# Cell 1 Regional Coastal Monitoring Programme Analytical Report 8: 'Full Measures' Survey 2015

## Northumberland County Council
## Final Report

**February 2016**

## Contents



## Appendices



## List of Figures



## List of Tables

| Authors | |
|---|---|
| Alex Bellis | CH2M |
| Dr Paul Fish – Review of Draft | CH2M |
| Dr Andy Parsons – Approval of Final | CH2M |

## Disclaimer

CH2M (formerly Halcrow) have prepared this report in accordance with the instructions of our client Scarborough Borough Council (SBC) for the client's sole and specific use. Any other persons who use any information contained herein do so at their own risk. This report is a review of coastal survey information made available by SBC. The objective of this report is to provide an assessment and review of the relevant background documentation and to analyse and interpret the coastal monitoring data. Halcrow has used reasonable skill, care and diligence in the interpretation of data provided to them and accepts no responsibility for the content, quality or accuracy of any Third party reports, monitoring data or further information provided either to them by SBC or, via SBC from a Third party source, for analysis under this term contract.

Raw data analysed in this report is available to download via the project's webpage: www.northeastcoastalobservatory.org.uk. The North East Coastal Observatory does not "license" the use of images or data or sign license agreements. The North East Coastal Observatory generally has no objection to the reproduction and use of these materials (aerial photography, wave data, beach surveys, bathymetric surveys), subject to the following conditions:

1. North East Coastal Observatory material may not be used to state or imply the endorsement by North East Coastal Observatory or by any North East Coastal Observatory employee of a commercial product, service, or activity, or used in any manner that might mislead.

2. North East Coastal Observatory should be acknowledged as the source of the material in any use of images and data accessed through this website, please state "Image/Data courtesy of North East Coastal Observatory". We recommend that the caption for any image and data published includes our website, so that others can locate or obtain copies when needed. We always appreciate notification of beneficial uses of images and data within your applications. This will help us continue to maintain these freely available services. Send e-mail to Robin.Siddle@scarborough.gov.uk

3. It is unlawful to falsely claim copyright or other rights in North East Coastal Observatory material.

4. North East Coastal Observatory shall in no way be liable for any costs, expenses, claims, or demands arising out of the use of North East Coastal Observatory material by a recipient or a recipient's distributees.

5. North East Coastal Observatory does not indemnify nor hold harmless users of North East Coastal Observatory material, nor release such users from copyright infringement, nor grant exclusive use rights with respect to North East Coastal Observatory material.

6. North East Coastal Observatory material is not protected by copyright unless noted (in associated metadata). If copyrighted, permission should be obtained from the copyright owner prior to use. If not copyrighted, North East Coastal Observatory material may be reproduced and distributed without further permission from North East Coastal Observatory.

## 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) Berwick upon Tweed | Holy Island | North Sunderland |
|---|---|---|---|
| 1 in 200 year | 3.4 | 3.4 | 3.5 |
| HAT | 2.8 | 2.8 | 2.8 |
| MHWS | 2.2 | 2.4 | 2.4 |
| MLWS | -1.9 | -1.8 | -1.7 |
| **Water Level Parameter** | **Water Level (m AOD) Amble** | **Blyth** | **River Tyne** |
| 1 in 200 year | 3.5 | 3.6 | 3.7 |
| HAT | 3.1 | 3.1 | 3.1 |
| MHWS | 2.4 | 2.4 | 2.4 |
| MLWS | -1.9 | -1.8 | -1.9 |

**Source:** *Scottish Border to River Tyne Shoreline Management Plan 2.* Royal Haskoning, May 2009.

## 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.

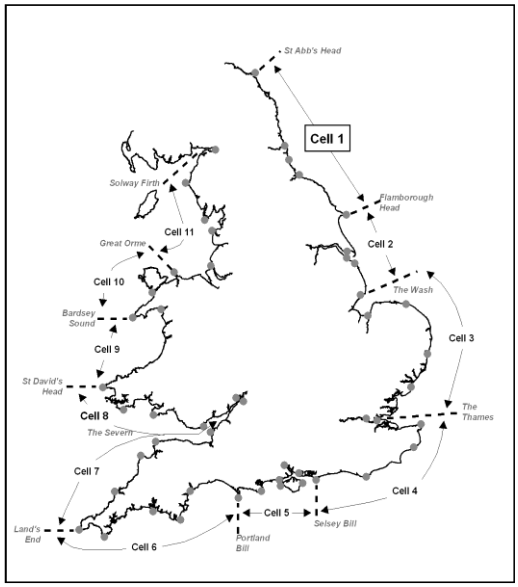



**Figure 1 Sediment Cells in England and Wales**

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

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

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 | July 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 | Feb13 | - |
| 5 | 2012/13 | Sept-Nov 12 | Mar 13 | Mar-April 13 | June 13 | |
| 6 | 2013/2014 | Sept-Oct 13 | Feb 14 | Mar-Apr 14 | July 14 | |
| 7 | 2014/2015 | Sept-Nov 14 | Feb 15 | Mar – Apr 15 | July 15 | |
| 8 | 2015/2016 | Sept–Dec 15 | Feb 16 (*) | | | |

(*) The present report is **Analytical Report 8** and provides an analysis of the 2015 Full Measures survey for Northumberland County 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

Northumberland County Council's frontage extends from the Scottish border in the north to Hartley, just south of Blyth, in the south. For the purposes of this report and for consistency with previous reporting, it has been sub-divided into 15 areas, namely:

- Sandstell Point (Spittal A)
- Spittal (Spittal B)
- Goswick Sands
- Holy Island
- Bamburgh
- Beadnell Village
- Beadnell Bay
- Embleton Bay
- Boulmer
- Alnmouth Bay
- High Hauxley and Druridge Bay
- Lynemouth Bay
- Newbiggin-by-the-Sea
- Cambois
- Blyth South Beach

## 1.2 Methodology

Along the Northumberland frontage, the following surveying is undertaken:

Full Measures survey annually each autumn comprising:

- Beach profile surveys along 78 transect lines (commenced 2002)
- Beach profile surveys along an additional ten transect lines (commenced 2007)
- Beach profile surveys along an additional 26 transect lines (commenced 2010)
- Topographic survey along Holy Island (commenced 2004)
- Topographic survey along Alnmouth Bay (commenced 2005)
- Topographic survey along Sandstell Point (commenced 2009)
- Topographic survey along Newbiggin Bay (commenced 2010)

Partial Measures survey annually each spring comprising:

- Beach profile surveys along 29 transect lines (commenced 2002)
- Beach profile surveys along an additional ten transect lines (commenced 2007)
- Beach profile surveys along an additional one transect line (commenced 2010)
- Beach profile surveys along an additional two transect lines (commenced 2011)
- Topographic survey along Alnmouth Bay (commenced 2005)
- Topographic survey along Sandstell Point (commenced 2009)
- Topographic survey along Newbiggin Bay (commenced 2010)

Cliff top survey (bi-annually) at:

- Cliff top survey at Lynemouth Bay (commenced 2008)
- Cliff top survey at Cambois Bay (Sandy Bay) (commenced 2008)
- Cliff top survey at Cambois Bay (Cambois) (commenced 2009)

Sand extent survey (bi-annually) at:

- Edge of sand survey at Newbiggin Bay, Spital Carrs, (commenced 2011 to determine potential adverse impact on foreshore SSSI of the Newbiggin beach recharge scheme)

For all cliff-top surveys prior to Full Measures 2011, the data was previously saved in '.kmz' format for plotting and visual comparison in GoogleEarth. This data has been visualised in GIS, which revealed the quality was variable and reliable interpretations of short-term cliff change could not be made. For the present and future surveys, the data will be plotted in GIS and change will qualified along a series of pre-defined transect lines. The resulting data on amount and rate of change is presented in tables and the survey results are compared.

The location of these surveys is shown in Figure 2. The Full Measures survey was undertaken along this frontage between 4th September and 29th November 2015. During this time 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 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 wave buoy located at Tyne and Tees deployed under the national monitoring programme and three Cell 1 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 are managed by Scarborough BC as part of the Cell 1 monitoring programme.

An assessment of baseline wave data was presented in the Cell 1 2011 Wave Data Analysis Report, which reviewed all readily available wave data in the region. Wave data update reports for 2013-14 and 2014-15 provide an update to the baseline with analysis of the wave data collected under the programme between 2011 and March 2015. These wave data reports are also available from the reports page on the Cell 1 monitoring website: http://www.northeastcoastalobservatory.org.uk/Default.aspx?view=pnlTexts&text=Reports

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 which includes storm analysis for data collected up to the end of November 2015, extending the wave analysis to cover the period prior to the Full Measure surveys.

An overview plot of wave height data from the three Cell 1 wave buoys is shown in Figure 3. Note that there were significant gaps in the data at both Scarborough and Whitby, but the record is nearly continuous from Newbiggin. There were a large number of small storms over the winter of 2014-15 with the largest wave heights occurring in mid-October 2014 and beginning of February 2015. A storm with significant wave heights over 4m occurred in early September, just before the 2015 Full Measures survey data were collected.

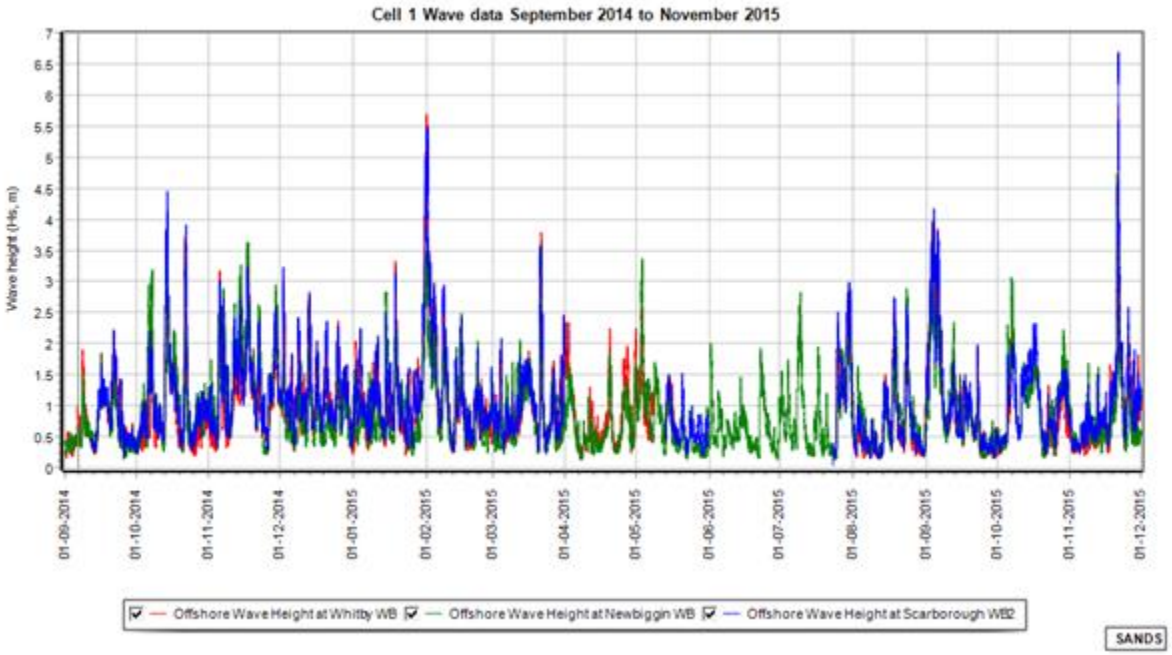



**Figure 3 Wave monitoring data from the three Cell 1 wave buoys**

## 2.2 Tyne/Tees WaveNet Buoy storms analysis

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 and results of a SANDS Storms analysis is presented in Table 4 below.

To aid interpretation of the results in Table 4 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 2007 and 2008.

**Table 4 SANDS Storm Analysis at Tyne/Tees WaveNet Buoy**

| General Storm Information | | | | | | | At Peak | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Start Time** | **End Time** | **Dur (hr)** | **Peak of Storm** | **Mean Dir (°)** | **No Events** | **Mean Dir Vector (°)** | **Hs (m)** | **Tp (s)** | **Tz (s)** | **Dir (°)** | **Energy @ Peak (KJ/m/s)** | **Total Energy (KJ/m)** |
| 19/03/2007 10:30 | 21/03/2007 05:30 | 43 | 20/03/2007 14:30 | 23 | 64 | 78.2 | 6.2 | 14.8 | 8.5 | 23 | 1.7E+04 | 1.4E+07 |
| 25/06/2007 20:30 | 26/06/2007 13:30 | 17 | 26/06/2007 10:00 | 54 | 18 | 77.3 | 4.4 | 10.3 | 7.2 | 23 | 4.0E+03 | 1.7E+06 |
| 26/09/2007 03:00 | 27/09/2007 05:00 | 26 | 26/09/2007 19:00 | 11 | 33 | 79.7 | 4.6 | 13.8 | 7.6 | 6 | **7.8E+03** | 3.6E+06 |
| **08/11/2007 20:00** | **12/11/2007 15:00** | **91** | **09/11/2007 08:30** | **16** | **58** | **77.7** | **6.2** | 15.9 | **9.0** | **6** | **1.9E+04** | **1.6E+07** |
| 19/11/2007 03:30 | 25/11/2007 21:30 | 162 | 23/11/2007 05:00 | 88 | 52 | 76.8 | 4.9 | 12.7 | 7.6 | 17 | 7.6E+03 | 6.8E+06 |
| 08/12/2007 03:00 | 10/12/2007 14:30 | 59.5 | 08/12/2007 03:30 | 106 | 8 | 82.9 | 4.1 | 12.8 | 7.6 | 17 | 5.4E+03 | 7.5E+05 |
| 03/01/2008 10:30 | 04/01/2008 01:30 | 15 | 03/01/2008 23:30 | 77 | 24 | 14.6 | 4.2 | 10.9 | 7.6 | 62 | 4.2E+03 | 2.5E+06 |
| 01/02/2008 15:00 | 02/02/2008 09:30 | 18.5 | 02/02/2008 | 41 | 30 | 80.1 | 6.0 | 16.4 | 9.0 | 17 | 1.9E+04 | 8.7E+06 |
| 10/03/2008 08:30 | 10/03/2008 12:30 | 4 | 10/03/2008 11:00 | 146 | 9 | 307.5 | 4.6 | 9.6 | 6.5 | 141 | 3.8E+03 | 7.3E+05 |
| **17/03/2008 15:00** | **25/03/2008 03:00** | **180** | **22/03/2008 05:00** | **81** | **58** | **82.1** | **7.9** | 14.8 | **9.0** | **6** | **2.7E+04** | **1.7E+07** |
| 05/04/2008 22:00 | 07/04/2008 05:00 | 31 | 06/04/2008 19:00 | 49 | 20 | 83.1 | 4.6 | 13.9 | 7.6 | 6 | 7.9E+03 | 3.0E+06 |
| 20/07/2008 16:00 | 21/07/2008 09:30 | 17.5 | 20/07/2008 23:30 | 15 | 8 | 76.0 | 4.2 | 11.8 | 7.6 | 11 | 4.9E+03 | 9.1E+05 |
| 03/10/2008 03:00 | 03/10/2008 20:30 | 17.5 | 03/10/2008 16:30 | 55 | 17 | 76.7 | 4.7 | 13.6 | 7.6 | 23 | **8.1E+03** | 2.8E+06 |
| 21/11/2008 04:00 | 25/11/2008 12:30 | 104.5 | 22/11/2008 11:30 | 15 | 112 | 75.8 | 6.0 | 15.6 | 8.5 | 11 | 1.7E+04 | 2.2E+07 |
| 10/12/2008 12:00 | 13/12/2008 18:00 | 78 | 13/12/2008 08:00 | 109 | 37 | 332.1 | 4.9 | 10.0 | 7.2 | 129 | 4.7E+03 | 4.0E+06 |
| 31/01/2009 16:30 | 03/02/2009 09:00 | 64.5 | 02/02/2009 22:00 | 84 | 57 | 7.2 | 5.8 | 11.4 | 8.5 | 84 | 8.7E+03 | 8.1E+06 |
| 23/03/2009 22:30 | 28/03/2009 20:30 | 118 | 28/03/2009 16:30 | 217 | 14 | 89.4 | 5.3 | 10.0 | 7.6 | 6 | 5.4E+03 | 1.3E+06 |
| 10/07/2009 01:30 | 10/07/2009 02:30 | 1 | 10/07/2009 01:30 | 13 | 2 | 78.7 | 4.2 | 11.9 | 7.2 | 11 | 5.0E+03 | 2.3E+05 |
| **29/11/2009 20:30** | **30/11/2009 15:00** | **18.5** | **30/11/2009 00:30** | **18** | **36** | **72.7** | **6.0** | 11.2 | **8.0** | **11** | **9.0E+03** | **5.9E+06** |
| 17/12/2009 10:30 | 18/12/2009 05:00 | 18.5 | 17/12/2009 19:30 | 64 | 36 | 26.3 | 5.4 | 12.7 | 8.0 | 68 | **9.4E+03** | 5.7E+06 |
| 30/12/2009 09:00 | 30/12/2009 23:00 | 14 | 30/12/2009 12:30 | 84 | 24 | 7.7 | 5.1 | 9.0 | 7.2 | 90 | 4.1E+03 | 2.3E+06 |
| 06/01/2010 05:30 | 06/01/2010 11:00 | 5.5 | 06/01/2010 06:30 | 30 | 10 | 63.6 | 4.2 | 12.7 | 7.2 | 11 | 5.7E+03 | 1.1E+06 |
| 29/01/2010 10:30 | 30/01/2010 00:30 | 14 | 29/01/2010 22:30 | 9 | 21 | 81.9 | 5.4 | 10.2 | 8.0 | 6 | 6.0E+03 | 2.1E+06 |
| 26/02/2010 22:30 | 27/02/2010 02:30 | 4 | 27/02/2010 01:00 | 18 | 7 | 72.4 | 4.6 | 10.1 | 7.6 | 17 | 4.2E+03 | 7.0E+05 |
| 19/06/2010 07:00 | 20/06/2010 08:30 | 25.5 | 19/06/2010 20:00 | 21 | 49 | 69.2 | 5.4 | 12.7 | 7.6 | 23 | **9.4E+03** | 8.5E+06 |
| 29/08/2010 14:00 | 30/08/2010 06:30 | 16.5 | 30/08/2010 01:00 | 243 | 17 | 92.8 | 4.7 | 10.3 | 7.6 | 6 | 4.7E+03 | 1.6E+06 |
| 06/09/2010 22:30 | 07/09/2010 16:00 | 17.5 | 07/09/2010 15:30 | 101 | 22 | 353.2 | 4.6 | 10.5 | 8.0 | 90 | 4.5E+03 | 2.3E+06 |
| 17/09/2010 07:00 | 17/09/2010 18:30 | 11.5 | 17/09/2010 08:30 | 10 | 17 | 80.7 | 4.7 | 13.1 | 8.0 | 11 | 7.5E+03 | 2.9E+06 |

| General Storm Information | | | | | | | At Peak | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | End Time | Dur (hr) | Peak of Storm | Mean Dir (°) | No Events | Mean Dir Vector (°) | Hs (m) | Tp (s) | Tz (s) | Dir (°) | Energy @ Peak (KJ/m/s) | Total Energy (KJ/m) |
| 24/09/2010 03:00 | 26/09/2010 | 45 | 24/09/2010 10:00 | 21 | 80 | 71.6 | 5.3 | 12.1 | 8.0 | 11 | 8.0E+03 | 1.2E+07 |
| 20/10/2010 02:00 | 24/10/2010 16:30 | 110.5 | 20/10/2010 10:00 | 13 | 16 | 78.2 | 4.2 | 13.4 | 7.2 | 17 | 6.4E+03 | 1.8E+06 |
| **08/11/2010 14:00** | **09/11/2010 20:30** | **30.5** | **09/11/2010 10:00** | **88** | **58** | **3.0** | **5.6** | 10.5 | **8.0** | **73** | **6.9E+03** | **7.8E+06** |
| 17/11/2010 11:00 | 17/11/2010 18:30 | 7.5 | 17/11/2010 12:00 | 136 | 9 | 322.4 | 4.7 | 9.2 | 6.9 | 129 | 3.7E+03 | 8.1E+05 |
| 29/11/2010 19:30 | 02/12/2010 08:30 | 61 | 29/11/2010 21:00 | 80 | 45 | 11.8 | 5.1 | 11.2 | 7.6 | 56 | 6.3E+03 | 5.4E+06 |
| 16/12/2010 15:00 | 17/12/2010 06:30 | 15.5 | 17/12/2010 03:30 | 12 | 22 | 79.1 | 4.6 | 12.5 | 7.6 | 17 | 6.4E+03 | 2.8E+06 |
| **23/07/2011 14:00** | **24/07/2011 11:00** | **21** | **24/07/2011 03:00** | **23** | **39** | **67.1** | **4.7** | 12.8 | **7.6** | **17** | **7.2E+03** | **5.8E+06** |
| 24/10/2011 18:30 | 25/10/2011 09:30 | 15 | 25/10/2011 09:30 | 103 | 26 | 348.5 | 4.1 | 11.3 | 6.9 | 79 | 4.2E+03 | 2.6E+06 |
| 09/12/2011 08:30 | 09/12/2011 10:00 | 1.5 | 09/12/2011 08:30 | 7 | 3 | 84.0 | 4.1 | 14.2 | 8.0 | 6 | 6.7E+03 | 4.8E+05 |
| 05/01/2012 16:00 | 06/01/2012 05:00 | 13 | 06/01/2012 03:00 | 12 | 19 | 79.0 | 4.6 | 12.5 | 7.6 | 17 | 6.4E+03 | 2.6E+06 |
| 03/04/2012 13:30 | 04/04/2012 10:30 | 21 | 03/04/2012 17:30 | 66 | 38 | 25.1 | 5.6 | 9.7 | 7.6 | 56 | 5.9E+03 | 5.5E+06 |
| 24/09/2012 08:30 | 25/09/2012 10:30 | 26 | 25/09/2012 01:30 | 74 | 50 | 16.7 | 4.7 | 12.3 | 8.0 | 62 | 6.6E+03 | 7.4E+06 |
| 26/10/2012 16:30 | 27/10/2012 14:30 | 22 | 26/10/2012 23:00 | 12 | 34 | 79.4 | 4.9 | 15.3 | 7.6 | 11 | 1.1E+04 | 4.9E+06 |
| 05/12/2012 16:00 | 15/12/2012 01:30 | 225.5 | 14/12/2012 19:30 | 78 | 31 | 18.4 | 5.4 | 10.5 | 7.6 | 96 | 6.4E+03 | 4.5E+06 |
| **20/12/2012 06:00** | **21/12/2012 14:30** | **32.5** | **20/12/2012 23:00** | **101** | **56** | **348.4** | **5.6** | 11.3 | **8.0** | **96** | **8.0E+03** | **8.8E+06** |
| 18/01/2013 18:30 | 22/01/2013 06:00 | 83.5 | 21/01/2013 10:00 | 81 | 54 | 9.2 | 6.7 | 11.2 | 8.5 | 84 | 1.1E+04 | 1.1E+07 |
| 06/02/2013 08:00 | 07/02/2013 06:00 | 22 | 06/02/2013 12:30 | 47 | 38 | 81.6 | 5.4 | 11.9 | 7.6 | 11 | 8.2E+03 | 6.1E+06 |
| 07/03/2013 21:00 | 10/03/2013 21:30 | 72.5 | 08/03/2013 04:00 | 67 | 37 | 24.6 | 4.9 | 10.7 | 7.6 | 73 | 5.4E+03 | 4.3E+06 |
| 18/03/2013 09:00 | 25/03/2013 00:30 | 159.5 | 23/03/2013 14:30 | 85 | 153 | 5.1 | 6.0 | 12.1 | 8.0 | 90 | 1.0E+04 | 2.8E+07 |
| **23/05/2013 18:00** | **24/05/2013 12:00** | **18** | **23/05/2013 22:30** | **13** | **32** | **77.5** | **6.7** | 12.5 | **8.5** | **17** | **1.4E+04** | **7.1E+06** |
| 10/09/2013 13:00 | 10/09/2013 19:30 | 6.5 | 10/09/2013 14:00 | 11 | 14 | 79.3 | 4.4 | 11.0 | 7.2 | 11 | 4.6E+03 | 1.5E+06 |
| 09/10/2013 22:30 | 11/10/2013 09:00 | 34.5 | 10/10/2013 17:00 | 68 | 62 | 79.8 | 5.4 | 12.7 | 7.6 | 22 | 9.4E+03 | 1.2E+07 |
| 29/11/2013 22:30 | 30/11/2013 06:30 | 8 | 30/11/2013 00:30 | 42 | 17 | 84.5 | 5.6 | 12.7 | 8.0 | 11 | 1.0E+04 | 3.3E+06 |
| 05/12/2013 14:00 | 07/12/2013 04:30 | 38.5 | 06/12/2013 20:00 | 24 | 59 | 80.8 | 4.7 | 17.0 | 9.0 | 6 | 1.3E+04 | 1.2E+07 |
| 27/12/2013 09:30 | 27/12/2013 12:30 | 3 | 27/12/2013 10:00 | 218 | 3 | 249.3 | 4.1 | 7.3 | 6.5 | 202 | 1.8E+03 | 1.3E+05 |
| 05/02/2014 04:00 | 05/02/2014 18:00 | 14 | 05/02/2014 05:30 | 139 | 9 | 318.4 | 4.4 | 9.3 | 6.9 | 129 | 3.3E+03 | 7.2E+05 |
| **12/02/2014 20:00** | **14/02/2014 19:00** | **47** | **12/02/2014 21:00** | **183** | **8** | **275.6** | **4.6** | 8.9 | **6.5** | **141** | **3.2E+03** | **7.8E+05** |
| 21/10/2014 22:00 | 22/10/2014 01:30 | 3.5 | 21/10/2014 23:00 | 6 | 5 | 84.4 | 4.4 | 11.5 | 7.6 | 6 | **5.0E+03** | 6.0E+05 |
| 31/01/2015 08:30 | 01/02/2015 19:30 | 35.0 | 31/01/15 23:30 | 78 | 71 | 88.7 | 6.2 | 13.1 | 8.0 | 6 | 1.3 E+4 | 1.4 E+7 |
| 03/09/2015 05:30:00 | 04/09/2015 06:00:00 | 24.5 | 03/09/2015 18:30:00 | 13 | 15 | 78.1 | 4.4 | 10.5 | 6.8 | 11 | 4.2 E+3 | 1.6 E+6 |
| **21/11/2015 01:30:00** | **21/11/2015 14:30:00** | **13.0** | **21/11/2015 05:30:00** | **72** | **27** | **85.9** | **7.1** | **11.8** | **8.5** | **356** | **1.4 E+4** | **5.7 E+6** |

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 years with the fewest storms was 2011, 2014 and 2015. In 2011 and 2014 this was reflected by a combination of accretion and overall stability recorded within 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 and 6th December 2013, 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.

