



Cell 1 Regional Coastal Monitoring Programme Analytical Report 16: 'Full Measures' Survey 2023



**Redcar and Cleveland
Borough Council
January 2024**

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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)
	Coatham Sands to Saltburn Sands
HAT	3.25
MHWS	2.65
MHWN	1.45
MLWN	-0.85
MLWS	-1.95

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.

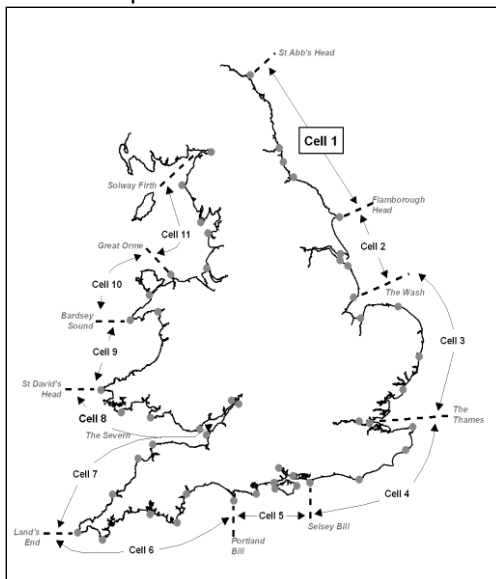


Figure 1 Sediment Cells in England and Wales

The programme commenced in its present guise in September 2008¹ and is managed by North Yorkshire 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 11	Sep 11
4	2011/12	Sep-Oct 11	Oct 12	Mar-May 12	Feb 13	
5	2012/13	Sep 12	Mar 13	Feb- Mar 13	May 13	
6	2013/14	Oct-Nov 13	Feb 14	Mar-Apr 14	Jul 14	
7	2014/15	Sep-Oct 14	Feb 15	Mar-Apr	Jul 15	
8	2015/16	Sep-Oct 15	Feb 16	Mar 16	Jul 16	Jun 16
9	2016/17	Sep-Nov 16	Feb 17	Mar 17	Jul 17	
10	2017/18	Oct 17	Mar 18	Mar-May 18	Jun 18	
11	2018/19	Sep 18	Mar 19	Mar-Apr 19	May 19	
12	2019/20	Oct-Nov 19	Jan 20	Mar-May 20	Aug 20	
13	2020/21	Oct-Dec 20	Feb 21	Mar 21	May 21	Aug 21
14	2021/22	Sep-Oct 21	Dec 21	Apr 22	Jul 22	
15	2022/23	Oct 22	Jan 23	Mar-Apr 23	Jun 23	
16	2023/24	Sep-Nov 23	Jan 23			

* The present report is **Analytical Report 16** and provides an analysis of the 2023 Full Measures survey for Redcar and Cleveland Borough Council's frontage.

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

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

Table 2 Sub-divisions of the Cell 1 Coastline

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

	Scarborough South Bay
	Cayton Bay
	Filey Bay

1. Introduction

1.1 Study Area

Redcar & Cleveland Borough Council's frontage extends from the South Gare breakwater at the mouth of the River Tees to Cowbar Nab, Staithes. For the purposes of this report, report and for consistency with previous reporting, it has been sub-divided into six areas, namely:

- Coatham Sands
- Redcar Sands
- Marske Sands
- Saltburn Sands
- Cattersty Sands (Skinningrove)
- Staithes

The Staithes frontage straddles the boundary of jurisdiction of Redcar & Cleveland Council and Scarborough Borough Council and therefore reporting has been duplicated in both reports.

1.2 Methodology

Along Redcar & Cleveland Borough Council's frontage, the following surveying is undertaken:

- Full Measures survey annually (since 2008) each autumn/early winter comprising:
 - Beach profile surveys along nine transect lines.
 - Topographic survey along Coatham Sands
 - Topographic survey along Redcar Sands
 - Topographic survey along Marske Sands
 - Topographic survey along Saltburn Sands
 - Topographic survey along Cattersty Sands
- Partial Measures survey annually each spring (since 2009) comprising:
 - Beach profile surveys along nine transect lines.
 - Topographic survey along Redcar Sands
 - Topographic survey along Saltburn Sands
 - Topographic survey along Cattersty Sands
- Cliff top survey annually at:
 - Staithes

The Full Measures survey was undertaken along this frontage between 21st September 2023 and 1st November 2023. The weather and sea state varied, for further details please refer to the Survey Report from Academy Geomatics.

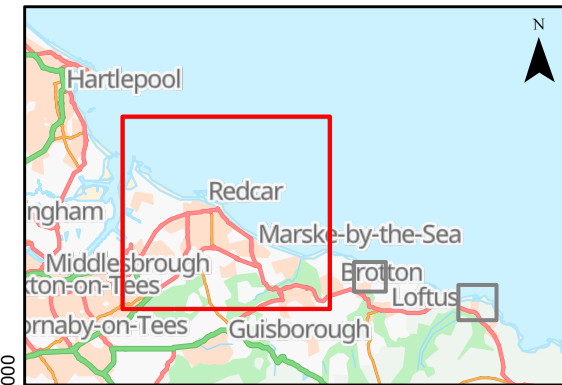
All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data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

Upon receipt of the data from the survey team, they are quality assured and then uploaded onto the programme's website for storage and availability to others and also input to SANDS and GIS for subsequent analysis.

The Analytical Report is then produced following a standard structure for each authority. This involves:

- description of the changes observed since the previous survey and an interpretation of the drivers of these changes (Section 2);
- documentation of any problems encountered during surveying or uncertainties inherent in the analysis (Section 3);
- recommendations for 'fine-tuning' the programme to enhance its outputs (Section 4); and
- providing key conclusions and highlighting any areas of concern (Section 5).

Data from the present survey are presented in a processed form in the Appendices.



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**
COATHAM SANDS TO SALT BURN SANDS
Redcar and Cleveland Borough Council Frontage

Report: **Survey Report**

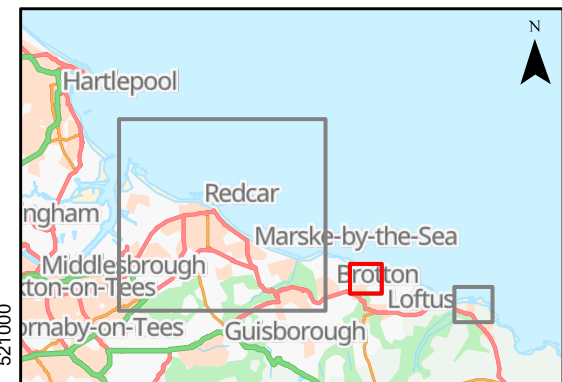
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Co-ordinate system: British National Grid

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 Hybrid Reference Layer: Esri UK, Esri, HERE, Garmin, METI/NASA, USGS
 Earthstar Geographics, Earthstar Geographics
 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 (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

CATTERSTY SANDS (SKINNINGROVE)

Redcar and Cleveland Borough Council Frontage

Report:

Survey Report

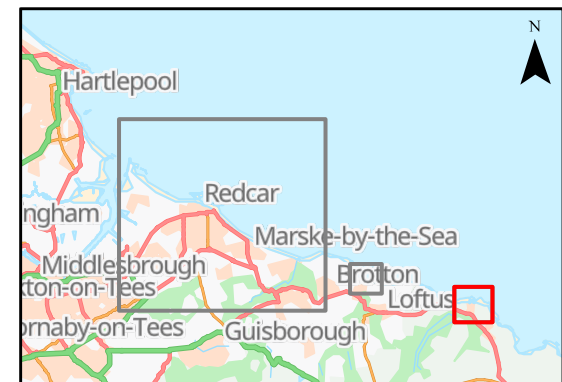
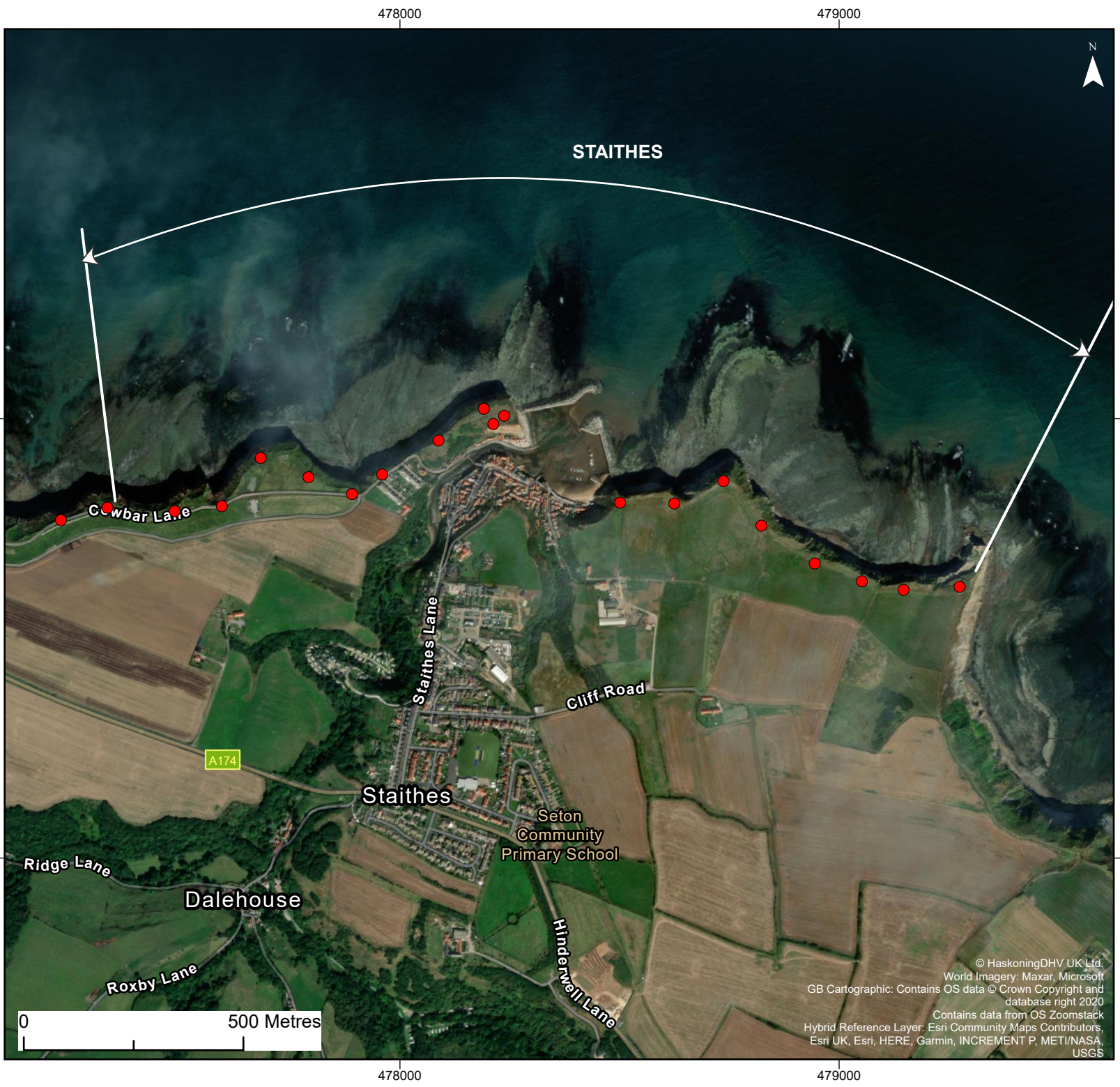
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0	n/a	TC	NJC	A4	1:10,000

Co-ordinate system: British National Grid

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



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

Figure 2 - Map 3

STAITHES

Redcar and Cleveland Borough Council Frontage

Report:

Survey Report

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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Co-ordinate system: British National Grid

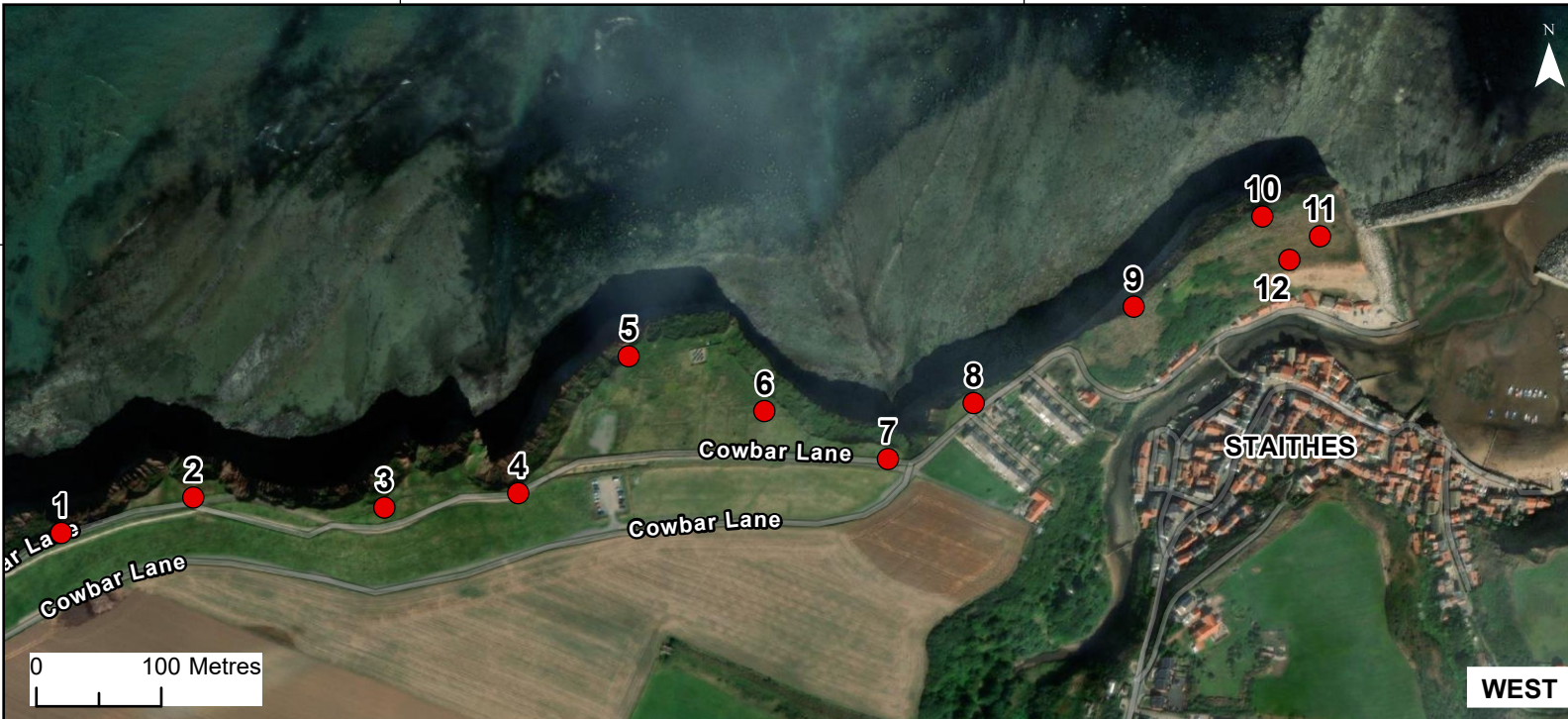
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World Imagery: Maxar, Microsoft
GB Cartographic: Contains OS data © Crown Copyright and database right 2020
Contains data from OS Zoomstack
Hybrid Reference Layer: Esri Community Maps Contributors, Esri UK, Esri, HERE, Garmin, INCREMENT P, METI/NASA,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

