Cell 1 Regional Coastal Monitoring Programme
Update Report 15: 'Partial Measures' Survey 2023

Sunderland City Council
May 2023

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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)
	Whitburn Bay to Ryhope
HAT	3.08
MHWS	2.58
MHWN	1.48
MLWN	-0.72
MLWS	-1.82

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.

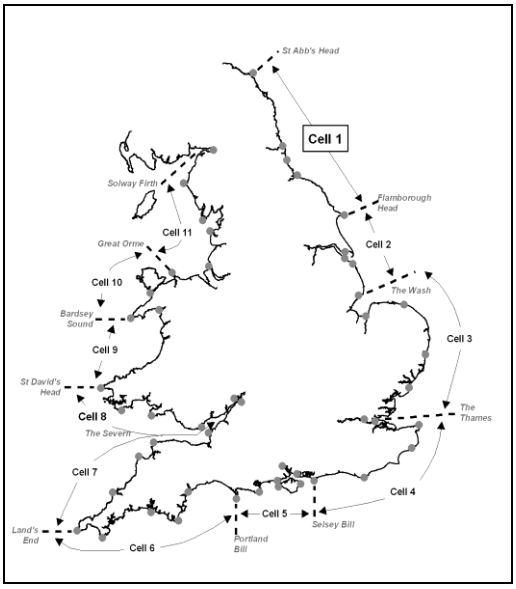


Figure 1 Sediment Cells in England and Wales

The programme commenced in its present guise in September 2008[1] 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 every year. Some of these surveys are then repeated the following spring as part of a 'Partial Measures' survey.

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	Oct-Nov 11	Oct 12	Mar-May 12	Oct 12	
5	2012/13	Sep-Oct 12	Mar 13	Mar 13	Jun 13	
6	2013/14	Sep-Oct 13	Feb 14	Mar 14	Jul 14	
7	2014/15	Sep-Nov 14	Feb 15	Mar-Apr 15	Jul 15	
8	2015/16	Sep-Nov 15	Feb 16	Mar 16	Jul 16	Jun 16
9	2016/17	Sep-Nov 16	Feb 17	Apr 17	Jul 17	
10	2017/18	Oct-Nov 17	Mar 18	Mar 18	May 18	Nov 18
11	2018/19	Oct-Nov 18	Feb 19	Feb-Mar 19	May 19	
12	2019/20	Sep-Nov 19	Jan 20	Mar 20	Apr 20	
13	2020/21	Sep-Oct 20	Jan 21	Mar-Apr 21	May 21	Aug 21
14	2022/23	Nov 21	Feb 22	Apr 22	Jun 22	
15	2022/23	Oct-Nov 22	Feb 23	Apr 23	May 23 (*)	

(*) The present report is **Update Report 15** and provides an analysis of the 2023 Partial Measures survey for Sunderland City Council's frontage.

1. Introduction

1.1 Study Area

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

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

1.2 Methodology

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

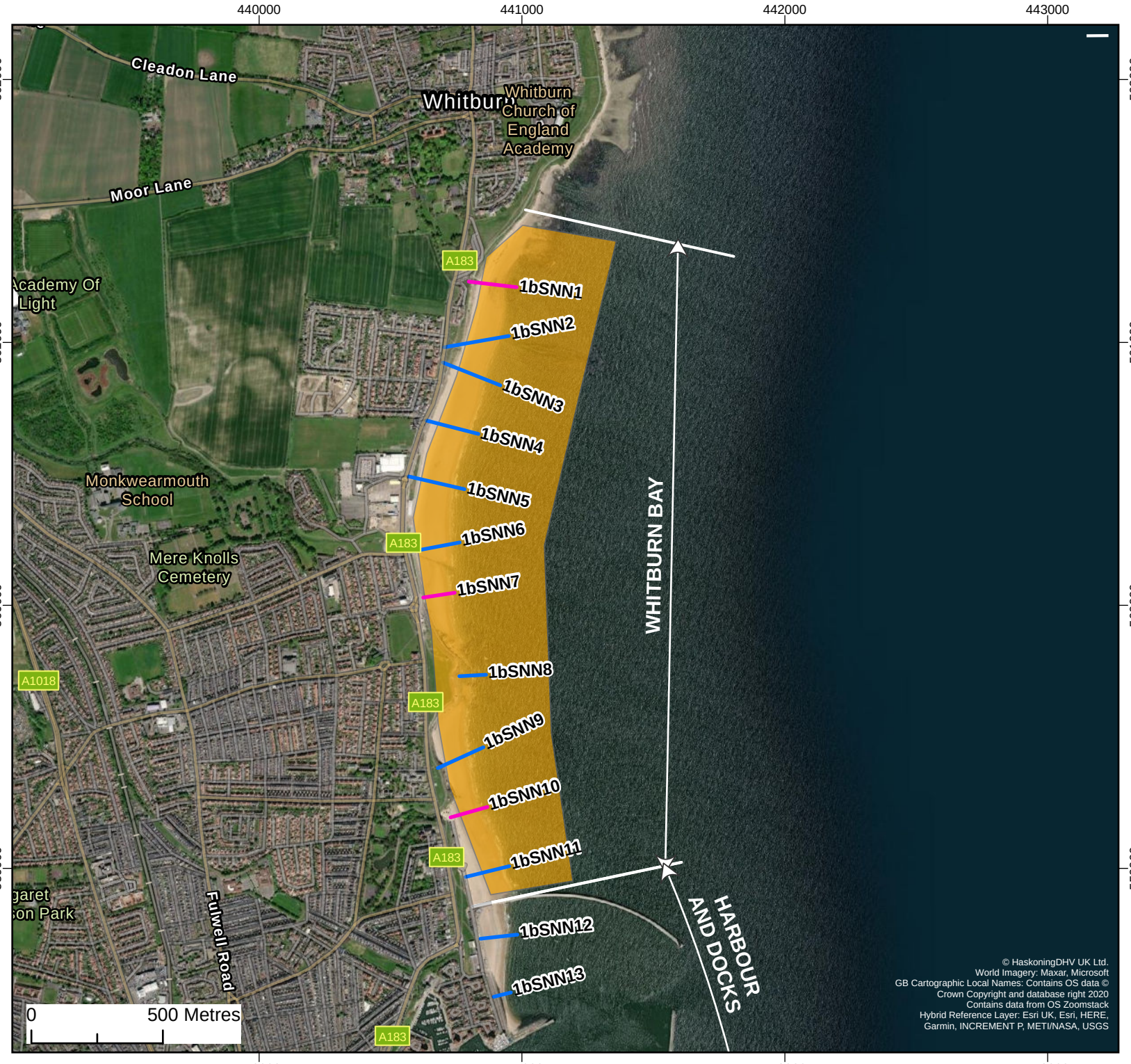
- Full Measures survey annually each autumn comprising:
  - Beach profile surveys along 58 transect lines (commenced 2009)
  - Topographic survey at Whitburn Bay (commenced 2009)
  - Topographic survey at Hendon to Ryhope (including Halliwell Banks) (commenced 2009)
- Partial Measures survey annually each spring comprising:
  - Beach profile surveys along 16 transect lines (commenced 2009)
- Cliff top survey bi-annually at:
  - Hendon to Ryhope (including Halliwell Banks) (commenced 2009)

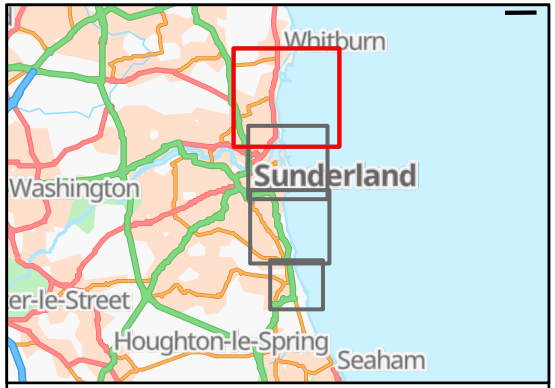
The location of these surveys is shown in Figure 2. The Partial Measures survey was undertaken along this frontage on 4th April 2023 (Whitburn Bay), and between 4th and 6th April 2023 (Hendon to Ryhope, including Halliwell Bank). During this time weather conditions varied, see surveyors reports for details.

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
- 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
- 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 1

WHITBURN BAY

Sunderland City Council Frontage

Report: Survey Report

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	n/a	TC	NJC	A4	1:20,000

Co-ordinate system: British National Grid

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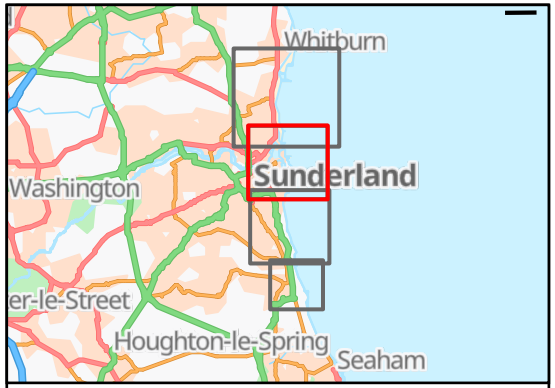

SURVEY LOCATIONS

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

HARBOUR AND DOCKS

Sunderland City 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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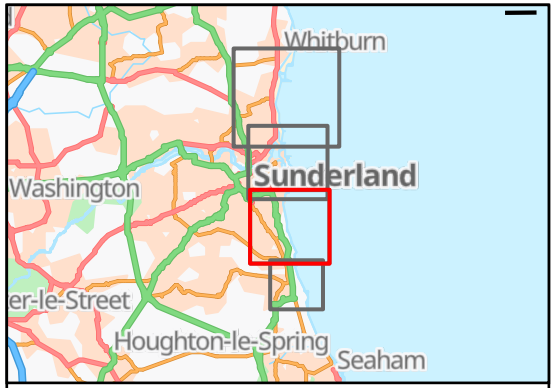

SURVEY LOCATIONS

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 3

HENDON TO RYHOPE (NORTH)

Sunderland City 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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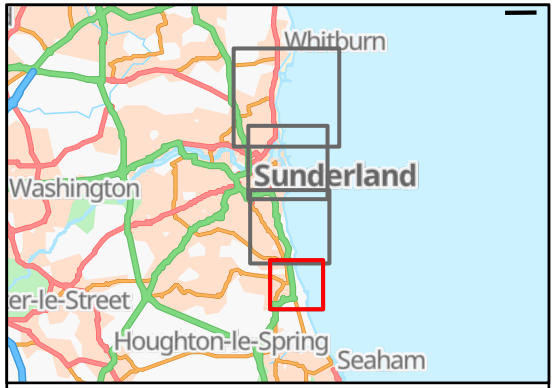

SURVEY LOCATIONS

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 4

HENDON TO RYHOPE (SOUTH)

Sunderland City 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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2. Analysis of Survey Data

2.1 Whitburn Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
4th April 2023	**Beach Profiles:** Whitburn Bay is covered by three beach profile lines for the Partial Measures survey (Appendix A). The last survey was Full Measures, undertaken in Autumn 2022. **1bSNN1** is just to the south of Sunderland City Council's northern boundary. Since the last survey, the backshore landward of chainage 43m has remained stable and not changed. The upper beach between chainage 43-51m has risen by up to less than 0.1m. The majority of the rest of the profile between chainage 51m and 190m has lowered by up to 0.3m on the upper beach, 0.4m on the middle beach and less than 0.1m on the lower beach. The rock at chainage 190m is still present, and the beach profile terminates at chainage 239m. Overall, the beach profile is at a medium level compared to the range recorded from previous surveys. **1bSNN7** is at Seaburn, north of Parson's Rock. Beach levels have risen on the upper beach between chainages 6-56m by up to 0.4m. The middle beach has risen by less than 0.1m and the lower beach has risen by up to 0.3m. Overall, the upper beach profile is at a medium level and the middle and lower beach is at a high level compared to the range recorded from previous surveys. **1bSNN10** is located mid-way between Parson's Rock and Roker Pier. The beach profile from the toe of the seawall across the upper and middle beach has lowered by up to 0.4m. The lower beach seaward of chainage 166m has risen by up to 0.5m. The profile across the upper and middle beach is at a medium level compared to the range recorded from previous surveys, whilst the lower beach is at a high level.	Beach levels across Whitburn Bay have generally lowered, except on the lower beach of 1bSNN10 and middle and lower beach of 1bSNN7. **Longer term trends:** Profiles in Whitburn Bay are within the bounds of previous surveys, with most profiles at a medium-high level.

2.2 Hendon to Ryhope (incl. Halliwell Banks)

Survey Date	Description of Changes Since Last Survey	Interpretation
4th-6th April 2023	**Beach Profiles:** Hendon to Ryhope is covered by twelve beach profile lines for the Partial Measures survey (Appendix A). The last survey was Full Measures, undertaken in Autumn 2022. Profile **1bSNS8** extends across the seawall, rock revetment, and sandy beach. Beach levels have lowered from the toe of the revetment to chainage 69m by up to 0.5m. The middle and lower beach has risen by up to 0.4m. The upper beach profile is at a medium level compared to the range recorded from previous surveys, whilst the middle to lower beach profile is at a high level. Profile **1bSNS11** starts at the coastal slope backing the sea wall and extends over the rock armour and beach. Beach levels have mostly risen across the beach profile by up to 0.8m on the upper beach (covering some rocks from the previous survey between chainage 50-56m) and 0.2m on the lower beach. One small section on the middle beach has lowered by up to 0.2m between chainages 76-86m. Overall, the beach profile is at a high level compared to the range recorded from previous surveys, except on the middle beach which is at a low level. Profile **1bSNS20** is located at Shirley Banks. The toe of the cliff has retreated by up to 1.0m. From the toe of the cliff to chainage 72m the beach has alternated between accretion and erosion by up to 0.2m. The beach between chainages 70-120m has lowered by up to 0.6m which now exposes more rocks than the previous survey. The survey continues past chainage 131m, exposing some more rocks. The beach is at a low level compared to the range recorded from previous surveys. Profiles **1bSNS25** to **1bSNS33** are located on Halliwell Banks to assess erosion of a former land fill site. Cliff tops are between 26m and 27mOD. At profile **1bSNS25**, the cliff toe has retreated by up to 3.0m and the beach has lowered by up to 0.2m to chainage 58m. The beach has mostly risen across the rest of the profile, by up to 0.6m on the upper beach and 0.4m on the lower beach. The rock patch between chainages 86-102m remains exposed. The cliff toe is at its most landward position recorded. The beach profile is at a medium-high level compared to the range recorded from previous surveys, except at the toe of the cliff which is at a low level.	Profiles 1bSNS8 to 1bSNS11 have undergone variable change. The cliff has remained mostly stable, except the toe of the cliff at 1bSNS20 at Shirley Banks which has retreated by up to 1.0m. Profiles 1bSNS25 to 1bSNS33 at Halliwell Banks show a relative stability of the cliff top at most profiles, except at 1bSNS31 which has retreated by up to 4.0m. The cliff toe has generally retreated at profiles 1bSNS25 to 1bSNS30 and remained stable from 1bSNS31 to 1bSNS33. **Longer term trends:** In general, the profile change along the Hendon to Ryhope frontage is within the bounds of previous surveys. At the landfill site, several profiles continue to show recession of the cliff top and toe. Overall, beach levels are at a medium-high level.

Survey Date	Description of Changes Since Last Survey	Interpretation
	At profiles **1bSNS26**, the toe of the cliff has retreated landward by approximately 0.5m. The beach level has generally risen by up to 0.6m on the upper beach and 0.4m on the lower beach. The profile between chainages 130-155m has not changed since the previous survey. Overall, the profile is at a relatively medium-high level compared to the range recorded from previous surveys. At **1bSNS27** there has been a recession in the cliff top by up to 0.5m. The beach level at the toe of the cliff has lowered by up to 1.4m. Similar to previous surveys, the beach has generally risen by up to 0.8m on the upper beach and 0.5m on the lower beach. The middle beach between chainages 130-140m has not changed since the previous survey. Overall, the beach at the toe of the cliff is at one of its lowest levels and the rest of the profile is at a high level compared to the range recorded from previous surveys. At **1bSNS28**, there has been very little change in the position of the cliff face. The beach profile has risen across the whole profile by up to 0.6m on the upper beach, less than 0.1m on the middle beach and 0.2m on the lower beach. Overall, the beach profile is at a high level compared to the range recorded from previous surveys. At profile **1bSNS29**, there has been very little change in the position of the cliff face. The beach profile at the toe of the cliff has lowered by up to 0.6m to chainage 102m. Seaward of this point, the beach has generally risen by up to 0.8m on the upper beach, less than 0.1m on the middle beach and 0.2m on the lower beach. The rock at chainage 147m remains exposed, however the rocks at chainage 175m are now covered by sediment. Overall, the beach is at a medium-high level compared to the range recorded from previous surveys. At profile **1bSNS30**, there has been a retreat of the cliff toe by up to 1.0m. The beach has undergone very little change from the toe of the cliff to chainage 103m. The beach profile seaward of this point has risen by up to 1.0m on the upper beach, less than 0.1m on the middle beach and up to 0.4m on the lower beach. Overall, the upper and middle beach profile is at a medium level compared to the range recorded from previous surveys, whilst the lower level is at a high level. The cliff top at profile **1bSNS31** shows a retreat by up to 4.0m. The beach has risen across the rest of the survey by up to 1.5m on the upper beach, 1.0m on the middle beach and 0.5m on the lower beach. Overall, the profile is at a medium-high level compared to the range recorded from previous surveys.	

