

**Cell 1 Regional Coastal Monitoring Programme  
Update Report 5: 'Partial Measures' Survey 2013**



**Sunderland City Council  
Final Report**

**June 2013**

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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)
	Souter Point to Chourdon Point
HAT	3.18
MHWS	2.48
MLWS	-1.92

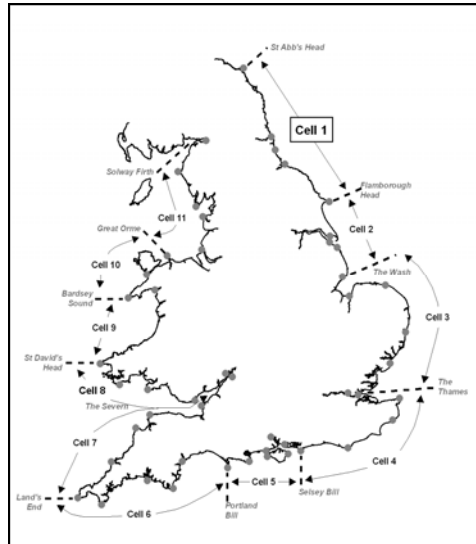
**Source:** *River Tyne to Flamborough Head Shoreline Management Plan 2.*  
Royal Haskoning, February 2007.

## 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).



**Figure 1 Sediment Cells in England and Wales**

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 every year. Some of these surveys are then repeated the following spring as part of a 'Partial Measures' survey.

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	Sept-Dec 08	May 09	Mar-May 09		
2	2009/10	Sept-Dec 09	Mar 10	Feb-Mar 10	Jul 10	
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 11	Sept 11
4	2011/12	Oct-Nov 11	Oct 12	Mar-May 12	Oct 12	
5	2012/13	Sept-Oct 12	Mar 13	Mar 13	June 13 (*)	

(\*) The present report is **Update Report 5** and provides an analysis of the 2013 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:

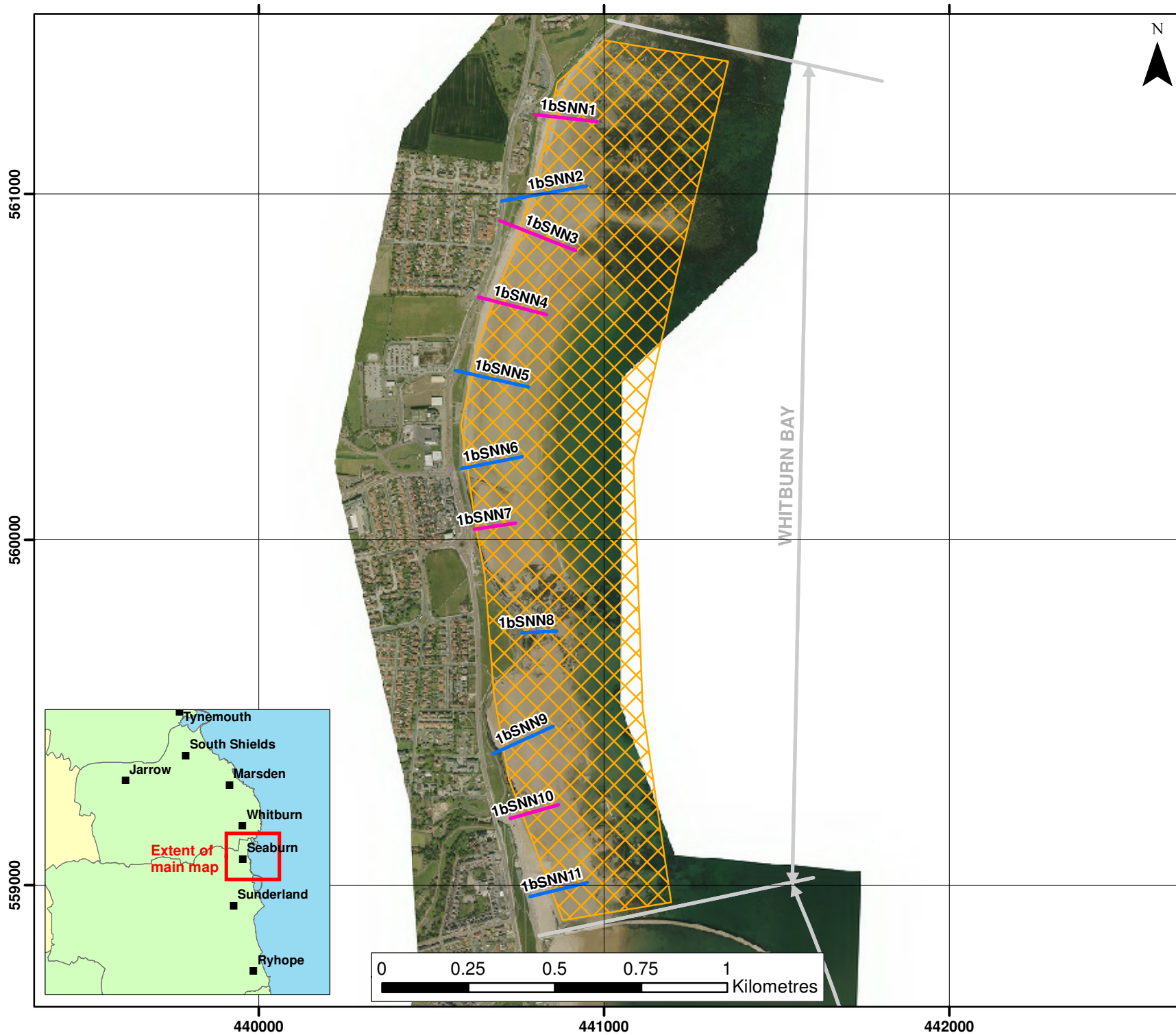
- Full Measures survey annually each autumn comprising:
  - Beach profile surveys along 58 transect lines (commenced 2009)
  - Topographic survey at Whitburn Bay (commenced 2009)
  - Topographic survey at Hendon to Ryhope (including Halliwell Banks) (commenced 2009)
- Partial Measures survey annually 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 the 13<sup>th</sup> March 2013 (Whitburn Bay) and between 14<sup>th</sup> March 2013 and 15<sup>th</sup> March 2013 (Hendon to Ryhope (incl. Halliwell Banks)). During this time weather conditions varied considerably. Refer to the survey reports for details of the weather conditions over this survey period.

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.



**KEY**

**Topographic Profiles**  
 — Annual (blue line)  
 — 6 monthly (pink line)

**Topographic Surveys**  
 ▨ 6 monthly (green cross-hatch)  
 ▨ yearly (orange cross-hatch)  
 ▨ 5 yearly (brown cross-hatch)

**Cliff Top Monitoring Pegs**  
 ■ 50m centres (purple square)  
 ■ 100m centres (green square)  
 ■ 300m centres (red square)

*(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  
 Whitburn Bay  
 Sunderland City Council**

Update Report 5  
 Partial Measures Survey  
 Spring 2013

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**KEY**

**Topographic Profiles**  
 — Annual  
 — 6 monthly

**Topographic Surveys**  
 [Yellow Hatched] 6 monthly  
 [Orange Hatched] yearly  
 [Brown Hatched] 5 yearly

**Cliff Top Monitoring Pegs**  
 [Purple] 50m centres  
 [Green] 100m centres  
 [Red] 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  
 Sunderland Harbour  
 and Docks  
 Sunderland City Council**

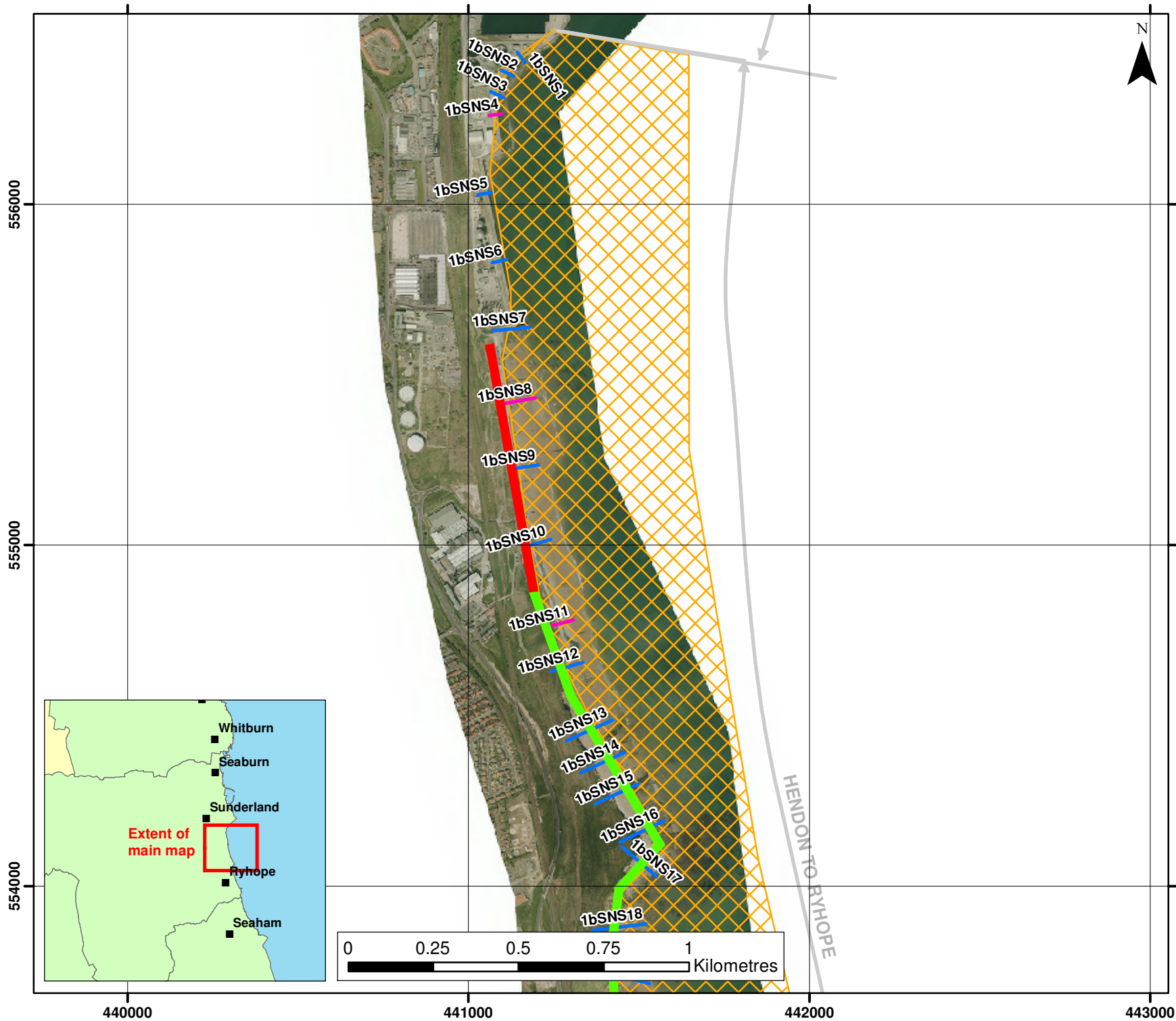
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 Partial Measures Survey  
 Spring 2013



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**KEY**

**Topographic Profiles**  
 — Annual  
 — 6 monthly

**Topographic Surveys**  
 [Green cross-hatch] 6 monthly  
 [Orange cross-hatch] yearly  
 [Brown cross-hatch] 5 yearly

**Cliff Top Monitoring Pegs**  
 [Purple bar] 50m centres  
 [Green bar] 100m centres  
 [Red bar] 300m centres  
*(Indicative survey extents shown)*

