CH2MHILL
Halcrow

Cell 1 Regional Coastal Monitoring Programme
Analytical Report 6: 'Full Measures' Survey 2013

Durham County Council

County Durham Council
Final Report

February 2014

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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 (m AOD)			
Water Level Parameter	**River Tyne to Frenchman's Bay**	**Frenchman's Bay to Souter Point**	**Souter Point to Chourdon Point**	**Chourdon Point to Hartlepool Headland**
1 in 200 year	3.41	3.44	3.66	3.91
HAT	2.85	2.88	3.18	3.30
MHWS	2.15	2.18	2.48	2.70
MLWS	-2.15	-2.12	-1.92	-1.90

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

Glossary of Terms

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

Preamble

The Cell 1 Regional Coastal Monitoring Programme covers approximately 300km of the north east coastline, from the Scottish Border (just south of St. Abb's Head) to Flamborough Head in East Yorkshire. This coastline is often referred to as 'Coastal Sediment Cell 1' in England and Wales (Figure 1). 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.

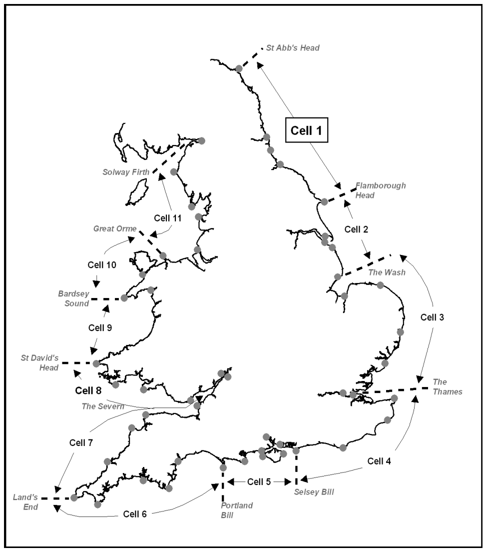


Figure 1 Sediment Cells in England and Wales

The work commenced with a three-year monitoring programme in September 2008 that was managed by Scarborough Borough Council on behalf of the North East Coastal Group. This initial phase has been followed by a five-year programme of work, which started in October 2011. The work is funded by the Environment Agency, working in partnership with the following organisations:

Northumberland County Council
Northumberland Coast Area of Outstanding Natural Beauty
North Tyneside Council
South Tyneside Council
Sunderland City Council
Durham County Council
Redcar & Cleveland Borough Council
Hartlepool Borough Council
Borough of Scarborough – Whitby, Scarborough, Filey – A great place to live, work & play
East Riding of Yorkshire Council
Environment Agency
Natural England
The National Trust

The original three year programme of work was undertaken as a partnership between Royal Haskoning, Halcrow and Academy Geomatics. For the current five year programme of work the data collection associated with beach profiles, topographic surveys and cliff top surveys is being undertaken by Academy Geomatics. The analysis and reporting for the programme is being undertaken by Halcrow (rebranded as CH2M HILL since 2013).

The main elements of the Cell 1 Regional Coastal Monitoring Programme involve:

- beach profile surveys
- topographic surveys
- cliff top recession surveys
- real-time wave data collection
- bathymetric and sea bed characterisation surveys
- aerial photography
- walk-over surveys

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

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.

Annually, 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	July 10	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 1	Sep 11
4	2011/12	Sep 2011	Aug 12	Mar-May 12	Feb 13	
5	2012/13	Sept 2012	Feb 13	Mar-Apr 13	May 2013	
6	2013/14	Oct 2013	Feb 14 (*)			

(*) The present report is **Analytical Report 6** and provides an analysis of the 2013 Full Measures survey for County Durham 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 sub-sections listed in the 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
	Embelton 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

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

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

1.2 Methodology

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

- Full Measures survey annually (since 2008) each autumn/early winter comprising:
    - Beach profile surveys along eight. transect lines
- Partial Measures survey annually (since 2009) each spring comprising:
    - Beach profile surveys along five. transect lines
- Cliff top survey bi-annually at:
    - Seaham (Dawdon)

The location of these surveys is shown in Figure 2. The 2013 Full Measures survey was undertaken along this frontage on 16th September and 21st October 2013. At Blackhall the weather was rainy with a light breeze from the north, the sea state was calm. At Easington and Seaham the weather was cloudy and wet with a gentle breeze the sea state was moderate.

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.

1.3 Uncertainties in data and analysis

While uncertainty due to survey accuracy or systematic error is likely to be present in all datasets, the work is carefully managed to ensure data are as accurate as possible and results are not misleading. Error may arise from the limits of precision of survey techniques used, from low accuracy measurements being taken or from systematic failings of equipment.

For beach profiles and topographic surveys, all incoming data are checked allowing systematic errors to be identified, and removed from plots and subsequent analysis. The accuracy of these surveys is not known, but it is likely that all measurements are correct to ±0.1m. Therefore, changes are less than ±0.1m are ignored and greyed out in the topographic change plots. For cliff top erosion surveys, there are commonly problems in precisely recognising the cliff edge due to vegetation growth and the convex shape of the feature. Errors manifest themselves as results that suggest the cliff edge has advanced, which is very unlikely unless a toppling failure has been initiated, but the block has not yet fully detached. The accuracy of cliff top surveys are also unknown, but it is assumed that each measurement is accurate to ±0.1m.

These limits of accuracy mean that comparison of annual or biannual data can be of limited value if the measured change is less than or equal to the assumed error. However, all results become more significant over longer time periods when the errors in measurement in years 1 and *x* are averaged over the monitoring period:

$$\text{Error rate of change per year} = \frac{\text{Error in first measurement + Error in last measurement}}{\text{Years between measurements}}$$

The effect of averaging error over different monitoring periods is summarised in Table 3, which assumes that each annual survey is accurate to 0.1m.

Table 3 Error bands for long-term calculations of change.

Years between surveys	**Error in inter-survey comparison** (±m/yr)
1	0.200
2	0.100
3	0.067
4	0.050
5	0.040
5	0.033
7	0.029
8	0.025
9	0.022
10	0.020

While considering the uncertainty in comparing and analysing change between monitoring data sets it is also relevant to raise caution about drawing conclusions about short or longer term trends. Clearly the longer the data set the more confidence that can be given to likely ranges of beach changes and trends in change. Potential for seasonal, annual and longer term cycles need to be considered. Studies of long term monitoring data sets for other coastal and estuarial data have established that there are long period cyclical trends related to the 18.6 years lunar nodal cycle which need to be accounted for. Simply put this means that although the Cell 1 monitoring programme now has data in some locations up to 11 years, another 8 to 10 years of consistent data is needed before confidence can be given in trends from the analysis. In the context of this report "Longer Term Trends" are mentioned in each section and it should be noted that this is based on simple visual interpretation of the available data since the current programme began, and is generally based on only 5 years of data.

2. Wave Data and Interpretation

2.1 Introduction

Wave monitoring data relevant to the Cell 1 Regional Coastal Monitoring Programme is available from one offshore regional wave buoy located at Tyne and Tees and. three regional wave buoys, which are further inshore at Newbiggin, Whitby and Scarborough. The Tyne Tees buoy is managed by Cefas as part of the WaveNet system, whilst the three inshore buoys is managed by Scarborough BC as part of the Cell 1 monitoring programme.

An assessment of baseline wave data is presented in Halcrow's 2011 Wave Data Analysis Report, which reviewed all readily available data in the region. In 2014 a wave data update report will update the baseline with analysis of the wave data collected under the programme for 2013, including the 5th and 6th December storm. In order to help put the beach and cliff changes discussed in this report into context analysed storm data for the wave buoys is presented in this section.

The longest consistent relevant wave data record in the Cell 1 region is from the WaveNet Tyne Tees buoy deployed under the national coastal monitoring programme by Cefas. Data has been downloaded from WaveNet and loaded into SANDS for analysis alongside the beach and cliff monitoring data. Results from analysis of the data to extract details of significant storms are presented in Table 3 below.

To aid interpretation of the results in Table 3 alternate years have been shaded and the storm with the largest peak wave height each year has been highlighted in bold. The annual storm with the highest wave energy at peak has also been highlighted in bold red text as this depends on wave period as well as wave height and so is not always the same as the largest wave height, e.g. in 2009 and 2010.

Table 4 SANDS Storm Analysis at Tyne/Tees WaveNet Buoy

General Storm Information					At Peak			
Start Time	**End Time**	**Duration (Hours)**	**Peak of Storm**	**Mean Direction Vector (Degrees)**	**Hs (m)**	**Tp (s)**	**Direction (Degrees)**	**Energy @ Peak (KJ/m/s)**
19/03/2007 10:30	21/03/2007 05:30	43	20/03/2007 14:30	79.0	6.2	12.4	22	11759.3
25/06/2007 20:00	26/06/2007 13:30	17.5	26/06/2007 10:00	81.6	4.4	8.6	22	2832.6
26/09/2007 03:00	27/09/2007 05:00	26	26/09/2007 19:00	80.4	4.6	11.6	6	5488.7
08/11/2007 20:00	**12/11/2007 15:00**	**91**	**09/11/2007 08:30**	**78.7**	**6.2**	**13.4**	**6**	**13698.9**
19/11/2007 03:30	25/11/2007 21:30	162	23/11/2007 05:00	78.8	4.9	10.7	17	5353.7
08/12/2007 03:00	10/12/2007 14:30	59.5	08/12/2007 03:30	85.1	4.1	10.8	17	3816.4
03/01/2008 10:30	04/01/2008 01:30	15	03/01/2008 23:30	14.8	4.2	9.1	62	2964.9
01/02/2008 15:00	02/02/2008 09:30	18.5	02/02/2008	80.9	6.0	13.8	17	13641.7
10/03/2008 08:30	10/03/2008 12:30	4	10/03/2008 11:00	307.6	4.6	8.0	141	2631.9
17/03/2008 15:00	**25/03/2008 03:00**	**180**	**22/03/2008 05:00**	**83.8**	**7.9**	**12.4**	**6**	**19123.9**
05/04/2008 22:00	07/04/2008 05:00	31	06/04/2008 19:00	83.8	4.6	11.6	6	5520.5
20/07/2008 16:00	21/07/2008 09:30	17.5	20/07/2008 23:30	75.9	4.2	9.9	11	3492.5
03/10/2008 03:00	03/10/2008 20:30	17.5	03/10/2008 16:30	82.4	4.7	11.4	22	5728.4
21/11/2008 04:00	25/11/2008 12:30	104.5	22/11/2008 11:30	75.8	6.0	13.1	11	12267.5

General Storm Information					At Peak			
Start Time	End Time	Duration (Hours)	Peak of Storm	Mean Direction Vector (Degrees)	Hs (m)	Tp (s)	Direction (Degrees)	Energy @ Peak (KJ/m/s)
10/12/2008 12:00	13/12/2008 18:00	78	13/12/2008 08:00	331.9	4.9	8.3	129	3286.2
31/01/2009 16:30	03/02/2009 09:00	64.5	02/02/2009 22:00	7.1	5.8	9.5	84	6078.5
23/03/2009 20:30	28/03/2009 20:30	120	28/03/2009 18:30	89.7	4.9	9.3	0	4053.0
10/07/2009 01:30	10/07/2009 02:30	1	10/07/2009 01:30	78.8	4.2	9.9	11	3504.3
29/11/2009 20:00	**30/11/2009 15:00**	**19**	**30/11/2009 00:30**	**73.4**	**6.0**	**9.4**	**11**	**6331.4**
17/12/2009 10:30	18/12/2009 05:00	18.5	17/12/2009 19:30	26.4	5.4	10.6	68	**6549.5**
30/12/2009 09:00	30/12/2009 23:00	14	30/12/2009 12:30	7.7	5.1	7.5	90	2866.0
06/01/2010 05:30	06/01/2010 11:00	5.5	06/01/2010 06:30	63.7	4.2	10.7	11	4044.1
29/01/2010 10:30	30/01/2010 00:30	14	29/01/2010 22:30	83.9	5.4	8.6	6	4258.2
26/02/2010 22:30	27/02/2010 02:30	4	27/02/2010 01:00	72.6	4.6	8.5	17	2925.7
19/06/2010 07:00	20/06/2010 08:30	25.5	19/06/2010 20:00	69.4	5.4	10.7	22	**6611.8**
29/08/2010 14:00	30/08/2010 06:30	16.5	29/08/2010 22:30	91.8	4.9	8.9	0	3715.5
06/09/2010 22:30	07/09/2010 16:00	17.5	07/09/2010 15:30	353.3	4.6	8.8	90	3192.5
17/09/2010 07:00	17/09/2010 18:30	11.5	17/09/2010 08:30	80.8	4.7	11.0	11	5323.3
24/09/2010 03:00	26/09/2010	45	24/09/2010 10:00	73.1	5.3	10.1	11	5564.7
20/10/2010 02:00	24/10/2010 16:30	110.5	20/10/2010 10:00	78.3	4.2	11.3	17	4514.5
08/11/2010 14:00	**09/11/2010 20:30**	**30.5**	**09/11/2010 10:00**	**3.1**	**5.6**	**8.8**	**73**	**4870.6**
17/11/2010 11:00	17/11/2010 18:30	7.5	17/11/2010 12:00	322.2	4.7	7.8	129	2646.0
29/11/2010 19:30	02/12/2010 08:30	61	29/11/2010 21:00	11.8	5.1	9.4	56	4474.2
16/12/2010 15:00	17/12/2010 06:30	15.5	17/12/2010 03:30	80.2	4.6	10.5	17	4504.6
23/07/2011 14:00	**24/07/2011 11:00**	**21**	**24/07/2011 03:00**	**67.5**	**4.7**	**10.8**	**17**	**5082.6**
24/10/2011 18:30	25/10/2011 09:30	15	25/10/2011 09:30	348.5	4.1	9.5	79	2986.1
09/12/2011 08:30	09/12/2011 10:00	1.5	09/12/2011 08:30	84.4	4.1	11.9	6	4669.0
05/01/2012 15:30	06/01/2012 05:00	13.5	06/01/2012 00:30	81.4	4.5	9.9	14	3896.6
03/04/2012 13:30	04/04/2012 10:30	21	04/04/2012 03:00	26.5	5.7	8.4	90	4510.0
24/09/2012 07:30	25/09/2012 11:00	27.5	24/09/2012 17:30	17.2	5.3	9.3	77	4786.2
26/10/2012 12:00	27/10/2012 15:00	27	26/10/2012 23:00	78.9	4.9	12.9	11	**7839.9**
05/12/2012 15:00	**15/12/2012 01:30**	**226.5**	**14/12/2012 18:30**	**39.6**	**6.1**	**8.4**	**107**	**5080.9**
20/12/2012 06:00	21/12/2012 14:30	32.5	20/12/2012 23:30	347.3	6.0	8.8	103	5436.3
18/01/2013 17:30	22/01/2013 07:30	86	21/01/2013 09:30	7.6	6.8	9.3	83	7978.4
06/02/2013 08:00	07/02/2013 08:30	24.5	06/02/2013 12:30	82.6	5.6	9.9	11	6039.7
07/03/2013 21:00	11/03/2013 04:00	79	08/03/2013 04:00	24.3	5.1	8.4	82	3667.4
18/03/2013 07:00	**25/03/2013 02:00**	**163**	**23/03/2013 10:30**	**4.5**	**7.3**	**9.3**	**89**	**9164.3**

General Storm Information					At Peak			
Start Time	**End Time**	**Duration (Hours)**	**Peak of Storm**	**Mean Direction Vector (Degrees)**	**Hs (m)**	**Tp (s)**	**Direction (Degrees)**	**Energy @ Peak (KJ/m/s)**
23/05/2013 18:00	24/05/2013 12:00	18	23/05/2013 22:30	77.5	6.7	10.5	17	**9678.4**
10/09/2013 13:00	10/09/2013 19:30	6.5	10/09/2013 14:00	79.3	4.4	9.2	11	3237.0
29/11/2013 22:30	30/11/2013 05:30	7	30/11/2013 00:30	82.8	5.6	10.7	11	7071.5
05/12/2013 14:00	07/12/2013 04:30	38.5	06/12/2013 20:00	80.4	4.7	14.3	6	8937.4
27/12/2013 09:30	27/12/2013 12:30	3	27/12/2013 10:00	249.3	4.1	6.1	202	1237.4

The storms mostly arrive from the north to northeast direction, 0 to 40 degrees, which has the longest fetch, but there are also a significant number of storms from other directions, particularly 80 to 140 degrees.

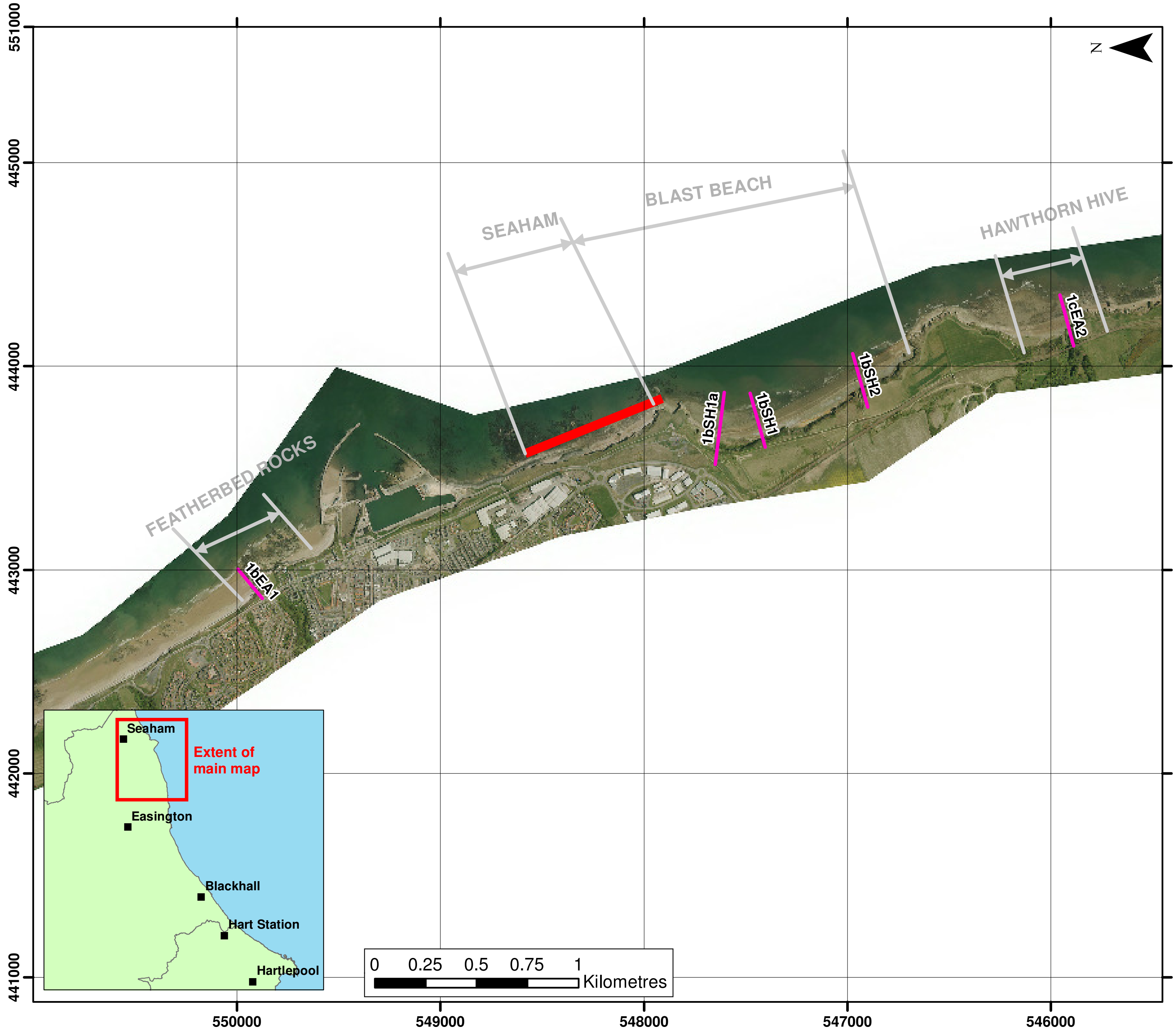
Comparing the annual storm records it can be seen that 2010 had the most storms (13). In 2010 the largest storm had an incident direction of 73 degrees which is unusual. We might therefore expect that the alongshore drift on the Cell 1 beaches in 2010 may have been atypical with unusual changes from the storm conditions. This was indeed noted in several of the 2010 Full Measures reports.

The year with the fewest storms was 2011. This was reflected by accretion recorded in a number of the annual Full Measures reports.

The winter of 2012 to 2013 appears to have suffered with larger storms than usual, with the second largest peak wave height (7.3m) recorded on 23rd March 2013. The longest duration storm in the record was from 5th to 15th December 2012 (226.5 hours).

The storm on the 5th to 7th December, was particularly notable. Although this event did not have such large waves as the 23rd March 2013 storm, it had a high peak energy and exceptionally long wave period at 14.3 seconds. The 6th December storm was also accompanied by a significant storm surge with recorded water levels around 1.75m higher that predicted tides. The combined high water levels and large waves causing significant damage to many coastal defences and beaches. However, the Autumn 2013 full-measures survey data set which is assessed in this report was collected in October and November and so as no post storm surveys were available the impacts will not be seen until the Spring 2014 Partial Measures surveys.

All of the beaches except Blackhall were surveyed in October, some time after the 10th September storm and as a result were not likely to show recent storm impacts. At Blackhall the observed erosion may have been exacerbated by the 10th September storm.



KEY

Topographic Profiles

Annual

6 monthly

Topographic Surveys

6 monthly

yearly

5 yearly

Cliff Top Monitoring Pegs

50m centres

100m centres

300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 1
Survey Locations
Featherbed Rocks to Hawthorne Hive
Durham County Council

Analytical Report 6
Full Measures Survey
Autumn 2013

CH2MHILL.
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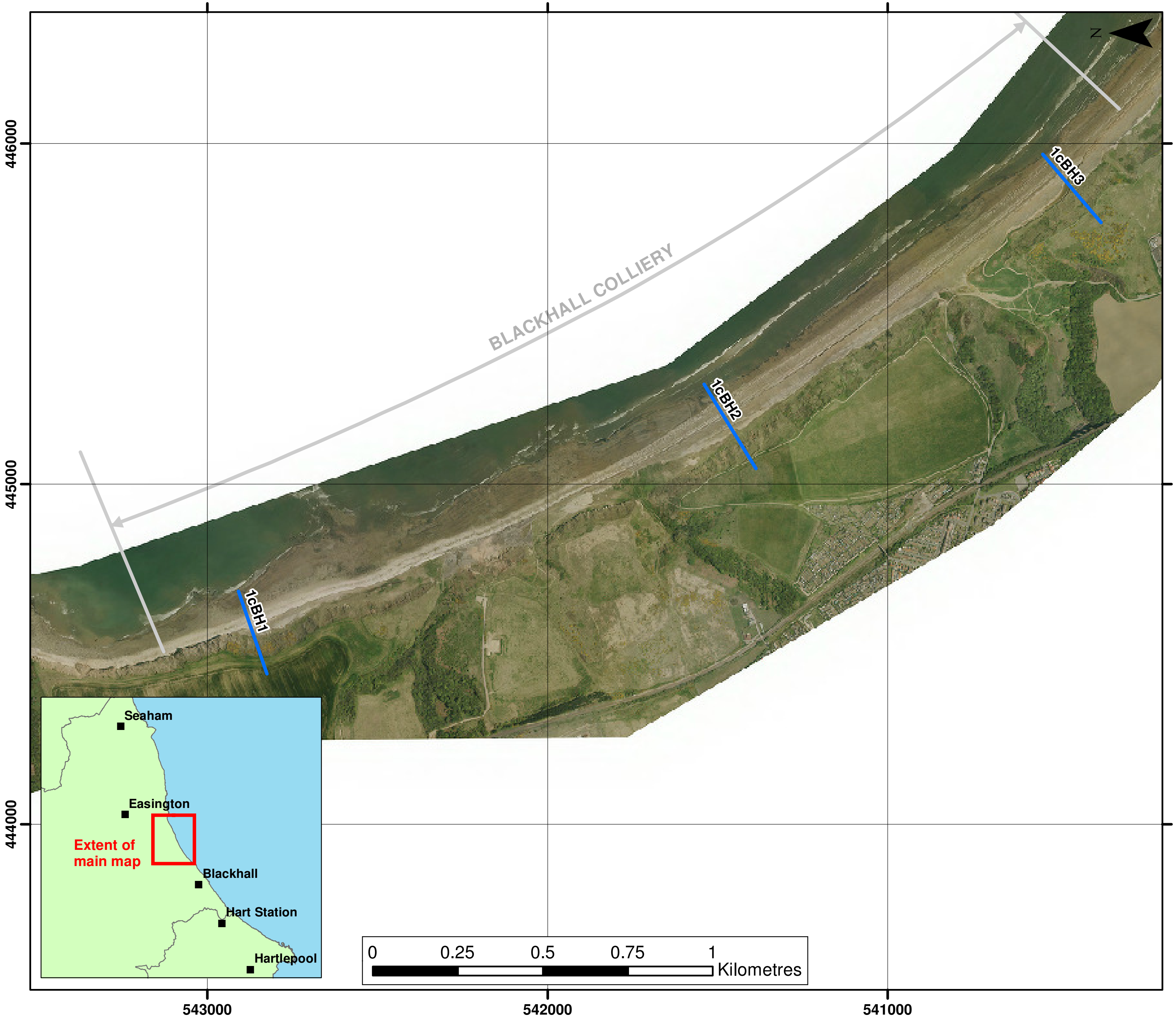
www.halcrow.com

Photography courtesy of North East Coastal Observatory
www.northeastcoastalobservatory.org.uk



KEY

Topographic Profiles
- Annual
- 6 monthly

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs
- 50m centres
- 100m centres
- 300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 2
Survey Locations
Blackhall Colliery
Durham County Council

Analytical Report 6
Full Measures Survey
Autumn 2013

CH2MHILL.
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www.halcrow.com

Photography courtesy of North East Coastal Observatory
www.northeastcoastalobservatory.org.uk

3. Analysis of Survey Data

3.1 Featherbed Rocks

Survey Date	Description of Changes Since Last Survey	Interpretation
21st Oct 2013	**Beach Profiles:** One beach profile line, **1bEA1**, is located at Featherbed Rocks (Appendix A) and has been monitored at this location since March 2009. The profile extends across the cliff top and cliff face then extends across the promenade and beach. The autumn 2013 data shows a significant quantity of shingle has accumulated at the toe of the sea wall. At the base of the sea wall at 55m chainage the profile is more uneven than in previous years, which represents rock armour and underlying shore platform exposed due to the low beach levels shown on the photographs. Between 75m and 80m chainage the beach has accreted by 0.5m over the summer of 2013. From 80m chainage to the end of the survey at 110m chainage the beach level is very low, exposing the rocks on the foreshore.	The rocky nature of this foreshore means it is unlikely to undergo significant changes in morphology unless sediment is deposited upon it. A veneer beach tends to accumulate over the summer and is subsequently stripped off during winter storms. **Longer term trends:** The profile for October 2013 is one of the lowest recorded and exposed the rocky shore platform along much of its length. The previous data, from April 2013, also showed a low beach profile, suggesting a veneer beach has not accumulated over the previous summer.

3.2 Seaham (Dawdon)

Survey Date	Description of Changes Since Last Survey	Interpretation
October 2013	**Cliff-top Survey:** Three ground control points have been established along the cliff top at Dawdon (Figure B1). The separation between any two points is nominally 300m. These cliff top surveys are intended to inform on erosion rates of the undefended sea cliffs extending south of the rock armour revetment to the south of Seaham Harbour. The cliff top surveys at Dawdon are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top. Appendix B provides information about the ground control points and results from between the 2008 (baseline) cliff top survey and the current (October 2013) survey. Between April 2013 and October 2013 two of the posts showed little or no change, with the remaining post retreating by 0.1m. Appendix C provides results from the October 2012 survey, showing the distance from the ground control point to the edge of the cliff top along the defined bearing and changes in position since the November 2008 baseline survey.	Long-term recession rates calculated from the data collected since November 2008 show that two of the three monitoring locations show retreat at around 0.2m/yr. The third monitoring point shows no change. **Longer term trends:** the greatest recession has been observed at markers 1 and 3, which are on each end of the bay. Marker 2 is in the centre of the bay and shows little or no change over the recent period.

3.3 Blast Beach

Survey Date	Description of Changes Since Last Survey	Interpretation
21st Oct 2013	**Beach Profiles:** Blast Beach is covered by three beach profile lines (Appendix A). Profile **1bSH1a** was added to the programme during the Full Measures survey in September 2009. It is located to the north of the previously-established SH1. All three profiles along Blast Beach exhibit similar forms, with a rock cliff, wide spoil beach with a distinct cliff at the eroding face of the colliery spoil, and a gravel and sand foreshore that extends to MLW. **1bSH1a** has a very similar profile to the previous year down to the eroding face of the spoil deposit at 140m chainage. There has been some variability at the toe of the spoil cliff (between 140 and 180m chainage) with the beach having flattened overall. Between 140m chainage and 165m chainage the beach has accreted by 0.5m. From 165m to 200m a berm on the shore has been lost, due to the erosion of up to 1m of material. From 200m chainage to the end of the survey at 265m chainage the beach has changed very little because of dominance of boulders on this part of the beach. The width of the spoil beach along SH1a is around 60m, reducing to around 35m along SH1 and SH2. Profile **1bSH1** is similar to all of the previous surveys to the beach crest at 75m. The beach crest has eroded slightly on the seaward side over the last year since October 2012 survey. Between April 2013 and October 2013 the beach between 75m and 105m chainage has accreted by up to 0.4m. From 105m to 150m chainage the beach has eroded by 0.5m consistently. From 150m chainage to the end of the survey at 165m the beach has changed very little due to the rocky foreshore. Profile **1bSH2** is largely similar to the previous surveys to the beach crest at 125m change. The crest in the beach has shown progressive erosion since 2009, with the crest retreating by around 16m. The beach from 125m to 150m chainage had eroded by 0.5m. From 150m chainage to the end of the survey at 180m chainage the beach has accreted by 0.4m.	The cliffs behind Blast Beach are currently inactive due to the protective effect of colliery spoil that fronts them. The crest of the spoil material on profiles 1bSH1 and SH1a have remained reasonably stable since 2009. Profile 1bSH2 has been progressively eroding since 2009. The beaches at profiles 1bSH1 and SH1a are both high, due to a berm accumulating in the sandy part of the profile. Profile 1bSH2 has retreated uniformly, with the beach gradient remaining stable while the beach retreats. **Longer term trends:** The sea cliffs will reactivate in the near future as on-going erosion of the colliery spoil removes the protection it affords to the cliffs.

3.4 Hawthorne Hive

Survey Date	Description of Changes Since Last Survey	Interpretation
21st Oct 2013	**Beach Profiles:** One beach profile line, **1cEA2**, is located at Hawthorne Hive (Appendix A). The river part of this profile could not be surveyed safely and as a result it starts at 95m chainage. The outlet channel of Hawthorne Burn is usually located between 100 and 110m chainage, but in October 2013 the mound of material which separates the channel from the beach had been eroded. As a result there was no channel on the beach for the first time since 2008. The photographs show that the channel was present, but it has migrated so was no longer located on the profile line in October 2013. Between HAT at 110m and MHWS at 120m chainage the beach had remained stable. From 120m chainage to 150m chainage the beach had accreted by up to 0.5m between April and October 2013. From 150m chainage to the end of the survey at 210m the beach has remained stable, due to the exposure of the rocks on the lower shore.	The lowest recorded profile was taken in April 2013. The centre of the beach has recovered to some extent over the summer of 2013, but the October 2013 profile is still one of the lowest. A stream previously passed across the profile, but channel migration means this is n o longer the case, and therefore the middle part of the profile has changed significantly. Channel migration is likely to be a short-lived effect following a storm. **Longer term trends:** The beach level was around 1m lower when compared to previous surveys from December 2008. The beach level has only recovered a small amount since its lowest recorded level in April 2013 due to winter storm conditions. More rapid recovery is expected over the summer, unless sediment has been lost from the beach system during storms. Limited cliff erosion occurs in this section and therefore sediment supply is limited to erosion of colliery spoil that is likely to be too fine-grained to persist on the beach.

3.5 Blackhall Colliery

Survey Date	Description of Changes Since Last Survey	Interpretation
16th Sept 2013	**Beach Profiles:** Blackhall Colliery is covered by three beach profile lines (Appendix A). As at Blast Beach, profiles are dominated by colliery spoil and exhibit similar forms with a rock cliff, wide spoil beach with a distinct cliff at the eroding face of the colliery spoil, and a gravel and sand foreshore that extends to MLW. **1cBH1** is located near Horden Point and shows that the upper part of the beach, associated with the colliery spoil has eroded by around 1m since the previous survey in September 2012. The erosion has led to lateral retreat of the beach by about 5m at the HAT level over the previous year. The beach profile is more concave than the September 2012 profile. The whole beach has eroded by 0.5m, with the maximum erosion being on the upper beach while the lowest part of the beach appears to have remained stable through 2013. Profile **1cBH2** exhibits no change in the cliff profile, but the cliffed-edge of the spoil beach has eroded landwards by a further 3m since September 2012, leaving only around 45m to the cliff toe. The rate of erosion in the last year was similar as the year before. Between October 2009 and September 2010 10m was lost. The gradient of the intertidal zone has remained similar throughout the profiles, but has slightly steepened in 2013. The beach level has dropped by 0.5m between September 2012 and September 2013. The profile **1cBH3** shows that since 2008 there has been periodic deepening of the outlet channel of Castle Eden Burn, which crosses the profile. The channel has eroded by 0.8m since September 2012. From the crest of the beach at around 175m chainage and 200m chainage the beach has eroded by 0.5m. From 200m to 220m chainage the beach has remained stable overall. From 200m to the end of the survey at 235m chainage the beach has eroded by 0.5m.	All of the Blackhall Colliery profiles have shown a similar trend. The profile above HAT stays stable while the crest of the spoil (if present) and the beach below HAT have reduced or retreated. The rate of erosion may have increased due to the 10th September storm **Longer term trends:** The surveys show that the spoil beach along much of the Blackhall Colliery shore continues to provide effective protection to the backing cliffs. However, the spoil beach is eroding landwards at high rates of retreat (3m during 2013) and therefore the cliffs are likely to be reactivated in the near future.

4. Problems Encountered and Uncertainty in Analysis

The cliff top position surveys at Dawdon are assumed to have a limit of accuracy of ±0.1m due to the techniques used. The accuracy of short-term recession data are therefore limited, but longer-term recession rates will become more reliable as further data is obtained (see section 1.3).

The cliff toe was not accessible in a number of places at Seaham and Easington due to vegetation. In many cases the vegetated section was not an actively accreting or eroding part of the beach profile so it will not be a source of large errors in the analysis.

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

It is worthwhile considering increasing the number of surveys along Seaham Beach in view of the anticipated study to investigate and better manage accretion at the southern end of the frontage.

Adding an additional cliff top survey point to the north of Nose's Point could be beneficial through future years because the spoil beach has only a narrow width fronting the cliff. Any reactivation of the cliff at this location will need to be monitored. The new point could suitably be located mid-way between points 2 and 3.

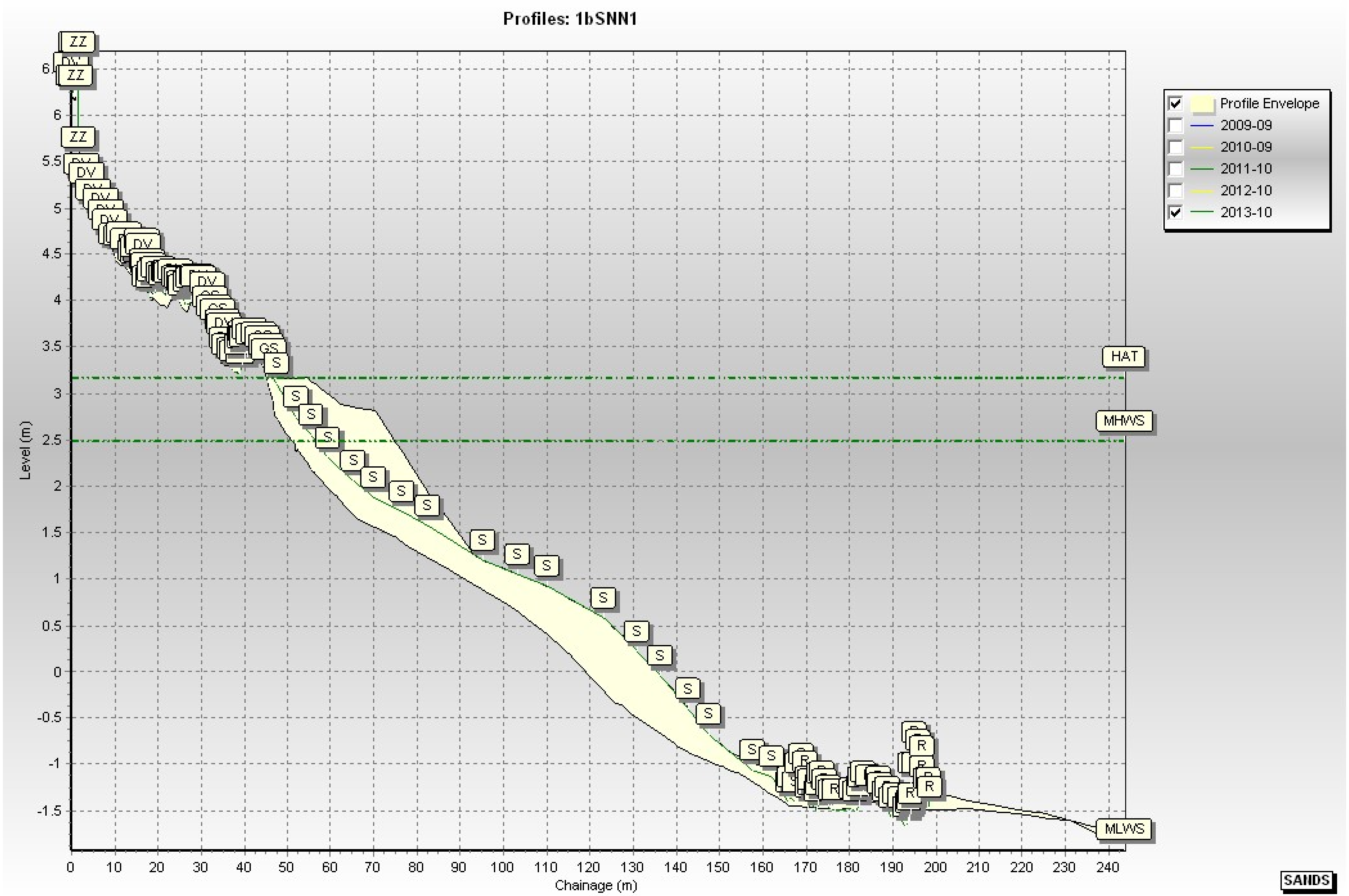
6. Conclusions and Areas of Concern

- At Featherbed Rocks the veneer beach has eroded through 2013, exposing the rocky foreshore platform.
- At Seaham cliffs there has been recession along ground control points 1 and 3 of around 0.1m/yr since the records began in November 2008. No significant change has occurred along ground control point 2. Further years of data collection will help to understand the long term trends on these cliffs and the stability of the bay.
- At the Blast Beach and Blackhall a colliery spoil still prevents the sea from acting directly at the natural cliff toe. The spoil deposit is eroding and it is expected that the cliffs, which are currently protected by the colliery spoil, will reactivate in coming years.
- At Hawthorne Hive the levels on the foreshore are very low, but they have recovered since their lowest recorded level in April 2013. The channel on the beach has moved away from the profile line, but is still shown in the photographs.

