



Cell 1 Regional Coastal Monitoring Programme Update Report 9: 'Partial Measures' Survey 2017



**Scarborough Borough Council
July 2017**

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Authors	
Emma Hick	Royal HaskoningDHV
Dr Nick Cooper – Approval	Royal HaskoningDHV

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Abbreviations and Acronyms

Acronym / Abbreviation	Definition
AONB	Area of Outstanding Natural Beauty
DGM	Digital Ground Model
HAT	Highest Astronomical Tide
LAT	Lowest Astronomical Tide
MHWN	Mean High Water Neap
MHWS	Mean High Water Spring
MLWS	Mean Low Water Neap
MLWS	Mean Low Water Spring
m	metres
ODN	Ordnance Datum Newlyn

Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (m AOD)			
	Hartlepool Headland to Saltburn Scar	Skinningrove	Hummersea Scar to Sandsend Ness	Sandsend Ness to Saltwick Nab
1 in 200 year	3.87	3.86	4.1	3.88
HAT	3.25	3.18	3.15	3.10
MHWS	2.65	2.68	2.65	2.60
MLWS	-1.95	-2.13	-2.15	-2.20
Water Level Parameter	Water Level (m AOD)			
	Saltwick Nab to Hundale Point	Hundale Point to White Nab	White Nab to Filey Brigg	Filey Brigg to Flamborough Head
1 in 200 year	3.88	3.93	3.93	4.04
HAT	3.10	3.05	3.05	3.10
MHWS	2.60	2.45	2.45	2.50
MLWS	-2.20	-2.35	-2.35	-2.30

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

Glossary of Terms

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

Preamble

The Cell 1 Regional Coastal Monitoring Programme covers approximately 300km of the 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).

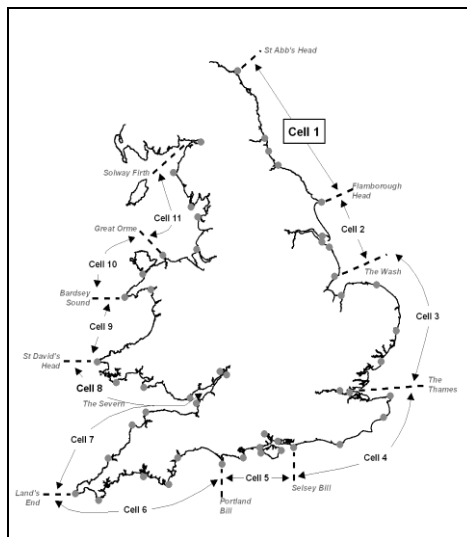


Figure 1 Sediment Cells in England and Wales

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. 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	Jun 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	Feb 12	Mar-May 12	Jul 13	-
5	2012/13	Sep 12	Mar 13	Apr-May 13	May 13	-
6	2013/14	Oct-Nov 13	Feb 14	Mar-Apr 14	Jul 14	-
7	2014/15	Sep 14	Feb 15	Mar 15	Jul 15	-
8	2015/16	Sep 15	Feb 16	Mar-Apr 16	Jul 16	Jun 16
9	2016/17	Sep-Nov 16	Feb 17	Feb-Apr 17	Jul 17 (*)	

(*) The present report is **Update Report 9** and provides an analysis of the 2017 Partial Measures survey for Scarborough Council's frontage.

1. Introduction

1.1 Study Area

Scarborough Council's frontage extends from Staithes Harbour in the north, to Speeton in Filey Bay in the south. For the purposes of this report, it has been sub-divided into eight areas, namely:

- Staithes¹
- Runswick Bay
- Sandsend Beach, Uppgang Beach and Whitby Sands
- Robin Hood's Bay
- Scarborough North Bay
- Scarborough South Bay
- Cayton Bay
- Filey Bay

1.2 Methodology

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

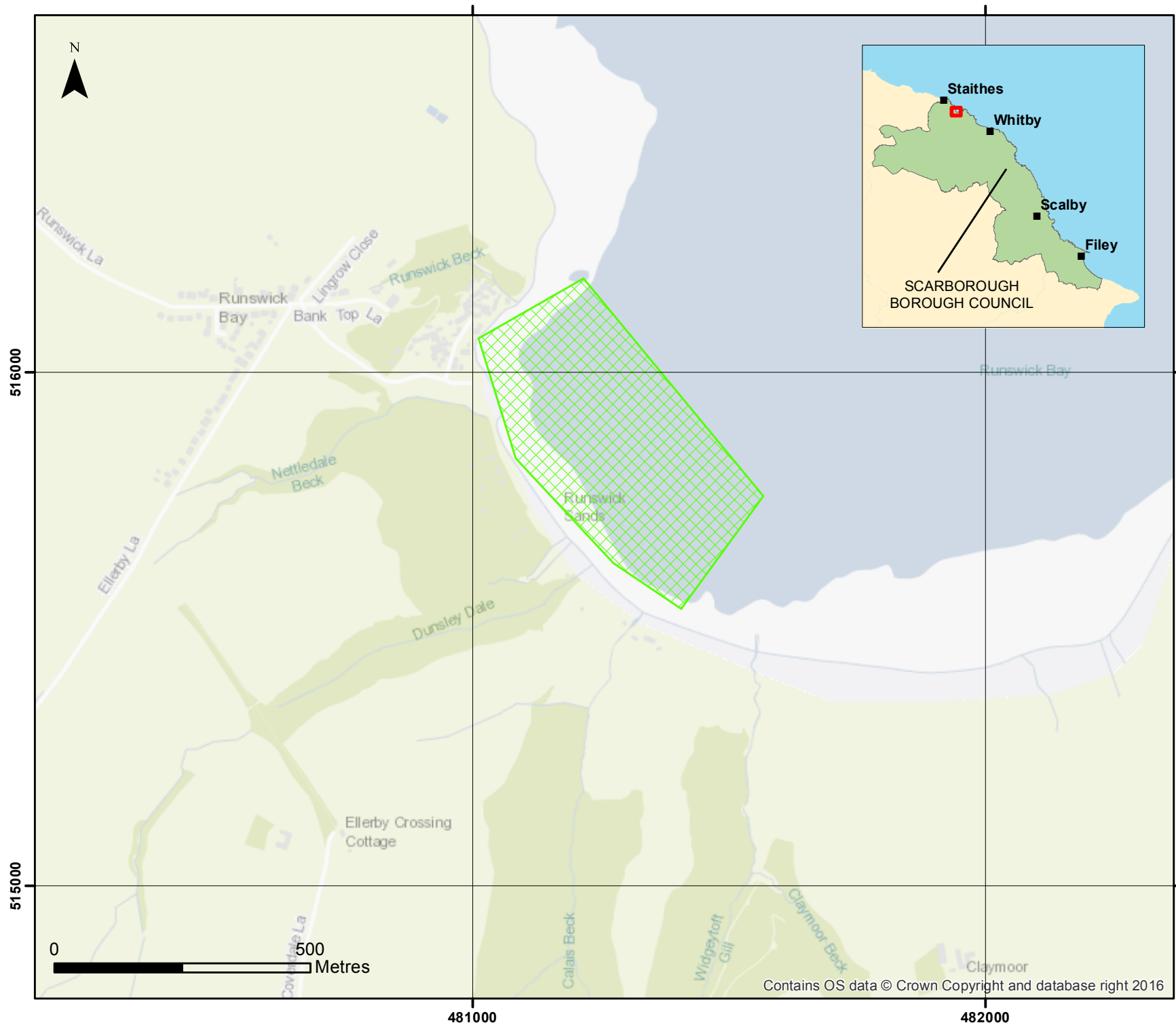
- Full Measures survey annually each autumn/early winter comprising:
 - Beach profile surveys along 20 transect lines
 - Topographic survey at Runswick Bay
 - Topographic survey along the Sandsend to Whitby frontage
 - Topographic survey at Robin Hood's Bay
 - Topographic survey at Scarborough North Bay
 - Topographic survey at Scarborough South Bay
 - Topographic survey at Cayton Bay
 - Topographic survey at Filey Bay
- Partial Measures survey annually each spring comprising:
 - Beach profile surveys along 20 transect lines
 - Topographic survey at Runswick Bay
 - Topographic survey at Robin Hood's Bay
 - Topographic survey at Filey Bay (Town coverage)
- Cliff top survey bi-annually at:
 - Staithes
 - Robin Hoods Bay (new addition Spring 2010)
 - Scarborough South Bay (new addition Spring 2010)
 - Cayton Bay
 - Filey

The location of these surveys is shown in Figure 2. The Partial Measures survey was undertaken along this frontage between 27th February and 25th April 2017, more specifically:

- Runswick Bay – 27th February 2017;
- Whitby – 3rd March 2017;
- Robin Hood's Bay – 25th April 2017;
- Scarborough – 2nd March 2017;
- Cayton Bay – 1st March 2017; and
- Filey – 28th February 2017.

During this time weather conditions varied considerably; refer to the survey reports for details of the weather conditions over this survey period. Data from the present survey are presented in a processed form in the Appendices.

¹ The Staithes frontage straddles the boundary of jurisdiction of both Redcar & Cleveland Borough Council and Scarborough Borough Council.



Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 1

Scarborough Borough Council Frontage

Analytical Report
Topo Surveys

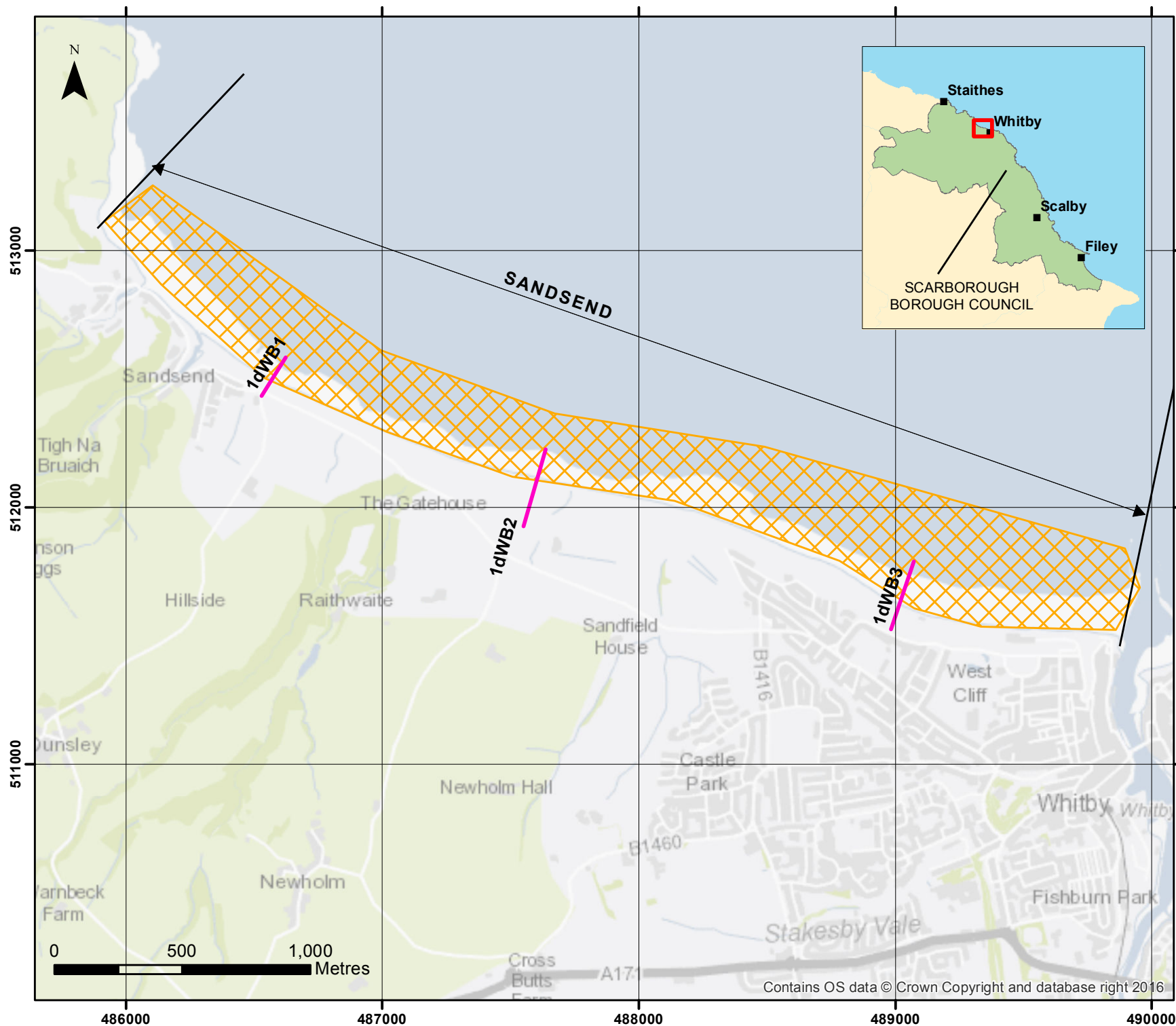
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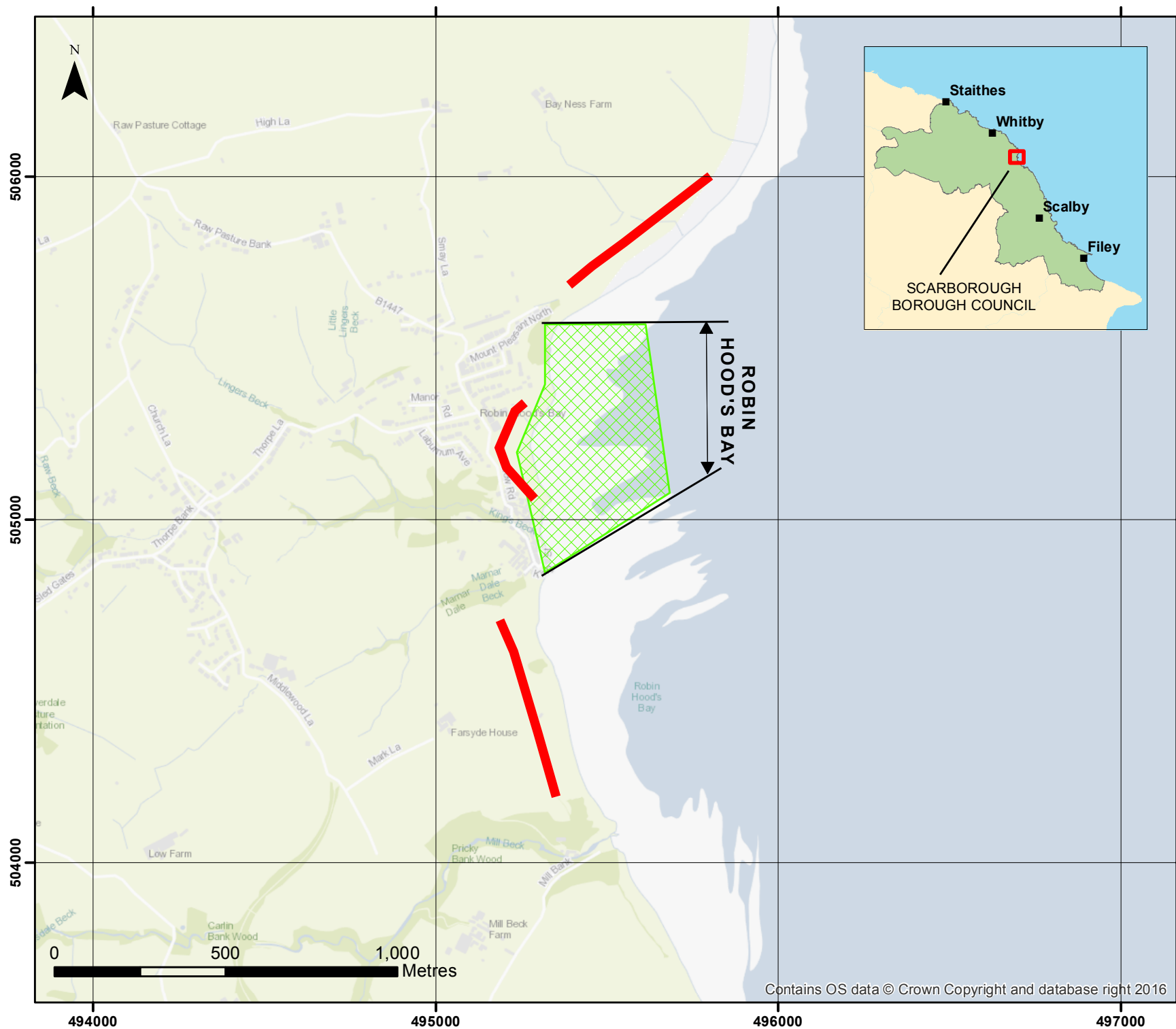
WATER

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

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







Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly

Cliff Top Monitoring Pegs

- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 3

Scarborough Borough Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:15,000

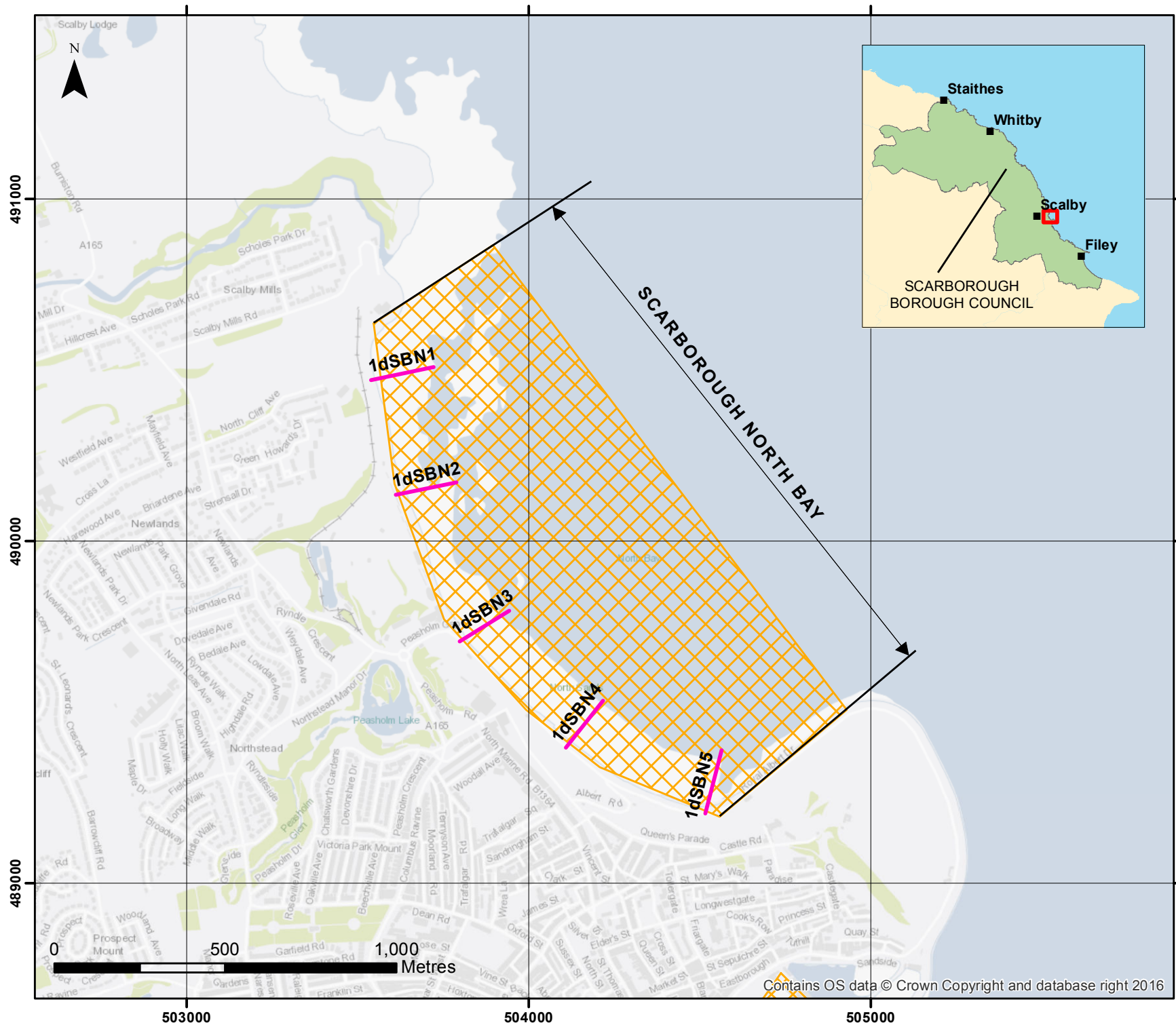
WATER

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

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



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Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 4

Scarborough Borough Council Frontage

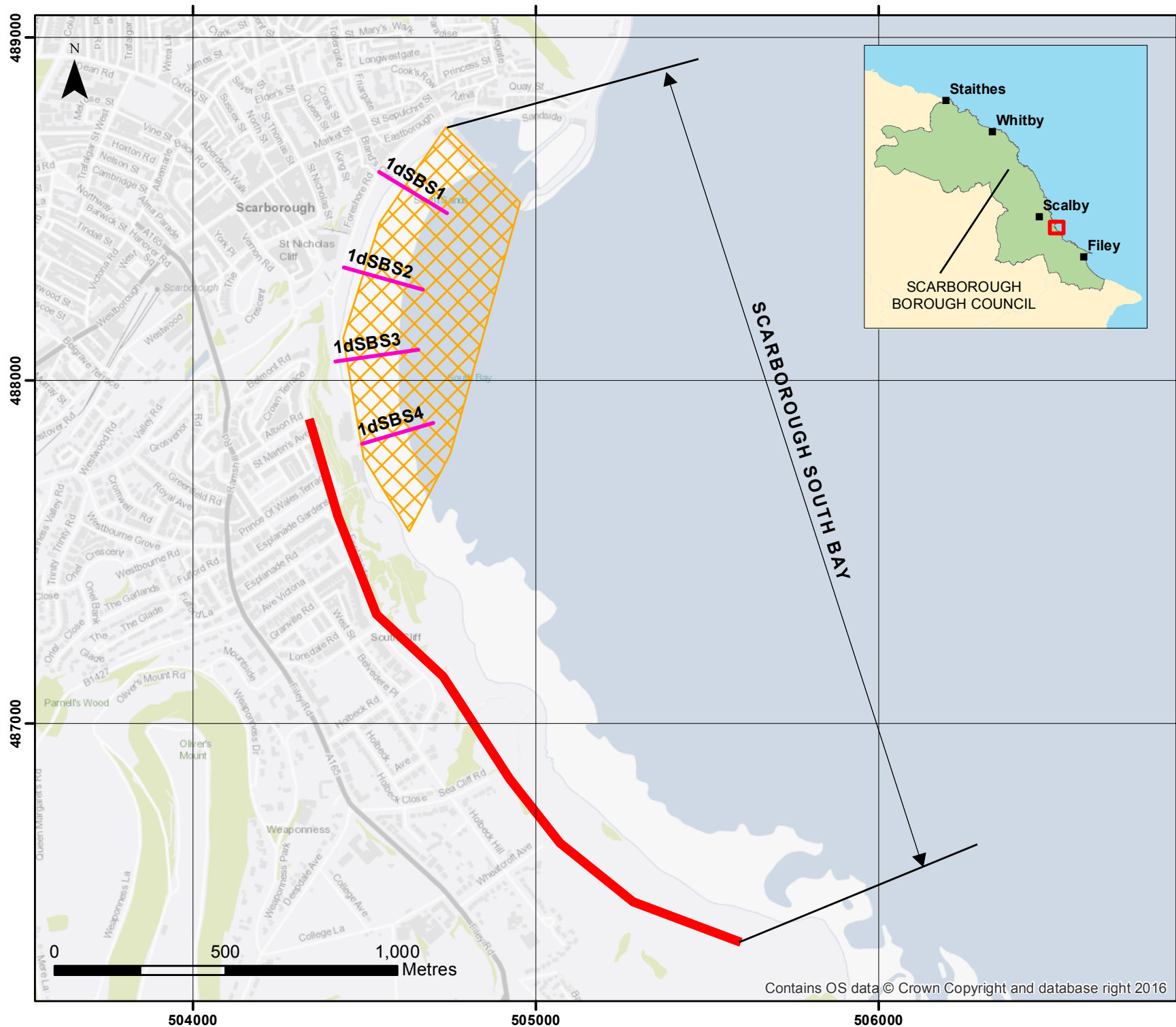
Analytical Report
Topo Surveys

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

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

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Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly

Cliff Top Monitoring Pegs

- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 5

Scarborough Borough Council Frontage

Analytical Report
Topo Surveys

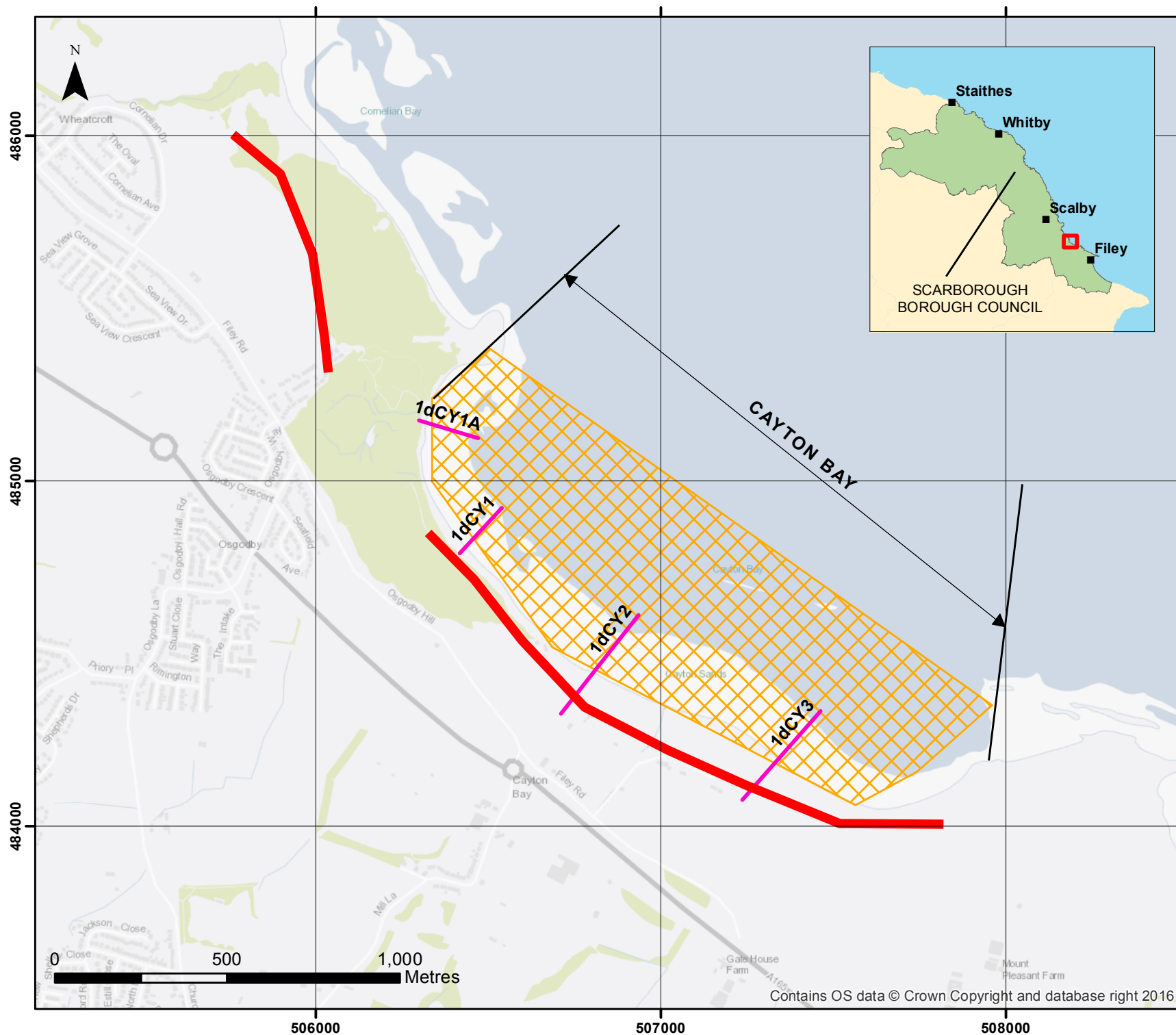
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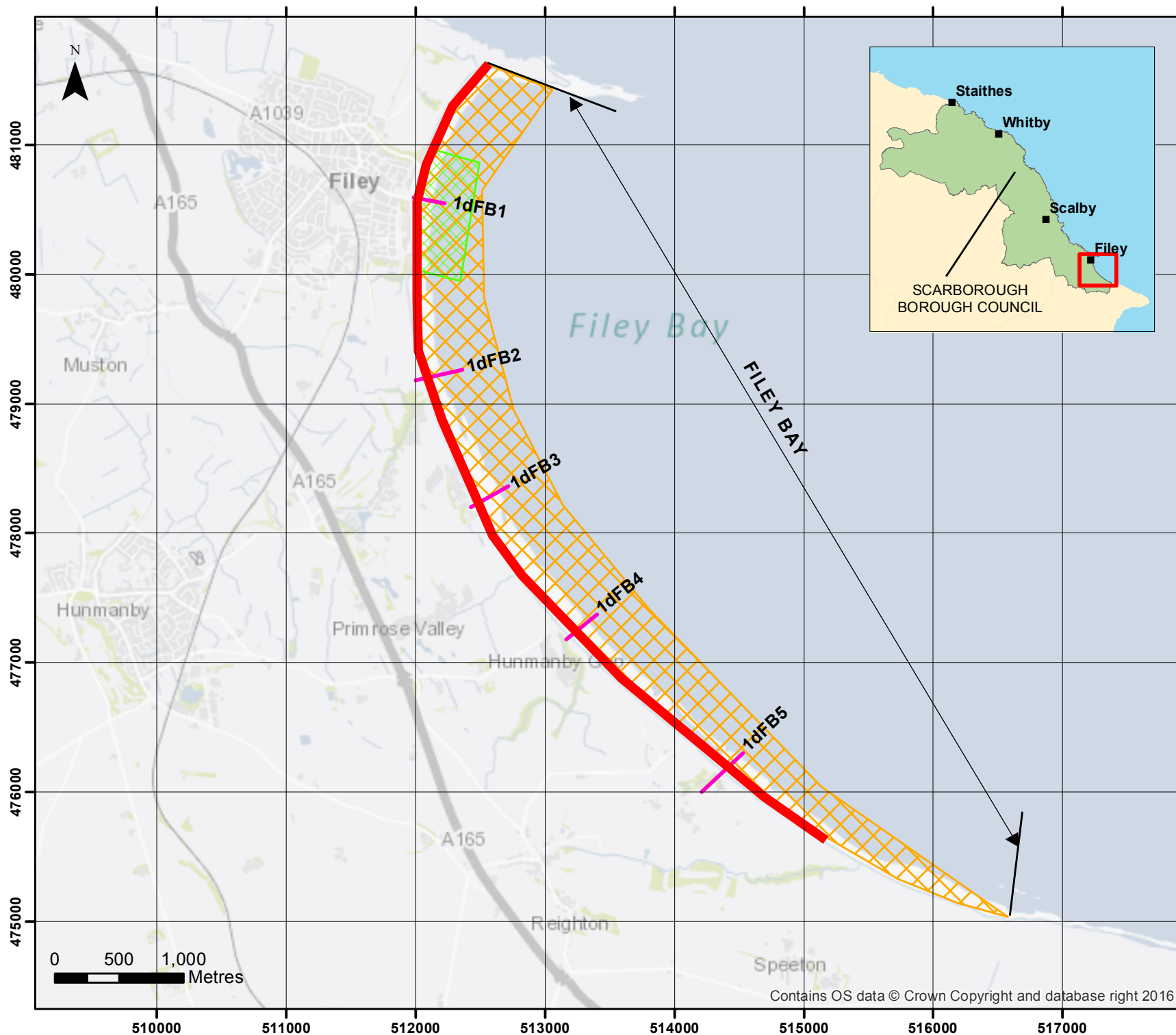
WATER
Royal HaskoningDHV
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
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Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly