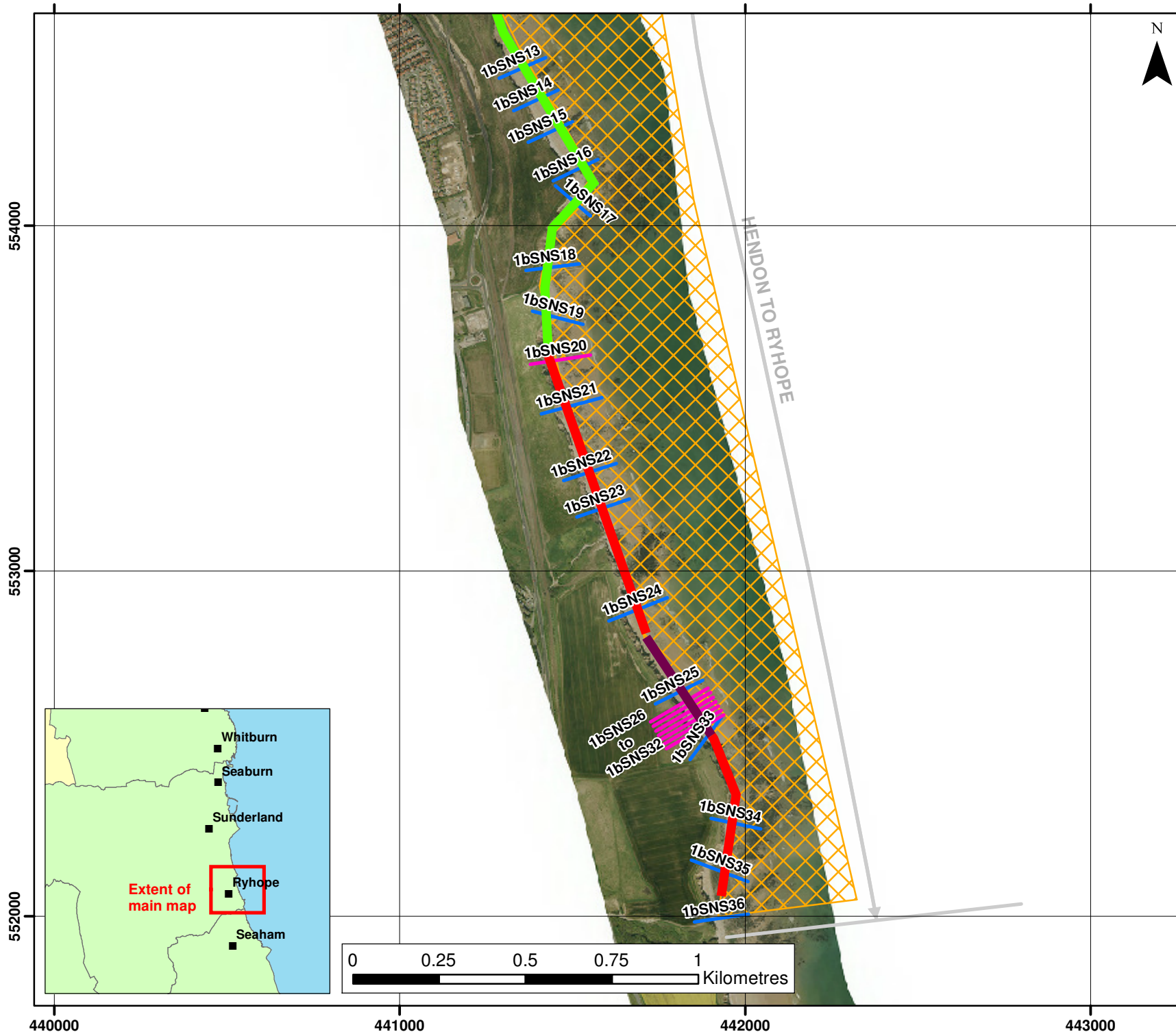
Client: North East Coastal Group  
 Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

**Figure 2- Map 3  
 Survey Locations  
 Hendon to Ryhope North  
 Sunderland City Council**

Analytical Report 5  
 Full Measures Survey  
 Autumn 2012

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**KEY**

**Topographic Profiles**  
 — Annual (blue line)  
 — 6 monthly (magenta line)

**Topographic Surveys**  
 ▨ 6 monthly (green hatched)  
 ▨ yearly (orange hatched)  
 ▨ 5 yearly (brown hatched)

**Cliff Top Monitoring Pegs**  
 ■ 50m centres (purple)  
 ■ 100m centres (green)  
 ■ 300m centres (red)

*(Indicative survey extents shown)*

Client: North East Coastal Group  
 Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

**Figure 2 - Map 4**  
**Survey Locations**  
**Hendon to Ryhope South**  
**Sunderland City Council**

Update Report 5  
 Partial Measures Survey  
 Spring 2013

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## 2. Analysis of Survey Data

### 2.1 Whitburn Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
Mar 2013	<p><b>Beach Profiles:</b></p> <p>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 2011.</p> <p><b>1bSNN1</b> is just to the south of Sunderland City Council's northerly boundary of jurisdiction. Since the last survey, beach levels on the upper beach (between HAT and a level of 1.4m) have reduced by 0.4m. As shown by the survey photographs in Plate 1 and Plate 2, the composition of the upper beach has changed from cobbles overlain by sand to just cobbles. This suggests some form of sediment sorting has occurred with preferential draw down of sand-sized sediment, which is a typical response to storm waves. Seaward of a level of 1.4m (chainage 80m), beach levels have increased by up to 0.6m to form a berm. The survey photograph in Plate 3 shows the presence of small berms/hummocks, indicative of stormy conditions. Material eroded from the upper beach could have also been transported across shore and deposited here.</p> <p><b>1bSNN7</b> is at Seaburn, just to the north of Parson's Rock. Beach levels have dropped considerably since the last survey, with up to 1.4m loss at the seawall/beach interface. The amount of change in beach level decreases in a seaward direction, such that the profile of the beach is flatter than the previous survey.</p> <p><b>1bSNN10</b> is located approximately mid-way between Parson's Rock and Roker Pier. Since the last survey, beach levels have dropped considerably across the profile, by up to 1m. The beach profile has changed from one with a continuous slope to one that is more steeply sloping to a chainage of 100m, seaward of which a large, low berm has formed.</p>	<p>Along the length of Whitburn Bay since the last survey, beach levels have fallen across the width of the beach. To the north of the bay, lowering of beach levels of the upper beach is offset by an increase of beach levels on the lower shore. However, to the centre and south of the bay, beach levels have fallen across the profile. Sediment sorting, with preferential erosion of sand, has occurred, leading to the upper beach having a surface of cobbles. These changes suggest the occurrence of significant storms over the winter months, which has resulted in draw-down of the overlying sand (and a lowering of beach levels), and its storage on the lower beach or further offshore.</p> <p><b>Longer term trends:</b> At all locations in Whitburn Bay, beach levels are the lowest observed to date (April 2009, when monitoring began). This suggests that the storms that occurred over the winter 2012/2013 were particularly strong.</p>



Plate 1 – Survey photograph 1bSNN1\_20130313\_N3.JPG



Plate 2 – Survey photograph 1bSNN1\_20121004\_N4.jpg



Plate 3 – Survey photograph 1bSNN1\_20130313\_N7.JPG

## 2.2 Hendon to Ryhope (incl. Halliwell Banks)

Survey Date	Description of Changes Since Last Survey	Interpretation
Mar 2013	<p><b>Beach Profiles:</b></p> <p>Hendon to Ryhope is covered by thirteen beach profile lines for the Partial Measures survey (Appendix A). The last survey was Full Measures, undertaken in autumn 2011.</p> <p>Profile <b>1bSNS4</b> includes a seawall and rock revetment, after which it extends into water (refer to the survey photograph shown in Plate 2). Therefore it has not been analysed.</p> <p>Profile <b>1bSNS8</b> extends across the seawall, rock revetment, a rocky upper beach and sandy middle and lower beach. Beach levels at the toe of the seawall to a chainage of approximately 35m have increased by approximately 0.3m. Seaward of a chainage of 35m, beach levels have reduced by 0.5m across the profile and the profile is domed-shaped.</p> <p>Profile <b>1bSNS11</b> starts at the coastal slope/cliff backing the Hendon Sea Wall and extends across the wall and fronting rock armour before reaching sand levels and then extending down to low water. Beach levels have decreased across the profile, from the toe of the rock armour to the end of the profile at a chainage of 80m, by up to 0.5m.</p> <p>Profile <b>1bSNS20</b> is located at Shirley Banks. The beach profile surveys suggest that the cliff face has retreated by approximately 1-2m. Across the profile there are small variations in beach level, which is likely to reflect the movement of pebbles and rocks across the foreshore rather than actual level changes.</p> <p>Profile <b>1bSNS25</b> is located at Halliwell Banks. The cliffs have remained stable since the last survey. Beach levels have fallen across the profile by approximately 0.5m.</p> <p>Profiles <b>1bSNS26 to 1bSNS33</b> are all located at close spacings at Halliwell Banks specifically to assess risks from erosion at a former land fill. Cliff height is between 26m and 27mOD, with beaches at the cliff toe typically at levels between 3.3m and 3.9mOD.</p> <p>At Profiles <b>1bSNS26</b> and <b>1bSNS27</b>, the cliff faces have remained stable and accreted respectively.</p> <p>At profiles <b>1bSNS28 to 1bSNS32</b>, the cliff face has retreated by up to 2m. The topographic survey report notes that <i>'there are a number of landslips that are evident'</i>. These slope failures explain the cliff</p>	<p>Profile 1bSNS4 extends into water and has therefore not been analysed.</p> <p>At South Hendon (1bSNS8), beach levels at the toe of the seawall have increased, but reduced seaward of the there. This along, with the formation of a convex profile suggests a dynamic beach, where movement has been governed by storm waves and water levels. At profile 1bSNS11, a reduction beach levels further suggests erosion due to storms.</p> <p>At the landfill site (profiles 1bSSN25 to 1bSSN33) the cliff face has remained stable, however, to the centre and south of the site, they have retreated by 1m to 2m. Along the length of this section of coastline, beach levels have fallen to expose the underlying rocky foreshore on the lower beach. This is further evidence of beach lowering with subsequent cliff erosion due to storm conditions.</p> <p><b>Longer term trends:</b> With the exception of 1bSNS8 and 1bSNS20, where beach levels have fluctuated within the bounds of previous survey, beach levels are the lowest observed to date (March 2009, when monitoring began). As at Whitburn Bay to the north, this suggests that the storms of winter 2012/2013 were particularly strong.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>erosion and the resulting talus probably explains the evidence for cliff advance. At all profiles, from 1bSNS26 to 1bSNS33, beach levels have fallen in the order of 0.5m, increasing towards 1m along the more southerly profiles exposing the underlying rocky foreshore. These findings are reinforced by the topographic survey report, which notes '<i>the beaches seemed lower than usual, with more bedrock and stones showing</i>'.</p>	
<p><b>Mar 2013</b></p>	<p><b>Cliff-top Survey:</b></p> <p>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. Note: the numbering of ground control points is not intended to correlate with that of the beach profile lines and reference should be made to Appendix B - Map 1 and Appendix B – Map 2 for the location of ground control points.</p> <p>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.</p> <p>The results from the cliff top monitoring are anticipated to have an accuracy of <math>\pm 0.2\text{m}</math> 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 (October 2011) cliff top surveys.</p> <p>Results show erosion or an amount of movement greater than the survey error has occurred at 21 ground control points since surveys began in March 2009 (or September 2009 for 28A and 28B). Other locations have change within the error band.</p> <p>Since the last survey, the cliff at 10 locations is indicated to have eroded: (i) Points 10-11, 13, 16-17, (immediately north of and around Salterfern Rocks) - erosion is less than 1m; (ii) Points 21-22 and 25 (northern end of Halliwell Banks) - erosion is greater than 2m; and (iii) Points 28-28A (immediately north of Pincushion) - erosion is 1.6m or less. The remaining points indicate change within the error band,</p>	<p>Since the last survey, the cliffs immediately north of and around Salterfern Rocks, at the northern end of Halliwell Banks, and immediately north of Pincushion have eroded (by an amount greater than the survey error).</p> <p><b>Longer term trends:</b> Erosion or an amount of movement greater than the survey error has occurred at 21 ground control points since surveys began in March 2009 (or September 2009 for 28A and 28B).</p> <p>An additional assessment of cliff recession will be derived from analysis of time-series remote sensing data. A high quality baseline survey, comprising LiDAR and aerial photography, was collected in 2010, a repeat survey was completed in Sept/Oct 2012 and a second repeat survey is planned for 2014. These data will be analysed to give more accurate information on the behaviour of the cliffs in a separate report.</p>

<b>Survey Date</b>	<b>Description of Changes Since Last Survey</b>	<b>Interpretation</b>
	advance or no change.	



### **3. Problems Encountered and Uncertainty in Analysis**

#### **Individual Profiles**

Profile 1bSNS4 includes a seawall and rock revetment, after which it extends into water. Therefore it has not been analysed. It is uncertain why this profile has been surveyed, unless it is specifically to monitor changes to the rock revetment. If so, it is suggested that the method used to survey this profile is reviewed for suitability.

At profiles 1bSNS27, the plotted profile appears to show the cliff face to have accreted. This could be related to debris from cliff falls at the toe, slumping of the toe of this cliff, the cliffs tendency to heave seawards prior to toppling or survey interpretation (as described in Cliff Top Surveys below). Such cliff behaviour could bring about health and safety issues relating to the surveying of the cliff toe where the cliffs are unstable or overhanging, resulting in different interpretation of the survey locations.