Survey Date	Description of Changes Since Last Survey	Interpretation
	At profile **1bSNS32,** the cliff top shows a minor retreat of 0.1-0.2m. Similar to previous profiles, the beach has risen across the beach by up to 0.7m on the upper beach, less than 0.1m on the middle beach and 0.5m on the lower beach. h Overall, the beach profile is at a medium level on the middle beach and a high level on the upper and lower beach compared to the range recorded from previous surveys. At profile **1bSNS33**, the cliff has not changed position since the previous survey. The beach profile has risen on the upper beach by up to 1.4m and the lower beach by up to 0.2m. The middle beach between chainages 105-127m has lowered by 0.2m. Overall, the upper and lower beach profile is at a high level compared to the range recorded from previous surveys, whilst the middle beach is at a medium level.	
6th April 2023	**Cliff-top Survey:** 32 ground control points (numbered 1-32) were established along the cliff top between Hendon and Ryhope in March 2009, with a further three (28A, 28B and 28C) added in September 2009 (Figure 3). Note: the numbering of ground control points is not intended to correlate with that of the beach profile lines. Measurements are taken from each ground control point along a fixed bearing to the edge of the cliff top. These cliff top surveys are undertaken bi-annually and are intended to inform on erosion rates of the sea cliffs extending from the defended industrial areas at Hendon southwards along the undefended cliffs to Ryhope Dene. The results from the cliff top monitoring are anticipated to have an accuracy of ±0.2m due to the technique used. These cliff top surveys are undertaken bi-annually and are intended to inform on erosion rates of the sea cliffs extending from the defended industrial areas at Hendon southwards along the undefended cliffs to Ryhope Dene. Appendix B – Table B1 provides results from the March 2009 cliff top survey, showing the position from the ground control point to the edge of the cliff top along a defined bearing. Also shown is the change in measurement since the original (March 2009) and previous (November 2022) cliff top surveys. Results show that since the last survey, two locations have shown erosion greater than the anticipated survey error; Point 14 by 0.37m and Point 30 by 0.28m.	Since the last survey, the cliffs at Points 14 and 30 have shown erosion greater than the anticipated error of survey methods, with minimal change elsewhere. Several profiles have shown a minor seaward movement of the cliff top, however this is more likely due to differences in placement of survey equipment due to vegetation. **Longer term trends:** Since 2009, the majority of the points south of the sea defences have eroded. The greatest erosion has occurred at points 10, 11, 21, 25, 26, 27, 28, 28A, 30, 31 and 32 where between 6.15m and 12.55m has been lost.

Survey Date	Description of Changes Since Last Survey	Interpretation
	Since surveys began in March 2009 (or September 2009 for 28A, 28B, and 28C) erosion greater than the survey error has occurred at around 83% of the ground control points, where total losses are 12.55m (at Point 25) at their greatest, and more typically less than 5m. The long-term erosion rates are 0.90m/yr at their highest (Point 25), with up to 0.5m/yr being more typical.	

3. Problems Encountered and Uncertainty in Analysis

Individual Profiles

- No problems were encountered.

Cliff Top Surveys

- The largest cliff erosion encountered since the previous survey was located at Points 14 and 30 where cliff top recession of between 0.28m and 0.37m was recorded.

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

- No changes are recommended at the present time.

5. Conclusions and Areas of Concern

- At Whitburn Bay, the recorded profiles are within the bounds of previous surveys and present no causes for concern.
- At Hendon to Ryhope (incl. Halliwell Banks), cliff top erosion at the landfill site in Halliwell Banks is ongoing at a few profiles, with two points recording erosion greater than the survey error (see Table B1 in Appendix B). The greatest amount of erosion recorded to have taken place between March 2009 and April 2023 was 12.55m at Point 25 which is along the border of the landfill site.
- Elsewhere at Hendon to Ryhope, the recorded profiles and cliff top surveys show no cause for concern. Profiles have undergone variable change, with no discernible pattern. Beach levels are at a medium-high levels compared to the range recorded from previous surveys.