477500

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SURVEY LOCATIONS

- Cliff Top Survey Points

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

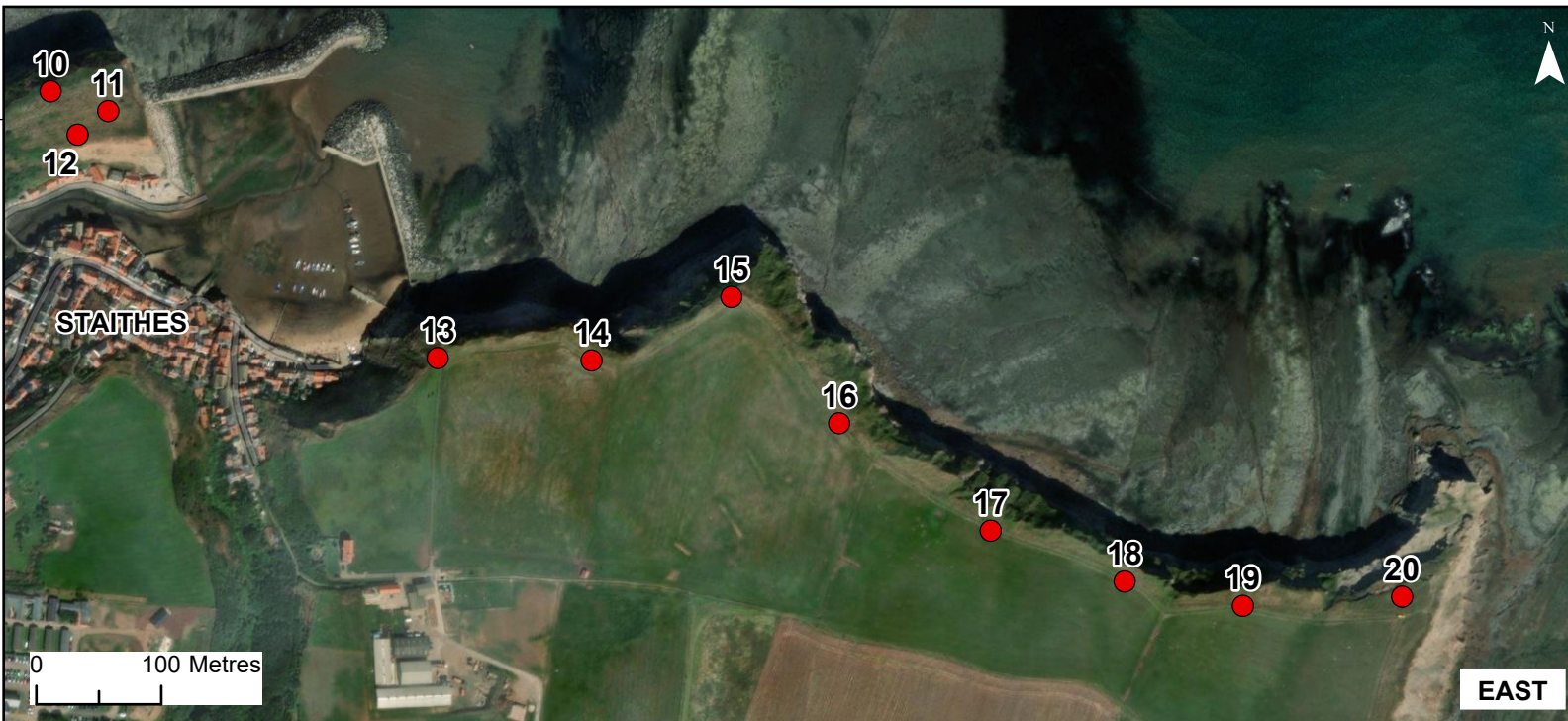
Client:	Project:
North East Coastal Group	Cell 1 Regional Coastal Monitoring Programme

Title:
Figure 3 - Map 1
STAITHES
Redcar and Cleveland Borough Council Frontage

Report:
 Survey Report

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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Co-ordinate system: British National Grid



478500

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2. Analysis of Survey Data

2.1 Coatham Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>26th Oct – 1st Nov 2023</p>	<p>Beach Profiles:</p> <p>Coatham Sands is covered by four beach profile lines (RC1 to RC4; Appendix A) that are monitored twice yearly. The previous inspection was in April 2022.</p> <p>Profile 1cRC1 is located approximately 300m south of the South Gare breakwater, in the lee of the German Charlies slag banks. The upper profile is dominated by dunes that have experienced minor accretion, limited to +0.1m. The movement of sediment across the beach has created alternating lengths of erosion and accretion since the previous survey. The beach has accreted between chainages 106m and 123m (up to 0.3m) and again between chainages 200m and 300m (up to 0.6m). Erosion has occurred between chainages 123m and 198m (0.45m). Compared to the range of the previous surveys the dunes remain at very high level, where the beach varies between high and medium.</p> <p>At Profile 1cRC2, the dunes, covering up to chainage 98m, have generally accreted at a low magnitude (+0.1m) since the previous survey. At the toe of the foredune the beach has dropped by 1.0m. This erosion continues across the entire profile up to chainage 338m, albeit at a gradually decreasing magnitude. Compared to the range of the previous surveys, the dunes are at the highest on record whereas the beach is at a very low level following the erosion.</p> <p>Profile 1cRC3 is covered by dunes up to chainage 55m. Change across the dunes is limited to ±0.3m which is largely concentrated in the depression to the rear of the foredune. The face of the foredune has accreted between chainage 45m and 65m up to 0.3m. Seawards of chainage 65m, the beach has been dominated by erosion peaking at a loss of 0.45m on the lower beach where a berm has been removed. Seawards of chainage 318m, the previously steep profile has slackened resulting in an increase in level of 0.5m at chainage 340m. The profile remains at a high level when compared to the range of the previous surveys.</p>	<p>The profiles suggest that whilst the dunes at Coatham sands have remained stable, change across the beach itself has varied with neither erosion nor accretion appearing to have dominated.</p> <p>It is understood that the dunes fronting the caravan park to the south are locally eroding at a greater rate, possibly exacerbated by the higher footfall. It is understood that the council is looking into commissioning a management plan that encompasses this and the wider Coatham dunes that would also align with the SMP2 refresh's change in policy recommendations.</p> <p>Longer term trends: With the exception of 2018, there appears to have been a general trend of net accretion observed in the Autumn analysis over the years. This is offset with a general erosion in the spring analysis following the winter months.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>Profile 1cRC4 is the beginning of the defended section at Redcar. Between the toe of the seawall and chainage 26m, the upper beach has accreted by up to 0.3m in level ramping up steeply against the seawall. The change across the rest of the beach is varied albeit modest in magnitude, limited to $\pm 0.3\text{m}$. Between chainages 34m and 164m the beach has eroded, whereas seawards of 164m the beach has overall accreted. The beach level generally remains within the range envelope of the previous surveys; however, it is locally at the lowest in places where erosion has occurred.</p>	
<p>26th Oct – 1st Nov 2023</p>	<p>Topographic Survey:</p> <p>Coatham Sands is covered by an annual topographic survey extending from the South Gare Breakwater. The survey is contiguous with the 6-monthly Redcar Sands survey. Data have been used to create a DGM (Appendix B – Map 1) using GIS. This shows that the beach contours remain shore parallel along the frontage, with a gentle beach slope. The beach is narrower and steeper to the north west of the subtle promontory around 1km SE of the breakwater and of shallower gradient further south-east.</p> <p>GIS has also been used to calculate the differences between the current topographic survey (November 2023) and the earlier topographic survey (October 2022), as shown in Appendix B – Map 6.</p> <p>The plot shows that the change across Coatham Sands has varied since October 2022. In the north of the bay, the change is more intense. Accretion has generally occurred across the lower beach and erosion across the upper beach. The change is limited to $\pm 1.25\text{m}$. In the south of the bay the change is more modest, large swathes of no change are interspersed with low magnitude pockets of erosion and accretion.</p>	

2.2 Redcar Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>26th Oct – 1st Nov 2023</p>	<p>Beach Profiles:</p> <p>Redcar Sands is covered by three beach profile lines during the Full Measures survey (RC5 to RC7; Appendix A), with RC7 being approximately on the boundary with the Marske Sands area.</p> <p>Profile 1cRC5, located adjacent to Redcar Rocks, is defended by a recurve seawall and stepped revetment. Beach levels at the toe of the revetment, although unchanged, remain at a very low level exposing the concrete apron below the steps. The upper beach between chainage 19m and chainage 70m has accreted by up to 0.35m in level. Seawards of chainage 70m, the rocky foreshore remains exposed with all changed limited to ± 0.1m. The profile remains at a very low level when compared to the range of the previous surveys.</p> <p>At profile 1cRC6, the section is defended up to chainage 52m and has remained unchanged over this length. From the toe of the defences to chainage 68m, the cobbly upper beach has accreted marginally by 0.1m in level. Seawards of 68m, the beach profile has been dominated by erosion across its entirety. The beach has dropped by up to 0.45m in level. In general, the profile is at a very low level when compared to the range of the previous surveys, including in a number of places where the profile is at the lowest level on record.</p> <p>Profile 1cRC7 has experienced very little change on the cliff top, face and upper beach up until chainage 88m. Seawards of chainage 88m, the profile has been dominated by erosion of varying magnitude between 0.1m and 0.4m in level. The upper beach, although unchanged, remains at the lowest level on record between chainage 59m and 96m. The lower beach is at a medium level compared to the range of the previous surveys.</p>	<p>The widescale erosion, particularly in Profiles 1cRC6 and 1cRC7, can be explained due to the timing of the 2023 Full Measures Survey. The survey followed storm Babet that occurred late October which hit the coast from a North Eastly direction (perpendicular to the frontage). Widescale erosion was observed across much of the North East coastline as a result. It is expected the beach will recover given time.</p> <p>Unlike the adjacent beaches, some minor accretion has been observed, particularly adjacent to Redcar Rocks.</p> <p>The significant drop in beach level at Coatham Rocks is understood to have caused structural and operation issues with the adjacent slipways and associated steps.</p> <p>Longer term trends:</p> <p>There is an overall trend of sediment moving from north to south along Redcar sands. Beach levels remains at a medium level highlighting recovery since the storms and surge of winter 2013/14, although remain low between Redcar rocks where the rocky foreshore is exposed.</p>
<p>26th Oct – 1st Nov 2023</p>	<p>Topographic Survey:</p> <p>Redcar Sands is covered by a six-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 2) using GIS. The plot shows shore-parallel contours for most of the frontage with the exception of the section between the Redcar Rocks and West Scar where there is less sediment</p>	<p>The new hard defences at Redcar have affected the patterns of accretion on the upper beach due to the introduction of a less reflective seawall.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>and so the contours are distorted by the rocky foreshore. The shore-parallel contours to the south of Redcar Rocks are locally indented where beach groynes are affecting sediment movement.</p> <p>The GIS has also been used to calculate the differences between the current topographic survey (November 2023) and the previous full measures survey (October 2022) and the most recent (April 2023) topographic survey, as shown in Appendix B – Maps 7 and 11, to identify areas of erosion and accretion.</p> <p>Since October 2022, change has occurred in alternating shoreline parallel blocks, At the transition to Coatham sands the beach has experienced low level accretion. At Coatham Rocks, Intense erosion up to -1.5m spans has occurred, before transitioning back to low level accretion at Redcar Rocks. To the east of Redcar Rocks, the beach has been completely dominated by erosion, a pattern that extends into the adjoining Marske and Saltburn sands (discussed below). The magnitude of erosion is generally between -0.5m and -1.0m.</p>	

2.3 Marske Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>26th Oct – 1st Nov 2023</p>	<p>Beach Profiles:</p> <p>Marske Sands is covered by two beach profile lines during the Full Measures survey (RC7 to RC8; Appendix A), with RC7 being approximately on the boundary with the Redcar Sands area.</p> <p>Profile 1cRC7 is located along The Stray and has been discussed in Section 2.2. At profile 1cRC8, there is no significant change to the face of the cliff and upper beach up until chainage 90m. The beach generally has been dominated by erosion, with the beach dropping in level by up to 0.3m between chainage 90m and 240m. Minor accretion is observed seawards of 240m over a 30m length. The profile is generally at a medium level when compared to the range of previous surveys, however it is locally a at a very low level between chainage 82m and 108m.</p>	<p>The widescale erosion observed in both the profile and the topographic survey can be explained due to the timing of the 2023 Full Measures Survey. The survey followed storm Babet that occurred late October which hit the coast from a North Eastly direction (perpendicular to the frontage). Widescale erosion was observed across much of the North East coastline as a result. It is expected the beach will recovery given time.</p>
<p>26th Oct – 1st Nov 2023</p>	<p>Topographic Survey:</p> <p>Marske Sands is covered by an annual topographic survey. This survey is contiguous with the Redcar Sands and Saltburn Sands topographic surveys that are both surveyed six-monthly. Data have been used to create a DGM (Appendix B – Map 8) using GIS. The figure shows that the topographic contours are generally shore parallel on the upper and middle beach but become less uniform on the lower beach as the profile plateaus.</p> <p>The GIS has also been used to calculate the differences between the October 2022 and November 2023 topographic survey, as shown in Appendix B – Map 8. The plot shows that Marske Sands has been totally dominated by erosion since the previous survey. The magnitude of erosion is generally between -0.5m and -1.0m. One local band of accretion is observed on the lower beach fronting cliff house.</p>	<p>Longer term trends: Current beach profiles are at a medium level compared with the range of previously recorded results having recovered from the particularly low levels after winter 20/21. Recorded changes are largely due to the movement of bars on the beach, which is also shown on the topographic difference plots.</p>

2.4 Saltburn Sands

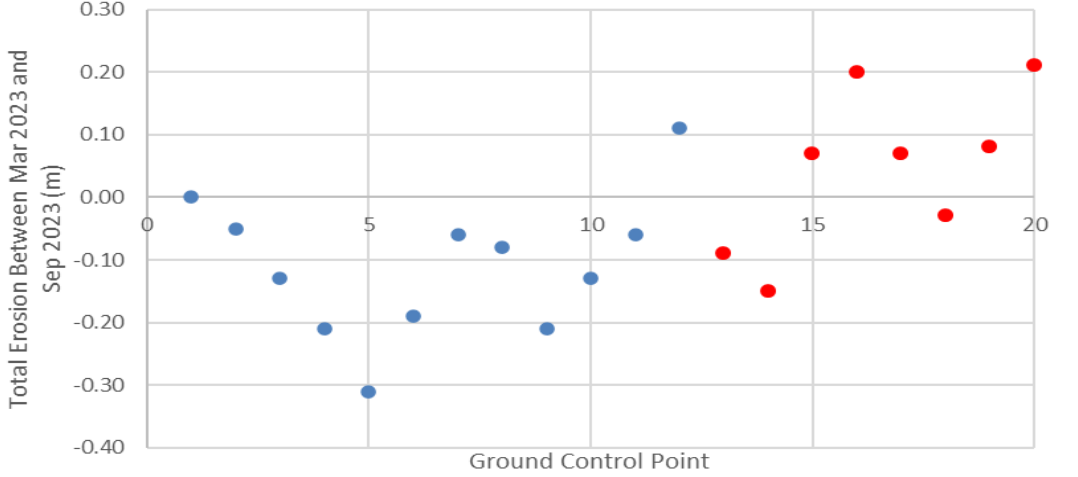
Survey Date	Description of Changes Since Last Survey	Interpretation
<p>26th Oct – 1st Nov 2023</p>	<p>Beach Profiles:</p> <p>Saltburn Sands is covered by one beach profile during the Full Measures survey (RC9; Appendix A).</p> <p>At profile 1cRC9, there has been no change across the defended section of the profile (chainage 0m to 21m). At the toe of the seawall, the steep cobble berm has locally accreted by 0.35m, tapering to no change by chainage 26m. From the toe of berm seawards, the beach level has dropped consistently by 0.3m across the whole profile. Overall, the beach is at a medium to low level compared to the range recorded from previous surveys.</p>	<p>The widescale erosion observed in both the profile and the topographic survey can be explained due to the timing of the 2023 Full Measures Survey. The survey followed storm Babet that occurred late October which hit the coast from a North Eastly direction (perpendicular to the frontage). Widescale erosion was observed across much of the North East coastline as a result. It is expected the beach will recovery given time.</p>
<p>26th Oct – 1st Nov 2023</p>	<p>Topographic Survey:</p> <p>Saltburn Sands is covered by a six-monthly topographic survey, although the survey is contiguous with the Marske Sands topographic survey that is surveyed annually. Data have been used to create a DGM (Appendix B – Map 4) using a GIS software package. This shows that the beach contours are shore parallel and gently shelving for the majority of the frontage. The contours are distorted where Skelton Beck outfalls across the foreshore and at the interface with Saltburn Pier.</p> <p>The GIS has also been used to calculate the differences over the six month period between April 2023 and October 2023 topographic survey, as shown in Appendix B – Map 12, and also the change since the last full measures survey in October 2022, to identify areas of net erosion and accretion (Appendix B – Map 9).</p> <p>The six-month difference plot (between April 2023 and October 2023) shows that change across the frontage has been limited to $\pm 0.75\text{m}$. The dominant process over that time has been erosion, particularly at, and to the west of, Saltburn pier where it has occurred in shoreline parallel bands. At the mouth of Skelton Beck, the change is more erratic with small areas of erosion and accretion observed. To the east of Skelton Beck, the erosion is again less uniform but still modest in magnitude. The annual difference plot highlights a similar pattern of dominant erosion, albeit more widescale and at a greater magnitude. The only accretion observed across the whole bay has occurred locally at the eastern extents and at the mouth of Skelton Beck.</p>	<p>It is understood the local accretion at the toe of the sea wall observed in profile 1cRC9 is creating a ramping effect for approaching waves exacerbating flooding issues. It is understood that the council is looking to commission a beach management plan to for the area to help address this.</p> <p>Longer term trends: The trend of increasing erosion through the winter months with some recovery over the summer appears to be leading to the progressive erosion and drawdown of the beach. This pattern has been experienced for several years.</p>