Cliff Top Monitoring Pegs

- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 7

Scarborough Borough Council Frontage

Analytical Report
Topo Surveys

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WATER

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

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



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2. Analysis of Survey Data

2.1 Staithes

Survey Date	Description of Changes Since Last Survey	Interpretation
6 th March 2017	<p>Cliff-top Survey:</p> <p>Twenty ground control points have been established at Staithes for the purposes of cliff top monitoring. The separation between any two points is a nominal 100m. The cliff top surveys at Staithes are undertaken bi-annually. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing.</p> <p>Appendix C provides results from the March 2017 survey, showing the distance from the ground control point to the edge of the cliff top along the defined bearing and changes in position since the November 2008 baseline survey and the previous September 2016 survey.</p> <p>The results provided in Appendix C show that the majority of the profiles show little or no erosion, <0.1m. The exception is at Point 1, where a significant landslide resulting in the cliff top retreating by 1.75m occurred over winter of 2016/17. Points 18 and 19 have recorded a negative movement of 0.5m and 0.6m respectively; this is likely to be due to difficulties in accurately identifying the cliff edge through vegetation.</p>	<p>The recorded changes to the cliff top between September 2016 and March 2017 are generally small. There has been one failure which has significantly affected the cliff top at the survey transects.</p> <p>Longer term trends: Table C1 in Appendix C presents the erosion rates calculated from the data collected since 2008. Points 1, 4 and 13 have a recession rate of 0.2, 0.2 and 0.3m/yr respectively. Other points have not recorded erosion.</p>

2.2 Runswick Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
27 th February 2017	<p>Topographic Survey:</p> <p>Runswick Bay is covered by a 6-monthly topographic survey. A consistently applied GIS processing routine has been used to create a digital ground model (DGM) (Appendix B - Map 1a) and to calculate the differences between the current topographic survey (Spring 2017) and the previous survey (Autumn 2016) to highlight areas and amounts of erosion and deposition. In all cases, a 5m resolution raster grid has been used to identify areas of erosion and accretion. (Appendix B – Map 1b).</p> <p>Appendix B - Map 1b shows changes that are primarily shore-parallel, with erosion on the upper beach and accretion on the lower beach. The exception is the southern end of the bay where erosion dominates across the whole beach, with just a small area of accretion right at the top of the beach. The greatest magnitude of change is immediately to the south of the rock armour revetment at the village.</p>	<p>Material appears to have been moved from the top of the beach to the bottom of the beach. The pattern indicates seasonal draw down, with material moving down the beach and temporary stored below MLW.</p> <p>Longer term trends: The data collected since 2008 indicate a general pattern of winter drawdown and spring recovery with no net change. The trends from this survey are comparable with observations since 2013.</p>

2.3 Sandsend Beach, Upgang Beach and Whitby Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
3 rd March 2017	<p>Beach Profiles:</p> <p>The Sandsend, Upgang and Whitby frontage is covered by three beach profile lines for the Partial Measures survey (Appendix A). The profiles were surveyed in October 2016 (2016 Full Measures) and in March 2017.</p> <p>Profile 1dWB1 is located around 400m south of Sandsend village. There has been accretion of up to 1.0m at the toe of the new coastal defence, covering several of the lower steps, up to chainage 65m. Seawards of chainage 65m there has been erosion of up to 1.0m, but more typically 0.4m. Overall the profile is at a medium level compared to the range recorded from previous surveys.</p> <p>Profile 1dWB2 is located in the centre of Upgang beach. The profile remained stable to the face of the cliff at 145m chainage. From 145m to 175m chainage there is has been a drop in the beach of up to 0.5m since the previous survey. Between chainage 175m and 220m there has been accretion of up to 0.7m, creating a berm at chainage 185m. Seawards of chainage 220m there has been erosion of up to 1.0m. The upper beach is at a relatively low level compared to the range recorded from previous surveys, whilst the rest of the beach is at a more medium level.</p> <p>Profile 1dWB3 is located on Whitby Sands and showed erosion of up to 1.0m, but more typically 0.3m, across the whole beach profile. Overall the beach is at a medium level compared to the range recorded from previous surveys.</p>	<p>All of the profiles are in the middle of the range of previous profiles, which shows that this frontage is dominated by seasonal fluctuation of the beach levels.</p> <p>Longer term trends:</p> <p>The beach profiles appear to be reasonably stable showing only seasonal fluctuations. The long term difference plot for Autumn 2008 to Autumn 2016 show accretion in the eastern and western ends of the bay and erosion in the centre.</p>

2.4 Robin Hoods Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
25 th April 2017	<p>Topographic Survey:</p> <p>Data from the most recent topographic survey (Partial Measures, Spring 2017) have been used to create a digital ground model (DGM) (Appendix B – Map 2a) using a Geographical Information System (GIS). A difference plot has also been produced using the DGM (Appendix B – Map 2b) from the last topographic survey (Full Measures, Autumn 2016) and the present survey.</p> <p>The difference plot shows changes in level between Autumn 2016 and Spring 2017 and highlights a patchy distribution of erosion and accretion. The majority of the bay has seen very little change ($\pm 0.25\text{m}$) over the winter of 2016/17, associated with rocky outcrops that run perpendicular to the shore. The main area of erosion is on the beach below the eroding cliffs which form the small promontory in the centre of the bay. The largest patches of accretion are located towards the north and south ends of the survey area.</p>	<p>The distribution of change is very patchy. There has been little change over the rock promontories in the bay, although there has been localised erosion and accretion. The loss of 1m of material at the bottom of the cliff is likely to be due to erosion of debris from earlier cliff failures</p> <p>Longer term trends: The difference plots show a continuation of the trend of patchy distribution of erosion and accretion. Overall, the observed changes are of limited magnitude and within the range of changes previously seen. The long term difference between Autumn 2008 and Autumn 2016 shows stability with accretion limited to the defended part of the frontage.</p>
25 th April 2017	<p>Cliff-top Survey:</p> <p>Thirteen ground control points have been established at Robin Hood's Bay since 3rd March 2010 to monitor cliff top recession. The separation between any two points is a nominal 200m and monitoring is undertaken bi-annually. Appendix C provides results from the April 2017 survey showing change since the last survey in November 2016 and the baseline survey in March 2010 (Appendix C- Map 2). The accuracy of the survey technique means change of less than 0.1m is assumed to be error. Six of the monitoring points show erosion since the last survey: Points 2, 3, 4, and 12 all show erosion of 0.1-0.2m, and points 1 and 5 show erosion of 0.6-0.8m. Only Point 1 shows significant long term erosion, with total erosion of 4.4m since the baseline survey in 2010 and a rate of 0.6m/yr.</p>	<p>The cliff top has been largely stable since the previous survey in November 2016, with significant erosion only recorded at two points to the north of the main village.</p> <p>Longer term trends: The erosion rates calculated from the changes since March 2010 show stability at most of the monitoring locations. The longer term rates show that point 1 has a recession rate of 0.6m/yr with other points having a rate of less than 0.1m/yr. This reflects localised and episodic cliff failure through rock fall.</p>

2.5 Scarborough North Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
2 nd March 2017	<p>Beach Profiles:</p> <p>Scarborough North Bay is covered by five beach profile lines for the Partial Measures survey (Appendix A) that are monitored biannually. The previous Full Measures survey was undertaken in October 2016, with an additional post-storm survey undertaken in January 2017.</p> <p>Profile 1dSBN1 is located around 200m south of the Sea Life Centre. The beach level in front of the seawall to chainage 80m dropped by up to 0.8m following the January storm surge event, though had recovered by 0.5m by the March survey. From chainage 80m seawards the beach level increased slightly by up to 0.2m in the January post-storm survey, retaining this level in the March survey. The upper beach is at a medium level compared to the range recorded from previous surveys, whilst the lower beach is at a relatively high level.</p> <p>Profile 1dSBN2 is located close to the former chair lift. The January post-storm survey shows a drop of 0.8m at the toe of the seawall, with the formation of a berm 0.5m above the October 2016 beach level at chainage 40m, and erosion seawards of chainage 60m by up to 1.0m. The March survey shows the levels at the toe of the seawall dropped a further 0.4m, with the removal of the berm (0.9m lowering) creating a flatter mid beach. Seawards of chainage 60m the beach levels have recovered by 0.5m. The upper beach is at a relatively low level compared to the range recorded from previous surveys, with a high middle beach, and medium lower beach.</p> <p>Profile 1dSBN3 is located near Royal Albert Drive. The January post-storm survey shows accretion across the whole profile compared to the October 2016 profile, with 0.4m accretion at the toe of the seawall, little change between chainage 30m and 70m, and up to 0.5m accretion seawards of chainage 70m. The March 2017 profile shows erosion of up to 0.4m across the whole profile when compared to the January post-storm survey. When compared to the October 2016 profile however, the most recent survey shows erosion of up to 0.2m on the upper beach up to chainage 75m, and then accretion of up to 0.3m to chainage 130m, with erosion of up to 0.3m at the toe of the beach. The upper beach is at a medium-low level compared to the range recorded from previous surveys, but a medium-high level over the lower beach.</p> <p>Profile 1dSBN4 is located at the northern end of Clarence Gardens. The January post-storm survey</p>	<p>The January post-storm survey generally shows a pattern of erosion at either end of the bay but accretion in the centre, as well as the drawdown of material across the individual profiles.</p> <p>The March 2017 profiles show a general pattern of little change in the south of the bay, erosion in the centre, and accretion in the north of the bay.</p> <p>Longer term trends: The beach is within the mid-range of profiles with changes typical of seasonal drawdown and recovery, with the exception of 1dSBN4 which has the lowest levels recorded for the mid beach area. Levels indicate recovery since the severe storms of December 2013.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>shows no change at the toe of the seawall, but erosion of up to 0.6m seawards of chainage 60m. The March 2017 shows accretion of up to 0.7m at the toe of the seawall until the exposed rock between chainage 35m and 70m. Between chainage 60m and 110m there has been further erosion of up to 0.4m exposing c.10m more of the rock platform. Seawards of chainage 110m the beach levels have recovered slightly but remain up to 0.3m below the October 2016 levels. Upper and lower beach levels are at a relatively medium level compared to the range recorded from previous surveys, but in the middle of the beach between chainage 65m and 110m the beach levels are the lowest on record.</p> <p>Profile 1dSBN5 is located southern of Clarence Gardens. The January post-storm survey shows erosion across the whole profile of up to 0.5m, but more typically 0.3m. The most recent survey shows very little change since the January survey, ± 0.1m. Overall the profile is at a medium-low level compared to the range recorded from previous surveys.</p>	

2.6 Scarborough South Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
2 nd March 2017	<p>Beach Profiles:</p> <p>Scarborough South Bay is covered by four beach profile lines for the Partial Measures survey (Appendix A). The profiles were surveyed during the Full Measures survey of October 2016.</p> <p>Profile 1dSBS1 is located around 250m south of the West Pier. The profile is unchanged to the upper edge of the sea defences at 15m chainage. Between the sea wall and chainage 90m there has been erosion of up to 0.4m. Seawards of chainage 90m the changes in beach level have been minimal, ± 0.1m. Overall the profile is at a medium-high level compared to the range recorded from previous surveys.</p> <p>Profile 1dSBS2 is located on the shore fronting St Nicolas Cliff. Between the sea wall and chainage 80m there has been erosion of up to 0.4m. Between chainage 80m and 120m there has been very little change. Seawards of chainage 120m there has been accretion of up to 0.3m. The profile is low at the base of the sea wall, but at a medium-high level across the rest of the profile compared to the range recorded from previous surveys.</p> <p>Profile 1dSBS3 is located 250m north of the Scarborough Spa complex. From the sea wall at 10m to 170m chainage the beach level has dropped by up to 0.3m. Seawards of chainage 170m there has been accretion of 0.2m. The profile is relatively low at the base of the sea wall rising to relatively high at the toe of the beach, compared to the range recorded from previous surveys.</p> <p>Profile 1dSBS4 is located on the beach in front of the Scarborough Spa Complex. There has been slight erosion across the profile of <0.2m. The upper beach is at a relatively low-medium level, whilst the lower beach is relatively high compared to the range recorded from previous surveys.</p>	<p>All of the profiles show erosion of 0.2-0.4m, particularly across the upper beach. The lower beach in profiles SBS2 and SBS3 show slight accretion on the lower beach.</p> <p>Longer term trends: The observed changes in the profiles in South Bay are consistent with the seasonal fluctuations of sediment with a bay system.</p>
2 nd March 2017	<p>Cliff-top Survey:</p> <p>Thirteen cliff top monitoring control points have been established at Scarborough South Bay and from Cornelian Bay to Knipe Point. The separation between points is around 300m. The cliff top surveys at Scarborough South Bay are undertaken bi-annually. Appendix C provides results from the March 2010 baseline survey to March 2017, showing the distance from the ground control point to the edge of the cliff top along the defined bearing (Appendix C- Map 3). Error in the technique means change of less</p>	<p>No locations have shown erosion over the winter of 2016/17. Points 11 and 12 show recession rates of 0.5 and 0.4m/yr respectively.</p> <p>Longer term trends: The recession rates for the longer term only show erosion at Points 11 and 12 of between 0.4 and 0.5m/yr. The rest of the study area</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>than 0.1m cannot be relied on. Calculated advances of the cliff line are also assumed to be error associated with difficulty precisely identify the cliff top, particularly where vegetation is present.</p> <p>The recorded changes between October 2016 and March 2017 were within the survey error of 0.1 for all points. .</p>	has remained stable.

2.7 Cayton Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
1 st March 2017	<p>Beach Profiles:</p> <p>Cayton Bay is covered by three beach profile lines for the Partial Measures survey (Appendix A). The previous survey was undertaken in October 2016.</p> <p>Profile 1dCY1A is located on the beach below Knipe Point at the north of the bay, and was added to the programme in November 2015. There has been very little change along the profile until chainage 90m. Seawards of chainage 90m the beach level has dropped by 0.4m. Overall the profile is at a medium level compared to the range recorded from previous surveys.</p> <p>Profile 1dCY1 is located on the beach in front of Tenants' Cliff in the north of the Bay. The surveyors report states that 'the top of section 1 could not be measured due to dense vegetation'. The profile to 20m chainage is similar to the November 2015 record. At around 20m chainage rocks are exposed on the upper beach, to chainage 35m. From 25m to 80m chainage the beach has remained stable, dropping by a maximum of 0.2m. Seawards of chainage 80m very little change has occurred. From 125m to the end of the survey at 140m chainage the rocks on the lower beach are exposed. The profile is at a medium-high level in the middle, but low where the rocks are exposed on the upper and lower beach.</p> <p>Profile 1dCY2 is close to the former pumping station in the middle of Cayton Bay. The cliffed part of the profile has not changed a great deal. From the toe of the cliff at 120m chainage to the end of the profile at chainage 325m there has been erosion of up to 0.4m, though changes at the toe are minimal. Overall the profile is at a relatively medium level compared to the range recorded from previous surveys, except for the toe which is relatively high.</p> <p>Profile 1dCY3 is located around 600m southeast of the pumping station. The cliffed part of the profile has not changed a great deal. From the toe of the cliff at 120m chainage to chainage 240m there has been erosion of up to 0.5m removing the upper beach berm. The lower beach seawards of chainage 240m has accreted by 0.2m. The upper beach is at a relatively low level compared to the range recorded from previous surveys, the middle beach is at a medium-low level and the lower beach is at a relatively high level.</p>	<p>Each of the beach profiles saw a drop in beach level, of up to 0.5m.</p> <p>Longer term trends:</p> <p>The beach close to the toe of the cliff was comparatively low in March 2017, which means that the destabilisation of the cliff continues. Additional cliff failures will feed additional material onto the beach and driver erosion of the cliff top.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
1 st March 2017	<p>Cliff-top Survey:</p> <p>Eight ground control points have been established within Cayton Bay for the purposes of cliff top monitoring. The separation between any two points is typically around 300m. The cliff top surveys at Cayton Bay are undertaken bi-annually. Appendix C provides results from the March 2017 survey showing the distance from the ground control point to the edge of the cliff top along the defined bearing and changes in position since the November 2008 baseline survey and the previous November 2016 survey. The accuracy of the technique means results of less than 0.1m are not considered reliable.</p> <p>Points 2 and 7 show cliff recession since October 2016, where there has been 0.3m and 0.2m of erosion respectively over the winter. Little change was recorded at other locations.</p>	<p>Only points 2 and 7 have shown erosion, the rest of the locations have been stable since October 2016.</p> <p>Longer term trends: The recession rates show that locations 2,4 and 6 all have significant rates of 0.1 to 0.6m/yr.</p>

2.8 Filey Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
28 th February 2017	<p>Beach Profiles:</p> <p>Filey Bay is covered by five beach profile lines for the Partial Measures survey (Appendix A). The previous programmed survey (Full Measures 2016) was undertaken in September 2016.</p> <p>Profile 1dFB1 is located in front of Filey town in the north of the bay. There has been erosion of up to 1m at the base of the sea wall, with erosion of up to 0.4m up to chainage 120m. There has been little change between chainage 120m and 150m. Seawards of chainage 150m there has been accretion of up to 0.4m. The upper beach is at a relatively low level compared to the range recorded from previous surveys, and a high level over the rest of the profile (chainage 140m to 200m is at its highest recorded level).</p> <p>Profile 1dFB2 is located north of Primrose Valley Holiday Village. The surveyor noted it was not possible to measure the beginning of the profile due to vegetation. There has been erosion of up to 0.4m across the whole profile over the winter of 2016/17. Overall the profile is at a medium-high level relative to the range recorded from previous surveys.</p> <p>Profile 1dFB3 is located in front of Flat Cliffs hamlet. There has been erosion of 0.4m between chainage 40m and 200m. Between chainage 200m and 260m there has been accretion of 0.3m. Between chainage 260m and 300m there has been erosion of 0.2m. The most seaward end of the survey appears to show accretion. Overall the profile is at a medium-high level relative to the range recorded from previous surveys.</p> <p>Profile 1dFB4 is located near Humanby Gap. There has been variable erosion of 0.1m to 1.3m between chainages 30m and 240m. This has created a stepped profile with berms at chainage 60m, 140m, and 240m. Seawards of chainage 240m there has been accretion of up to 0.8m at the toe of the beach. Overall the profile is at a medium-high level compared to the range recorded from previous surveys, with the toe of the beach being at its highest recorded level.</p> <p>Profile 1dFB5 is located close to Reighton Gap. The surveyor noted that the middle of profile 1dFB5 was unable to be measured from 65m to c. 204m chainage due to vegetation. There has been variable erosion across the whole beach profile of up to 0.7m, smoothing out the profile. Overall the profile is at a</p>	<p>All of the profiles show erosion over the winter of 2016/17, though all remain within the range recorded from the previous surveys.</p> <p>Longer term trends:</p> <p>The apparent stability of the beach is more likely to be due to the recovery of the beach following the winter storms, it is likely that the beach level was much lower in the mid-winter but that was not recorded.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	relatively medium level compared to the range recorded from previous surveys.	
Spring 2017	<p>Topographic Survey:</p> <p>Data from the most recent topographic survey (Partial Measures, Spring 2017) have been used to create a digital ground model (DGM) (Appendix B – Map 5a) using a Geographical Information System (GIS). The topographic plot shows the gently sloping shore parallel bathymetry in front of Filey town. A difference plot has also been produced using the DGM (Appendix B – Map 5b) comparing the last topographic survey (Full Measures, Autumn 2016) to the present survey.</p> <p>The difference plot shows bands of change running parallel to the shore. In front of the sea wall and on the upper beach there is a wide band of erosion of up to 1.0m. The middle beach shows little change, with the lower beach showing a wide band of accretion. The toe of the beach shows a very narrow band of little change.</p>	<p>The erosion at the top of the beach next to the sea wall was observed in the previous partial measures report. The erosion of this part of the beach is probably due to the refraction of wave energy on the hard defences through the winter. Overall the beach has flattened with some of the material lost on the upper beach being held on the lower beach close to the extent of the survey.</p> <p>Longer term trends:</p> <p>The erosion of the upper beach, close to the sea wall is observed over the winter of 2014/15, 2015/16, and 2016/17 does not reflect the long term trend between Autumn 2008 and Autumn 2016 that shows with accretion on the upper beach and erosion on the lower beach. The atypical pattern seen in recent years probably reflects changes in wave climate</p>
28 th February 2017	<p>Cliff-top Survey:</p> <p>Twenty-three ground control points were established within Filey Bay for the purposes of cliff top monitoring in November 2008. Additional points were added in September 2010 and March 2011 (as shown in Appendix C – Maps 5 and 6) taking the total number of ground control points in Filey Bay to 28. The maximum separation between points is 300m. The cliff top surveys at Filey Bay are undertaken bi-annually. Appendix C provides results from the February 2017 survey. The accuracy of the technique means results of less than 0.1m are not reliable. Furthermore, indications of an advancing cliff are erroneous and related to problems in precise identification of the cliff edge, particularly where vegetation is present.</p> <p>Between the September 2016 and the current survey 9 out of the 28 markers showed erosion greater than the survey error. Of these 9, all except one showed erosion of 0.1-0.4m. Three of the markers</p>	<p>Over the winter of 2016/17 a third of the monitoring points showed erosion, generally up to 0.4m. Point 6 showed significant erosion however some may be due to a survey error in the previous survey.</p> <p>Longer term trends: Greatest long term recession rates are seen at Point 5, south of the Filey town defences, where 0.7m/yr is recorded; Points 6 and 7 at Muston Sands shows recession of 0.1 and 0.3m/yr respectively. Points 14 and 18 near Hunmanby Gap have eroded by 0.2 and 0.1m/yr respectively.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>showing erosion are adjacent to one another to the north of Reighton Gap (points 18, 19, and 20). Point 6 (located between Filey town and Primrose Valley) had recorded erosion of 1.5m, however some of this apparent erosion is likely due to an erroneous advancing cliff measurement in the previous survey. The total erosion recorded at point 6 since the survey began in November 2008 is 1.0m, with an erosion rate of 0.1m/yr.</p>	

3. Problems Encountered and Uncertainty in Analysis

Individual Profiles

At Runswick Bay there was construction taking place on the sea defence wall at the northernmost part of the beach, which restricted access to this area for the survey.

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

At Cayton Bay:

- the top of profile 1dCY1 cannot be measured due to dense vegetation;
- The middle of profile 1dCY2 could not be measured due to the ground make-up, soft mud flows, and unstable grass;
- The middle of profile 1dCY3 could not be measured due to the ground make-up, soft mud flows, unstable grass, and landslips;
- Profile 1dCY3 was measured to cliff edge on top and as close to the cliff face at the bottom as possible.

At Filey Bay:

- The surveyor was unable to measure the start of section 1dFB2 due to vegetation.
- The middle of profile 5 was unable to be measured from chainage 65m to c. 204m, due to undergrowth and bushes.

Cliff Top Surveys

At Staithes:

- There was a significant landslide at survey point 1 at Staithes of approximately 1.7m.
- Survey points 9 to 12 at Staithes have been cordoned off by the National Trust due to a landslide on the headland and could not be surveyed, as was the case for the September 2016 survey.

At Robin Hoods Bay:

- The dumping of waste vegetation at monitoring point 5 is a known source of error.
- Constant rock/gravel falls were noted by the surveyor along the cliff.

At Filey Bay:

- Point 13 was inaccessible due to heavy vegetation.

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

No changes are recommended at the present time.

5. Conclusions and Areas of Concern

- At Staithes, the recorded changes to the cliff top between September 2016 and March 2017 are generally small. There has been one failure which has significantly affected the cliff top at the survey transects. There are erosion rates which are calculated from the data collected since 2008. Points 1, 4, and 13 have a recession rate of 0.2, 0.2, and 0.3m/yr respectively.
- Runswick Bay shows shore-parallel changes, with erosion at the top of the beach and accretion at the bottom. This may be due to beach draw-down over the winter.

- At Sandsend, Upgang and Whitby, the profiles show seasonal fluctuation. There has been significant accretion at the toe of the new defence at Sandsend. At profile B2, where the frontage is undefended there was the formation of a beach berm through the winter.
- At Robin Hoods Bay, there was a patchy distribution of accretion and erosion. Overall the cliff top has been stable since the previous survey in November 2016. The longer term rates show that only point 1 shows a recession rate, which was 0.6m/yr.
- At Scarborough North Bay, the January post-storm survey generally shows a pattern of erosion at either end of the bay but accretion in the centre, as well as the drawdown of material across the individual profiles. The March 2017 profiles show a general pattern of little change in the south of the bay, erosion in the centre, and accretion in the north of the bay. The March 2017 profiles are within the range of the previous recording of beach levels, with the exception of the middle section of profile SBN4 which shows its lowest recorded levels, so the observed changes are likely to be due to the drawdown of beach material.
- The profiles at Scarborough South Bay show erosion of 0.2-0.4m, particularly on the upper beach, but all profiles remain within the range recorded from previous surveys. No locations have shown erosion over the winter of 2016/17. Points 11 and 12 show recession rates of 0.5 and 0.4m/yr respectively
- Each of the beach profiles in Cayton Bay saw a drop in beach level of up to 0.5m, though all profiles remained within the range recorded from previous surveys. The cliff monitoring shows that locations 2, 4 and 6 all have significant rates of 0.1 to 0.6m/yr.
- At Filey all of the profiles show variable amounts of erosion over the winter of 2016/17, though all remain within the range recorded from the previous surveys. The topographic difference plot showed erosion on the upper beach, little change in the centre of the beach and accretion at the seaward extent of the survey. The cliff monitoring shows the highest long term recession rates are seen at Point 5, south of the Filey town defences, where 0.7m/yr is recorded; Points 6 and 7 at Muston Sands shows recession of 0.1 and 0.3m/yr respectively. Points 14 and 18 near Hunmanby Gap have eroded by 0.2 and 0.1m/yr respectively.

