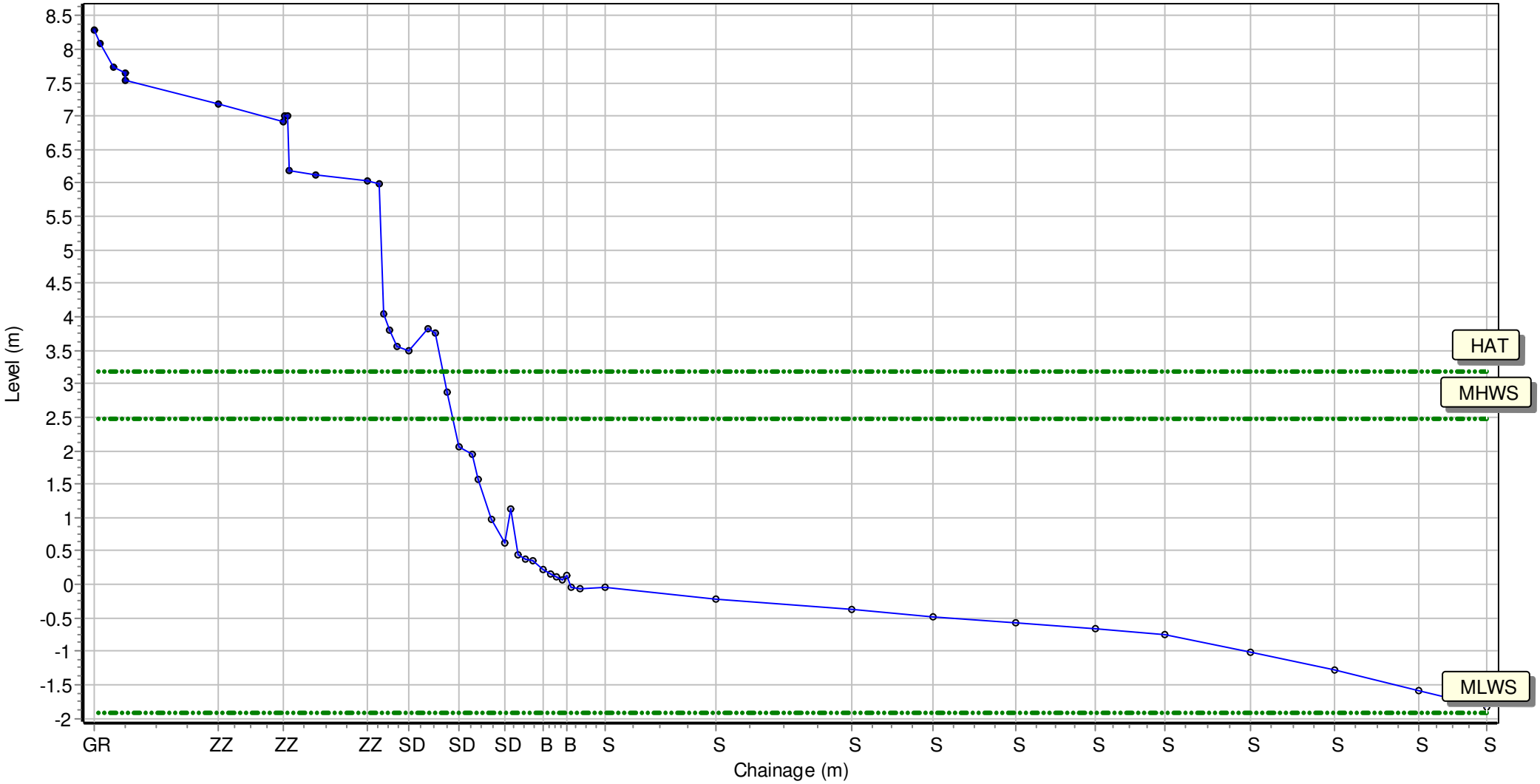
Location: **1bSNS8**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441092.263 **Northing:** 555414.414 **Profile Bearing:** 80 ° from North



Beach Profile

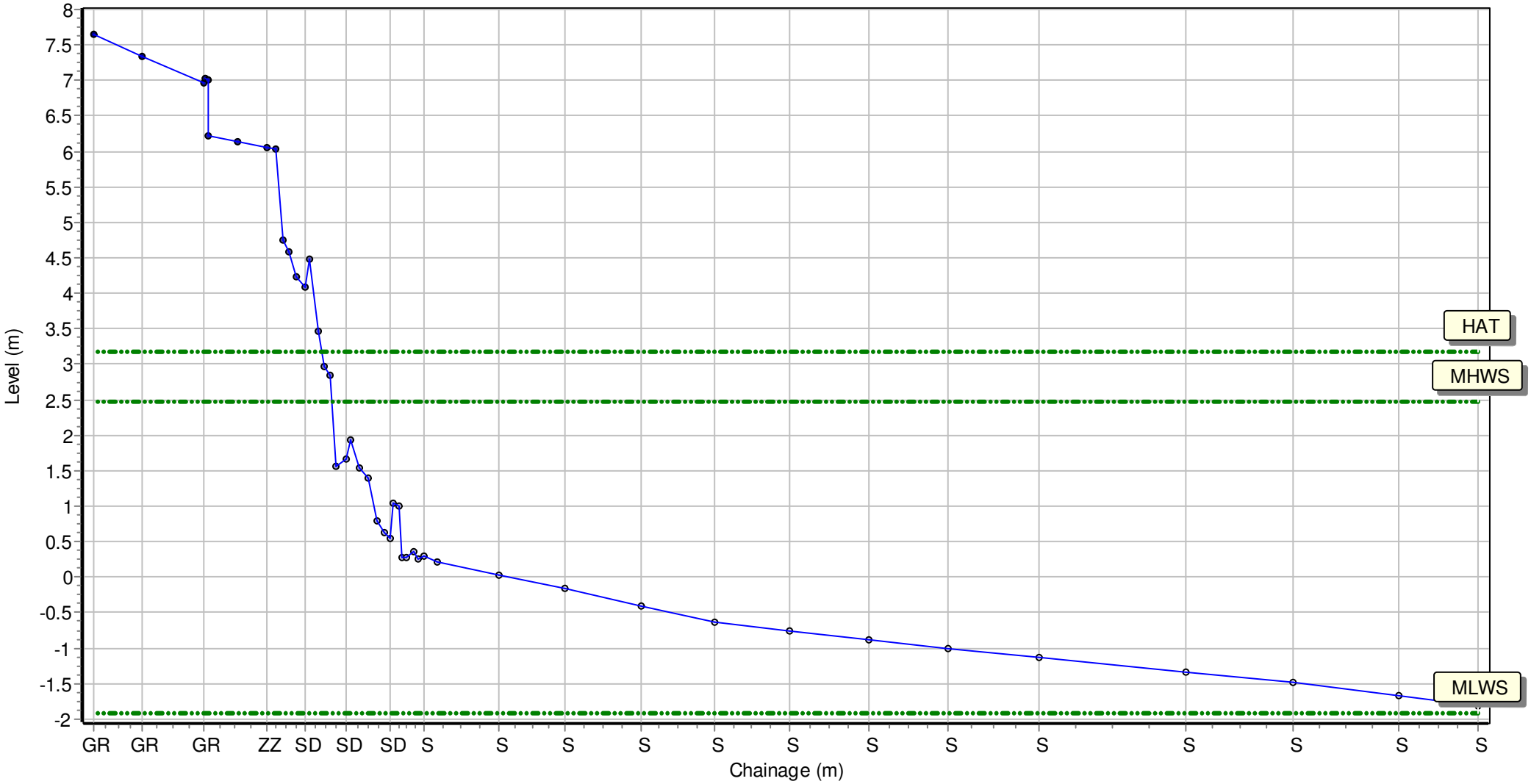
Location: **1bSNS9**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441118.722 **Northing:** 555223.928 **Profile Bearing:** 82 ° from North



Beach Profile

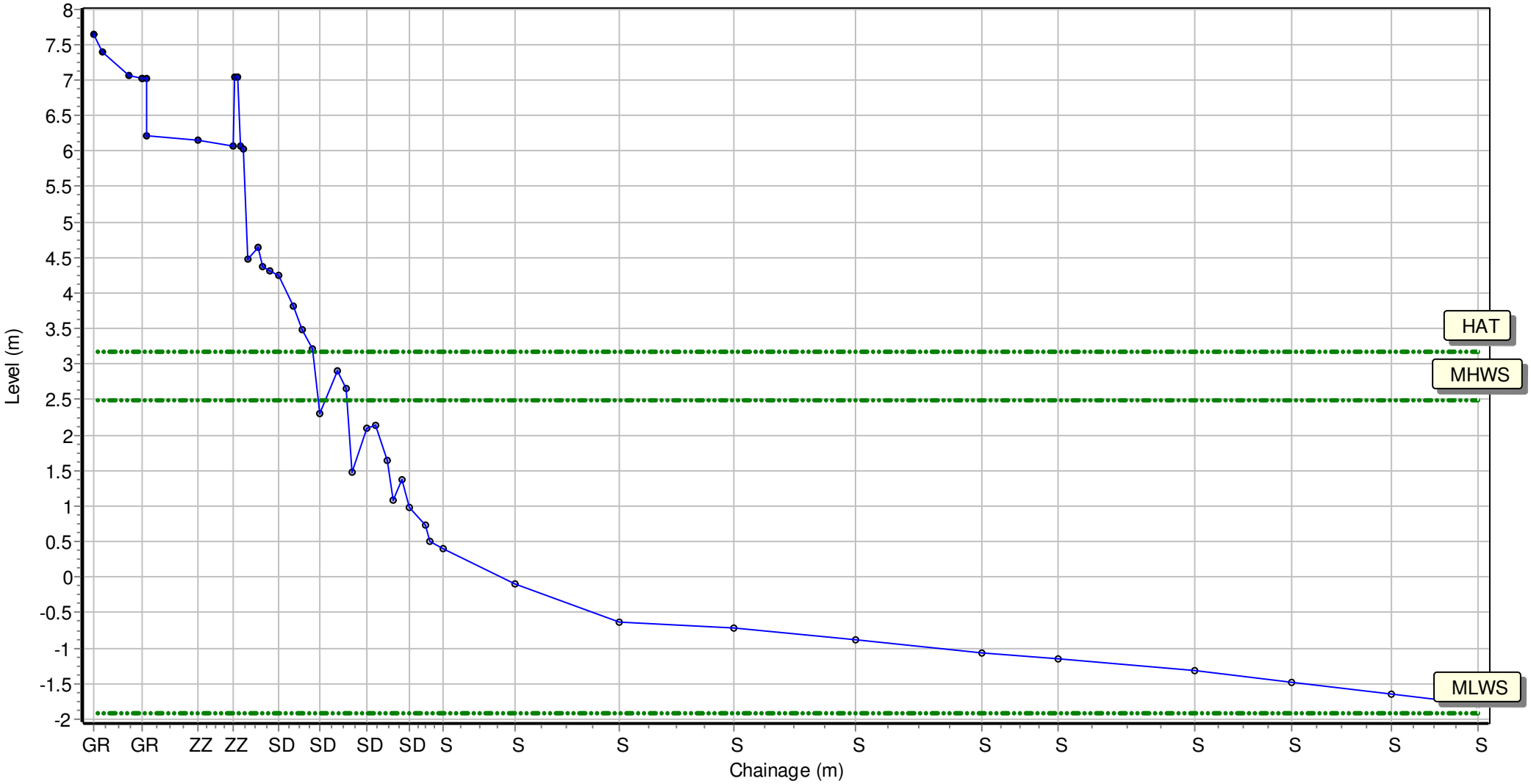
Location: **1bSNS10**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441176.256 **Northing:** 554997.913 **Profile Bearing:** 73 ° from North



Beach Profile

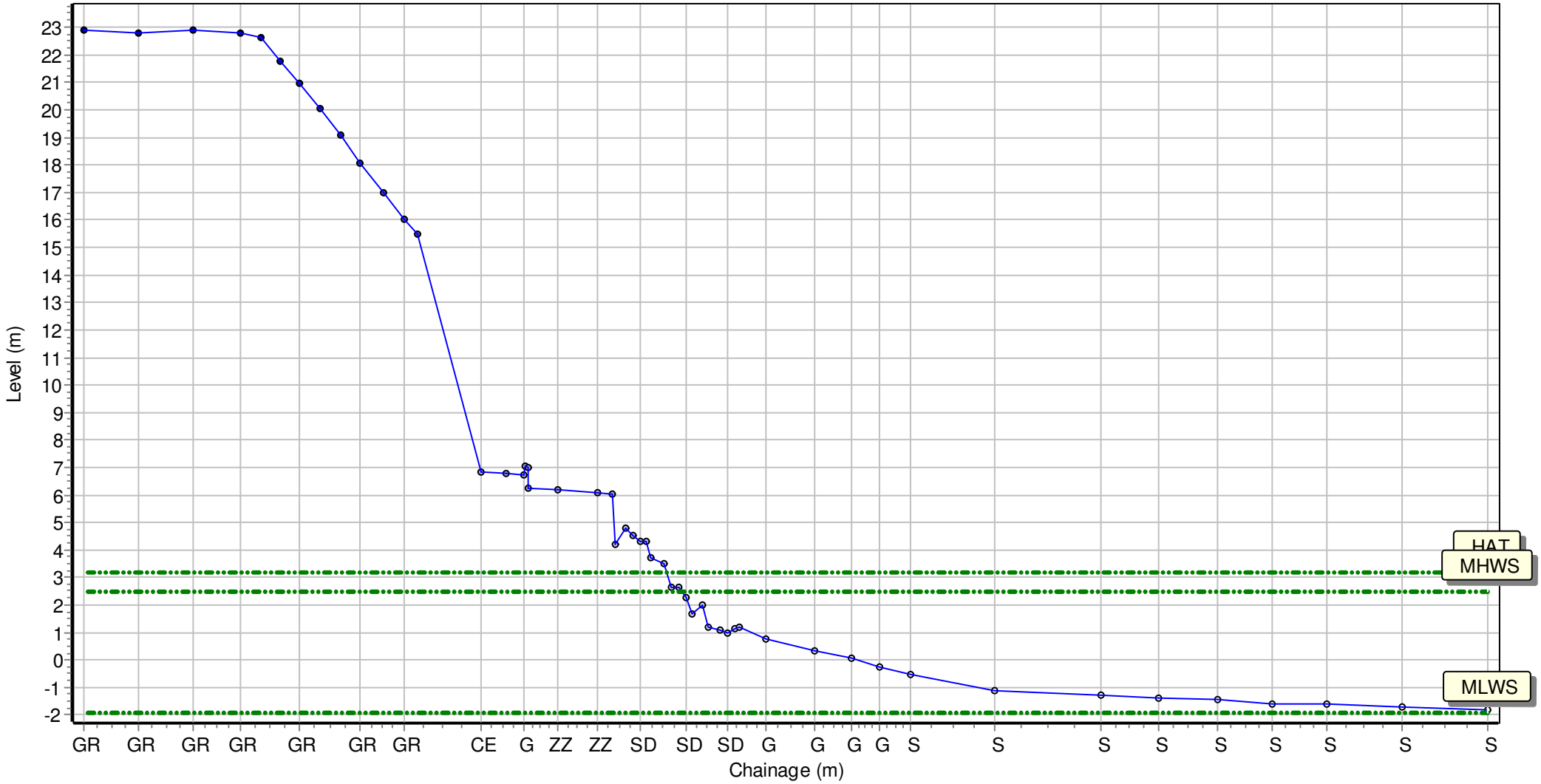
Location: **1bSNS11**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441225.182 **Northing:** 554759.021 **Profile Bearing:** 75 ° from North



Beach Profile

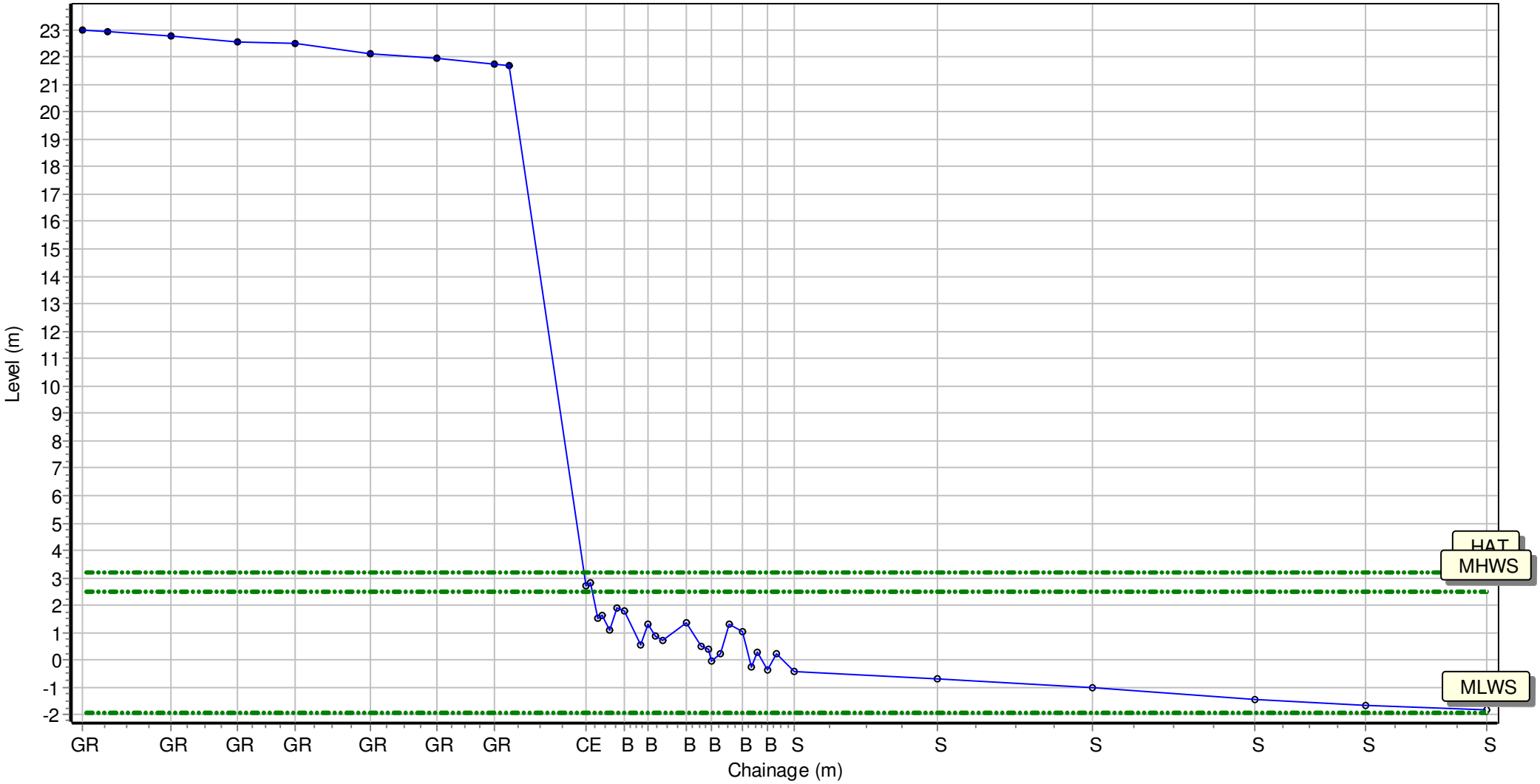
Location: **1bSNS12**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441242.249 **Northing:** 554630.678 **Profile Bearing:** 75 ° from North



Beach Profile

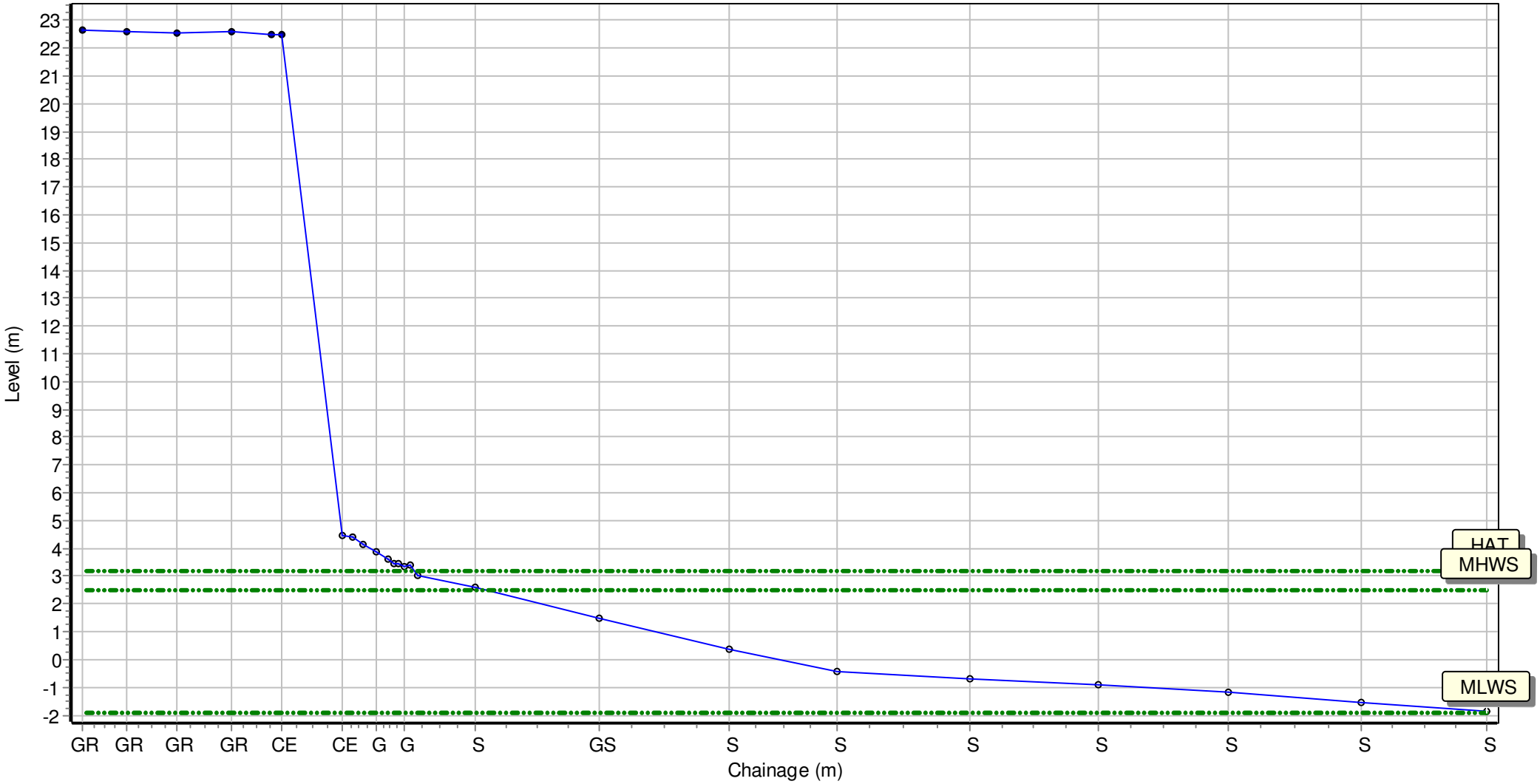
Location: **1bSNS13**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441288.083 **Northing:** 554427.126 **Profile Bearing:** 66 ° from North



Beach Profile

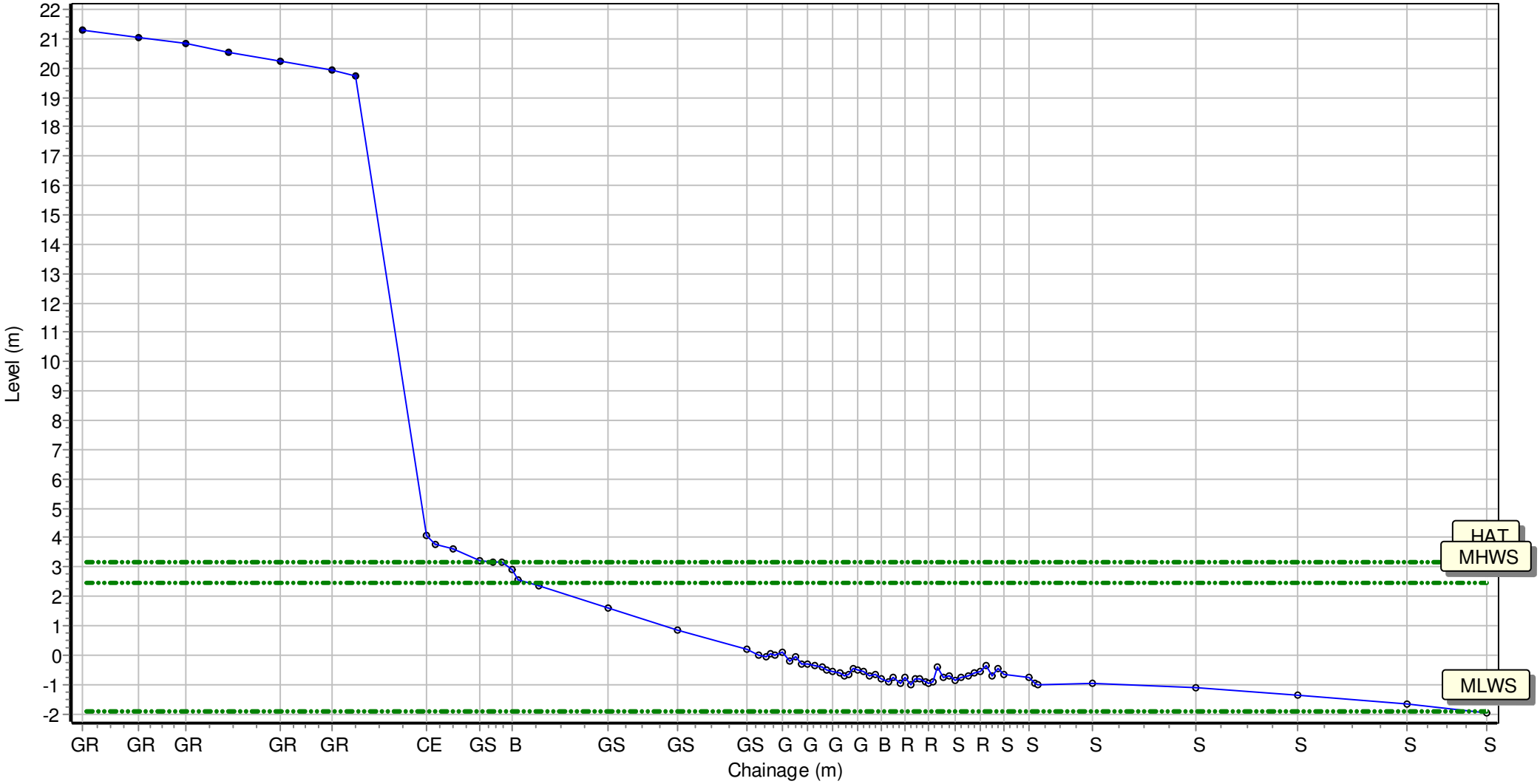
Location: **1bSNS14**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441329.465 **Northing:** 554332.663 **Profile Bearing:** 65 ° from North



Beach Profile

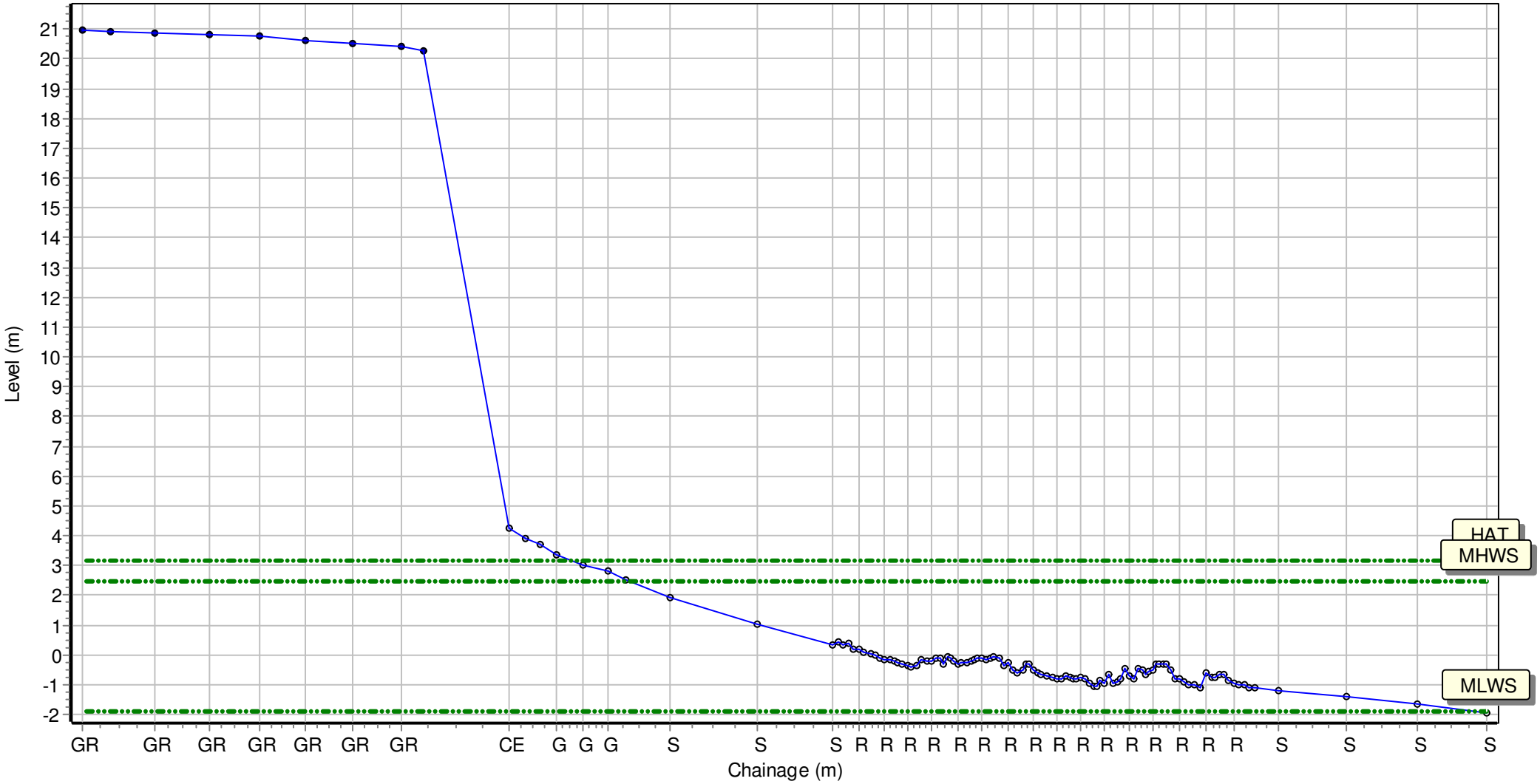
Location: **1bSNS15**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441371.425 **Northing:** 554241.889 **Profile Bearing:** 65 ° from North



Beach Profile

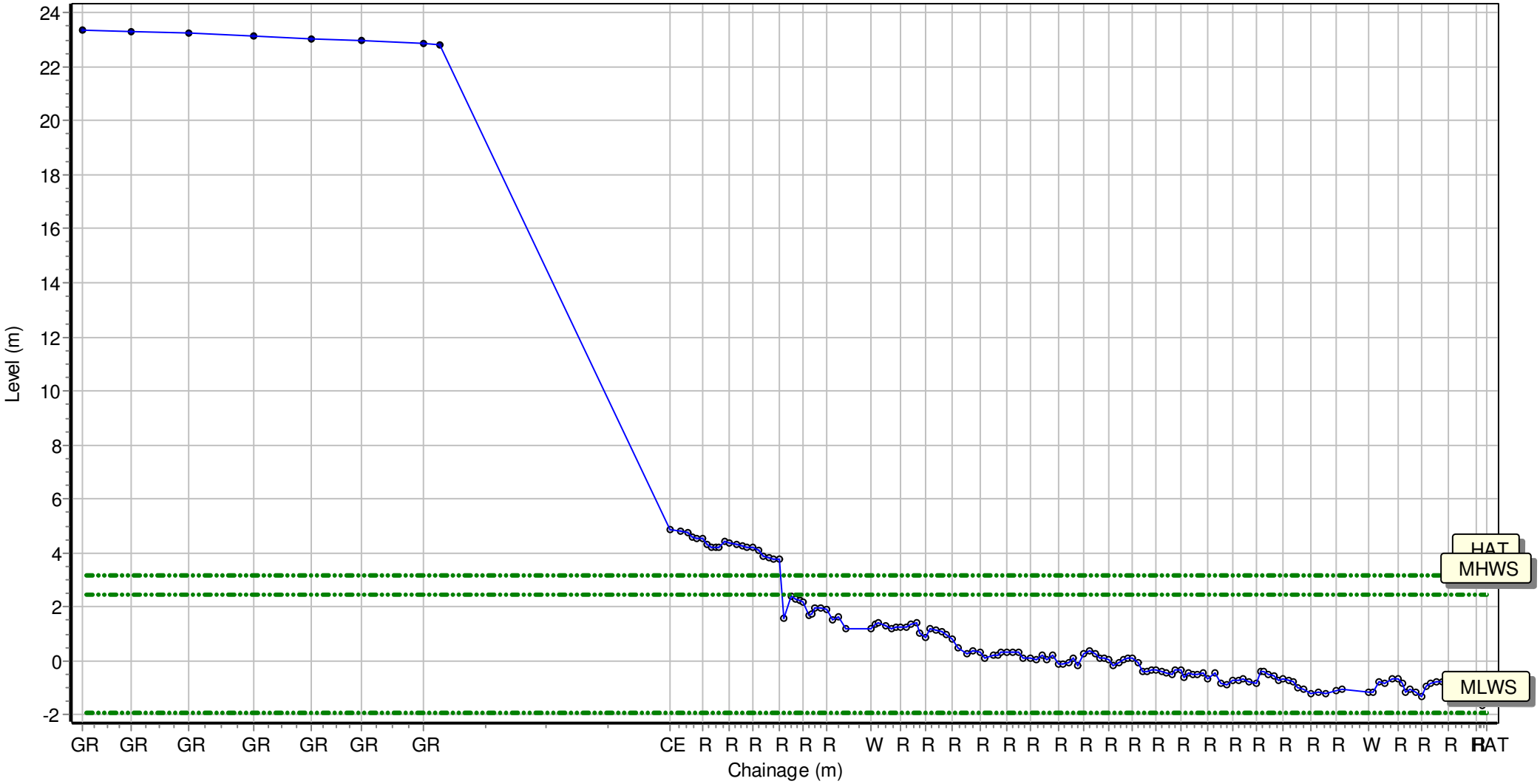
Location: **1bSNS16**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441444.352 **Northing:** 554130.231 **Profile Bearing:** 64 ° from North



Beach Profile

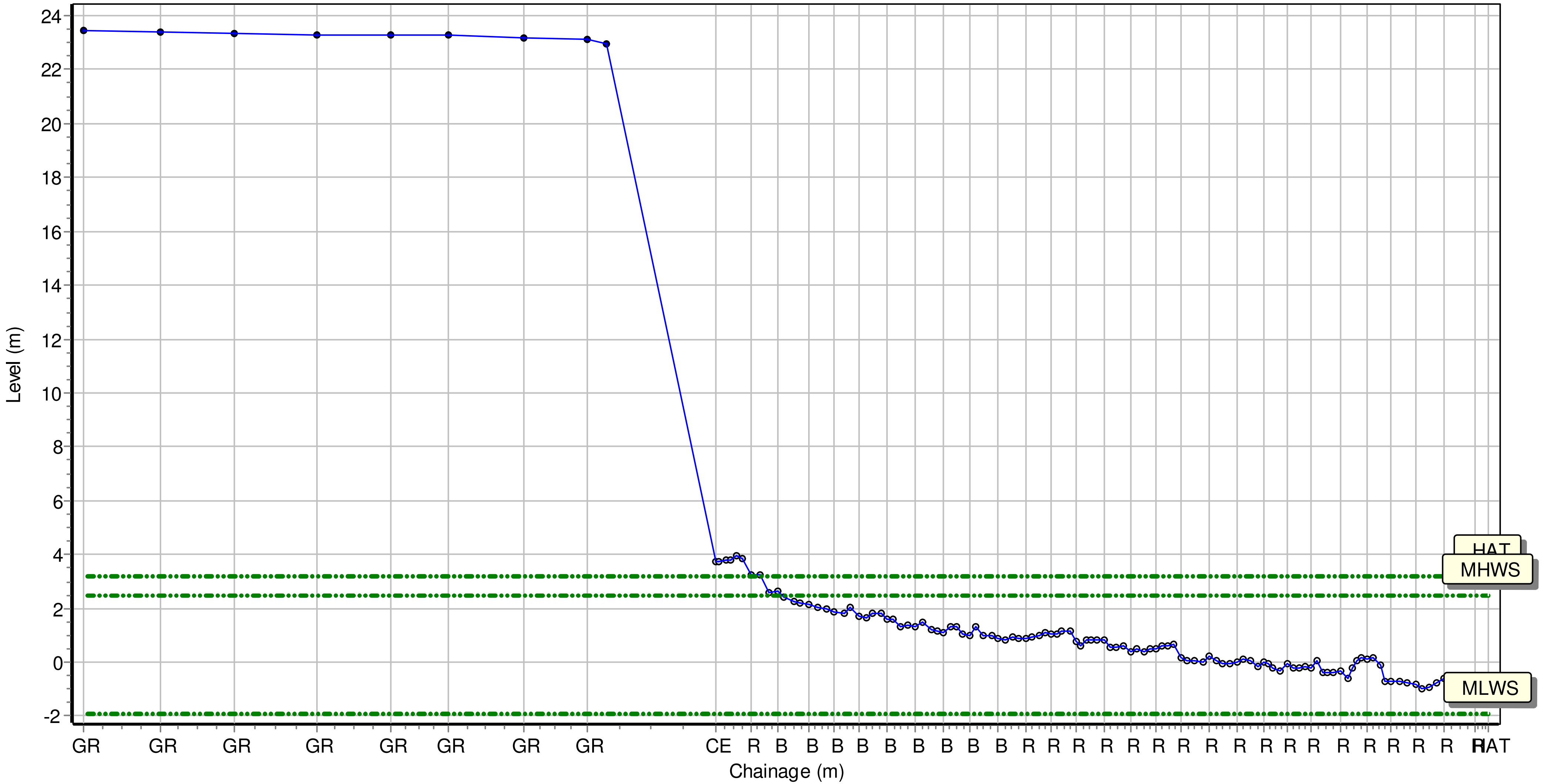
Location: 1bSNS17

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441450.289 **Northing:** 554115.925 **Profile Bearing:** 131 ° from North



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Beach Profile

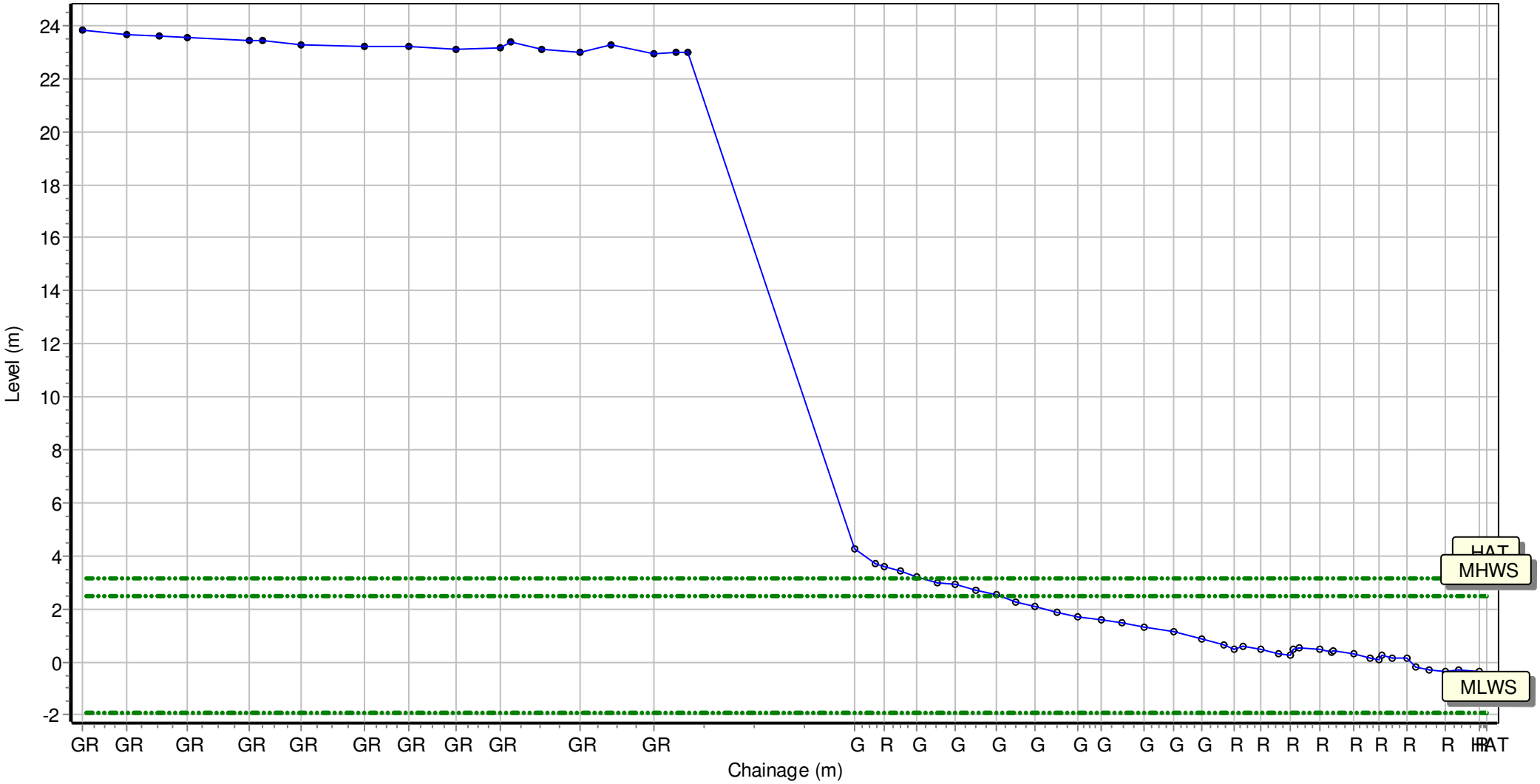
Location: **1bSNS18**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441365.488 **Northing:** 553870.605 **Profile Bearing:** 83 ° from North



