CH2MHILL
Halcrow

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

South Tyneside Council

South Tyneside 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 Parameter	Water Level (m AOD)	
	River Tyne to Frenchman's Bay	Frenchman's Bay to Souter Point
		2.88
HAT	2.85	2.18
MHWS	2.15	-2.12
MLWS	-2.15	

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.

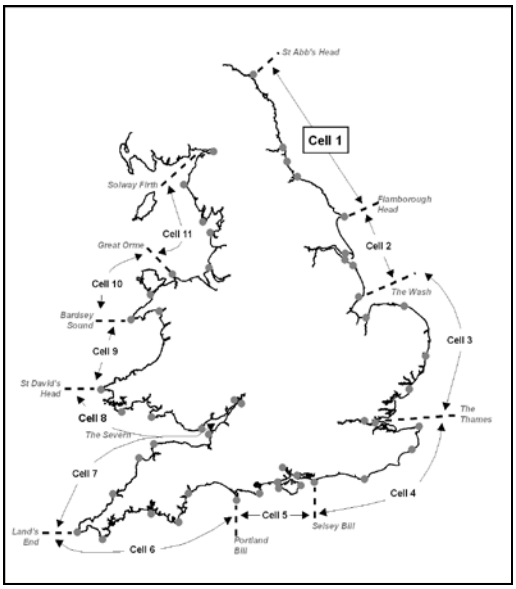

Figure 1 Sediment Cells in England and Wales

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
North Tyneside Council
South Tyneside Council
Northumberland Coast AONB
Sunderland City Council
Durham County Council
Redcar & Cleveland Borough Council
Hartlepool Borough Council
White Scarborough Filey Borough of Scarborough
East Riding of Yorkshire Council
A great place to live, work & play
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).

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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	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	Feb 13	-
5	2012/13	Nov 12	Mar 13	Mar 13	June 13	
6	2013/2014	Nov 13	Feb 14(*)			

(*) The present report is **Analytical Report 6** and provides an analysis of the 2013 Full Measures survey for South Tyneside 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)
	Staithes
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

South Tyneside Council's frontage extends from the mouth of the River Tyne Estuary to the outfall south of Whitburn. For the purposes of this report and for consistency with previous reporting, it has been sub-divided into four areas, namely:

- Littehaven Beach
- Herd Sands
- Trow Quarry (incl. Frenchman's Bay)
- Marsden Bay

1.2 Methodology

Along South Tyneside Council's frontage, the following surveying is undertaken:

- Full Measures survey annually each autumn comprising:
    - Beach profile surveys along 17 transect lines (commenced 2008)
    - Topographic survey along Littlehaven Beach (commenced 2010)
    - Topographic survey along Herd Sands (commenced 2008
    - Topographic survey along Trow Quarry (commenced 2008*)

- Partial Measures survey annually each spring comprising:
    - Beach profile surveys along 11 transect lines (commenced 2008)
    - Topographic survey along Littlehaven Beach (commenced 2010)

- Cliff top survey bi-annually at:
    - Cliff top survey at Trow Quarry (incl. Frenchman's Bay) (commenced 2008)

*Please note that the 2008 surveys at beach profiles 1bSS11, 1bSS12 and 1bSS13 were found to be undertaken at a different location to all the profiles surveyed since then. For this reason, the 2008 profiles have been extracted from analysis undertaken herein.

For all cliff-top surveys prior to Full Measures 2011, data was reported separately in Trow Quarry Coastal Defence Scheme - Monitoring Plan Year 2 (available from South Tyneside Council). The data was saved in '.kmz' format for plotting and comparison in GoogleEarth. For the present survey report, this data has been visualised in GIS, which revealed the quality was variable and reliable interpretations of cliff change could not be made. For this reason, the 'kmz' files are not presented or analysed as part of the present report. Therefore, cliff top survey data collected from Full Measures survey (autumn 2011) going forward is presented in this report.

The location of these surveys is shown in Figure 2. The Full Measures survey was undertaken along this frontage between 18th and 21st November 2013. During this time the weather conditions varied considerably; refer to the survey reports for details of the weather conditions over this survey period.

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 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 can 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:

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

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 bands 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 to 10 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, while 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 the 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.

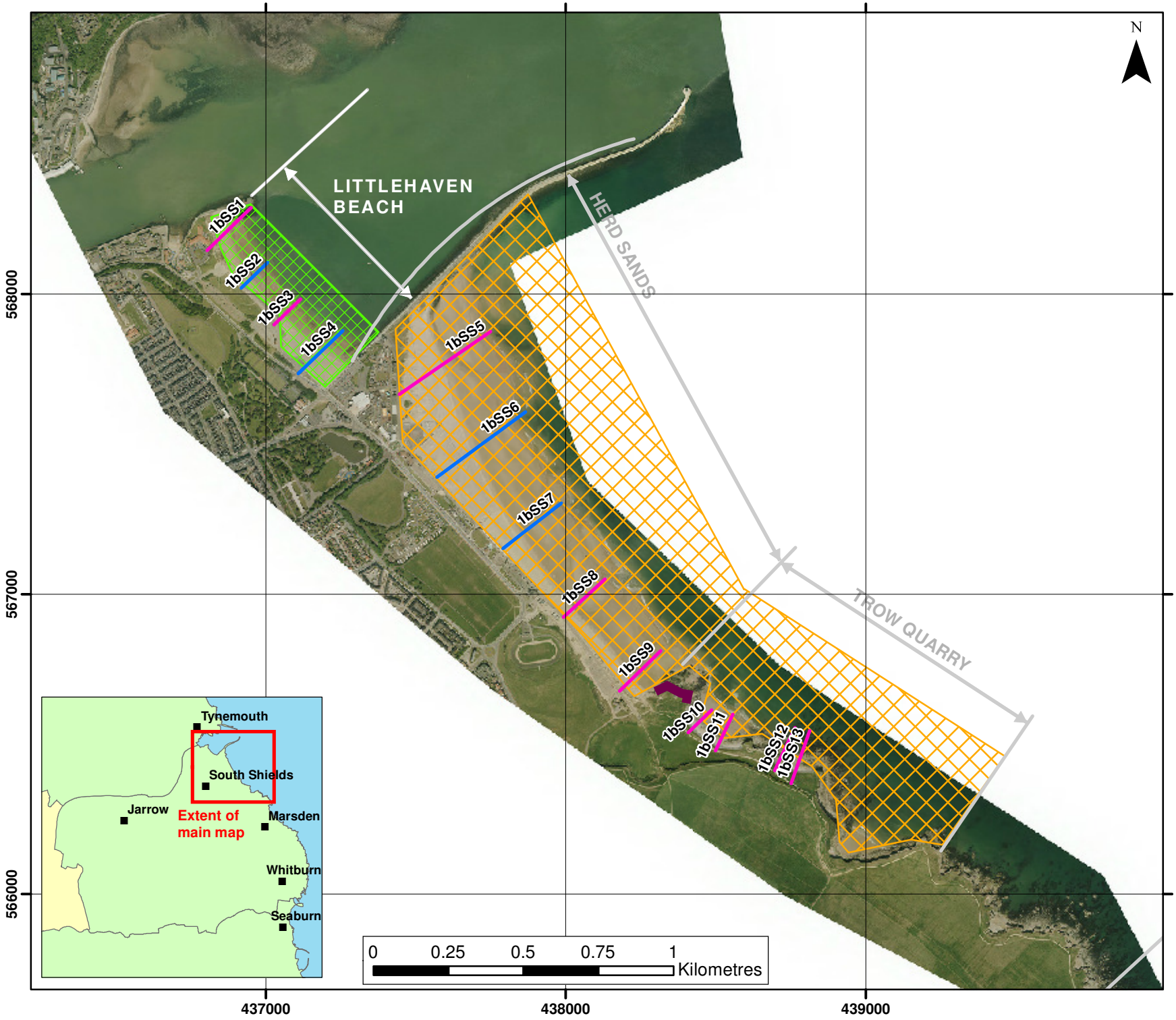
Comparing the annual storm records it can be seen that 2010 had the most storms (13). In 2010 the largest storm had an incident direction of 73 degrees which is unusual. We might therefore expect that the alongshore drift on the Cell 1 beaches in 2010 may have been atypical with unusual changes from the storm conditions. This was 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 in some locations. The combined high water levels and large waves causing significant damage to many coastal defences and beaches in the north east. However, the autumn 2013 full-measures survey data set which is assessed in this report was collected in September and October and as no post storm surveys were available the impacts will be seen until the spring 2014 Partial Measures surveys.

The surveys for this frontage were undertaken between the 18th and 21st November, a considerable time after the 10th September storm and therefore should not be impacted by recent storms.



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 Littlehaven Beach to Trow Quarry South Tyneside Council

Analytical Report 6
Full Measures Survey
Autumn 2013

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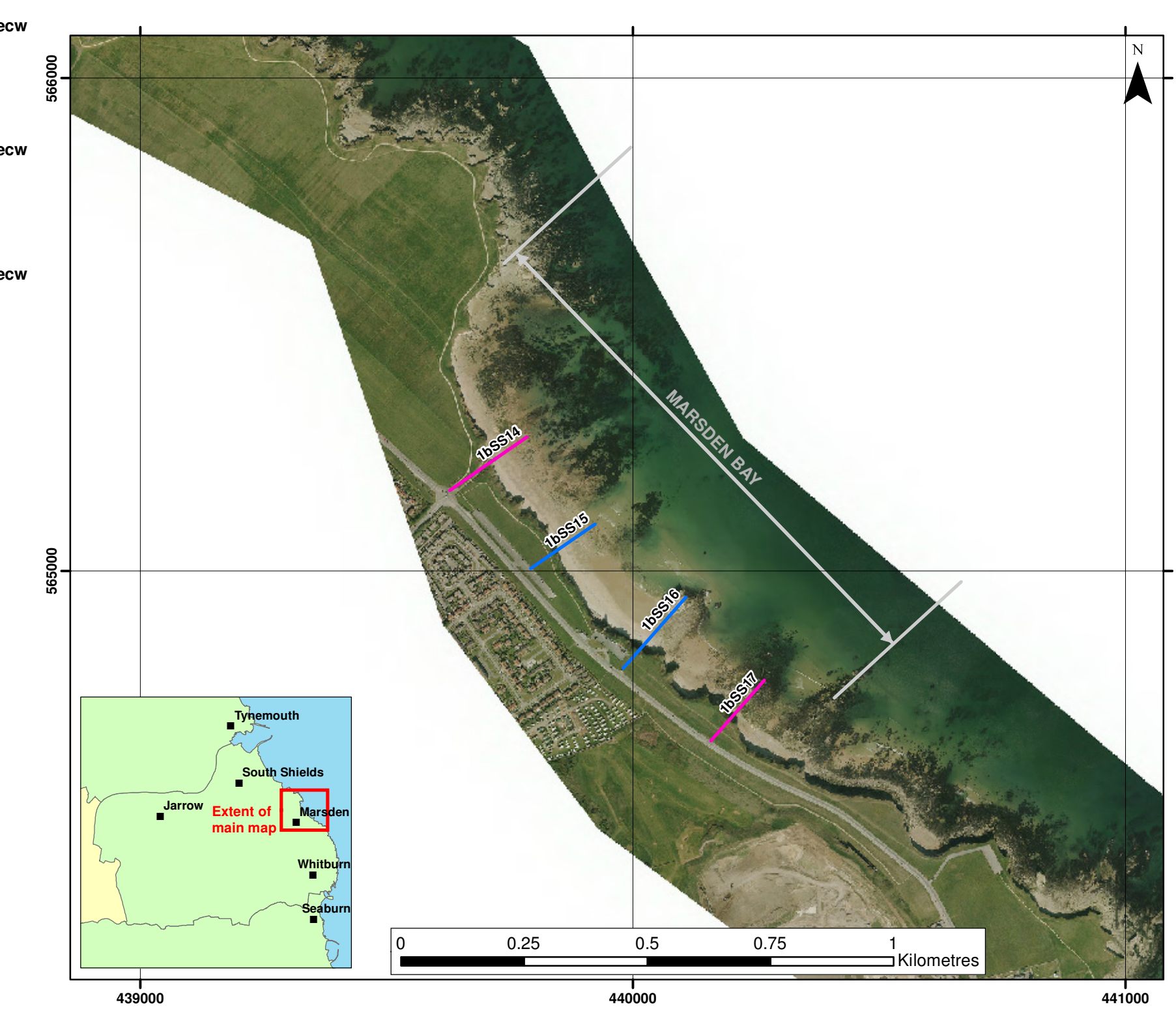

KEY

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
Marsden Bay
South Tyneside Council

Analytical Report 6
Full Measures Survey
Autumn 2013

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3. Analysis of Survey Data

3.1 Littlehaven Beach

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2013	**Beach Profiles:** Littlehaven Beach is covered by four beach profile lines for the Full Measures survey, spaced between South Groyne and South Pier (Appendix A). The previous survey was the partial measures survey undertaken in March 2013 and the previous full measures survey was undertaken in November 2012. Profile **1bSS1** is located to the north of Littlehaven beach, in the lee of a rocky outcrop and South Groyne. As seen in the previous survey the dunes have accreted, with a small increase in height and a similar widening of the dune face. Between the dune and approximately 85m chainage, there is little change in the beach profile. From 85m chainage to the boulders at the seaward end of the profile, the beach level has fallen by up to 0.5m resulting in a slightly steeper beach. The top of profile **1bSS2** to the north of Littlehaven Beach could not be measured due to construction works which were underway. The top of the measured profile where it has been measured is significantly lower than previous profiles (in the region of 0.5m lower), which is the result of large volumes of sand being moved during construction to protect the works. The lower part of the profile, from 80m chainage to the seaward end of the profile, shows little change since the previous survey in March 2013. The top of profile **1bSS3** could also not be measured due to the construction works. As for 1bSS2 the points which have been measured at the top of the profile are considerably lower than the previous survey (over 1m lower) due to large volumes of sand being moved to protect the works. The lower part of the profile, 30m chainage and seawards, shows some erosion with beach levels being between 0.1m and 0.5m lower than the March 2103 survey. A new outfall has been constructed to the north of 1bSS3, approximately 10m from and running roughly parallel to the survey line. This should be considered in future surveys. Access to the top of profile **1bSS4** was also limited by the construction works. The profile measurements begin at around 60m chainage. From this chainage to 135m the profile has eroded and	The trends identified since the last survey were affected by the construction works in progress at the time of the November 2013 survey. The top of the profiles had been artificially changed and access limitations restricted the survey. The section near MLW of the northernmost profiles show little change, while the same area of the southernmost profiles show some erosion. **Longer term trends:** The sand dunes at profile **1bSS1** are at the highest level of all the surveys to date and a general trend of accretion of the dunes can be identified since 2008. Beach levels have varied across the surveys for all profiles, but there is no clear trend. Where the profiles have not been directly affected by the construction works, the current surveys are within the bounds of previous surveys.

