



Cell 1 Regional Coastal Monitoring Programme Update Report 14: 'Partial Measures' Survey 2022

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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)
	Featherbed Rocks to Blackhall Colliery
HAT	3.0
MHWS	2.5
MHWN	1.4
MLWN	-0.7
MLWS	-2.0

Source: UKHO Admiralty Tide Tables, 2020

Glossary of Terms

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

Preamble

The Cell 1 Regional Coastal Monitoring Programme covers approximately 300km of the north east coastline, from the Scottish Border (just south of St. Abb's Head) to Flamborough Head in East Yorkshire. This coastline is often referred to as 'Coastal Sediment Cell 1' in England and Wales (Figure 1). Within this frontage the coastal landforms vary considerably, comprising low-lying tidal flats with fringing salt marshes, hard rock cliffs that are mantled with glacial sediment to varying thicknesses, softer rock cliffs and extensive landslide complexes.

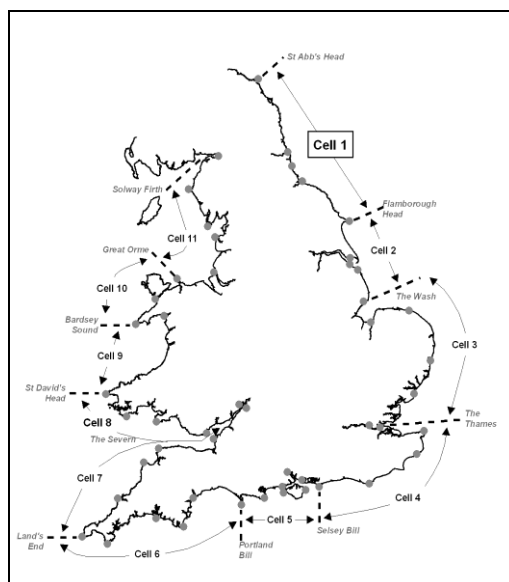


Figure 1 Sediment Cells in England and Wales

The 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 sea bed characterisation surveys
- aerial photography
- LiDAR Surveys
- walk-over cliff and coastal defence asset surveys

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

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

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

Table 1 Analytical, Update and Overview Reports Produced to Date

Year		Full Measures		Partial Measures		Cell 1 Overview Report
		Survey	Analytical Report	Survey	Update Report	
1	2008/09	Sep-Dec 08	May 09	Mar-May 09		-
2	2009/10	Sep-Dec 09	Mar 10	Feb-Mar 10	Jul 10	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 1	Sep 11
4	2011/12	Sep 11	Aug 12	Mar-May 12	Feb 13	-
5	2012/13	Sep 12	Feb 13	Mar-Apr 13	May 13	-
6	2013/14	Oct 13	Feb 14	Mar-Apr 14	Jul 14	-
7	2014/15	Nov 14	Feb 15	Mar 15	Jun 15	-
8	2015/16	Nov 15	Feb 16	Apr 16	Jul 16	Jun 16
9	2016/17	Aug-Sep 16	Jan 17	Mar 17	Jul 17	
10	2017/18	Sep 17	Feb 18	Apr 18	Jun 18	Nov 18
11	2018/19	Oct - Dec 18	Jan 19	Apr 19	May 19	
12	2019/20	Oct-Nov 19	Jan 20	May 20	Jul 20	
13	2020/21	Oct 20	Jan 21	Mar 21	May 21	Aug 21
14	2021/22	Nov 21	Jan 22	Apr 22	Jun 22(*)	

(*) The present report is **Update Report 14** and provides an analysis of the 2022 Partial Measures survey for Durham County Council's frontage.

1. Introduction

1.1 Study Area

Durham Council's frontage extends from Ryhope Dene to Crimdon Beck. For the purposes of this report, it has been sub-divided into five areas, namely:

- Featherbed Rocks
- Seaham (Dawdon)
- Blast Beach
- Hawthorn Hive
- Blackhall Colliery

1.2 Methodology

Along Durham County Council's frontage, the following surveying is undertaken:

- Full Measures survey annually each autumn/early winter comprising:
 - Beach profile surveys along nine transect lines
- Partial Measures survey annually each spring comprising:
 - Beach profile surveys along six transect lines
- Cliff top survey bi-annually at:
 - Seaham (Dawdon)

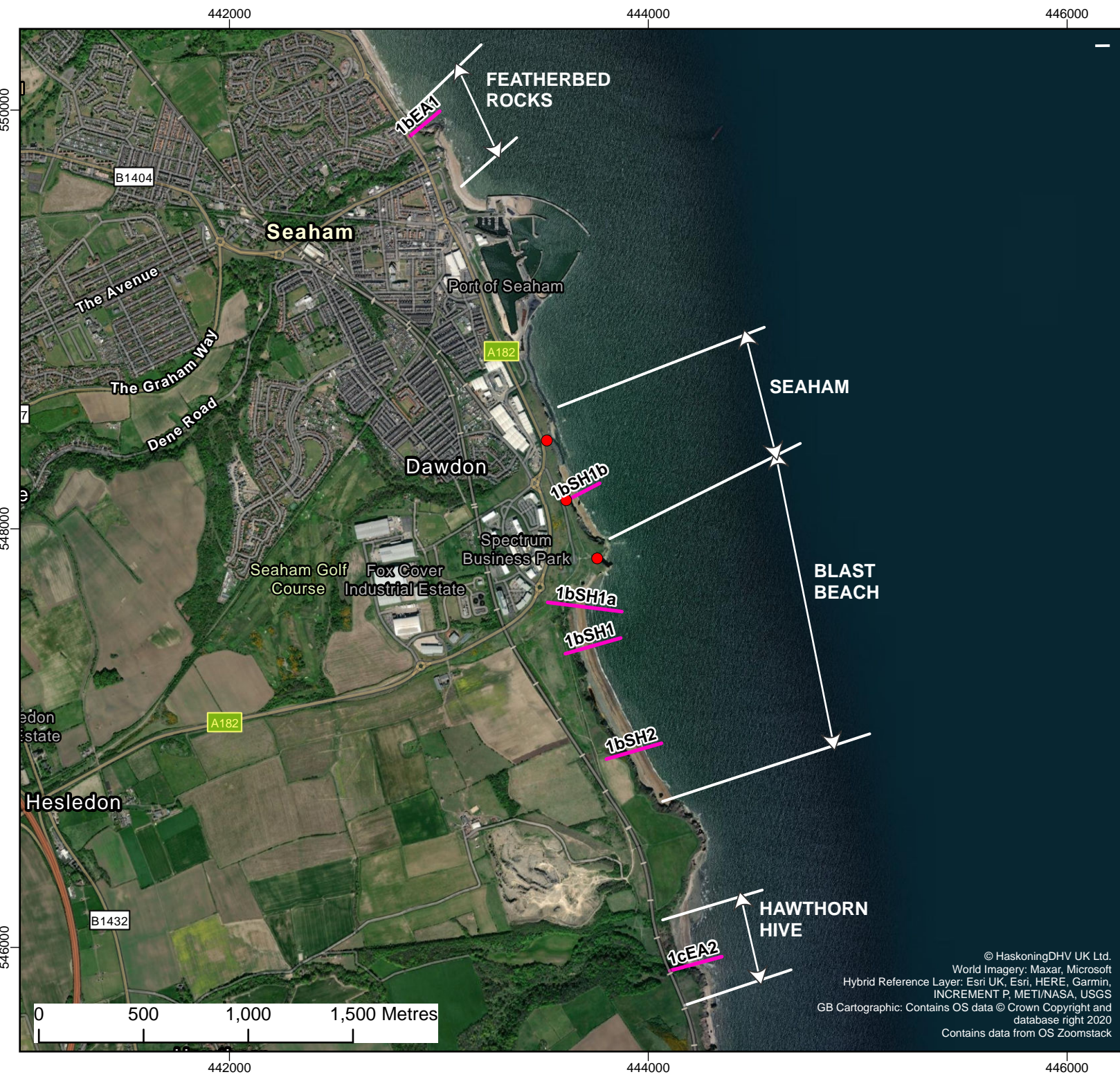
The location of these surveys is shown in Figure 2. The Partial Measures survey was undertaken along this frontage on 6th April 2022. During the survey the weather was dry and sunny, with a force 4 wind from the west and a slight sea state.