The 2014 storms did appear to have an influence on beach behaviour, as shown by the profile analysis included within the 2014 Full Measures reports, with the movement of material across and along the beach. Dune toe erosion was more dominant than in previous years and could be explained by particularly high tides rather than storm erosion alone.

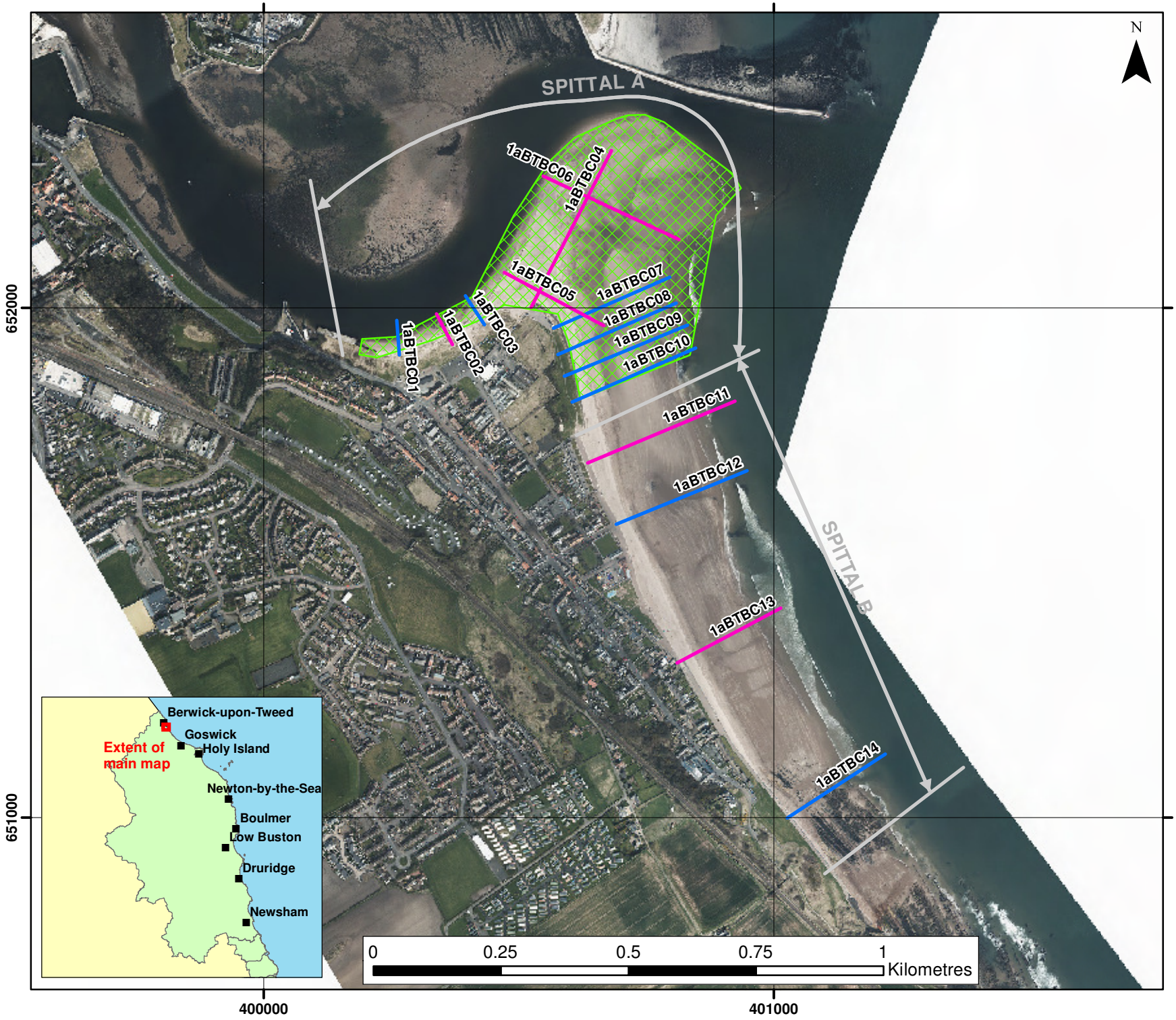
During 2015 there were only three storms with peak wave heights above the threshold, but all had large wave heights and much greater wave energy than the 2014 storms. All the surveys undertaken within the Northumberland County Council area were undertaken after the 3rd/4th September 2015 storm. In the case of the Boulmer and northernmost profiles in Alnmouth Bay, this was immediately after with the topographic survey at Alnmouth taking place several days later. The signature of this change at Boulmer and the northernmost part of Alnmouth Bay, but these areas would have been reasonably well sheltered from a storm with an at peak direction of 11°. The Alnmouth Bay shows more erosion in the upper beach and northernmost parts of the survey area, with deposition more prevalent on the foreshore and further south in the survey area indicating the 3rd/4th September storm which happened a week earlier may have influenced this sediment distribution pattern. The majority of other surveys happened an increasingly long time after this storm, making it difficult to draw conclusions about the storms influence, although at several points along the coast there is evidence of dune toe erosion which may be attributable to it. Only the surveys of profiles at Cambois Bay, the majority of Alnmouth Bay and Newbiggin Bay were undertaken after the 21st November storm. Relatively fresh dune toe erosion in some parts of the bay and due accretion in others is evident at Alnmouth Bay which is most likely attributable to this storm, there is little evidence for it in the Newbiggin profiles and at Cambois Bay there has been a reasonable amount of sediment since the last survey. However, at Cambois it is difficult to be certain about the influence of any particular storm as the profiles are only surveyed once every six months.

## 2.3 Newbiggin Cell 1 wave buoy storms analysis

The Cell 1 regional monitoring wave buoy on the Northumberland Council frontage at Newbiggin-by-the-Sea was deployed in January 2013. Analysed storm data for this buoy is presented in Table 5.

**Table 5 SANDS Storm Analysis at Newbiggin Wave Buoy**

| General Storm Information | | | | | | | At Peak | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Start Time** | **End Time** | **Dur (hr)** | **Peak of Storm** | **Mean Dir (°)** | **No Events** | **Mean Dir Vector (°)** | **Hs (m)** | **Tp (s)** | **Tz (s)** | **Dir (°)** | **Energy @ Peak KJ/m/s** | **Total Energy (KJ/m)** |
| 06/09/2013 18:30:00 | 06/09/2013 22:30:00 | 4.0 | 06/09/2013 22:30:00 | 47 | 8 | 44.9 | 3.1 | 9.1 | 5.9 | 48 | 1.5 E+3 | 3.2 E+5 |
| **10/10/2013 00:30:00** | **14/10/2013 08:00:00** | **103.5** | **10/10/2013 18:30:00** | **47** | **65** | **43.7** | **4.2** | **11.8** | **7.0** | **46** | **4.7 E+3** | **5.0 E+6** |
| 30/11/2013 01:00:00 | 30/11/2013 05:00:00 | 4.0 | 30/11/2013 05:00:00 | 38 | 5 | 54.9 | 3.1 | 11.1 | 7.4 | 37 | 2.4 E+3 | 3.1 E+5 |
| 06/12/2013 01:30:00 | 06/12/2013 21:30:00 | 20.0 | 06/12/2013 16:30:00 | 47 | 27 | 44.4 | 3.2 | 16.7 | 8.5 | 53 | 5.7 E+3 | 2.5 E+6 |
| 01/01/2014 16:30:00 | 01/01/2014 17:30:00 | 1.0 | 01/01/2014 17:30:00 | 142 | 2 | 329.2 | 3.1 | 8.3 | 5.8 | 118 | 1.3 E+3 | 6.1 E+4 |
| **19/01/2014 05:30:00** | **20/01/2014 10:30:00** | **29.0** | **19/01/2014 20:00:00** | **69** | **48** | **21.3** | **4.2** | **11.8** | **8.7** | **70** | **4.9 E+3** | **3.9 E+6** |
| 29/01/2014 04:00:00 | 05/02/2014 21:30:00 | 185.5 | 05/02/2014 18:30:00 | 100 | 63 | 350.2 | 3.8 | 10.0 | 6.7 | 114 | 2.8 E+3 | 3.7 E+6 |
| 12/02/2014 16:00:00 | 14/02/2014 19:30:00 | 51.5 | 12/02/2014 18:00:00 | 126 | 7 | 329.3 | 3.4 | 9.1 | 5.9 | 118 | 1.9 E+3 | 2.6 E+5 |
| 26/03/2014 23:00:00 | 28/03/2014 01:00:00 | 26.0 | 27/03/2014 00:00:00 | 73 | 12 | 20.1 | 3.4 | 11.1 | 6.7 | 68 | 2.9 E+3 | 7.6 E+5 |
| 07/10/2014 17:00:00 | 07/10/2014 21:00:00 | 4.0 | 07/10/2014 18:00:00 | 67 | 6 | 23.6 | 3.2 | 13.3 | 9.8 | 66 | 3.5 E+3 | 5.4 E+5 |
| 13/10/2014 21:30:00 | 14/10/2014 03:00:00 | 5.5 | 14/10/2014 00:00:00 | 78 | 9 | 16.5 | 3.3 | 8.3 | 6.1 | 76 | 1.4 E+3 | 3.2 E+5 |
| 13/11/2014 19:00:00 | 17/11/2014 13:30:00 | 90.5 | 17/11/2014 08:00:00 | 70 | 28 | 20.8 | 3.6 | 11.1 | 6.8 | 65 | 3.2 E+3 | 1.8 E+6 |
| 31/01/2015 22:00:00 | 01/02/2015 11:30:00 | 13.5 | 01/02/2015 00:00:00 | 36 | 26 | 53.7 | 3.4 | 11.8 | 6.7 | 41 | 3.2 E+3 | 1.7 E+6 |
| 21/03/2015 14:30:00 | 21/03/2015 16:00:00 | 1.5 | 21/03/2015 16:00:00 | 45 | 3 | 47.5 | 3.2 | 11.1 | 7.1 | 44 | 2.4 E+3 | 1.8 E+5 |
| 03/05/2015 08:30:00 | 03/05/2015 16:00:00 | 7.5 | 21/03/2015 16:00:00 | 111 | 13 | 342.9 | 3.2 | 9.1 | 6.6 | 107 | 1.7 E+3 | 4.9 E+5 |
| 07/10/2015 06:30:00 | 07/10/2015 10:00:00 | 3.5 | 03/05/2015 14:30:00 | 66 | 3 | 25.4 | 3.1 | 10.5 | 8.0 | 63 | 2.0 E+3 | 1.6 E+5 |
| **21/11/2015 02:30:00** | **21/11/2015 11:00:00** | **8.5** | **07/10/2015 06:30:00** | **39** | **18** | **51.3** | **4.6** | **11.1** | **7.1** | **38** | **5.1 E+3** | **1.8 E+6** |




## 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

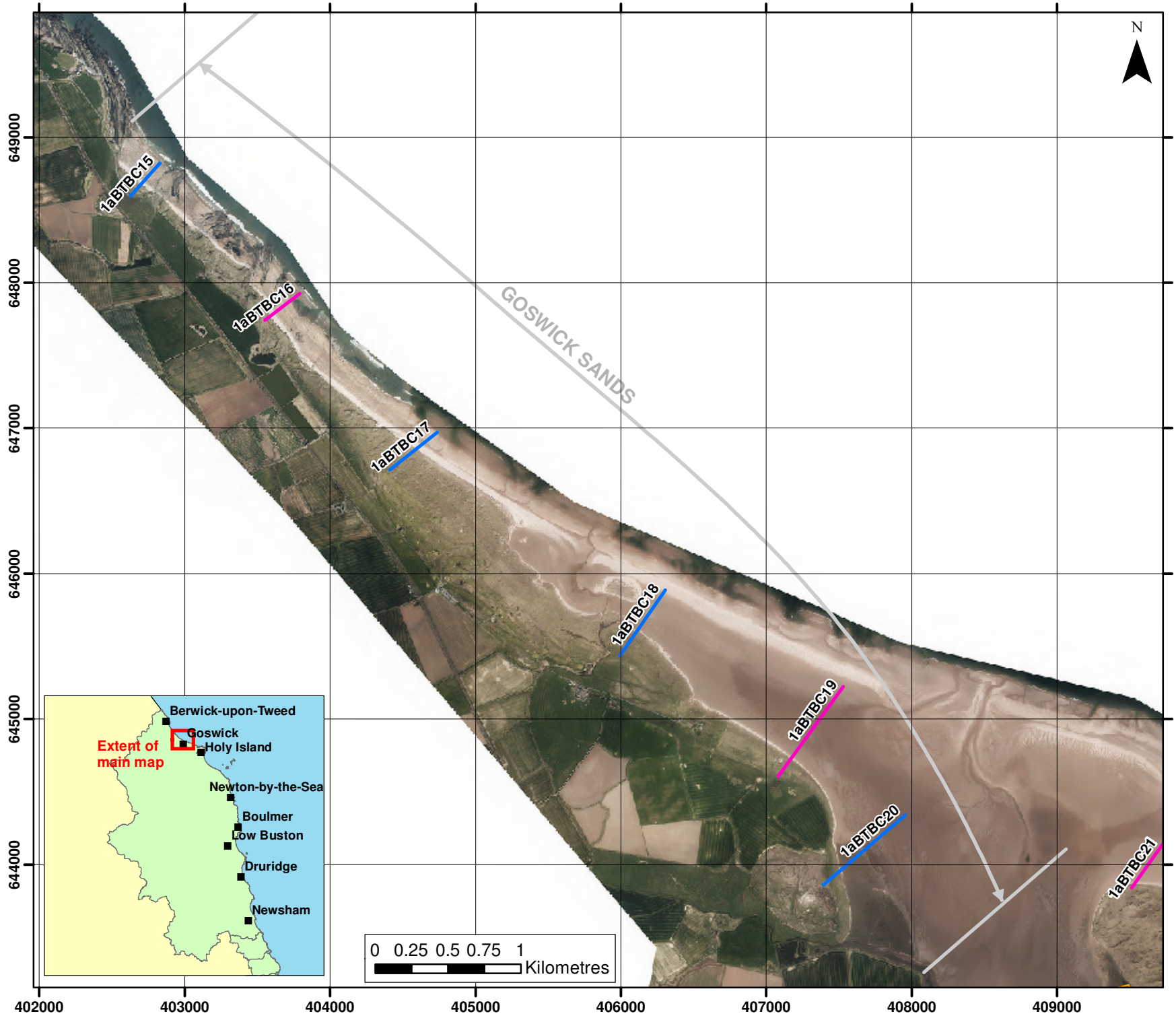
# Figure 2 - Map 1
# Survey Locations
# Sandstell Point (Spittal A)
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015


ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




## 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

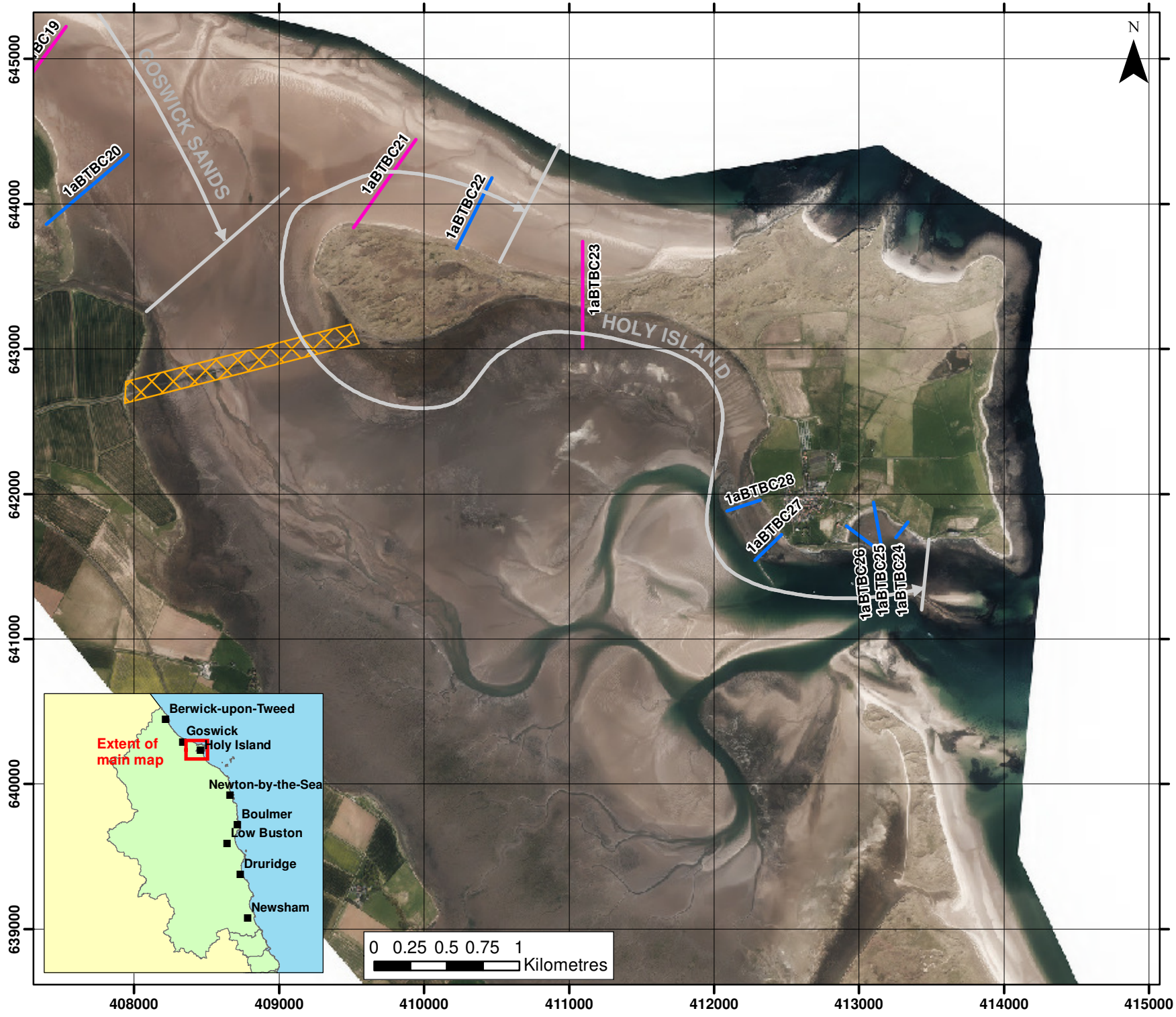
# Figure 2- Map 2
# Survey Locations
# Goswick Sands
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015


ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




## 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

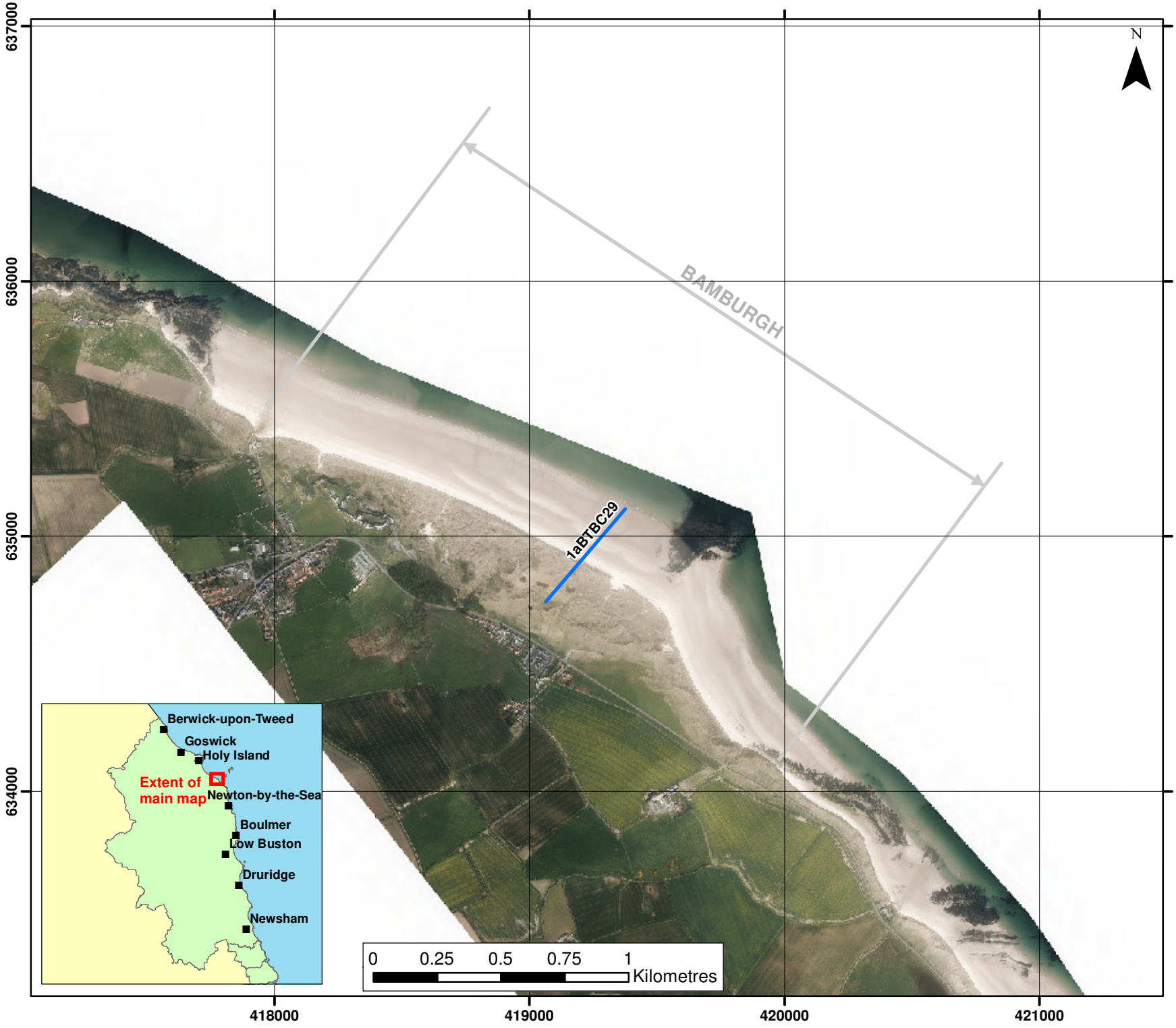
# Figure 2 - Map 3
# Survey Locations
# Holy Island
# Northumberland
# County Council

Analytical Report 8
Full Measures Survey
Autumn 2015


ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




## 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

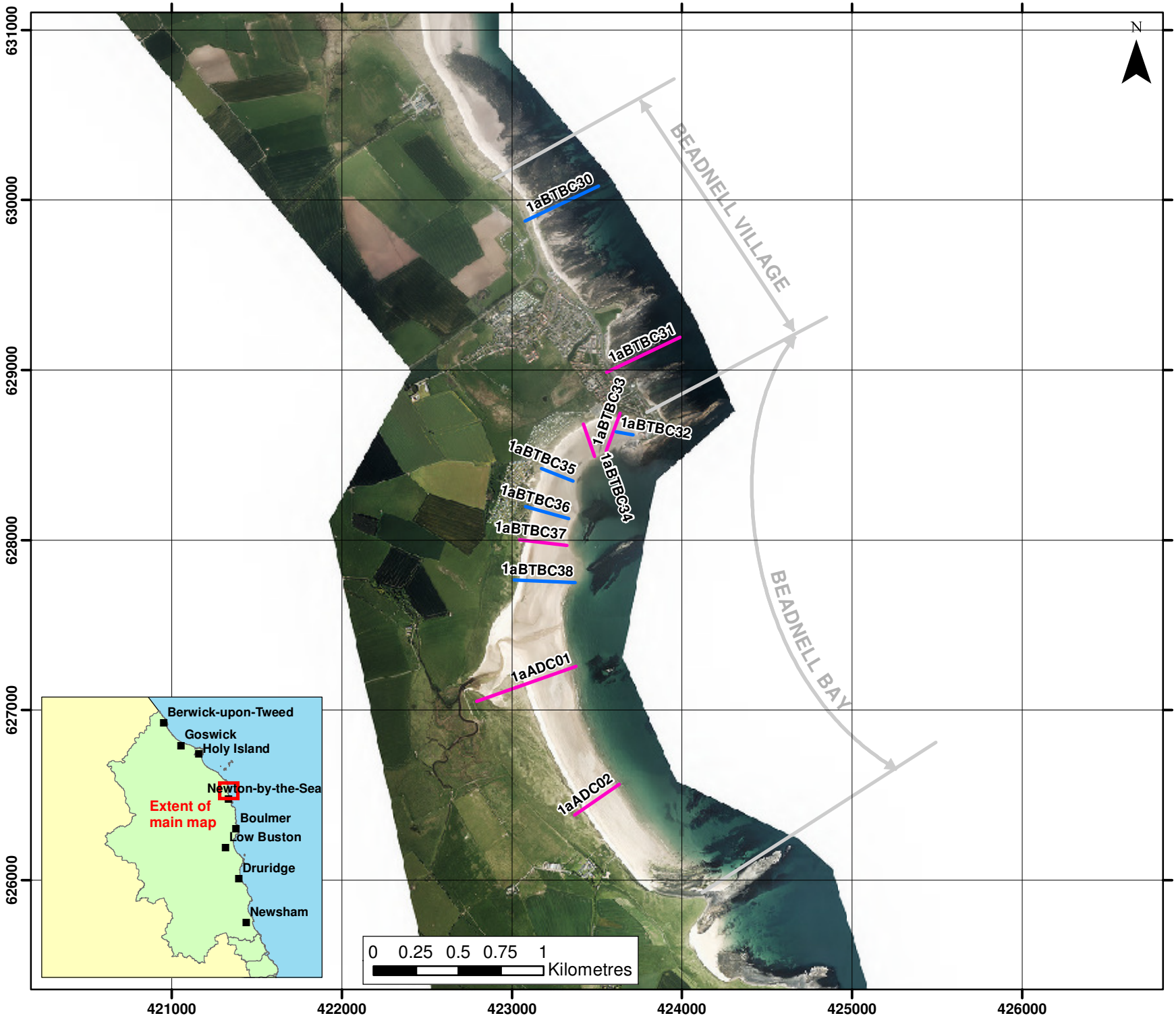
# Figure 2 - Map 4
# Survey Locations
# Bamburgh
# Northumberland
# County Council