Survey Date	Description of Changes Since Last Survey	Interpretation
	steepened, cutting back by up to 0.8m. From 135m chainage and seawards however the profile has accreted slightly (about 0.2m).	
Nov 2013	**Topographic Survey:** Littlehaven Beach is covered by bi-annual topographic survey between the South Groyne and the South Pier, which commenced in March 2010. Data from the most recent topographic survey (full measures, autumn 2013) have been used to create a DGM (Appendix B – Map 1a) using GIS. A difference plot has also been produced using the DGM (Appendix B – Map 1b) produced from the last produced topographic survey (partial measures, spring 2013) and the present survey. In particular, the difference plot shows: (i) general stability, with elevation increase and decrease being less than 0.2m across the beach (ii) a wide band of small elevation decrease along the toe of the beach and a parallel band of small elevation increase towards the shore which widens at either end of the bay in the lee of the breakwaters (iii) patches of elevation decrease at the back of the beach, which are likely to be the result of construction works in progress at the time of the survey. **Longer Term Topographic Trends Autumn 2010 to Autumn 2013:** The long term difference plot (Appendix B – Map 1c) shows a general pattern for a small increase in beach level across the lower half of the beach that extends across much of the beach at the northern end in the lee of the breakwater. In contrast, the back of the beach there is consistent elevation decrease, particularly in the middle of the bay where over a metre has been eroded. This is likely to be the result of construction works in progress at the time of the survey.	Comparison of the present topographic survey with the previous partial measures (spring, 2013) shows that the beach is generally stable with bands of elevation increase at the beach toe and decrease on the middle and upper beach, indicating seawards movement of the bar feature. There are significant changes in level at the back of the beach in the middle of the bay, most likely the result of construction works at the time of the survey. **Long term topographic trends Autumn 2010 to Autumn 2013:** The plot shows an overall pattern of increased beach levels along the toe of Littlehaven Beach, and to the north of the bay. This is backed by a band of decreased levels, indicating cross shore movement of material. There is a trend of increased beach levels in the lee of the northern breakwater. These changes in level are small indicating a stable beach. There is a drop in beach level at the toe of the sea defence which can be attributed to construction works in progress. This location will be reviewed following future surveys.

Plate 1 – Survey photograph 1bSS3_20131119_N1.JPG (Shows new and realigned Littlehaven seawall)

Plate 2 – Survey photograph 1bSS4_20131119_N1.JPG (Works underway to Littlehaven seawall)

3.2 Herd Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2013	**Beach Profiles:** Herd Sands is covered by five beach profile lines for the Full Measures survey (Appendix A). The previous survey was the partial measures survey in March 2013 and previous to that the Full Measures survey was completed in November 2012. Profile **1bSS5** is located to the north of Herd Sands and is in the lee of the breakwater. The dunes have largely retained a similar form to the previous survey but have increased in height between 0m and 85m chainage. Sand fences were constructed on these dunes in 2012 to encourage accretion; the increase in dune height indicates the fences have been successful. From 135m chainage seawards the profile exhibits a mixture of erosion and accretion. The berm present at HAT in the March 2012, survey, which was not present in the March 2013 survey, has reformed at a slightly lower level (180m chainage, elevation 2.65mAOD). Seaward of the berm the beach has eroded and steepened compared to the previous (March 2013) survey. The survey report noted that a ship wreck hull was visible, which has never before been observed. This indicates very low beach levels around 10m to the north of 1bSS5 at around 280m chainage. Profile **1bSS6** and **1bSS7** were last surveyed in November 2012. Profile **1bSS6** shows some variation since the previous survey in November 2012. At the top of the profile, between 15m and 100m chainage, the dunes have accreted with an increase in height of up to 0.8m at the back face of the primary dune ridge and 0.2m at the top. On the beach profile, the berm present between HAT and the primary dune face in the previous survey has moved slightly seawards to around HAT and increased in size. Below this berm, at around 260m chainage, a dip has developed in the beach profile and another berm has formed below this at the toe of the profile (at around 280m chainage). Profile **1bSS7** is located at the centre of Herd Sands. Along this profile the berm crest located above HAT has moved seawards and increased slightly in size (moving from about 3.8mOD to about 3m mAOD). The beach below this feature has steepened. As a result of this, between 30m and 65m chainage beach levels have fallen by up to 0.6m and between 0.65m and1.2m chainage they have risen by up to 1m. Below the berm feature the beach level has dropped by about 0.5m. Profile **1bSS8** shows the development of a berm at about 3.8mAOD (20m to 60m chainage), with beach	On most profiles berm features have developed or increased in size above HAT, and on many profiles an additional berm has developed towards the toe of the profile. This could be a seasonal trend, with wave action moving material up the beach, building up the berms. The beach level below the berm (or where two are present between the berms) has lowered on all profiles. As the berms on the upper beach have accreted it is possible that this material has been moved up the beach by wave action. It was noted in the survey report that the beach level lower on the beach has dropped and the hull of the ship wreck near 1bSS5 has been exposed. The upper beach has however accreted indicating that this material may have been moved up the beach by a period of exceptional wave action. Future surveys will indicate whether the lower beach will continue to erode or recover. **Longer term trends:** The beach profile forms observed in the November 2013 profile survey shows more distinct berm features than previous surveys. As a result the beach levels at the berm crest(s) is towards the higher bounds of previous surveys, but the beach levels adjacent to the berm(s) are towards the lower bounds, often being the lowest recorded to date. This is due to a reshaping of

Survey Date	Description of Changes Since Last Survey	Interpretation
	levels in this region increasing by up to 1.4m. Below this feature, down to 125m chainage, the beach has eroded but a second berm at the toe of the profile resulting in accretion from 125m seawards. Profile **1bSS9** is located to the south of Herd Sands. Beach levels across the profile have dropped by up to 1m here since the previous Full Measures survey. Since the March 2013 survey, however, the berm feature has accreted by up to 0.8m between 35m and 70m chainage and below this the beach levels have dropped by between 0.3m to 0.7m.	the beach rather than net erosion or accretion.
Nov 2013	**Topographic Survey:** Herd Sands is covered by an annual topographic survey between the South Pier and Trow Point, which commenced in November 2008. Data from the most recent topographic survey (full measures, autumn 2013) have been used to create a DGM (Appendix B – Map 2a) using GIS. A difference plot has also been produced using the DGM (Appendix B – Map 2b) produced from the last topographic survey (full measures, autumn 2011) and the present survey. The difference plot shows parallel bands of erosion and accretion with change of up to 1m, as bars move across the beach. The back of the beach, particularly in the north, shows a very patchy distribution of lower magnitude change **Longer Term Topographic Trends Autumn 2010 to Autumn 2013:** The long term difference plot (Appendix B – Map 2c) reporting net change in beach levels between autumn 2010 and autumn 2013 shows a very similar pattern to that seen over the short term. The plot shows general accretion of the upper beach of up to 2m in places, and erosion of the lower beach by up to 1m. The back of the beach in the north again shows a patchy distribution of lower magnitude change.	Comparison of the present topographic survey with the previous full measures (autumn, 2013) shows a consistent pattern of sand bars migrating over the shore face, giving alternating parallel bands of erosion and accretion. This agrees with the beach profile data. **Longer term topographic trends Autumn 2010 to Autumn 2013:** The plot shows general trend of an accretion of the upper beach and erosion along the lower beach. However, the data record is limited and this apparent trend may not be representative.

3.3 Trow Quarry (incl. Frenchman's Bay)

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2013	**Beach Profiles:** Trow Quarry is covered by four beach profile lines for the Full Measures survey (Appendix A), two in Graham's Sand and two in Southern Bat. The previous survey was the partial measures survey undertaken in March 2013. Profiles **1bSS10** and **1bSS11** are located in Graham's Bay. At profile **1bSS10** the backshore has remained stable. The beach levels along the boulder beach then decrease slightly (maximum of 0.5m). The sand beach then shows an increase in level down to approximately 71m chainage. The berm feature previously present at approximately 71m chainage is no longer present and the toe of the profile is steeper. This could indicate loss of material offshore or the berm may have been moved seawards outside of the survey extents. At profile **1bSS11,** the profile has remained stable. The small changes in level are most likely attributable to the movement of cobbles rather than a change in beach level. Profile **1bSS12** and **1bSS13** are located in Southern Bay. At both locations the beach profile has remained stable since the previous survey. Any small changes in level which can be identified are most likely attributable to the movement of cobbles rather than a change in beach level.	At both Graham's Bay and Southern Bay, the cliff and rock revetment have remained stable. At Graham's Bay, the upper cobble/boulder beach has remained fairly stable, however, at the western end the sand beach has reshaped and the berm is no longer present. At Southern Bay, the rocky foreshore has generally retained the same form and position. **Longer term trends:** Beach levels at profile 1bSS10 from 75m chainage seawards are the lowest observed since 2008 and result in a much steeper profile toe. Otherwise, overall the beach at Graham's Bay and Southern Bay has retained the same form and position since November 2008.
Nov 2013	**Topographic Survey:** Trow Quarry is covered by an annual topographic survey within Graham's Sand, Southern Bay and Frenchman's Bay, which commenced in November 2008. Data from the most recent topographic survey (full measures, autumn 2013) have been used to create a DGM (Appendix B – Map 2a) using GIS. A difference plot has also been produced using the DGM (Appendix B – Map 2b) produced from the last topographic survey (full measures, autumn 2011) and the present survey. The difference plot shows a complex pattern of change in beach elevation with small areas of up to 2m change on and around the headlands that separate Graham's Sand and Southern Bay, and Herd Sands from Trow Quarry. This may reflect movement of cobbles, or be attributed to the data interpolation errors.	**Topographic Survey:** Trow Quarry is covered by an annual topographic survey within Graham's Sand, Southern Bay and Frenchmans Bay, which commenced in November 2008. Data from the most recent topographic survey (full measures, autumn 2013) have been used to create a DGM (Appendix B – Map 2a) using GIS. A difference plot has also been produced using the DGM (Appendix B – Map 2b) produced from the last topographic survey (full measures, autumn 2011) and the present survey.

Survey Date	Description of Changes Since Last Survey	Interpretation
	Longer Term Topographic Trends Autumn 2010 to Autumn 2013: The long term difference plot (Appendix B – Map 2c) shows the net change in beach levels between autumn 2010 and autumn 2013. The pattern and magnitude of change is very similar to that seen over the short term, with are pockets of beach elevation reduction and increase interspersed across the beach. The increase in elevation on and around the headlands that separate Graham's Sand and Southern Bay, and Herd Sands form Trow Quarry, can be attributed to the data interpolation methods used to create the difference grids.	The difference plot shows a sporadic change in beach elevation with no clear trends. The increase in elevation on and around the headlands that separate Graham's Sand and Southern Bay, and Herd Sands form Trow Quarry, can be attributed to the data interpolation methods used to create the difference grids. In the past there have been works to deal with health and safety hazards due to unstable cliff formations in this area; if this has occurred again this year, then a small amount of change could be due to debris from cliff falls. **Longer Term Topographic Trends Autumn 2010 to Autumn 2013:** The long term difference plot (Appendix B – Map 2c) shows the net change in beach levels between autumn 2010 and autumn 2013. There are pockets of beach elevation reduction and increase interspersed across the beach. The increase in elevation on and around the headlands that separate Graham's Sand and Southern Bay, and Herd Sands form Trow Quarry, is likely to be due to the data interpolation methods used to create the difference grids.
Nov 2013	**Cliff-top Survey:** Cliff top survey data collected for baseline survey (autumn, 2011), the partial measures survey (spring, 2012), the full measures survey (autumn, 2012), partial measures survey (spring, 2013) and the present full measures survey (autumn, 2013) is presented in this report. Six ground control points (numbered points 1 to 6) were established along the cliff top at Trow Point in 2008 to monitor cliff erosion at the site of a former landfill. 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	**Cliff-top Survey:** Six ground control points (numbered points 1 to 6) are established along the cliff top at Trow Point and distance to cliff edge data have been collected since Sept 2011. Results show that erosion can only reliably be identified at locations 1, 3 and 6, with error at other

Survey Date	Description of Changes Since Last Survey	Interpretation
	Appendix C – Map 1 for the location of ground control points. These cliff top surveys are undertaken bi-annually. Measurements are taken from each ground control point along a fixed bearing to the edge of the cliff top. The results from the cliff top monitoring are anticipated to have an accuracy of ±0.1m due to the technique used. The results from the cliff top survey are presented in Appendix C – Table C1, showing the position from the ground control point to the edge of the cliff top along a defined bearing. Results show that erosion was recorded at five points since the last survey, with up to 0.6m loss measured. However, since the baseline survey, the long-term erosion rate is only significant at points 1 and 6 where 0.3m/yr and 0.1m/yr erosion have occurred. Despite recording some change between consecutive surveys, error in measurements means there is no net change at the intervening locations The monitoring work currently extends across a short time period of 5 years; further years of monitoring are required to enable a better understanding of the average trends.	locations indicating no net change. The erosion at point 3 is very low and therefore the calculated long-term erosion rate is too low to be reliable. The long-term rates for points 1 and 6 are more reliable at 0.3 and 0.1m/yr respectively. The small changes seen may relate to works undertaken by National Trust to remove unstable overhangs due to health and safety concerns. Further years of monitoring are required to enable a better understanding of the average trends.

3.4 Marsden Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2013	**Beach Profiles:** Marsden Sands is covered by four beach profile lines for the Full Measures survey (Appendix A). The previous survey was the partial measures survey undertaken in Autumn 2013 and the previous full measures survey was undertaken in March 2012. Profile **1bSS14** is located to the north of the bay and covers the cliff and the former lifeguard station adjacent to the Redwell Steps. The cliff has retained the same form and position since the last survey. It does show a small increase in level but this is likely to be due to the thicker vegetation cover noted in the survey reports or a variation in the survey points measured. The sand beach has steepened with accretion of up to 1.2m at the toe of the sea defence down to 135m chainage, and erosion of up to 1.3m below this. This is the reverse of the change observed in the previous survey (March 2013) and the beach profile now shows very similar levels to the previous full measures survey in November 2012.	Along the length of Marsden Bay, the cliff has retained the same form and position as the previous surveys. To the north, profile **1bSS14** has steepened with accretion of the upper beach and erosion of the lower beach. The profile has returned to similar levels to those recorded in March 2013. **1bSS15** has remained stable with only a very small drop in beach level. Profiles **1bSS16** and **1bSS17** show some lowering of the sand/gravel part of the beach.