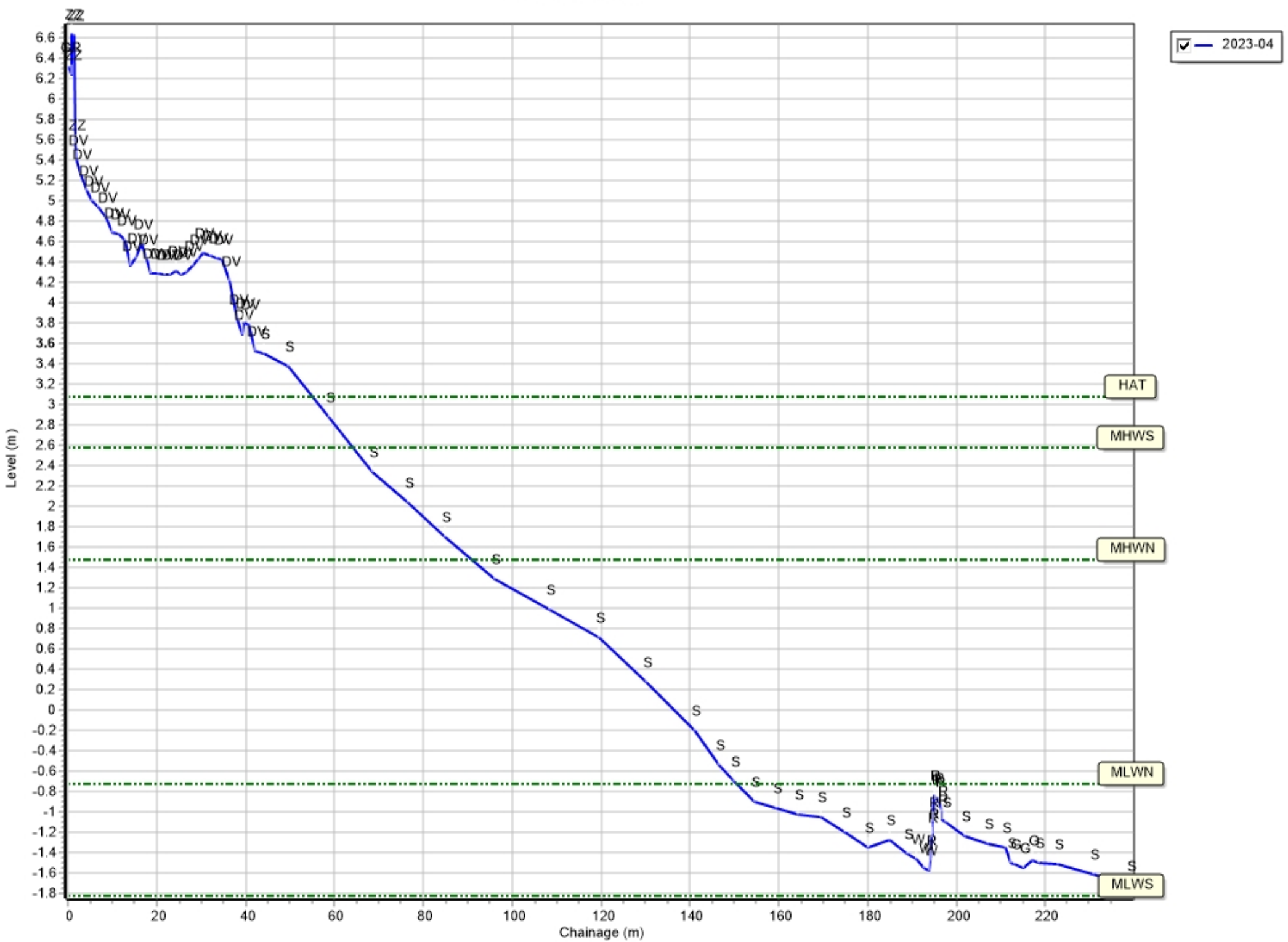
Appendices

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: 1bSNN1
2023-04
HAT
MHWS
MHWN
MLWN
MLWS
Level (m)
Chainage (m)
6.6
6.4
6.2
6
5.8
5.6
5.4
5.2
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4.6
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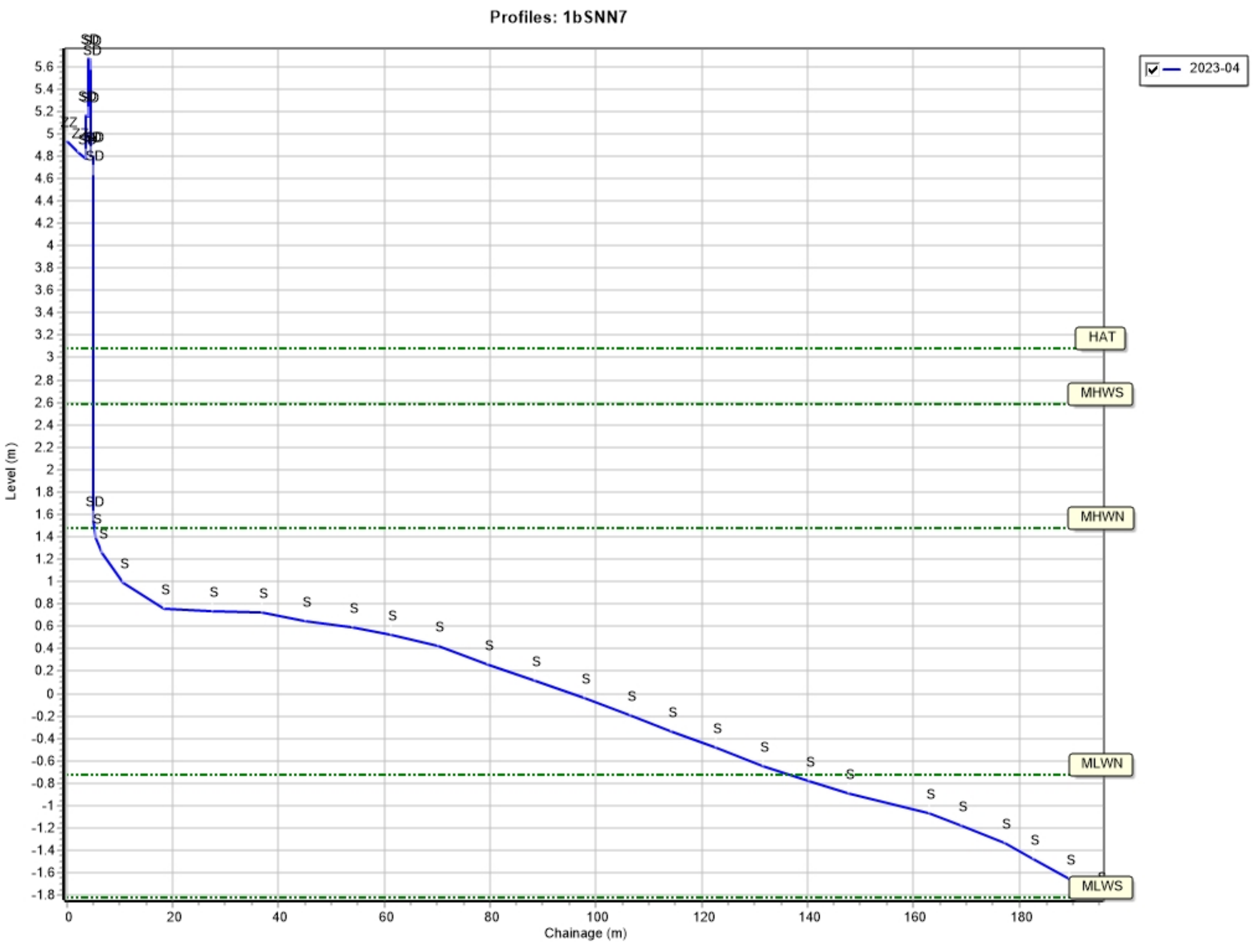
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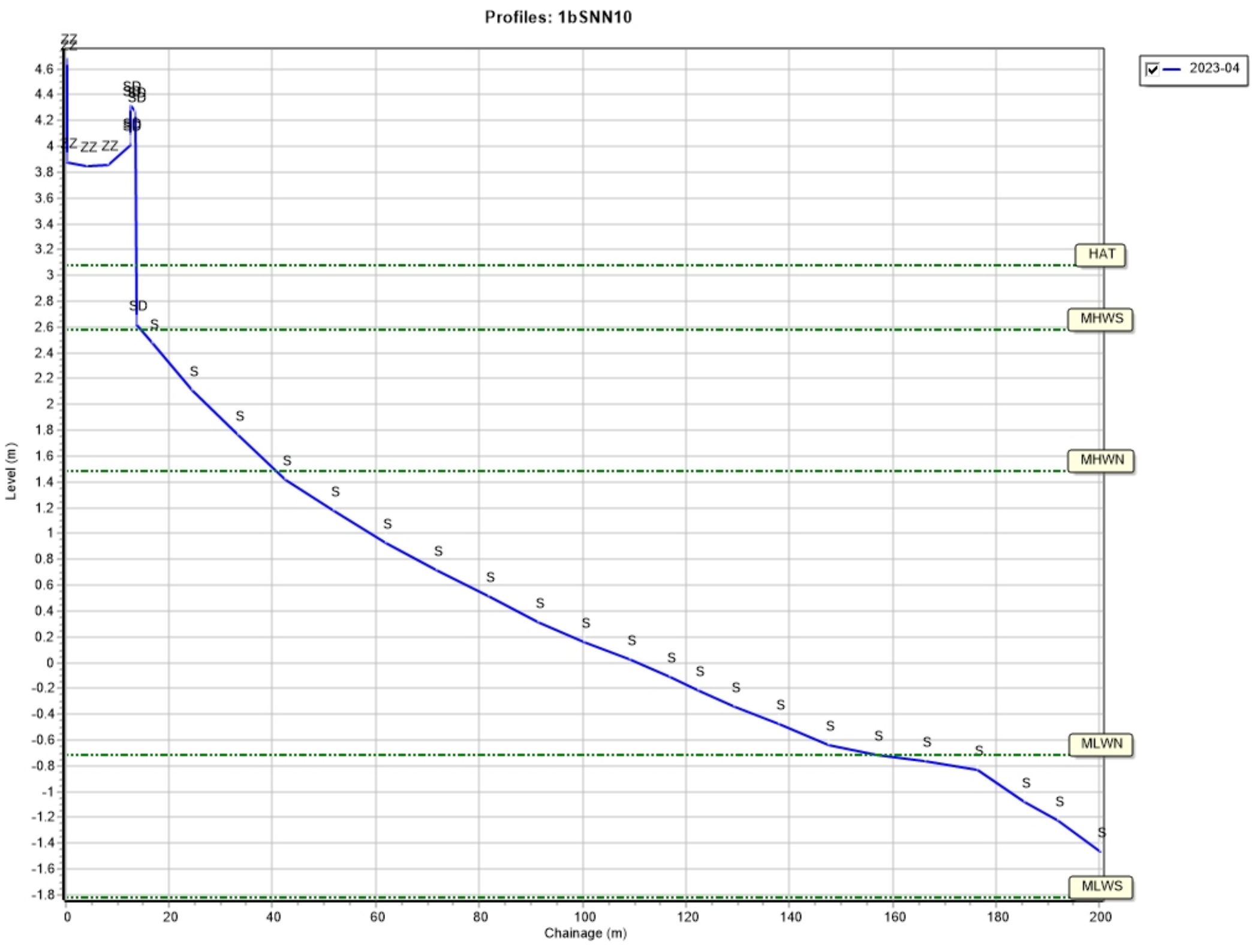
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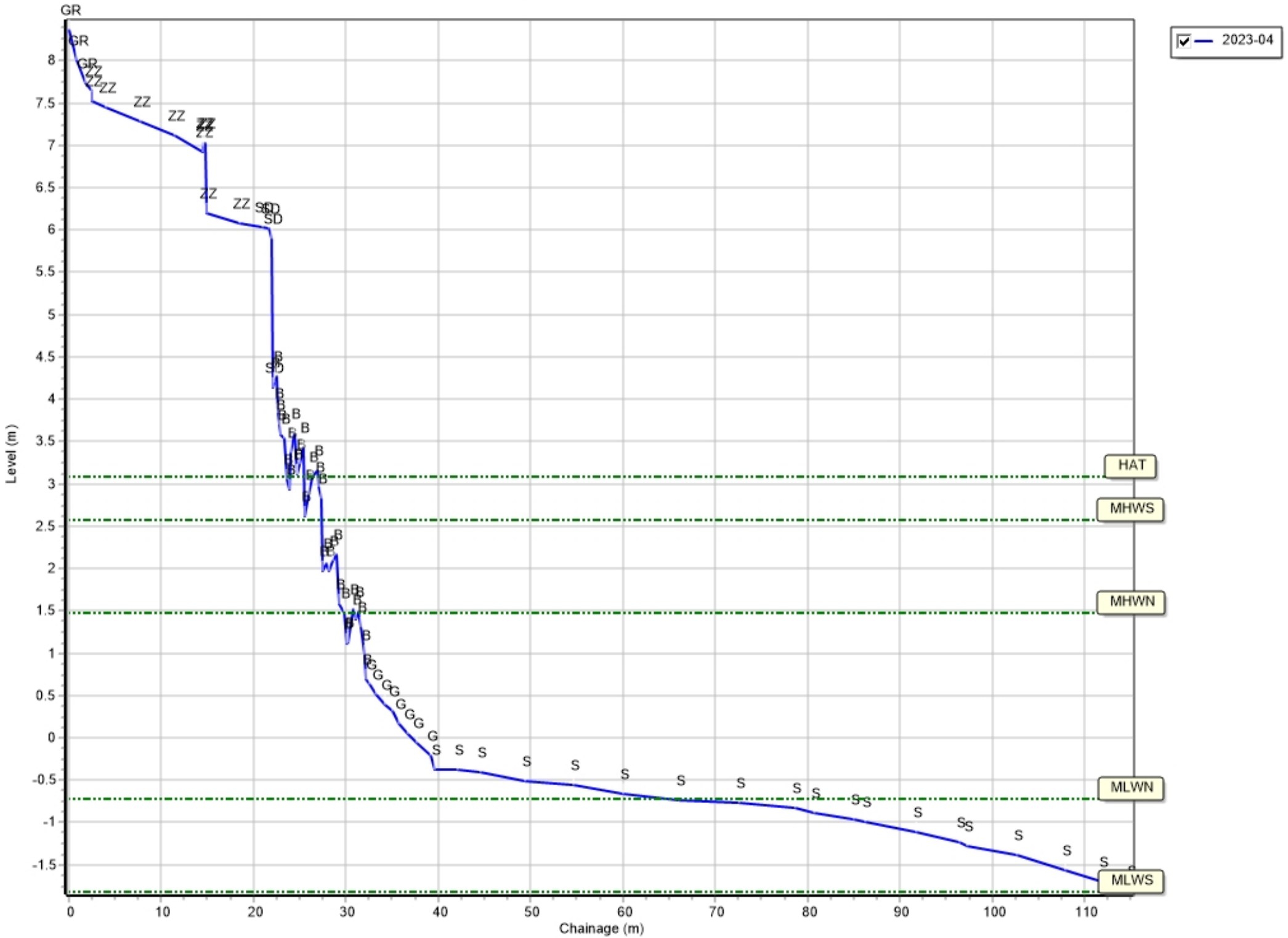
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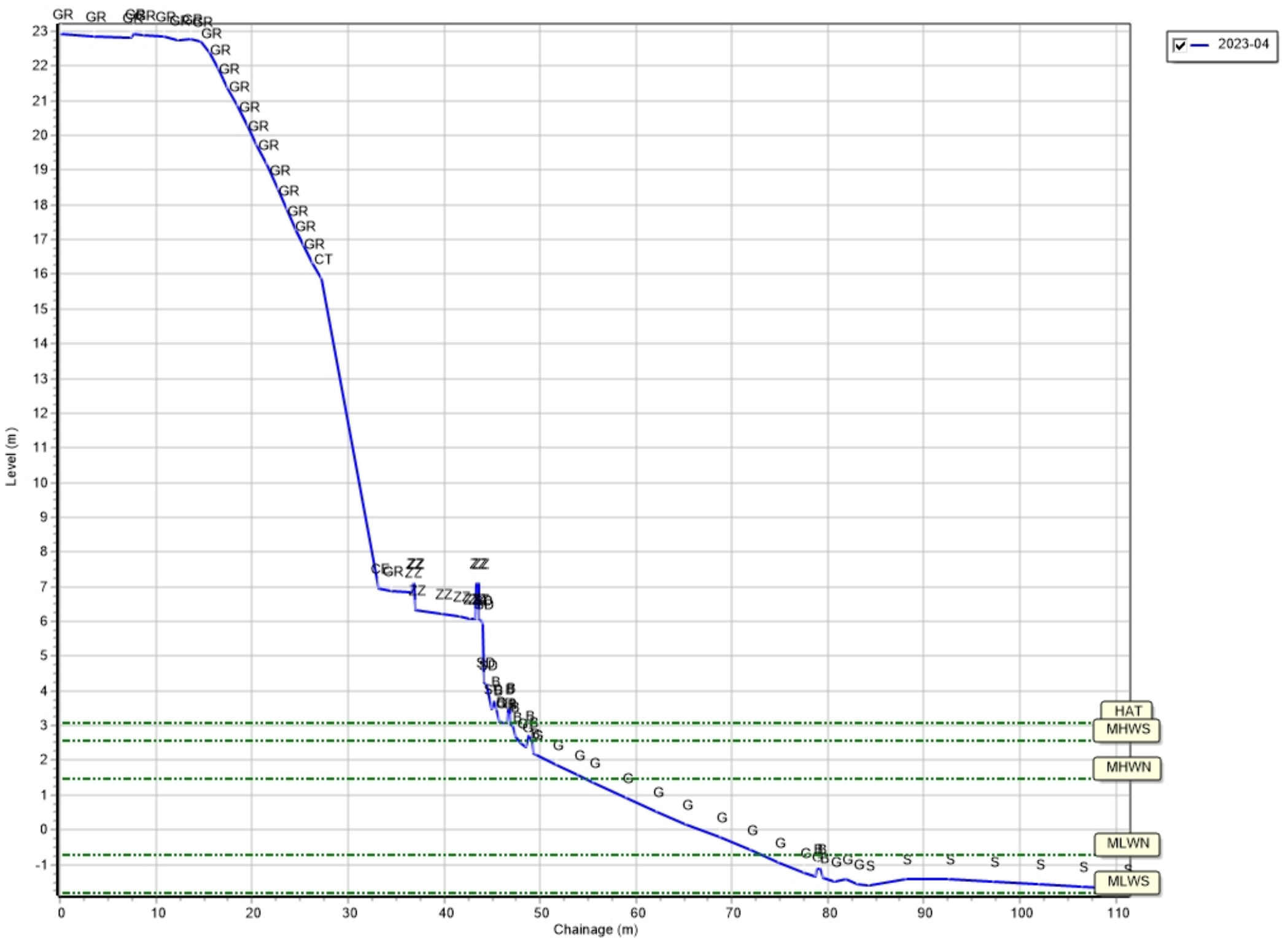