Appendices

Appendix A

Beach Profiles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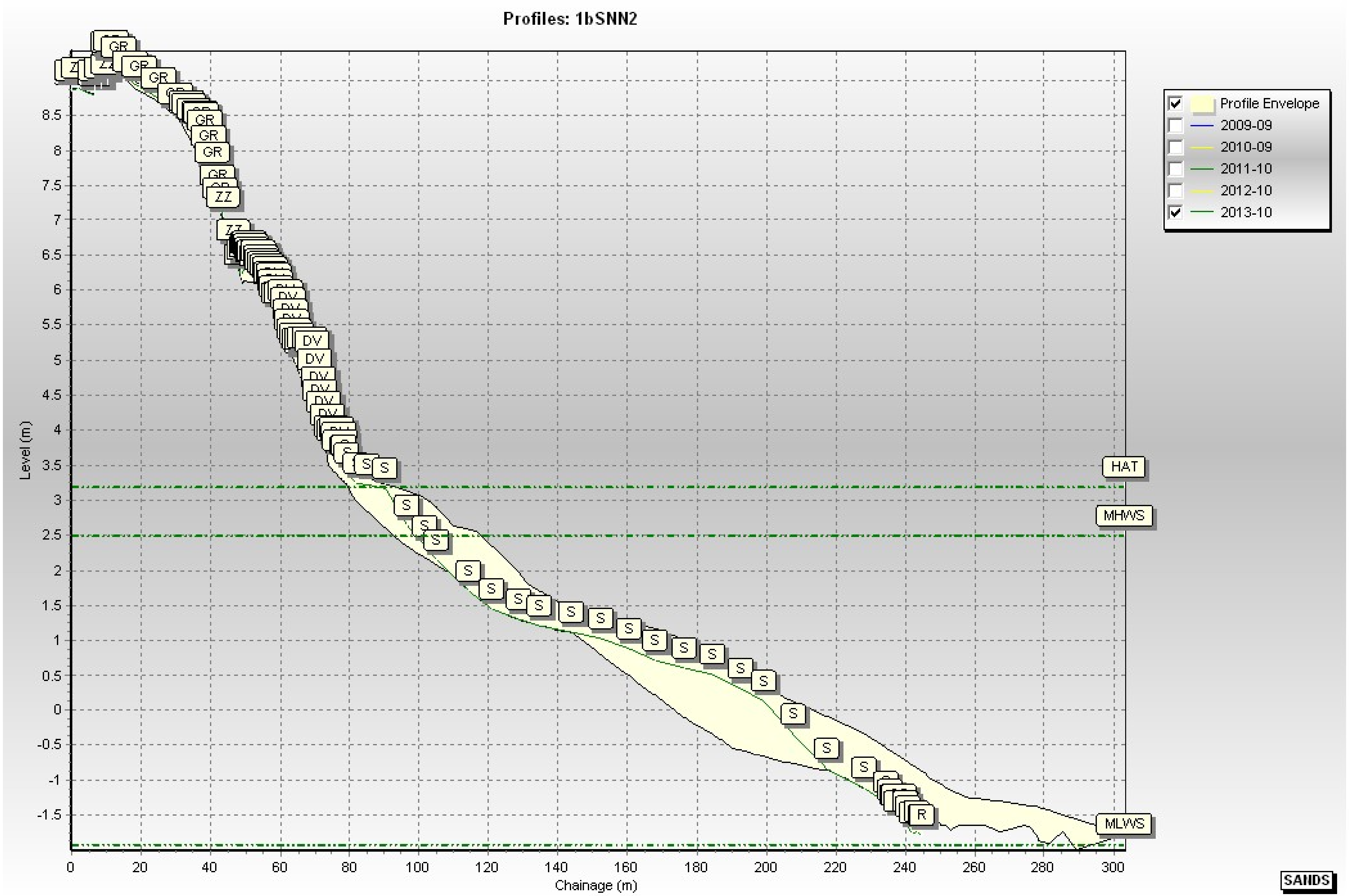

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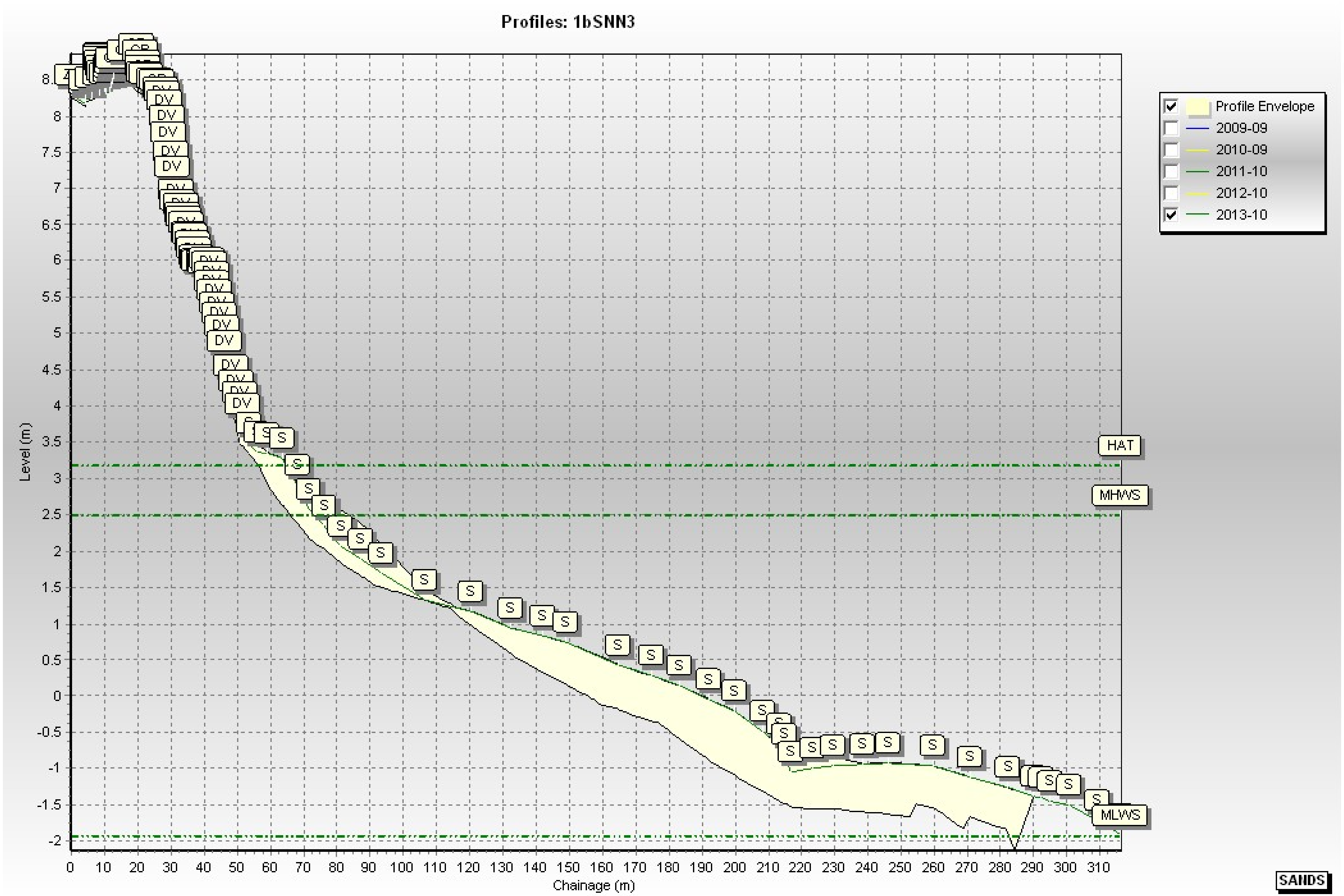

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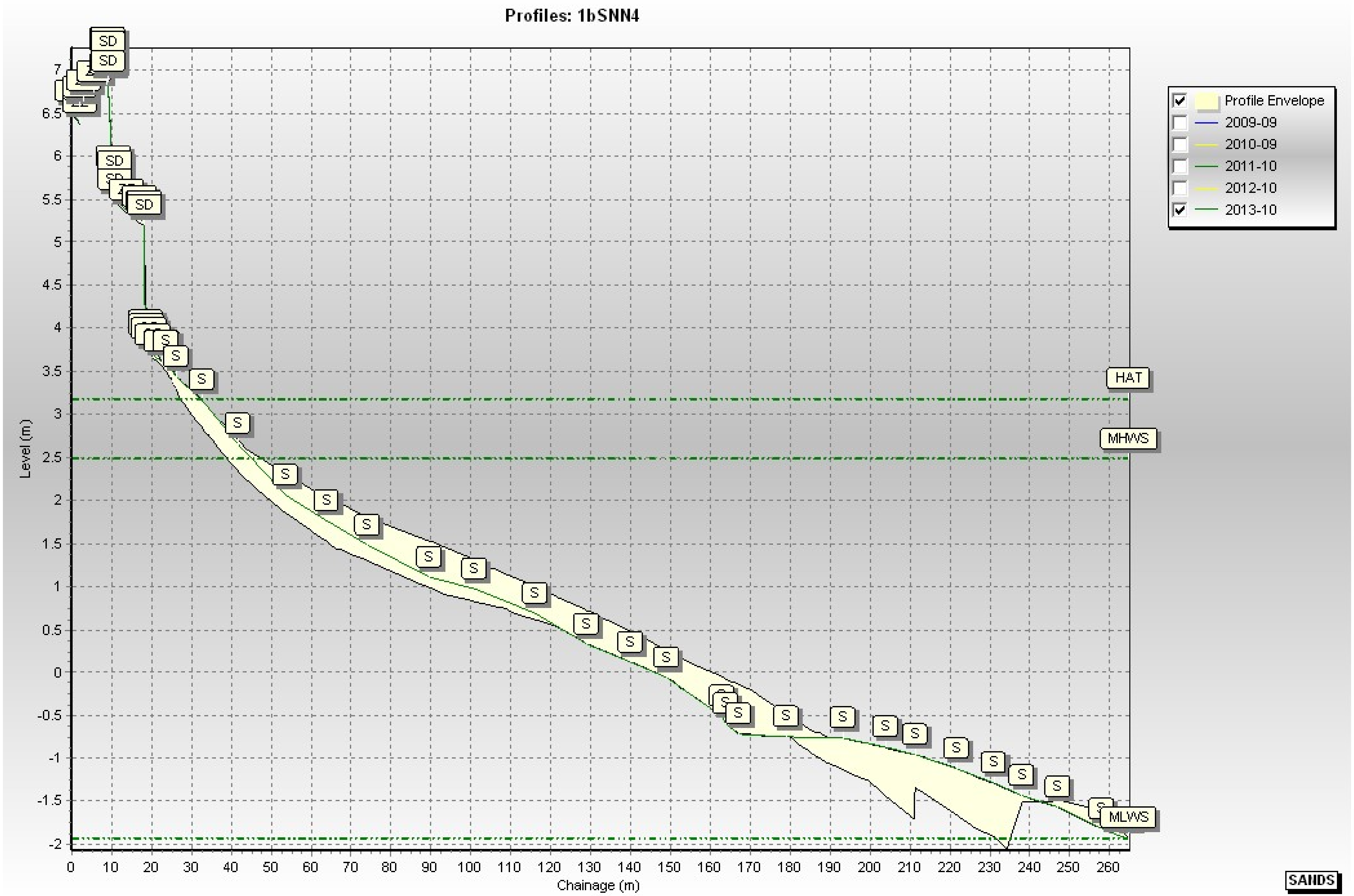

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MLWS
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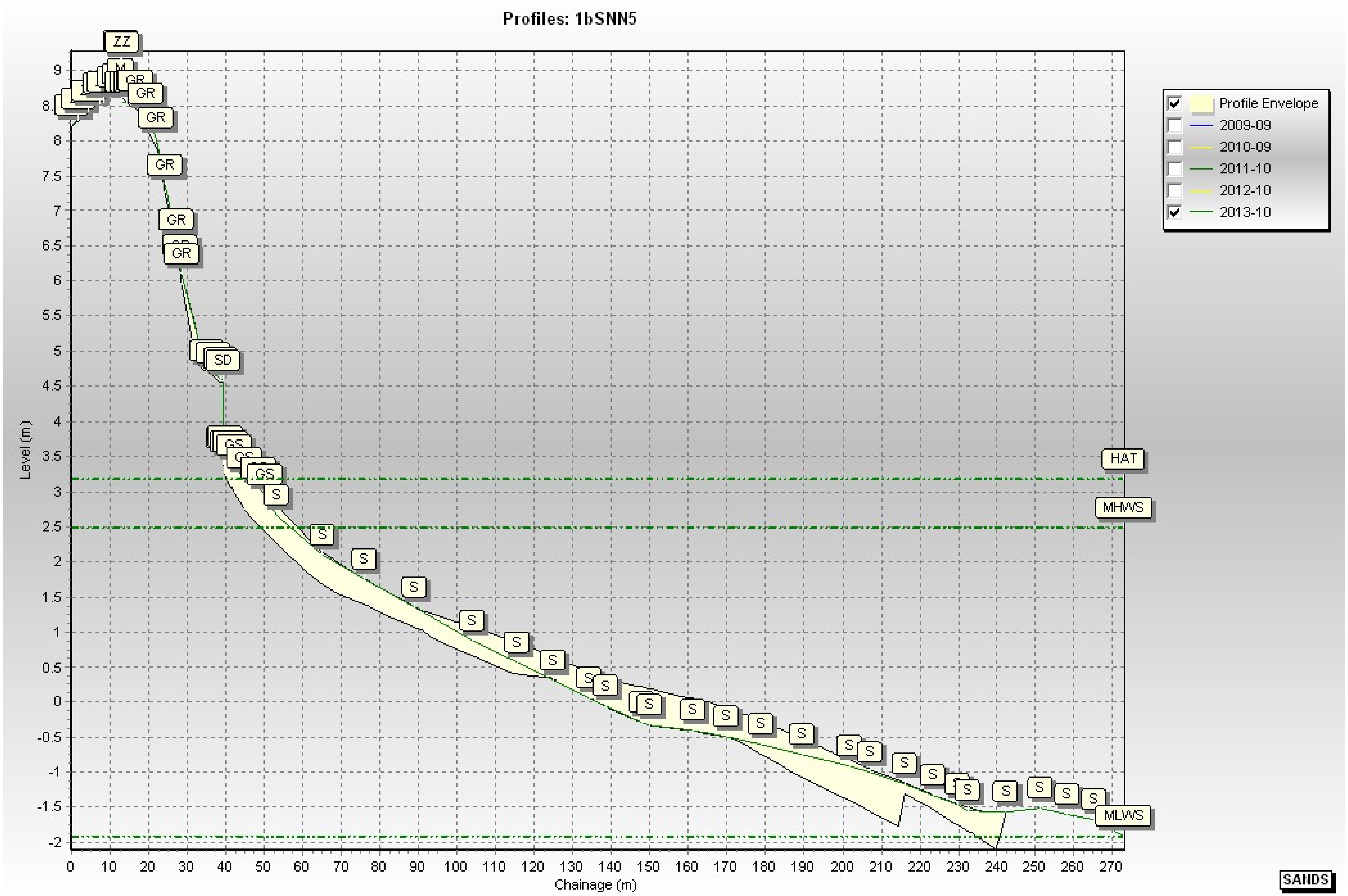

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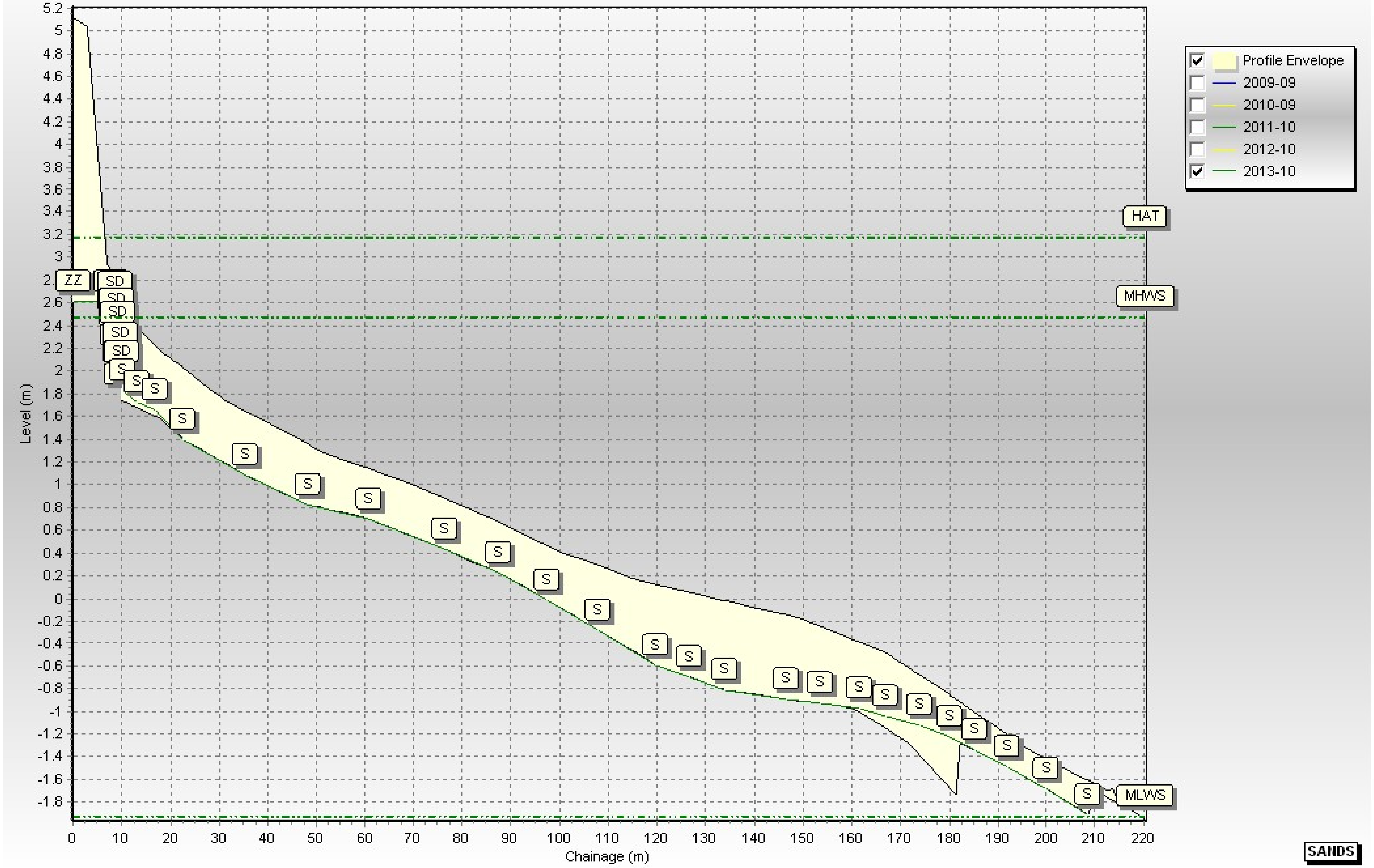

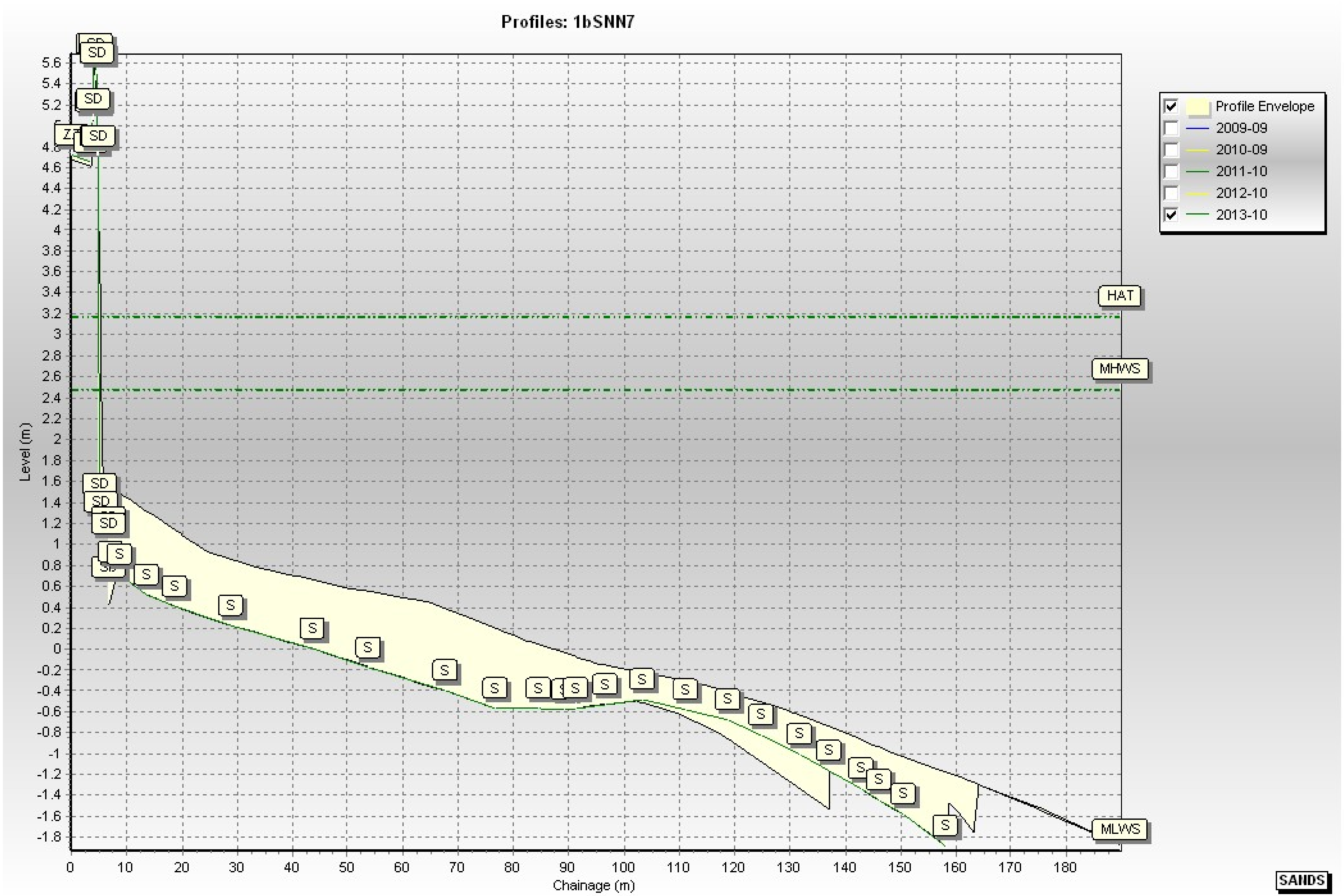

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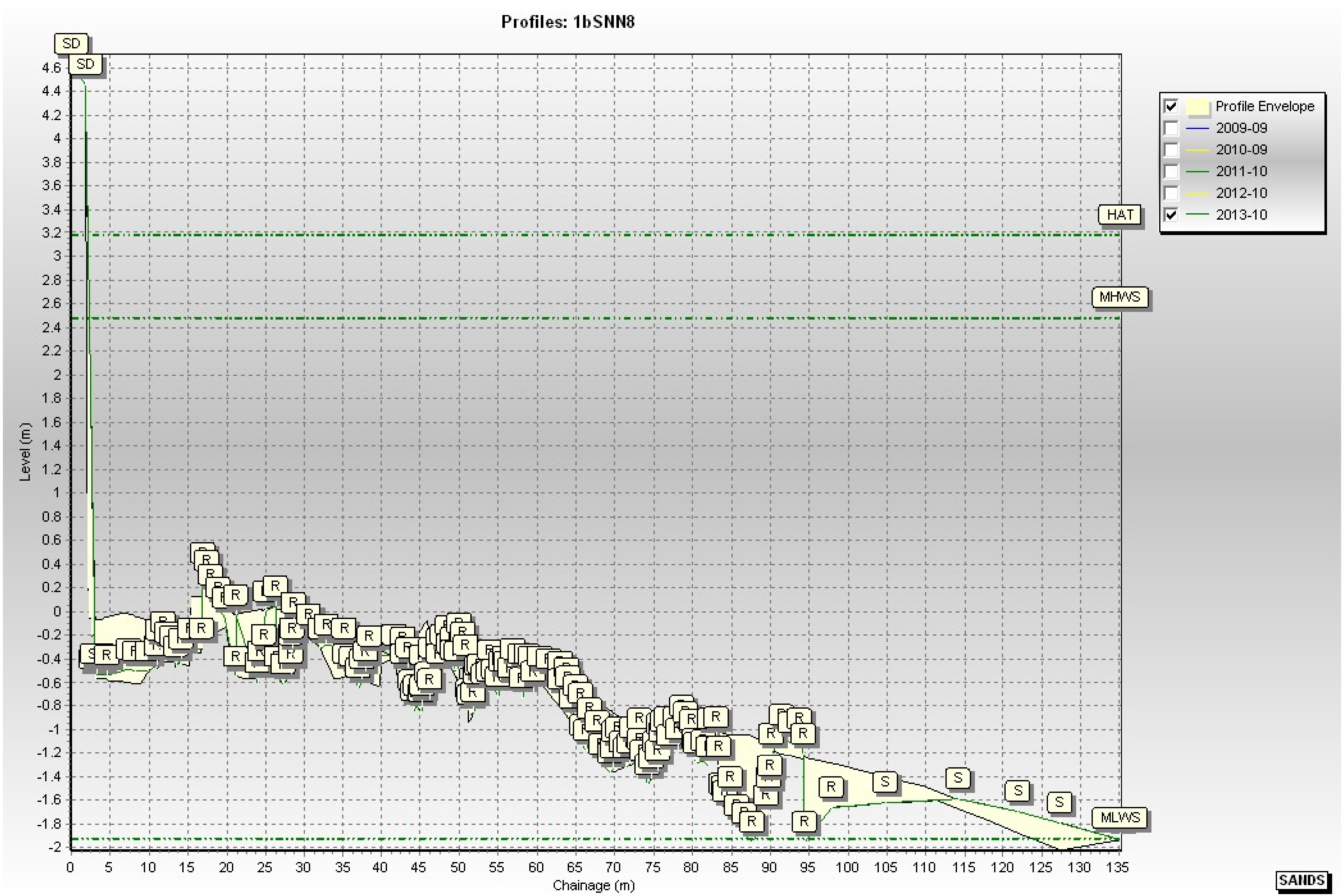

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Chainage (m)
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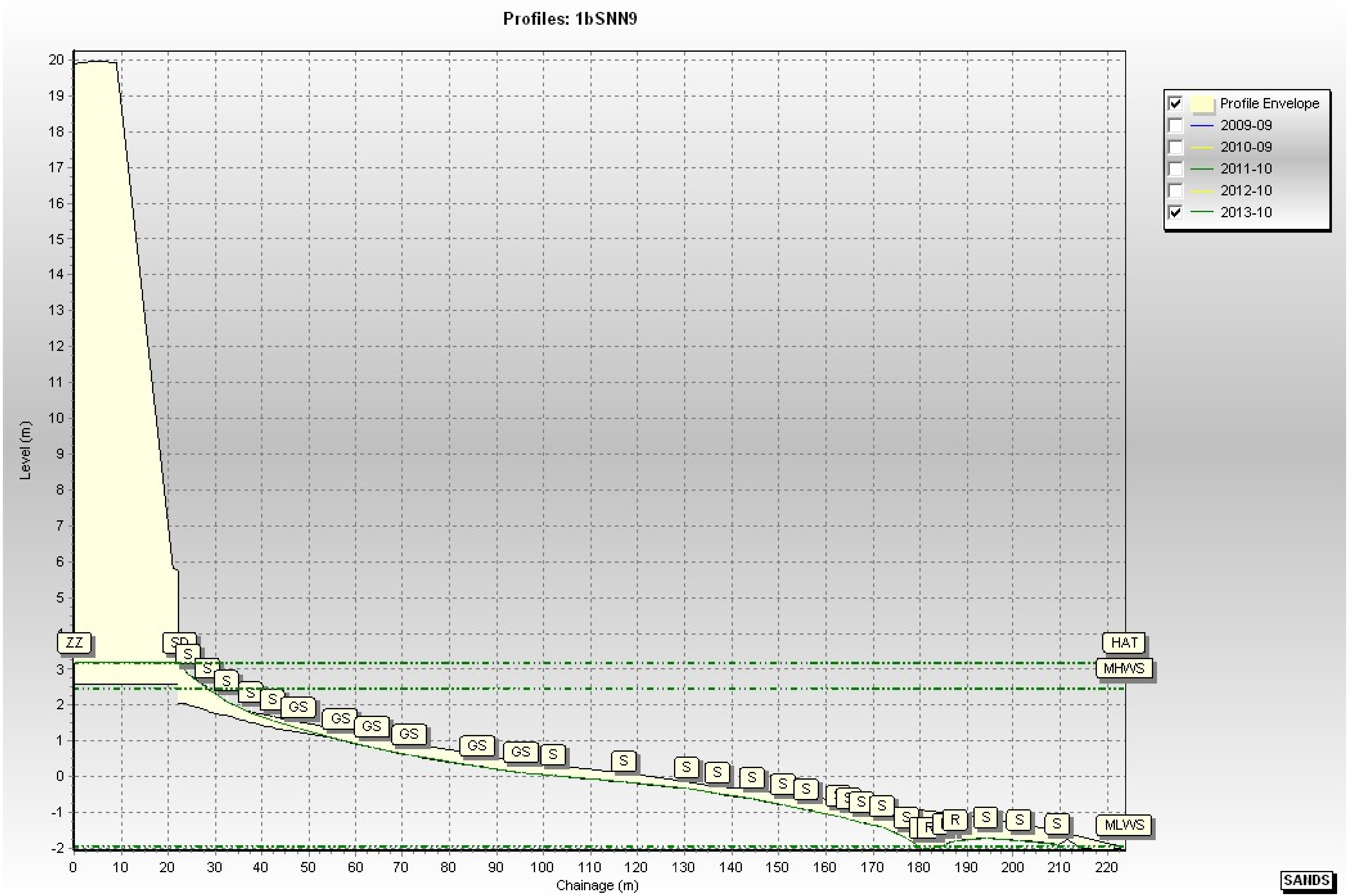

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Chainage (m)
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S
GS
R
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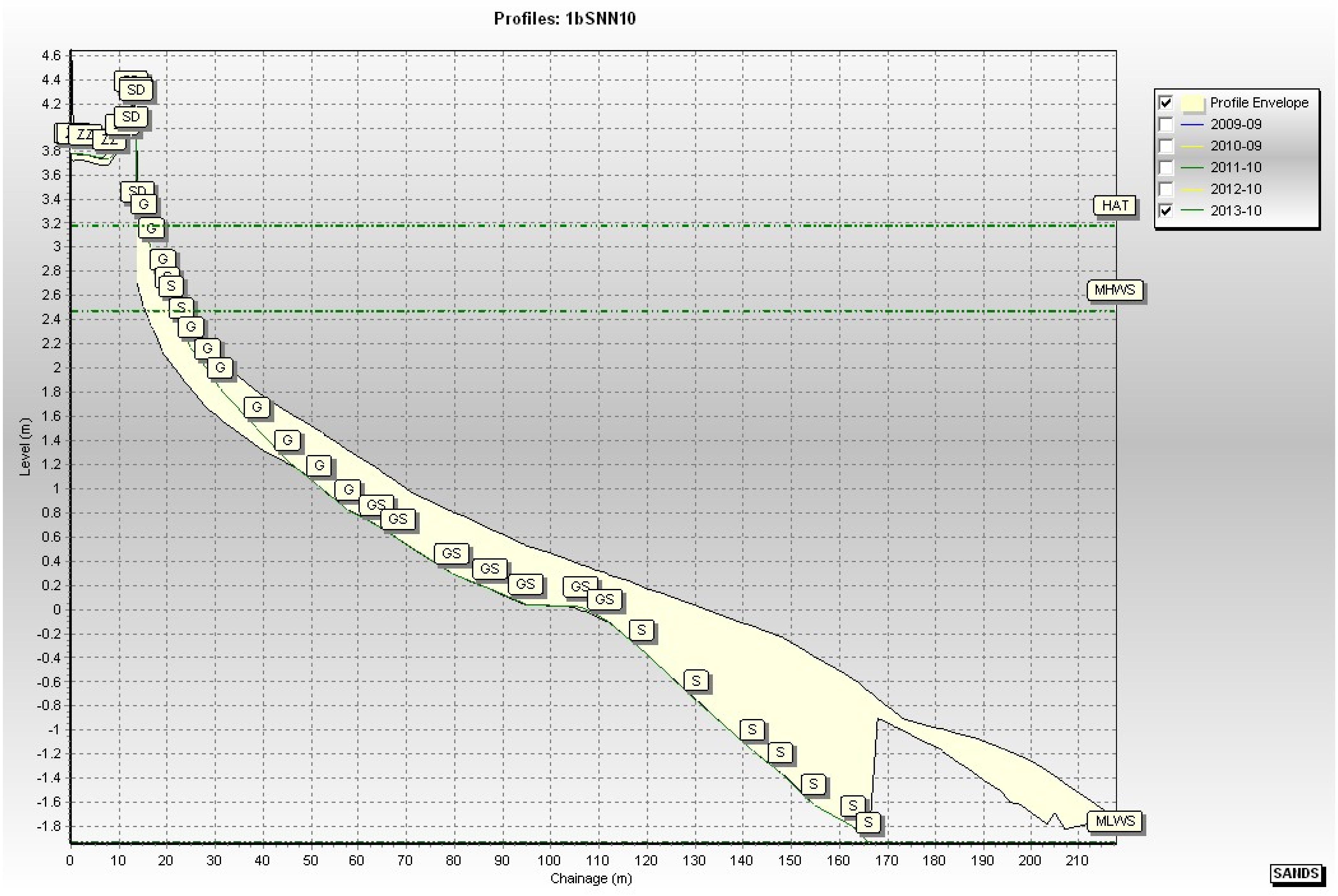
MHWS
MLWS
SANDS



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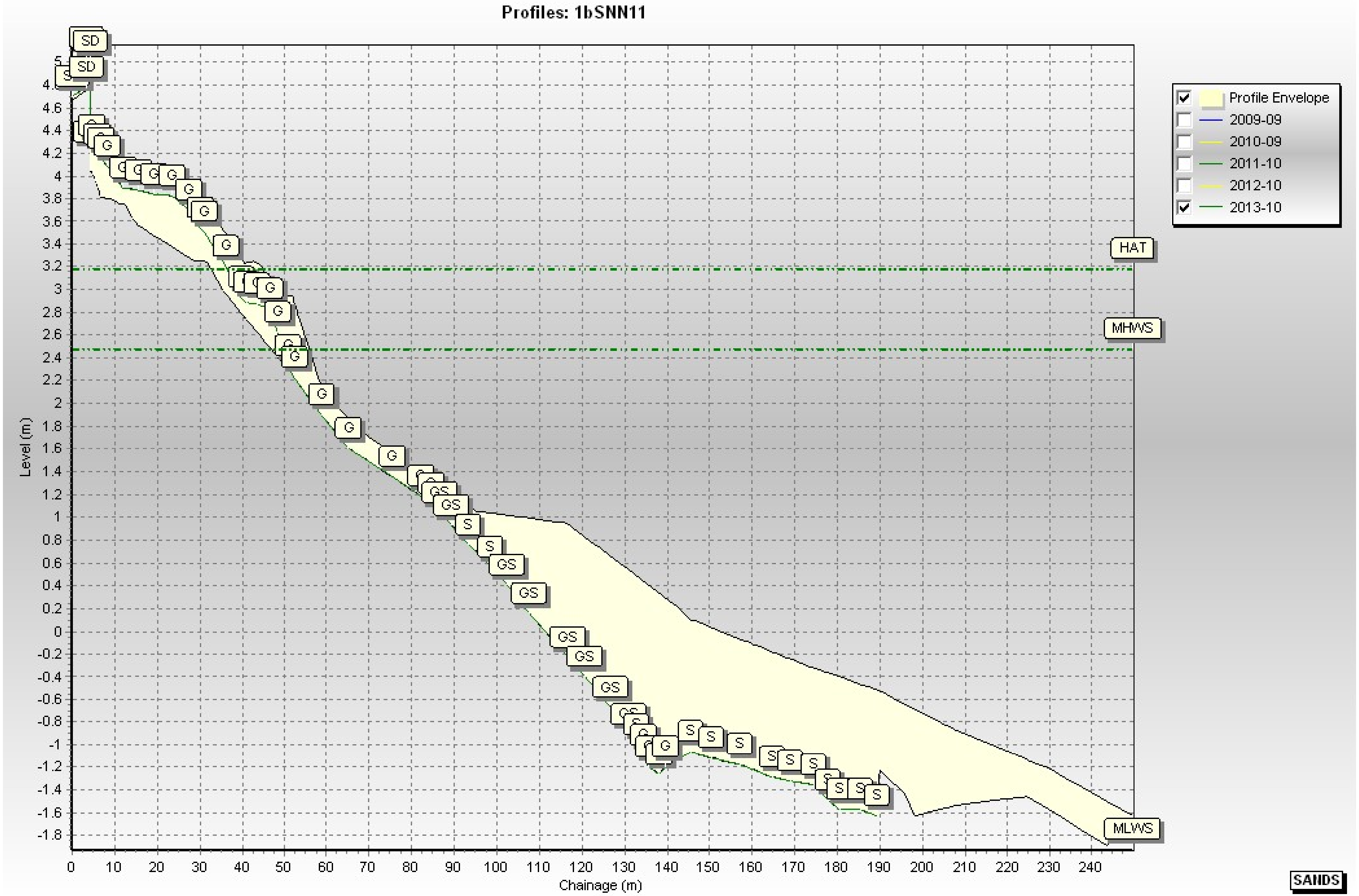

