

**Cell 1 Regional Coastal Monitoring Programme
Scarborough 'Post Storm' Beach Monitoring
Survey Report 2024**

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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.

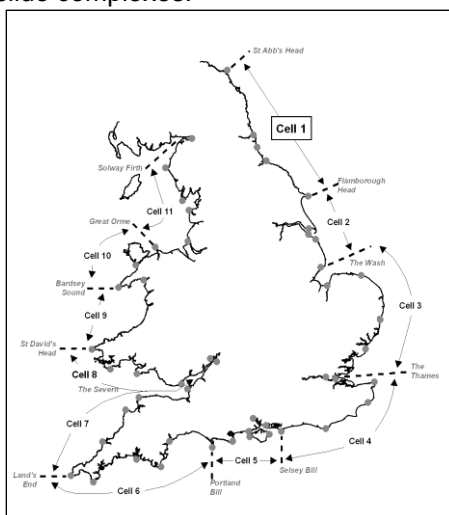


Figure 1 Sediment Cells in England and Wales

The programme commenced in its present guise in September 2008¹ and is managed by Scarborough Borough Council on behalf of the North East Coastal Observatory. It is funded by the Environment Agency, working in partnership with the following organisations:



¹ Prior to 2008, coastal monitoring was undertaken on a consistent basis across Northumberland and North Tyneside as part of the (then) Northumbrian Coastal Authorities Group's monitoring programme which commenced in 2002, whilst several authorities between the River Tyne and Flamborough Head undertook their own local monitoring programmes.

Royal HaskoningDHV has been appointed to provide Analytical Services in relation to the present phase of the Cell 1 Regional Coastal Monitoring Programme, between 2016 - 2027.

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 seabed characterisation surveys
- aerial photography
- LiDAR Surveys
- walk-over cliff and coastal defence asset surveys

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

Each year, an Analytical Report is produced for each individual authority, providing a detailed analysis and interpretation of the 'Full Measures' surveys. This is followed by a brief Update Report for each individual authority, providing ongoing findings from the 'Partial Measures' surveys.

Between the 16th October 2023 and 2nd January 2024, the UK was subject a particularly stormy period, where seven named storms occurred (Table 1). To assess the impact of these storms on the coastline, a series of targeted **Post Storm Beach Profile / Topographic / Cliff Top Recession Surveys** were undertaken as part of the Cell 1 Regional Coastal Monitoring Programme. The report presents the analysis of the post-storm surveys undertaken at Scarborough's North and South Bays.

Name	Date named	Date of impact on UK and/or Ireland and/or Netherlands
Agnes	25 September 2023	27 - 28 September 2023
Babet	16 October 2023	18 - 21 October 2023
Ciarán	29 October 2023	1 - 2 November 2023
Debi	12 November 2023	13 November 2023
Elin	9 December 2023	9 December 2023
Fergus	9 December 2023	10 December 2023
Gerrit	26 December 2023	27 - 28 December 2023
Henk	2 January 2024	2 January 2024
Isha	19 January 2024	21 - 22 January 2024
Jocelyn	22 January 2024	23 - 24 January 2024

Table 1 UK Named storms 2023/24 ([UK Storm Centre - Met Office](#))

Year		Full Measures		Partial Measures		Post Storm		Cell 1 Overview Report
		Survey	Analytical Report	Survey	Update Report	Survey	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	Sep 11	Aug 12	Mar-May 12	Feb 13	-	-	-
5	2012/13	Sep 12	Mar 13	Apr-May 13	May 13	-	-	-
6	2013/14	Sep 13	Feb 14	Mar-Apr 14	Jul 14	-	-	-
7	2014/15	Sep 14	Feb 15	Mar 15	Jul 15	-	-	-
8	2015/16	Sep 15	Feb 16	Mar-Apr 16	Jul 16	-	-	Jun 16
9	2016/17	Sep-Nov16	Feb 17	Feb-Apr 17	Jul 17	-	-	-
10	2017/18	Sep-Oct 16	Jan 17	Mar-May 18	Jun 18	-	-	-
11	2018/19	Sep-Oct 18	Mar 19	Mar-Apr 19	July 19	-	-	-
12	2019/20	Sep-Nov 19	Jan 20	Feb-Apr 20	June 20	-	-	-
13	2020/21	Nov-Dec 20	Mar 21	Mar-Apr 21	Jun 21	-	-	Aug 21
14	2021/22	Oct-Nov 21	Feb 22	Apr-May 22	Aug 22	-	-	-
15	2022/23	Sept-Oct 22	Jan 23	Mar 23	June 23	-	-	-
16	2023/24	Aug-Sep 23	Feb 23	-	-	Jan 24	Feb 24 (*)	-

Table 2 Analytical, Update and Overview Reports Produced to Date

(*) The present report provides an analysis of the 2024 Post Storm survey for Scarborough North and South frontage.

1. Introduction

1.1 Study Area

This report presents the Post Storm Walkover Inspection for Scarborough North Bay and South Bay.

1.2 Methodology

Along the Scarborough frontage, the following post-storm surveys were undertaken;

- Beach profile surveys along five transect lines at Scarborough North Bay
- Topographic survey of Scarborough North Bay
- Beach profile surveys along four transect lines at Scarborough South Bay
- Topographic survey of Scarborough South Bay

The location of these surveys is shown in **Figure 2**. The Post-Storm survey was undertaken along this frontage on 12th January 2024 and 15th January 2024. During the surveys the weather was dry, the wind varied between force 5 and 8 . The sea state varied between moderate (12th January) and rough (15th January).

The Analytical Report produced follows a standard structure, involving:

- 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.



SURVEY LOCATIONS

Topographic Profile

- Annual (Blue line)
- Bi-Annual (Pink line)

Topographic Area

- 6 monthly (Light Green)
- yearly (Yellow)
- 5 yearly (Light Purple)

- Cliff Top Survey Points (Red dot)

(refer to Figure 3 for details)

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

Title:

Figure 2 - Map 1

SCARBOROUGH NORTH BAY

Scarborough Borough Council Frontage

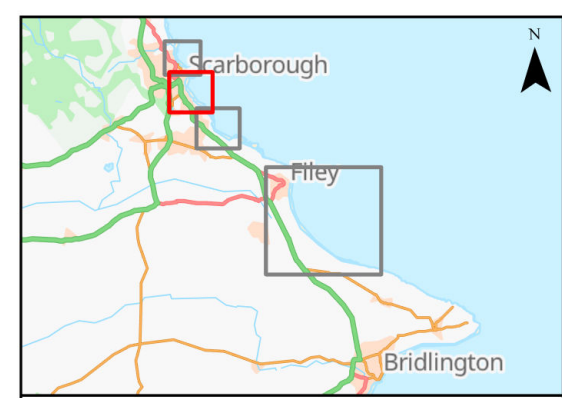
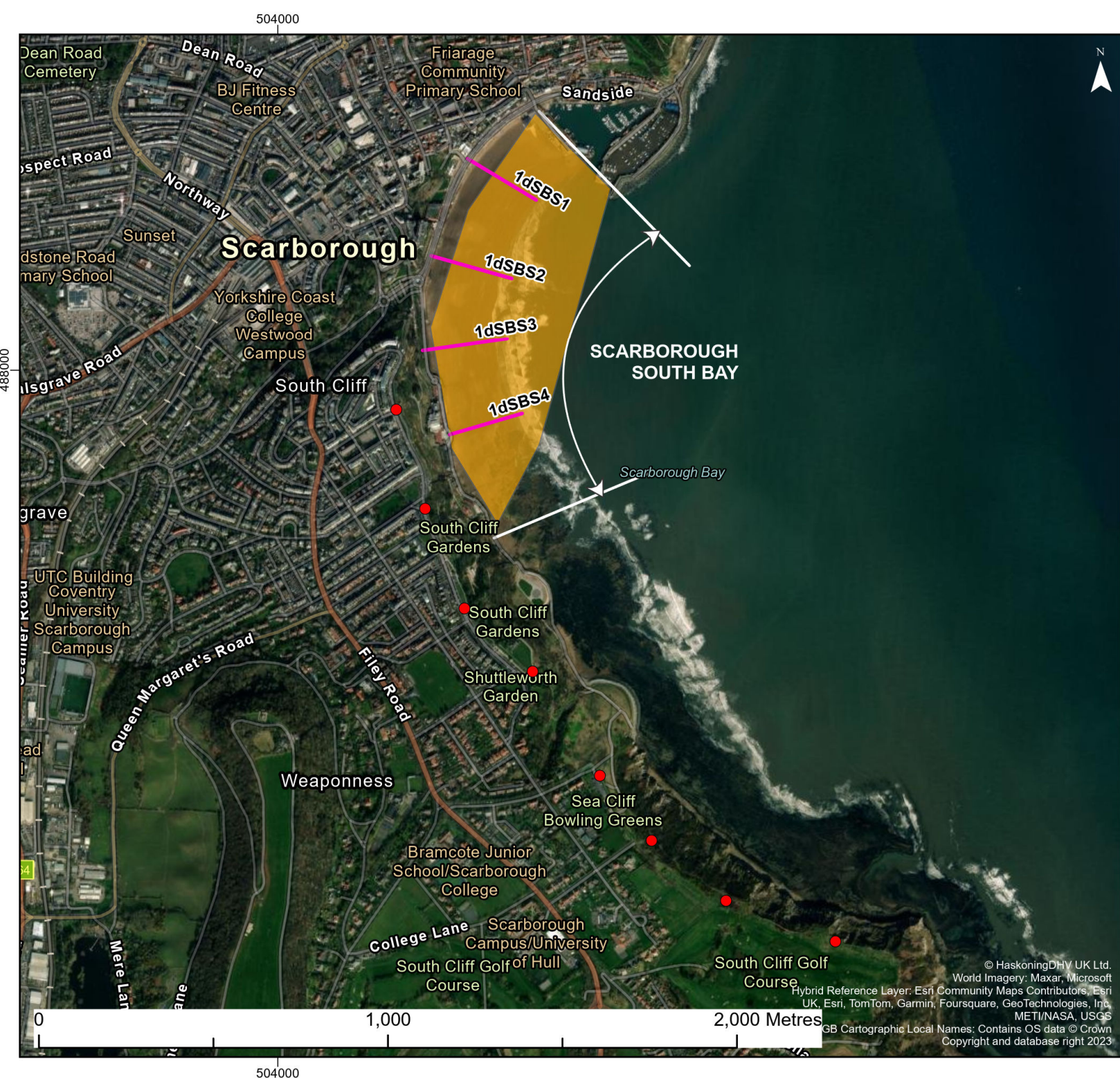
Report:

Survey Report

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	n/a	TC	NJC	A4	1:12,500

Co-ordinate system: British National Grid



SURVEY LOCATIONS

Topographic Profile

- Annual
- Bi-Annual

Topographic Area

- 6 monthly
- yearly
- 5 yearly

- Cliff Top Survey Points (refer to Figure 3 for details)

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

Title:

Figure 2 - Map 2

SCARBOROUGH SOUTH BAY

Scarborough Borough Council Frontage

Report:

Survey Report

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	n/a	TC	NJC	A4	1:15,000

Co-ordinate system: British National Grid

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2.1 Scarborough North Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
12 th January 2024	<p>Beach Profiles:</p> <p><i>Scarborough North Bay is covered by five beach profile lines, distributed between the Sealife Centre at Scalby Mills and Clarence Gardens (Appendix A).</i></p> <p>Profile 1dSBN1 is located around 200m south of the Sea Life Centre. The profile is covered by promenade and seawall up to chainage 9m. The toe of the seawall is protected by a stepped apron, beach levels at this apron have dropped locally by 0.4m exposing an additional step. This erosion tapers out to no change by chainage 18m. Between chainages 18m and 105m, the beach has accreted by up to 0.3m in level. A shallow channel has been incised between 118m and 146m, before low magnitude accretion up to chainage 166m. Compared to the range of the previous surveys, the beach overall is at medium level with locally very low spots.</p> <p>Profile 1dSBN2 is located close to the former cliff lift. Beach levels at the toe of the seawall (chainage 8m) have dropped in level by 0.8m. This erosion gradually tapers out to no change at chainage 67m. At which point the profile begins to accrete, increasing in magnitude up to chainage 118m with a magnitude of 0.8m. Seawards of chainage 118m, the rocky foreshore remains exposed. The profile remains within the range envelope of the previous surveys.</p> <p>Profile 1dSBN3 is located near Royal Albert Drive. At the toe of the seawall (chainage 13m), the beach has dropped in level by up 0.6m. This magnitude of erosion continues across the profile up to chainage 134m. At which point, the erosion drops in magnitude to -0.1m up until the end of the profile at chainage 172m. The beach has dropped to a medium level when compared to the range of the previous survey.</p> <p>At profile 1dSBN4, the beach levels between the toe of the defences (chainage 25m) and the beginning of the exposed rocky outcrop (chainage 34m) have eroded by up to 0.2m in level. Accretion of up to 0.8m between chainages 40m and 48m has submerged a portion of previous exposed rocky foreshore. Seawards of the remaining length of rocky foreshore the beach has eroded by up to 0.6m in level tapering to no change by chainage 137m. The final 50m of profile has experienced low level accretion (+0.1m). The apparent drawdown of material has resulted in the section of the middle beach</p>	<p>The January 2024 survey indicates that Scarborough North Bay has generally experienced a net erosion as a result of the recent storms.</p> <p>The data suggests that material has been both drawn down the profile from upper to lower beach and also transported from the south to the north.</p> <p>Notably however, the profiles indicate that the majority of the beach has remained with the range envelope of the previous surveys, suggesting the beach has been lower and has recovered in the past.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>(chainage 78m to 104m) being the lowest level on record, with sections of the lower beach (chainage 147m to 184m) the highest level on record.</p> <p>Profile 1dSBN5 is located to the south of Clarence Gardens. The profile is covered by the promenade, upstand wall and rock revetment up to chainage 29m and has remained unchanged since the previous survey. Seawards of the revetment, the beach has been eroded, dropping in level initially by up to 0.4m at the toe. This erosion continues up to the end of the profile at chainage 163m. The profile has dropped to a medium level compared to the range of the previous surveys.</p> <p>Topographic Survey:</p> <p>Scarborough North Bay is covered by an annual topographic survey, typically undertaken as part of the Full Measures surveys in the autumn. This additional topographic survey was undertaken in January 2024 to assess the impact of a particular stormy period between October 2023 and Jan 2024 where seven named storms occurred.</p> <p>Utilizing a GIS software, the data has been used to create a DGM, the plot of which is shown in Appendix B - Map 1. The plot shows a distinct pattern of change between the north and south of the bay. In the north, fronting North Bay Promenade, the beach is typically steeper and narrow, transitioning to exposed rocky foreshore on the lower beach. Whereas in the south, the bay appears to be shallower in gradient and lower in elevation. Rocky outcrops are exposed more sporadically and are not limited to the lower beach.</p> <p>The DGM has also been used to calculate the differences between the post storm survey (January 2024) and the previous Full Measures topographic survey (August 2023) (as shown in Appendix B – Map 3), to identify areas of erosion and accretion.</p> <p>The plot shows that the change the south of the bay has been dominated by erosion (lowering) up to -1.25m in magnitude. Very minor accretion (deposition) on the lower beach indicates a drawdown of material down the profile typically of stormy conditions. In the North of the bay the change is more balanced. The upper beach, up to the subtle promontory, has experienced erosion. However, the lower beach extending north has experienced accretion up to +1.0m in level. This indicated both a drawdown of material down the profile, but also potentially net drift across the bay from south to north.</p>	

2.2 Scarborough South Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
15 th Jan 2024	<p>Beach Profiles:</p> <p><i>Scarborough South Bay is monitored by four beach profiles, between the harbour in the north and the Spa Complex in the south (Appendix A).</i></p> <p>At profile 1dSBS1, the beach has initially accreted at the toe of the seawall by 0.2m in level. This low level accretion continues across the upper beach up until chainage 52m. The mid beach, between chainages 52m and 130m, has eroded by up to 0.3m in level. Seawards of 130m the beach has again accreted by up to 0.25m. This apparent drawn down of material has resulted in the lower beach being at a high level (compared to the range of the previous surveys) with the mid beach at a low level.</p> <p>Profile 1dSBS2 is located on the shore fronting St Nicholas Cliff. At the toe of the wall, beach levels have dropped by 0.6m in level. The is erosion continues seawards, tapering out to no change at chainage 100m. At which point the beach starts to accrete up the end of the profile at chainage 200m (+0.5), indicating the draw down of material. Incidentally, compared to the range of the previous surveys, the upper beach is at a high level and the lower beach a low level.</p> <p>Profile 1dSBS3 is located 250m north of the Scarborough Spa complex and is defended up until chainage 9m by the seawall. At the toe of the seawall, beach levels have dropped locally by up to 0.7m in level, exposing the vertical section of concrete toe beam. This erosion continues seawards, tapering out by chainage 129m. At which point the beach starts to accrete up to the end of the profile at chainage 210m, indicating the draw down of material. As per profile 1dSBS2, compared to the range of the previous surveys, the upper beach is at a high level and the lower beach a low level.</p> <p>Profile 1dSBS4 is located on the beach in front of the Scarborough Spa Complex. The beach at the toe of the seawall has eroded 1m in level since the previous inspection, this has not only exposed the concrete toe beam but also the bedrock it is founded on. The beach profile itself displays a similar pattern of widescale erosion (although slightly lower magnitude – 0.4m). Levels at the seawall are at a very low (second only flowing the beast from the east in 2018 and the winter storms in 2013). Levels across the beach are at medium to low level.</p>	<p>Similar to North Bay, the January 2024 survey indicates that Scarborough South Bay has generally experienced a net erosion as a result of the recent storms.</p> <p>The data suggests that material has been both drawn down the profile from upper to lower beach and also transported from the south to the north, accumulating in the lee of the harbour.</p> <p>Unlike Scarborough North Bay, the beach level at South Bay, particular to the south, are very low. In fact beach levels at the toe of the seawall have not been as low since the ‘Beast from the East’ storm in 2018 and, before that, the winter storms of 2013. Following the aforementioned recent historic events beach levels did recover over time. It is predicted that a similar pattern of slow recovery will be observed following the Winter 2023/24 storms.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>Topographic Survey:</p> <p>Scarborough South Bay is covered by an annual topographic survey typically undertaken in Autumn. This additional survey has been undertaken in January 2024 to assess the impact of a particular stormy period between October 2023 and Jan 2024 where seven named storms occurred.</p> <p>The data from this survey has been used to create a DGM (Appendix B - Map 1) using GIS. The plot shows in the north of the bay the beach contours follow a broadly shore parallel pattern, rising elevation towards the harbour. In the south of the bay the beach contours are more distorted reflecting the sections exposed rocky foreshore in this area.</p> <p>The GIS has also been used to calculate the differences between the current topographic survey DGM (January 2024) and the earlier topographic survey DGM (September 2023), with 5m resolution raster grids (as shown in Appendix B – Map 3), to identify areas of erosion and accretion.</p> <p>The plots shows that overall the bay appears to have experienced a net loss of material as a result of the recent storms. The southern half of the bay, fronting Royal Albert Drive, has been dominated by erosion up to 1.25m in level. Moving North this erosion continues across the upper beach, however the lower beach has experienced a shoreline parallel band of accretion (up to +1.25m in magnitude). This general patterns indicates a movement of material from the south to the north against the usual dominant drift (north to south).</p>	

3. Problems Encountered and Uncertainty in Analysis

No major problems were encountered during the survey (as per the survey report).

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

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

5. Conclusions and Areas of Concern

The January 2024 survey indicates that Scarborough North Bay generally experienced a net erosion as a result of the Winter 2023/24 storms. The data suggest that material has been both drawn down the profile from upper to lower beach and also potentially transported from the south to the north of the bay. Notably however, the profiles indicate that the majority of the beach has remained within the range envelope of the previous surveys, suggesting the beach has been lower and has recovered in the past.

A similar pattern is observed in Scarborough South Bay with a net erosion occurring. The data again suggests that material has been both drawn down the profile from upper to lower beach and also transported from the south to the north, accumulating in the lee of the harbour.

Unlike Scarborough North Bay, the beach levels at South Bay, particularly in the south, are very low. In fact, beach levels at the toe of the seawall have not been as low since the 'Beast from the East' storm in 2018 and, before that, the winter storms of 2013. Following those recent historic events beach levels did progressively recover over time. It is predicted a similar pattern of slow recovery will be observed following the Winter 2023/24 storms.