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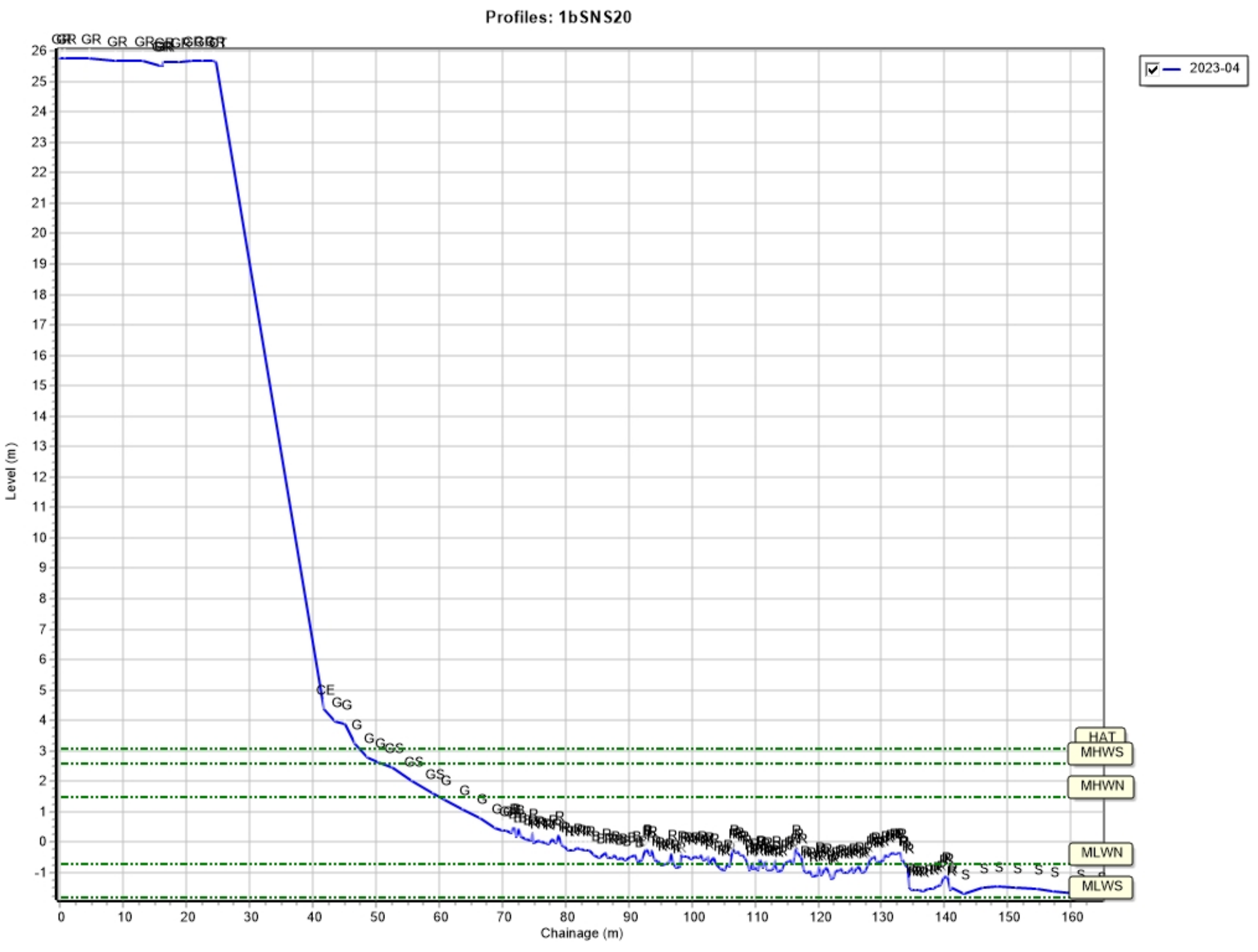
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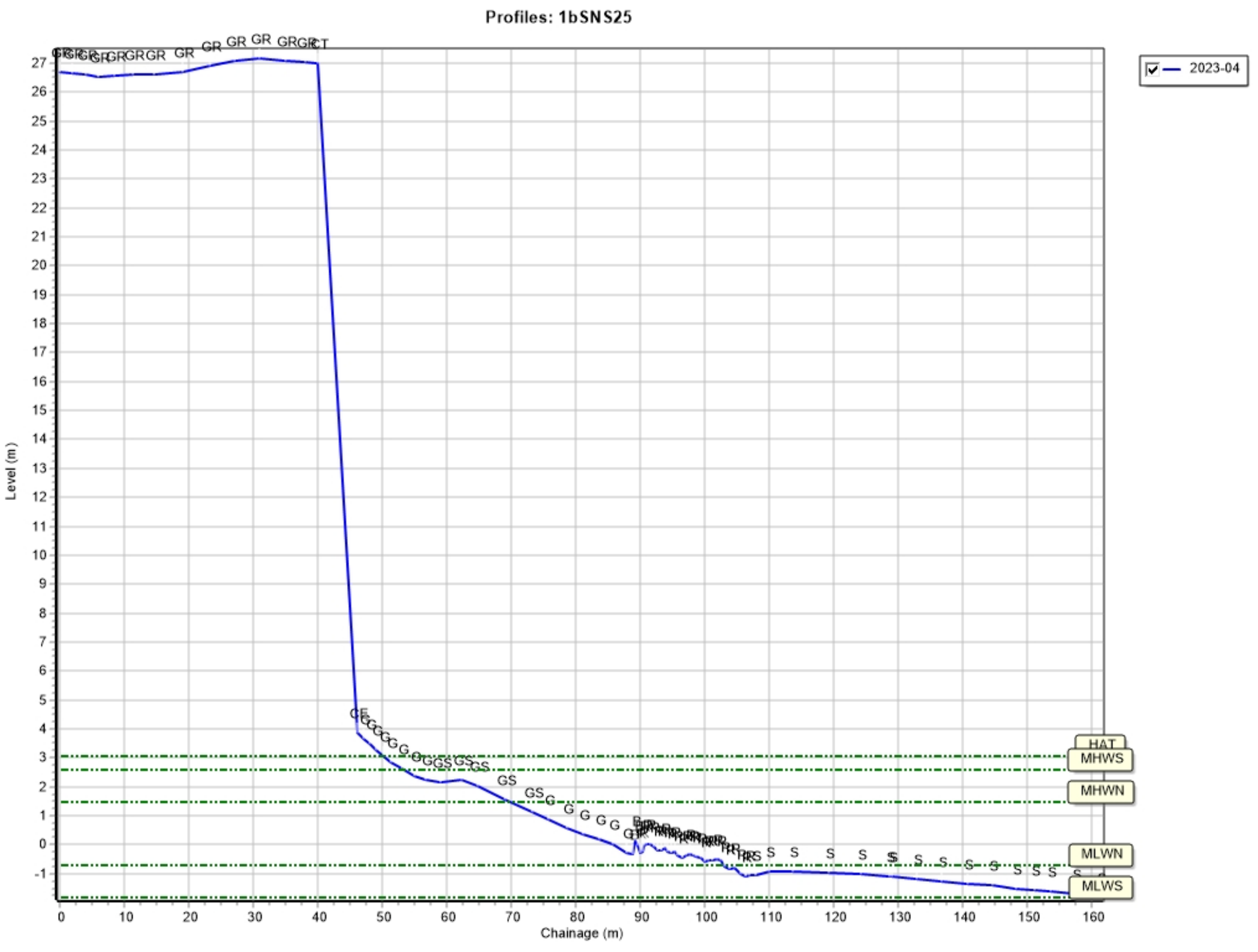
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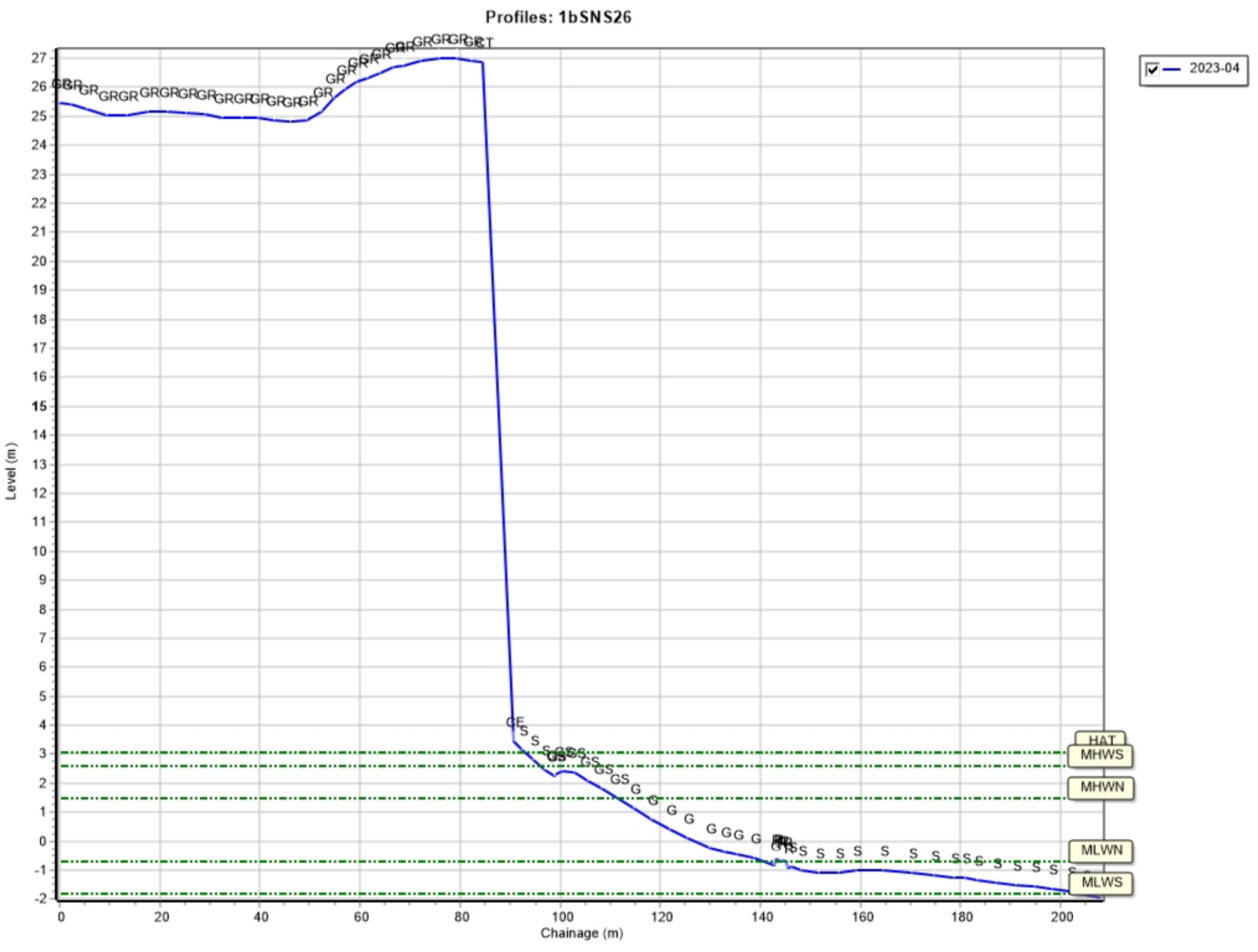
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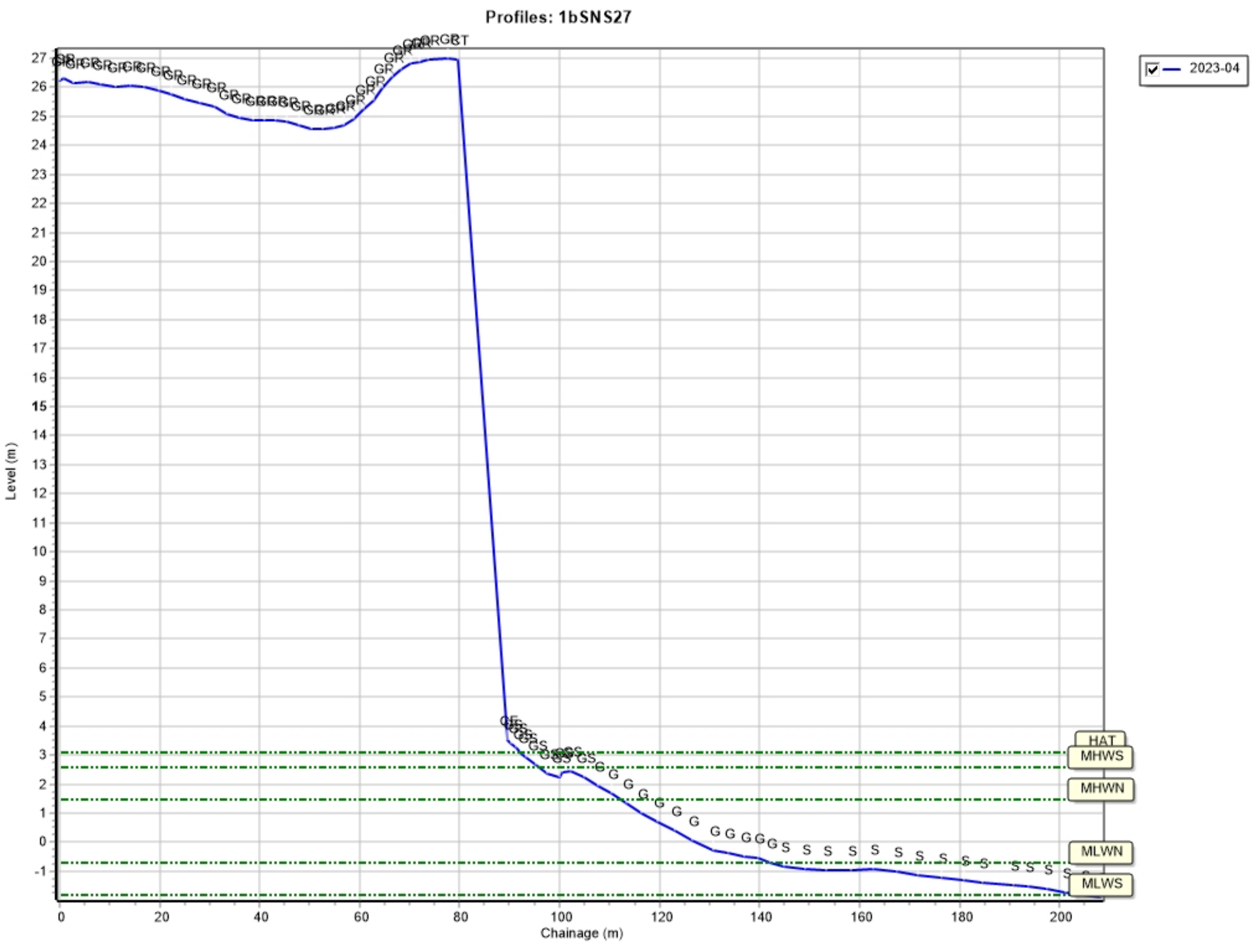
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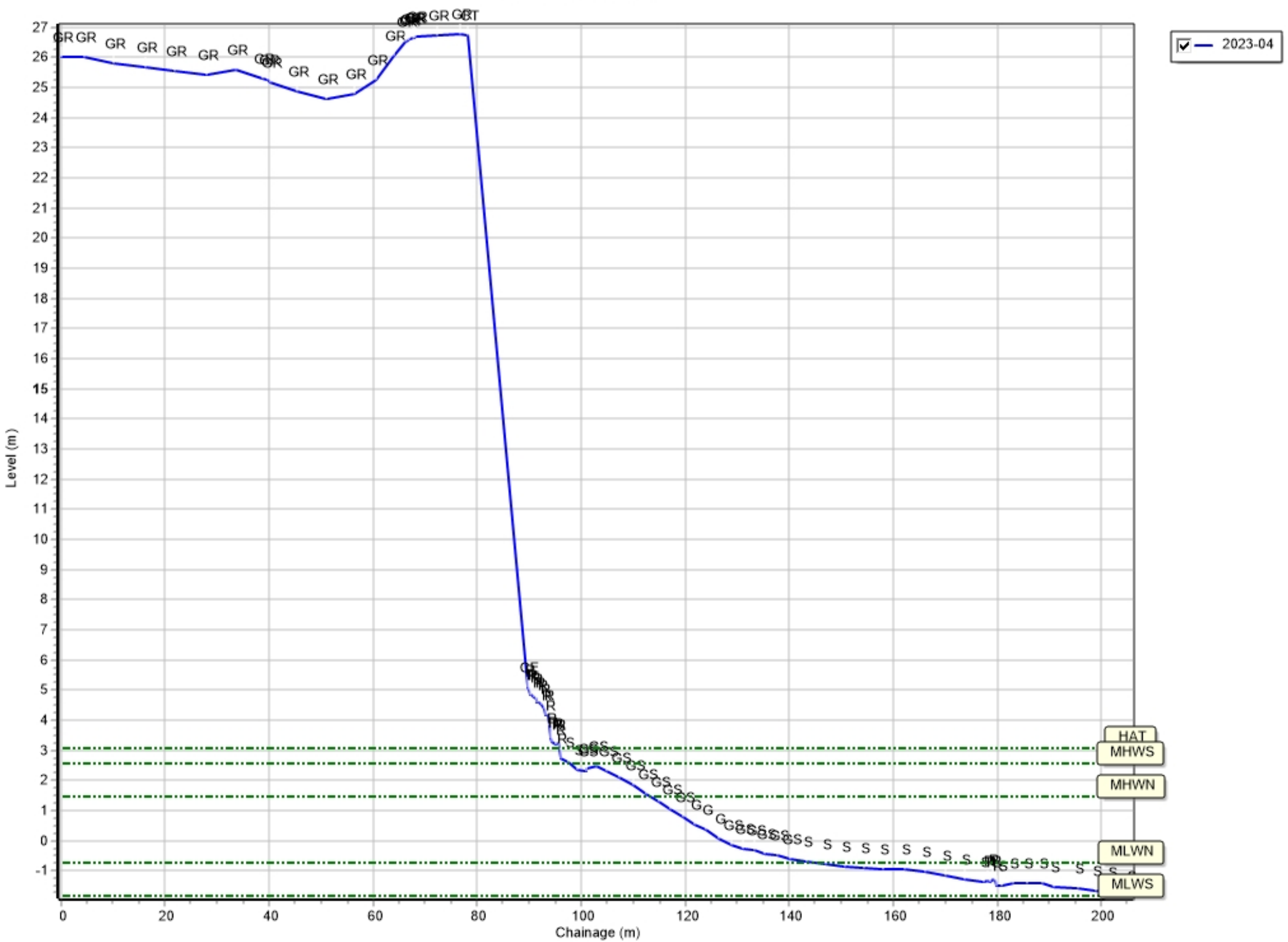
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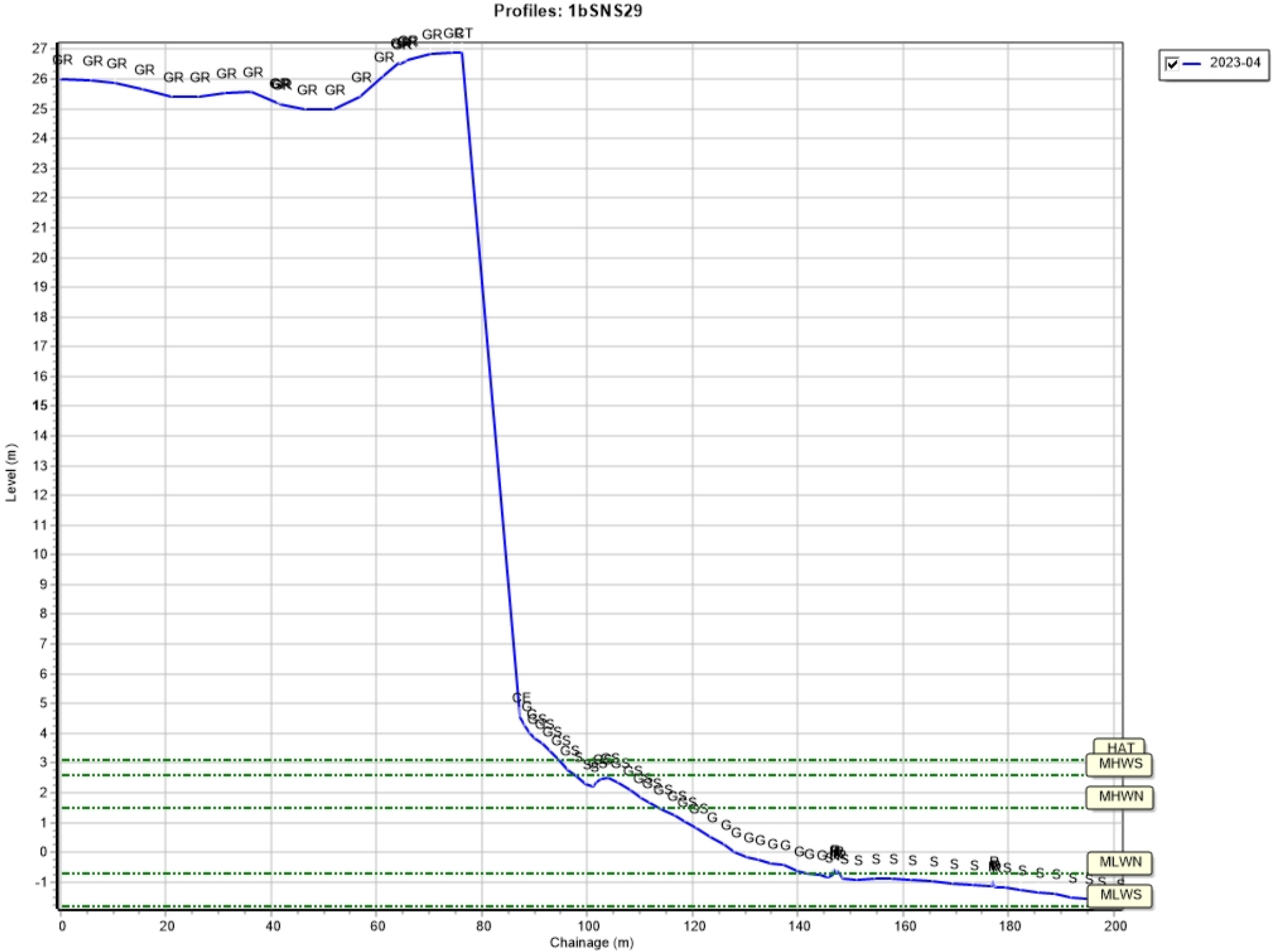