#### **Cliff Top Surveys**

The survey report notes *'there are a number of landslips that are evident'*, although it is not certain as to which profiles the report is referring to in particular.

Surveying any cliff top is difficult due to: (i) the Health and Safety risks posed to surveyors, especially during adverse weather; and (ii) the apparent changes that can arise due to problems in interpretation of the cliff edge on successive surveys. In particular, surveying the cliff top has been made challenging by growth of vegetation that makes identification of cliff edge in successive surveys difficult. For these reasons, it has been assumed that any changes of  $\pm 0.2\text{m}$  may be considered as being within the accuracy of the surveying technique.

In the short term, more reliable assessments of cliff recession will be derived from analysis of time-series remote sensing data. A high quality baseline survey, comprising LiDAR and aerial photography, was collected in 2010, a repeat survey was completed in late 2012 and a second repeat survey is planned for 2014. These data will be analysed to give more accurate information on the behaviour of the cliffs in a separate report.

### **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 present no causes for concern.
- At Hendon to Ryhope (incl. Halliwell Banks), the recorded profiles present no causes for concern. Consideration should be given to the continuation of the cliff top survey.

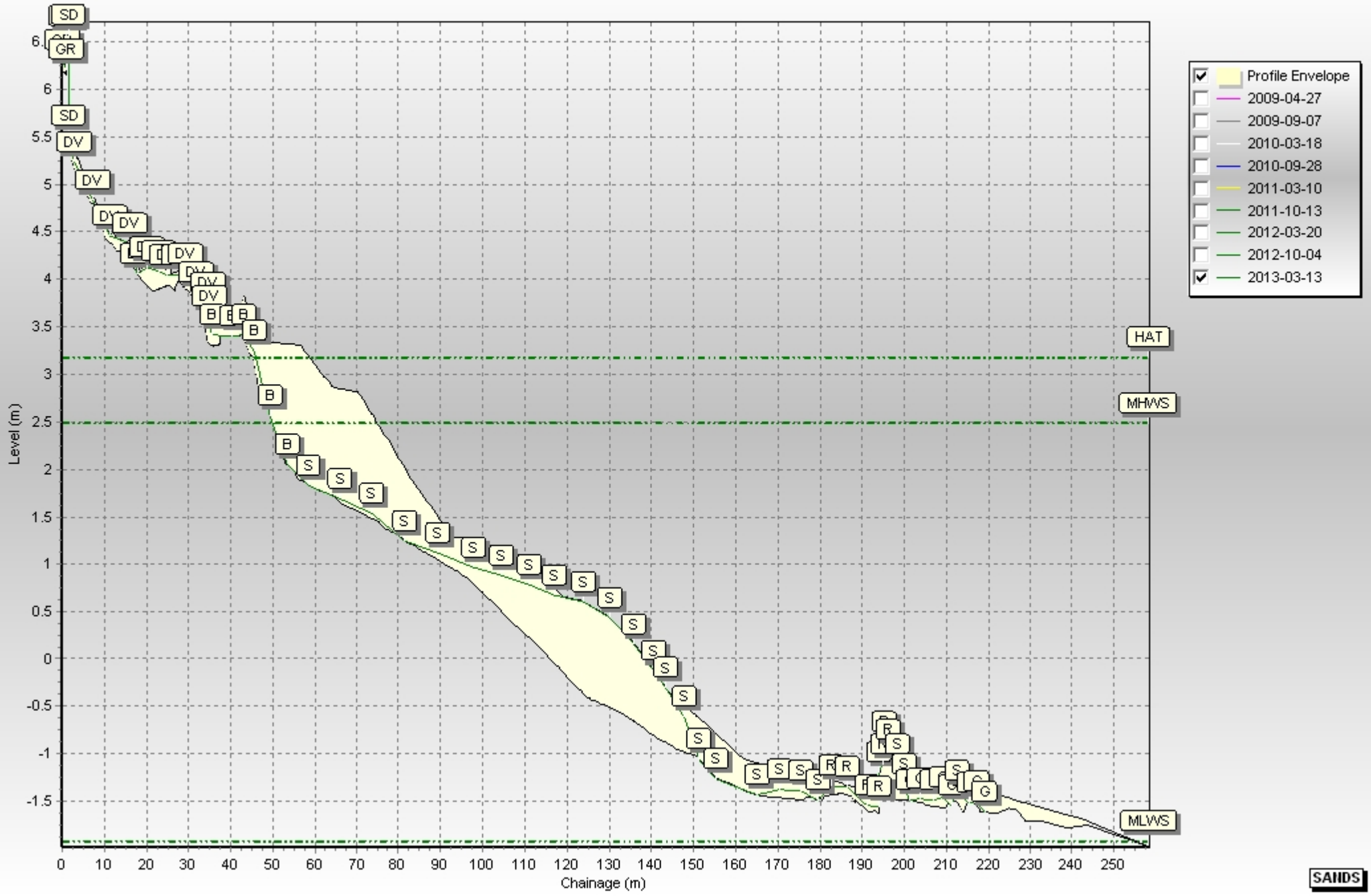
## **Appendices**

**Appendix A**  
**Beach Profiles**

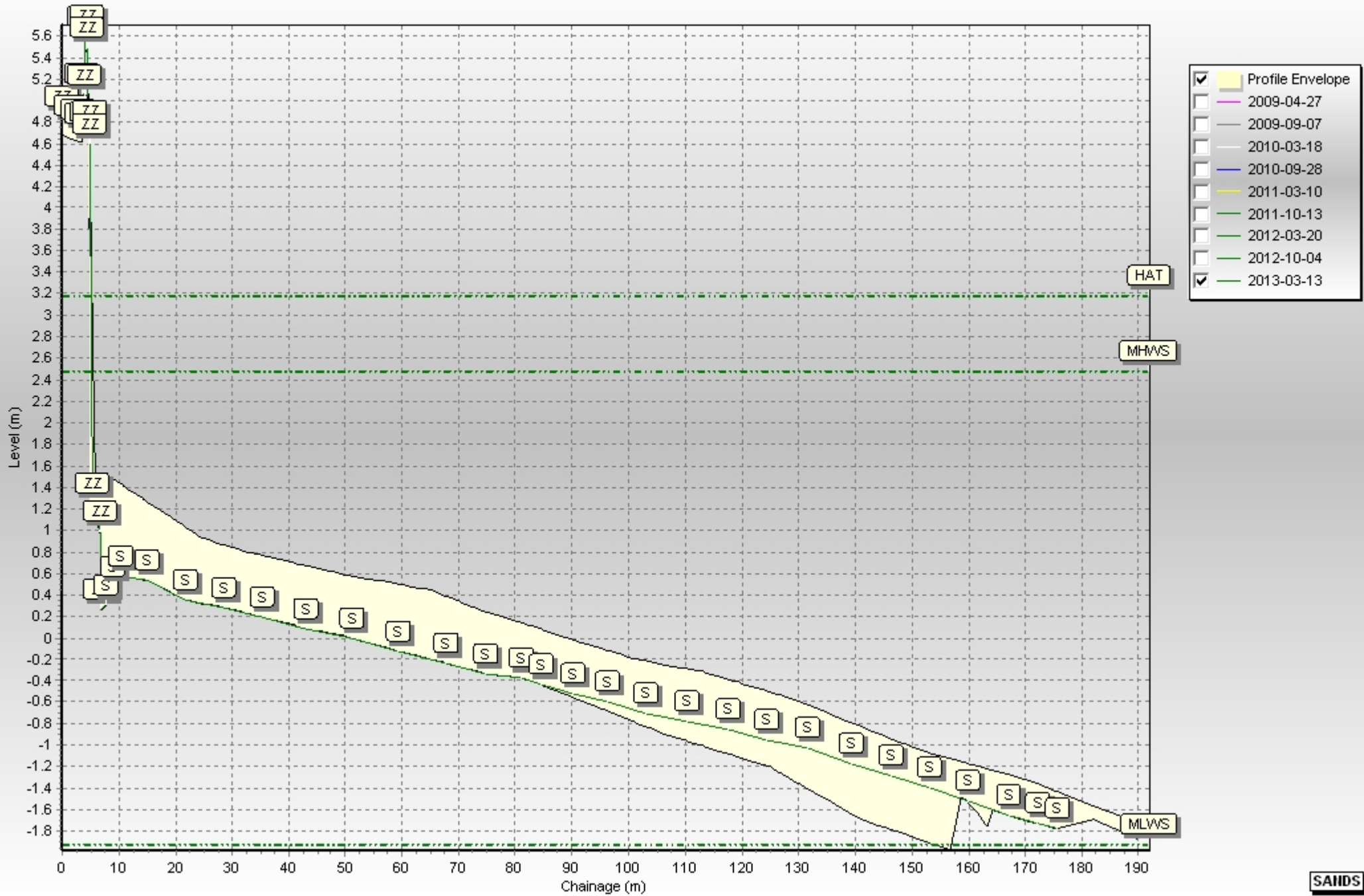
The following sediment feature codes are used on some profile plots:

<b>Code</b>	<b>Description</b>
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