Analytical Report 8
Full Measures Survey
Autumn 2015

ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




## 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

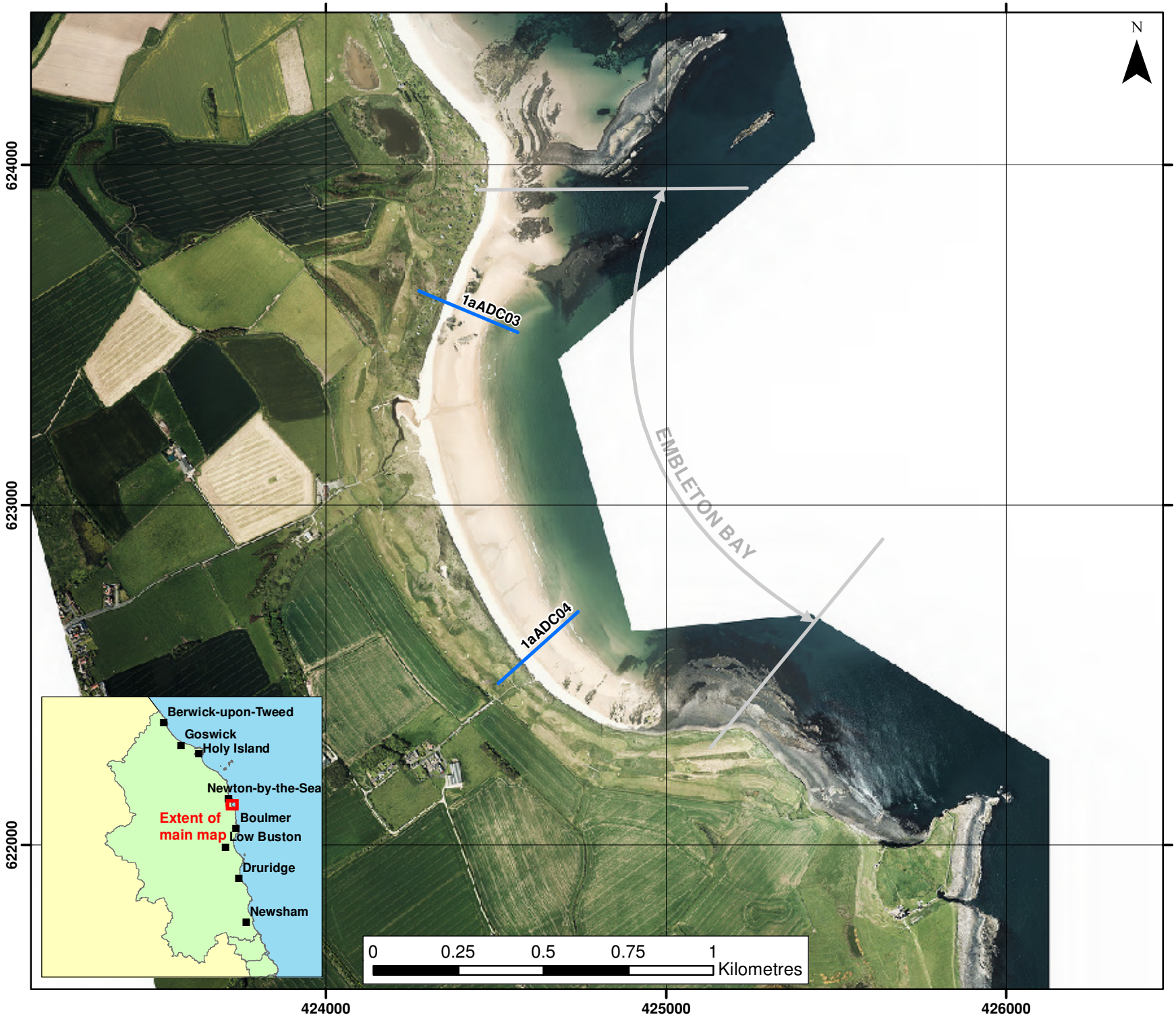
# Figure 2 - Map 5
# Survey Locations
# Beadnell Village and Bay
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015


ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




## 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

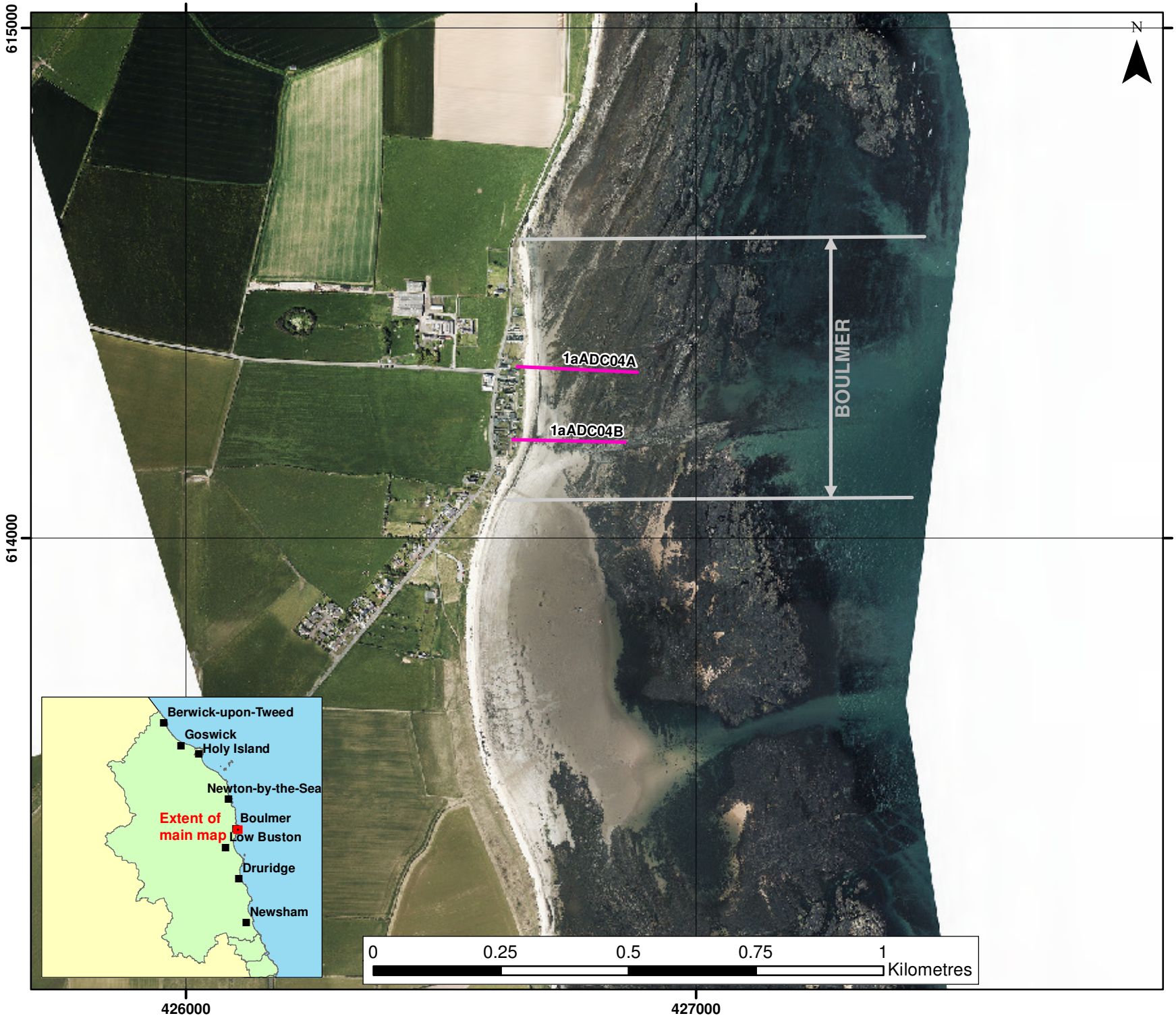
# Figure 2 - Map 6
# Survey Locations
# Embleton Bay
# Northumberland
# County Council

Analytical Report 8
Full Measures Survey
Autumn 2015

ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




## 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

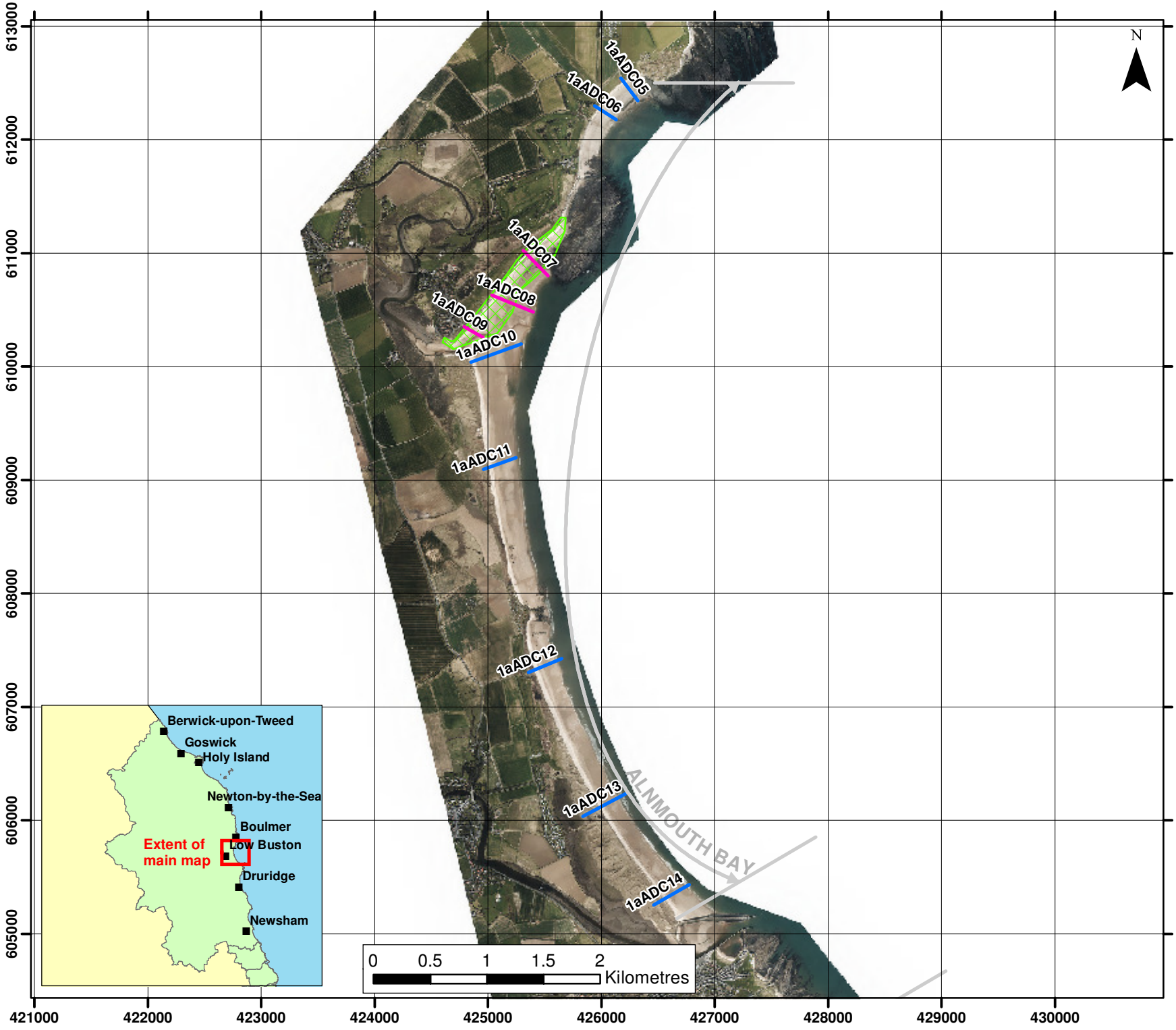
**Figure 2 - Map 7**
**Survey Locations**
**Boulmer**
**Northumberland**
**County Council**

Analytical Report 8
Full Measures Survey
Autumn 2015


ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




## 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

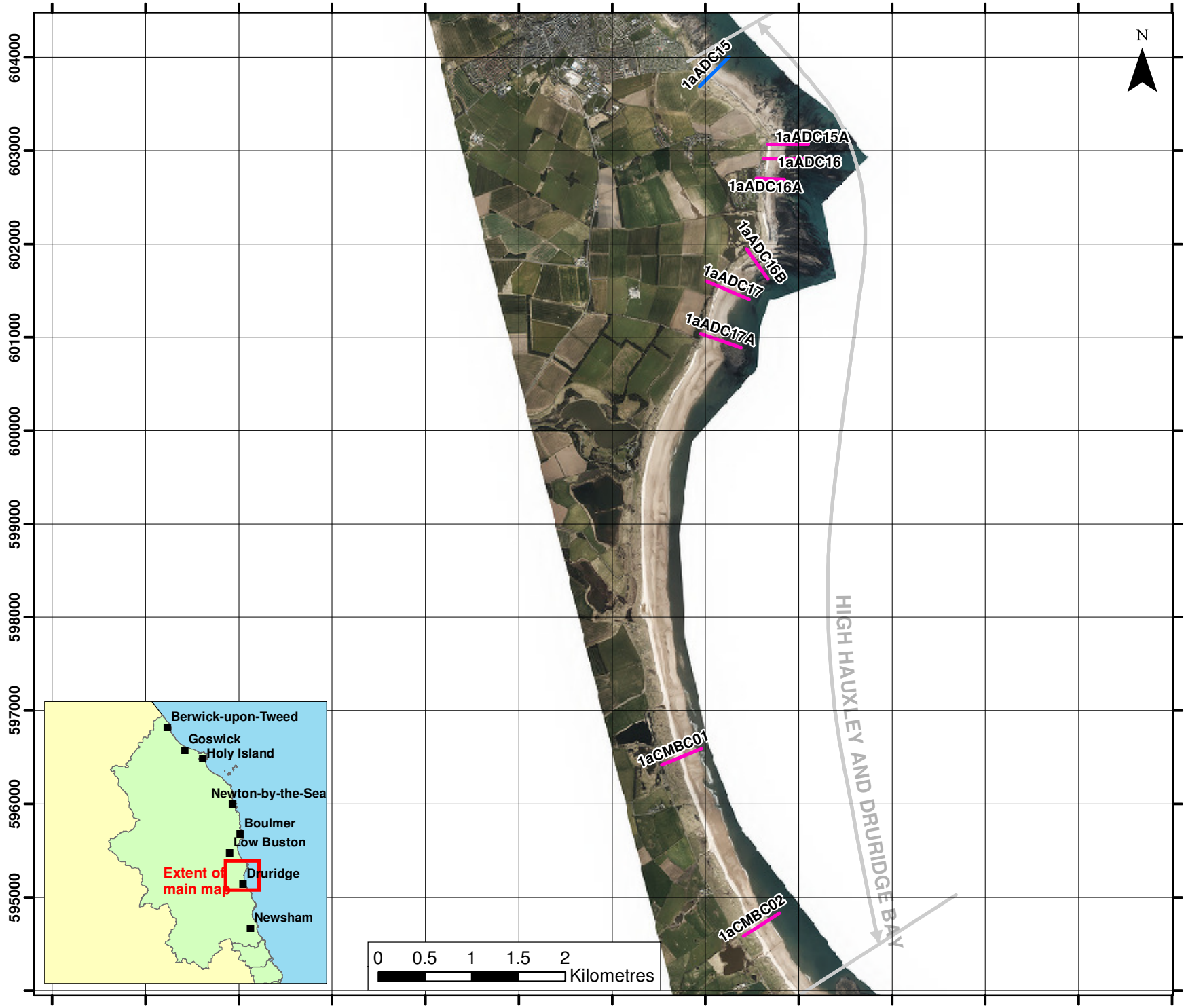
# Figure 2 - Map 8
# Survey Locations
# Alnmouth Bay
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015


ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




## 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

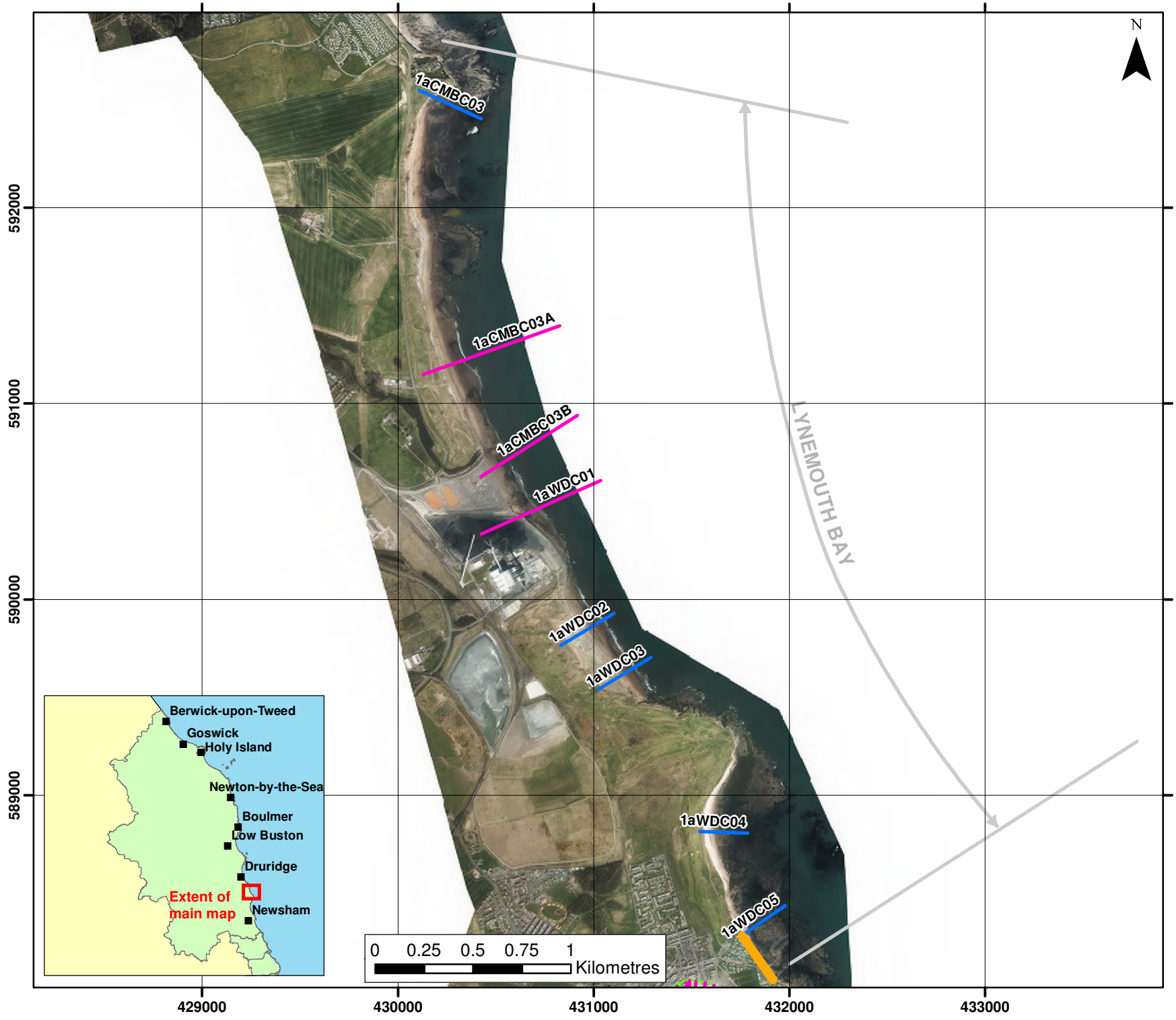
# Figure 2 - Map 9
# Survey Locations
# High Hauxley & Druridge Bay
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015


ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




## KEY

**Topographic Profiles**
- Annual
- 6 monthly

**Topographic Surveys**
- 6 monthly
- yearly
- 5 yearly

**Cliff Top Monitoring Pegs**
- 50m centres
- 100m centres
- 300m centres
- Cliff Top Edge Survey

*(Indicative survey extents shown)*

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

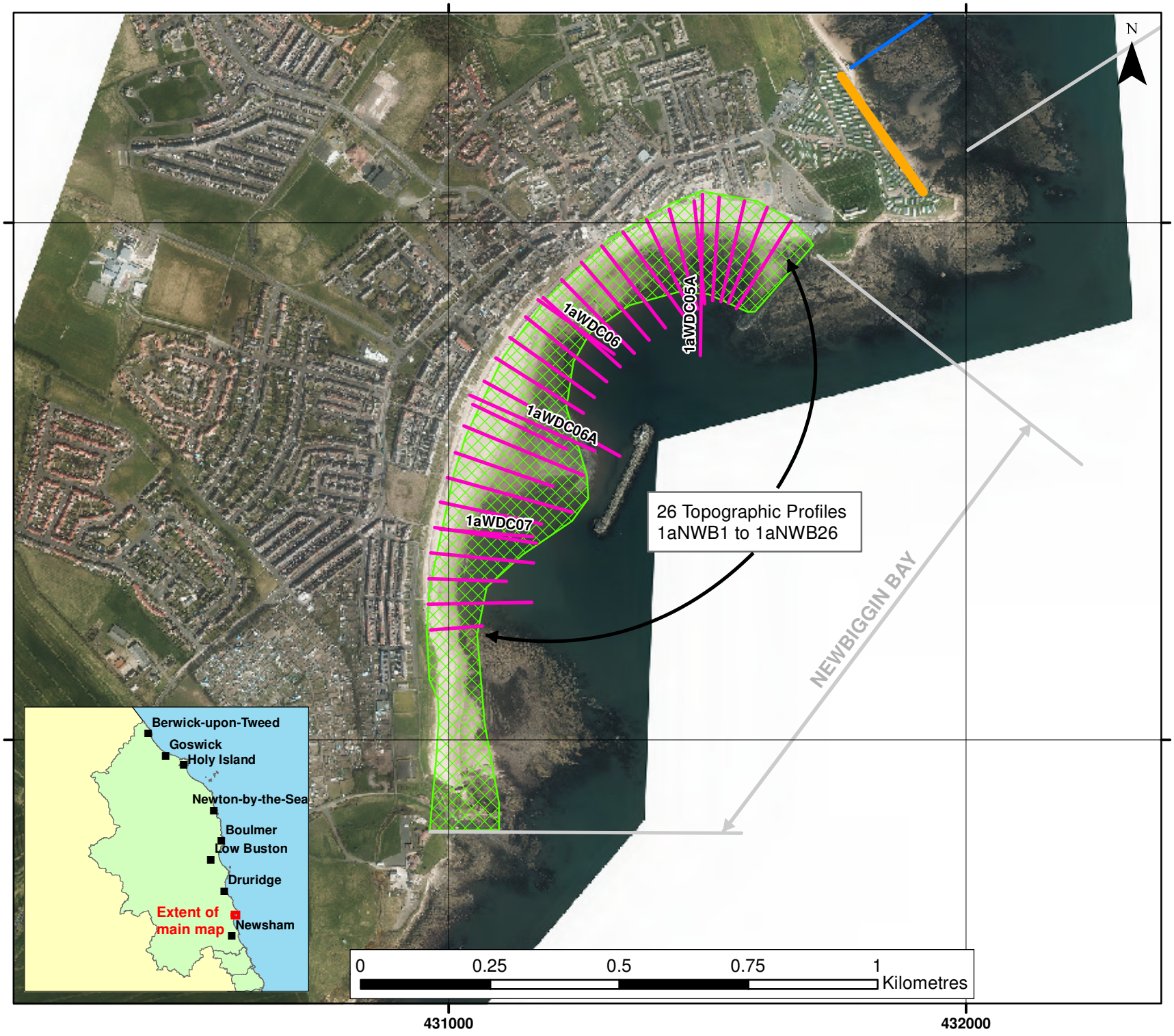
# Figure 2 - Map 10
# Survey Locations
# Lynemouth Bay
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015


ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




## KEY

**Topographic Profiles**
- Annual
- 6 monthly

**Topographic Surveys**
- 6 monthly
- yearly
- 5 yearly

**Cliff Top Monitoring Pegs**
- 50m centres
- 100m centres
- 300m centres
- Cliff Top Edge Survey

*(Indicative survey extents shown)*

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

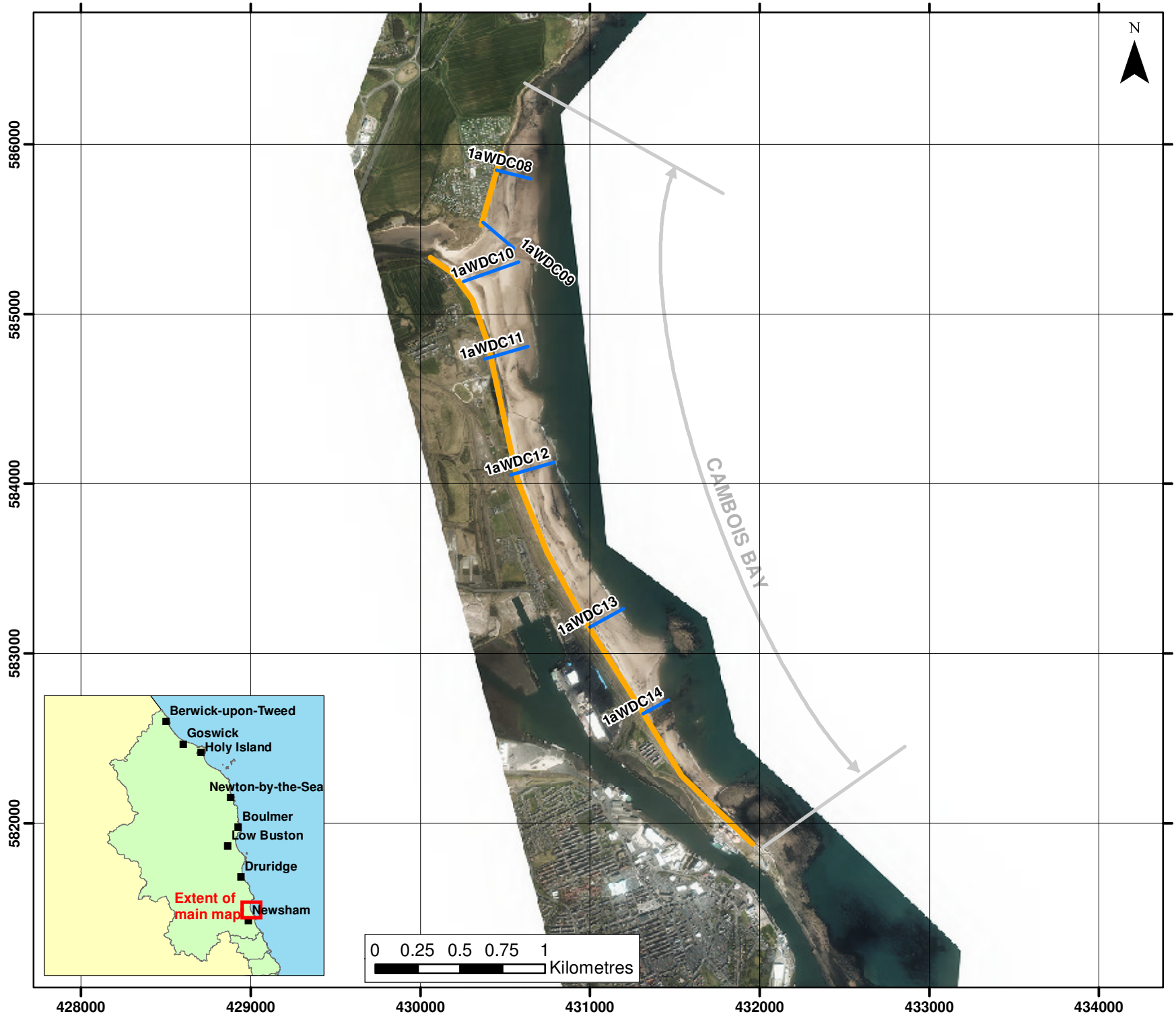
# Figure 2 - Map 11
# Survey Locations
# Newbiggin Bay
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015


ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




## KEY

**Topographic Profiles**

- Annual
- 6 monthly

**Topographic Surveys**

- 6 monthly
- yearly
- 5 yearly

**Cliff Top Monitoring Pegs**

- 50m centres
- 100m centres
- 300m centres
- Cliff Top Edge Survey

*(Indicative survey extents shown)*

Client: North East Coastal Group

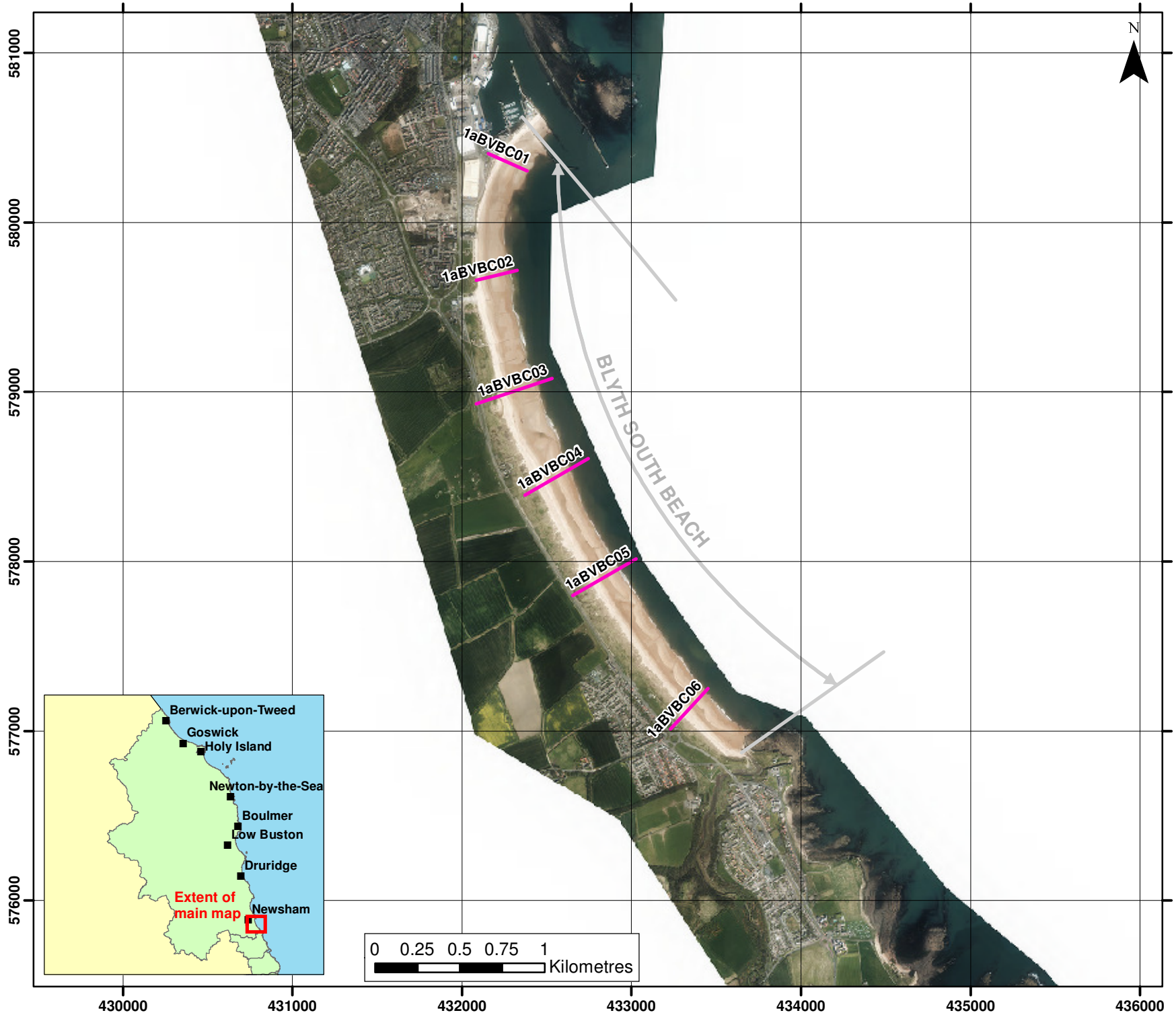
Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

# Figure 2 - Map 12
# Survey Locations
# Cambois Bay
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




## KEY

**Topographic Profiles**
- Annual
- 6 monthly

**Topographic Surveys**
- 6 monthly
- yearly
- 5 yearly

**Cliff Top Monitoring Pegs**
- 50m centres
- 100m centres
- 300m centres
- Cliff Top Edge Survey

*(Indicative survey extents shown)*

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

# Figure 2 - Map 13
# Survey Locations
# Blyth South Beach
# Northumberland
# County Council

Analytical Report 8
Full Measures Survey
Autumn 2015


ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com

# 3. Analysis of Survey Data

## 3.1 Sandstell Point (Spittal A)

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Sept 2015** | **Beach Profiles:**<br><br>Sandstell Point is covered by ten beach profile lines for the Full Measures survey (Appendix A). Profiles 1aBTBC02, 1aBTBC04, 1aBTBC05, 1aBTBC06, 1aBTBC11 and 1aBTBC13 were last surveyed during the Partial Measures Spring survey, 2015. Profiles 1aBTBC01, 1aBTBC03, 1aBTBC7 to 10, 1aBTBC12 and 1aBTBC14 were last surveyed during the Full Measures autumn survey 2014.<br><br>Profiles **1aBTBC01** to **1aBTBC03** are located on the southern bank of the River Tweed in front of the dunes.<br><br>At **1aBTBC01** the dunes have remained mostly stable with only a slight increase (<0.2m) in height over the seaward face of the dunes between 40m and 44m chainage. Between 44m chainage and the end of the profile at 61m there has been a reduction in beach elevation of ≤0.2m.<br><br>At profile **1aBTBC02** there has been little change in the dunes with accretion or erosion ≤0.1m. Between HAT and 55m chainage, beach levels have recovered by around 0.2m since the Spring 2015 survey but remain roughly similar seaward of this. Overall the beach is at medium to low levels compared to earlier surveys.<br><br>At profile **1aBTBC03** the seaward face of the dunes between 50m and 62m chainage has accreted by c.0.2m since the previous survey. There is little change between 62m and 68m chainage. Seaward of 68m chainage beach levels have reduced by up to 1.1m but remain at medium levels compared to the longer survey record.<br><br>Profiles **1aBTBC04** (longitudinal section) and **1aBTBC05** and **1aBTBC06** (both cross-sections) cover the spit at Sandstell Point.<br><br>At profile **1aBTBC04**, the beach profile shows significant change. The berm which developed between the Autumn 2015 and Spring 2015 surveys has increased in height by up to 0.25m between 20m and 85m chainage. However, its seaward facing slope has steepened substantially (see Plate 1) between 80m and 160m chainage reducing the beach level by up to 2.5m. Between 160m chainage and the | Since the last survey the dunes on south bank of River Tweed have remained unchanged, the beach sections of the profile are at medium to low levels.<br><br>There have been significant changes at the spit, with changes in the position of the berm. Rollover of sediment from the seaward side of the berm to the river side has occurred. An increase in height of the berm crest nearer to the shore line and reductions further out indicate sediment being driven towards and into the river mouth by wave action.<br><br>This is supported by the pattern in the profiles along the open coast which show a general movement of sediment towards the back of the beach and erosion in the lower foreshore.<br><br>**Longer term trends:** The dunes have remained stable over the past 12 years, and along the south bank of the River Tweed the seaward face of the dunes are the highest since surveys began (April 2002).<br><br>Changes in beach levels are generally within the bounds of previous surveys. |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | end of the profile at 340m chainage, erosion has been limited to <0.5m with a low bar being maintained seaward of 280m chainage. Overall the upper beach remains relatively high compared to previous surveys, but the lower beach and nearshore are relatively low.<br><br>Profiles **1aBTBC05** and **1aBTBC06** are transects across the spit, with the open sea on the left-hand side of the plot and the river channel to the right.<br><br>At profile **1aBTBC05** between the start of the profile and 46m chainage accretion of 0.4m has occurred. Between 46m and 96m chainage, erosion of the seaward face of the berm has led to it steepening and also led to the re-exposure of the groyne which had previously been buried by sand. The elevation of the berm crest at 110m chainage has increased by c.0.2m as has most of the berm slope facing the river as far as the end of the profile at 230m chainage.<br><br>At profile **1aBTBC06**, the beach profile has changed considerably. The berm which previously rose to 2.2m OD at 260m chainage has been eroded by c. 2.8m. A maximum elevation of 1.1m OD is attained at the end of the profile, indicating lowering of the berm crest and migration of the berm towards the estuary. Seaward of 270m chainage the profile is low compared to previous surveys but relatively high between 270m chainage and the end of the survey. There is also a pronounced runnel in the centre of the profile at c.140m chainage (see Plate 2)<br><br>Profiles **1aBTBC07** to **1aBTBC10** are located along the open coast, at the intersection of the southern side of the spit at Sandstell Point and northern end of Spittal Beach.<br><br>At profile **1aBTBC07**, between the rock revetment and 70m chainage beach levels have increased by up to 1.8m. Between 70m and 110m chainage the level of the beach has reduced by up to 0.4m but between 120m chainage and the end of the profile at 270m chainage the development of a berm has increased the level of the foreshore by up to 1.2m.<br><br>At profile **1aBTBC08**, a similar pattern is observed with an increase in beach levels of over 1.7m between 30m (toe of the rock revetment) and 70m chainage, a small (<0.5m) fall in beach levels between 70m and 90m chainage and an increase of >0.7m seaward from there to the end of the profile at 160m chainage.<br><br>Profile **1aBTBC09** again shows a similar pattern, with an increase in beach levels in front of the rock revetment as far as 60m chainage, a small reduction in beach level (<0.5m) between 60m and 80m chainage and an increase of up to 1m between 80m and 200m chainage. However, erosion of a bar | |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | has meant the foreshore between 200m chainage and the end of the profile at 280m chainage has reduced by up to 1m.<br><br>At profile **1aBTBC10** the beach levels have increased up to 1m between the rock revetment and 190m, with beach levels falling by over 1m seaward of this to the end of the profile. | |
| **Oct 2015** | **Topographic Survey:**<br><br>Due to the significant changes that have been observed from the beach profiles along the spit at Sandstell Point, and the three dimensional nature of these changes, a topographic survey was introduced to the monitoring programme in November 2011. The previous survey was undertaken for the Partial Measures survey in spring 2015.<br><br>Data from the most recent topographic survey (Full Measures, autumn 2015) have been used to create a digital ground model (DGM) (Appendix B – Map 1a) using a Geographical Information System (GIS). A difference plot has also been produced using the DGM (Appendix B – Map 1b) produced from the last topographic survey and the present survey.<br><br>The difference plot shows movement of sediment from the seaward parts of the spit to the middle of the beach and a linear strip of erosion c.10-20m from the rock revetment which extends towards the river, becoming more intense (up to 3m of change) further north. A contrasting, narrow, linear strip of accretion is also evident immediately in front of the rock revetment which also grows in intensity nearer the river (up to 3m of accretion at the very edge of the survey).<br><br>**Longer Term Topographic Trends autumn 2008 to autumn 2015:**<br><br>The long term difference plot (Appendix B – Map 1c) shows the net change in beach levels between autumn 2011 and autumn 2015. The plot shows that over the long term, the pattern of change is similar to the short term, with erosion and accretion up to c.1m in the foreshore and south bank of the River Tweed and an intense strip of erosion running north-south across the spit and along the open coastline. | Together the changes shown in the topographic survey comparison indicate a redistribution of sediment across the spit over summer, resulting in a repositioning of the berm crest further towards the river mouth.<br><br>**Longer term topographic trends autumn 2011 to autumn 2015:** The plot shows distinct zones of beach elevation increase and decrease, similar to earlier surveys. This is characteristic of a spit, with berms and troughs generated from seasonal changes in fluvial or tidal flows at the river mouth. While there have been areas of significant erosion, these are matched by areas of significant accretion indicating that the spit is a dynamic landform in the short term but stable over the longer term. |


**Plate 1 – Survey photograph 1aBTBC04_20150927_NW12**

**Plate 2 – Survey photograph 1 BTBC06_20150927_NE11**

## 3.2 Spittal (Spittal B)

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Sept 2015** | **Beach Profiles:**<br><br>Spittal B is covered by four beach profile lines for the Full Measures survey (Appendix A). Profiles 1aBTBC11 and 1aBTBC13 were last surveyed during the Partial Measures spring survey, 2015. Profiles 1aBTBC12 and 1aBTBC14 were last surveyed during the Full Measures autumn survey 2014.<br><br>Profile **1aBTBC11** is located to the north of Spittal Beach. Since the last survey, the upper beach profile as far as 50m chainage has straightened and the berm observed during the last survey has disappeared. Very little change is apparent seaward of 50m chainage, with accretion and erosion being ≤0.2m.<br><br>Profiles **1aBTBC12** and **1aBTBC13** have undergone limited erosion and accretion of up to 0.7m which appear to be redistribution of sediment throughout the profile.<br><br>At profile **1aBTBC14**, there has been more significant change, with a reduction in beach levels of approximately 0.4m between the start of the profile and 8m chainage, and an increase in beach levels seaward of this by up to 0.7m, covering the previously exposed rocky shore platform between 30m and 50m chainage. The upper part of the profile is at a low to medium level but the lower part of the profile, seaward of 100m chainage, is at its lowest on record. | Since the last survey, beach levels along Spittal have fluctuated, with broadly equal areas of beach level fall and beach level increase.<br><br>**Longer term trends:** At all profile locations along Spittal Beach, the changes observed from the present survey are within the bounds of previous surveys, with the exception of the lowest part of the foreshore in profile 1aBTBC14 where levels are at their lowest. |

## 3.3 Goswick Sands

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Oct 2015** | **Beach Profiles:**<br><br>Goswick Sands are covered by six beach profile lines for the Full Measures survey (Appendix A. Profiles 1aBTBC16 and 1aBTBC19 were last surveyed during the partial measures spring survey, 2015. Profiles 1aBTBC15, 1aBTBC17 to 1aBTBC18, and 1aBTBC20 were last surveyed during the full measures autumn survey, 2014.<br><br>The profiles along this frontage extend from **1aBTBC15** to **1aBTBC20** in a north to south direction. The seaward face of the dunes along the length of Goswick Sands has not changed form or position since the last survey (Partial Measures, spring 2014).<br><br>At profile **1aBTBC15** there has been a mixture of erosion and accretion seaward of HAT, but all changes are ≤0.2m indicating very minimal change.<br><br>At profile **1aBTBC16** the beach has accreted by up to 0.5m between 35m chainage and MHWS at 70m chainage where a small berm has developed over the summer. Changes seaward of this are minimal. The profile is at or near its highest level when compared to earlier surveys.<br><br>At profile **1aBTBC17** the small berm at the toe of the dunes has translated seawards, continuing the pattern seen between the previous surveys. Below HAT, whilst accretion of up to 0.5m has occurred in the upper part of the foreshore (landward of 350m chainage) and up to 1m in the lower foreshore (seaward of 350m chainage). Compared to earlier surveys, the beach is at or near its highest level.<br><br>At profile **1aBTBC18** beach levels have changed very little as far as 430m chainage. No data is available from the previous two surveys seaward of this point, but there is in even earlier surveys. The data indicates the reappearance of a barrier feature with its crest at c.3m OD at 550m chainage and a relatively steep seaward face, falling to 0m OD by 715m chainage.<br><br>At profile **1aBTBC19** beach levels have fallen across the length of the profile by <0.1m with no change to the profile form and could therefore be the result of error within the survey methods.<br><br>At **1aBTBC20** the beach has generally remained stable since the last survey, only with some discrete areas of accretion of 0.1m or less, notably a small accumulation of gravel at around 280m chainage. | Beach level change has varied along the length of Goswick Sands since the last survey. Greater movement appears to have occurred in the north of the area, although these appear to be redistributions of sediment across the profile. At the southern end of Goswick Sands, the beach has remained stable with no discernible change to the profile form or position. One notable exception is the development of a barrier feature visible in the seaward end of profile 1aBTBC18<br><br>**Longer term trends:** The majority of change is a continuation of seasonal behaviour. In the previous analytical report, the formation of a new vegetated mound at profile 1aBTBC18 was identified, which still remains. A notable barrier feature has also developed further seaward in this profile which has not attained its current height since 2003. Subsequent surveys show a gradual reduction in the feature's height and ongoing landward migration. |

## 3.4 Holy Island

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Nov 2015** | **Beach Profiles:**<br><br>Holy Island is covered by eight beach profile lines for the Full Measures surveys (Appendix A). Profiles 1aBTBC21 and 1aBTBC23 were last surveyed during the Partial Measures spring survey, 2015. Profiles 1aBTBC22, 1aBTBC24 to 1aBTBC28 were last surveyed during the Full Measures autumn survey, 2014.<br><br>**1aBTBC21** to **1aBTBC23** are located on the northwest side of the island, along The Snook. **1aBTBC24** to **1aBTBC28** are located on the south side of the island in the vicinity of the castle and priory. **1aBTBC27** extends out to and across the small island upon which the remains of a chapel stand.<br><br>At all profiles on the north side of the island, the dunes have not changed in form or position since the last survey. On the whole, beach levels have also remained largely the same since the last survey with only minor increases/decreases in beach level observed (<0.1m). **1aBTBC21** shows an increase of up to 0.35m seaward of 700m chainage, indicating a development of a berm, which has also appeared in earlier surveys, at the seaward end of the profile.<br><br>On the south of the island, profiles show very little change since the previous survey, with only minor increases/decreases in beach level observed (<0.15m). A slight exception is the development of a gravel berm through accretion of 0.2m of sediment at 1.5m OD (28m chainage) in profile 1aBTBC24. | The dunes, sandy foreshore and sand flats around The Snook on Holy Island have remained stable in both form and position since the last survey.<br><br>On the south side of the island, the backshore and beach have remained stable since the last survey.<br><br>**Longer term trends:** Generally, the trends observed in the present survey are a continuation of those observed in the past, with the dunes and beach retaining the same form and position. The exception to this is at profile 1aBTBC21, where the dune front and toe have advanced by c.20m through the accumulation of nearly 2m of sand since 2002, and 1aBTBC22 and 1aBTBC23, where the advance of the dune toe is similar but less pronounced. The survey photographs reflect this change (see Plates 3 and 4, which show ongoing stabilisation of the dune front between the previous and current surveys), which shows sand accumulation and the establishment of vegetation. |
| **Nov 2015** | **Topographic Survey:**<br><br>Holy Island causeway and the adjacent sand flats are covered by an annual topographic survey, which commenced in October 2004. The purpose of this survey was to determine whether raising the level of the causeway had any adverse impacts on the adjacent sand flats.<br><br>Data from the most recent topographic survey (Full Measures, autumn 2015) have been used to create a DGM (Appendix B – Map 2a) using a Geographical Information System (GIS). A difference | The topographic survey shows that the causeway has remained stable since the last survey.<br><br>**Longer term topographic trends autumn 2010 to autumn 2014:** The long term difference plot of topography shows that over the long term, there has been very little change, with elevation difference being a general increase of less than 0.5m. Greatest |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | plot has also been produced using the DGM (Appendix B – Map 2b) produced from the last produced topographic survey (Full Measures, autumn 2014) and the present survey.<br><br>In particular, the difference plot shows overall stability with pockets of elevation change in the order of +/-0.5m.<br><br>**Longer Term Topographic Trends autumn 2008 to autumn 2015:**<br><br>The long term difference plot (Appendix B – Map 2c) shows the net change in beach levels between autumn 2010 and autumn 2015. The plot shows that over the long term, there has been a trend of overall stability to the east and pockets of elevation increase and decrease to the west in the order of +/-0.5m. As observed previously, the area of most change is associated with the channel. | change is associated with natural migration of a channel. |

**Plate 3 – Survey photograph 1a BTBC21_20151101_N7**

**Plate 4 - Survey photograph 1aBTBC21_20141027_W6**

## 3.6 Bamburgh

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Nov 2015** | **Beach Profiles:**<br><br>Bamburgh is covered by one beach profile line for the Full Measures survey (Appendix A). Profile 1aBTBC29 was last surveyed during the Full Measures autumn survey, 2014.<br><br>Profile **1aBTBC29** is located approximately 750m south-east of the castle. The seaward face of the dune has advanced since the last survey, by up to 3m, from vertical accretion of up to 1m. Beach levels seaward of the dune toe (367m chainage) as far as 400m chainage have increased c.0.4m. Beyond this changes in elevation are ≤0.1m. | The dunes at Bamburgh have remained stable, and the seaward face of the dune and the upper beach have accreted (see Plate 5) indicating recovery following the erosion (likely caused by the December 2013 storm surge event) noted in the previous analytical report.<br><br>**Longer term trends:** The 2015 profile shows that the seaward face of the dune is still near its most eroded position since 2004, but also shows signs of recovery since the erosion noted in the 2014 analytical report. The beach is at a low-medium level compared to earlier surveys. |

**Plate 5 – Survey Photograph 1aBTBC29_20151113_N26**

## 3.7 Beadnell Village

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Sept 2015** | **Beach Profiles:**<br><br>Beadnell Village is covered by two beach profile lines for the Full Measures survey (Appendix A). Profiles 1aBTBC31 was last surveyed during the Partial Measures spring survey, 2015. Profile 1aBTBC30 was last surveyed during the Full Measures autumn survey, 2014.<br><br>**1aBTBC30** is around 300m to the north of the village. The dune has remained stable since the last survey. Since the previous survey, a small berm has developed at HAT level, with its crest at 55m chainage, through the accumulation of up to 0.2m of sediment. Between 55m chainage and 100m chainage there has been minor (<0.2m) erosion. Change seaward of 100m chainage is limited to <0.1m<br><br>**1aBTBC31** is in Nacker Hole and extends across the promenade and seawall. Since the last survey, beach levels at the toe of the seawall have increased 0.3m. The remainder of the profile has generally remained stable with intermittent pockets of subtle beach change along the length of the profile of no more than 0.1m. | The dunes and beach to the south of Beadnell Village have generally remained stable, although there is evidence for a small amount of sediment having been moved across the beach at profile 1aBTBC30 since the last survey.<br><br>**Longer term trends:** The changes observed since the last survey are within the bounds of previous surveys albeit at relatively low levels |