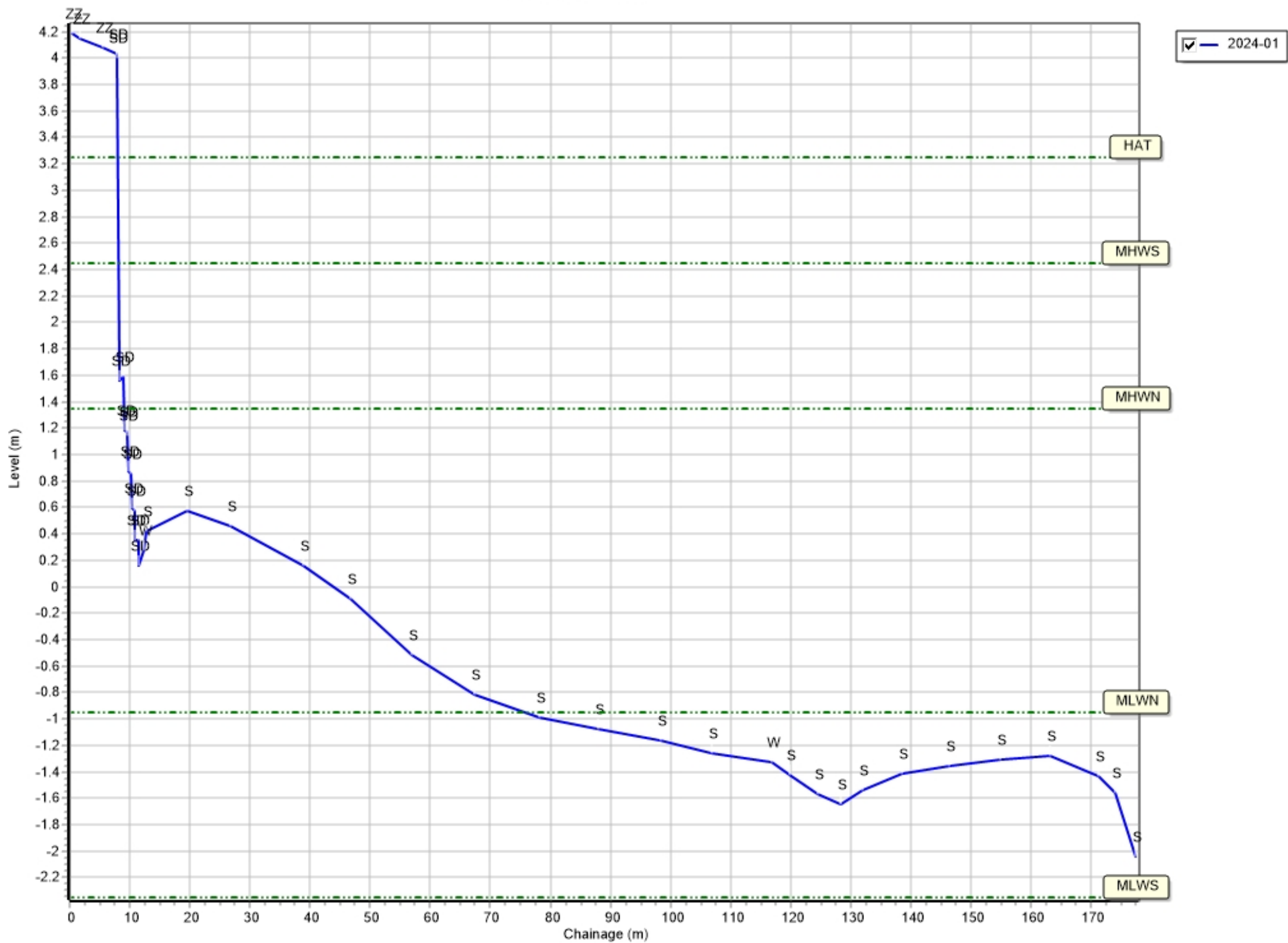
Appendices

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

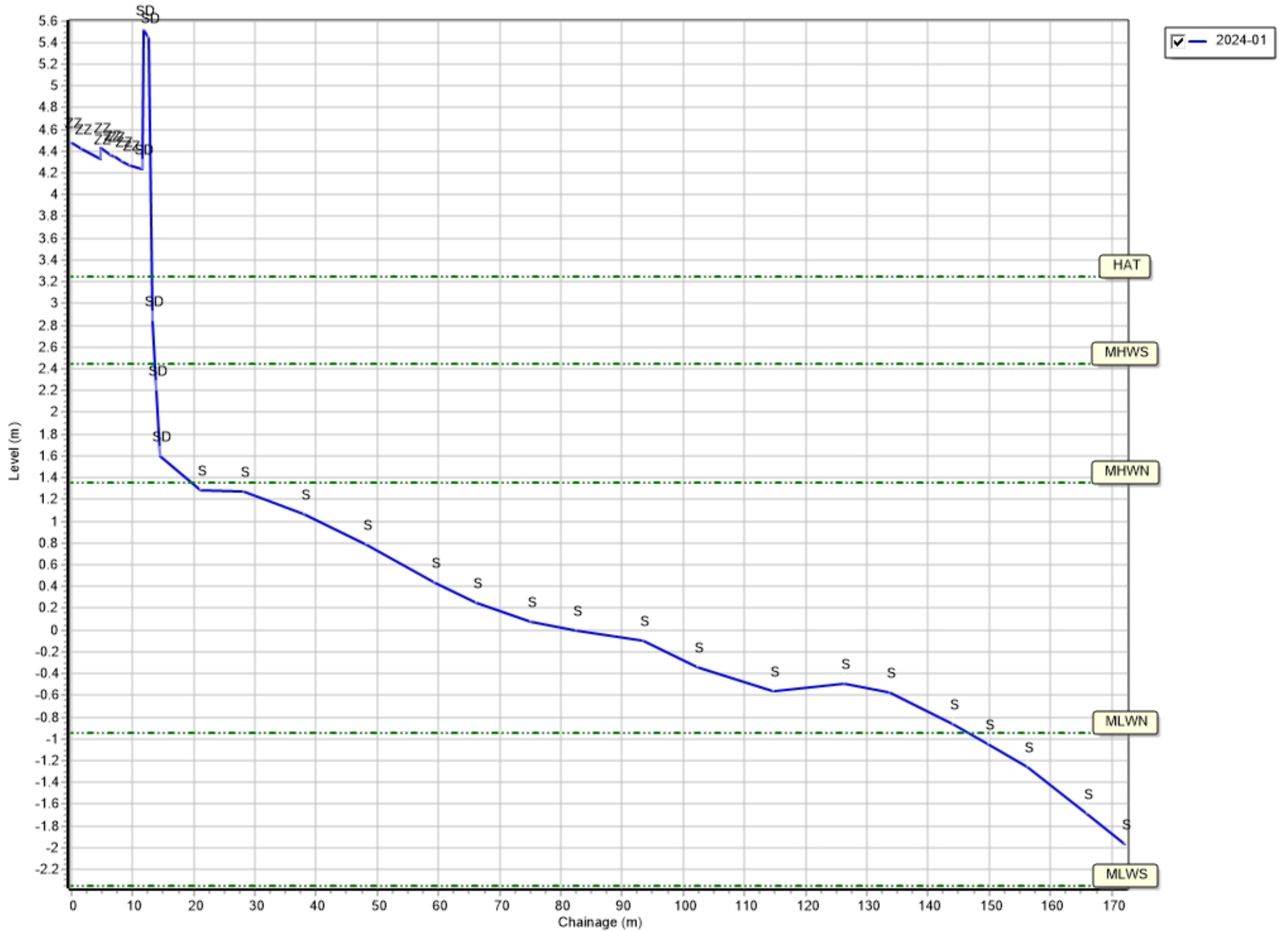
Profiles: 1dSBN1



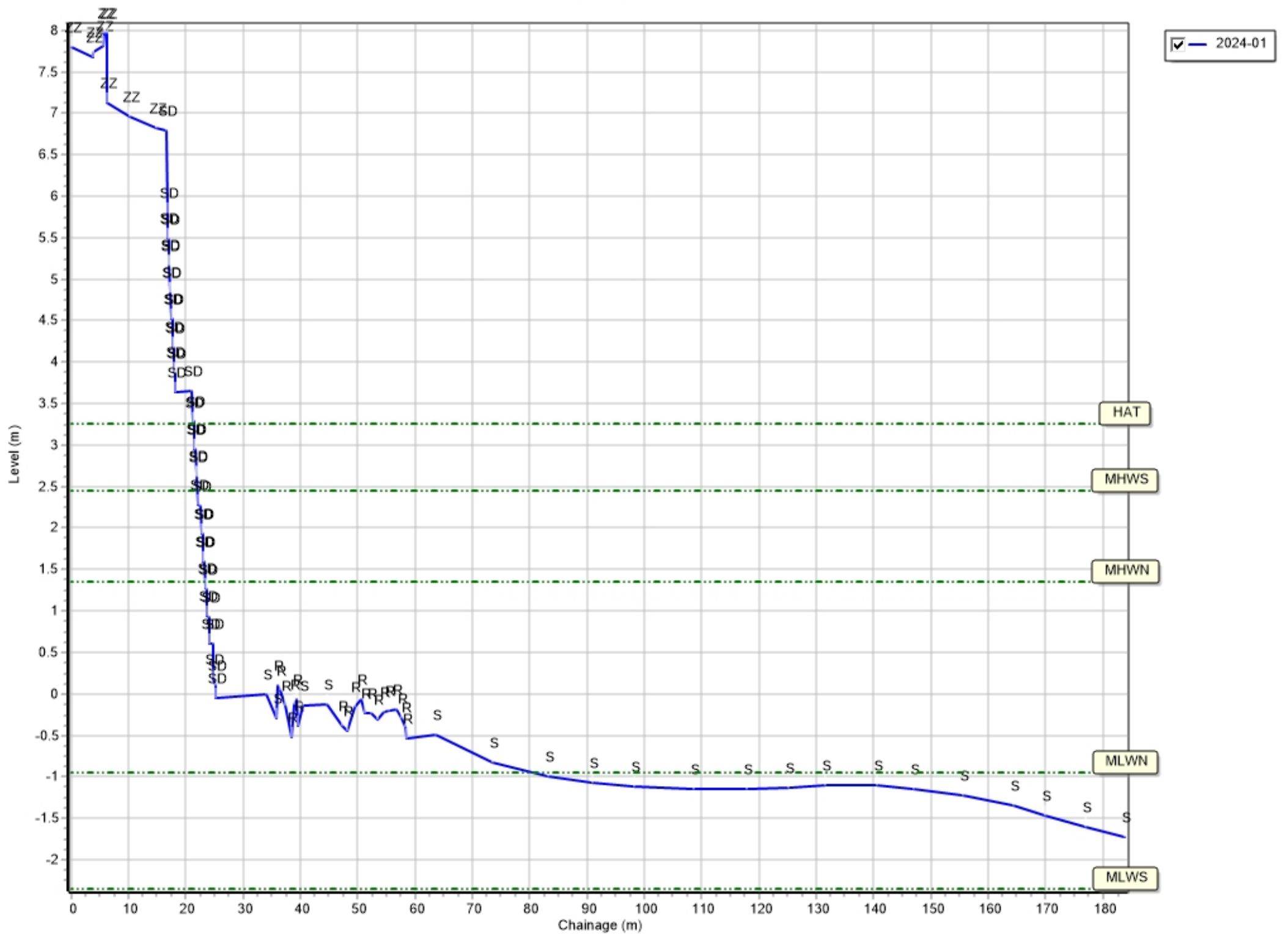