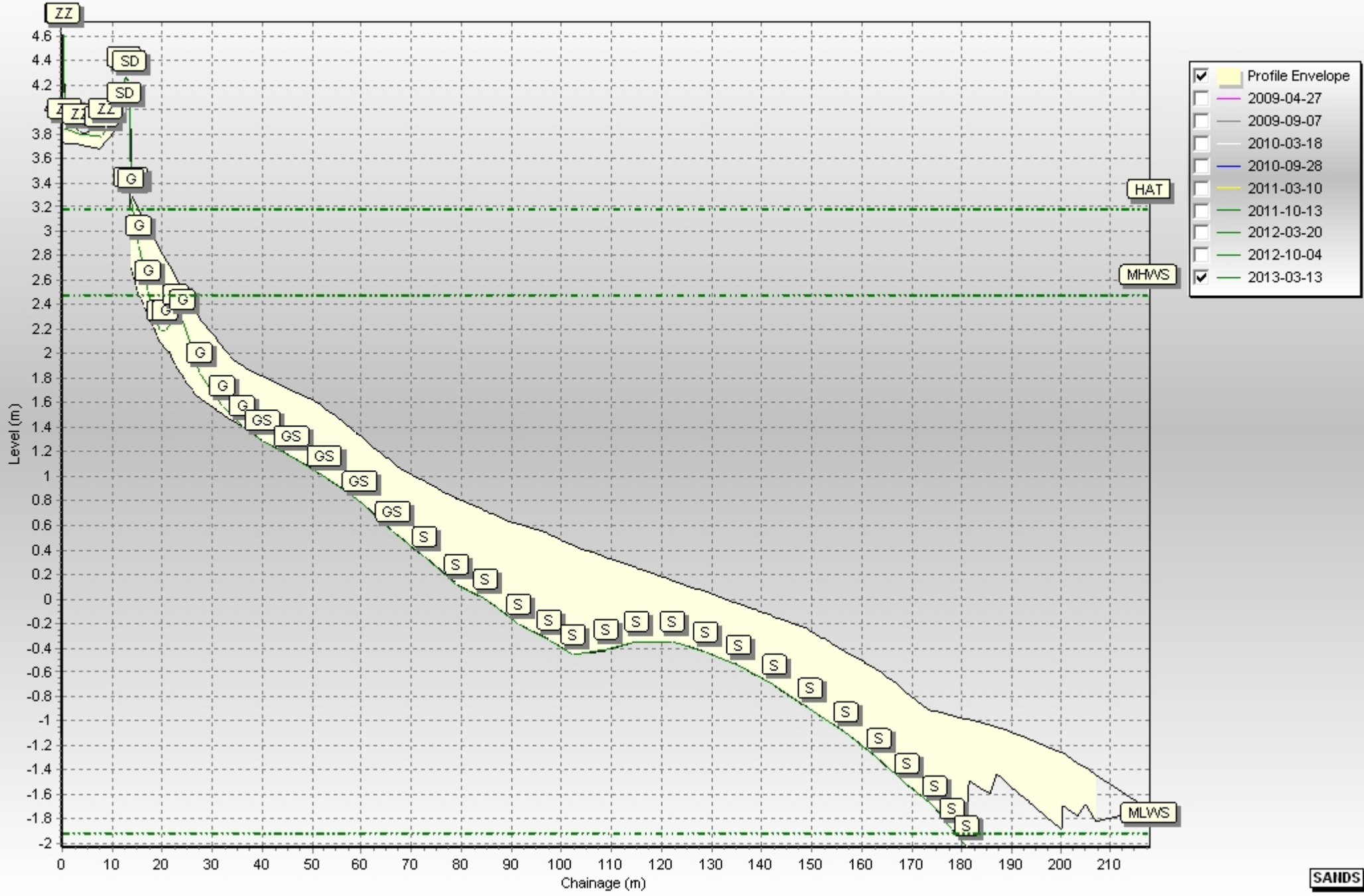
Profiles: 1bSNN1



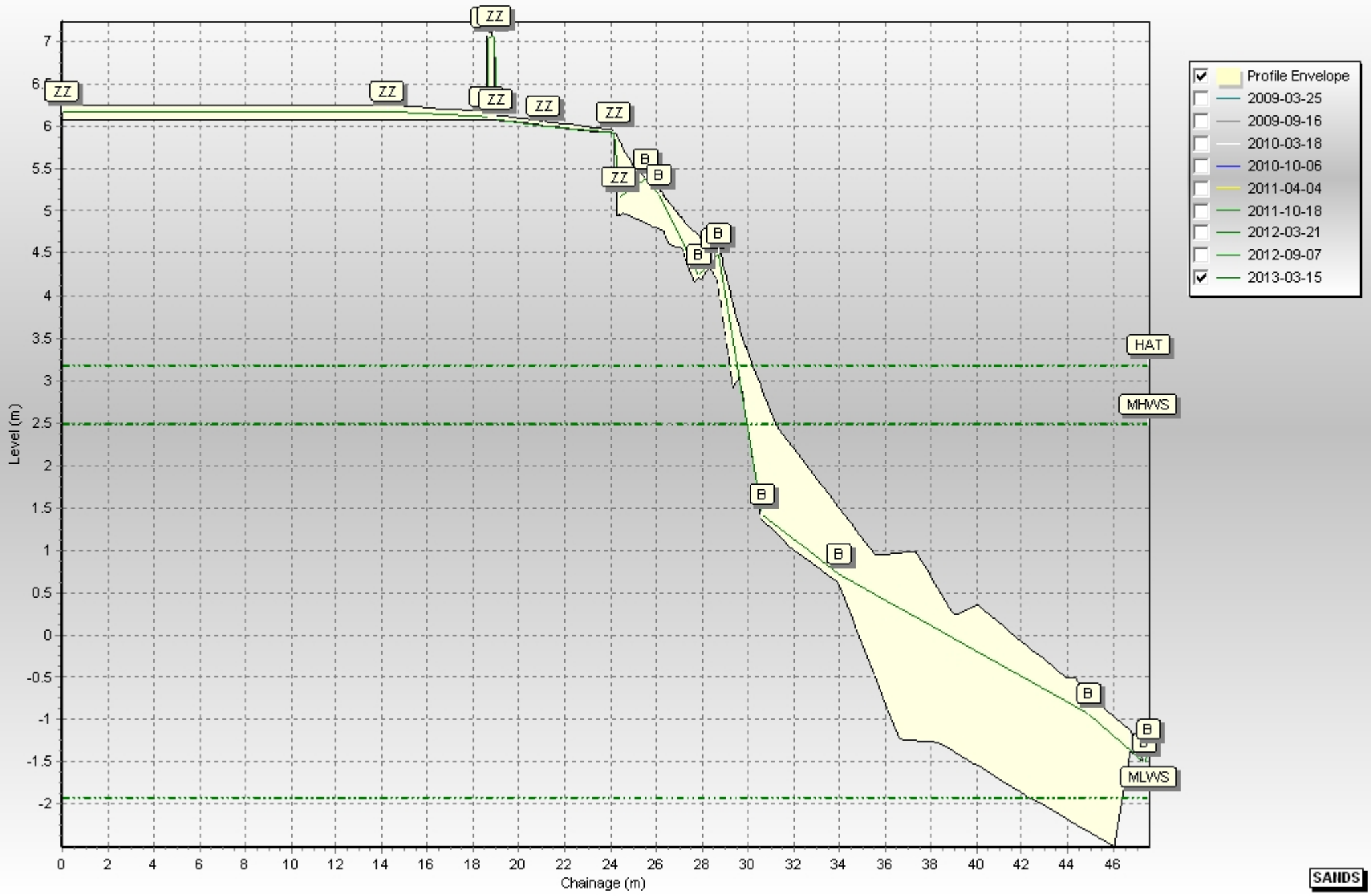
### Profiles: 1bSNN7



Profiles: 1bSNN10

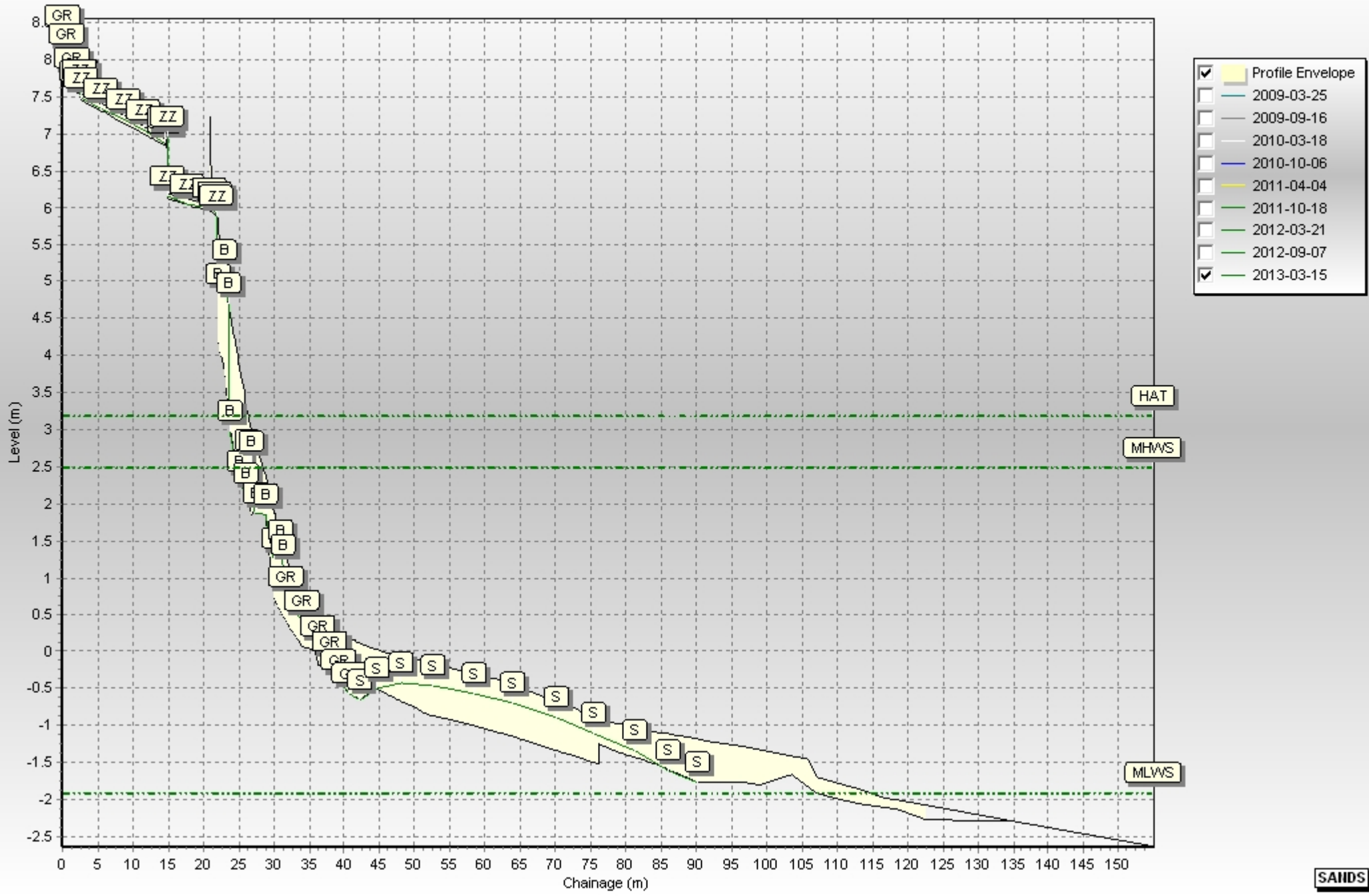


Profiles: 1bSNS4

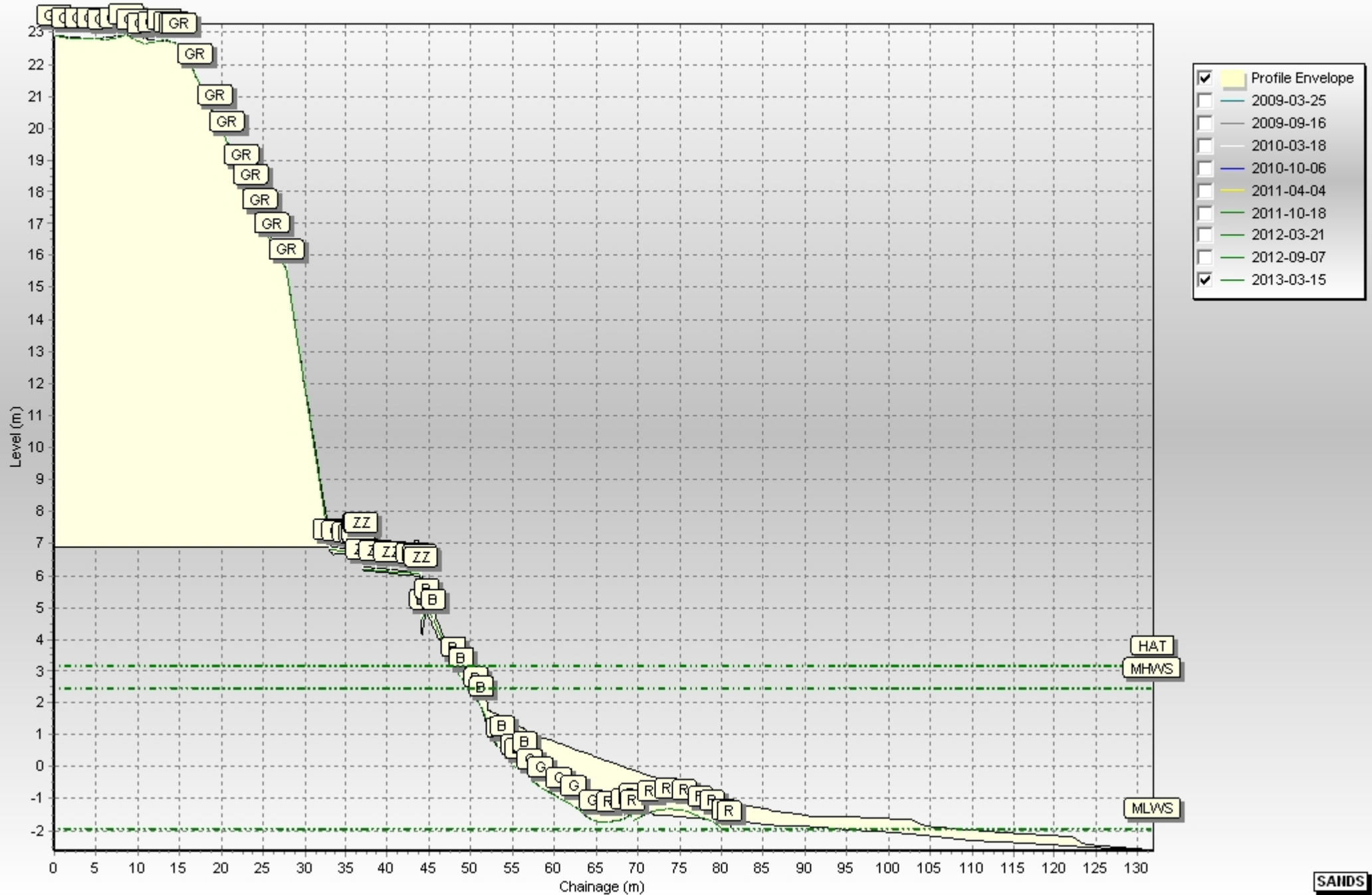




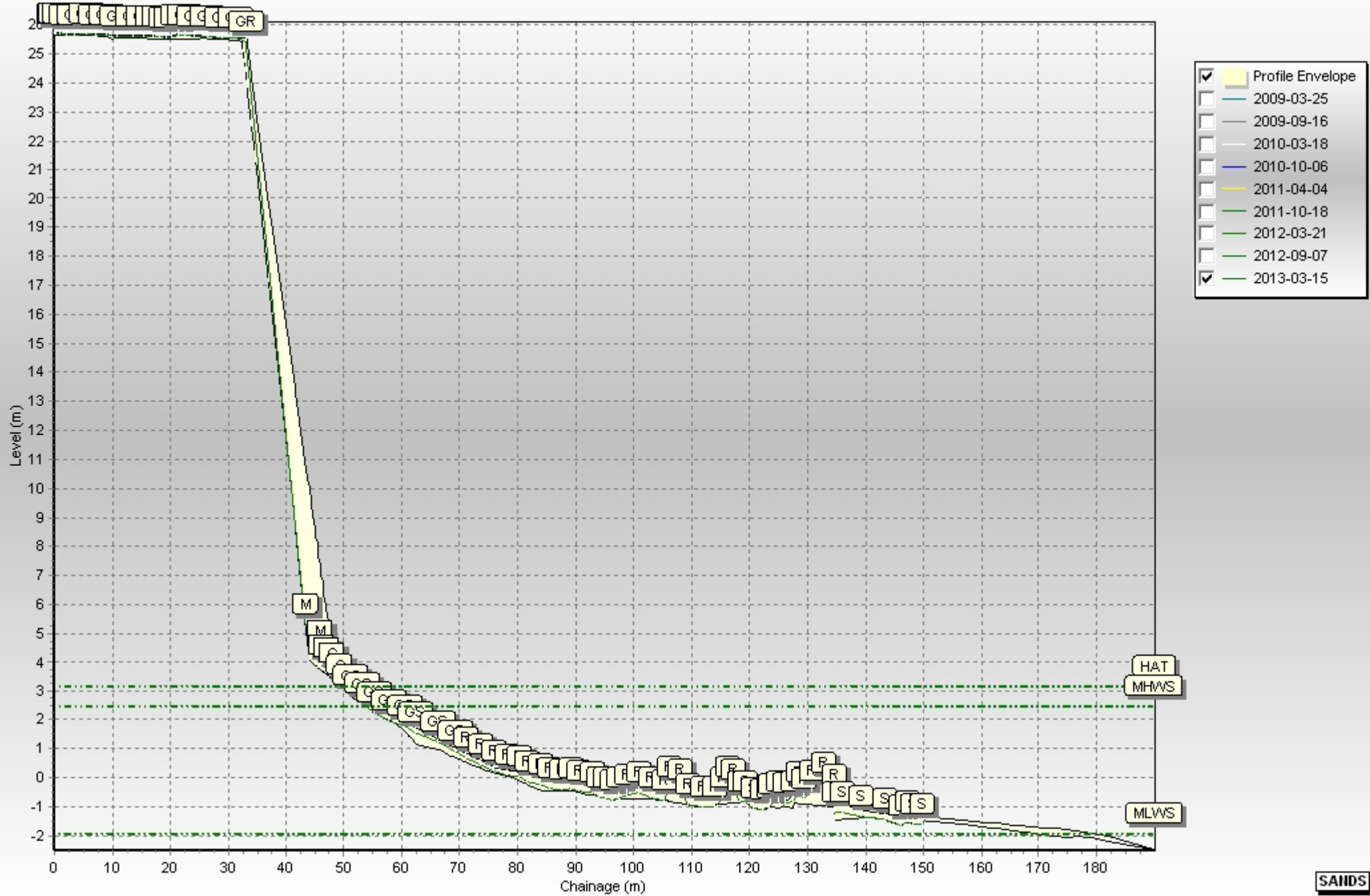