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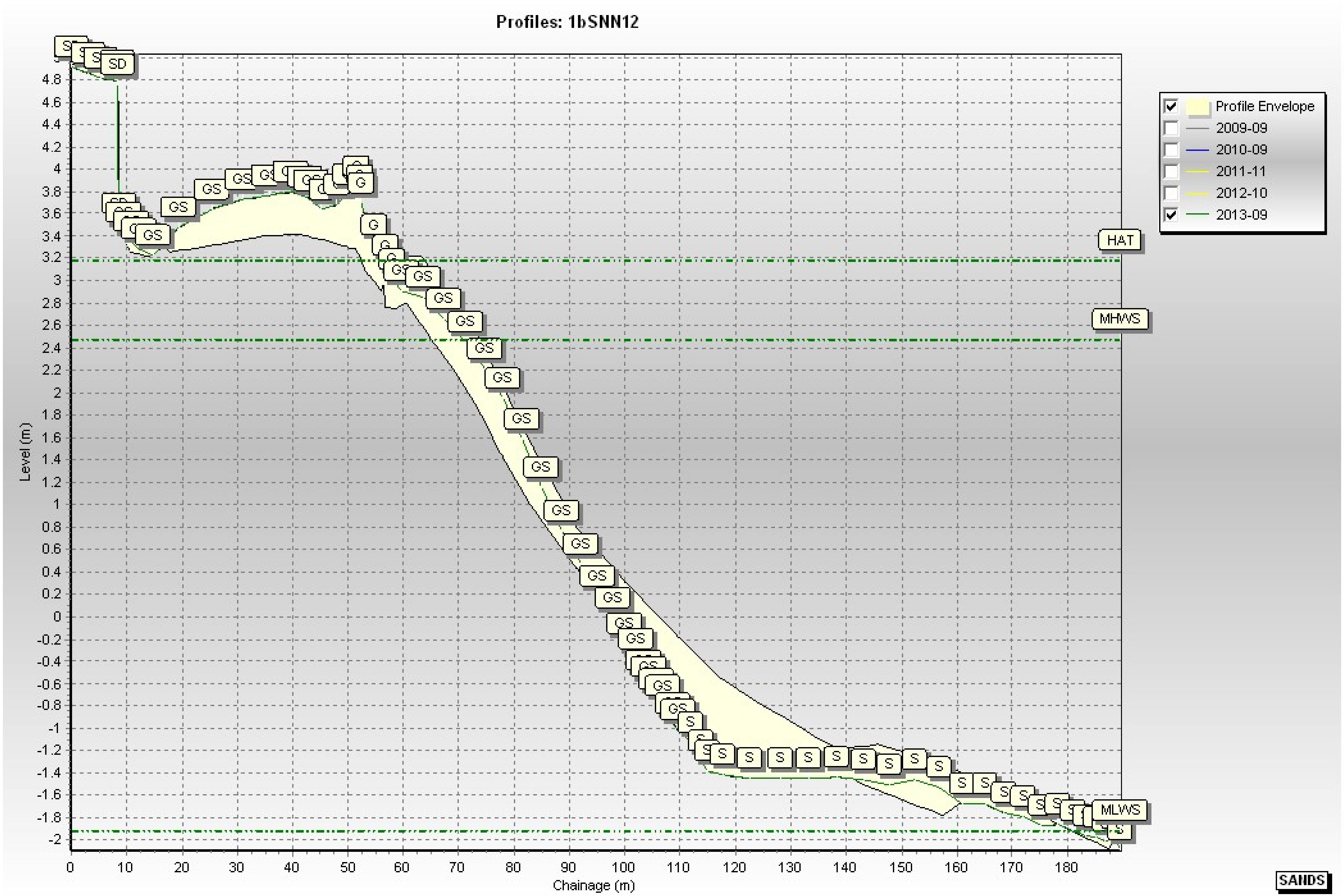
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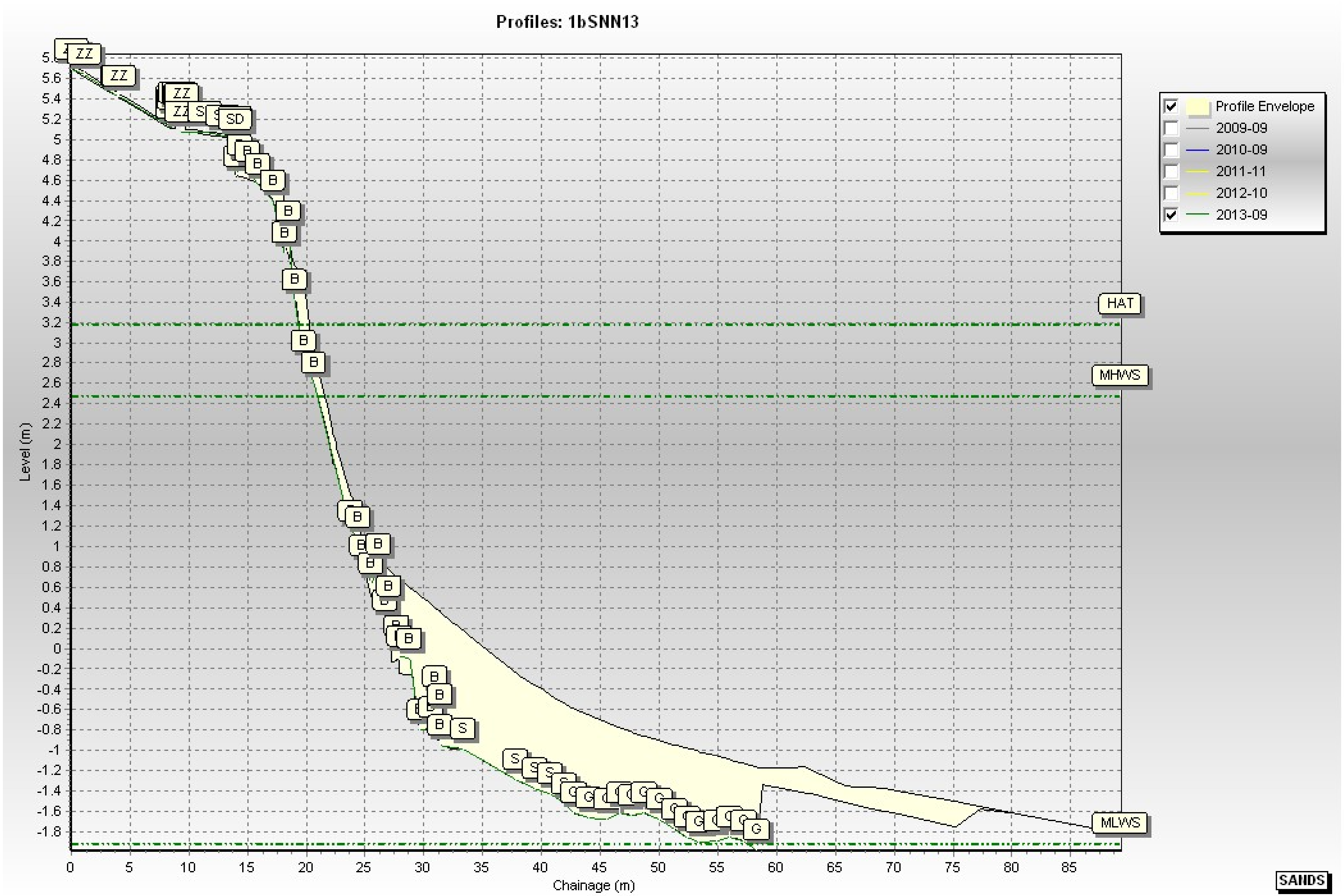

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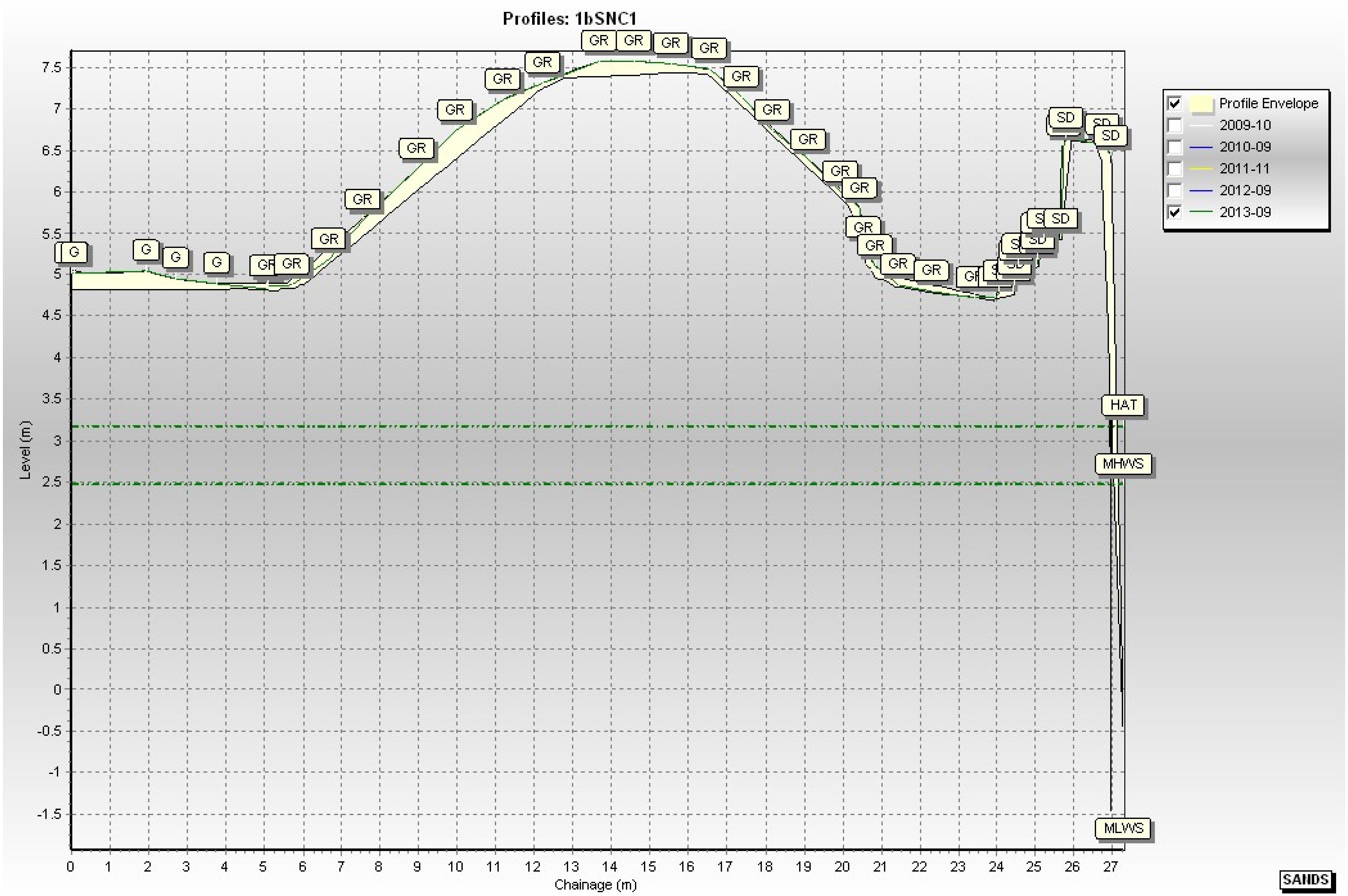

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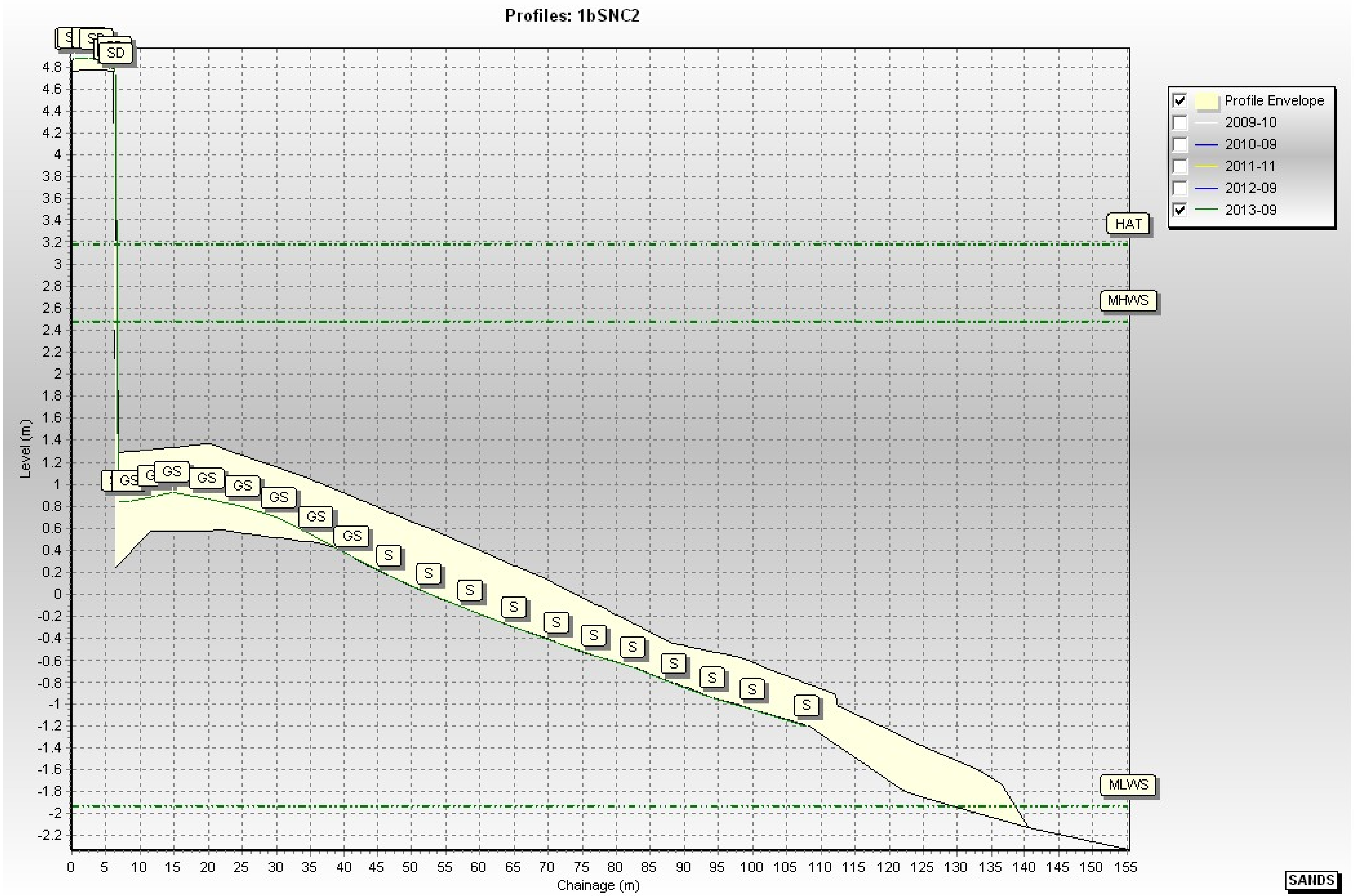

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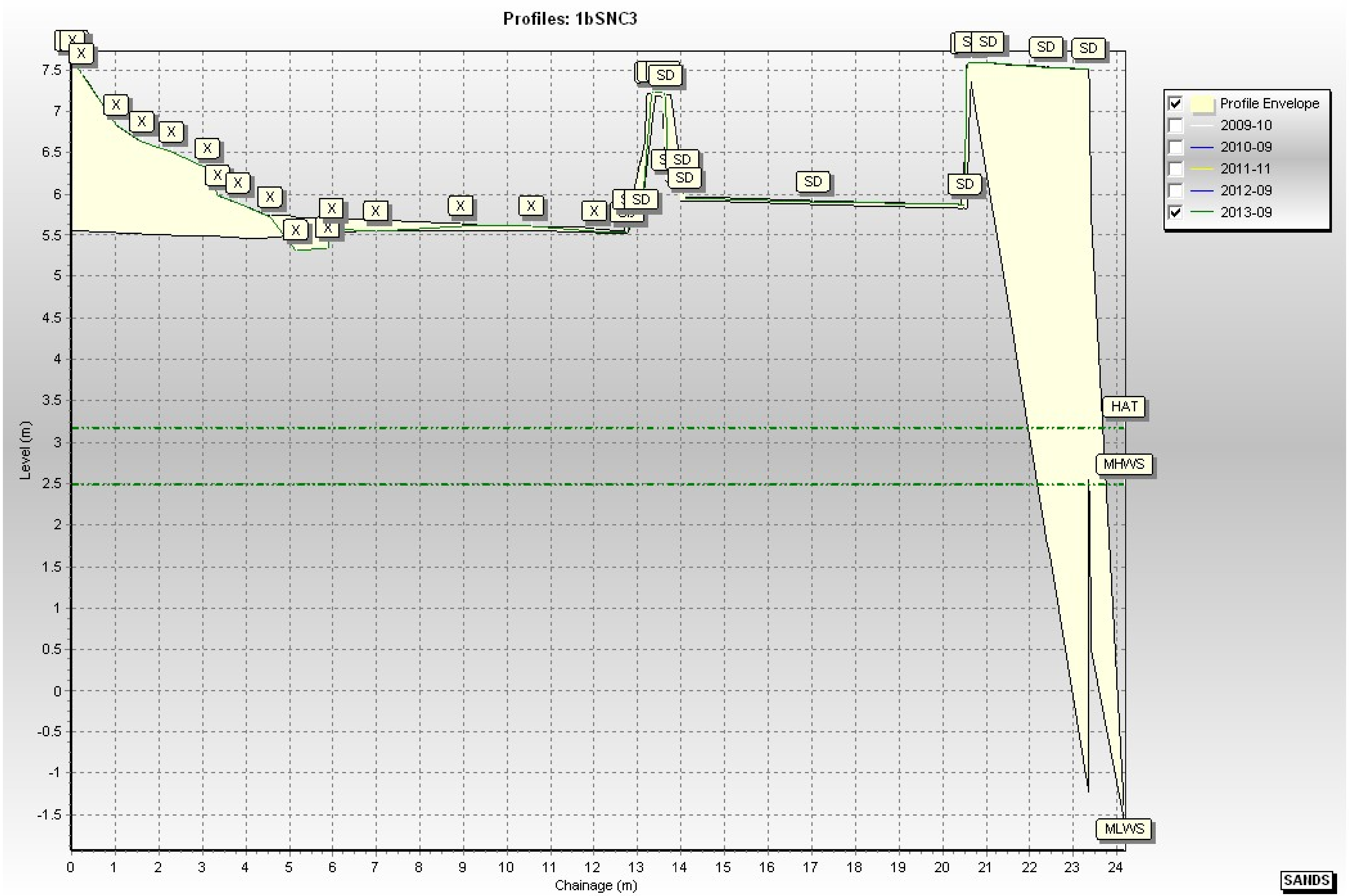

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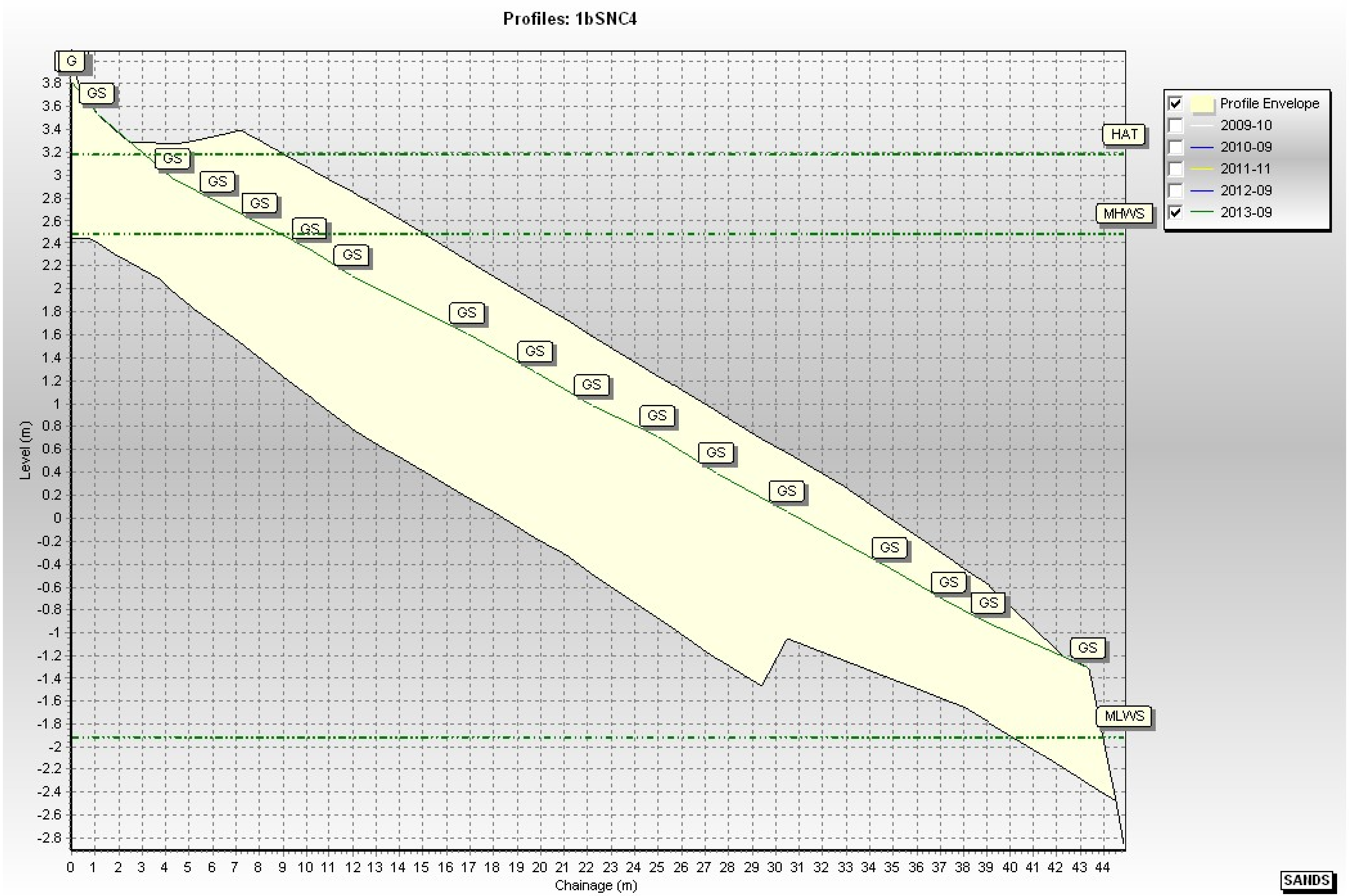
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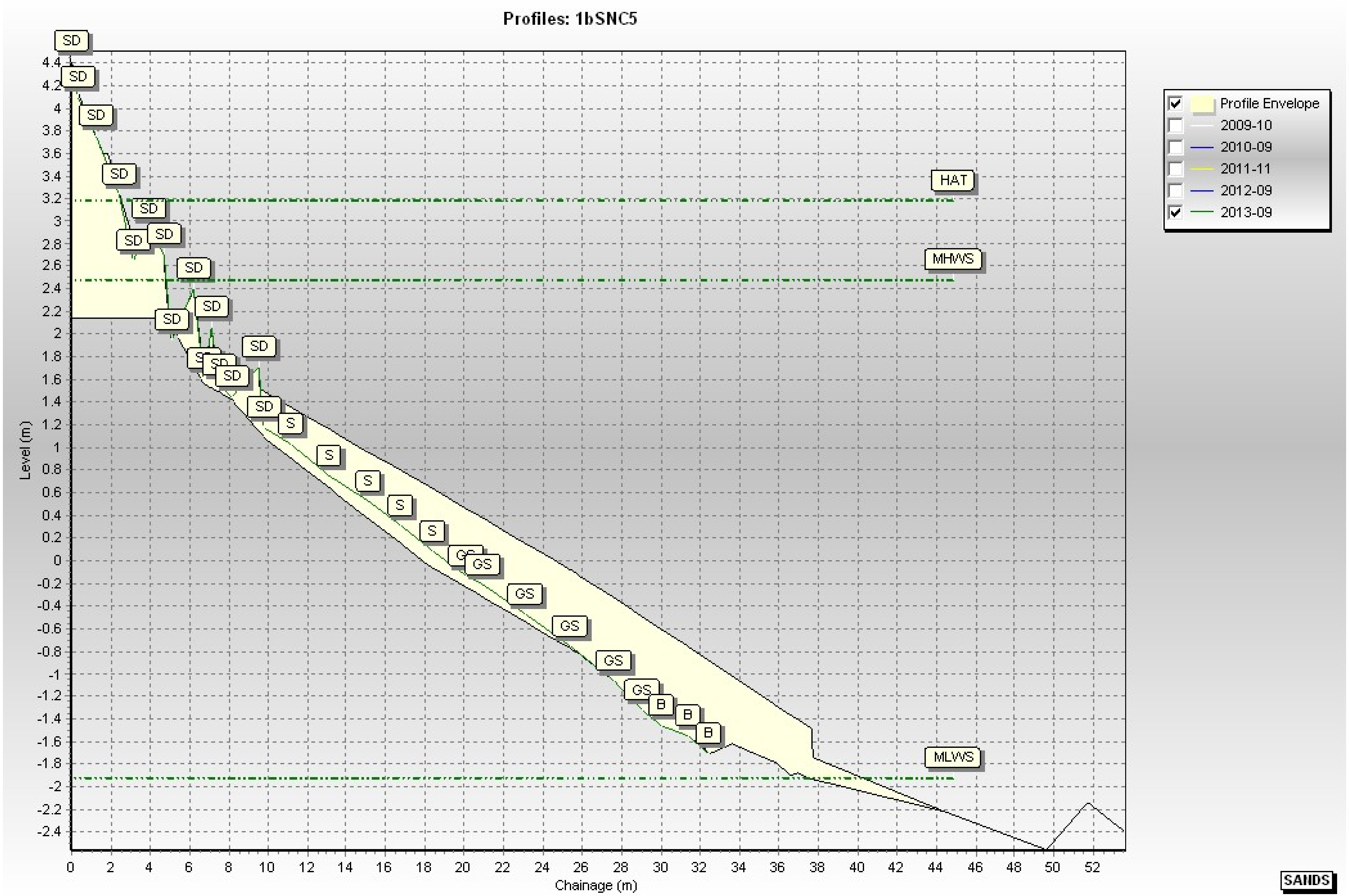

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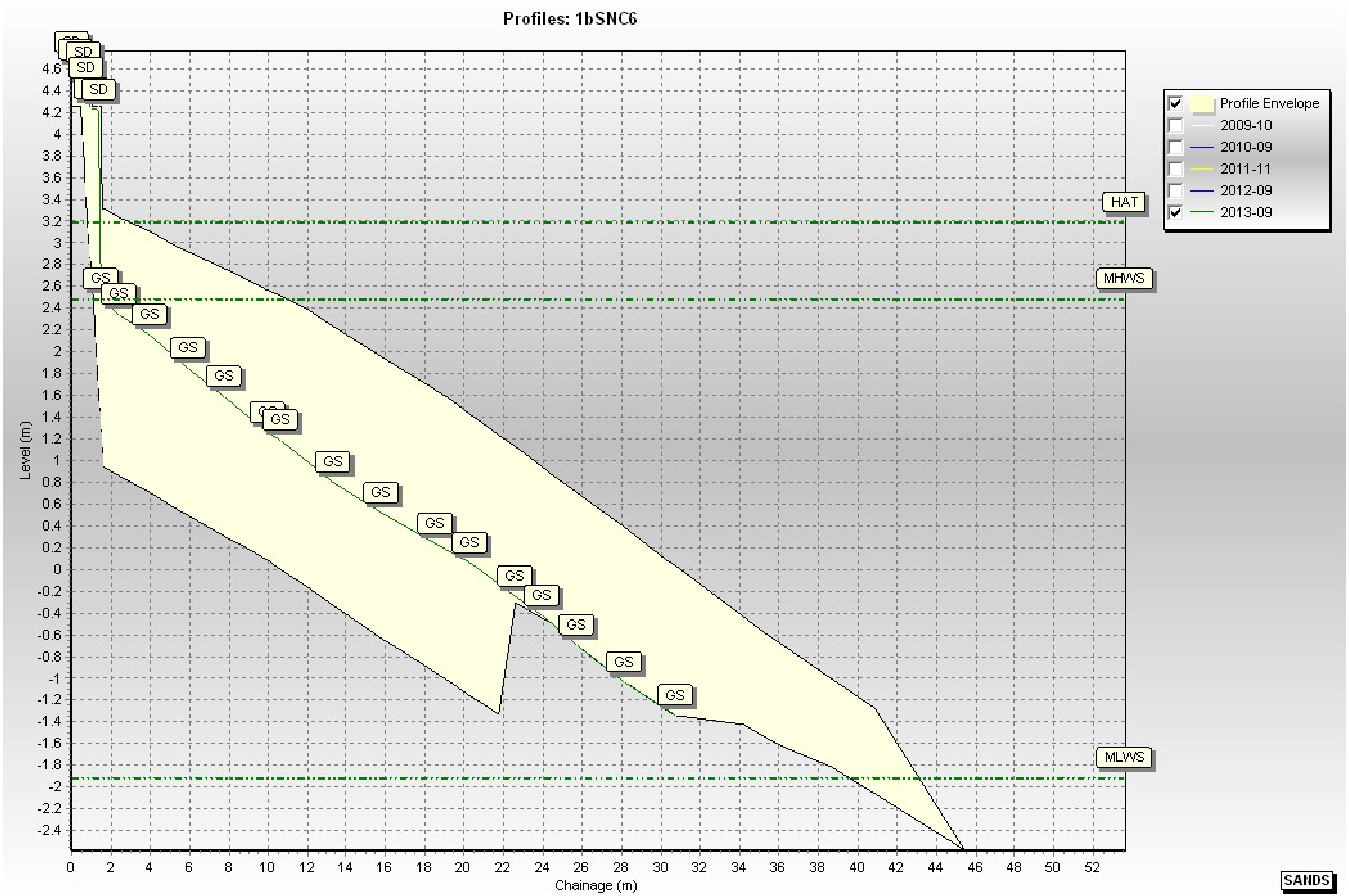

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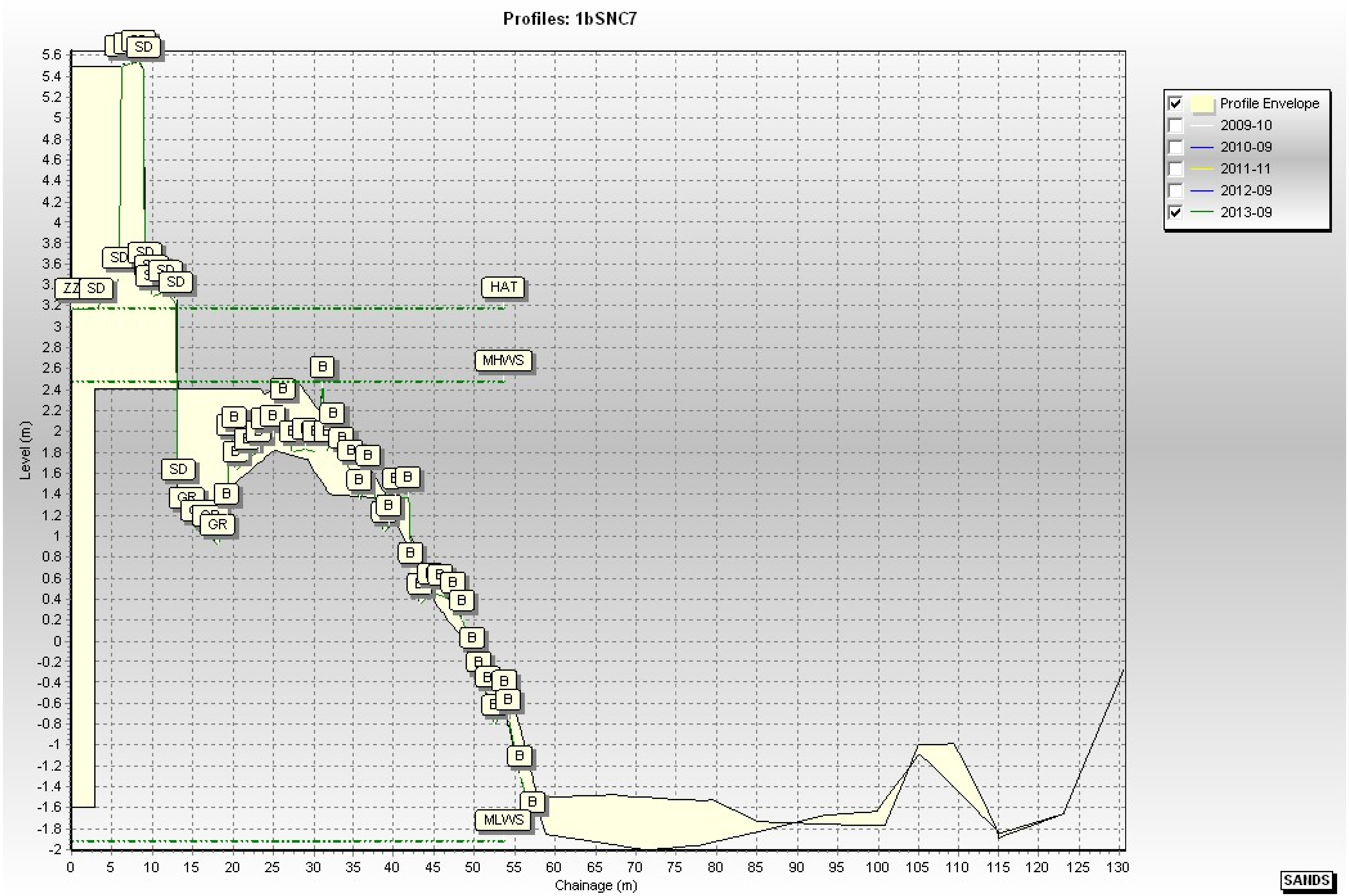

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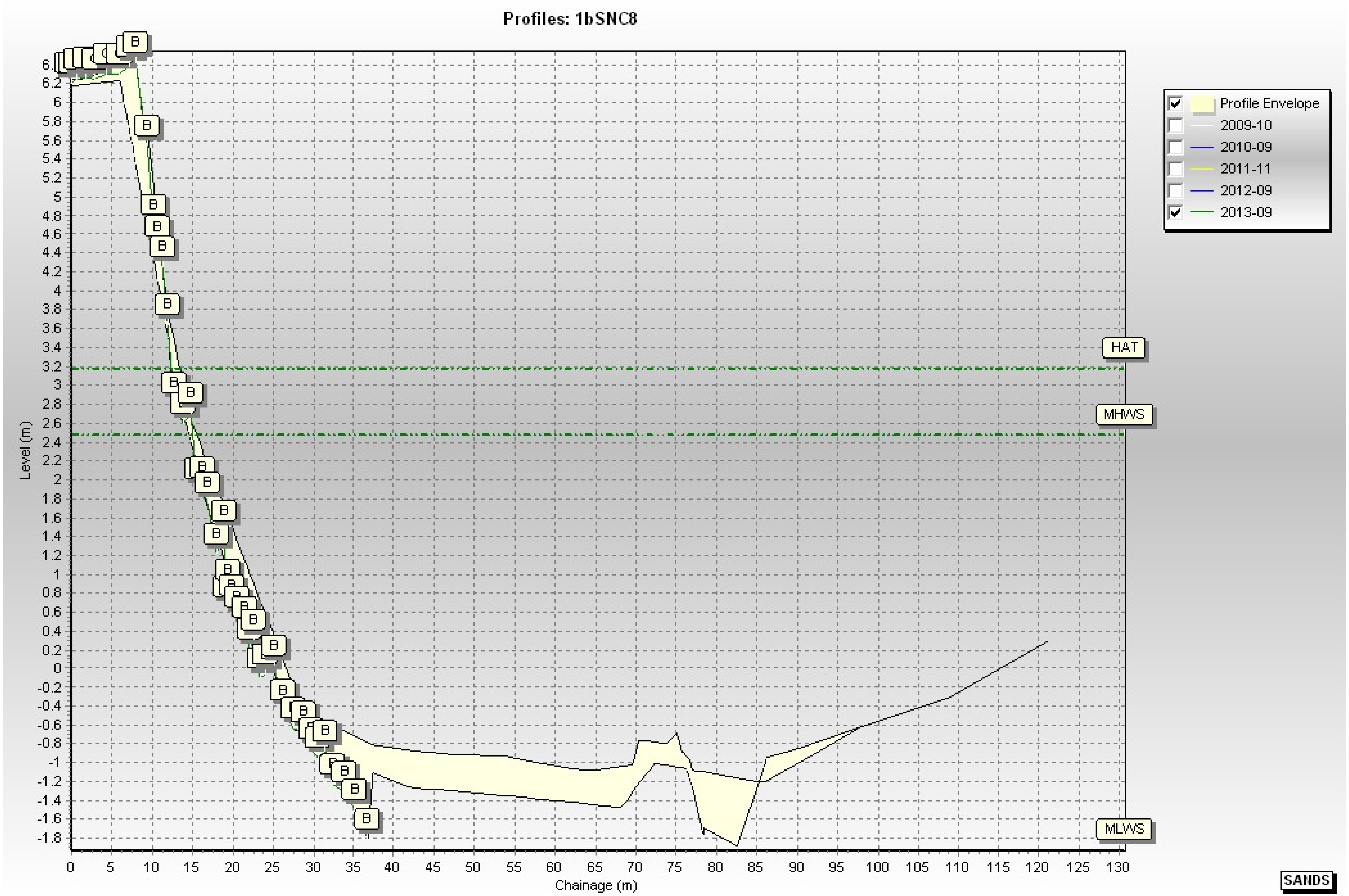

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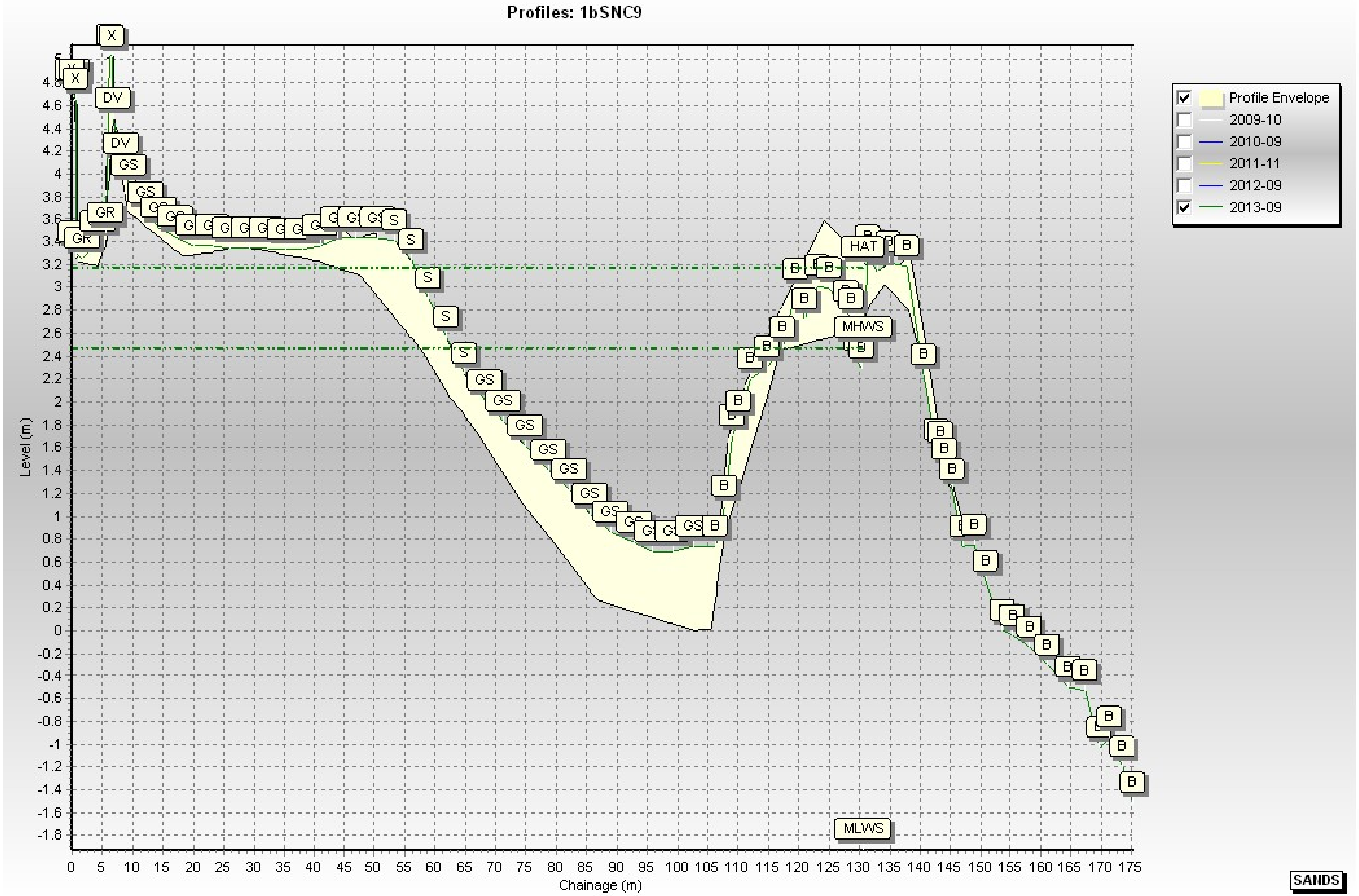