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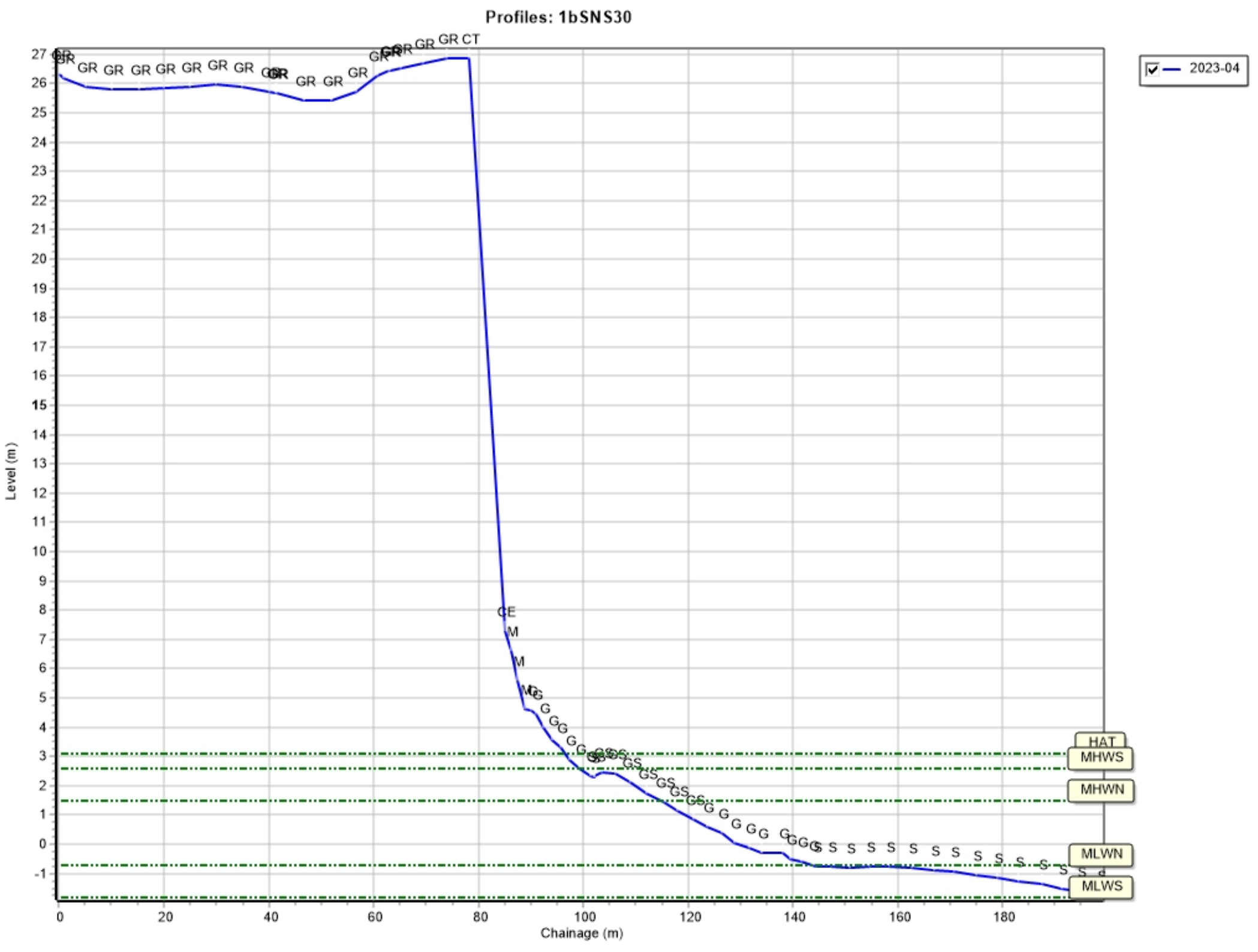
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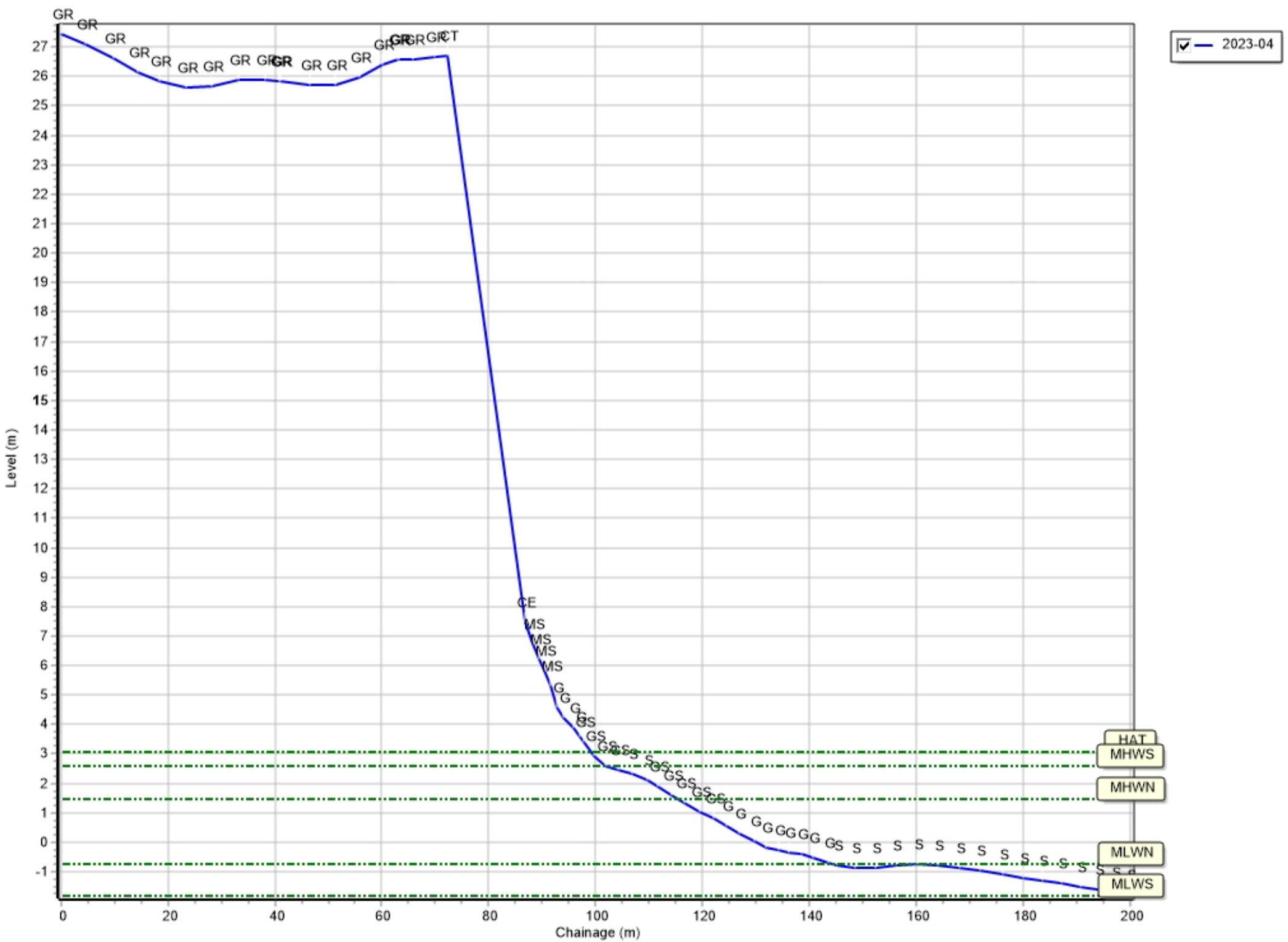
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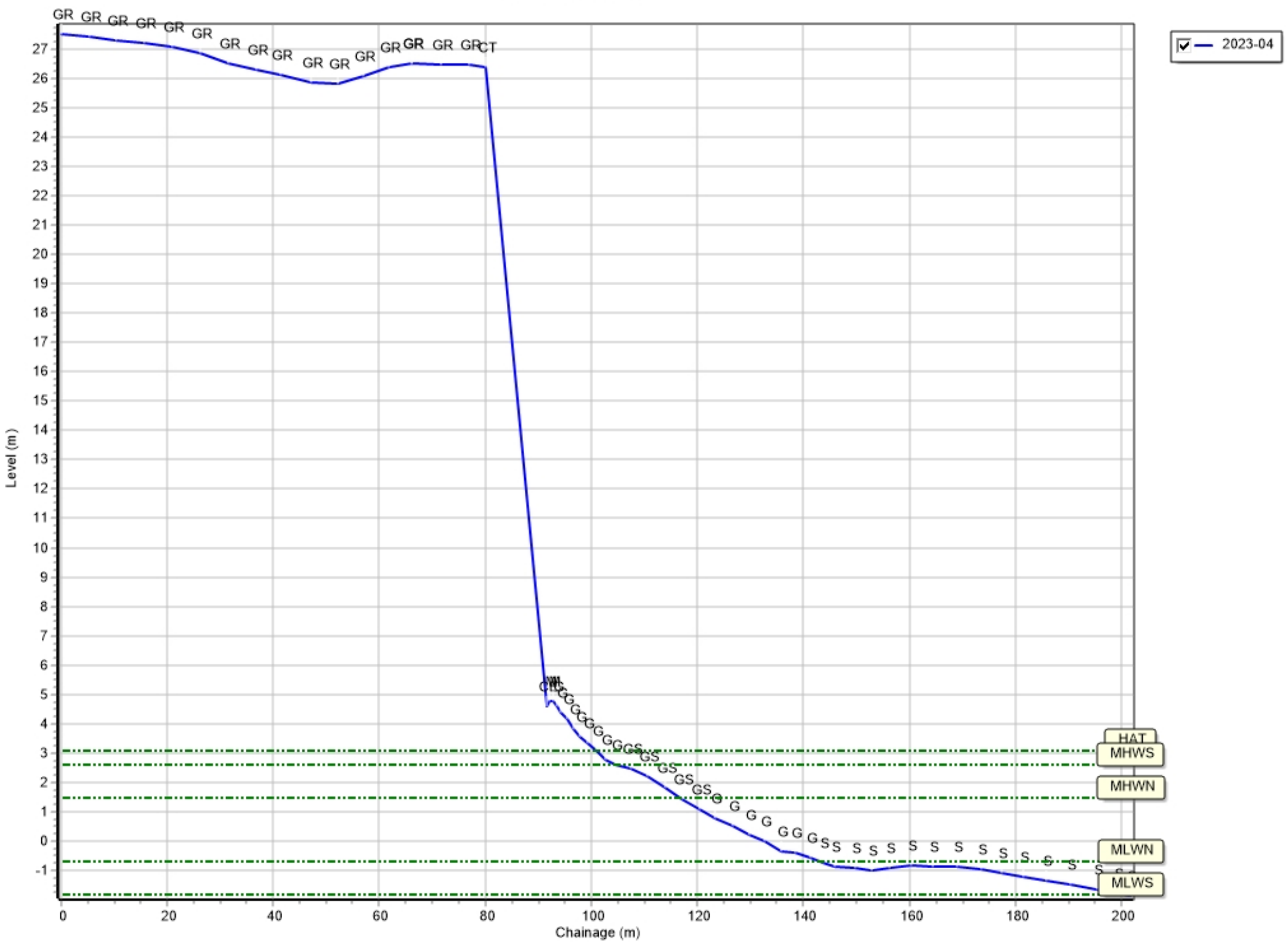
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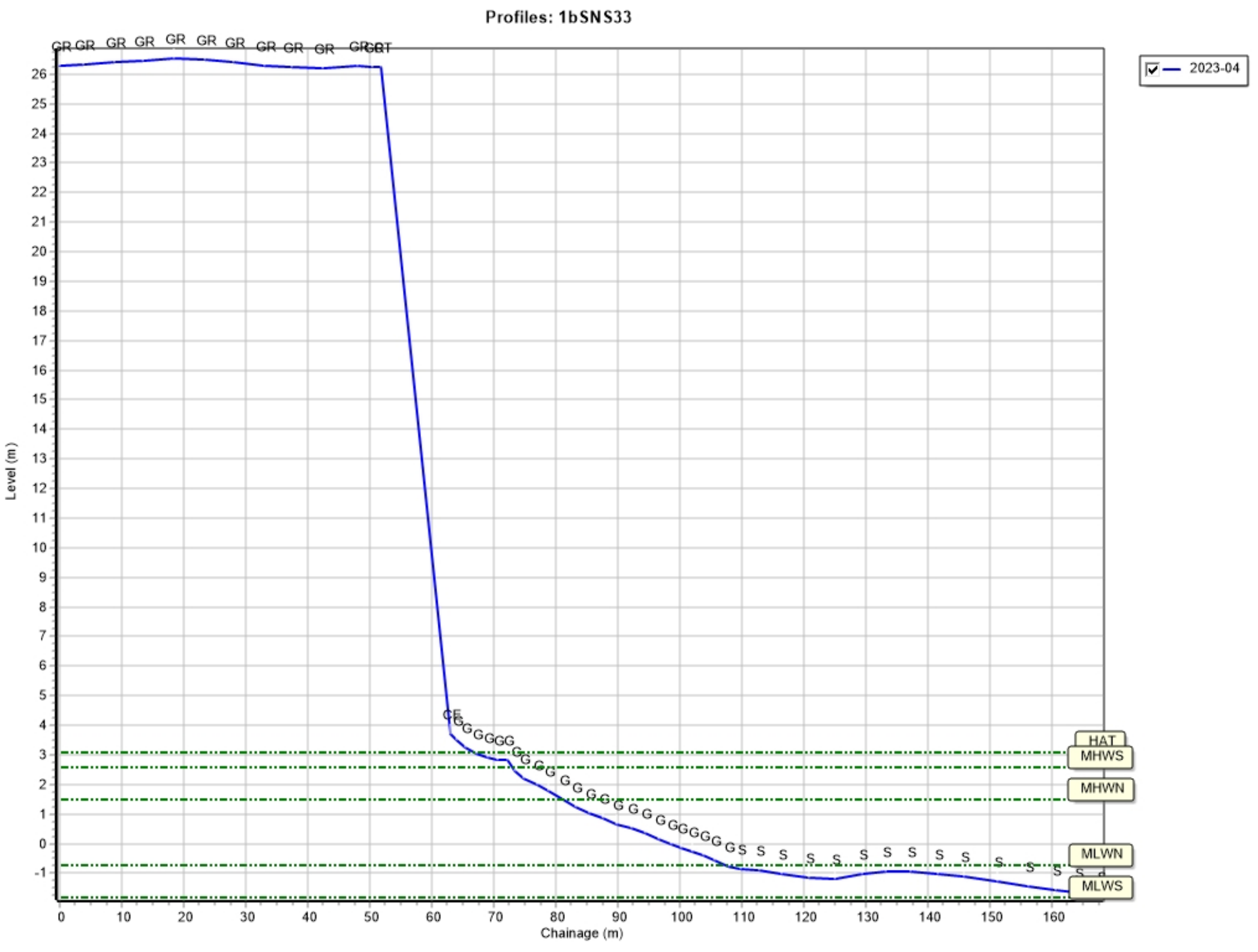
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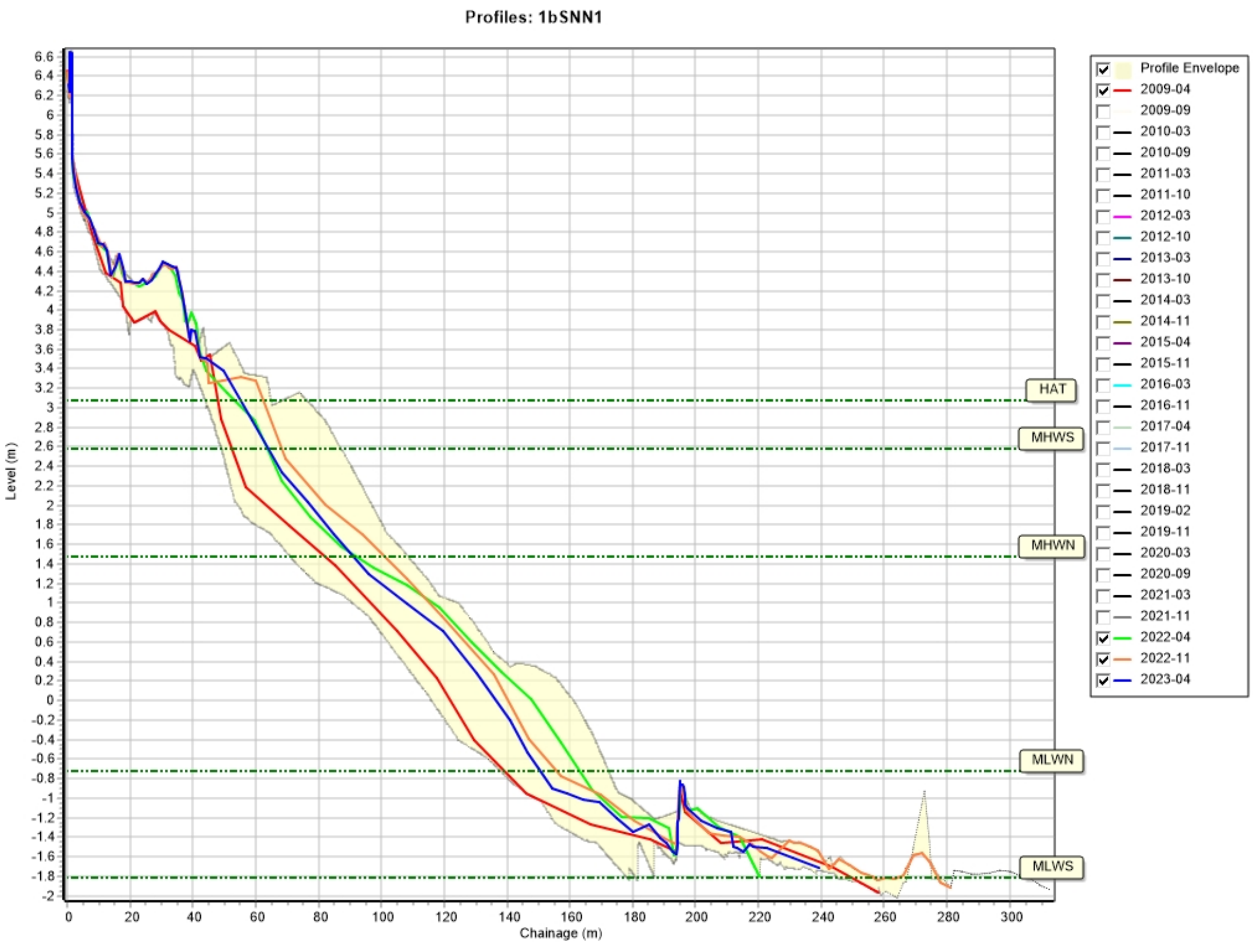
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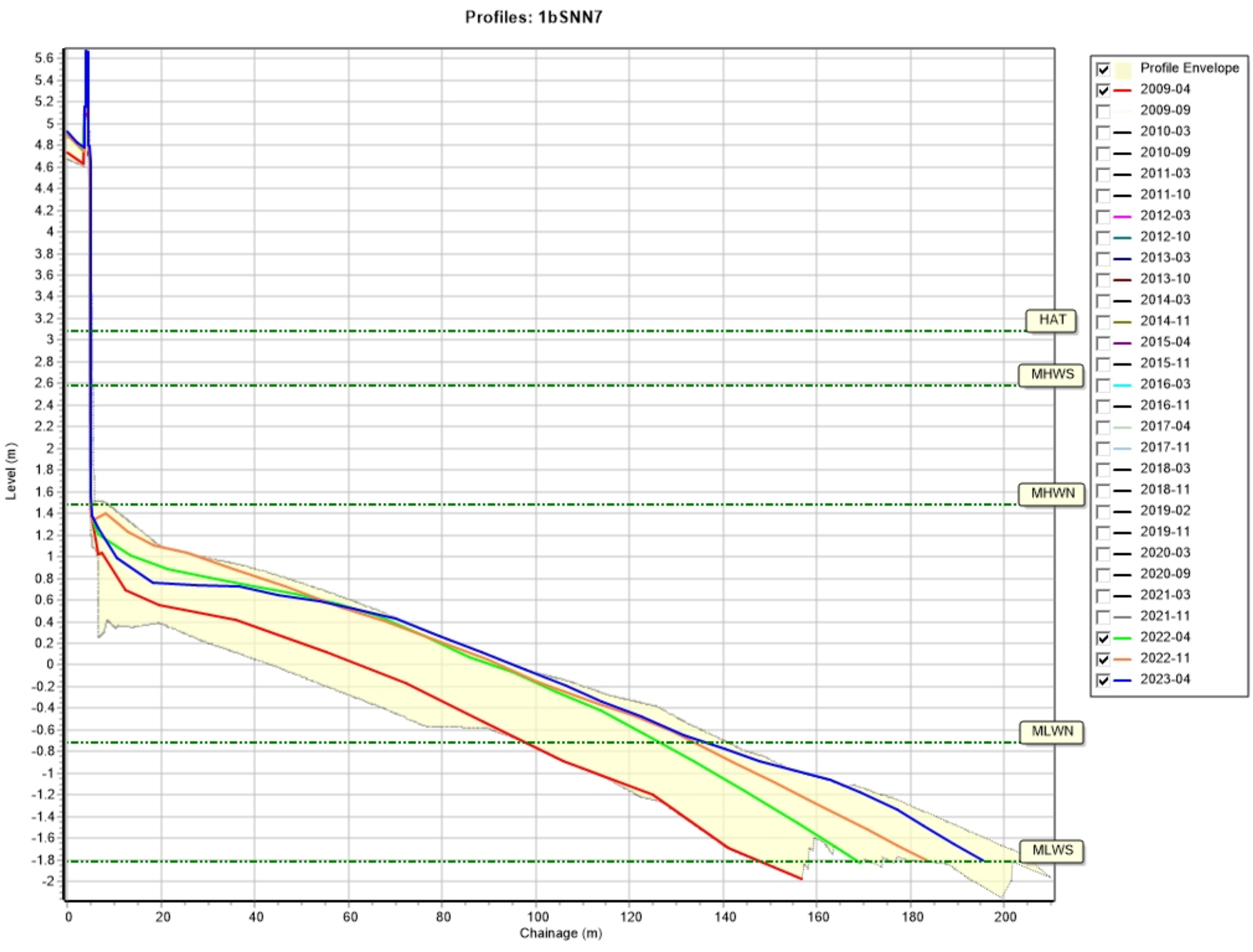
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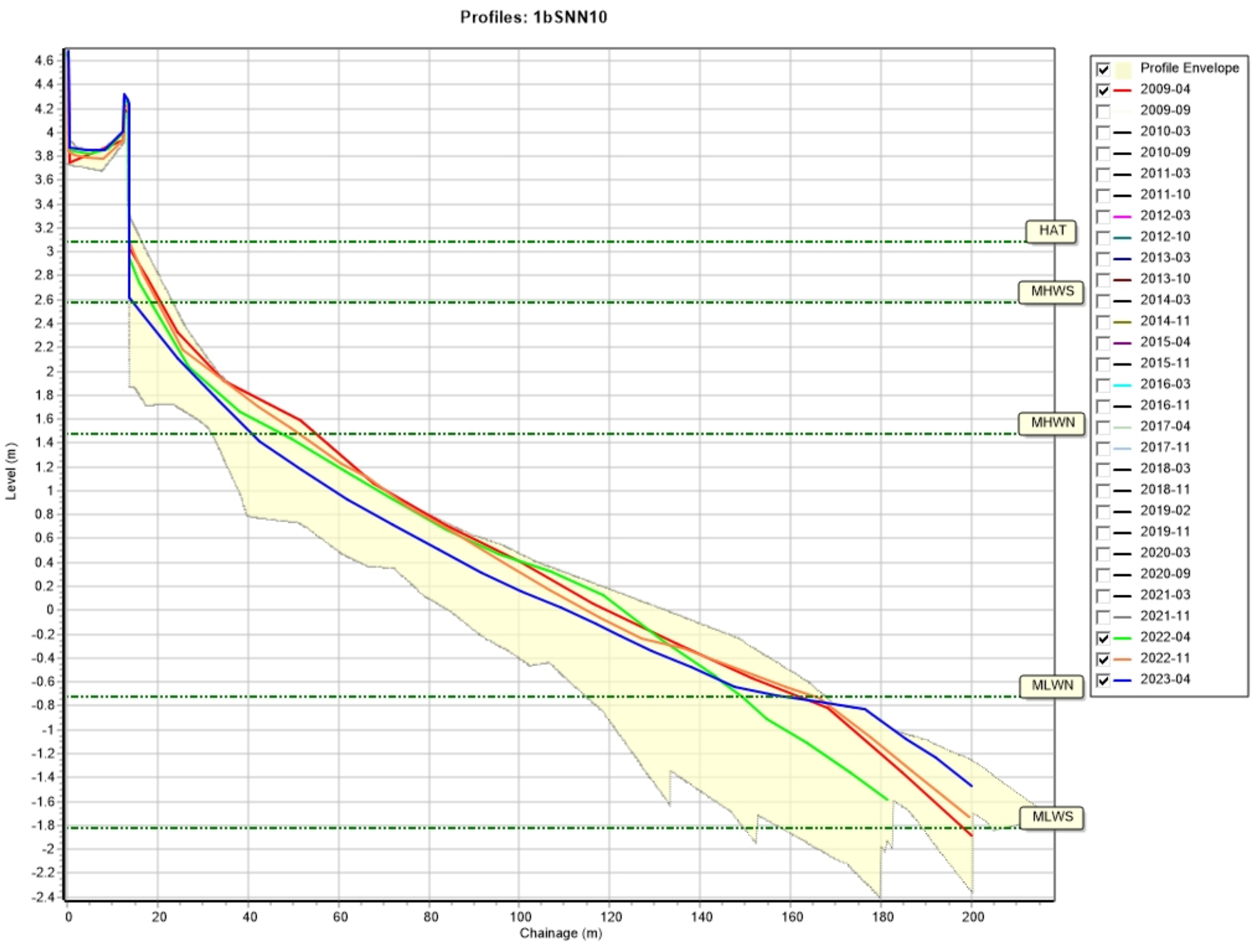