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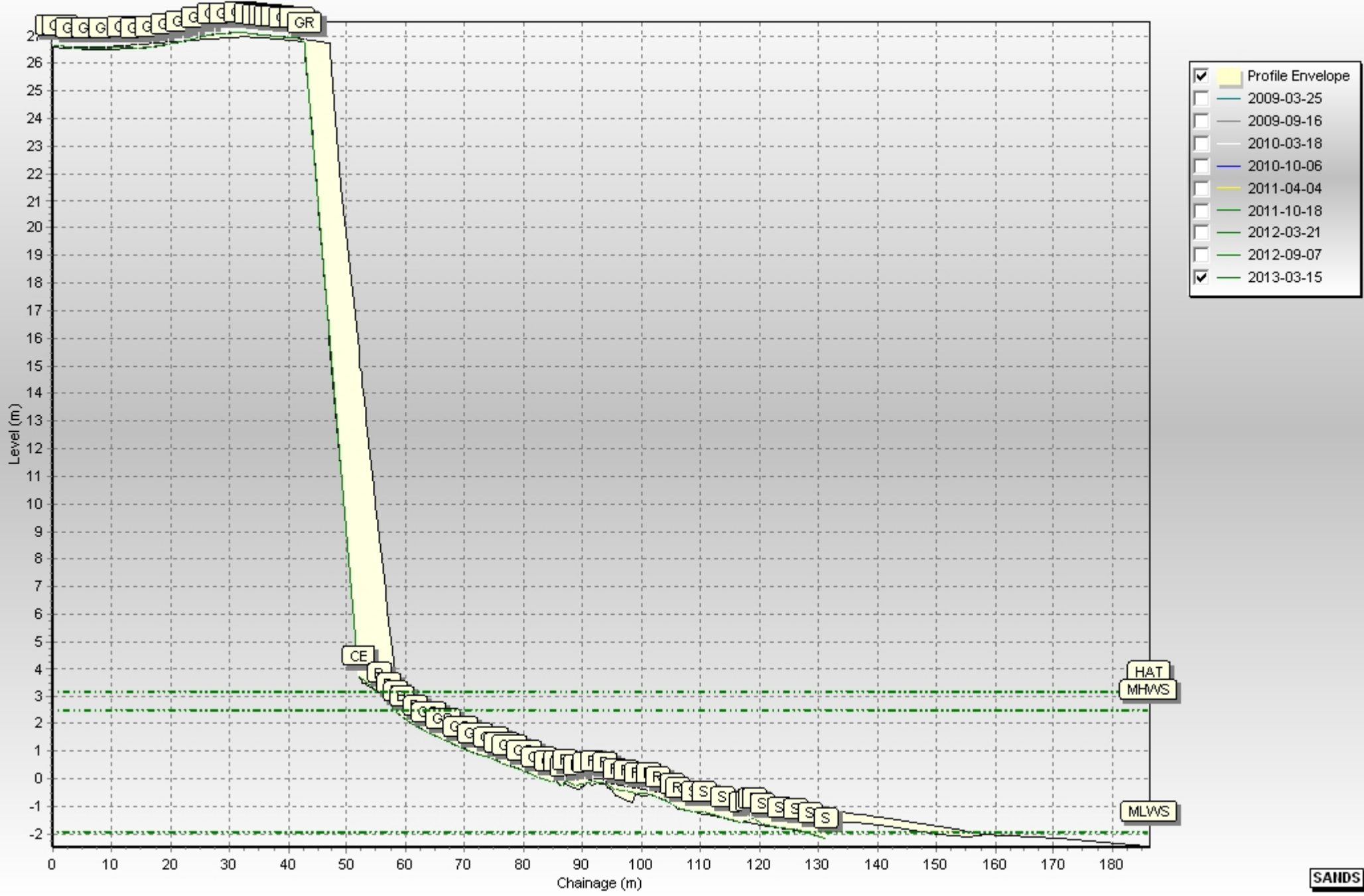
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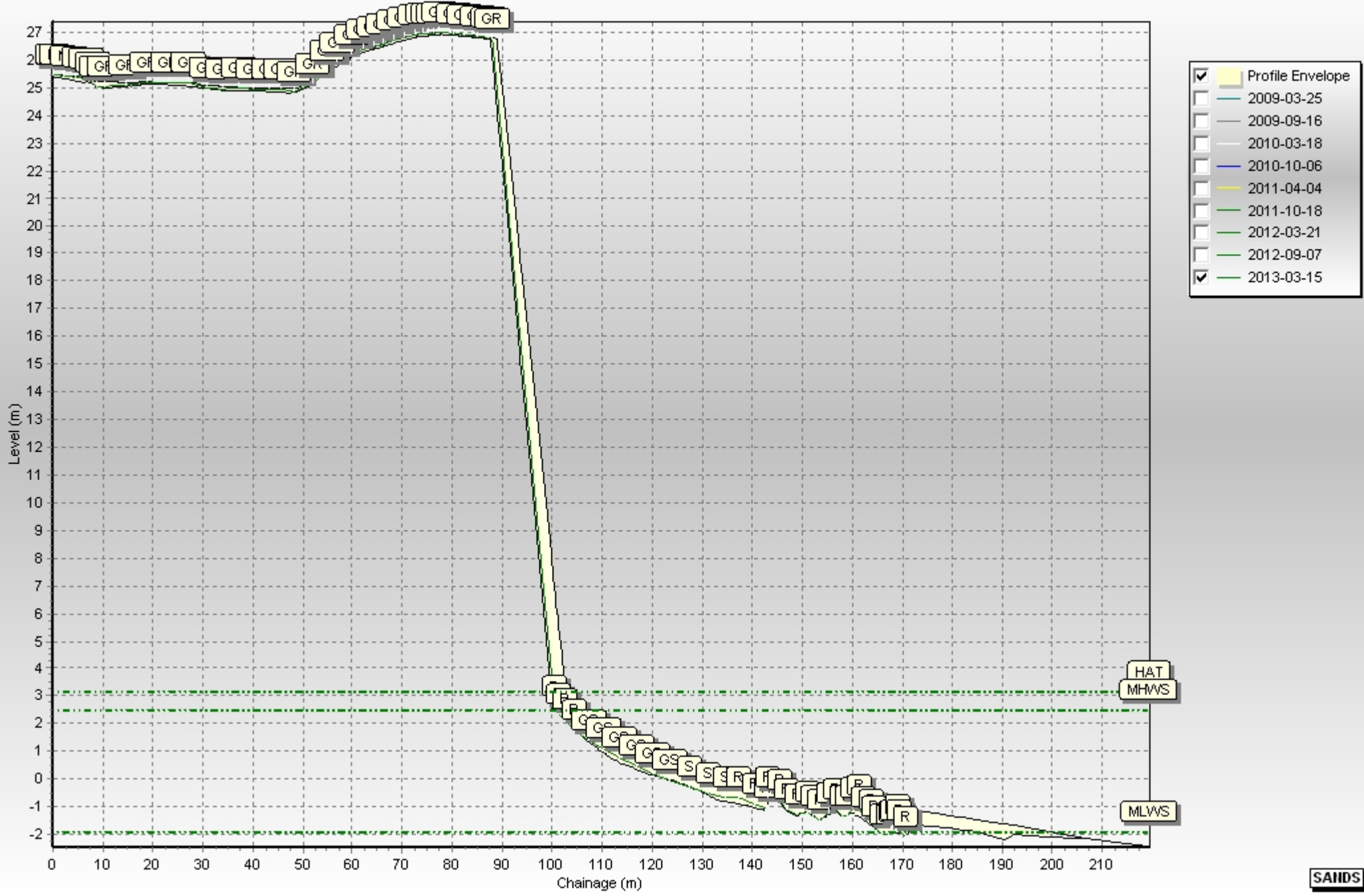
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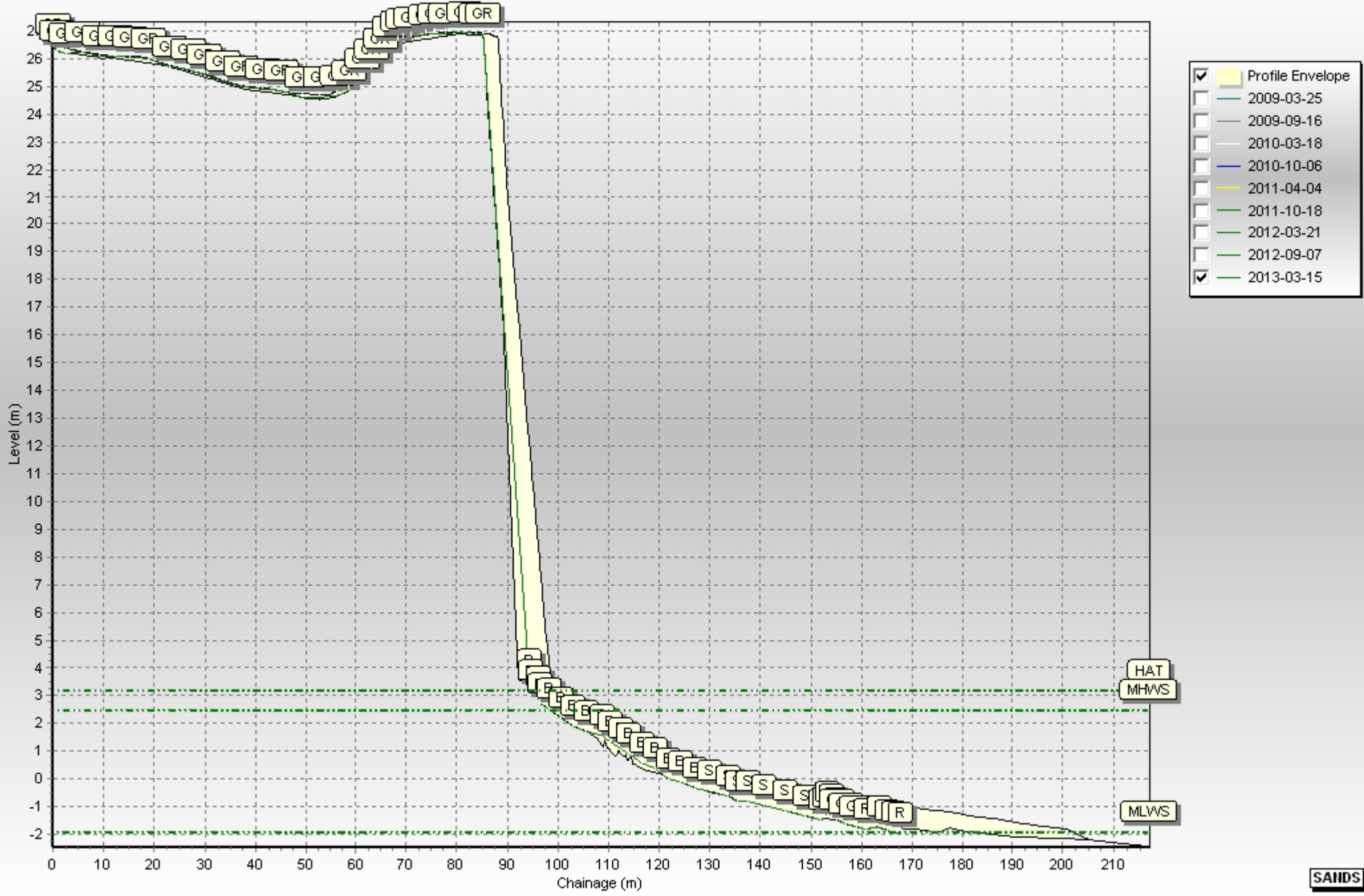