Appendices

Appendix A

Beach Profiles

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

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

Beach Profile

Location: 1dWB1

Date: 03/03/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

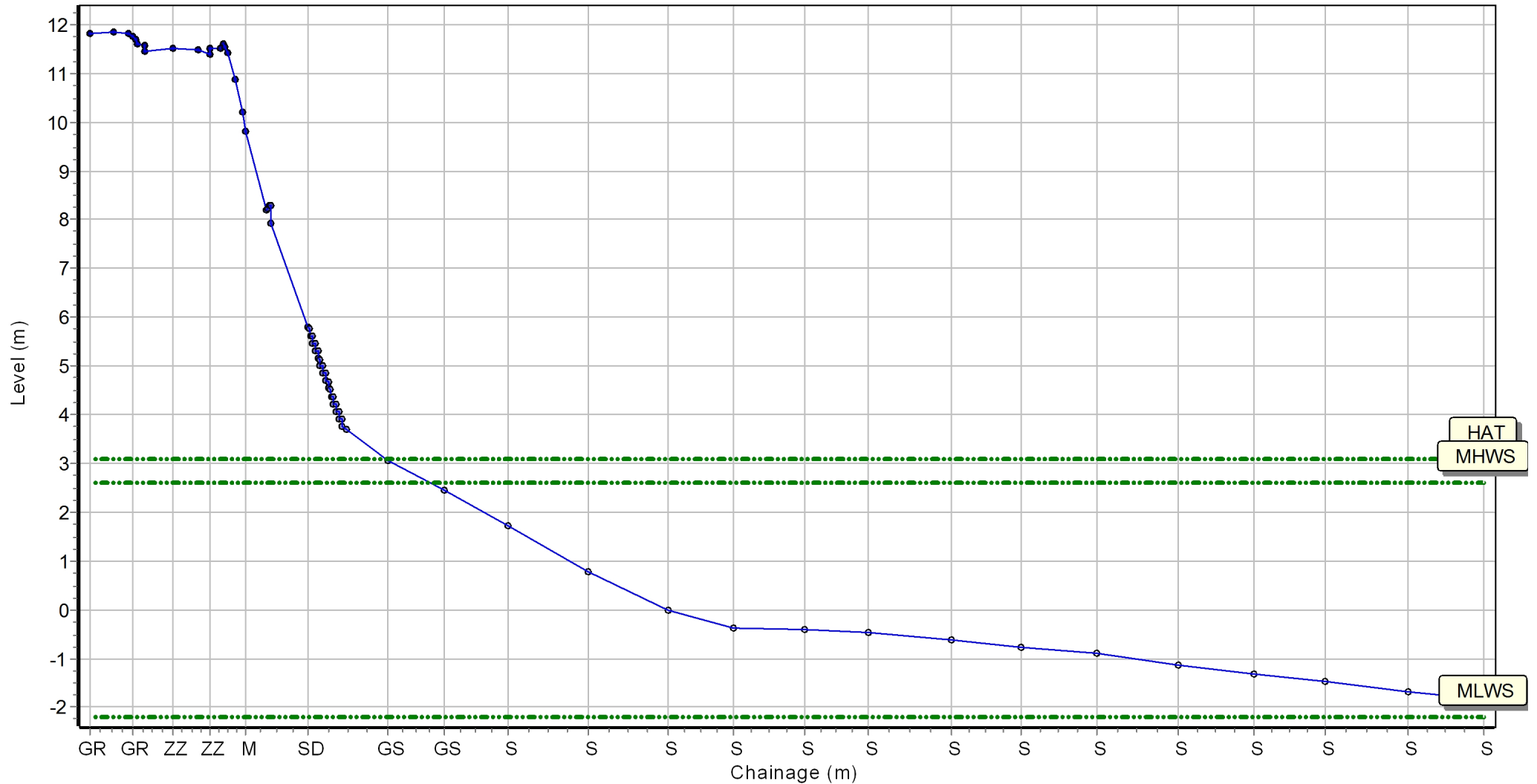
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Location: 1dWB2

Low Tide Time:

Rain:

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



Beach Profile

Location: 1dWB3

Date: 03/03/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

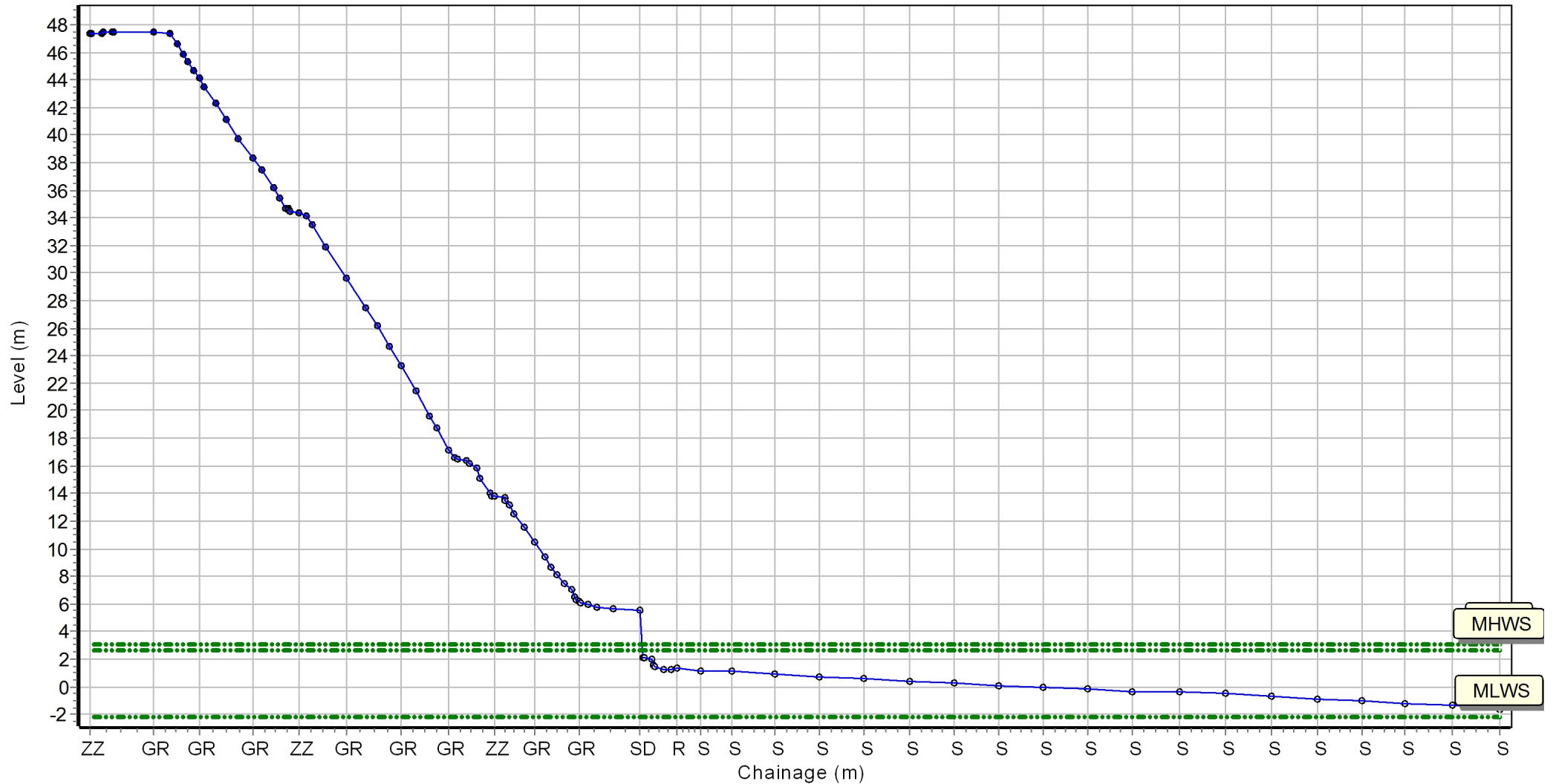
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dSBN1

Date: 02/03/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

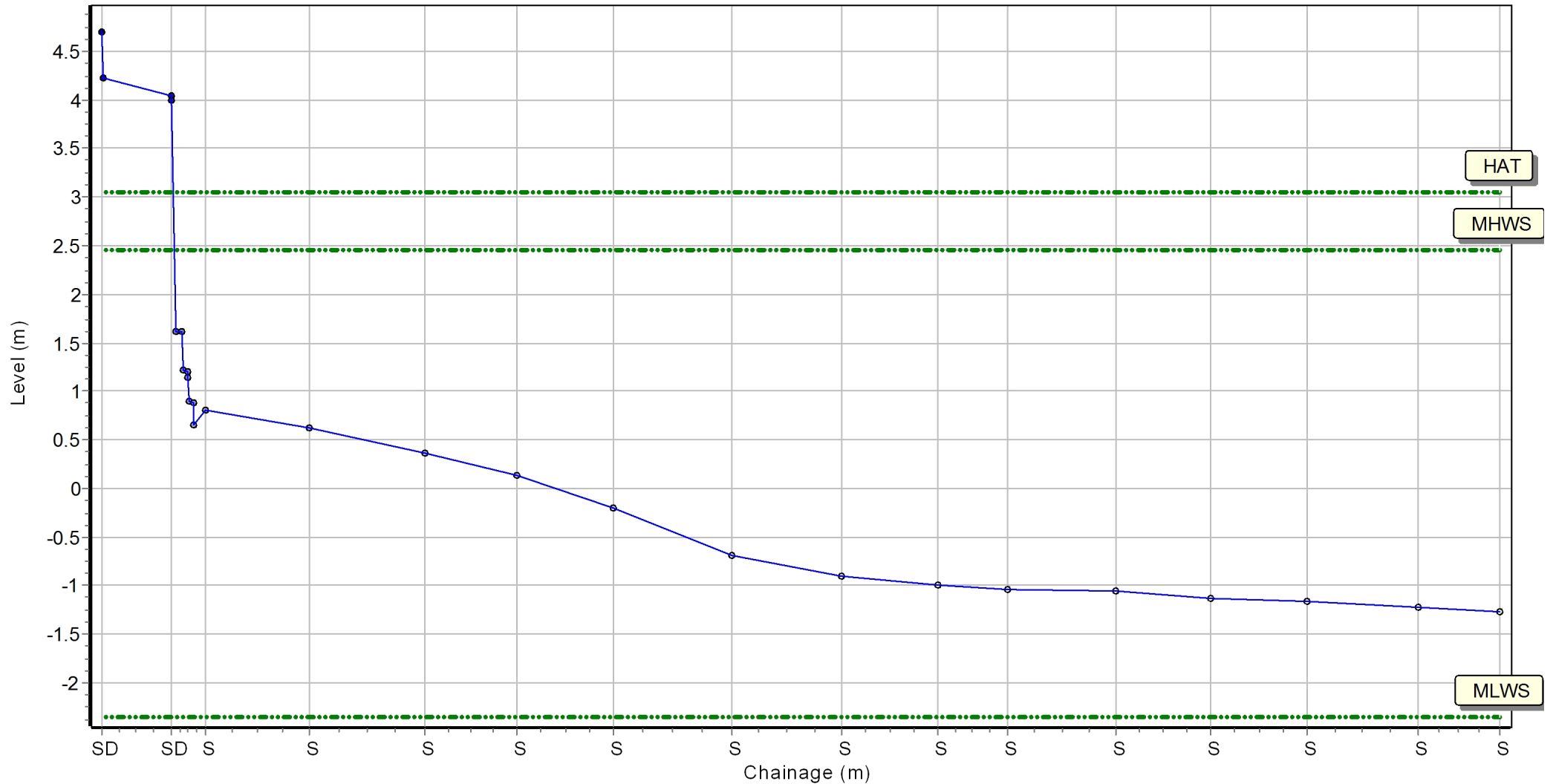
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Location: 1dSBN2

Low Tide Time:

Rain:

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



Beach Profile

Location: 1dSBN3

Date: 02/03/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

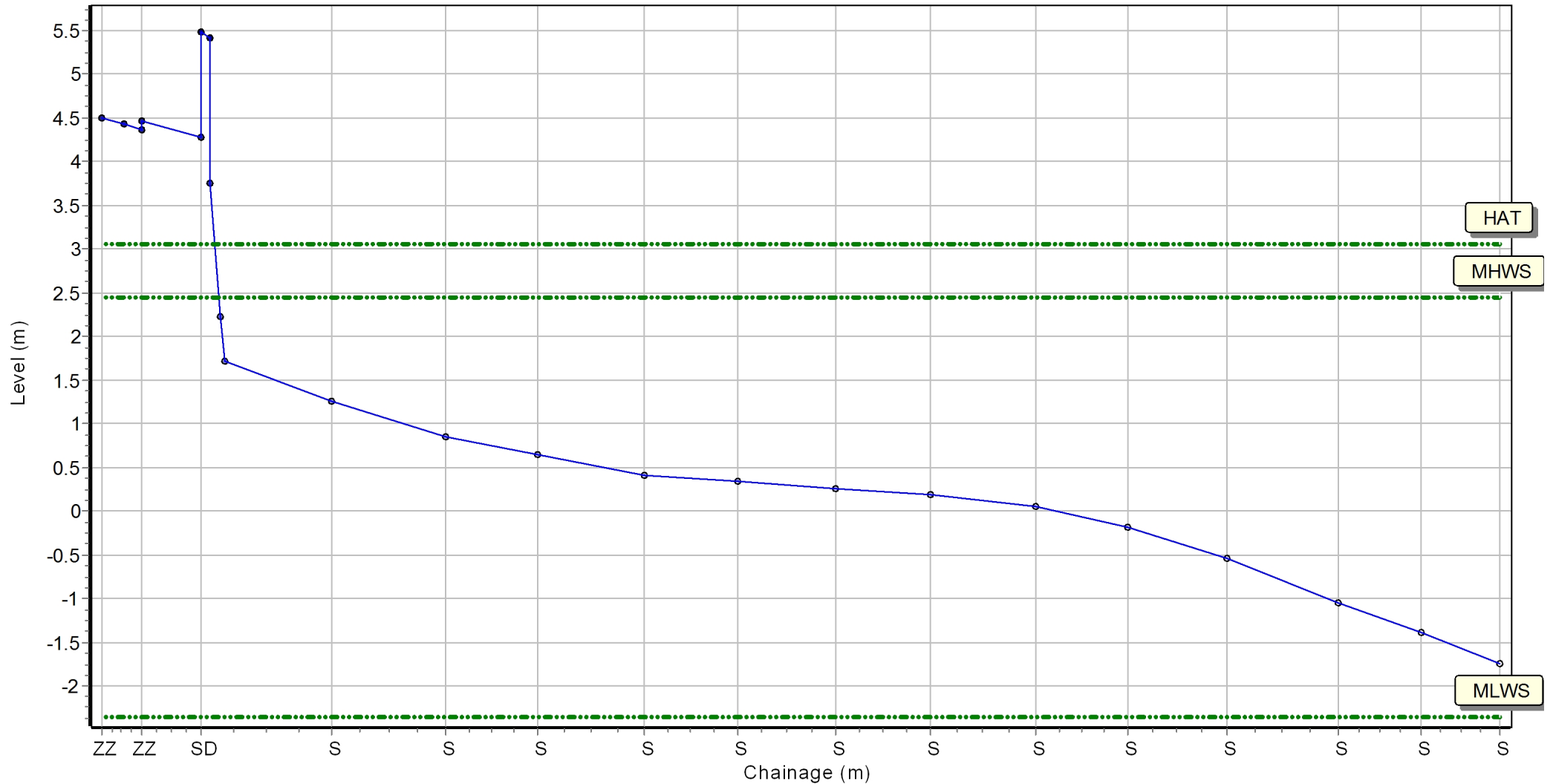
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dSBN4

Date: 02/03/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

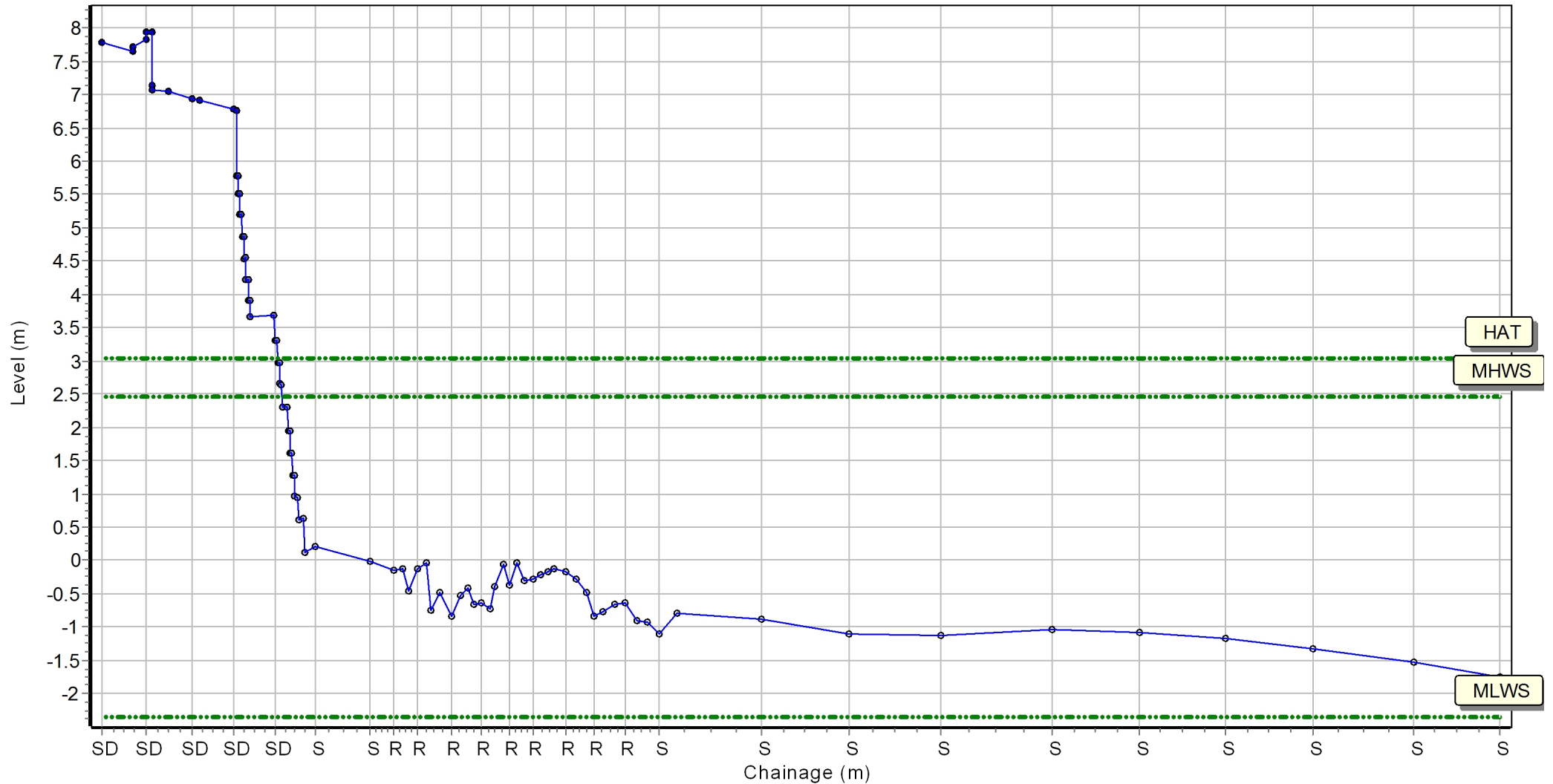
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dSBN5

Date: 02/03/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

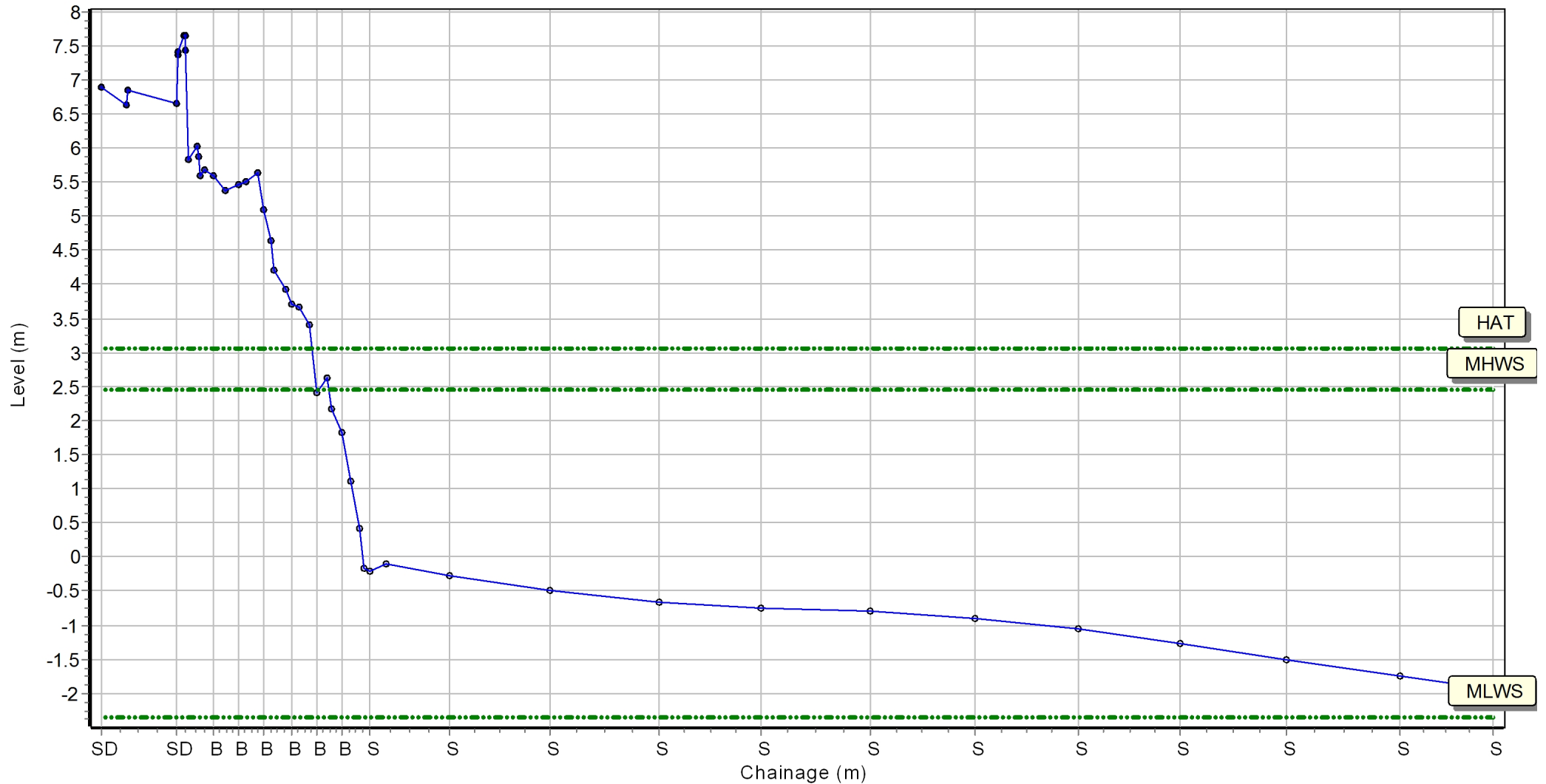
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dSBS1

Date: 02/03/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

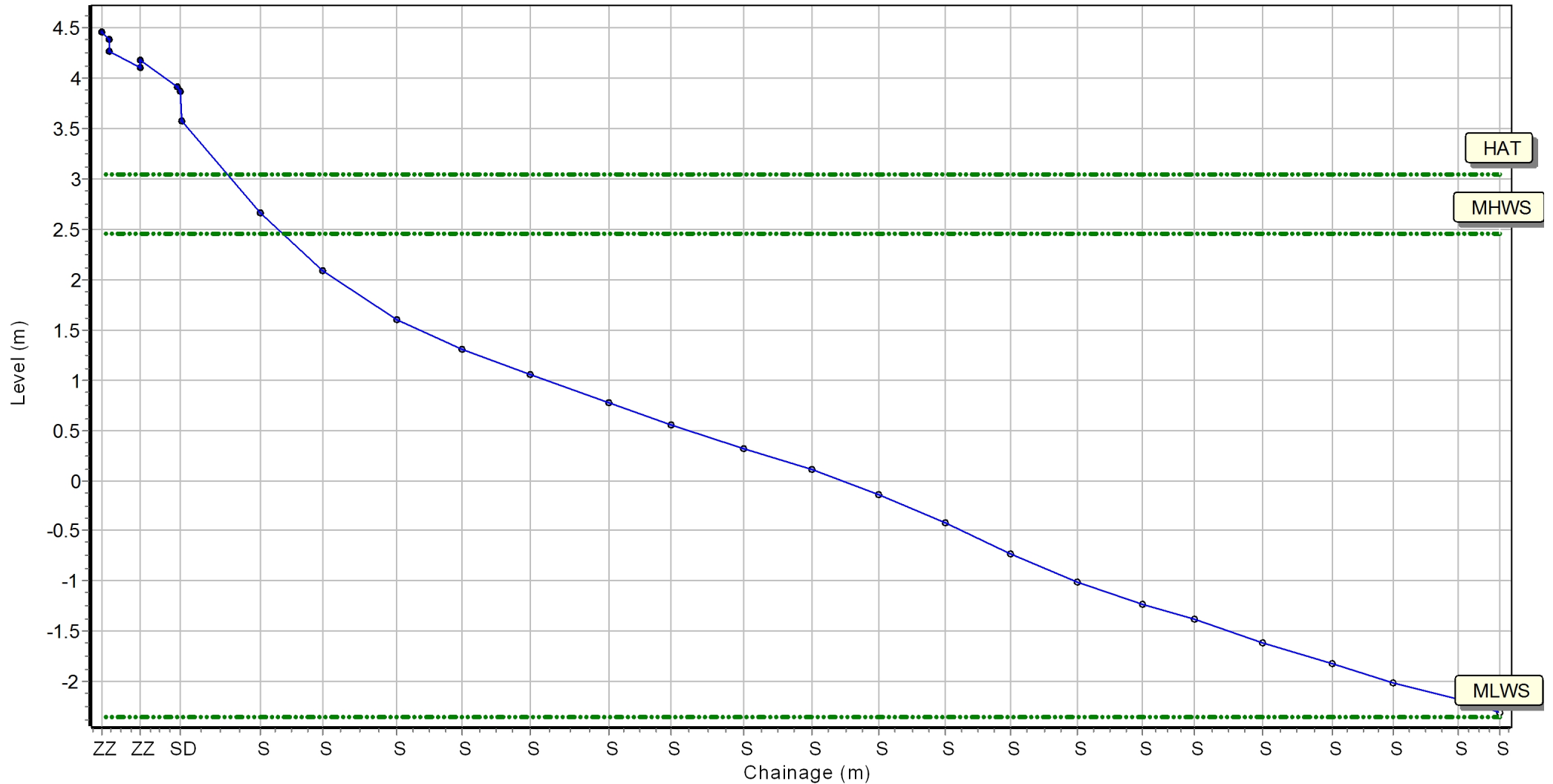
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dSBS2

Date: 02/03/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

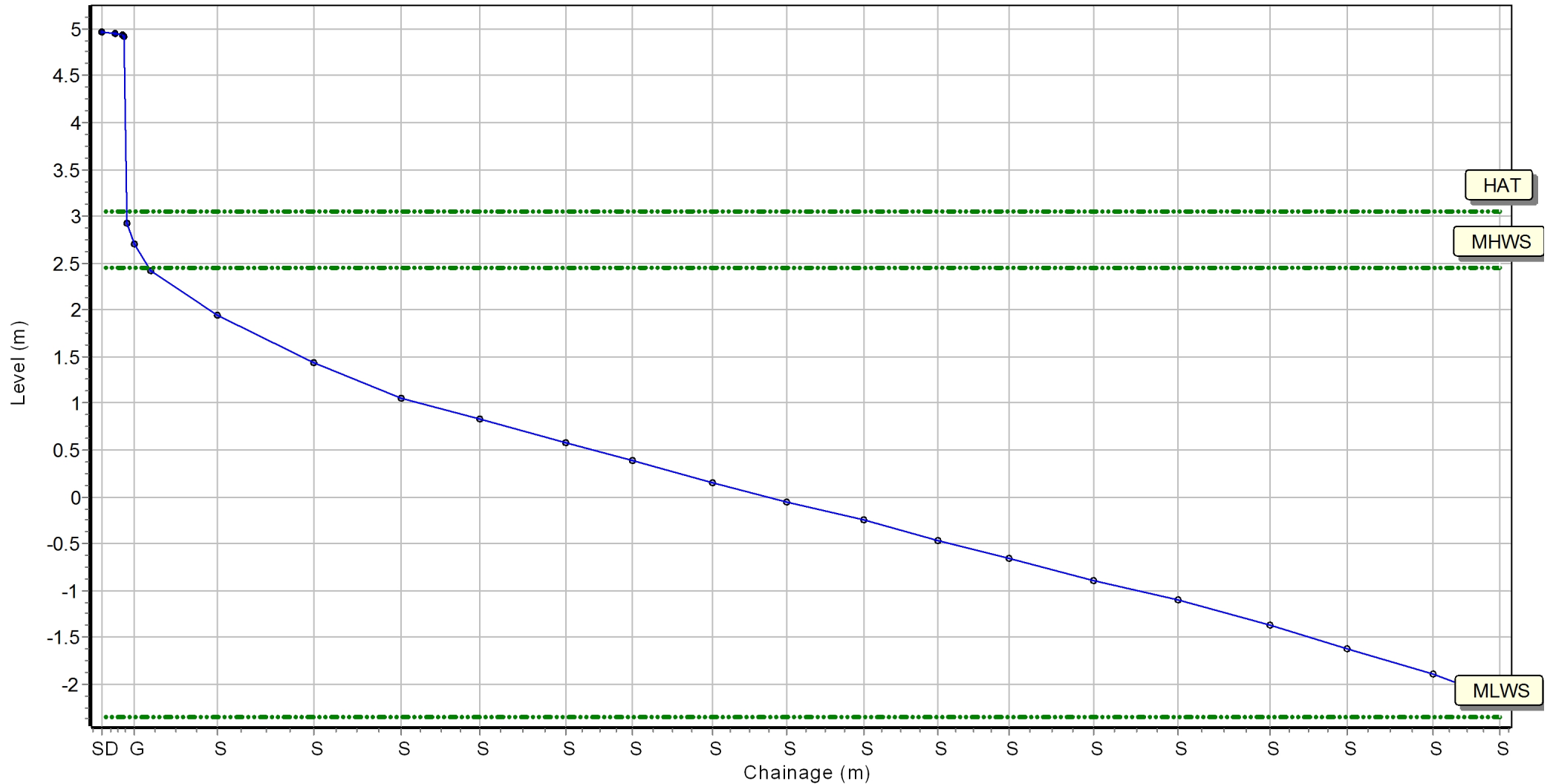
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dSBS3