2.5 Cattersty Sands (Skinningrove)

Survey Date	Description of Changes Since Last Survey	Interpretation
<p style="text-align: center;">29th September 2023</p>	<p>Topographic Survey:</p> <p>Cattersty Sands is covered by a six-monthly topographic survey.</p> <p>Data have been used to create a DGM (Appendix B – Map 4) using a GIS package. The beach is steeper to the west of the breakwater than the east, but in both areas the gradient is relatively smooth. East of the breakwater, the beach is punctuated by Skinningrove Beck and the harbour, so the gradient is shallower. Immediately east of the former fishtail groyne (which has since been modified to a rock breakwater arm), the stream has cut a channel, which is most deeply incised at its landward extent.</p> <p>The GIS has also been used to calculate the differences between April 2023 and September 2023 topographic surveys and is presented as DGM (as shown in Appendix B – Map 10), to identify areas of net erosion and accretion.</p> <p>The difference plot shows a mixture of accretion and erosion across Cattersty Sands. To the west of the breakwater, the beach is influenced by two clear areas of change. The upper beach has been dominated by accretion whereas the lower beach has been dominated by erosion., indicating the movement of sediment up the profile. The magnitude of change is up to ±1.5m.</p> <p>To the east of the breakwater, the pattern of change is more varied. Accretion has dominated around the modified fish tail groyne and in the lee of the breakwater. Erosion is observed in the channel itself and on the lower beach between the breakwater and groyne. The magnitude of change is more modest than that to the west of the breakwater.</p>	<p>To the west of the breakwater the bay is displaying patterns typical of seasonal fluctuations with movement of sediment up the profile during calmer summer months.</p> <p>The pattern to the east of the breakwater is less defined with erosion and accretion both observed. The processes here are likely influenced by the Skinning Beck and modified fishtail groyne.</p> <p>Longer term trends:</p> <p>The topographic change data shows Cattersty Sands is very dynamic, influenced by coastal and fluvial processes, along with the breakwater and the shorter rock armour groyne. As such the long term pattern of change is convoluted, broadly following seasonal fluctuations of winter drawdown and summer recovery.</p>

2.6 Staithes

Survey Date	Description of Changes Since Last Survey	Interpretation
<p style="text-align: center;">21st September 2023</p>	<p>Cliff-top Survey:</p> <p>Twenty ground control points have been established at Cowbar and Staithes for biannual cliff top monitoring. Points 13 to 20 are located on the cliffs to the south of Staithes Beck and therefore sit in the North Yorkshire Council area. Points 1 to 7 are north of the beck and therefore are within the Redcar and Cleveland unitary authority area. The separation between any two points is around 100m. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing.</p> <p>Between March 2023 and September 2023, only 3 of the 20 ground control points experienced a retreat greater than +0.1m. These were Points 12, 16 and 20 experiencing 0.11m, 0.2m and 0.21m respectively, indicating a period of relative stability. The data also shows that between the survey dates 13 of the 20 points have advanced seawards, of which 7 were outside the assumed margin of error of the survey technique (± 0.1). It is unlikely this is true change and more likely a reflection in varying vegetation levels between surveys creating difficulty in identifying the cliff top.</p> <p>Intriguingly, the plot below highlights that the vast majority of these ‘advancements’ have occurred on the cliffs to north of Staithes Beck (blue dots), whilst the limited erosion has occurred south of Staithes (Red dots). This is not easily explained and could be a number of factors including varying vegetation levels or different surveying teams.</p>	<p>Only 3 of the 20 control points have experienced retreat greater than the margin of error (± 0.1m) indicating a period of stability.</p> <p>Longer term trends: Table C1 shows that survey Location 1 has shown the greatest total erosion with a loss of 7.60m between the November 2008 baseline and September 2023, resulting in a long-term average recession rate of 0.51m/yr.</p> <p>Location 4 has also showed progressive erosion with an average recession rate of 0.15m/year. Both stations are located adjacent the old Cowbar Lane which in places has now collapsed entirely.</p> <p>Location 13 has also experienced ongoing erosion of with an average recession rate of 0.21m/year.</p> <p>Despite these long-term recessions zero of these three points have retreated since the previous survey.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	 <p>Plot 1</p> <p>Calculation of longer-term erosion rates based on the recorded change between 2008 and 2023 indicates that 17 of the 20 posts on the frontage recorded a change rate within a range of ± 0.1 m/year. Points 1, 4, and 13 show average erosion rate of above 0.1 m/yr., experiencing 0.51 m, 0.15 m and 0.21 m respectively.</p>	

3. Problems Encountered and Uncertainty in Analysis

Cliff Top Surveys

The cliff top surveys at Staithes are assumed to have a limit of accuracy of $\pm 0.1\text{m}$ due to the techniques used. In previous surveys, it was reported that posts 9 to 12 were inaccessible due to a landslip on the headland; these posts have been accessible again since 2021.

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

There are no current recommendations for 'fine-tuning' the monitoring programme.

5. Conclusions and Areas of Concern

- At Coatham Sands, It is understood that the dunes fronting the caravan park to the south are locally eroding at a greater rate, possibly exacerbated by the higher footfall. It is understood that the council is looking into commissioning a management plan that encompasses this and the wider Coatham dunes that would also align with the SMP2 refresh's change in policy recommendations.
- At Redcar Sands, Marske Sands and Saltburn Sands, widescale erosion is observed in both the profiles and the topographic surveys. This can be explained due to the timing of the 2023 Full Measures Survey. The survey followed Storm Babet that occurred late October which hit the coast from a North Eastly direction (perpendicular to the frontage). Widescale erosion was observed across much of the North East coastline as a result. It is though the beaches will recover in time.
- It is understood the significant drop in beach levels at Coatham Rocks is understood to have caused structural and operational issues with the adjacent slipways and associated steps.
- It is understood the local accretion at the toe of the sea wall observed in profile 1cRC9 is creating a ramping effect for approaching waves exacerbating flooding issues. It is understood that the council is looking to commission a beach management plan to for the area to help address this.
- At Cattersty Sands, To the west of the breakwater the bay is displaying patterns typical of seasonal fluctuations with movement of sediment up the profile during calmer summer months. The pattern to the east of the breakwater is less defined with erosion and accretion both observed. The processes here are likely complicated by the Skinningrove Beck and modified fishtail groyne.
- At Cowbar and Staithes, only 3 of the 20 control points have experienced retreat greater than the margin of error ($\pm 0.1\text{m}$) indicating a period of stability. 13 of the 20 points appeared to advanced seawards ,7 of which were outside the assumed margin of error of the survey technique (± 0.1). It is unlikely this is true change and more likely a reflection in varying vegetation levels between surveys creating difficulty in identifying the cliff top.

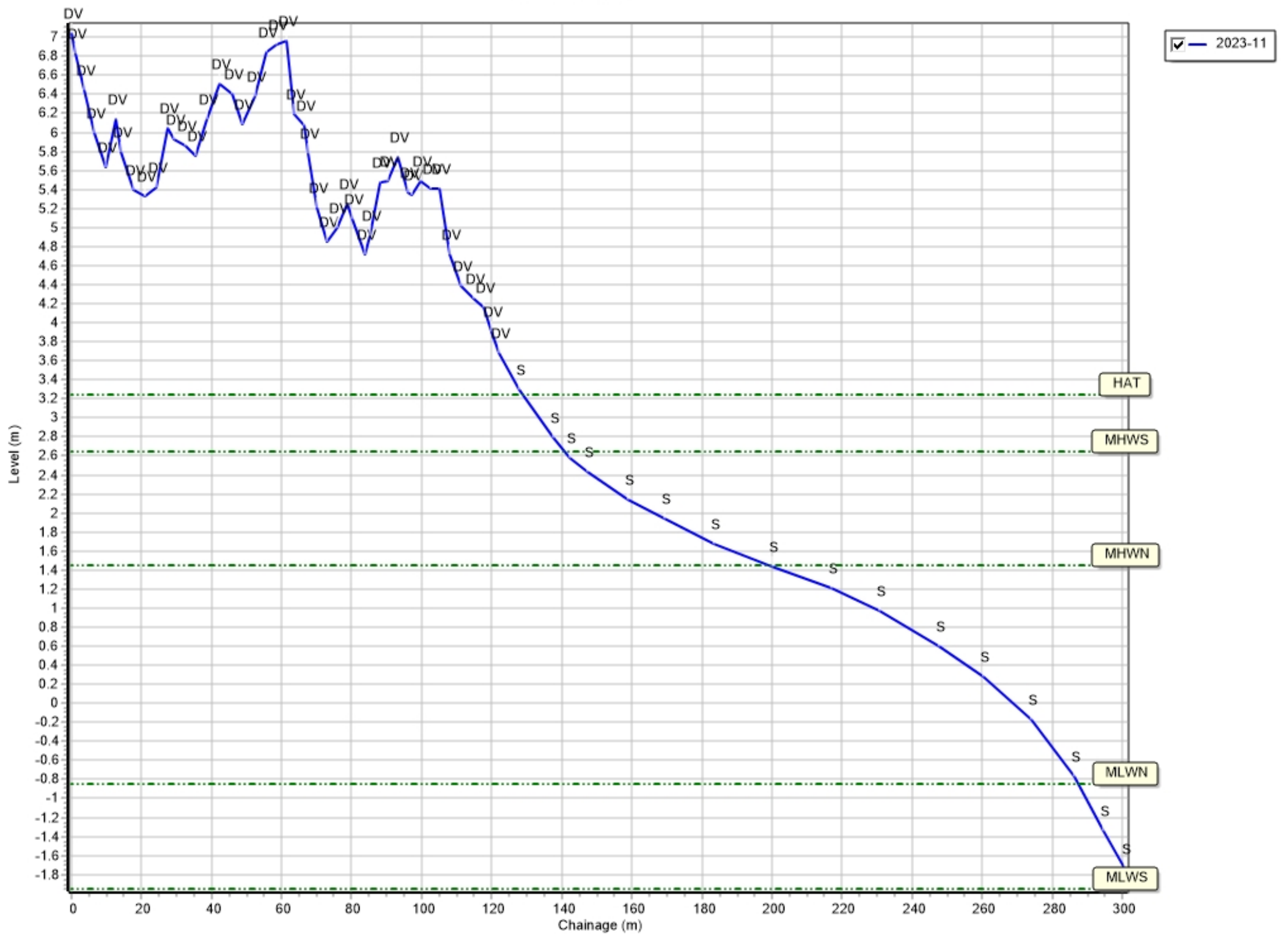
Appendices

Appendix A
Beach Profiles

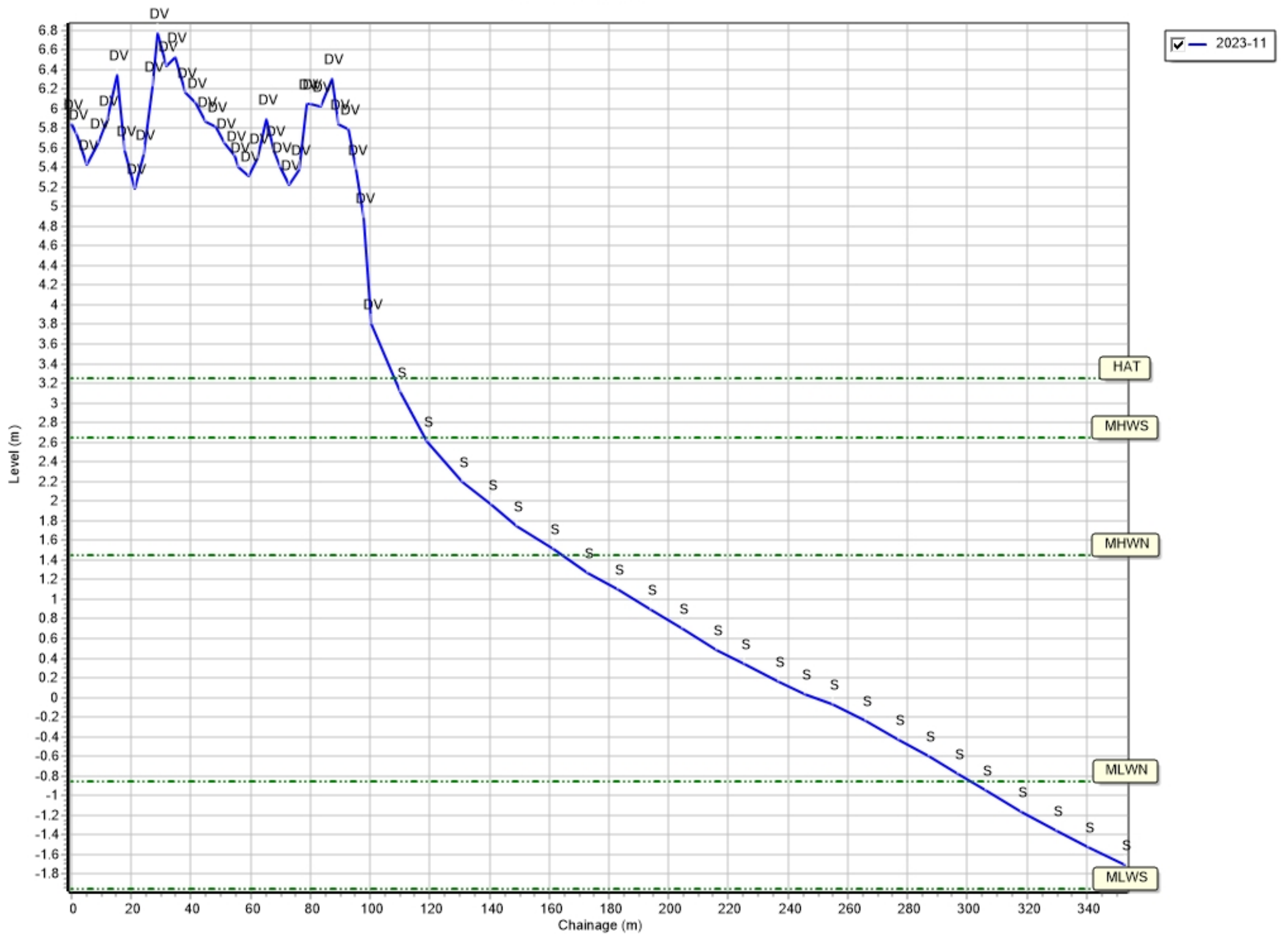
The following sediment feature codes are used on some profile plots:

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

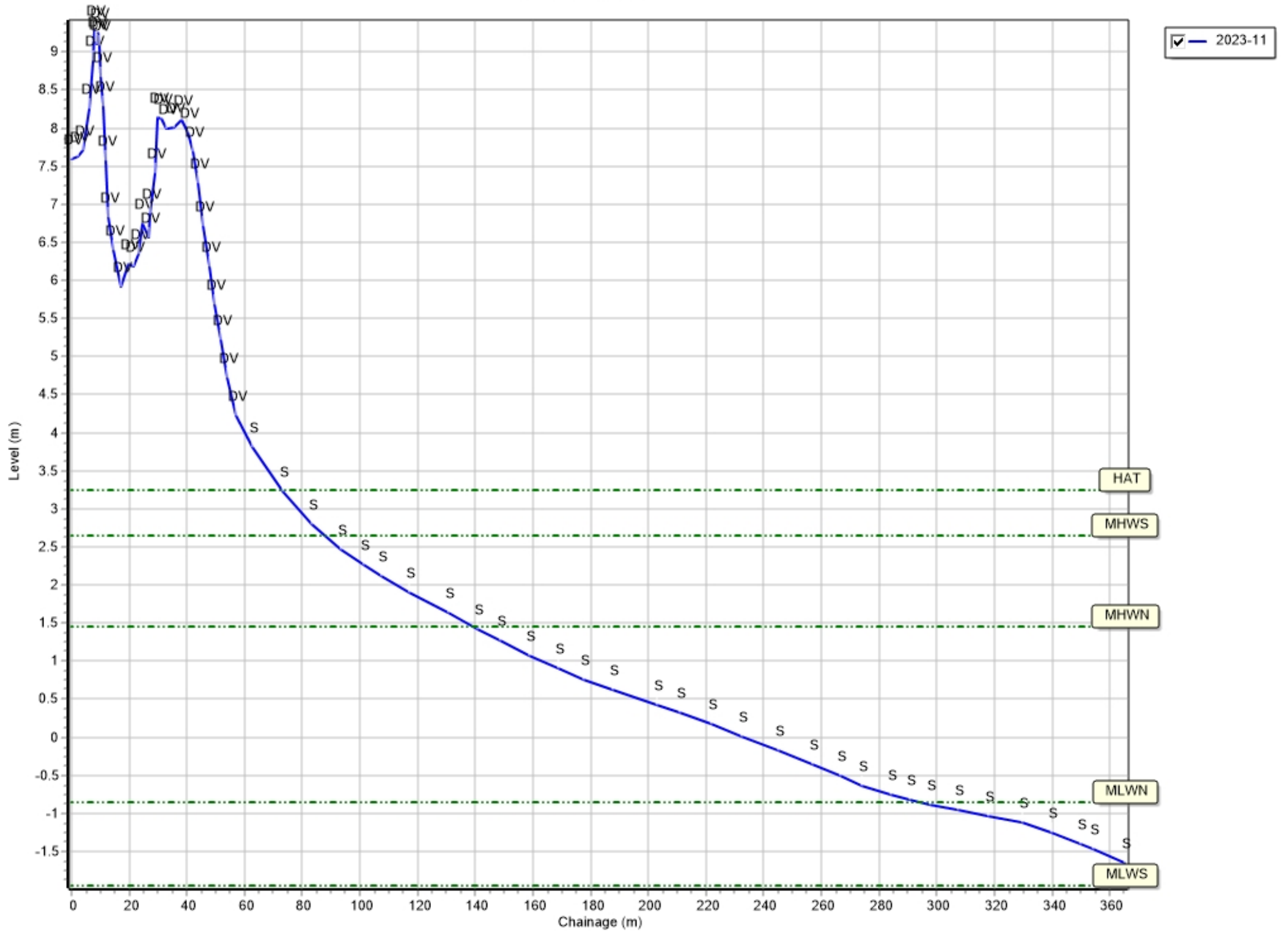
Profiles: 1cRC1



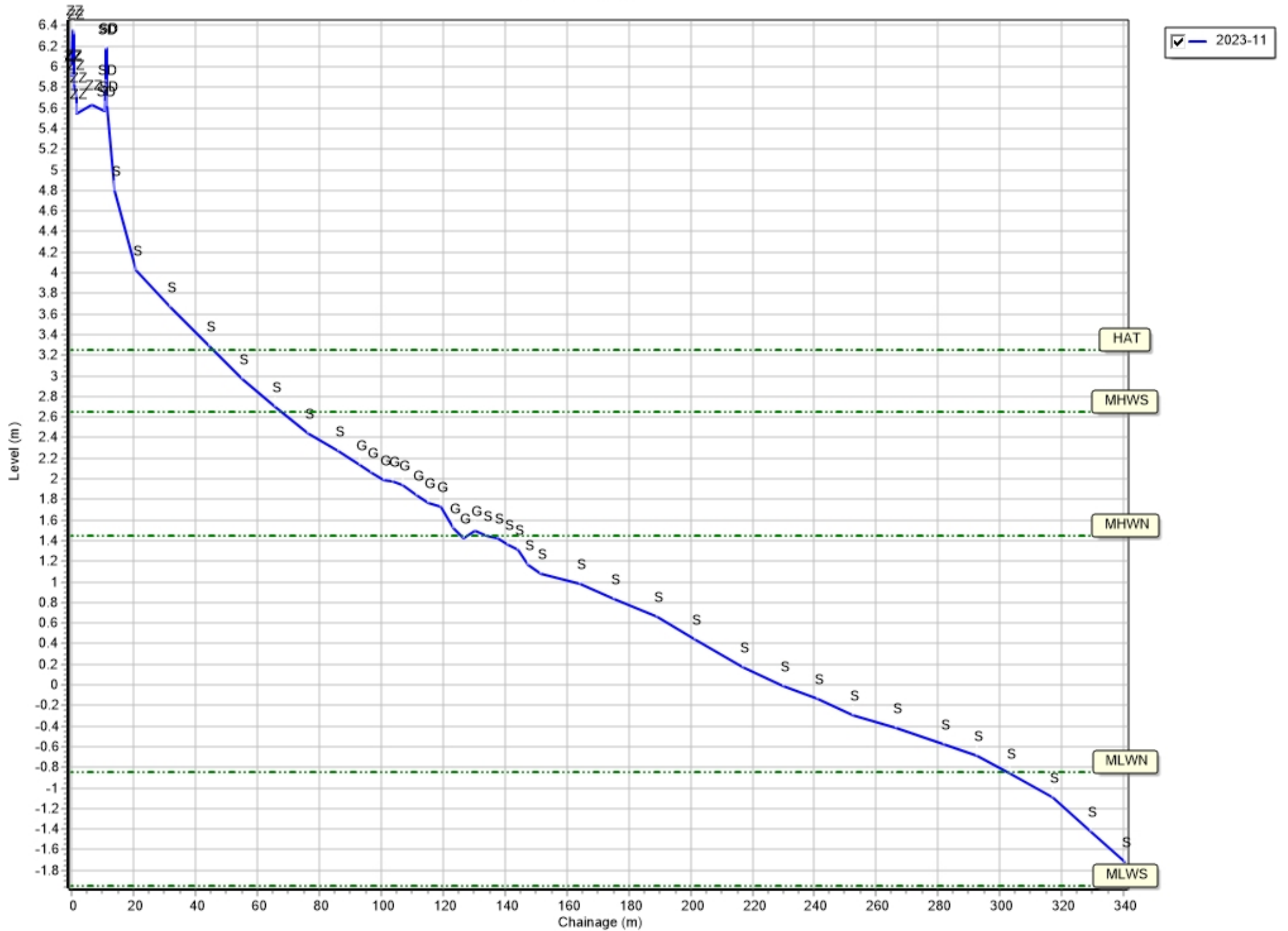
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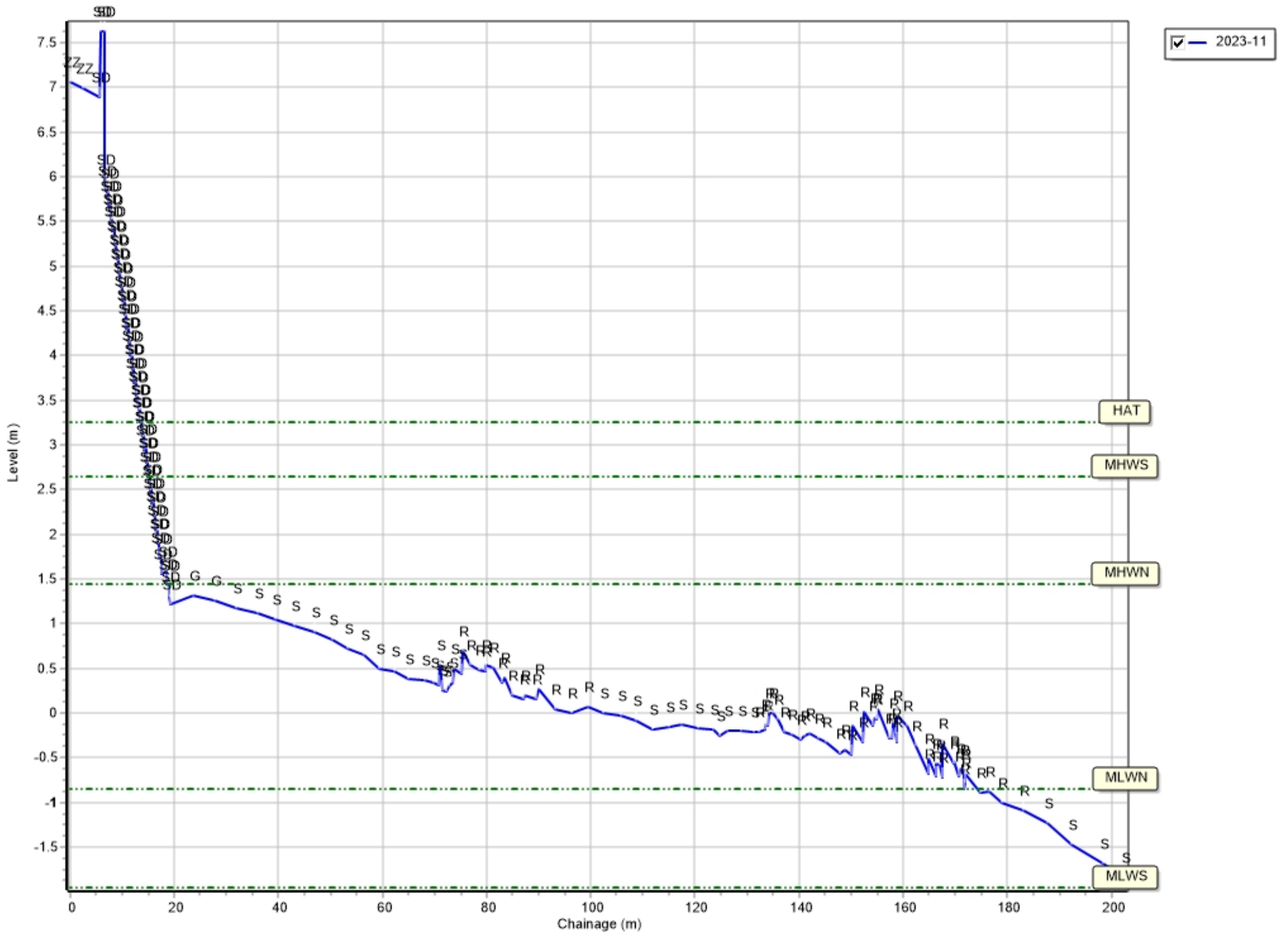
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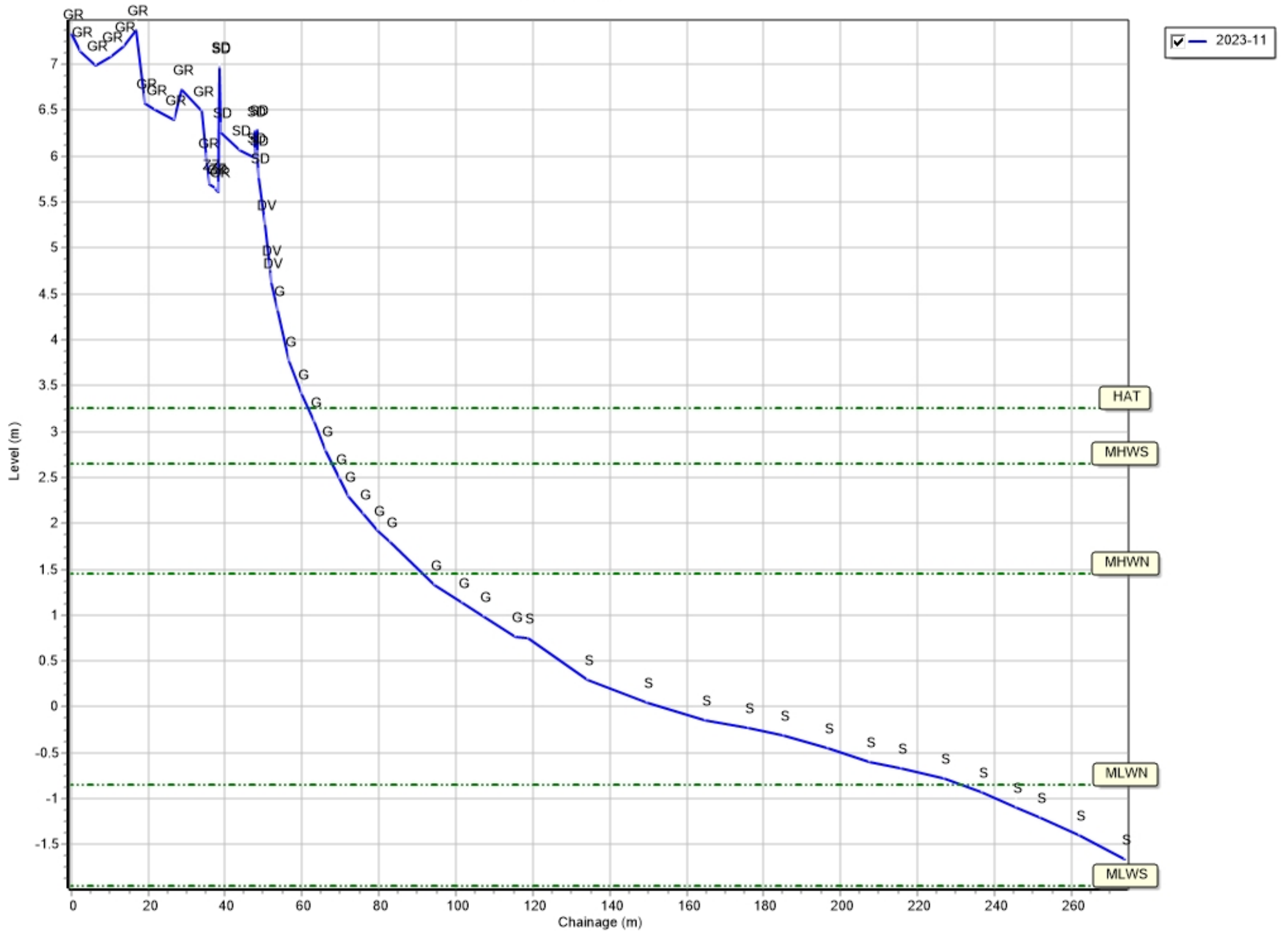
Profiles: 1cRC4