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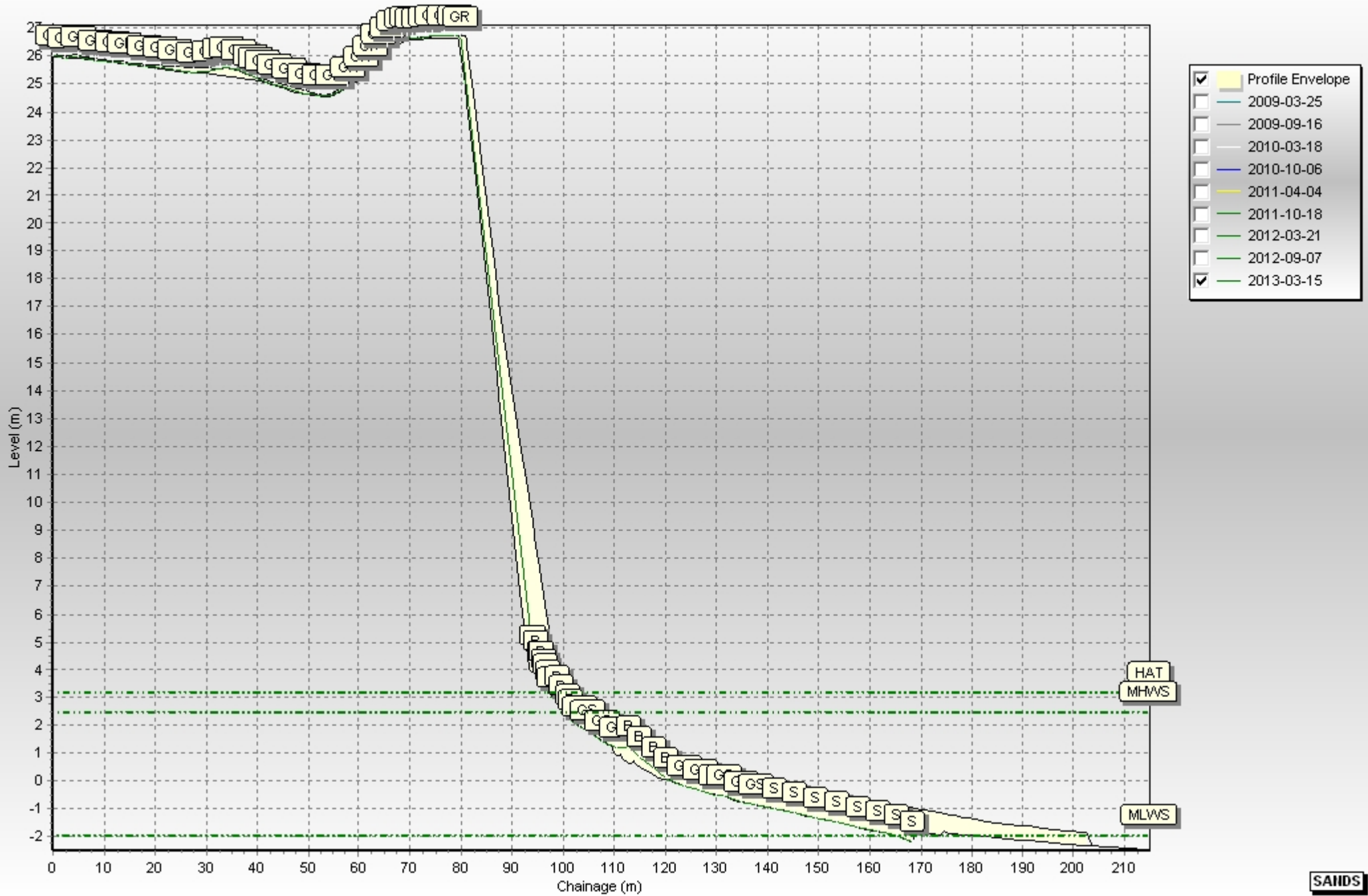
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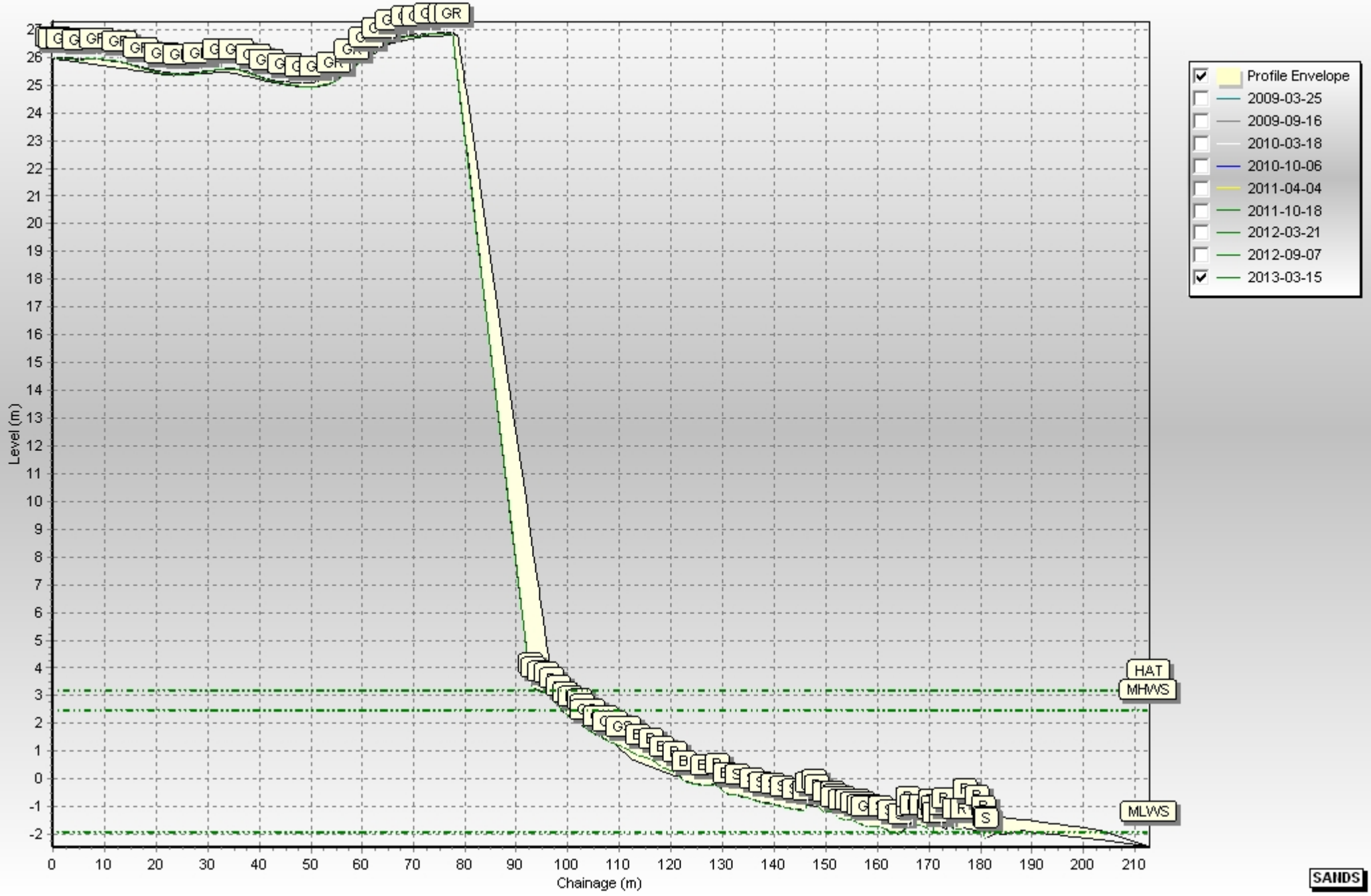
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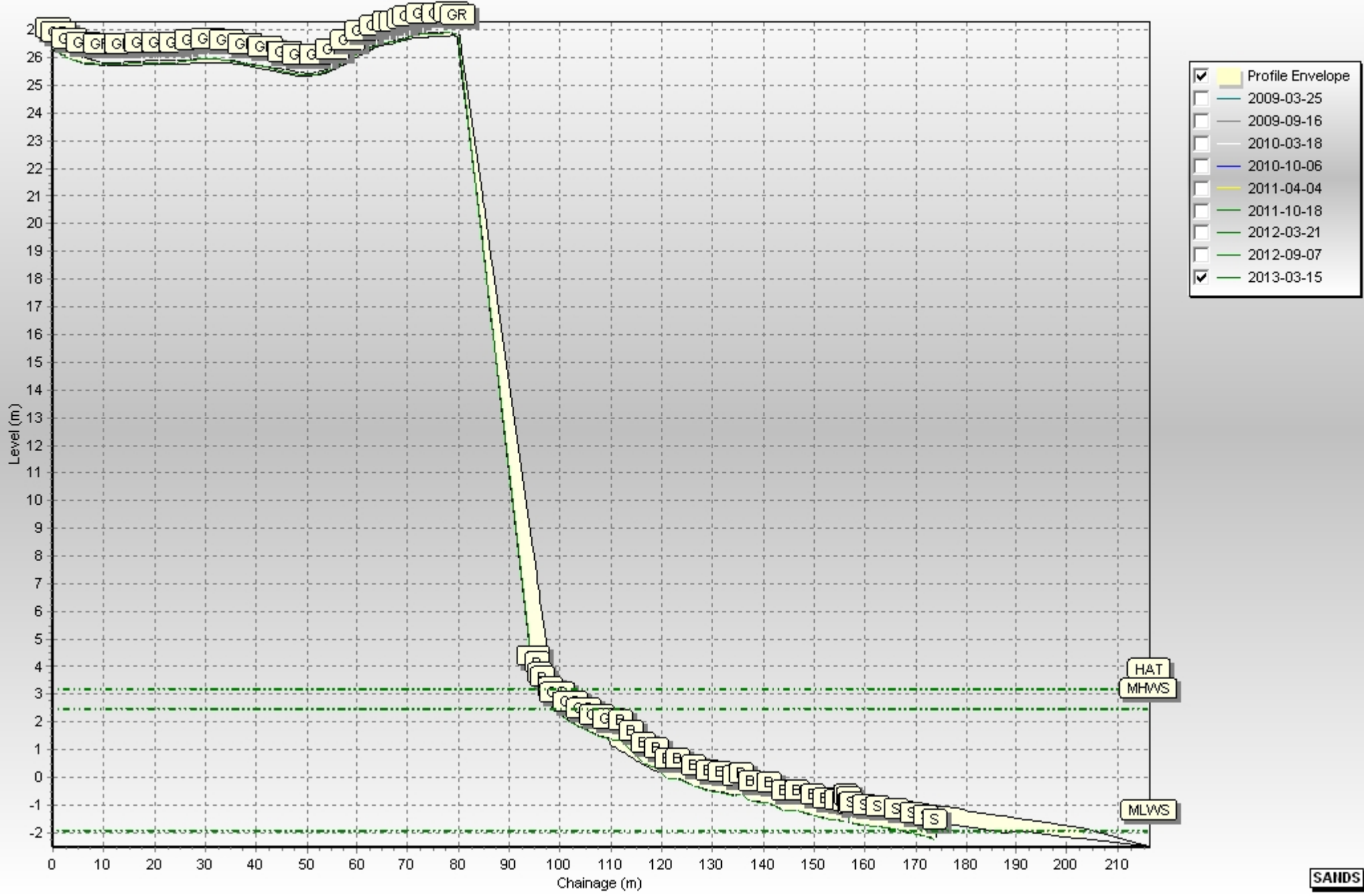