Date: 02/03/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

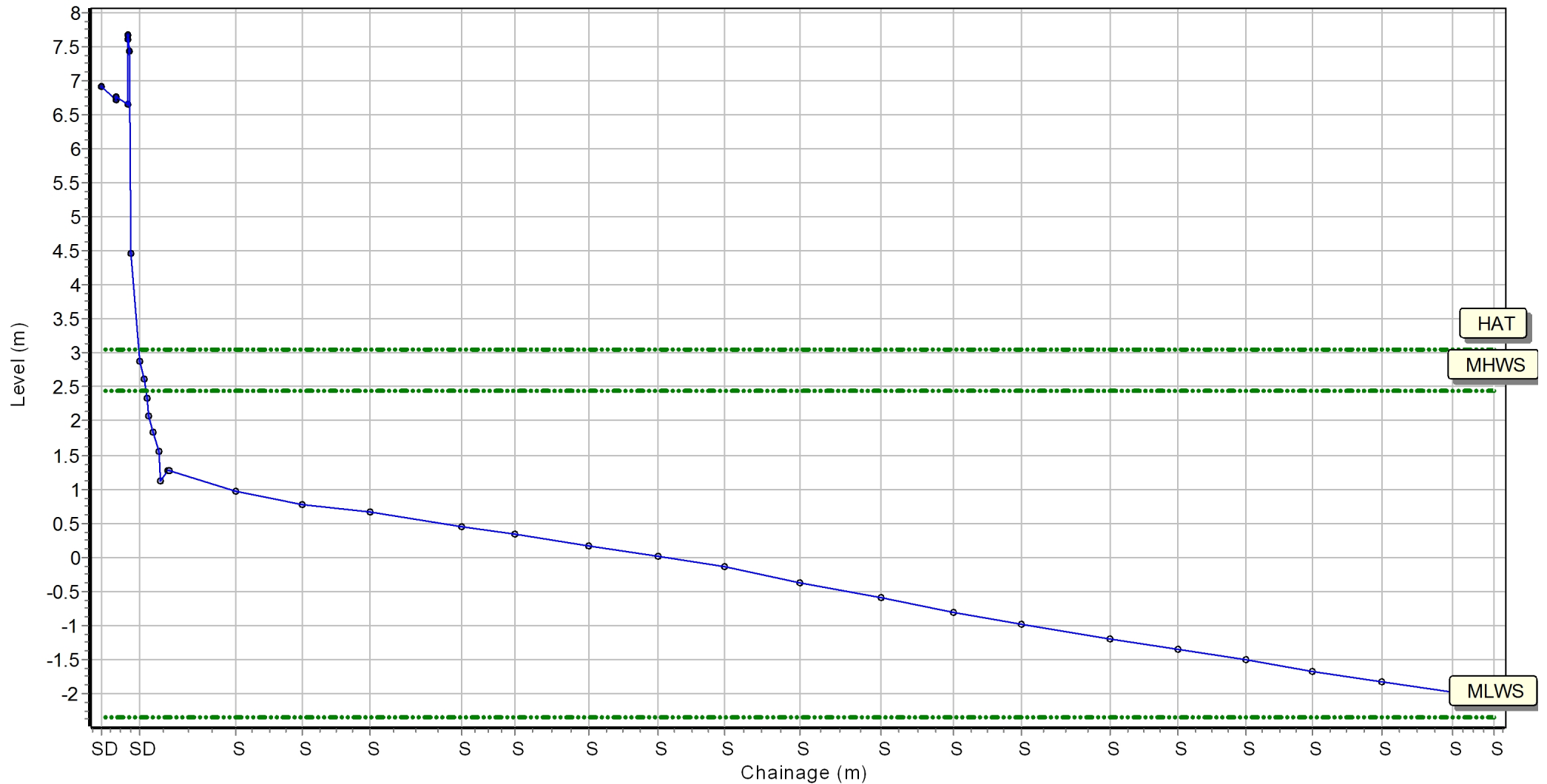
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dSBS4

Date: 02/03/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

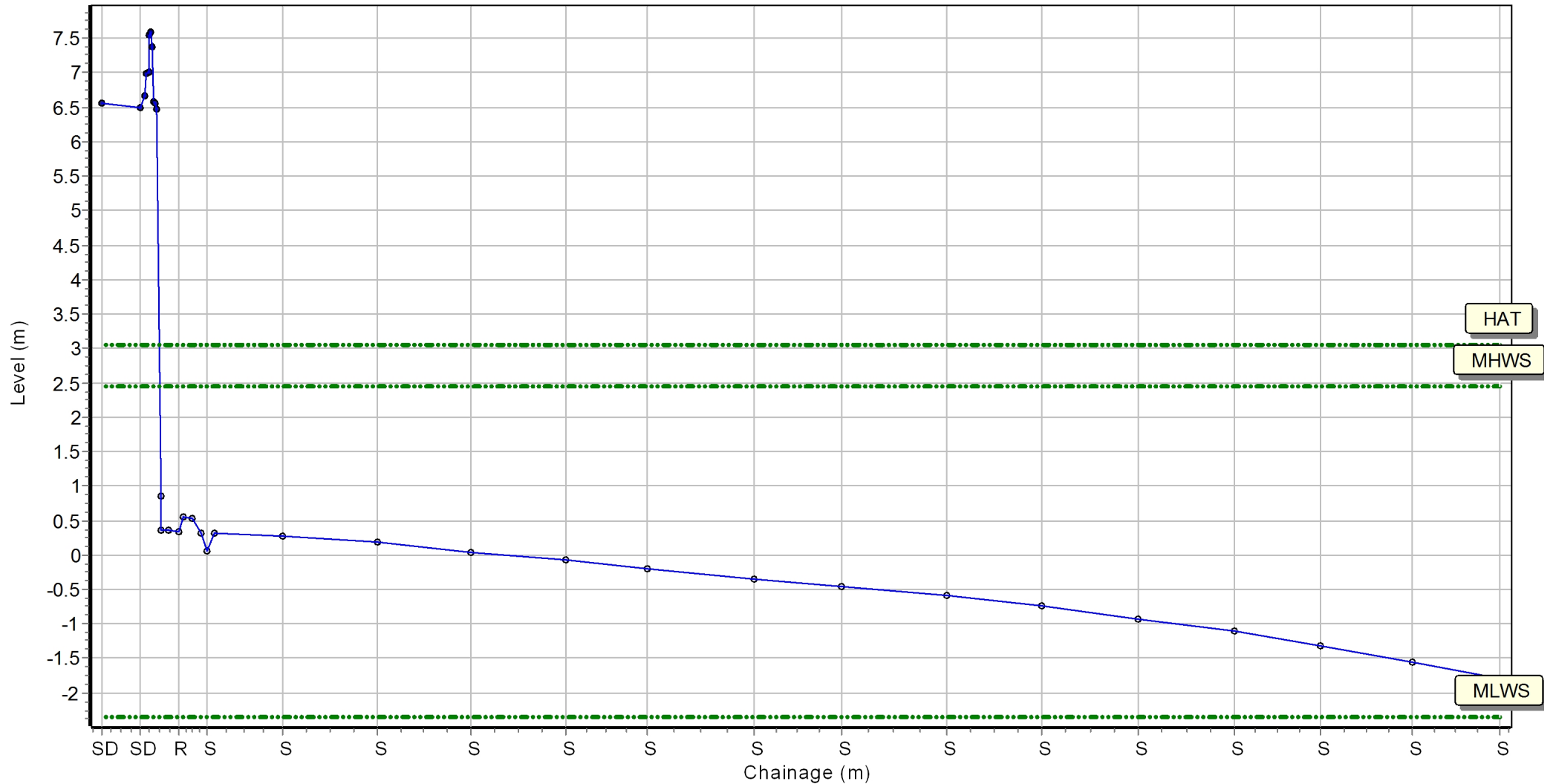
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dCY1

Date: 01/03/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

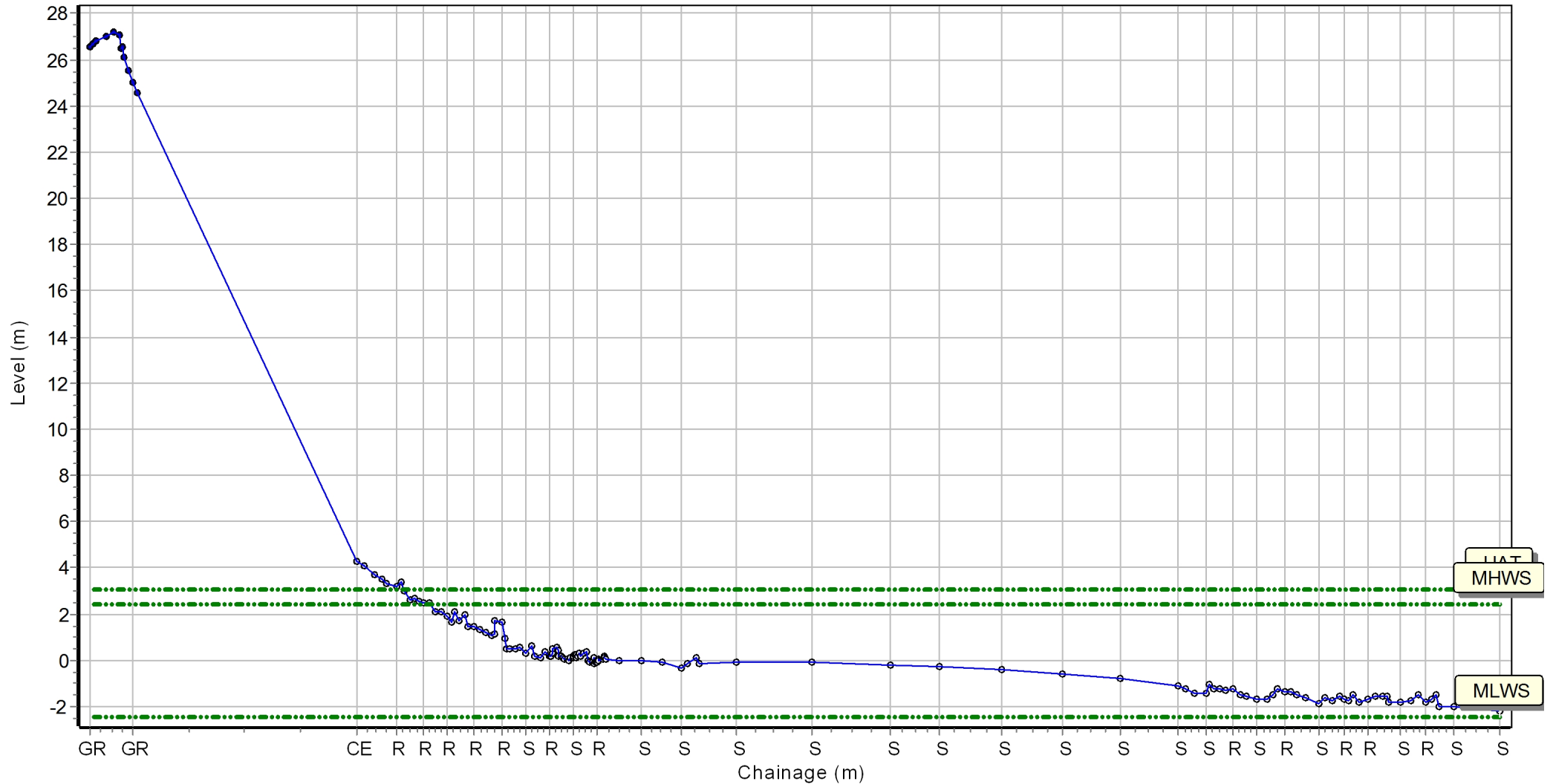
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dCY1A

Date: 01/03/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

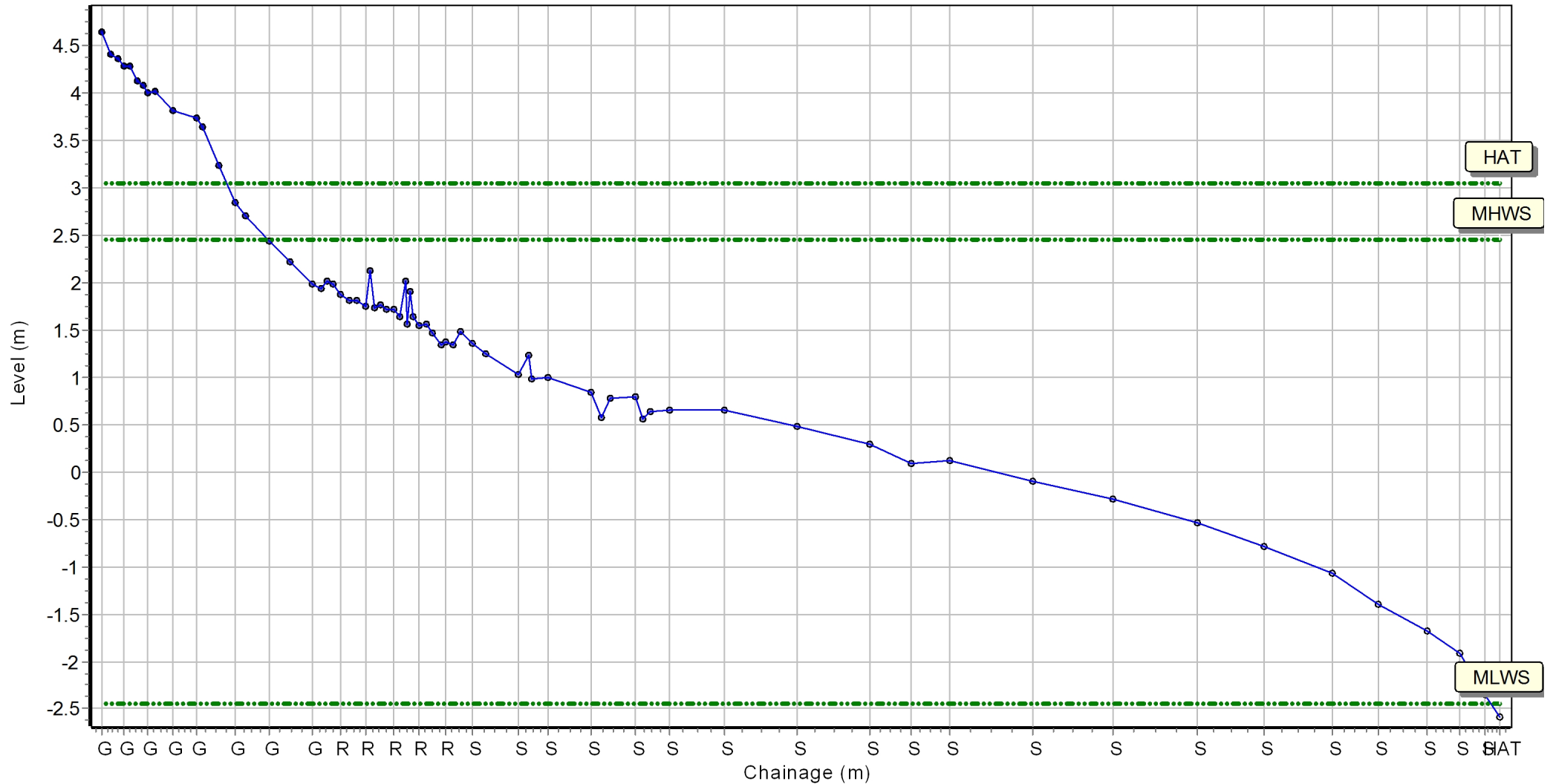
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dCY2

Date: 01/03/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

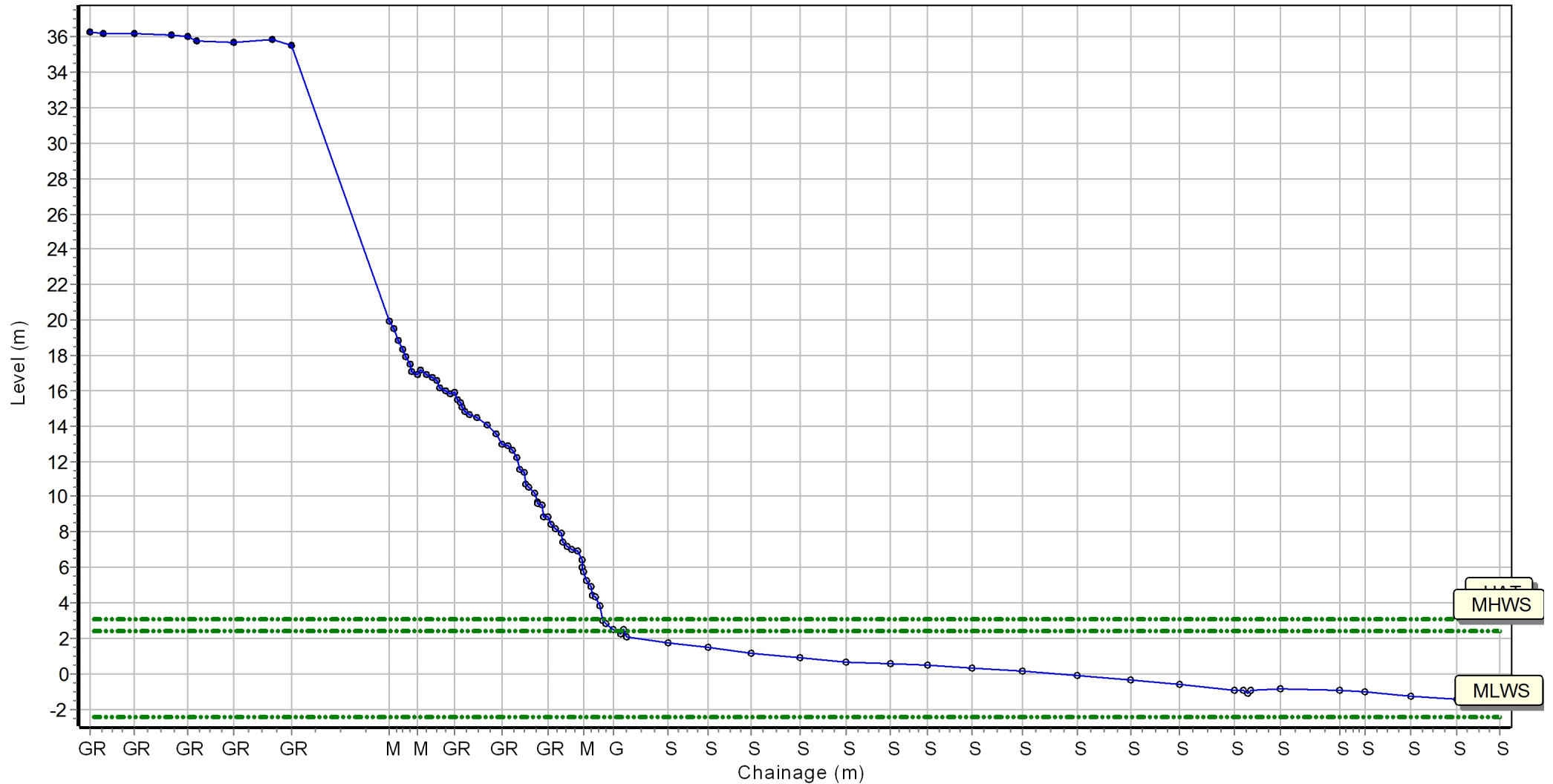
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dCY3

Date: 01/03/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

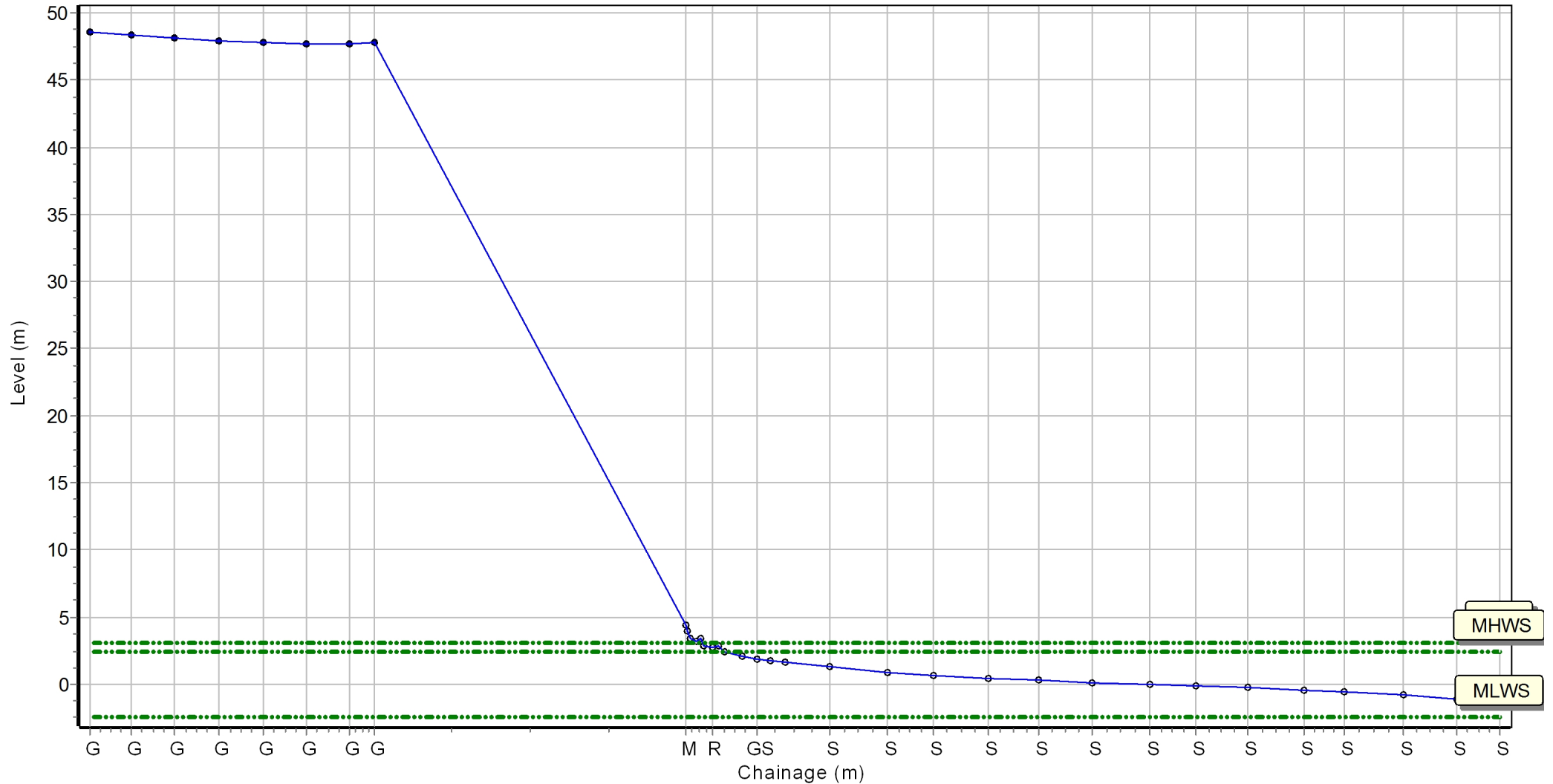
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dFB1

Date: 28/02/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

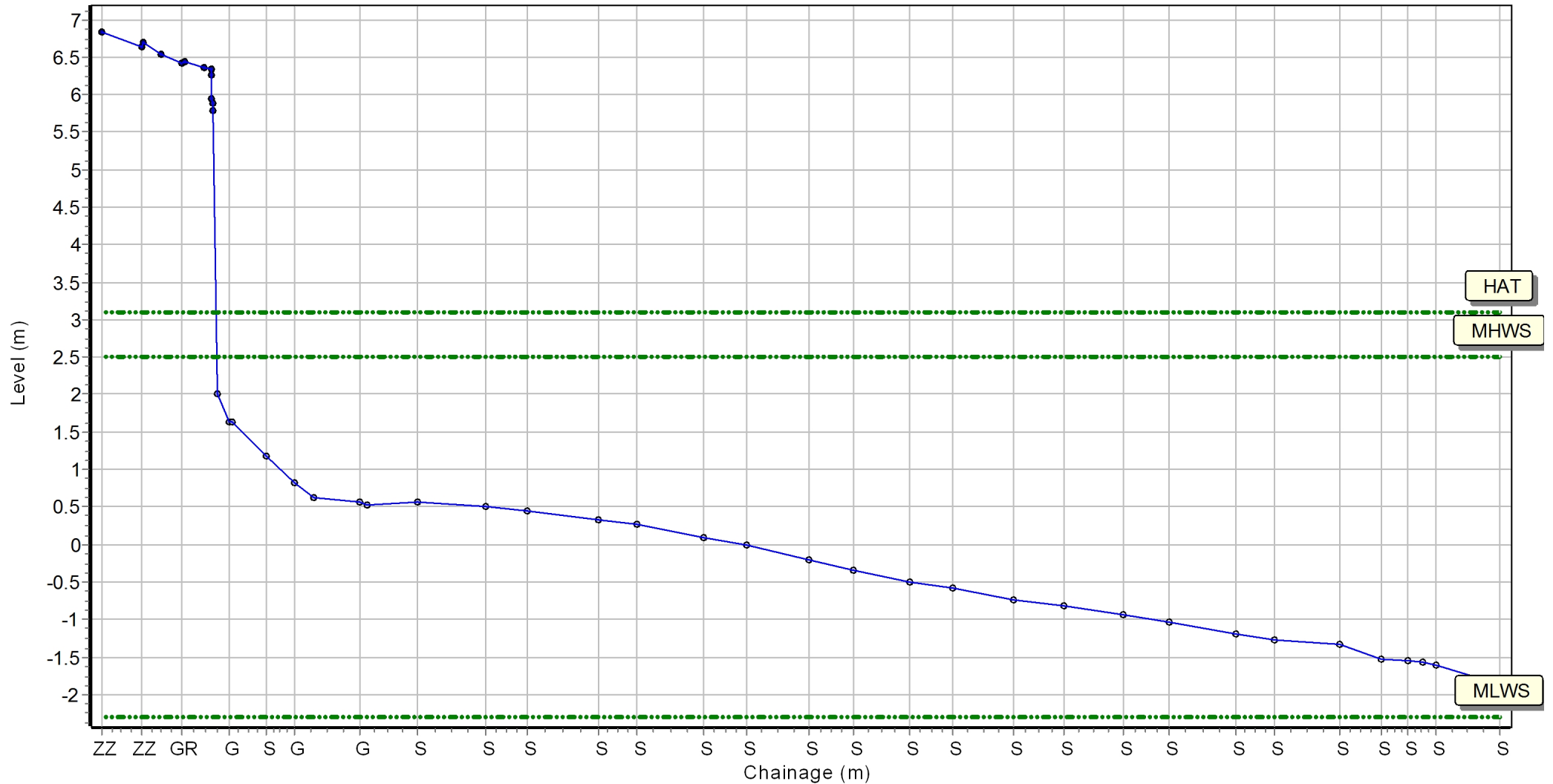
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dFB2

Date: 28/02/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

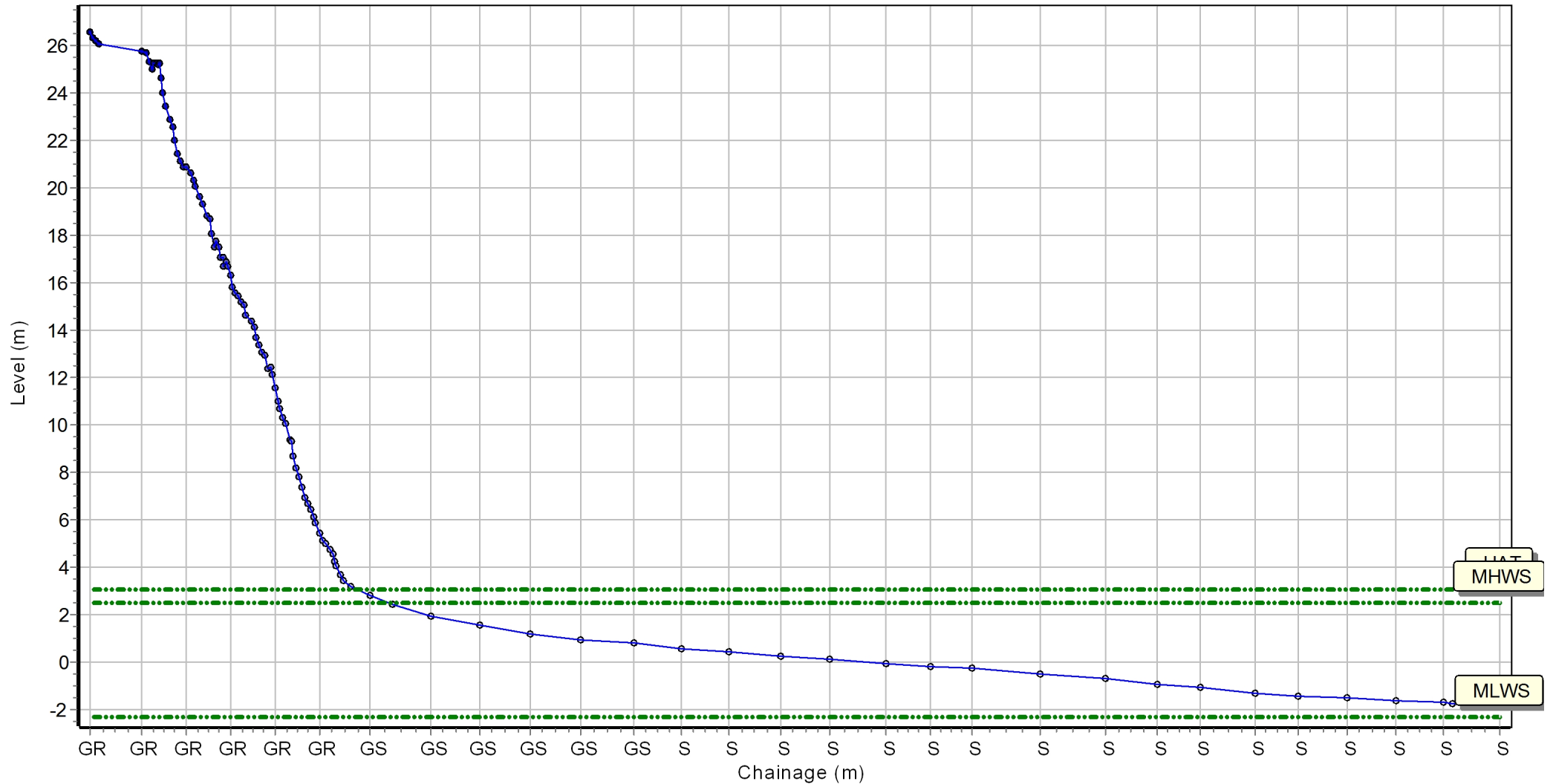
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dFB3