All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data collection approach and file format is comparable to that being used on other regional coastal monitoring programmes around England.

The Update Report presents the following:

- 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
- key conclusions and highlighting of 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 (Orange)
- 5 yearly (Light Purple)

● 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 1**
FEATHERBED ROCKS TO HAWTHORN HIVE
Durham County Council Frontage

Report: **Survey Report**

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	n/a	TC	NJC	A4	1:25,000

Co-ordinate system: British National Grid

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 World Imagery: Maxar, Microsoft
 Hybrid Reference Layer: Esri UK, Esri, HERE, Garmin,
 INCREMENT P, METI/NASA, USGS
 GB Cartographic: Contains OS data © Crown Copyright and
 database right 2020
 Contains data from OS Zoomstack



SURVEY LOCATIONS

Topographic Profile

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

Topographic Area

- 6 monthly (Light Green)
- yearly (Orange)
- 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 2

BLACKHALL COLLIERY

Durham County Council Frontage

Report:

Survey Report

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	n/a	TC	NJC	A4	1:25,000

Co-ordinate system: British National Grid

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Hybrid Reference Layer: Esri UK, Esri, HERE, Garmin, INCREMENT P, METI/NASA, USGS
GB Cartographic: Contains OS data © Crown Copyright and database right 2020
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SURVEY LOCATIONS

- Cliff Top Survey Points

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 Contains data from OS Zoomstack
 Hybrid Reference Layer: Esri Community Maps Contributors, Esri UK, Esri, HERE, Garmin, INCREMENT P, METI/NASA, USGS

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

Title:
Figure 3 - Map 1
SEAHAM
Durham County Council Frontage

Report:
 Survey Report

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	n/a	TC	NJC	A4	1:10,000

Co-ordinate system: British National Grid



2. Analysis of Survey Data

2.1 Featherbed Rocks

Survey Date	Description of Changes Since Last Survey	Interpretation
4 th April 2022	<p>Beach Profiles:</p> <p>Featherbed Rocks is monitored by one beach profile line (1bEA1) during the Partial Measures survey (Appendix A). The previous survey was November 2021.</p> <p>Over the winter months, Profile 1bEA1 has experienced very little change. Chainage 0m to 55m covers the cliff top, cliff face and promenade and remains largely constant due to protection offered by the rock armour. It is assumed small variabilities observed in the cliff face is due to the margin of error of the survey technique rather than true change. The uneven profile at the base of the sea wall between 55m and 80m is due to the rock armour. Beyond 90m there remains no sediment over the shore platform which is reflected in an uneven profile.</p>	<p>Very little to no change has occurred at Profile 1bEA1 since the previous survey in November 2021. The rocky foreshore remains exposed fronting the defended section.</p> <p>Longer term trends:</p> <p>The rocky nature of the foreshore means it is unlikely to undergo significant changes in morphology unless sediment is deposited. Previous monitoring indicates that a veneer beach tends to accumulate over the summer and is stripped off by winter storms, giving rise to small and localised changes in profile. The upper part of the profile, which covers the cliff, promenade and rock armour remains unchanged, as does the lower part of the profile which covers the rocky foreshore.</p>

2.2 Seaham (Dawdon)

Survey Date	Description of Changes Since Last Survey	Interpretation
4 th April 2022	<p>Cliff-top Survey:</p> <p>Three ground control points have been established along the cliff top at Dawdon (Figure B1). The separation between any two points is nominally 300m. These cliff top surveys are intended to inform on erosion rates of the undefended sea cliffs extending south of the rock armour revetment to the south of Seaham Harbour. The cliff top surveys at Dawdon are undertaken bi-annually.</p> <p>Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top. Appendix B provides results from the April 2022 survey showing the position from the ground control point to the edge of the cliff top along the defined bearing and changes since the November 2008 baseline survey.</p> <p>The cliff monitoring data shows that only one control point experienced significant change over the winter of 2021/22, with Point 2 retreating 0.29m since November 2021. Points 1 and 3 experienced a negligible retreat of 0.01m and 0.02m respectively which is comfortably within the survey error of $\pm 0.2\text{m}$.</p>	<p>Points 1 and 3 have experienced little to no change over the winter, retreating 0.01m and 0.02m respectively. Point 2, which over the long term has been the most stable, experienced a change of 0.29m since November 2021.</p> <p>Longer term trends:</p> <p>There is more confidence in the long-term pattern of change, where the cumulative measured erosion is greater than the error inherent in the technique.</p> <p>Points 1 and 3 have shown an average recession rate of 0.11m/yr and 0.13/yr since monitoring began in 2008, whilst Point 2 has shown an average recession rate of 0.04m/yr.</p>

2.3 Blast Beach

Survey Date	Description of Changes Since Last Survey	Interpretation
4 th April 2022	<p>Beach Profiles:</p> <p>Blast Beach is covered by four beach profile lines during the Partial Measures survey (Appendix A).</p> <p>Profile 1bSH1B, added in October 2015, is adjacent to the sewage works south of Seaham. The profile consists of cliff to chainage 30m followed by a gravelly beach, the beach characterised by a concrete obstruction at chainage 59m. The 2022 Partial Measures survey showed that there has been local accretion at the toe of the rock cliff between chainages 28m and 38m in the order of 0.4m in level. Seaward of the accretion, a small berm observed in the November 2021 survey has been eroded. Between chainages 45m to 59m, the beach has remained unchanged except a local drop (0.3m) in beach level immediately landward of the concrete blocks. Seaward of the concrete blocks, the lower rocky foreshore has experienced little to no change. Overall the upper beach is at a high to medium level and the exposed rocky foreshore at a low level.</p> <p>Profile 1bSH1A was added to the programme during the Full Measures survey in September 2009. It is located to the north of the previously-established 1bSH1. The Survey Report notes dense vegetation restricts access to the cliff top and cliff base. The 2022 Partial Measures survey showed that the eroding face of the spoil deposit has retreated a further 5m since the previous survey in November 2021 (now at chainage 135m). The beach from the spoil face to the exposed rocky foreshore at chainage 170m has also retreated over the winter months by a similar magnitude resulting in an apparent net loss of material. Seaward of chainage 170m the rocky foreshore remains exposed and has experienced little change.</p> <p>At profile 1bSH1 dense vegetation again restricted access to the cliff tops. The 2022 Partial Measures survey shows that the eroding face of the spoil deposit, now at chainage 75m, has retreated 0.5m over the winter months. Seaward of this, the beach has showed alternating areas of erosion and accretion limited to 0.45m in level. From chainage 124m, the rocky foreshore remains exposed and has experienced little to no change other than differences in surveying points.</p> <p>At profile 1bSH2 dense vegetation again restricted access to the cliff tops skewing the profile across the cliff face up chainage 97m. Seaward of this, the upper beach platform between chainages 97m and 119m has remained unchanged. Low level accretion has occurred on the upper beach between</p>	<p>The April 2022 Partial Measures survey showed that erosion has dominated the profiles through Winter 21/22. This is particular noticeable at the northern end Blast Beach where the spoil deposits have retreated significantly (1bSH1A). To the south of Blast Beach the erosion is less significant and some local, low level, accretion is observed. The rocky foreshore is exposed across all profiles.</p> <p>Longer term trends:</p> <p>The cliffs behind Blast Beach are currently inactive because they are fronted by colliery spoil. The sea cliffs will eventually reactivate as ongoing erosion of the colliery spoil removes the protection it affords to the cliffs. In the past this has been deemed most likely to occur at the southern end of the bay where the spoil was more rapidly eroding. The (previously) accumulating sediment seaward of the colliery spoil in the northern part of the bay was thought to offer the cliffs more protection. However, since the winter of 2014 there has been a reversal in the trend with erosion in the north of the bay and accretion in the south. This trend was continued in the April 2022 survey and so should remain an area of focus.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	chainages 125m to 145m, followed by low level lowering of the lower beach up the end of the profile at chainage 185m. The change is limited to $\pm 0.4\text{m}$. Overall, the beach is at a medium level compared to the range recorded from previous surveys.	