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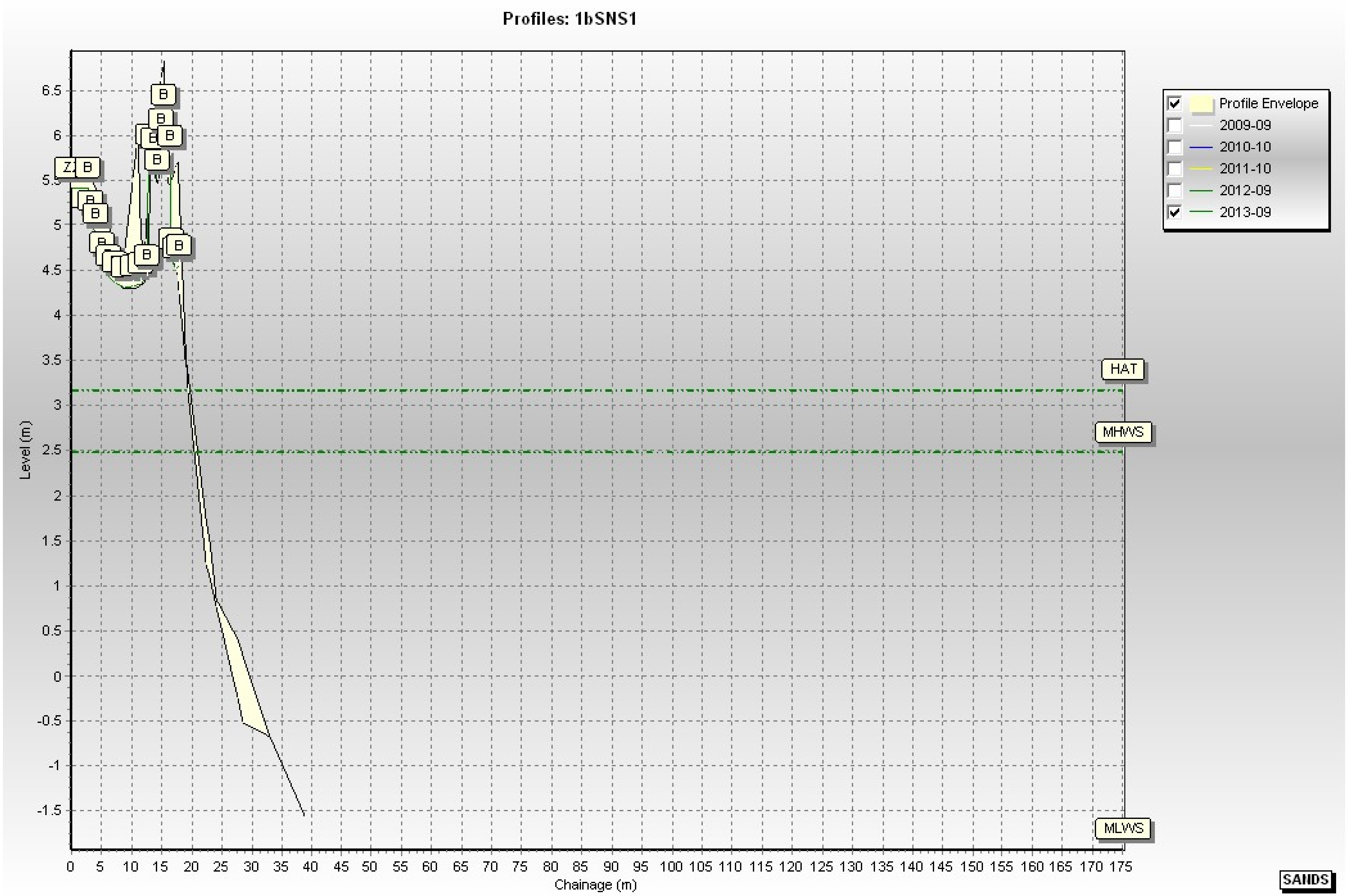

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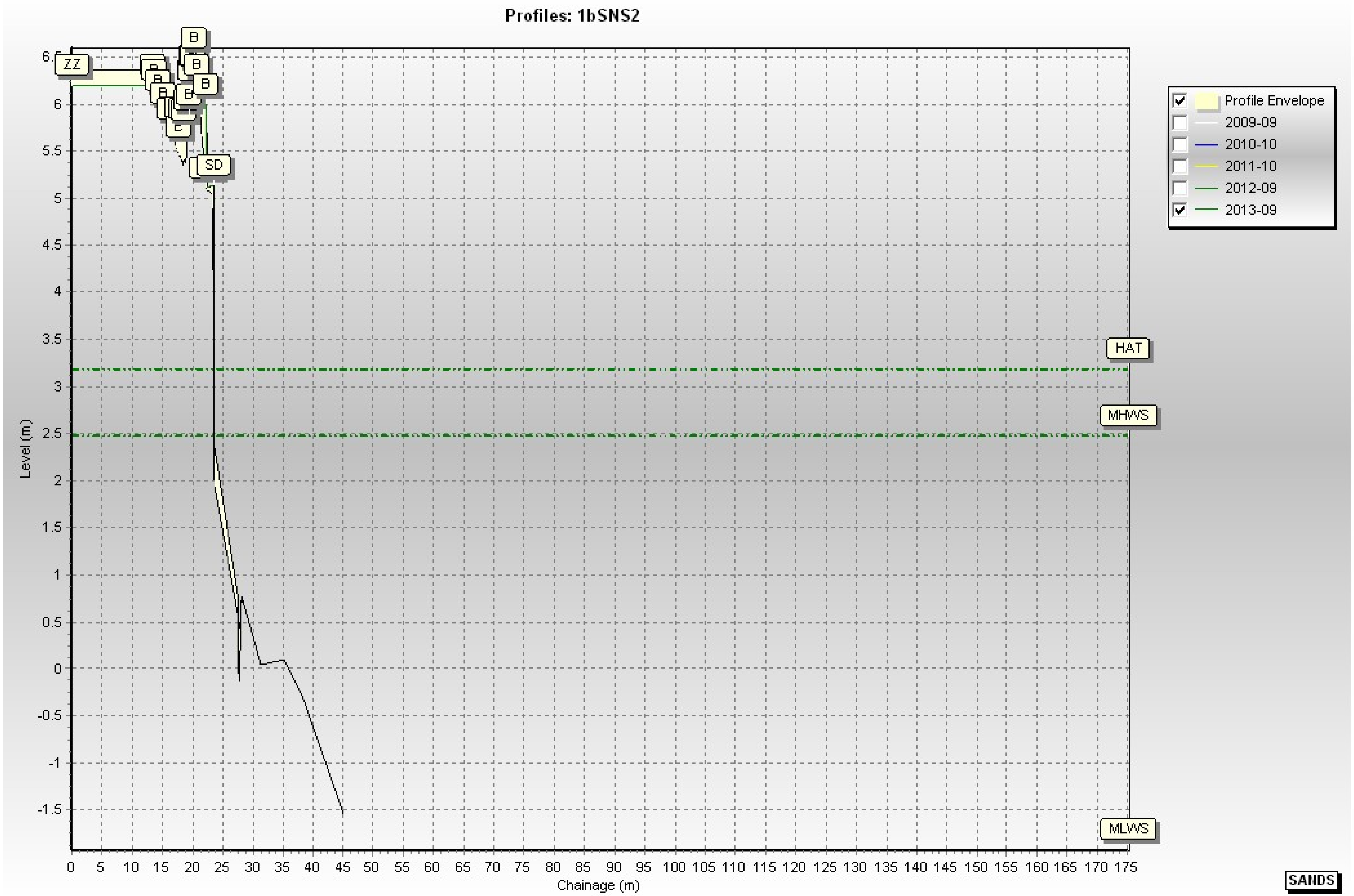

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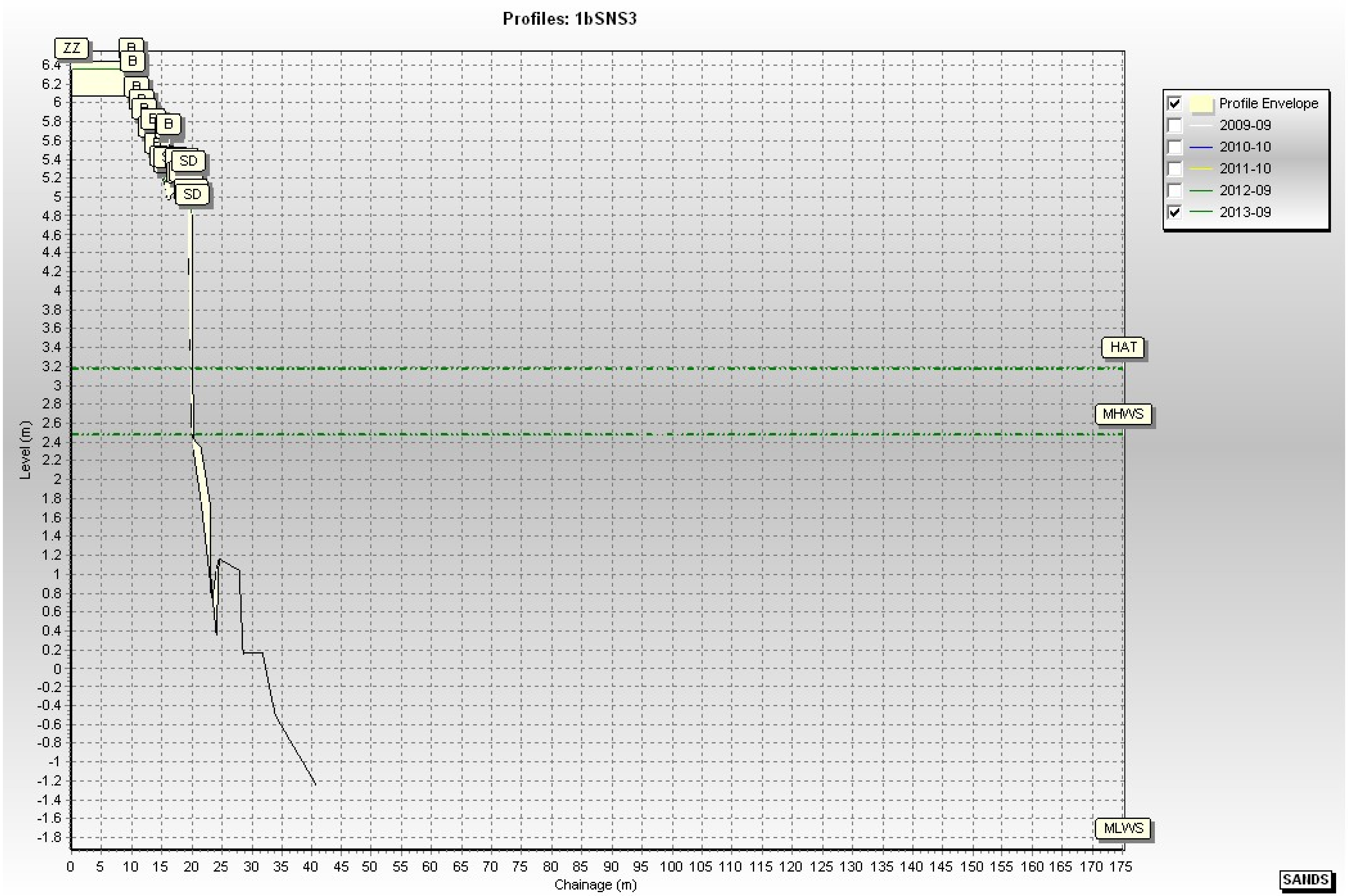

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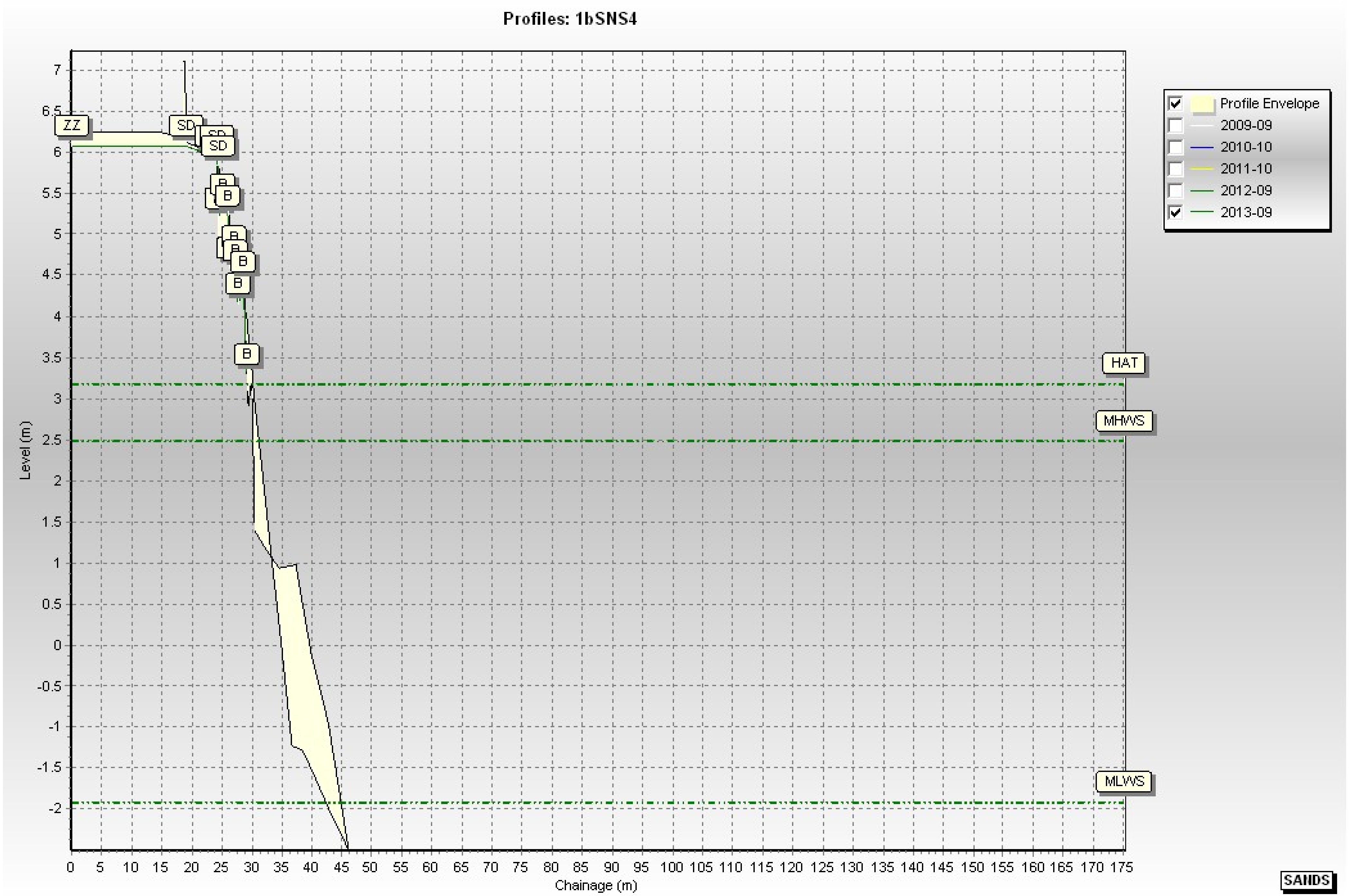

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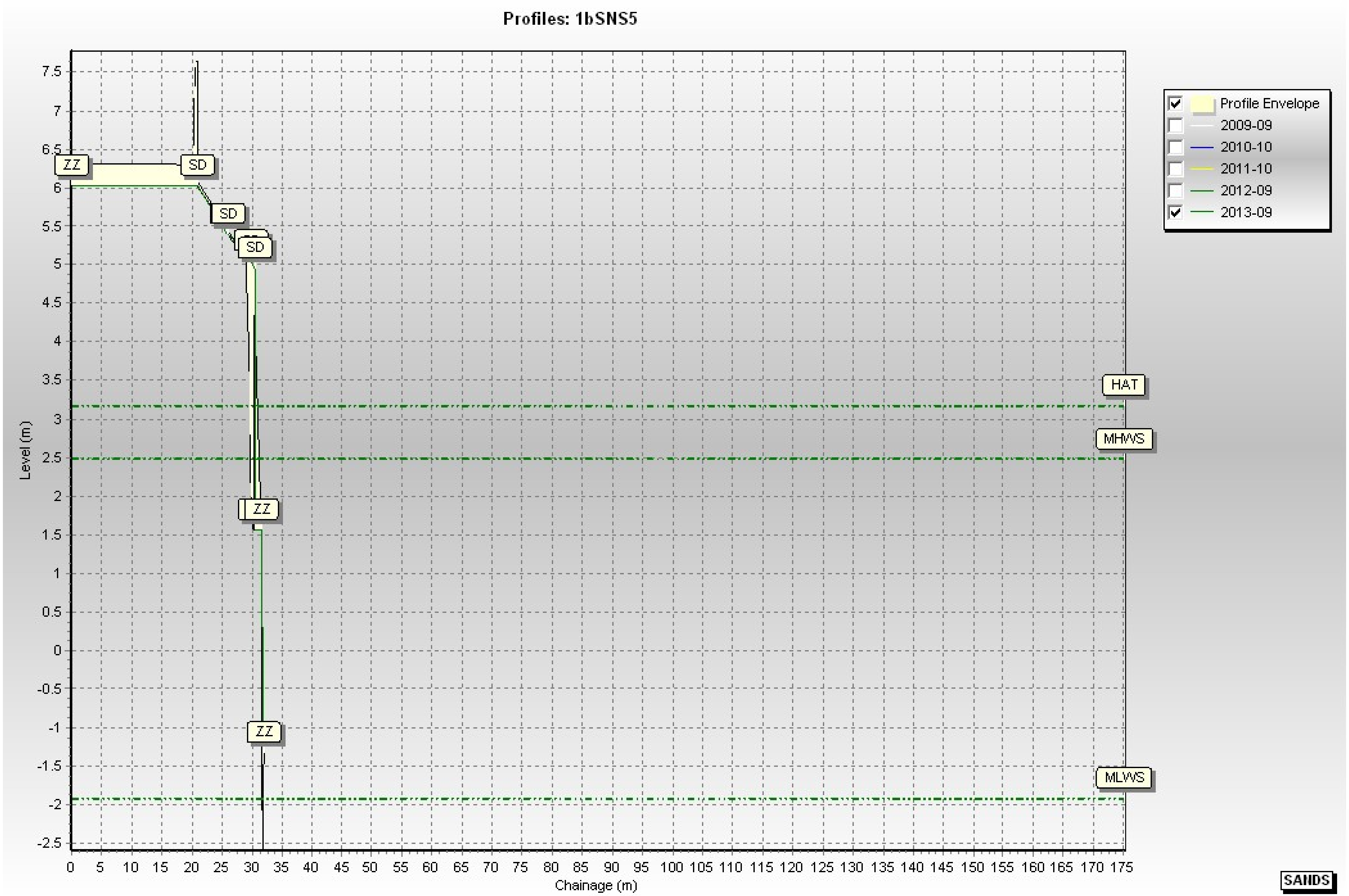

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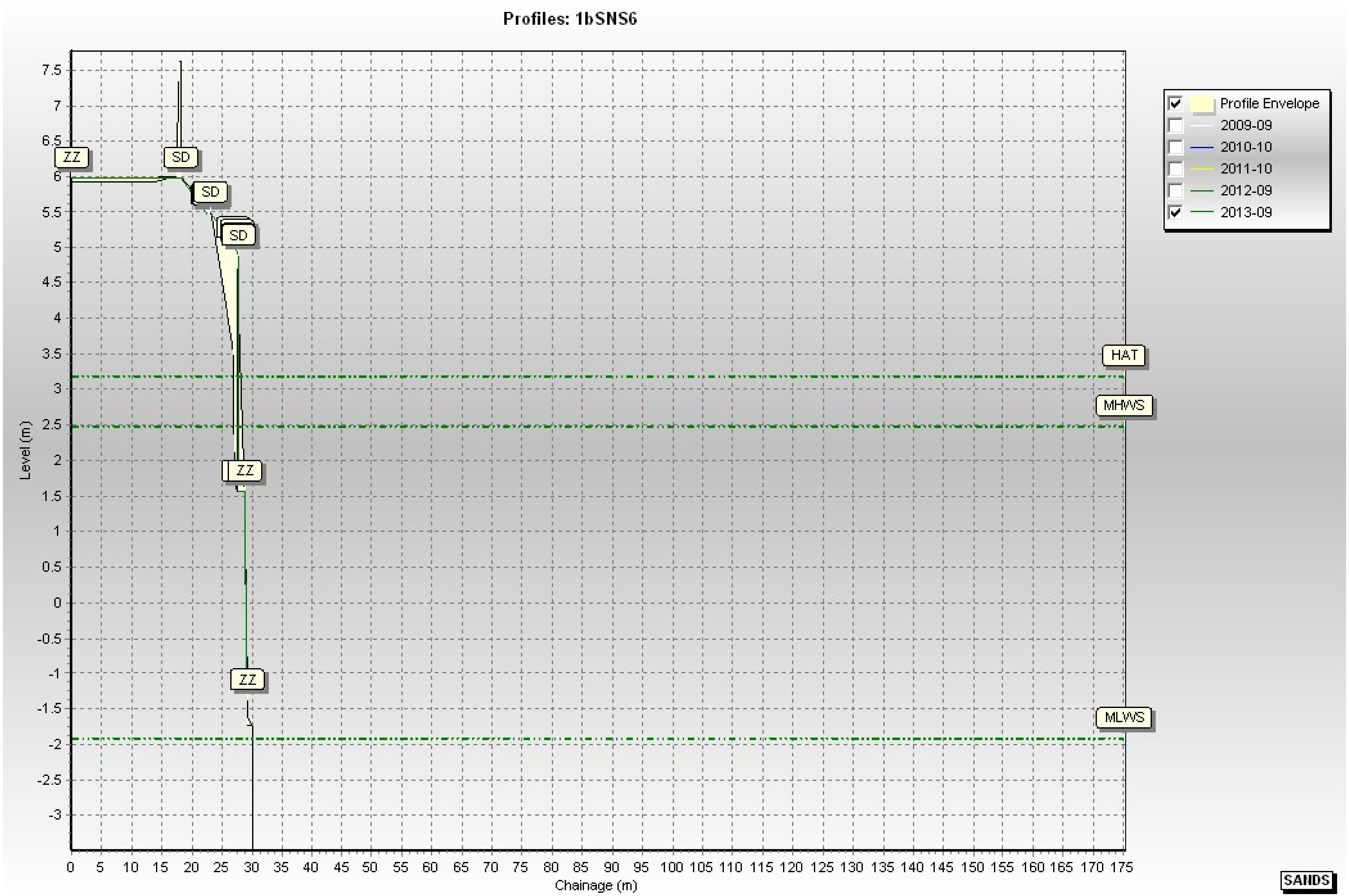

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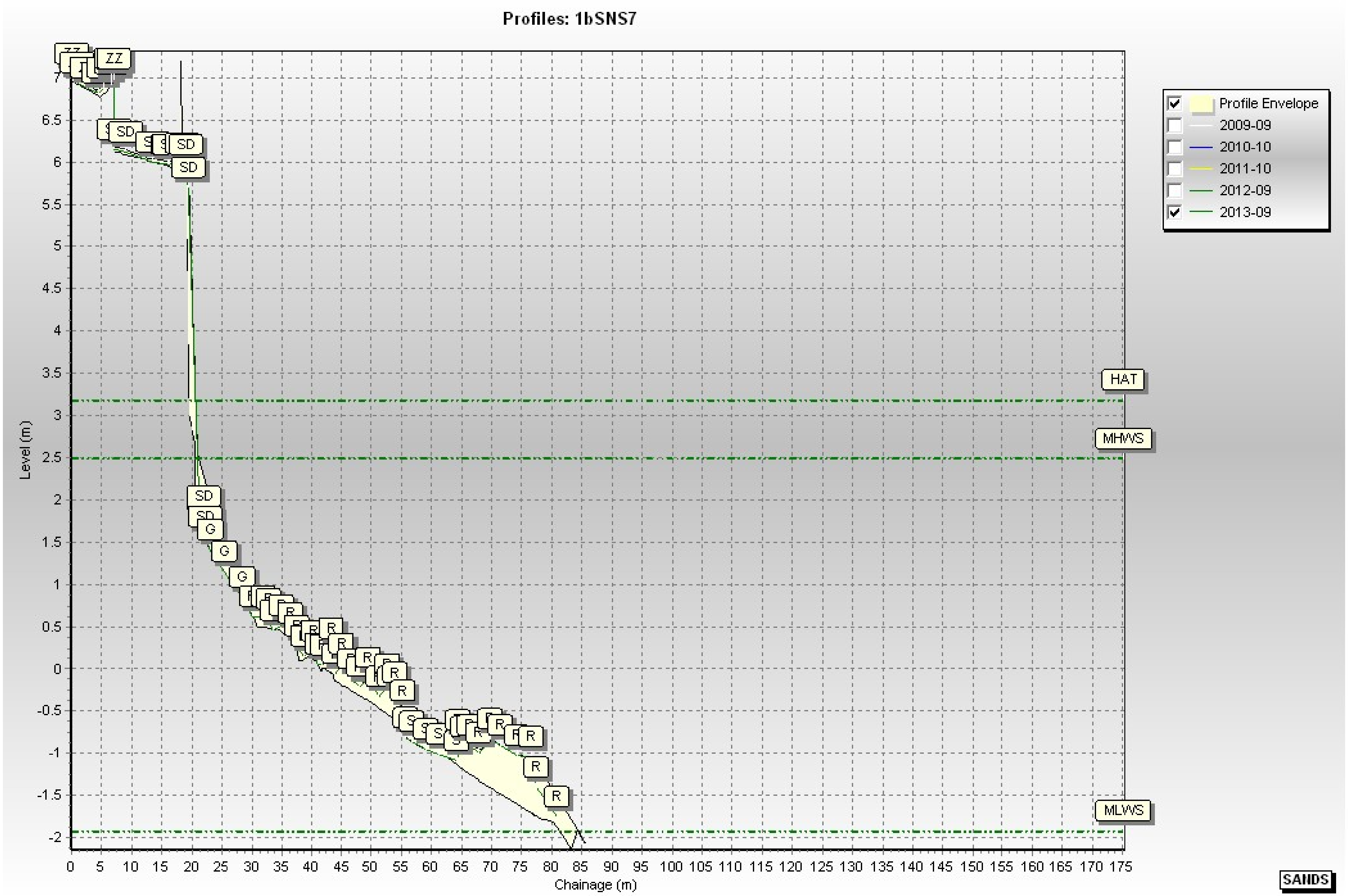

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Chainage (m)
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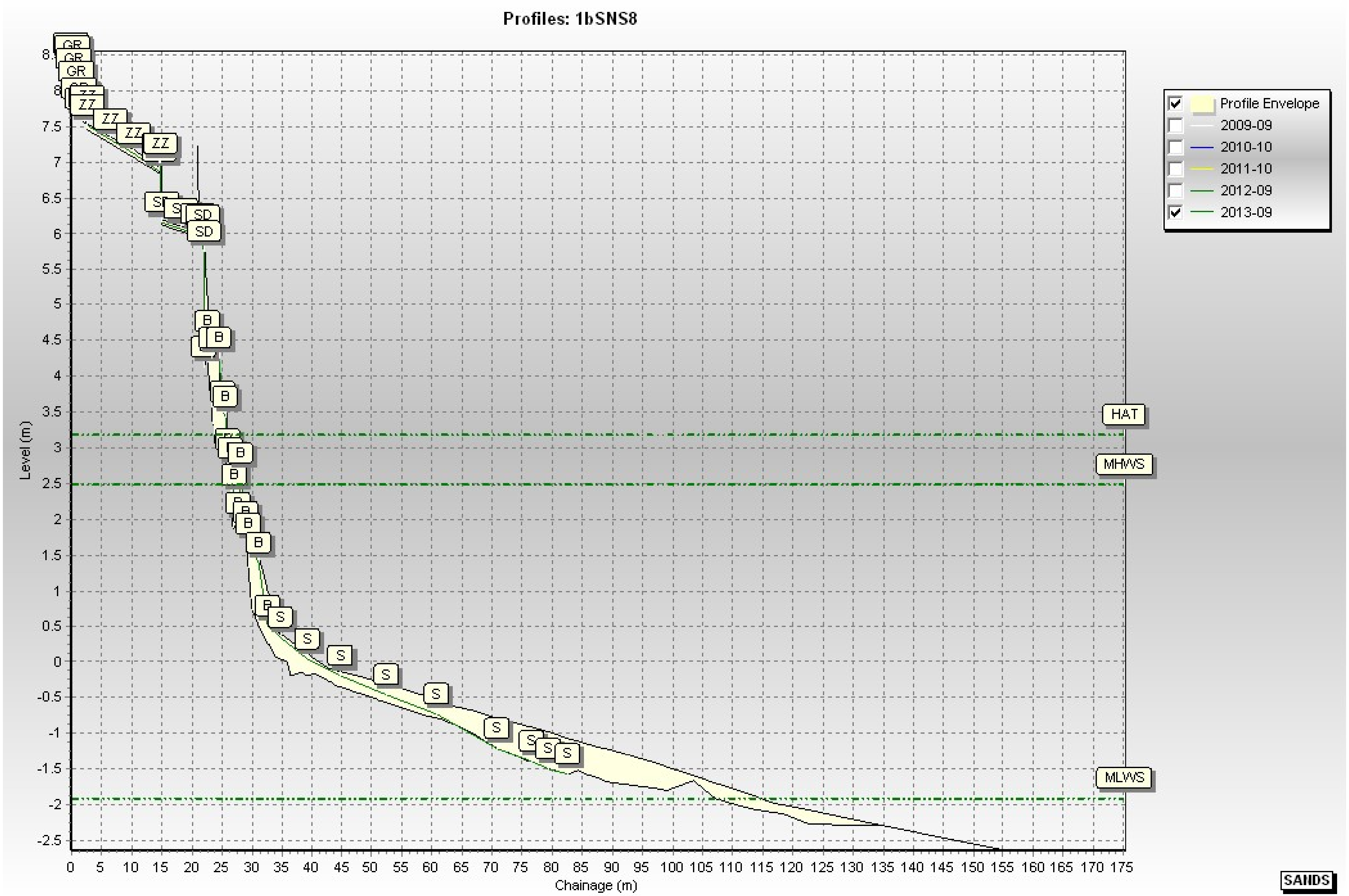
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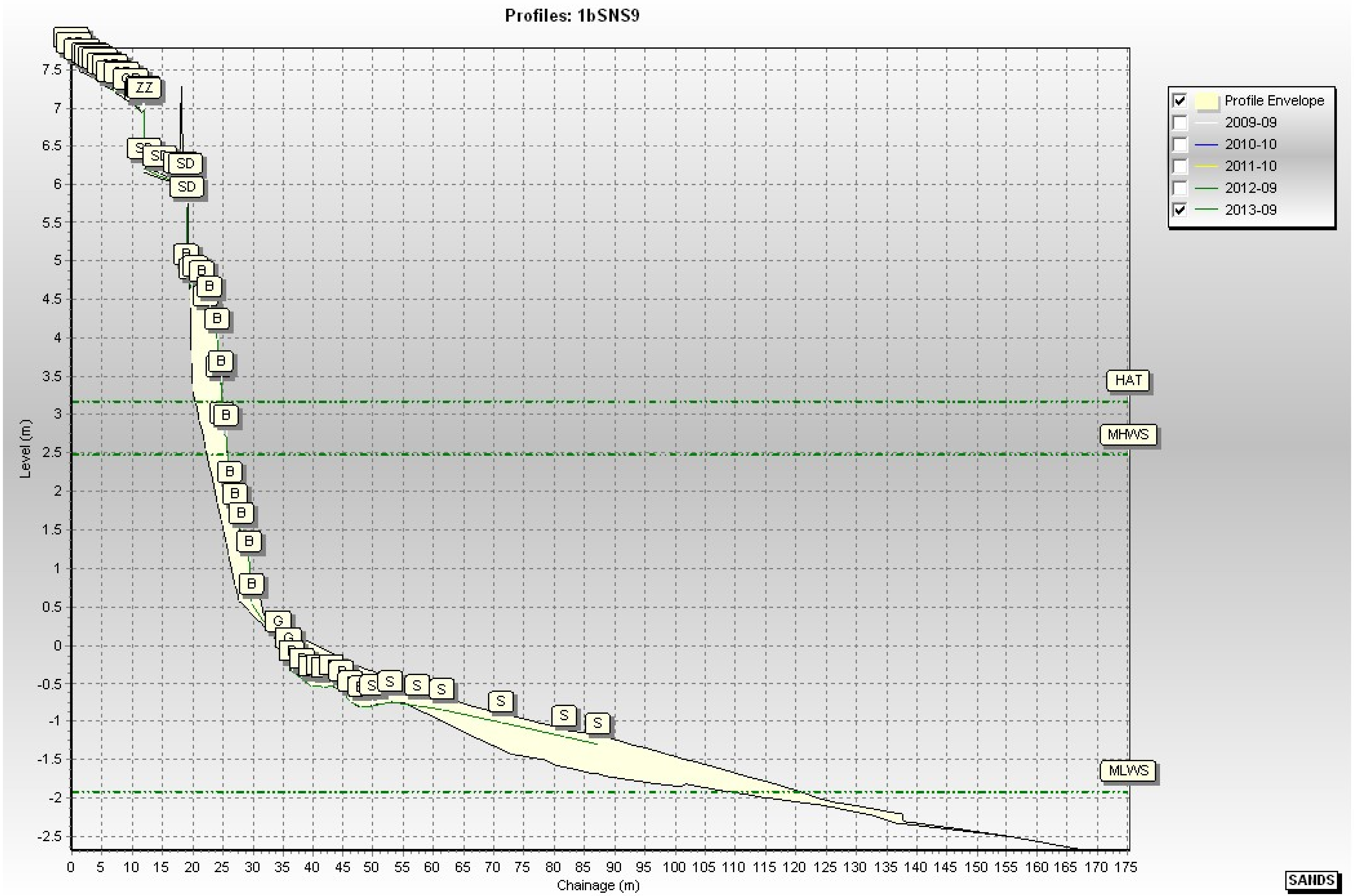
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Chainage (m)
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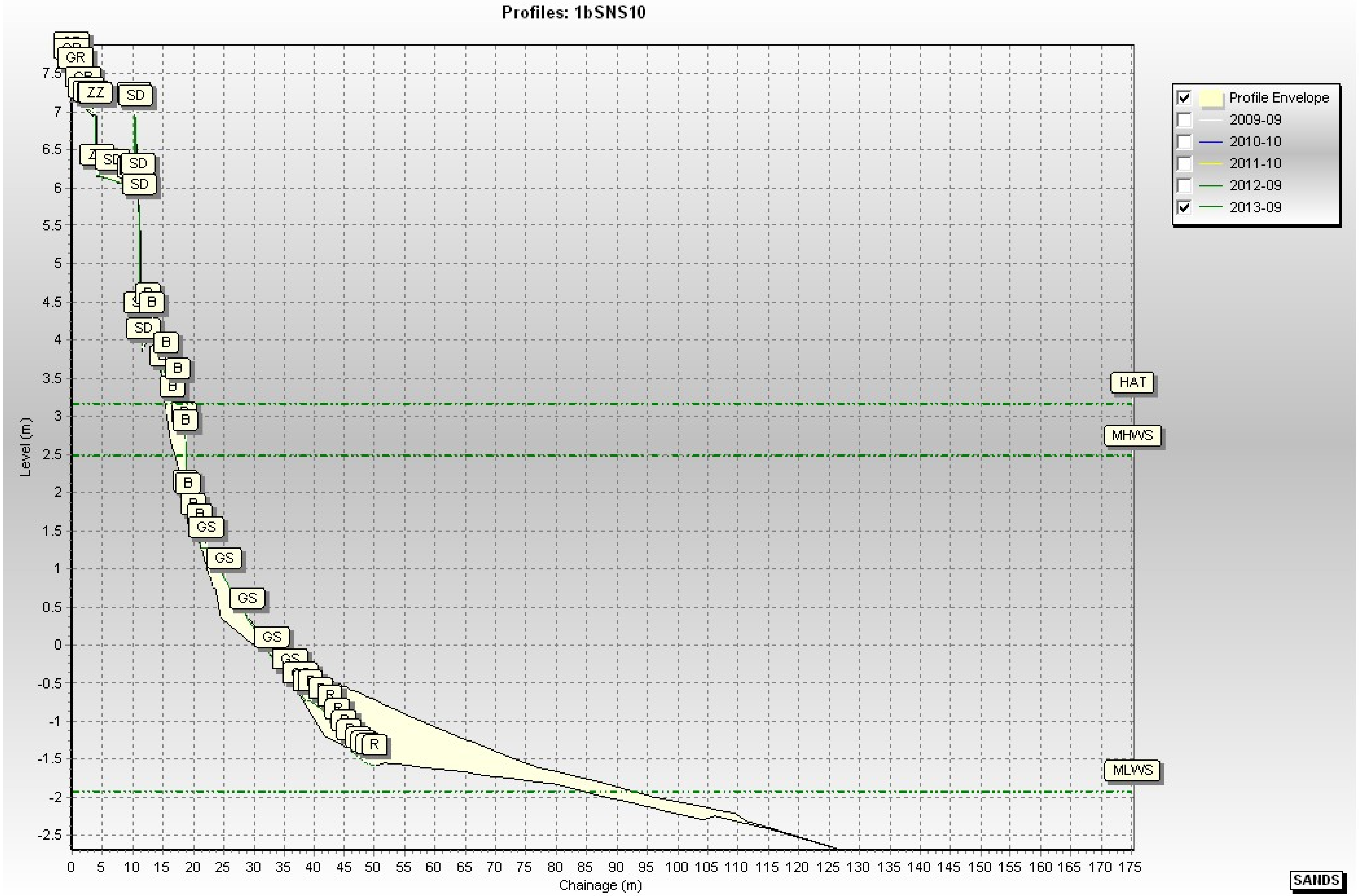

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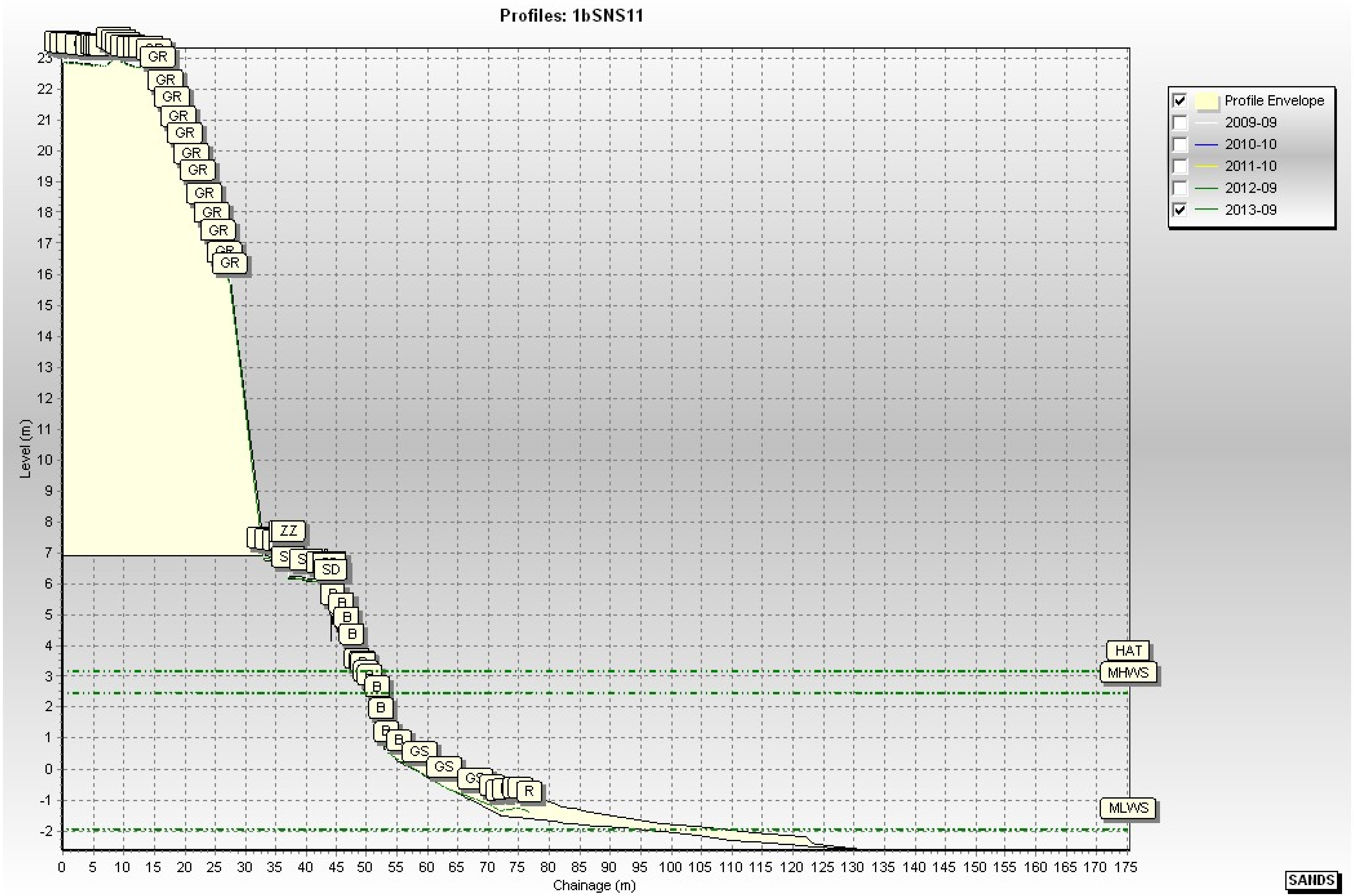