## 3.8 Beadnell Bay

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Sept 2015** | **Beach Profiles:**<br><br>Beadnell Bay is covered by nine beach profile lines for the Full Measures survey (Appendix A). Profiles 1aBTBC33 to 1aBTBC34, 1aBTBC37 and 1aADC01 to 1aDC02 were last surveyed during the Partial Measures spring survey, 2015. Profiles 1aBTBC32, 1aBTBC35 to 1aBTBC36 and 1aBTBC38 were last surveyed during the Full Measures autumn survey, 2014.<br><br>**1aBTBC32** to **1aBTBC34** are located at the northern end of Beadnell Bay, in Beadnell Harbour. At profile **1aBTBC32**, the dune ridge has generally remained stable since the last survey. The dune toe and upper beach between HAT and 2m OD (7m to 22m chainage) have accreted by up to 0.4m since the last survey. Seaward of this point, beach levels have reduced by up to 0.3m. This is almost an exact reversal of the pattern seen during the previous survey.<br><br>At profile **1aBTBC33**, the back of the dunes has remained stable since the last survey. The survey report notes '*middle of dunes missing due to dense vegetation*', as it did in the previous survey, so the profile for the dune face has not been analysed any further. The beach has remained stable, with change limited to the accumulation of up to c.0.4m sand to form a small berm at the dune toe.<br><br>At profile **1aBTBC34**, the crest of the seaward dune has continued to erode. This is recorded in the survey photograph (Plate 6) that shows dune face collapse. Throughout the rest of the profile change is mostly <0.2m.<br><br>**1aBTBC35** to **1aBTBC38** are located between Burn Carrs and the outfall of Brunton Burn/Long Nanny. The dunes along this northern section of coast have remained stable since the last survey, although at some locations there has been some erosion of the dune face and advance at others.<br><br>At profile **1aBTBC35**, there has been up to 0.4m of accretion at the dune toe and in the upper beach to form a small berm with its crest at c.15m chainage. Between 15m chainage and 120m chainage there has been up to 0.3m of accretion but no change seaward of 120m chainage.<br><br>At profile **1aBTBC36**, beach levels have remained stable since the last survey, except for accretion of c.0.5m to form a berm at HAT level. There has also been c.0.3m of accretion on the lower dune face. | Along the length of Beadnell Bay, the dunes have remained stable, however, the dune face and dune toe has been subject erosion in some locations and accretion in others. Beach levels generally remained stable throughout the bay except for minor variations in the upper beach.<br><br>**Longer term trends:** Along the length of Beadnell Bay, the majority of the dune and beach form are similar to those observed in the past and the profile form and position is within the bounds of previous surveys. Exceptions include:<br><br>• The most seaward extent of profile 1aBTBC32 where the foreshore is at its lowest level to date.<br><br>• The foreshore 1aBTBC35 is at its highest level to date.<br><br>• The upper beach at 1aBTBC38 is at its lowest level to date, due to the erosion evident in Plate 8. |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | At profile **1aBTBC37**, the dunes have remained stable since the last survey with very limited accretion of the seaward dune face. Beach levels between the toe of the dunes (25m chainage) to approximately 60m chainage have generally reduced by up to 0.3m but accreted by a similar amount between 60m and 120m chainage. Seaward of here there has been negligible change. Overall the dune face is at its furthest seaward position on record (see Plate 7)<br><br>At profile **1aBTBC38**, the retreat observed at the last survey between a height of 4m and 6m, has reversed, but there has been a reduction in beach level above MHWS of up to 0.6m, creating a small cliff at the dune toe (see Plate 8). A runnel in the middle foreshore between 140m chainage and 230m chainage has infilled to straighten the profile. The infilling sediment is likely to have been derived from the eroding dune toe.<br><br>**1aADC01** and **1aADC02** are located south of the outfall of Brunton Burn/Long Nanny. The dunes (other than at their toe) have not changed from or position.<br><br>At profile **1aADC01**, there has been c.0.2m of erosion from the dune toe between 260m chainage (above HAT) and 258m chainage (just below MHWS) and accretion between 300m chainage and 420m chainage in the middle foreshore, indicating a cross-shore movement of sediment to produce a slightly more concave profile. Otherwise, the profile has remain stable with little change.<br><br>At profile **1aADC02**, the profile has remained relatively more stable with some erosion at the toe of the dune immediately above HAT (see Plate 9), but accretion further up the dune face of c.0.5m. | |

**Plate 6 – Survey photograph 1aBTBC34_20150930_E3**

**Plate 7 – Survey photograph 1aBTBC37_20150930_N3**

**Plate 8 – Survey photograph 1aBTBC38_20150930_N3**

**Plate 9 – Survey photograph 1aADC02_20150930_Up2**

## 3.9 Embleton Bay

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Nov 2015** | **Beach Profiles:**<br><br>Embleton Bay is covered by two beach profile lines for the Full Measures survey (Appendix A). Profiles 1aADC03 and 1aADC04 were last surveyed during the Full Measures autumn survey, 2014.<br><br>**1aADC03** is located towards the north of the bay, north of Embleton Burn mouth. **1aADC04** is located towards the south of the bay.<br><br>At profile **1aADC03** there has been minor accretion between the dune toe at 65m chainage and the middle foreshore at 140m chainage, reaching a maximum of c.0.6m at immediately above HAT, but little change on the dunes themselves or seaward of 140m chainage.<br><br>At profile **1aADC04**, the dune face has advanced by c.1.5m. A berm has developed with its crest at the level of HAT through accumulation of up to 1m of sand between 155m chainage and 185m chainage. Minor (<0.2m) erosion has occurred in the middle foreshore between 185m chainage and 220m chainage. Seaward of 220m chainage a bar has developed in the lower foreshore through the accumulation of up to 1m of sand. | The dunes at Embleton Bay are generally stable. In the last analytical report erosion at the dune toe was reported, but this appears to have now reversed and the advance of the dunes is recorded.<br><br>The upper beach levels have generally increased, possibly as a result of sediment being redistributed across the shoreline.<br><br>**Longer term trends:** The dunes have remained stable over the longer term and beach levels are within the range of those surveyed since 2002. The upper beach is still relatively low but shows signs of recovery towards higher levels. |

## 3.10 Boulmer

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Sept 2015** | **Beach Profiles:**<br><br>Boulmer is covered by two beach profile lines for the Full Measures survey (Appendix A). These were added to the programme in October 2007. Profiles 1aADC04A to 1aADC04B were last surveyed during the Partial Measures spring survey, 2015.<br><br>At profile **1aADC04A** accretion c.0.1m has occurred throughout the majority of the profile. As this is within the error bounds of the survey it is unlikely to be significant.<br><br>At profile **1aADC04B** the changes are all less than 0.1m and therefore not significant, with the exception of a small section of the profile between 65m and 80m chainage where 0.2m of sand has accumulated, deepening the beach sediments immediately landward of the exposed rocky foreshore. | The dune cliff backshore at Boulmer has remained stable since the last survey.<br><br>The changes to beach profile are minimal.<br><br>**Longer term trends:** Beach elevations are high in comparison to the long-term record of surveys. |

## 3.11 Alnmouth Bay

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Sept and Nov 2015** | **Beach Profiles:**<br><br>Alnmouth Bay is covered by ten beach profile lines for the Full Measures survey (Appendix A). Profiles 1aADC07 to 1aADC09 were last surveyed during the Partial Measures spring survey, 2015. Profiles 1aADC05, 1aADC06 and 1aADC10 to 1aADC14 were last surveyed during the Full Measures autumn survey, 2014.<br><br>**1aADC05** and **1aADC06** are located in the small pocket beach that is situated between the rock outcrops of Seaton Point and Marden Rocks. These profiles were surveyed in early September 2015, whereas those further south in the bay were surveyed in late November 2015.<br><br>At profile **1aADC05**, the cliffs have remained stable since the last survey. Beach levels have increased between 20m chainage (just above HAT) and 90m chainage by up to 0.5m and fallen by up to 0.4m between 90m chainage and the end of the profile at 180m chainage. The effect of these changes is to straighten the beach profile. These change are likely to be caused by movement of sediment across the beach.<br><br>At profile **1aADC06**, changes are more minimal, with the majority of the profile accreting by up to 0.2m with accretion focused in the mid and lower foreshore.<br><br>**1aADC07**, **1aADC08** and **1aADC09** are located to the north of Alnmouth Bay between Marden Rocks and the mouth of the River Aln Estuary.<br><br>At profile **1aADC07**, the toe of the dune has receded by 3-4m since the last survey. The beach profile has straightened between 20m chainage and 100m chainage due to the infilling of a depression between 35m chainage and 60m chainage, along with a reduction in beach level of 0.35m between 60m chainage and 100m chainage to erode a berm present in earlier surveys. Between 100m chainage and 170m chainage a runnel feature is unchanged since the previous survey and continues to expose the sands and gravels. Seaward of this a significant bar has accumulated between 170m chainage and the end of the profile through the accumulation up to 0.8m of sand. Beach levels in the mid foreshore remain low compared to earlier surveys and medium to high levels in upper beach, backshore and lower foreshore | To the north of Alnmouth Bay, the dune cliffs and beach levels have remained relatively stable with a limited amount of sediment redistributed across the beach.<br><br>At the centre of bay, north of the mouth of the River Aln Estuary, the dunes have remained stable since the last survey. Since the last survey, the beach has shown some mobility with bars forming in the lower foreshore at 1aADC07 and 1aADC08 and migration of the river channel at profile 1aADC09.<br><br>Immediately south of the mouth of the River Aln, there has been further erosion of the dune toe and an upper beach berm. Further south there has been a mixture of erosion and accretion except at the southernmost profile where the dune toe has eroded with no equivalent amount of deposition in the profile, suggesting sediment has been transferred within the bay.<br><br>**Longer term trends:**<br><br>The cliffs in the far north of the bay have retreated slowly since 2002, by around 1m in total.<br><br>The dunes have generally demonstrated long-term stability. The exception is on the south bank of the Aln Estuary at profiles 1aADC10 and 1aADC14 where the dune toe and upper beach have eroded significantly over the past year. |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | At profile **1aADC08** beach levels between the dune toe and 85m chainage beach levels have increased by 0.2m, and decreased by 0.3m between 85m chainage and 140m chainage. Between 140m and 340m chainage, two bars separated by a runnel have developed through the deposition of up to 0.6m of sand where the bars are present and erosion of 0.4m of sand from the runnel. Upper beach and lower foreshore levels remain relatively high compared to earlier surveys, but middle foreshore levels remain low.<br><br>At profile **1aADC09**, accretion of 0.2m has occurred at the dune toe as far as 26m chainage. Between 26m chainage and 46m chainage up to 0.3m of erosion has occurred, whereas up to 0.5m of deposition has occurred to infill a depression between 46m chainage and 90m chainage. Seaward of 90m chainage, the profile descends into the Aln channel (see Plate 10) which has migrated 5m seaward since the previous survey.<br><br>**1aADC10** to **1aADC14** are located between the south bank of the River Aln Estuary and the north breakwater of Warkworth Harbour at the mouth of the estuary of the River Coquet.<br><br>At profile **1aADC10**, the eroding dune face has been re-exposed (see Plate 11) and the c.25m wide berm in the upper beach has been reduced to c.5m wide through the erosion of up to 1.5m of sediment, lowering the berm crest by c.0.5m. Between 70m chainage and 220m chainage the beach level has increased by up to 0.5m, indicating that the material eroded from the upper beach has been redistributed across the foreshore. The beach toe has steepened seaward of 220m through the removal of up to 0.8m of sediment. The upper beach is at its lowest level on record but the foreshore is relatively high.<br><br>At profile **1aADC11**, around 0.4m of sand has accumulated at the dune toe, extending it seaward c.2-3m. A berm has been eroded between 50m and 65m chainage to make a more concave profile. Seaward of 65m chainage to the end of the profile at 280m chainage there has been limited accretion (up to 0.4m). Except at the upper dune face, the profile is at a relatively high level compared to earlier surveys.<br><br>At profile **1aADC12**, beach levels have changed relatively little (<0.3m) landward of 130m chainage. Only limited accretion has occurred at HAT which has formed a small berm. There has also been limited erosion in the upper foreshore. The lower foreshore seaward of 130m chainage has accreted by up to 0.5m, pushing MHWS c.40m seaward. | Changes in beach profile form and position observed since the last survey are generally within the bounds of previous surveys although the middle foreshore is low in some profiles. |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | At profile **1aADC13**, the dunes and dune face have remained stable since the last survey albeit with a small amount of accretion at the dune toe. Further seaward, there has been limited change with erosion of up to 0.5m between 150m and 200m chainage and a similar level of accretion between 200m chainage and the end of the profile at 310m chainage.<br><br>At profile **1aADC14**, the dune toe has been eroded, causing it to recede up to 6m since the last survey (see Plate 12). Erosion and accretion in the rest of the profile is <0.2m. The profile is low relative to previous surveys. | |
| **Sept 2015** | **Topographic Survey:**<br><br>The northern part of Alnmouth Bay (to the north of the River Aln Estuary) is covered by a bi-annual topographic survey, which commenced in April 2005. Data from the most recent topographic survey (Full Measures, autumn 2015) have been used to create a DGM (Appendix B – Map 3a) using GIS. A difference plot has also been produced using the DGM (Appendix B – Map 3b) comparing the last produced topographic survey (Partial Measures, Spring 2015) with the present survey.<br><br>The difference plots shows clear zones of beach elevation increase and decrease; (i) largely shore parallel areas of erosion and accretion in the northern part of the survey area indicating cross-beach movements; (ii) erosion in front of the village near the channel of the Aln, but accretion at the toe of the dunes and (iii) alternating areas of erosion and deposition along the northern edge of the Aln channel indicating possible minor variations in its course since the last survey.<br><br>**Longer Term Topographic Trends autumn 2011 to autumn 2015:**<br><br>The long term difference plot shows a large area of erosion (up to 1.5m) in the northern part of the survey area. There is an area of accretion to the south of this which may account for some of the eroded sediment. In the southern and central area of the survey area, there are areas of erosion and accretion where beach elevation has changed up to 2m. | The findings of the topographic survey show cross beach movements of sediment related to seasonal effects in the northern part of the survey area and effects relating to migration of the Aln river channel in the southern part of the survey area.<br><br>**Longer term topographic trends autumn 2011 to autumn 2015:** From a comparison of 2015 aerial photography to 2010 aerial photography, the alternating patterns of erosion and deposition in the south of the survey area can be attributed to migration of the river channel across the beach. Those further north are more likely associated with marine processes redistributing sediment to different areas of the beach. |

**Plate 10 - Survey photograph 1aADC09_20150904_Dwn4**

**Plate 11 – Survey photograph 1aADC10_20150904__N3**

**Plate 12 – Survey photograph 1 aADC14_20151114_N14**

## 3.12 High Hauxley & Druridge Bay

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Oct 2015** | **Beach Profiles:**<br><br>High Hauxley to Druridge Bay is covered by nine beach profile lines for the Full Measures survey (Appendix A). Four of these (with 'A' or 'B' suffixes) were added to the programme in October 2007.All except 1aADC15 are resurveyed every 6-months.<br><br>Profile **1aADC15** extends across the extensive dunes at Amble Links and foreshore. The dunes have remained stable since the last survey (Full Measures, autumn 2014). The pronounced storm berm identified in the last report has been redistributed to form two other berms lower in the profile, just above HAT and between HAT and MHWS with the upper one being formed of gravel and the lower one gravel and sand. Seaward of 130m chainage the profile has lowered throughout by between 0.1 and 0.6m to form a more undulating profile.<br><br>**1aADC15A**, **1aADC16** and **1aADC16A** are located around Hauxley Haven. At all locations, the dunes has remained stable since the last survey (Partial Measures, Spring 2015).<br><br>At profile **1aADC15A**, there has been very little change except for c.0.3m of erosion over a short distance between 15m and 25m chainage in the uppermost part of the beach.<br><br>At profile **1aADC16**, beach levels between the toe of the tunes at 70m chainage and 110m chainage have reduced by c.0.2m. Seaward of this there have been minimal (<0.1m) changes to the beach elevation.<br><br>At profile **1aADC16A**, there has been very little change with the majority of the beach accreting slightly (<0.1m). At the toe of rock revetment, the pattern of accretion evident in previous reports appears to have continued.<br><br>**1aADC16B**, **1aADC17** and **1aADC17A** are located to the north of Druridge Bay, between Bondi Carrs and Hadston Carrs and extend seawards from Togston Links. At all locations, the dunes have remained stable since the last survey (Partial Measures, spring 2015).<br><br>At profile **1aADC16B**, beach levels have virtually remained the same since the last survey. | At High Hauxley (profile 1aADC15), the dune has remained stable. There has been some erosion of the dune toe, with sediment appearing to have been driven up the beach.<br><br>At Hauxley Haven (profiles 1aADC15A to 1aADC16), the dunes have remained stable since the last survey. Minor changes have occurred in the upper beach.<br><br>In the far north of Druridge Bay, there has been very little change since the last survey, with all variations in beach level <0.3m. Further south in Druridge Bay, erosion of the upper beach and some deposition on the lower foreshore has occurred suggesting a redistribution of material across the beach.<br><br>**Longer term trends:** At High Hauxley, Hauxley Haven and north and south Druridge Bay, the dunes have remained stable except for limited changes at the dune toe. The beach levels are mostly within the bounds of previous surveys. Exceptions are Hauxley Haven, where profiles are within the range of previous surveys in the upper beach but are low in their seaward extents, and 1aADC16B at the northern end of Druridge Bay which remains at its lowest level throughout the length of the profile. |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | At profile **1aADC17**, the dunes and beach remain virtually unchanged with all changes being <0.2m.<br><br>At profile **1aADC17A**, beach levels have changed little, although in general there has been an increase in beach profile of up to 0.3m, which has infilled a small runnel in the middle foreshore and created a small berm in the lower foreshore<br><br>**1aCMBC01** and **1aCMBC02** are located in the southern section of Druridge Bay. At both locations, the dunes have remained stable since the last survey (Partial Measures, Spring 2015).<br><br>At profile **1aCMBC01**, beach levels have fallen throughout most of the profile. In the upper beach, two pronounced berms which were present above HAT and at MHWS have been eroded by up to 1m, leaving a lower berm at 1.5m OD (240m chainage). Between 260m chainage and 365m chainage the foreshore level has reduced by up to 0.5m and a small bar has formed through the accretion of a similar amount between 365m chainage and the end of the profile at 420m chainage.<br><br>At profile **1aCMBC02**, there appears to have been a small amount of erosion from the upper dune face and deposition at the dune toe. The upper beach between 200m chainage (just above HAT) and 240m chainage (1.5m OD, below MHWS) has undergone variable degrees of erosion and deposition up to ±0.6m to create a new runnel and berm. The middle foreshore between 240m chainage and 320m chainage has fallen by up to 0.4m and there has been limited (c.0.2m) of accretion in the very lowest parts of the foreshore. | |

## 3.13 Lynemouth Bay

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Oct 2015** | **Beach Profiles:**<br><br>Lynemouth Bay is covered by six beach profile lines for the Full Measures survey (Appendix A). Profiles CMBC03A and CMBC03B were added to the programme in October 2007.<br><br>Profiles 1aCMBC03a to 1aWDC01were last surveyed during the Partial Measures spring survey, 2015. Profiles 1aCMBC01 and 1aWDC02 to 1aWDC05 were last surveyed during the Full Measures autumn survey, 2014.<br><br>**1aCMBC03** is located just to the south of Snab Point. The profile extends across the cliff and the rock platform below. The profile has not changed since the last survey indicating a stable cliff and rocky foreshore.<br><br>**1aCMBC03A** is located opposite Lynemouth and extends across the extensive slag banks before reaching the foreshore. A line of cobbles and small boulders is present at around HAT. The slag bank has not experienced any change since the last survey (Partial Measures, spring 2015) and changes to beach level are minimal, with the greatest change being a reduction of the beach level by 0.2m just above HAT<br><br>**1aCMBC03B** is located to the north of Lynemouth Power Station and extends across the extensive slag banks before reaching the foreshore. The process of slag bank erosion has been progressively ongoing for some years. Since the last survey, the slag bank has retreated by about 2.5m (Plate 13 shows cliff in slag bank), which is more than the recession in the previous period (autumn 2014 to spring 2015, but less than the two periods before that (between the winter 2013 and spring 2014 survey, there was 15m of recession). A very small amount of accretion has occurred on the upper beach between -17m chainage and -11m chainage, possibly residual sediment from the slag bank retreat. The foreshore has experienced variable erosion and accretion of up to 1m between 5m chainage and 80m chainage to create a distinctively convex profile.<br><br>**1aWDC01** extends from seaward of the rock revetment down to low water across the extensive slag banks. The survey report notes, '*unable to measure the face of the revetment - blocks to[o] slippy*'. The beach levels seaward of the rock revetment appear to have dropped slightly but this could be an | To the south of Snab Point, the shoreline has not changed in form or position since the last survey. Opposite Lynemouth, the slag bank and beach have remained stable.<br><br>To the north of the power station, the slag bank has continued to erode, retreating by approximately 2.5m. The beach has also eroded by up to 1m to present a concave profile. Beach levels have fallen since the last survey.<br><br>To the south of the power station, between Lyne Sands and Beacon Point, with the exception of 1aWDC02 where the beach level has fallen, there has been accretion or no change indicating a possible southwards movement of sediment. There have been no major changes in form at these profiles.<br><br>**Longer term trends:**<br><br>To the south of Snab Point, the changes observed from the present beach profiles are within the bounds of previous surveys.<br><br>Opposite Lynemouth, the slag bank has demonstrated a long term trend of stability. The changes in beach profile form and position observed since the last survey are within the bounds of previous surveys.<br><br>To the north of the power station, the slag bank has continued to erode and the beach has level has also |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | error in the survey data as fewer points than usual were measured due to the slippery rocks and the change in level is small.<br><br>**1aWDC02** is located to the south of the Power Station. The beach profile has lowered by up to 0.6m and has steepened slightly as erosion is slightly greater in the lower foreshore.<br><br>**1aWDC03** is located to the south of the Power Station and to the north of Beacon Point. There has been very little change (<0.1m accretion) as far as 90m chainage. Seaward of 90m chainage, accretion of up to 0.4m has occurred, increasing the crest height of the prominent berm (see Plate 14) and the elevation of its seaward face. The berm remains in roughly the same position as the previous two surveys, the last change in form being between the Full Measures 2012 and Full Measures 2013 survey<br><br>**1aWDC04** and **1aWDC05** are located between Beacon Point and Newbiggin Point.<br><br>At profile **1aWDC04**, the dunes have remained stable. The profile shows the dune face remains steep and there is accretion in the upper beach. The accretion is greatest at the dune toe where there has been up to 0.6m of accretion since the last survey. Seaward of 70m chainage change has been minimal (<0.1m). The beach is high relative to earlier surveys.<br><br>At **1aWDC05**, the cliffed section has remained stable. A berm, with it crest at 15m chainage, has developed in the upper beach against the cliff toe. Seaward of 40m chainage no change has occurred. | fallen, indicating that this section of shoreline has returned to its normal trend of progressive erosion of the slag bank cliff and beach.<br><br>To the south of the power station, the prominent berm crest has increased a little in height, but has retained the same form since 2013.<br><br>At the southern end of the bay, between Beacon Point and Newbiggin Point, the changes in beach profile form and position observed place the current beach levels at medium to high levels relative to earlier surveys dating back to 2002. |
| **Nov2015** | **Cliff-top Survey:**<br><br>Cliff top survey data collected for baseline survey (autumn, 2008), the previous Partial Measures survey (spring 2015) and the present Full Measures survey (autumn, 2015) is presented in this report.<br><br>Five virtual transect lines (numbered 1 to 3) have been establish in the north of Cambois Bay in GIS. Measurements are taken along these fixed transect lines from their landward end to the surveyed edge of the cliff top. The cliff top surveys are intended to inform on erosion rates of the sea cliffs to the north of Cambois Bay, opposite North Seaton Colliery. Note: the numbering of transect lines is not intended to correlate with that of the beach profile lines and reference should be made to Appendix C - Map 1 for the location of the transects ground control points. | Since the last survey, no movement greater than the survey error has been recorded.<br><br>**Longer term trends:** Since surveys began in October 2008, cliff movement greater than the survey error has occurred only at Transect 1, where cliffs are recorded to have eroded by 1.3m in total (a rate of 0.2m per year). |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | The results from the cliff top monitoring are anticipated to have an accuracy of ±0.2m due to the technique used. Furthermore, problems in precisely locating the cliff top, due to vegetation growth or the indistinct form of the cliff top, have also affected the data quality. Appendix C – Table C1 provides results from the cliff top survey, showing the position from the datum to the edge of the cliff top along each transect.<br><br>Since the last survey in April 2015, no cliff movement greater than the survey error has occurred. | |