Survey Date	Description of Changes Since Last Survey	Interpretation
	This indicates that the beach is expressing seasonal changes, with material being transported up the beach during the calmer summer period. At profile **1bSS15** the cliff has retained the same form and position since the last survey. Beach levels across the profile have increased slightly (by up to 0.2m) from 74m chainage seawards. There is a slight decrease in level at the toe of the cliff, but this is small enough to be the result of the movement of cobbles and cliff material, rather than a change in beach volume. At Profile **1bSS16** the profile suggests that the cliff has advanced seawards, however the survey photographs do not reflect this change and it is likely to be due to survey methods employed and access issues. The beach maintains the same general shape as previous surveys, but a drop in level of up to 0.8m can be observed on the sand/ gravel part of the beach between 76m and 102m chainage. Profile **1bSS17** is located to the south of the bay. The measured profile indicates erosion at the toe of the cliff, at 57m to 65m chainage, with a maximum drop in level of 0.5m. The previous full measures survey noted an increase in sand level here of around 0.3m and comparison with earlier surveys shows that the current beach levels are close to the levels measured in March 2012 and earlier.	**Longer term trends:** Although beach movements are observed since the last survey, the overall changes are within the bounds of changes observed since the first survey in November 2008. The profiles located towards the southern end of Marsden Sands are near the lowest recorded.

4. Problems Encountered and Uncertainty in Analysis

Individual Profiles

During the survey there was limited access to Littlehaven beach as a new sea wall was under construction. As a result surveyors were unable to measure section starts on SS2, SS3, SS4.

Topographic Survey

As with the individual profile survey, there was limited access to Littlehaven beach during the topographic survey as a new realigned (set back) sea wall was under construction. Due to these works, there was also heavy construction traffic in constant movement on the beach plateau (436990, 567930) which could impact upon the survey results.

Cliff Top Surveys

Surveying any cliff top is difficult due to the need for a consistent interpretation of the 'cliff edge' in successive surveys, which can be challenging when vegetation is thick.

For these reasons, it has been assumed that any changes of ±0.2 may be considered as being within the accuracy of the surveying technique and that any indication of an advancing cliff line is error.

Future surveys will provide a longer data-set over which to make comparisons, and therefore provide more clarity to observed trends. Additionally, analysis of aerial photography will provide additional information on rate of cliff erosion.

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

No changes are recommended at the present time.

6. Conclusions and Areas of Concern

- At Littlehaven Beach, the recorded profiles and topographic survey present no causes for concern. This survey was restricted by construction works and the beach profiles had been impacted by artificial movement of sand as part of the works. Future monitoring will identify impacts of the new sea defences on the beach profiles.
- At Herd Sands, the beach profile at 1bSS5 shows the dunes to be accreting, suggesting that the sand fencing installed recently has been successful.
- Elsewhere along Herd Sands, the recorded profiles present no causes for concern. It was noted that the beach level lower on the beach has dropped and the hull of the ship wreck near 1bSS5 has been exposed. The upper beach has however accreted indicating that this material may have been moved up the beach by wave action. Future surveys will indicate whether the lower beach will continue to erode.
- At Trow Quarry, the recorded profiles show no causes for concern. The cliffs to the north west of Trow Headland appear to have been stable and the data does not indicate cause for concern.
- At most of Marsden Bay, the recorded profiles present no causes for concern, although those at the southern part of Marsden Sands are near their lowest recorded level.