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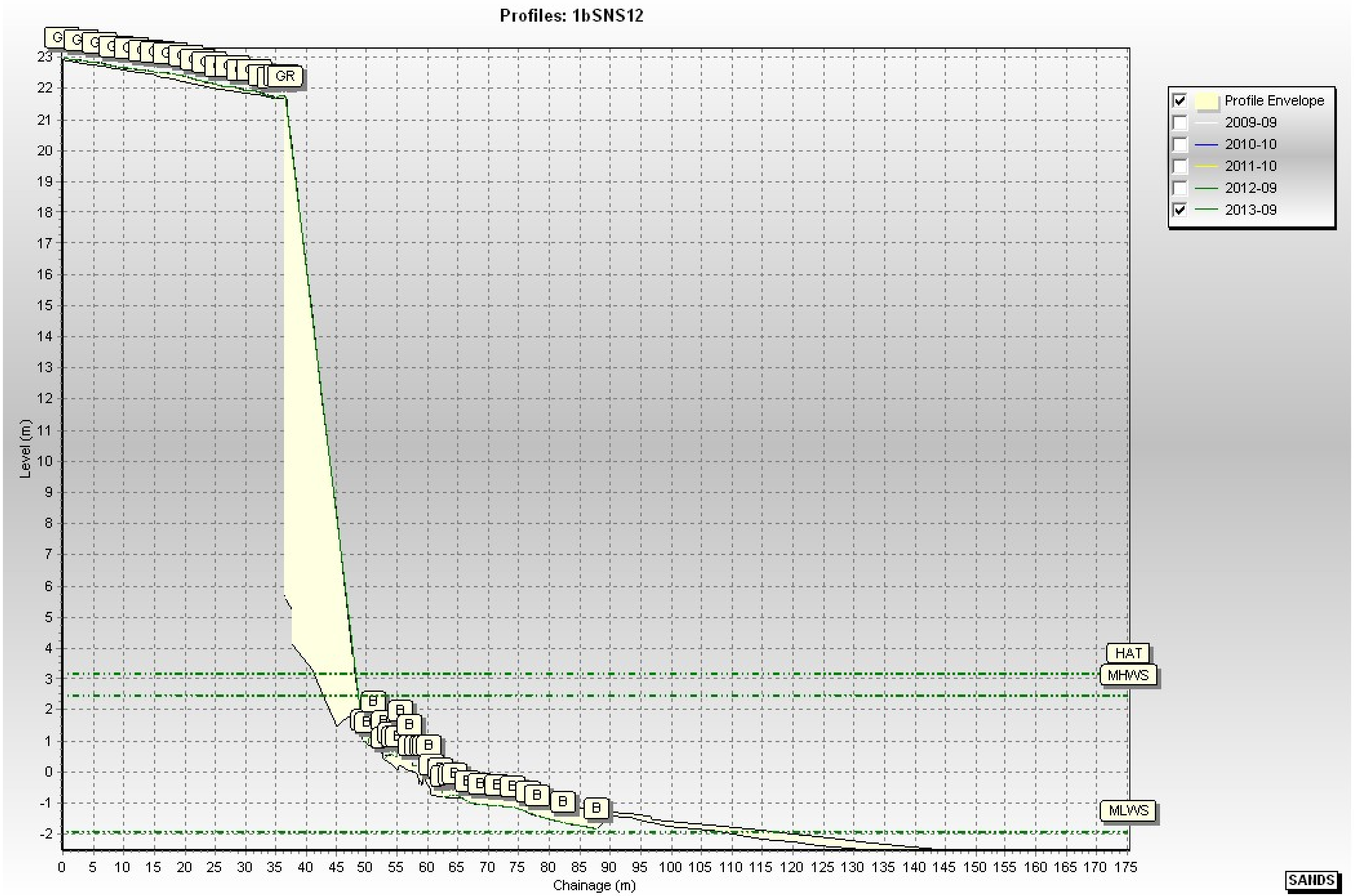
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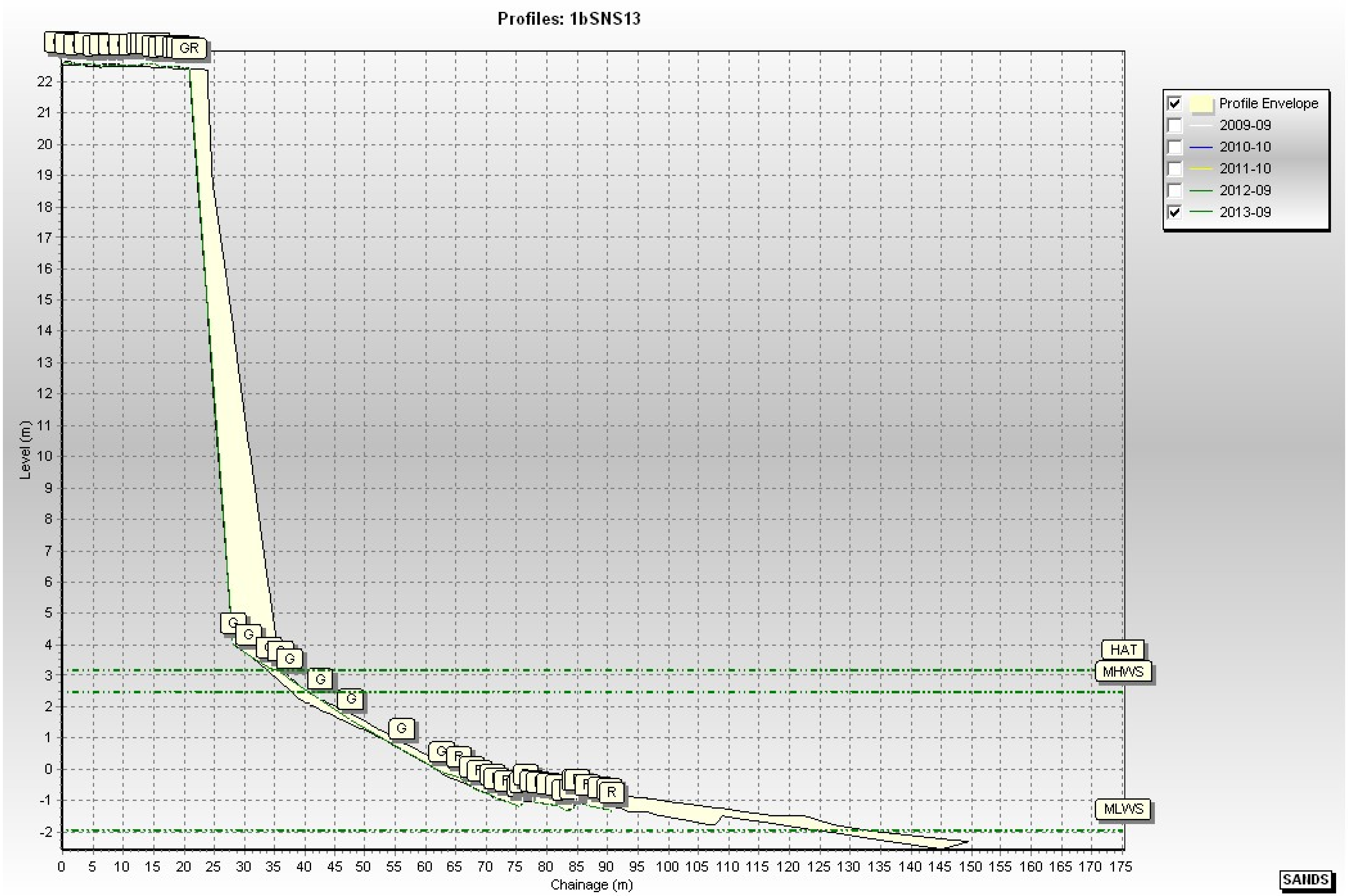

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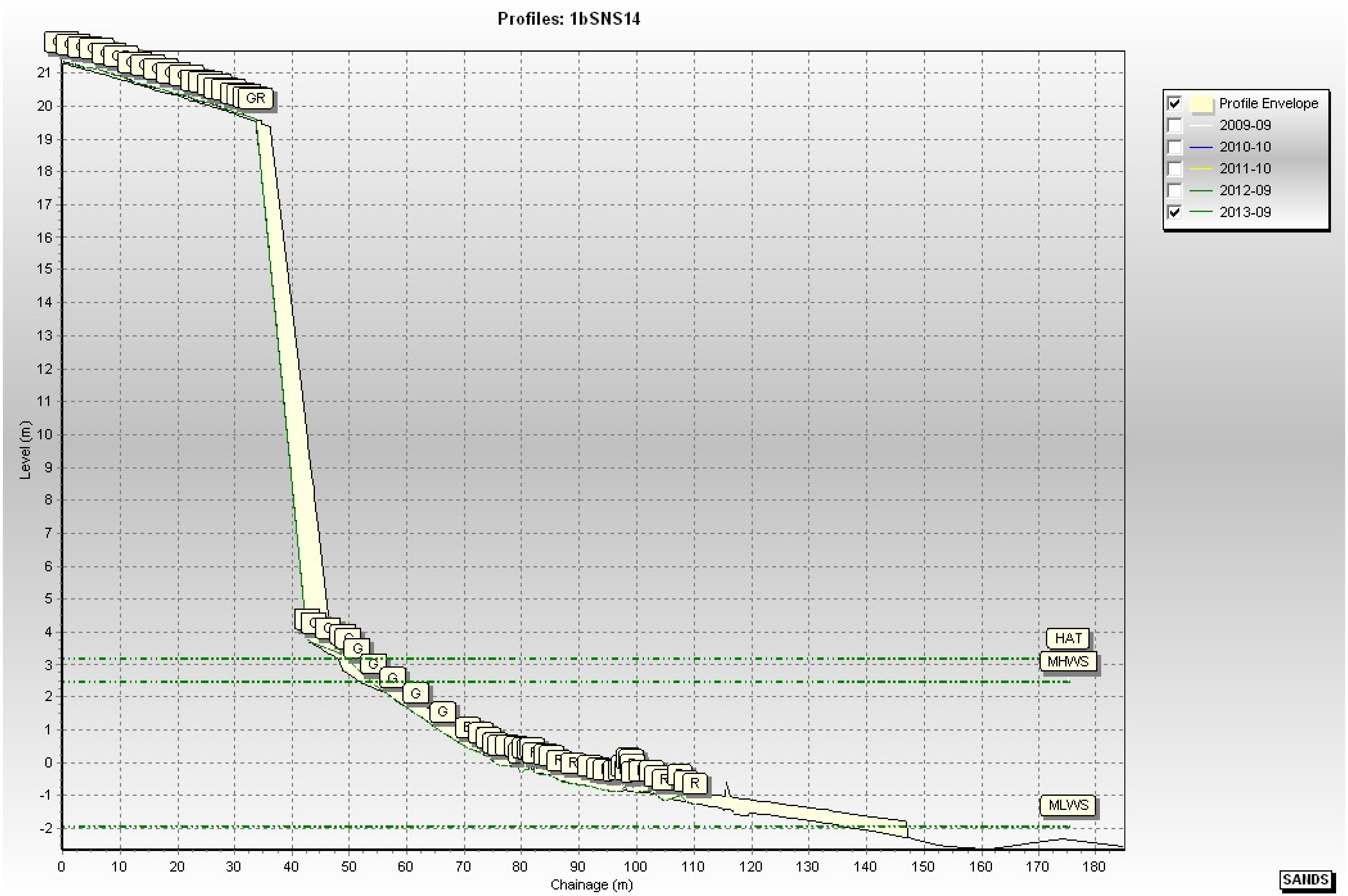

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R
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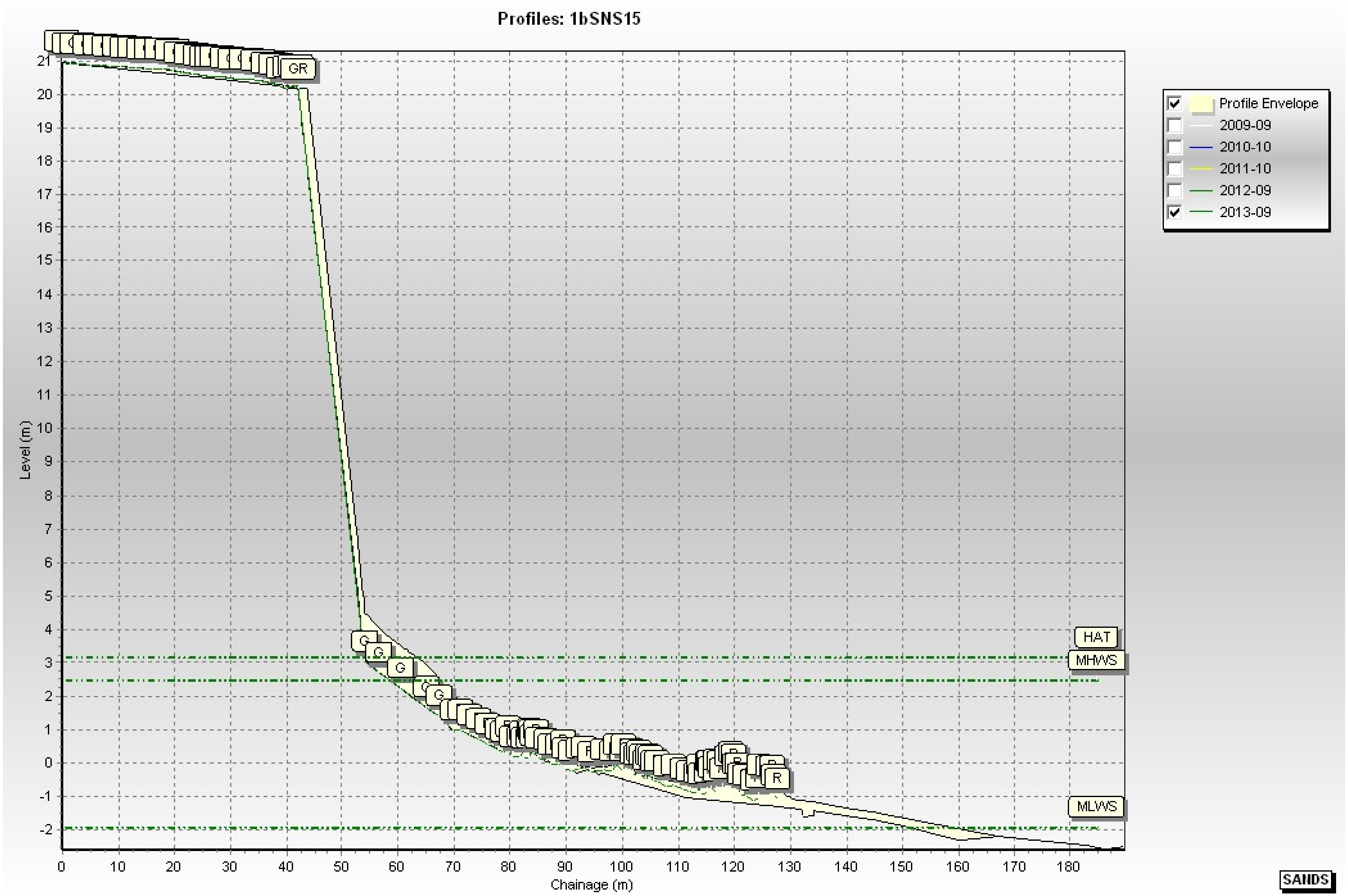

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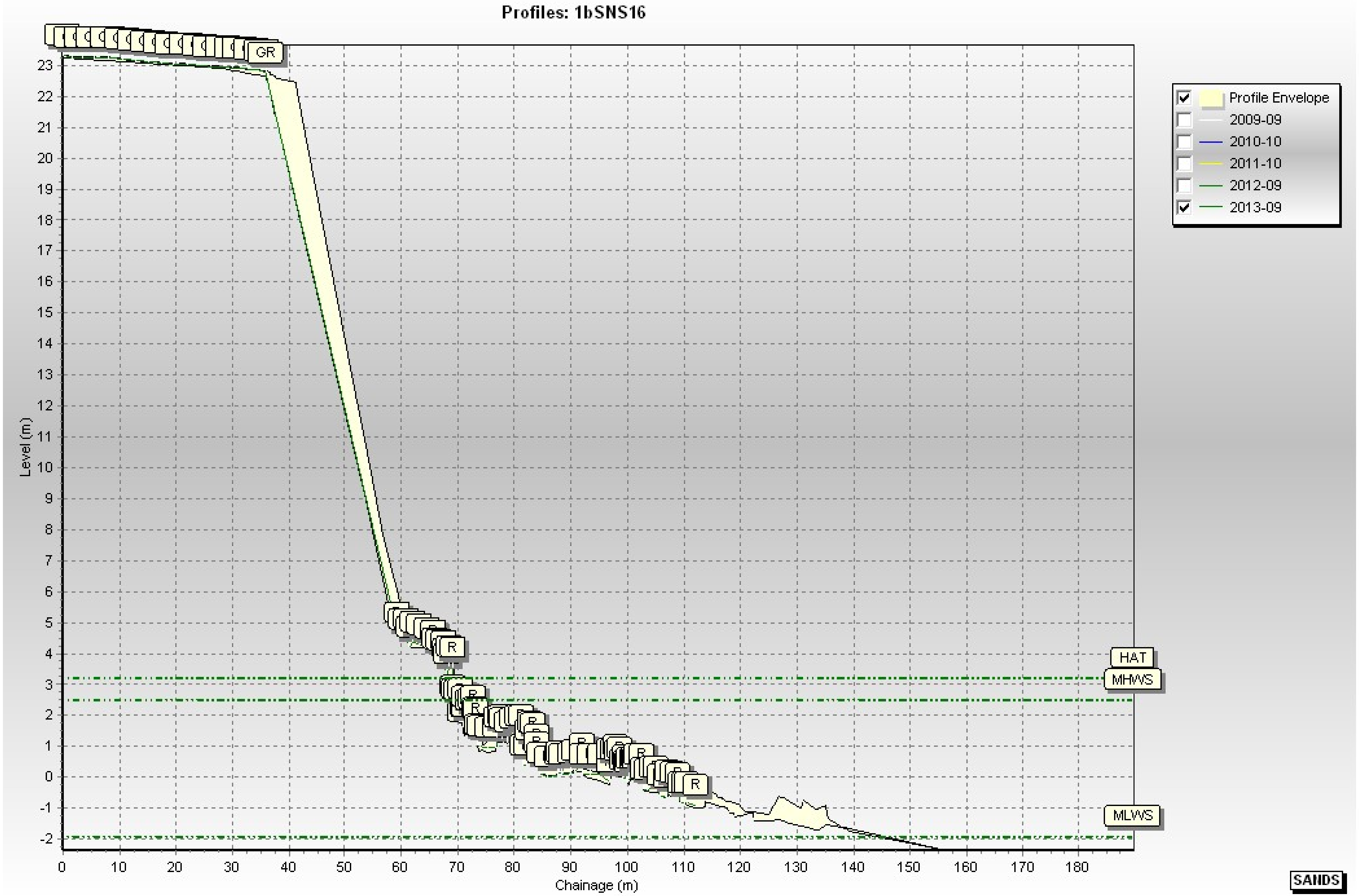
R
SANDS



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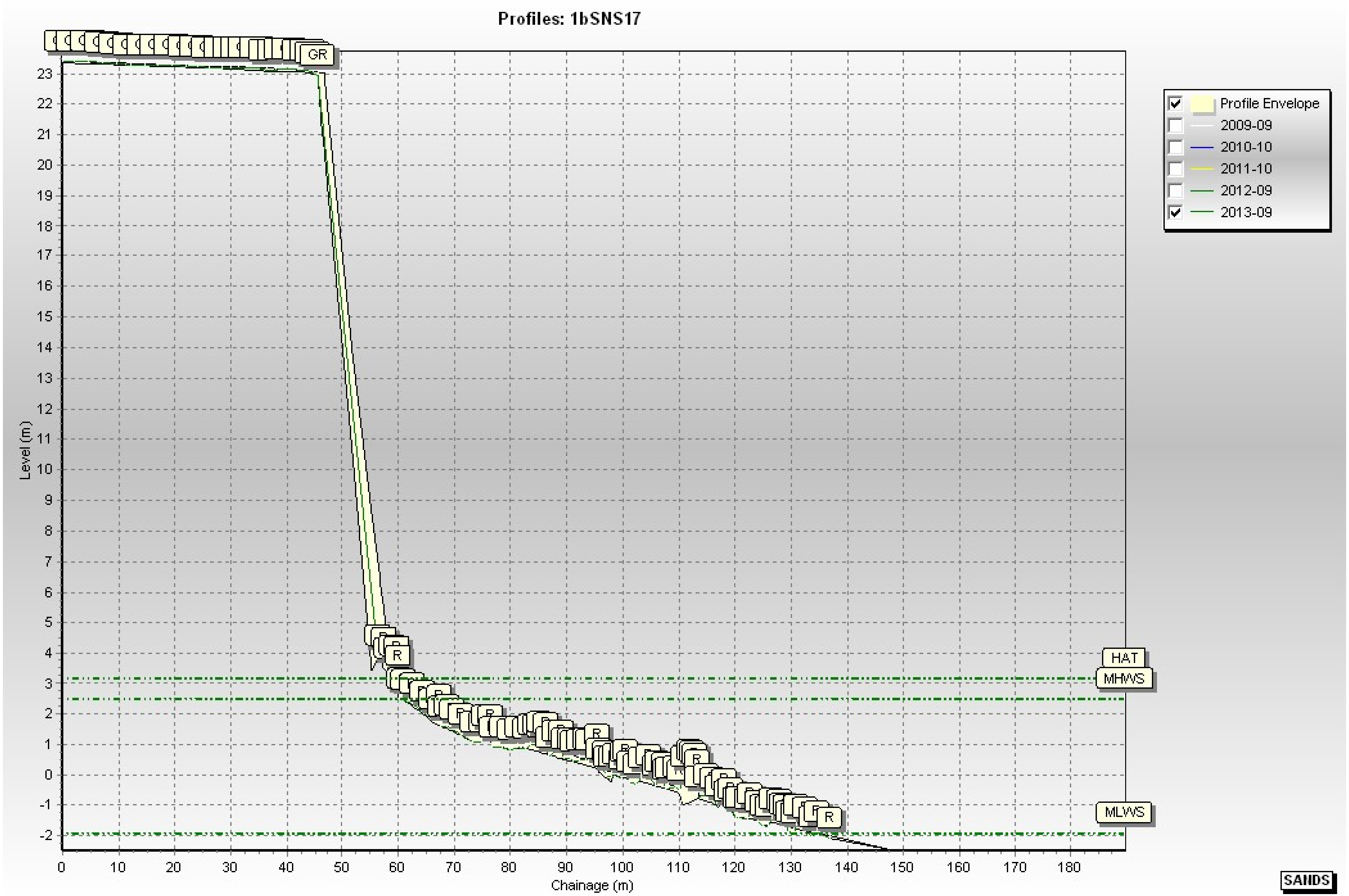
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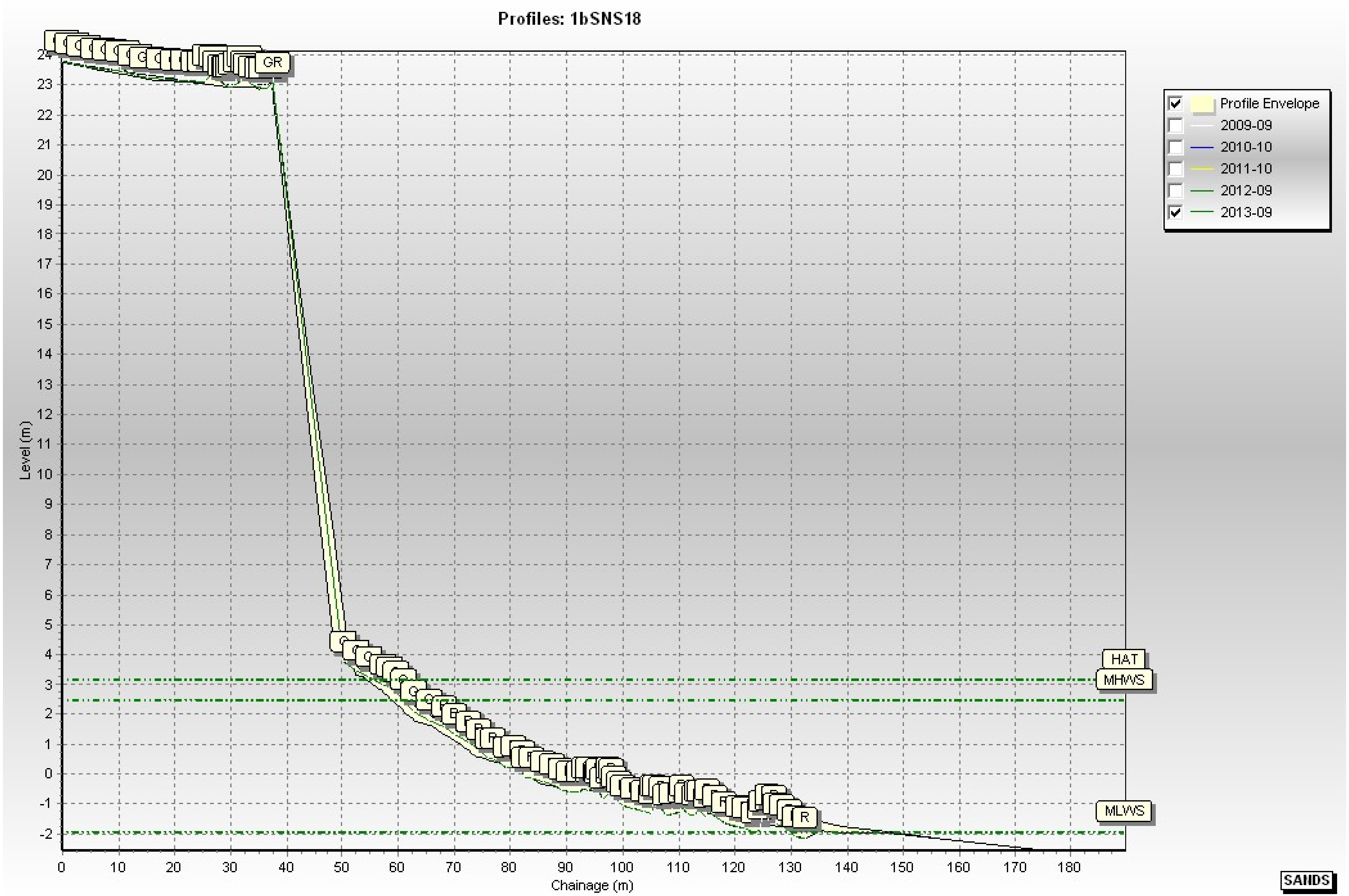
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9
8
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MHWS
MLWS
Profile Envelope
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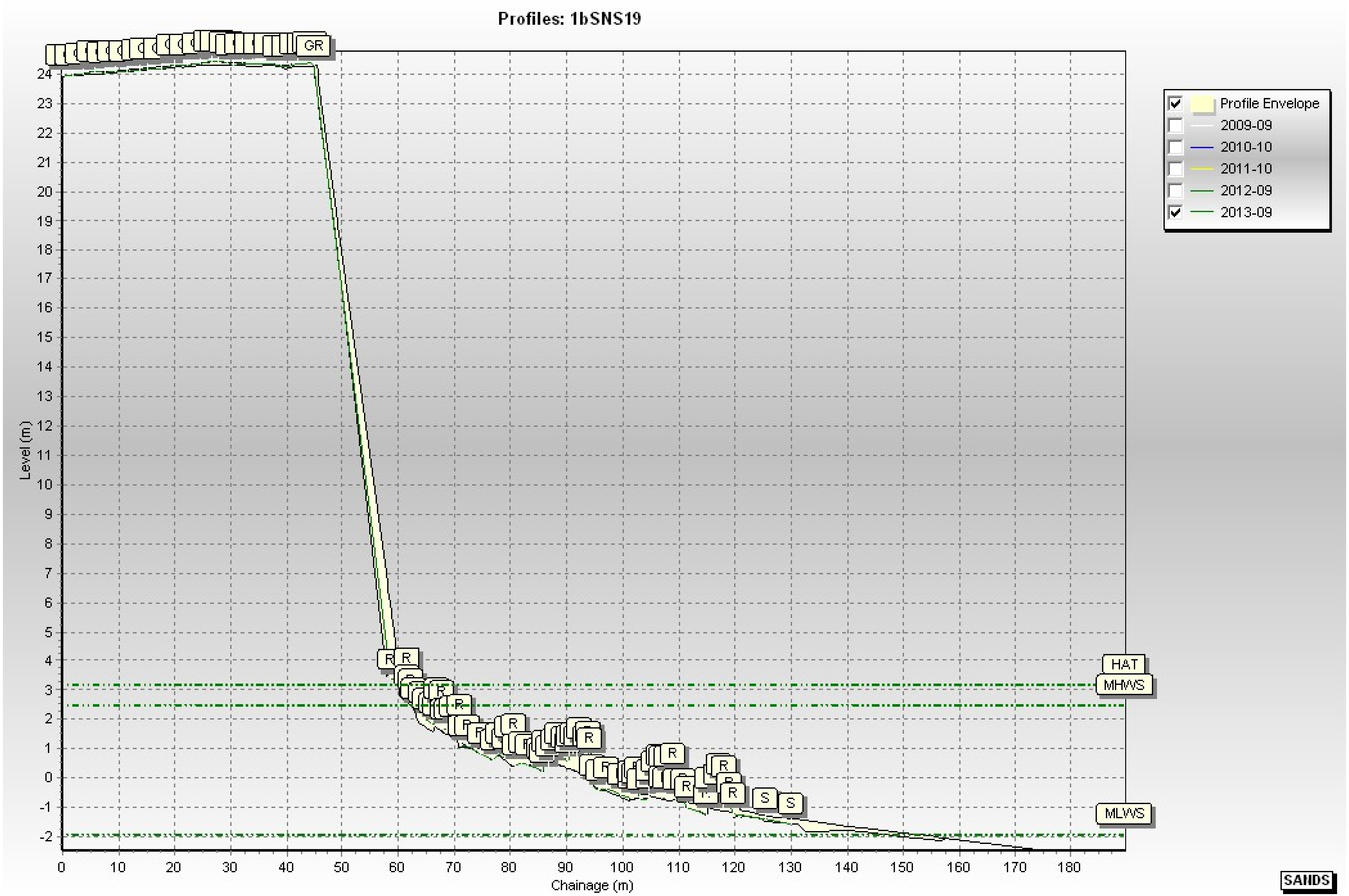
2011-10
2012-09
2013-09
SANDS



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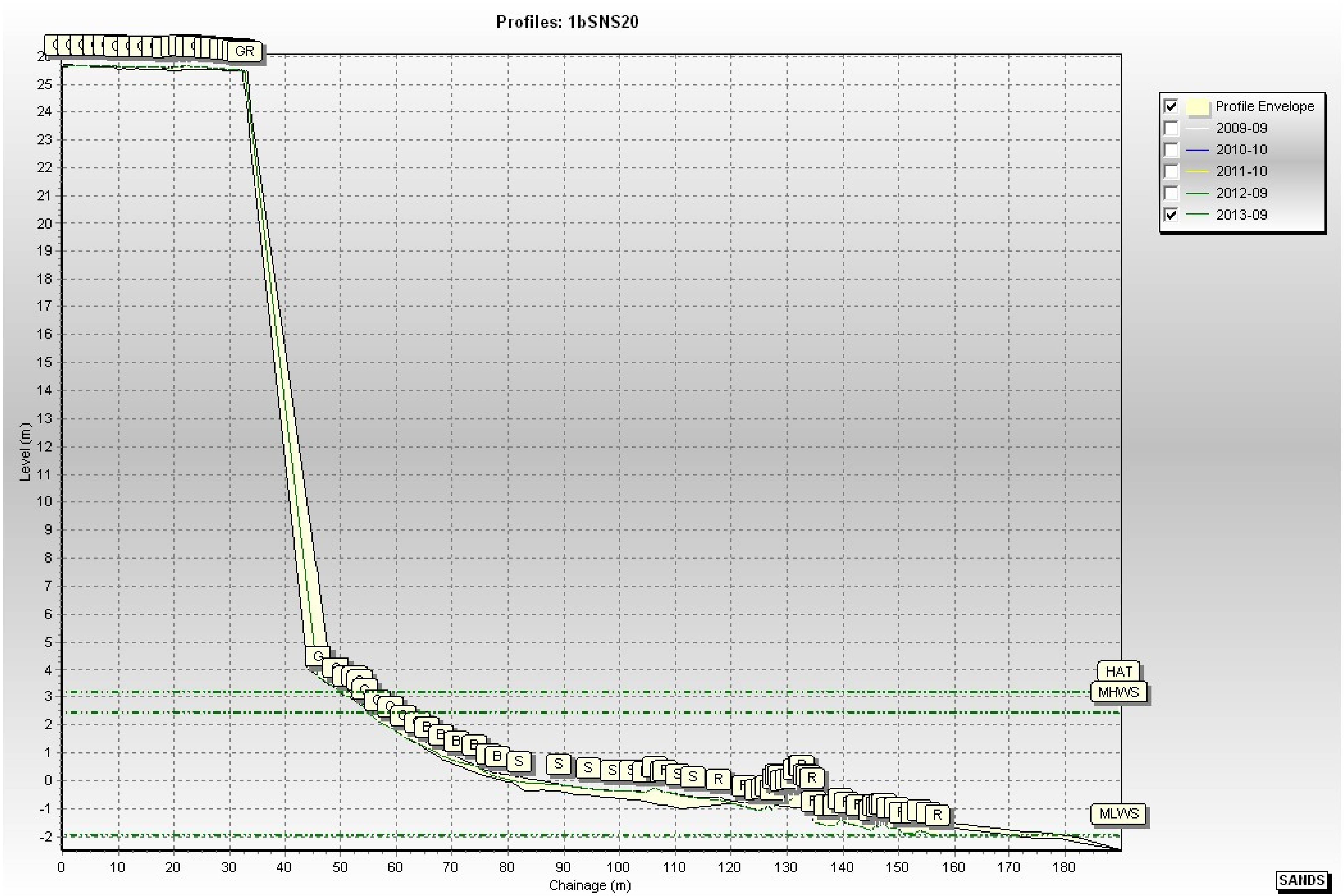
SANDS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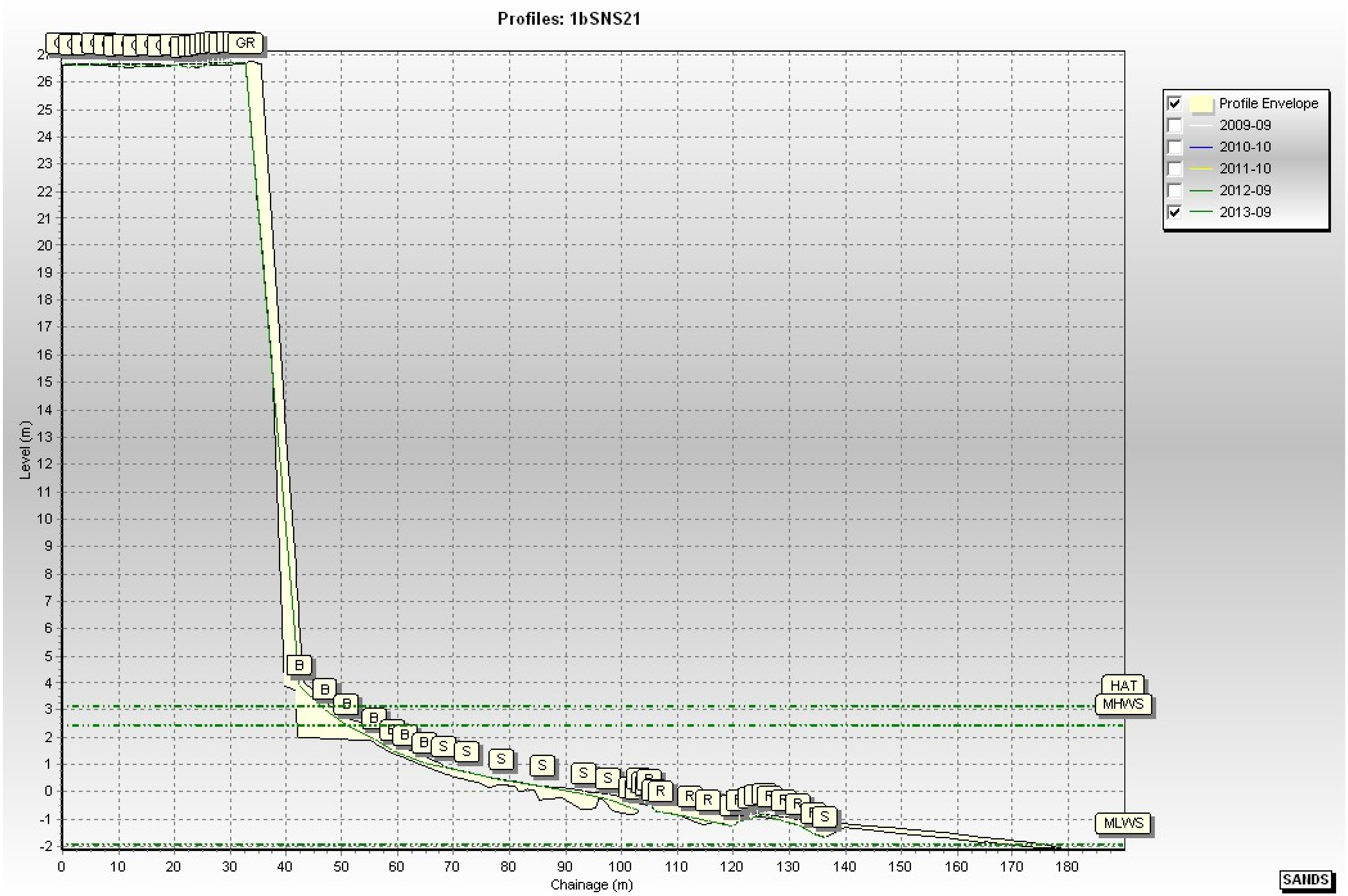
MLWS
SANDS



Profiles: 1bSNS21
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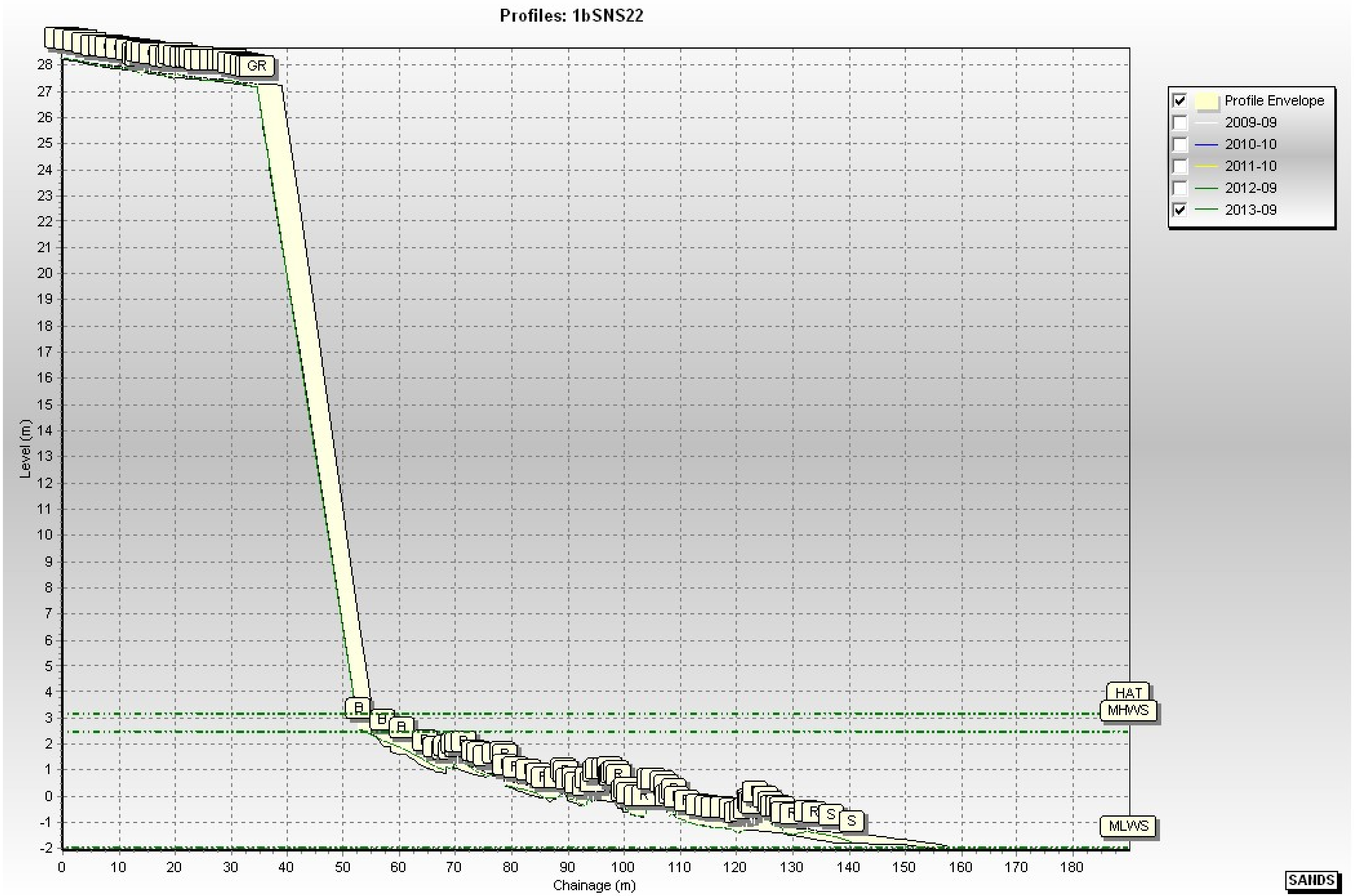
MLWS
SANDS