Profiles: 1dSBN2



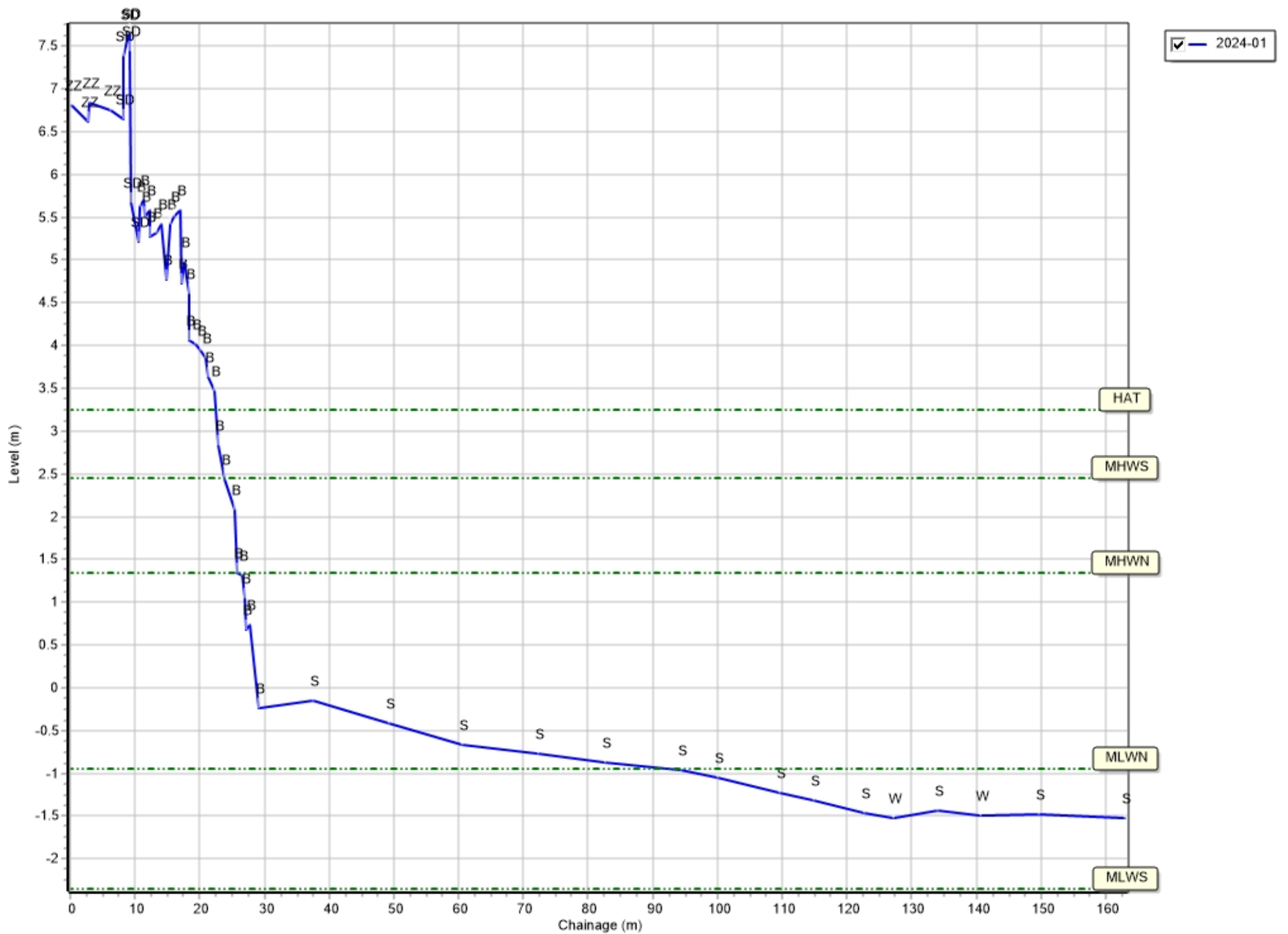
Profiles: 1dSBN3



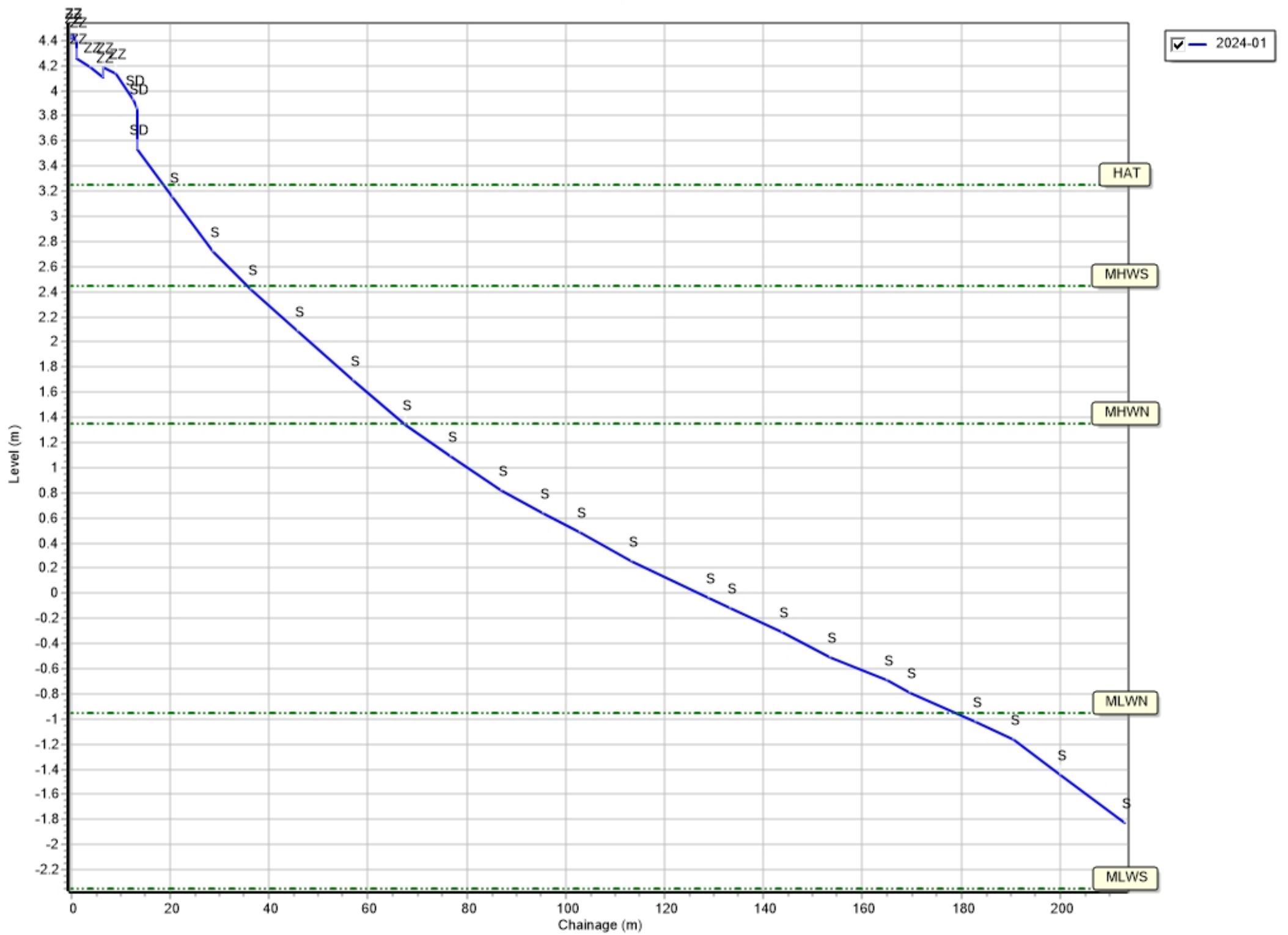
Profiles: 1dSBN4



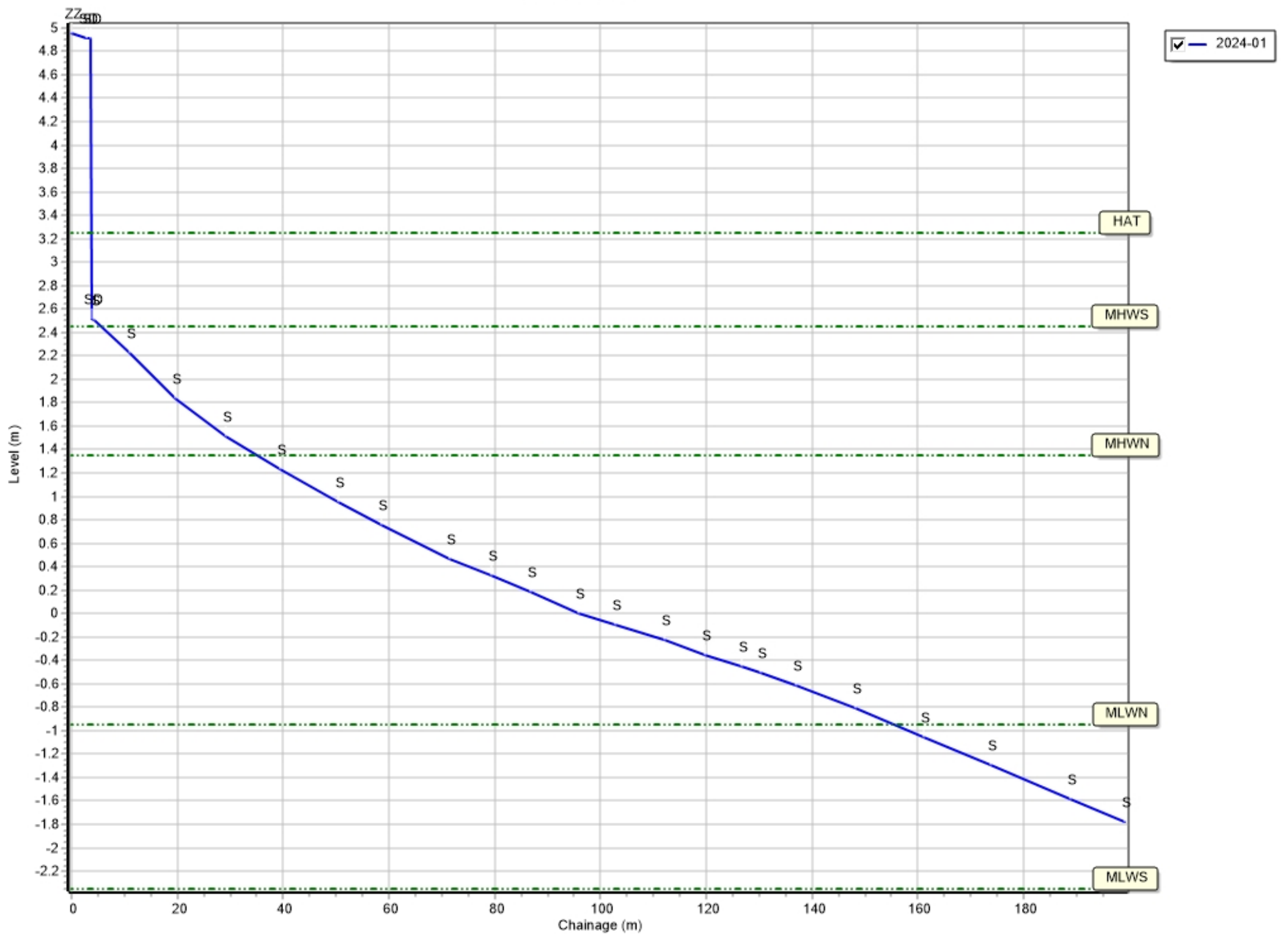
Profiles: 1dSBN5