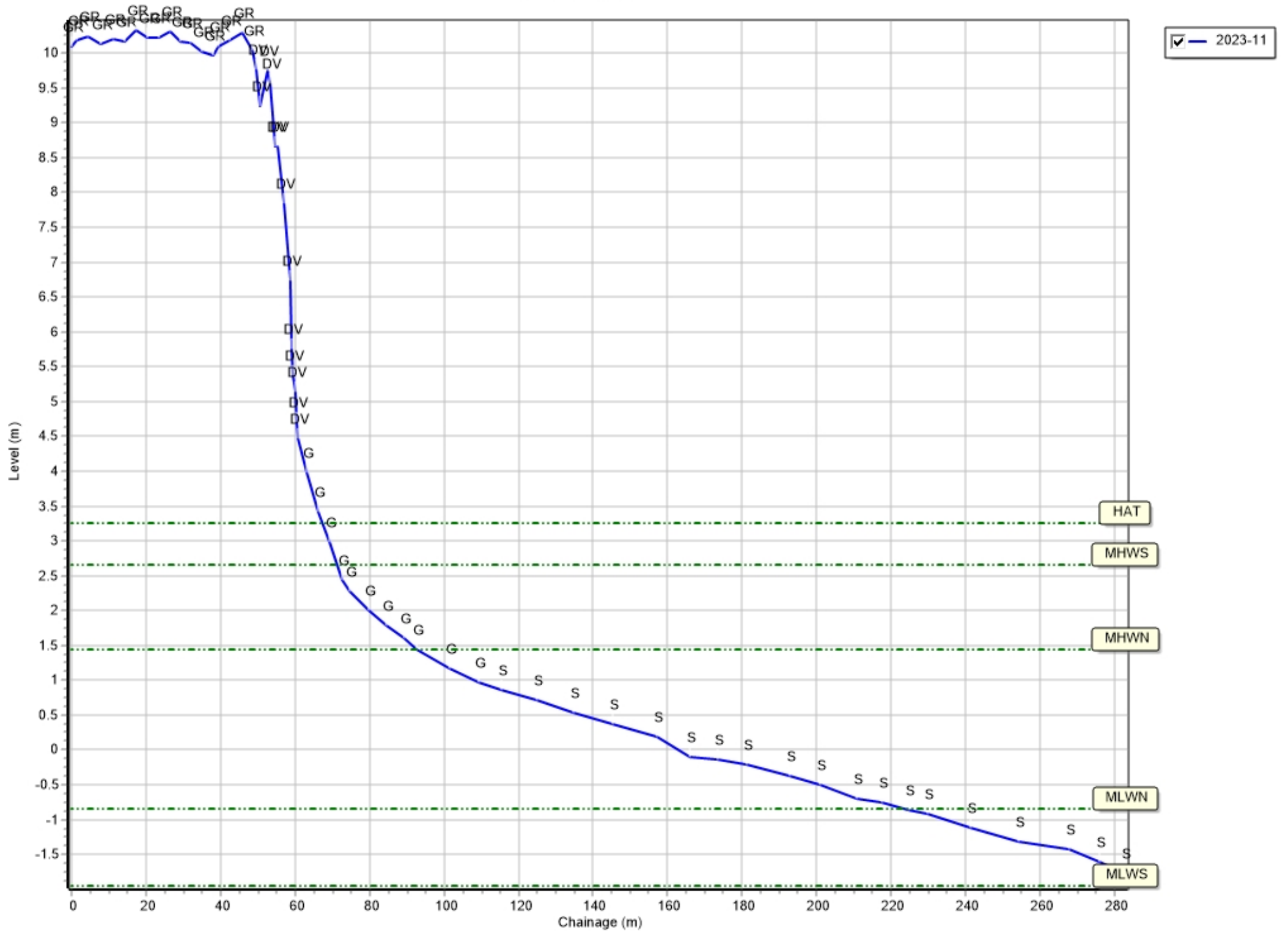
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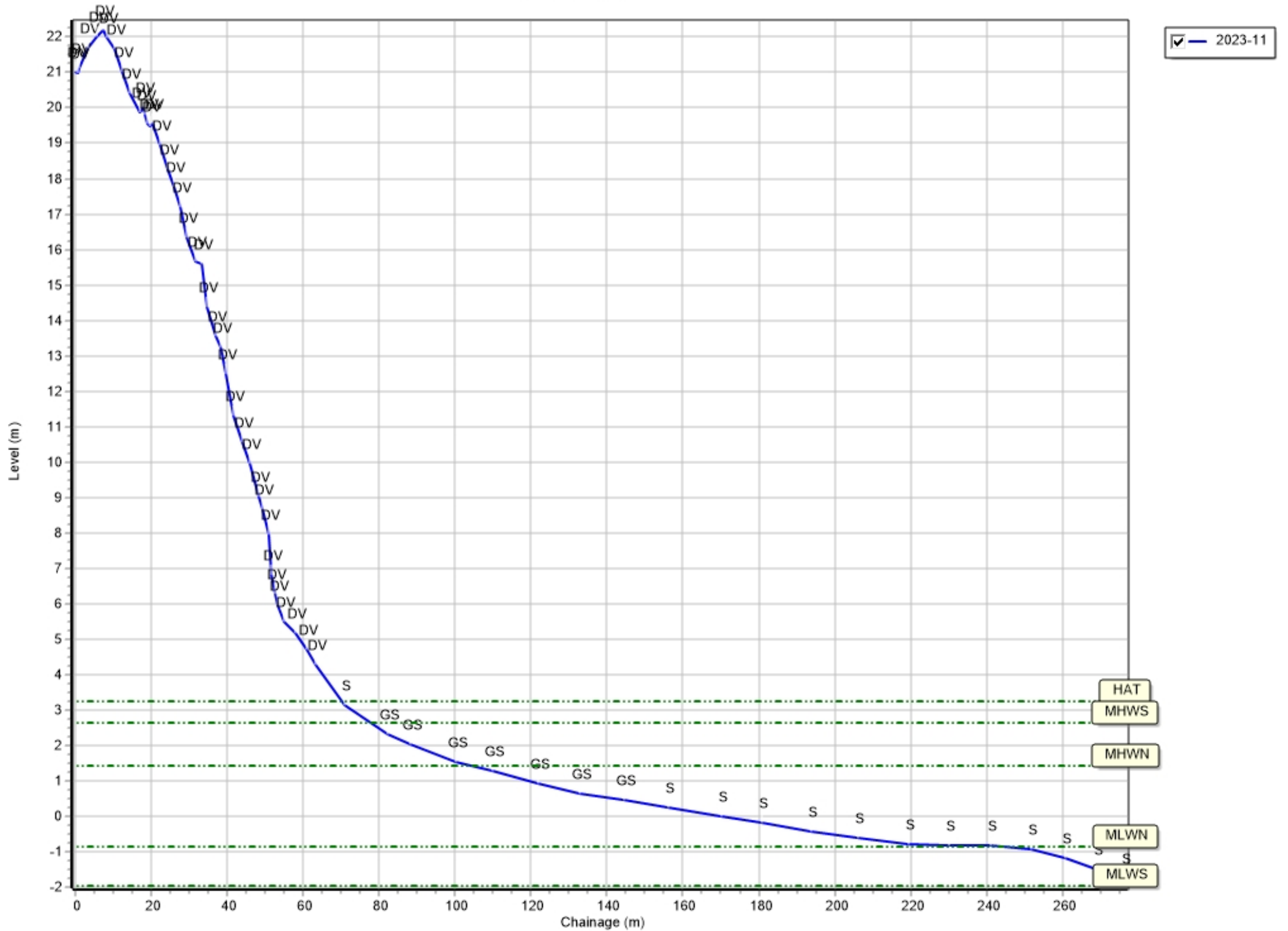
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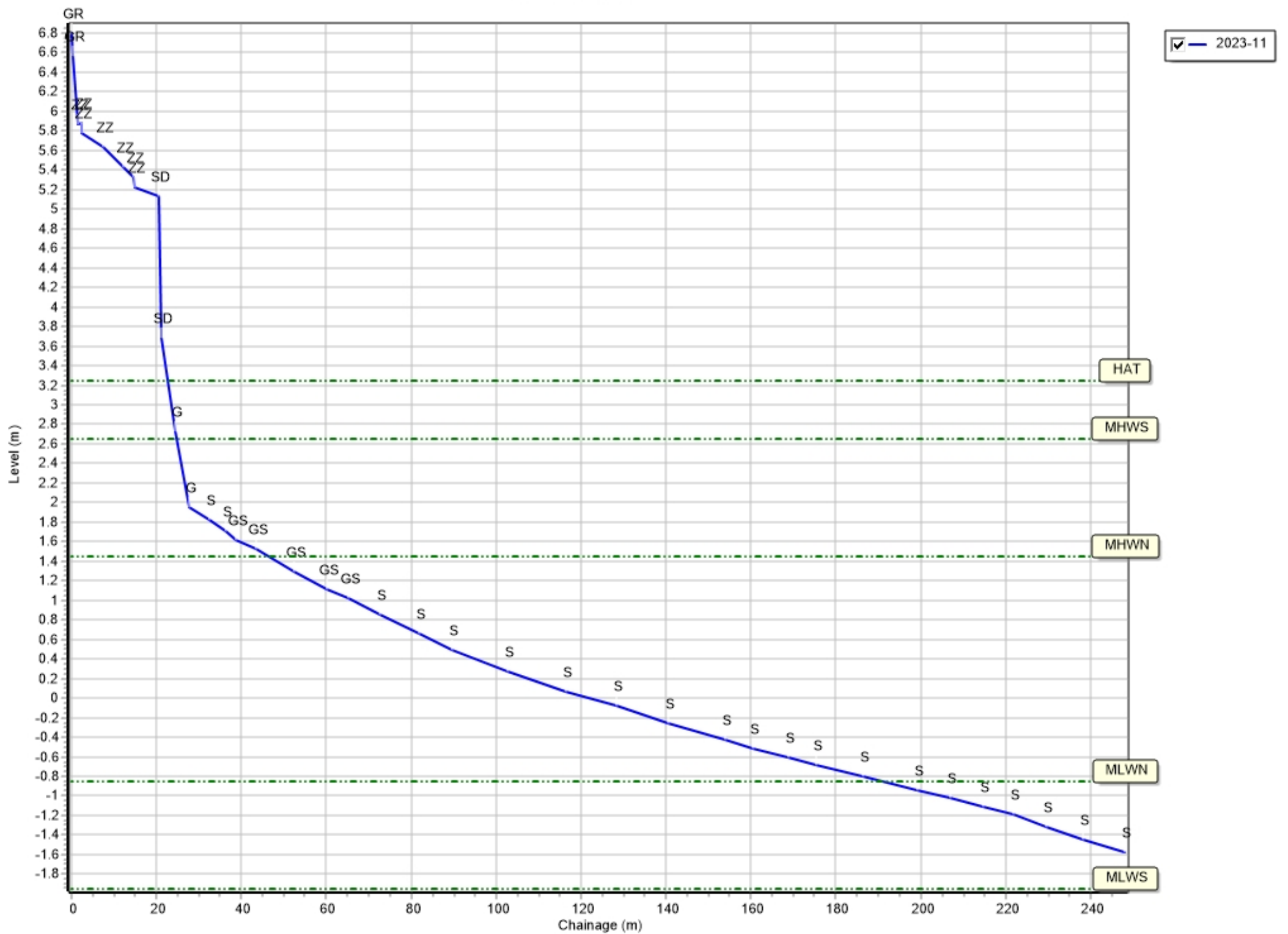
Profiles: 1cRC7