2.4 Hawthorne Hive

Survey Date	Description of Changes Since Last Survey	Interpretation
4 th April 2022	<p>Beach Profiles:</p> <p>Hawthorne Hive is covered by one beach profile line 1cEA2 during the Partial Measures survey (Appendix A). The survey report notes “unable to measure start of Section EA2 as the vegetation has choked out the section line and route over cliff faces” and therefore all surveys following October 2012 start at 95m chainage.</p> <p>Until the Partial Measures survey in April 2013, a channel was present between 95m and 105m chainage, but it has infilled.</p> <p>The survey shows that over the winter months, the upper beach, from chainage 95m to 120m, has lowered by up to 0.5m. From chainage 120m to 150m the beach profile has remained unchanged. Seaward of chainage 150m the rocky foreshore remains exposed. Overall, the beach is at a low level compared to the range recorded from previous surveys.</p>	<p>Since November 2021, the beach at profile 1cEA2, particularly the upper beach, appears to have experienced winter drawn down.</p> <p>Longer term trends:</p> <p>The profiles show the beach is undergoing progressive erosion.</p> <p>The infilling and incision of the channel seems to be an episodic process and is likely to reflect a combination of annual and seasonal variations in the flow of Hawthorn Burn and storm events which move sediment onshore to block the outflow of the burn.</p>

3. Problems Encountered and Uncertainty in Analysis

Individual Profiles

- The surveyor noted difficulties accessing the cliff tops of sections SH1, SH2 and SH1A and the cliff base of SH1A due to dense vegetation.
- At Hawthorne Hive the surveyor was unable to measure the start of Section EA2 due to vegetation cover.

Cliff Top Surveys

- Whilst there is low confidence in the short-term erosion rates due to the error in the method, longer-term data are more reliable and suggest erosion rates of up to 0.1m/yr.

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

- No changes are recommended at the present time.

5. Conclusions and Areas of Concern

- At Featherbed Rocks the shore platform remains exposed seaward of the rock armour. As a result of the absence of superficial beach sediment, there has been very little change since the previous survey.
- At Seaham Cliffs, only Point 2 experienced significant cliff top recession over the winter months, retreating 0.29m since November 2021. The survey data indicates that the average recession rate since monitoring began in 2008 is 0.11m/yr at Point 1, 0.04m/yr at Point 2 and 0.13m/yr at Point 3.
- The April 2022 Partial Measure survey showed that lowering has dominated the profiles through Winter 2021/22. This is particularly noticeable at the northern end of Blast Beach where the spoil deposits have retreated significantly (1bSH1A). To the south of Blast Beach the landward recession of the spoil deposits is less significant and some local, low level, accretion is observed. The rocky foreshore is exposed across all profiles.
- At Hawthorn Hive, the beach level appears to have experienced winter drawn down since November 2021, particularly along the upper beach. It is likely that the long-term trend of progressive erosion will continue on this profile.