Date: 28/02/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

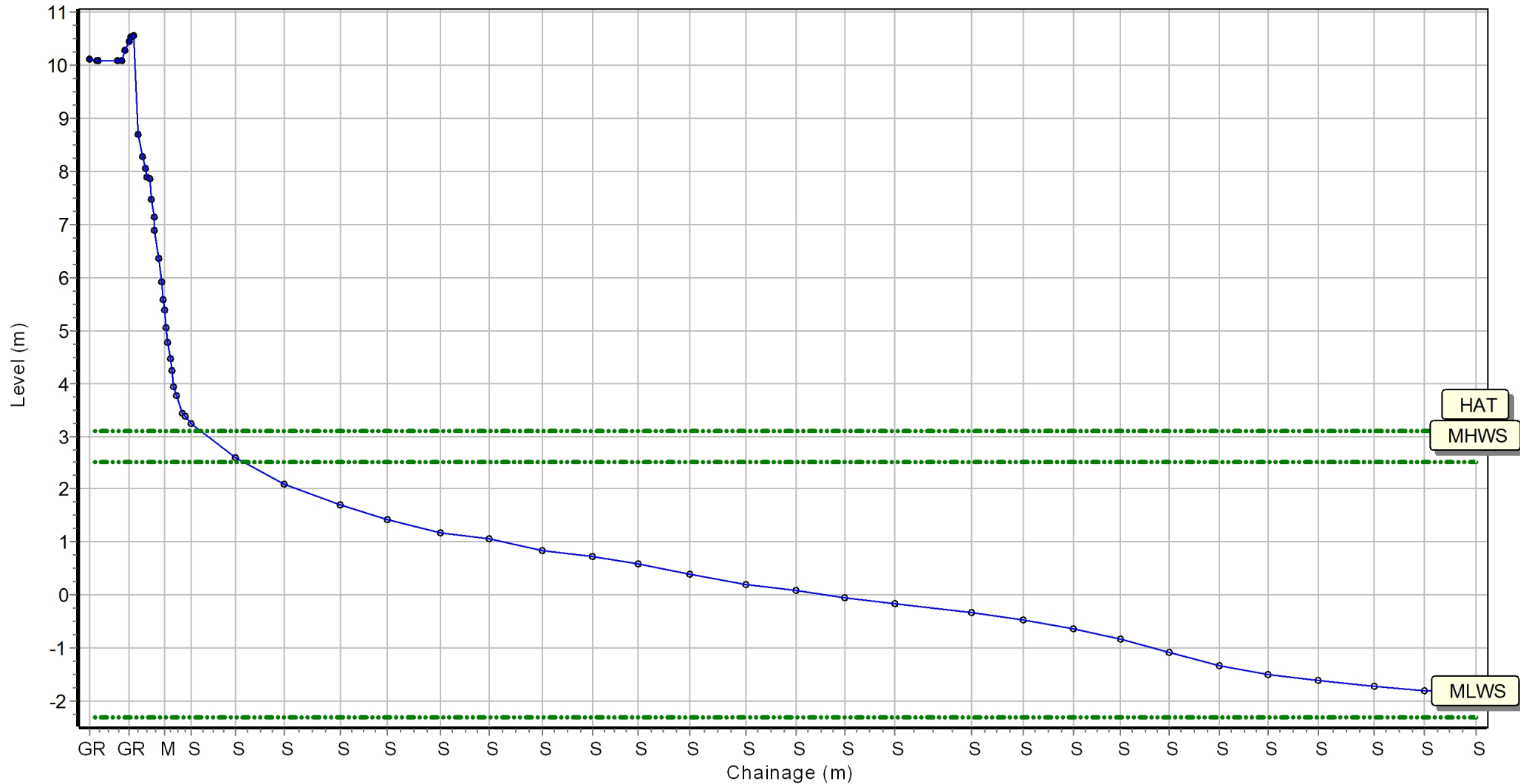
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dFB4

Date: 28/02/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

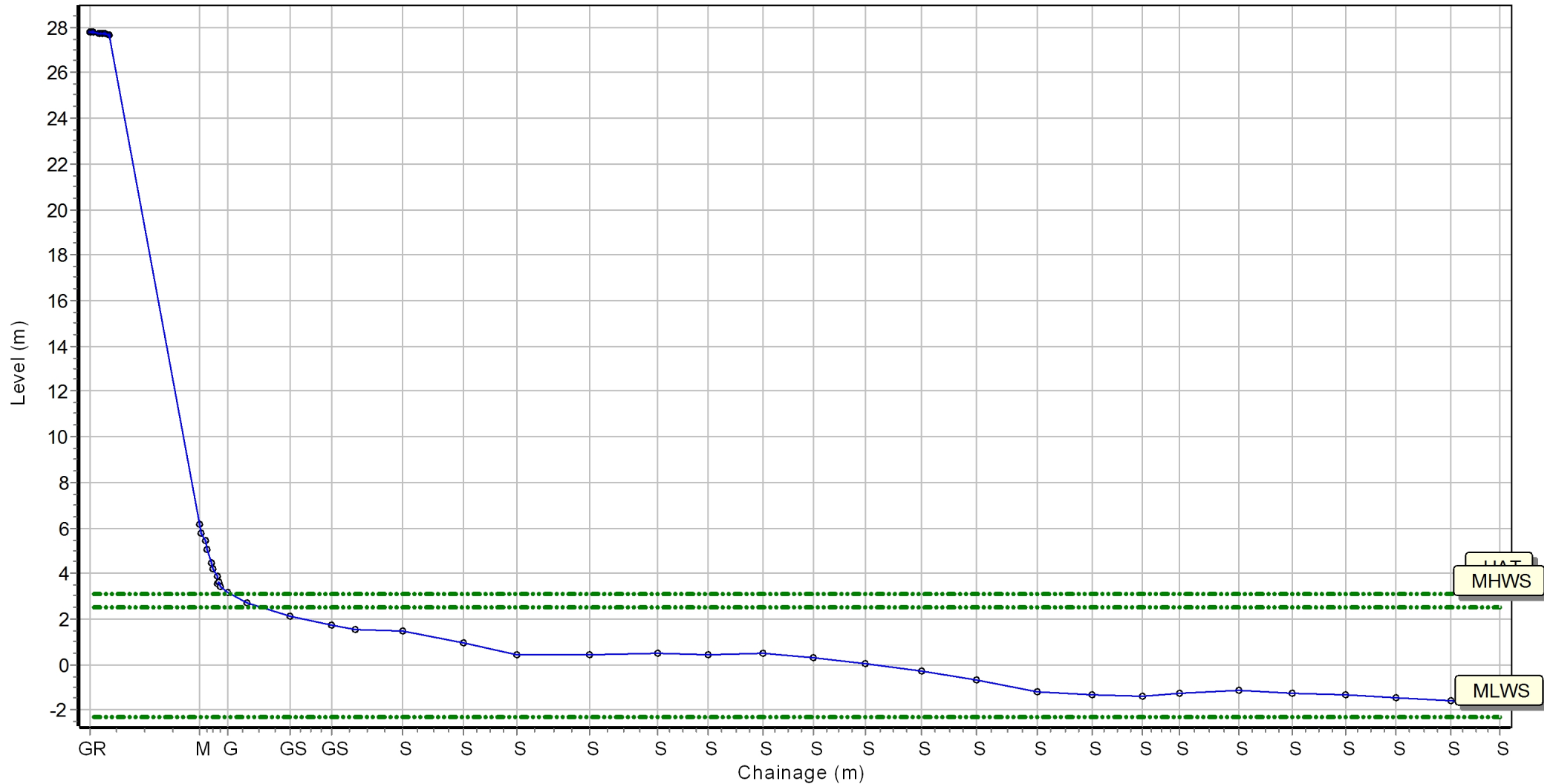
Sea State:

Visibility:

Rain:

Summary: 2017 Partial Measures Topo Survey

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



Beach Profile

Location: 1dFB5

Date: 28/02/2017

Inspector: AG

Low Tide:

Low Tide Time:

Wind

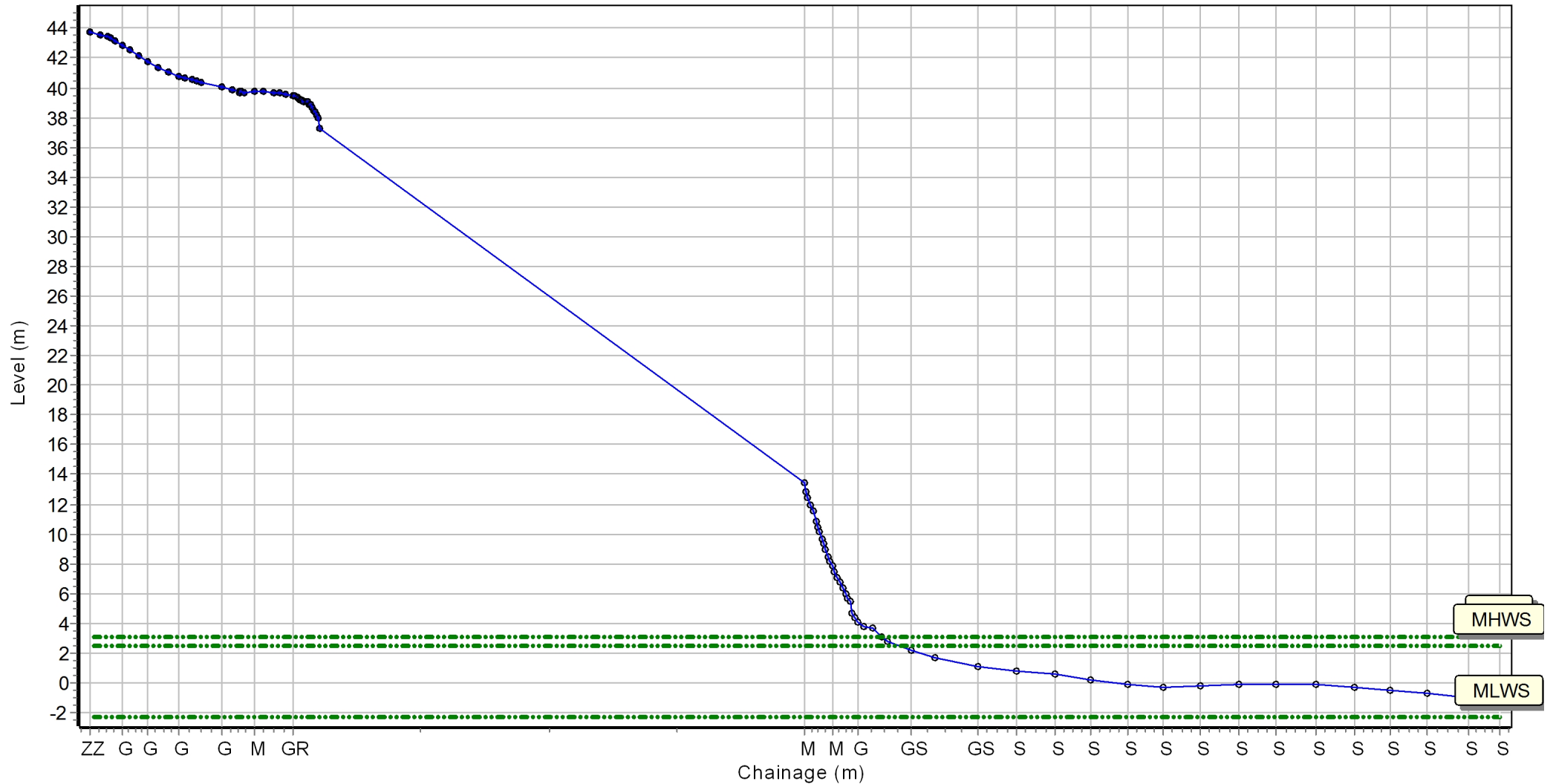
Sea State:

Visibility:

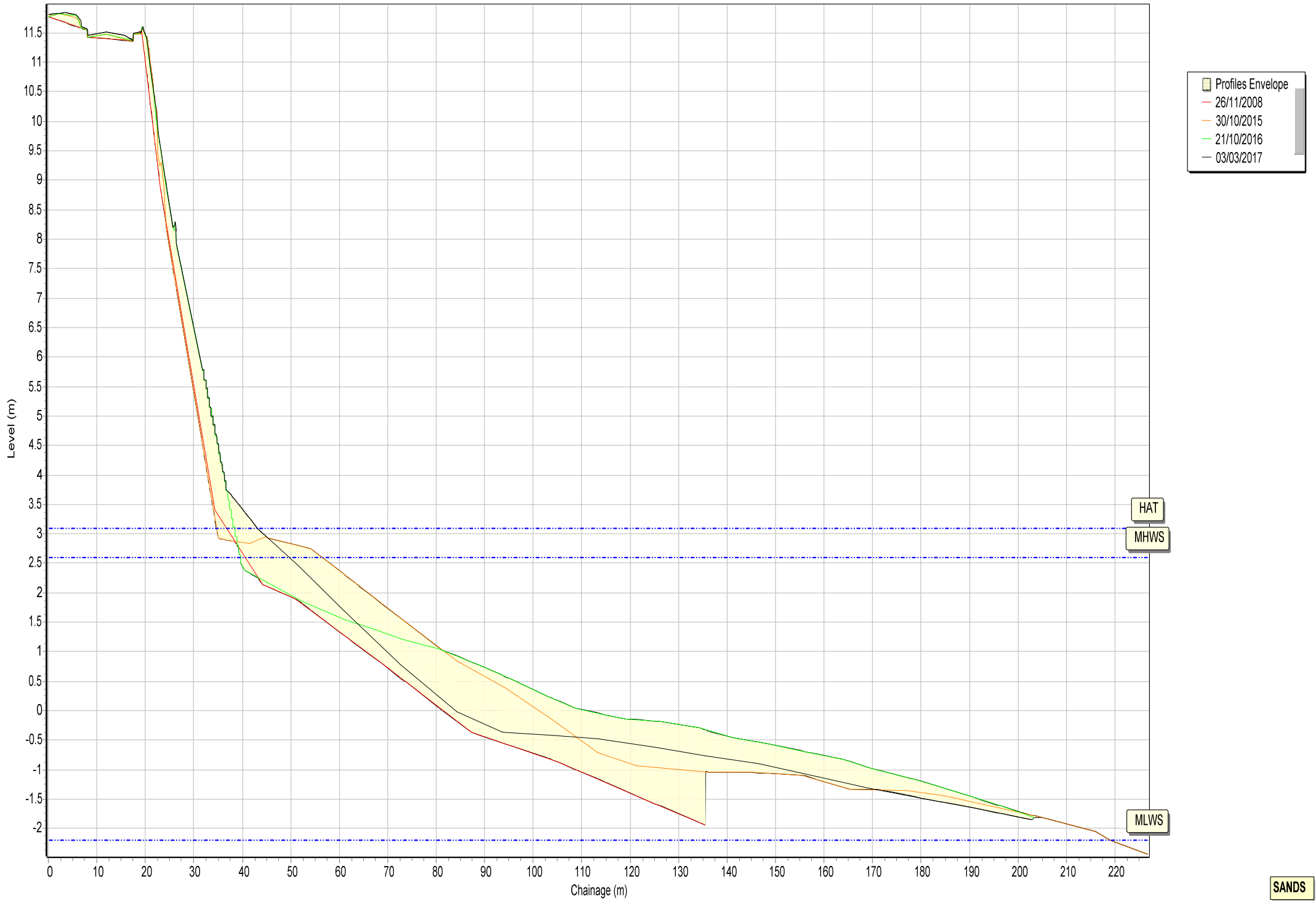
Rain:

Summary: 2017 Partial Measures Topo Survey

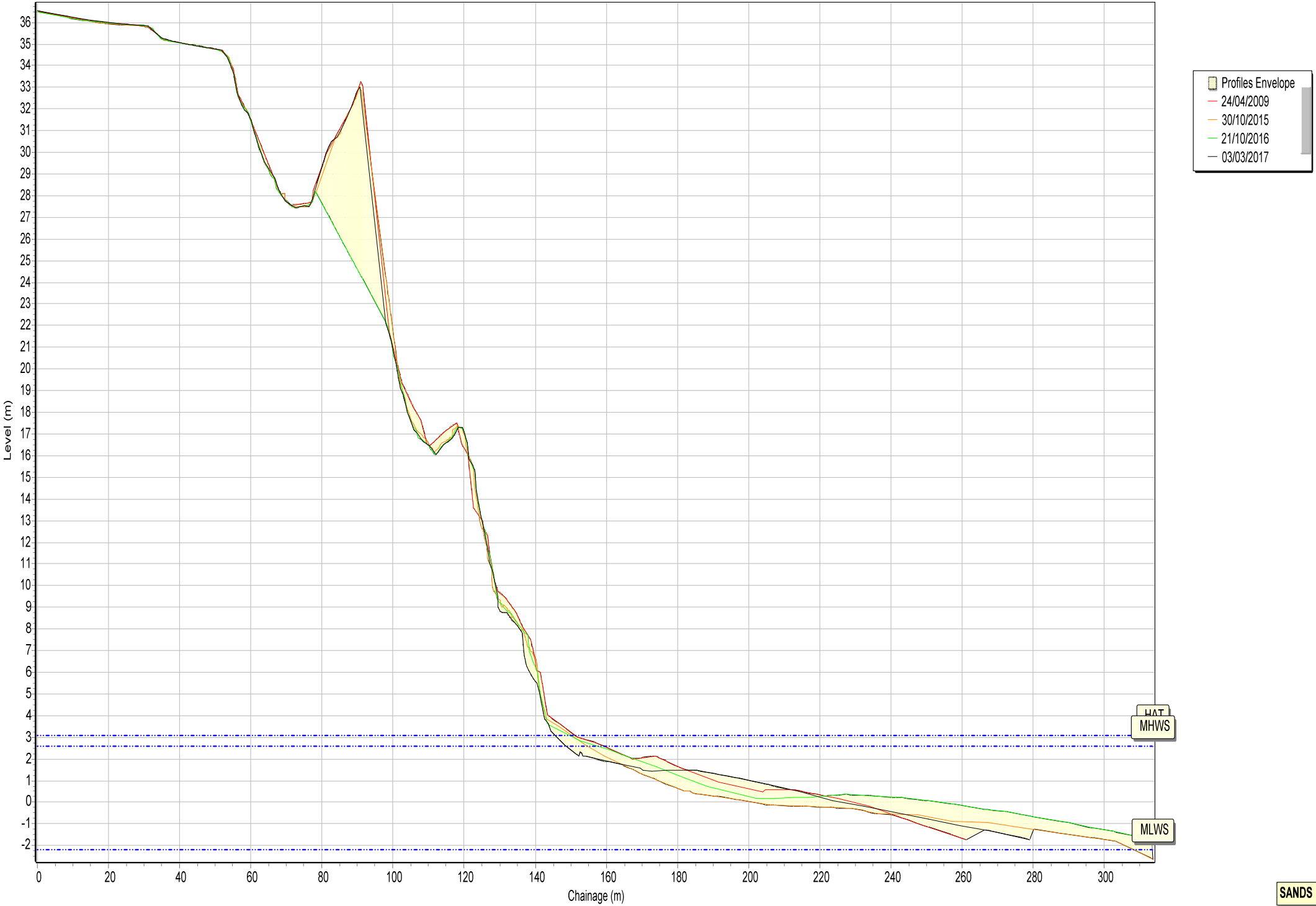
Easting: 514207.792 Northing: 476001.334 Profile Bearing: 47 ° from North



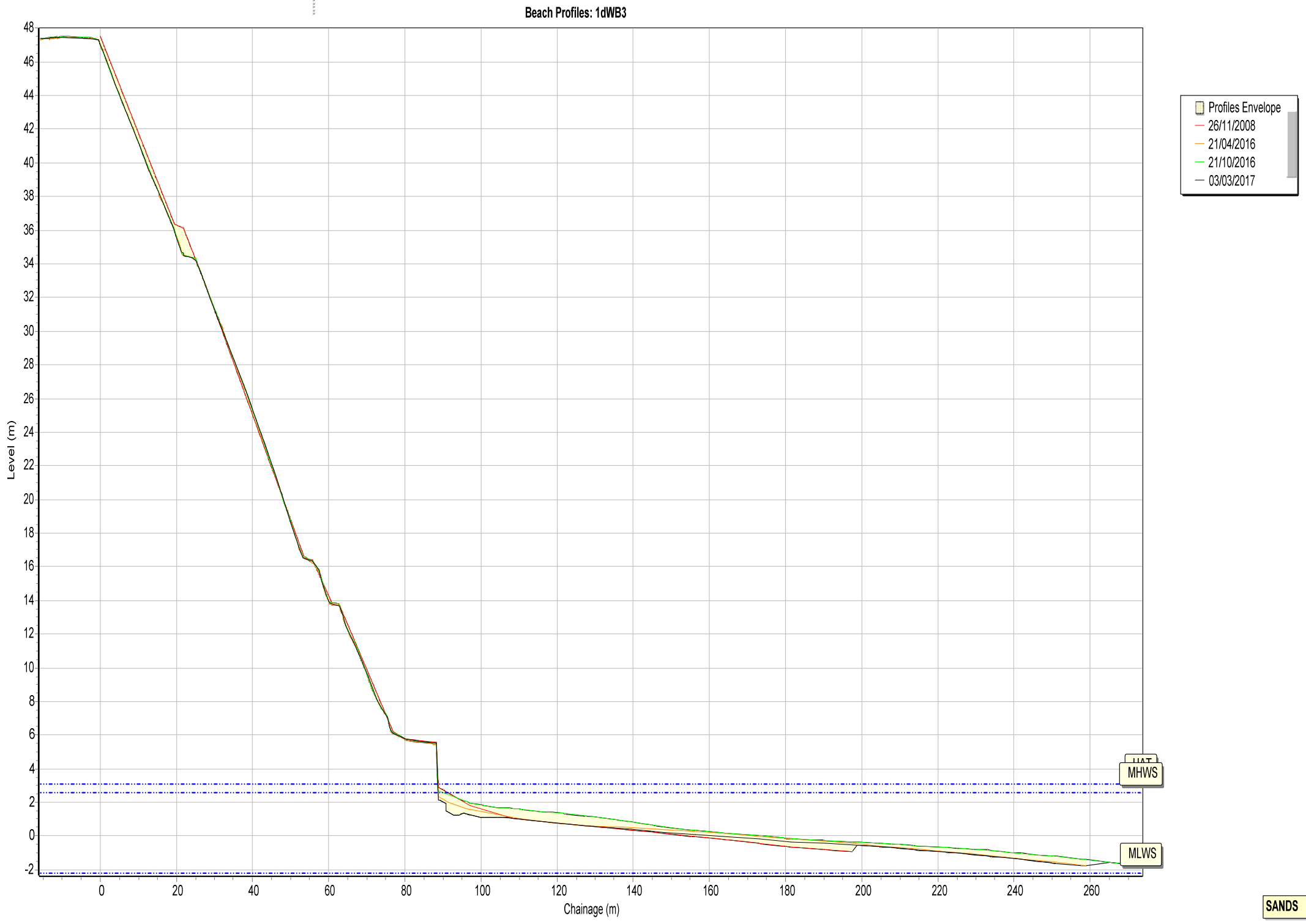
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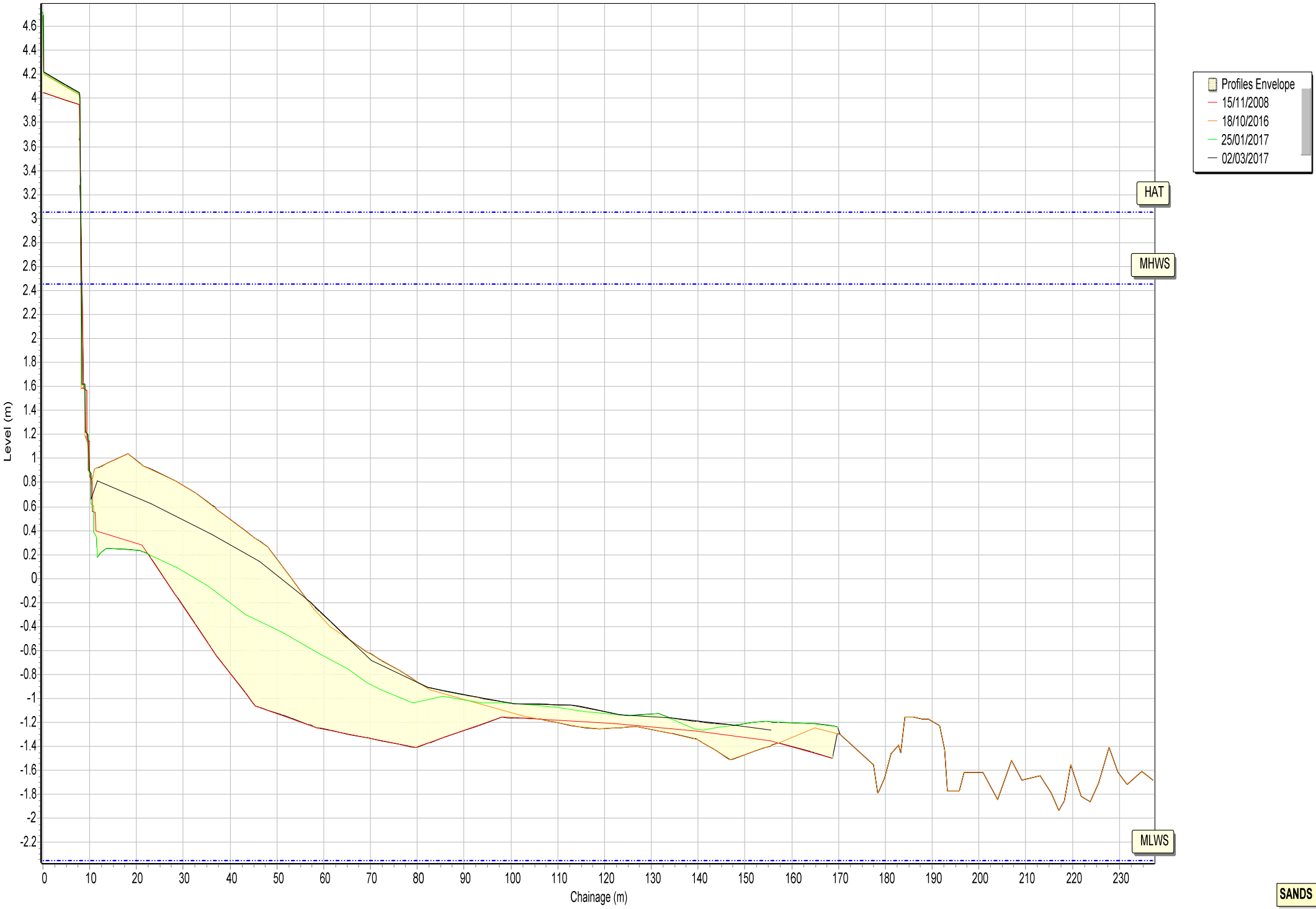
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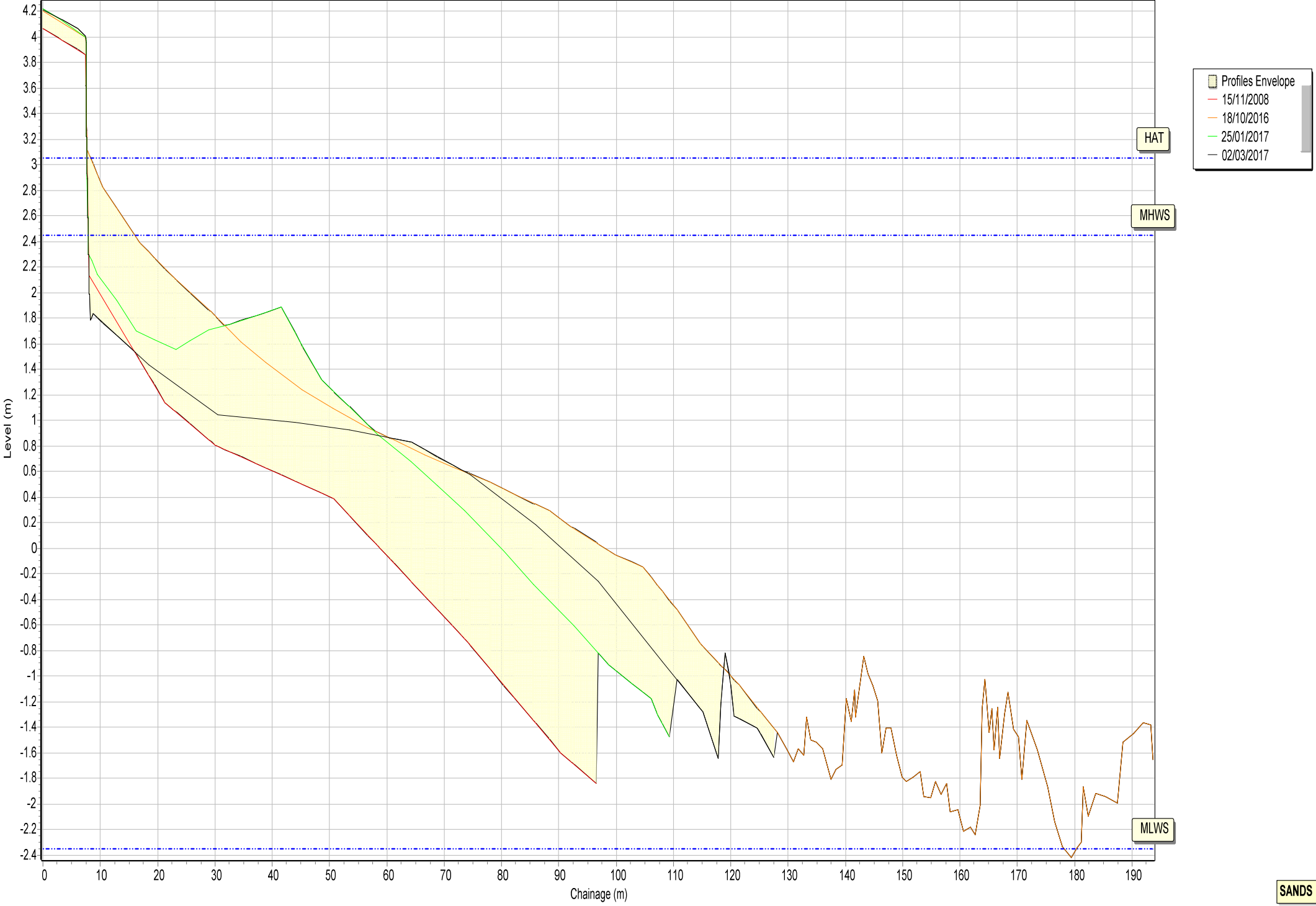
SANDS