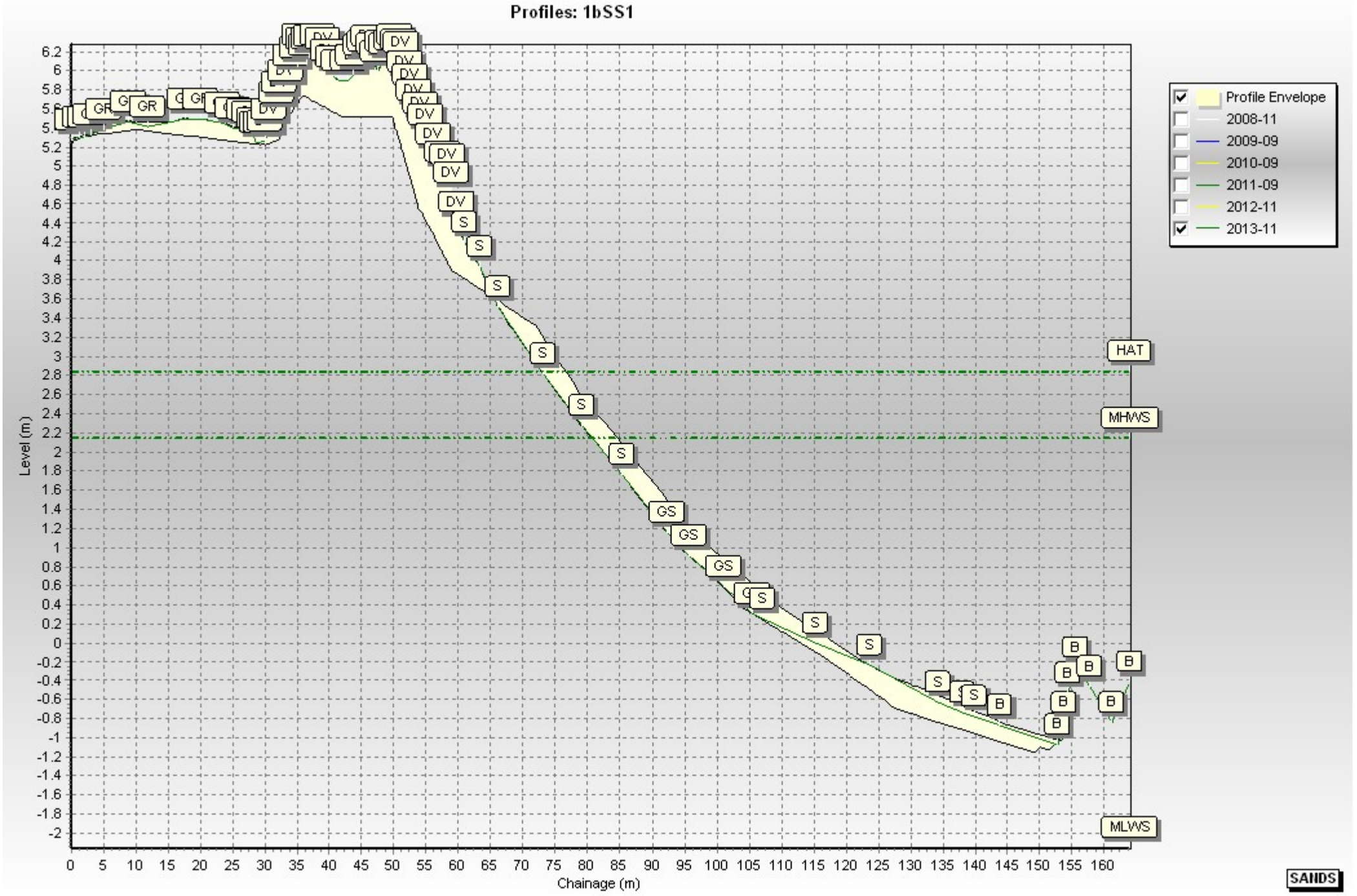
Appendices

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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Profile Envelope
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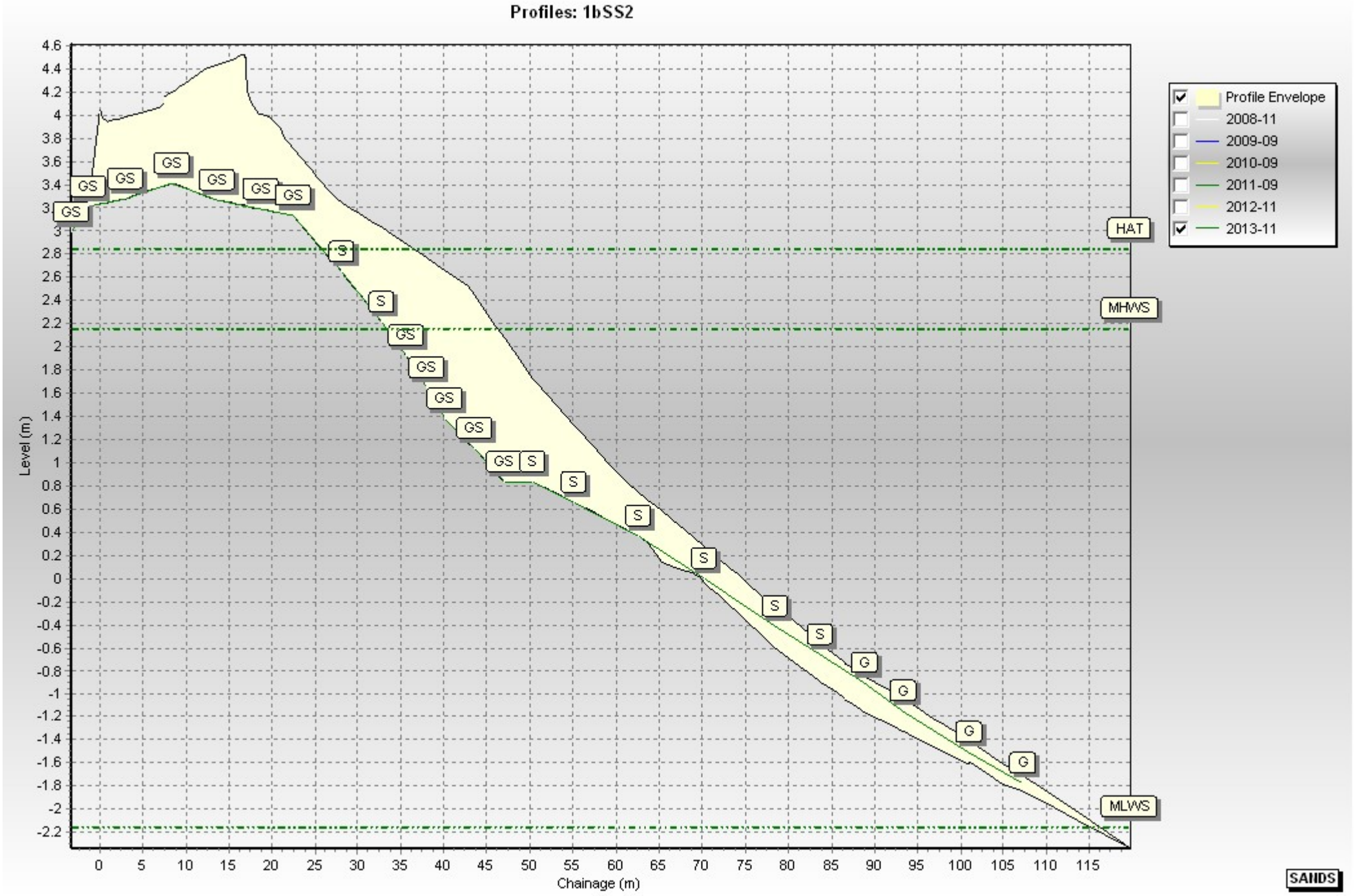
2009-09
2010-09
2011-09
2012-11
2013-11
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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HAT
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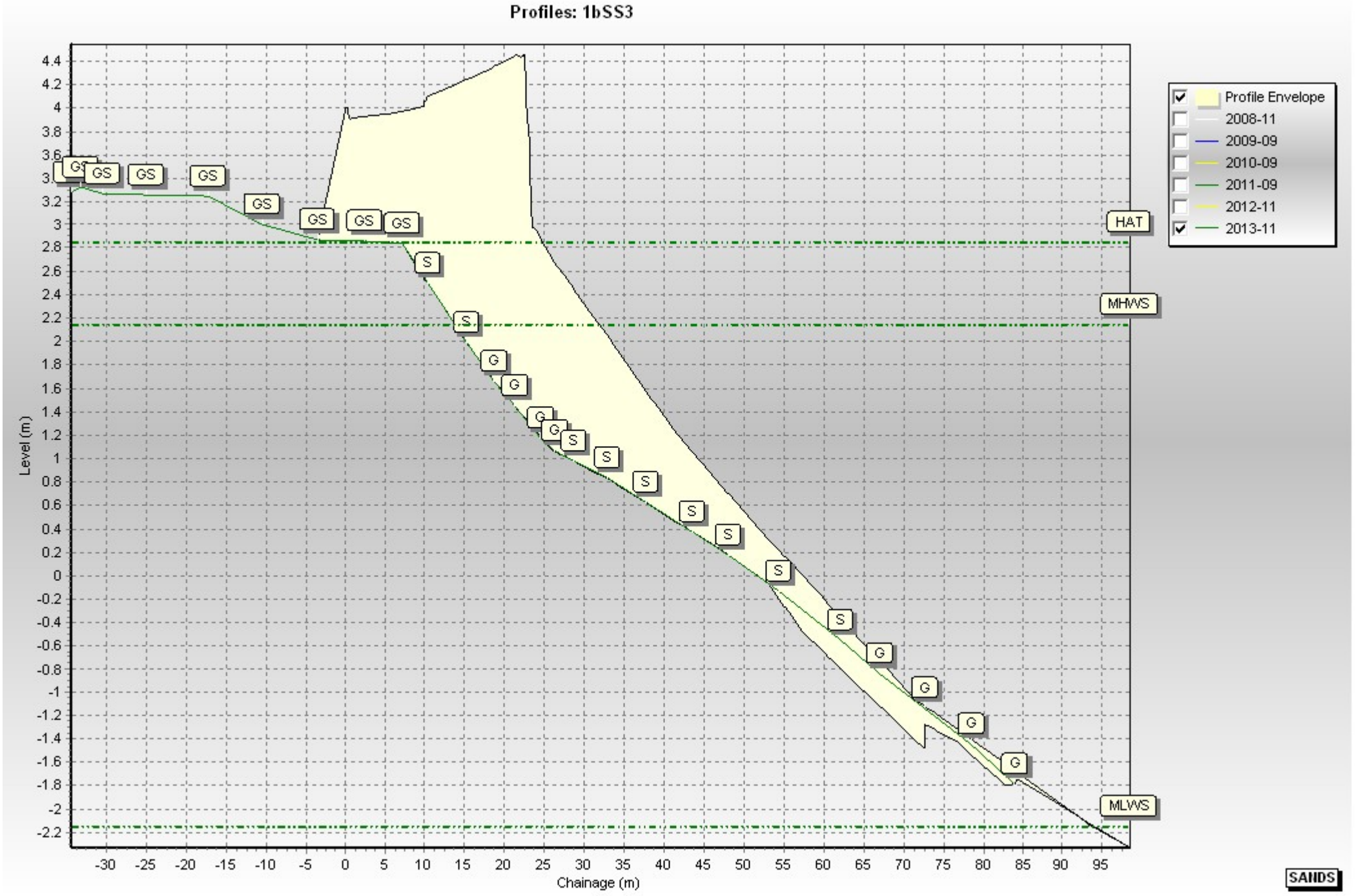
SANDS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Profile Envelope
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HAT
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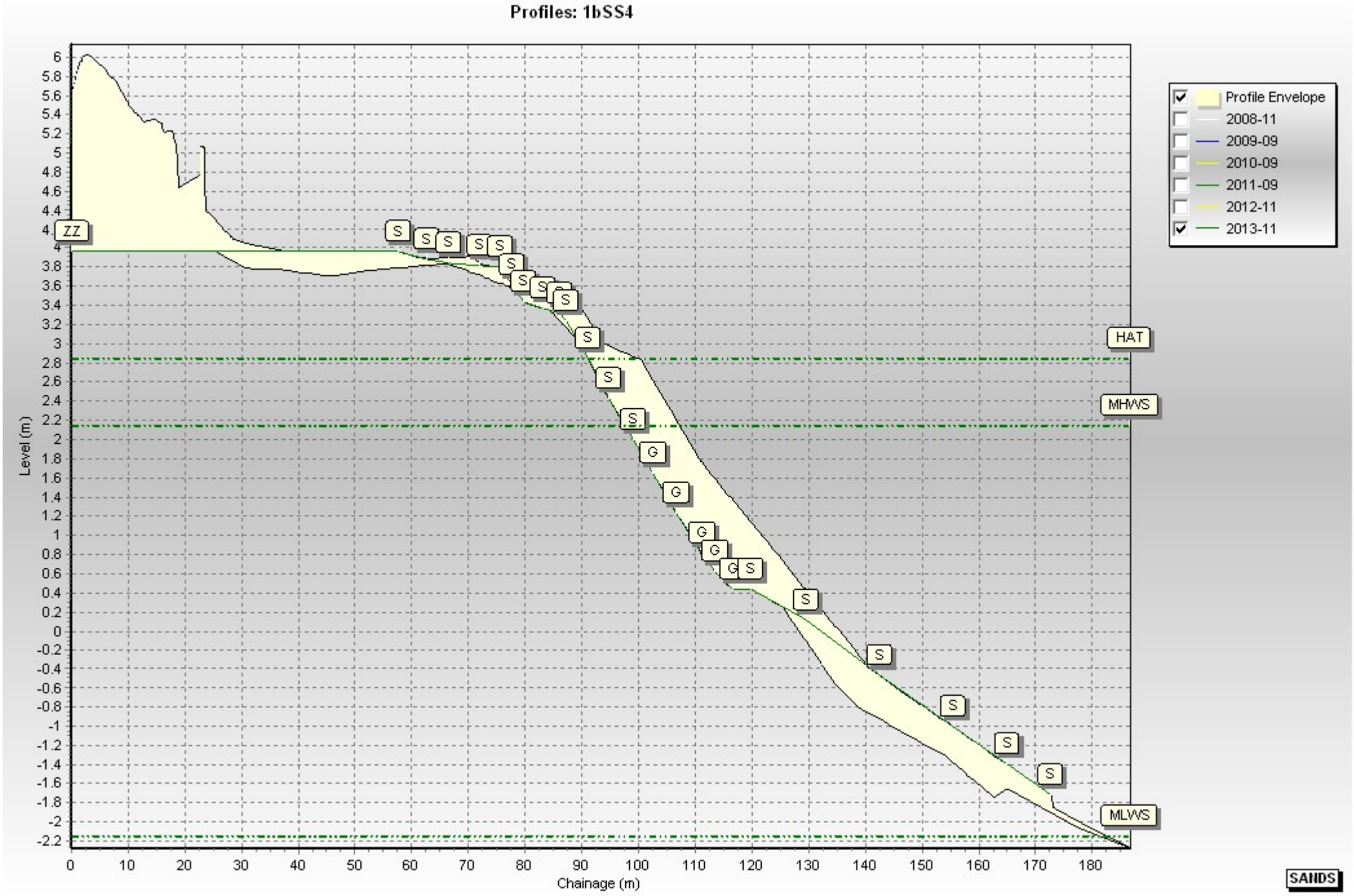
MLWS
Level (m)
Chainage (m)
SANDS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Profile Envelope
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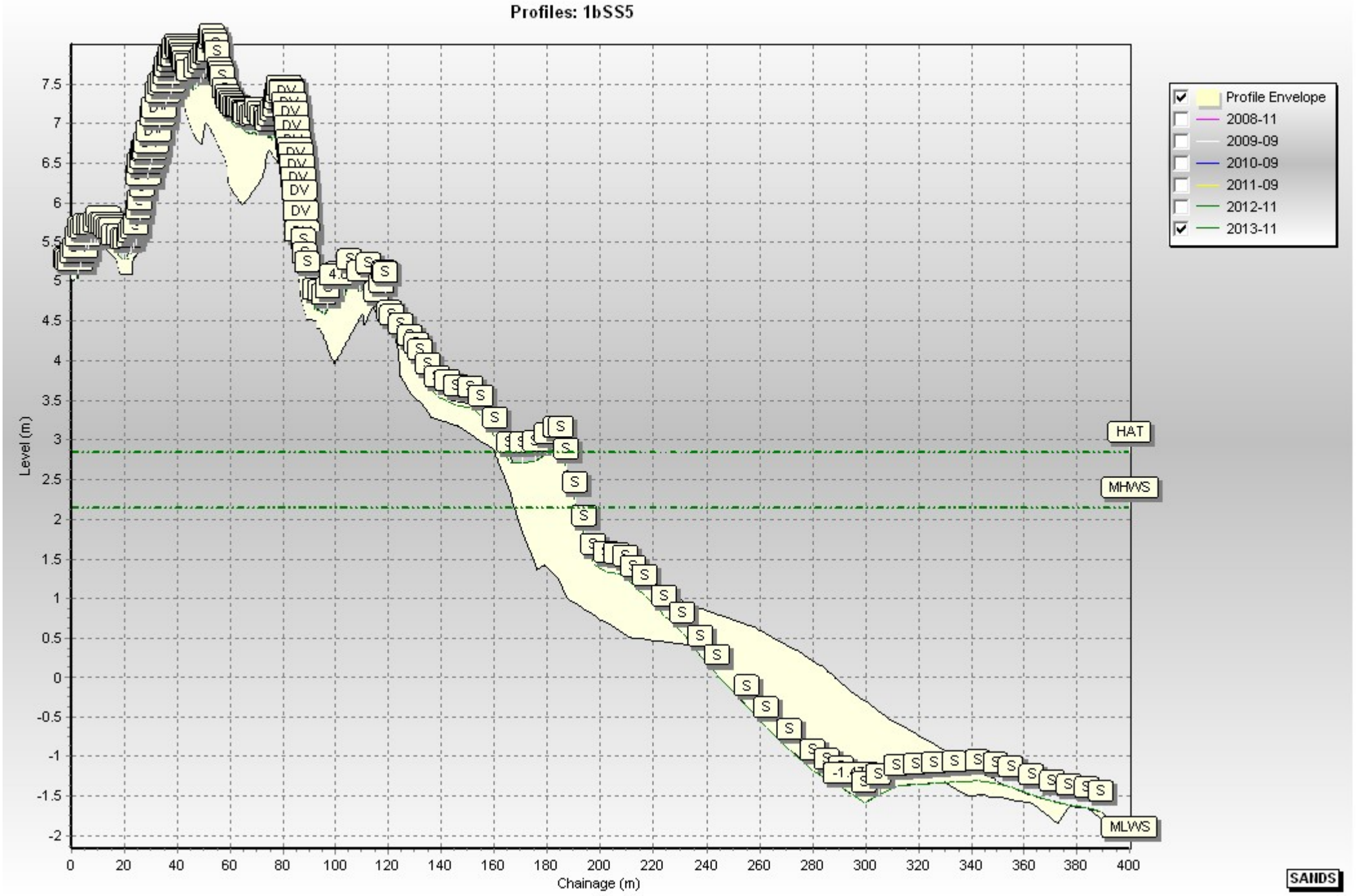
SANDS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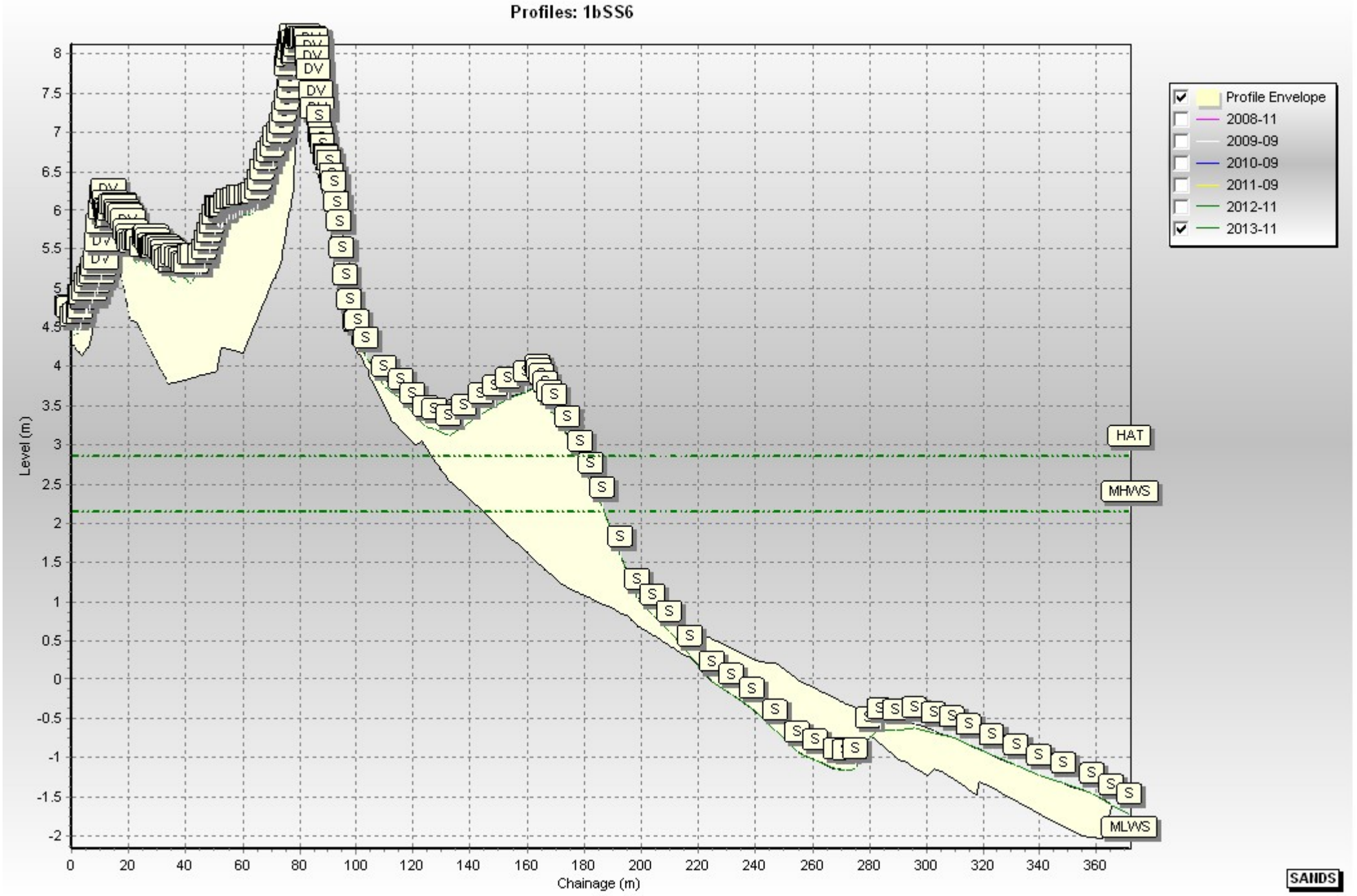