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MLWS
S
Profile Envelope
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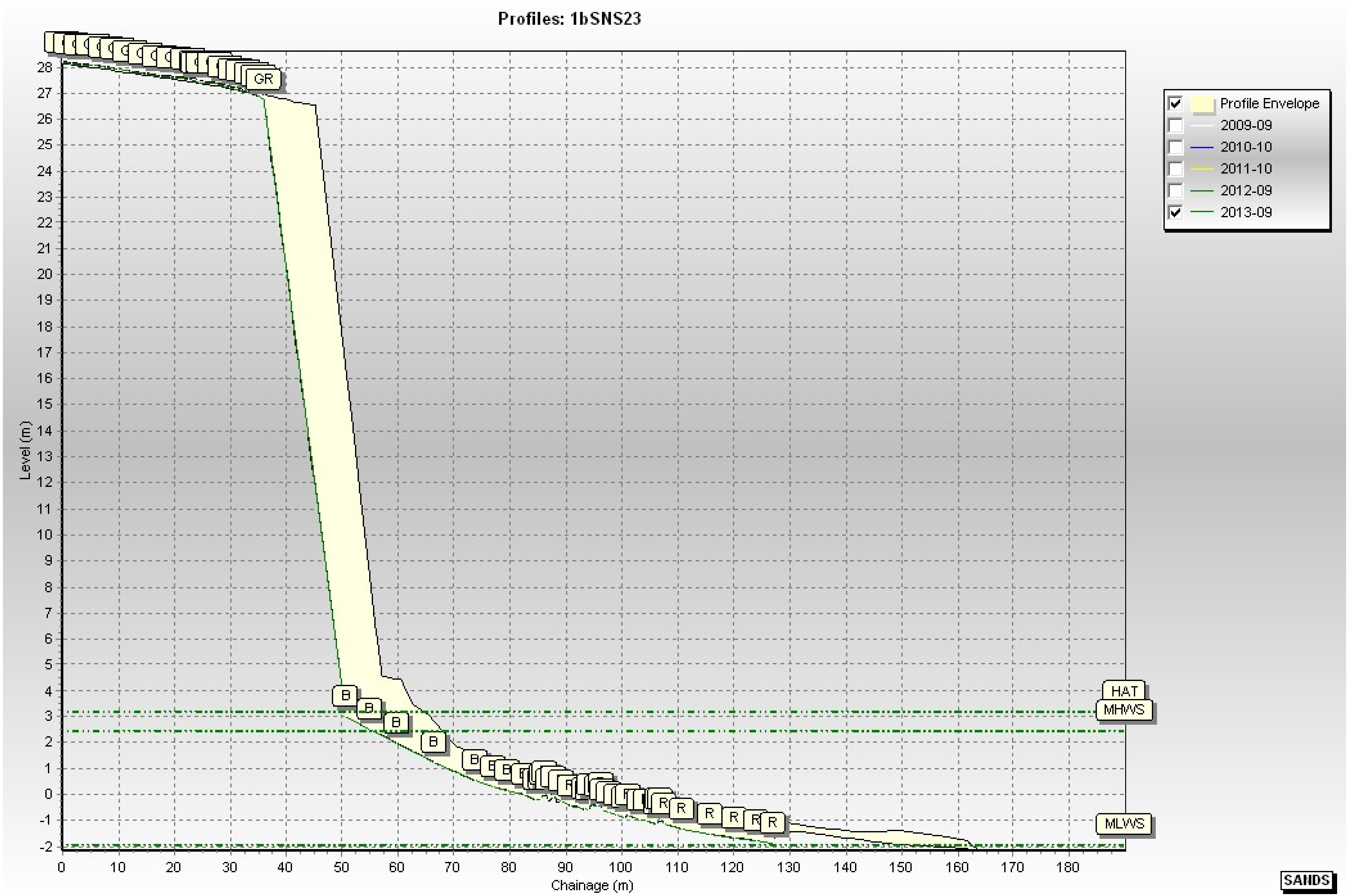

Profiles: 1bSNS23
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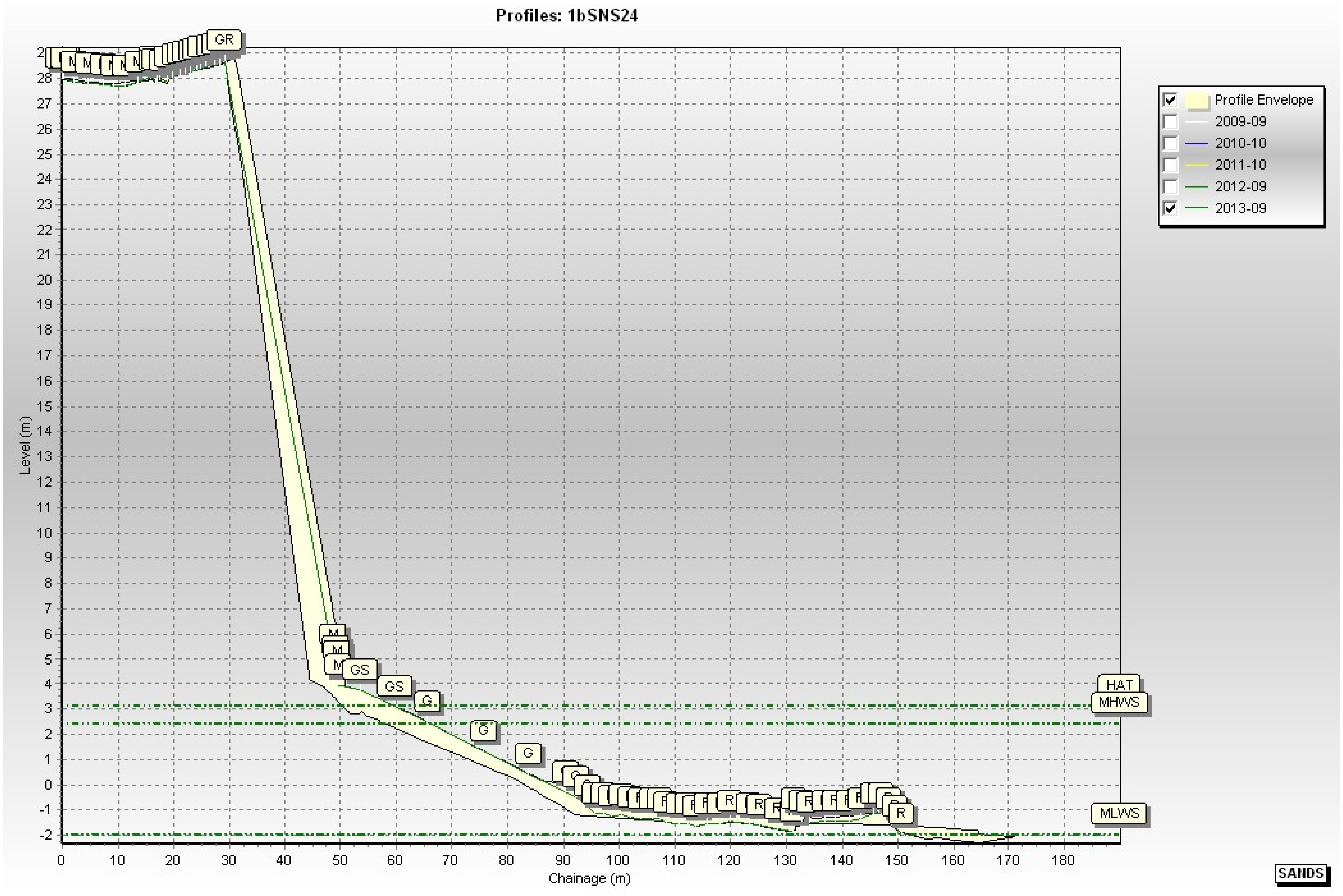
SANDS



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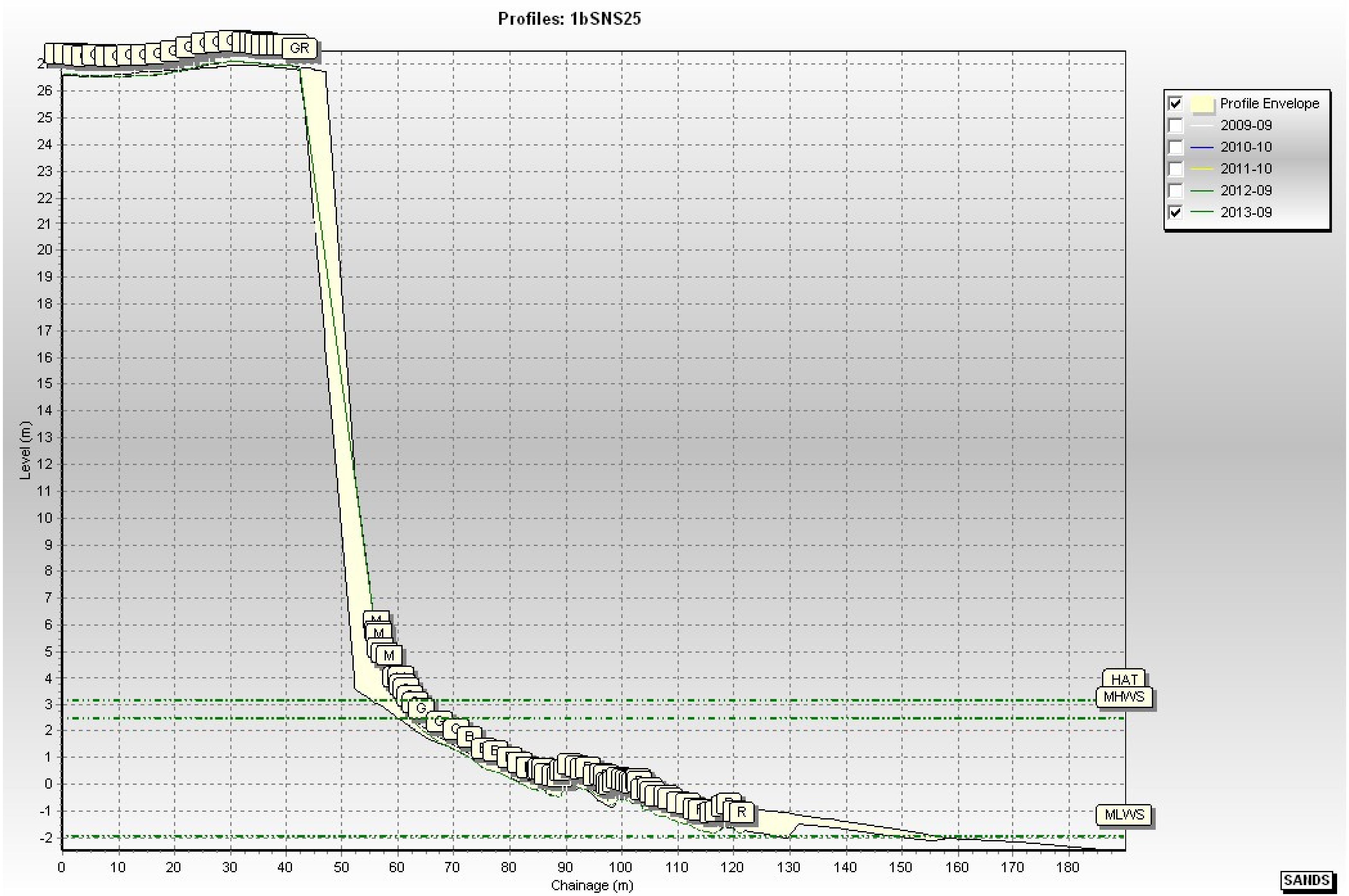
MLWS
SANDS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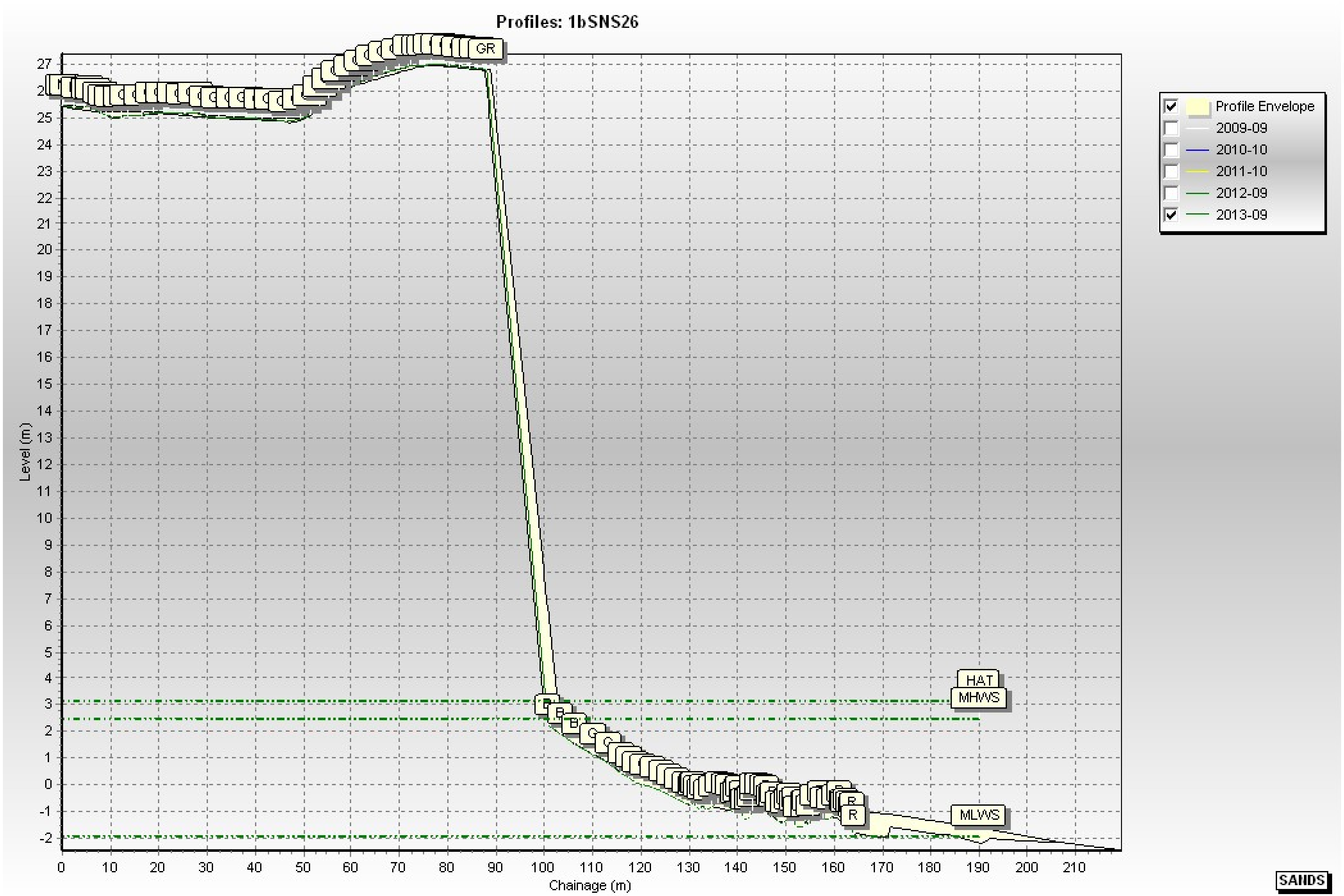
SANDS



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MLWS
Profile Envelope
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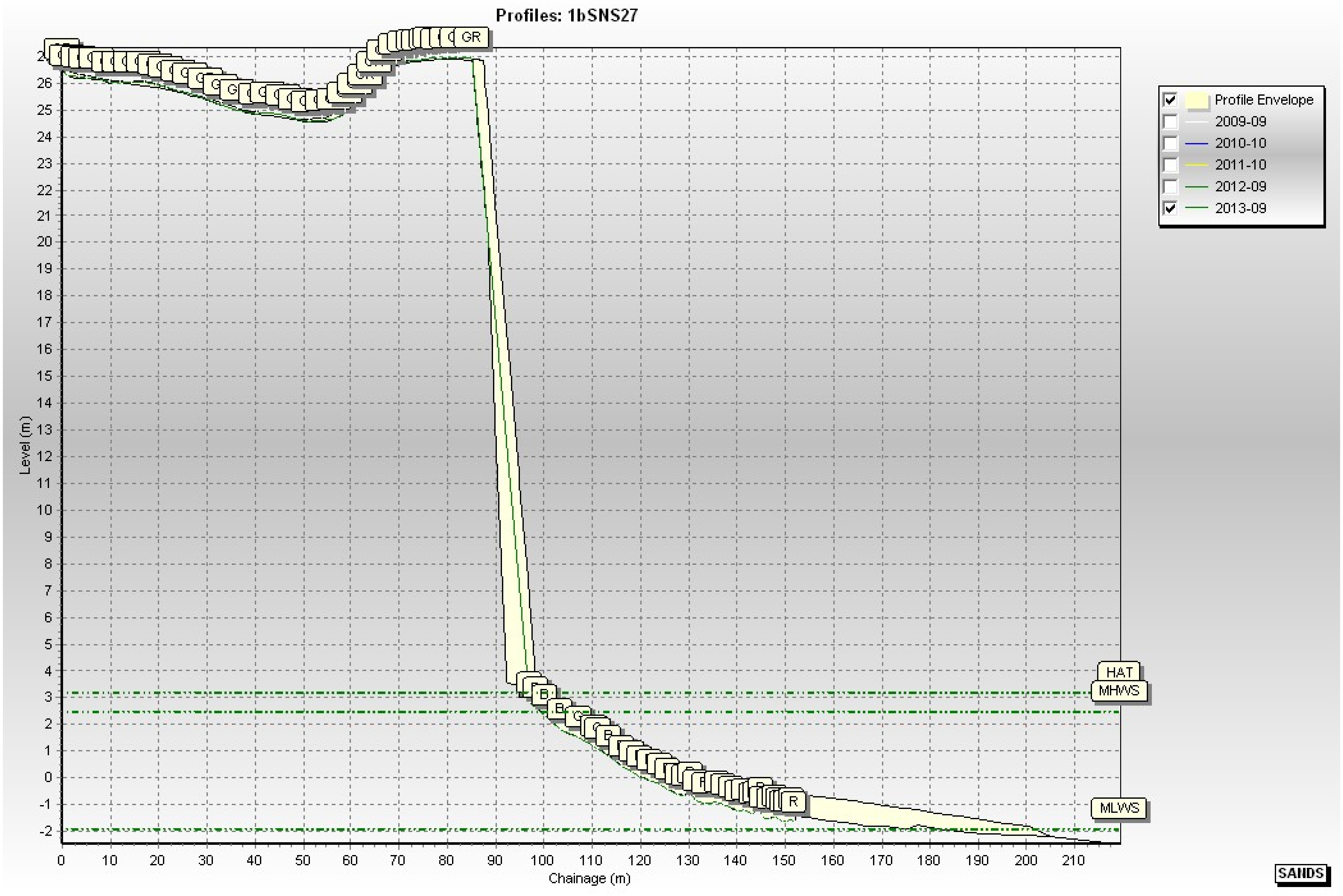

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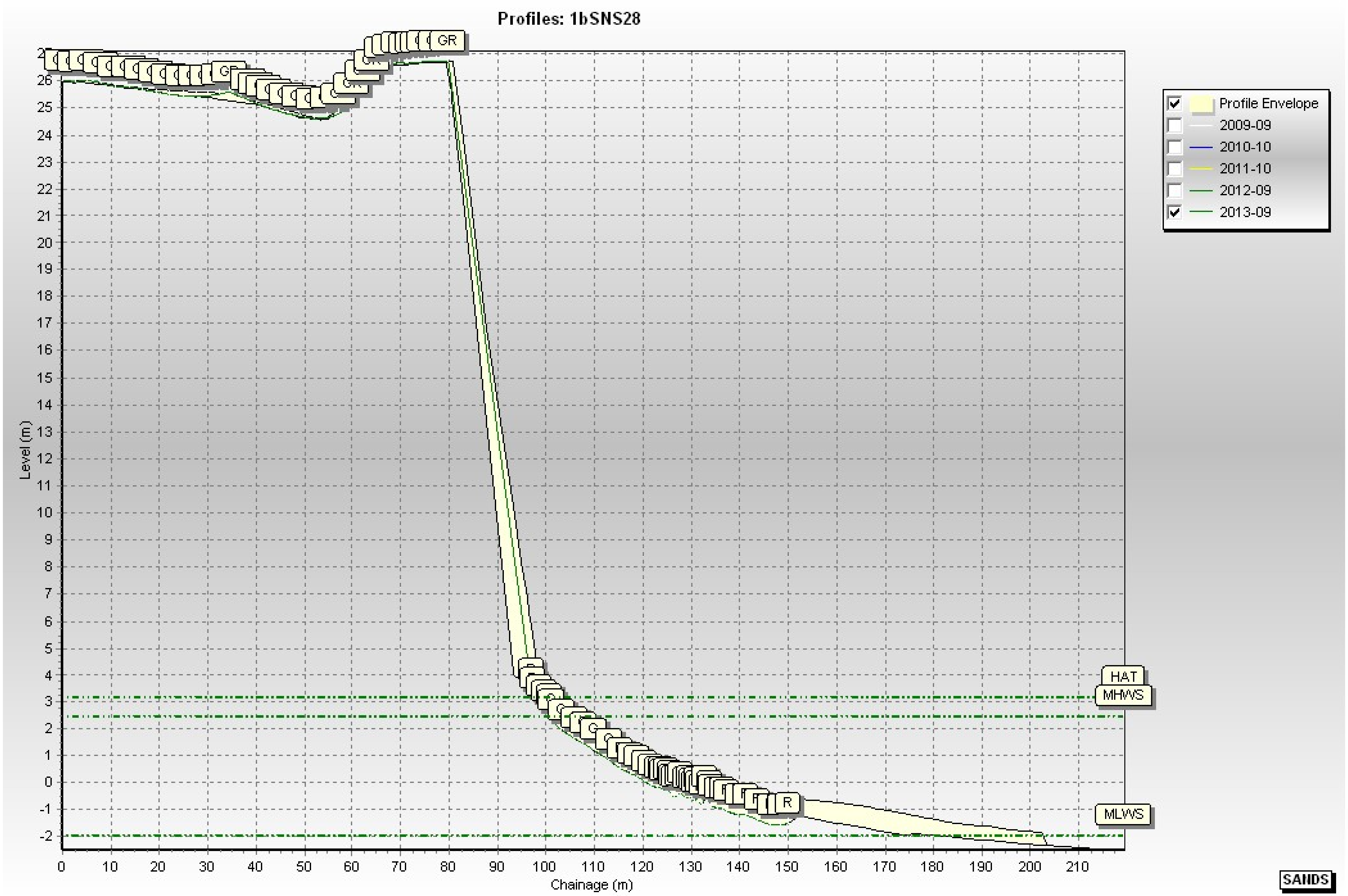

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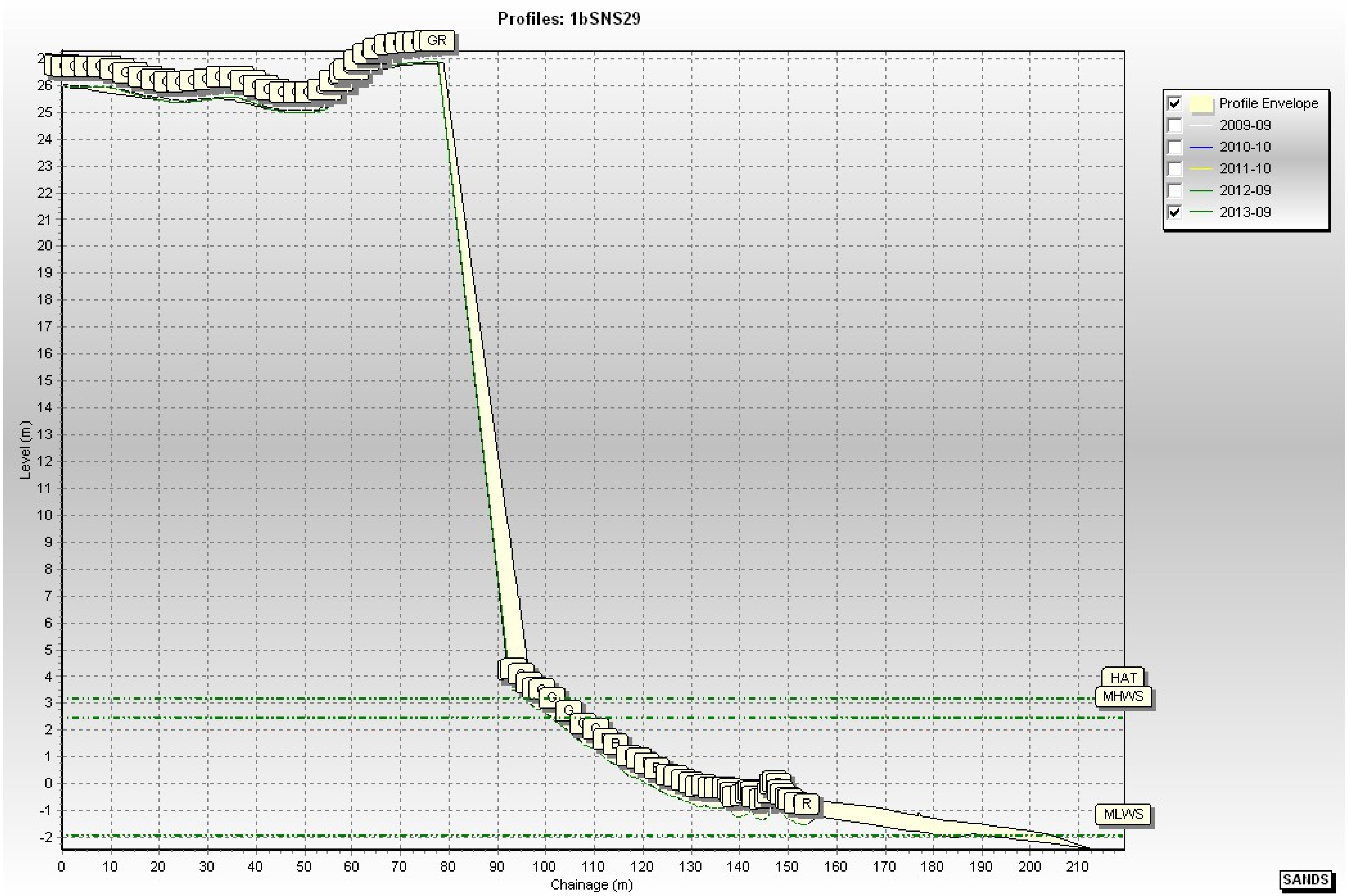
R
SANDS



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MLWS
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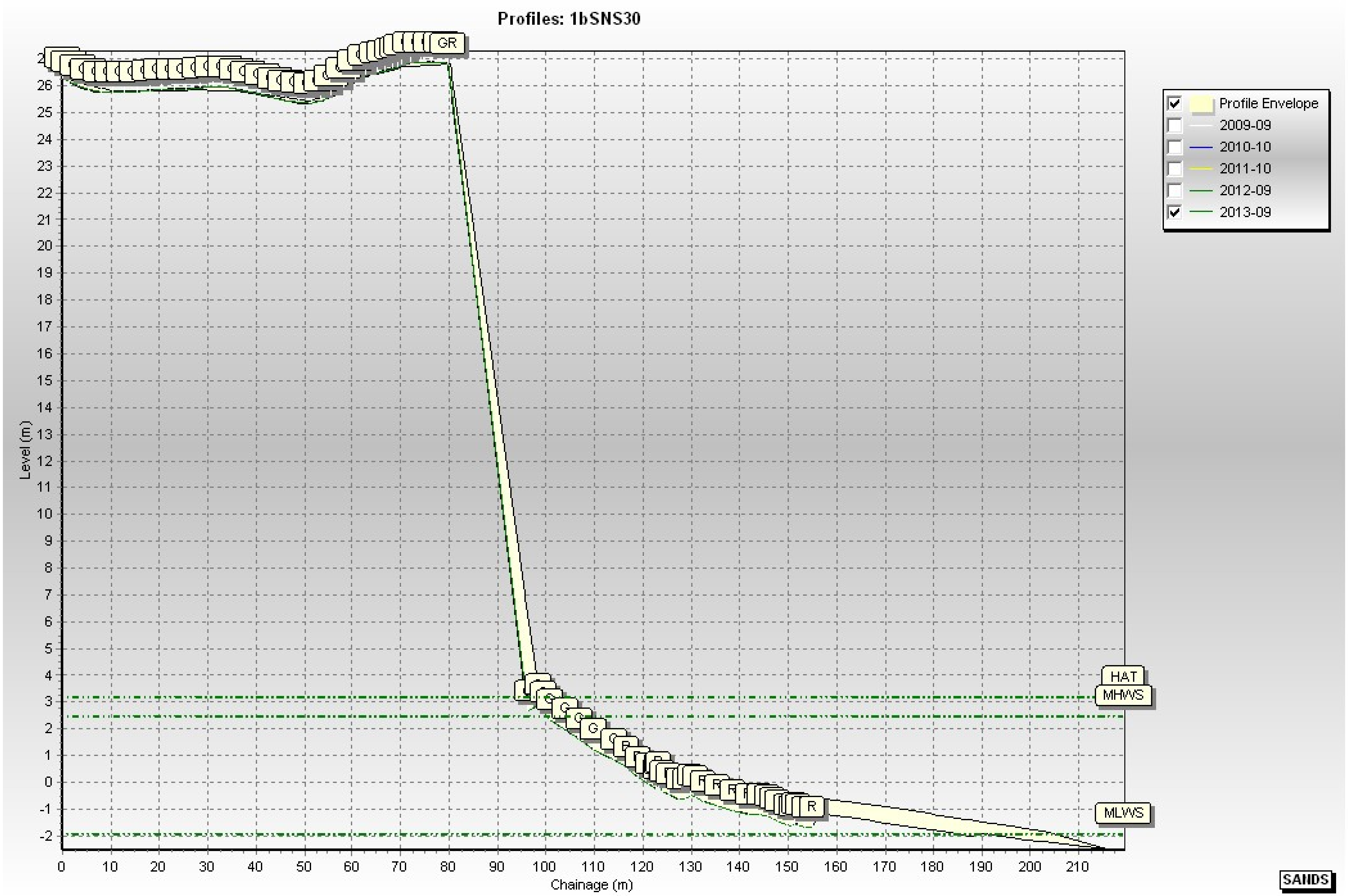
SANDS



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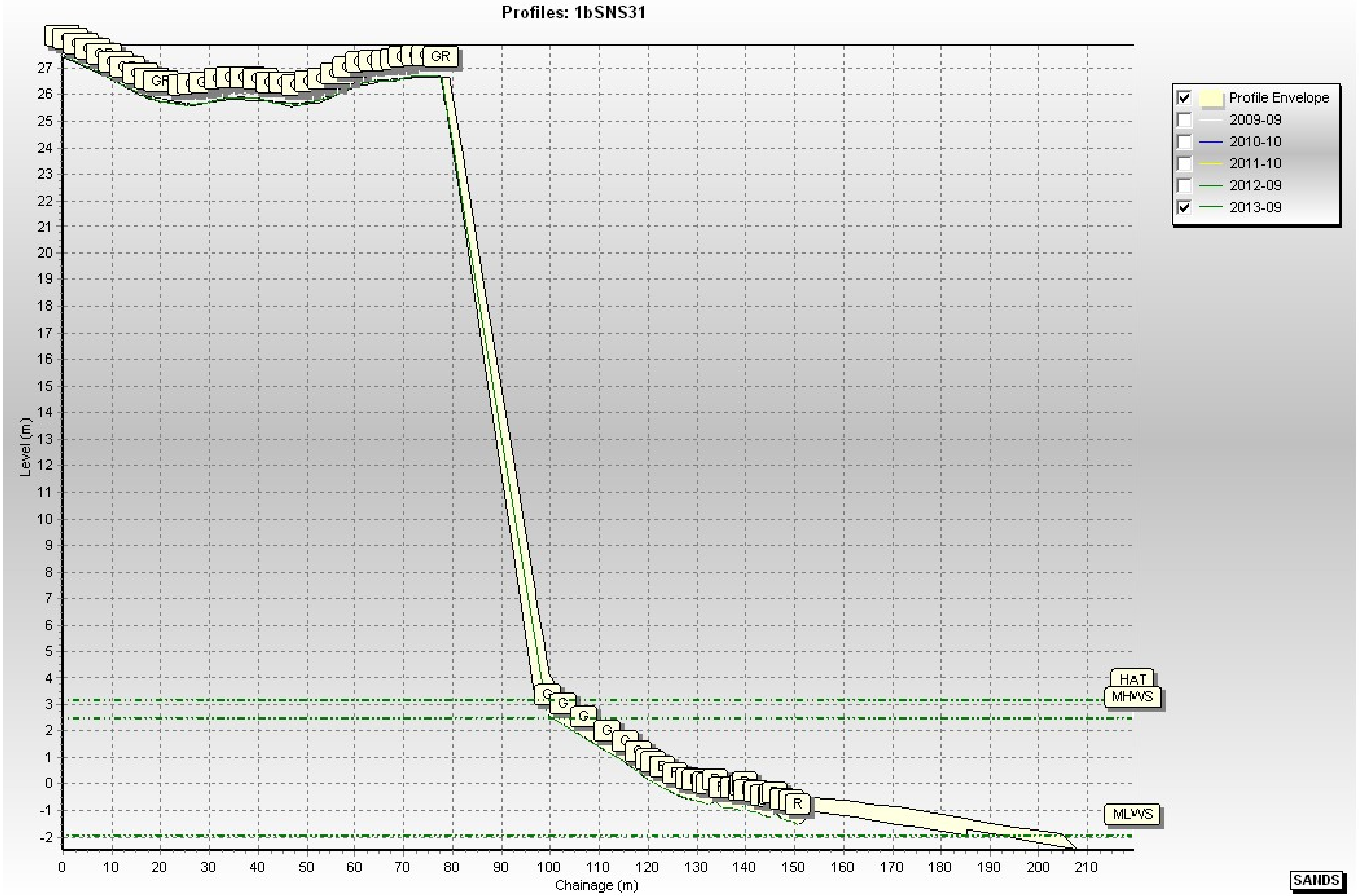

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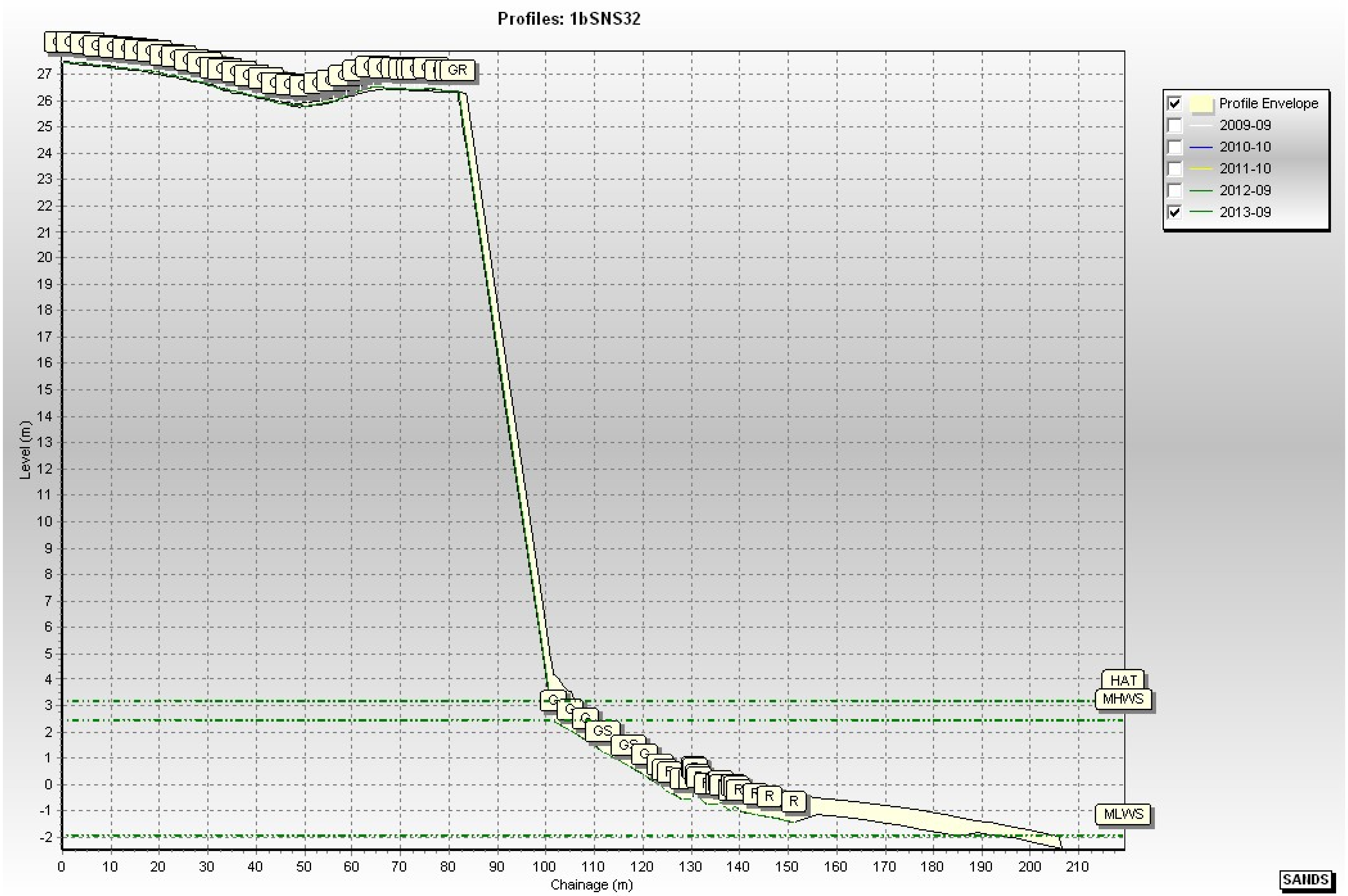
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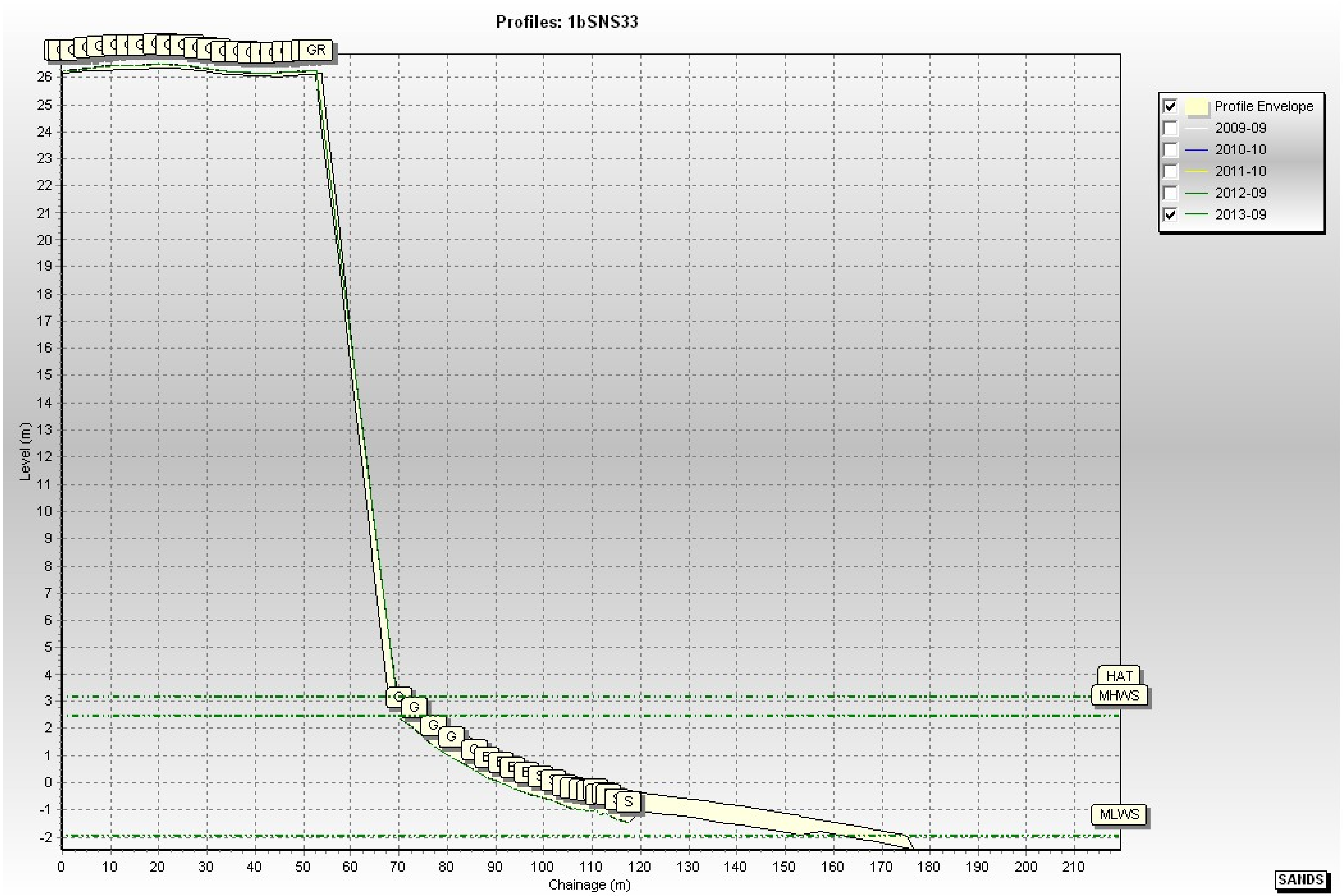