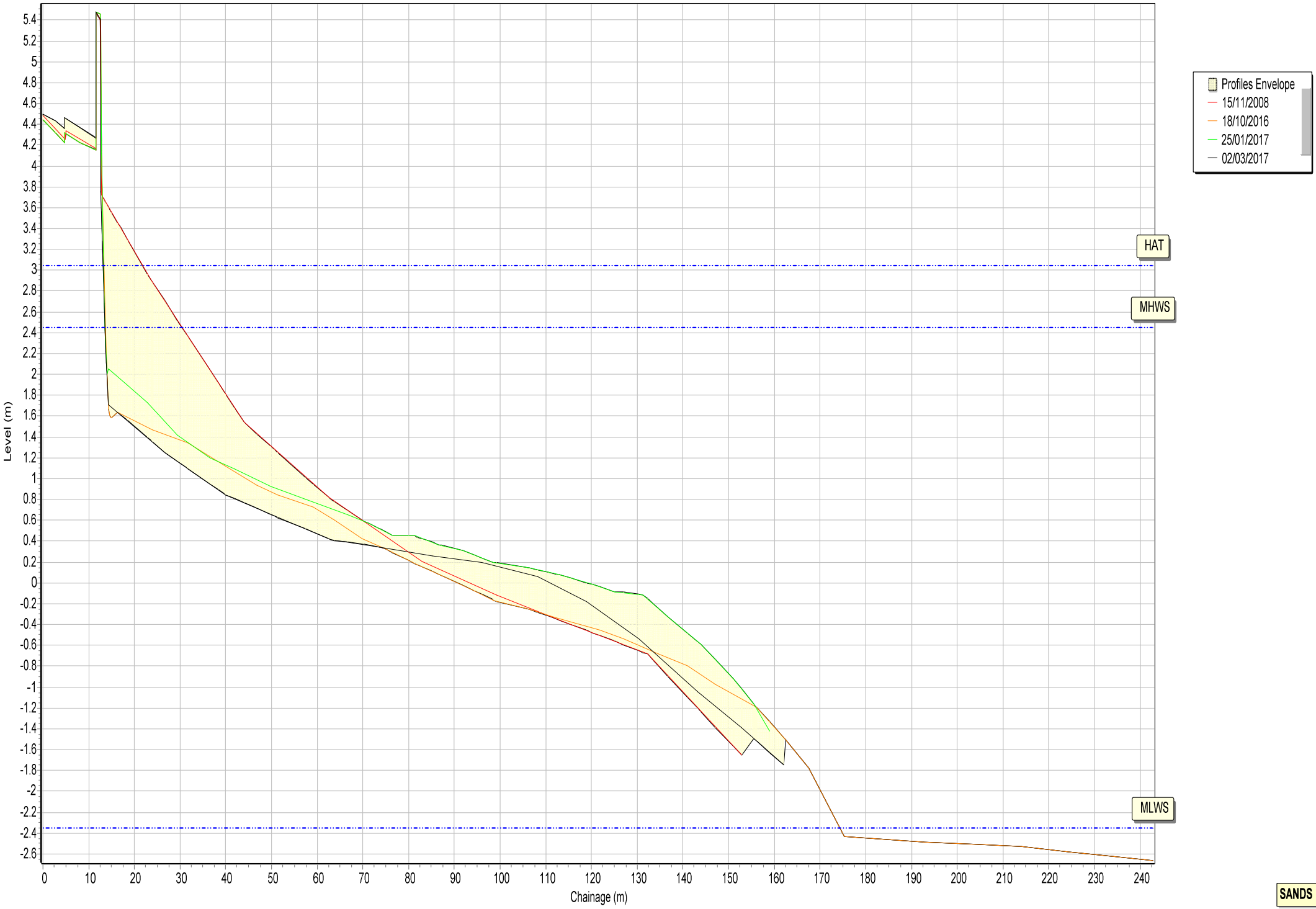
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Beach Profiles: 1dSBN2



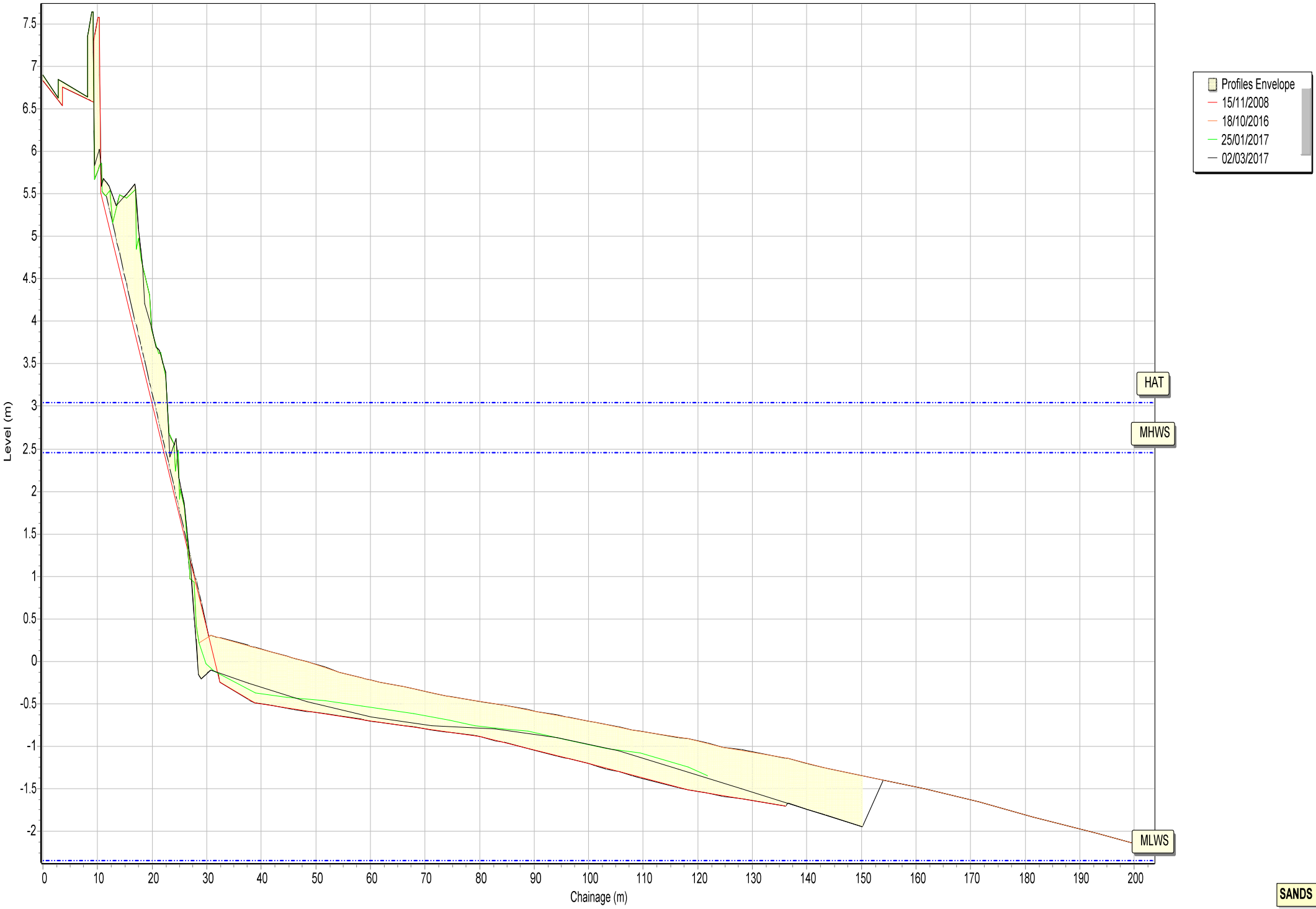
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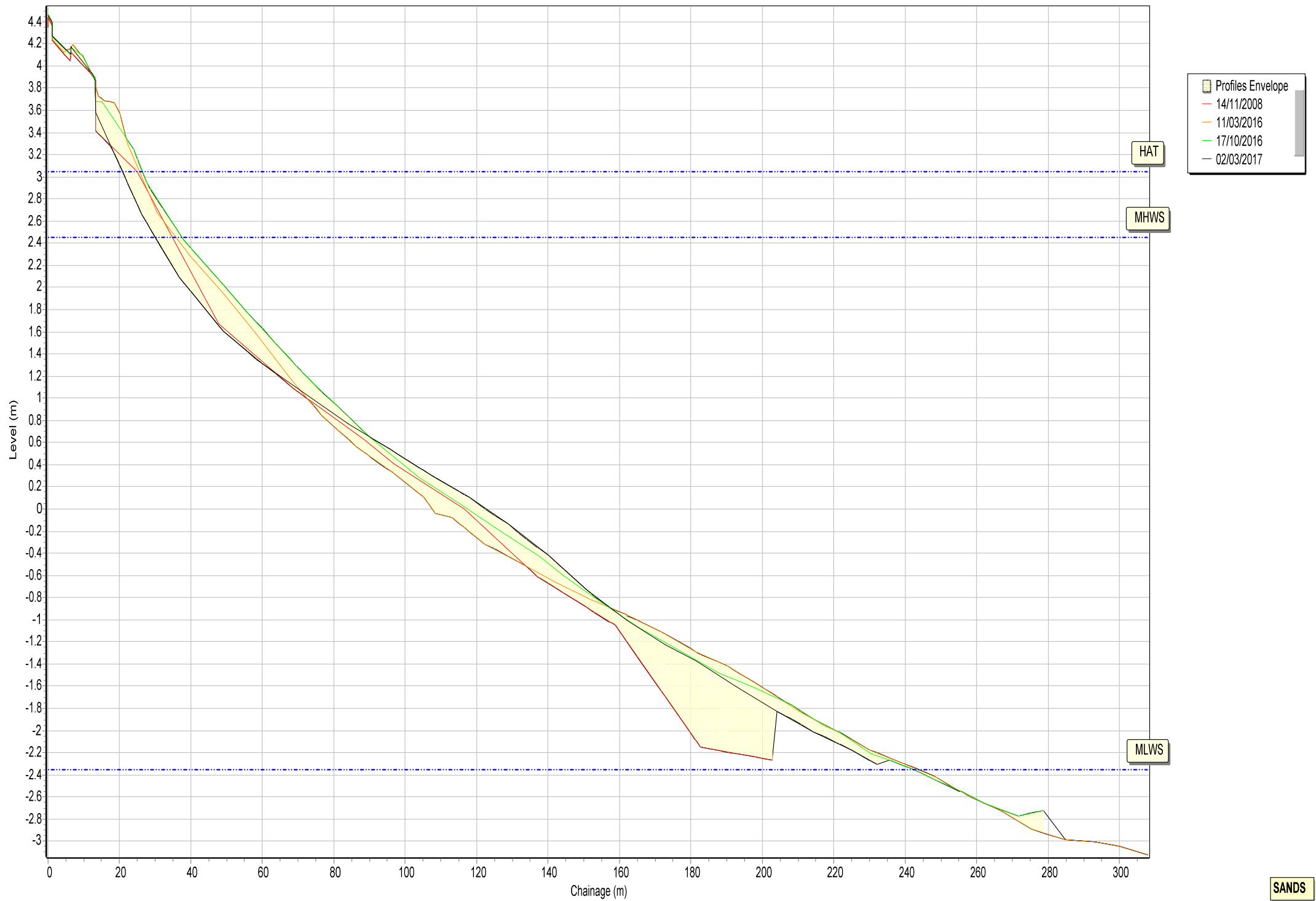
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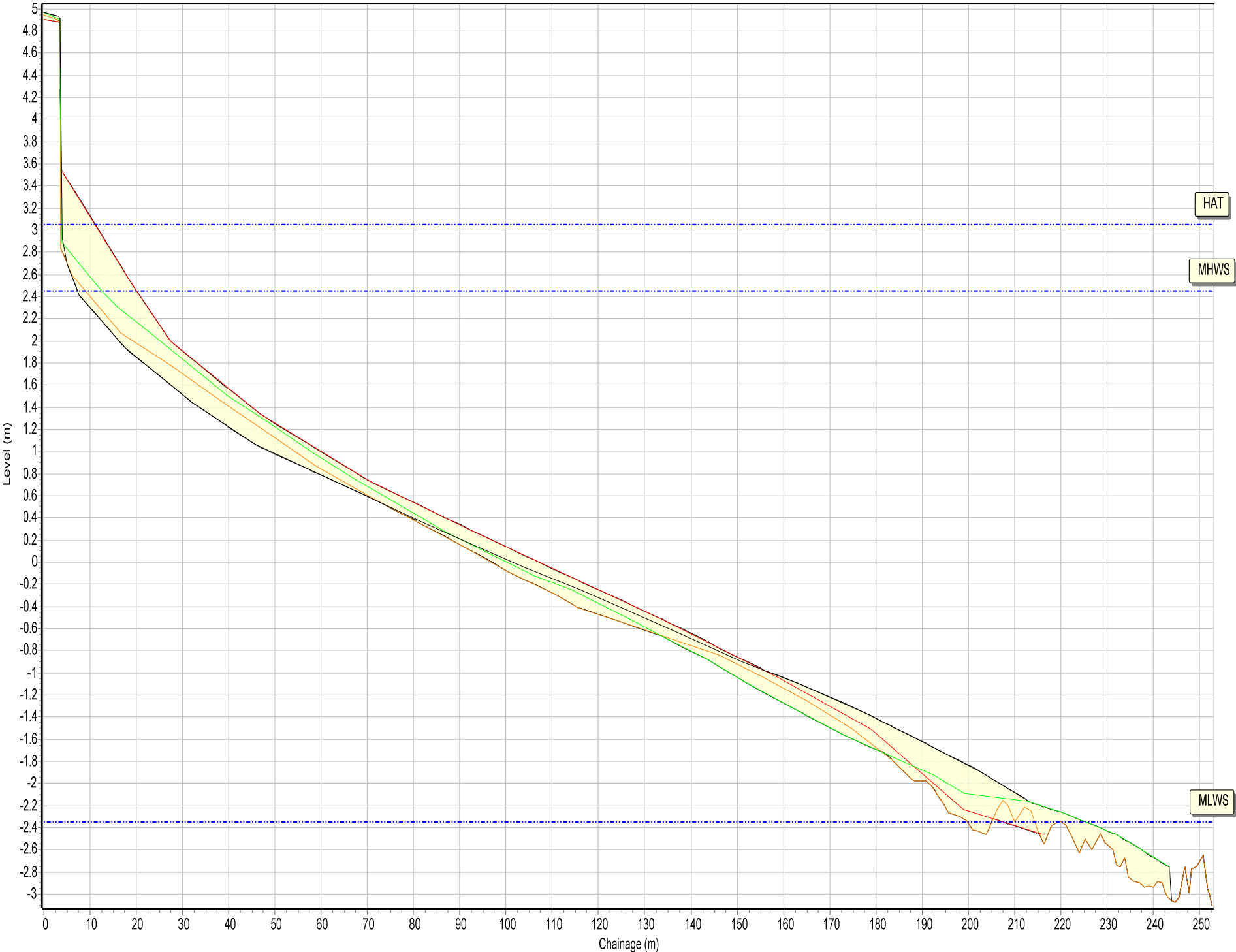
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Beach Profiles: 1dSBS1



Beach Profiles: 1dSBS2



Profiles Envelope

14/11/2008

11/03/2016

17/10/2016

02/03/2017

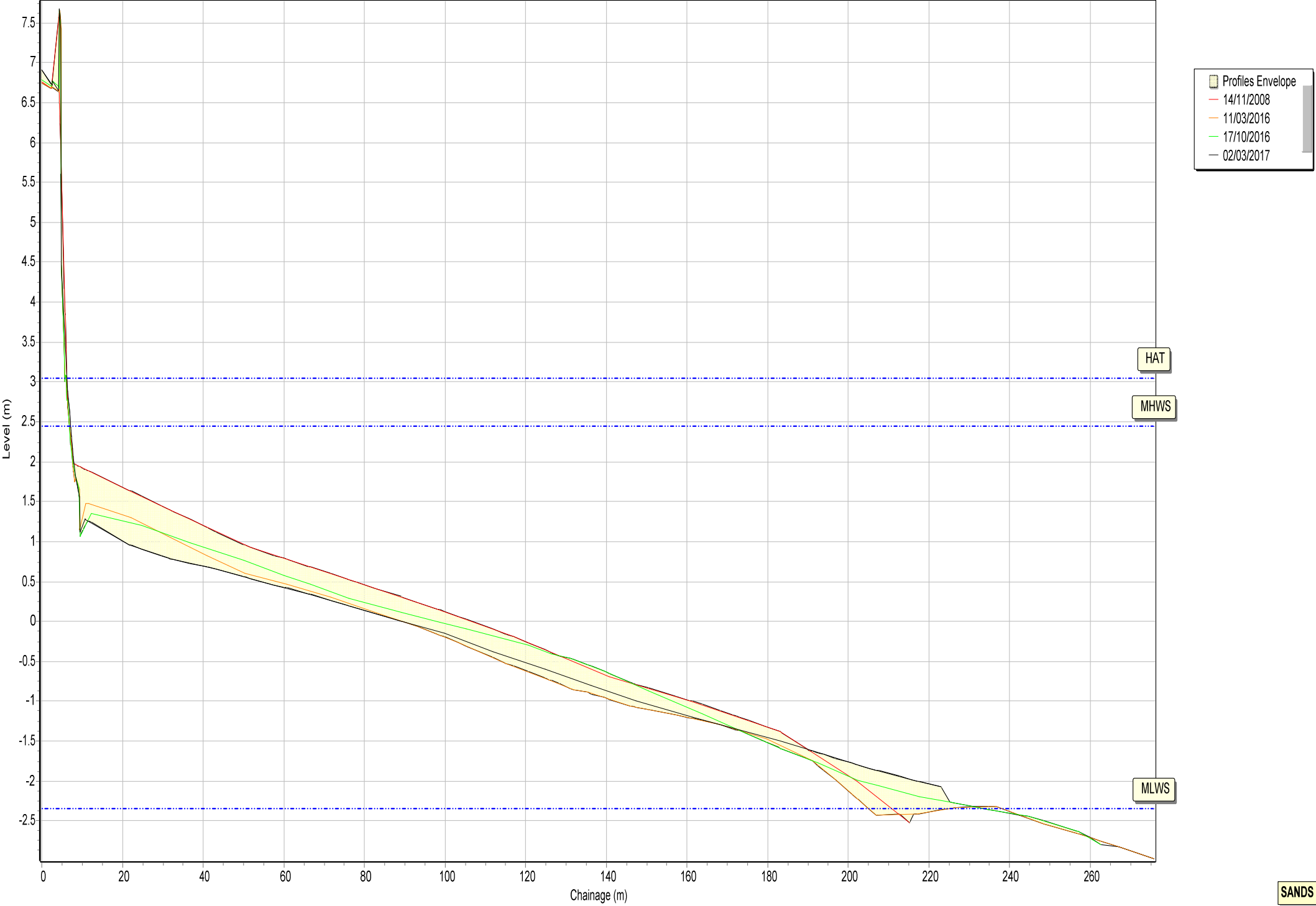
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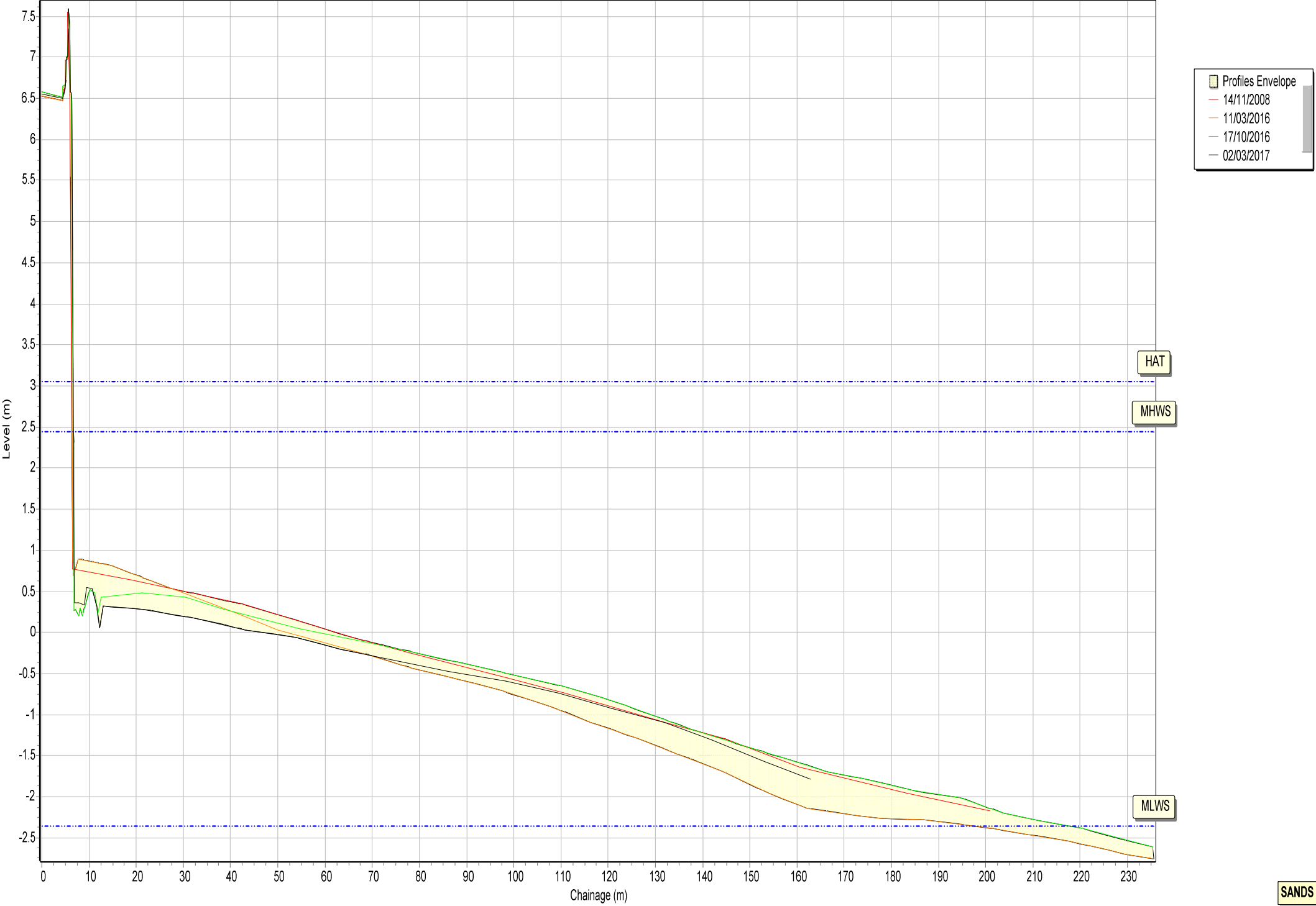
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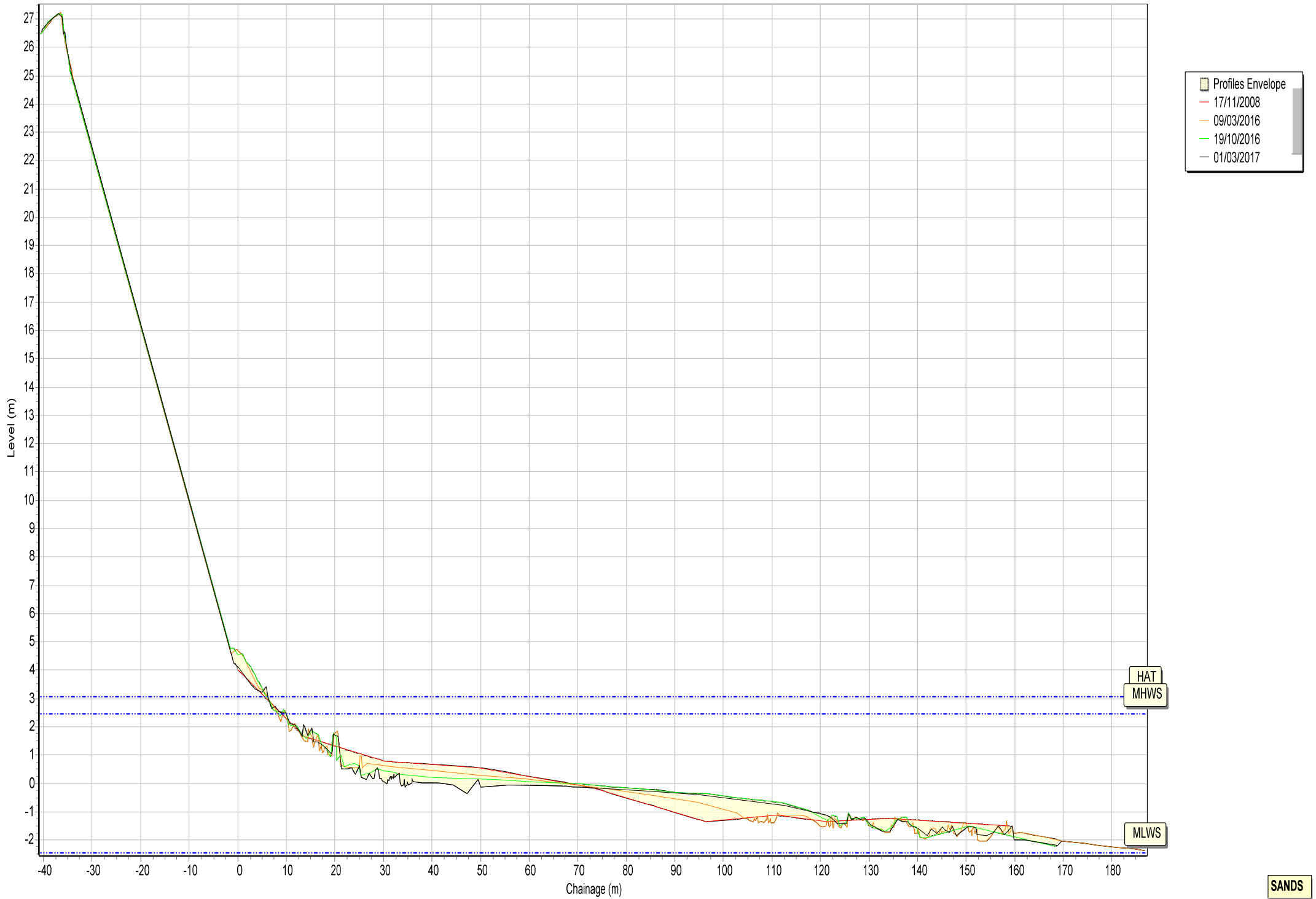
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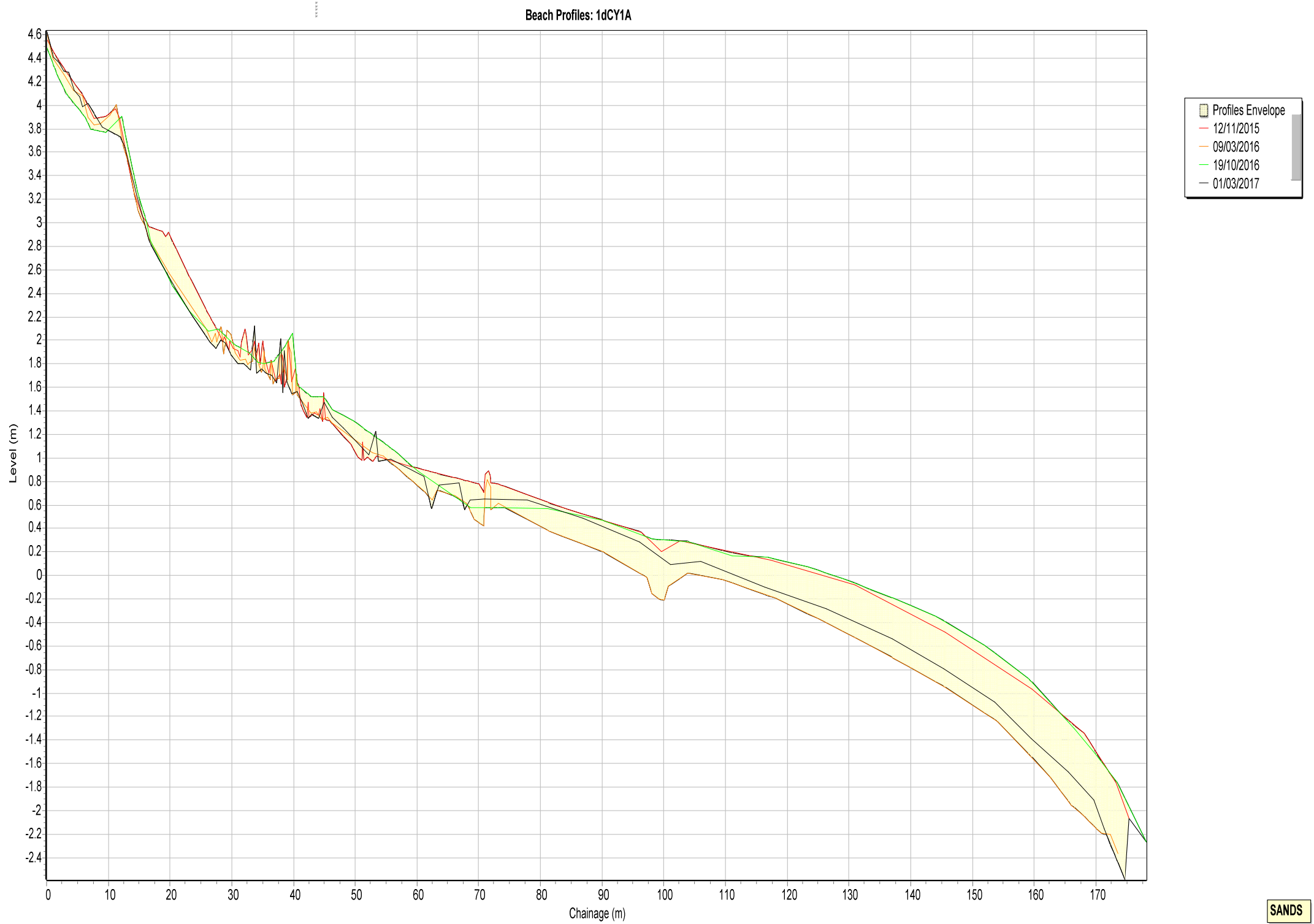