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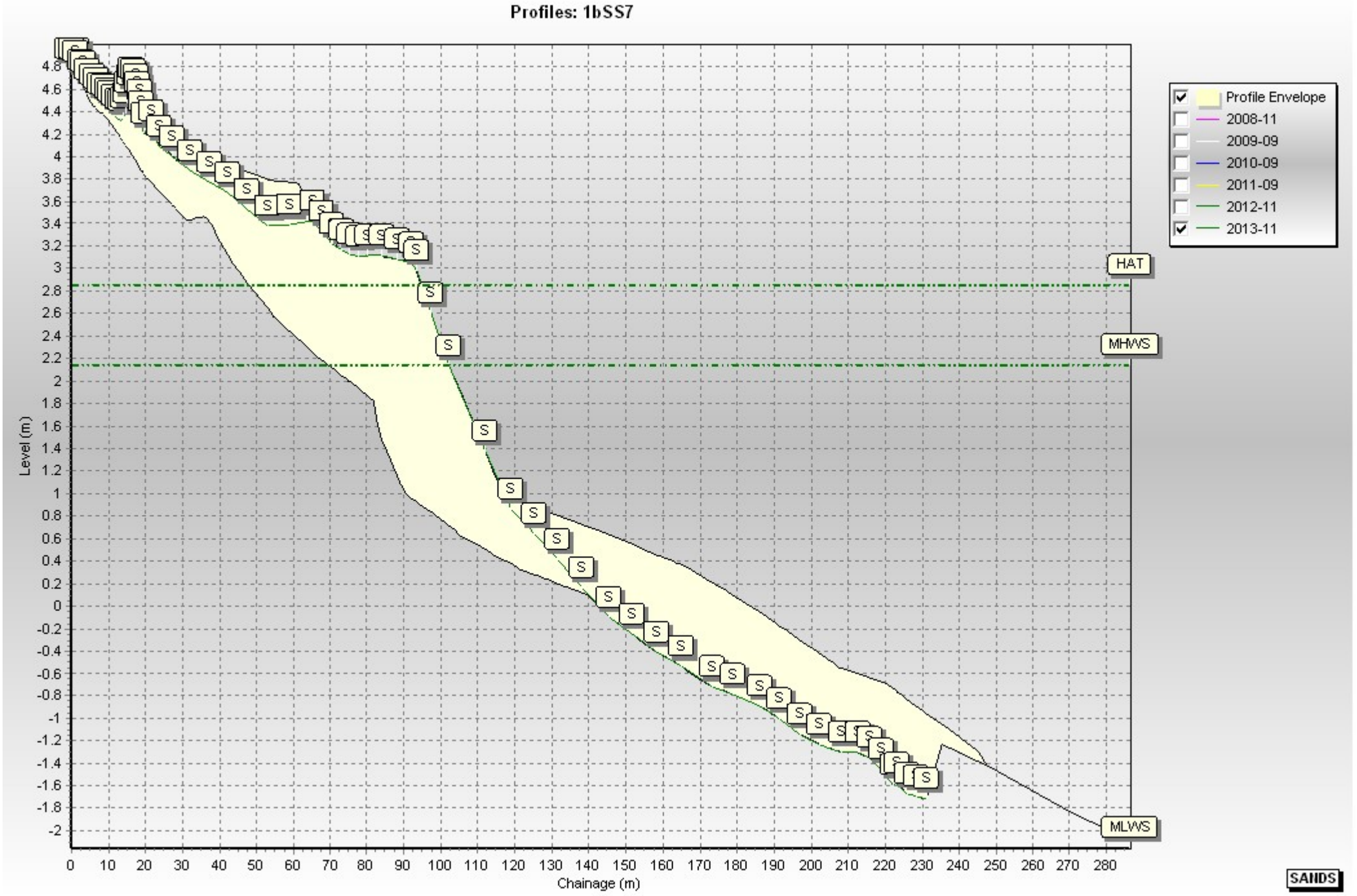
Profiles: 1bSS7
Profile Envelope
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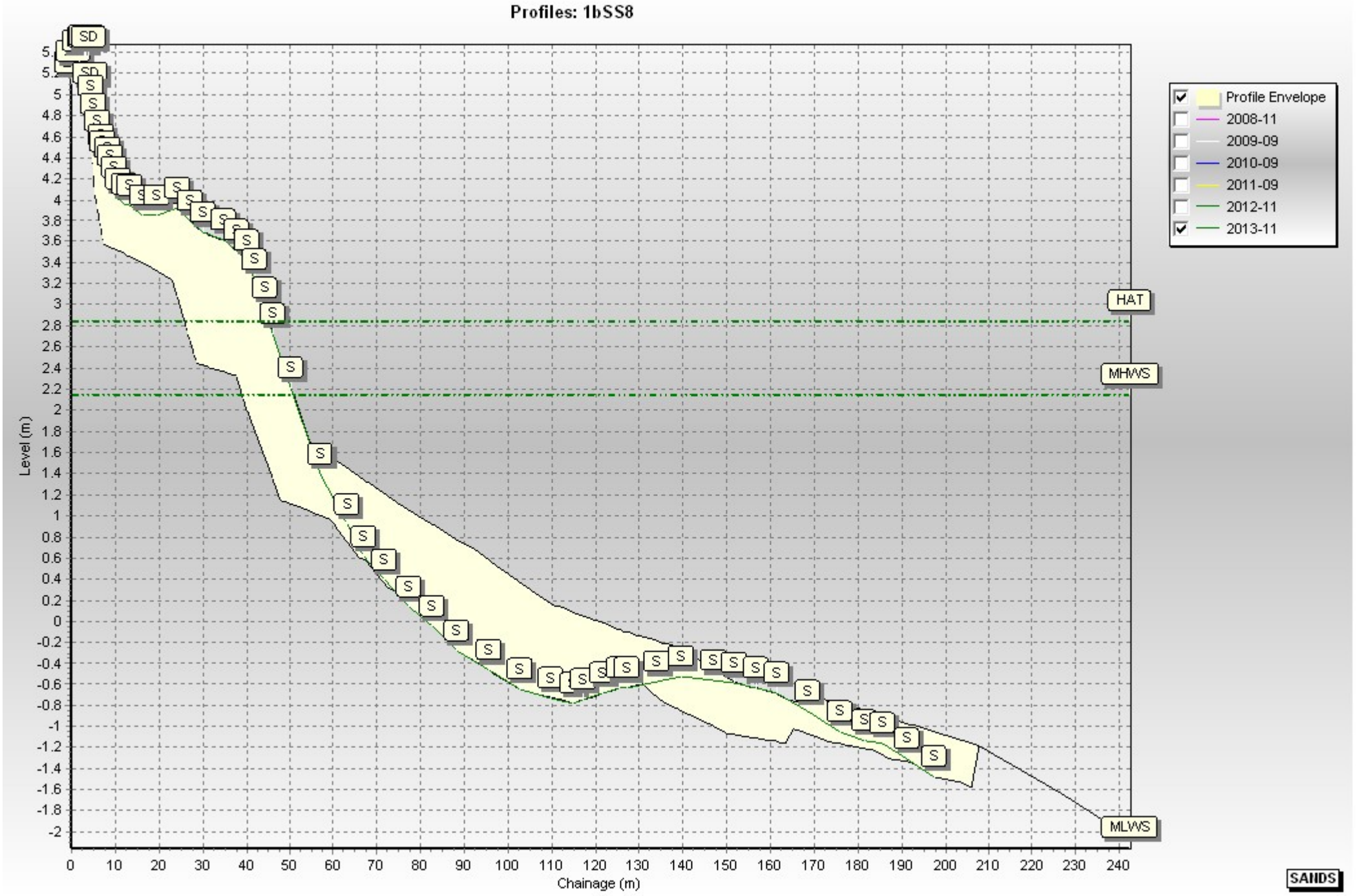
2009-09
2010-09
2011-09
2012-11
2013-11
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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SD
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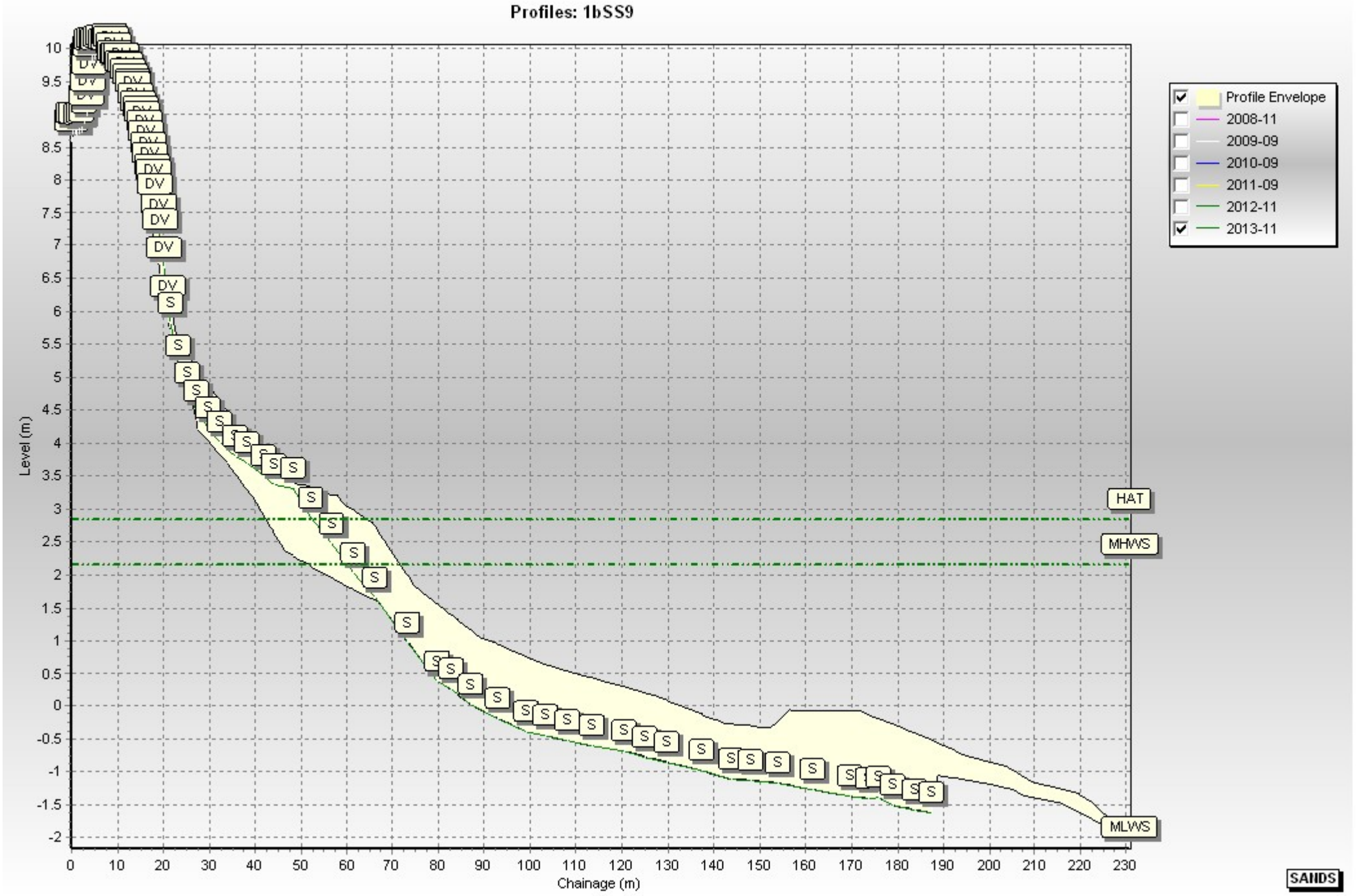
Level (m)
Chainage (m)
SANDS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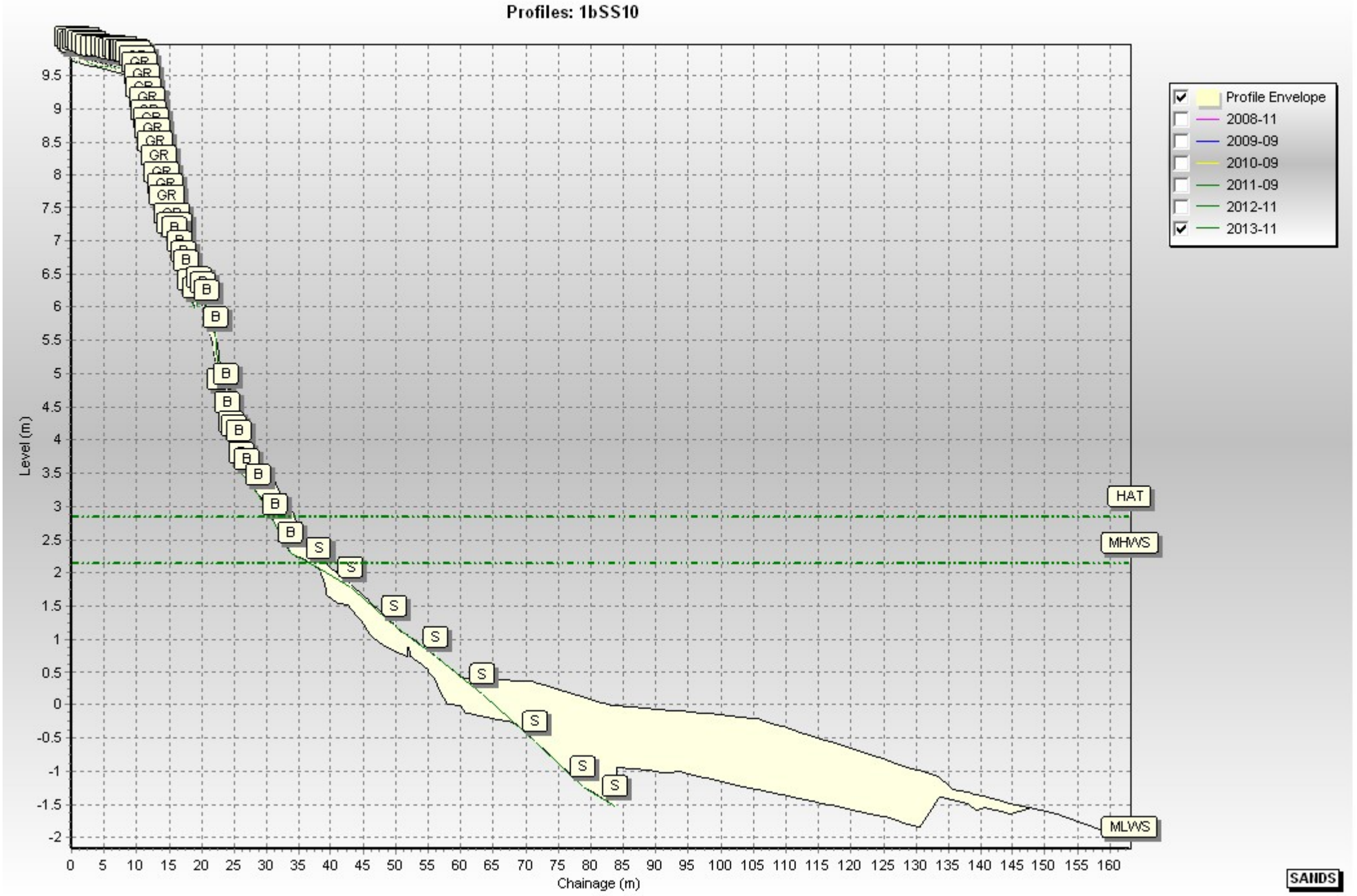
Level (m)
Chainage (m)
SANDS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Level (m)
Chainage (m)
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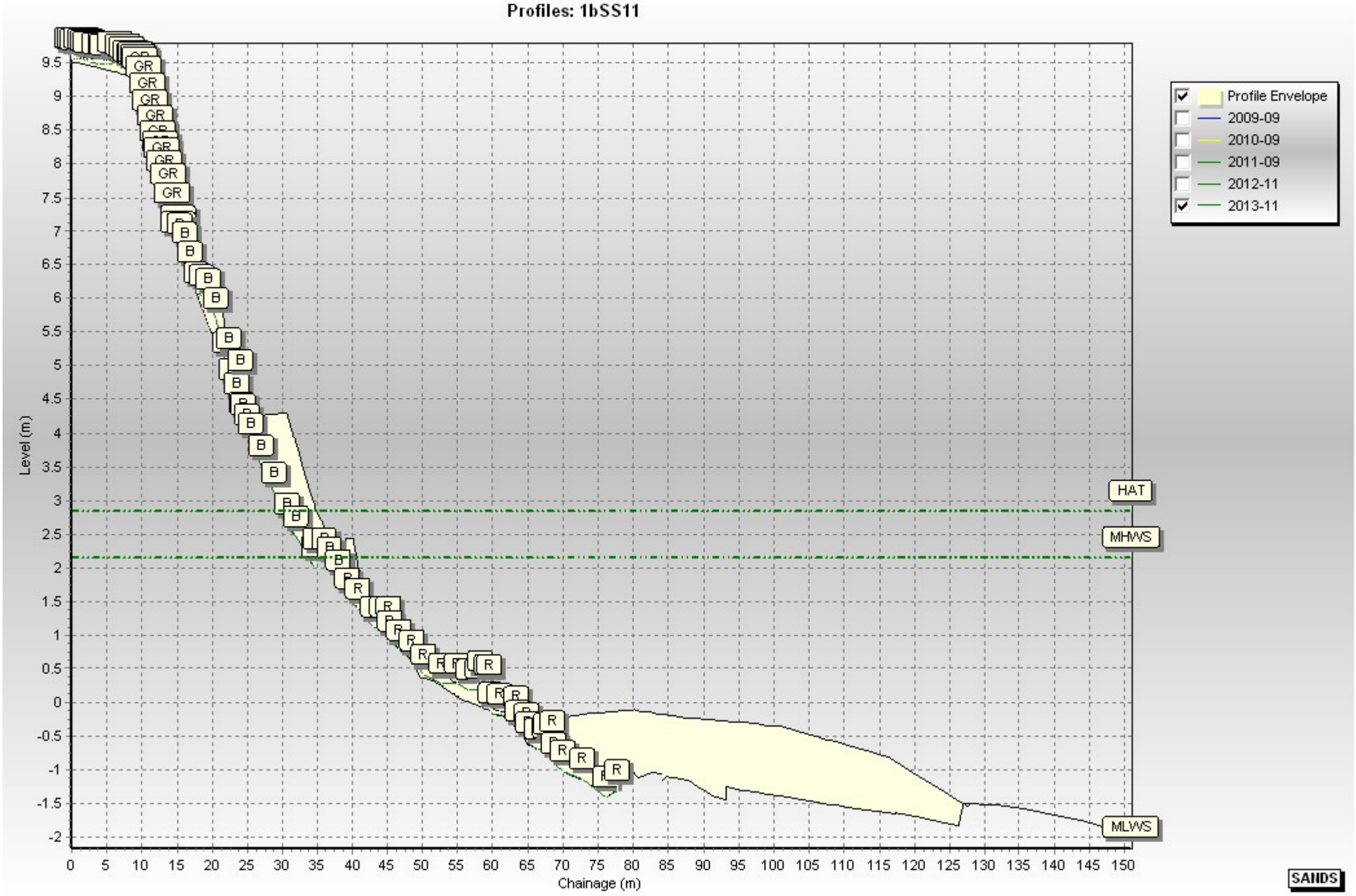
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Level (m)
Chainage (m)
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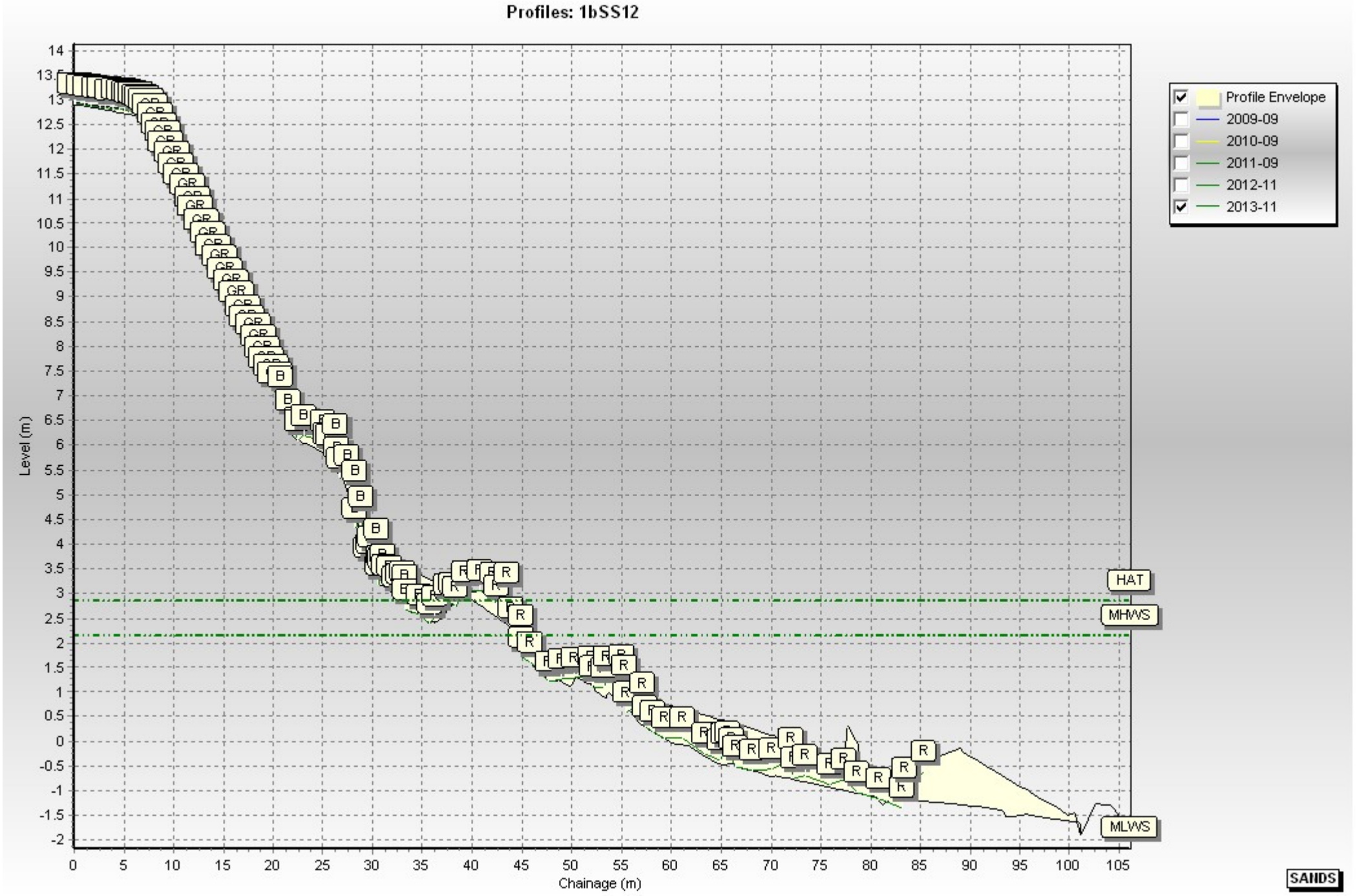
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Level (m)
Chainage (m)