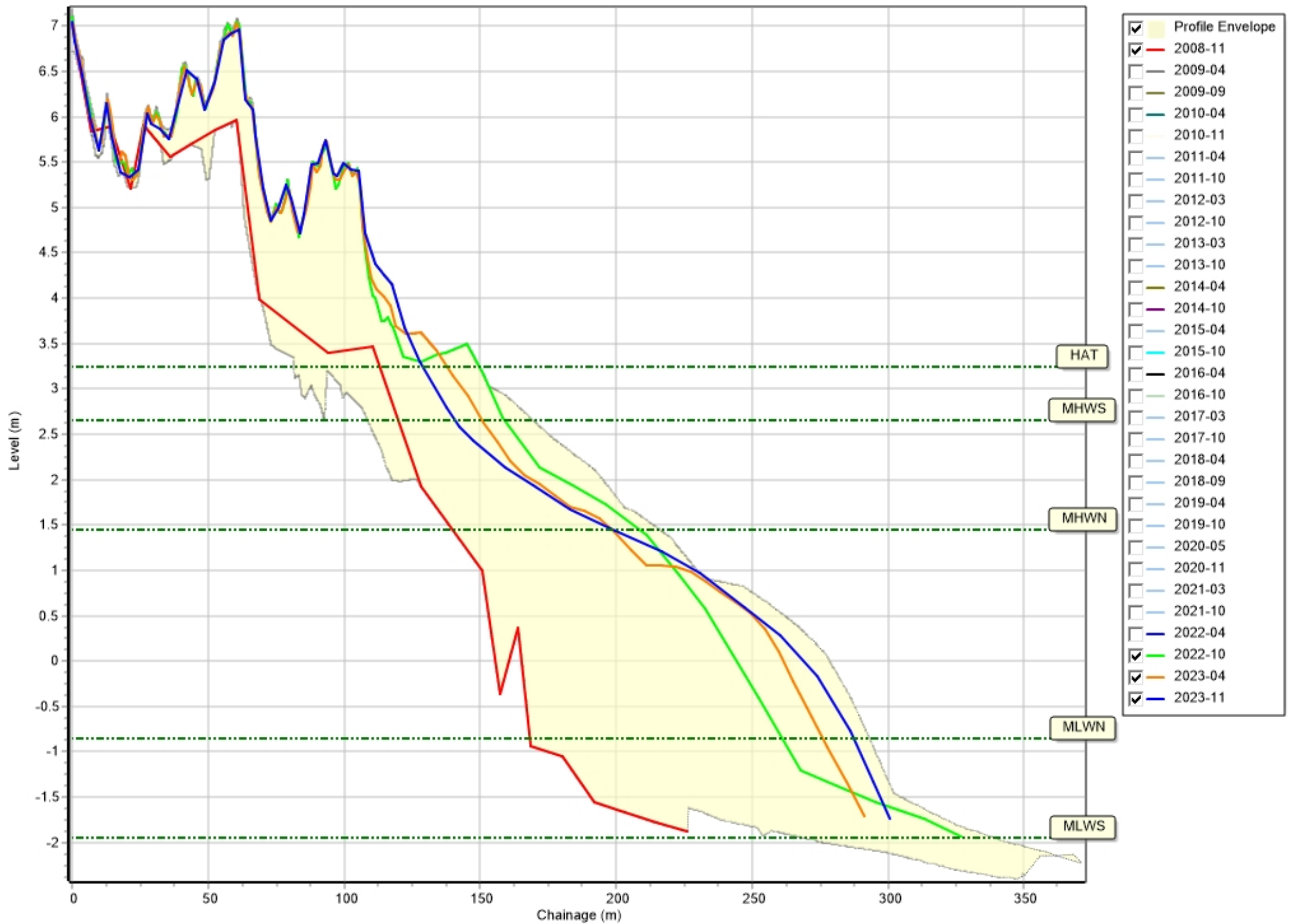
Profiles: 1cRC8



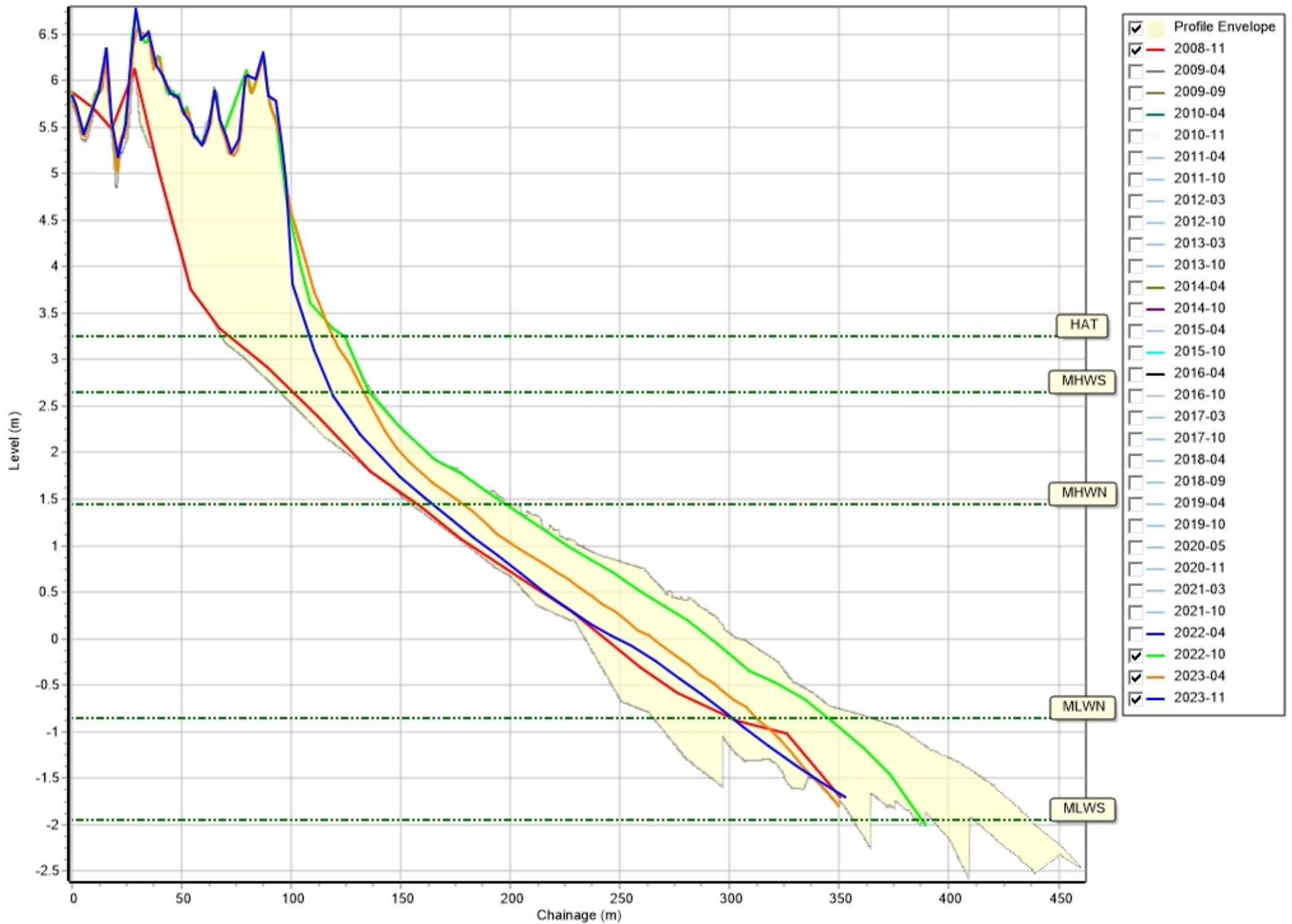
Profiles: 1cRC9



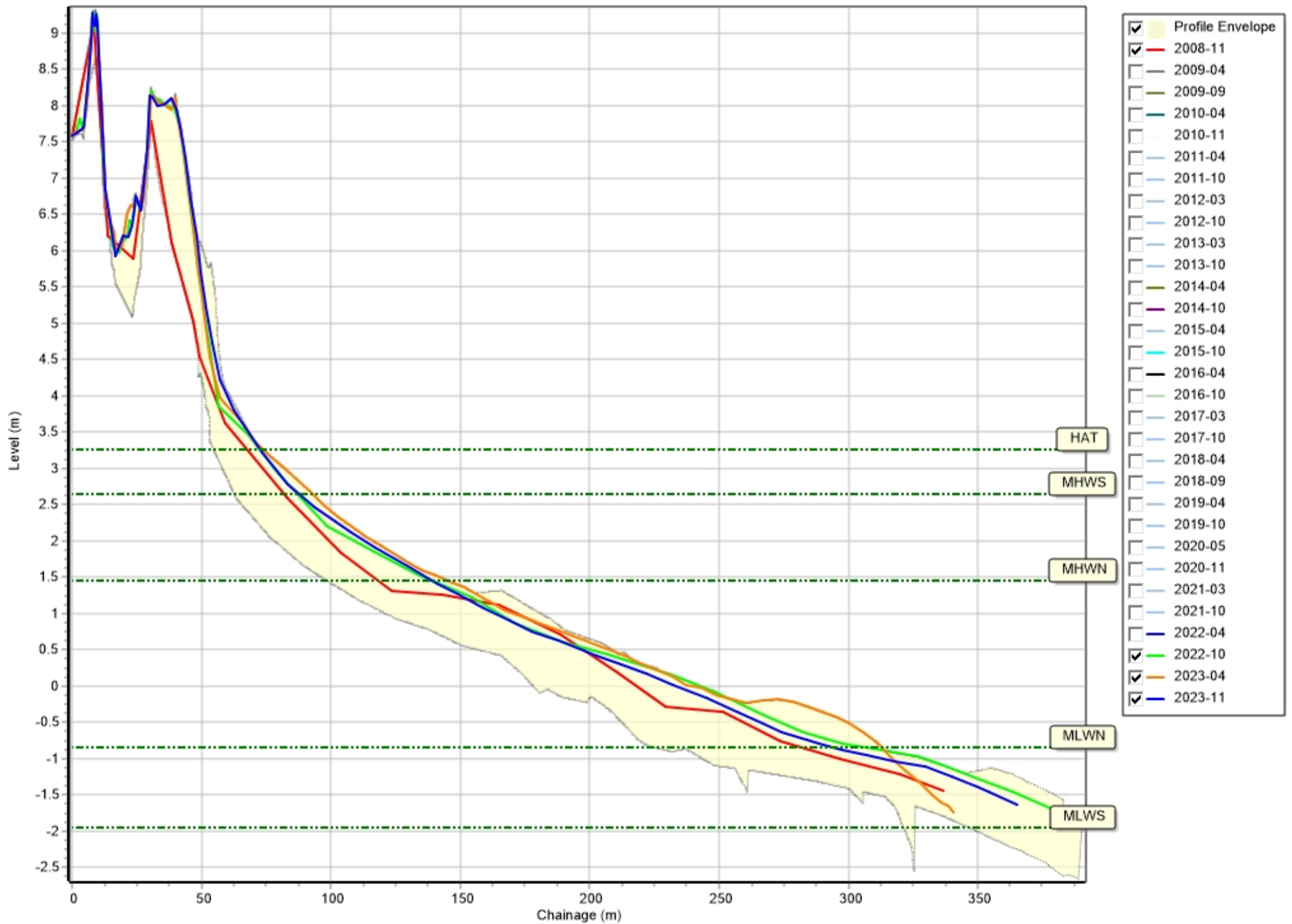
Profiles: 1cRC1



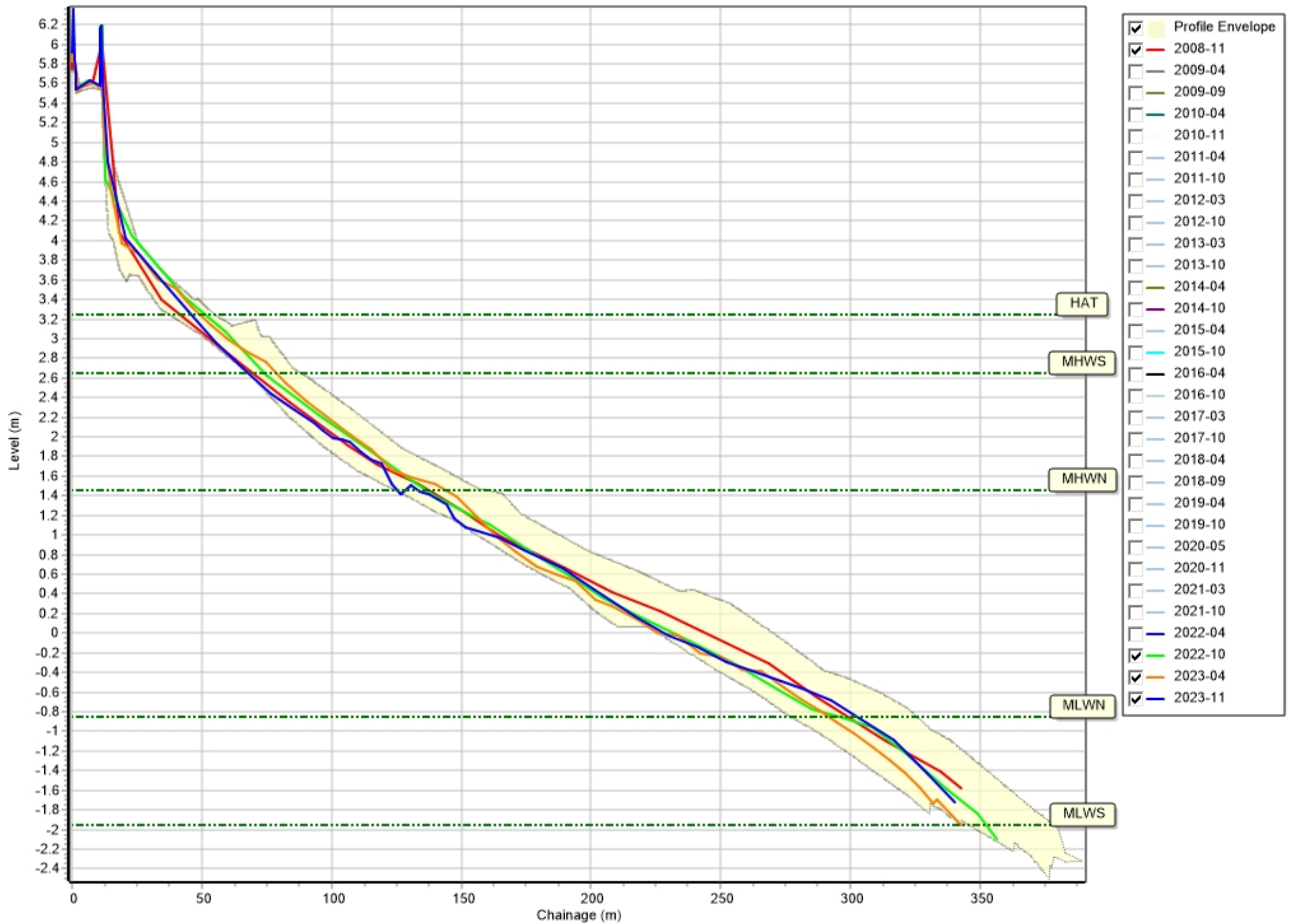
Profiles: 1cRC2



Profiles: 1cRC3



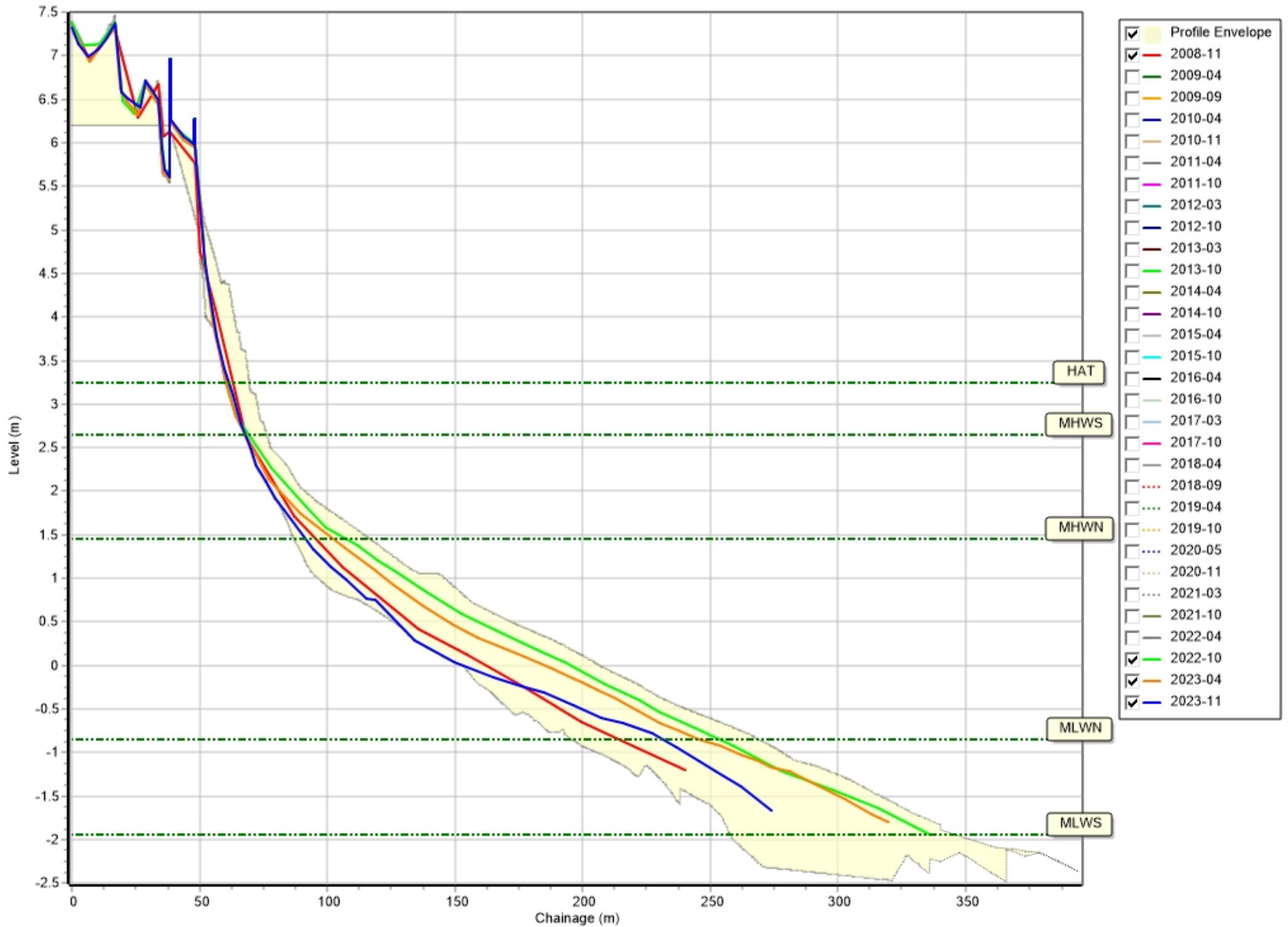
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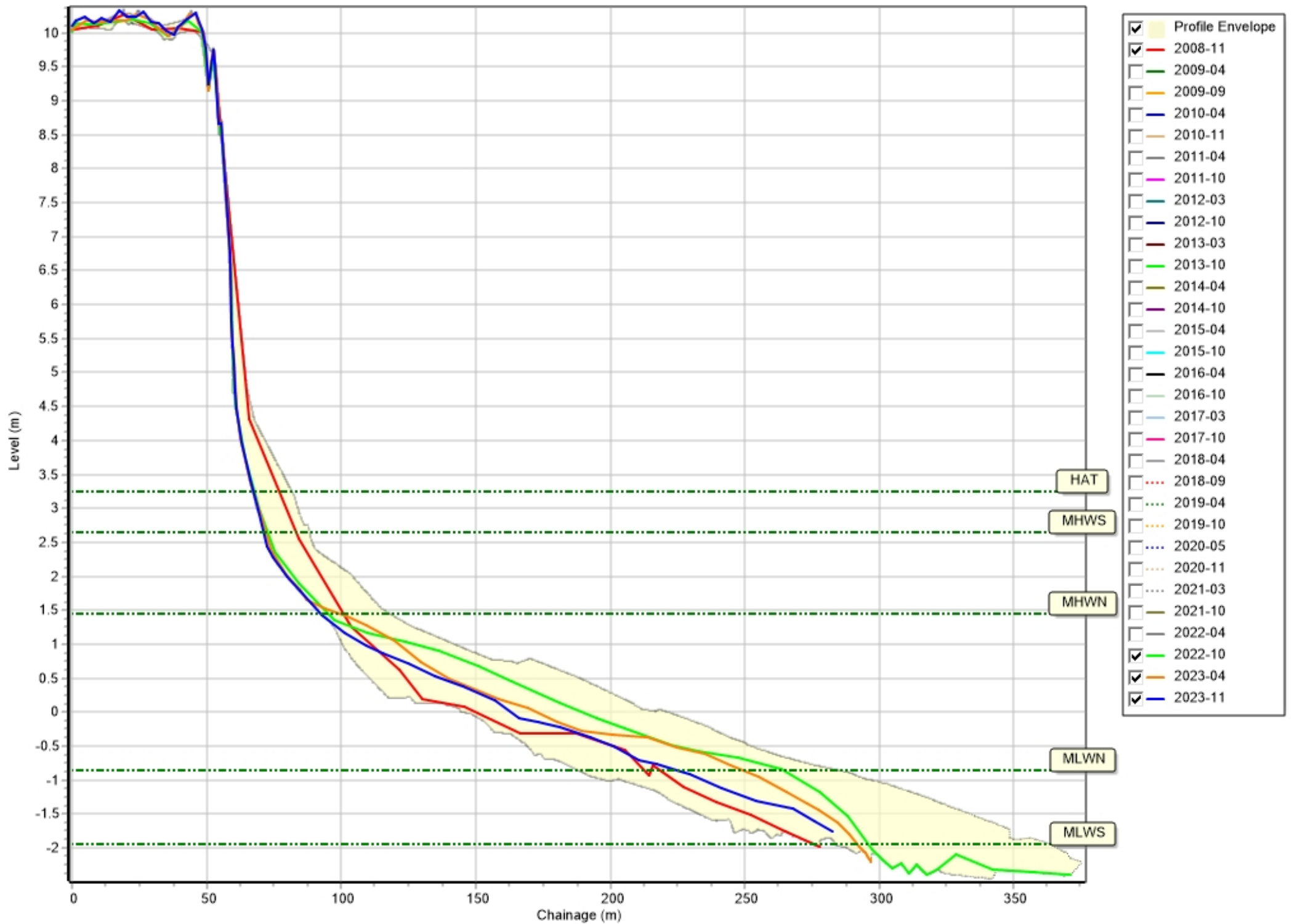
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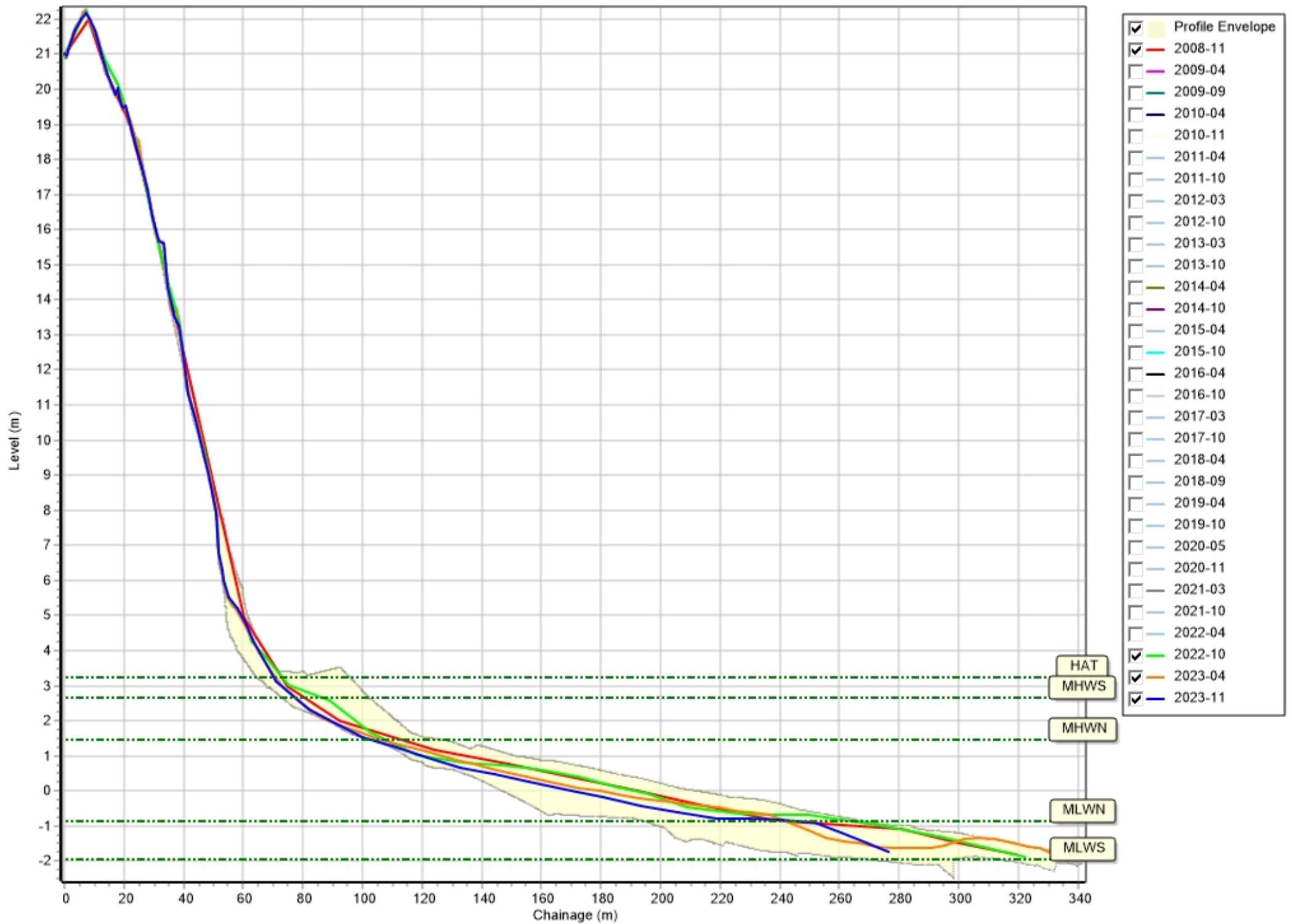
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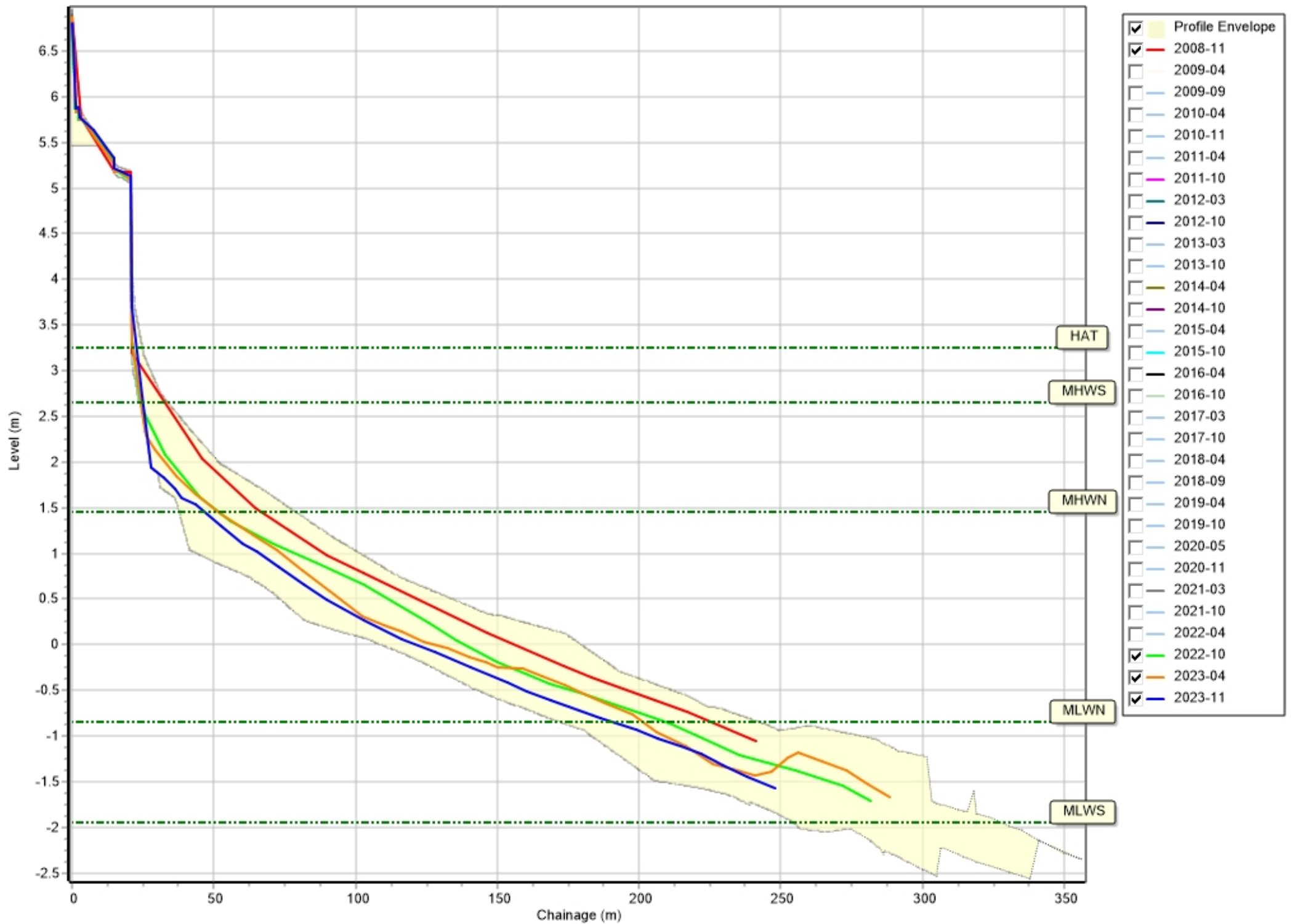
Profiles: 1cRC7