Beach Profile

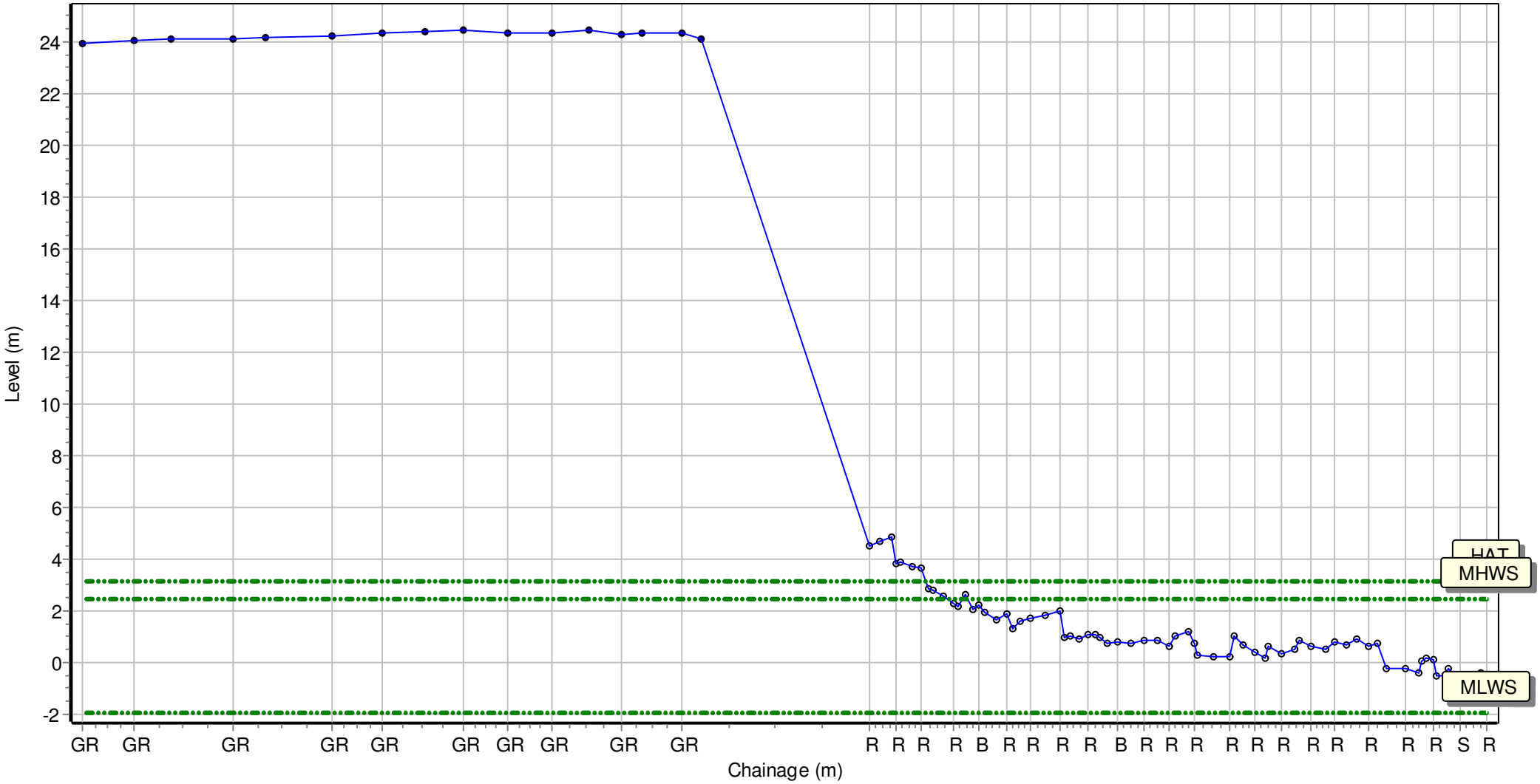
Location: **1bSNS19**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441384.336 **Northing:** 553752.319 **Profile Bearing:** 105 ° from North



Beach Profile

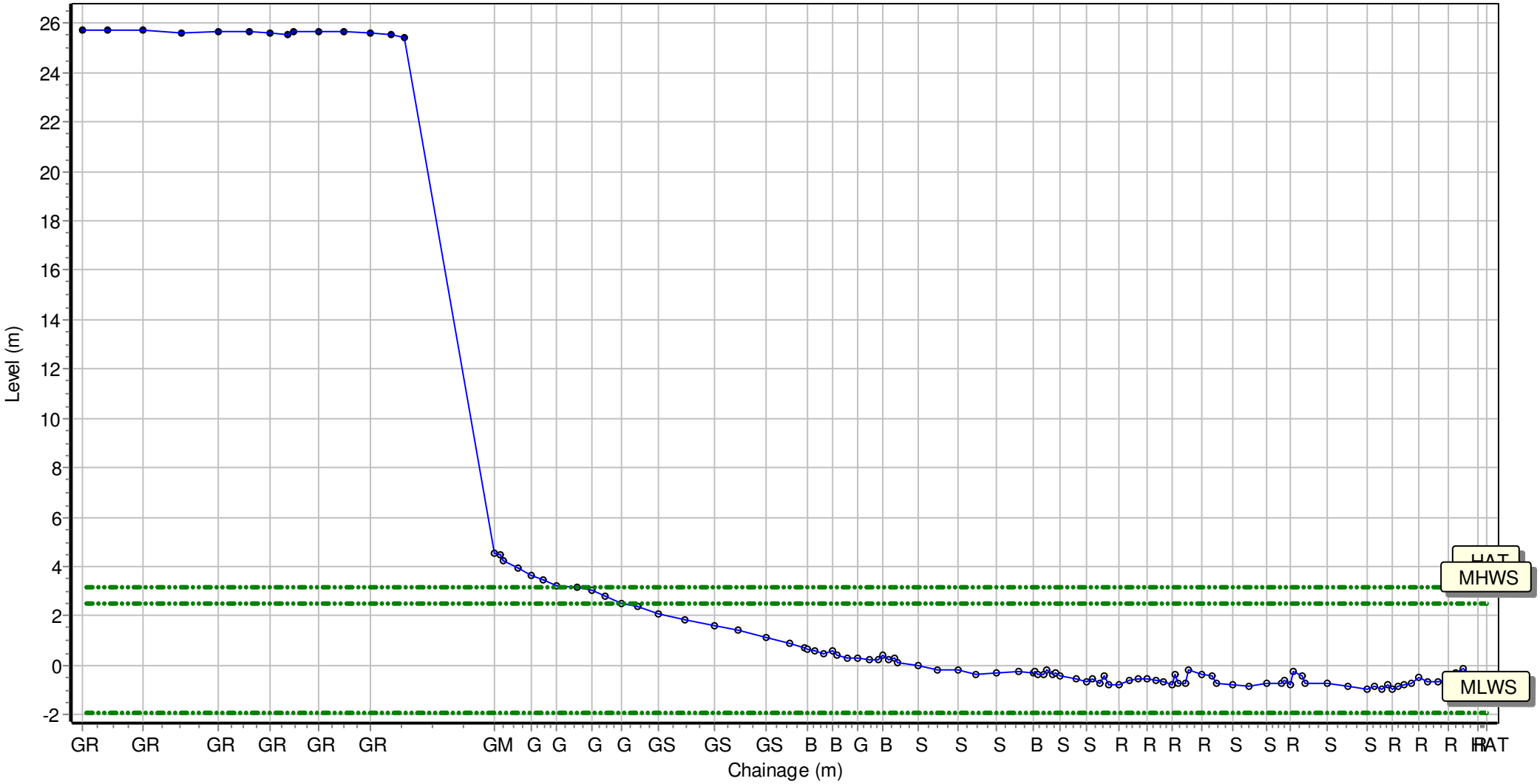
Location: **1bSNS20**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441378.054 **Northing:** 553599.123 **Profile Bearing:** 81 ° from North



Beach Profile

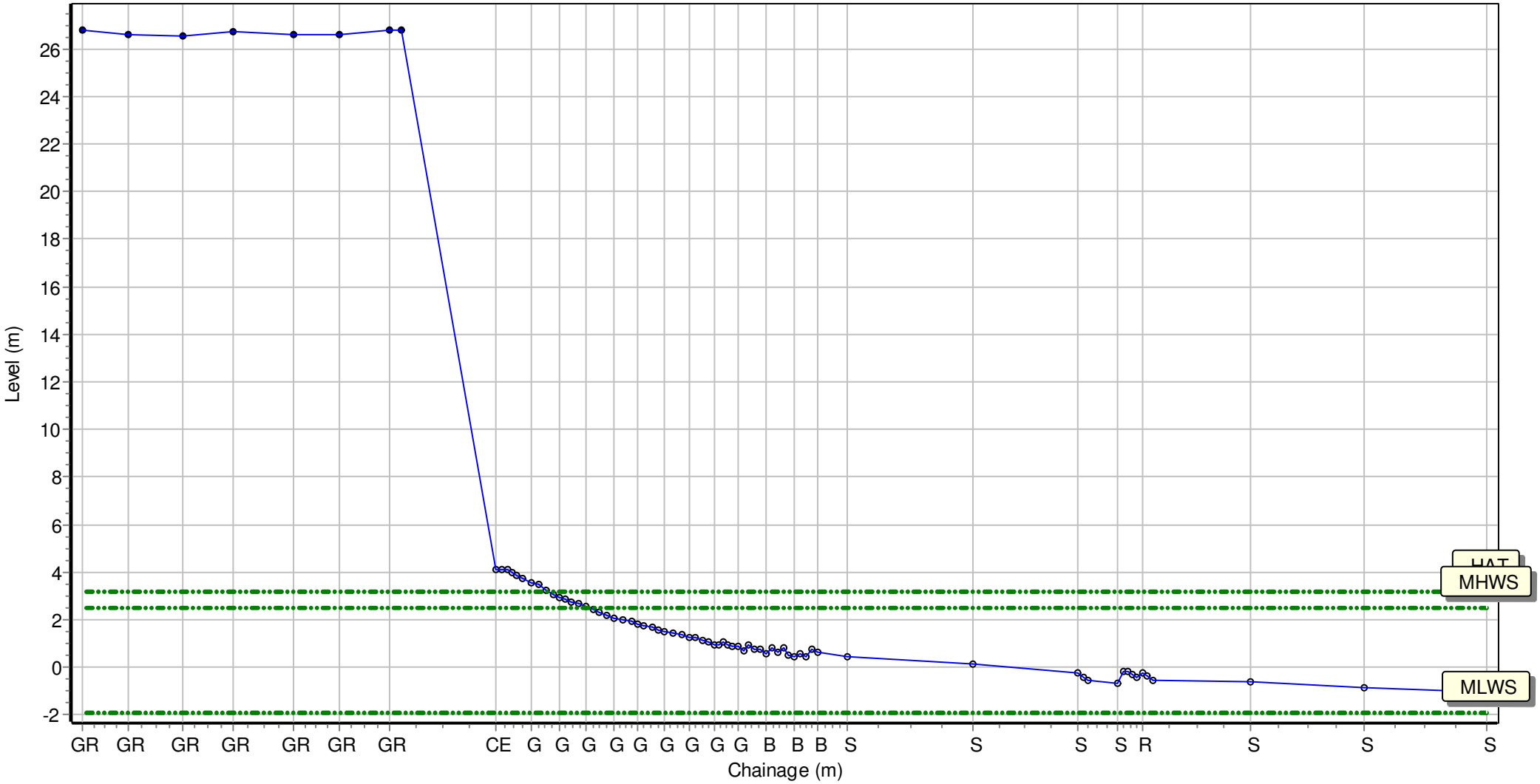
Location: **1bSNS21**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441410.506 **Northing:** 553455.364 **Profile Bearing:** 75 ° from North



Beach Profile

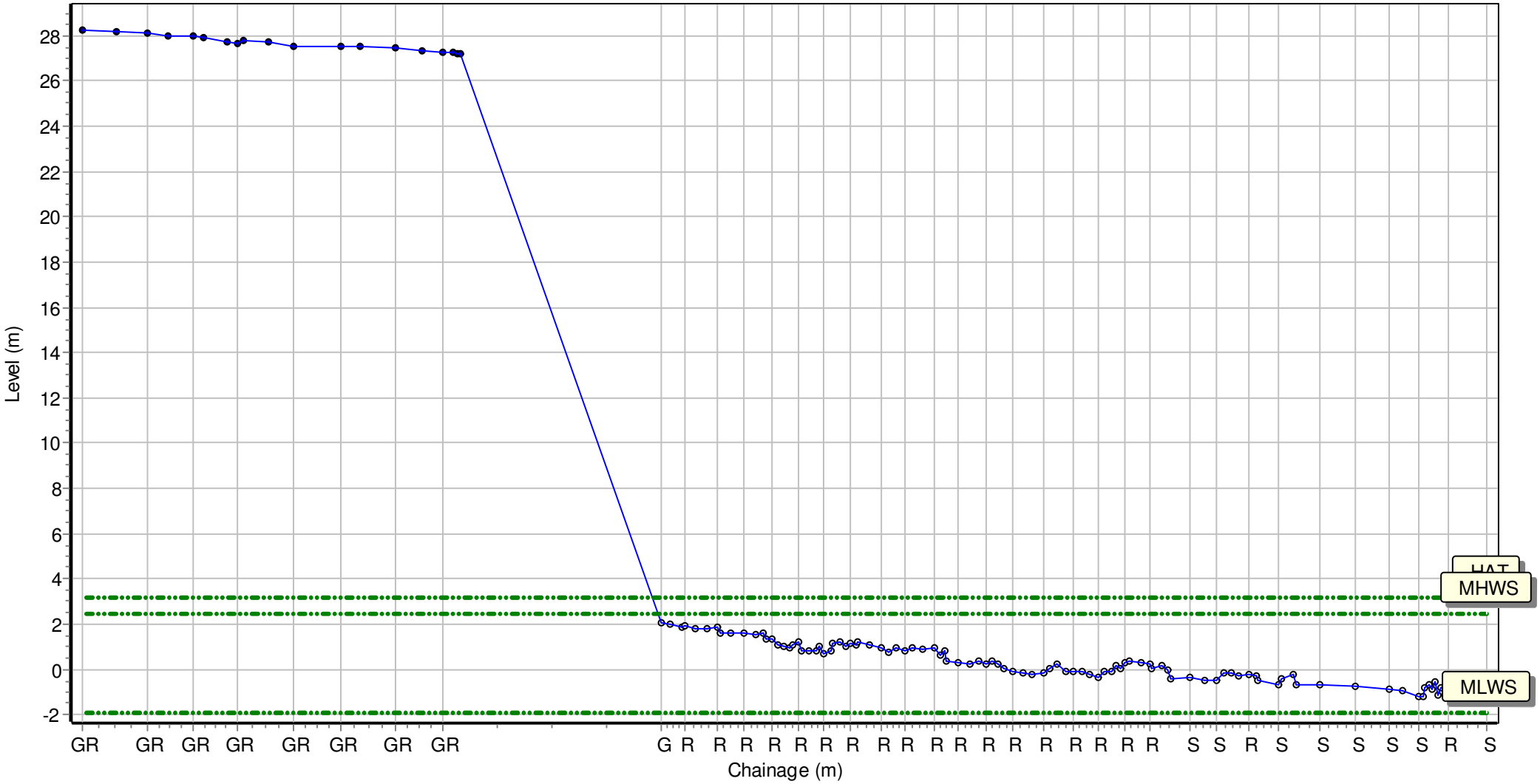
Location: **1bSNS22**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441474.364 **Northing:** 553262.39 **Profile Bearing:** 72 ° from North



Beach Profile

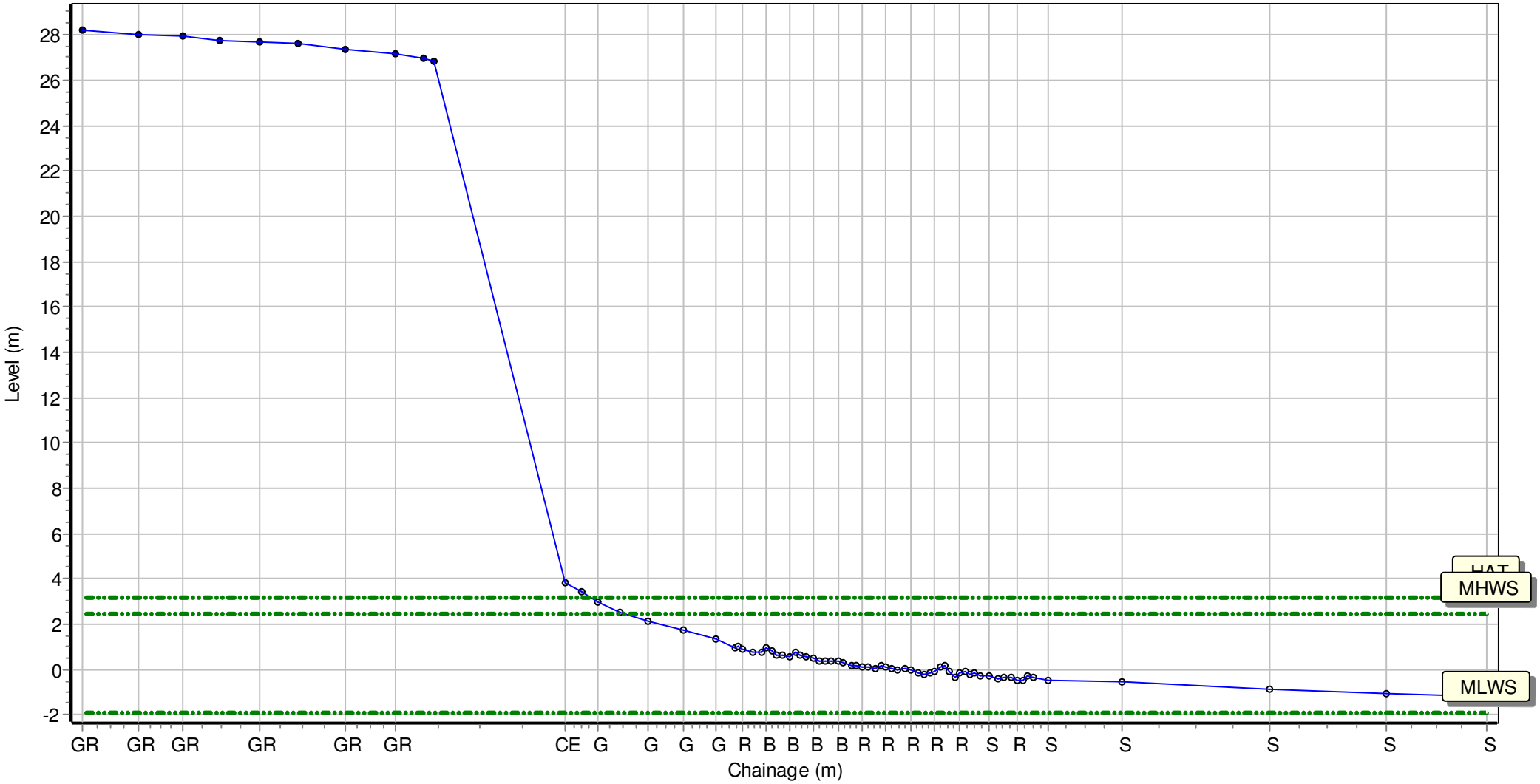
Location: **1bSNS23**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441513.099 **Northing:** 553157.01 **Profile Bearing:** 71 ° from North



Beach Profile

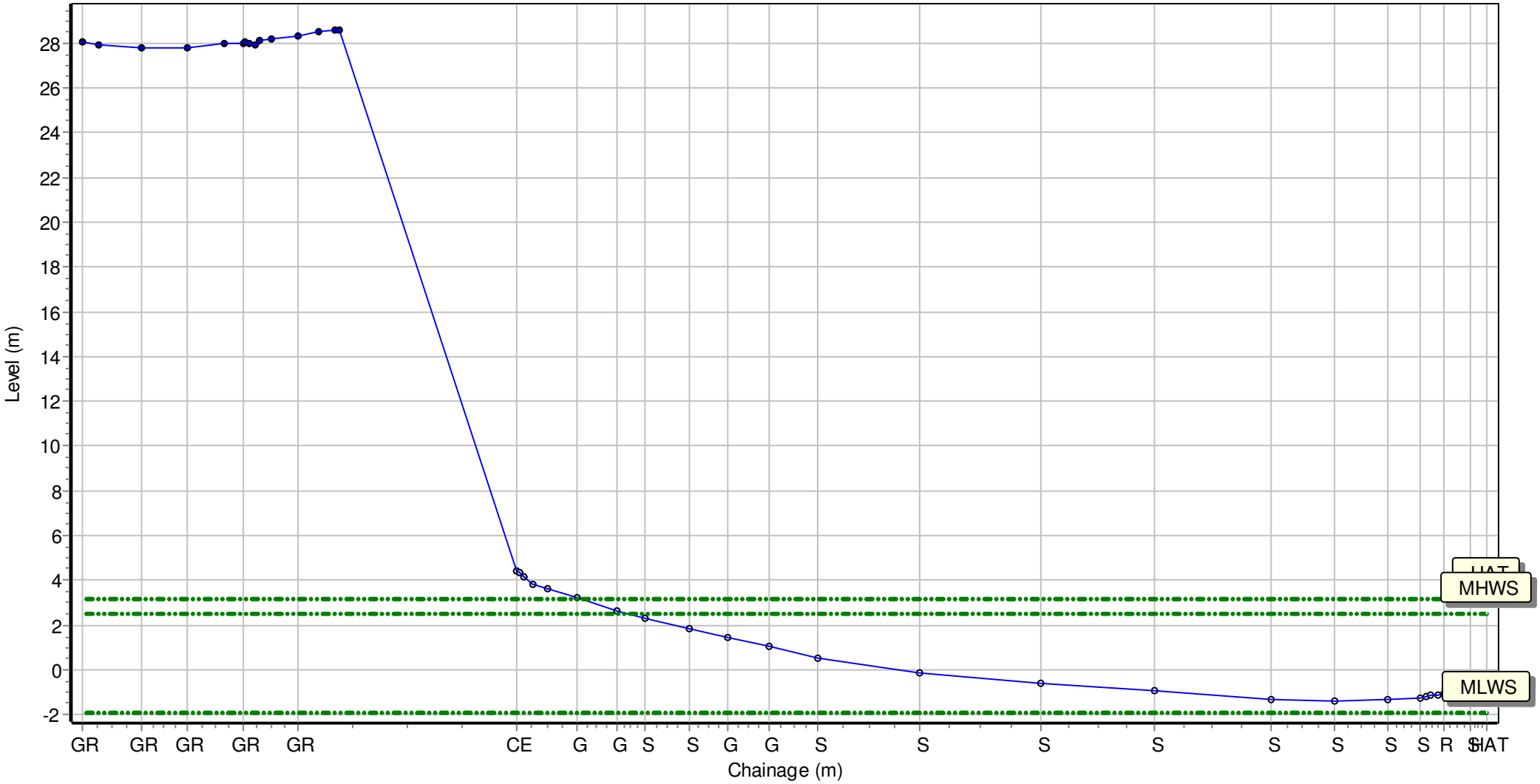
Location: **1bSNS24**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441605.914 **Northing:** 552855.516 **Profile Bearing:** 68 ° from North



Beach Profile

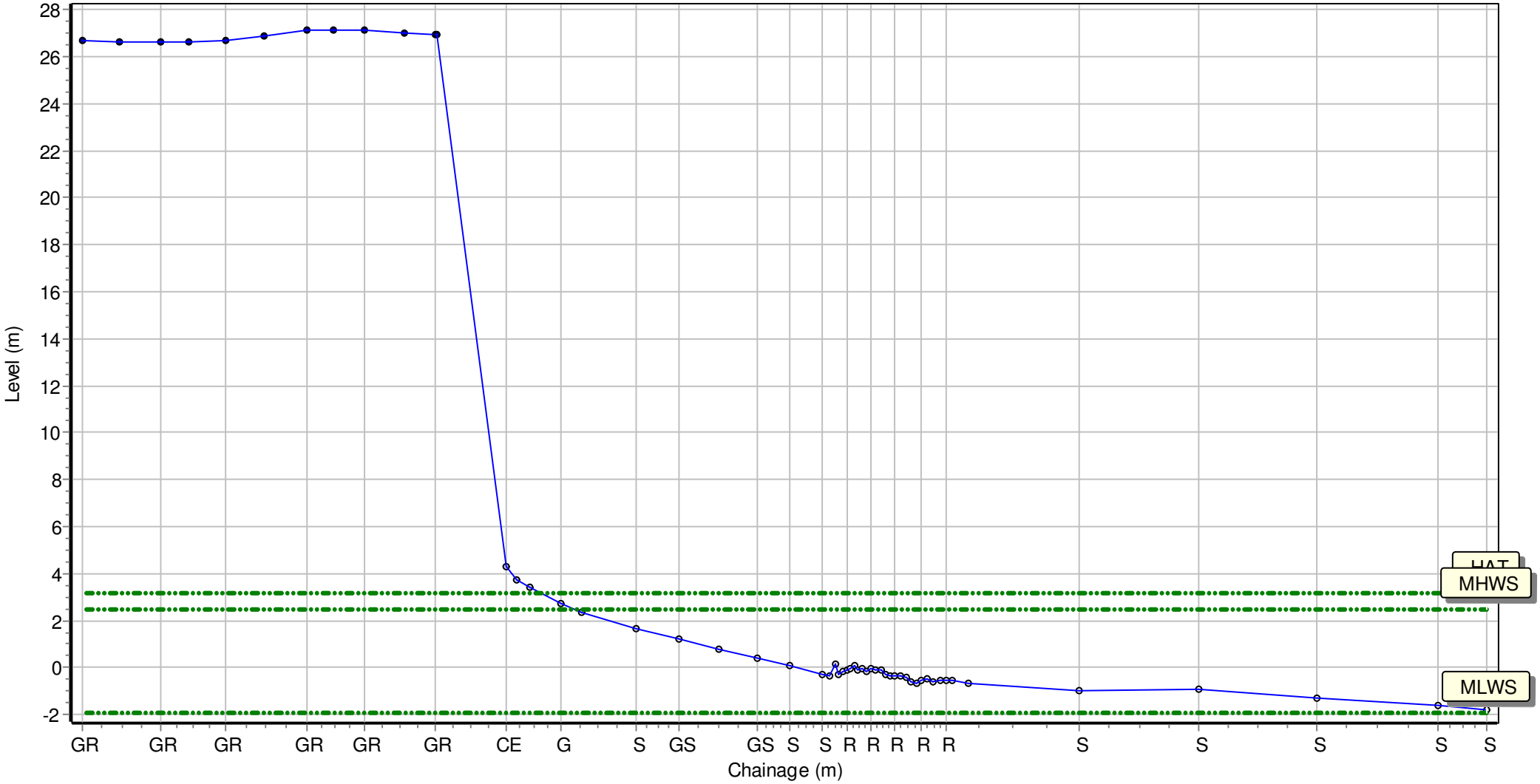
Location: **1bSNS25**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441740.614 **Northing:** 552616.135 **Profile Bearing:** 64 ° from North



Beach Profile

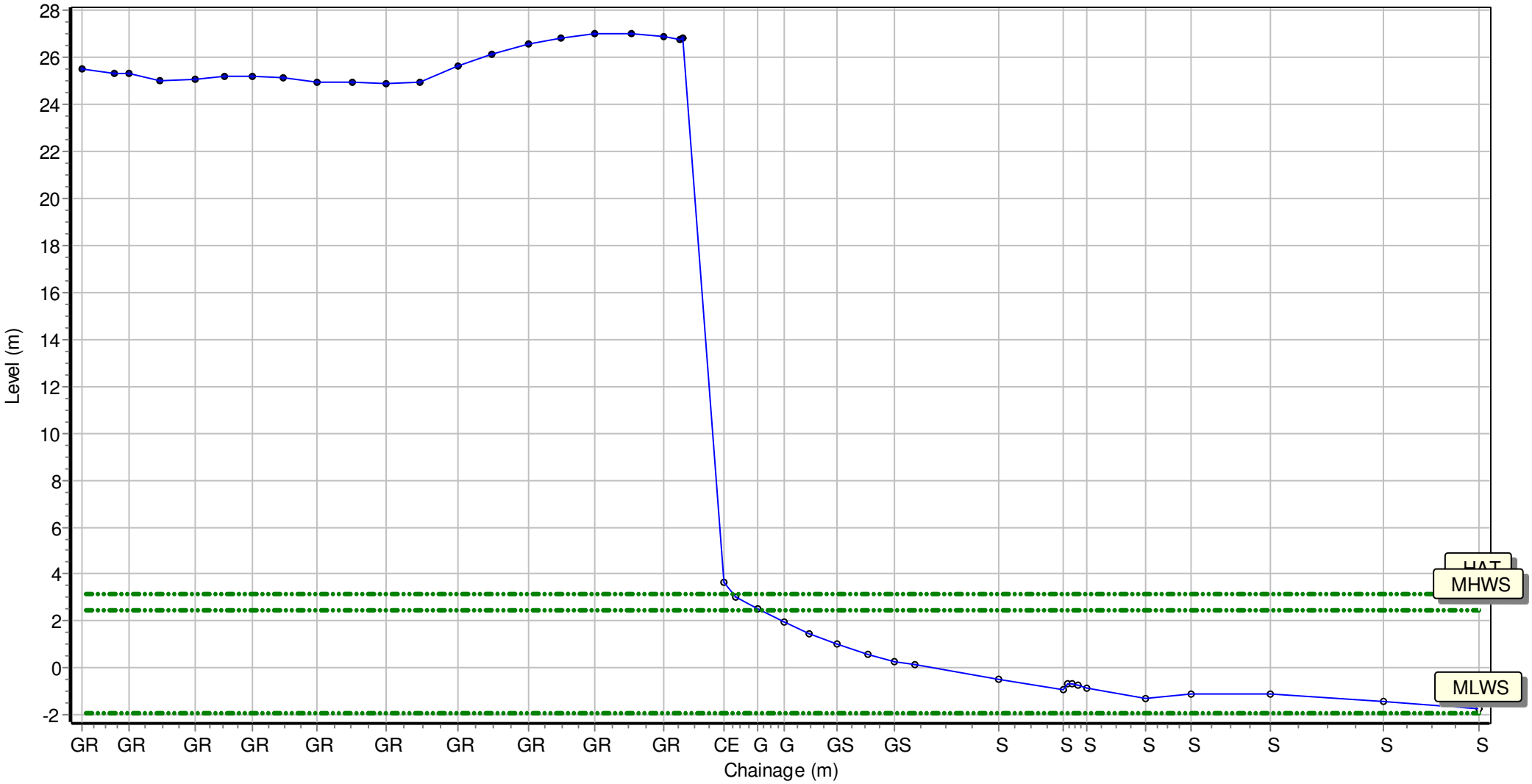
Location: **1bSNS26**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441726.053 **Northing:** 552563.41 **Profile Bearing:** 60 ° from North



Beach Profile

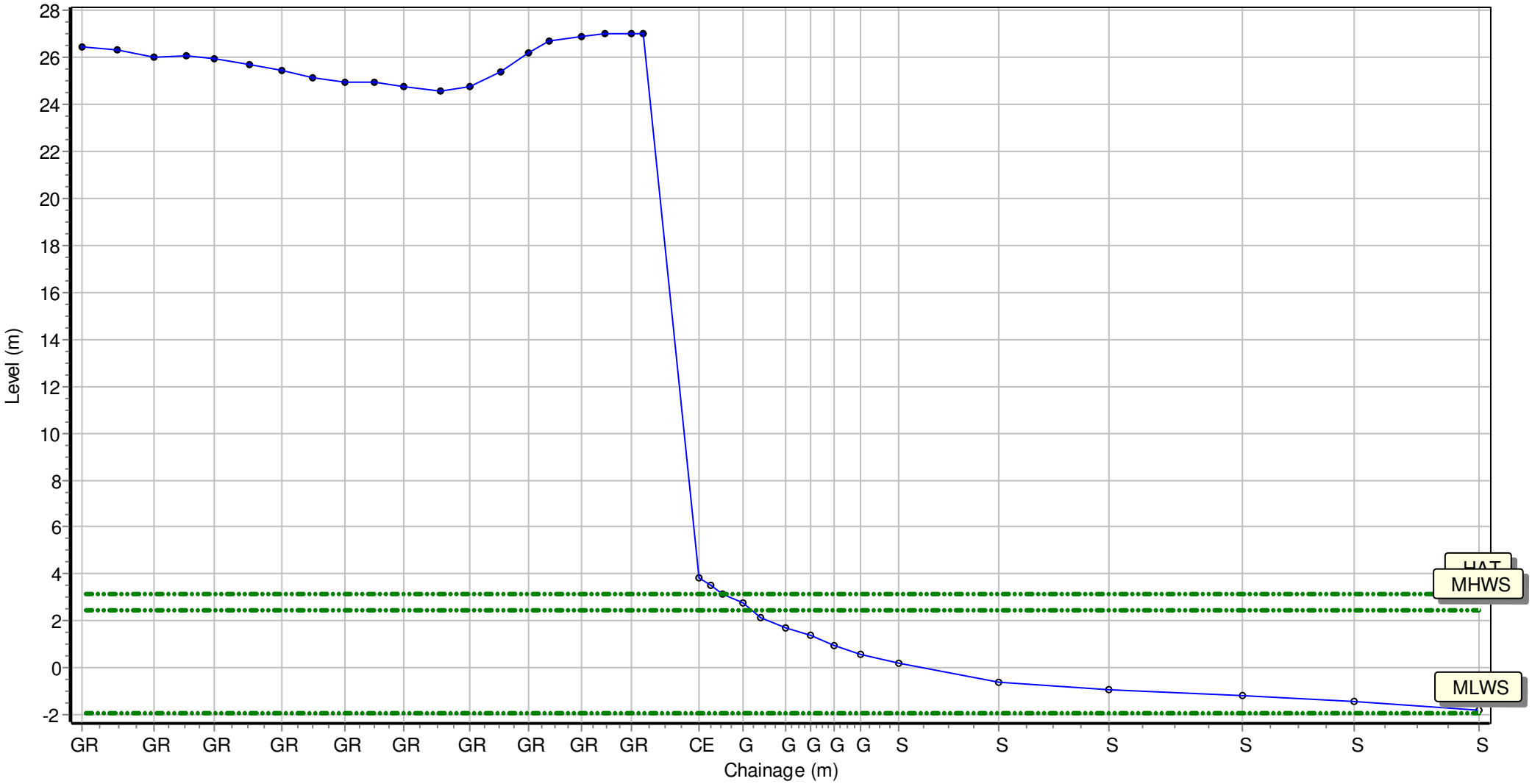
Location: **1bSNS27**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441733.63 **Northing:** 552550.463 **Profile Bearing:** 60 ° from North



Beach Profile

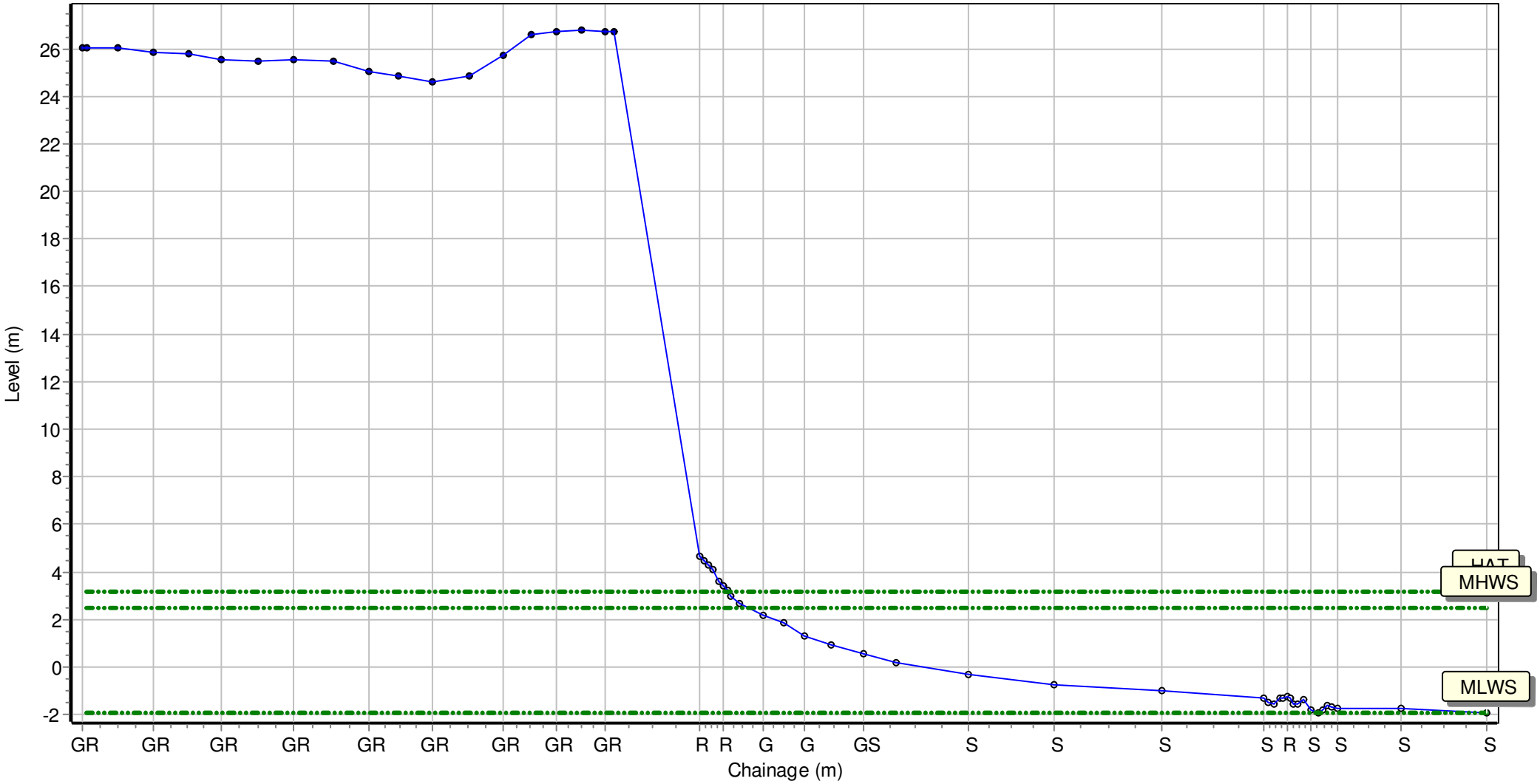
Location: **1bSNS28**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441741.207 **Northing:** 552537.517 **Profile Bearing:** 60 ° from North