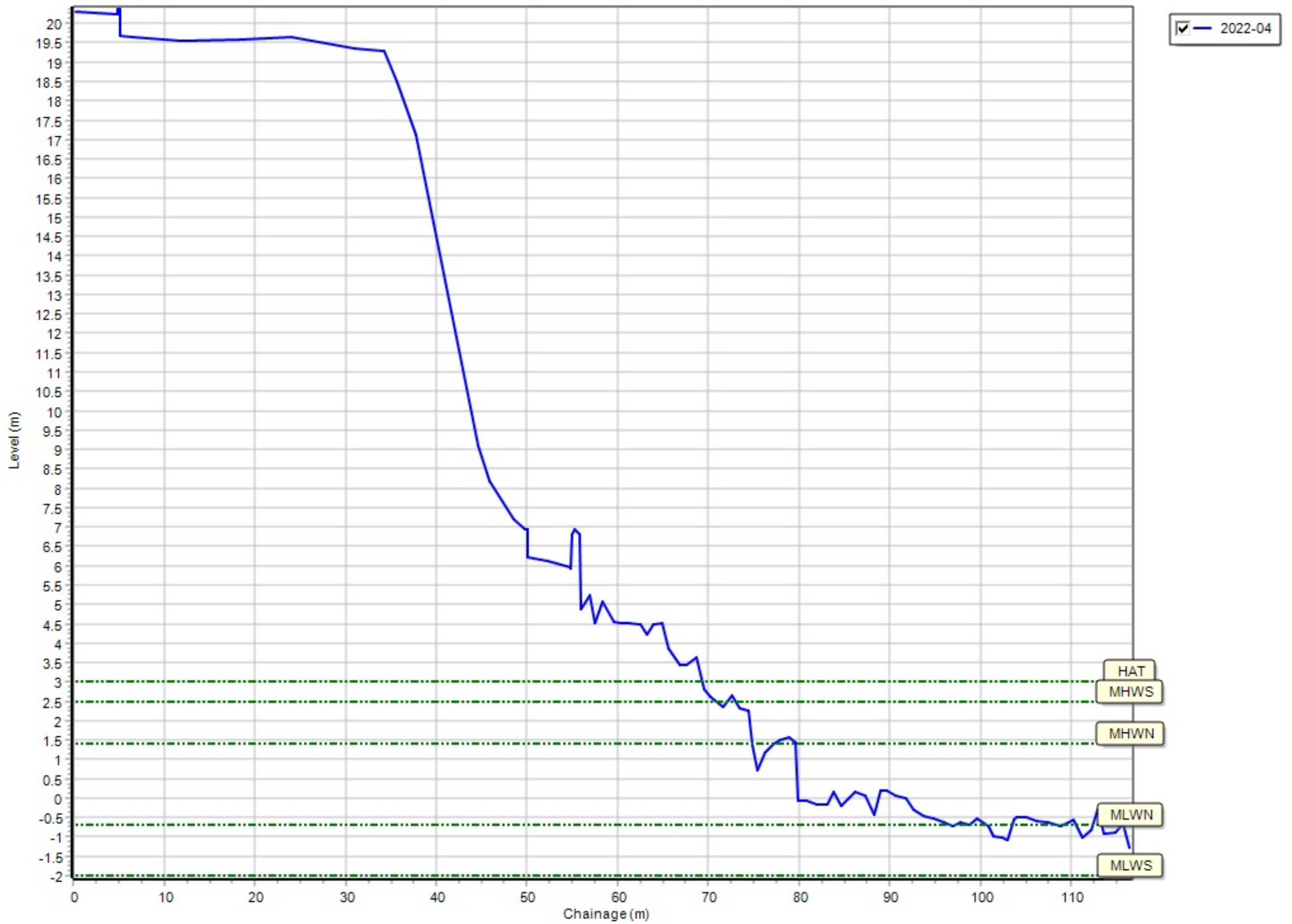
Appendices

Appendix A
Beach Profiles

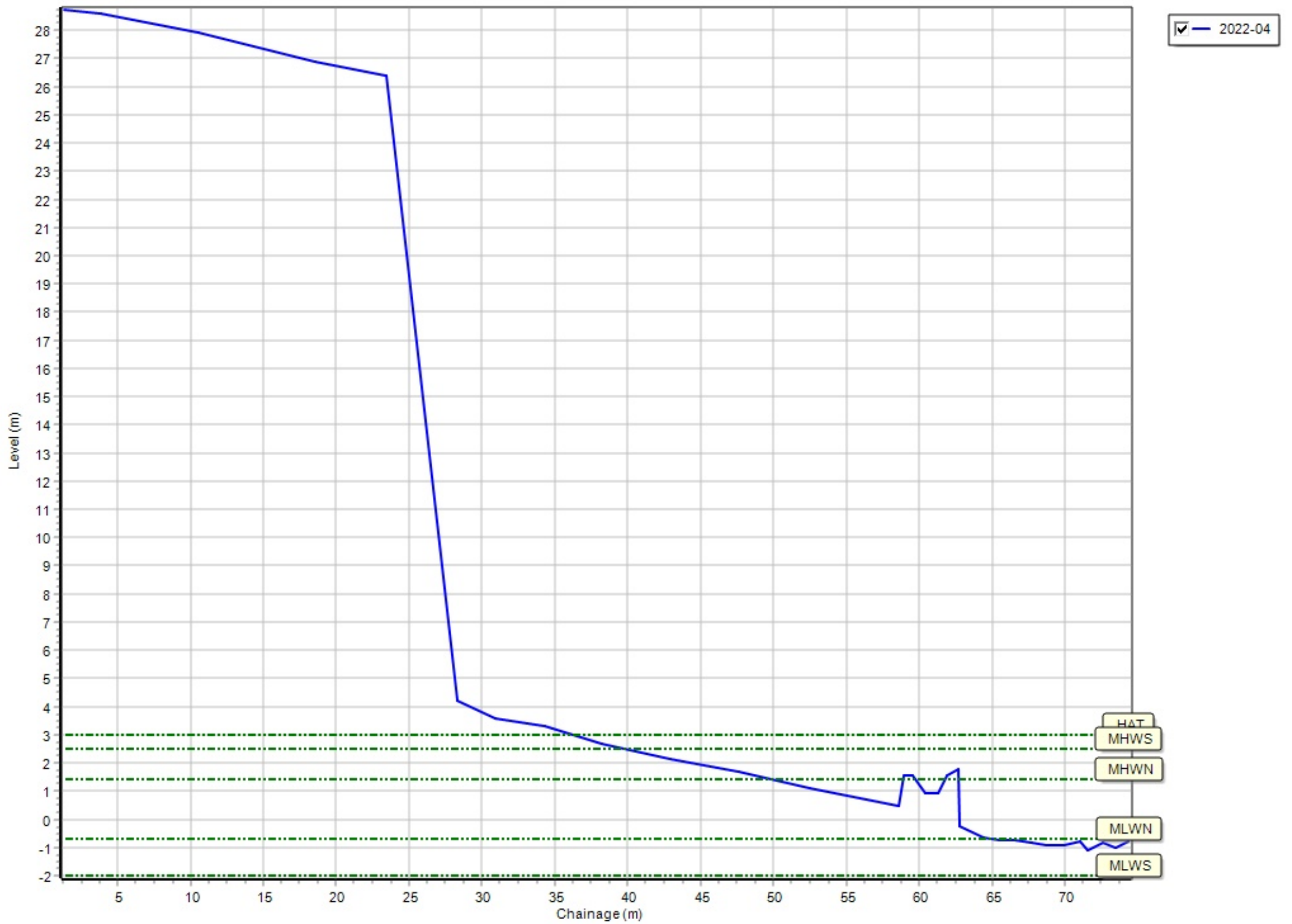
The following sediment feature codes are used on some profile plots:

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

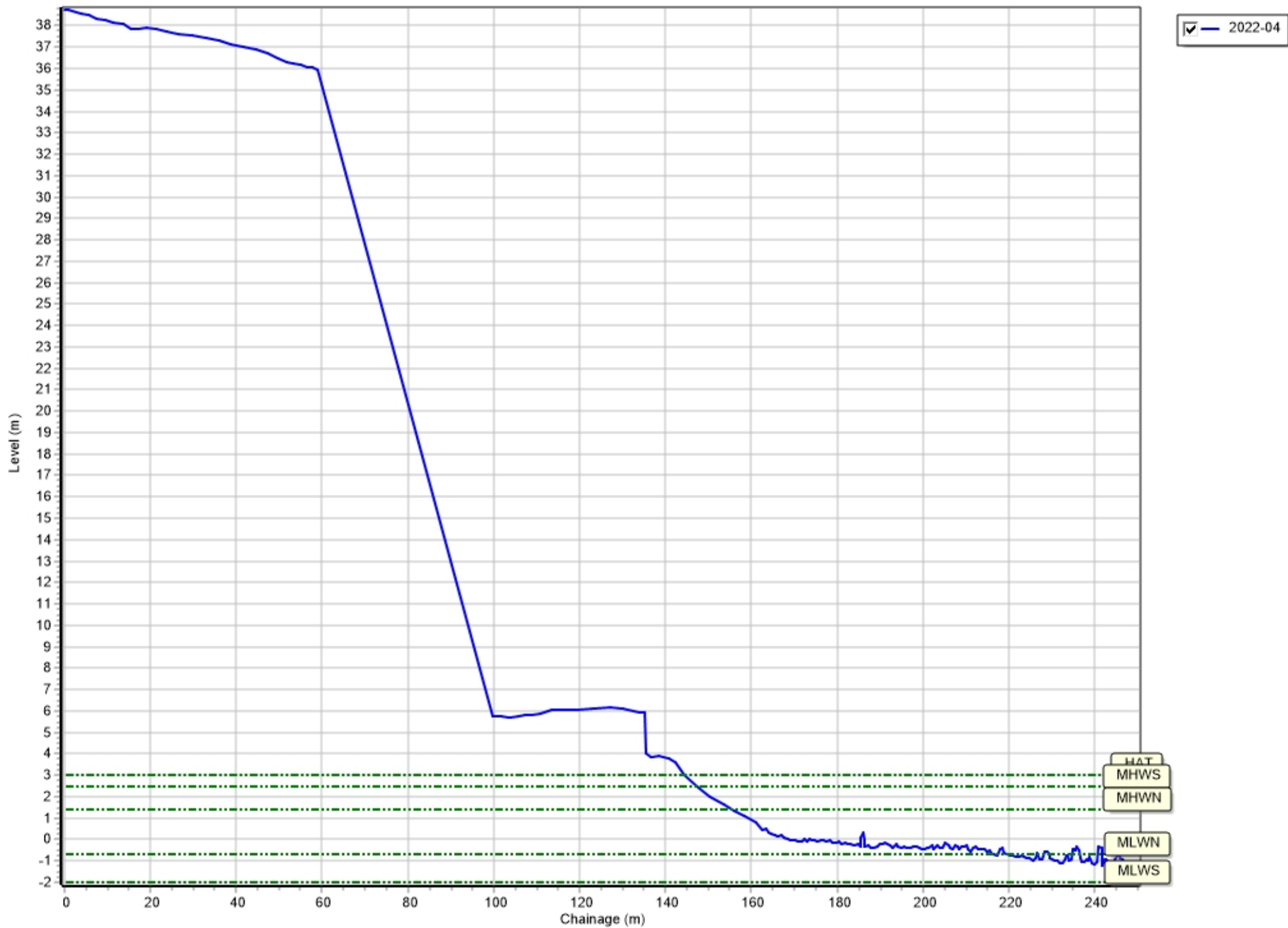
Profiles: 1bEA1



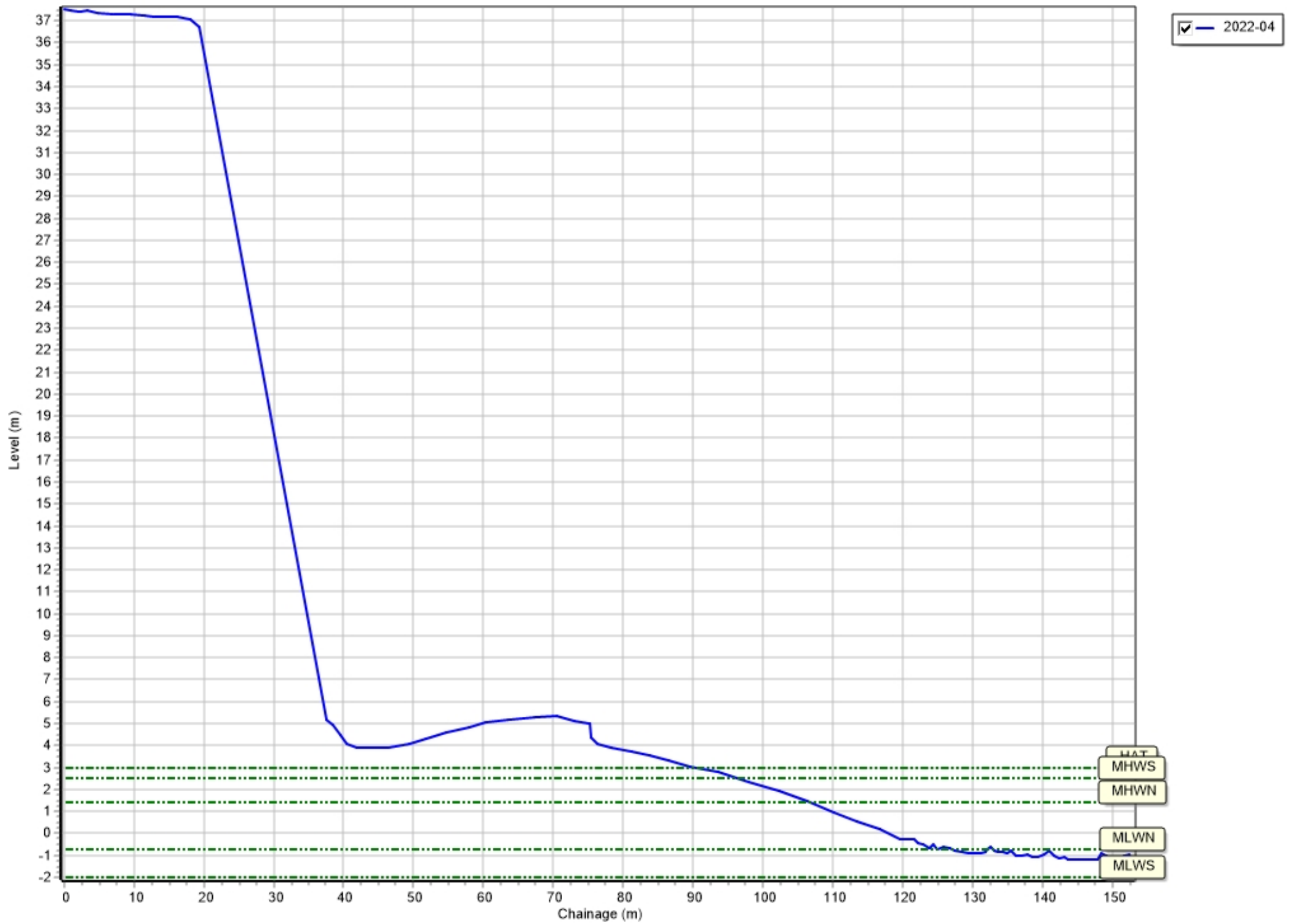
Profiles: 1bSH1B



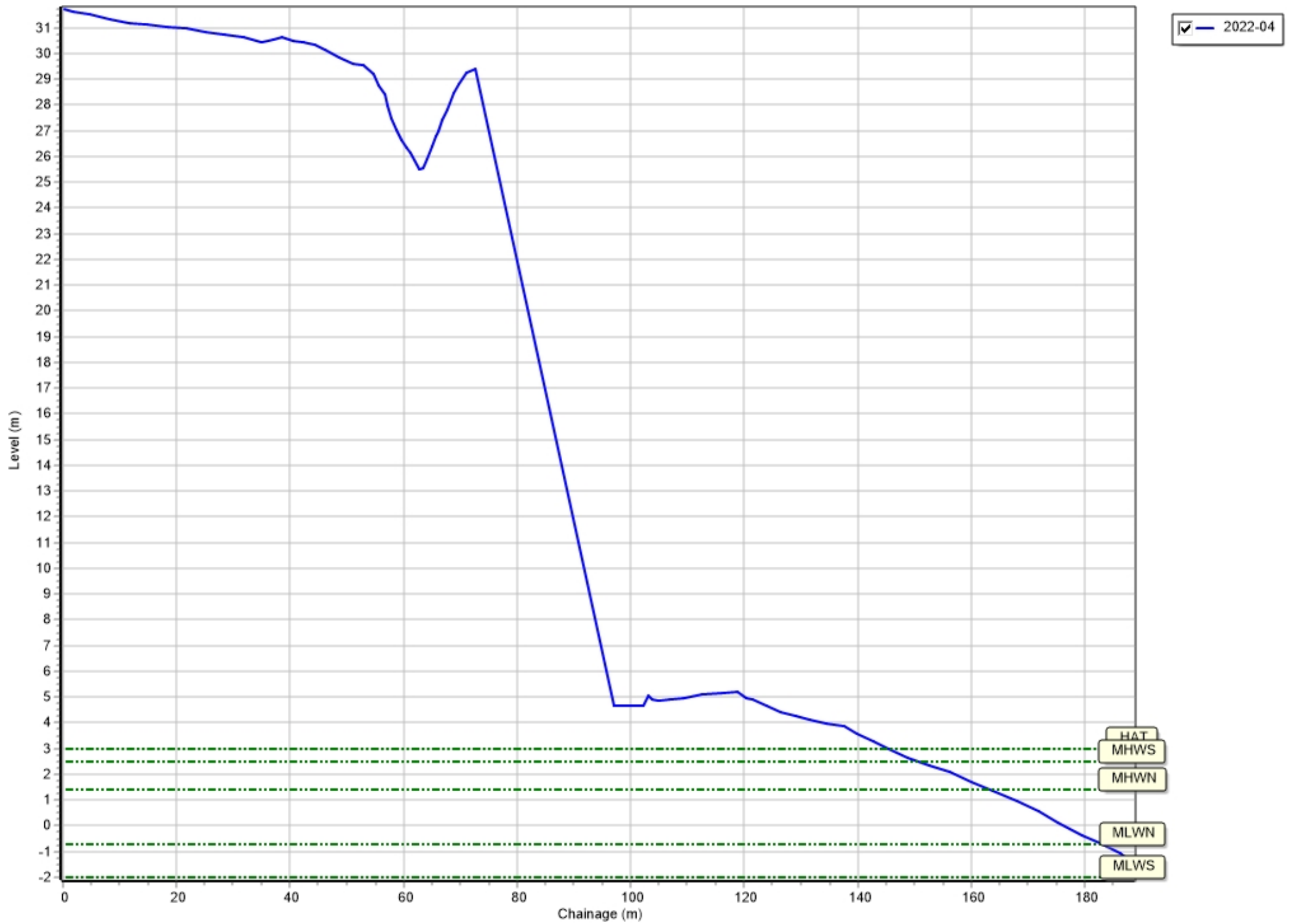
Profiles: 1bSH1A



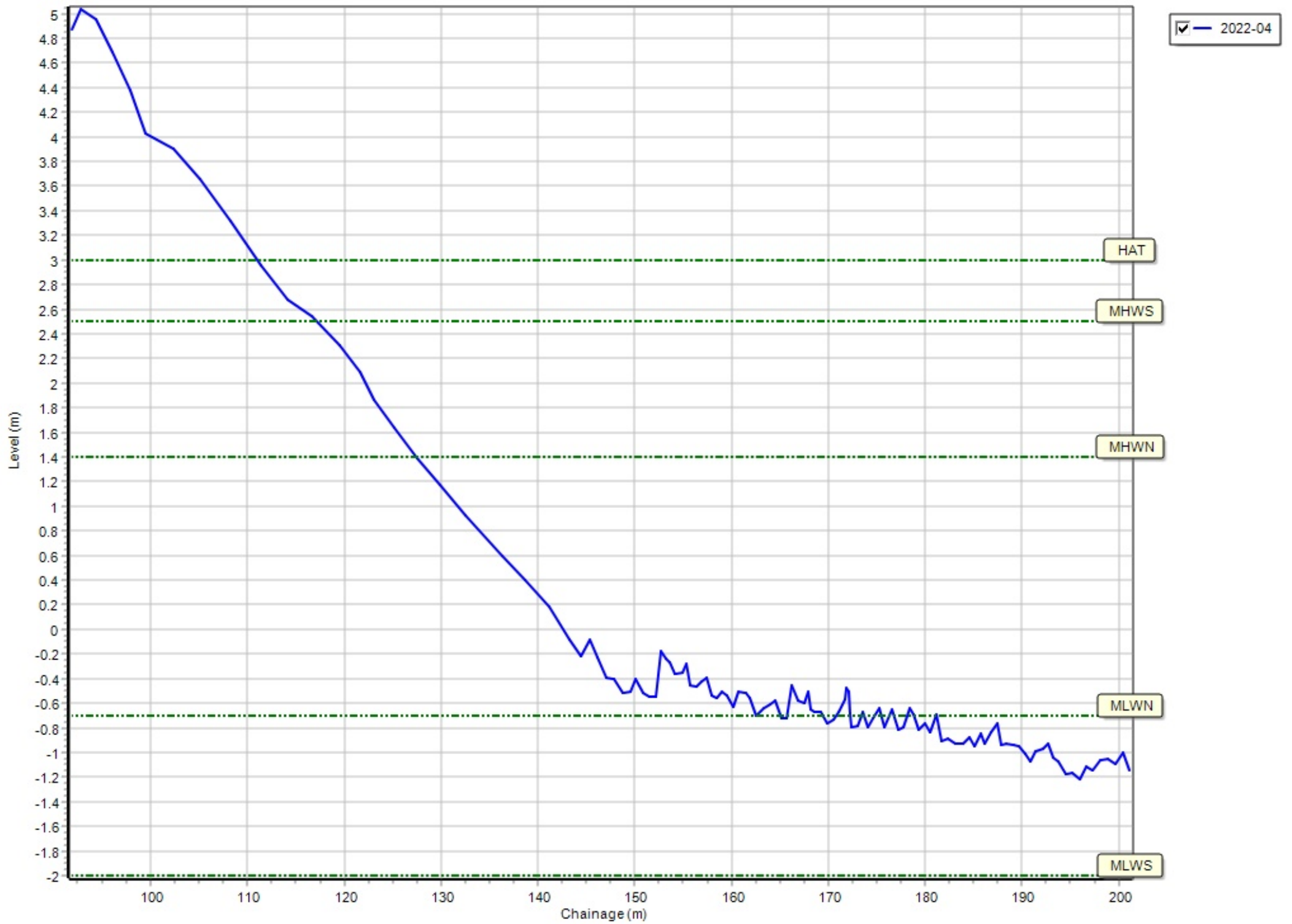
Profiles: 1bSH1



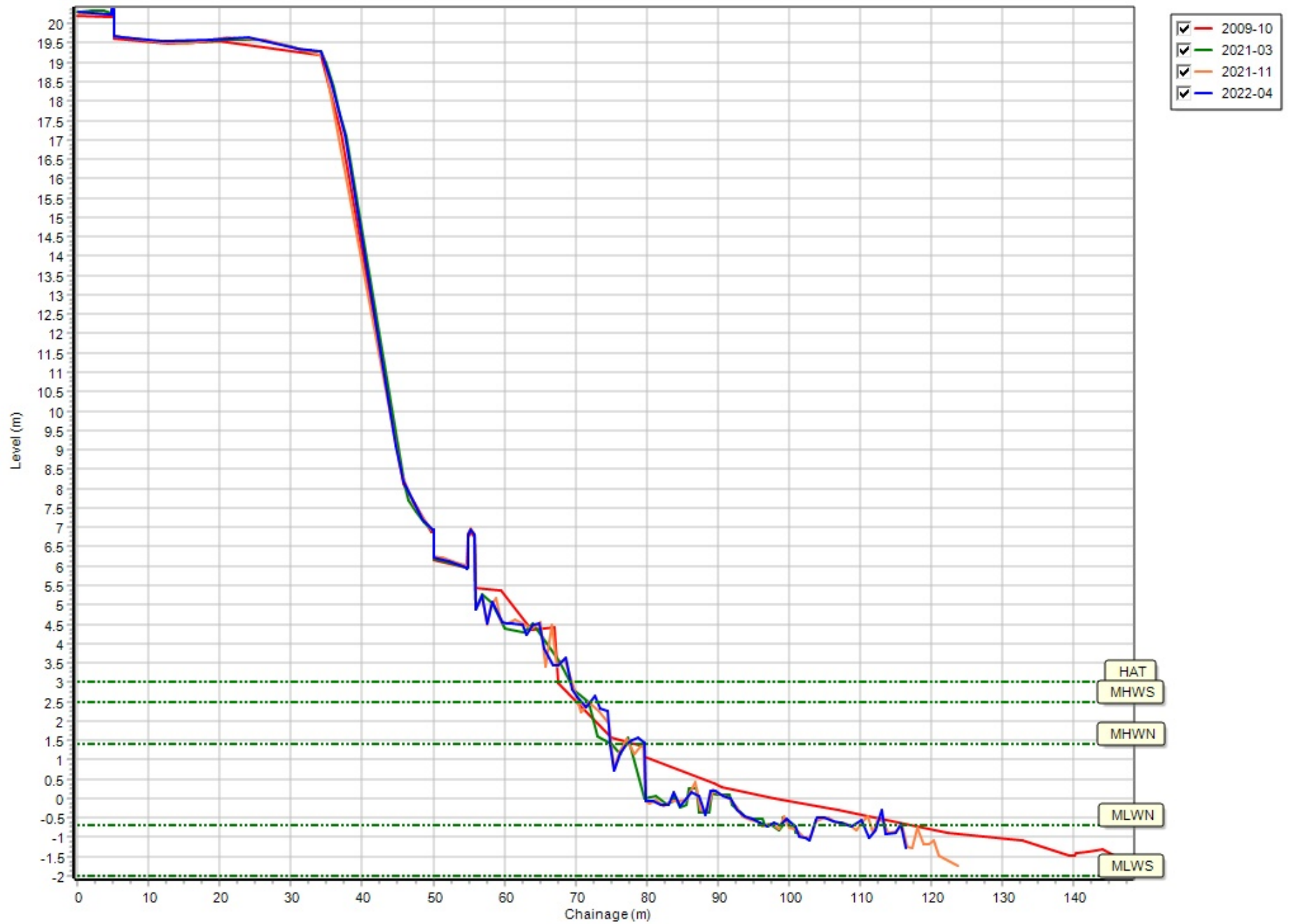