Profiles: 1cRC8



Profiles: 1cRC9



Appendix B
Topographic Survey



TOPOGRAPHIC SURVEY (November 2023)

Elevation (mOD)	Contours (mOD)*
-1.9 -- -2	— 1.0m interval
-1.9 -- -1.5	
-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	
3.6 - 4	
4.1 - 4.5	
4.6 - 5	
5.1 - 5.5	
5.6 - 6	
6.1 - 6.5	
6.6 - 7	
7.1 - 7.5	

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

Title:

Appendix B - Map 2

REDCAR SANDS

Redcar and Cleveland Borough Council Frontage

Report:

Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	TW	A3	1:15,000

Co-ordinate system: British National Grid



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 FourSquare, GeoTechnologies, Inc, METI/NASA, USGS



TOPOGRAPHIC SURVEY (November 2023)

Elevation (mOD)	Contours (mOD)*
-1.9 -- -2	— 1.0m interval
-1.9 -- -1.5	
-1.4 -- -1	
-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	
4.1 - 4.5	
4.6 - 5	
5.1 - 5.5	
5.6 - 6	
6.1 - 6.5	
6.6 - 7	
7.1 - 7.5	

* Contours only cover sandy beach areas.

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

Title:

Appendix B - Map 3

MARSKE SANDS

Redcar and Cleveland Borough Council Frontage

Report:

Analytical Report
 'Full Measures' Survey 2023

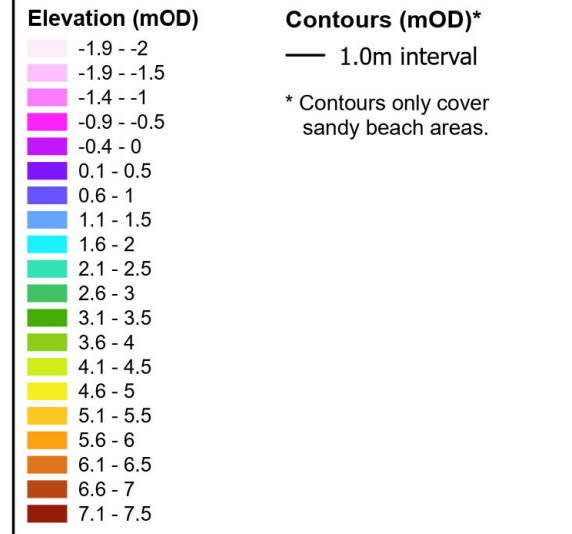
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0	15/12/2023	TC	TW	A3	1:15,000

Co-ordinate system: British National Grid





TOPOGRAPHIC SURVEY (November 2023)



Client: North East Coastal Group	Project: Cell 1 Regional Coastal Monitoring Programme
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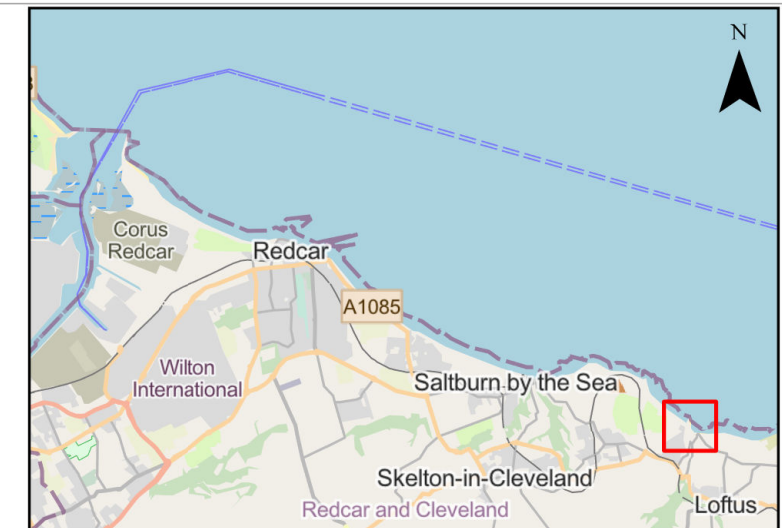
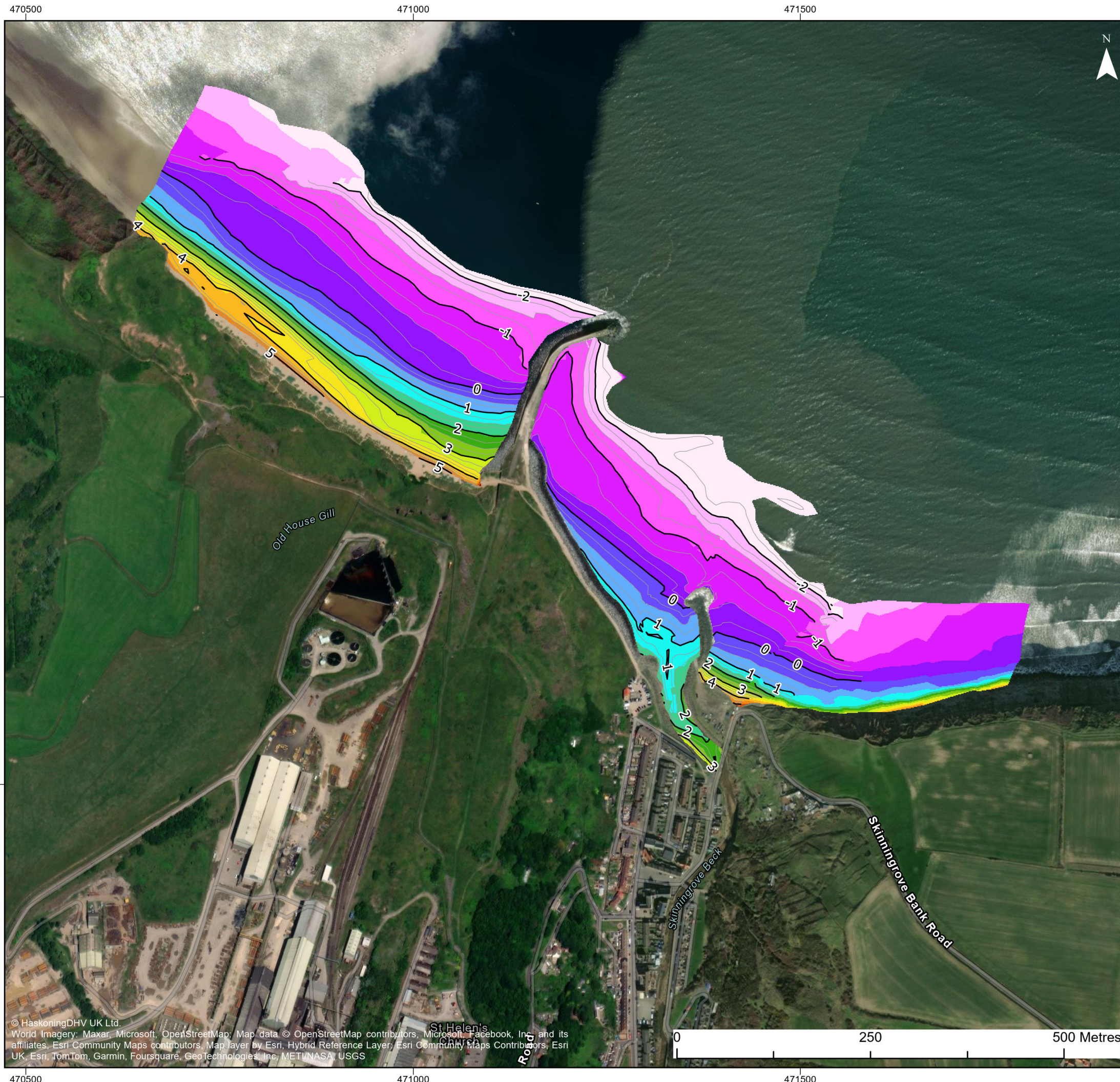
Title:
Appendix B - Map 4
SALTBURN SANDS
Redcar and Cleveland Borough Council Frontage

Report:
Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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Co-ordinate system: British National Grid





TOPOGRAPHIC SURVEY (September 2023)

Elevation (mOD)	Contours (mOD)*
-2.3 - -2	— 1.0m interval
-1.9 - -1.5	— 0.25m interval
-1.4 - -1	
-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	
4.1 - 4.5	
4.6 - 5	
5.1 - 5.5	
5.6 - 6	

* Contours only cover sandy beach areas.

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

Title:

Appendix B - Map 5

CATTERSTY SANDS (SKINNINGROVE)

Redcar and Cleveland Borough Council Frontage

Report:

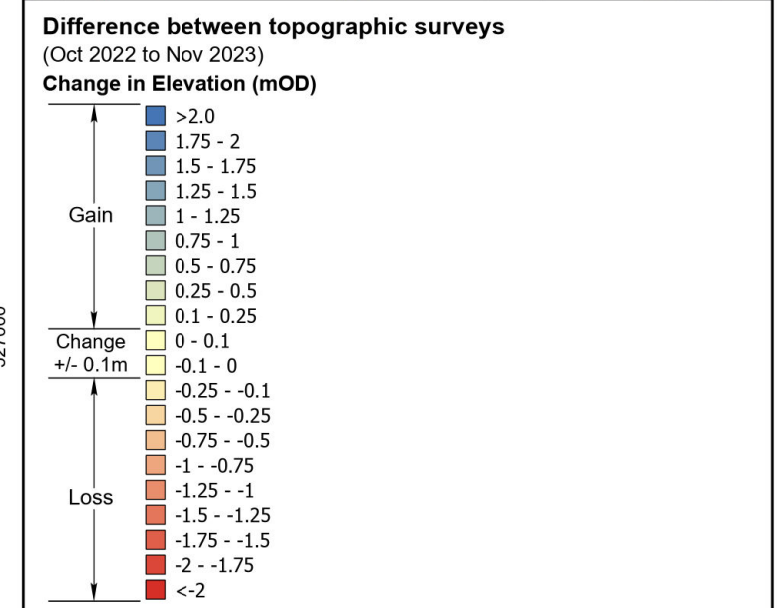
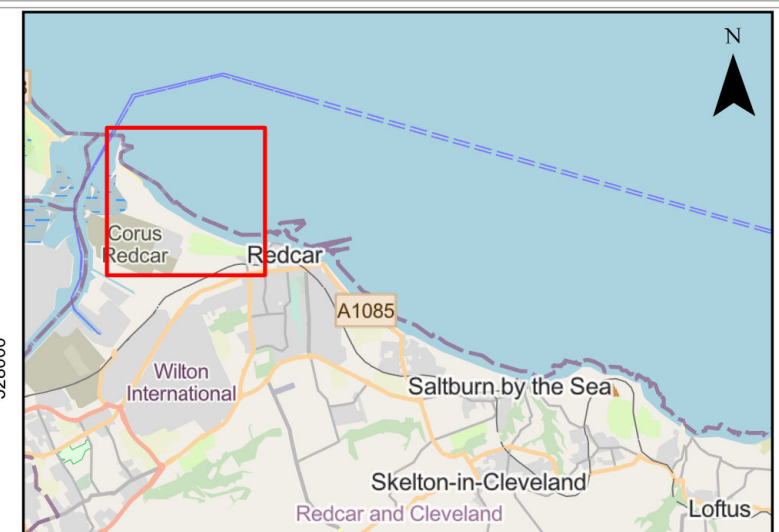
Analytical Report
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Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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Co-ordinate system: British National Grid



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Client: North East Coastal Group	Project: Cell 1 Regional Coastal Monitoring Programme
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Title:
Appendix B - Map 6
COATHAM SANDS
Redcar and Cleveland Borough Council Frontage