Beach Profile

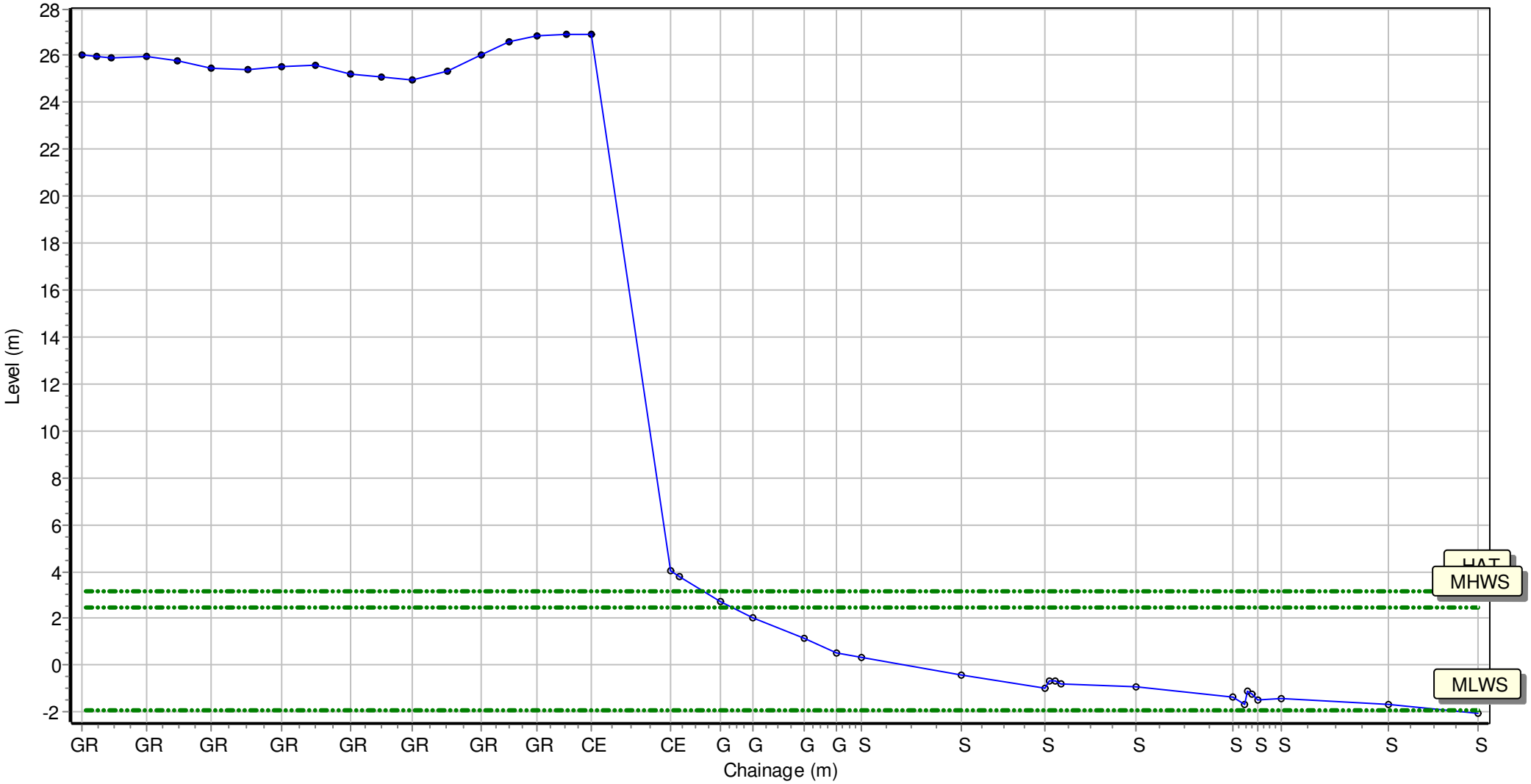
Location: **1bSNS29**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441748.776 **Northing:** 552524.571 **Profile Bearing:** 60 ° from North



Beach Profile

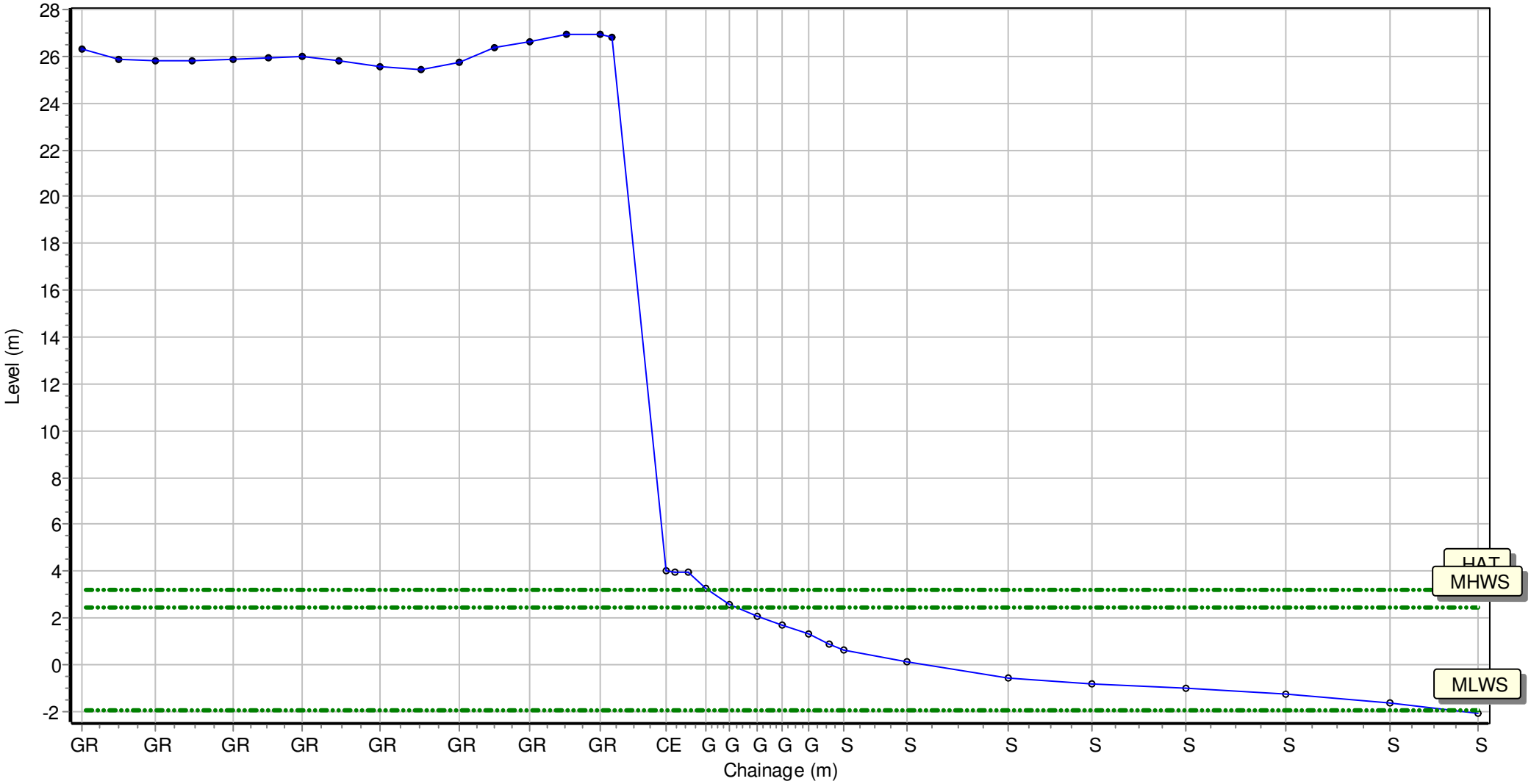
Location: **1bSNS30**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441756.353 **Northing:** 552511.624 **Profile Bearing:** 60 ° from North



Beach Profile

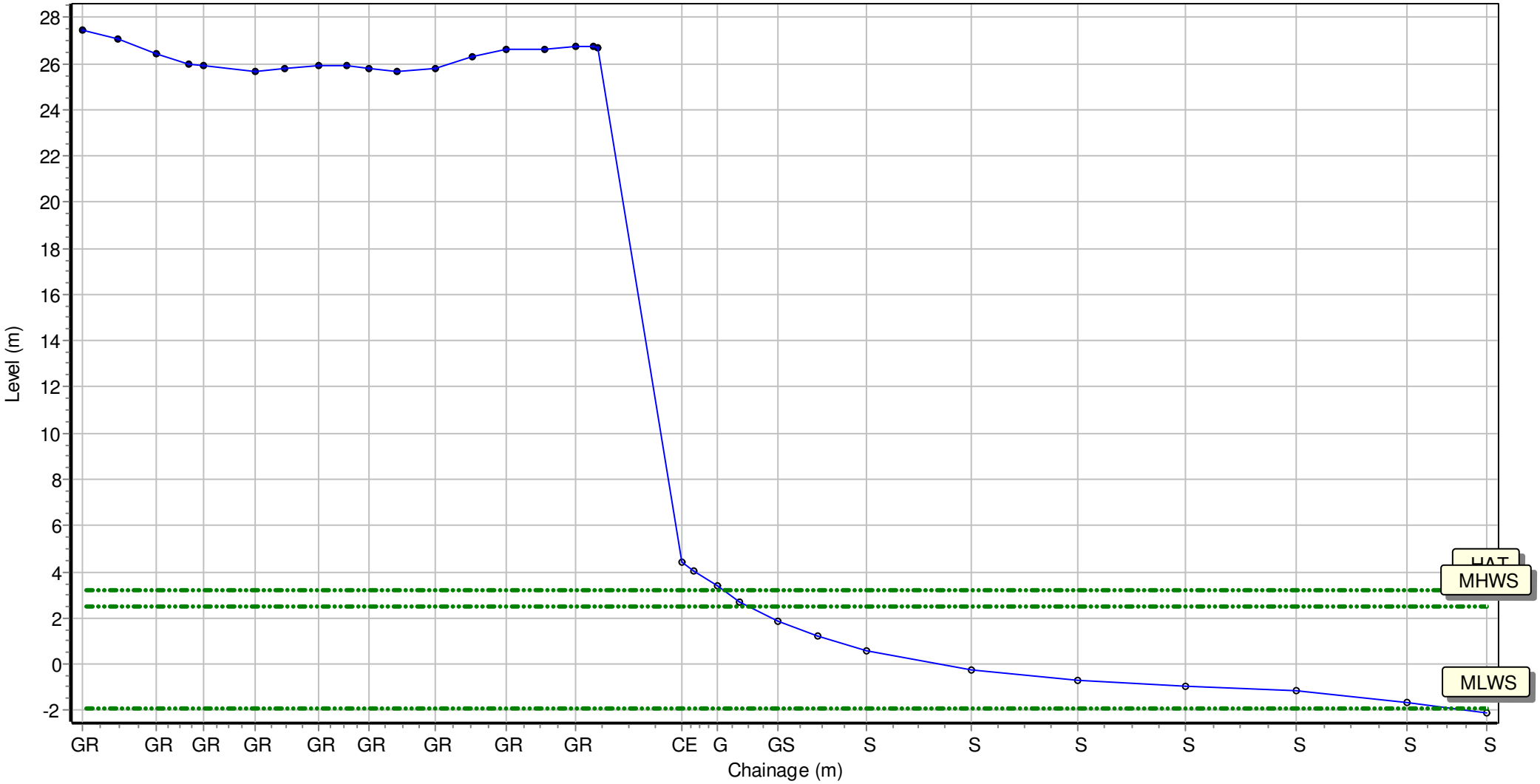
Location: **1bSNS31**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441763.931 **Northing:** 552498.678 **Profile Bearing:** 60 ° from North



Beach Profile

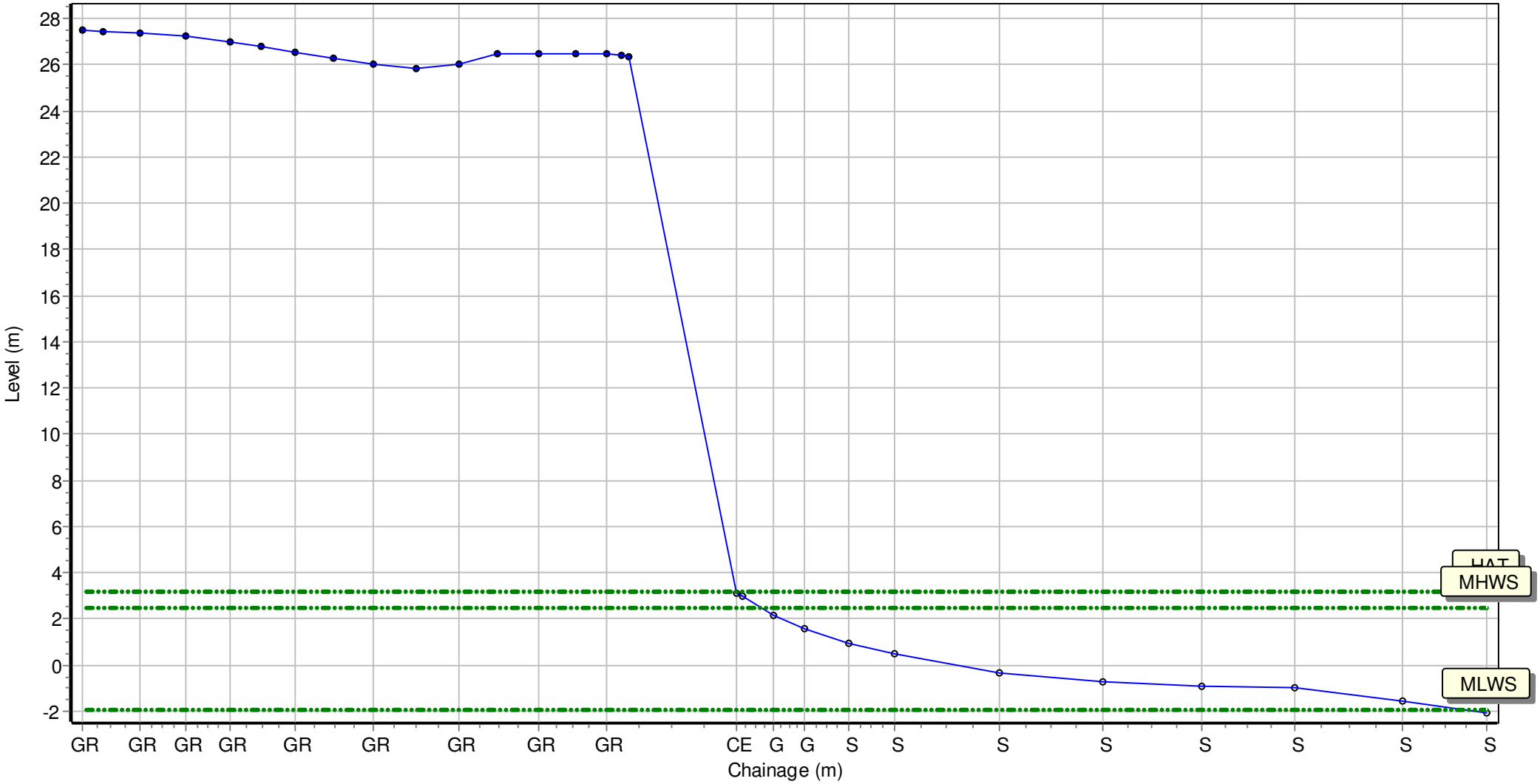
Location: **1bSNS32**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441771.5 **Northing:** 552485.732 **Profile Bearing:** 60 ° from North



Beach Profile

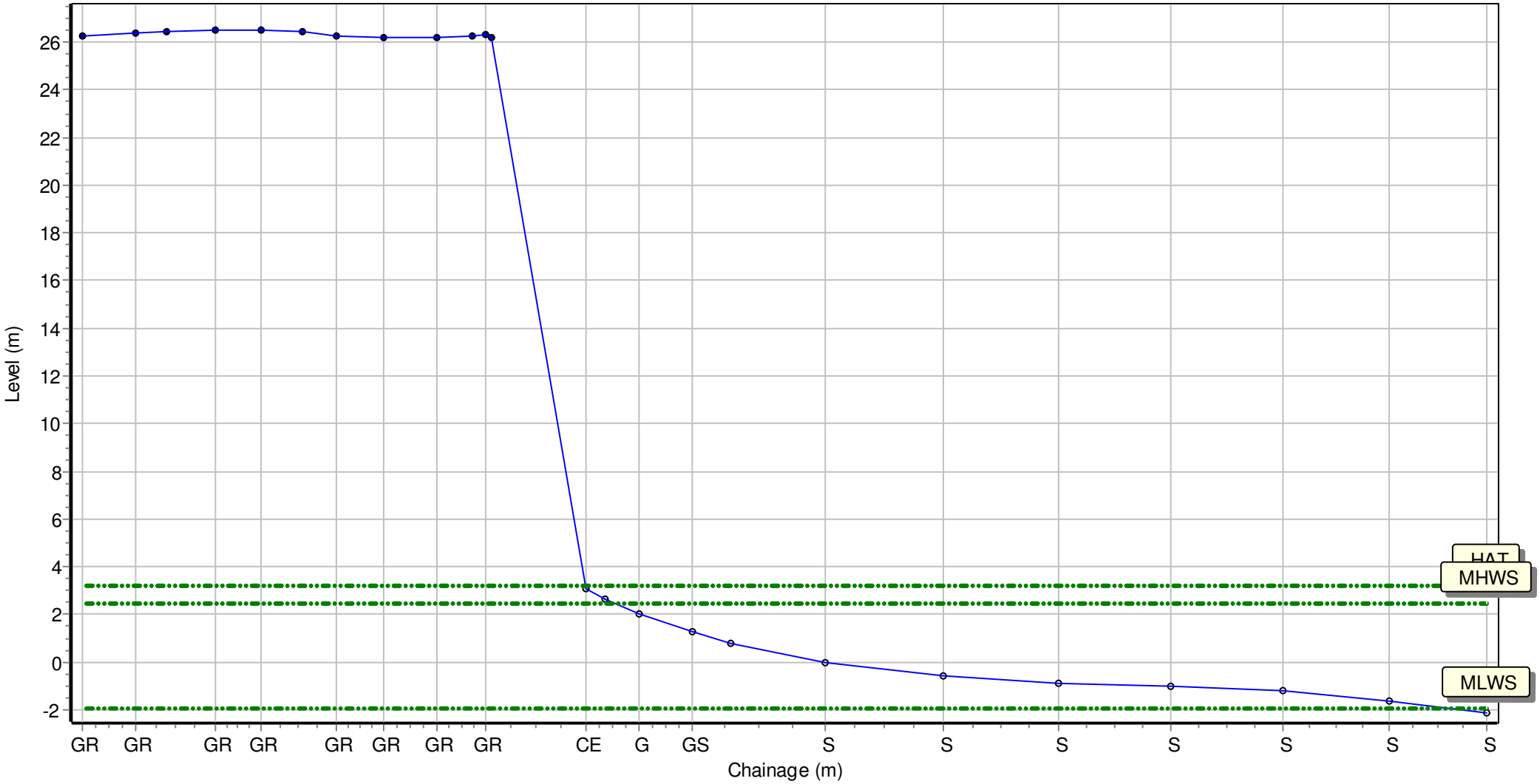
Location: **1bSNS33**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441841.104 **Northing:** 552454.571 **Profile Bearing:** 37 ° from North



Beach Profile

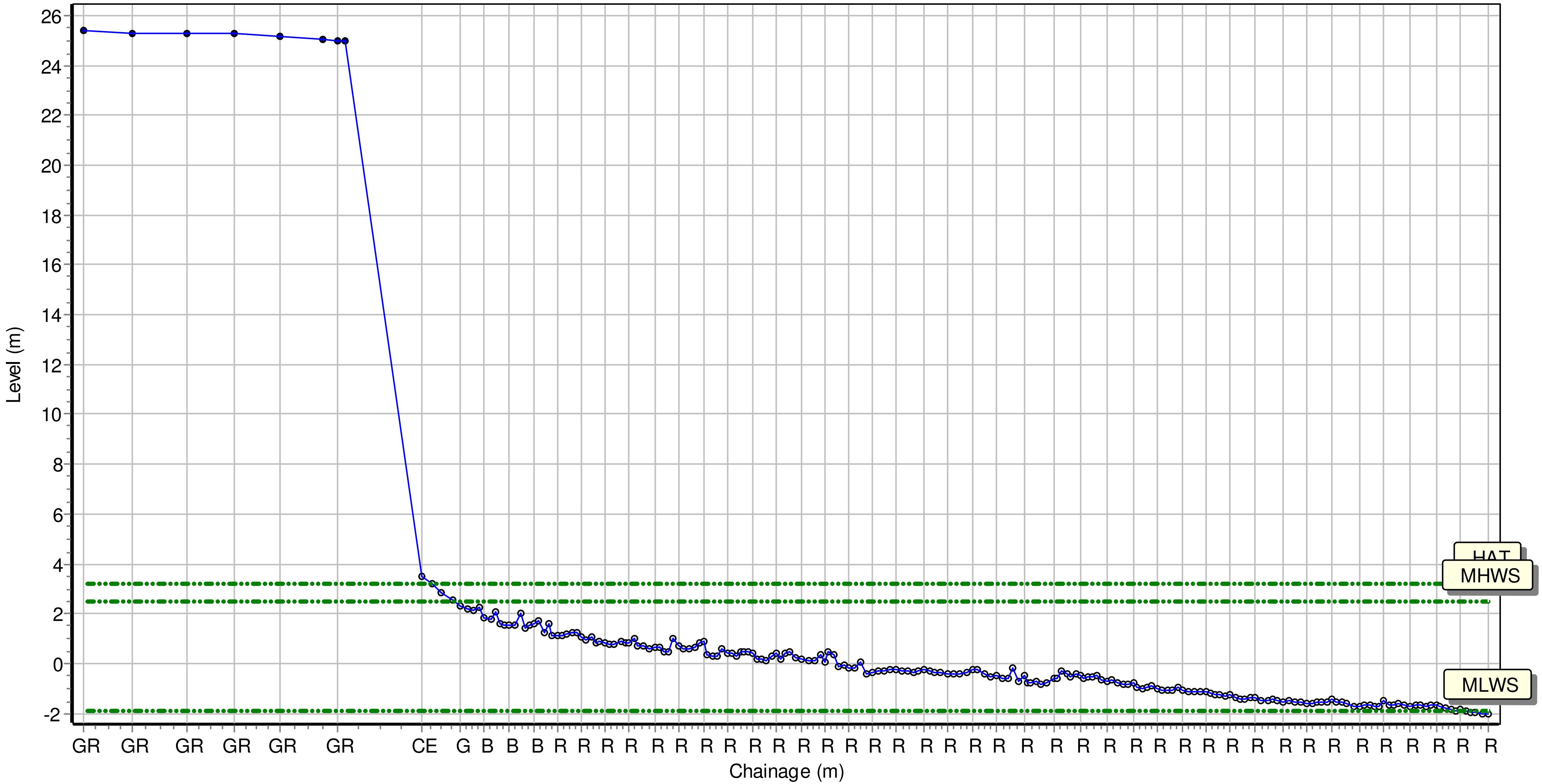
Location: **1bSNS34**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441901.161 **Northing:** 552284.09 **Profile Bearing:** 102 ° from North



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Beach Profile

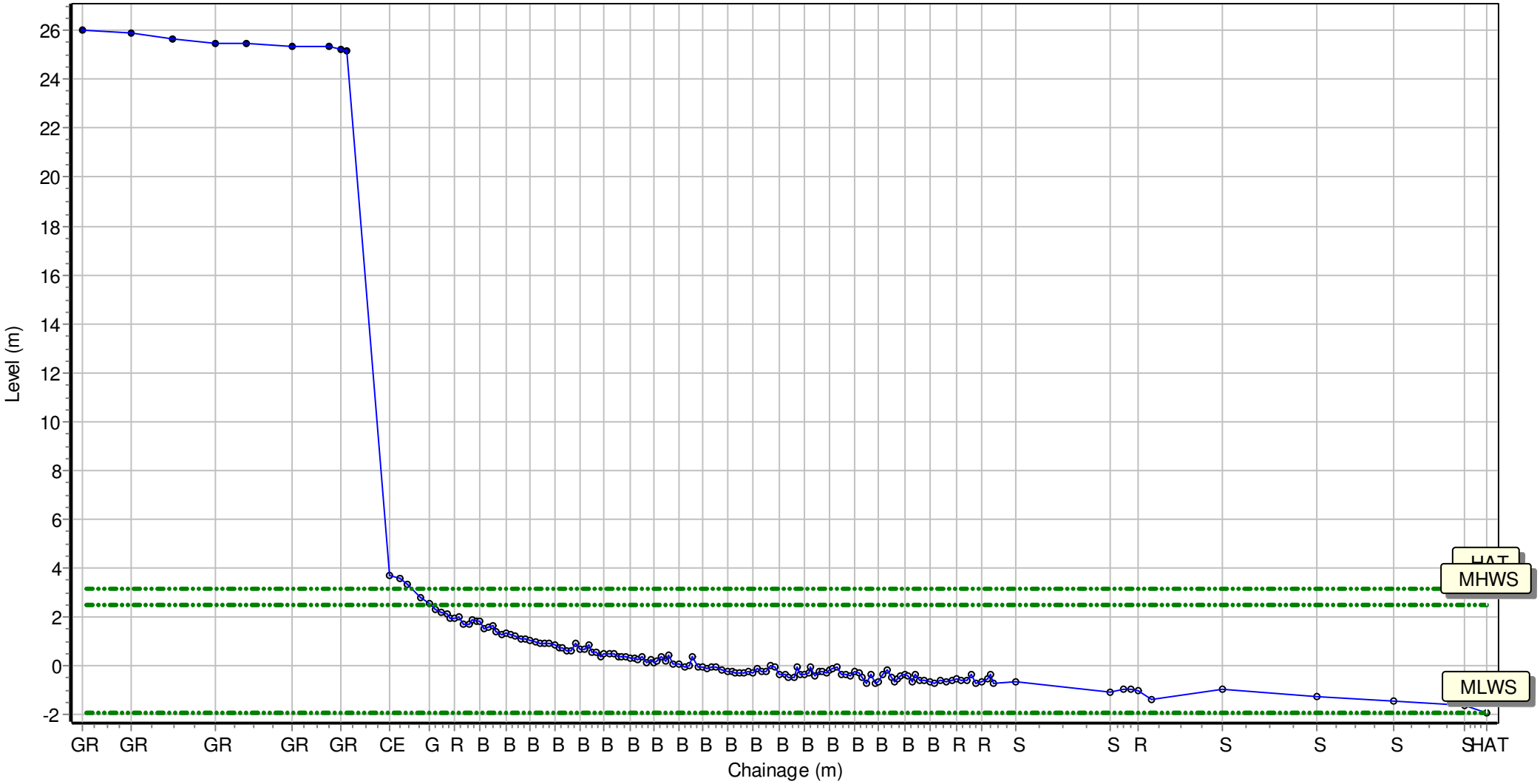
Location: **1bSNS35**

Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441844.023 **Northing:** 552163.994 **Profile Bearing:** 111 ° from North



Beach Profile

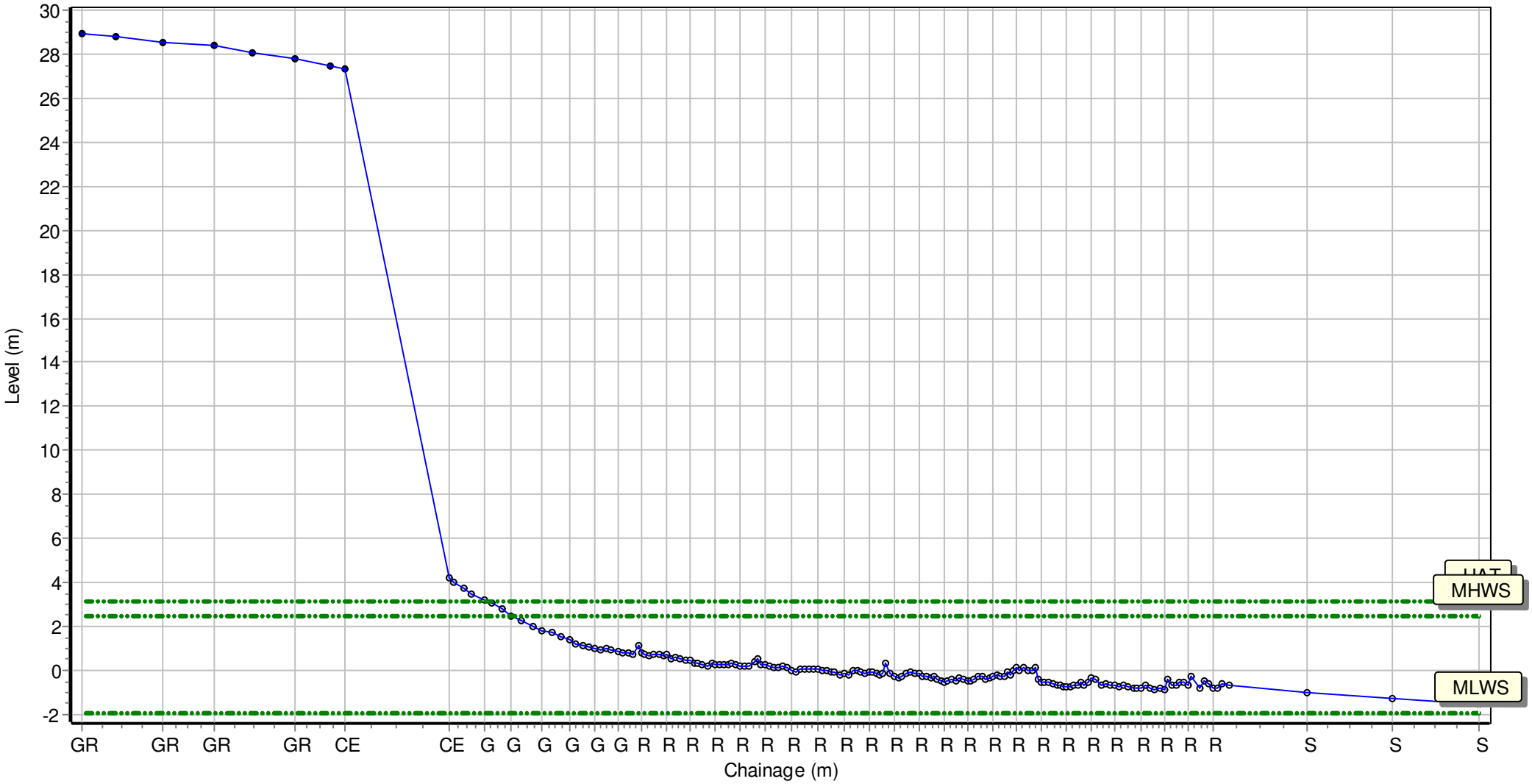
Location: **1bSNS36**

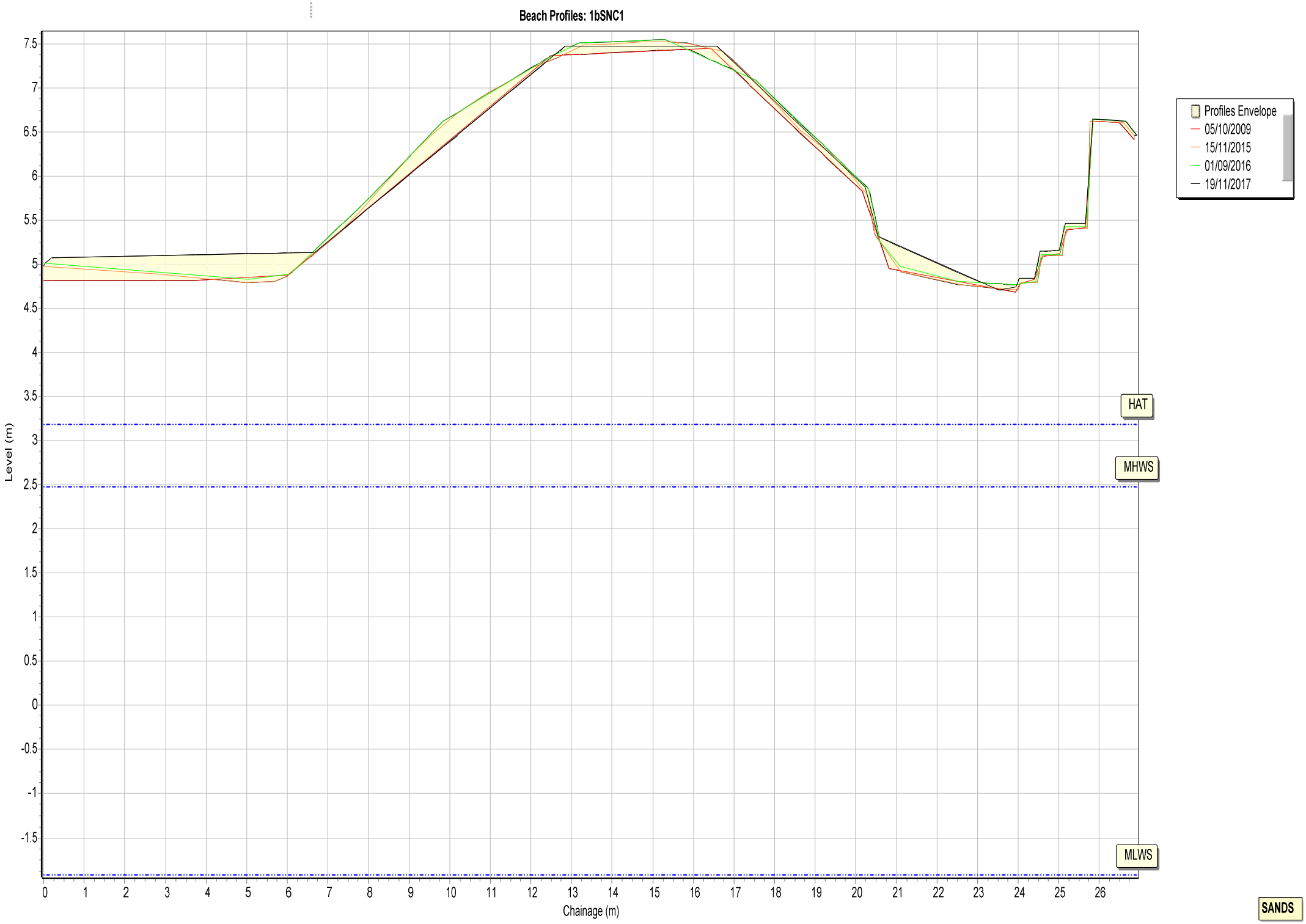
Date: 04/11/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Full Measures Topo Survey

Easting: 441853.315 **Northing:** 551983.836 **Profile Bearing:** 81 ° from North