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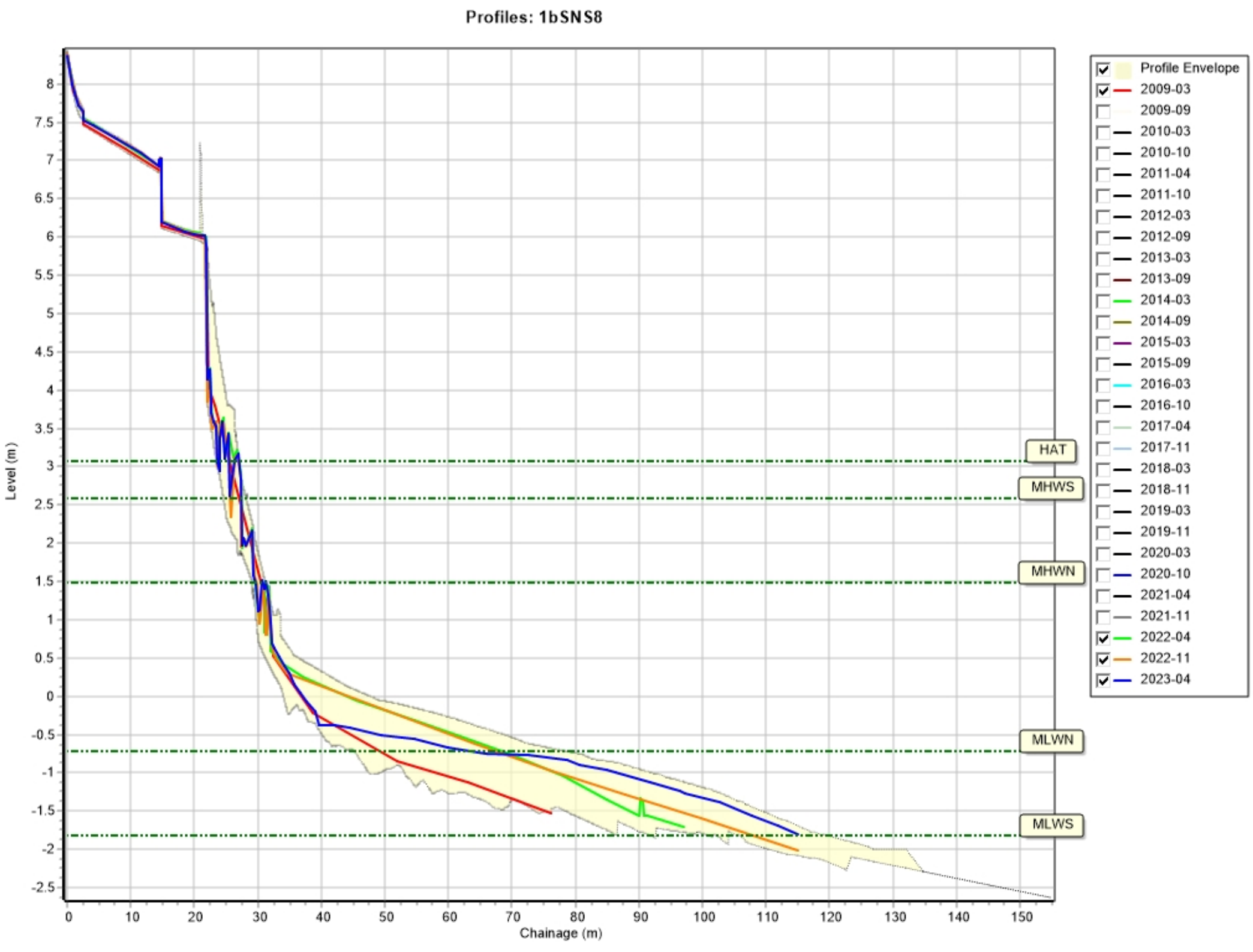
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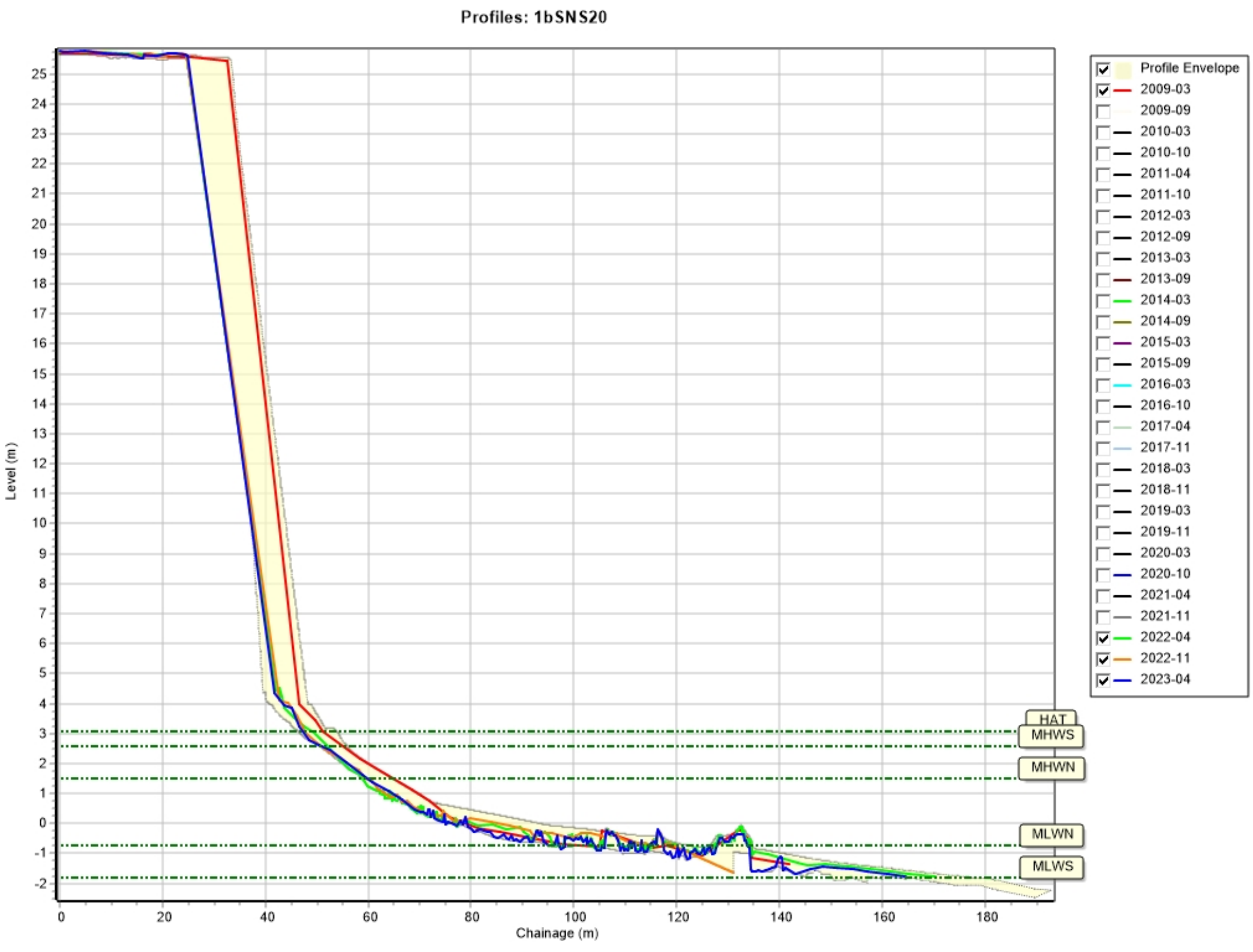
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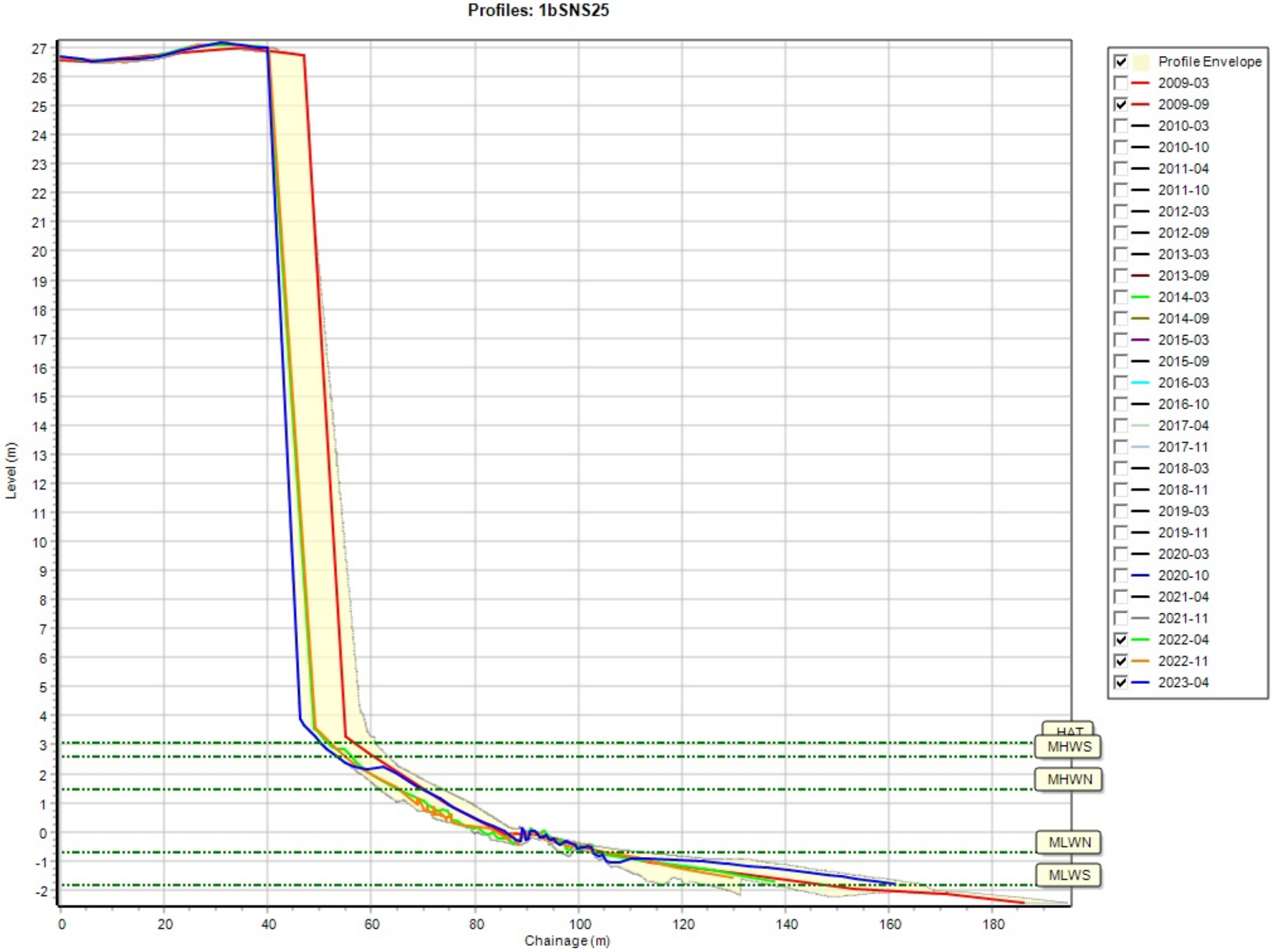
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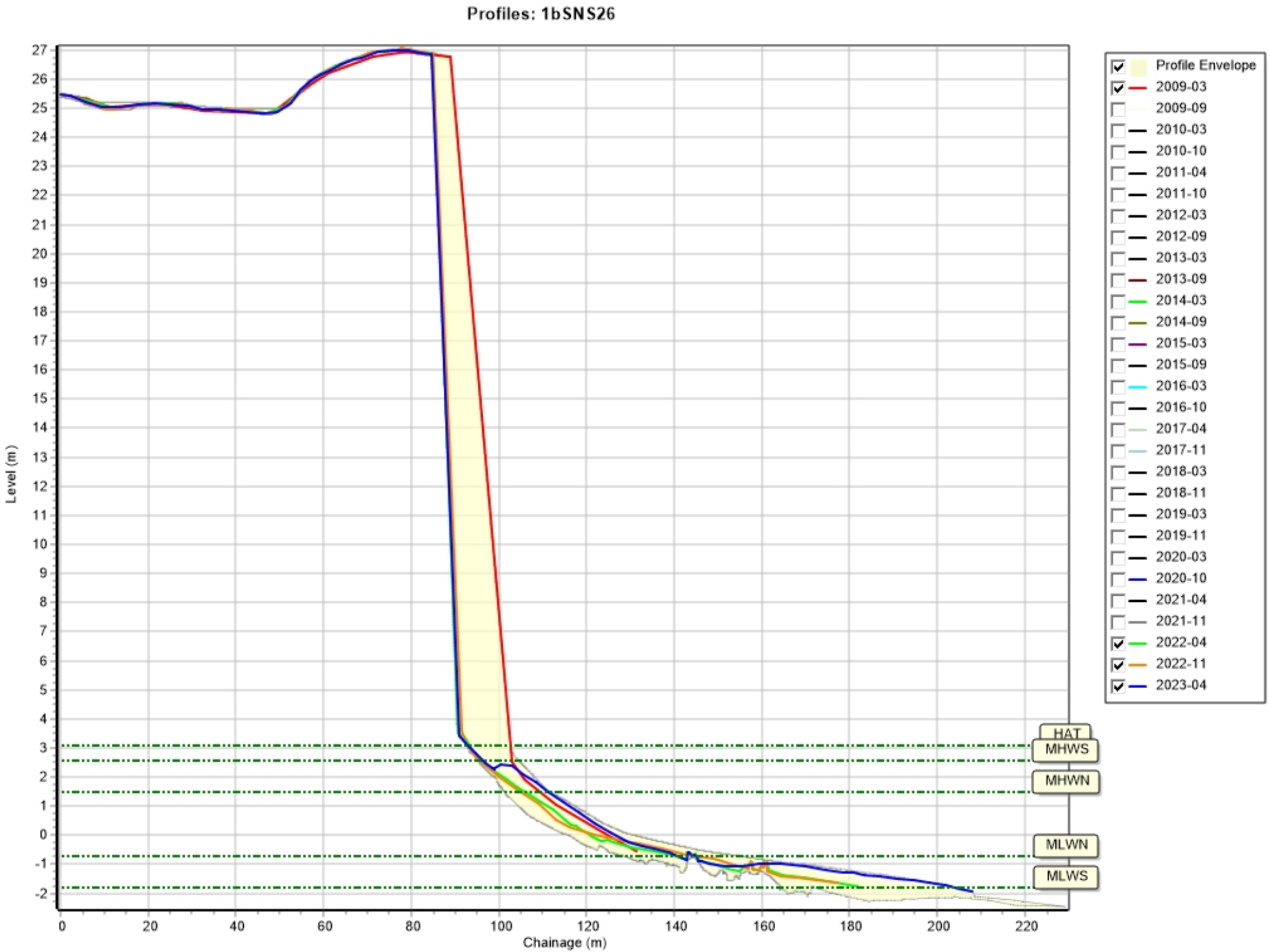
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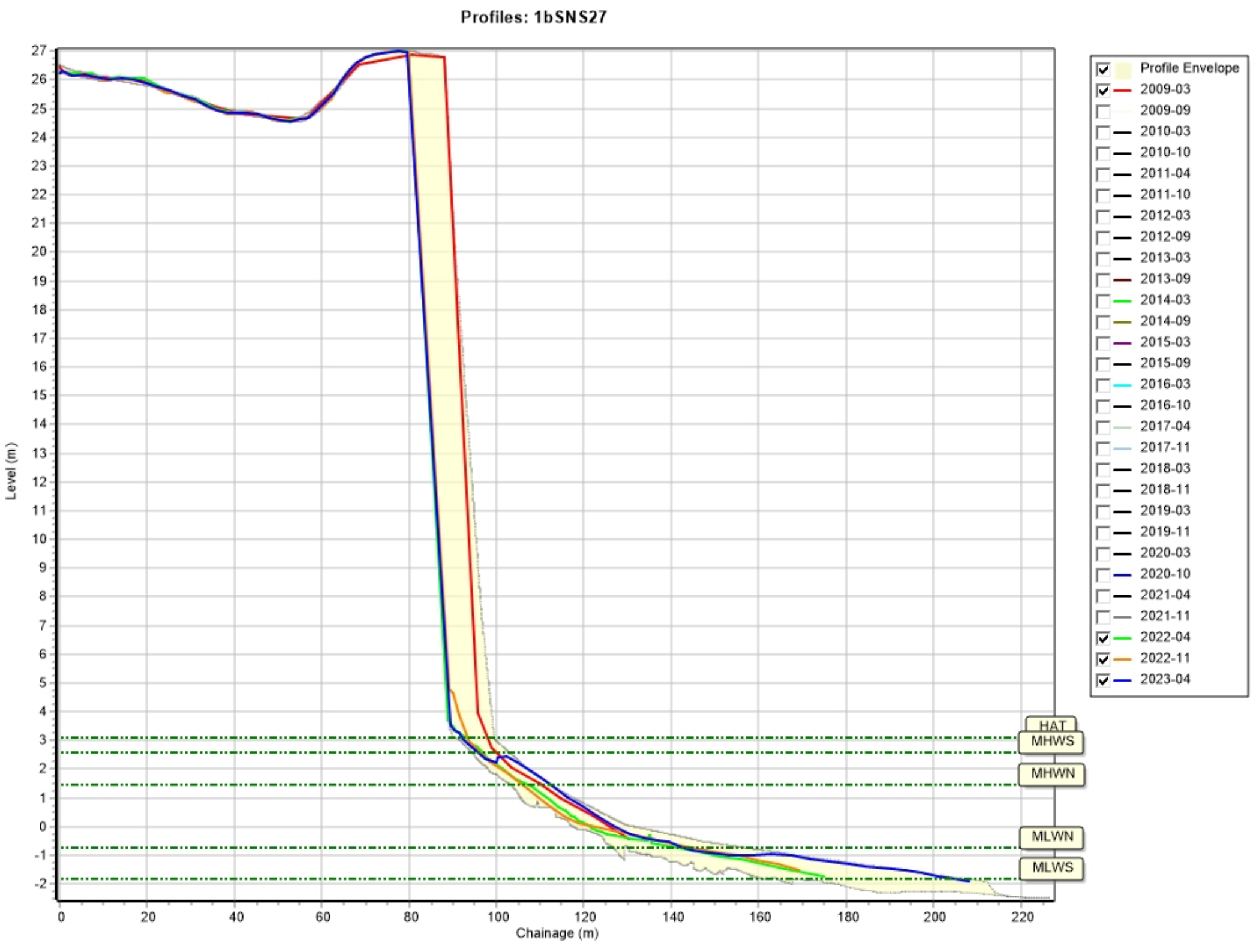
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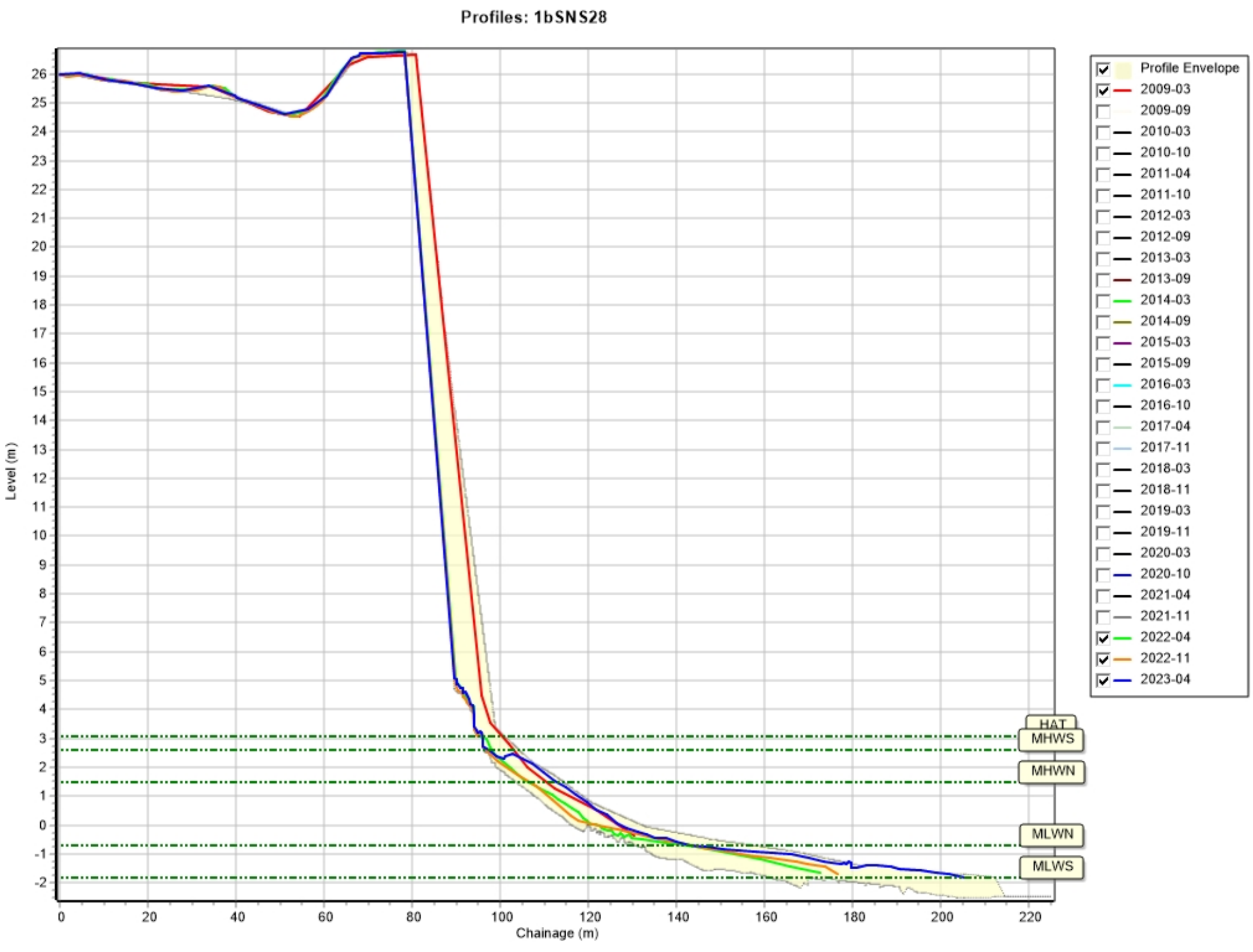