**Plate 13 - Survey photo 1aCMBC03B_20151031_N18 (brightness adjusted)**

**Plate 14 - Survey photo 1aWDC03_20151031_N14**

## 3.14 Newbiggin-by-the-Sea

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Nov 2015** | **Beach Profiles:**<br><br>Newbiggin-by-the-Sea is covered by four beach profile lines for the Full Measures survey (Appendix A). Two of these, profiles WDC05A and WDC06A, were added to the programme in October 2007 specifically to help assess the performance of the capital scheme involving beach replenishment and construction of an offshore breakwater. Profiles 1aWDC05A and 1aWDC06A were last surveyed during the Partial Measures spring survey, 2015. Profiles 1aWDC06 and 1aWDC07 were last surveyed during the Full Measures autumn survey, 2014.<br><br>In addition a further 26 profiles (1aNWB1 to 1aNWB26) have been surveyed since September 2010 as part of a topographic survey of Newbiggin Bay. These profiles are not individually described.<br><br>Beach profiling works were completed here in September 2012. Four areas were re-profiled; 2 sections to the east of profile **1aWDC05A**, one section at **1aWDC06A** and a narrow section at the top of **1aWDC07.**<br><br>**1aWDC05A** is in the north of Newbiggin Bay. Between the seawall and 15m chainage, the accumulation of sand at the very back of the beach has reduced in elevation by up to 0.3m. Only minimal change has occurred between 15m and 35m on the upper beach. However, a small berm has accreted at HAT through the deposition of up to 0.2m of sand, which has seemingly originated from the upper foreshore between 47m and 65m chainage, from where a similar amount of material has been eroded. Seaward of here only very minimal changes have occurred. The upper beach is high and the foreshore at a medium level compared to earlier surveys.<br><br>**1aWDC06** is located in the centre of the northern part of Newbiggin Bay, between the two breakwaters. The beach has remained stable since the last survey (Partial Measures, 2015), slightly accreting by <0.2m between 20m chainage (just above HAT) and 55m chainage and eroding by a similar amount seaward of this. Compared to previous surveys the beach is at a medium level.<br><br>**1aWDC06A** is located in the centre of Newbiggin Bay, behind the offshore breakwater. Beach levels have changed little since the last survey; a small berm present at HAT in the previous survey and the upper foreshore have undergone limited (up to 0.3m, but more commonly <0.1m) of erosion as far as | Since the last survey, the beach at Newbiggin-by-the-Sea has remained stable.<br><br>**Longer term trends:** Data since monitoring began in May 2002 reflects the change in beach width resulting from the beach nourishment scheme implemented at Newbiggin-by-the-Sea. This change is also reflected in the beach profile plot in Appendix A.<br><br>The changes in beach profile form and position observed since the last survey are within the bounds of previous surveys. Compared to the record of earlier surveys, the beaches are at medium/high levels, with the upper beach being particularly high, indicating that there is a net transfer of sediment towards the back of the beach. |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | 110m chainage. Between 110m and 130m chainage, some of this eroded sediment has been deposited on the foreshore. Seaward of 110m chainage, the beach profile remains unchanged. The upper beach above HAT is at its highest level on record, the upper foreshore at a medium level and the lower foreshore is high compared to earlier surveys.<br><br>**1aWDC07** is located in towards the south of Newbiggin Bay. Between 0m and 6m chainage, up to 0.3m of sand has accumulated to nearly bury the rock revetment. Throughout the rest of the profile, areas of accumulation dominate and are only separated by short distances of limited erosion. The maximum beach level increases (c.0.3m) are found on the upper beach above HAT and in the lower foreshore. The very back of the beach is at a high level, but otherwise the profile is at a medium level compared to earlier surveys. | |
| **Nov 2015** | **Topographic Survey:**<br><br>Newbiggin-by-the-Sea is covered by bi-annual topographic survey, which commenced in September 2010. The surveys are planned to help assess the performance of a capital scheme constructed in 2007, which involved beach replenishment and construction of an offshore breakwater. Prior to incorporation in the programme, these surveys were undertaken on occasions between 2007 and 2010 as part of the scheme development.<br><br>Data from the most recent topographic survey (Full Measures, autumn 2015) have been used to create a DGM (Appendix B – Map 4a) using a GIS. A difference plot has also been produced using the DGM (Appendix B – Map 4b) produced from the last produced topographic survey (Partial Measures, spring 2014) and the present survey.<br><br>The topographic survey shows areas of both gain and loss across the beach. There have been patchy increases and decreases in beach elevation with patches of erosion concentrated in the lee of the northern breakwater, in the lee of the central break water, at the southern end of the survey area. The more exposed sections of beach to either side of the central breakwater appear to have experienced more continuous increases in beach elevation, with accretion more intense at the back of the beach in the north and on the foreshore further south. The survey photographs show substantial accumulations of material against the seawall which leave the rock revetment in the south of the survey area largely buried. | The topographic survey shows areas of both gain and loss across the beach. The general trend is for erosion at the northern and southern margins of the bay and behind the central breakwater, with accumulation of sediment either side of and on the southern edge of the tombolo in the lee of the offshore breakwater.<br><br>**Longer term topographic trends autumn 2011 to autumn 2015:**<br><br>The long term difference plot indicates that, relative to the 2011 baseline, sediment has been driven up from the mid beach against the sea wall (although this is less pronounced south of the central breakwater) and the tombolo behind the central breakwater has accreted except in its most seaward extent. The sand cover at Spittal Carrs is generally thinner than it was in 2011. |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | **Longer Term Topographic Trends autumn 2011 to autumn 2015:**<br><br>A band of beach elevation decrease extends along the length of the bay, following the contours of the embayment. The zone of beach elevation decrease intensifies on the southern Spital Carrs rock platform. Behind this strip of erosion, there is a band of beach level elevation increase of up to c.1m which is wider and more pronounced in the north than in the south. | |
| **Nov 2015** | **Sand Extent Survey**:<br><br>Spital Carrs is located to the south of Newbiggin Bay and is covered by a bi-annual sand extent survey, which commenced in 2012. The survey was designed to address concerns that the beach recharge scheme undertaken in the Newbiggin Bay may have impacts on the Spital Carrs SSSI and SPA if sand from the recharge scheme moves to the south. The sand extent survey therefore identifies the boundary of the sand beach on the rock platform.<br><br>Data from the most recent sand extent survey (Full Measures, autumn 2015) has been plotted onto aerial imagery (refer to Appendix D – Map 1). The plot shows that there is variable advance and retreat of the limit of sand cover between the spring 2015 and the autumn 2015 survey. There has been very limited advance in the north, no change in the centre and more pronounced advance in the south relative to the spring 2015 survey. However, this advance only takes the limit of the sand cover to the same extent as in autumn 2014, with the possible exception of a small area in the south where the sand has infilled a low point in the rocky shore platform to extend further seaward. | Since the last survey, there has been some movement of the sand extent but there are no discernible trends.<br><br>**Longer term trends:** Review of the sand extent surveys shows the sand front has oscillated by a small amount with no net trend. |

## 3.15 Cambois Bay

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Nov 2015** | **Beach Profiles:**<br><br>Cambois Bay is covered by seven beach profile lines for the Full Measures survey (Appendix A). Profiles. All profiles are resurveyed every 12-months.<br><br>**1aWDC08** and **1aWDC09** are located to the north of the River Wansbeck estuary in front of Sandy Bay Caravan Park.<br><br>**1aWDC08** extends from the cliff across the rock revetment onto the foreshore. Beach levels have decreased by up to 0.2m between the toe of the rock revetment and 65m chainage but have increased seaward of here by up to 0.5m, extending the profile further seaward. The beach is at a relatively high level compared to earlier surveys.<br><br>**1aWDC09** extends from the cliffs at the very southern end of the Caravan Park. The cliff remains unchanged since the previous survey and there has been an accumulation of up to 0.7m of sediment between the cliff toe and 160m chainage, forming a berm in the upper foreshore. Limited erosion has occurred at the toe of this berm where it encounters the mouth of the River Wansbeck at c.170-180m chainage. The profile is generally high compared to earlier surveys.<br><br>Profiles **1aWDC10** to **1aWDC14** are all located along Cambois Bay, between the River Wansbeck and River Blyth estuaries.<br><br>**1aWDC10** is located on the southern side of the Wansbeck Estuary, just to the south of Cambois House. The narrow block which has detached from the upper cliff face has moved slightly down the cliff face. Beach levels have fallen by up to 1.2m, except at the cliff toe where there has been minor accretion. The changes have created a berm with its crest at HAT and another low berm in the middle foreshore with its crest at c.65-70m chainage. Overall the beach level remains at medium to high levels.<br><br>**1aWDC11** extends across the rock revetment fronting the now disused foundry. Beach levels have fallen by 0.2m from the toe of the revetment seaward to 90m chainage. Seaward of 120m chainage, | To the north of the River Wansbeck, the cliffs remain unchanged since the previous survey and there has been variable erosion and deposition throughout the beach profiles, but they remain relatively high compared to earlier surveys.<br><br>To the south of the Wansbeck Estuary as far as profile 1aWDC12, the face of the dune cliffs have remained stable. Upper beach levels have generally fallen, but remain at medium to high levels and the mid to lower foreshore has accreted.<br><br>At the southernmost extent of Cambois Bay beach levels have generally fallen and erosion of the cliff face is ongoing.<br><br>The trends in beach profile change indicate accretion of sediment against the dune and cliff toe, erosion from the upper beach and accretion in the lower part of the foreshore, suggesting sediment drawdown.<br><br>**Longer term trends:** Beach profiles in the north of the survey area are at higher levels compared to those in the south, suggesting a north-south movement of sediment or a greater input of sediment (possibly from the River Wansbeck) in the north of the survey area. The till and dune cliffs have eroded little over the last 12 months compared to previous periods. |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | there has been up to 0.6m of deposition which has increased the height of the bar in the lower foreshore. Beach levels remain high compared to earlier surveys<br><br>**1aWDC12** is situated approximately mid-way along Cambois Bay. Since the last survey (Full Measures, autumn 2014), the face of the dune cliffs has remained stable with a small accumulation of sand occurring at the cliff toe. The upper beach shows very limited change as far as 70m chainage. Seaward of 70m chainage, the beach has accreted, with the maximum accretion at 190m chainage where a berm crest has formed in the lower foreshore The beach is at medium to high levels throughout.<br><br>At **1aWDC13** is located to the centre-south of Cambois Bay. There has been no change to the dune cliff face and a small amount of gravel and sand has accumulated to form a narrow berm at the toe of the dune cliff. Beach levels have fallen by up to 0.3m between HAT and 145m chainage, and a low bar has formed seaward of 145m chainage through the accumulation of 0.3m of sand. Except in the lower foreshore, beach levels are at their lowest recorded level.<br><br>**1aWDC14** is located to the south of Cambois Bay, at North Blyth. Minor recession is evident in the lower cliff and the survey photograph indicates ongoing erosion (See Plate 15). A small amount (0.2m) of deposition has occurred at the cliff toe to straighten the upper beach profile but throughout the rest of the profile the beach level has fallen slightly to expose more of the shore platform, with one exception between 80m and 110m chainage where there appears to have been limited accumulation to cover the shore platform. Beach levels are low compared to earlier surveys. | |
| **Nov 2015** | **Cliff-top Survey:**<br><br>Cliff top survey data collected for baseline survey (spring, 2009), the previous Partial Measures survey (Spring 2014) and the present Full Measures survey (autumn, 2015) is presented in this report.<br><br>Five virtual transect lines (numbered 1-5) have been establish in the north of Cambois Bay in GIS. Measurements are taken along these fixed transect lines from their landward end to the surveyed edge of the cliff top. The cliff top surveys are intended to inform on erosion rates of the sea cliffs to the north of Cambois Bay, opposite North Seaton Colliery. Note: the numbering of transect lines is not intended to correlate with that of the beach profile lines and reference should be made to Appendix C - Map 2 for the location of the transects ground control points. | Since the last survey in April 2015, no cliff erosion greater than the potential survey error has been detected.<br><br>**Longer term trends:** Since surveys began in May 2009, erosion has been recorded at one transect (Transect 5), where 2.9m has been lost, equivalent to a rate of 0.4m per year. |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | These cliff top surveys are undertaken bi-annually. Measurements are taken along each transect to the surveyed cliff top line. The results from the cliff top monitoring are anticipated to have an accuracy of ±0.2m due to the technique used.<br><br>The results from the cliff top survey are presented in Appendix C – Table C2, showing the position from the ground control point to the edge of the cliff top along a defined bearing.<br><br>Since the last survey in April 2014, no change greater than the survey error has occurred. | |
| **Nov 2015** | **Cliff/Dune-top Survey:**<br><br>Cliff top survey data collected for baseline survey (spring, 2009), the previous Partial Measures survey (spring 2014) and the present Full Measures survey (autumn, 2015) is presented in this report.<br><br>Five virtual transect lines (numbered 6-41) have been establish in the north of Cambois Bay in GIS. Measurements are taken along these fixed transect lines from their landward end to the surveyed edge of the cliff top. The cliff top surveys are intended to inform on erosion rates of the sea cliffs to the north of Cambois Bay, opposite North Seaton Colliery. Note: the numbering of transect lines is not intended to correlate with that of the beach profile lines and reference should be made to Appendix C - Map 3 for the location of the transects ground control points.<br><br>The results from the cliff/dune top monitoring are anticipated to have an accuracy of ±0.2m due to the technique used. Appendix C – Table C3 provides results from the cliff/dune top survey, showing the position from the landward end of the Transect to the edge of the cliff/dune top along the defined transect bearing. A distinction is made in the table between whether the coastline is cliff/dune at the survey location.<br><br>Results show that erosion or an amount of movement greater than the survey error has occurred at five transects since surveys began in May 2009 and the survey report also notes 'visible cliff collapse adjacent to the spot levels in the north of the survey area'. | Since the last survey in April 2015, erosion greater than the survey error occurred at transect 12, 17, 20, 24, and 33. Maximum erosion since the previous survey is 1.0m at transect 12, with a similar amount (0.8m) at transect 24. However, whilst recession at transect 24 is likely to be caused by an eroding dune front, the apparent erosion at transect 12 (which is in a defended section) is likely to have a risen as a result of difficulty establishing the exact position of the break of slope during the survey.<br><br>At points 17, 20 and 33 recession was <0.5m. Advance is recorded at several profiles, but this is likely to be error related to difficulty in precisely locating the cliff edge.<br><br>**Longer term trends:** Since surveys began in May 2009, erosion has occurred at 23 transects. At: (i) Transect 8 (to the north of Cambois, close to the mouth of the River Wansbeck); (ii) Transects 10 to 14 (on the south side of the mouth of the River Wansbeck); (iii) Transects 15 to 24 (between Cambois, and the centre of the frontage, opposite Cambois); (iv) Transects 26, 29 and 30 (opposite the tidal basin); and (v) Transects 32 to 35 (opposite |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | | Blyth). The fastest recession has occurred at transects 21-24, a section of undefended dunes in the middle of the bay where recession rates since the baseline survey have averaged 0.8-1.7m/yr. More typically rates of erosion are <0.5m/yr. |

**Plate 15 - Survey photograph 1aWDC14_20151125_N2**

## 3.16 Blyth South Beach

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| **Sept 2015** | **Beach Profiles:**<br><br>Blyth South Beach is covered by six beach profile lines for the Full Measures survey (Appendix A). All profiles are resurveyed every 6-months.<br><br>**1aBVBC01** is located towards the north of South Beach, in front of the area of land owned by Port of Blyth. There have been no significant changes to the position and form of the dunes since the last survey (Partial Measures, spring 2015). The upper beach has retained roughly the same form, accreting up to 0.3m between the dune toe and 100m chainage. Seaward of 100m chainage the beach profile is unchanged until 140m chainage where a small berm has formed with upward facing lobate features (possibly formed as waves at low tide just over top the berm and drain into a runnel on its landward side, see Plate 16). Seaward of 170m chainage there has been minor (up to 0.2m) lowering of the lower foreshore. The beach is generally at a medium to high level compared to earlier surveys.<br><br>Beach levels at **1aBVBC02** have fallen in the upper beach between the sea wall and 40m chainage, increased by up to 0.4m between 40m chainage and 110m chainage, and fallen in the lower foreshore between 100m chainage and the end of the profile at 180m chainage by a similar amount. The combined effect of these changes is a straighter profile - flatter in the upper beach and steeper at the toe. The beach is generally at a medium level compare to earlier surveys.<br><br>At **1aBVBC03** there have been no significant changes to the position and form of the dunes since the last survey (Partial Measures, spring 2015), which remain at their most landward extent since 2002. The runnel which was present in the previous two surveys at the toe of the dunes has infilled to create a slightly higher berm in the upper beach. Between 105m chainage and 170m chainage beach levels have fallen by up to 0.4m and between 190m chainage and 290m chainage also fallen by 0.3m. The intervening section of no change between 170m and 190m has formed a berm, on the seaward side of which a runnel (see Plate 17) has formed where the fall in beach elevation has been greatest. Seaward of 290m chainage there has been little change to the profile. Overall the profile is at a medium to high level compared to earlier surveys. , | Since the last survey, the dunes and dune face at Blyth South Beach have remained stable, retaining the same form and position.<br><br>Beach profiles have changed, with more pronounced changes being in the undefended central and southern parts of the beach. Here, the beach has changed from a relatively smooth concave profile to one with comparatively sharp undulations, with some steep slopes, more pronounced berms as well as runnels and bars in the foreshore.<br><br>**Longer term trends:** At Blyth South Beach, the dunes have generally demonstrated a long-term trend of stability.<br><br>The changes in beach profile form and position observed since the last survey are within the bounds of previous surveys, however in the central and southern parts of the bay, the upper beach is relatively high, and the lower beach relatively low, leaving a steeper beach in the middle foreshore. |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|---|---|---|
| | At **1aBVBC04** there have been no significant changes to the position and form of the dunes since the last survey (Partial Measures, spring 2015). The crest of the berm in the upper beach has receded c.6m landward, with a commensurate fall in the level of the seaward face of this berm of up to 0.5m between 45m chainage and 90m chainage. Between 90m chainage and 140m chainage the beach level has increased by up to 0.8m to form a berm in the mid foreshore. Seaward of this the changes have been less pronounced (<0.2m) although the beach toe has extended seaward c.20m since the last survey. Overall the beach level is high compared to earlier surveys.<br><br>At **1aBVBC05** there have been no significant changes to the position and form of the dunes since the last survey (Partial Measures, spring 2015). The uppermost berm crest has receded c.6m landward with a commensurate drop in beach level between 80m chainage and 105m chainage of up to 0.6m. Between 105m and 120m chainage there has been an increase in beach level to form a second berm lower in the beach, but between 120m chainage and 200m chainage the beach level has fallen by up to 1m. There has been limited change between 200m chainage and the end of the profile at 260m chainage. Overall the profile now has a more variable form than the previous survey and is high in the upper beach and low in the foreshore compared to earlier surveys in the record, making the upper beach profile one of the steepest on record (see Plate 18).<br><br>At profile **1aBVBC06** there have been no significant changes to the position and form of the dunes since the last survey (Partial Measures, Spring 2015). The uppermost berm crest has receded landwards slightly, with a commensurate fall in the elevation of the seaward face of this berm by up to 0.2m. A significant berm (see Plate 19) with a steep seaward face has formed between 120m chainage and 150m chainage through the accumulation of up to 1m of sand, A runnel has formed at the toe of this berm between 150m and 200m chainage, seaward of which a bar has formed in the lower foreshore between 200m chainage and the end of the profile at 280m chainage through the accumulation of up to 0.7m of sand. Overall the profile is more variable in form than in the previous survey and within the range of levels seen in earlier surveys. | |

**Plate 16 – Survey photograph 1aBVBC01_20152609_N15**

**Plate 17 – Survey photograph 1aBVBC04_20152609_N17**

**Plate 18 – Survey photograph 1aBVBC05_20152609_N12**

**Plate 19 – Survey photograph 1aBVB06_20152609_N21**

## 4. Problems Encountered and Uncertainty in Analysis

### Individual Profiles

- At profile BTBC07 and BTBC08, the offshore extent the survey report indicates that the profiles end at a lagoon, but the survey photographs indicate they end at open sea. This is possibly a note retained from earlier reports.
- At profile BTBC18, BTBC19 and BTBC20 to BTBC23, the survey report states that the offshore extent of the survey is limited by a drain. This drain is likely a runnel which separates the barrier feature in the lower foreshore from the rest of the beach, but is only visibly in the survey photographs from BTBC23
- At profile BTBC32, an 'obstruction' (survey code 'FB') was recorded in the survey photographs which appears to be a boat or its mooring. This should be taken into account when assessing the profile data so this is not misinterpreted as change in beach level.
- At profile BTBC33, there are gaps in the section (at the location of the middle of dunes) due to dense vegetation. This needs to be taken into account when assessing the profile data as the levels in these measurement gaps will not be reliable.
- At profile ADC09, the profile ends at the river.
- At profile ADC16, the surveyors noted that there were bushes on the section line and it is assumed that as a result there are gaps in the section. This needs to be taken into account when assessing the profile data as the levels in these measurement gaps will not be reliable.
- At profile ADC16A, there are gaps in section due to vegetation cover. This needs to be taken into account when assessing the profile data as the levels in these measurement gaps will not be reliable.
- At profile ADC16B, the section starts at new fence.
- At profile WDC01, the surveyors were unable to measure the face of the revetment as the blocks were too slippery.
- At profile WDC09 and WDC10, the profile ends at the river, although the profile and survey photographs indicate that the profile extends at least partially across the bed of the river mouth.

### Topographic Survey

No issues reported.

### Cliff Top Surveys

At Cambois Bay, the surveyors noted that undergrowth at north end of the cliffs hindered surveying. This was also noted in previous reports (Full Measures, autumn 2011, Partial Measures, spring 2012, Partial Measures spring 2014, Full Measures autumn 2015 and Partial Measures, spring 2015).

The surveyors also reported that there was a visible collapse of the cliff edge in the north of the survey area.

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

No changes are recommended at the present time.

## 6. Conclusions and Areas of Concern

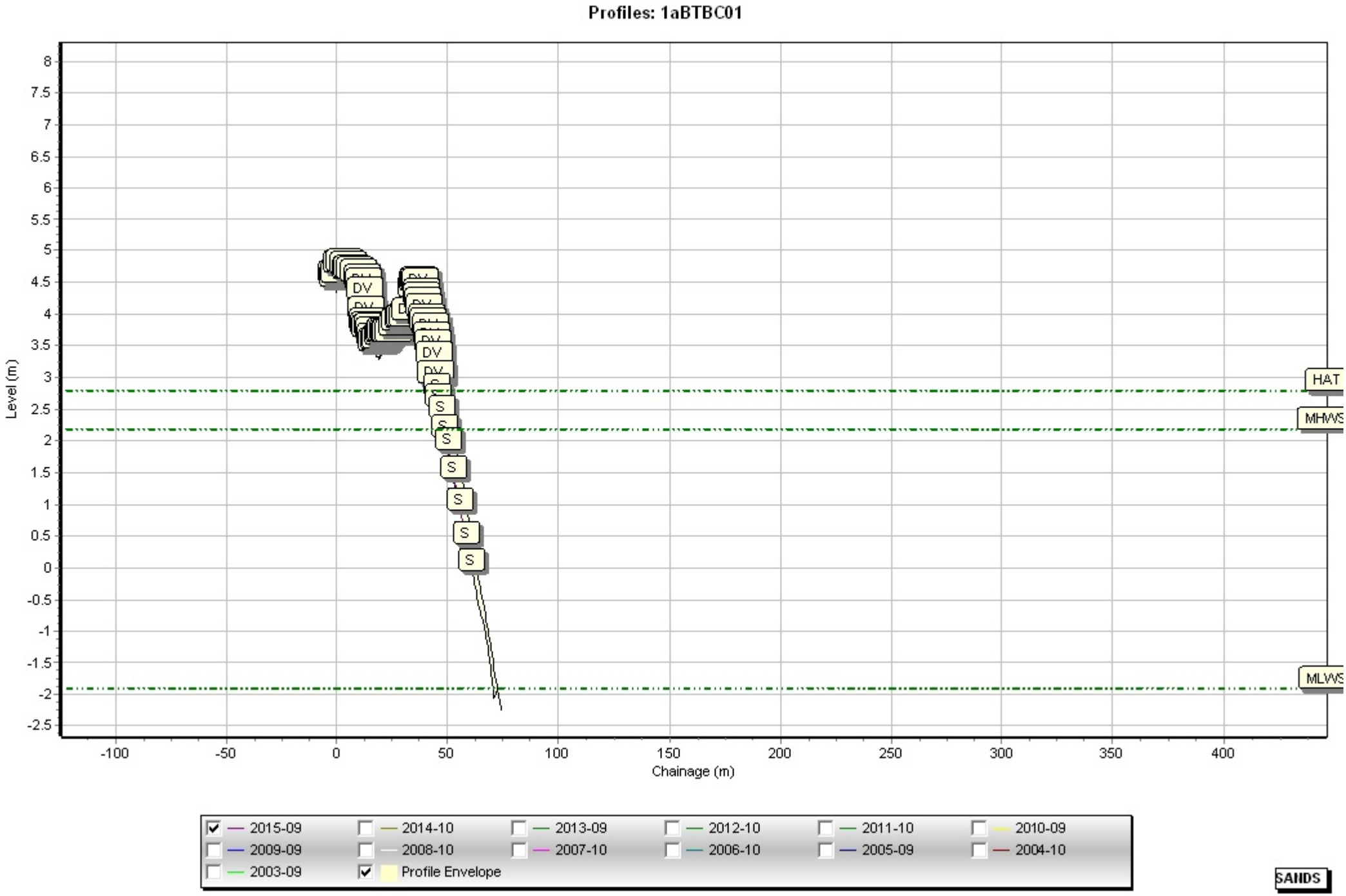
- At Sandstell Point (Spittal A), the recorded profiles and topographic survey present no causes for concern.
- At Spittal (Spittal B), the recorded profiles present no causes for concern.