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Chainage (m)
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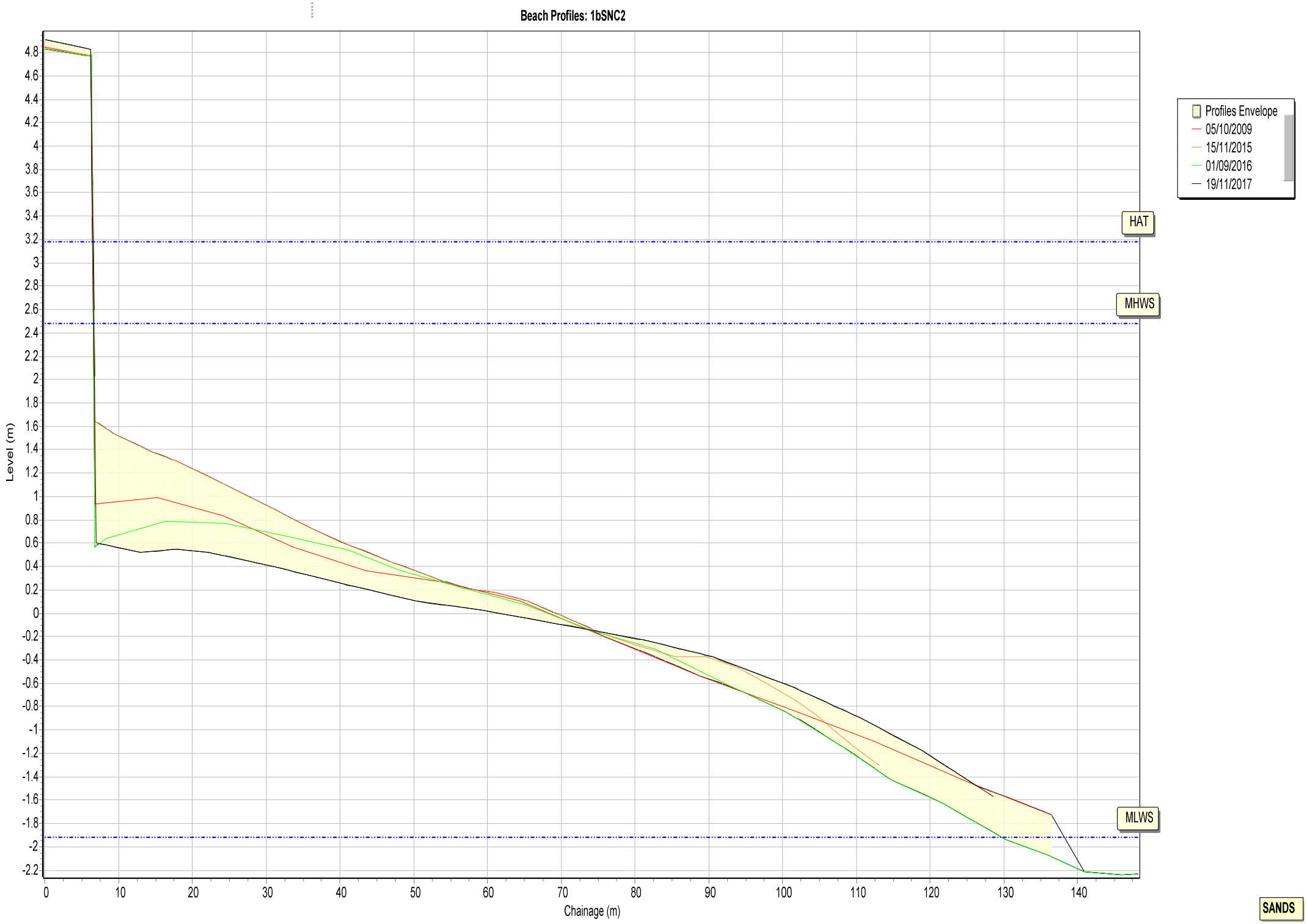
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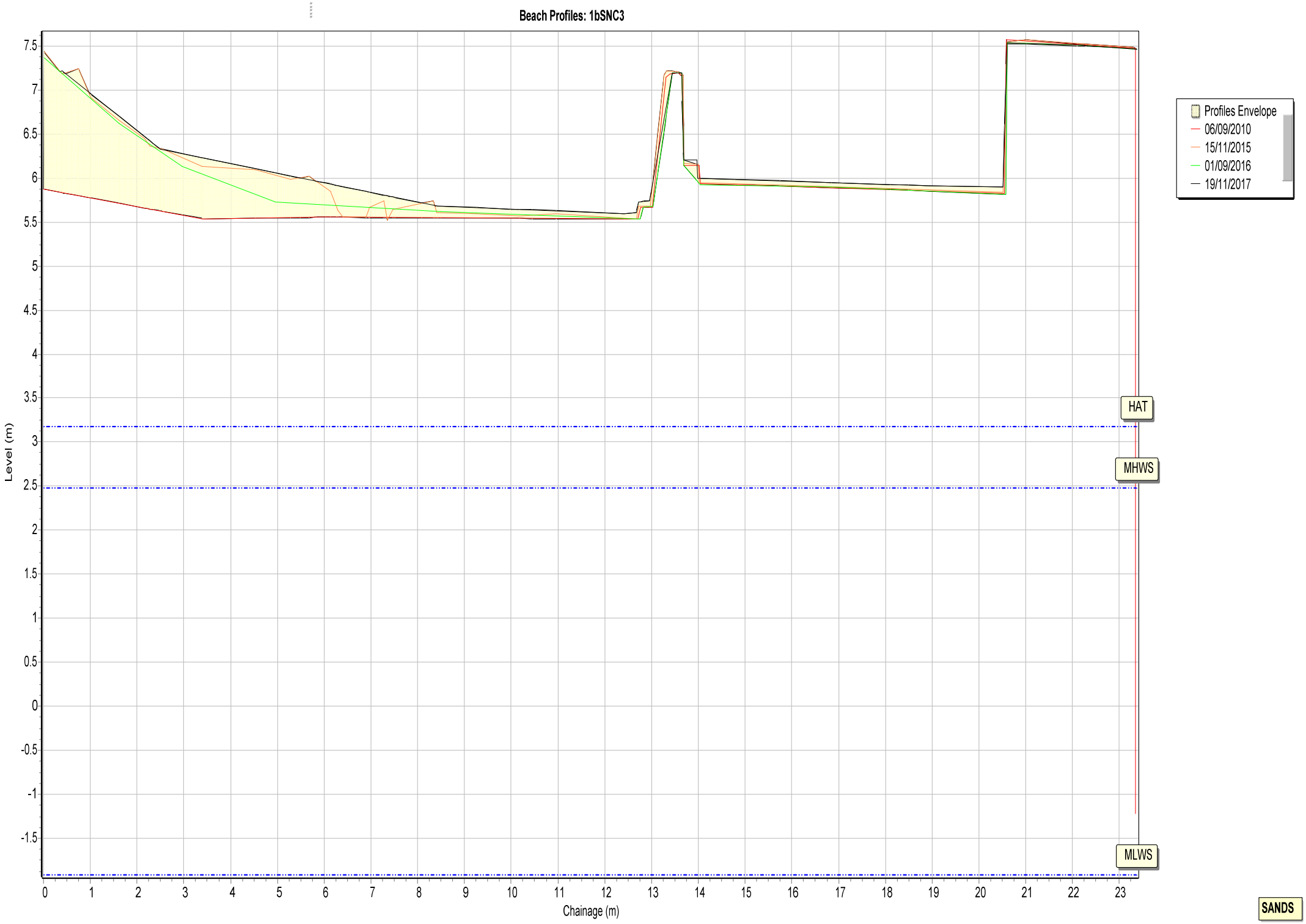
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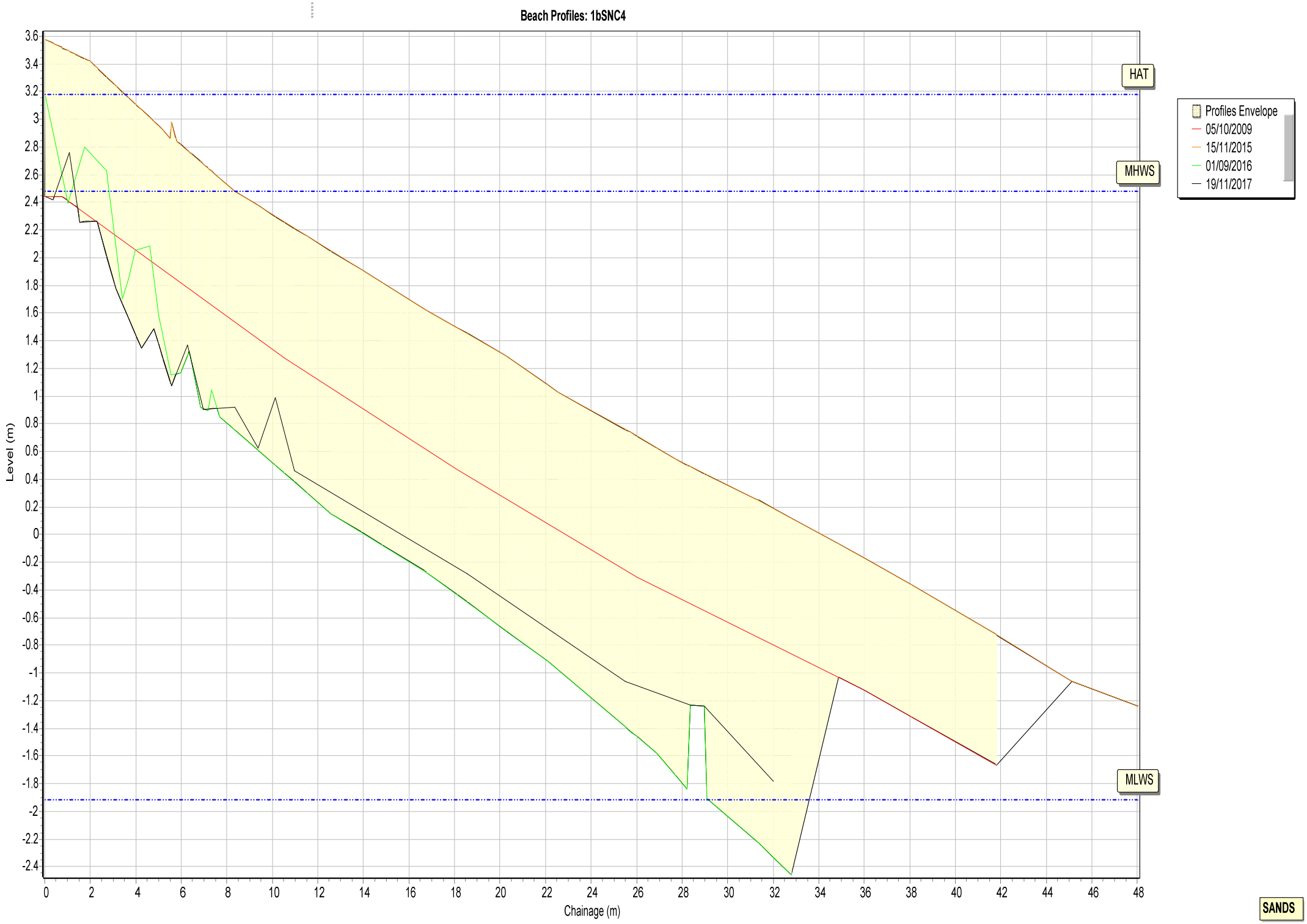
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Chainage (m)
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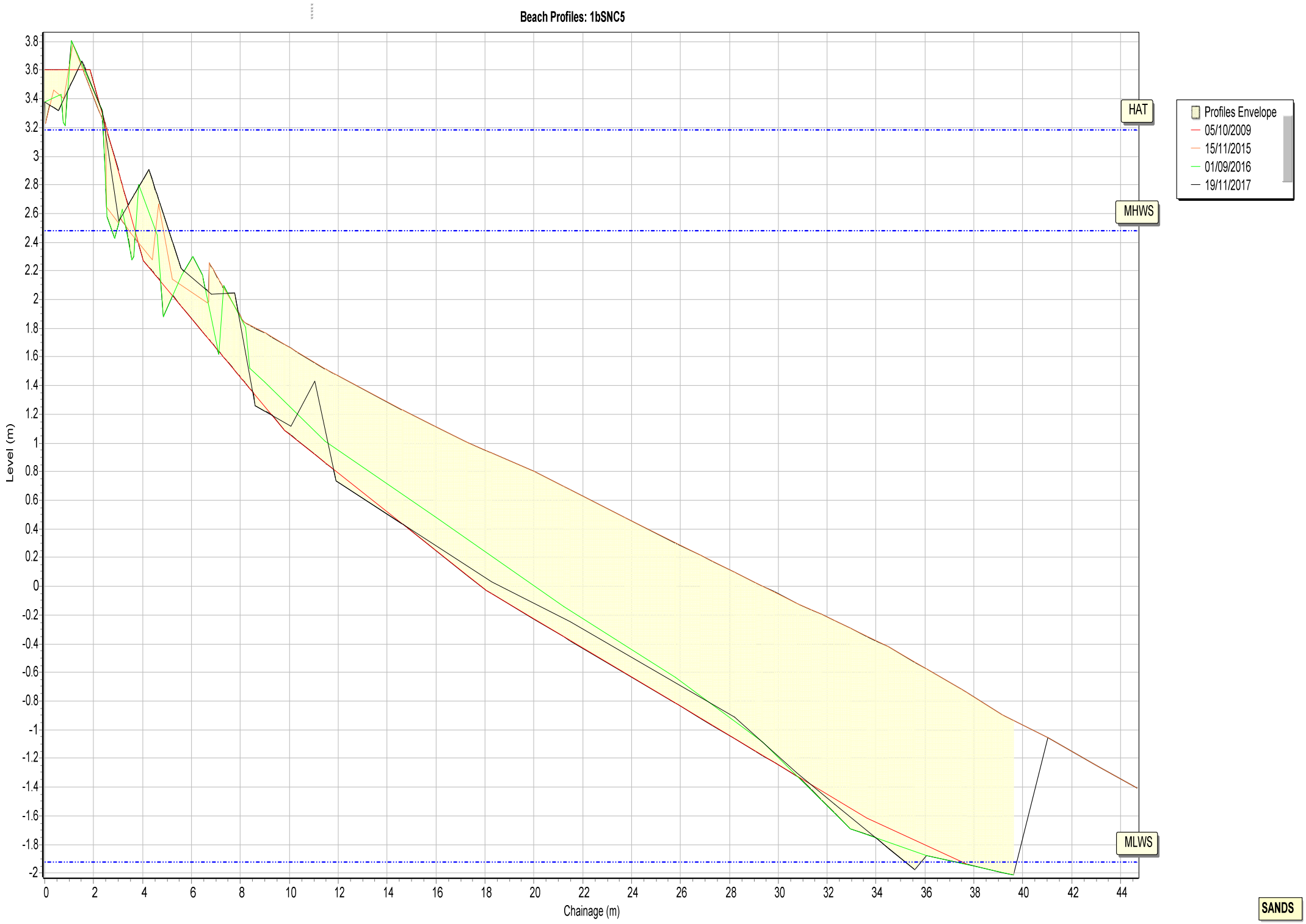
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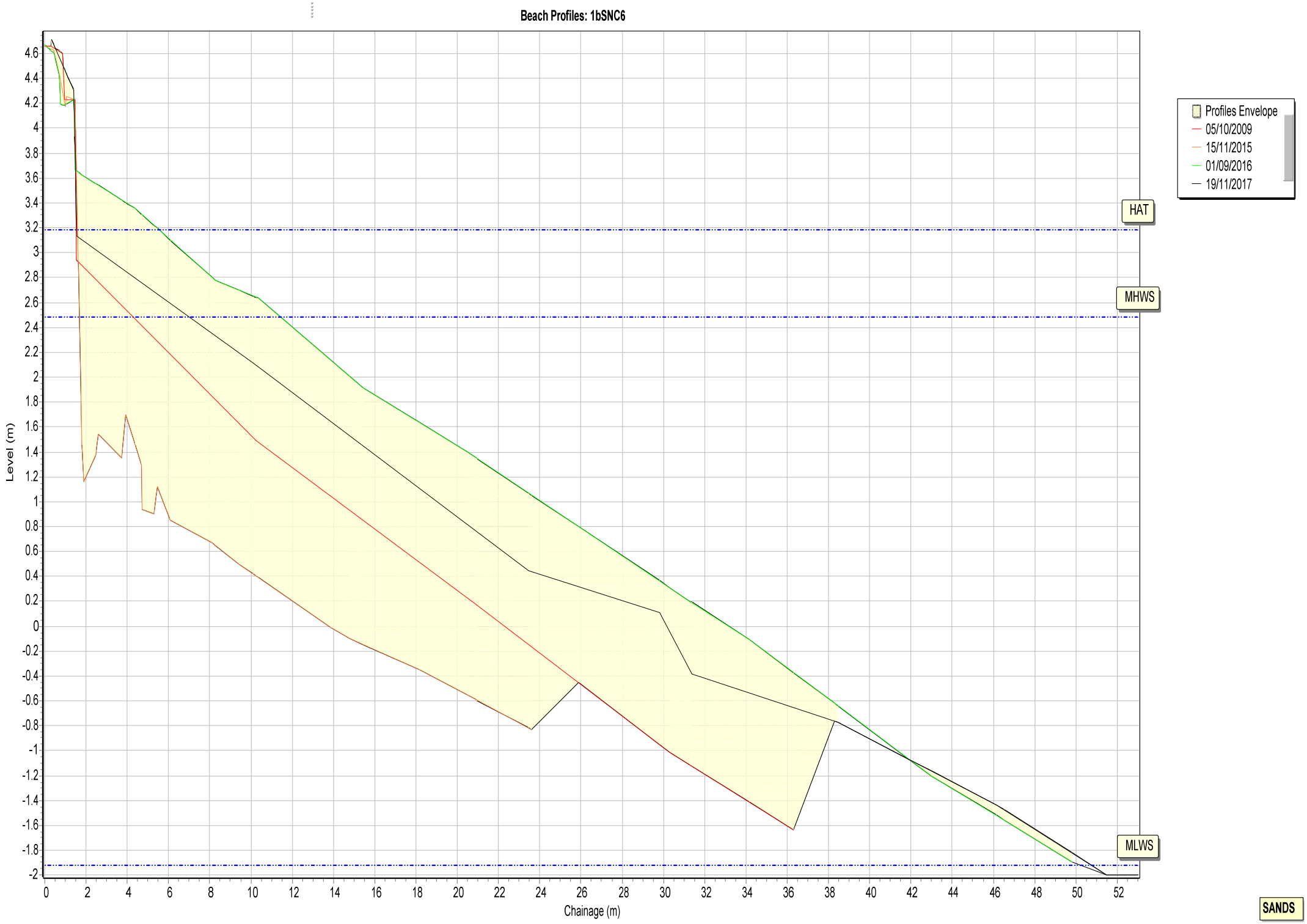
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Level (m)
Chainage (m)
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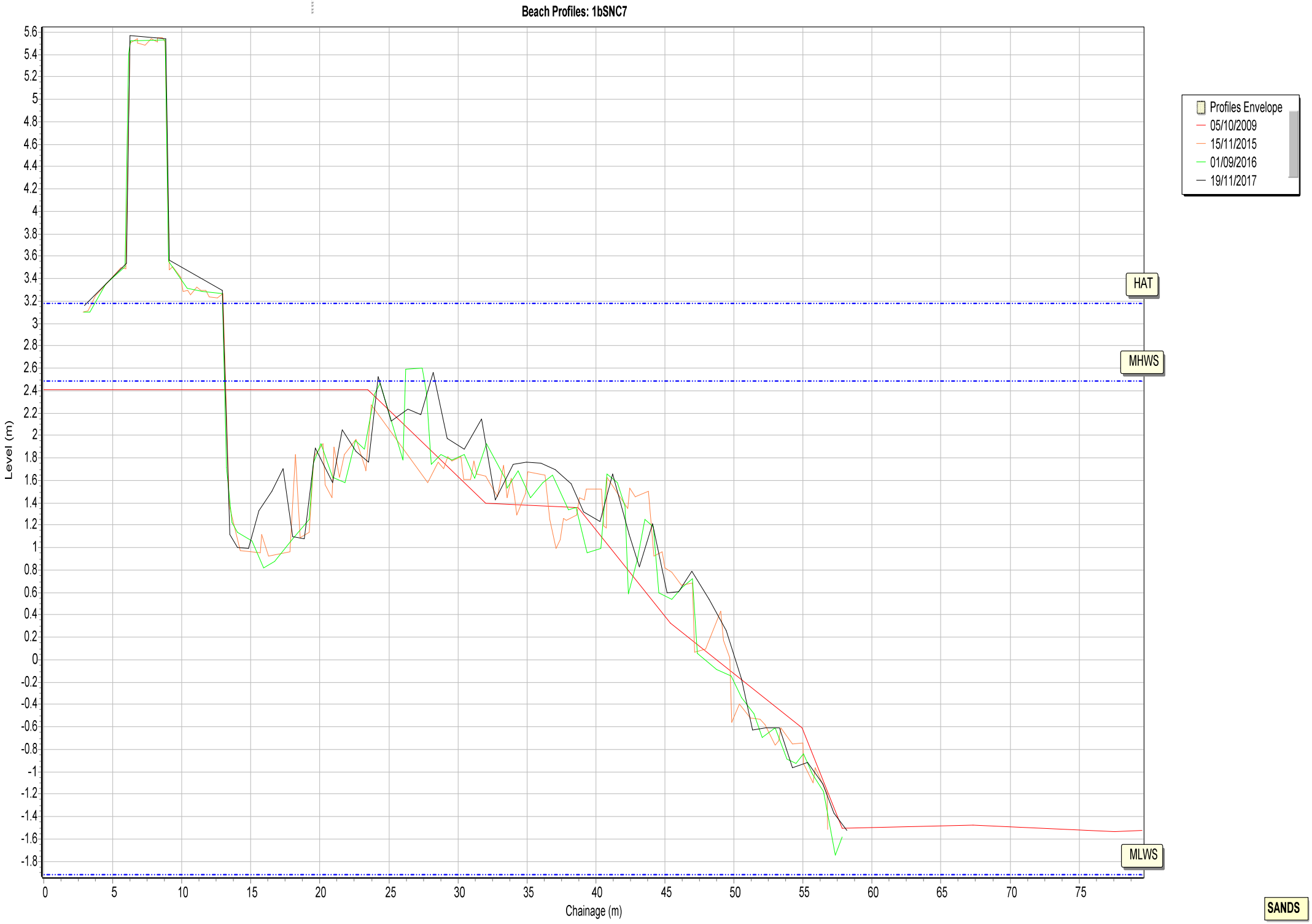
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MLWS
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1.4
1.2
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0.6
0.4
0.2
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-1.4
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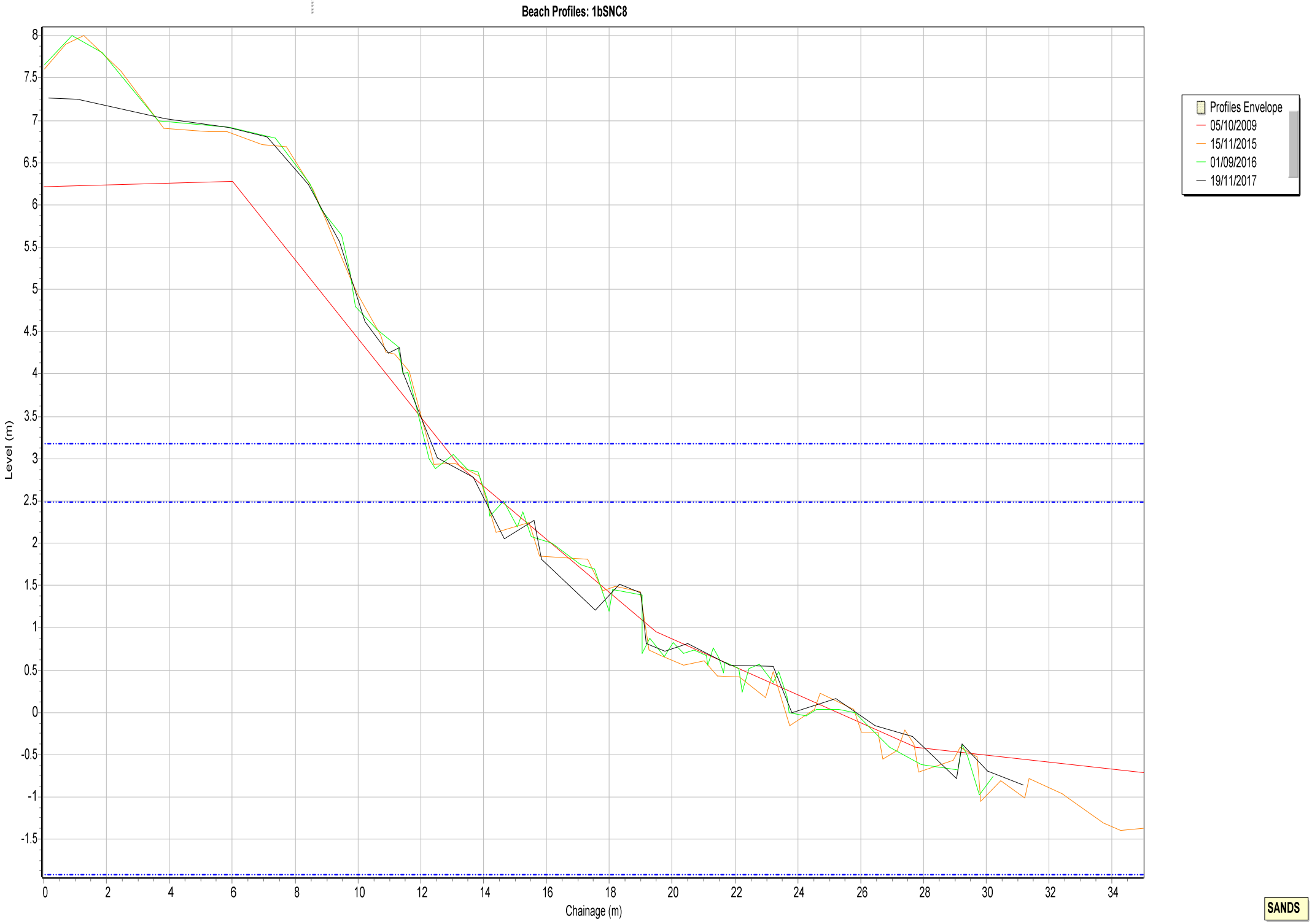
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Chainage (m)
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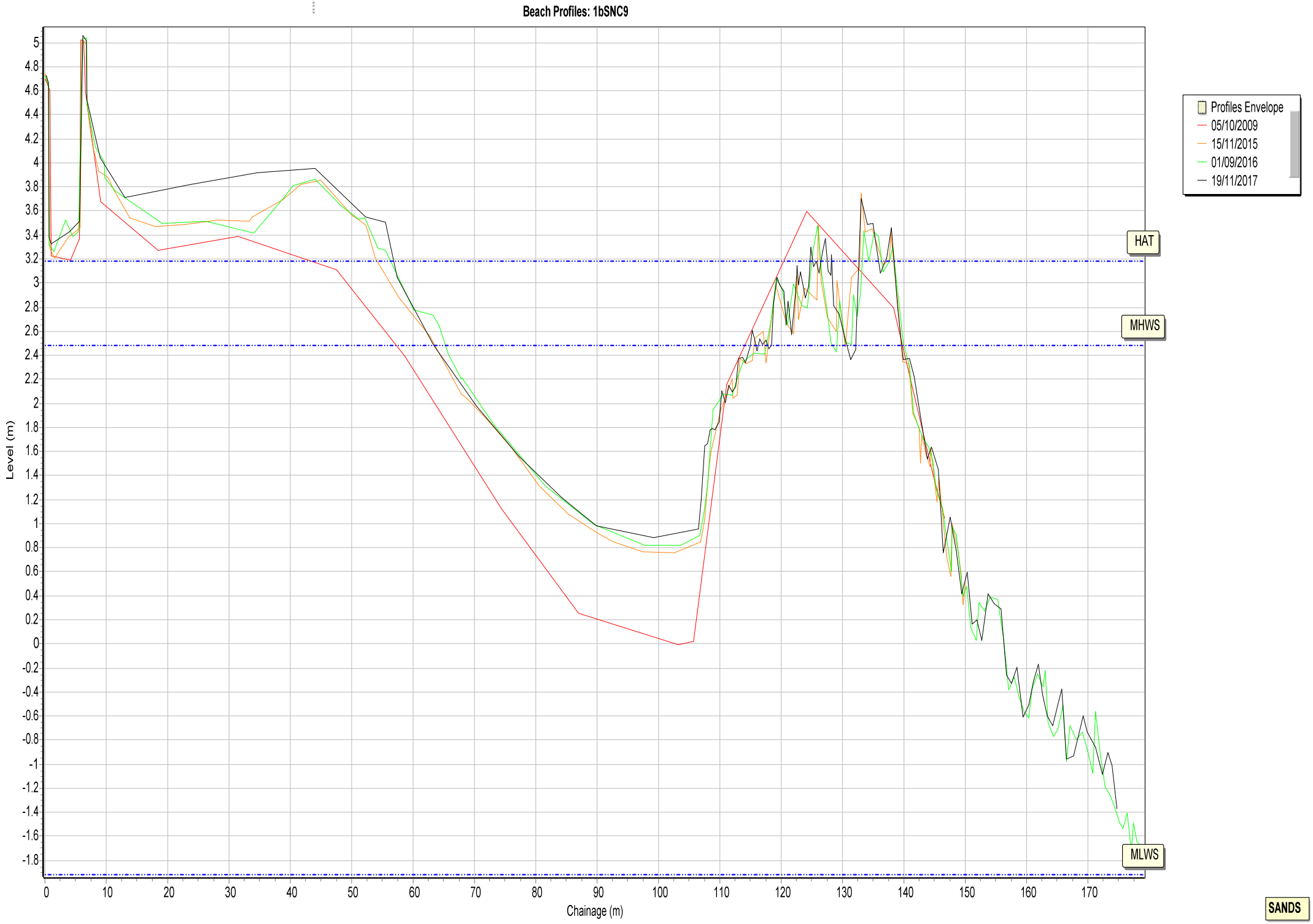
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Chainage (m)
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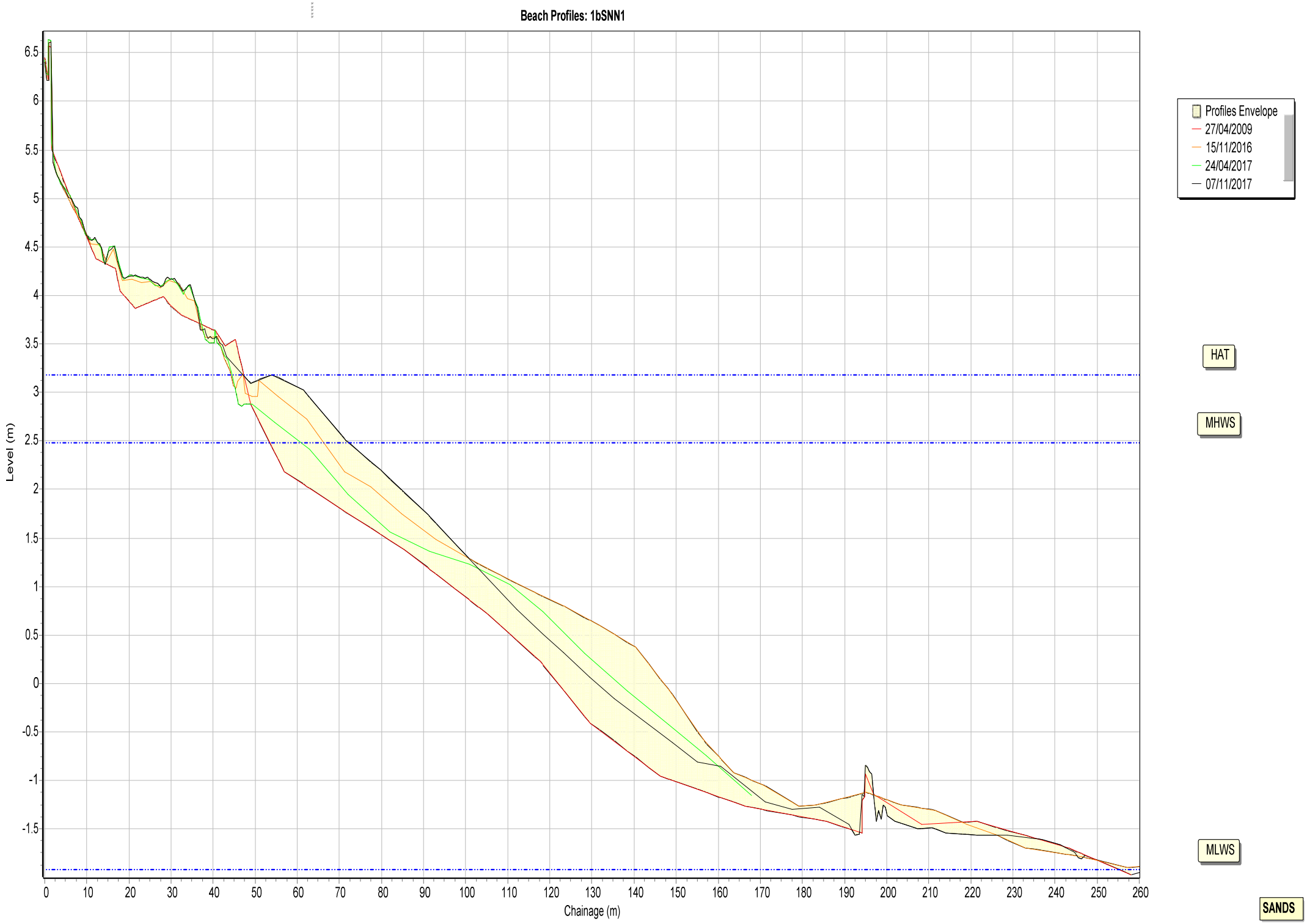
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Chainage (m)
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5.5
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4.5