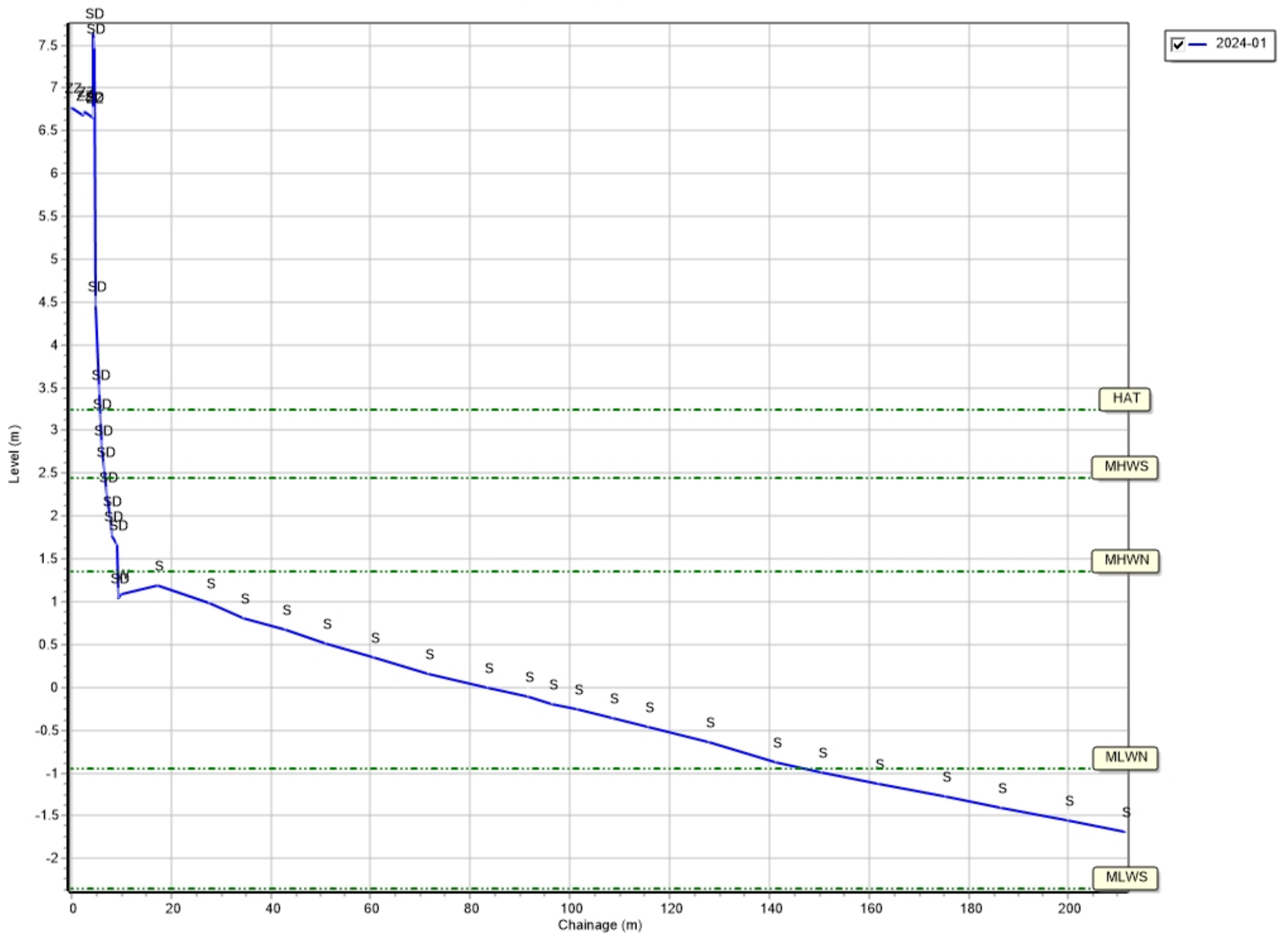
Profiles: 1dSBS1



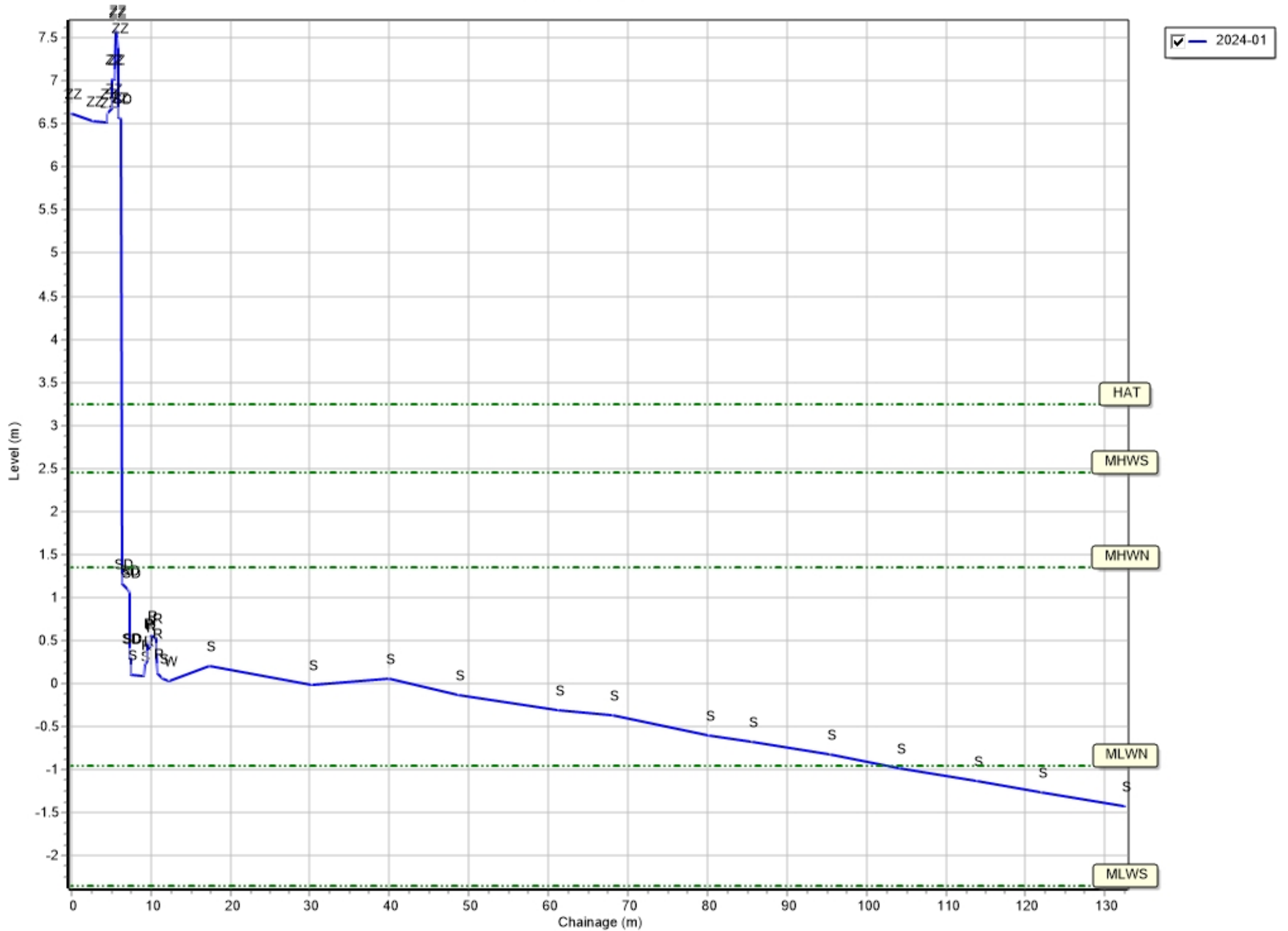
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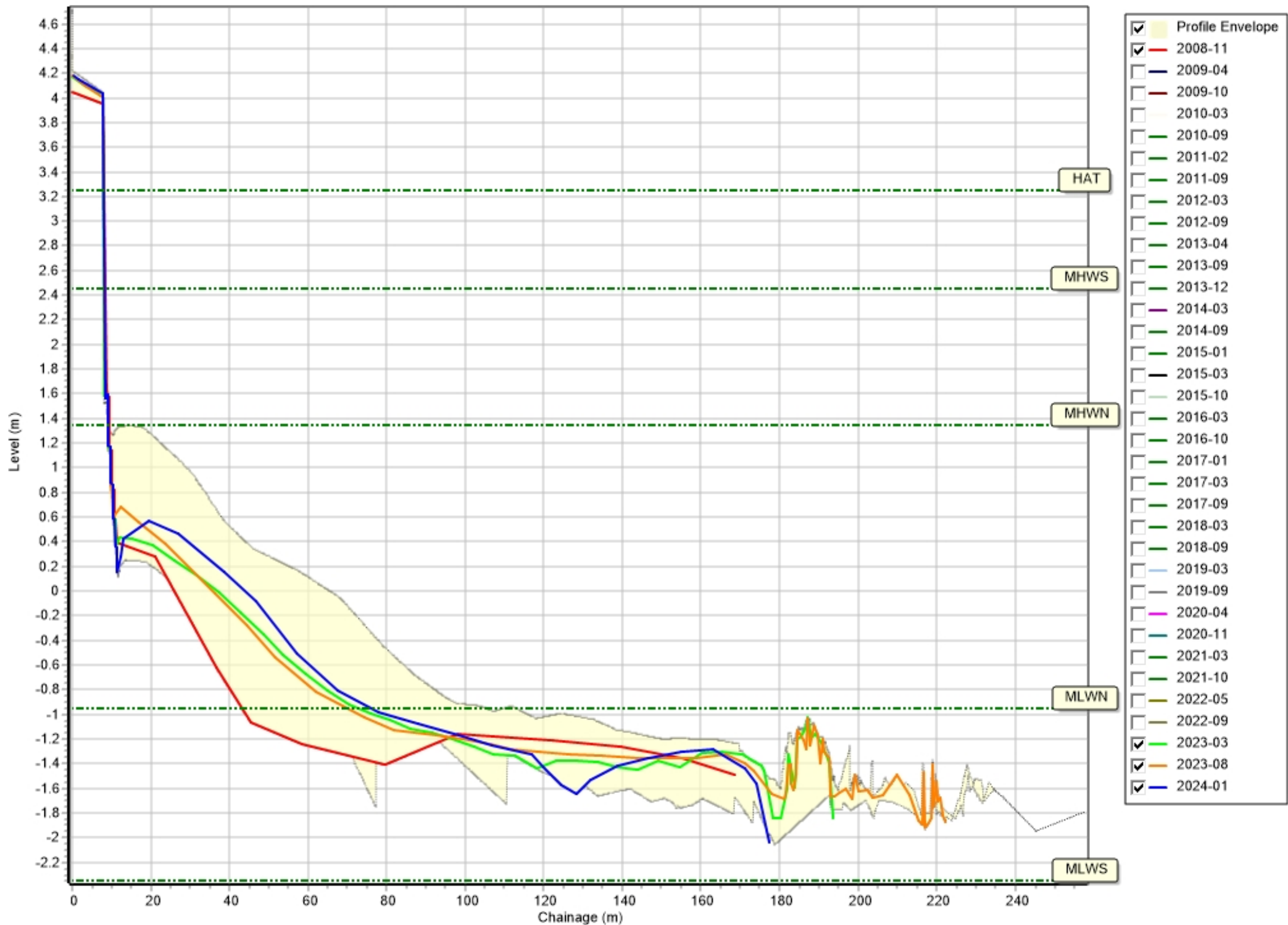
Profiles: 1dSBS3