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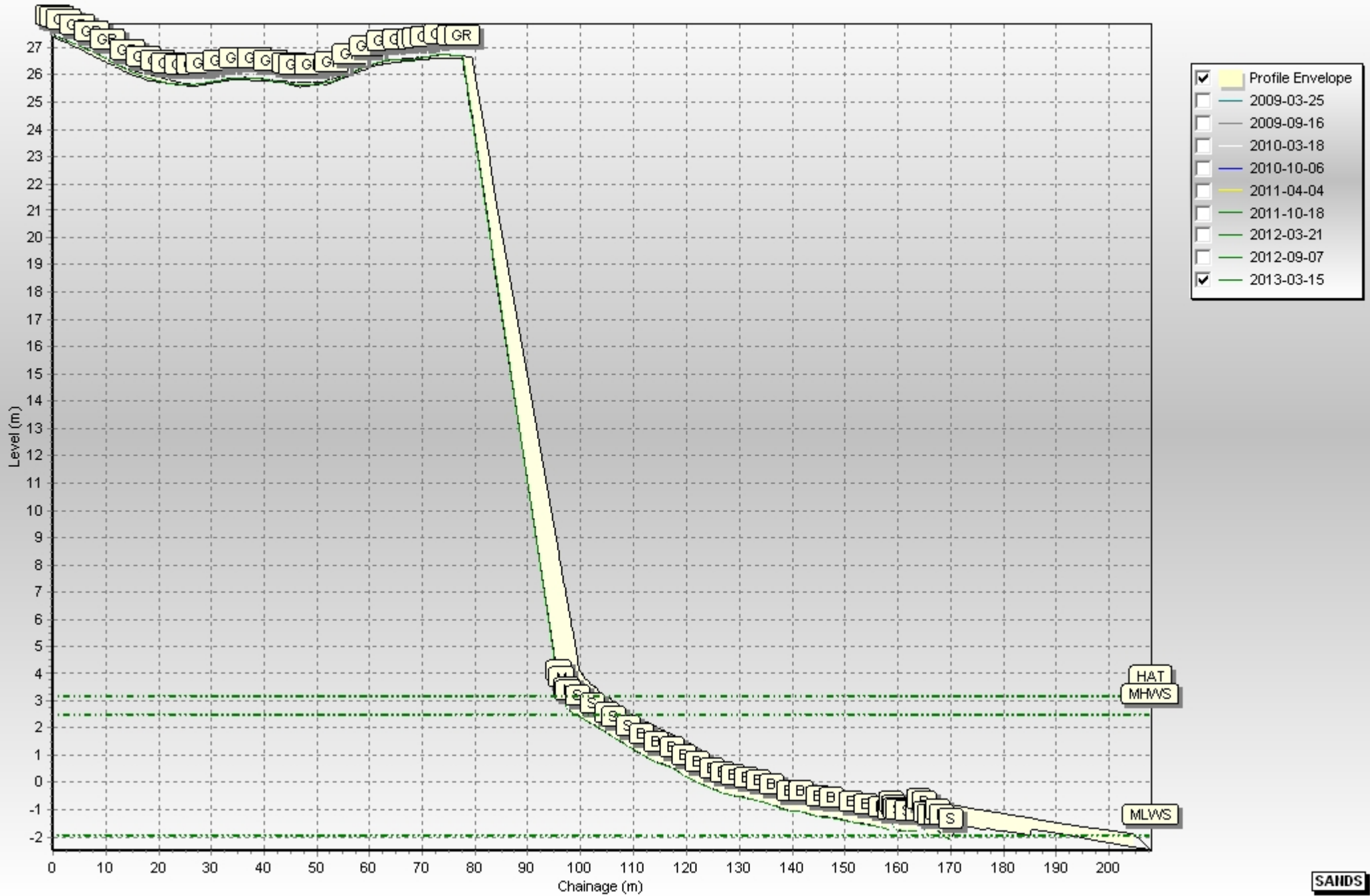




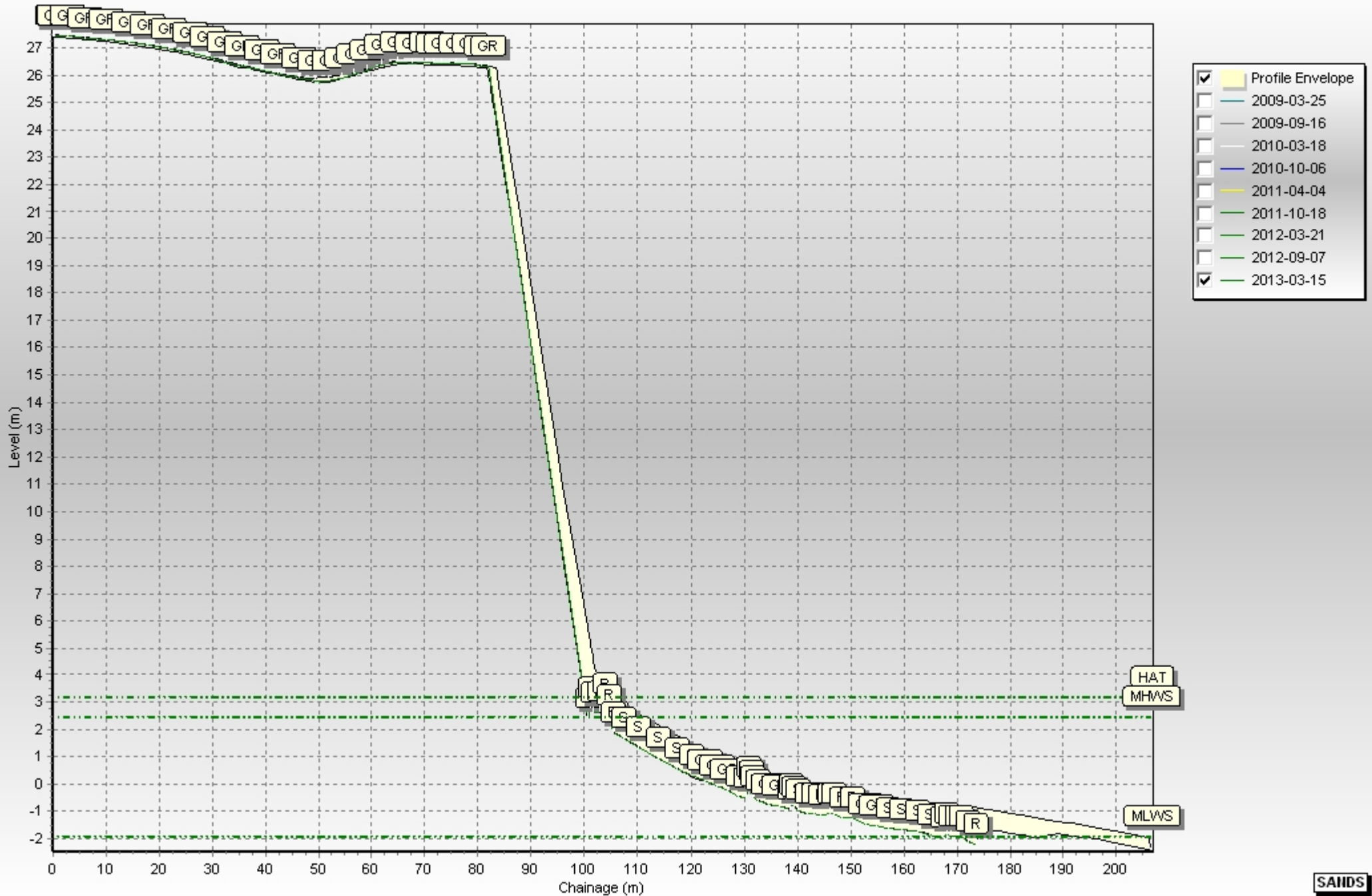
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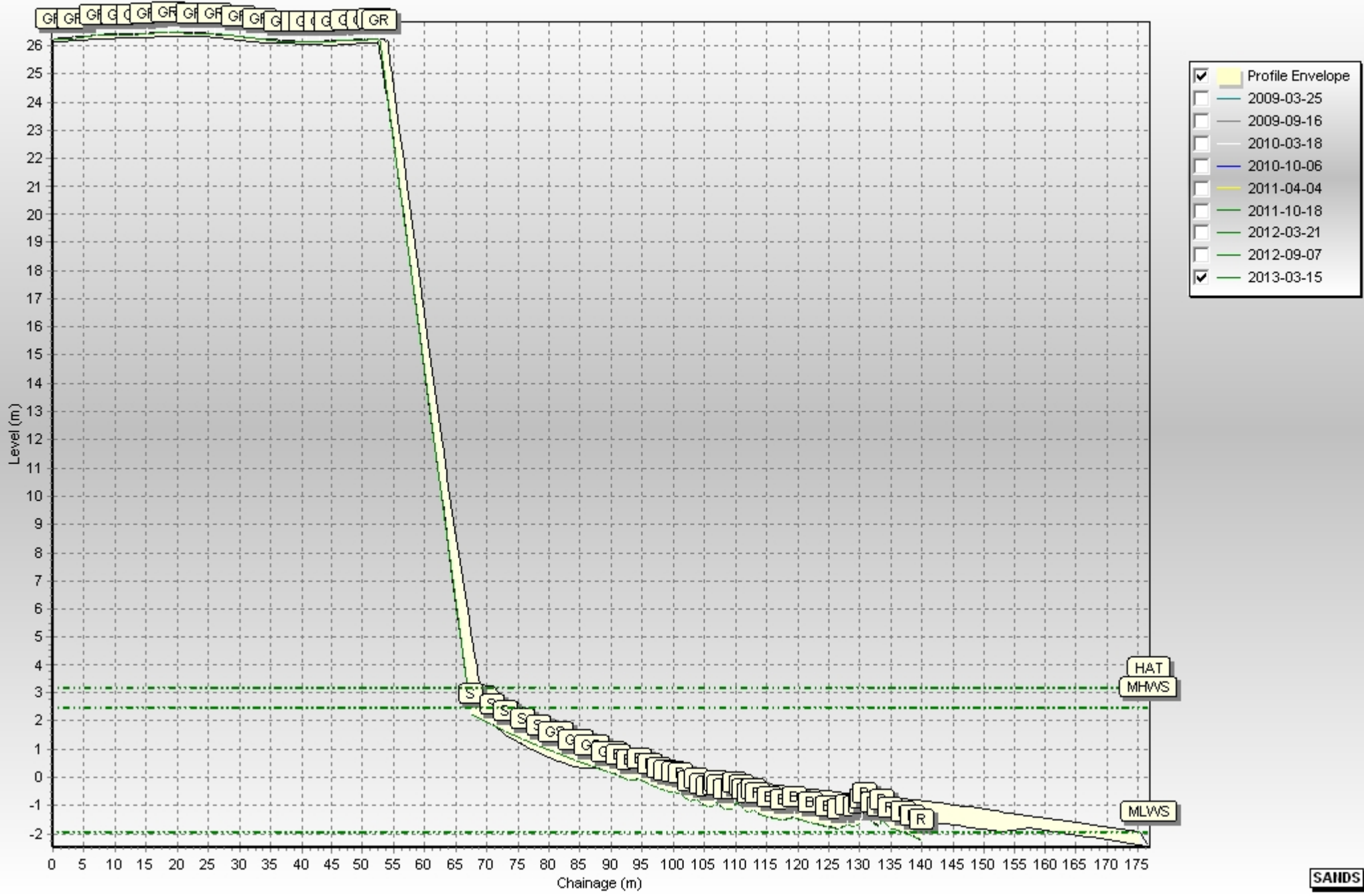
Profiles: 1bSNS31



Profiles: 1bSNS32



Profiles: 1bSNS33



**Appendix B**  
**Cliff Top Survey**

## Cliff Top Survey

### Hendon and Ryhope

Thirty-two ground control points have been established between Hendon and Ryhope (Map 1 and Map 2). 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.