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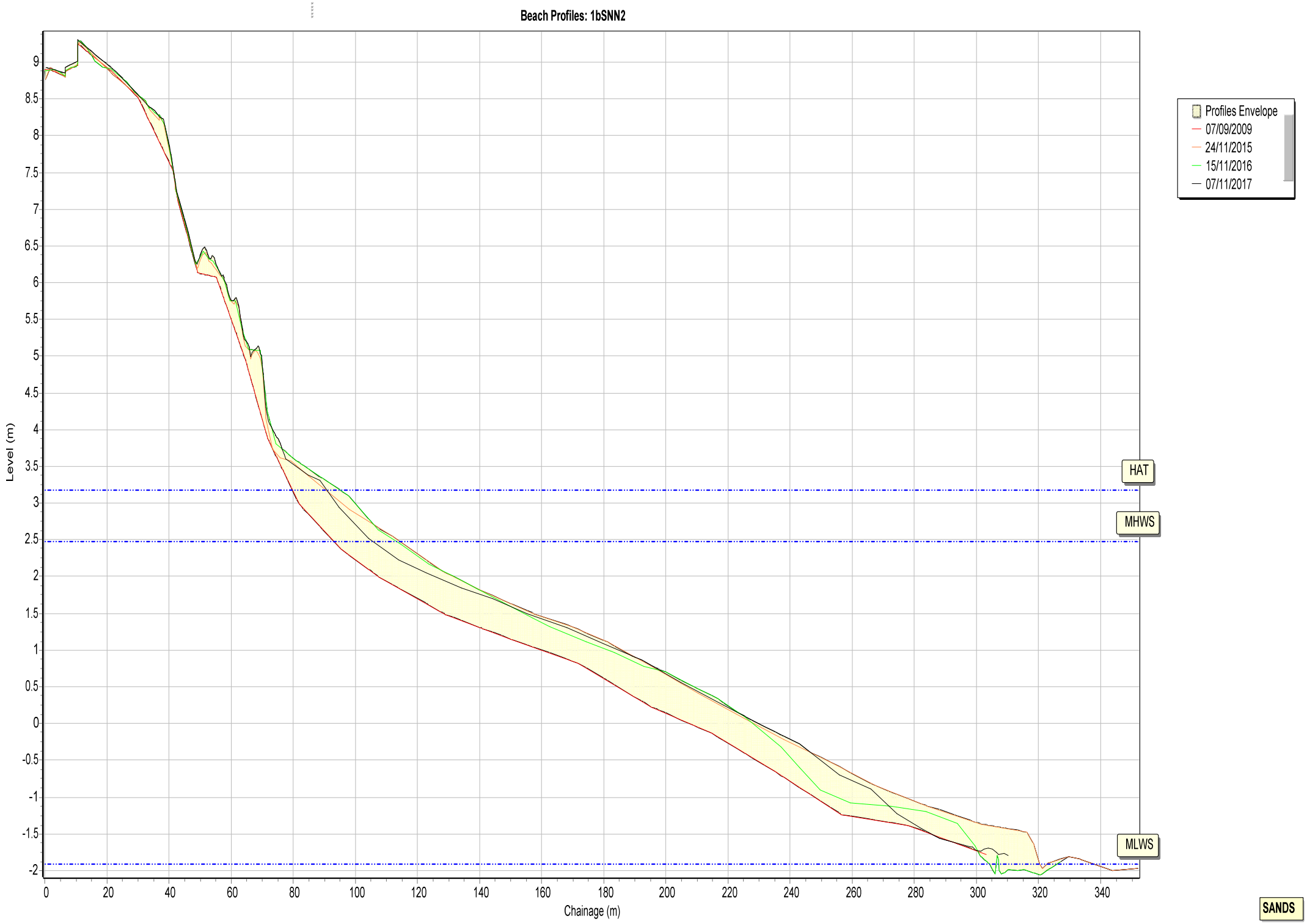
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HAT
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MLWS
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Chainage (m)
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7.5
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6.5
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5.5
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4.5
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3.5
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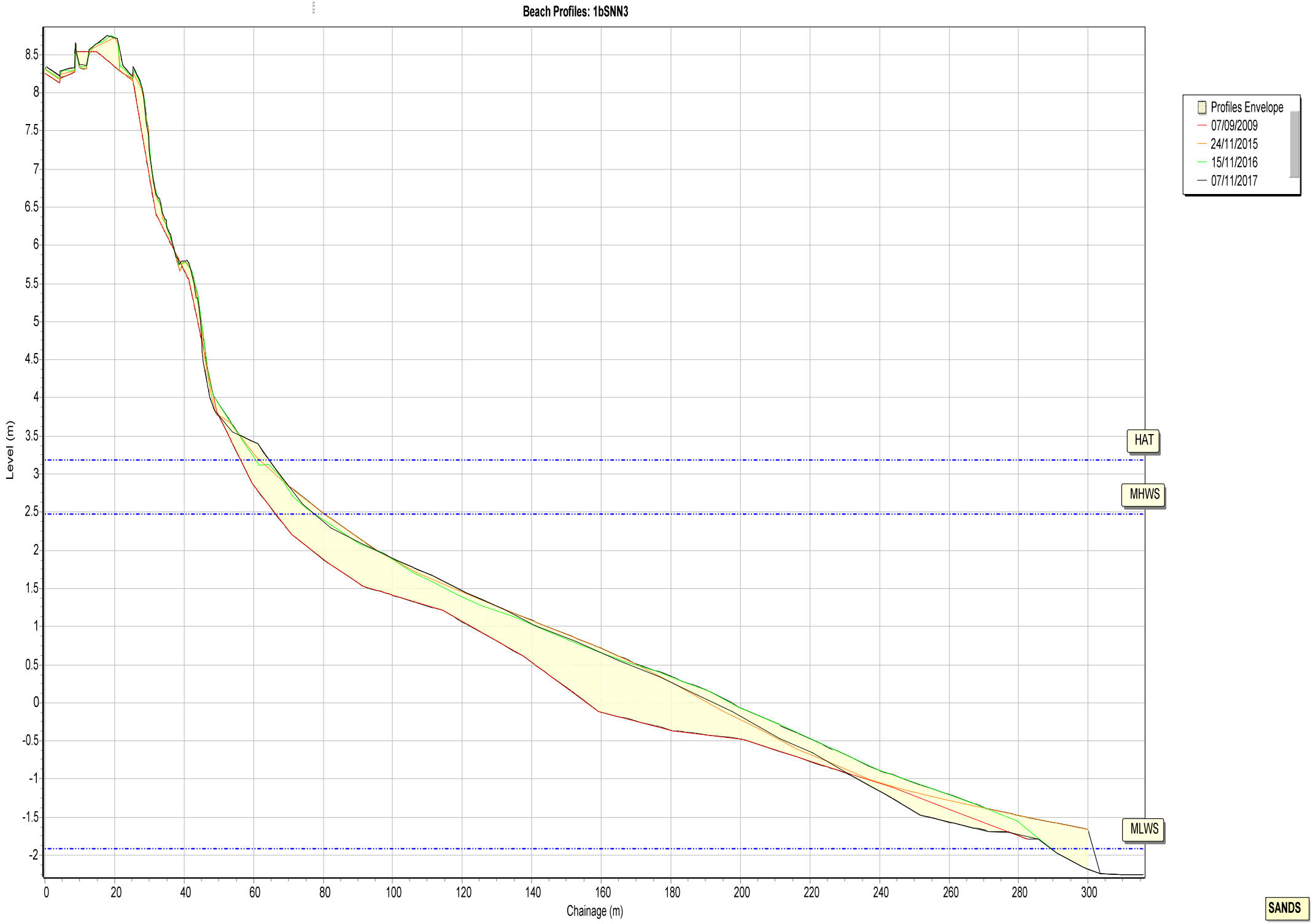
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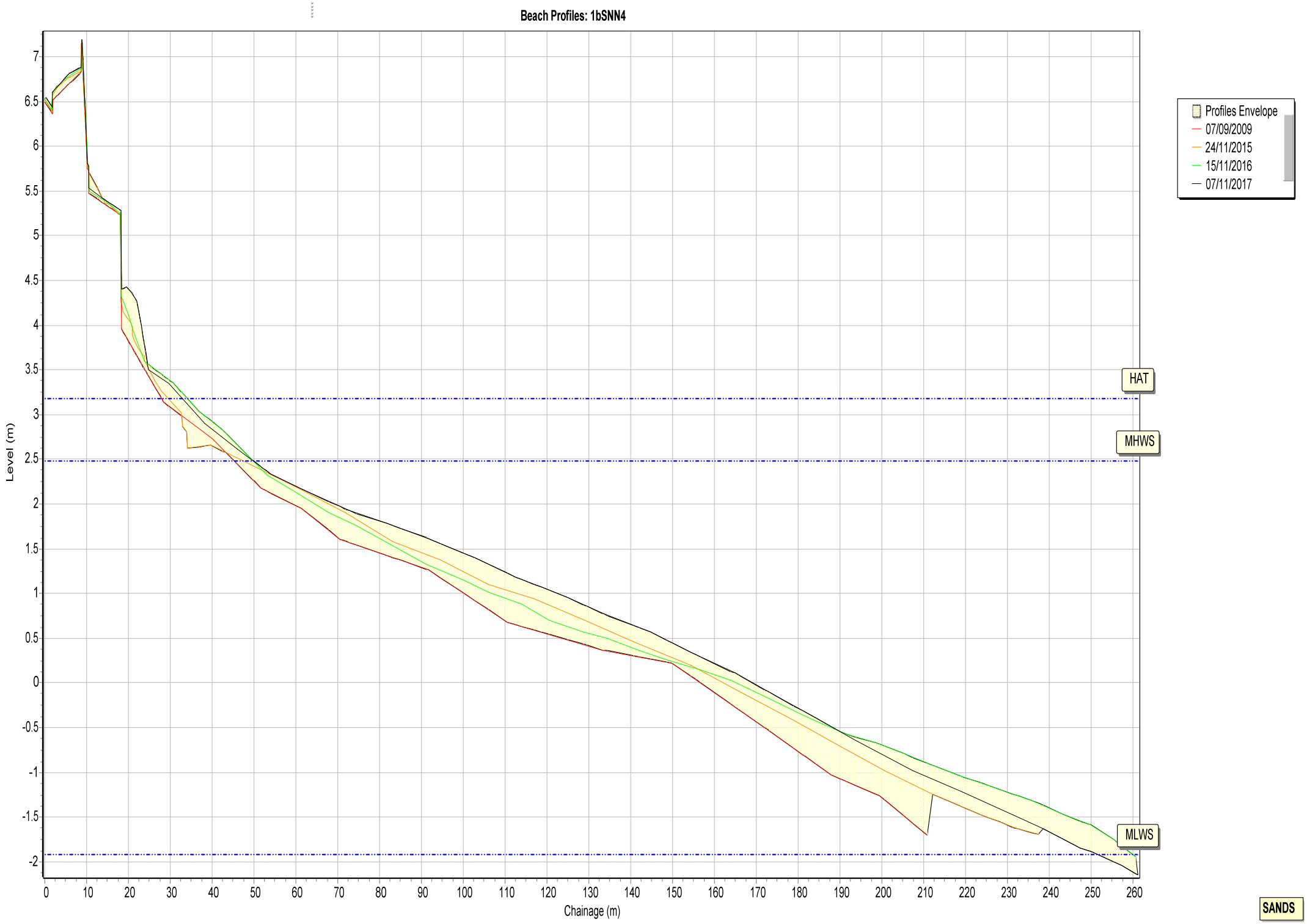
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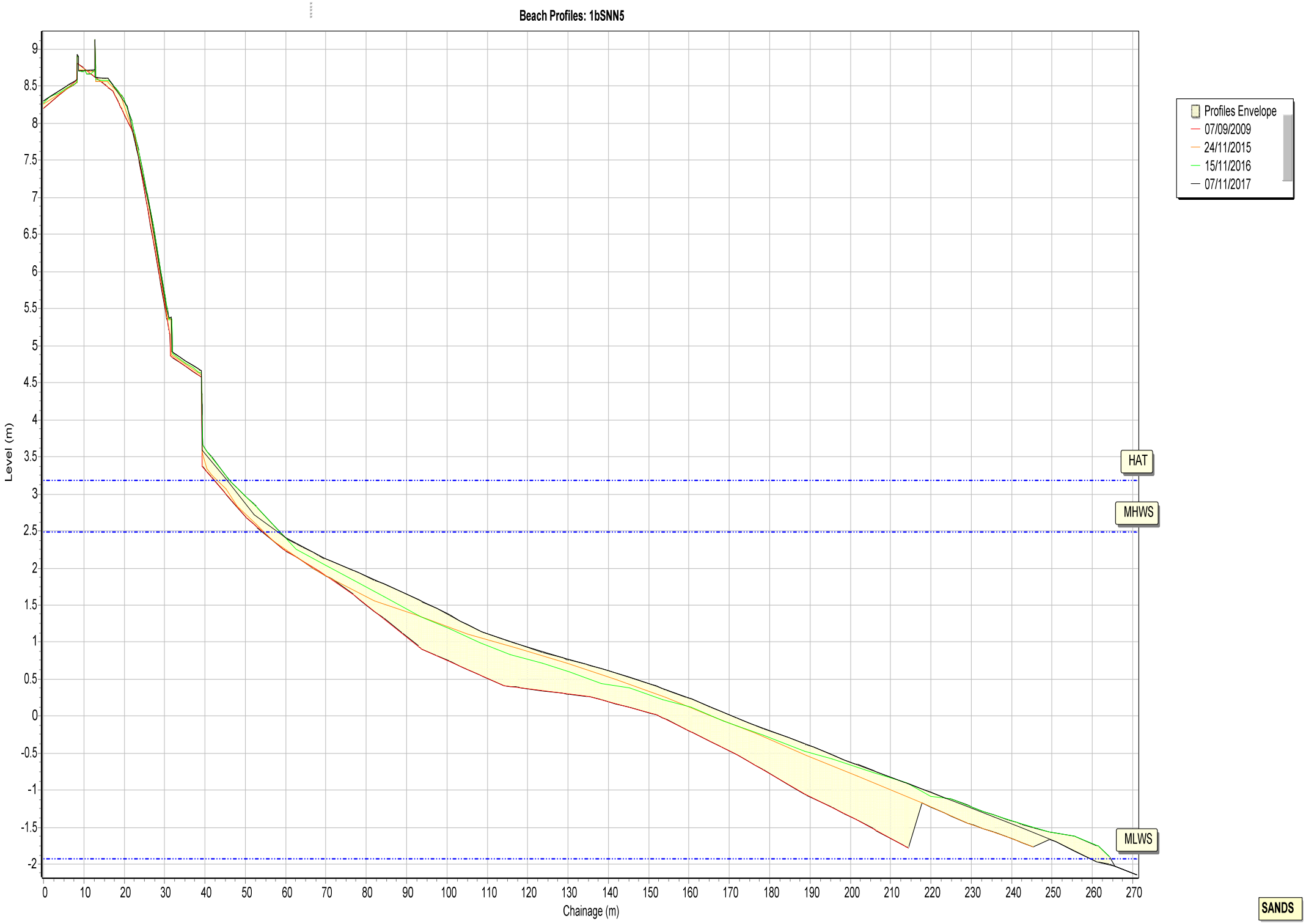
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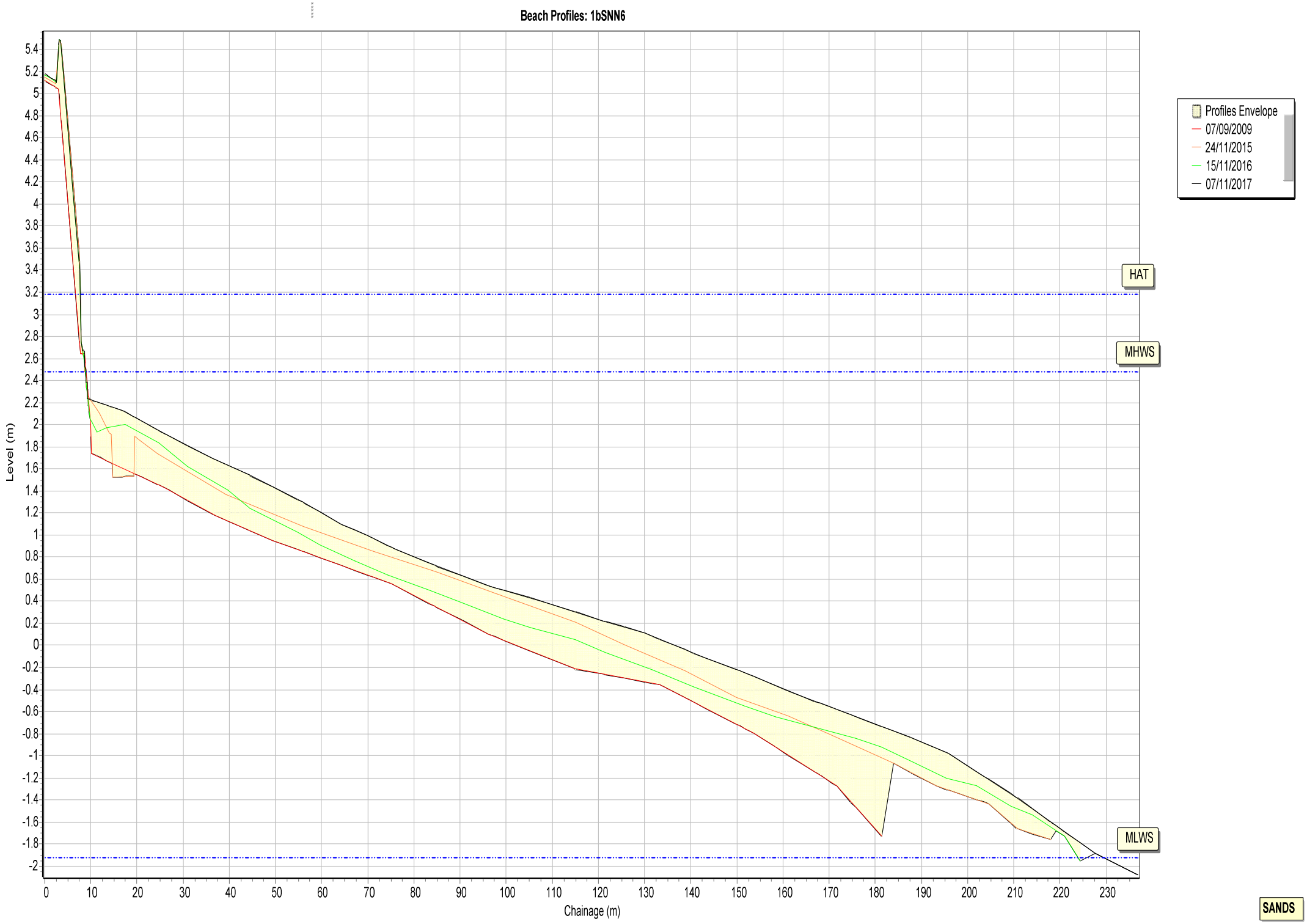
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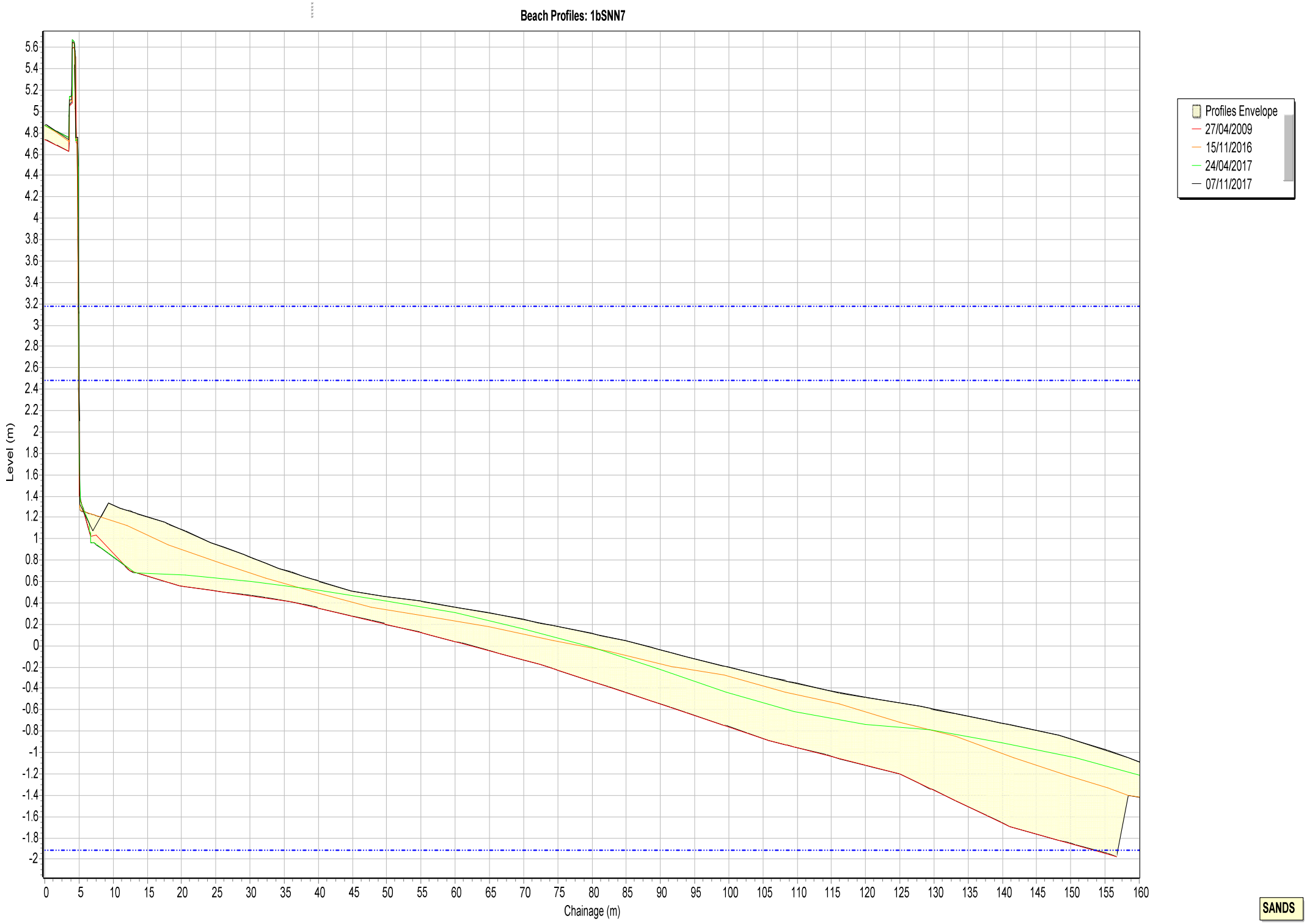
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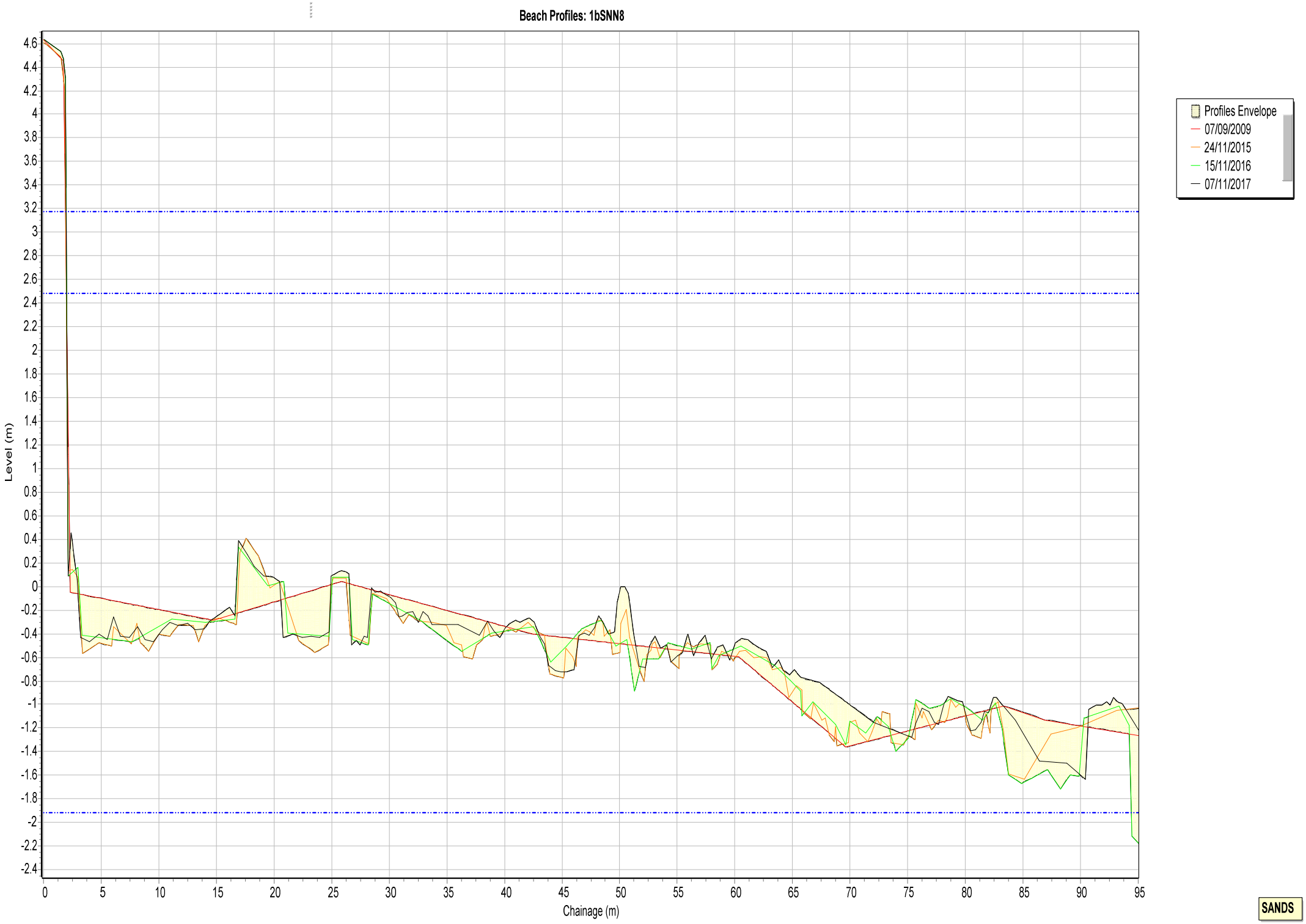
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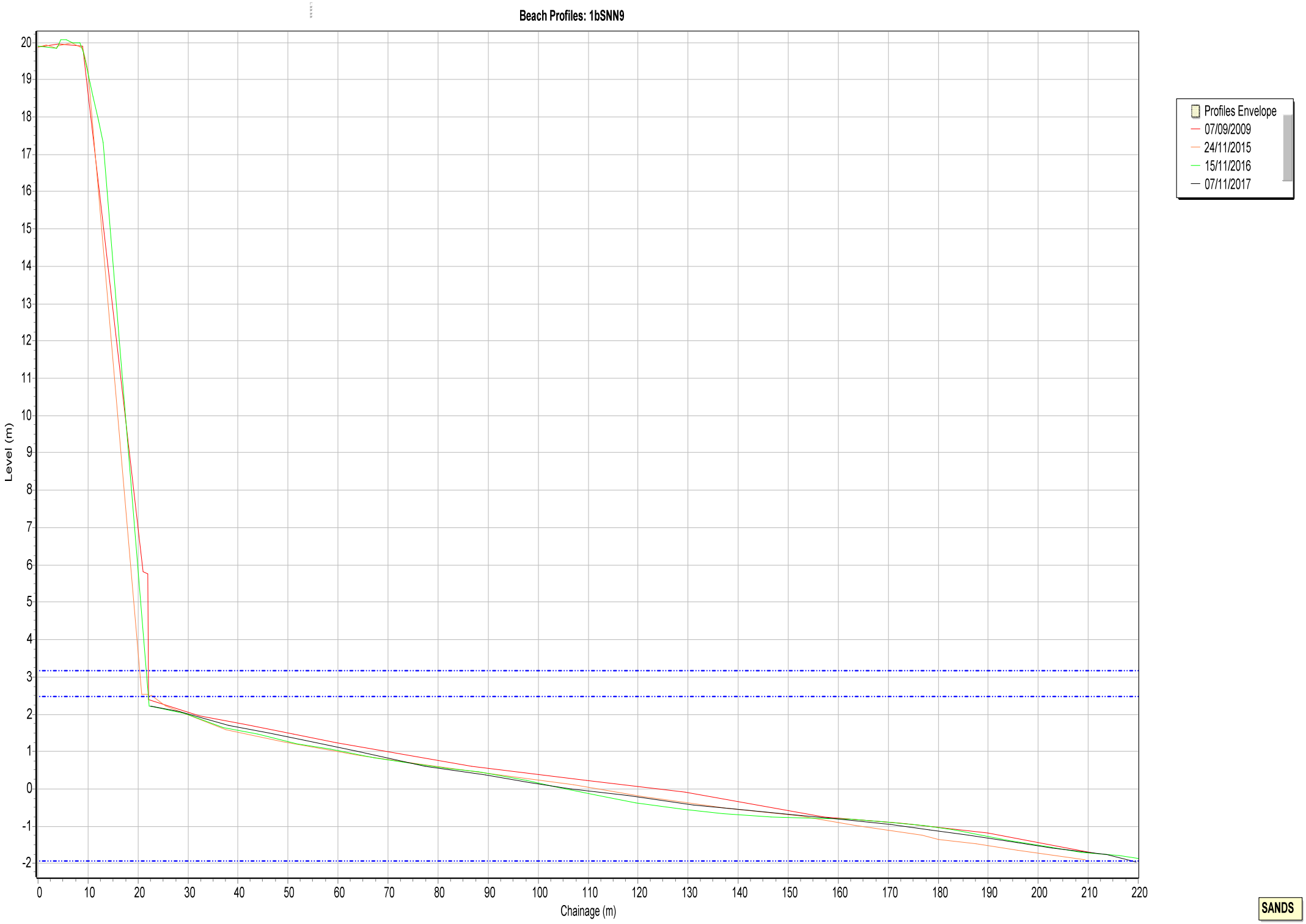
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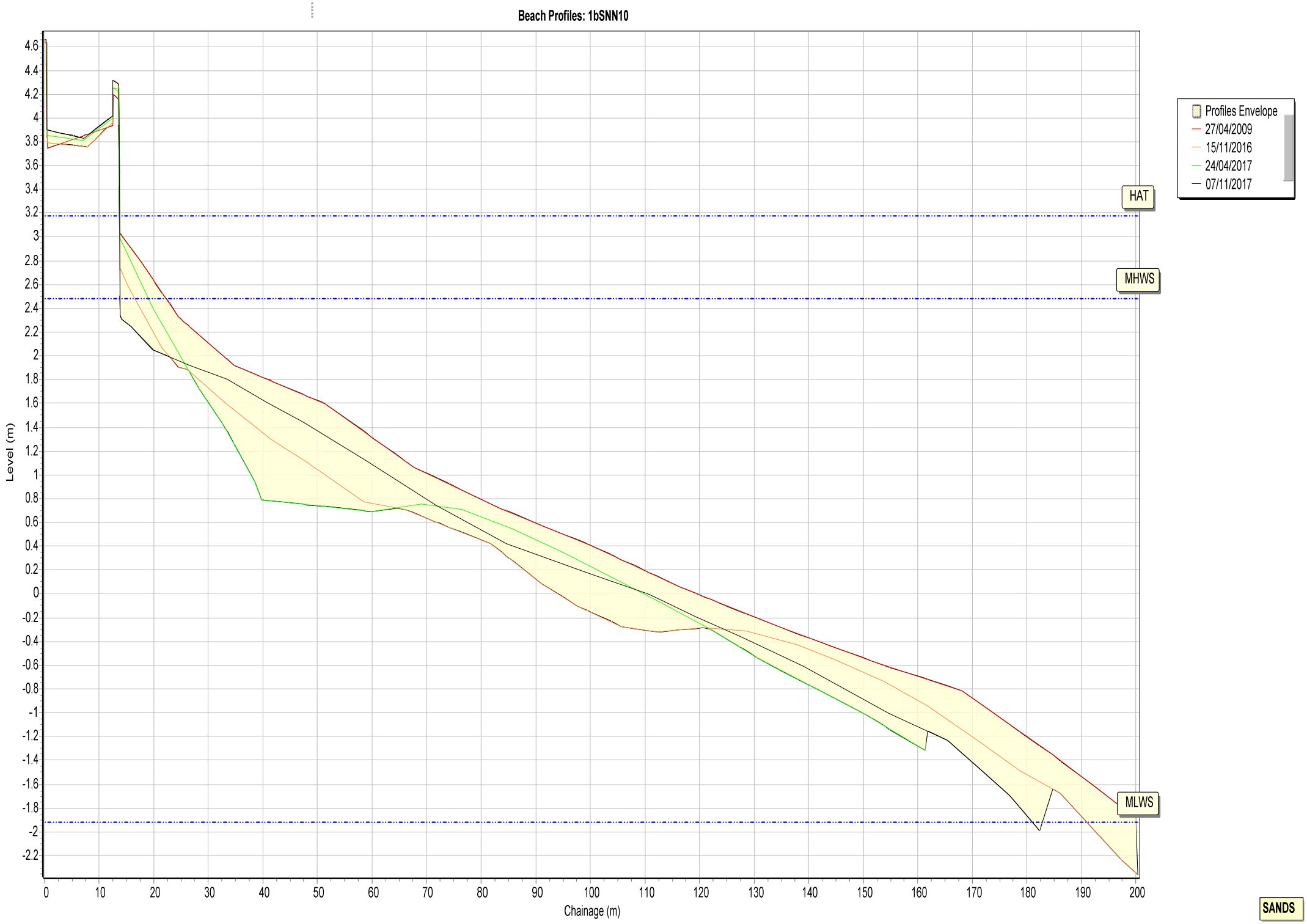
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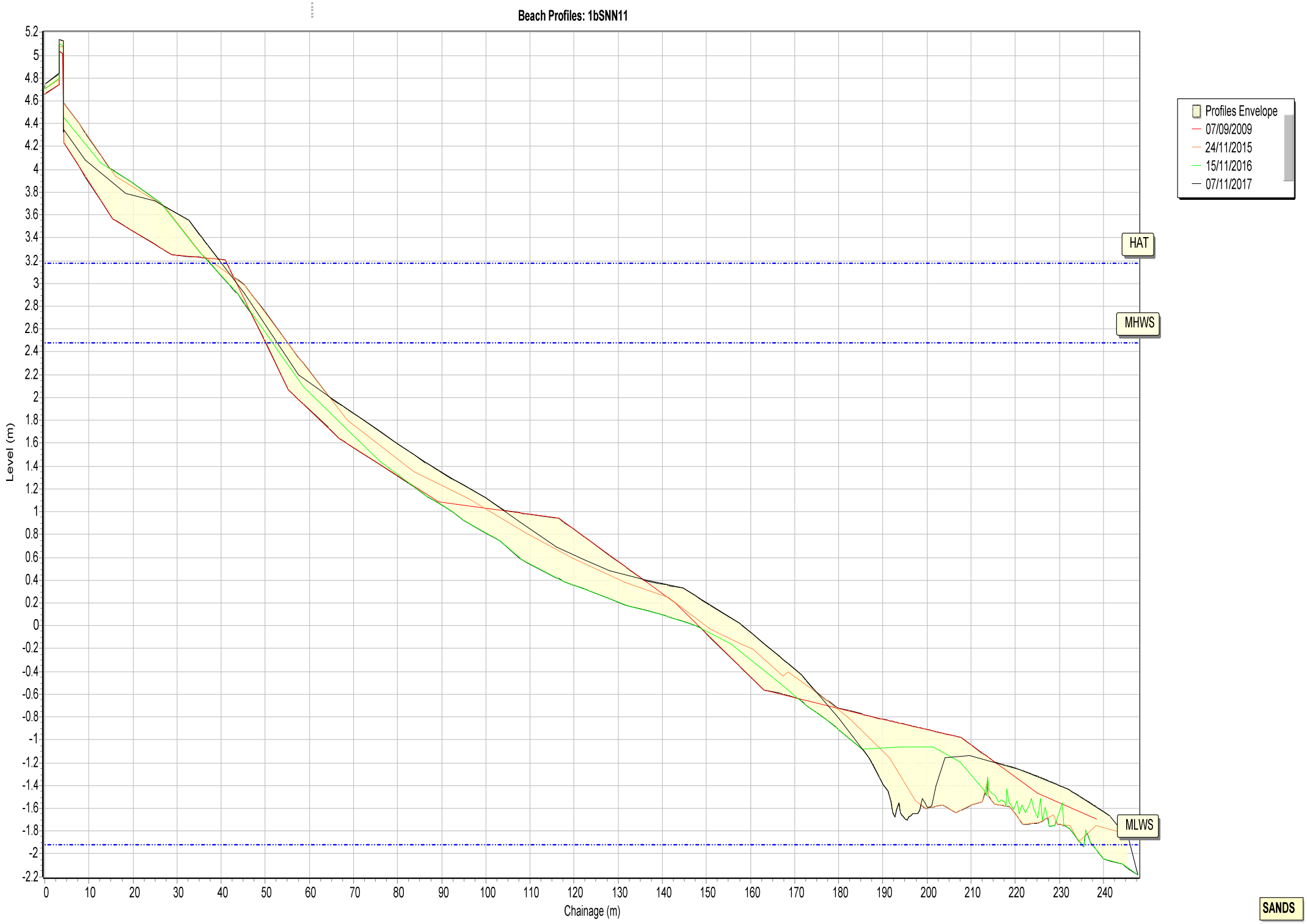
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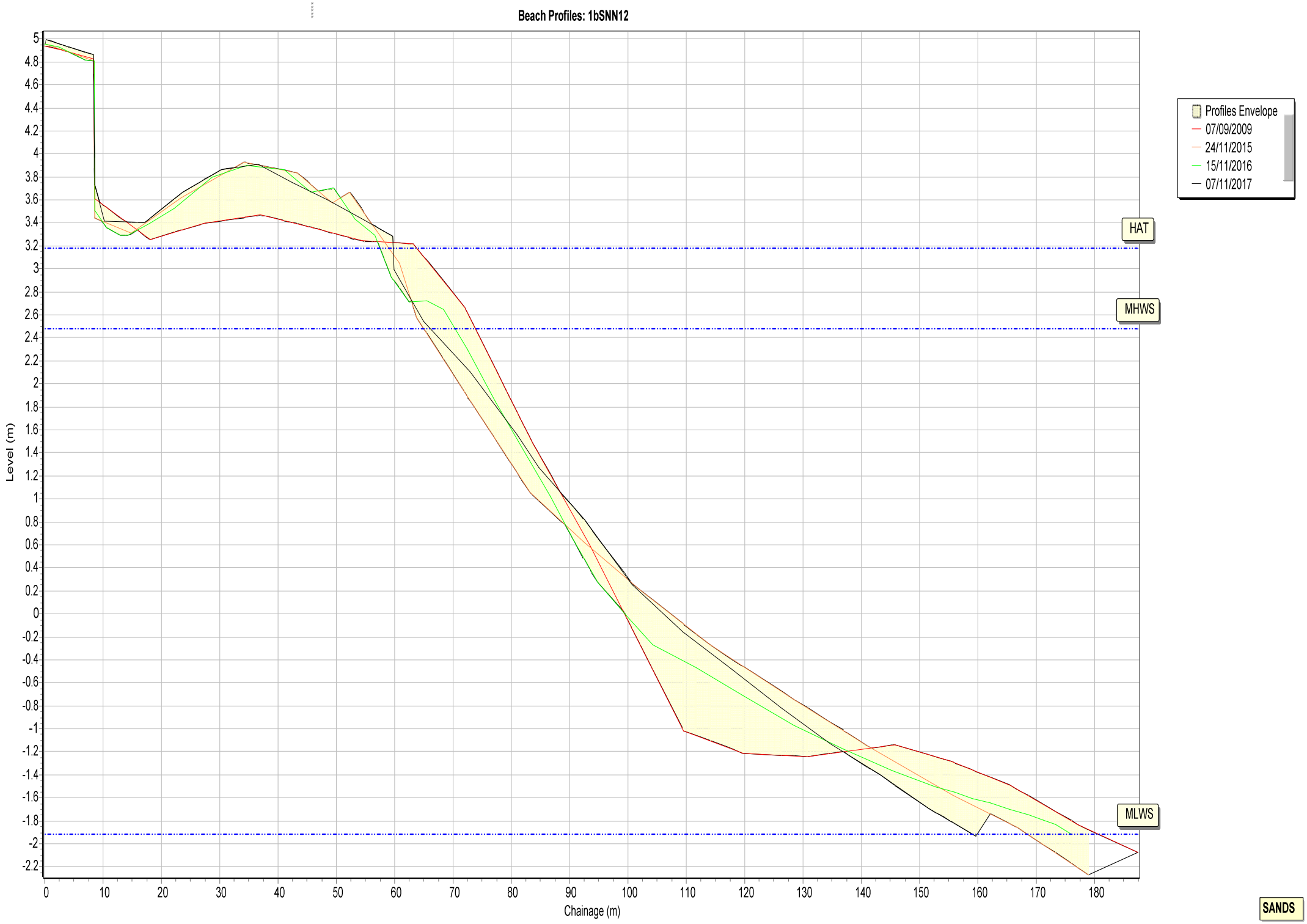
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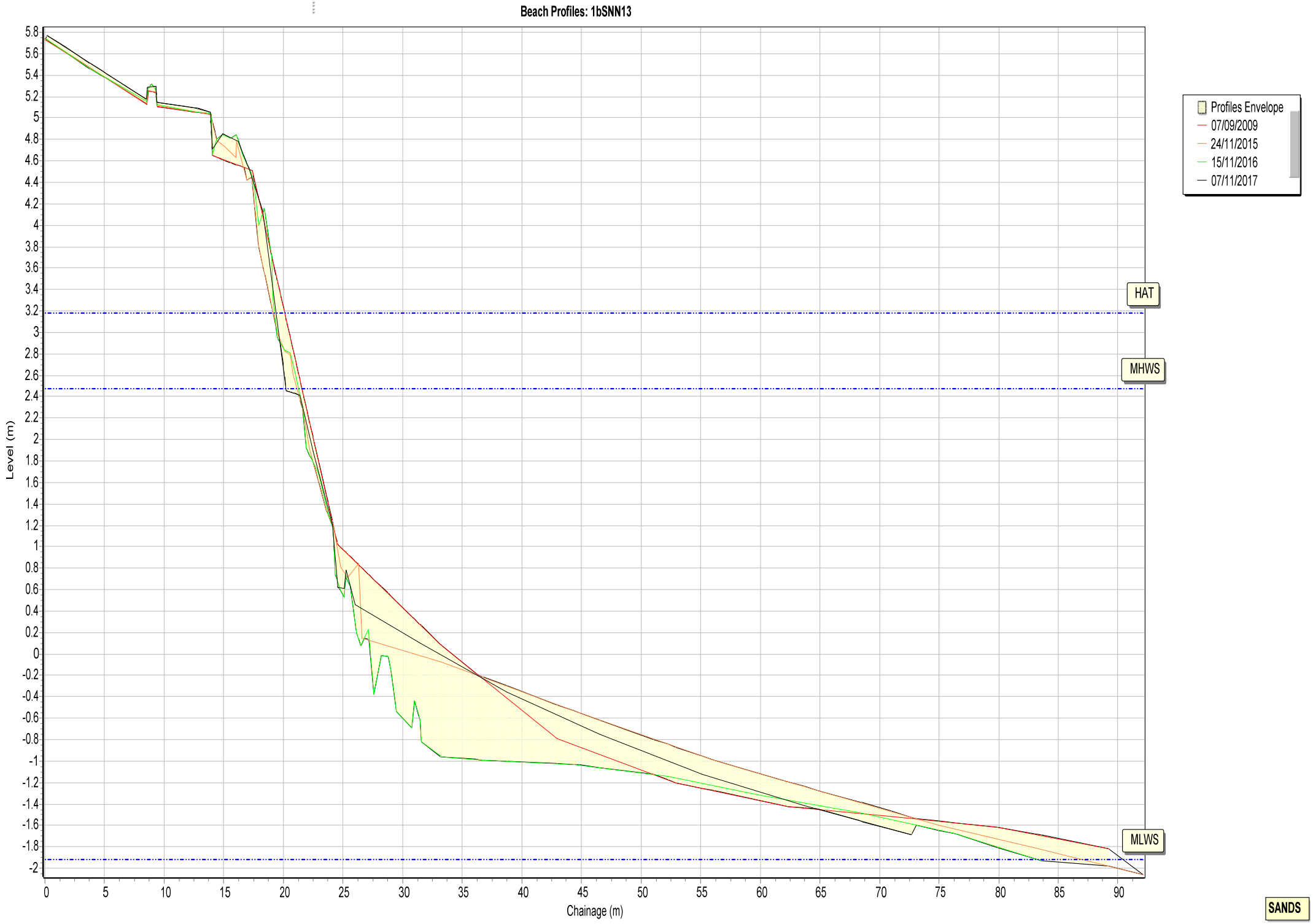