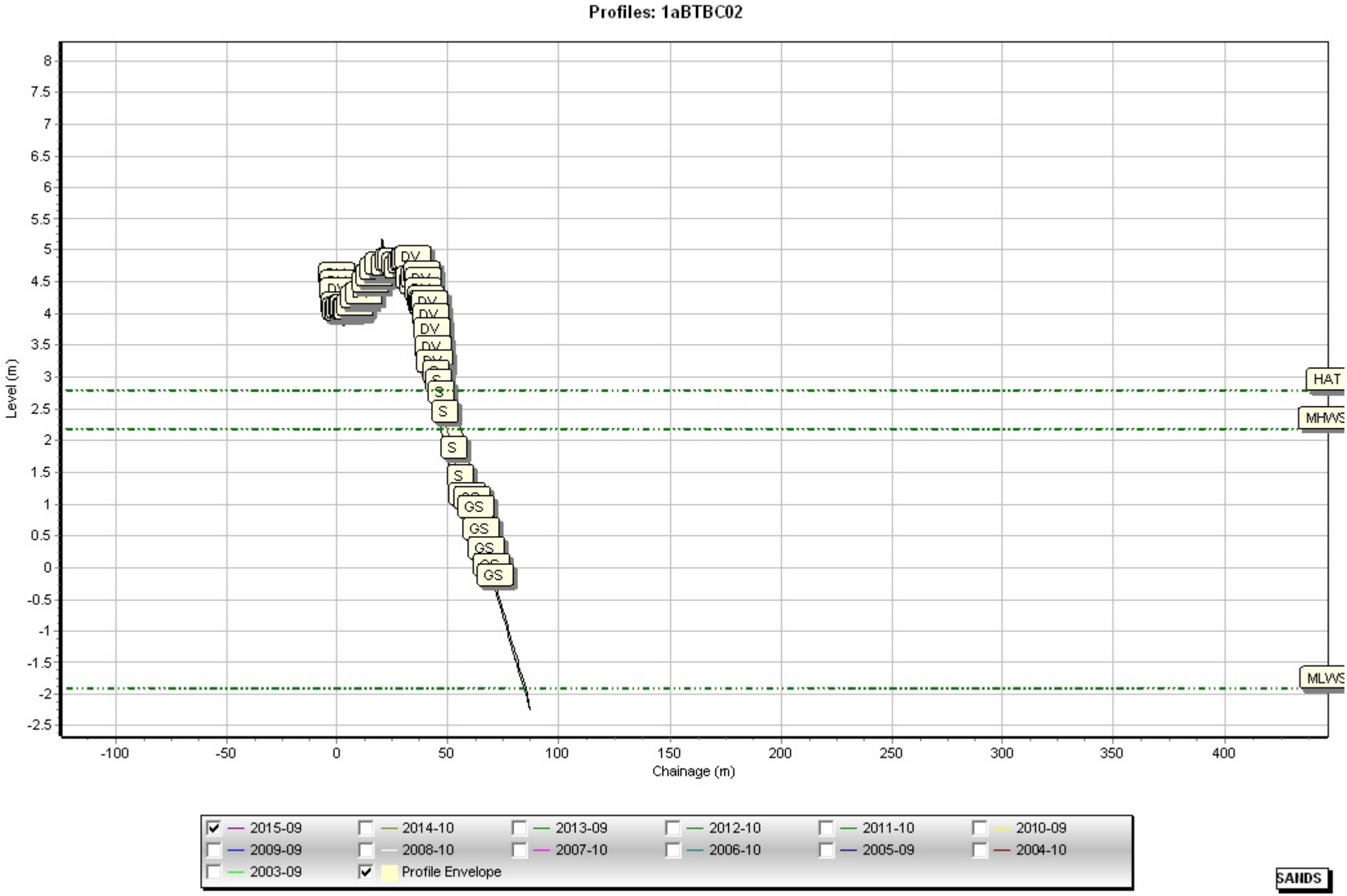
- At Goswick Sands, the recorded profiles present no causes for concern. However, a barrier feature has appeared in the seaward end of profile 1aBTBC18, which may be a cyclical feature.
- At Holy Island, the recorded profiles and topographic survey present no causes for concern.
- At Bamburgh, the recorded profiles present no causes for concern.
- At Beadnell Village, the recorded profiles present no causes for concern.
- At Beadnell Bay, despite evidence of some erosion in the uppermost part of the beach at profile 1aBTBC38 there are no causes for concern.
- At Embleton Bay, the dune toe and beach levels are still low but appear to have recovered somewhat, and therefore there is no cause for concern
- At Boulmer, the recorded profiles present no cause for concern.
- At Alnmouth Bay, the dune toe has eroded significantly in parts of the bay, but this is likely part of natural cycle of erosion and accretion. As such there is no cause for concern but this issue should be reviewed in the 2016 Full Measures report.
- At High Hauxley & Druridge Bay, the Hauxley Haven profiles are at their lowest levels on record in their most seaward extents and the most northerly profile in Druridge Bay (1aBTBC16) is at its lowest recorded level. These do not necessarily indicate a cause for concern but further surveys should be monitored specifically for any indications of accelerated recession of the cliff/dune toe.
- At Lynemouth Bay, to the north and south of the Power Station, has continued to erode at a similar rate to those seen previously.
- Elsewhere along Lynemouth Bay, the recorded profiles and cliff top survey present no causes for concern.
- At Newbiggin-by-the-Sea, little change has occurred since the previous survey and there have been no adverse impacts on the SSSI at Spital Carrs.
- At Cambois Bay, there has been localised erosion of the dunes and cliffs and, although they not of immediate concern, future monitoring will show if these trends continue.
- Elsewhere along Cambois Bay, the recorded profiles, cliff top survey and cliff/dune top survey present no causes for concern.
- At Blyth South Beach, the upper beach has steepened in the central and southern parts of the bay, but the beach remains at medium to high levels and the recorded profiles therefore present no causes for concern.

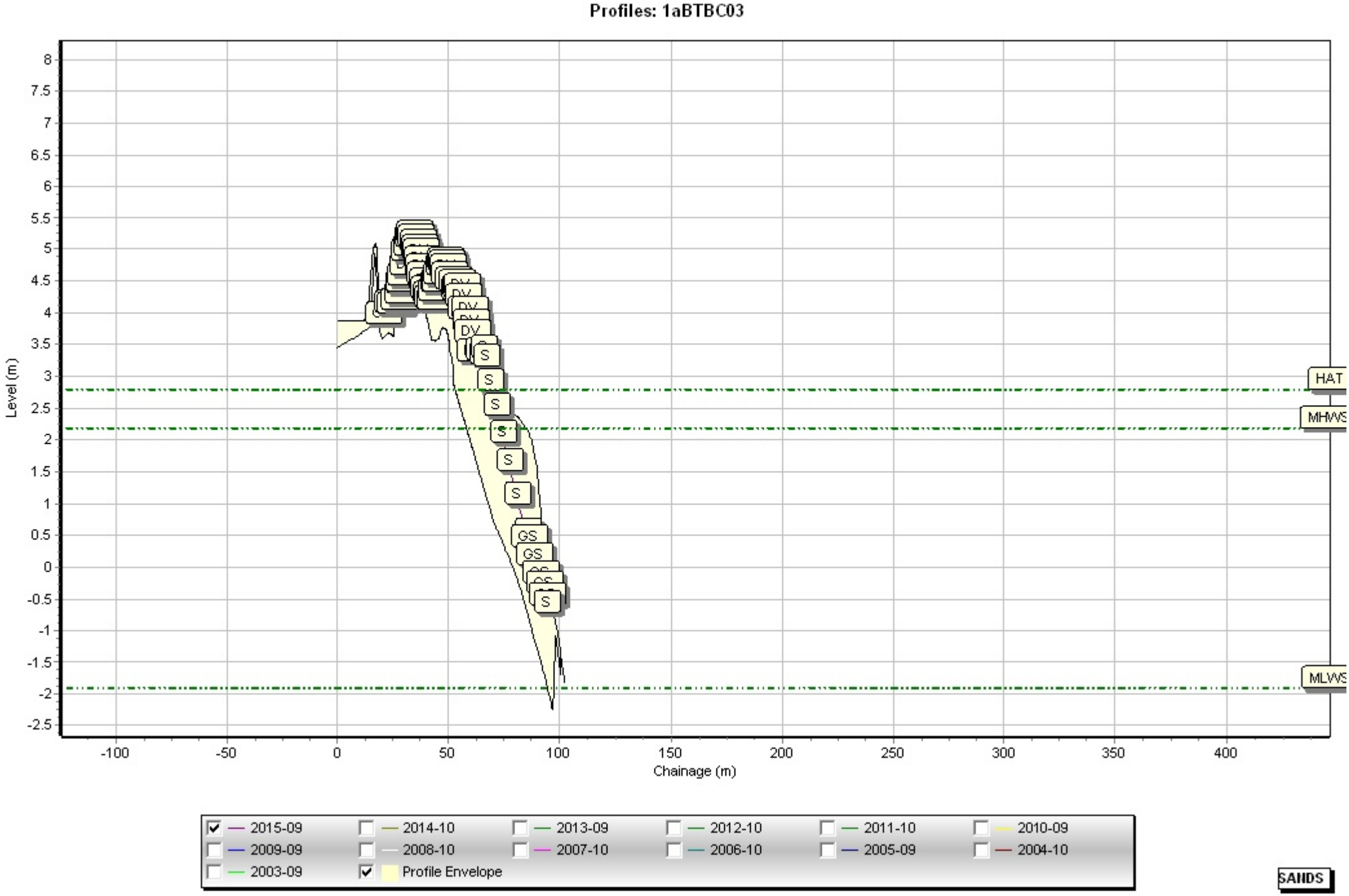
# Appendices

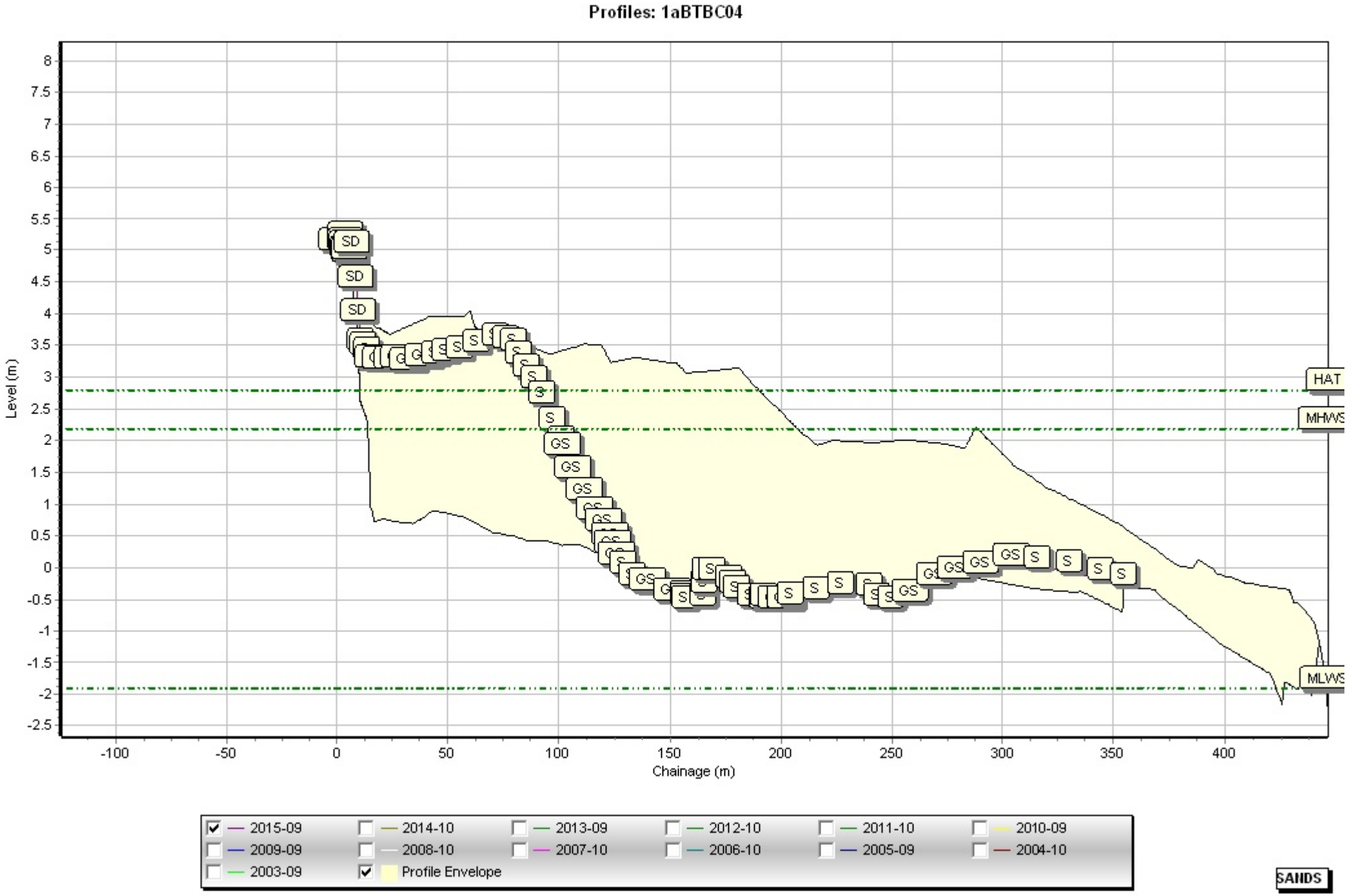
# Appendix A

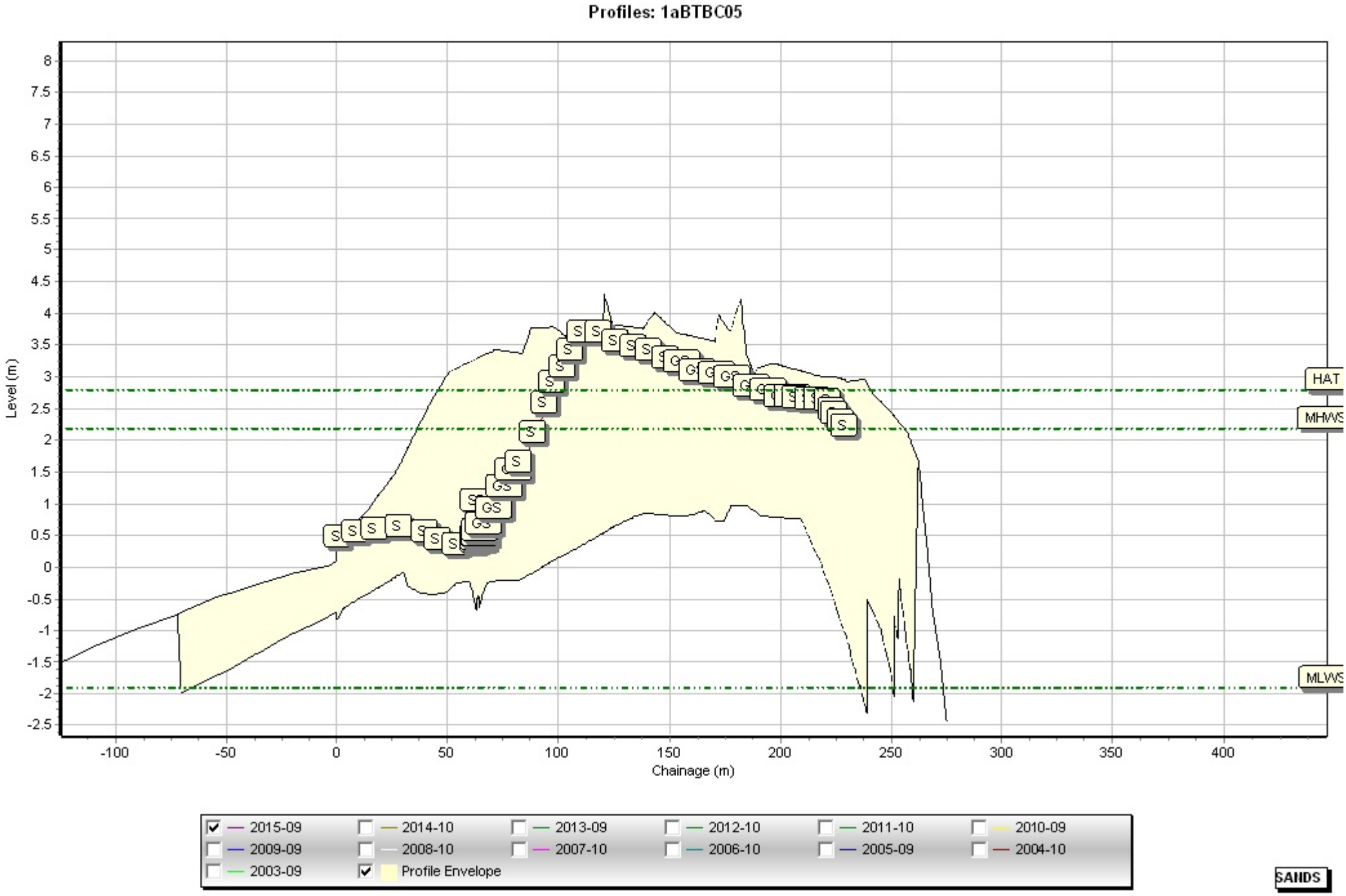
# Beach Profiles

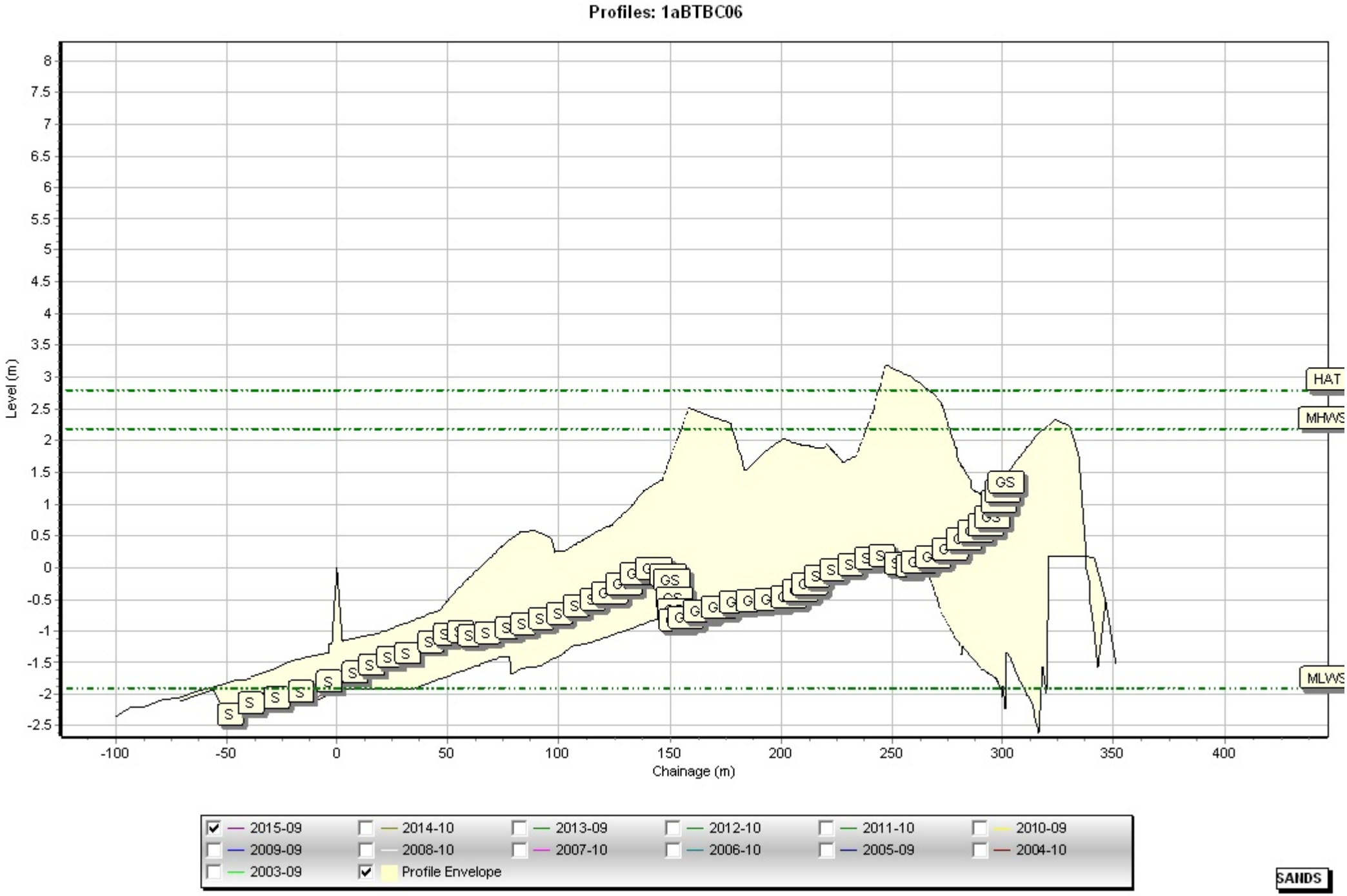

Profiles: 1aBTBC01
Level (m)
Chainage (m)
HAT
MHWS
MLWS
DV
S
2015-09
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

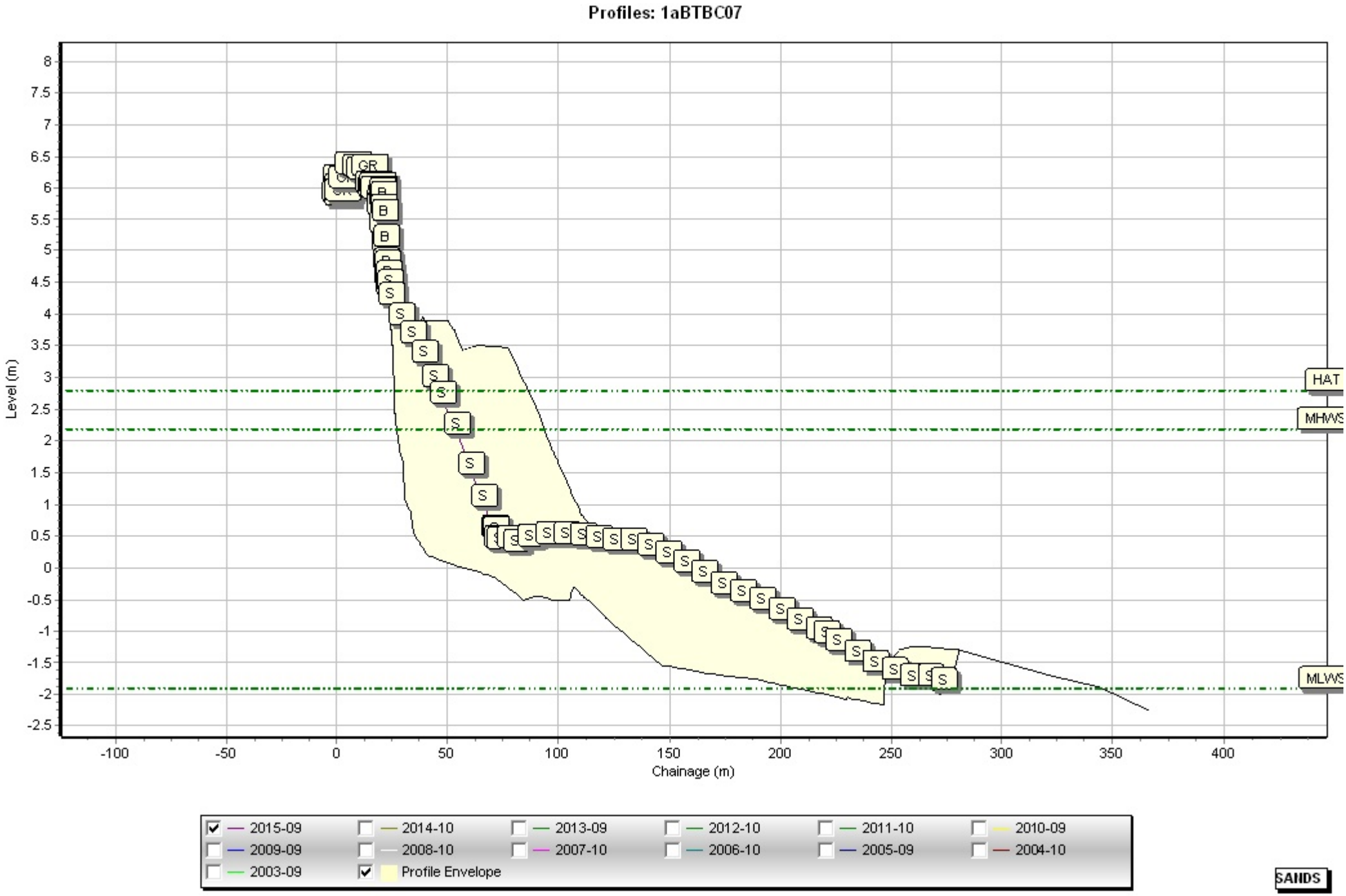

Profiles: 1aBTBC02
Level (m)
Chainage (m)
HAT
MHWS
MLWS
DV
S
GS
2015-09
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