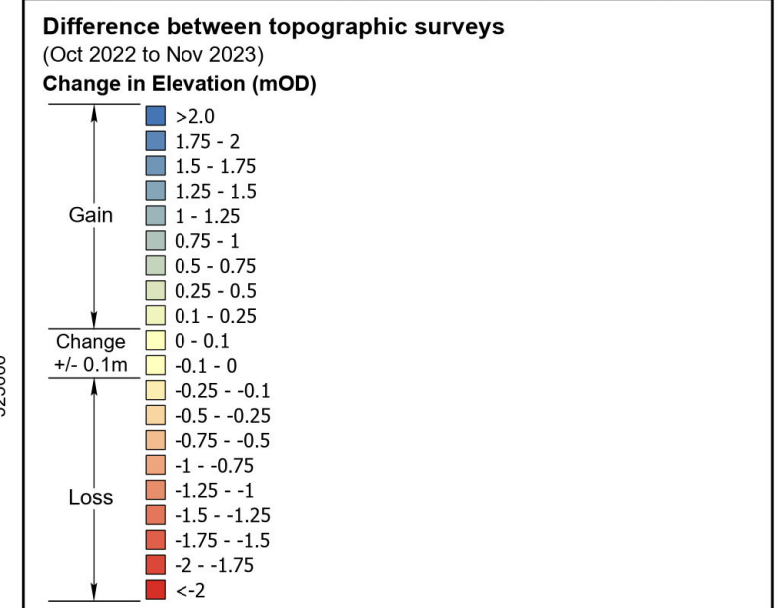
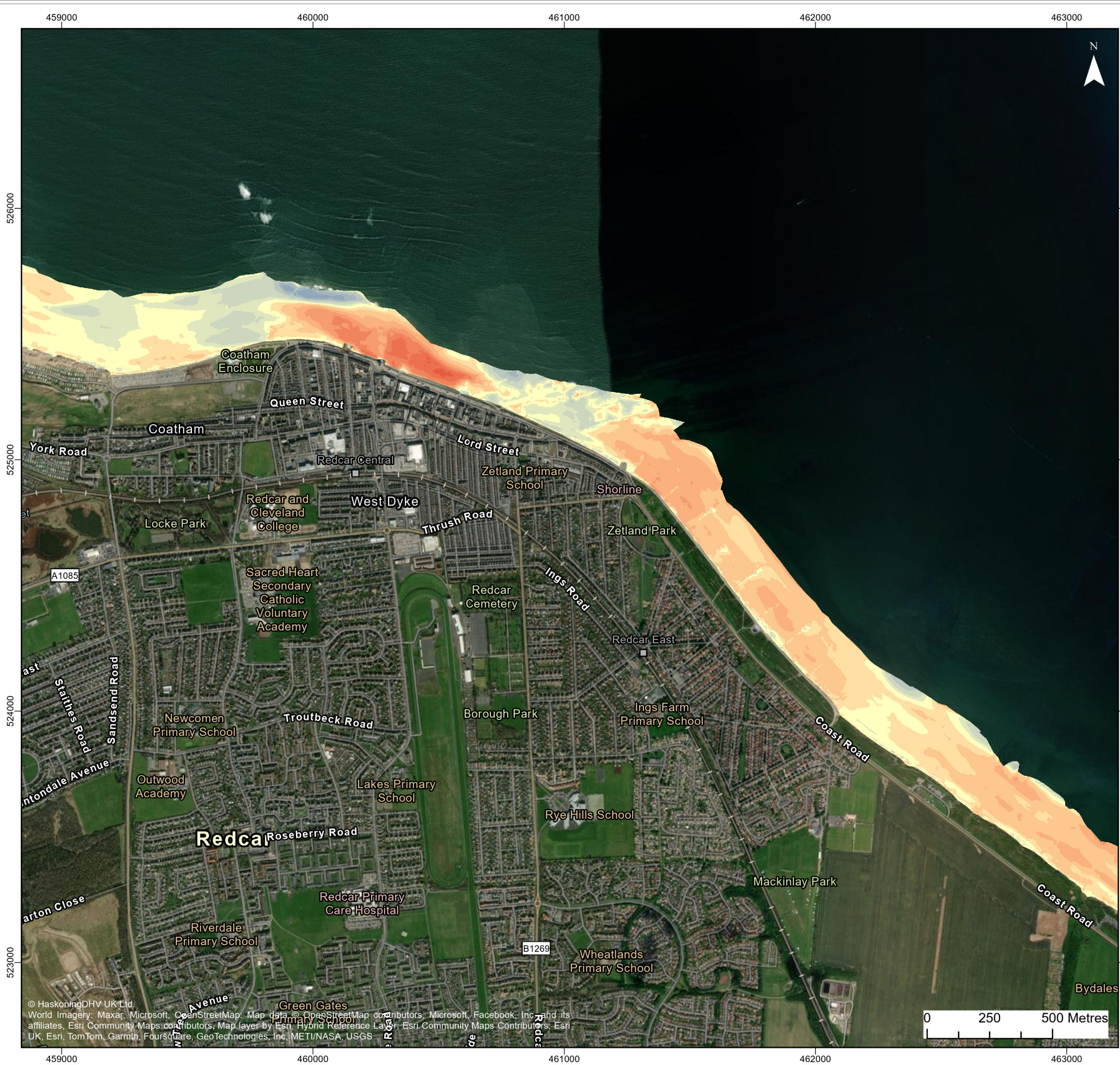
Report:
Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	TW	A3	1:15,000

Co-ordinate system: British National Grid

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

Title:

Appendix B - Map 7

REDCAR SANDS

Redcar and Cleveland Borough Council Frontage

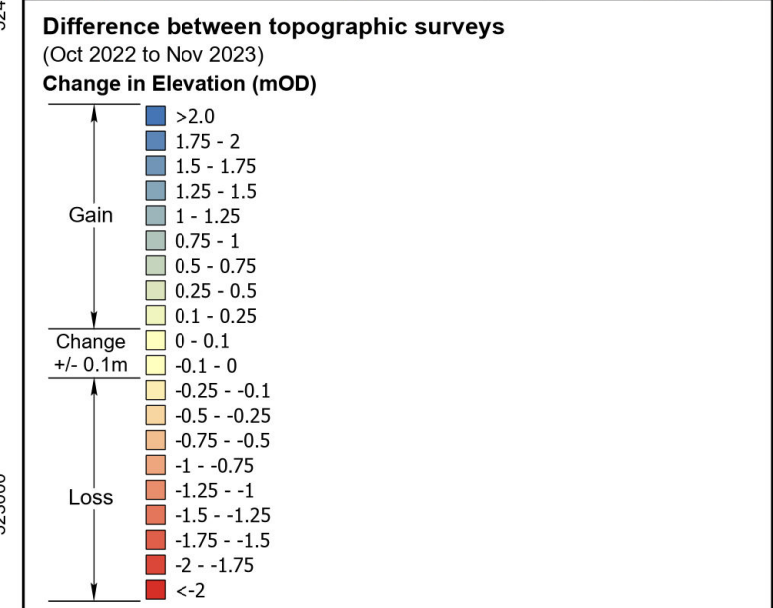
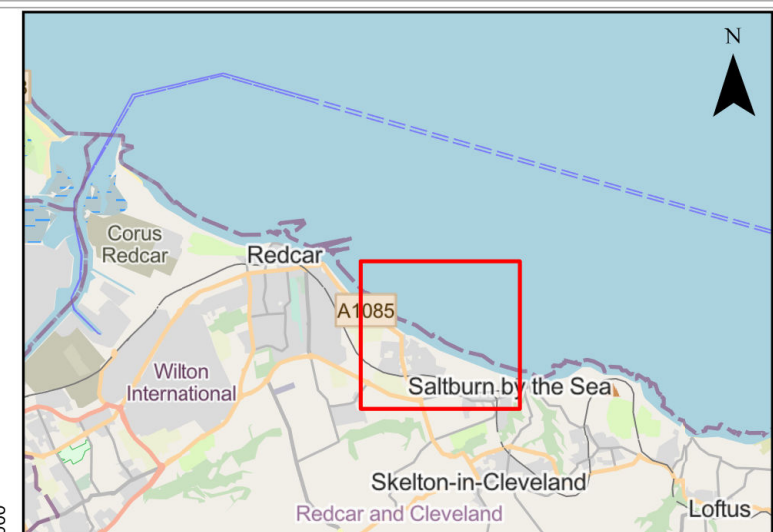
Report:

Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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Co-ordinate system: British National Grid

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

Title:

Appendix B - Map 8

MARSKE SANDS

Redcar and Cleveland Borough Council Frontage

Report:

Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	TW	A3	1:15,000

Co-ordinate system: British National Grid

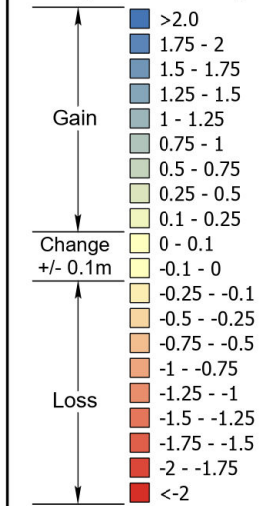


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Difference between topographic surveys
(Oct 2022 to Nov 2023)

Change in Elevation (mOD)



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

Title:

Appendix B - Map 9

SALTBURN SANDS

Redcar and Cleveland Borough Council Frontage

Report:

Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	TW	A3	1:8,000

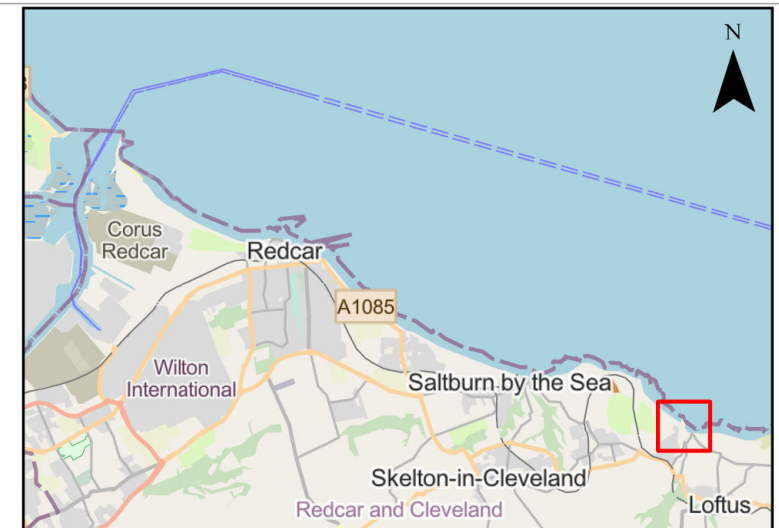
Co-ordinate system: British National Grid



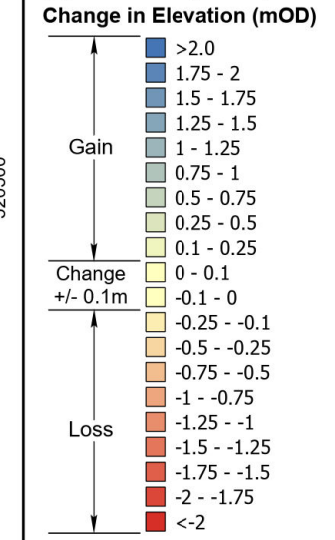
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Difference between topographic surveys
 (Apr 2023 to Sept 2023)



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

Title:

Appendix B - Map 10

CATTERSTY SANDS (SKINNINGROVE)

Redcar and Cleveland Borough Council Frontage

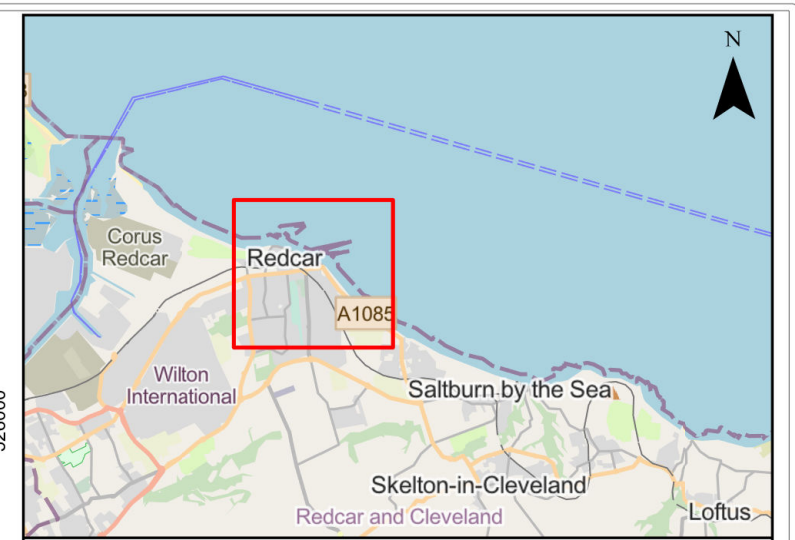
Report:

Analytical Report
 'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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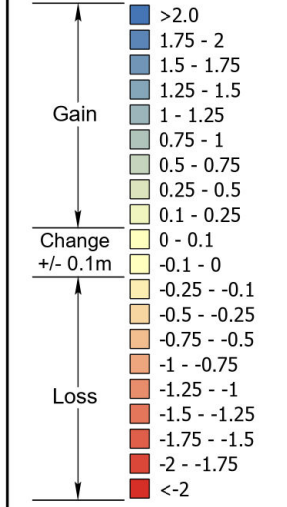
Co-ordinate system: British National Grid





Difference between topographic surveys
(Apr 2023 to Sept 2023)

Change in Elevation (mOD)



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

Title:

Appendix B - Map 11

REDCAR SANDS

Redcar and Cleveland Borough Council Frontage

Report:

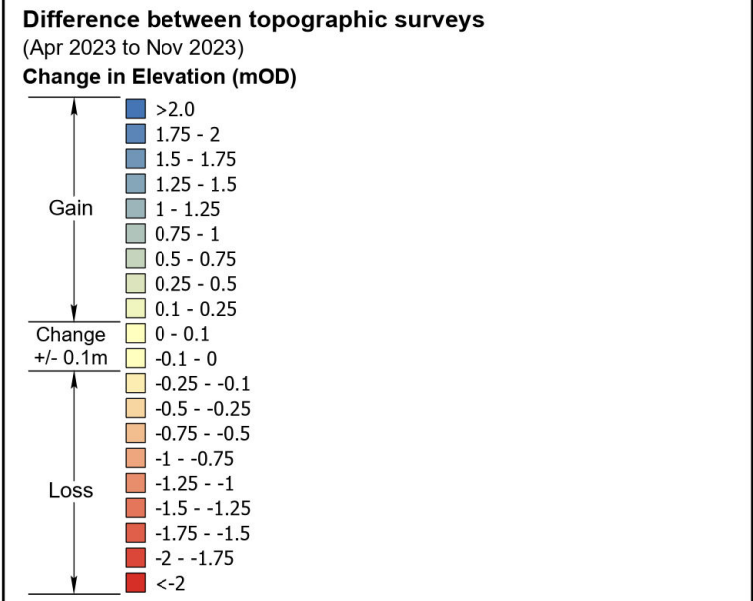
Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	TW	A3	1:15,000

Co-ordinate system: British National Grid



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Client: North East Coastal Group	Project: Cell 1 Regional Coastal Monitoring Programme
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Title:
Appendix B - Map 12
SALTBURN SANDS
Redcar and Cleveland Borough Council Frontage

Report:
Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	TW	A3	1:8,000

Co-ordinate system: British National Grid

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Appendix C
Cliff Top Survey

Cliff Top Survey

Staithes

Twenty ground control points have been established within Staithes. 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
STAITHES				Nov 2008	March 2023	Sep 2023	Nov 2008 - Sep 2023	Mar 2023 - Sep 2023	Nov 2008 - Sep 2023
1	477228	518769	320	1.90	-5.70	-5.70	7.60	0.00	0.51
2	477334	518798	0	10.90	10.61	10.66	0.24	-0.05	0.02
3	477487	518789	350	7.10	7.90	8.03	-0.93	-0.13	0.00
4	477594	518801	340	5.90	3.41	3.62	2.28	-0.21	0.15
5	477683	518911	350	8.40	8.21	8.52	-0.12	-0.31	0.00
6	477792	518867	30	8.60	8.44	8.63	-0.03	-0.19	0.00
7	477891	518828	60	7.70	7.17	7.23	0.47	-0.06	0.03
8	477959	518873	350	8.70	8.31	8.39	0.31	-0.08	0.02
9	478088	518950	350	7.60	7.84	8.05	-0.45	-0.21	0.00
10	478191	519023	340	8.40	8.53	8.66	-0.26	-0.13	0.00
11	478237	519007	60	6.90	6.50	6.56	0.34	-0.06	0.02
12	478213	518988	150	6.10	6.28	6.17	-0.07	0.11	0.00
13	478501	518809	15	11.40	8.15	8.24	3.16	-0.09	0.21
14	478624	518807	20	7.50	7.15	7.30	0.20	-0.15	0.01

15	478737	518858	60	6.10	6.19	6.12	-0.02	0.07	0.00
16	478823	518757	60	8.00	8.61	8.41	-0.41	0.20	0.00
17	478944	518671	30	9.30	8.62	8.55	0.75	0.07	0.05
18	479052	518630	20	9.20	9.02	9.05	0.15	-0.03	0.01
19	479147	518610	0	14.20	13.75	13.67	0.53	0.08	0.04
20	479274	518618	20	11.40	11.16	10.95	0.45	0.21	0.03

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ± 0.1 m. Therefore, observed changes have been altered by this amount prior to calculation of an erosion rate. Erosion rates are not calculated where the cliff line shows advance. This is likely to be the product of differing survey interpretation, and far less likely to be a toppling cliff edge.