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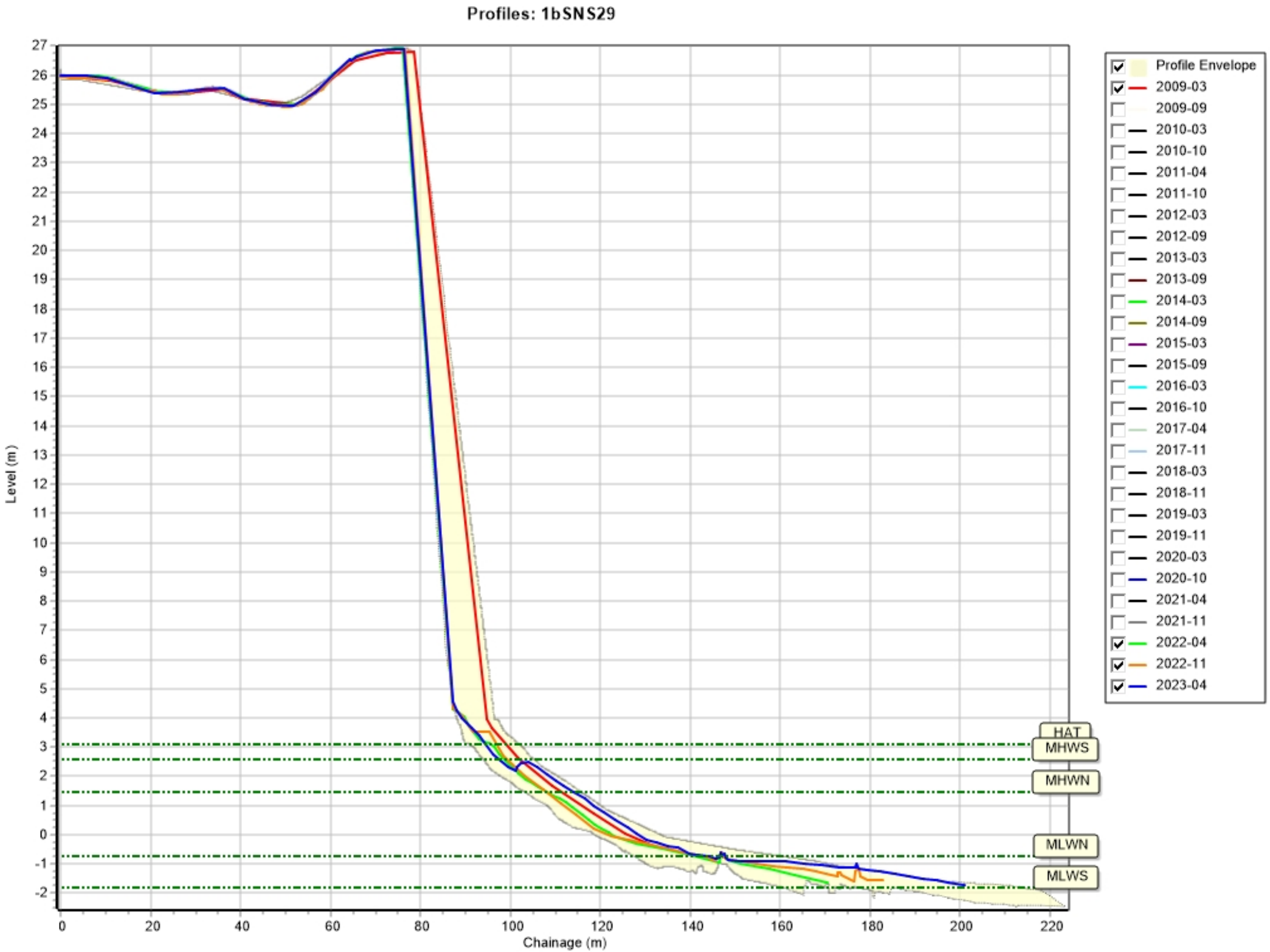
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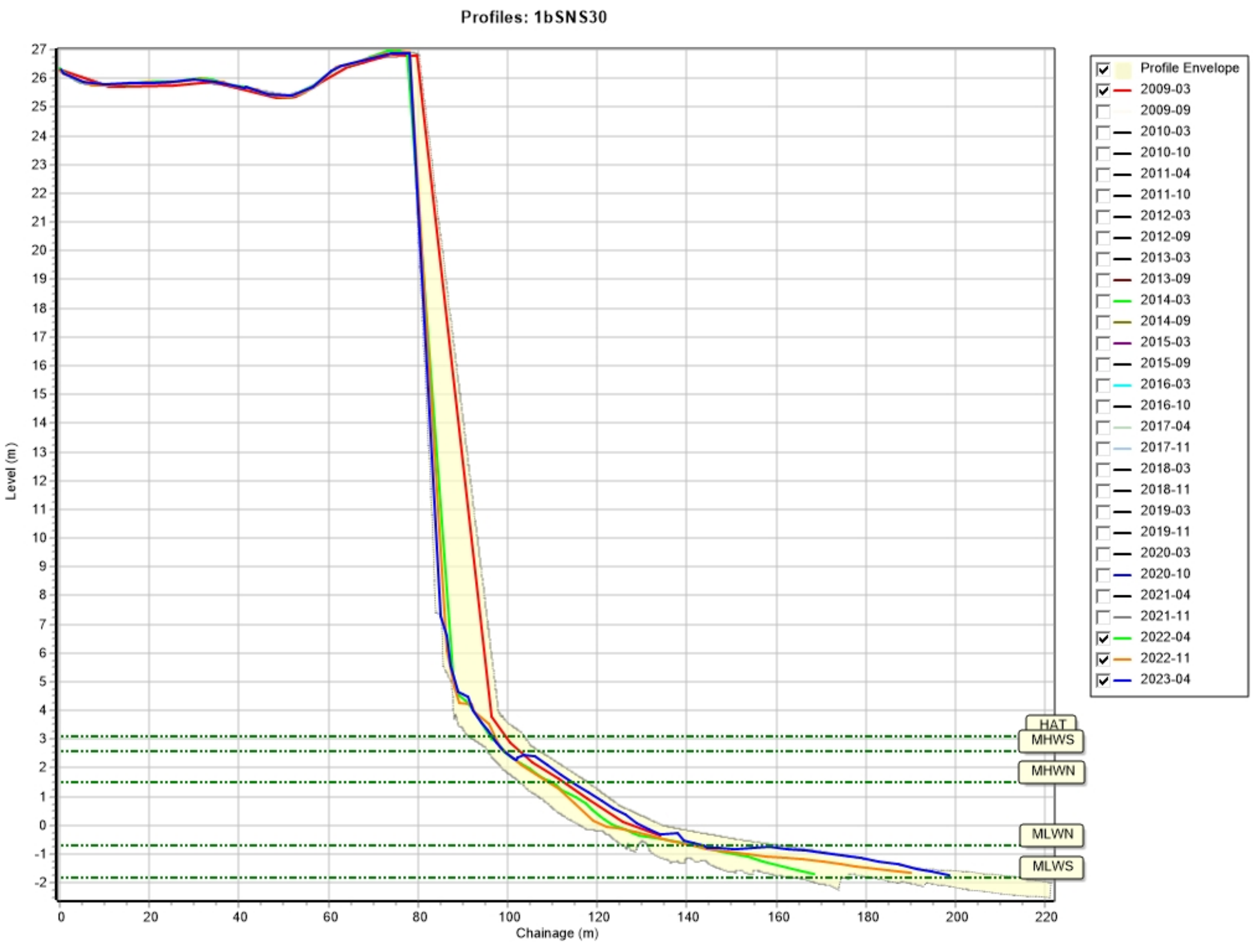
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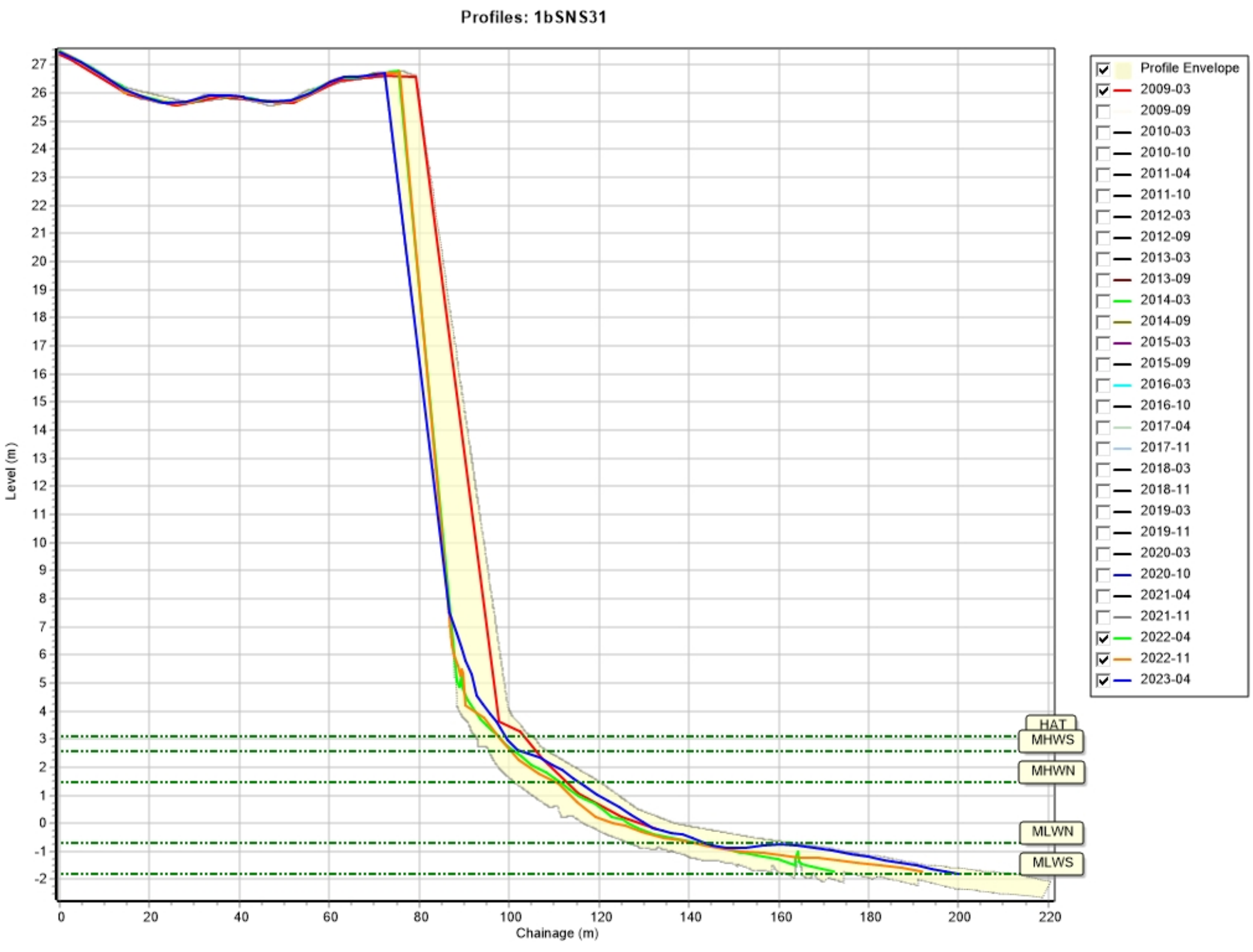
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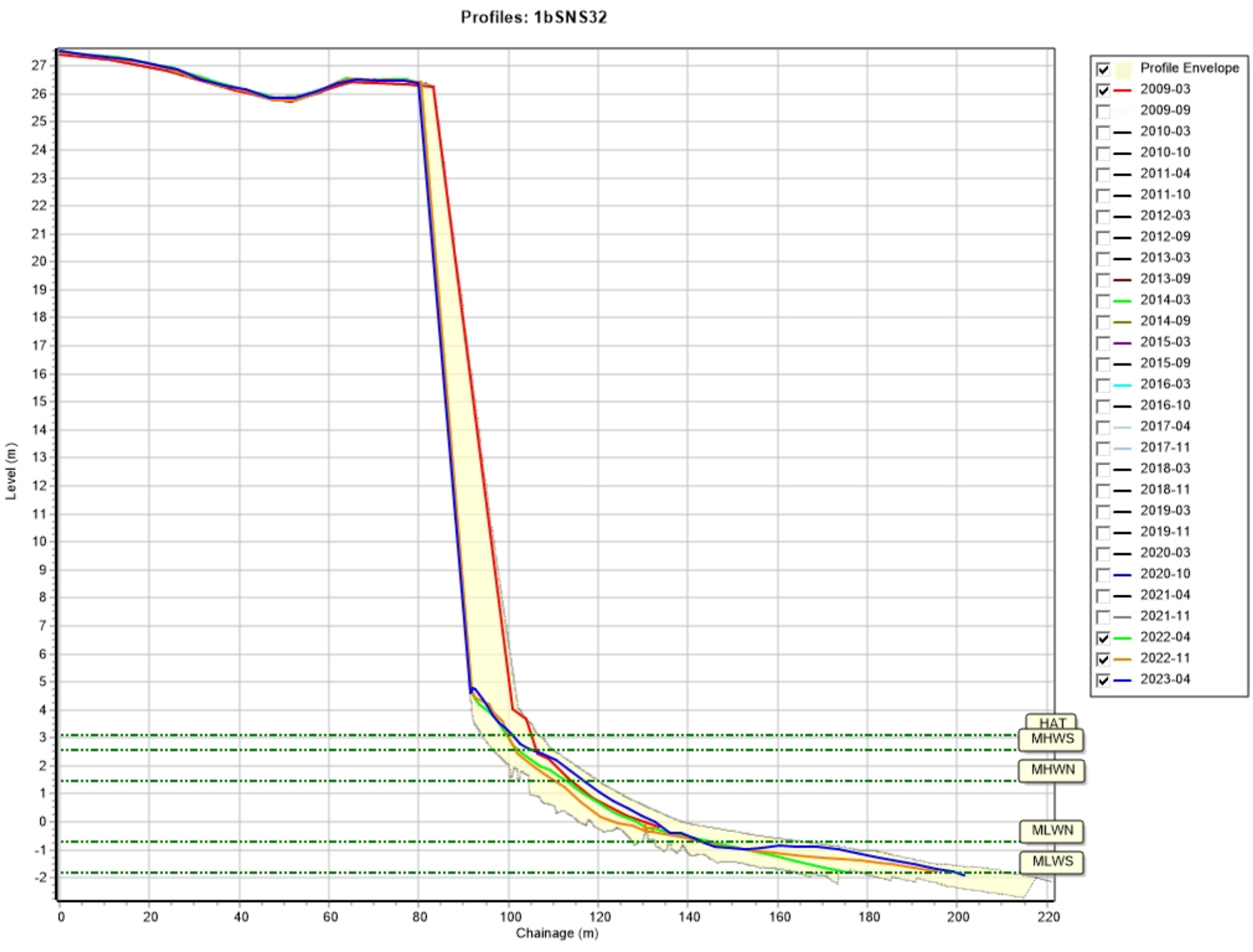
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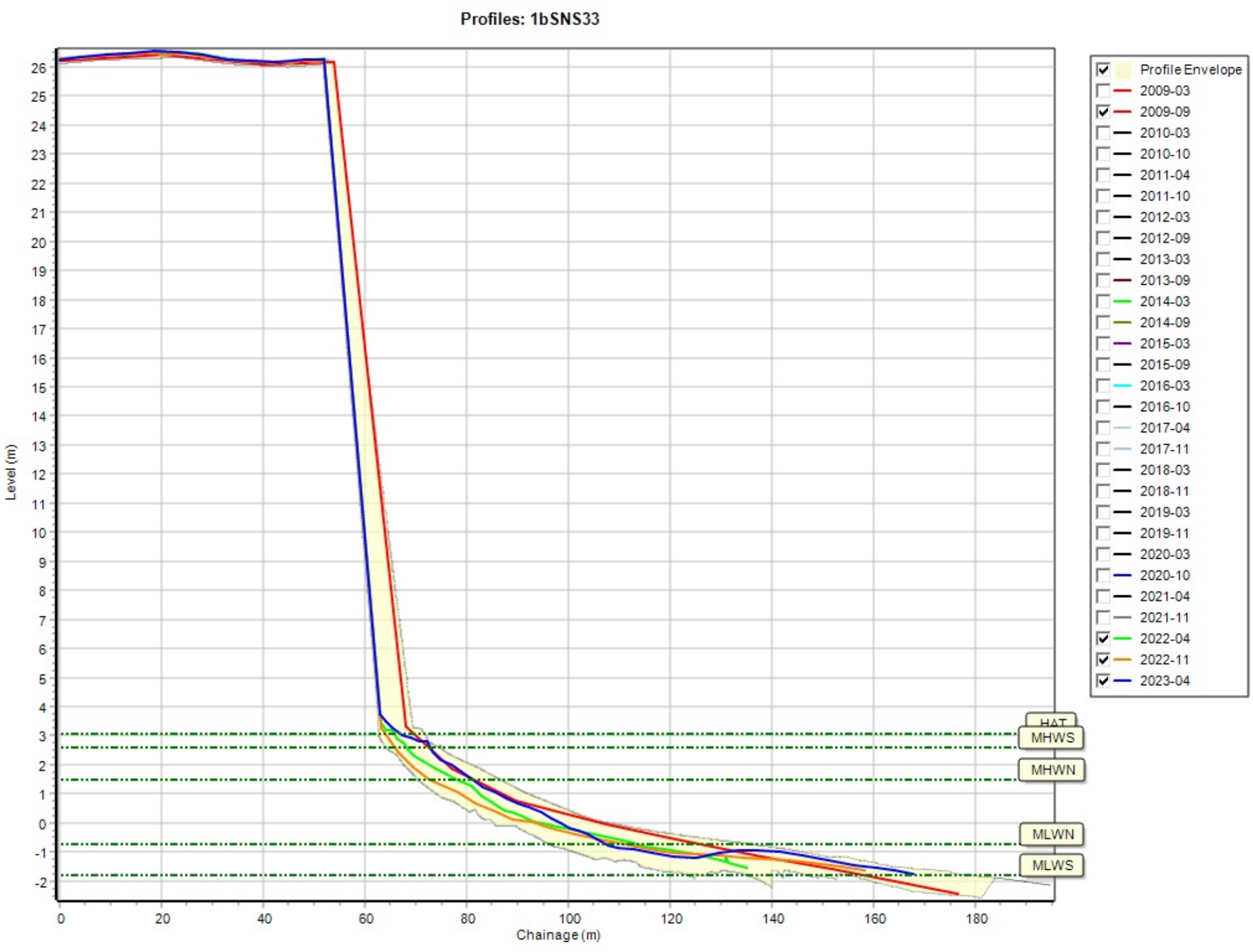
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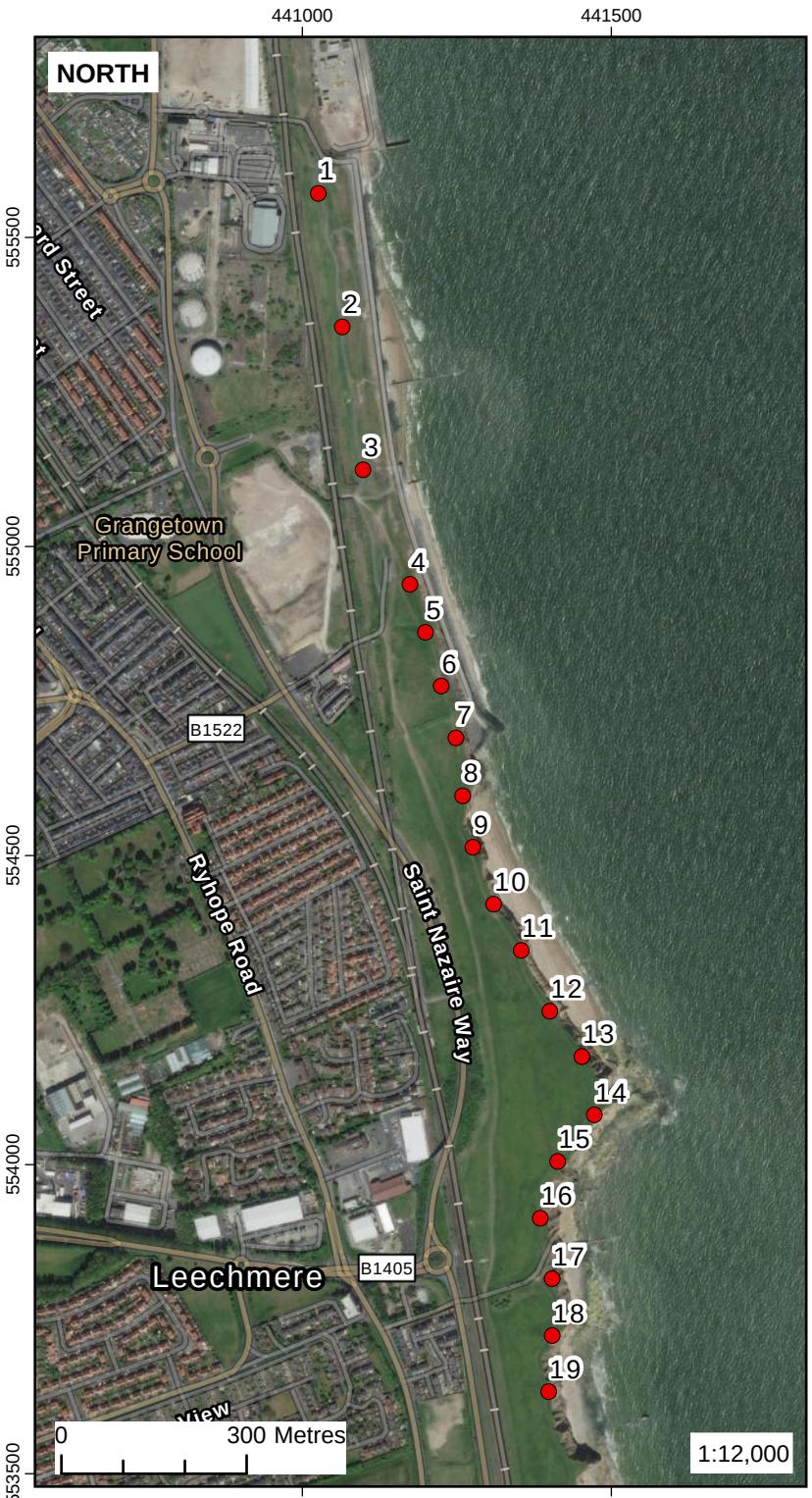
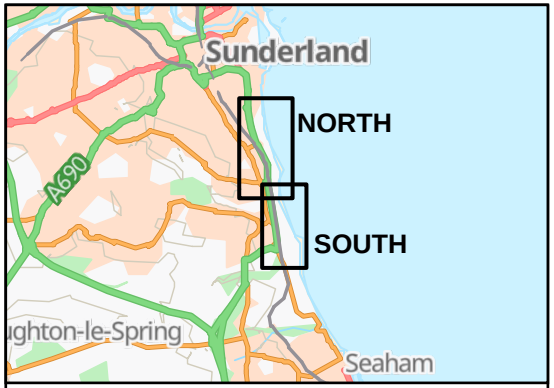
2023-04