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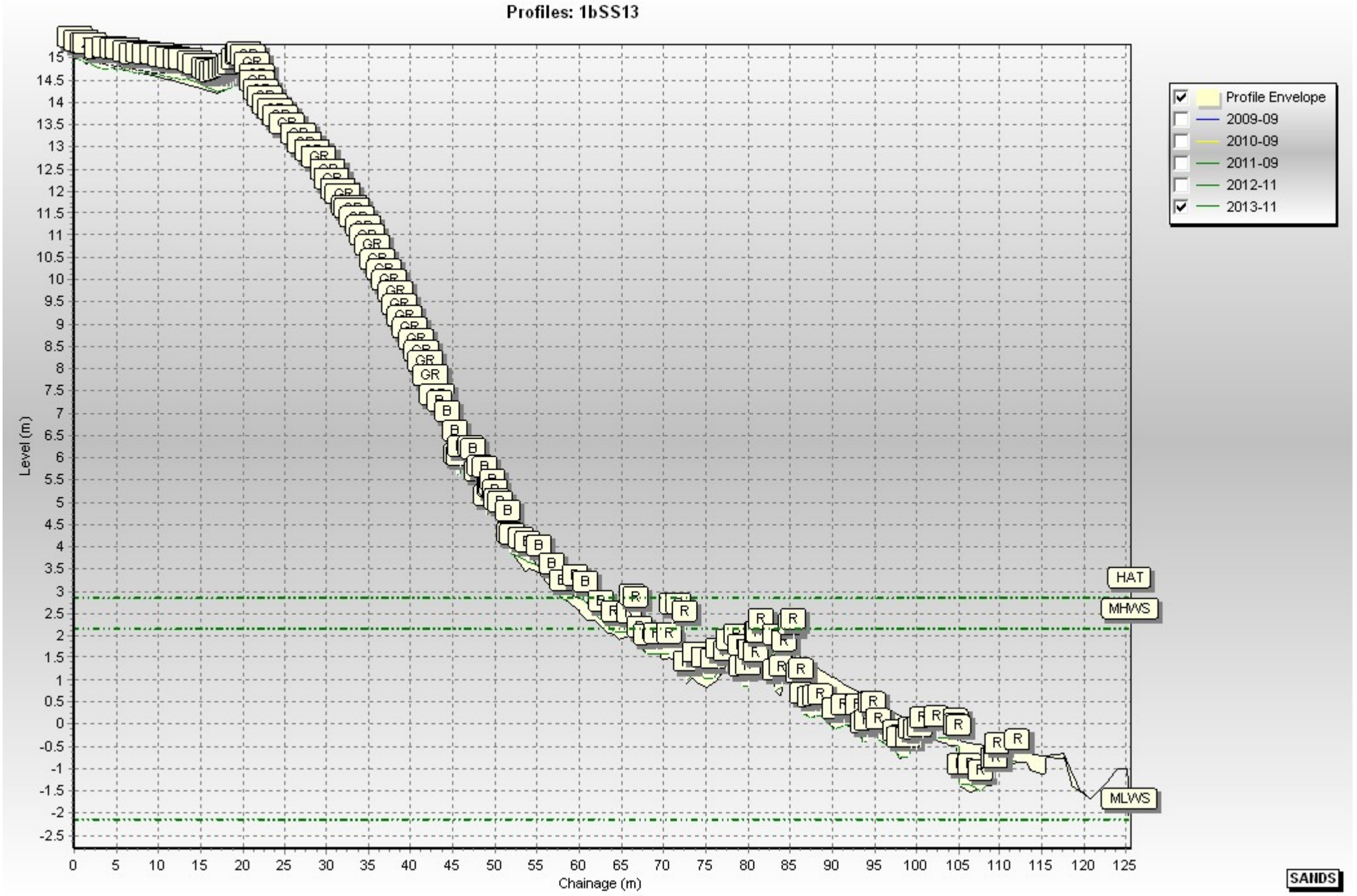
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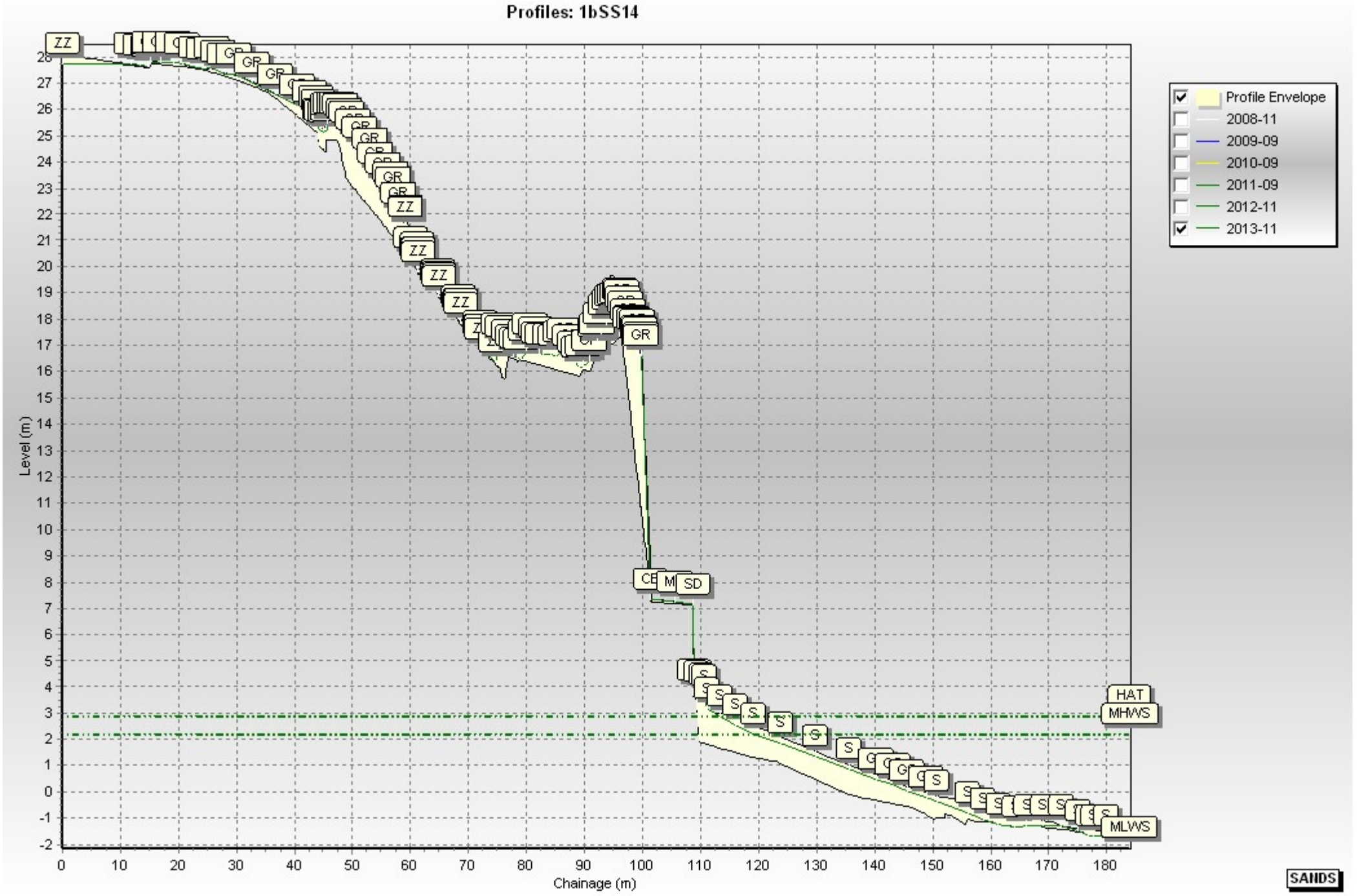
Level (m)
Chainage (m)
SANDS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2011-09
2012-11
2013-11
Level (m)
Chainage (m)
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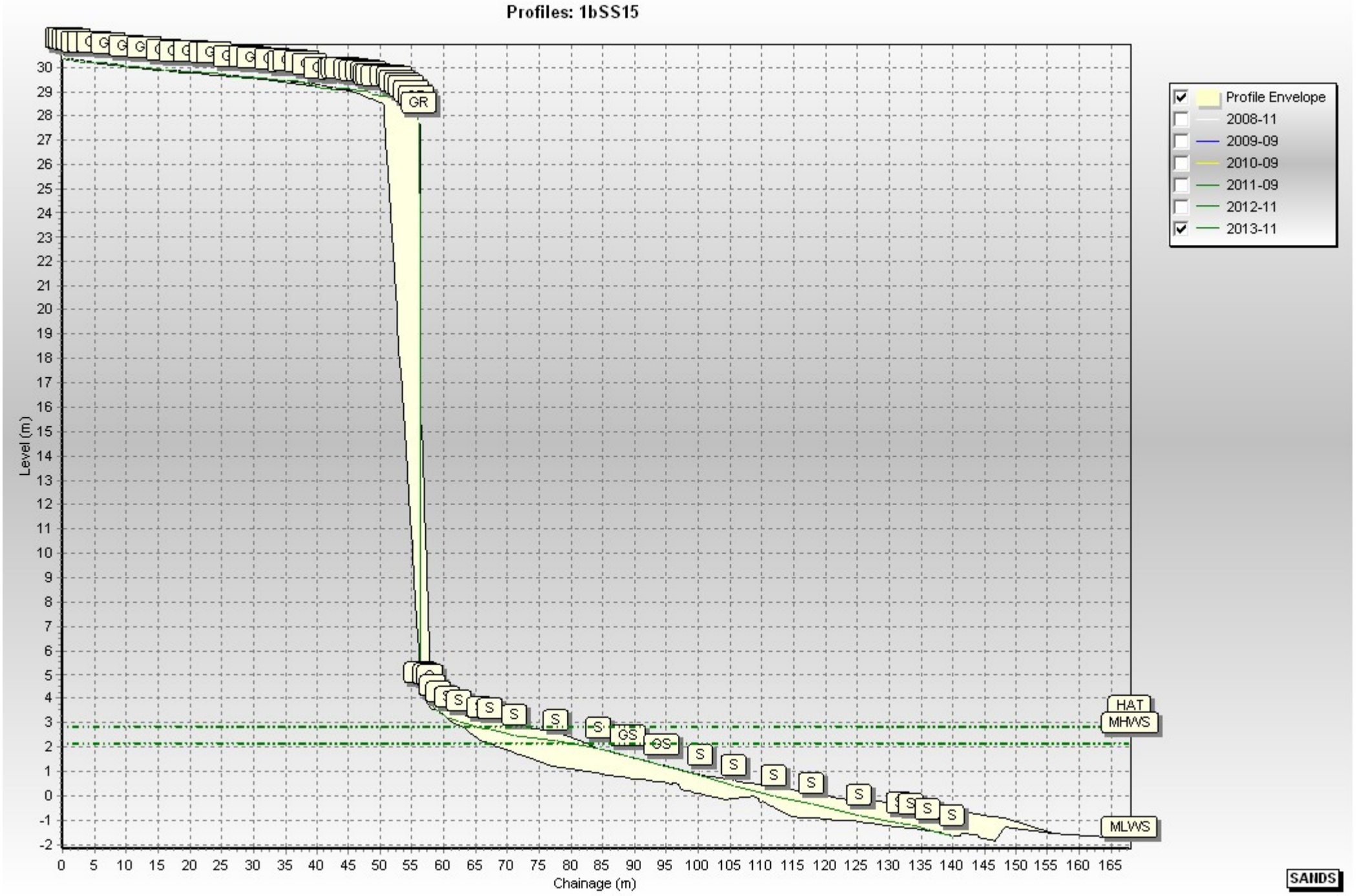
MHWS
MLWS
SD
SANDS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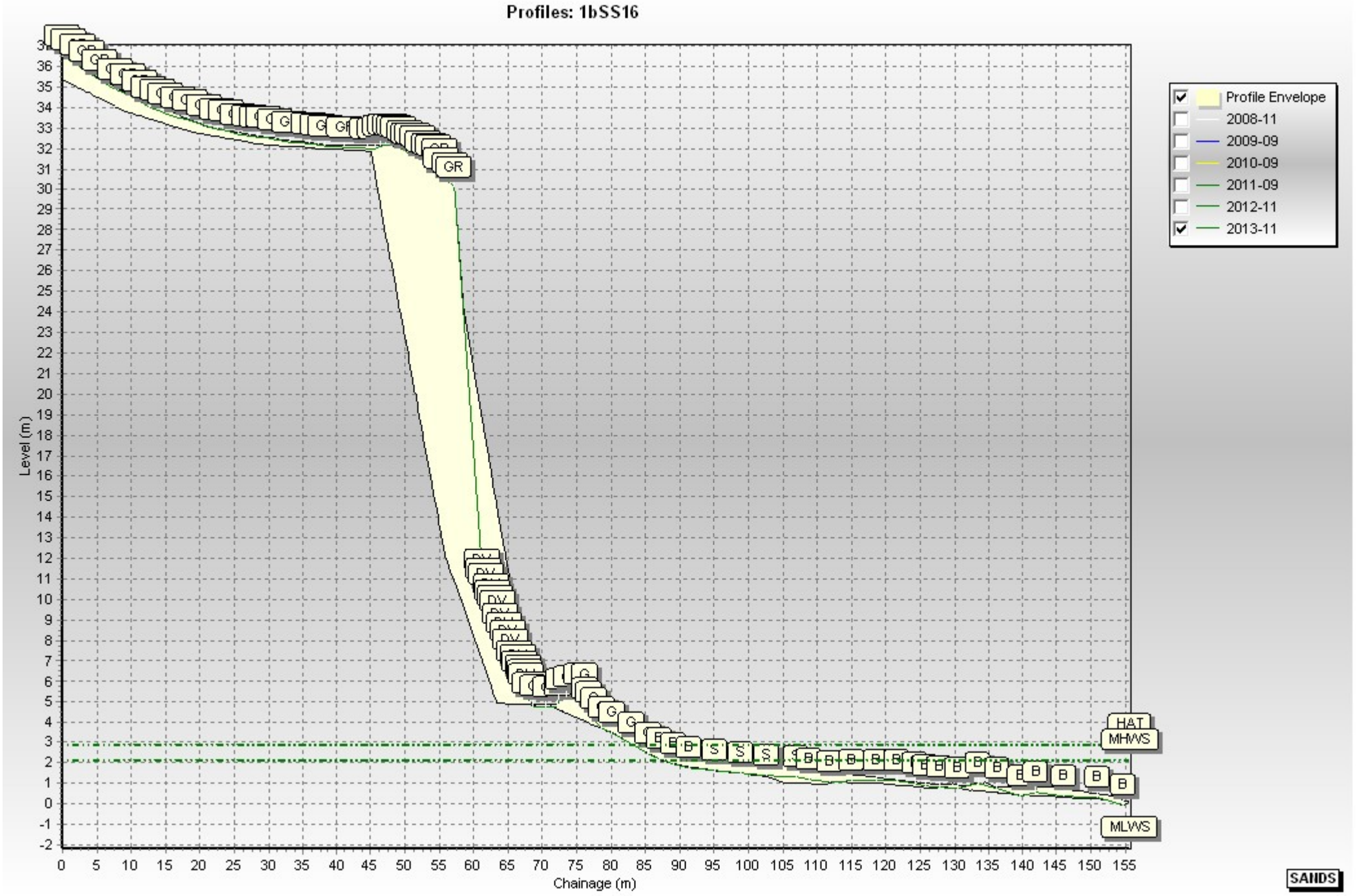
2011-09
2012-11
2013-11
GR
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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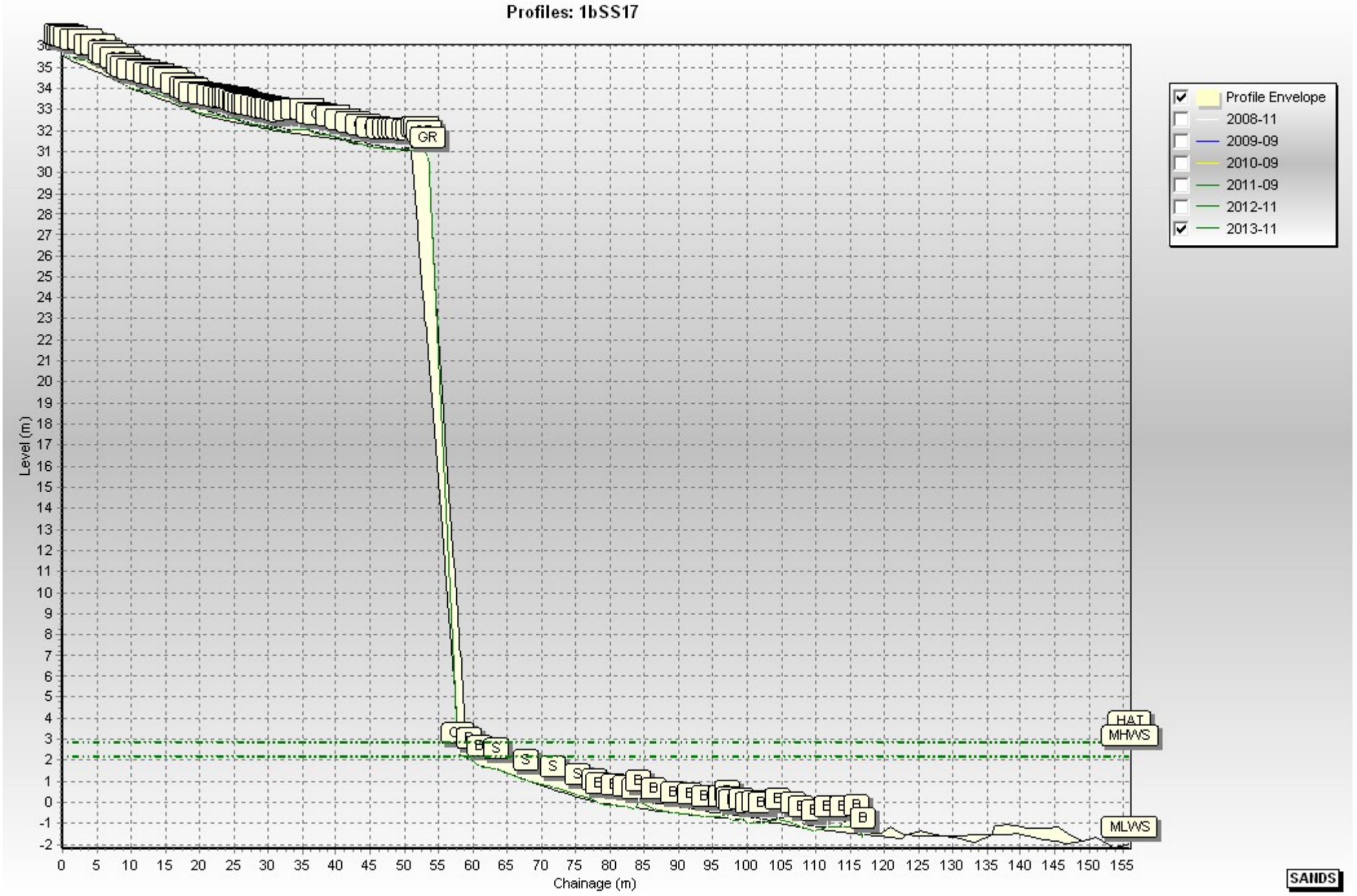
2009-09
2010-09
2011-09
2012-11
2013-11
GR
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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2008-11
2009-09
2010-09
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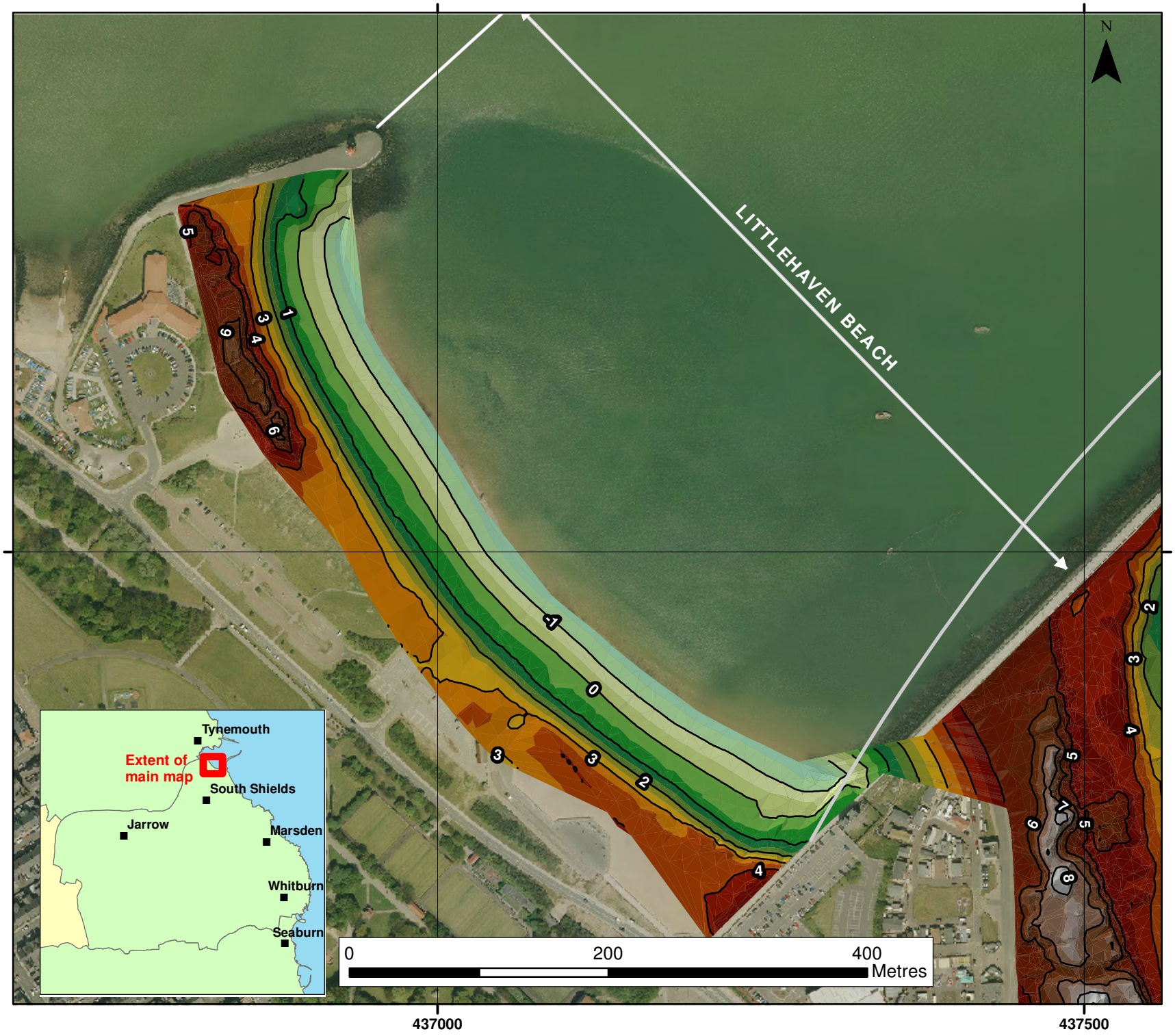
2013-11
GR
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS

Appendix B

Topographic Survey



KEY

Elevation (m OD)

9.5 - 10	3.5 - 4
9 - 9.5	3 - 3.5
8.5 - 9	2.5 - 3
8 - 8.5	2 - 2.5
7.5 - 8	1.5 - 2
7 - 7.5	1 - 1.5
6.5 - 7	0.5 - 1
6 - 6.5	0 - 0.5
5.5 - 6	-0.5 - 0
5 - 5.5	-1 - -0.5
4.5 - 5	-1.5 - -1
4 - 4.5	-2 - -1.5
	-2.5 - -2

Contour 1m

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B - Map 1a
Topographic Survey
Littlehaven Beach
SouthTyneside Council

Analytical Report 6
Fulll Measures Survey
Autumn 2013

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KEY Spring 2013 and Autumn 2013
Change in elevation (m)

<-2	Loss
-2 - -1.75	
-1.75 - -1.5	
-1.5- -1.25	
-1.25 - -1	
-1 - -0.75	
-0.75 - -0.5	
-0.5 - -0.25	
-0.25 - -0.1	
-0.1 - 0	Change < 0.1 m
0 - 0.1	
0.1 - 0.25	
0.25 - 0.5	
0.5 - 0.75	
0.75 - 1	
1 - 1.25	Gain
1.25 - 1.5	
1.5 - 1.75	
1.75 - 2	
>2	