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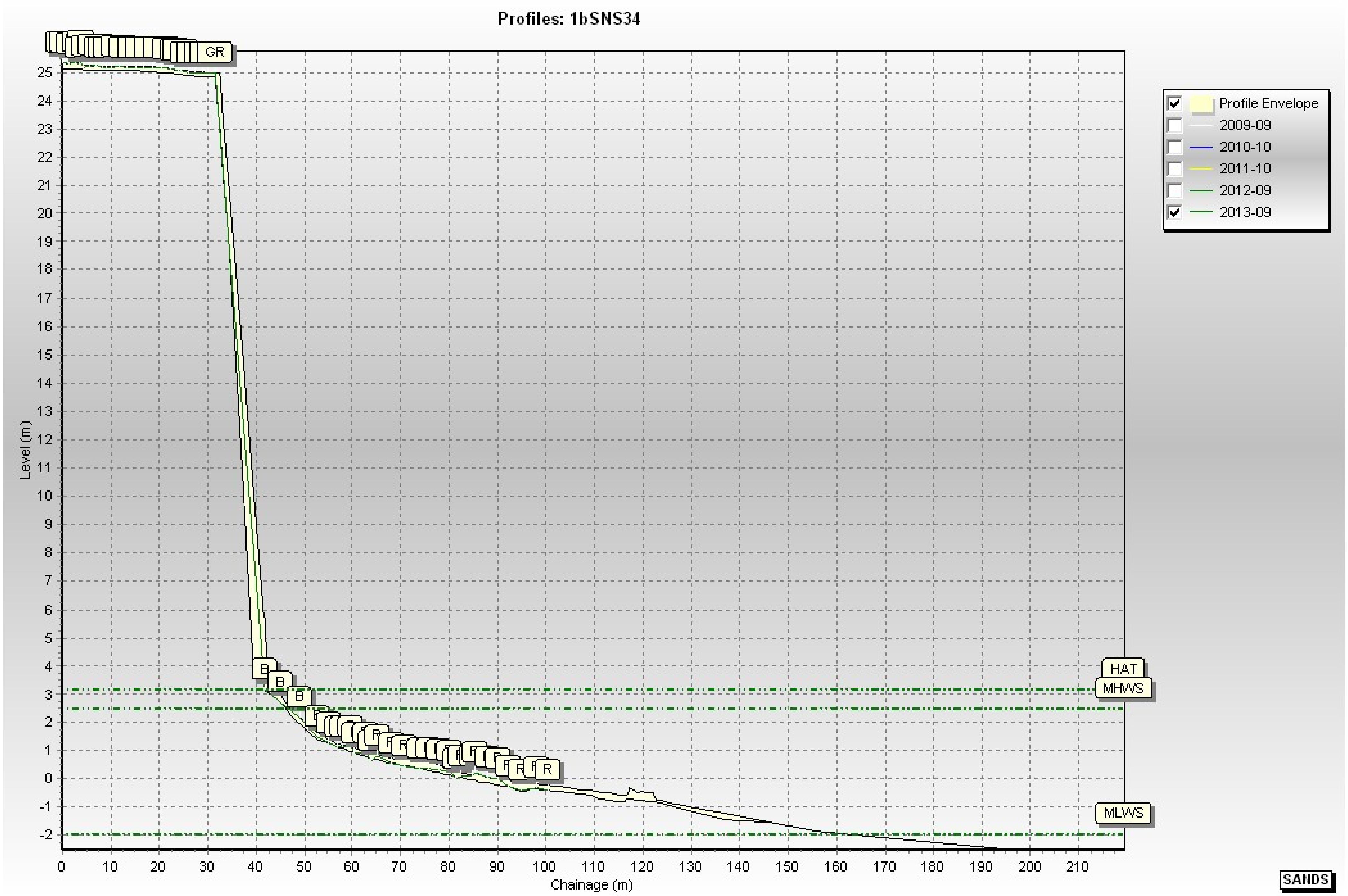

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MLWS
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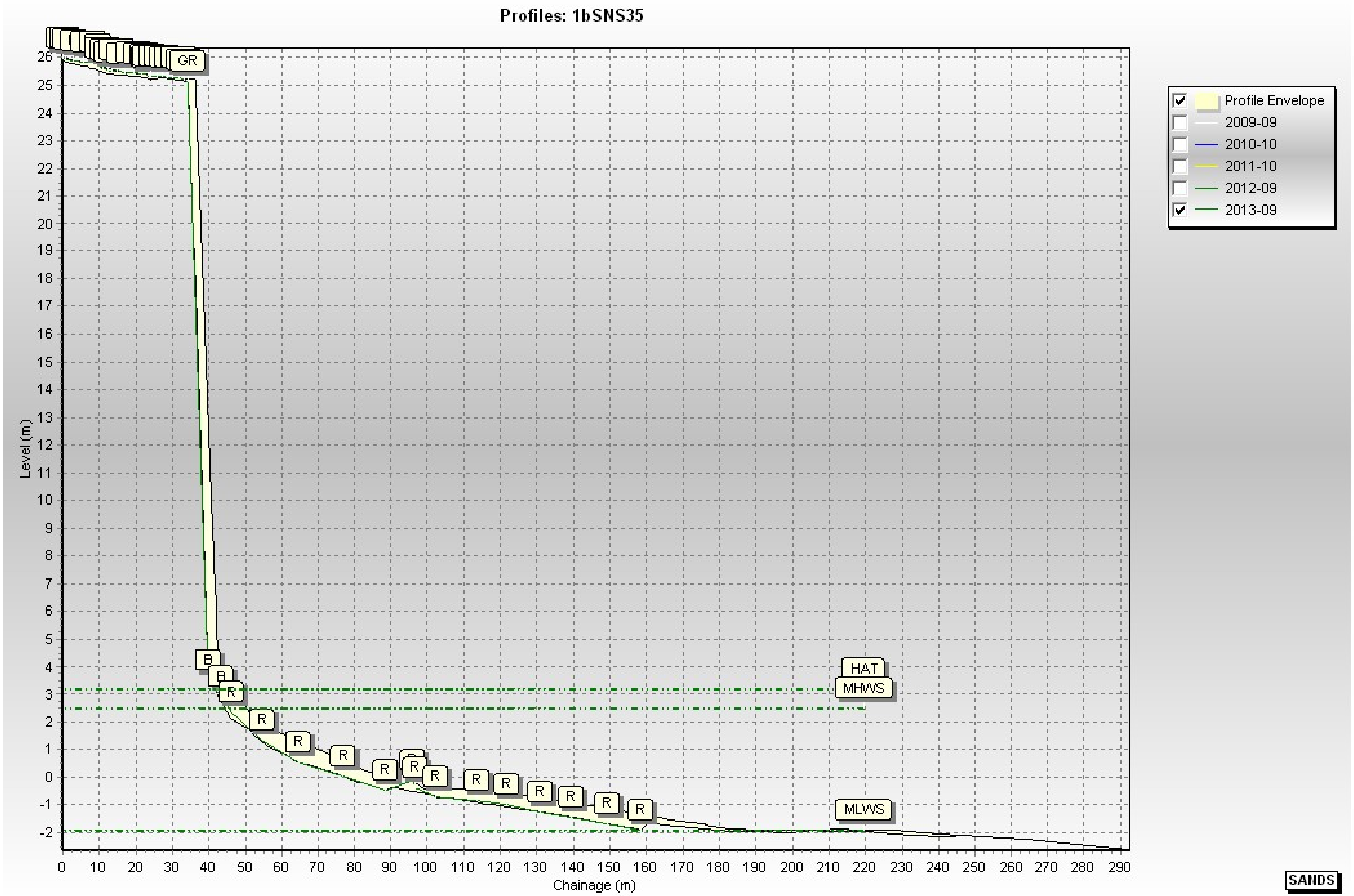
SANDS



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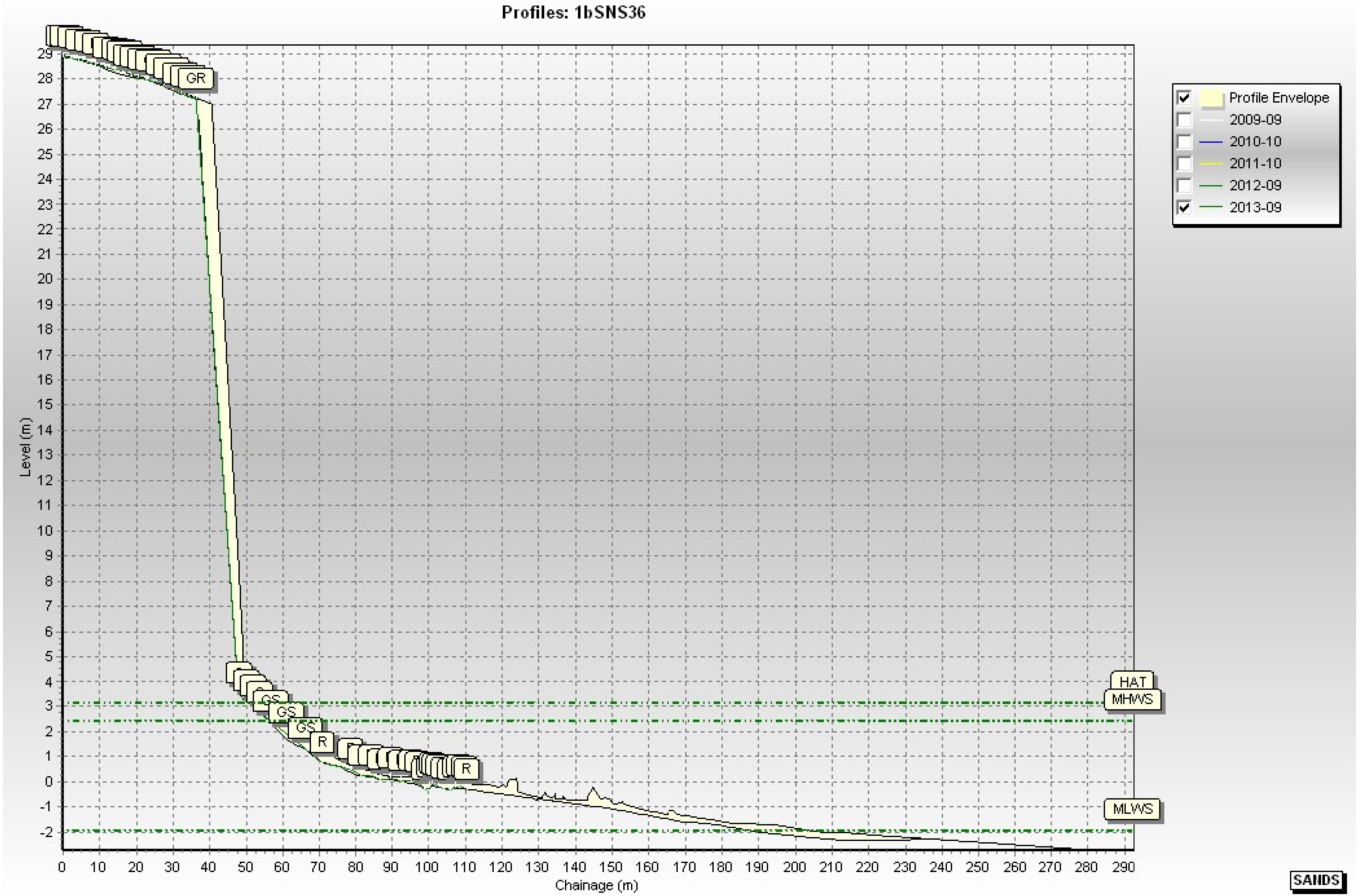
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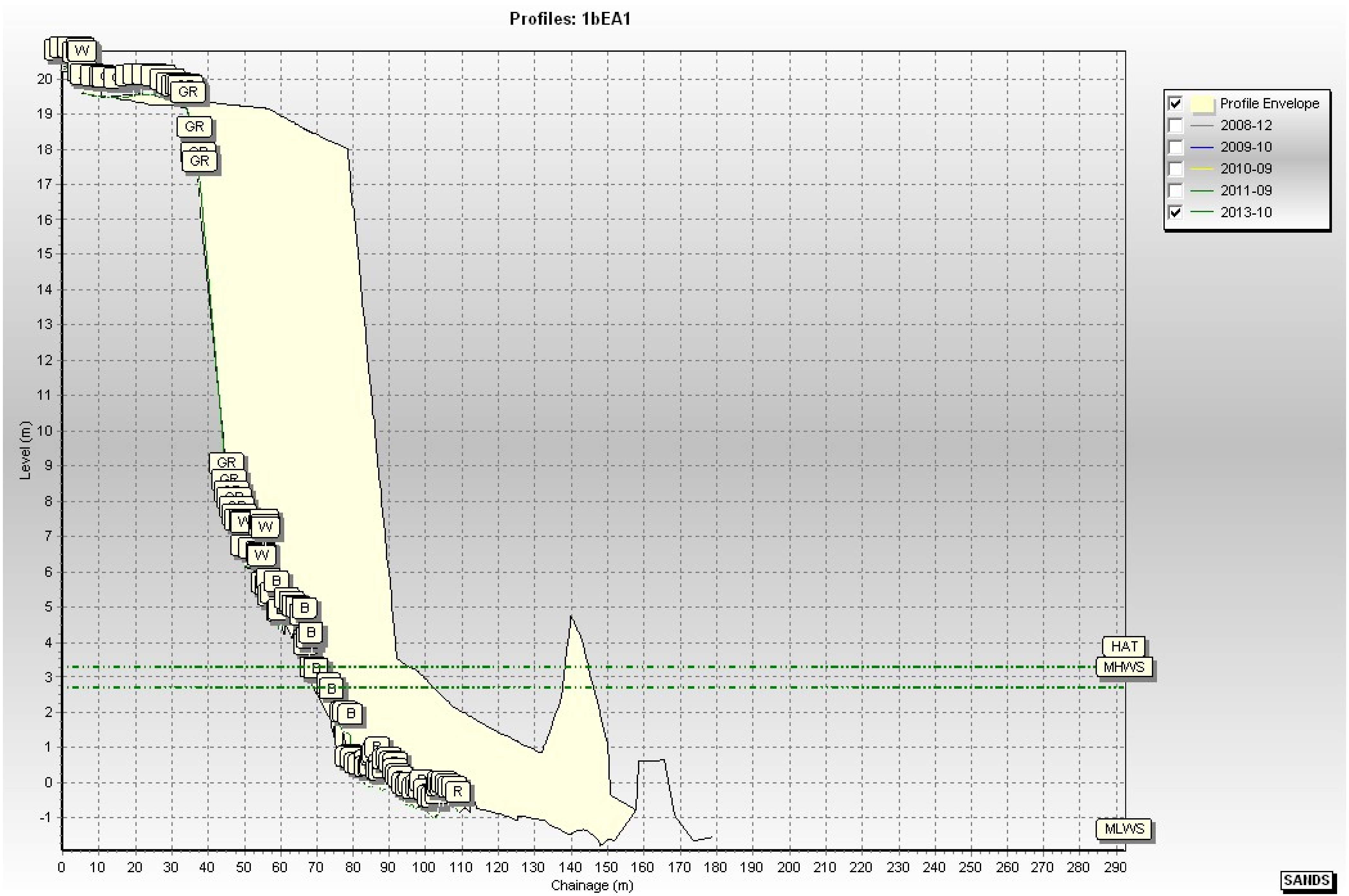

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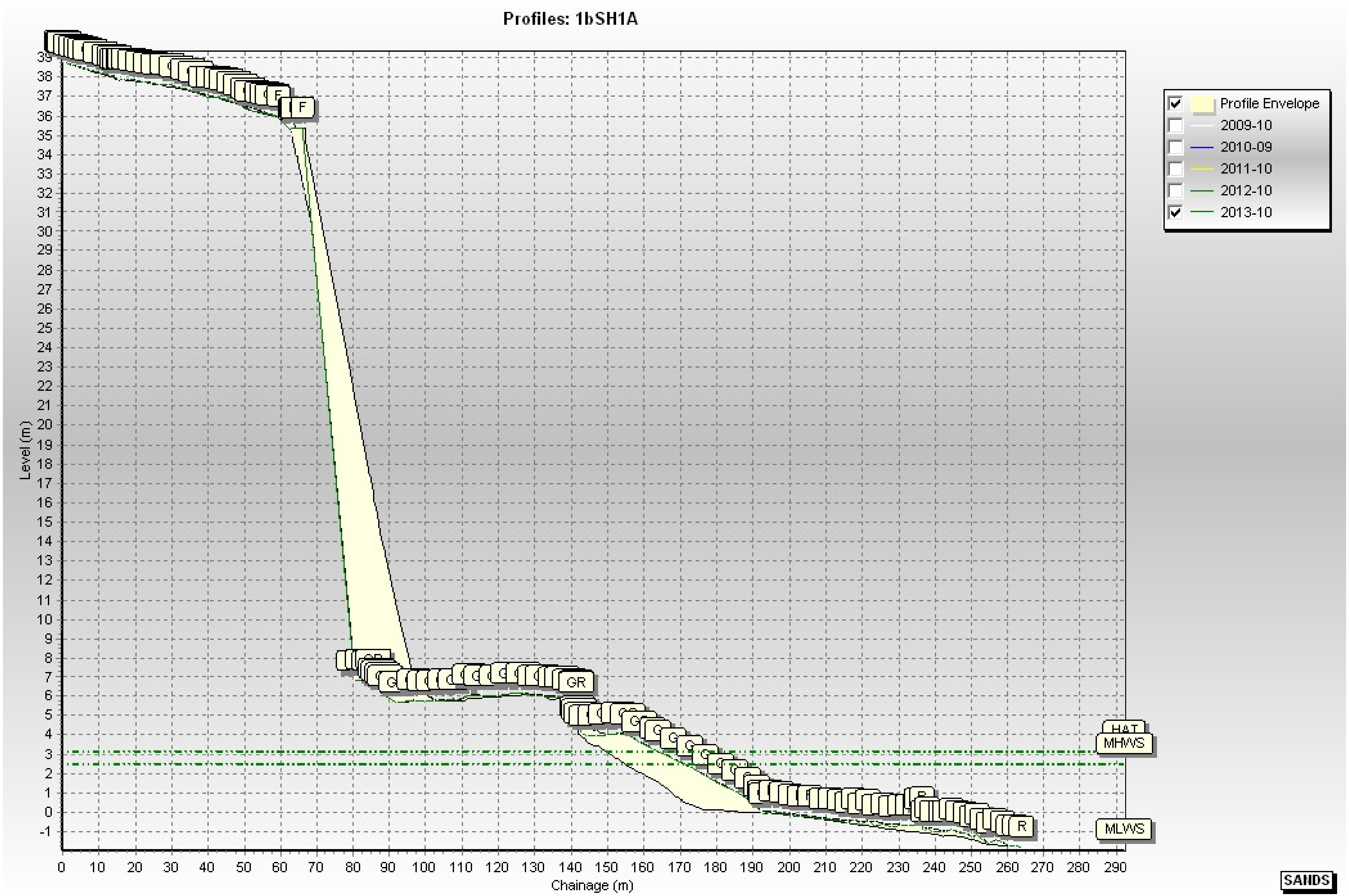
SANDS



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Level (m)
Chainage (m)
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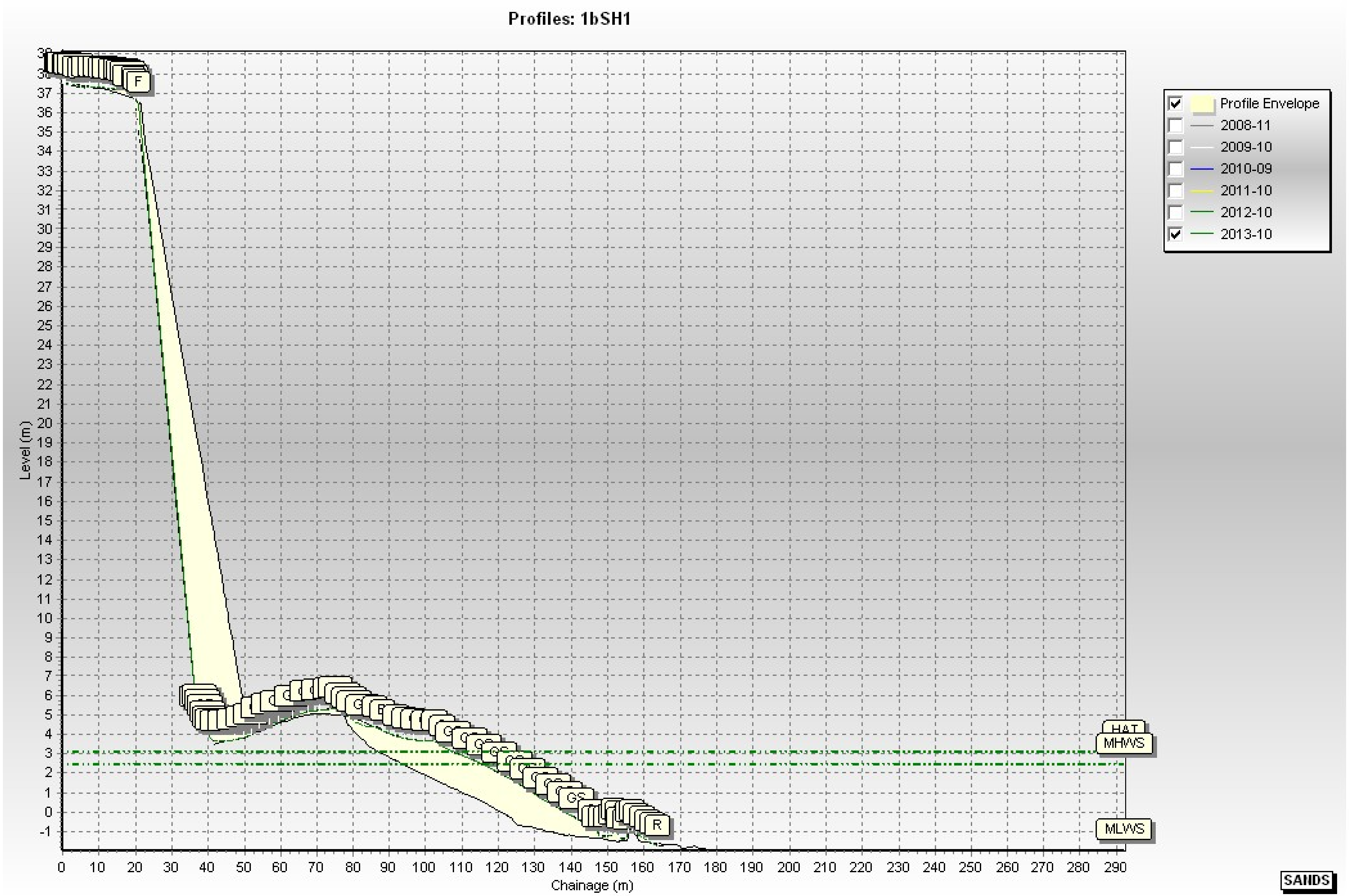
SANDS



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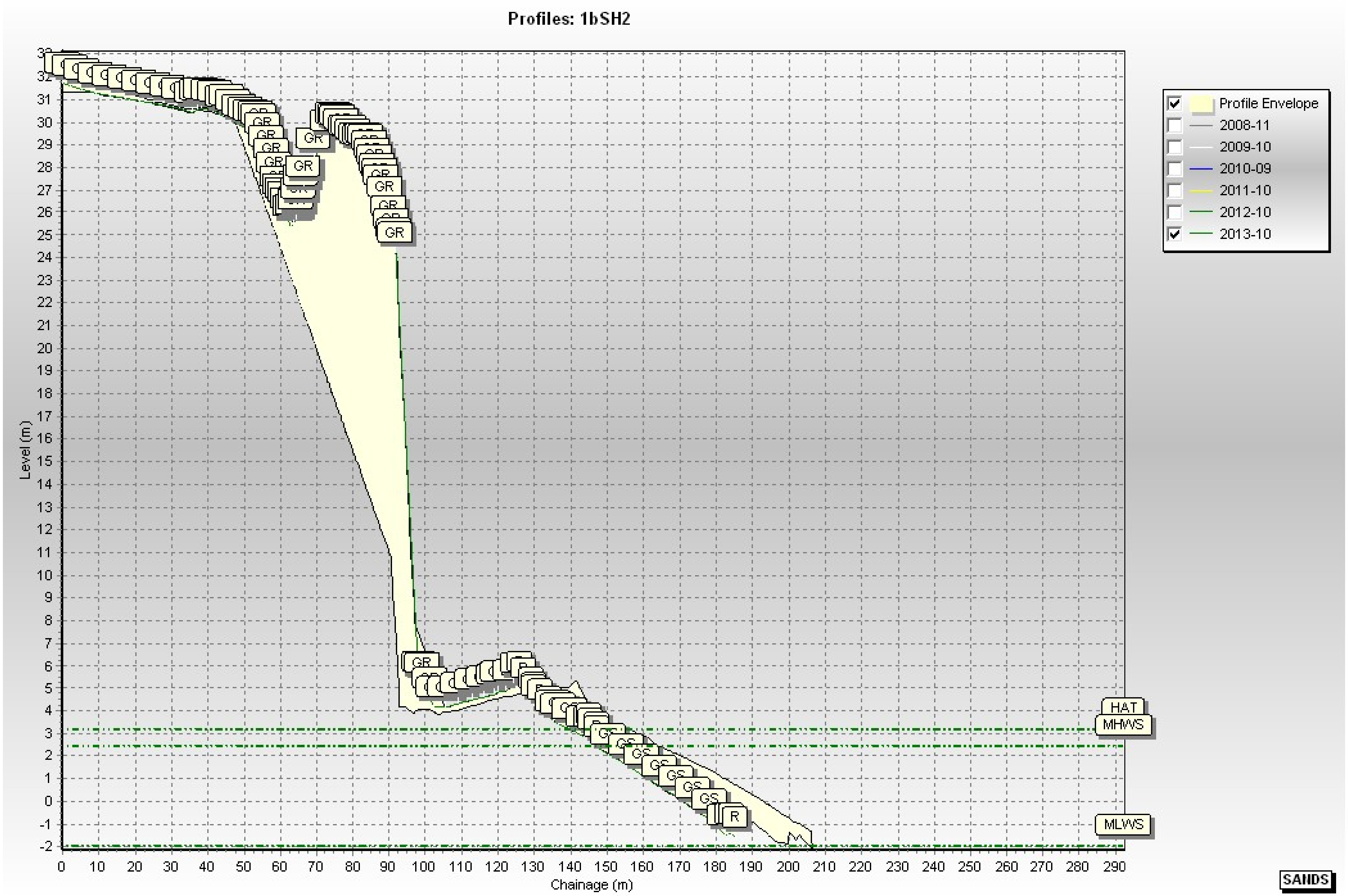
SANDS



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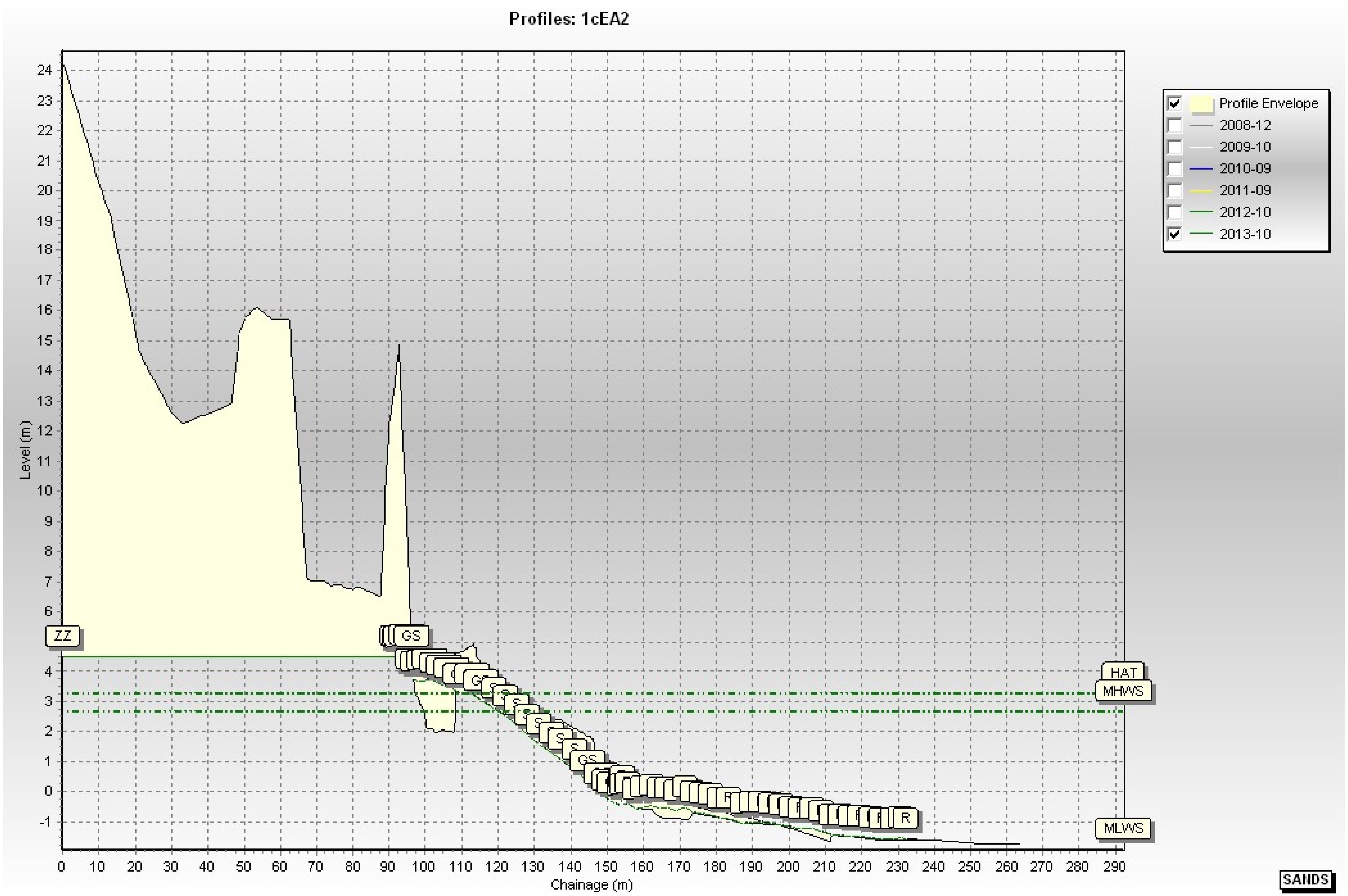

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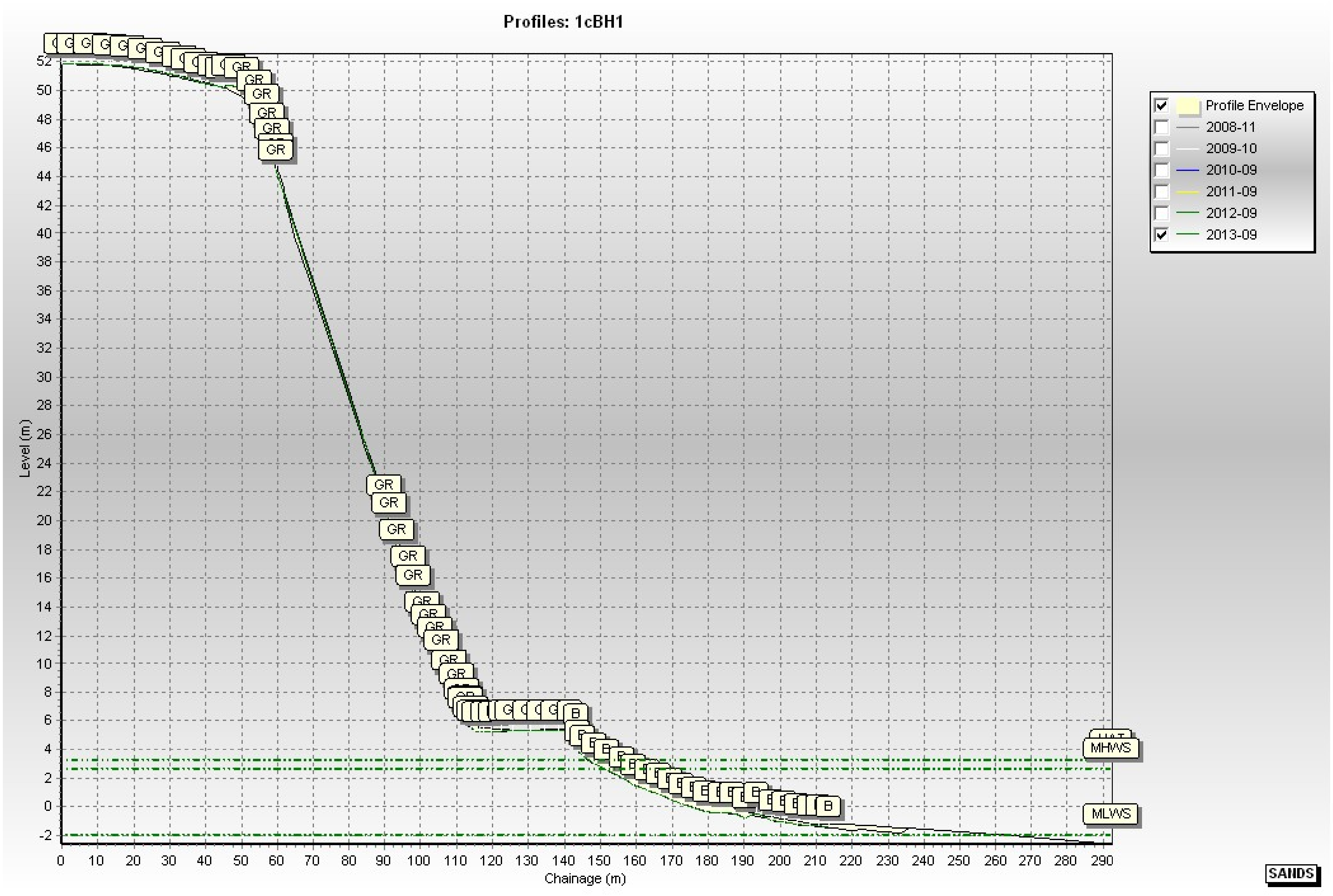

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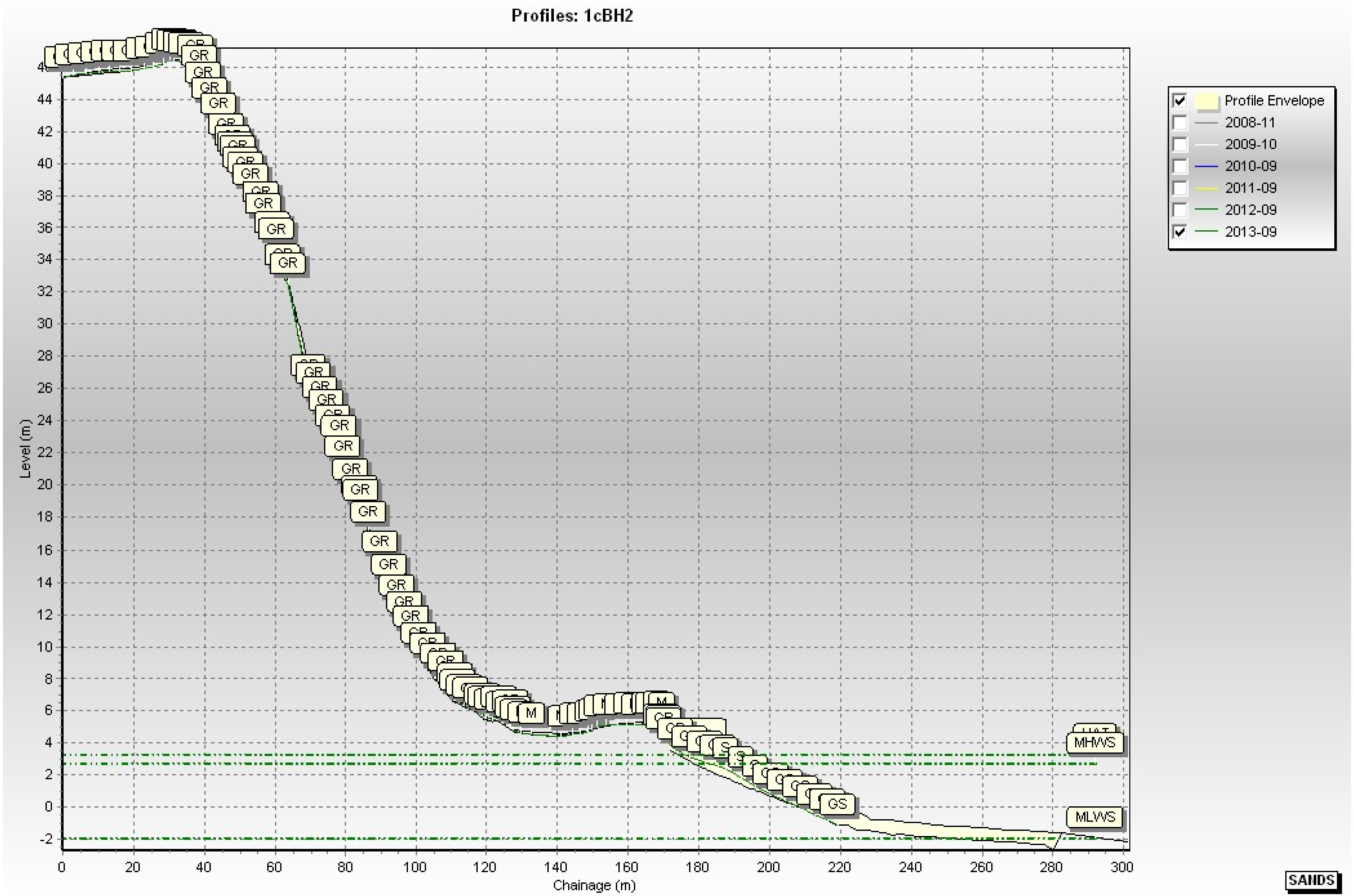