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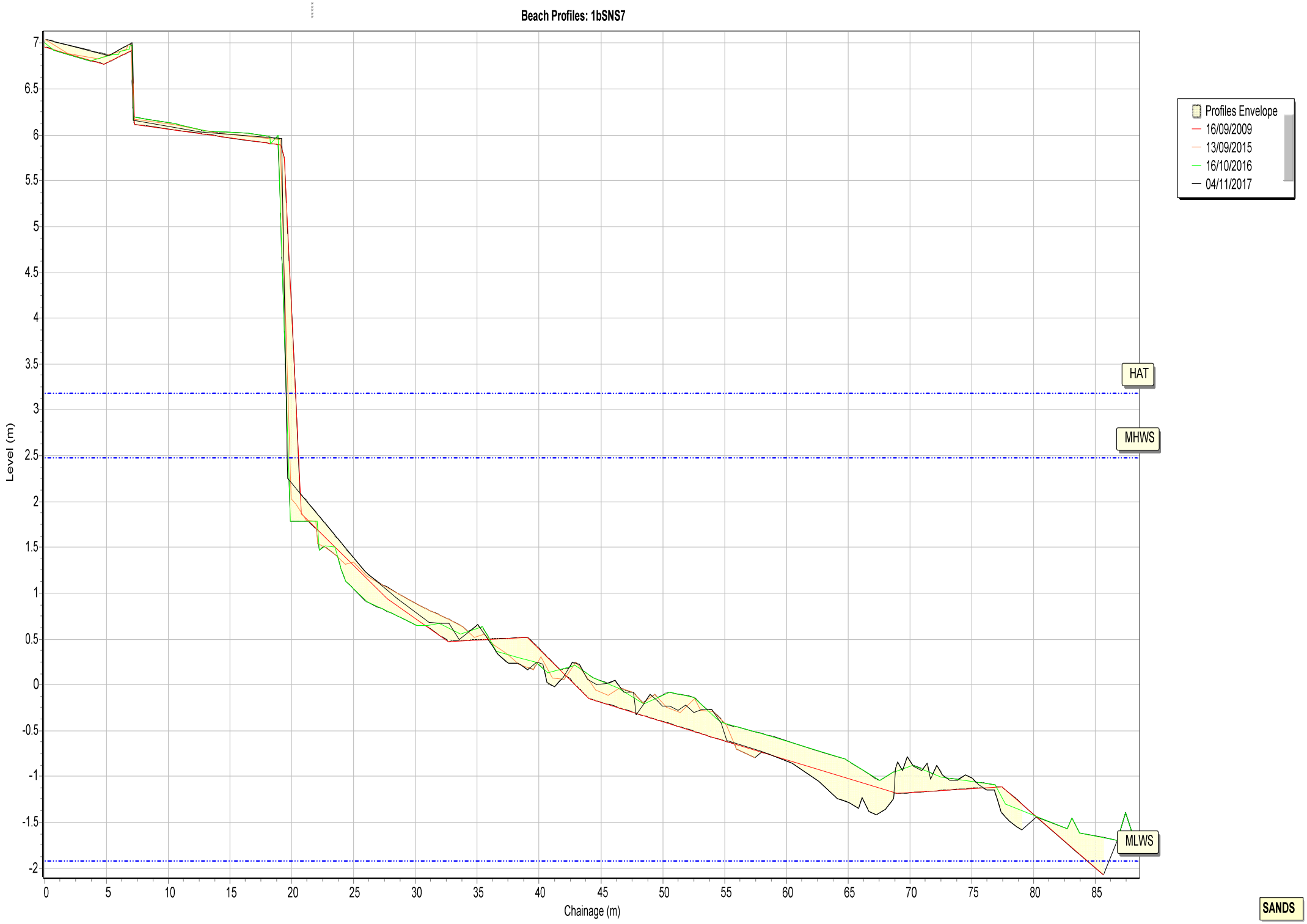
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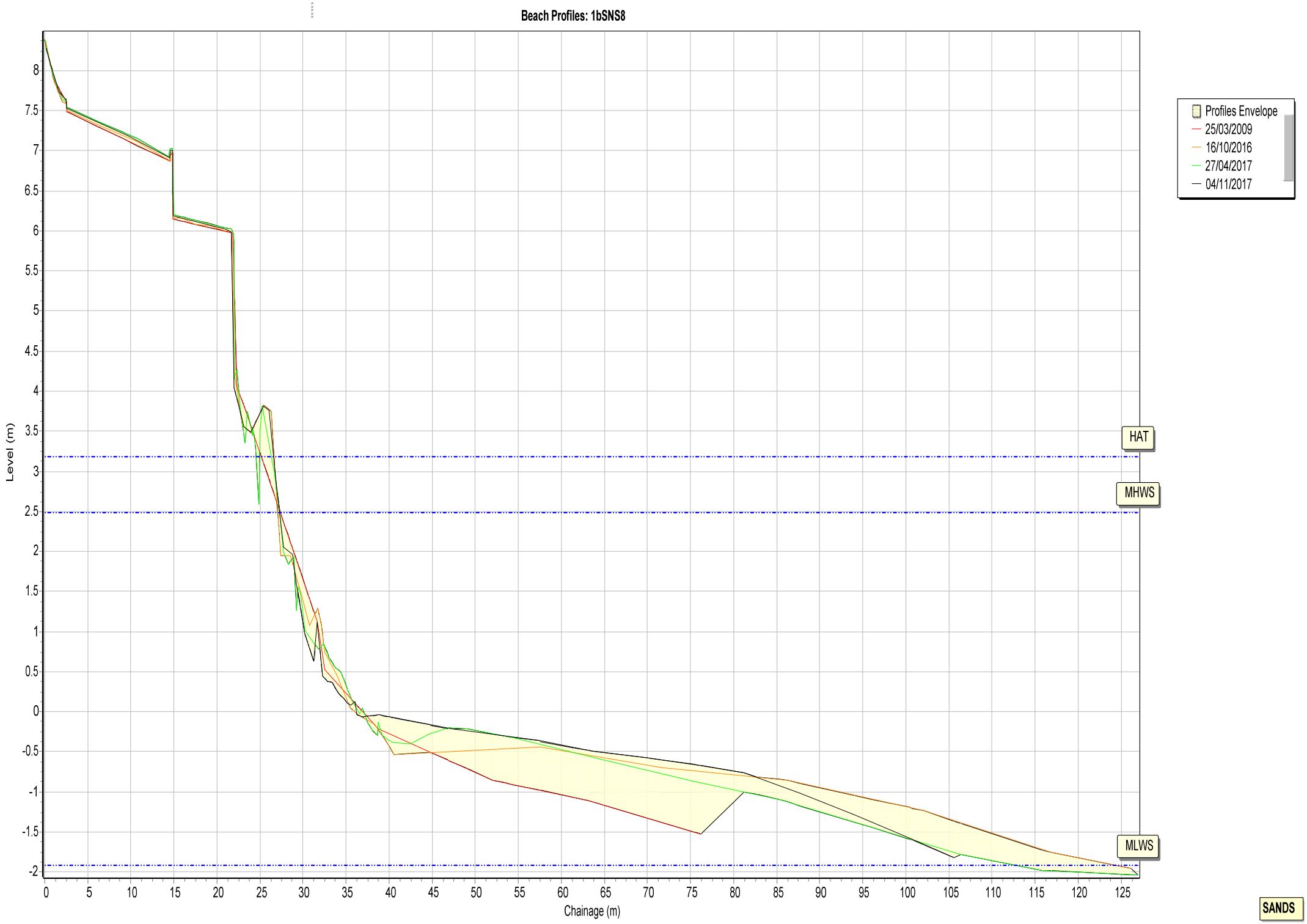
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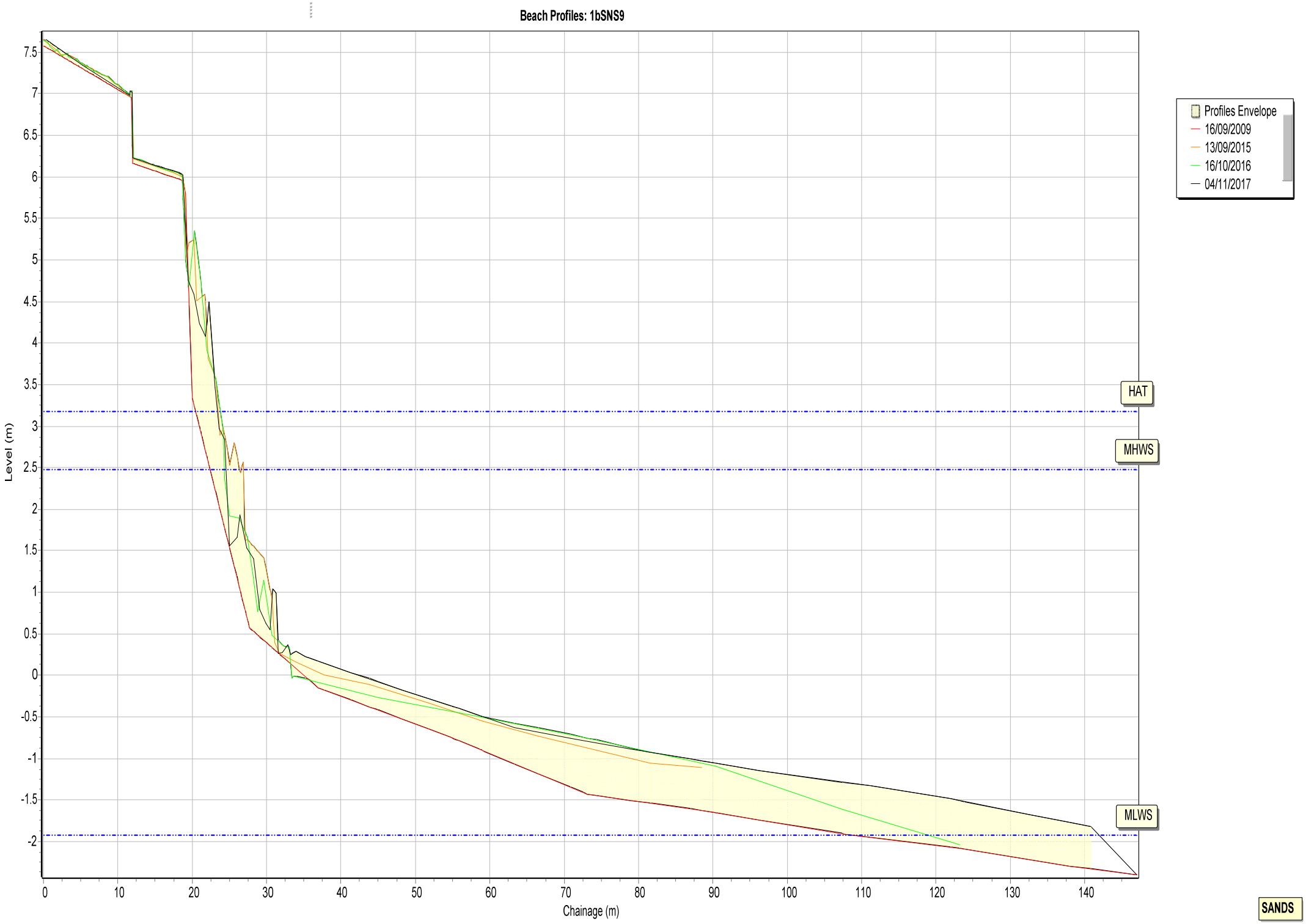
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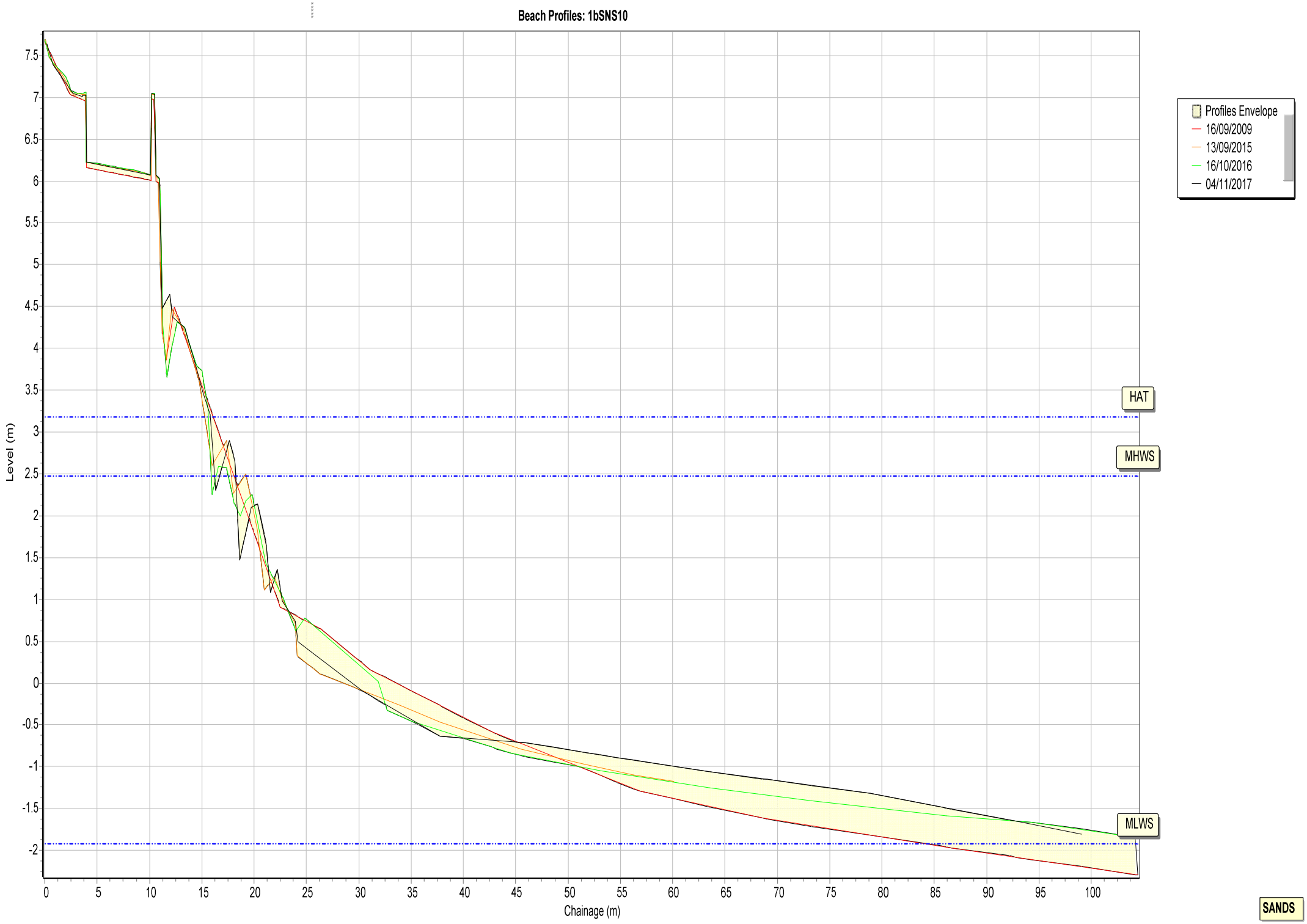
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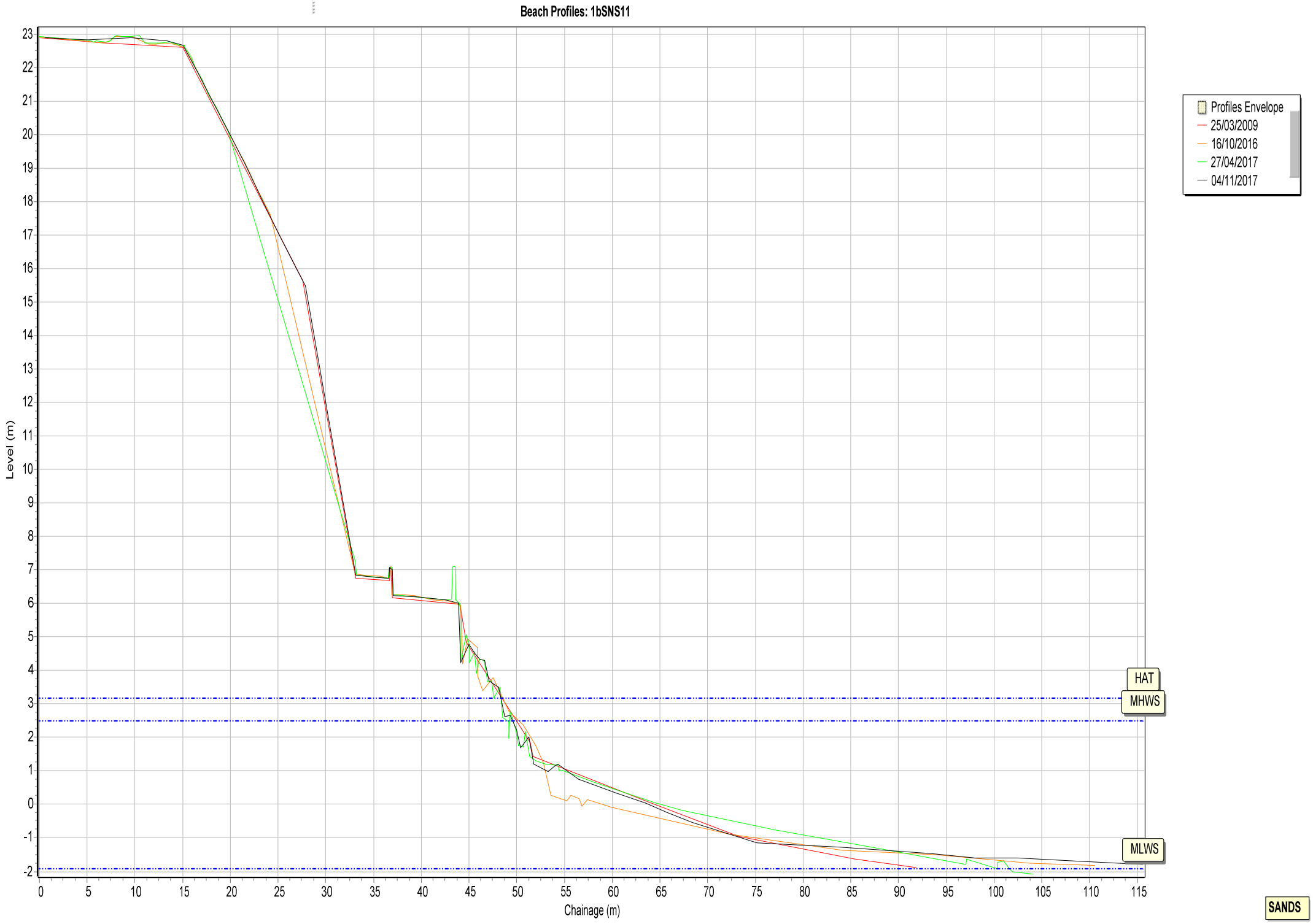
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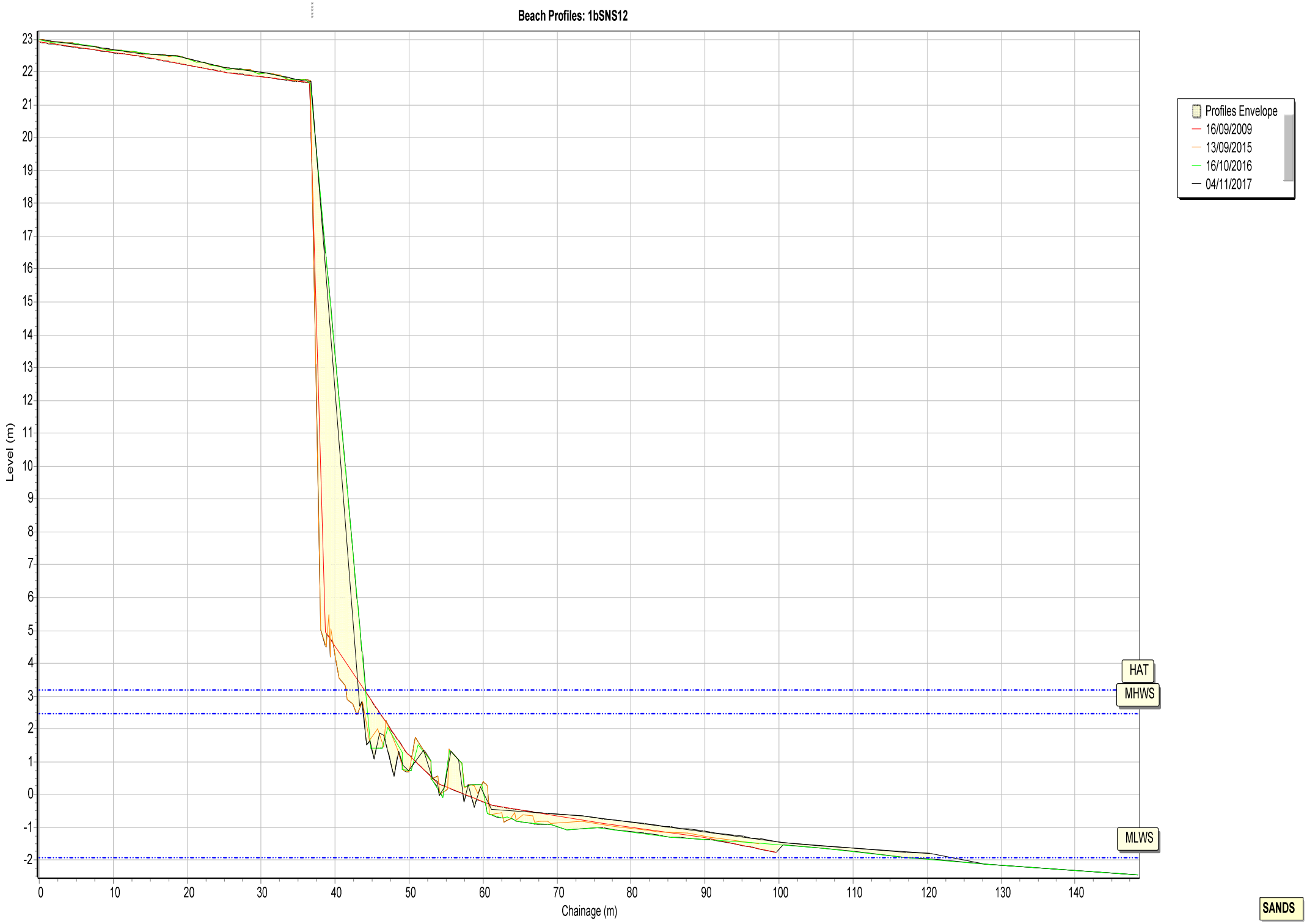
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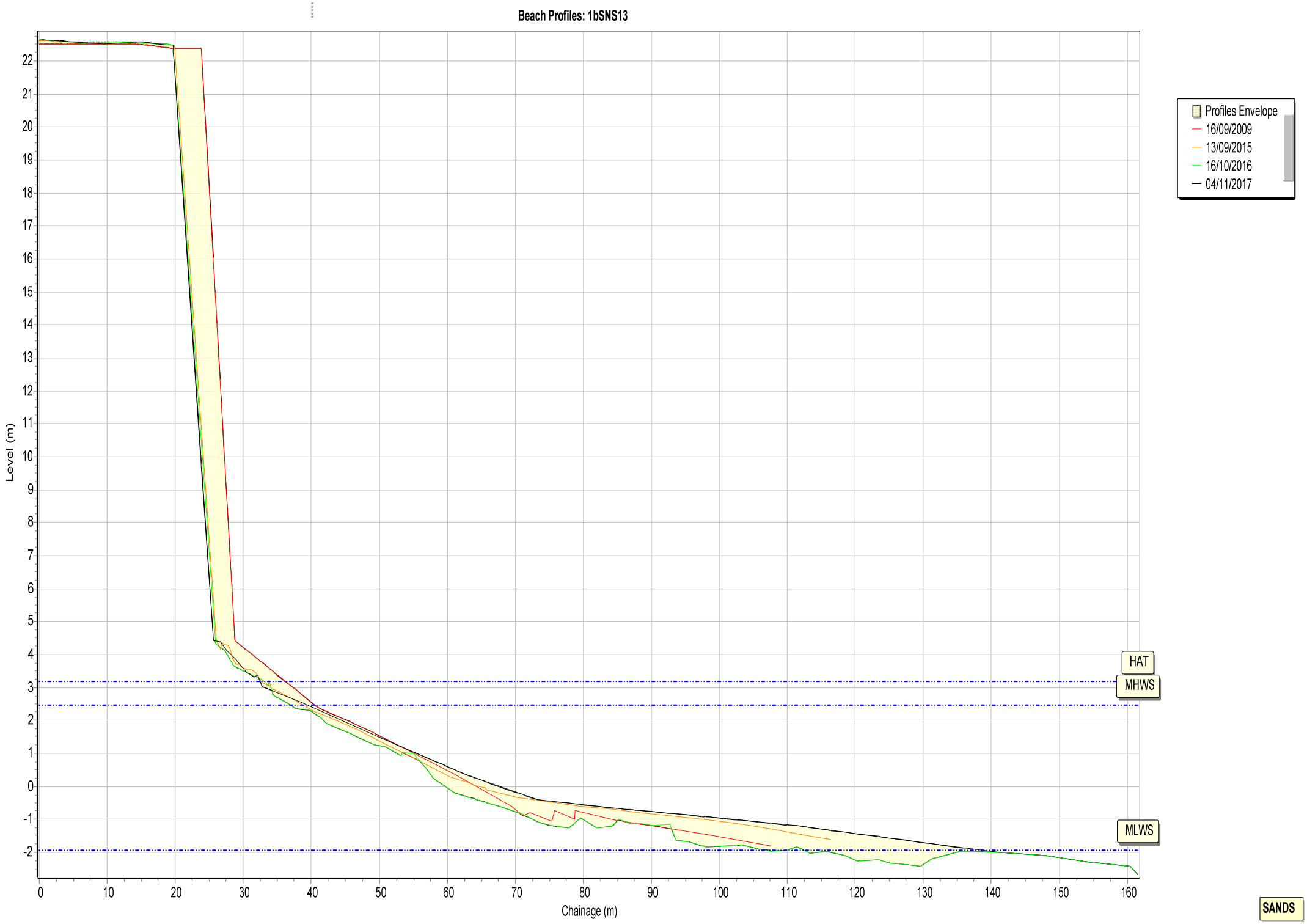
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Chainage (m)
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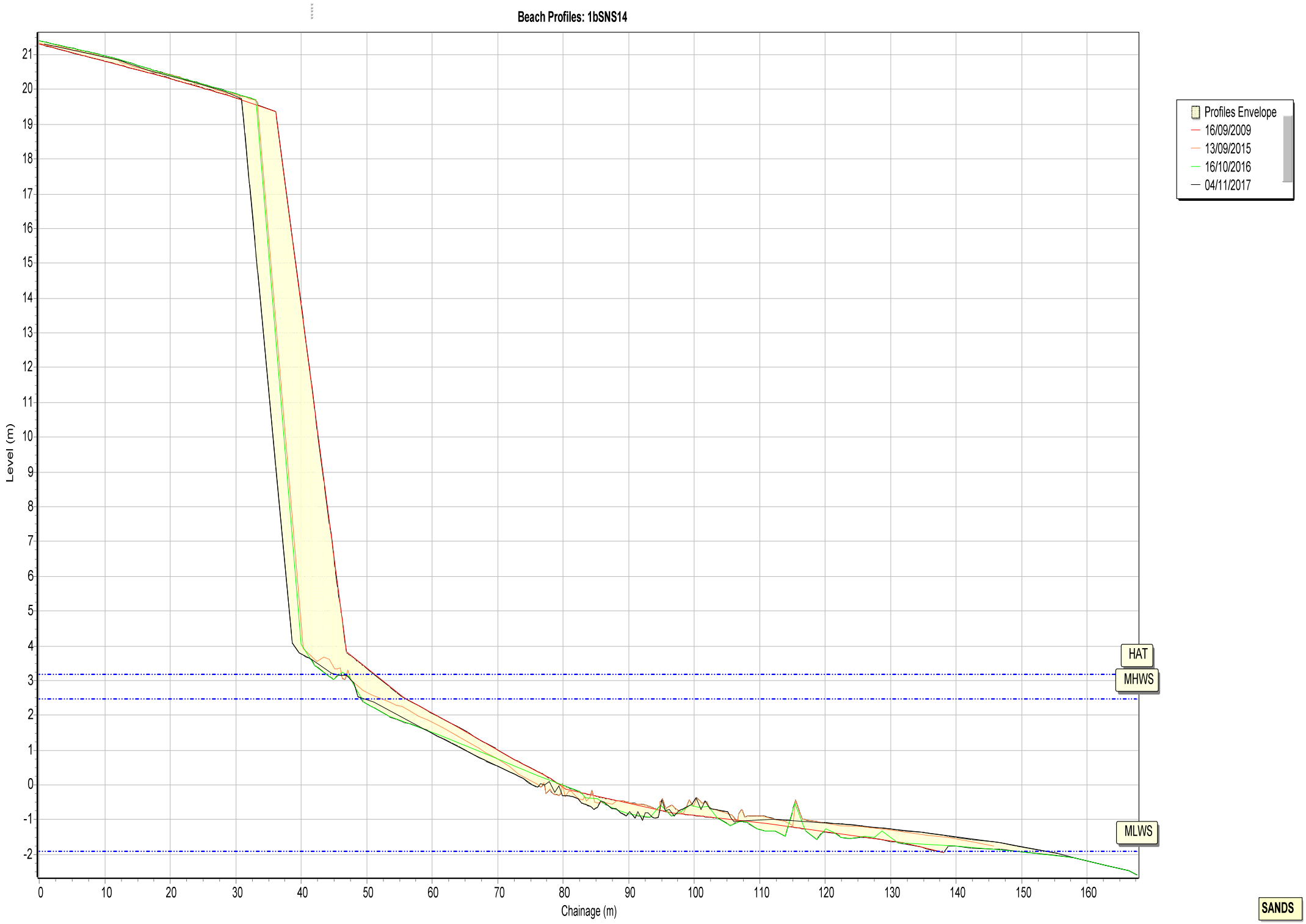
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Chainage (m)
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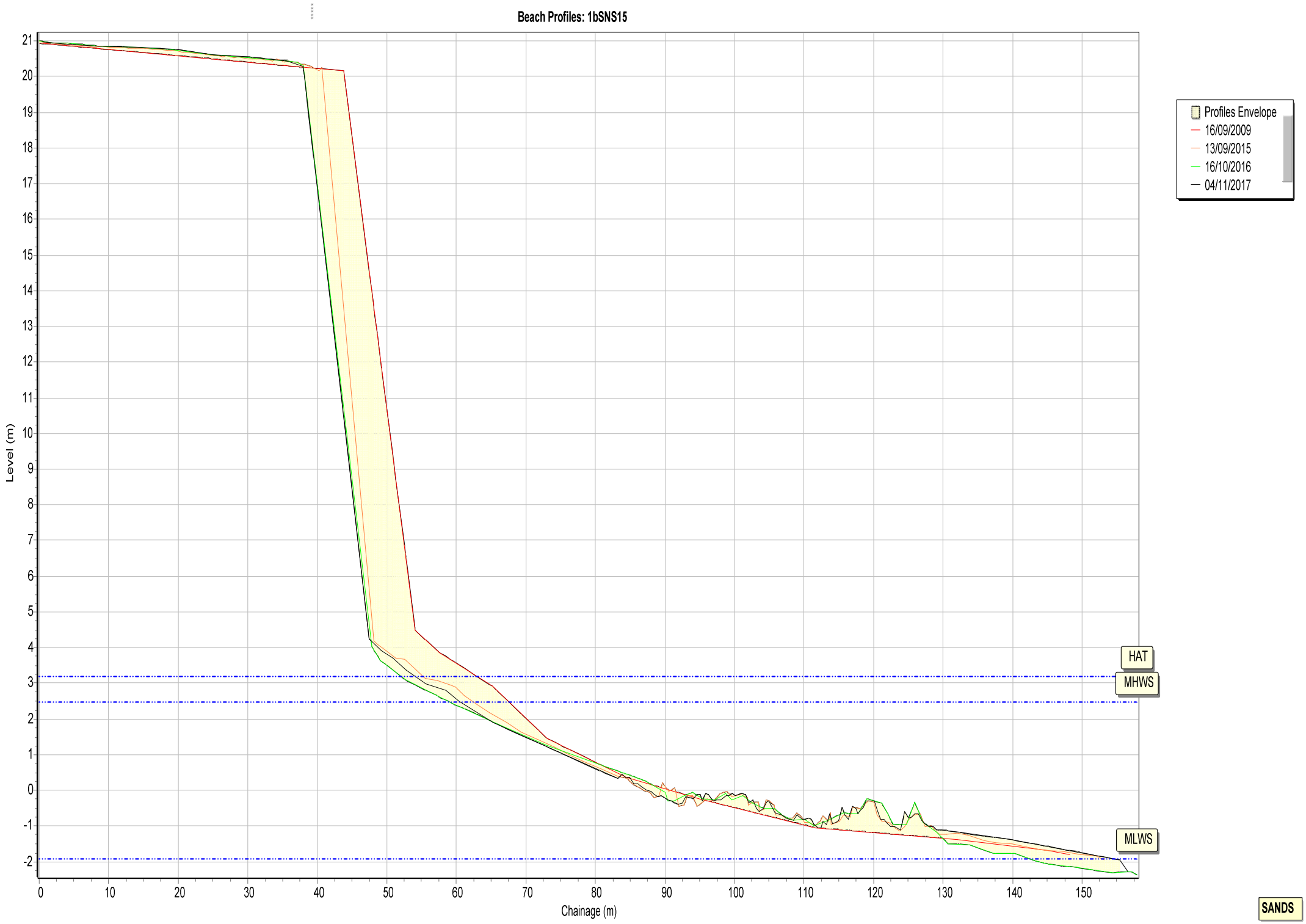
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Chainage (m)
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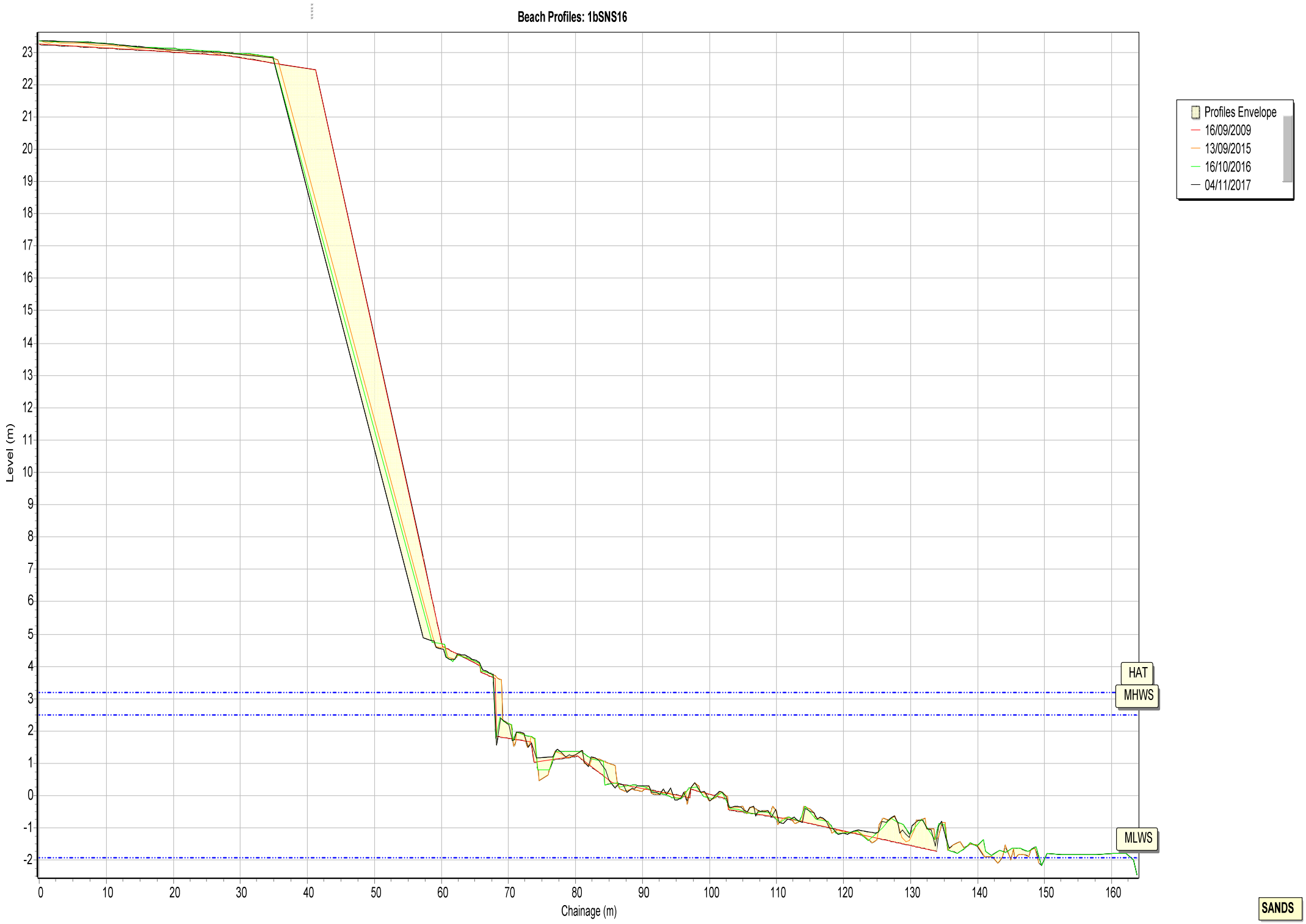
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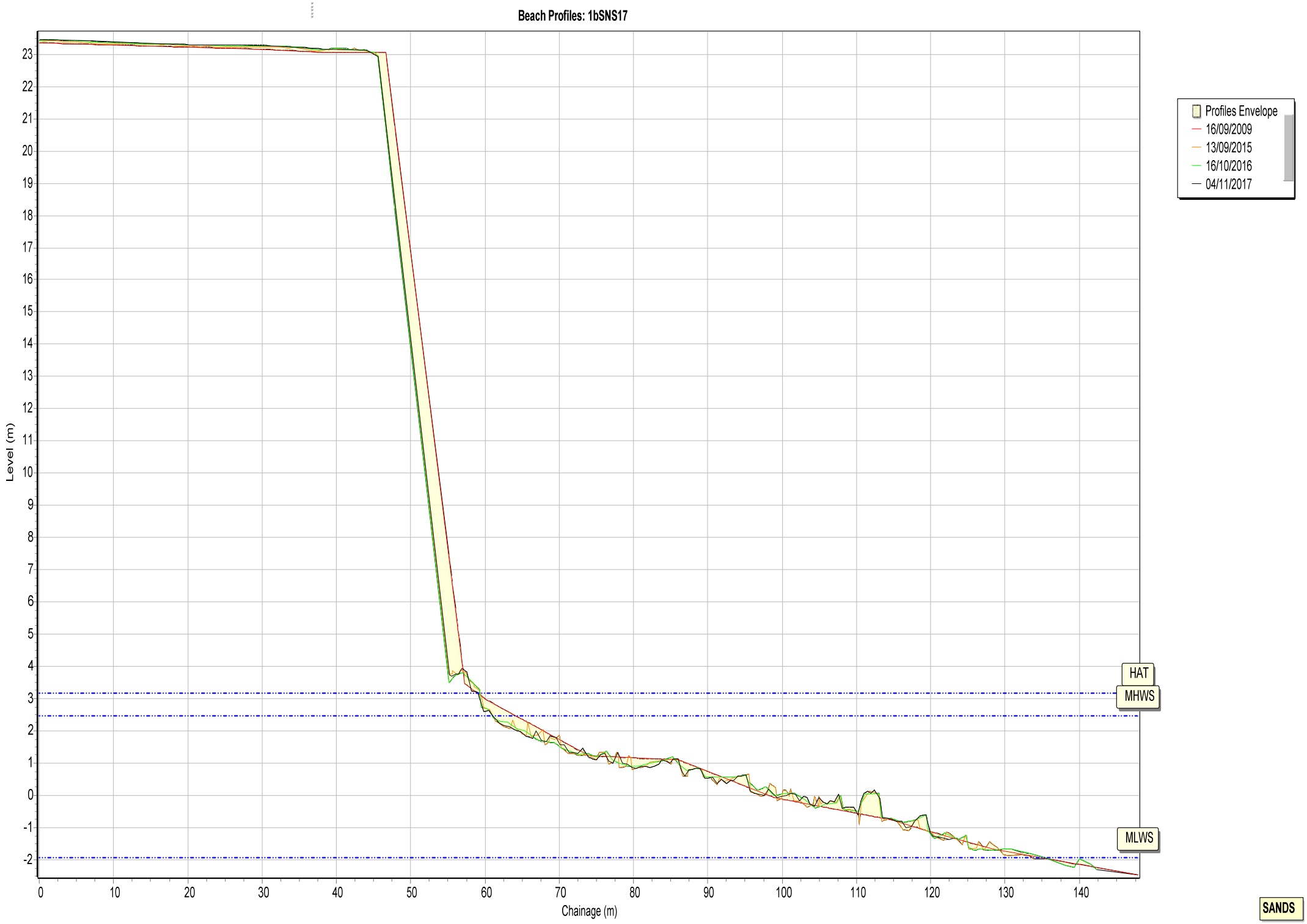
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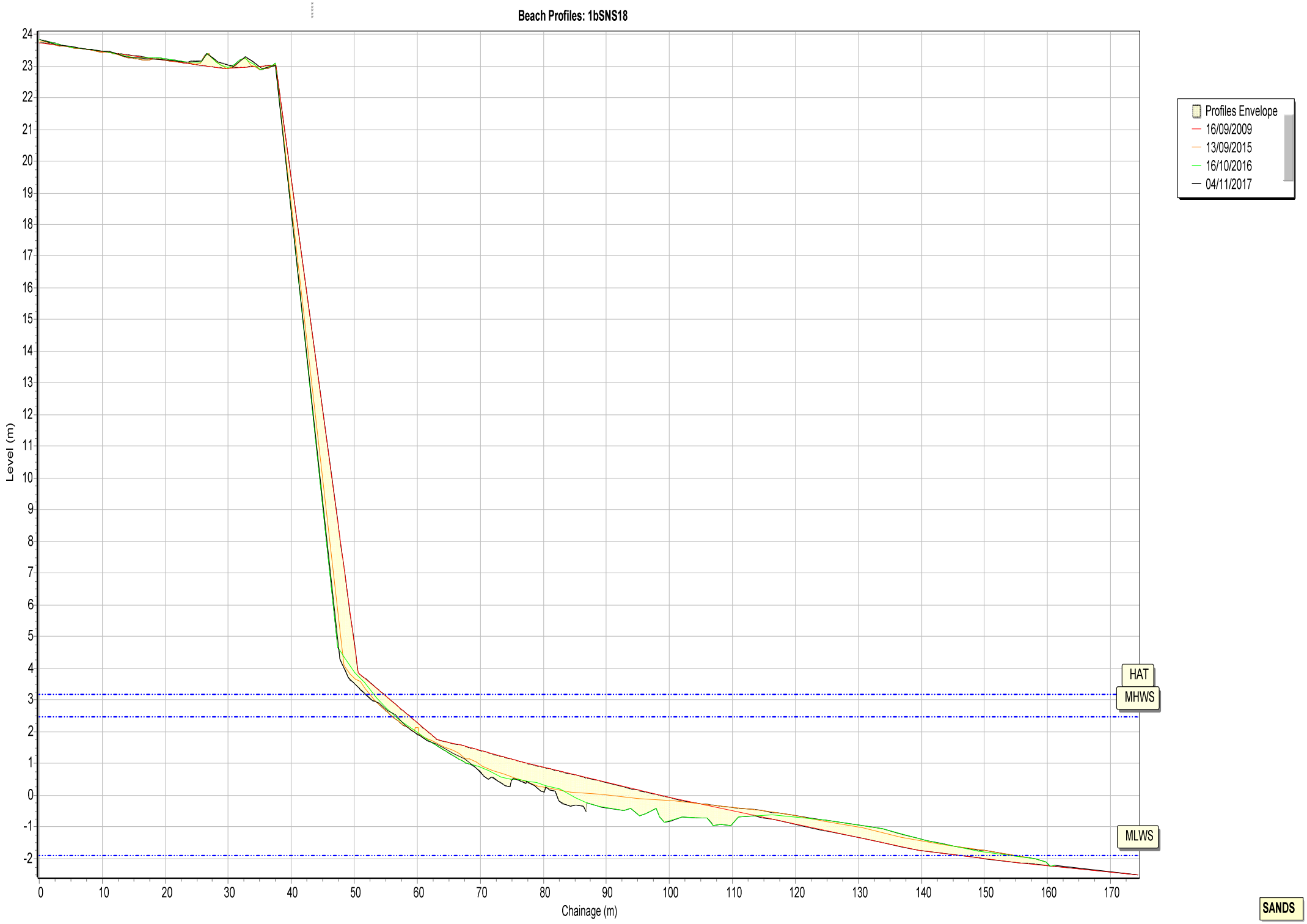
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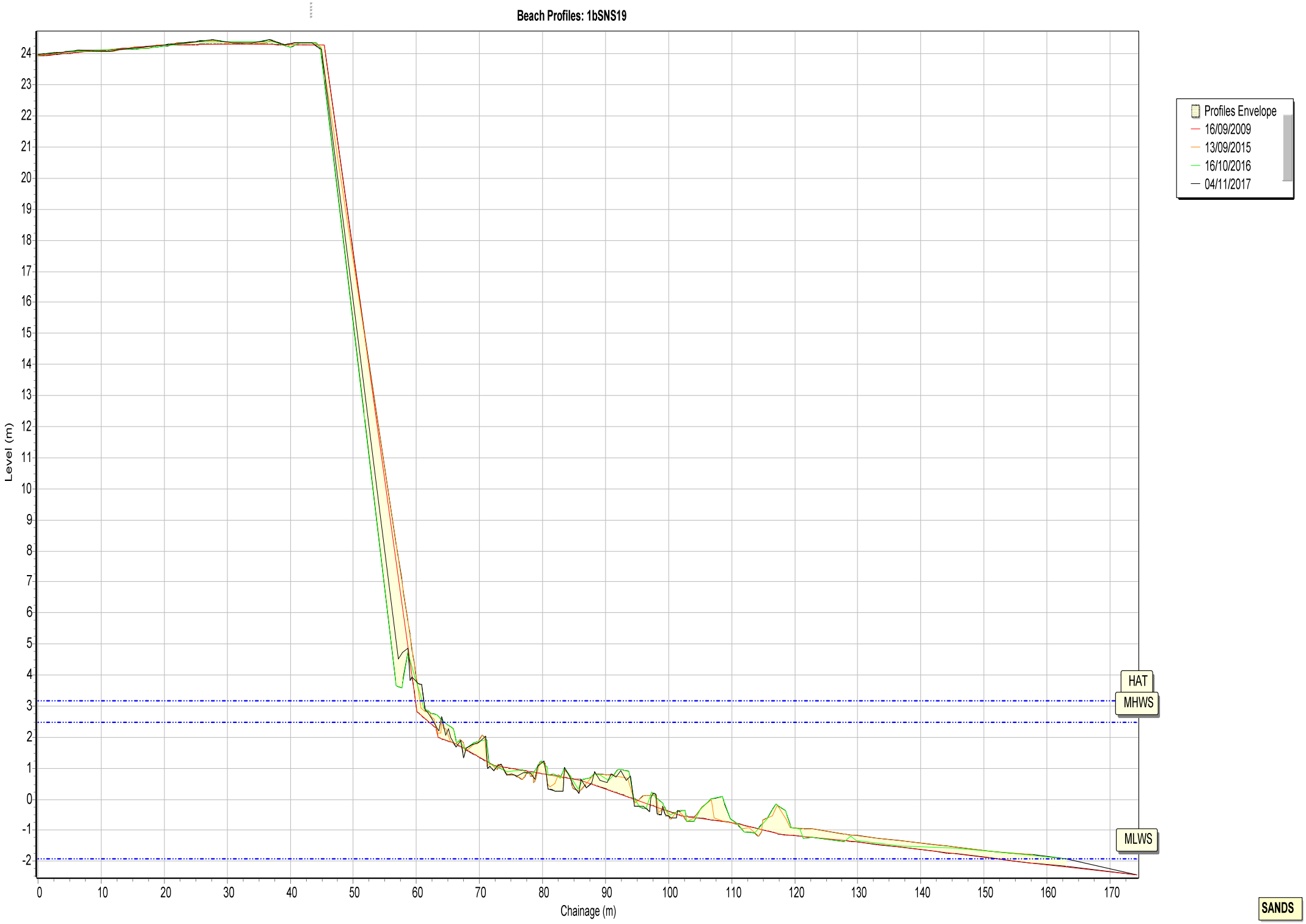
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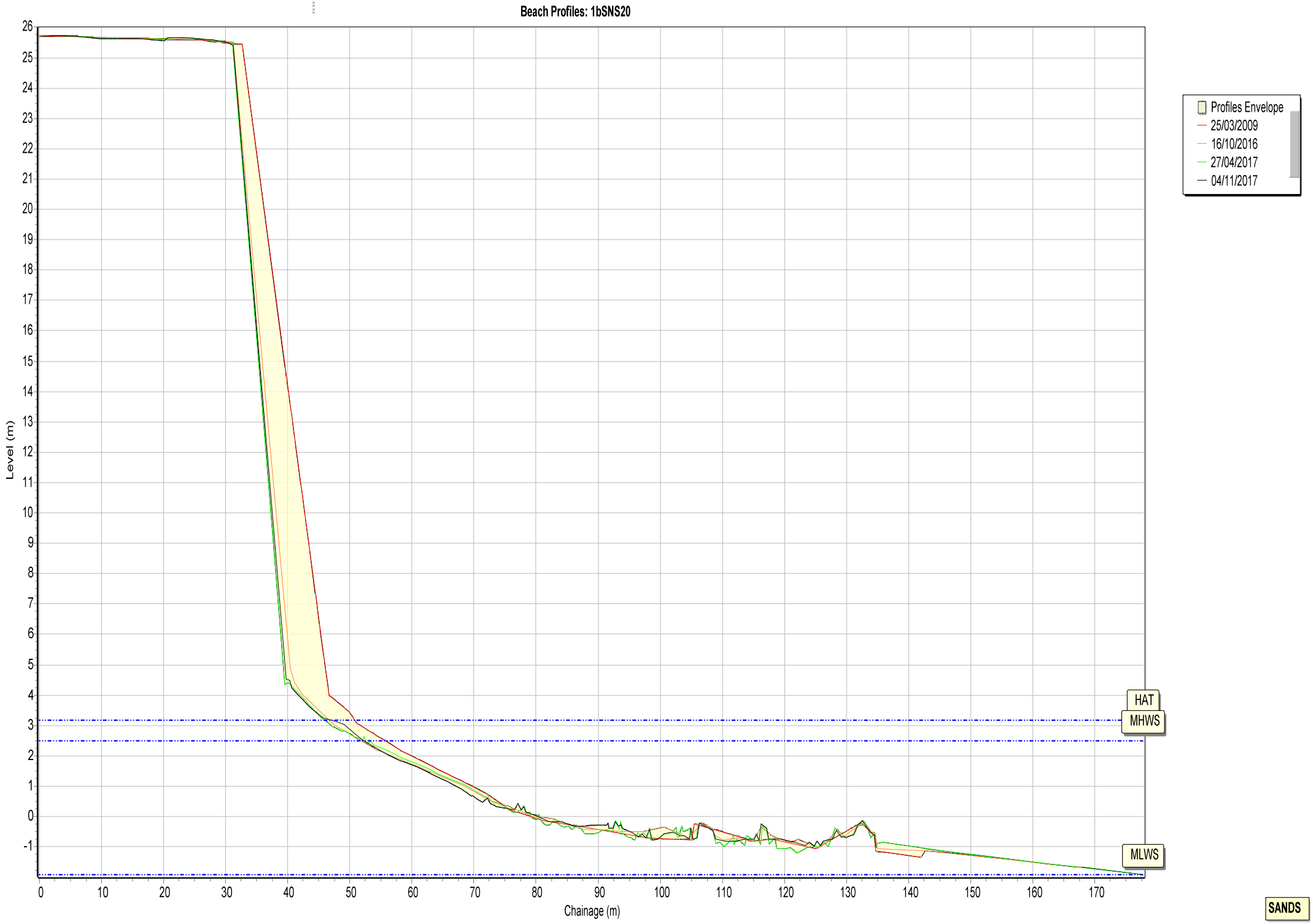