Contours of change

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

Appendix B- Map 1b
Short-term Elevation Change
Littlehaven
SouthTyneside Council

Analytical Report 6
Full Measures Survey
Autumn 2013

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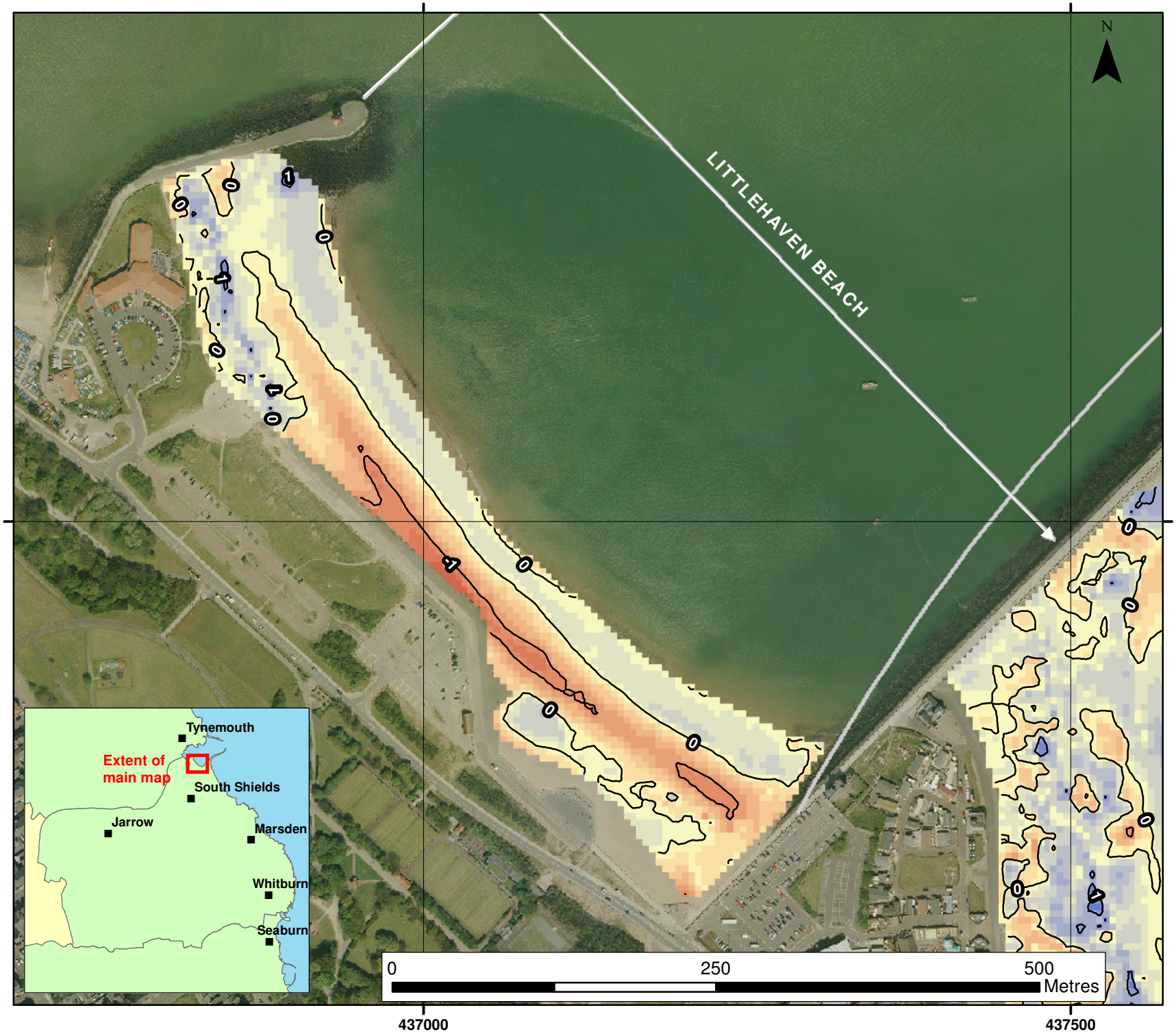

KEY Autumn 2010 and Autumn 2013
Change in elevation (m)

<-2	Loss
-2 - -1.75	
-1.75 - -1.5	
-1.5- -1.25	
-1.25 - -1	
-1 - -0.75	
-0.75 - -0.5	
-0.5 - -0.25	
-0.25 - -0.1	
-0.1 - 0	Change < 0.1 m
0 - 0.1	
0.1 - 0.25	
0.25 - 0.5	
0.5 - 0.75	
0.75 - 1	
1 - 1.25	Gain
1.25 - 1.5	
1.5 - 1.75	
1.75 - 2	
>2	

Contours of change

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

Appendix B- Map 1c
Long-term Elevation Change
Littlehaven
SouthTyneside Council

Analytical Report 6
Full Measures Survey
Autumn 2013

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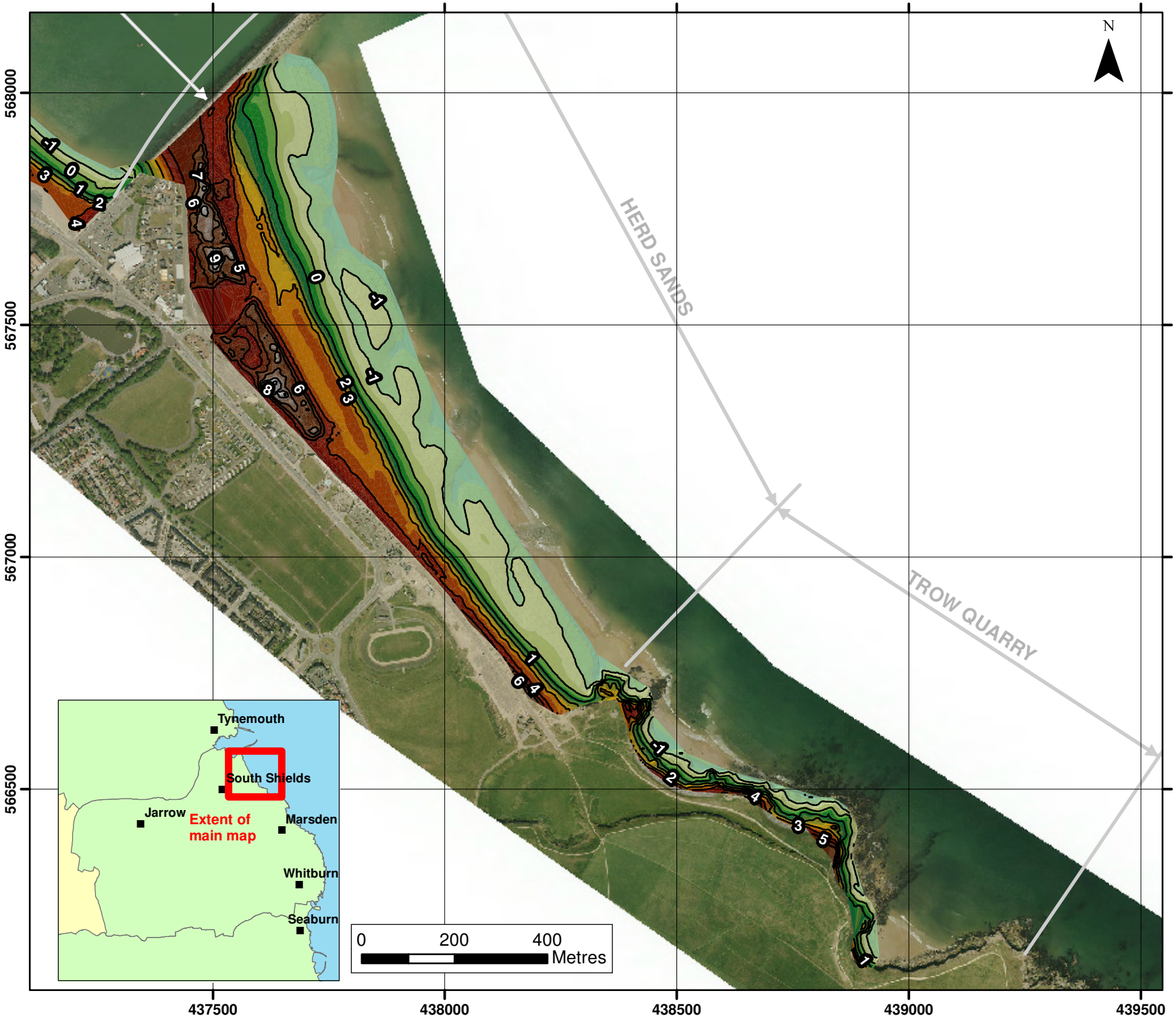

KEY

Elevation (m oD)

- 9.5 - 10
- 9 - 9.5
- 8.5 - 9
- 8 - 8.5
- 7.5 - 8
- 7 - 7.5
- 6.5 - 7
- 6 - 6.5
- 5.5 - 6
- 5 - 5.5
- 4.5 - 5
- 4 - 4.5
- 3.5 - 4
- 3 - 3.5
- 2.5 - 3
- 2 - 2.5
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0 - 0.5
- -0.5 - 0
- -1 - -0.5
- -1.5 - -1
- -2 - -1.5
- -2.5 - -2
- Contour 1m

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B - Map 2a
Topographic Survey
Herd Sands and Trow Quarry
South Tyneside Council

Analytical Report 6
Full Measures Survey
Autumn 2013

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KEY Autumn 2012 and Autumn 2013 Change in elevation (m)

- <-2
- -2 - -1.75
- -1.75 - -1.5
- -1.5- -1.25
- -1.25 - -1
- -1 - -0.75
- -0.75 - -0.5
- -0.5 - -0.25
- -0.25 - -0.1
- -0.1 - 0
- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- >2

Loss

Change < 0.1 m

Gain

Contours of change

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

Appendix B- Map 2b Short-term Elevation Change Herd Sands and Trow Quarry SouthTyneside Council

Analytical Report 6
Full Measures Survey
Autumn 2013

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www.halcrow.com

KEY Autumn 2010 and Autumn 2013
Change in elevation (m)

<-2	Loss
-2 - -1.75	
-1.75 - -1.5	
-1.5- -1.25	
-1.25 - -1	
-1 - -0.75	
-0.75 - -0.5	
-0.5 - -0.25	
-0.25 - -0.1	
-0.1 - 0	Change < 0.1 m
0 - 0.1	
0.1 - 0.25	Gain
0.25 - 0.5	
0.5 - 0.75	
0.75 - 1	
1 - 1.25	
1.25 - 1.5	
1.5 - 1.75	
1.75 - 2	
>2	

Contours of change

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

Appendix B- Map 2c Long-term Elevation Change Herd Sands and Trow Quarry SouthTyneside Council

Analytical Report 6
Full Measures Survey
Autumn 2013

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Appendix C

Cliff Top Survey

Cliff Top Survey

Trow Quarry

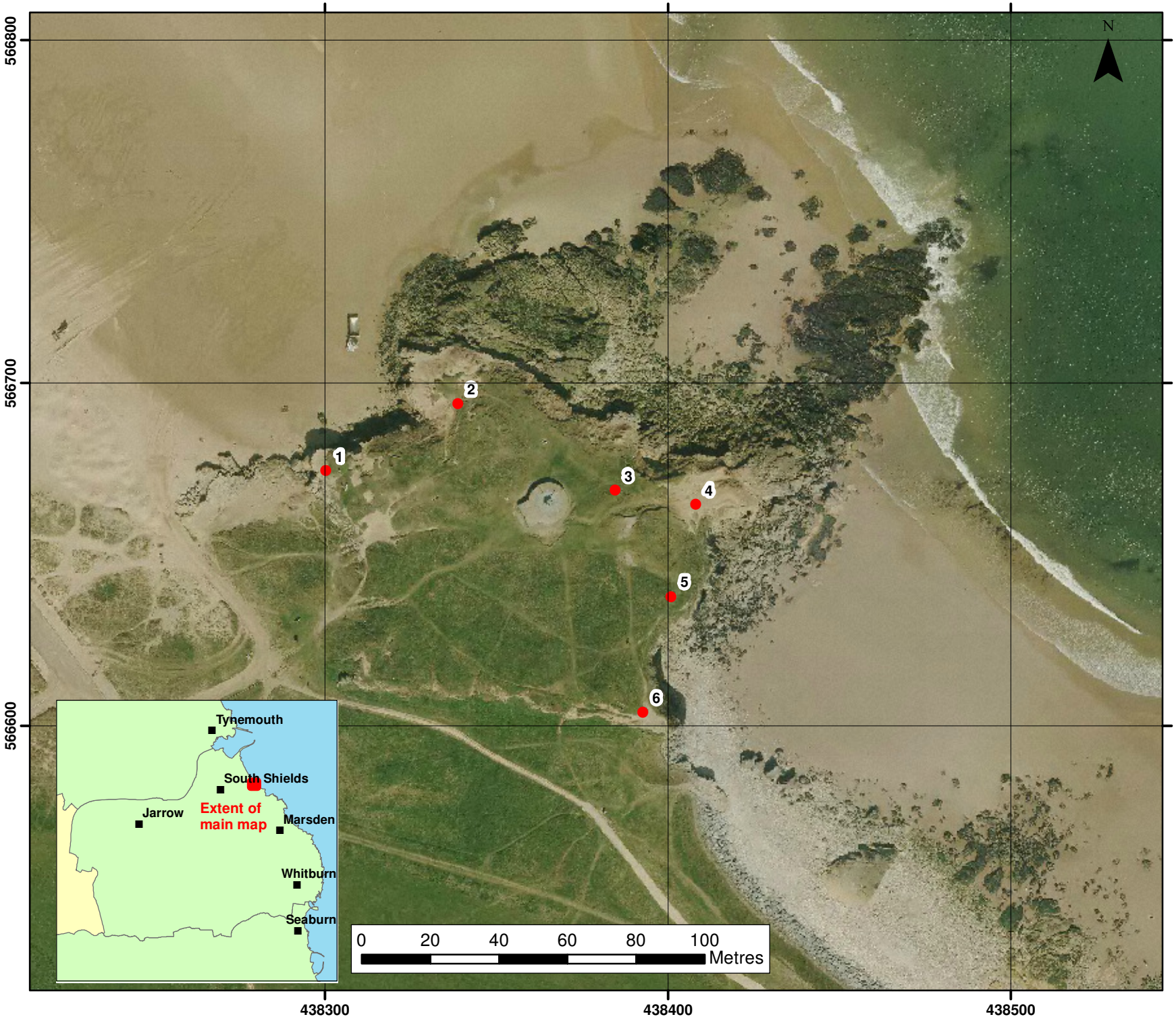
Six ground control points have been established at Trow Quarry (Figure C1). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion.

The cliff top surveys at Trow Quarry are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top.

Table C1 provides baseline information about these ground control points and results from the 2011 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table C1 – Cliff Top Surveys at Trow Quarry

Ground Control Point Details	Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Baseline Survey (Sept 2011)	Previous Survey (Mar 2013)	Present Survey (Nov 2013)	Baseline (Sept 2011) to Present (Nov 2013)	Previous Survey (Nov 2012) to Present (Nov 2013)	Baseline (Sept 2011) to Present (Nov 2013)
1	7.0	7.0	6.4	-0.6	-0.6	-0.3
2	9.4	9.4	9.4	0.0	0.0	0.0
3	7.0	7.3	6.9	-0.1	-0.4	0.0
4	10.5	11.1	10.5	0.0	-0.6	0.0
5	7.0	7.2	7.1	0.1	-0.1	0.0
6	10.2	10.2	9.9	-0.3	-0.3	-0.1



KEY

- Cliff top survey locations

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C- Map 1
Cliff Top Survey
Trow Quarry
South Tyneside Council

Analytical Report 6
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