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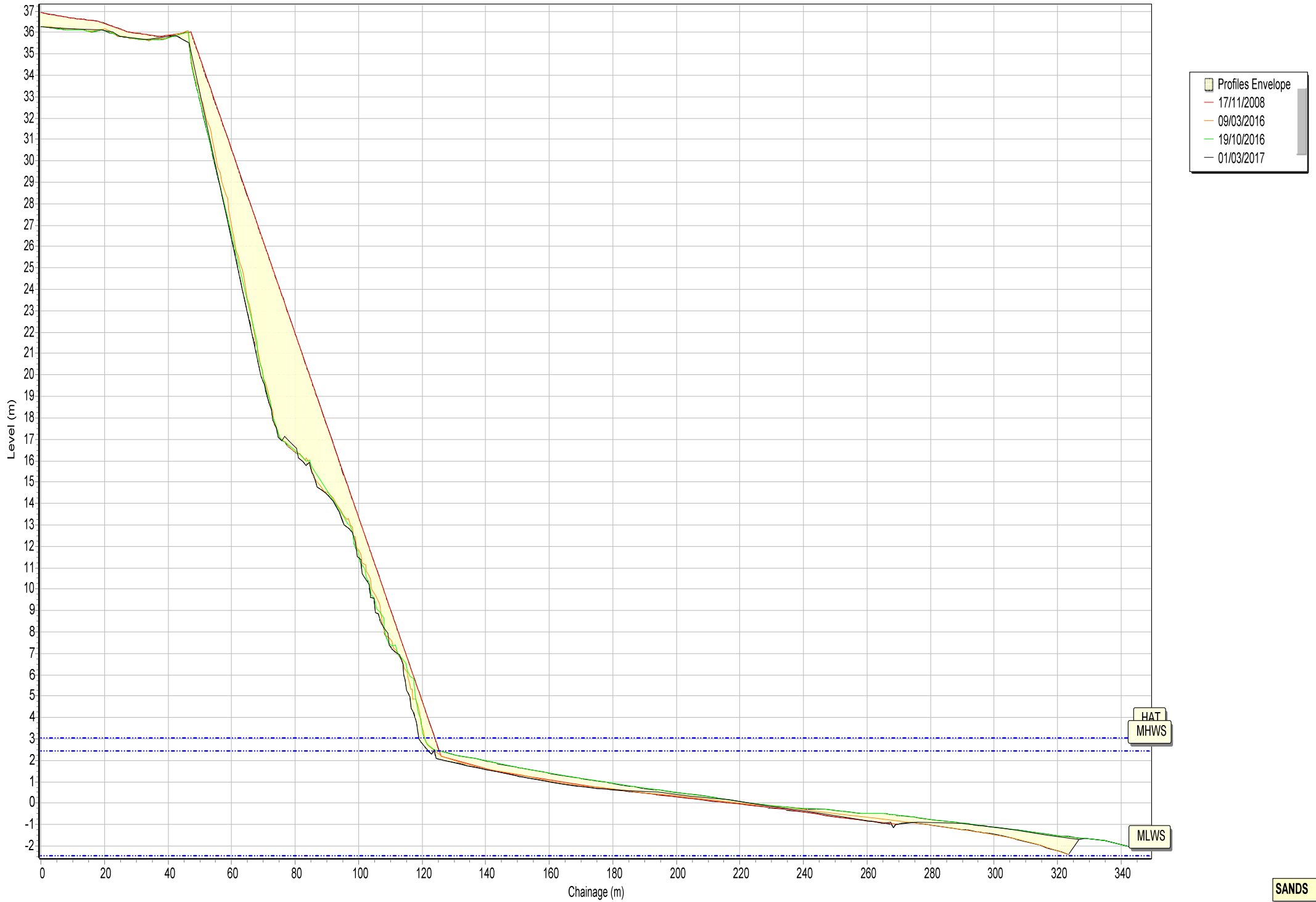


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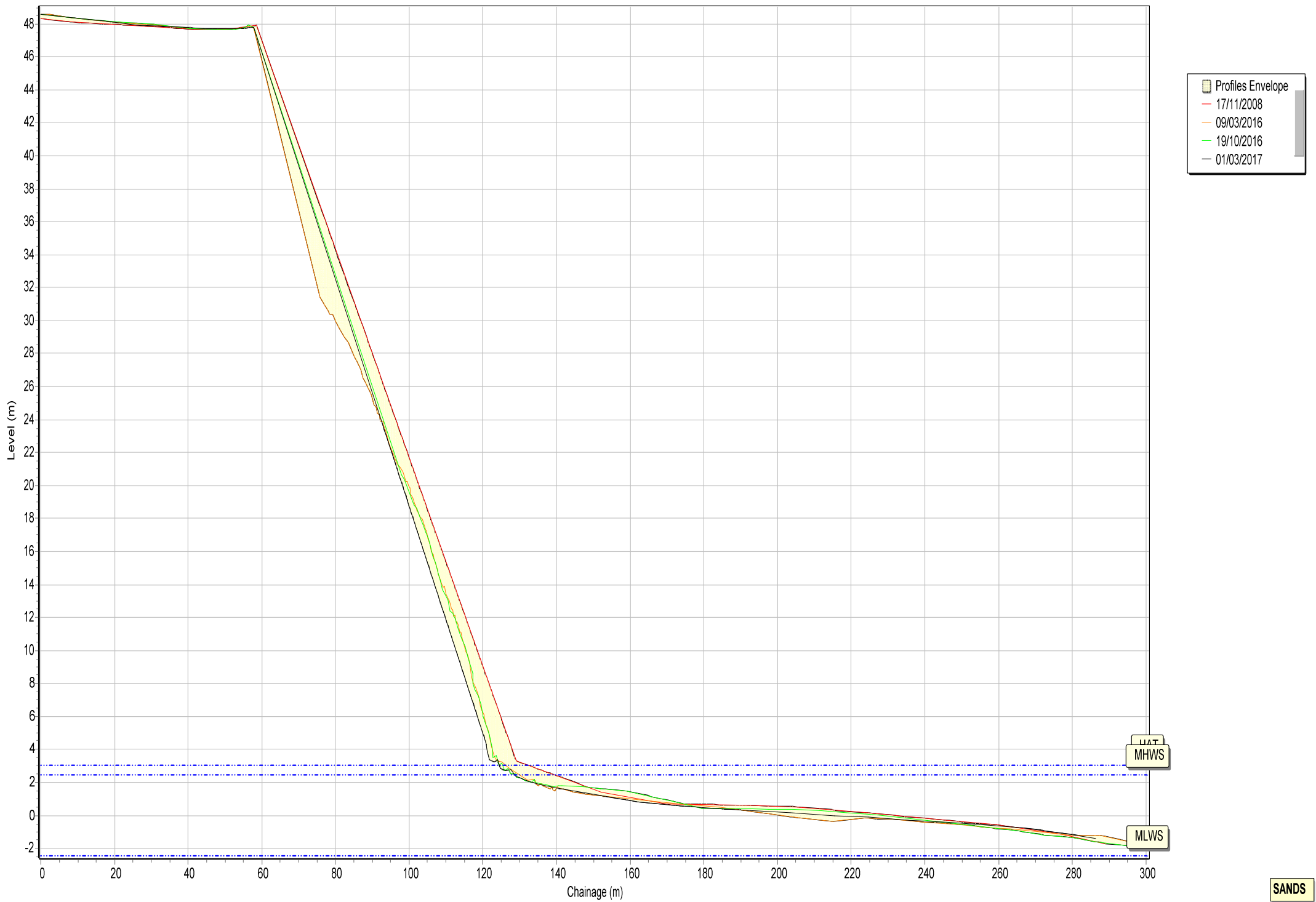




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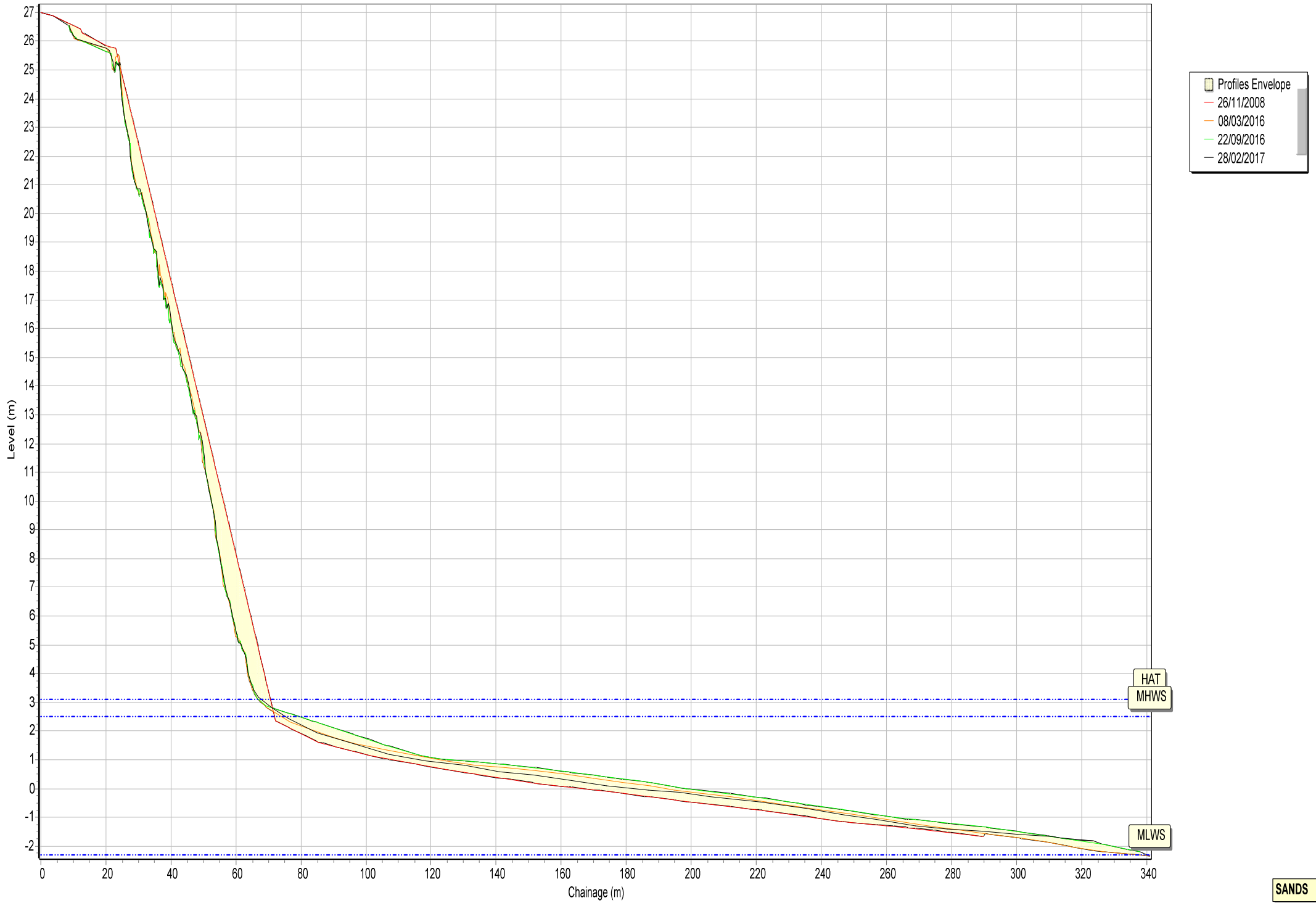
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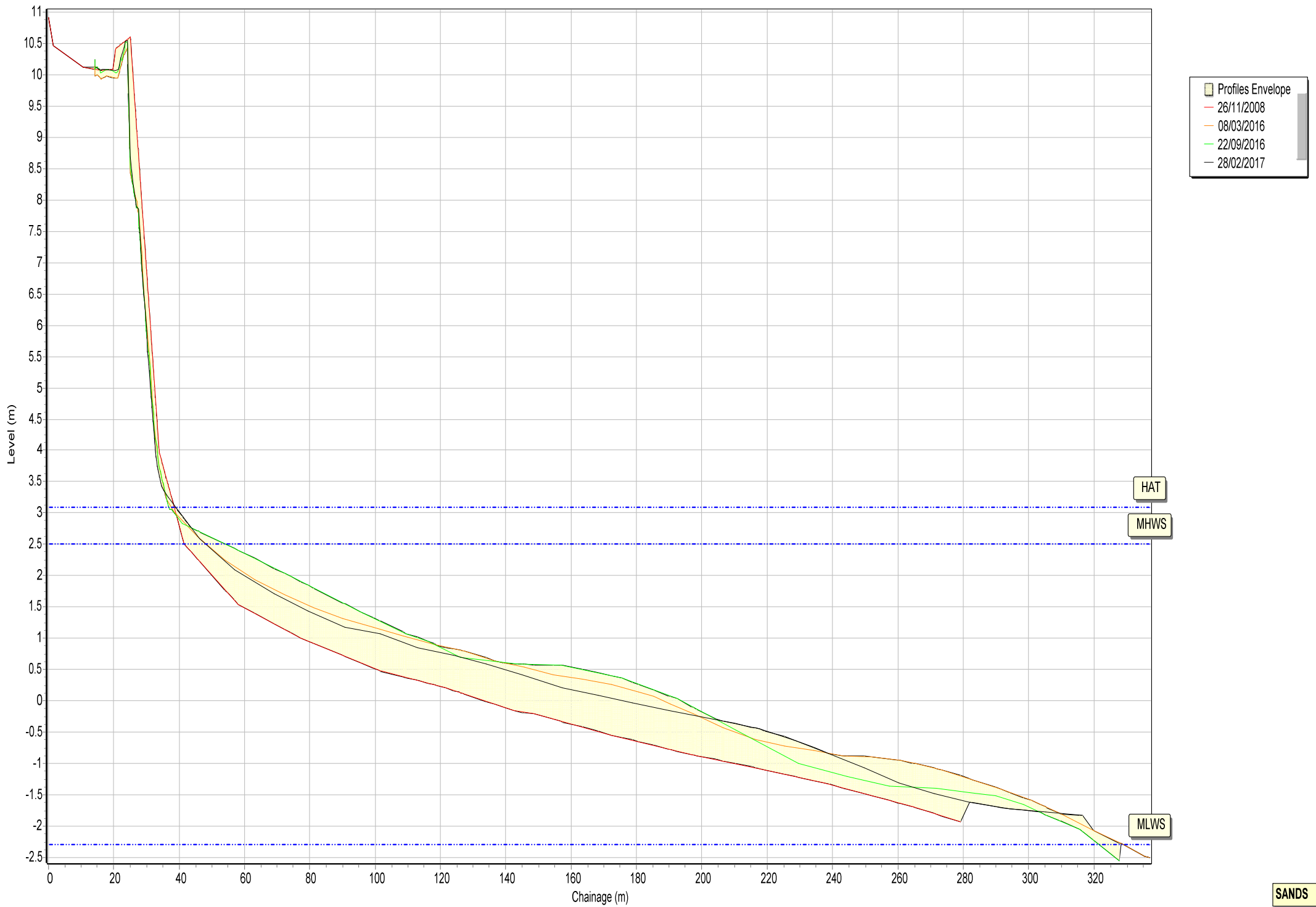
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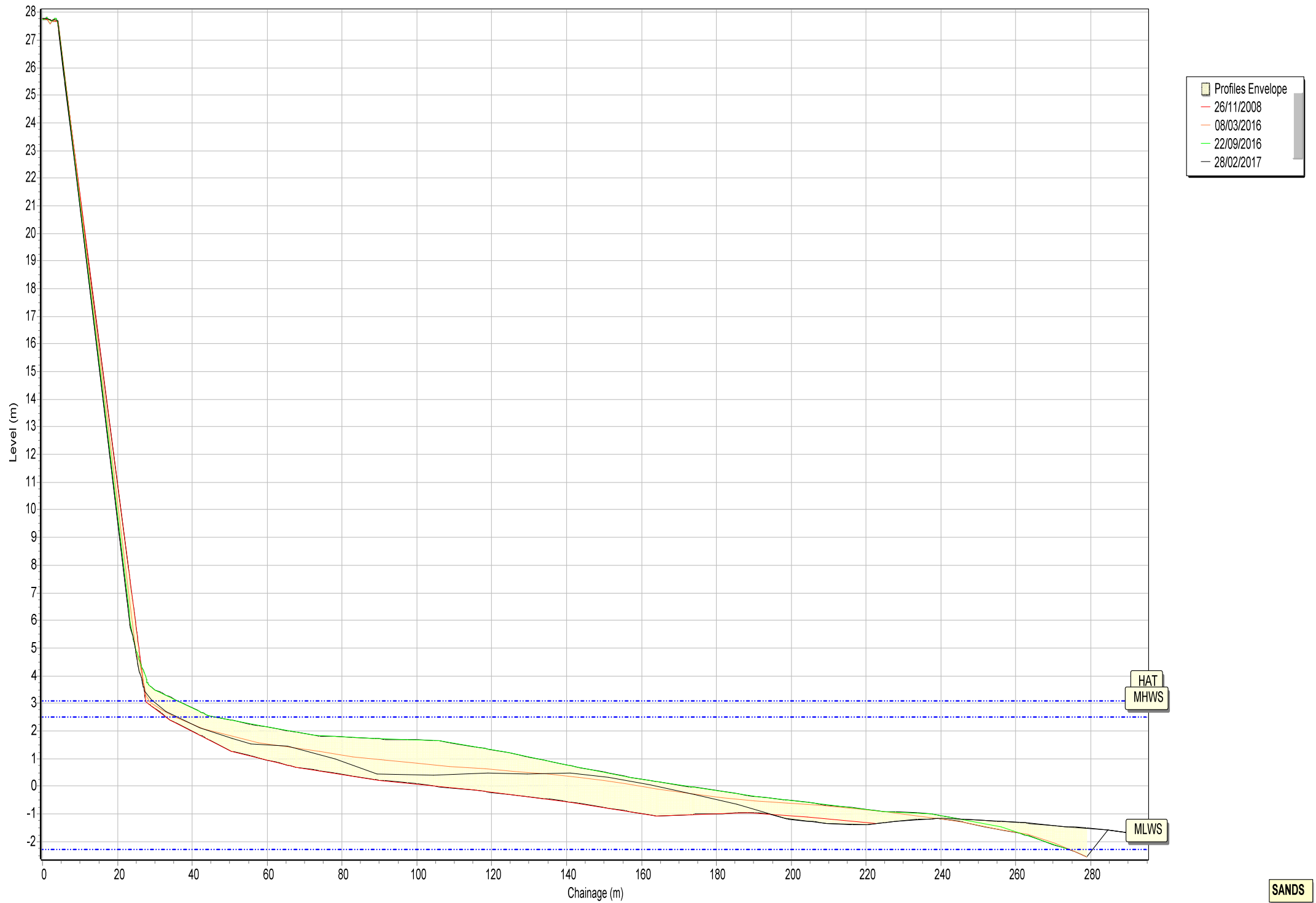
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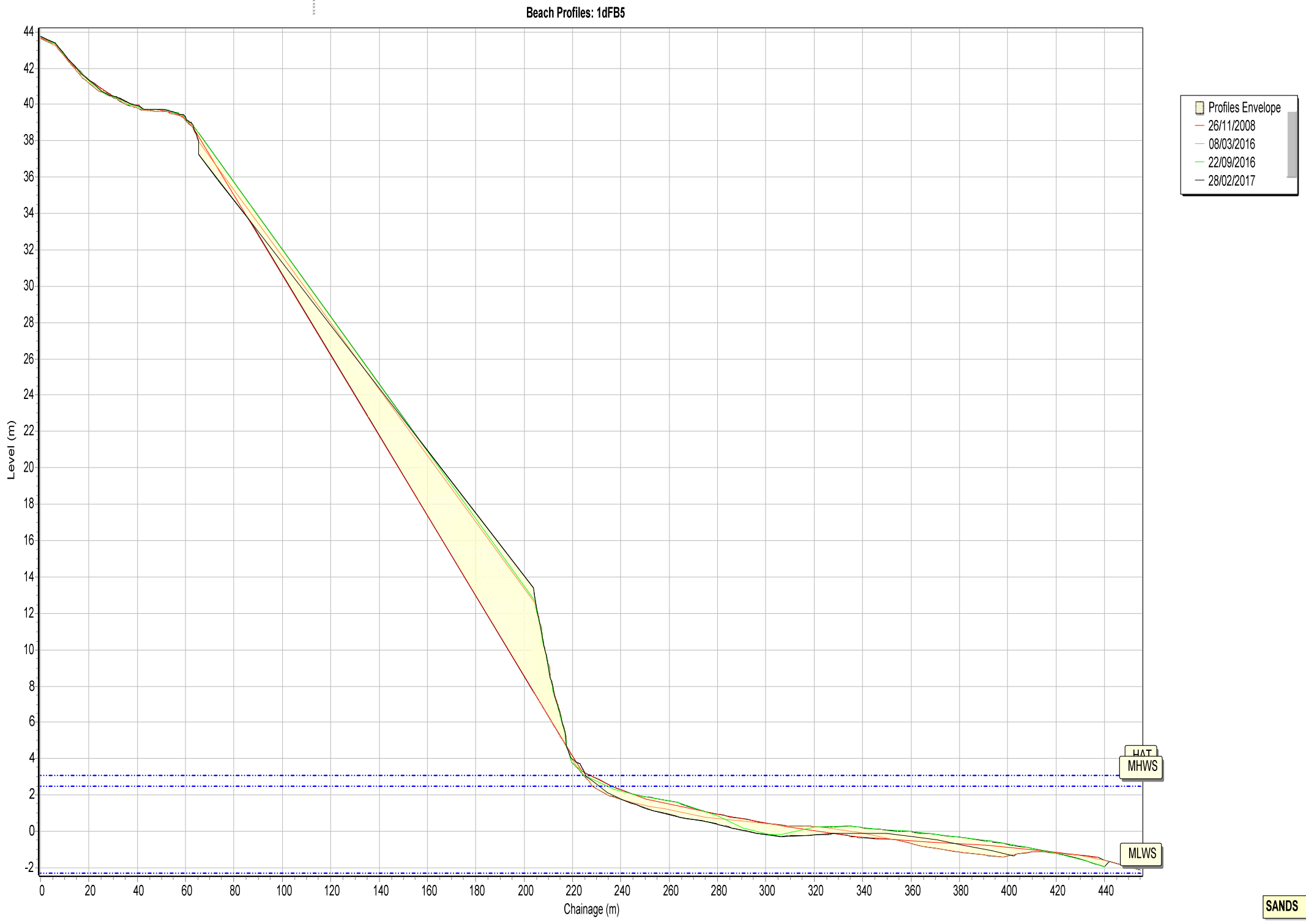
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Beach Profiles: 1dFB4