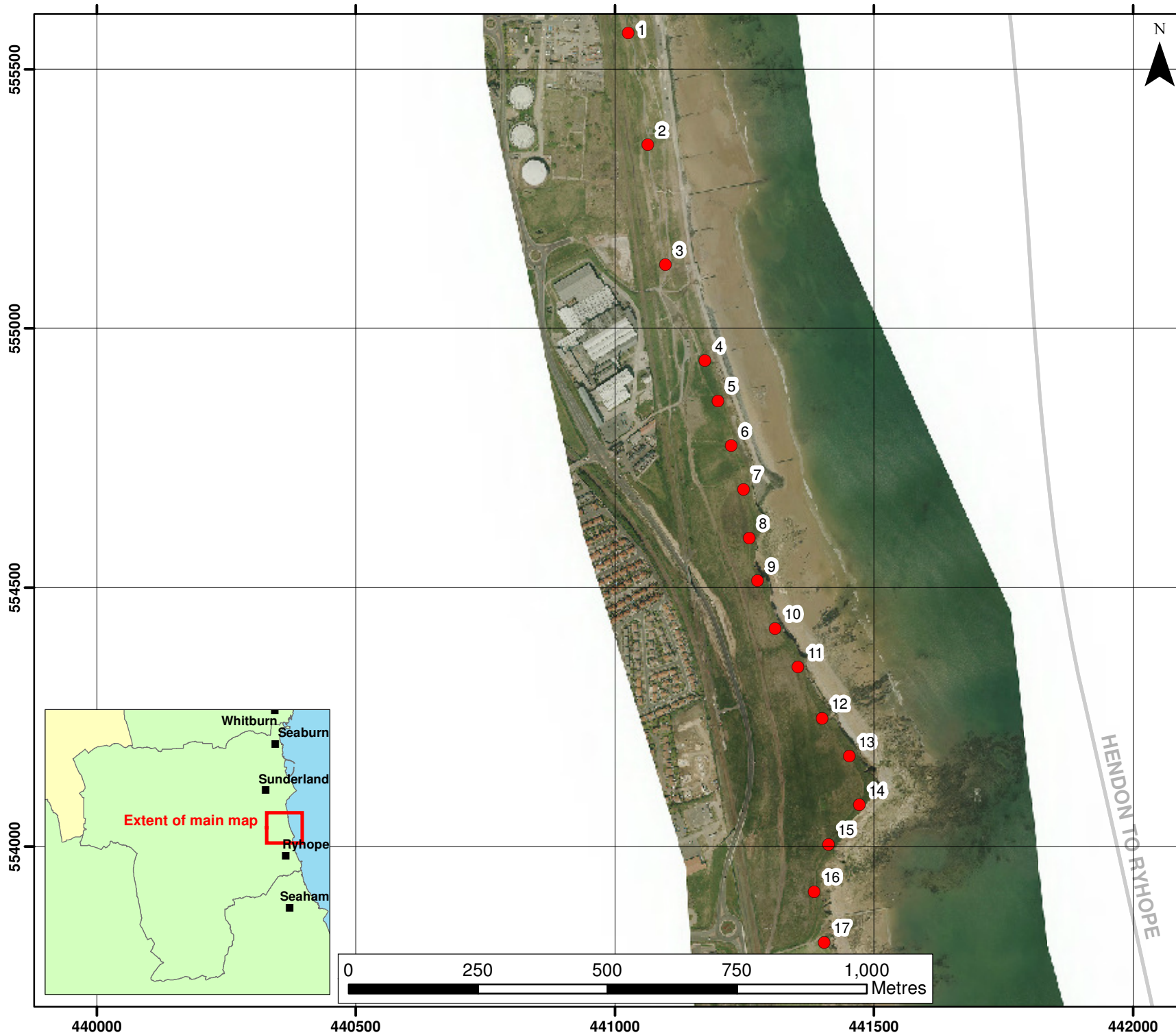
Table B1 provides baseline information about these ground control points and results from the 2009 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means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

**Table B1 – Cliff Top Surveys between Hendon and Ryhope**

Ground Control Point Details				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (°)	Baseline Survey (March 09)	Previous Survey (Sept 2012)	Present Survey	Baseline (March 2009) to Present (March 2013)	Previous (Sept 2012) to Present (March 2013)	Baseline (March 2009) to Present (March 2013)
1	1	441025.7	555571.1	75	8.16	8.7	8.5	0.4	-0.1
2	2	441064.4	555355.1	85	7.09	6.5	6.5	-0.6	0.0
3	3	441098	555124	82	10.01	10.4	10.4	0.4	0.1
4	4	441174	554938.7	65	10.3	10.5	10.7	0.4	0.1
5	5	441199.1	554861.1	65	7.71	7.8	8.0	0.2	0.2
6	6	441224.5	554774.2	71	10.83	11.0	11.0	0.2	0.0
7	7	441248.4	554690.3	74	10.18	10.3	10.4	0.2	0.1
8	8	441259.3	554596.6	101	10.08	10.2	10.2	0.1	0.0
9	9	441275.8	554513.4	66	10.52	6.6	6.6	-3.9	0.0
10	10	441309.4	554421.3	58	8.77	6.6	6.3	-2.4	-0.2
11	11	441354	554346.5	68	8.2	6.8	6.5	-1.7	-0.3

Ground Control Point Details				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (°)	Baseline Survey (March 09)	Previous Survey (Sept 2012)	Present Survey	Baseline (March 2009) to Present (March 2013)	Previous (Sept 2012) to Present (March 2013)	Baseline (March 2009) to Present (March 2013)
12	12	441400.2	554248.2	56	6.17	6.1	6.1	-0.1	0.0
13	13	441452.3	554174.7	63	11.61	11.8	11.2	-0.4	-0.6
14	14	441472.3	554080.5	127	7.33	7.4	7.4	0.1	0.0
15	15	441413	554005.1	122	7.84	8.0	7.9	0.1	0.0
16	16	441384.8	553913.3	90	9.89	10.0	9.2	-0.7	-0.8
17	17	441404.1	553815.5	93	6.32	6.5	6.2	-0.2	-0.3
18	18	441404.1	553723.6	119	8.1	8.1	8.1	0.0	0.0
19	19	441398.5	553632.8	78	8.23	5.9	5.8	-2.4	-0.1
20	20	441438.3	553452.9	71	10.09	6.9	6.9	-3.2	-0.1
21	21	441506.1	553256.1	62	8.57	4.6	1.9	-6.7	-2.7
22	22	441550.1	553158.7	103	6.57	6.7	3.8	-2.7	-2.9
23	23	441585.2	553076.5	64	8.11	8.0	8.1	0.0	0.1
24	24	441624.4	552870.7	69	7.53	5.2	5.3	-2.3	0.0
25	25	441689.1	552758	70	14.58	9.1	7.0	-7.6	-2.1
26	26	441715	552713.3	54	12.87	12.8	12.8	-0.1	0.0
27	27	441749.2	552674.4	62	14.56	10.7	10.7	-3.8	0.1
28	28	441776.6	552629.9	57	8.62	4.6	4.3	-4.4	-0.4
28A	28A	441798.6	552586.3	56	13.63*	12.7	11.1	-2.5	-1.6
28B	28B	441817.4	552542.4	64	12.30*	11.3	11.4	-1.0	0.1
28C	28C	441852.2	552502.6	52	13.11*	13.0	13.1	0.0	0.1
29	29	441880.1	552471.6	83	15.46	15.2	15.2	-0.2	0.0
30	30	441921.4	552269	97	8.55	7.9	7.8	-0.8	-0.2
31	31	441853.1	552094	75	11.2	7.9	7.9	-3.3	0.1
32	32	441883.3	551988.5	96	9.82	6.4	6.2	-3.6	-0.2

\*Note that 28a-c baseline is September 2009.



**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  
Hendon to Ryhope North  
Sunderland City Council**

Update Report 5  
Partial Measures Survey  
Spring 2013



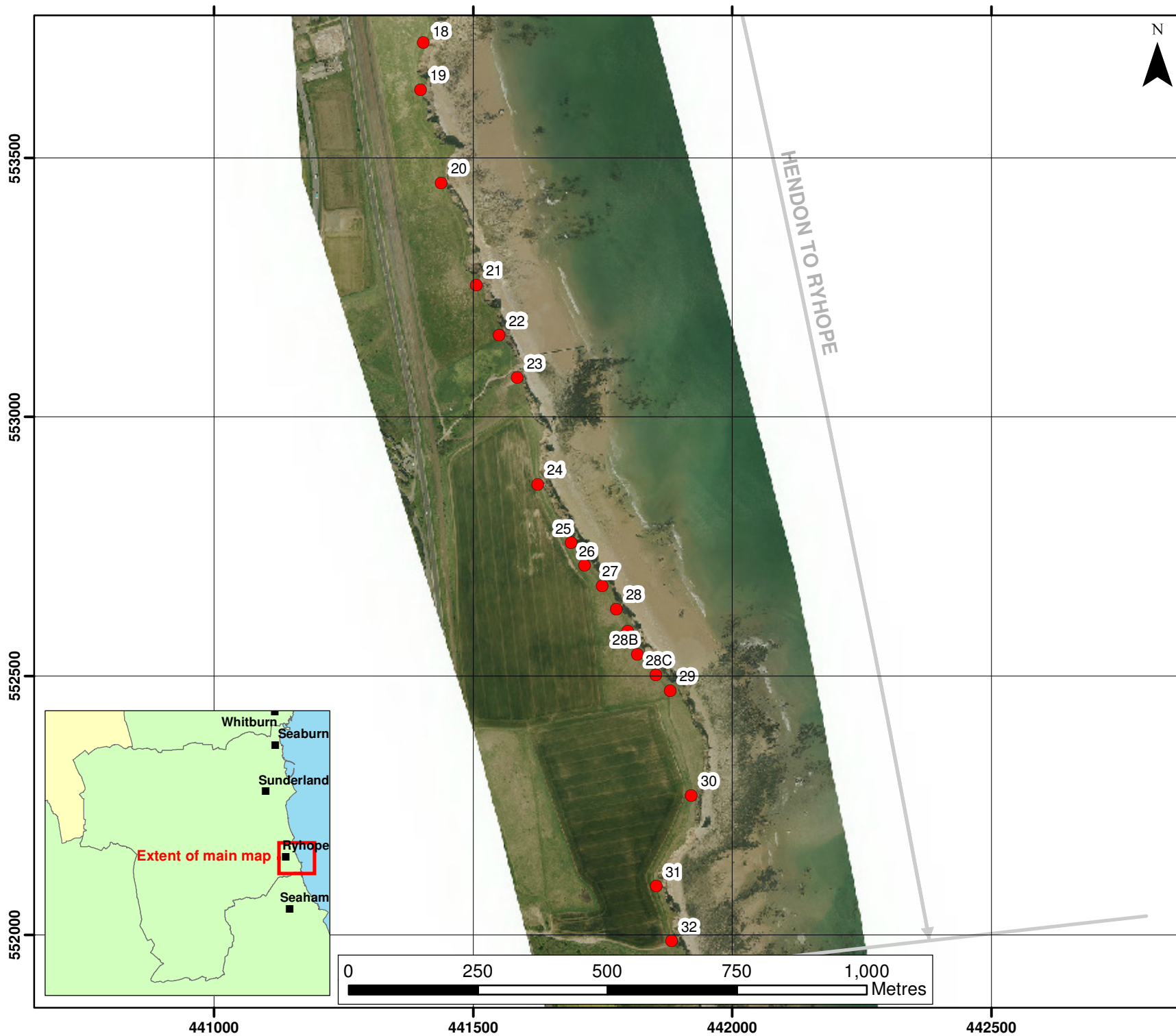
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www.halcrow.com

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





**KEY**

● Ground Control Points

Client: North East Coastal Group  
 Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

**Appendix B - Map 2  
 Ground Control Points  
 Hendon to Ryhope South  
 Sunderland City Council**

Update Report 5  
 Partial Measures Survey  
 Spring 2013



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