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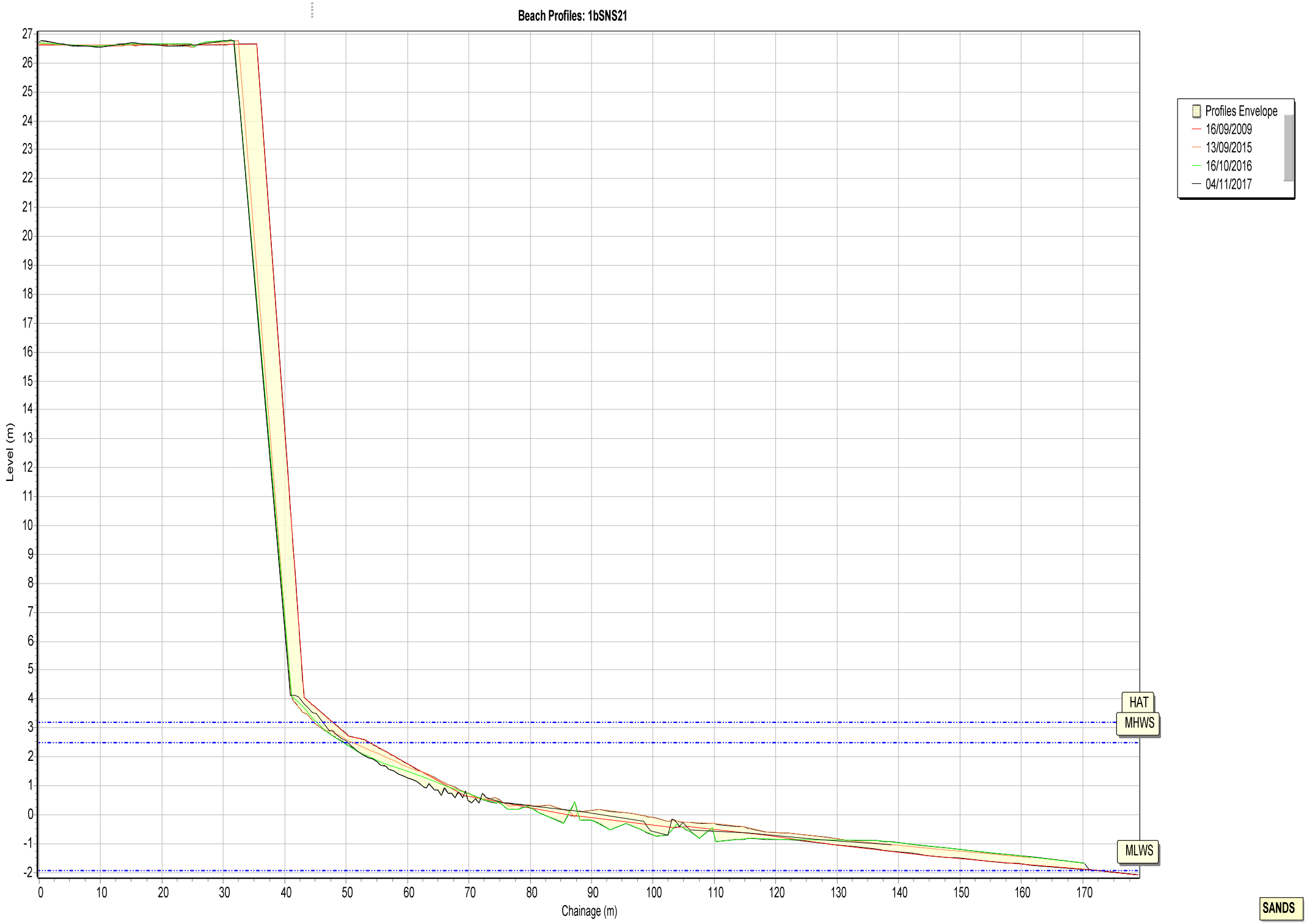
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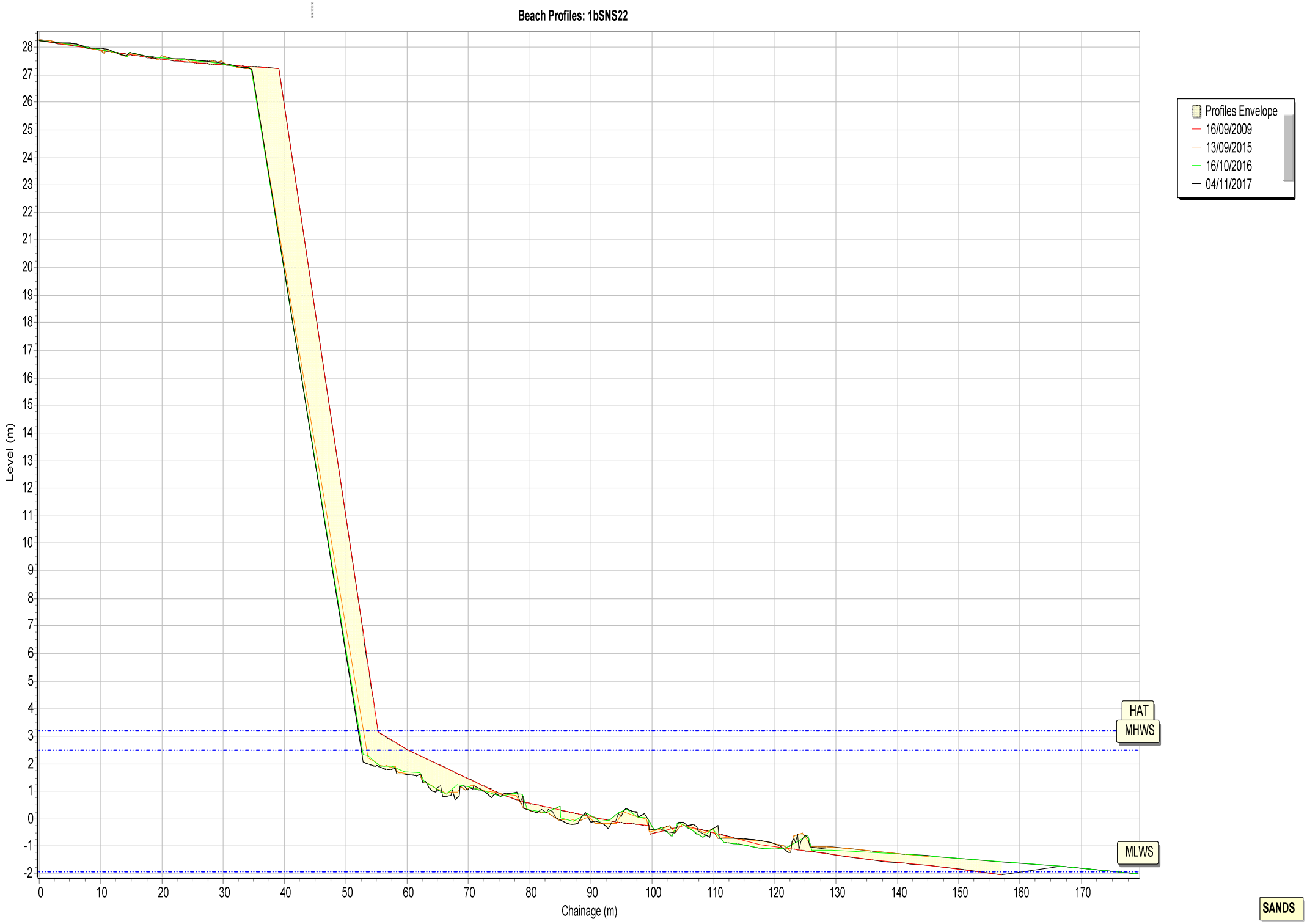
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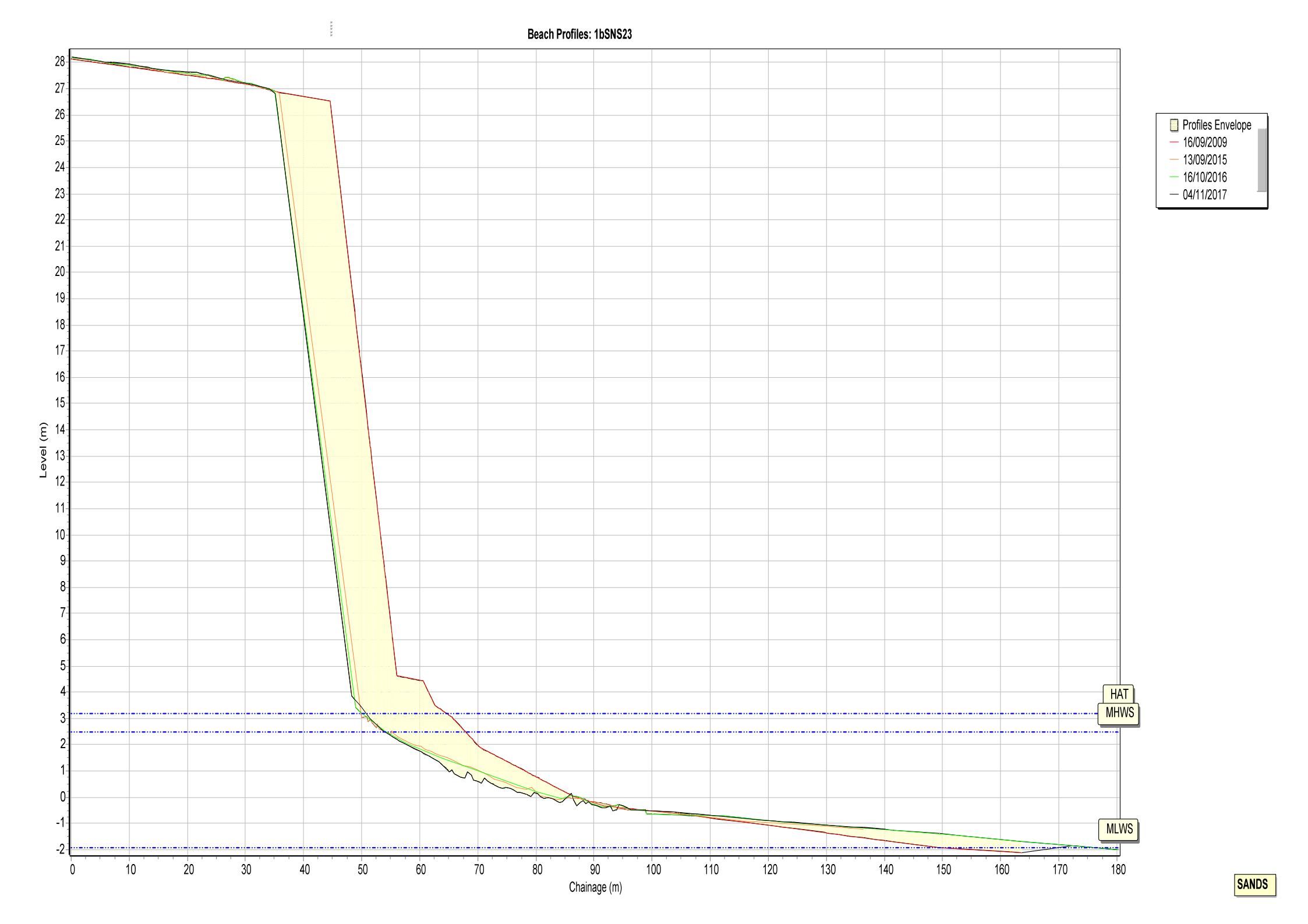
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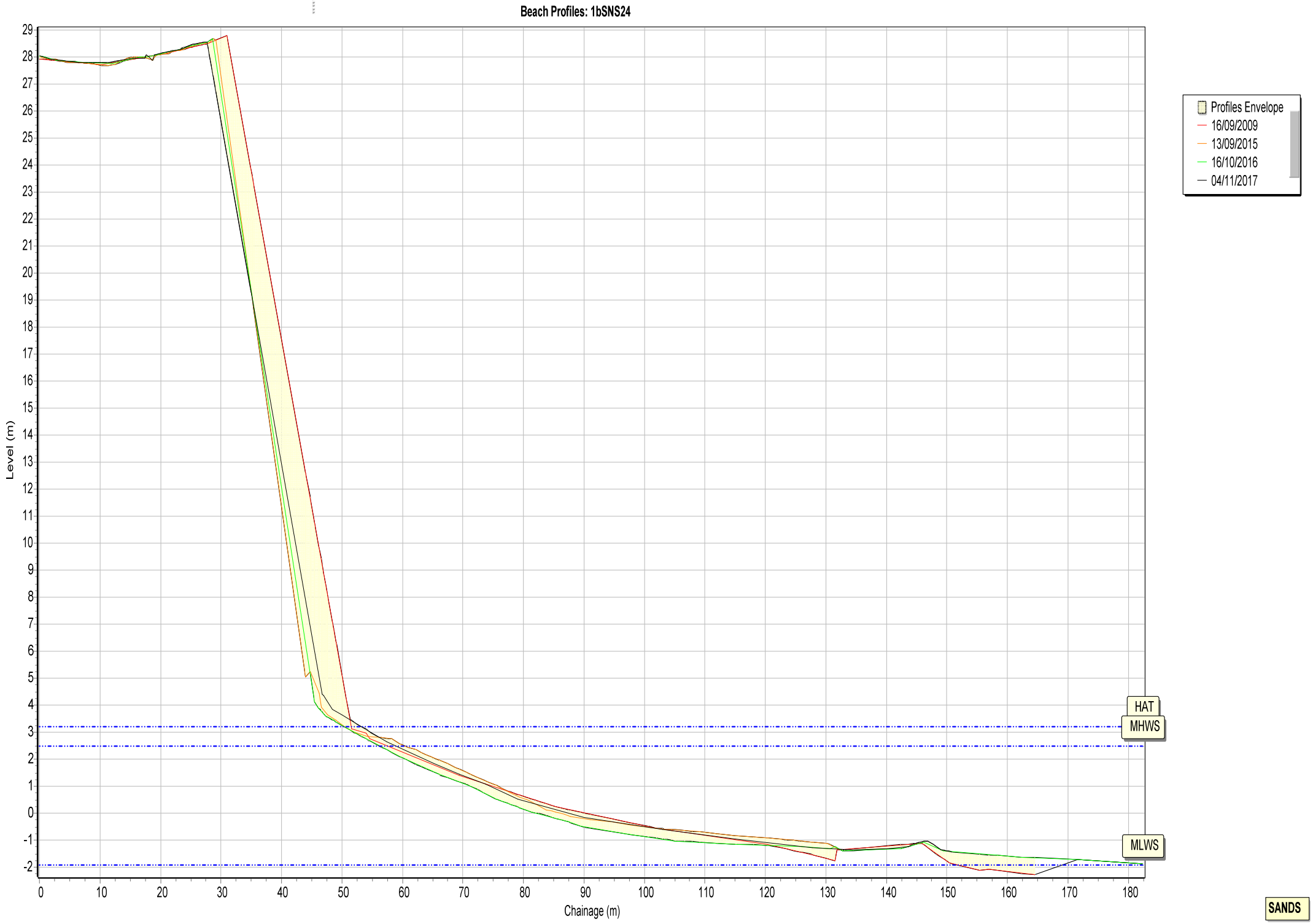
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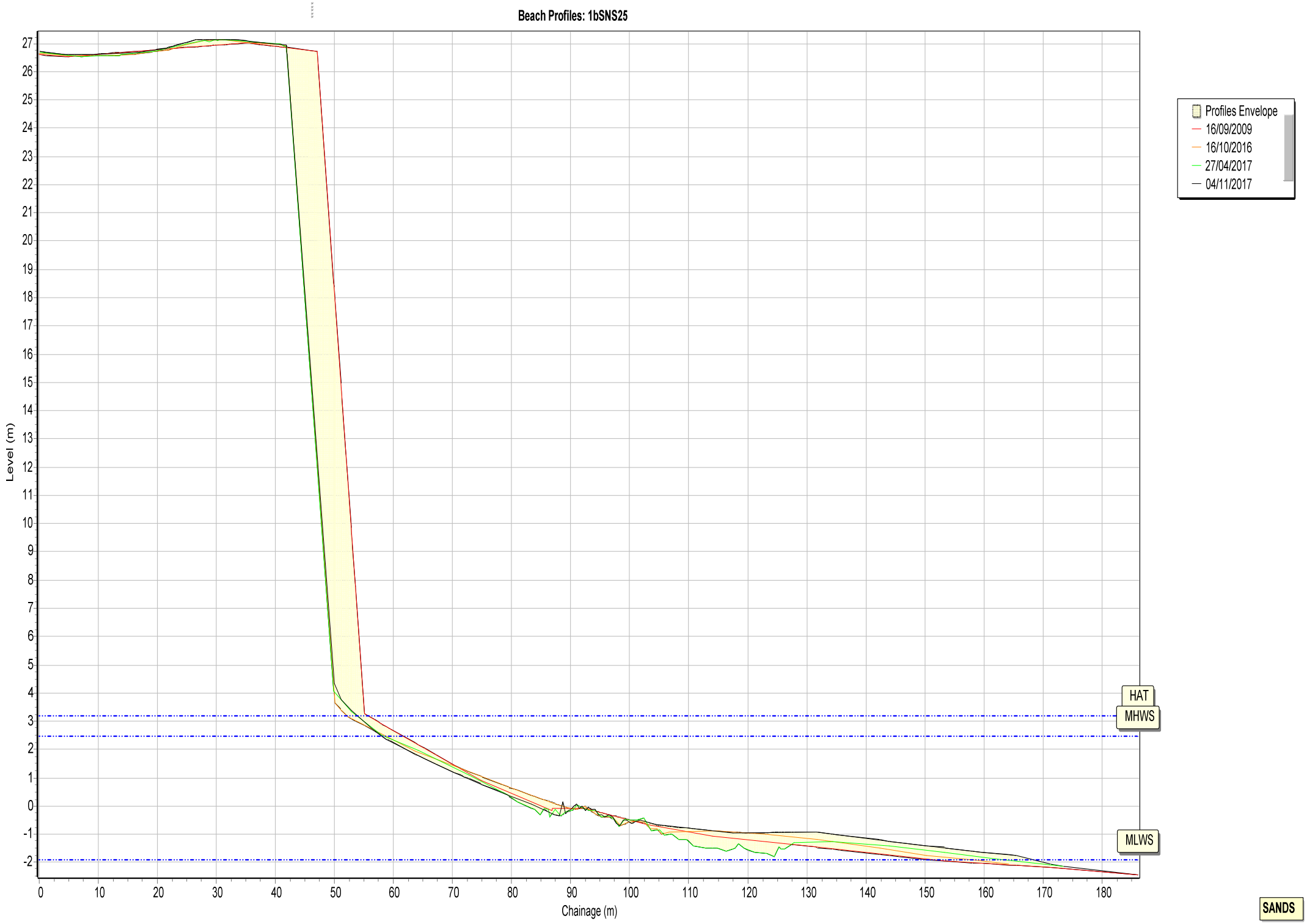
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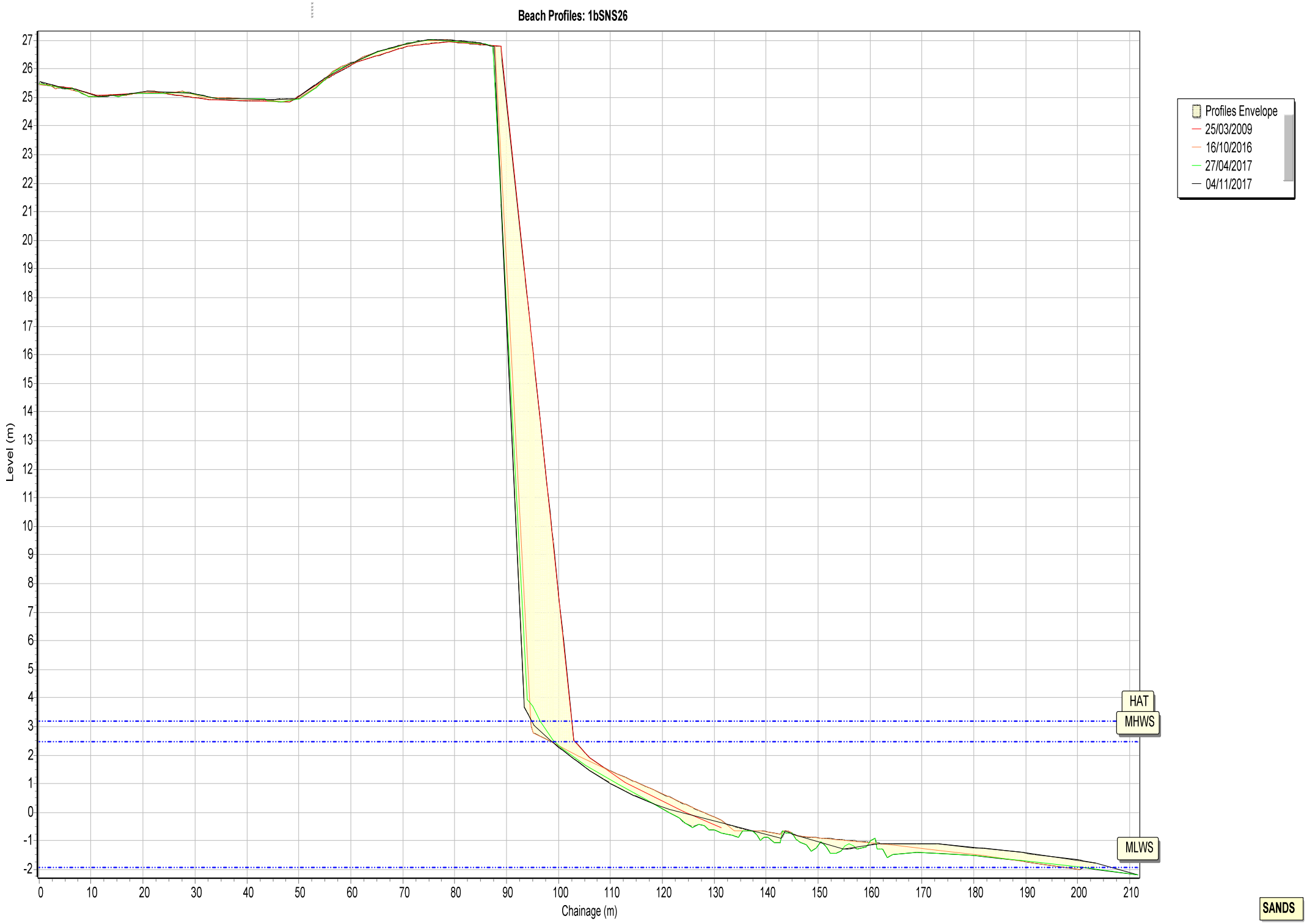
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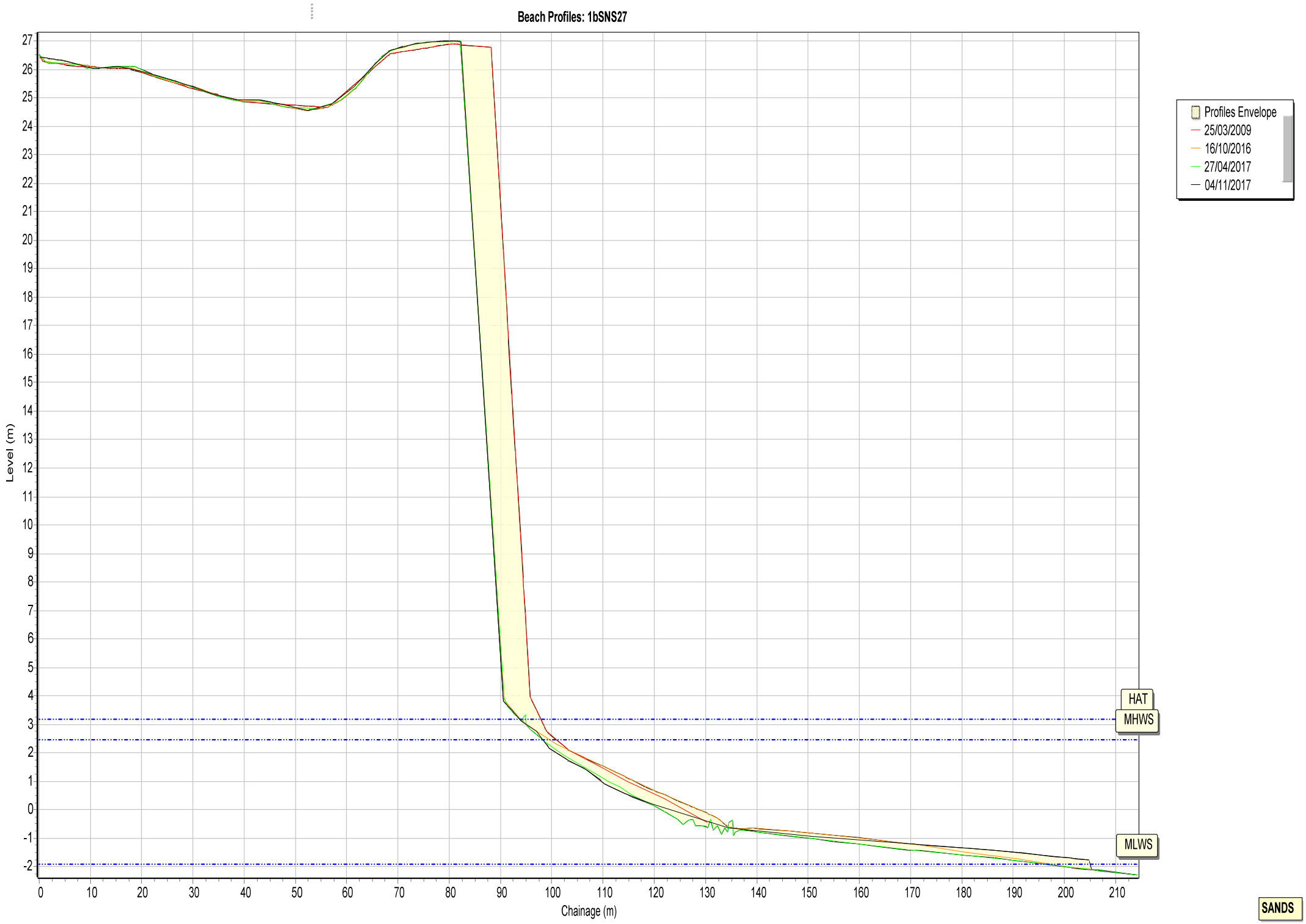
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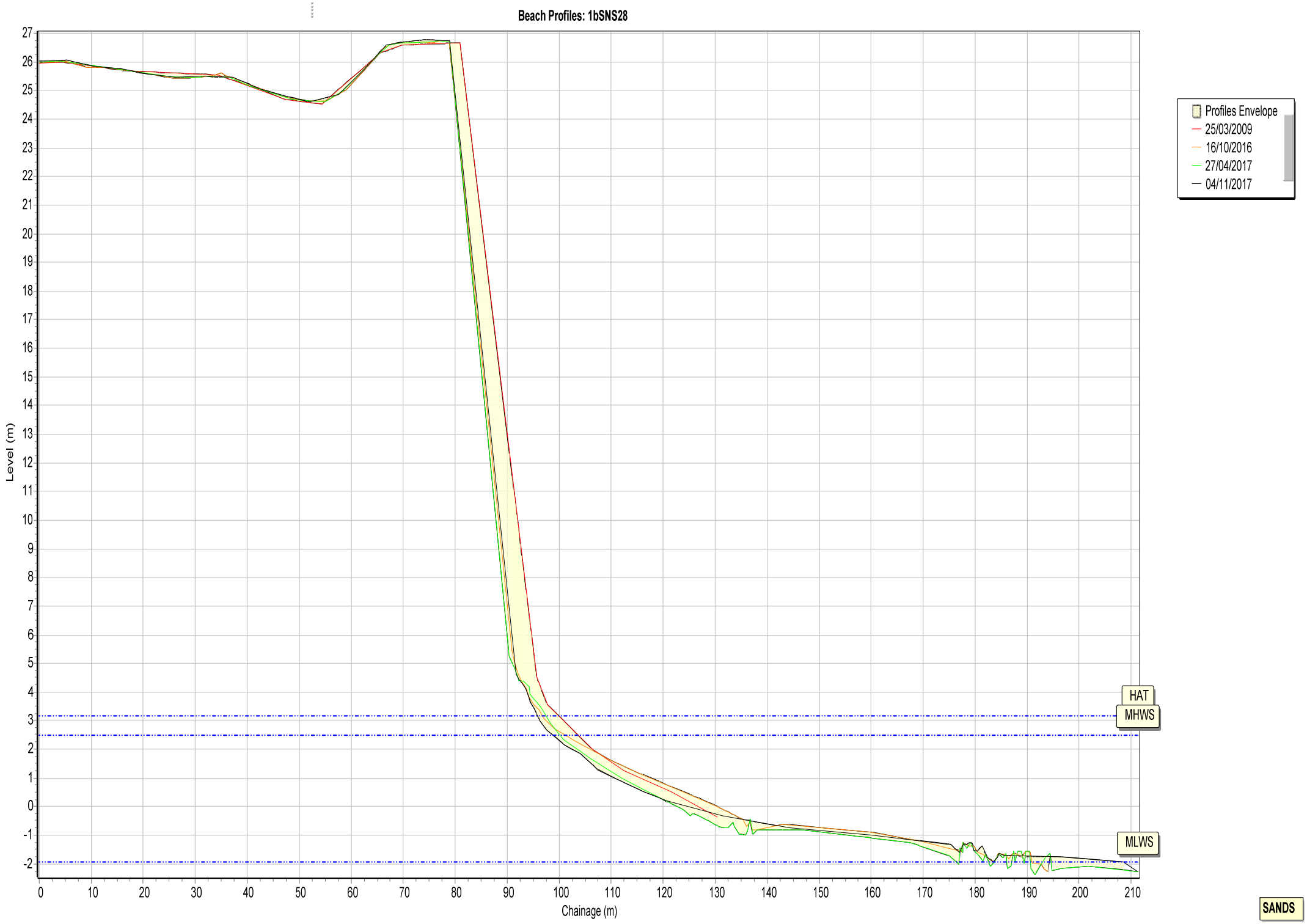
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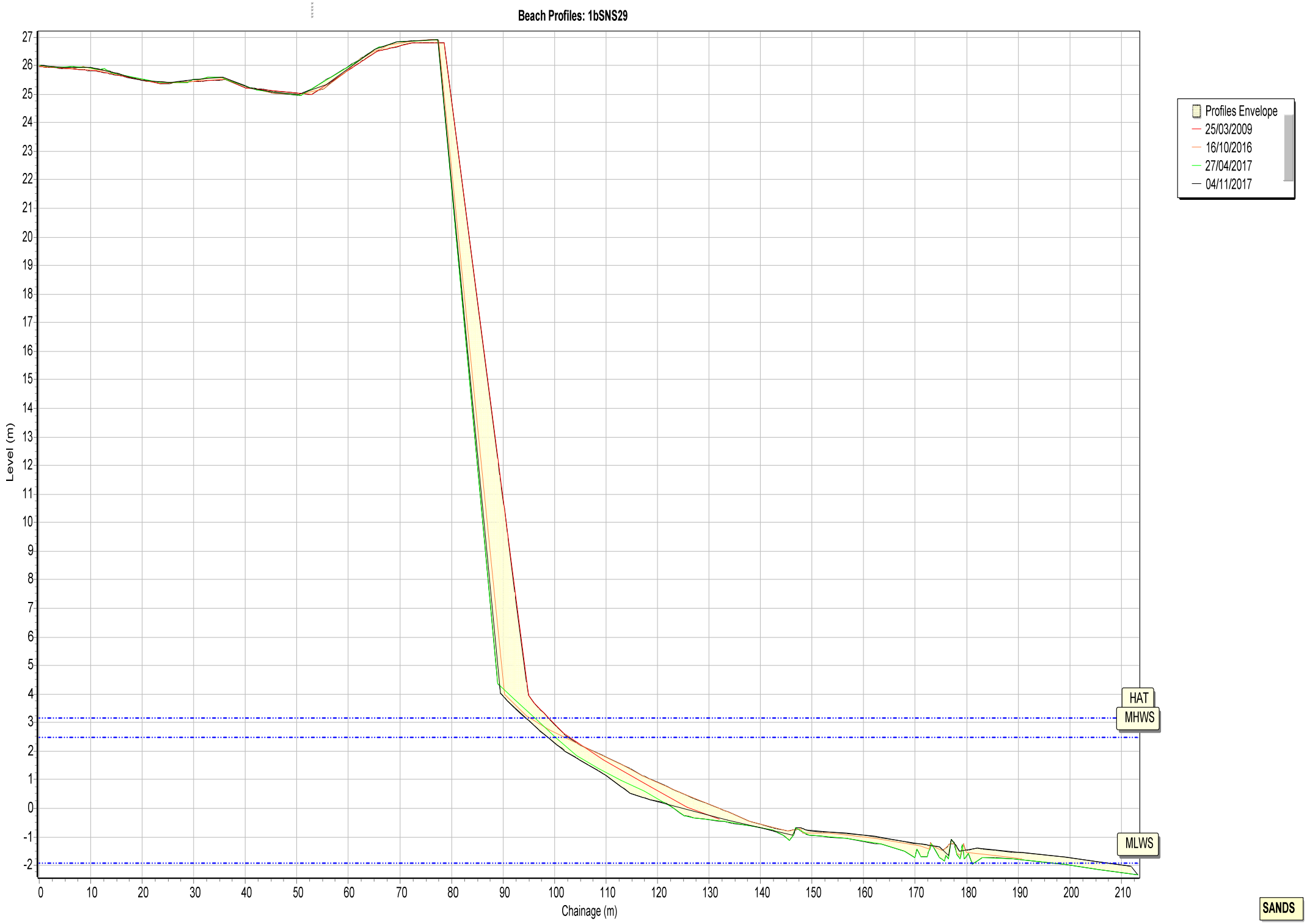
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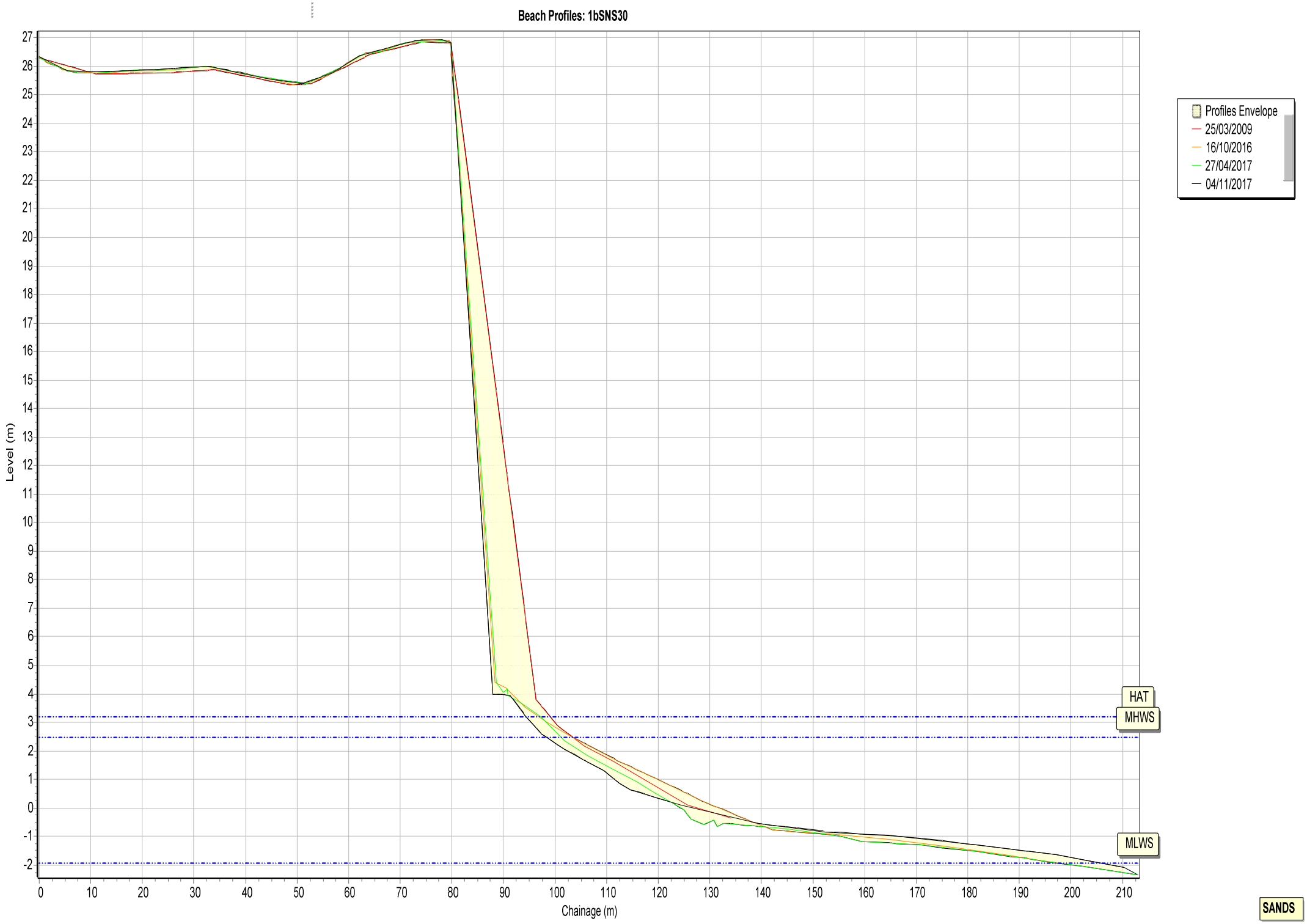
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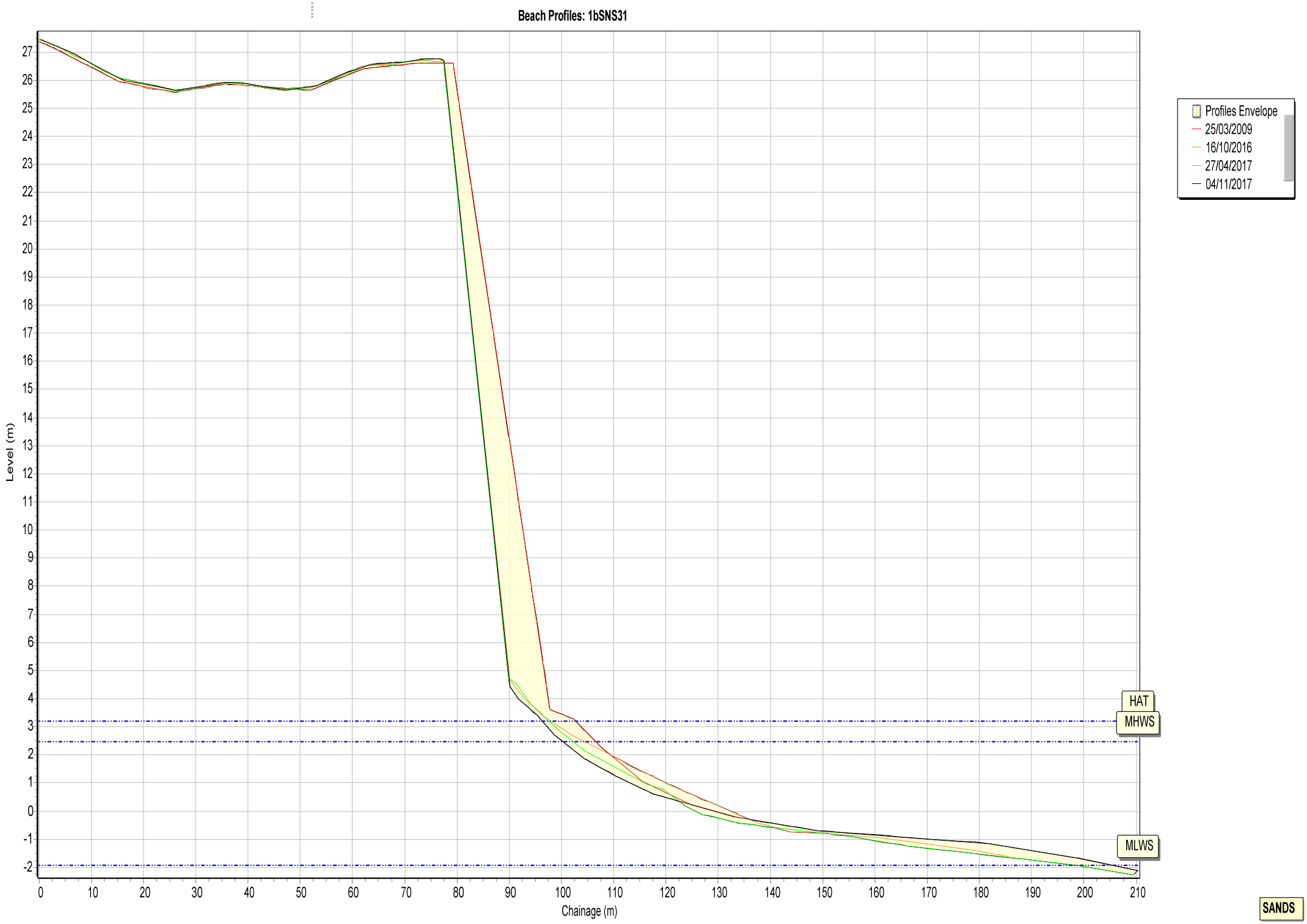
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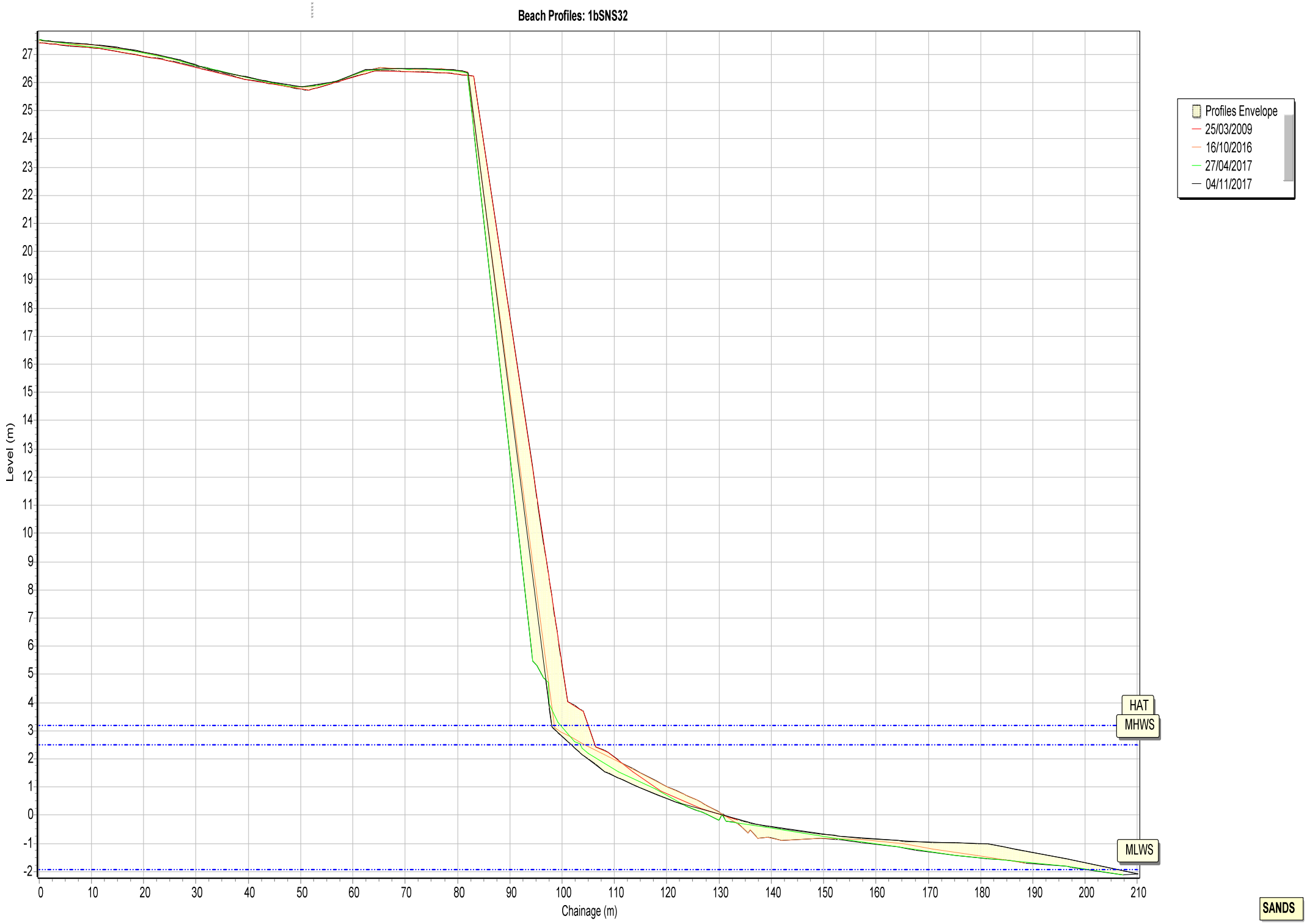
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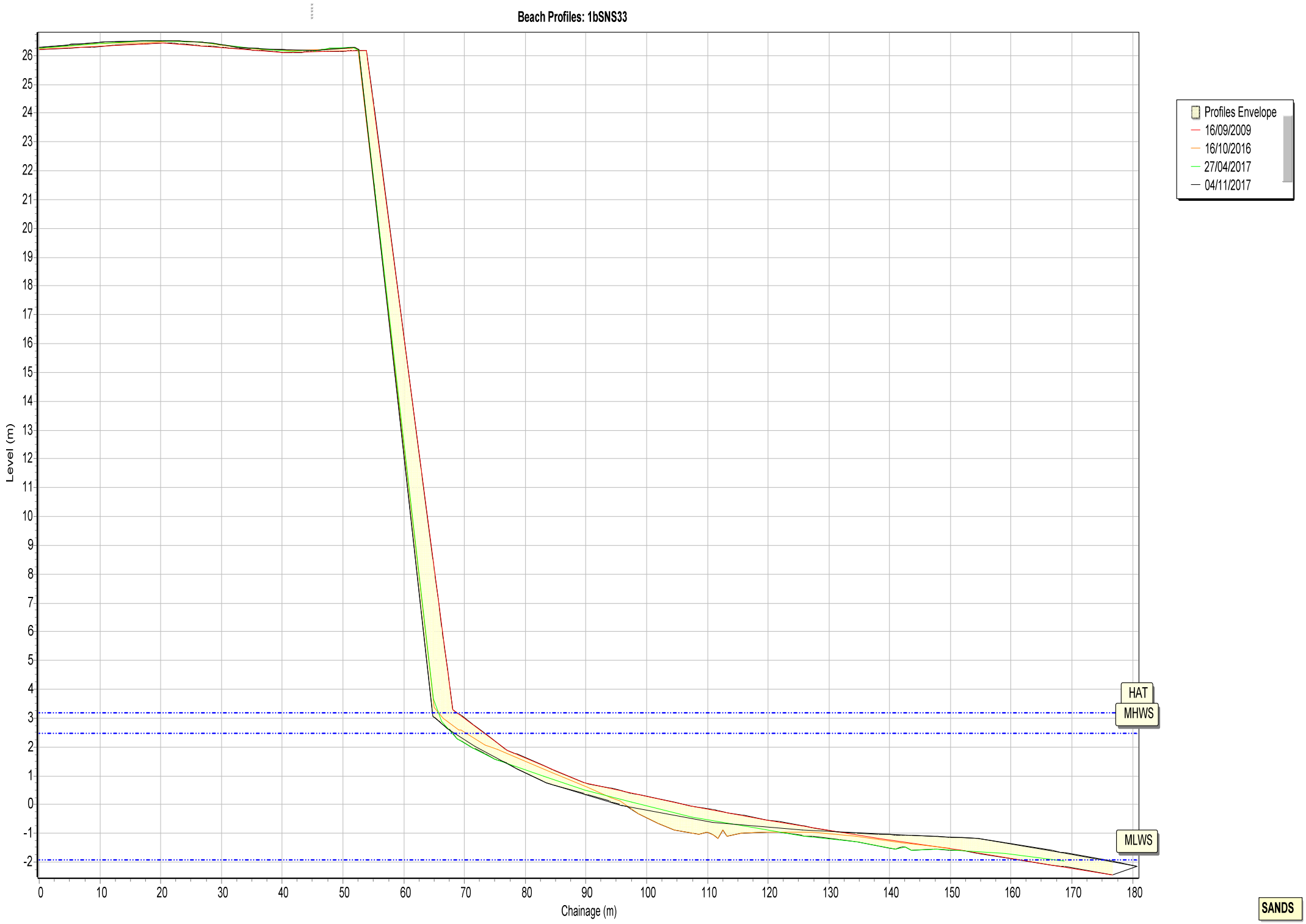
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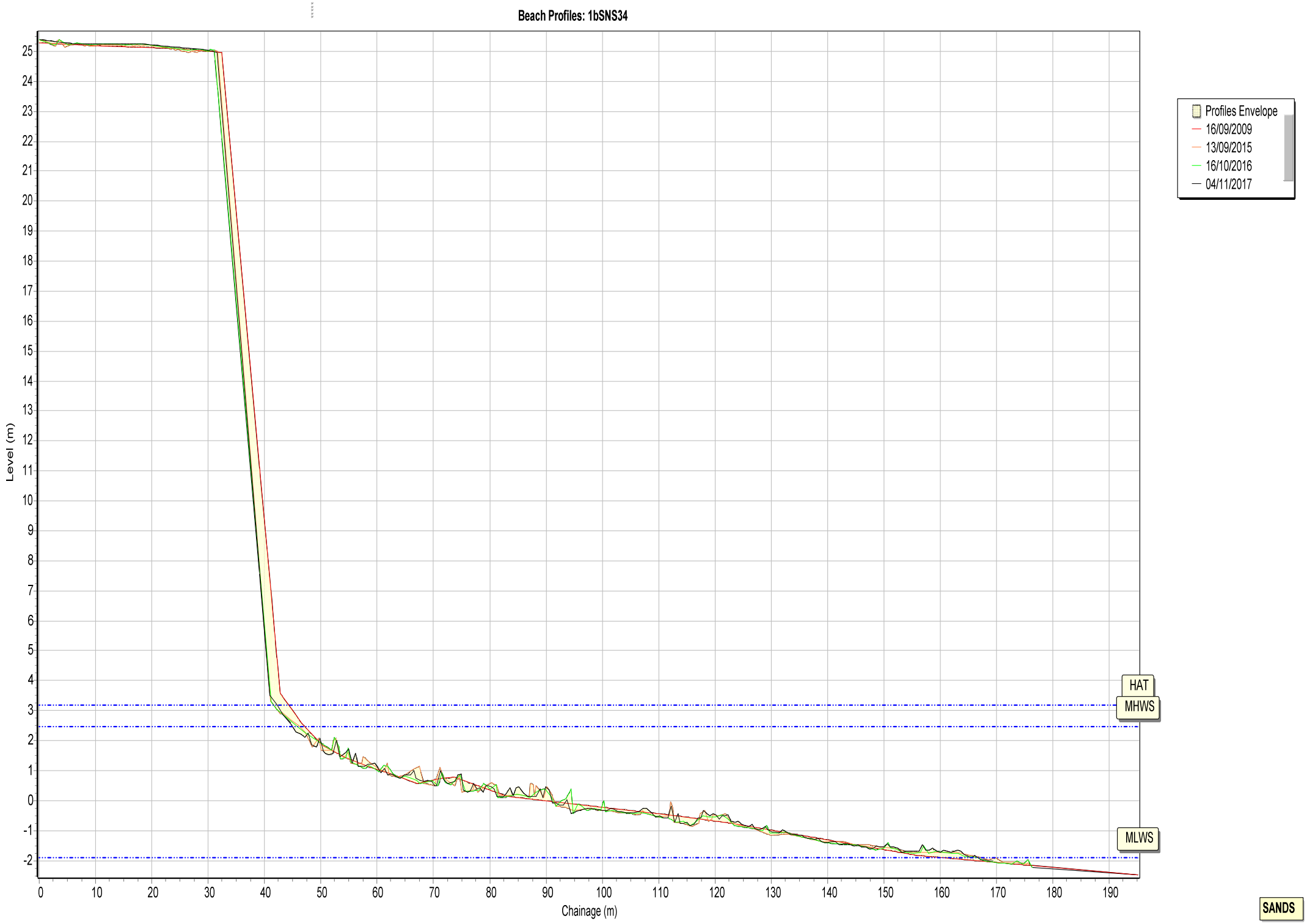
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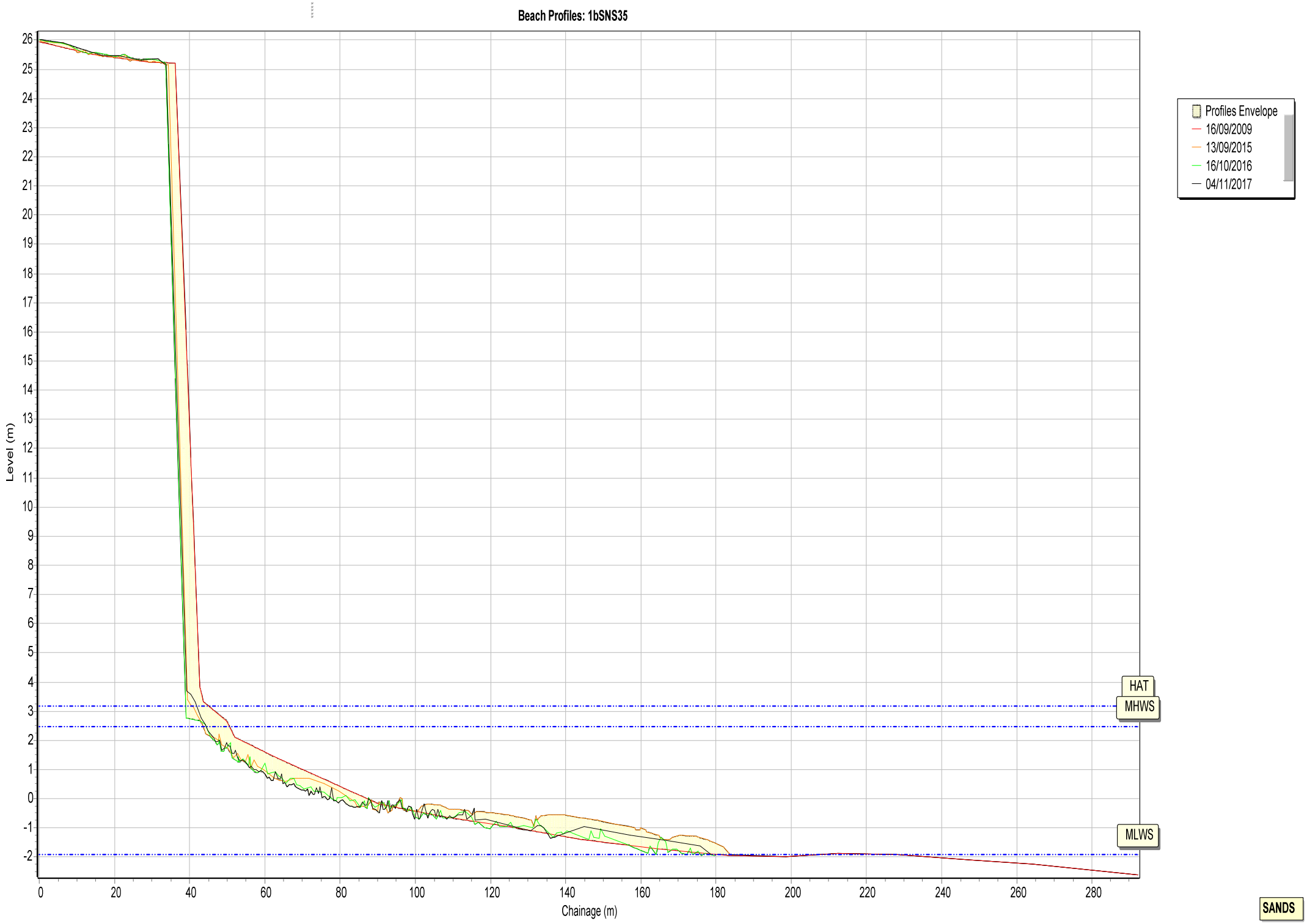
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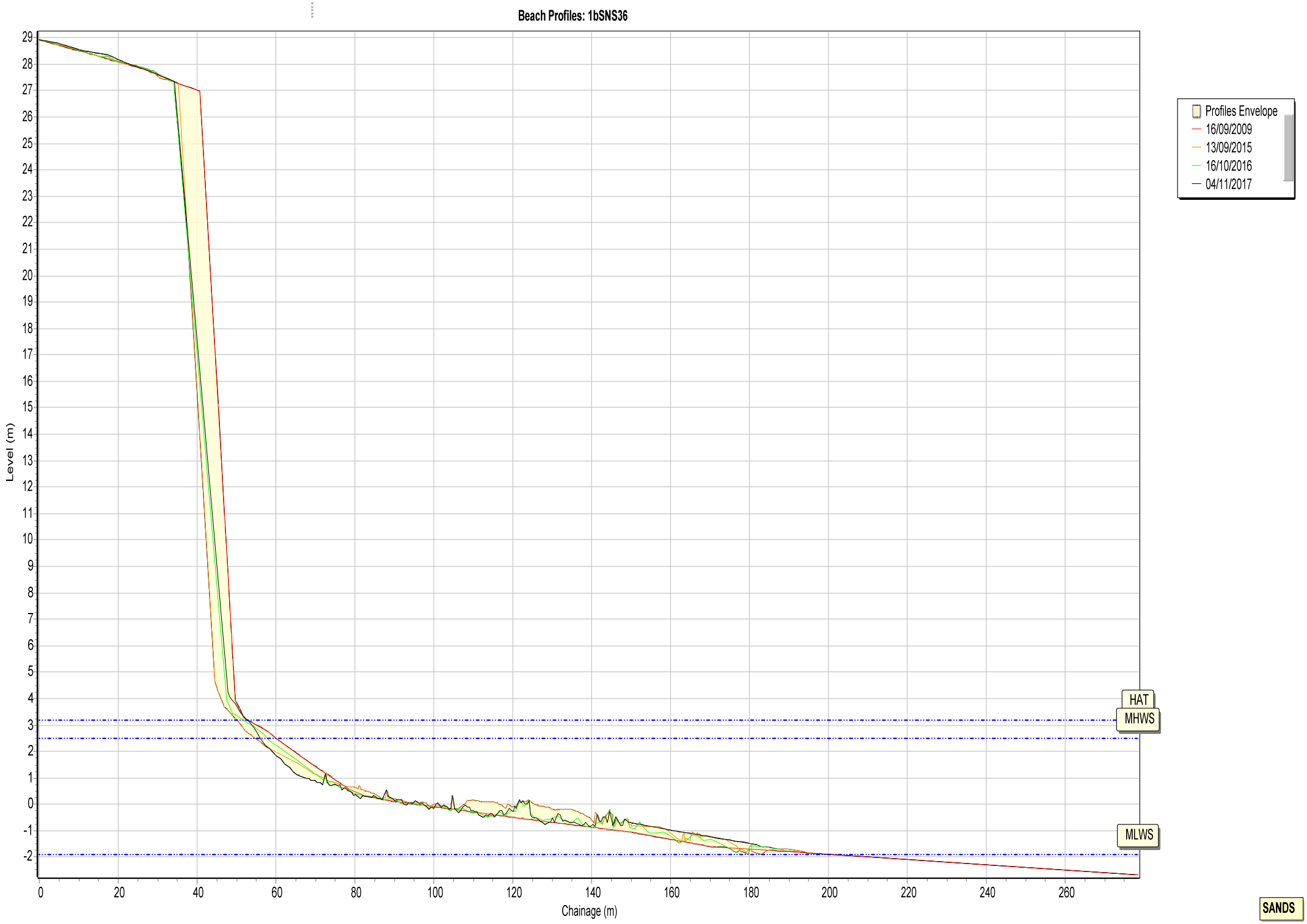
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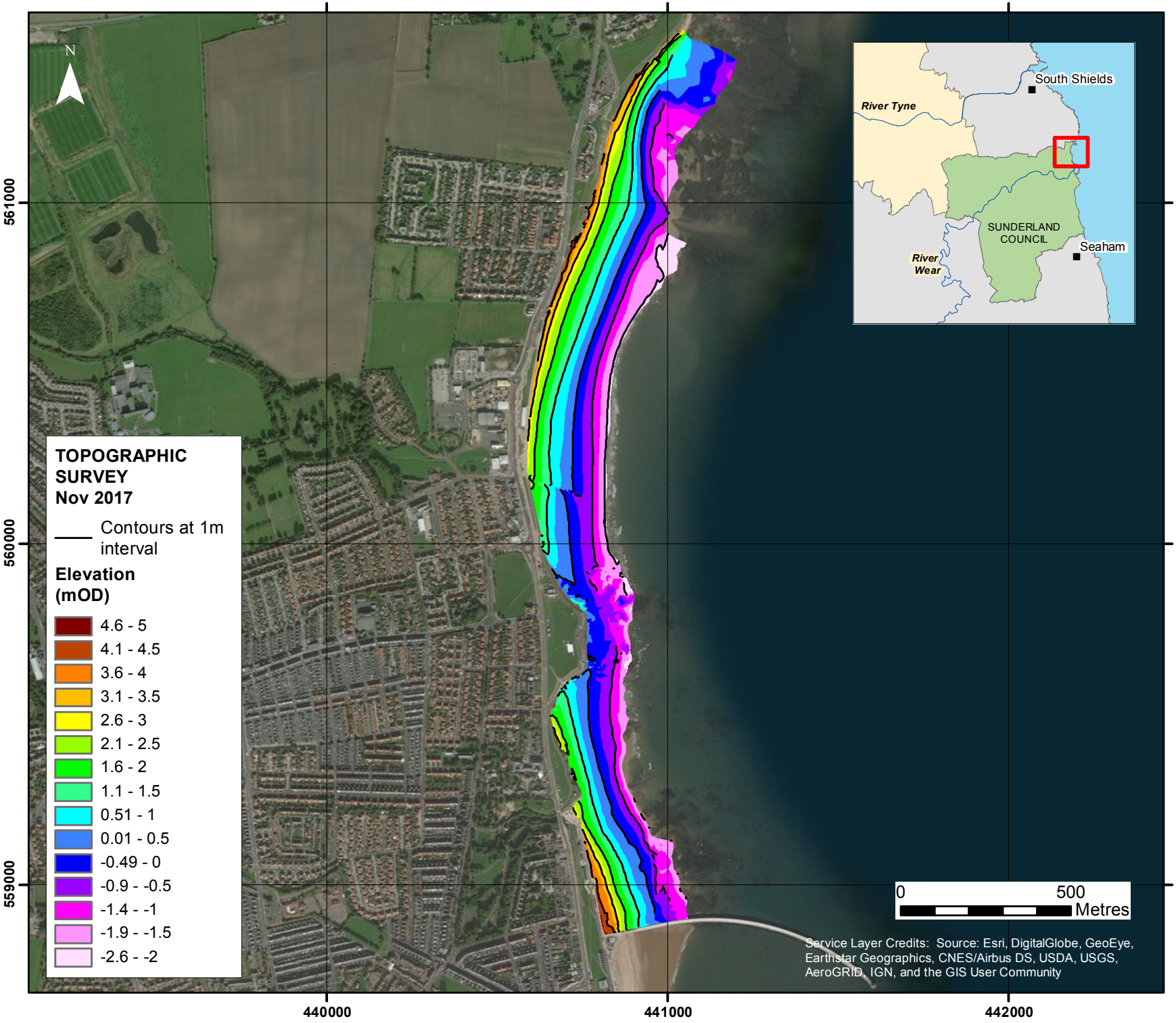
Appendix B