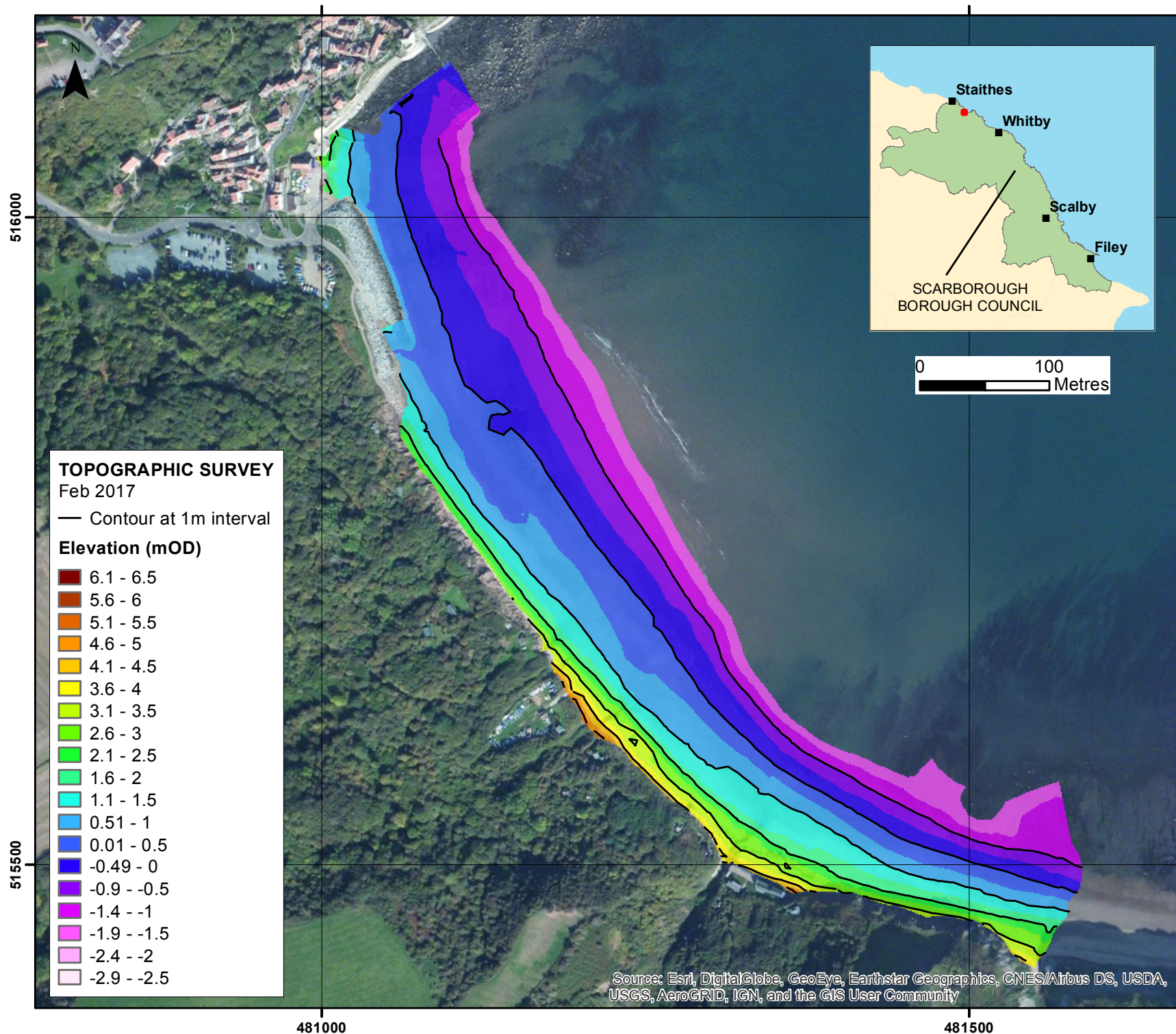


SANDS



Appendix B

Topographic Survey



Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal
Monitoring Programme

Appendix B - Map 1

RUNSWICK BAY

Scarborough Borough Council Frontage

Update Report
'Partial Measures' Survey 2017

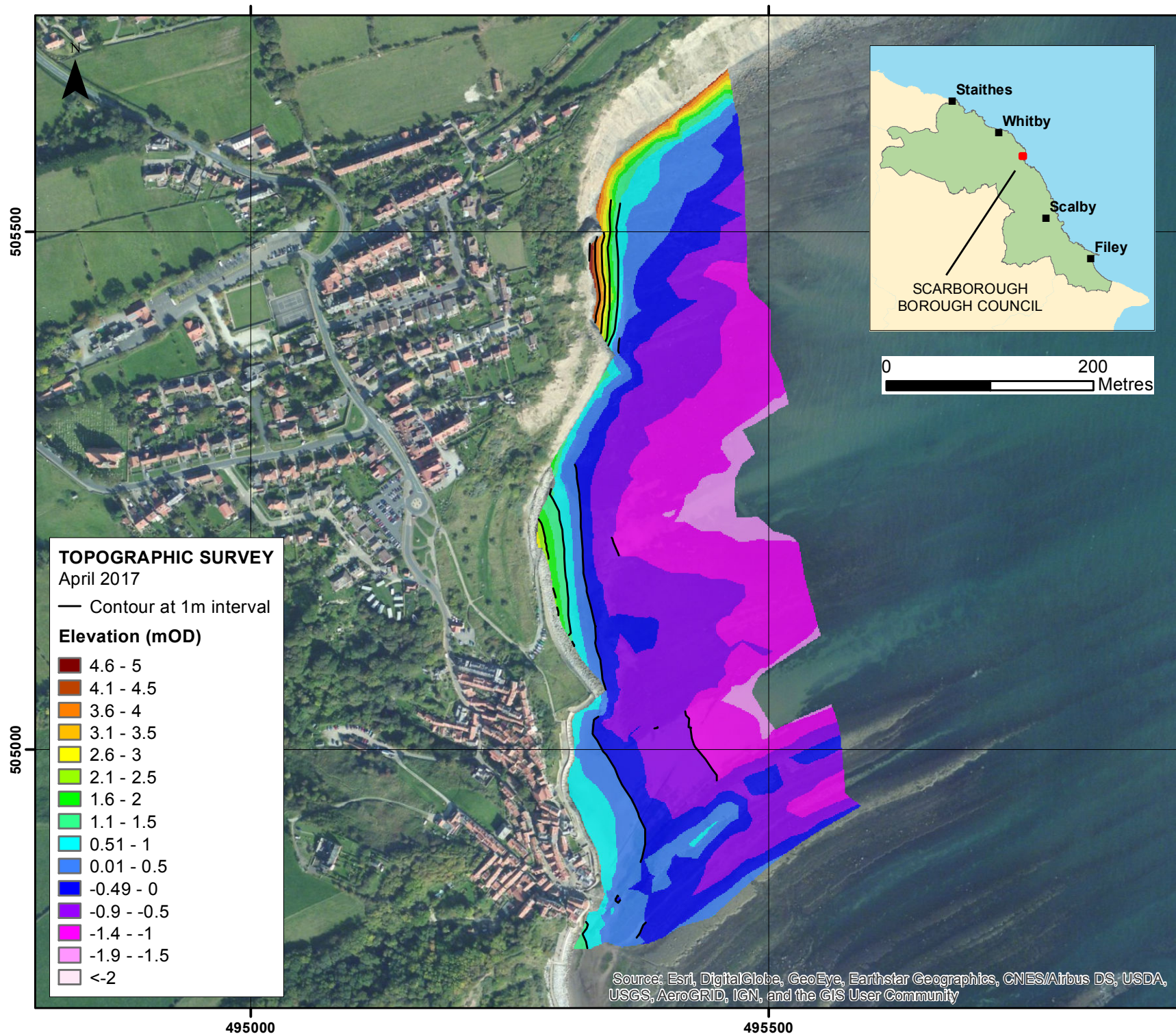
Drawing Scale at A4 1:4,000

WATER

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

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





Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal
Monitoring Programme

Appendix B - Map 2

ROBIN HOOD'S BAY

Scarborough Borough Council Frontage

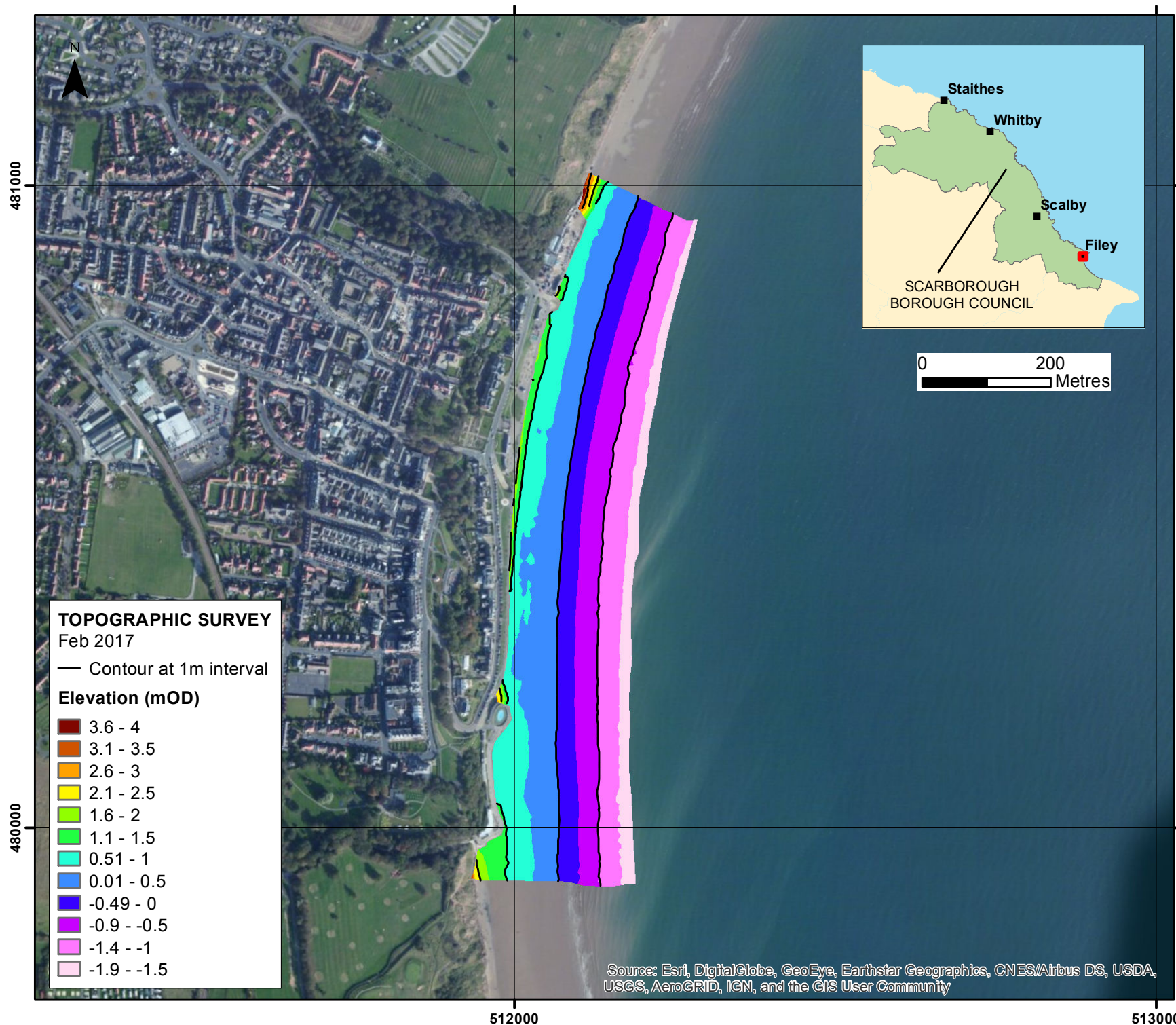
Update Report
'Partial Measures' Survey 2017

Drawing Scale at A4 1:5,000

WATER

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

Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
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Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal
Monitoring Programme

Appendix B - Map 3

FILEY BAY

Scarborough Borough Council Frontage

Update Report
'Partial Measures' Survey 2017

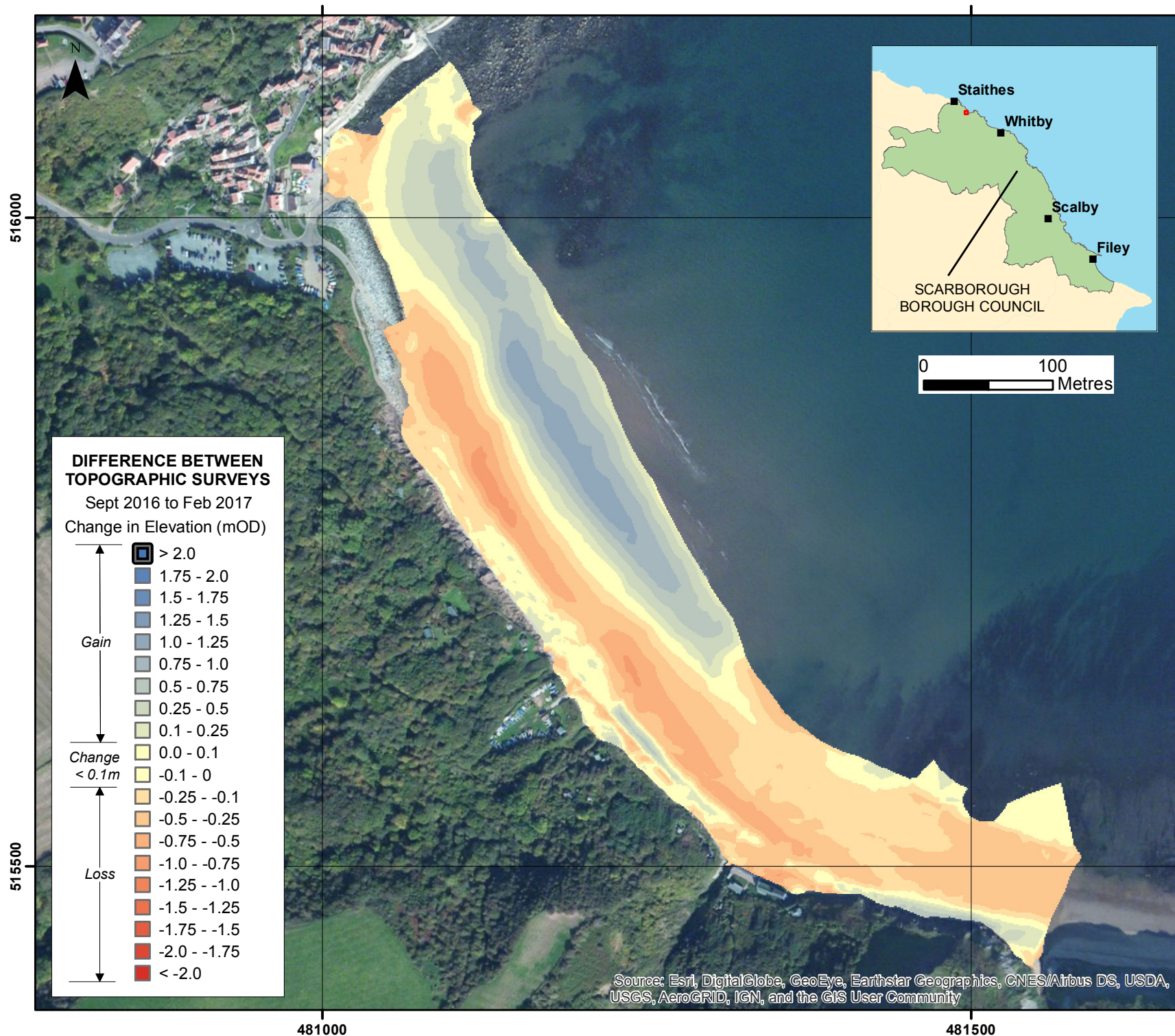
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WATER

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

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





Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 4

RUNSWICK BAY

Scarborough Borough Council Frontage

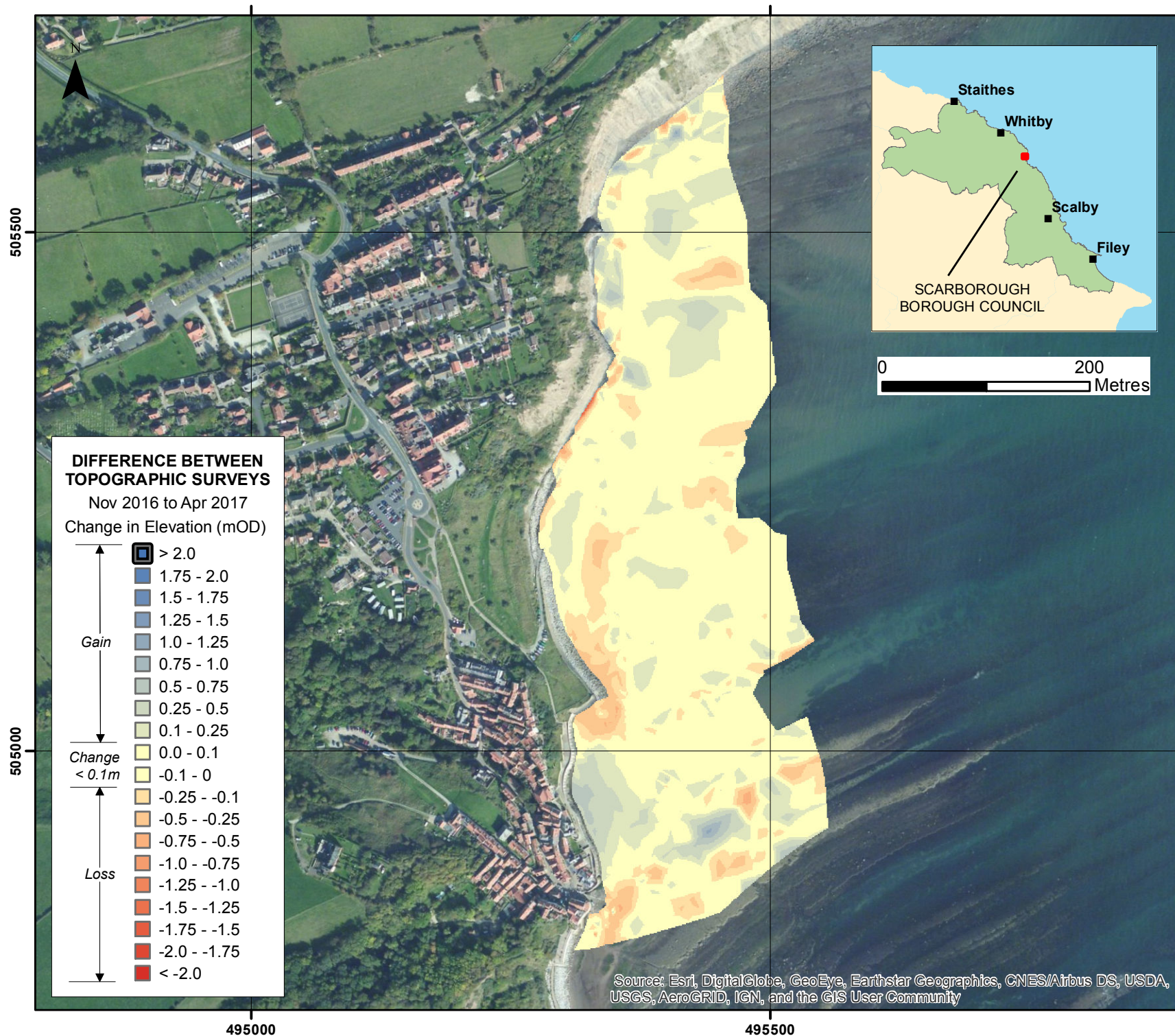
Update Report
 'Partial Measures' Survey 2017

Drawing Scale at A4 1:4,000

WATER

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

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



Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 5

ROBIN HOOD'S BAY

Scarborough Borough Council Frontage

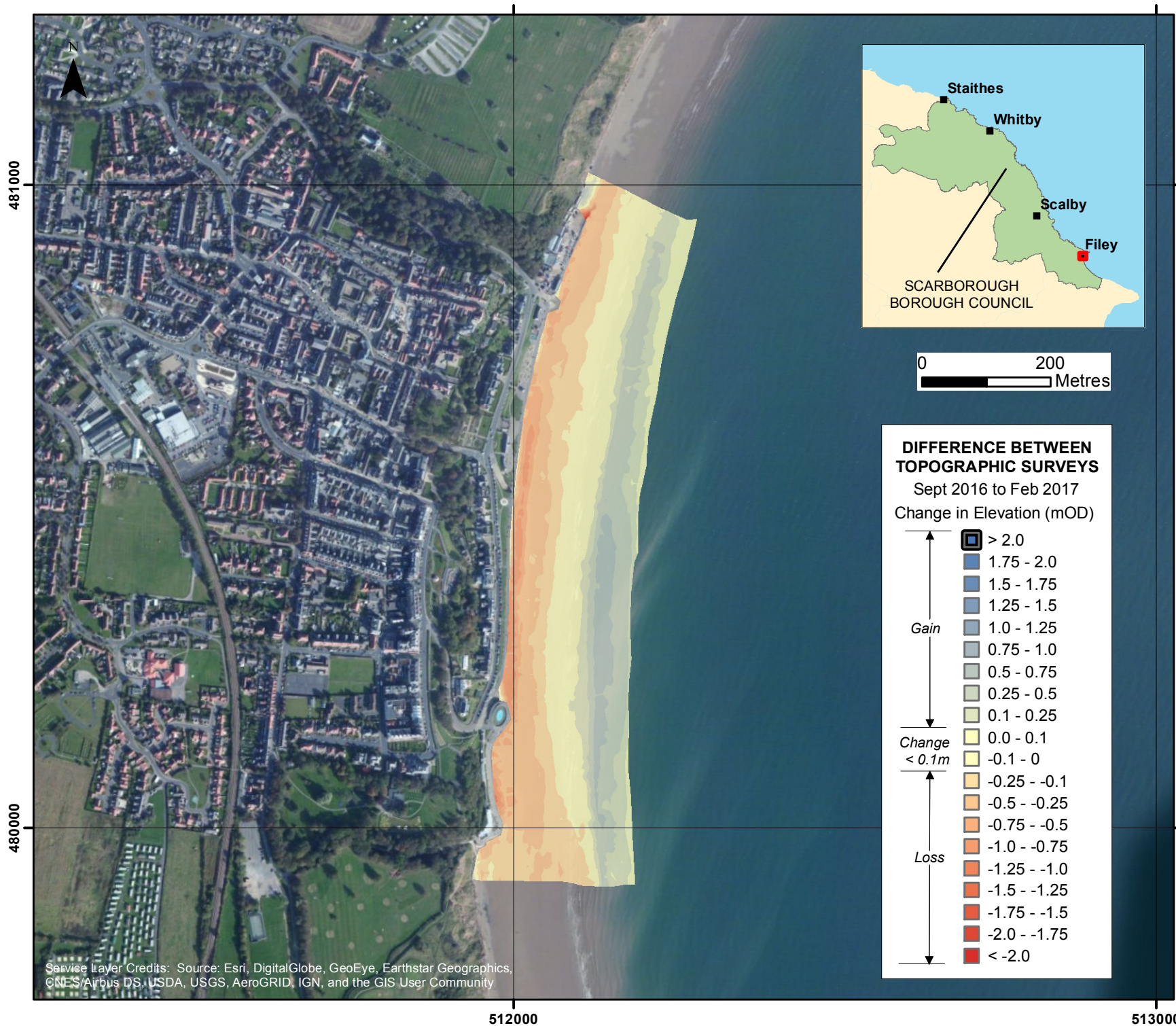
Update Report
'Partial Measures' Survey 2017

Drawing Scale at A4 1:5,000

WATER

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

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



Key

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 6

FILEY BAY

Scarborough Borough Council Frontage

Update Report
 'Partial Measures' Survey 2017

Drawing Scale at A4 1:8,000

WATER

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

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

Appendix C

Cliff Top Survey

Cliff Top Survey

Staithes

Twenty ground control points have been established at Staithes (Figure C1). The maximum separation between any two points is nominally 100m.

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

Table C1 provides baseline information about these ground control points and results from the 2008 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table C1 – Cliff Top Surveys at Staithes

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing	Baseline Survey	Previous Survey	Present Survey	Baseline to Present	Previous to Present	Baseline to Present
			(°)	Nov 2008	Sep 2016	Mar 2017	Nov 2008 - Mar 2017	Sep 2016 - Mar 2017	Nov 2008 - Mar 2017
1	477228	518769	320	1.9	1.62	-0.13	2.03	1.75	0.23
2	477334	518798	0	10.9	10.73	10.74	0.16	-0.01	0.02
3	477487	518789	350	7.1	8.14	8.35	-1.25	-0.21	0.00
4	477594	518801	340	5.9	4.48	4.35	1.55	0.13	0.17
5	477683	518911	350	8.4	8.75	8.73	-0.33	0.02	0.00
6	477792	518867	30	8.6	8.39	8.35	0.25	0.04	0.03
7	477891	518828	60	7.7	7.31	7.31	0.39	0.00	0.04
8	477959	518873	350	8.7	9.6	9.61	-0.91	-0.01	0.00
9	478088	518950	350	7.6	No Access	No Access	No Access	0	-0.06
10	478191	519023	340	8.4	No Access	No Access	No Access	0	-0.04
11	478237	519007	60	6.9	No Access	No Access	No Access	0	0.02
12	478213	518988	150	6.1	No Access	No Access	No Access	0	-0.14

13	478501	518809	15	11.4	9.07	9.07	2.33	0.00	0.26
14	478624	518807	20	7.5	7.44	7.51	-0.01	-0.07	0.00
15	478737	518858	60	6.1	6.33	6.23	-0.13	0.10	0.00
16	478823	518757	60	8	8.58	8.65	-0.65	-0.07	0.00
17	478944	518671	30	9.3	9.24	9.29	0.01	-0.05	0.00
18	479052	518630	20	9.2	8.87	9.36	-0.16	-0.49	0.00
19	479147	518610	0	14.2	13.79	14.41	-0.21	-0.62	0.00
20	479274	518618	20	11.4	11.33	11.4	0.00	-0.07	0.00

Cliff Top Survey

Robin Hoods Bay

Thirteen ground control points have been established at Robin Hoods Bay (Figure C2). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion. The cliff top surveys at Robin Hoods Bay 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 C2 provides baseline information about these ground control points and results from the 2010 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table C2 – Cliff Top Surveys at Robin Hoods Bay

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing	Baseline Survey	Previous Survey	Present Survey	Baseline to Present	Previous to Present	Baseline to Present
			(°)	Mar 2010	Nov 2016	Apr 2017	Mar 2010 - Apr 2017	Nov 2016 - Apr 2017	Mar 2010 - Apr 2017
1	495799.5	506002.2	130	11.6	7.87	7.19	4.41	0.68	0.63
2	495549.2	505807.3	135	9.3	9.04	8.93	0.37	0.11	0.05
3	495456.3	505740	130	5	5.09	4.98	0.02	0.11	0.00
4	495389.9	505683.7	140	6.3	6.18	5.98	0.32	0.20	0.05
5	495259.4	505342.5	130	11.3	12.58	11.81	-0.51	0.77	0.00
6	495231.2	505315.7	95	5.9	5.81	5.78	0.12	0.03	0.02
7	495184.8	505210.7	85	6.4	6.73	6.7	-0.30	0.03	0.00
8	495206.5	505153	75	5	5.22	5.16	-0.16	0.06	0.00
9	495287.8	505060.5	80	4.3	4.57	4.58	-0.28	-0.01	0.00
10	495187.8	504708.8	70	3.1	2.43	2.42	0.68	0.01	0.10
11	495226.2	504615.7	120	3.8	3.93	3.88	-0.08	0.05	0.00
12	495297.5	504380.2	80	11	11.04	10.91	0.09	0.13	0.01
13	495350.4	504193	55	3.7	3.78	3.77	-0.07	0.01	0.00

Cliff Top Survey

Scarborough South Bay

Thirteen ground control points have been established at Scarborough South Bay (Figure C3). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion. The cliff top surveys at Scarborough South Bay 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 C3 provides baseline information about these ground control points and results from the 2010 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table C3 – Cliff Top Surveys at Scarborough South Bay

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing	Baseline Survey	Previous Survey	Present Survey	Baseline to Present	Previous to Present	Baseline to Present
			(°)	Mar 2010	Oct 2016	Mar 2017	Mar 2010 - Mar 2017	Oct 2016 - Mar 2017	Mar 2010 - Mar 2017
1	504339.5	487887.3	70	7	6.96	6.93	0.07	0.03	0.01
2	504422.3	487603.7	80	4.8	4.83	4.8	0.00	0.03	0.00
3	504534.8	487318.3	40	15.1	15.12	15.02	0.08	0.10	0.01
4	504730.2	487137.9	55	9.6	9.59	9.62	-0.02	-0.03	0.00
5	504922.9	486837.8	60	8.8	8.71	8.71	0.09	0.00	0.01
6	50571.1	486652.1	75	3.8	3.77	3.69	0.11	0.08	0.02
7	505284.3	486480	35	7	6.52	6.72	0.28	-0.20	0.04
8	505597.9	486363.4	30	8.6	8.44	8.48	0.12	-0.04	0.02
9	505758.6	486005.1	45	9.1	8.63	8.71	0.39	-0.08	0.06
10	505896	485889.6	15	14.8	14.76	14.83	-0.03	-0.07	0.00
11	505990	485657.1	80	4.7	1.18	1.32	3.38	-0.14	0.48
12	506024.9	485421.8	55	6.1	3.19	3.31	2.79	-0.12	0.40
13	506036	485315.3	90	7	7.04	7.1	-0.10	-0.06	0.00

Cliff Top Survey

Cayton Bay

Eight ground control points have been established at Cayton Bay (Figure C4). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion.

The cliff top surveys at Cayton Bay 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 C4 provides baseline information about these ground control points and results from the 2008 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table C4 – Cliff Top Surveys at Cayton Bay

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing	Baseline Survey	Previous Survey	Present Survey	Baseline to Present	Previous to Present	Baseline to Present
			(°)	Nov 2008	Oct 2016	Mar 2017	Nov 2008 - Mar 2017	Oct 2016 - Mar 2017	Nov 2008 - Mar 2017
1	506325.5	484849.7	50	4	3.67	3.61	0.39	0.06	0.04
2	506459.4	484715.9	65	5	0.17	-0.08	5.08	0.25	0.56
3	506597.4	484538.6	65	5	6.26	6.26	-1.26	0.00	0.00
4	506778.1	484345.5	21	9	5.99	5.97	3.03	0.02	0.34
5	507018.6	484221.6	342	7.7	7.82	7.89	-0.19	-0.07	0.00
6	507242.3	484121.7	2	7.4	6.17	6.2	1.20	-0.03	0.13
7	507518.2	484008.2	25	7.5	7.81	7.65	-0.15	0.16	0.00
8	507818.7	484006	1	5.5	5.92	5.92	-0.42	0.00	0.00

Cliff Top Survey

Filey Bay

Twenty-eight ground control points have been established in Filey Bay (Figure C5 and C6). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion.

The cliff top surveys at Filey Bay 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 C5 provides baseline information about these ground control points and results from the 2008 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table C5 – Cliff Top Surveys in Filey Bay

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing	Baseline Survey	Previous Survey	Present Survey	Baseline to Present	Previous to Present	Baseline to Present
			(°)	Nov 2008	Sep 2016	Feb 2017	Nov 2008 - Feb 2017	Sep 2016 - Feb 2017	Nov 2008 - Feb 2017
1	512444.9	481630.9	130	8.7	8.79	8.42	0.28	0.37	0.03
2	512306.7	481490.3	144	7.6	7.78	7.87	-0.27	-0.09	0.00
3	512153.6	481234.6	122	8.3	8.16	8.14	0.16	0.02	0.02
4	512029.2	480959.9	115	7.4	7.51	7.27	0.13	0.24	0.01
5	511895.4	479888	89	7.1	0.7	0.66	6.44	0.04	0.72
6	511908.5	479597.1	48	6.7	7.2	5.66	1.04	1.54	0.12
7	511991.4	479310.4	69	6.7	4.39	4.37	2.33	0.02	0.26
8	512083.4	478981.5	66	10.2	10.21	10.12	0.08	0.09	0.01
9	512121.3	478786.3	76	8.3	8.33	8.39	-0.09	-0.06	0.00
10	512226.2	478547.9	74	7.5	7.18	7.17	0.33	0.01	0.04
11	512471.4	478153.5	53	6.6	7.77	7.54	-0.94	0.23	0.00
12*	512558.9	477901.9	66	7.7	6.41	7.17	0.53	-0.76	0.06

12A*	512655.8	477822.4	67	13.9	13.3	13.33	0.57	-0.03	0.06
13**	512697.6	477719	34	4.2	No Data	No Data	No Data	No Data	No Data
13A*	512805.5	477572.1	32	13.42	13.45	13.35	0.07	0.10	0.01
14	512939.4	477400.9	66	8	6.95	6.51	1.49	0.44	0.17
15	513157	477192.7	51	5.2	4.5	4.59	0.61	-0.09	0.07
16	513299.5	477024.6	30	7.7	7.07	7.05	0.65	0.02	0.07
17	513507.7	476821.1	34	10.7	10.5	10.5	0.20	0.00	0.02
18	513721	476602.3	31	7.2	6.26	6.16	1.04	0.10	0.12
19	513916.6	476354.1	51	6.6	6.42	6.15	0.45	0.27	0.05
20	514174.8	476179.4	32	7	6.95	6.73	0.27	0.22	0.03
21	514471.5	475965.7	66	7.6	7.44	7.44	0.16	0.00	0.02
22	514656.2	475728.8	101	8.1	8.12	8.15	-0.05	-0.03	0.00
23	514889.5	475537.6	60	9.1	8.49	8.47	0.63	0.02	0.07
24*	512603.7	481665.9	14	19.9	19.72	19.85	0.05	-0.13	0.01
25*	512607.1	481648.9	184	17.2	17.31	17.01	0.19	0.30	0.02
26*	512301.9	481825.5	18	11	10.87	10.88	0.12	-0.01	0.01
27*	512475.8	481712.1	20	11.6	11.41	11.45	0.15	-0.04	0.02

NOTE: *base line for 12A and 24-27 is March 2011

**Surveyor's report has previously stated that 'VMP 13 was unable to be measured due to vegetation growth and land shape change'