Profiles: 1dSBS4



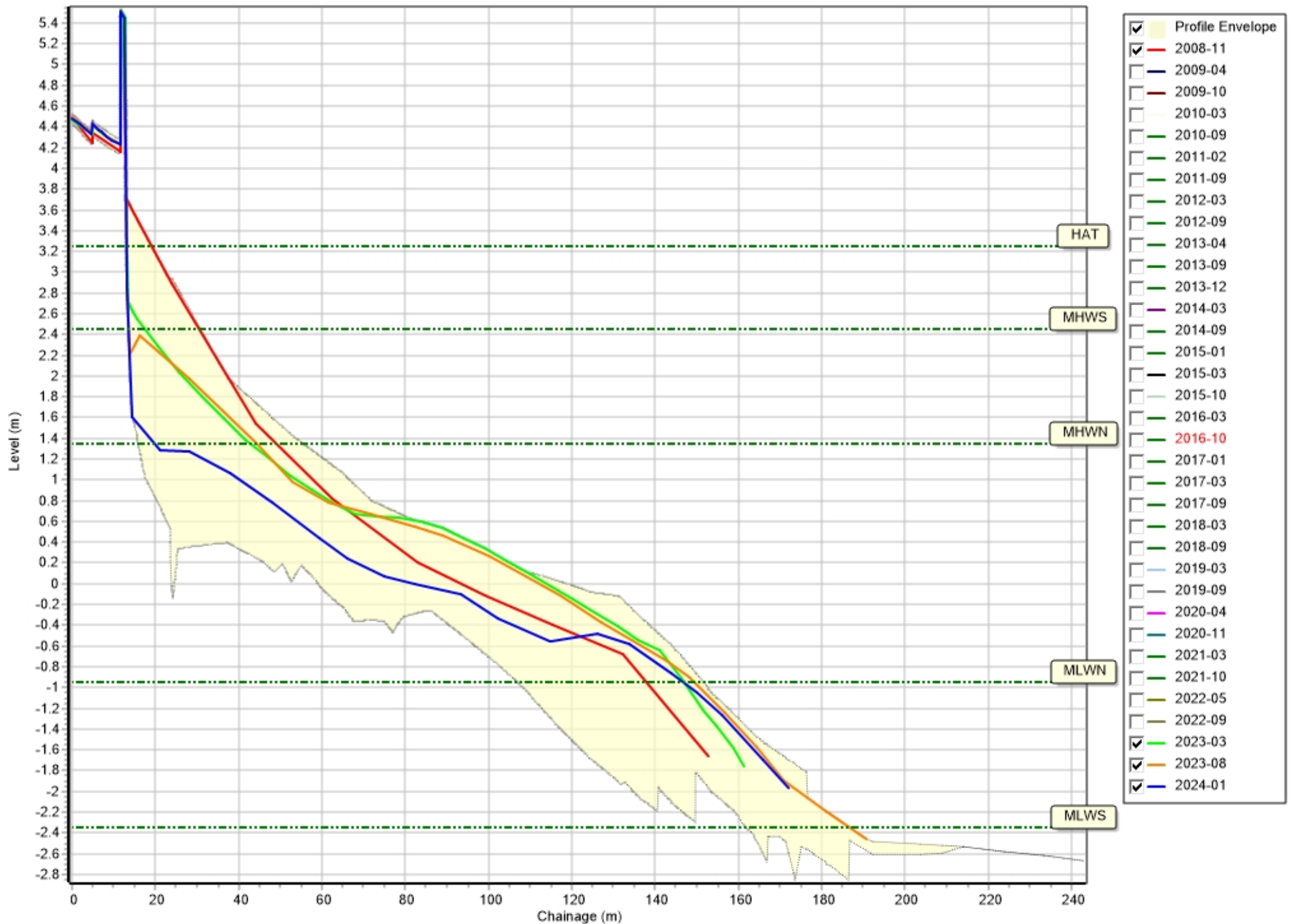
Profiles: 1dSBN1



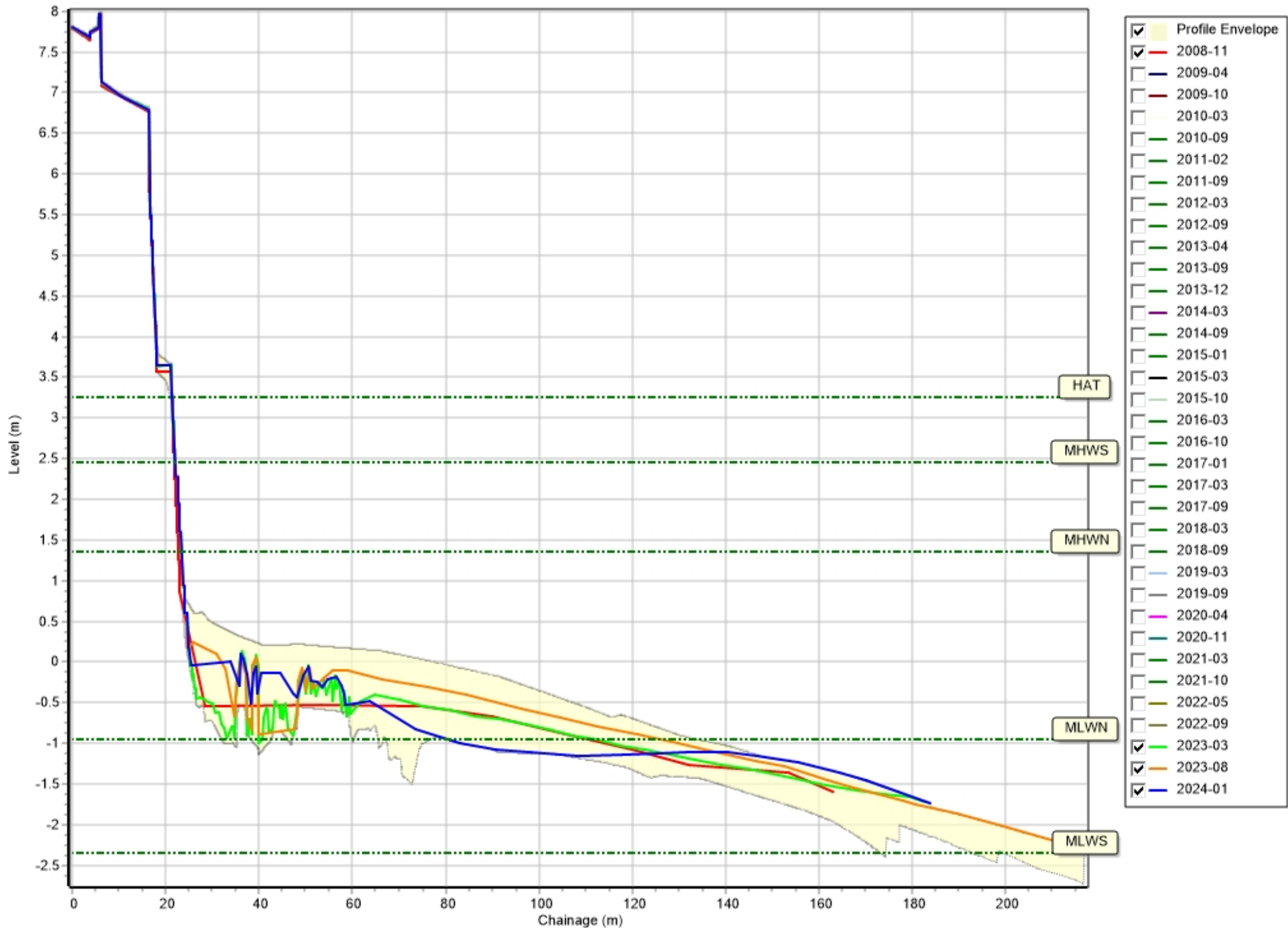
Profiles: 1dSBN2



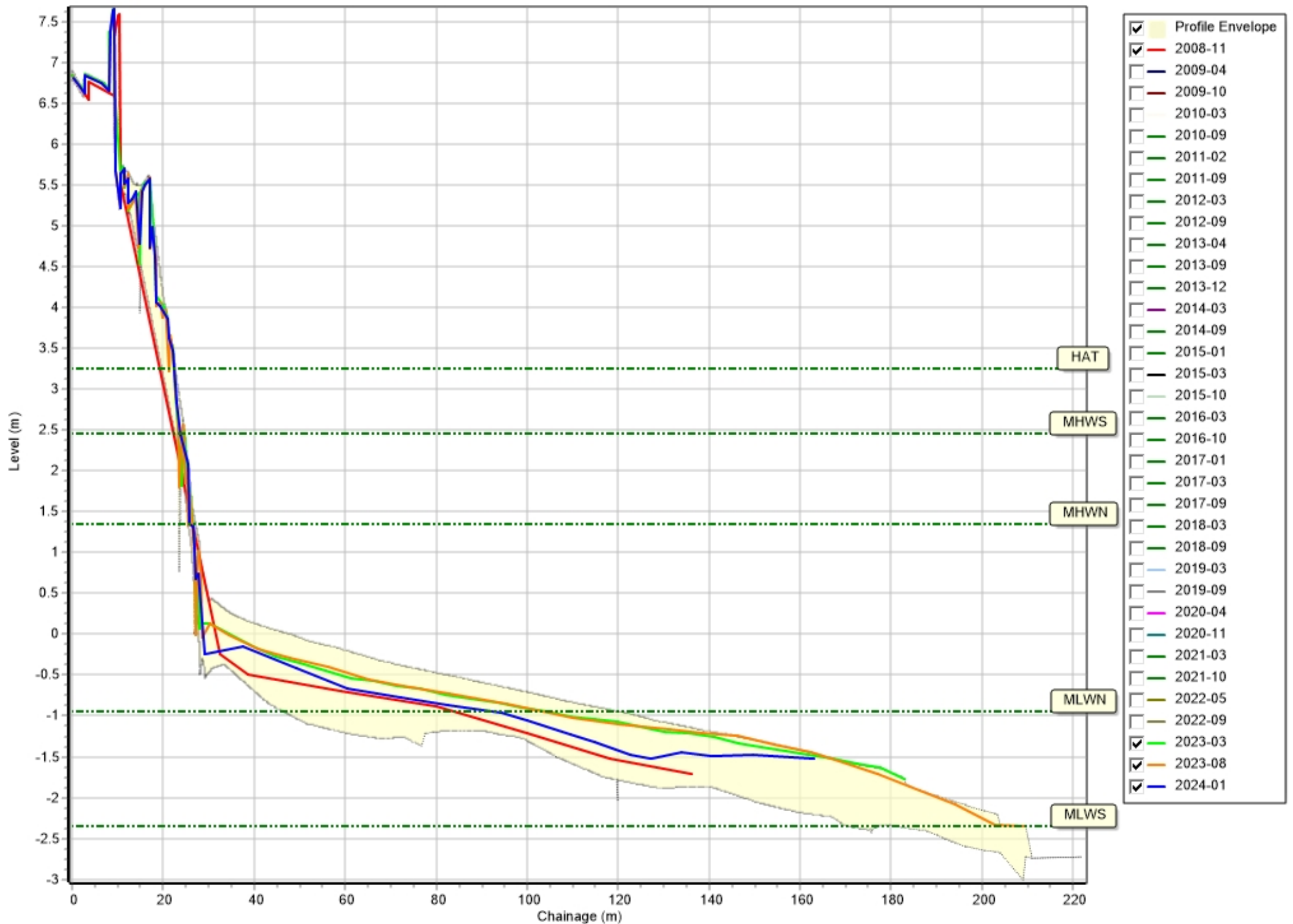
Profiles: 1dSBN3