Profiles: 1cBH2
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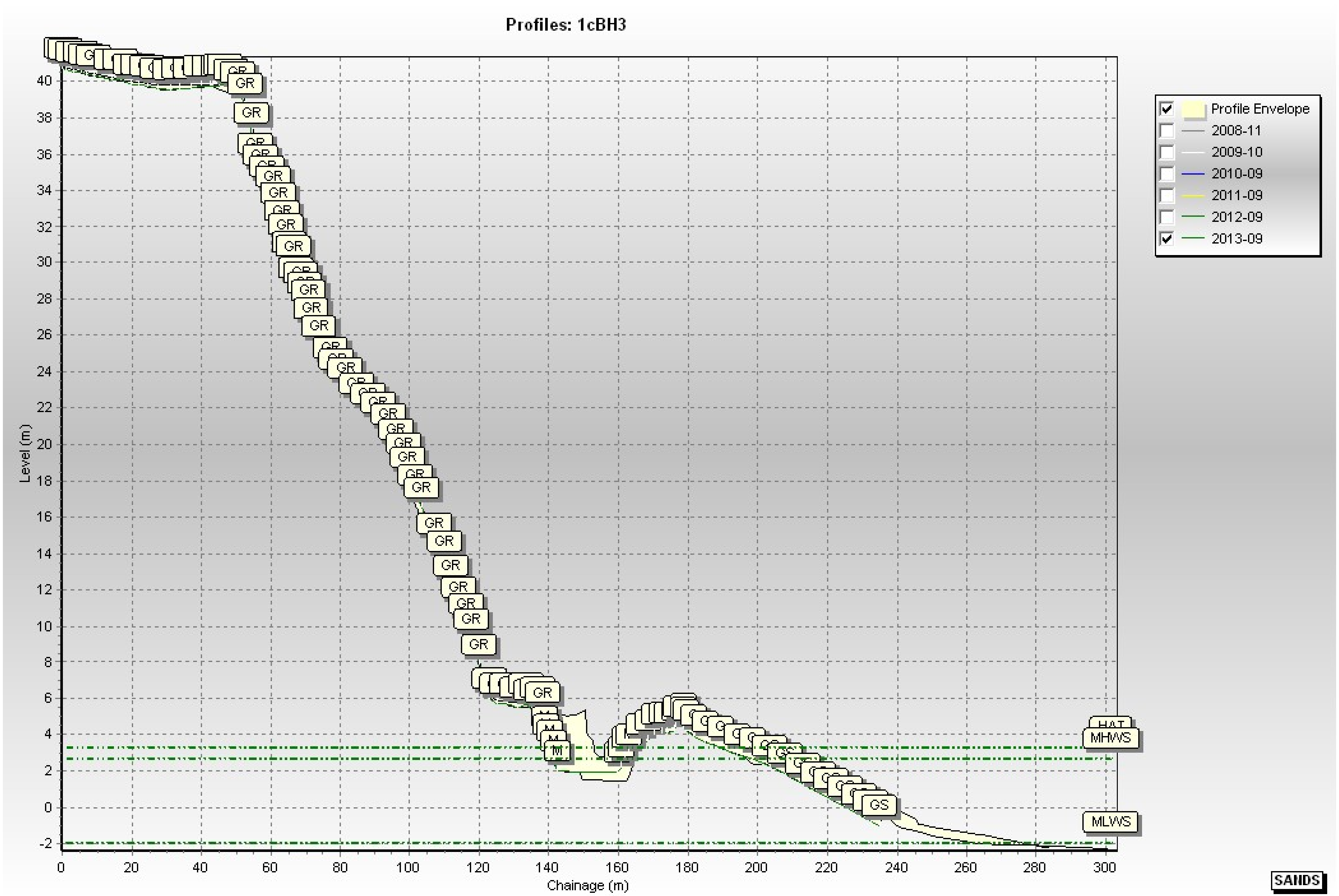

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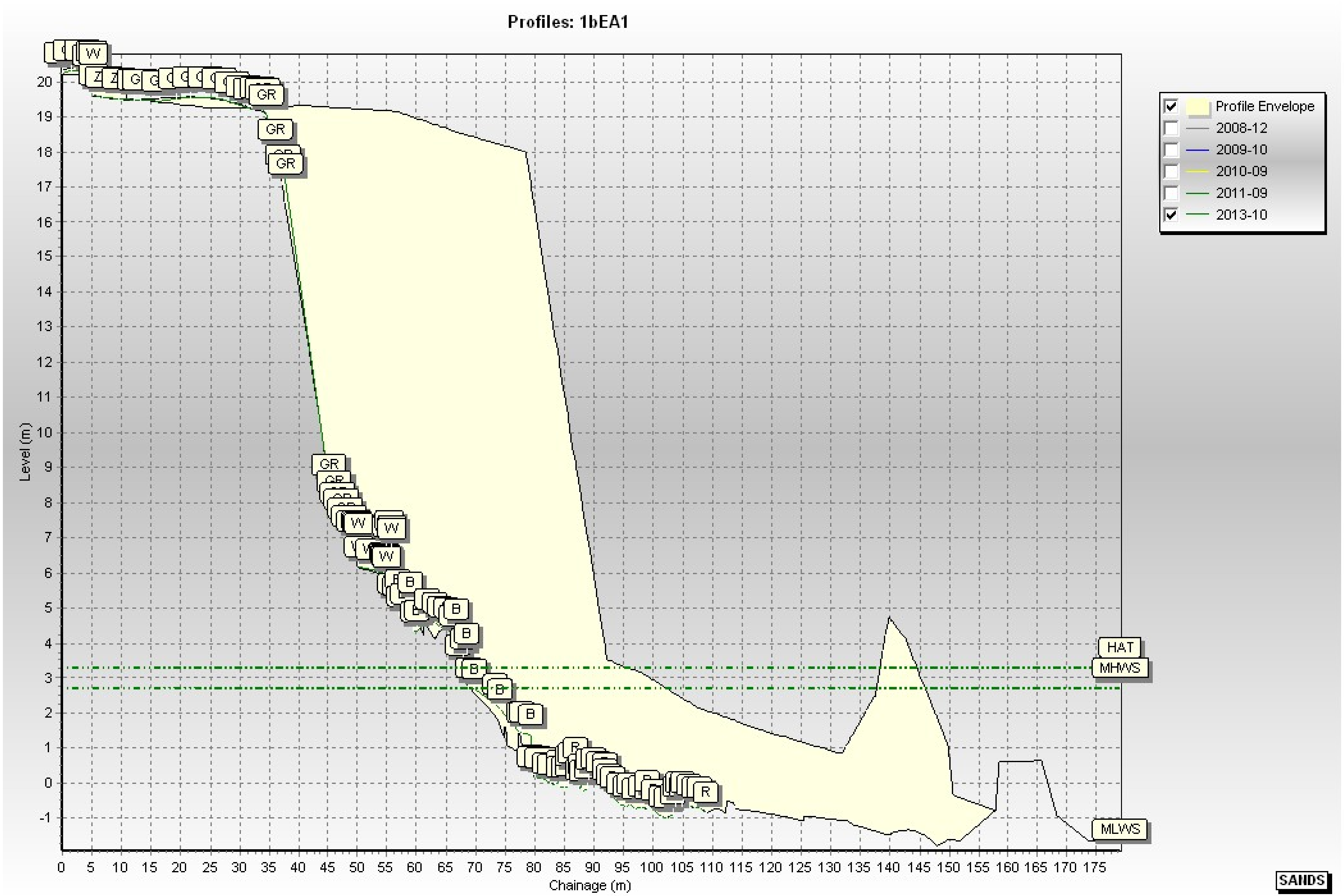
SANDS



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Chainage (m)
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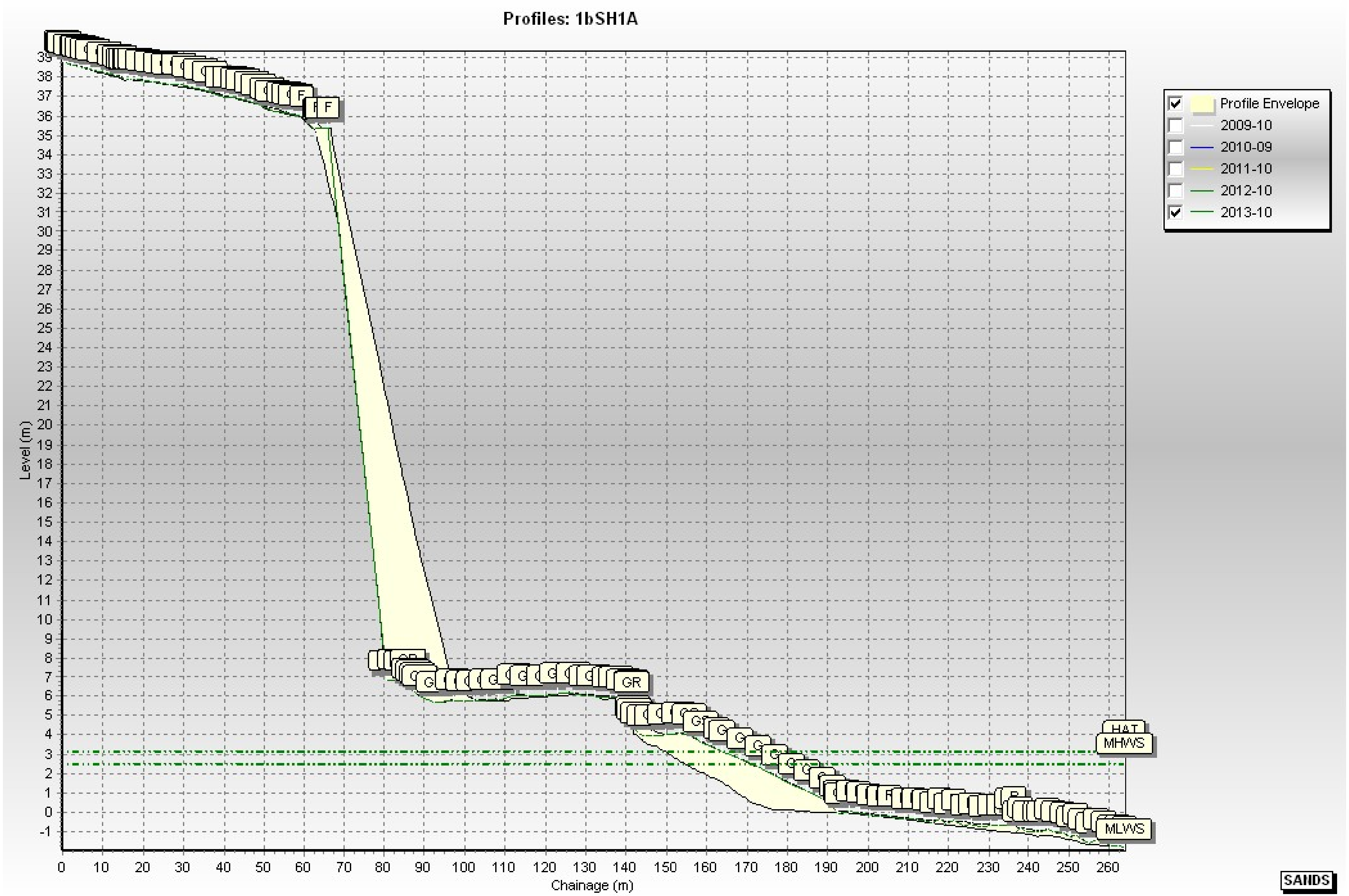
SANDS



Profiles: 1bSH1A
Level (m)
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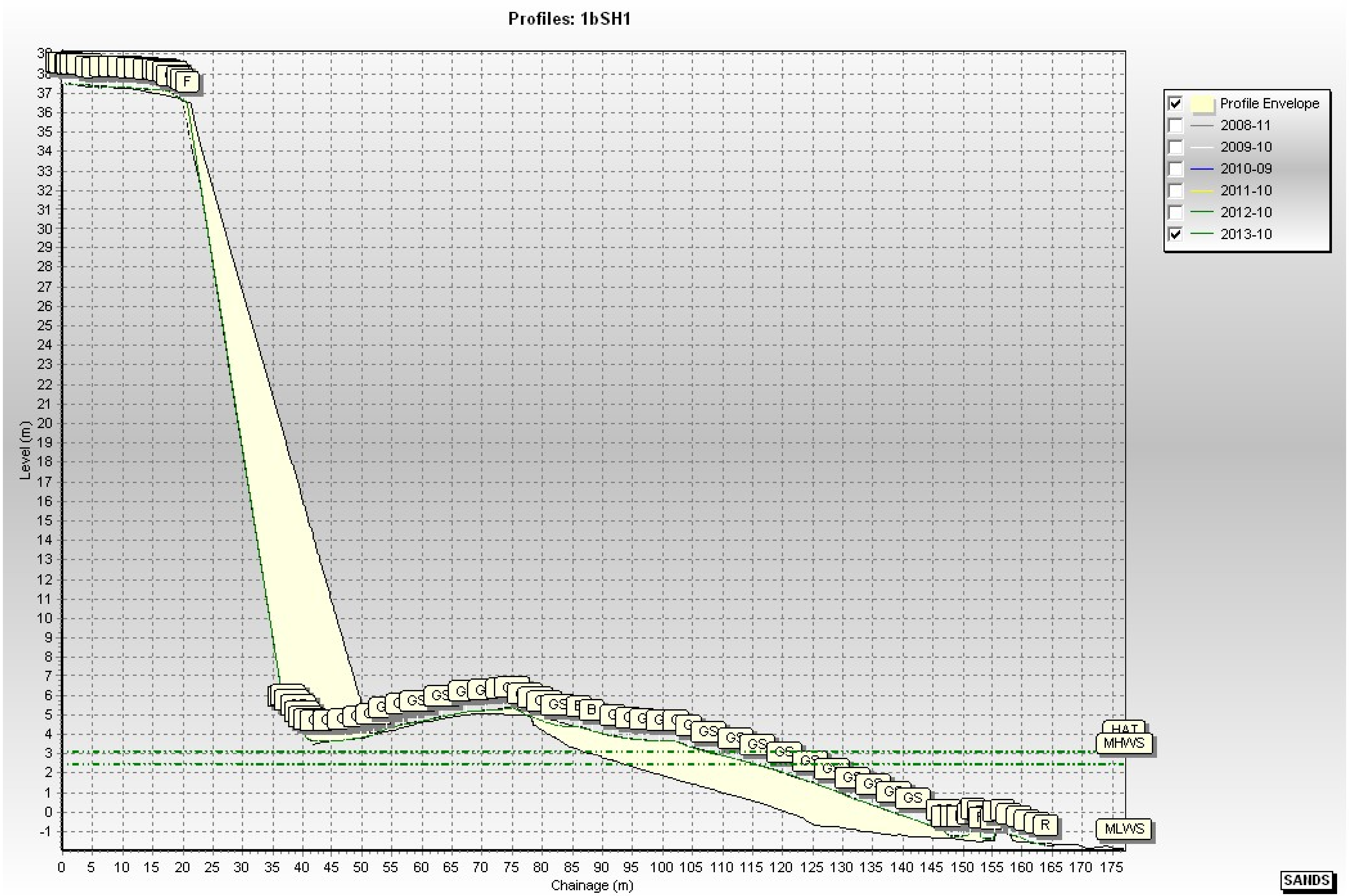
F
SANDS



Profiles: 1bSH1
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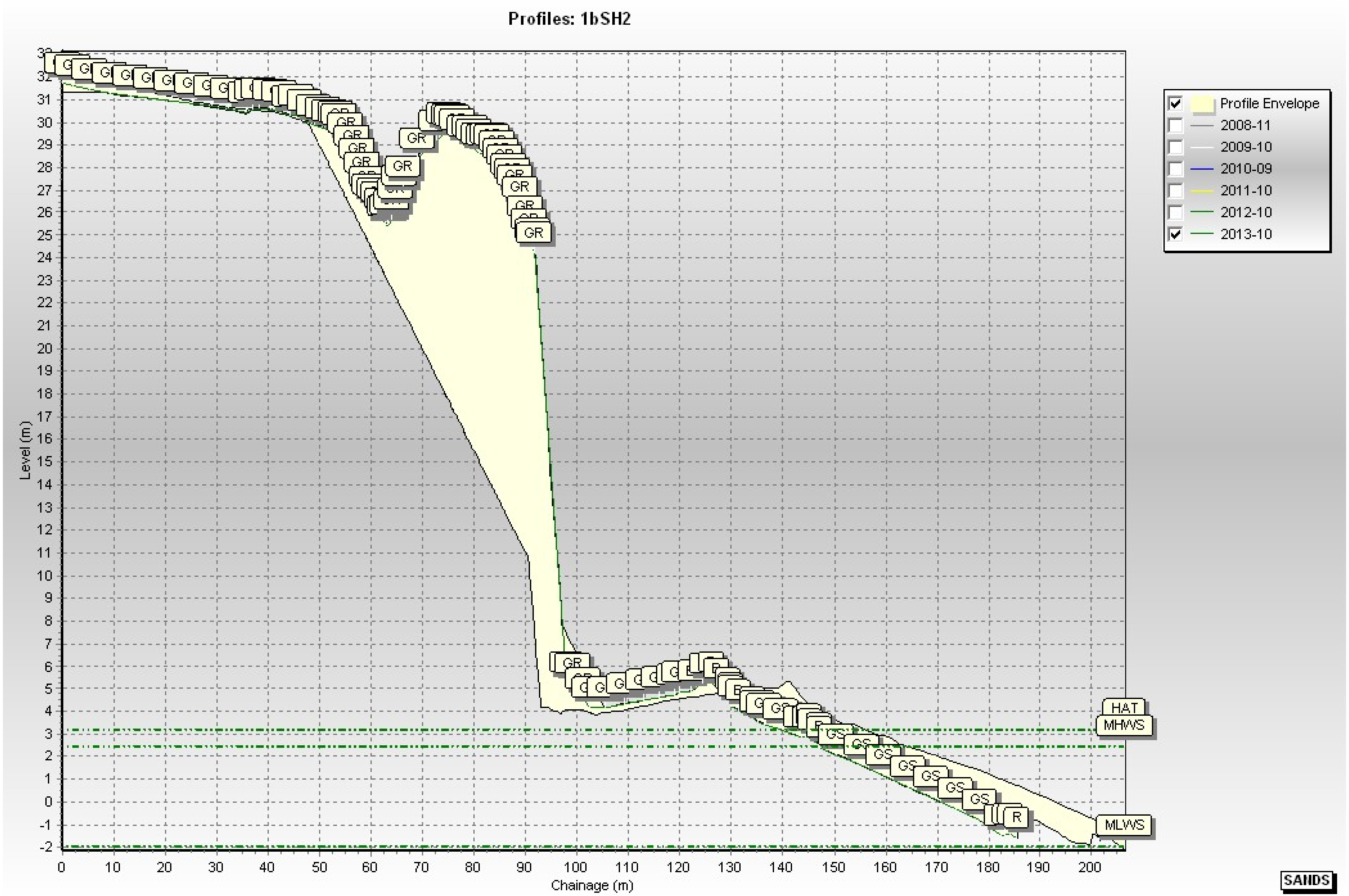
MLWS
SANDS



Profiles: 1bSH2
Level (m)
Chainage (m)
Profile Envelope
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MHWS
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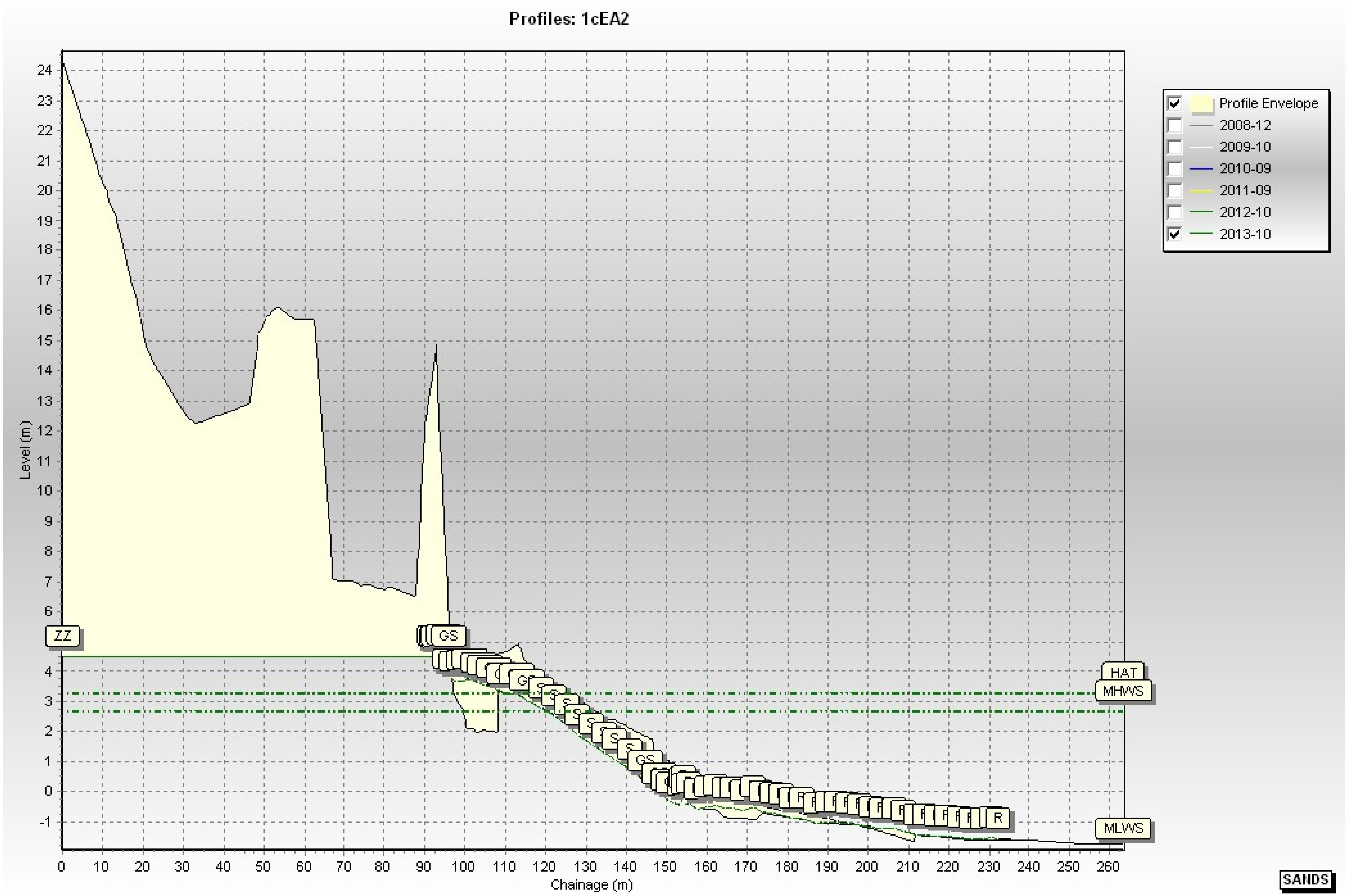
SANDS



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MLWS
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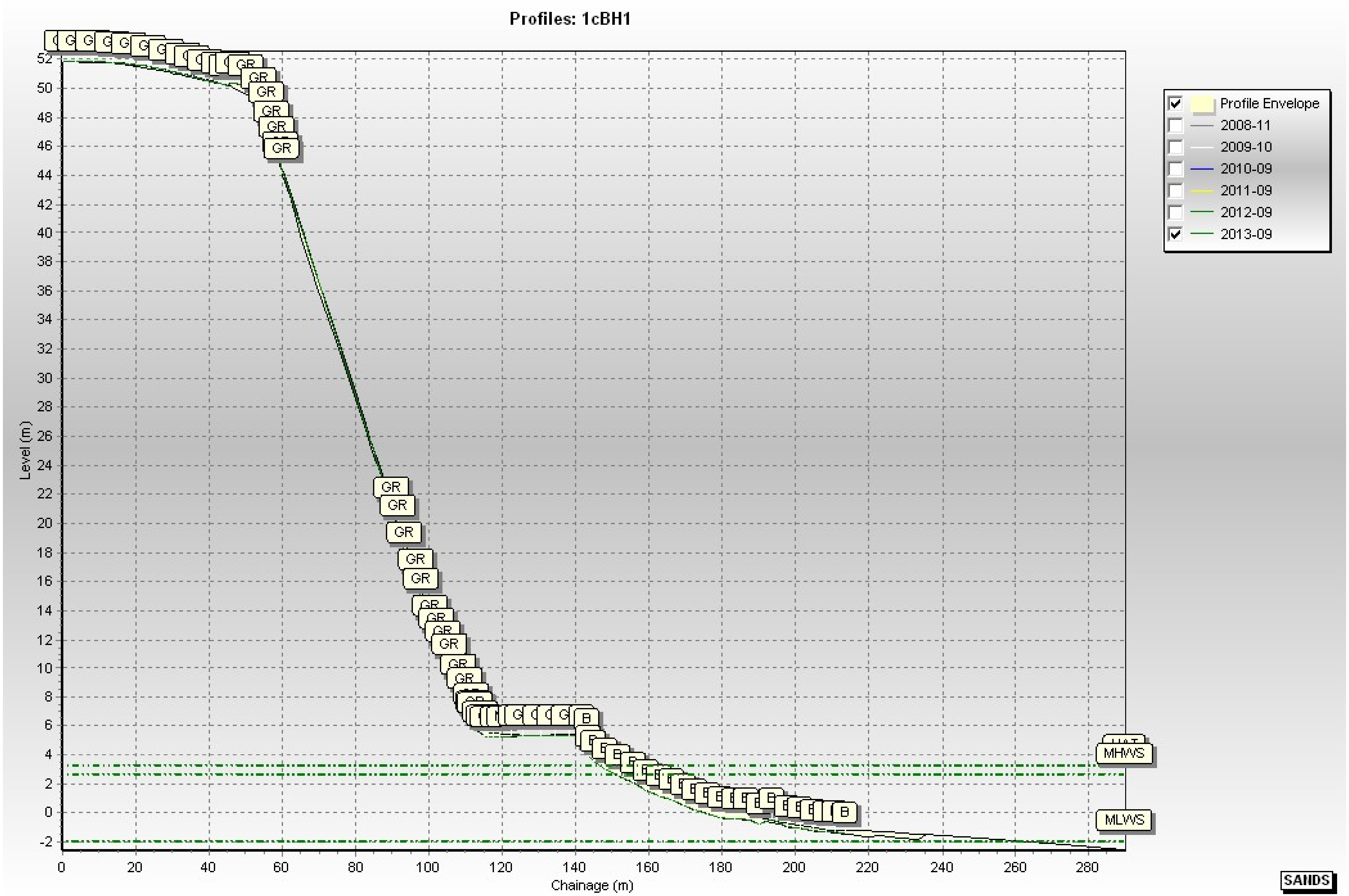

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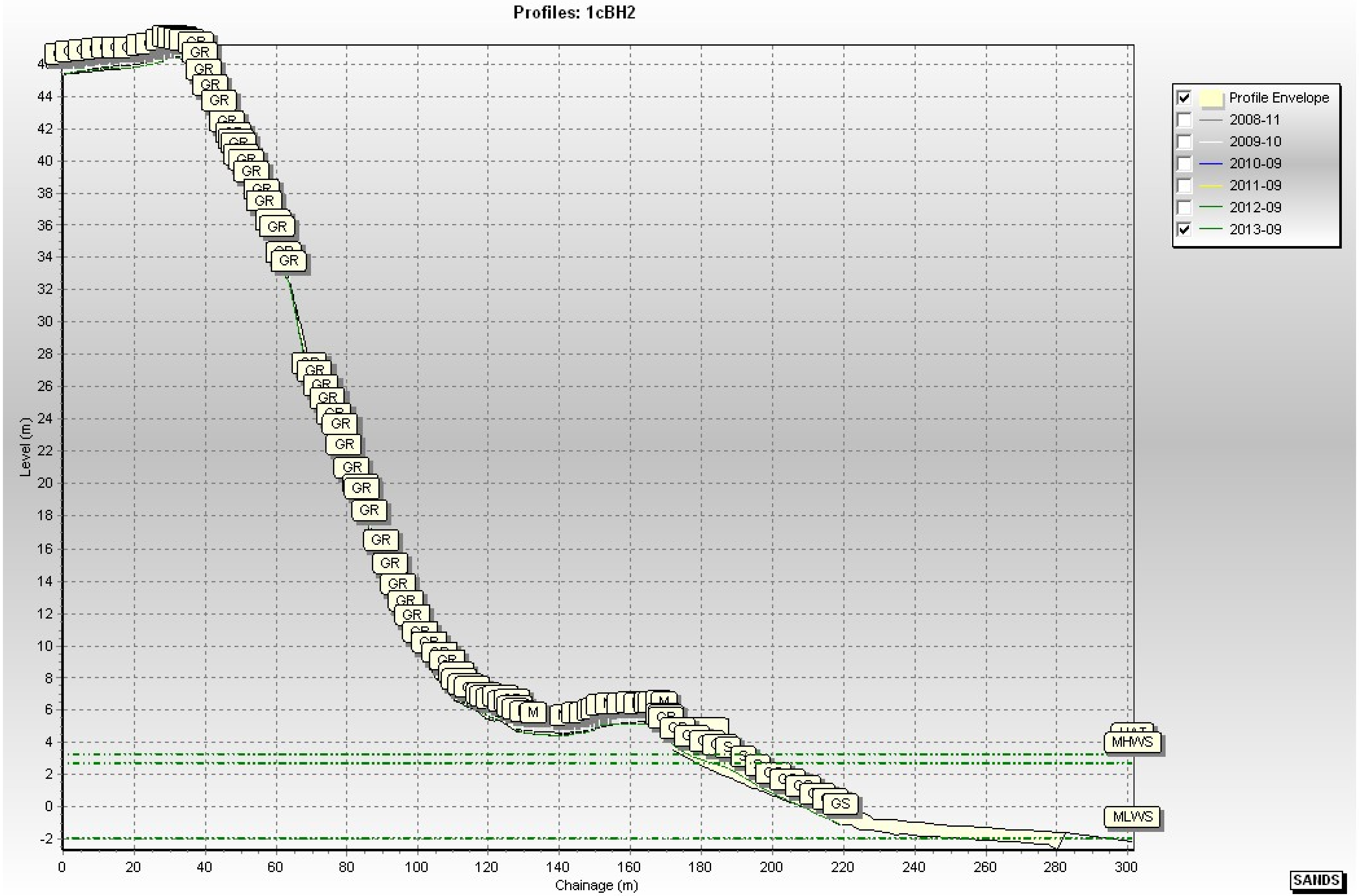

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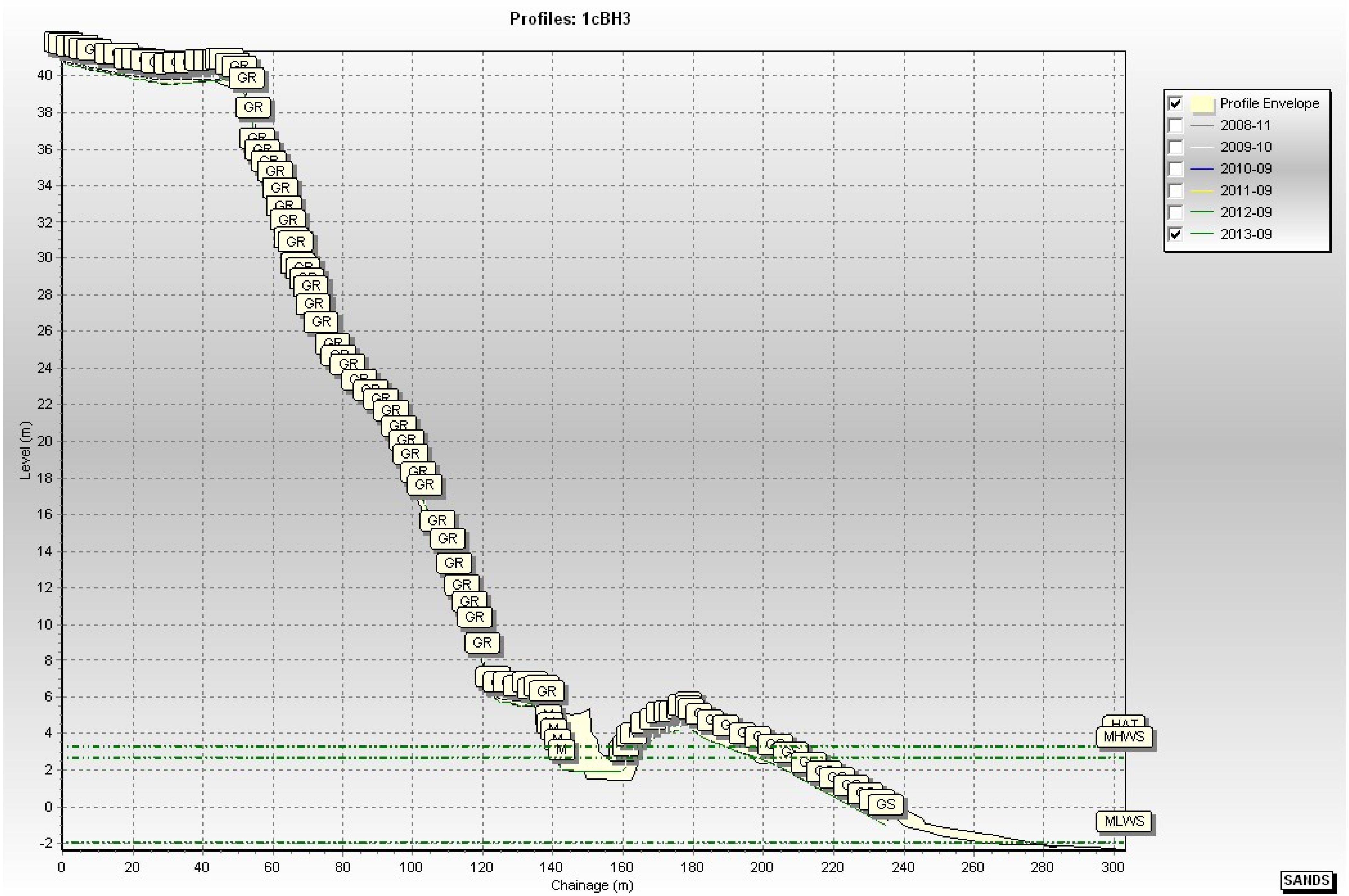

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2010-09
2011-09
2012-09
2013-09
HAT
MHWS
MLWS
GR
GS
SANDS

Appendix B

Cliff Top Survey

Cliff Top Survey

Seaham

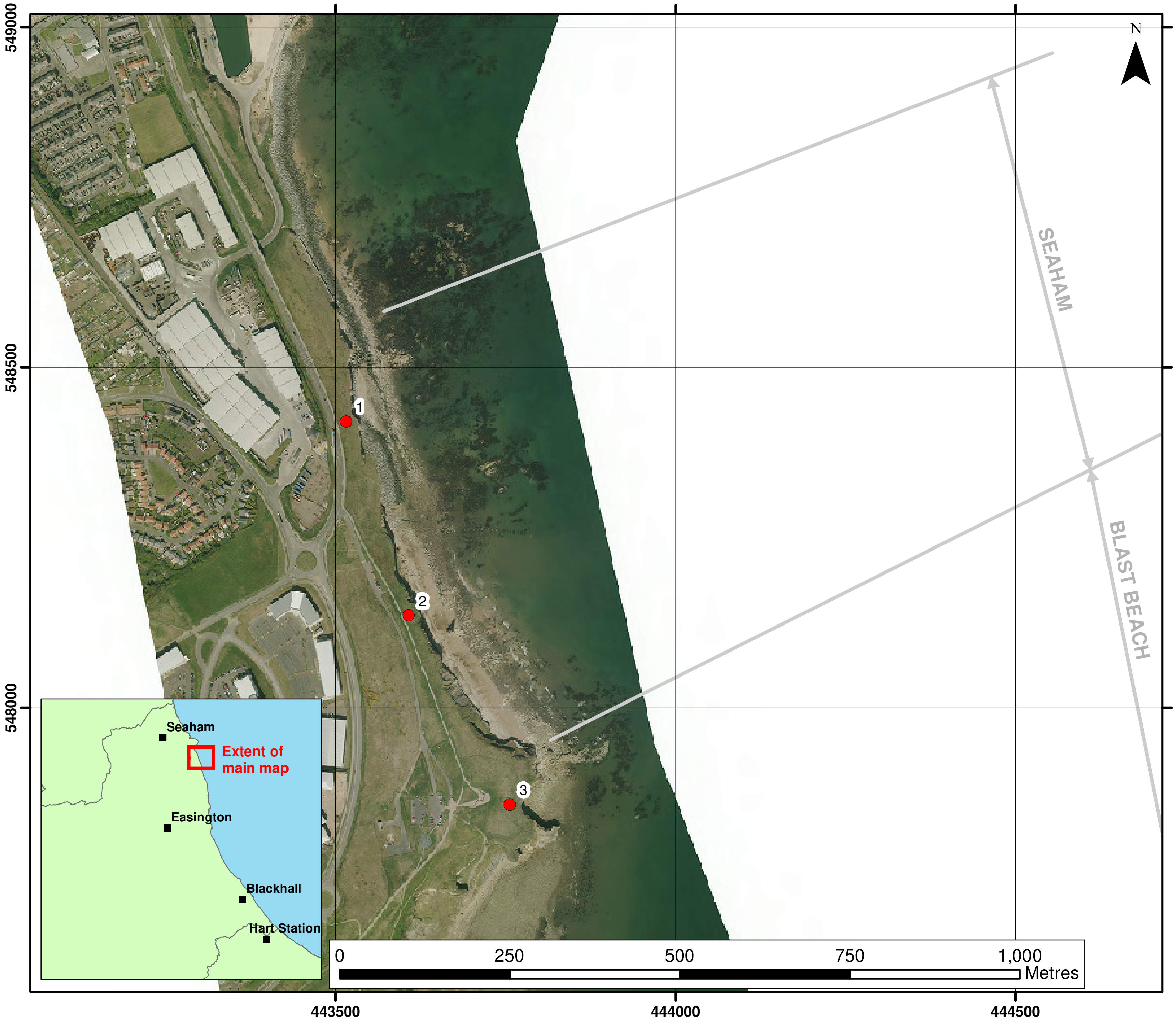
Three ground control points have been established on the Seaham frontage (Figure B1). The maximum separation between any two points is nominally 300m.

The cliff top surveys at Seaham are undertaken biannually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top.

Table B1 provides baseline information about these ground control points and results from the 2008 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table B1 – Cliff Top Surveys at Seaham

Ground Control Point Details				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (º)	Baseline Survey (Nov 2008)	Previous Survey (April 2013)	Present Survey (Oct 2013)	Baseline (Nov 2008) to Present (Oct 2013)	Previous (April 2013) to Present (Oct 2013)	Baseline (Nov 2008) to Present (Oct 2013)
1	443515.4	548421.7	70	16.1	15.2	15.2	-0.9	0.01	-0.19
2	443607.8	548136.3	90	13.3	13.4	13.3	0.0	-0.06	0.00
3	443756.1	547858.5	95	14.8	13.7	13.6	-1.2	-0.13	-0.24



KEY

Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B - Map 1
Ground Control Points
Seaham
Durham County Council

Analytical Report 6
Full Measures Survey
Autumn 2013

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Photography courtesy of North East Coastal Observatory
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