Appendix B

Cliff Top Survey





SURVEY LOCATIONS

- Cliff Top Survey Points

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

Title:

Figure 3 - Map 1

HENDON TO RYHOPE

Sunderland City Council Frontage

Report: Survey Report

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	n/a	TC	NJC	A4	as shown

Co-ordinate system: British National Grid

Royal HaskoningDHV
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North East Coastal Observatory

Cliff Top Survey

Hendon and Ryhope

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

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

Table B1 provides baseline information about these ground control points and results from the 2009 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table B1 – Cliff Top Surveys between Hendon and Ryhope

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing	Baseline Survey	Previous Survey	Present Survey	Baseline to Present	Previous to Present	Baseline to Present
			(°)	Mar 2009	Nov 2022	Apr 2023	Mar 2009 - Apr 2023	Nov 2022- Apr 2023	Mar 2009 - Apr 2023
1	441025.7	555571.1	75	8.16	8.03	8.03	-0.13	0	-0.01
2	441064.4	555355.1	85	7.09	4.81	4.82	-2.27	0.01	-0.16
3	441098	555124	82	10.01	10.08	10.08	0.07	0	0.01
4	441174	554938.7	65	10.3	10.23	10.23	-0.07	0	-0.01
5	441199.1	554861.1	65	7.71	10.88	10.89	3.18	0.01	0.23
6	441224.5	554774.2	71	10.83	10.75	10.75	-0.08	0	-0.01
7	441248.4	554690.3	74	10.18	10.29	10.29	0.11	0	0.01
8	441259.3	554596.6	101	10.08	9.17	9.17	-0.91	0	-0.07
9	441275.8	554513.4	66	10.52	5.63	5.71	-4.81	0.08	-0.34
10	441309.4	554421.3	58	8.77	1.09	1.13	-7.64	0.04	-0.55
11	441354	554346.5	68	8.2	-0.18	-0.2	-8.4	-0.02	-0.60
12	441400.2	554248.2	56	6.17	5.61	5.62	-0.55	0.01	-0.04
13	441452.3	554174.7	63	11.61	5.37	5.36	-6.25	-0.01	-0.45

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
14	441472.3	554080.5	127	7.33	5.68	5.31	-2.02	-0.37	-0.14
15	441413	554005.1	122	7.84	7.5	7.43	-0.41	-0.07	-0.03
16	441384.8	553913.3	90	9.89	6.91	6.83	-3.06	-0.08	-0.22
17	441404.1	553815.5	93	6.32	5.6	5.58	-0.74	-0.02	-0.05
18	441404.1	553723.6	119	8.1	2.74	2.66	-5.44	-0.08	-0.39
19	441398.5	553632.8	78	8.23	3.78	3.75	-4.48	-0.03	-0.32
20	441438.3	553452.9	71	10.09	5.22	5.18	-4.91	-0.04	-0.35
21	441506.1	553256.1	62	8.57	-3.64	-3.64	-12.21	0	-0.87
22	441550.1	553158.7	103	6.57	2.01	2.09	-4.48	0.08	-0.32
23	441585.2	553076.5	64	8.11	2.02	2.05	-6.06	0.03	-0.43
24	441624.4	552870.7	69	7.53	1.44	1.44	-6.09	0	-0.44
25	441689.1	552758	70	14.58	2.14	2.03	-12.55	-0.11	-0.90
26	441715	552713.3	54	12.87	2.26	2.28	-10.59	0.02	-0.76
27	441749.2	552674.4	62	14.56	2.45	2.46	-12.1	0.01	-0.86
28	441776.6	552629.9	57	8.62	2.49	2.47	-6.15	-0.02	-0.44
28A	441798.6	552586.3	56	13.63	5.44	5.45	-8.18	0.01	-0.58
28B	441817.4	552542.4	64	12.3	8.12	8.03	-4.27	-0.09	-0.31
28C	441852.2	552502.6	52	13.11	12.41	12.39	-0.72	-0.02	-0.05
29	441880.1	552471.6	83	15.46	14.57	14.5	-0.96	-0.07	-0.07
30	441921.4	552269	97	8.55	4.23	3.95	-4.6	-0.28	-0.33
31	441853.1	552094	75	11.2	2.11	2.12	-9.08	0.01	-0.65
32	441883.3	551988.5	96	9.82	2.53	2.39	-7.43	-0.14	-0.53

*Note that 28A-28C baseline is September 2009.