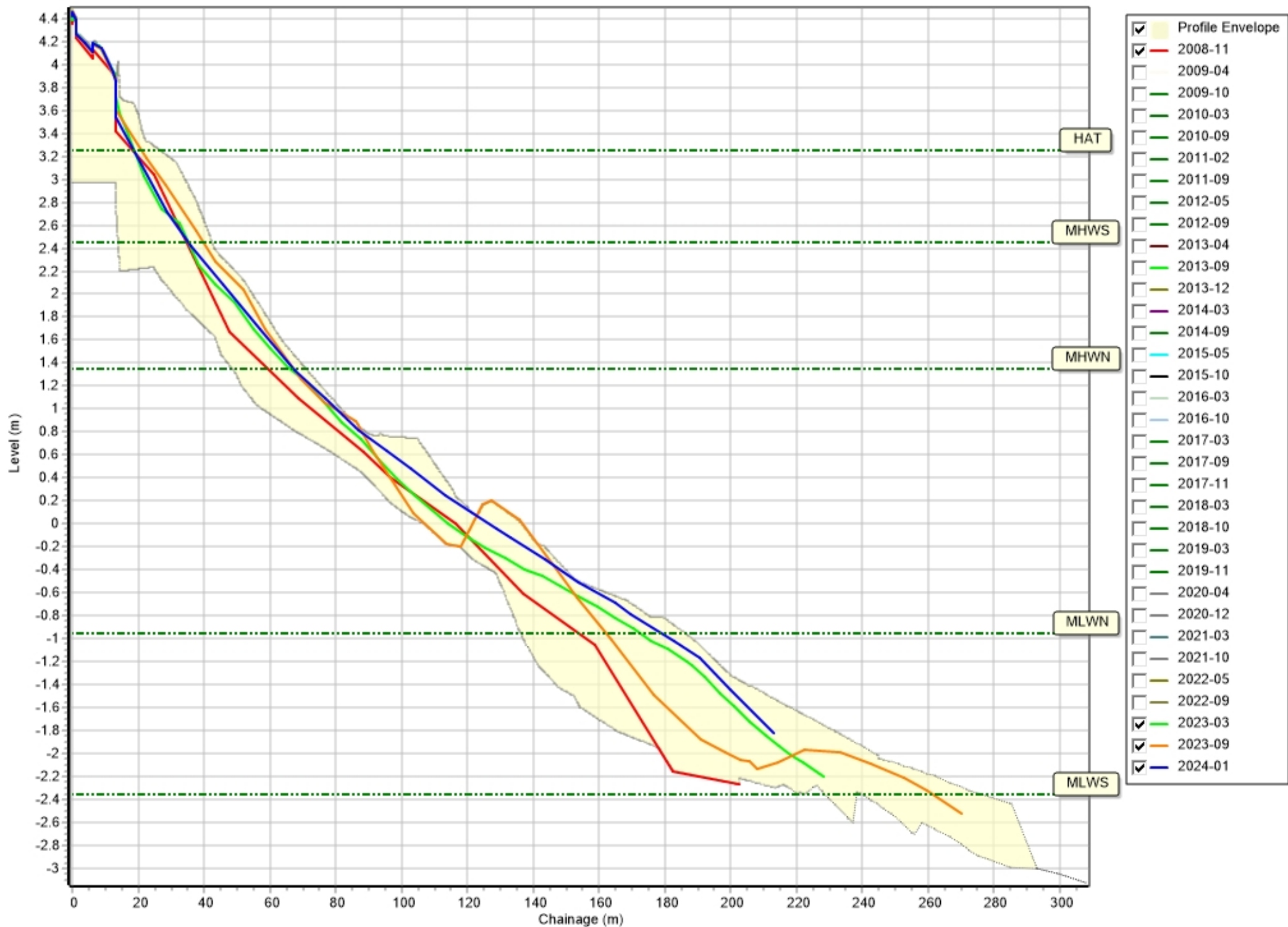
Profiles: 1dSBN4



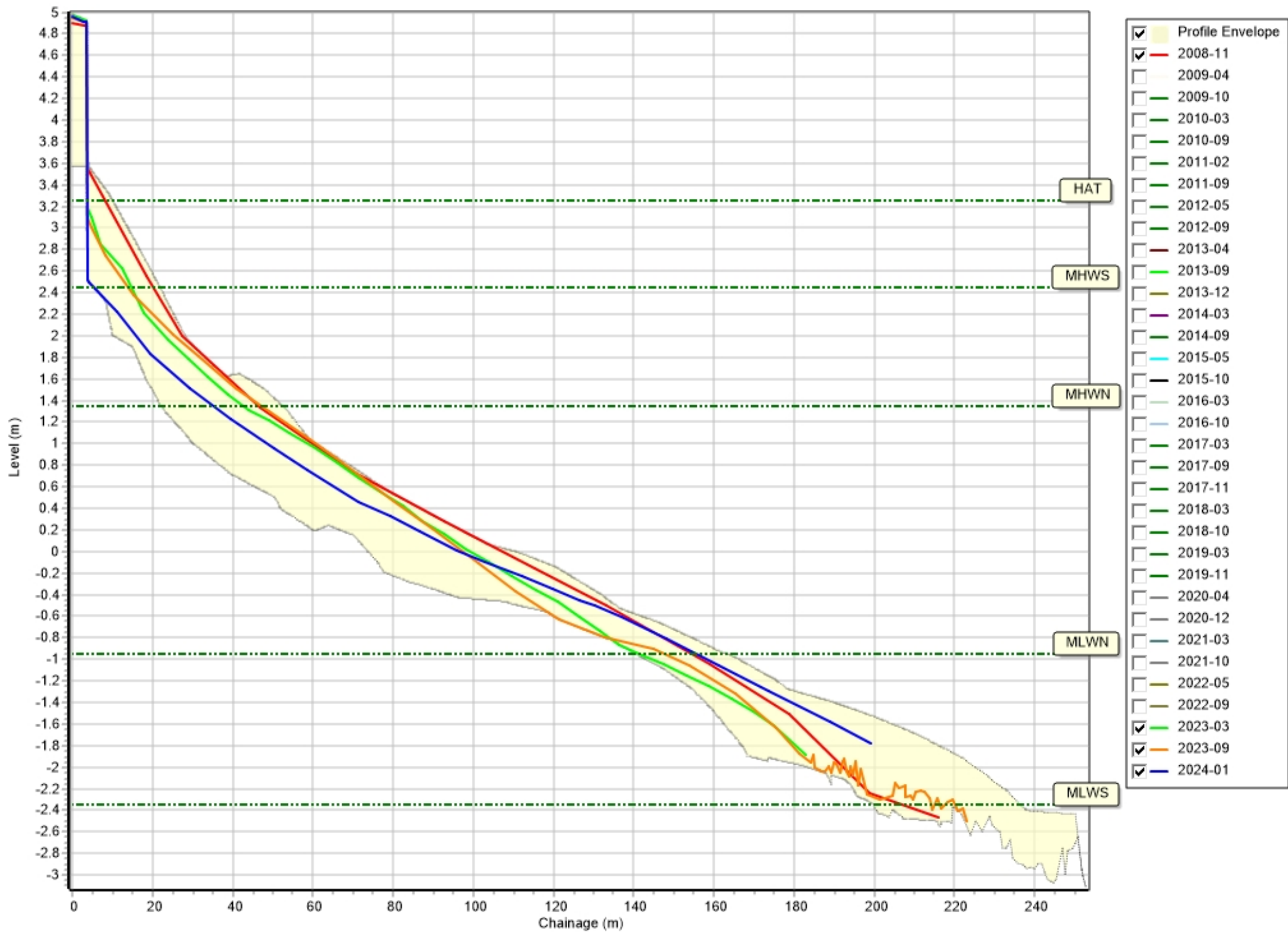
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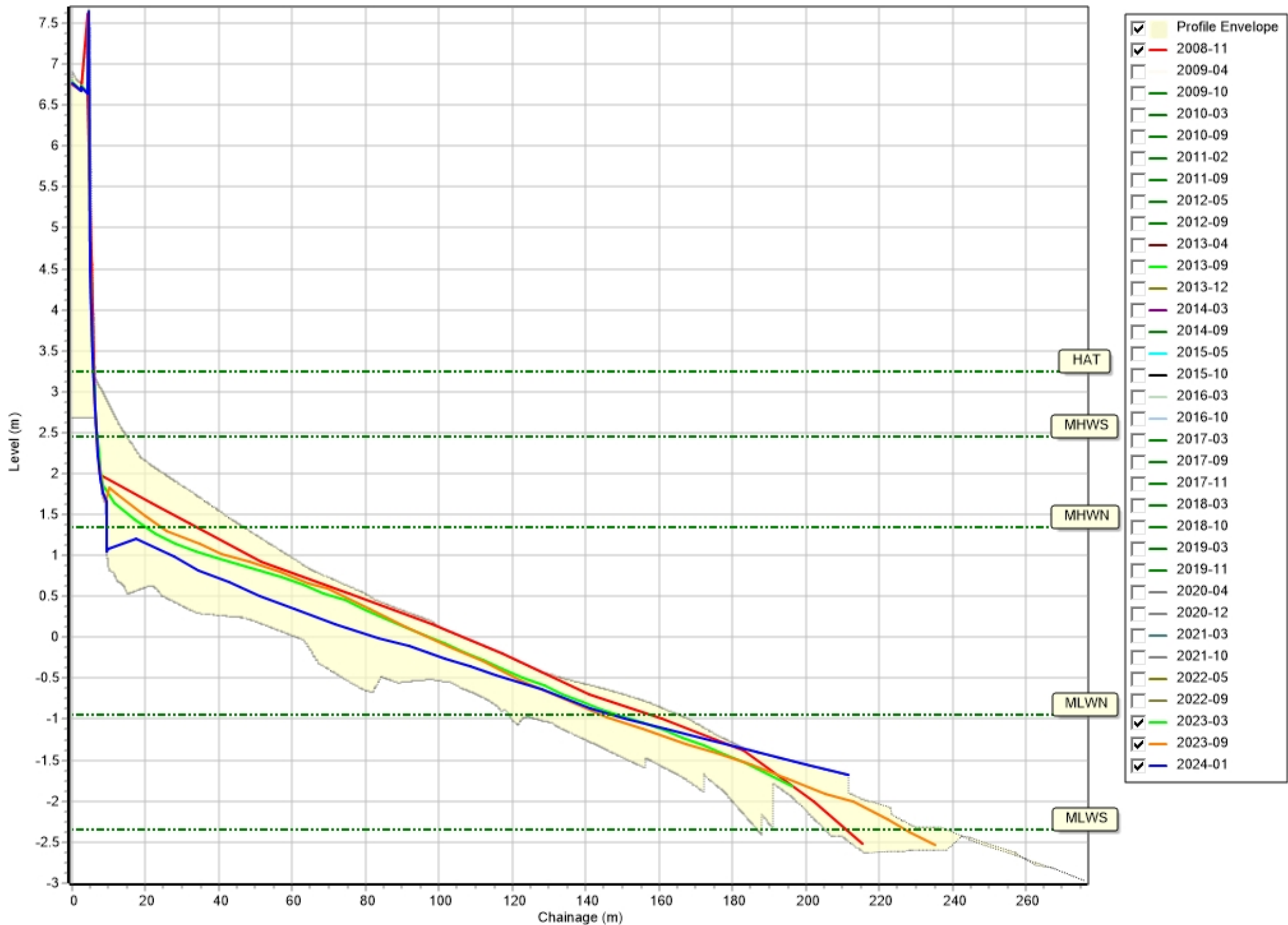
Profiles: 1dSBS1