Topographic Survey



Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 1

SUNDERLAND NORTH

Sunderland Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:15,000

WATER
Royal HaskoningDHV
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Royal HaskoningDHV
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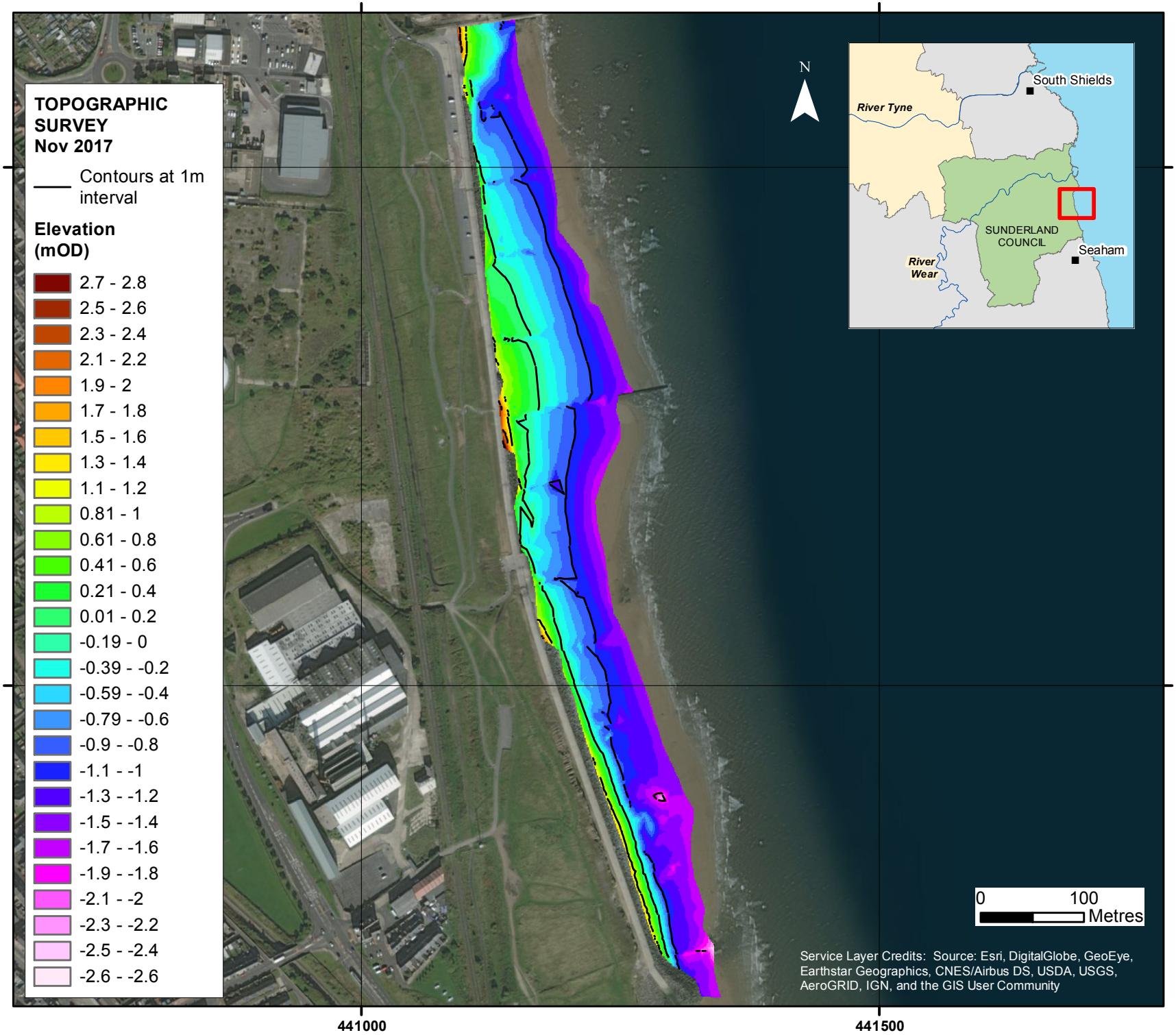

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 2

SUNDERLAND SOUTH

Sunderland Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:5,000

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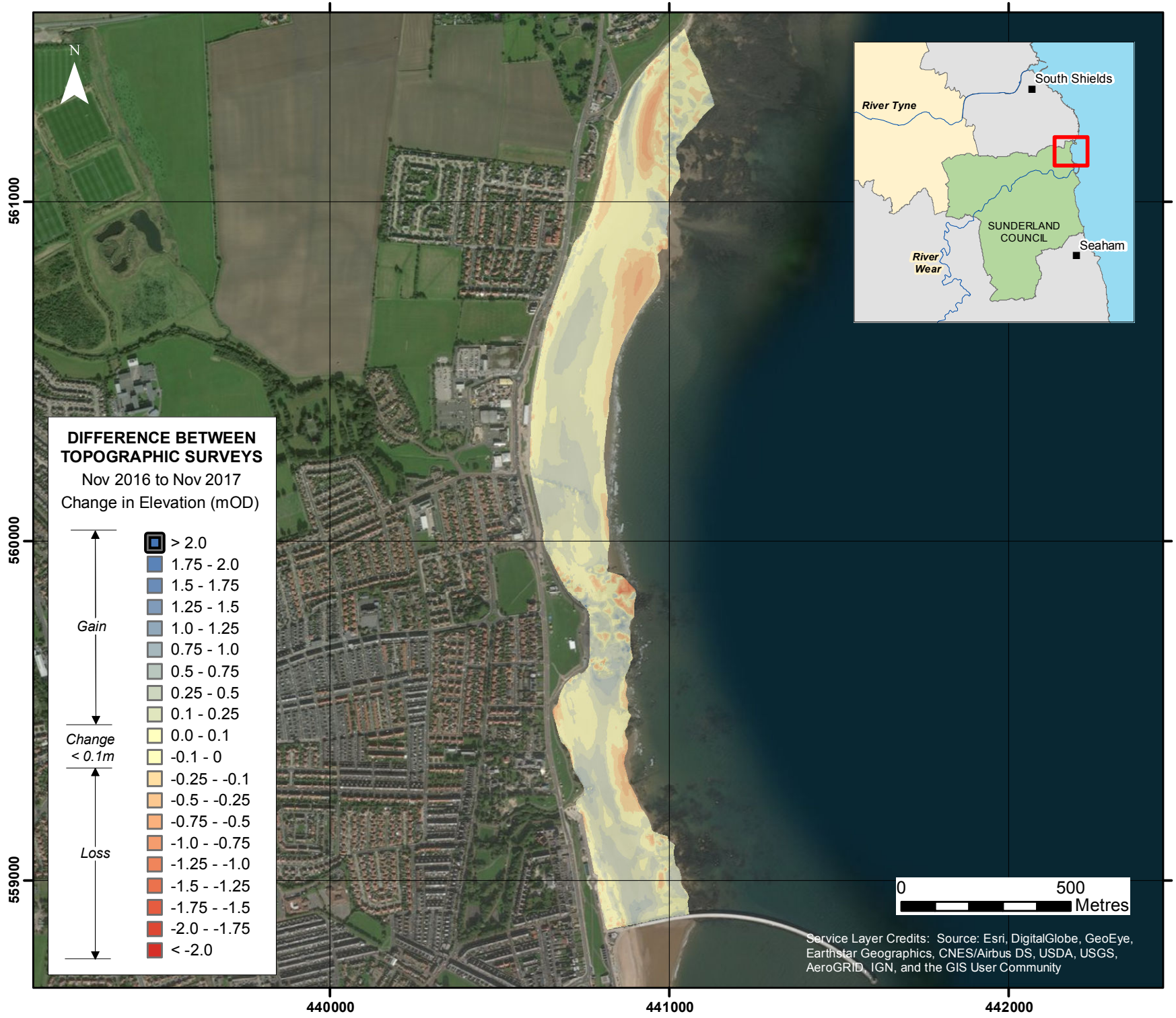

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 3

SUNDERLAND NORTH

Sunderland Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:15,000

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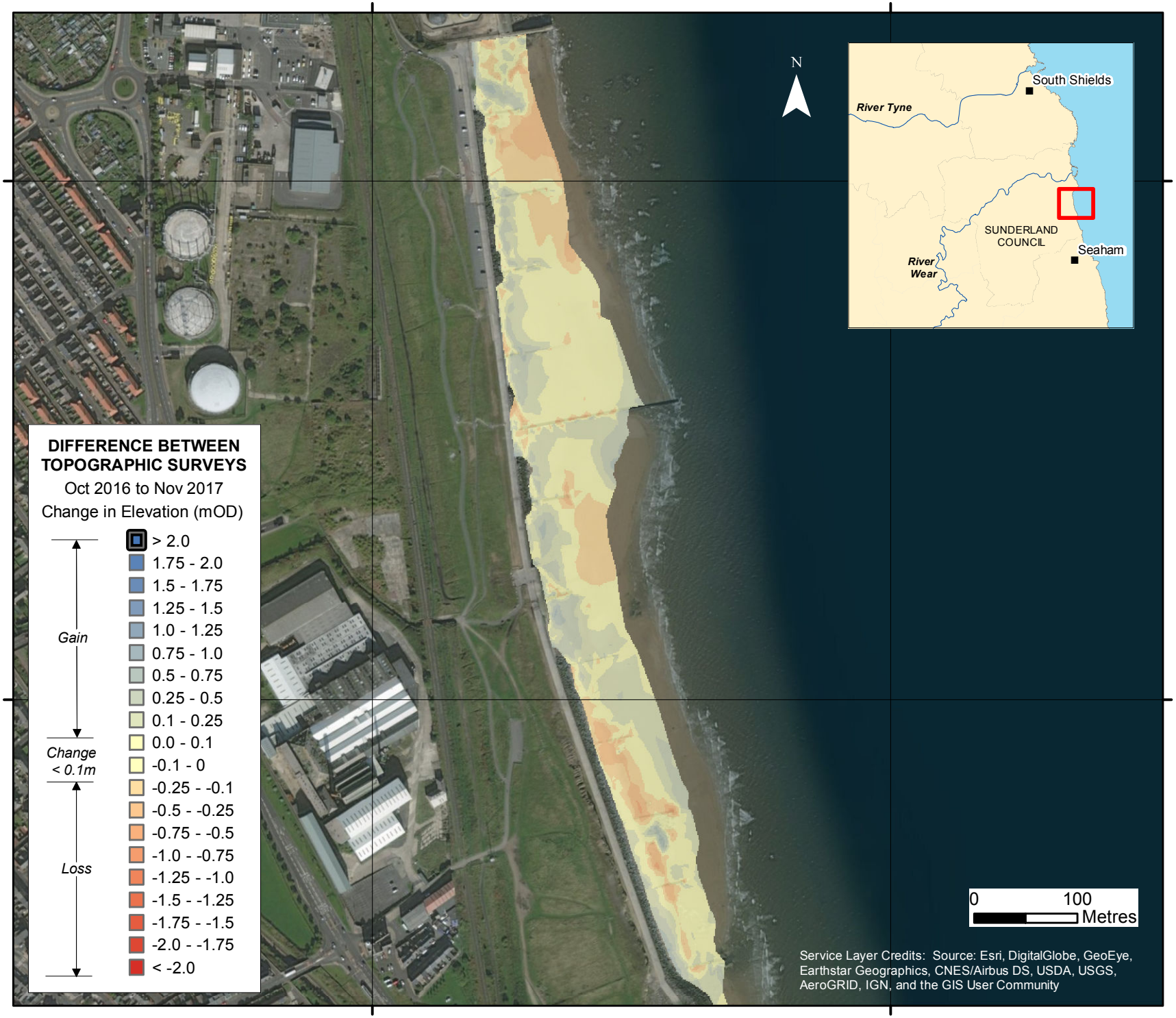

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 4

SUNDERLAND SOUTH

Sunderland Council Frontage

Analytical Report
'Full Measures' Survey 2017

Drawing Scale at A4 1:5,000

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Appendix C

Cliff Top Survey

Cliff Top Survey

Hendon and Ryhope

Thirty-two ground control points have been established between Hendon and Ryhope. The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion.

The cliff top surveys between Hendon and Ryhope are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top.

Table C1 provides baseline information about these ground control points and results from the 2009 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table C1 – Cliff Top Surveys between Hendon and Ryhope

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing	Baseline Survey	Previous Survey	Present Survey	Baseline to Present	Previous to Present	Baseline to Present
			(°)	March 2009	Apr 2017	Nov 2017	Mar 2009 - Nov 2017	Apr 2017 - Nov 2017	Mar 2009 - Nov 2017
1	441025.7	555571.1	75	8.16	8.22	8.24	-0.08	-0.02	-0.01
2	441064.4	555355.1	85	7.09	5.29	5.31	1.78	-0.02	0.22
3	441098	555124	82	10.01	10.32	10.36	-0.35	-0.04	-0.04
4	441174	554938.7	65	10.3	10.44	10.46	-0.16	-0.02	-0.02
5	441199.1	554861.1	65	7.71	10.87	10.89	-3.18	-0.02	-0.40
6	441224.5	554774.2	71	10.83	10.95	10.97	-0.14	-0.02	-0.02
7	441248.4	554690.3	74	10.18	10.47	10.50	-0.32	-0.03	-0.04
8	441259.3	554596.6	101	10.08	9.9	9.88	0.20	0.02	0.02
9	441275.8	554513.4	66	10.52	6.47	6.48	4.04	-0.01	0.51
10	441309.4	554421.3	58	8.77	1.37	1.45	7.32	-0.08	0.92
11	441354	554346.5	68	8.2	4.05	4.18	4.02	-0.13	0.50
12	441400.2	554248.2	56	6.17	5.88	5.86	0.31	0.02	0.04
13	441452.3	554174.7	63	11.61	8.65	8.72	2.89	-0.07	0.36

14	441472.3	554080.5	127	7.33	6.04	6.17	1.16	-0.13	0.15
15	441413	554005.1	122	7.84	7.9	7.89	-0.05	0.01	-0.01
16	441384.8	553913.3	90	9.89	7.85	7.82	2.07	0.03	0.26
17	441404.1	553815.5	93	6.32	5.98	6.06	0.26	-0.08	0.03
18	441404.1	553723.6	119	8.1	3.19	3.30	4.80	-0.11	0.60
19	441398.5	553632.8	78	8.23	4.5	4.50	3.73	0.00	0.47
20	441438.3	553452.9	71	10.09	5.65	5.68	4.41	-0.03	0.55
21	441506.1	553256.1	62	8.57	1.5	1.56	7.01	-0.06	0.88
22	441550.1	553158.7	103	6.57	3.35	3.36	3.21	-0.01	0.40
23	441585.2	553076.5	64	8.11	7.93	7.96	0.15	-0.03	0.02
24	441624.4	552870.7	69	7.53	3.85	3.50	4.03	0.35	0.50
25	441689.1	552758	70	14.58	6.89	7.03	7.55	-0.14	0.94
26	441715	552713.3	54	12.87	10.7	10.77	2.10	-0.07	0.26
27	441749.2	552674.4	62	14.56	3.12	3.41	11.15	-0.29	1.39
28	441776.6	552629.9	57	8.62	4.17	4.27	4.35	-0.10	0.54
28A	441798.6	552586.3	56	13.63	7.98	8.13	5.50	-0.15	0.69
28B	441817.4	552542.4	64	12.3	11.28	11.40	0.90	-0.12	0.11
28C	441852.2	552502.6	52	13.11	12.63	12.65	0.46	-0.02	0.06
29	441880.1	552471.6	83	15.46	15.1	15.21	0.25	-0.11	0.03
30	441921.4	552269	97	8.55	6.47	6.52	2.03	-0.05	0.25
31	441853.1	552094	75	11.2	5.89	5.81	5.39	0.08	0.67
32	441883.3	551988.5	96	9.82	3.62	3.71	6.11	-0.09	0.76