Profiles: 1bSH2



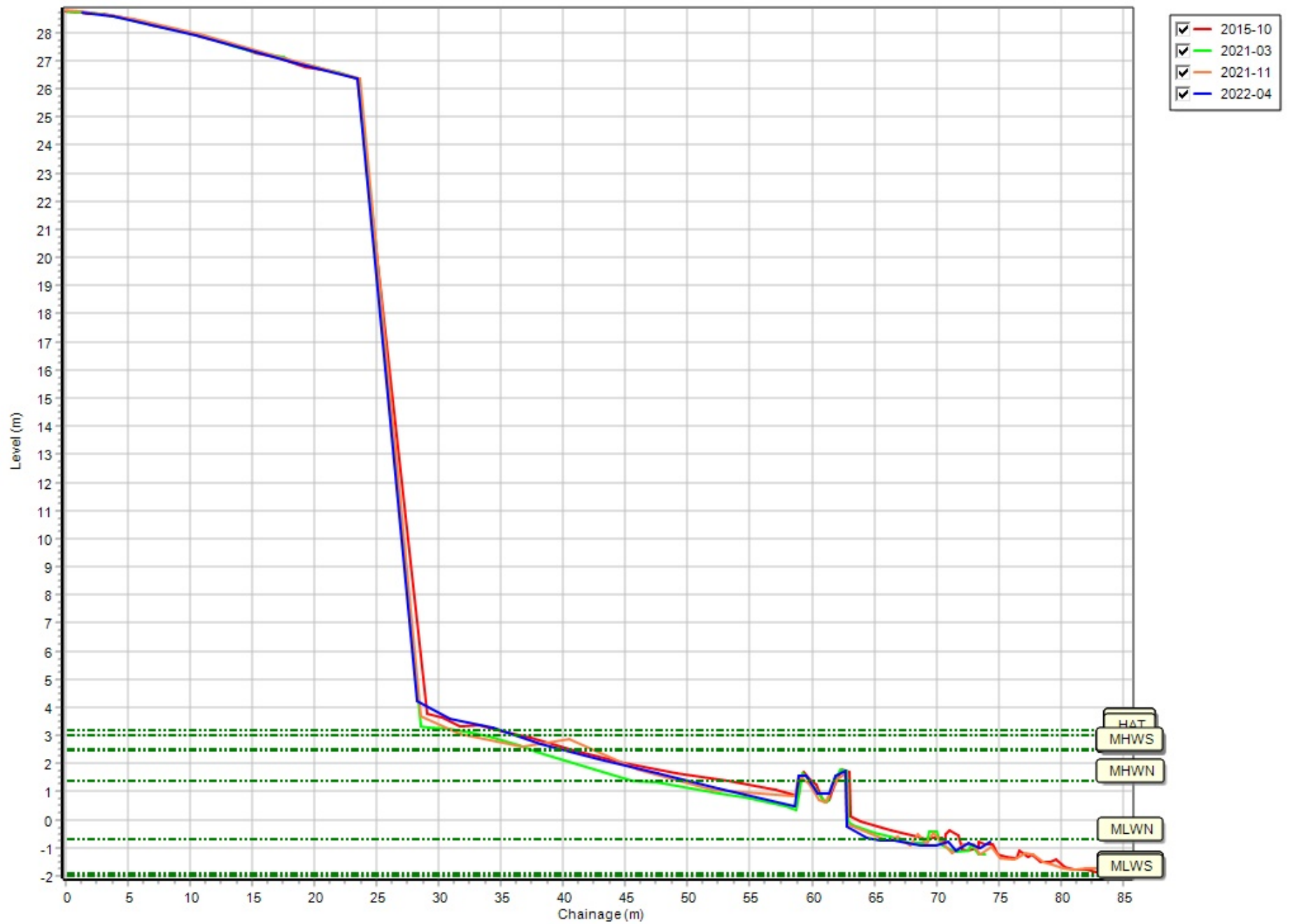
Profiles: 1cEA2



Profiles: 1bEA1



Profiles: 1bSH1B



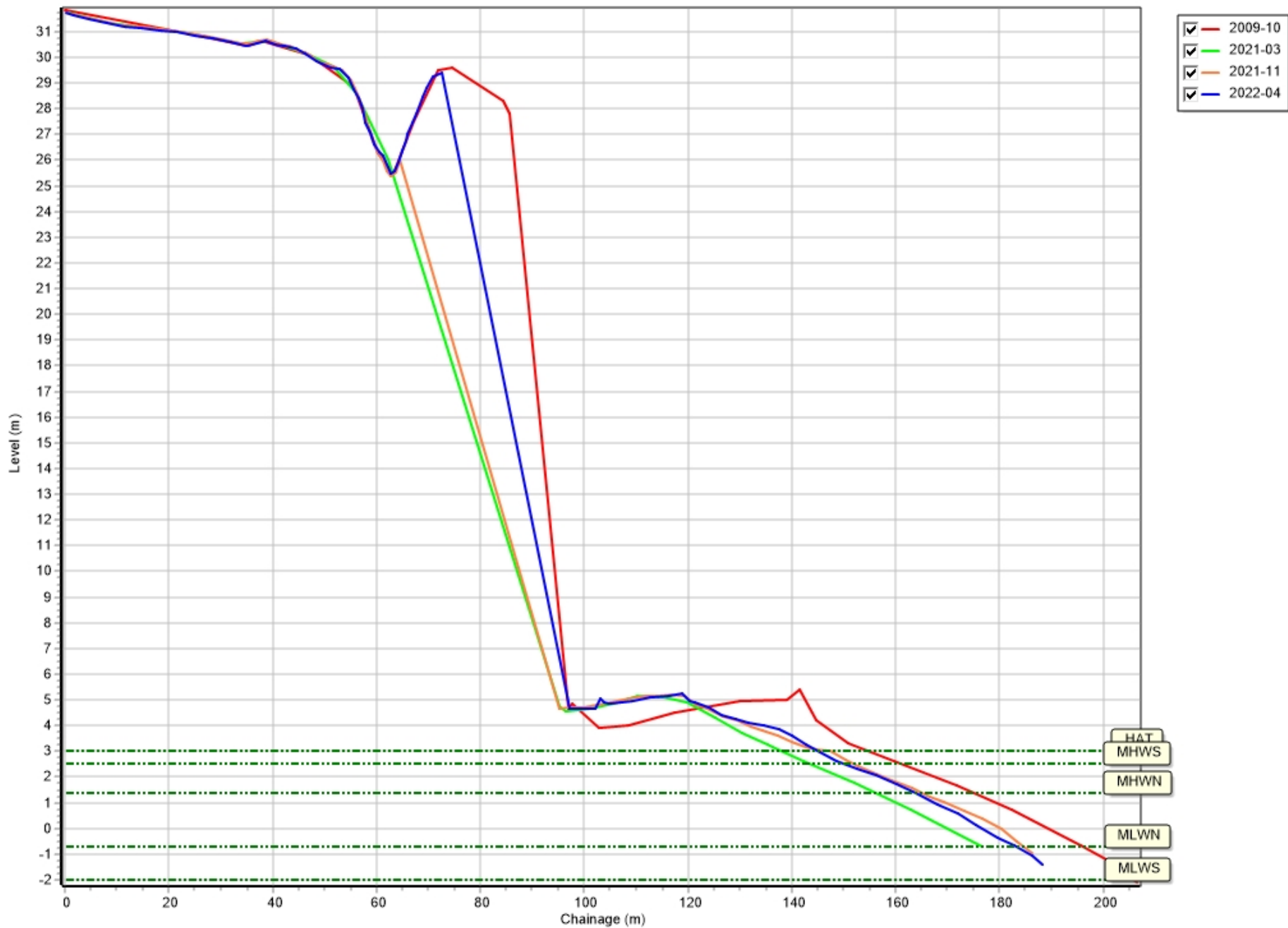
Profiles: 1bSH1A



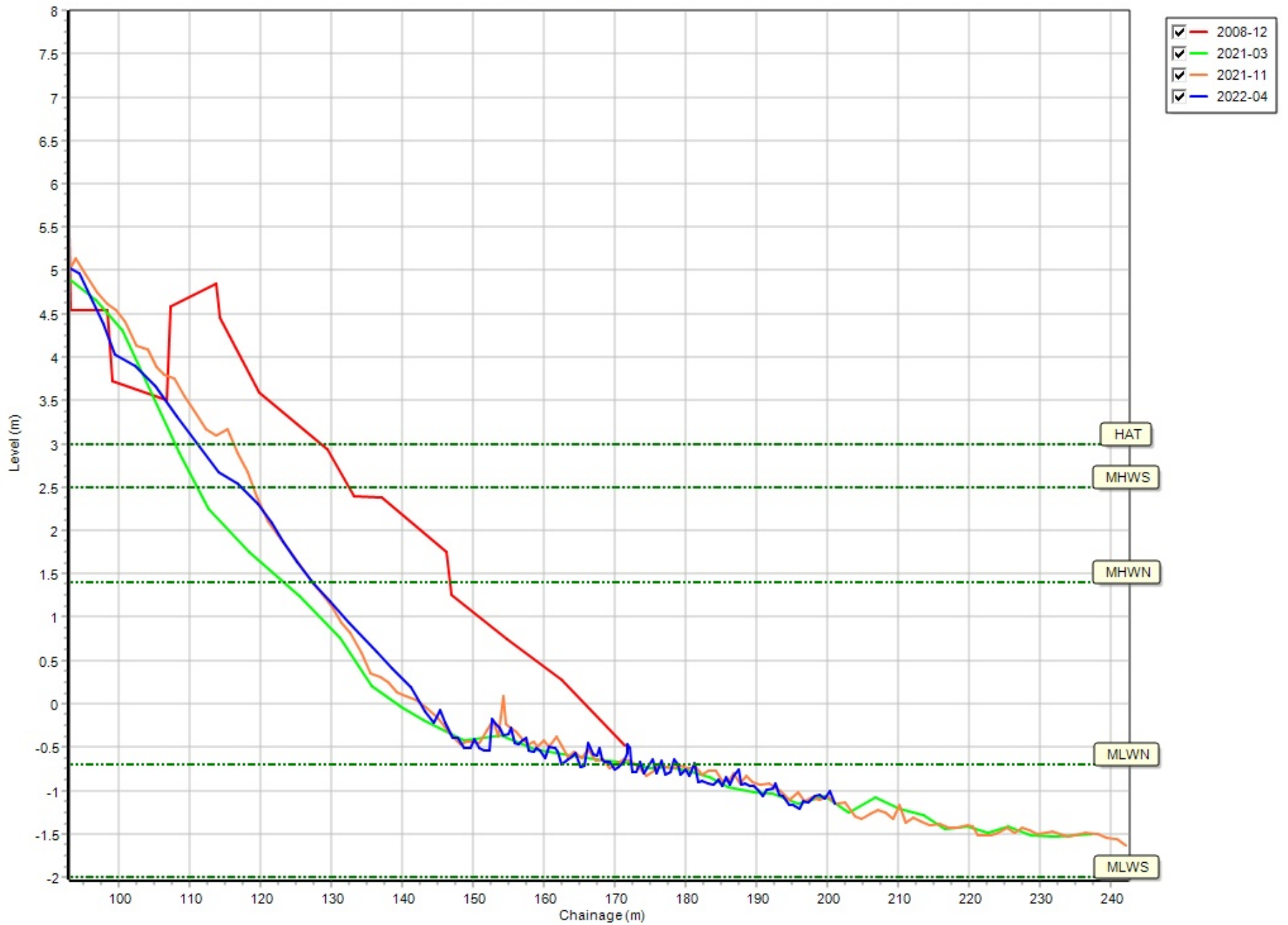
Profiles: 1bSH1



Profiles: 1bSH2



Profiles: 1cEA2



Appendix B
Cliff Top Survey

Cliff Top Survey

Seaham (Dawdon)

Three ground control points have been established at Dawdon (Figure B1). The maximum separation between any two points varies along the coast, reflecting the degree of risk from erosion.

The cliff top surveys at Dawdon 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 B1 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 B1 – Cliff Top Surveys at Dawdon

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	Nov 2021	April 2022	Nov 2008 - April 2022	Nov 2021 - April 2022	Nov 2008 - April 2022
1	443515.4	548421.7	70	16.1	14.94	14.93	1.17	0.01	0.11
2	443607.8	548136.3	90	13.3	13.21	12.92	0.38	0.29	0.04
3	443756.1	547858.5	95	14.8	13.48	13.46	1.34	0.02	0.13