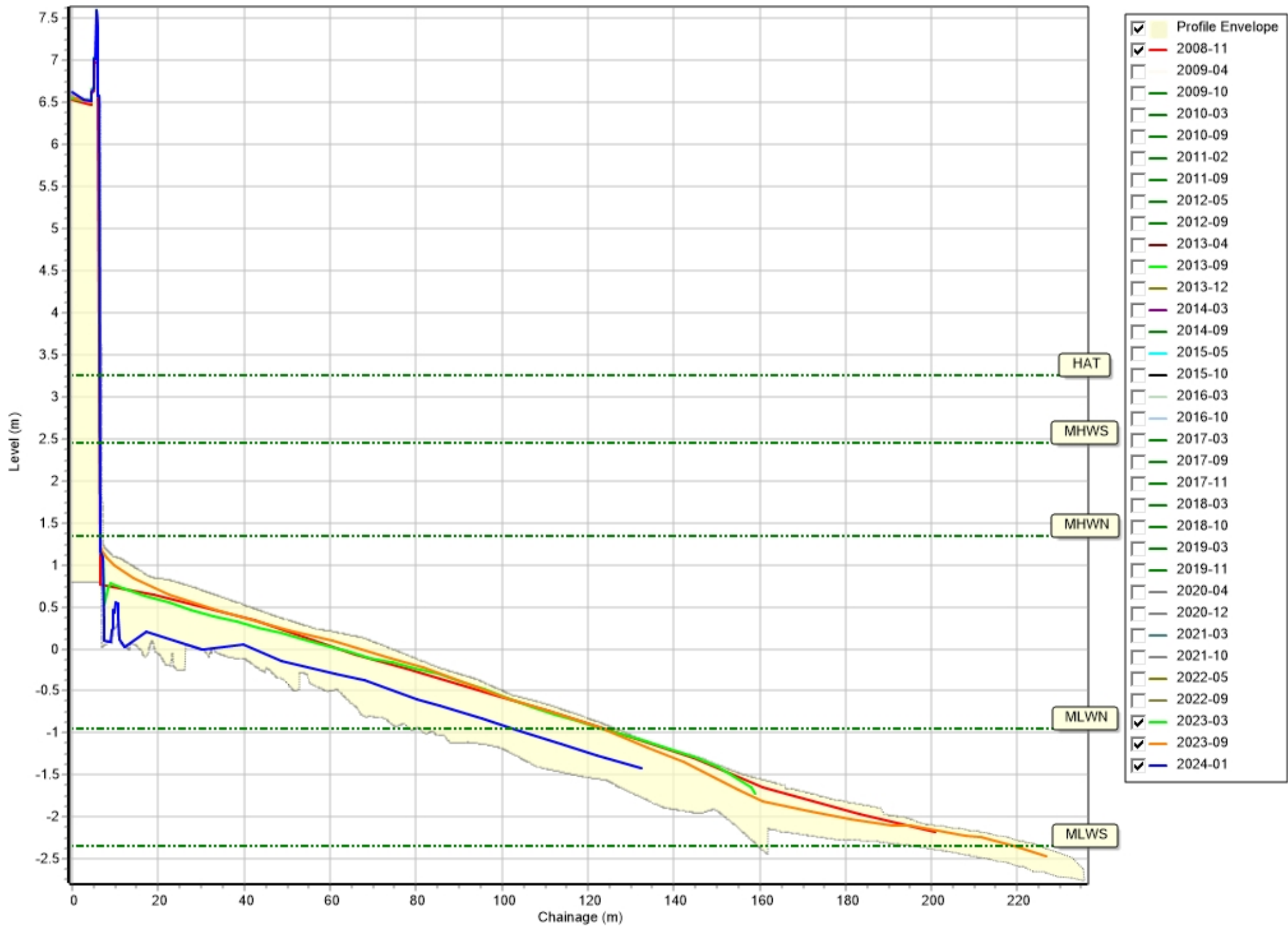
Profiles: 1dSBS2



Profiles: 1dSBS3



Profiles: 1dSBS4



Appendix B
Topographic Survey



TOPOGRAPHIC SURVEY (January 2024)

Elevation (mOD)	Contours (mOD)*
-2.3 - -2	— 1.0m interval
-1.9 - -1.5	— 0.25m interval
-1.4 - -1	
-0.9 - -0.5	* Contours only cover sandy beach areas.
-0.4 - 0	
0.1 - 0.5	
0.6 - 1	
1.1 - 1.5	
1.6 - 2	
2.1 - 2.5	
2.6 - 3	
3.1 - 3.5	

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

Title:

Appendix B - Map 1

SCARBOROUGH NORTH BAY

North Yorkshire Council Frontage

Report:

'Post Storm' Survey 2024

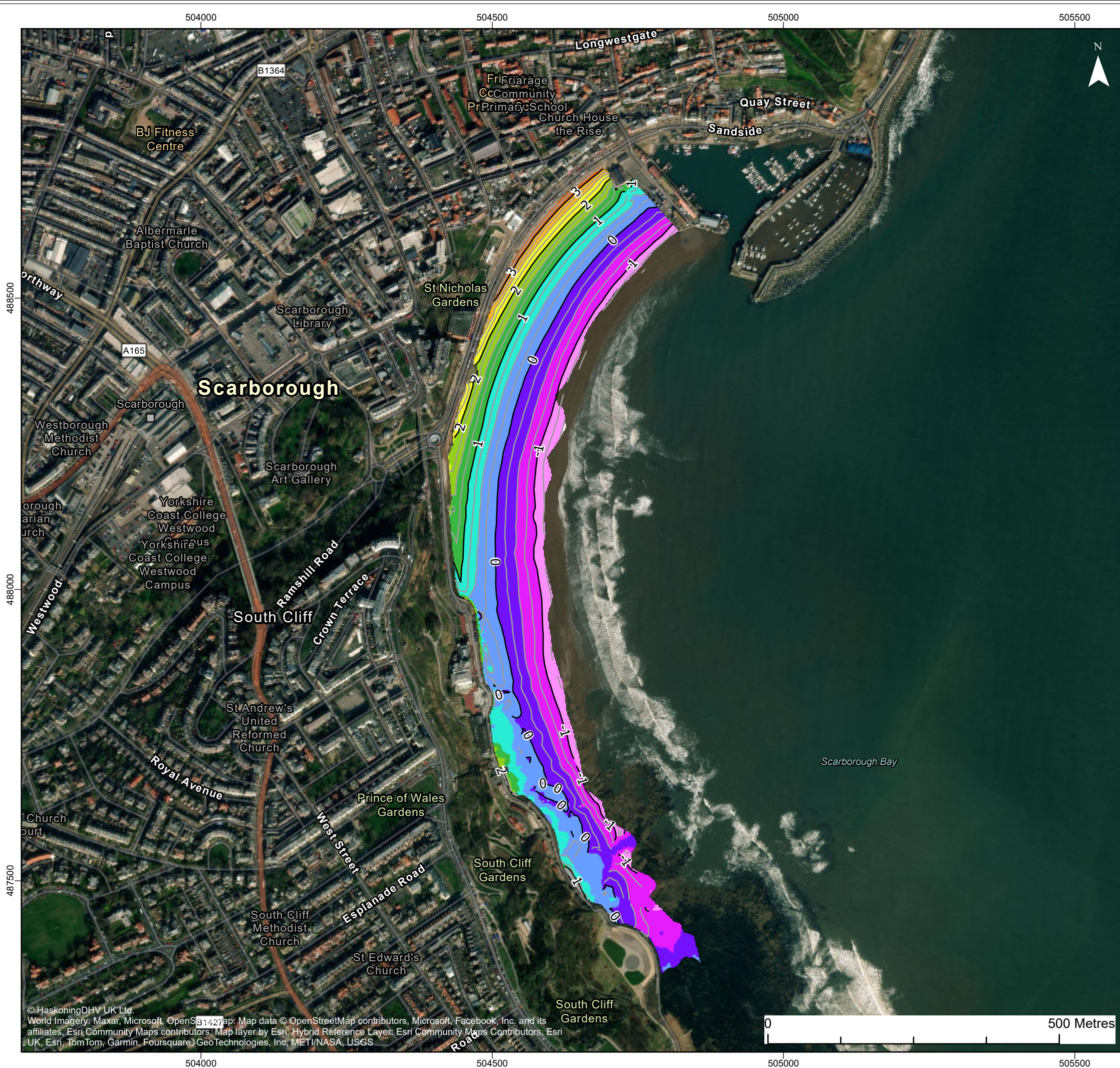
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TOPOGRAPHIC SURVEY (January 2024)

Elevation (mOD)	Contours (mOD)*
-1.5 - -1.5	— 1.0m interval
-1.4 - -1	— 0.25m interval
-0.9 - -0.5	
-0.4 - 0	
0.1 - 0.5	
0.6 - 1	
1.1 - 1.5	
1.6 - 2	
2.1 - 2.5	
2.6 - 3	
3.1 - 3.5	
3.6 - 4	

* Contours only cover sandy beach areas.

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

Title:

Appendix B - Map 2

SCARBOROUGH SOUTH BAY

North Yorkshire Council Frontage

Report:

'Post Storm' Survey 2024

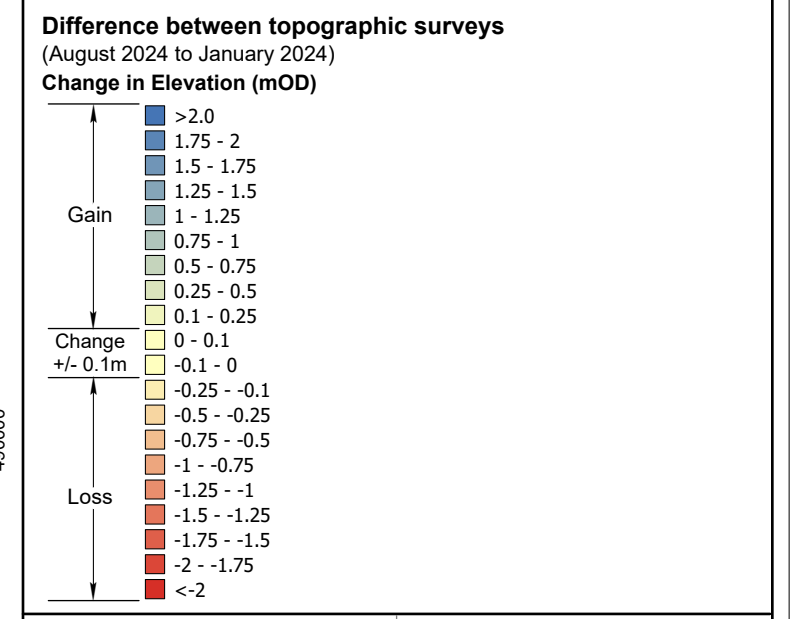
Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	31/01/2024	TC	NJC	A3	1:6,500

Co-ordinate system: British National Grid

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North East Coastal Observatory

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

Title:

Appendix B - Map 3

SCARBOROUGH NORTH BAY

North Yorkshire Council Frontage

Report:

'Post Storm' Survey 2024

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	31/01/2024	TC	NJC	A3	1:7,000

Co-ordinate system: British National Grid

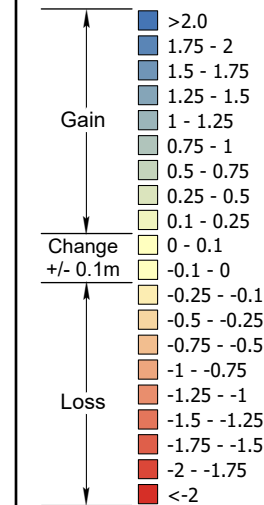


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Difference between topographic surveys
 (September 2024 to January 2024)

Change in Elevation (mOD)



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

Title:

Appendix B - Map 4

SCARBOROUGH SOUTH BAY

North Yorkshire Council Frontage

Report:

'Post Storm' Survey 2024

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	31/01/2024	TC	NJC	A3	1:6,500

Co-ordinate system: British National Grid