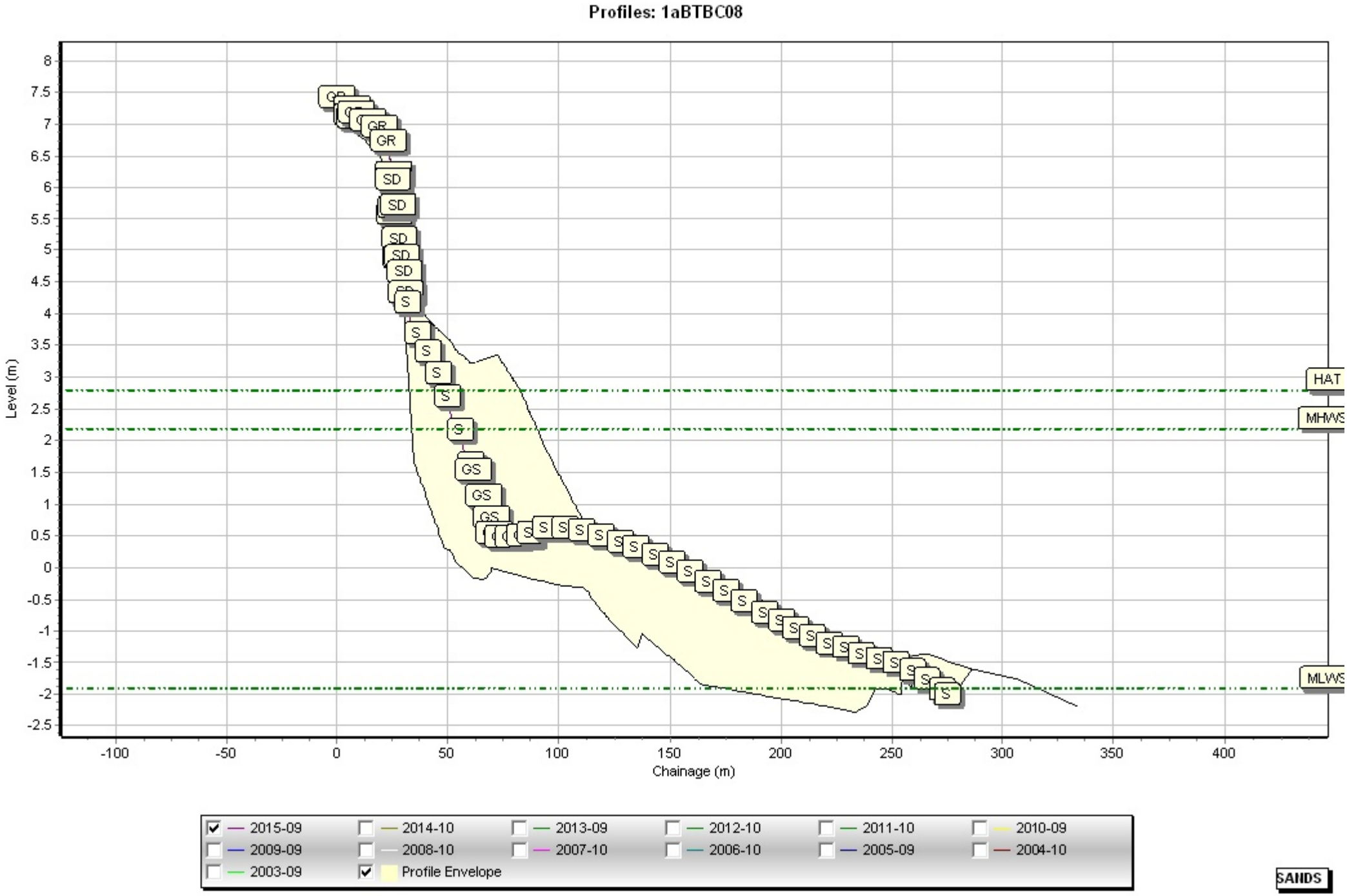

Profiles: 1aBTBC03
Level (m)
Chainage (m)
HAT
MHWS
MLWS
DV
S
GS
2015-09
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

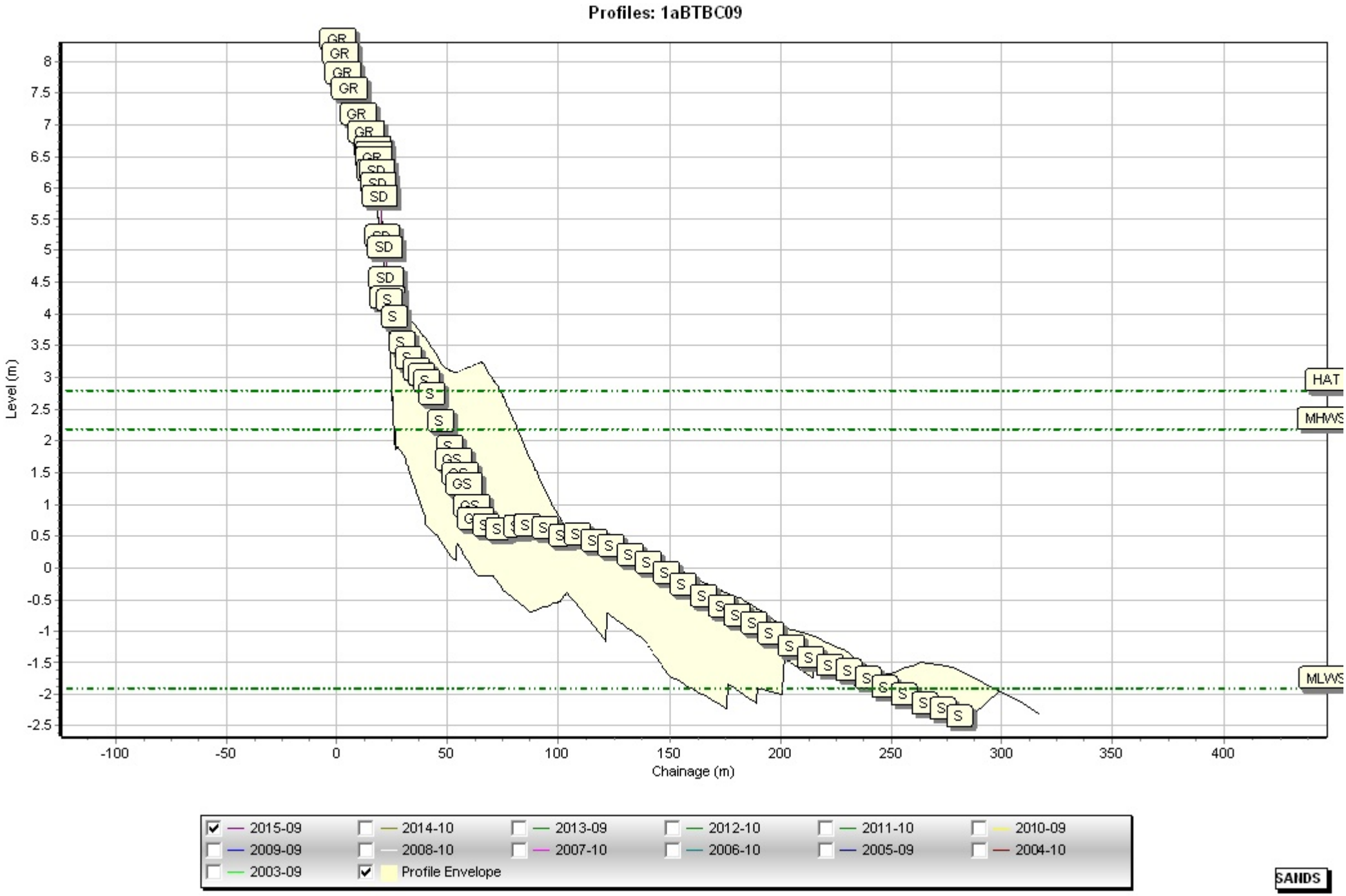

Profiles: 1aBTBC04
Level (m)
Chainage (m)
HAT
MHWS
MLWS
SD
S
GS
2015-09
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

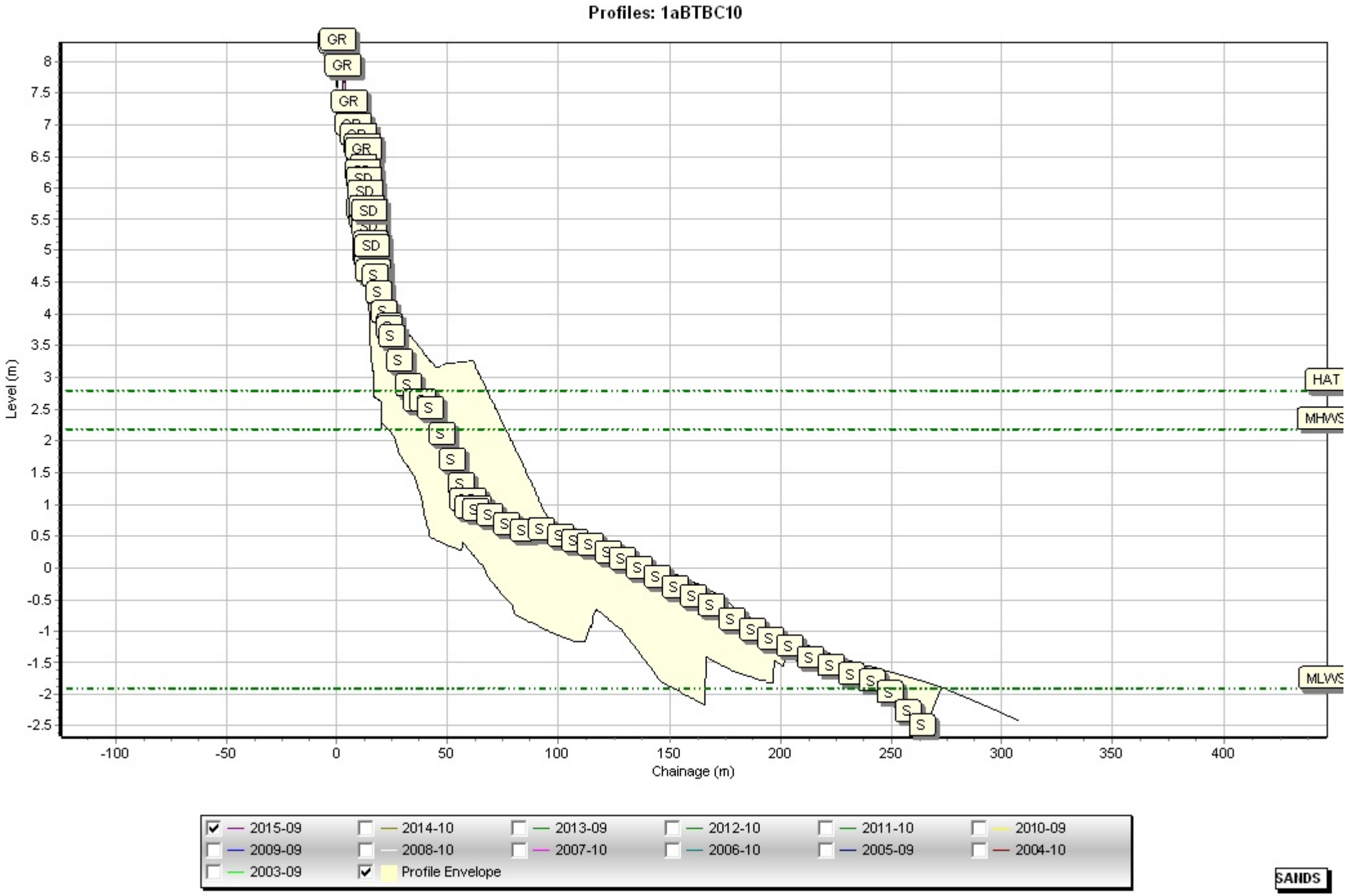

Profiles: 1aBTBC05
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

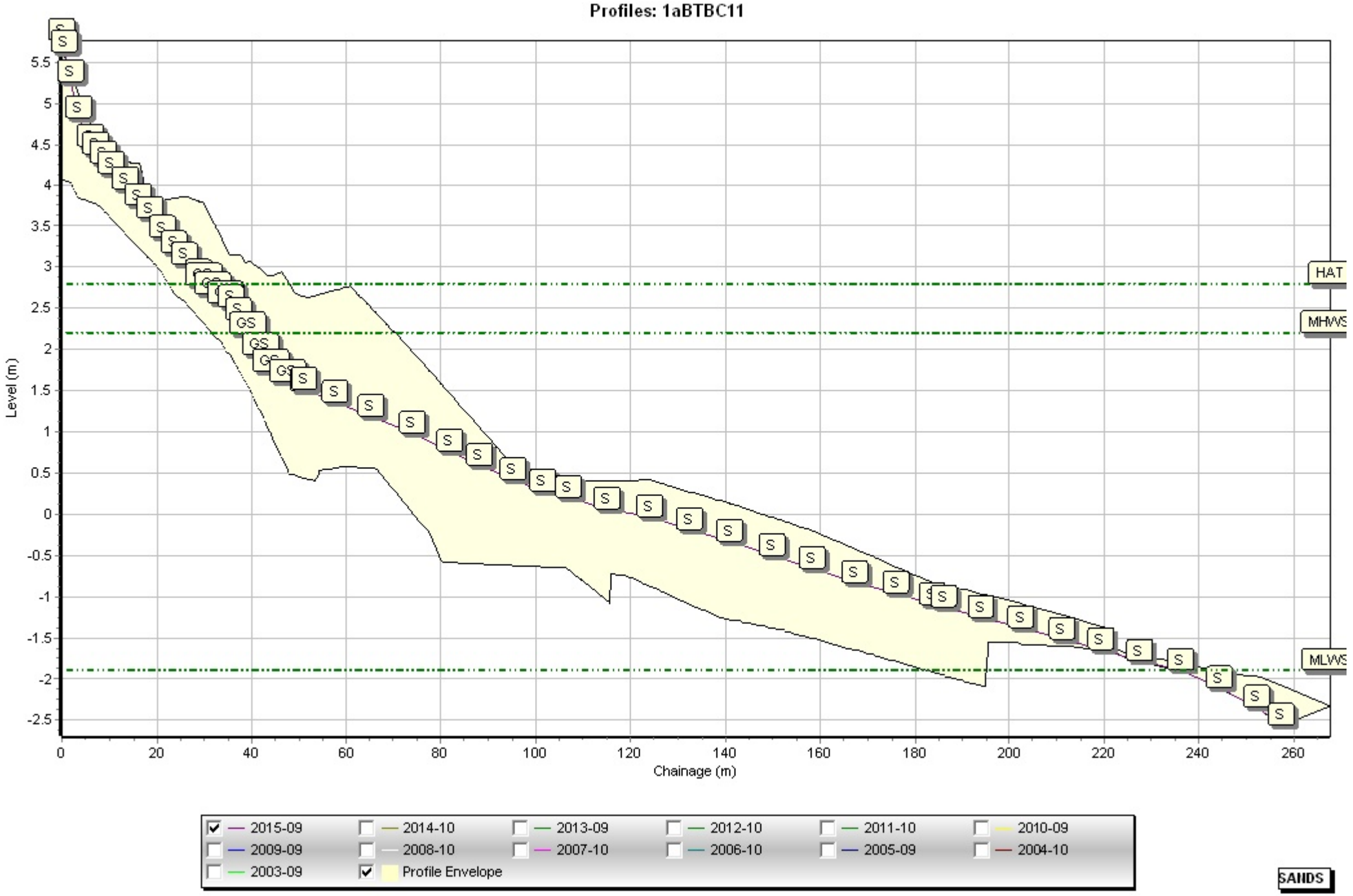

Profiles: 1aBTBC06
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

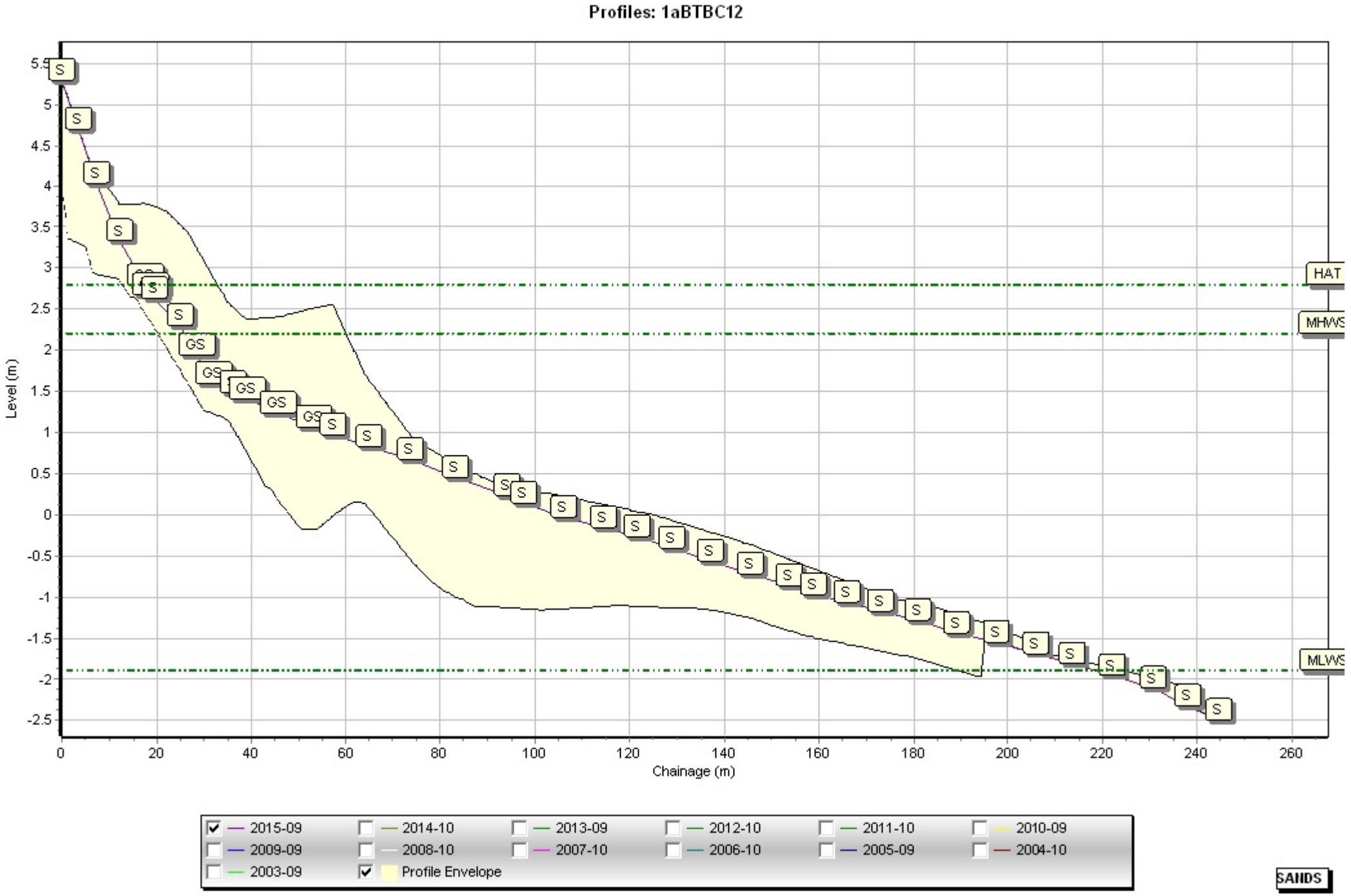

Profiles: 1aBTBC07
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

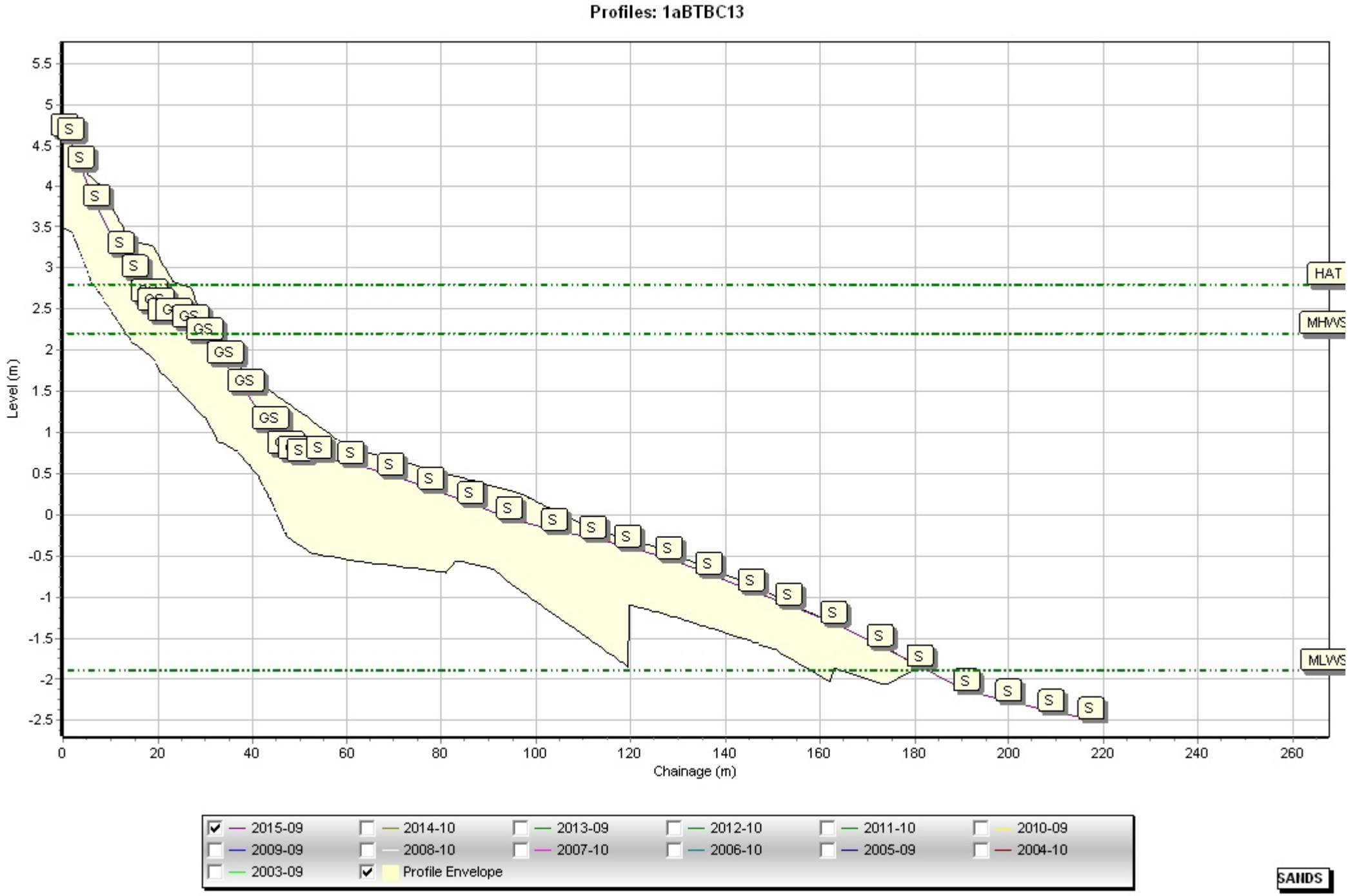

Profiles: 1aBTBC08
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

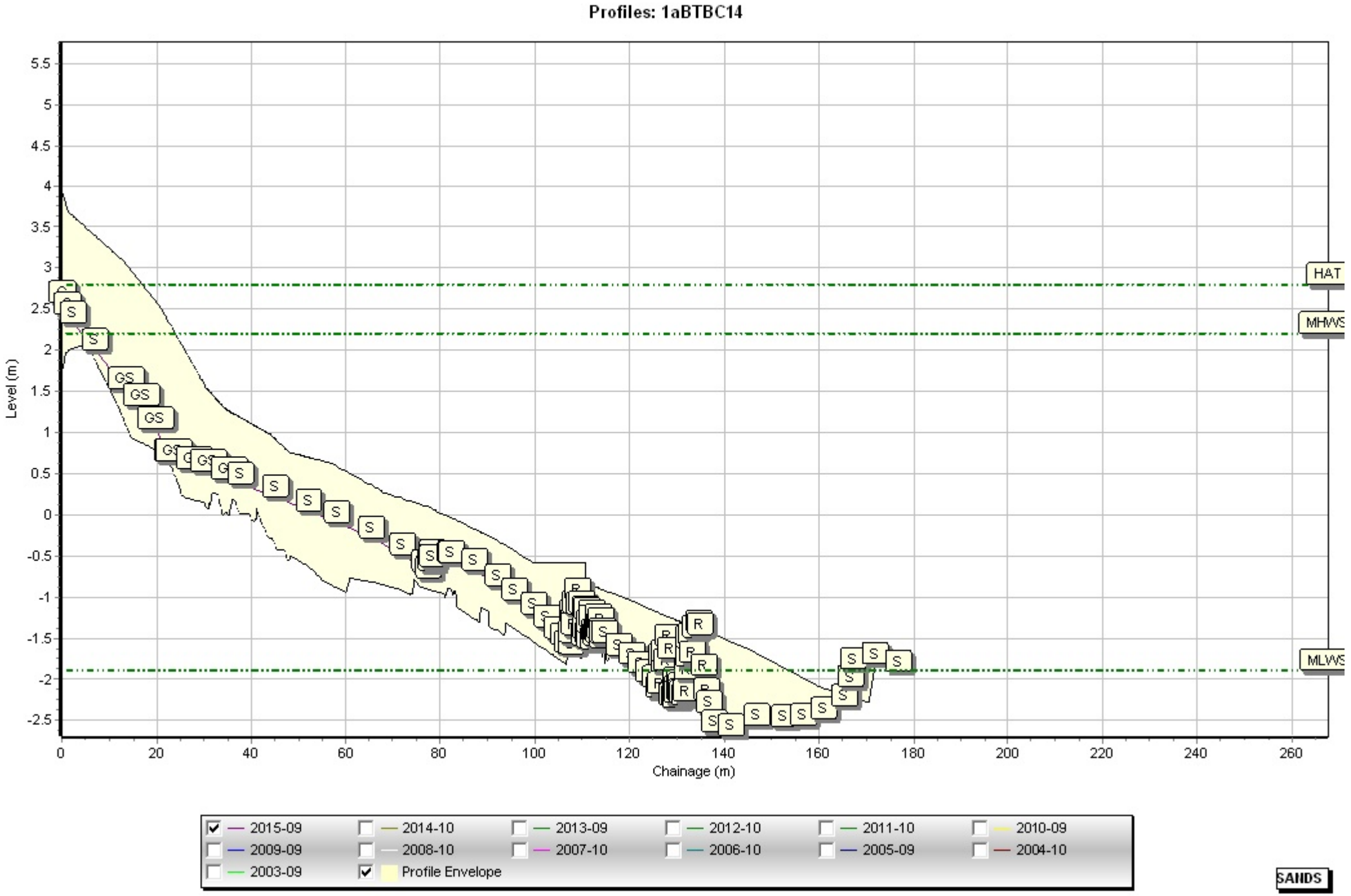

Profiles: 1aBTBC09
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

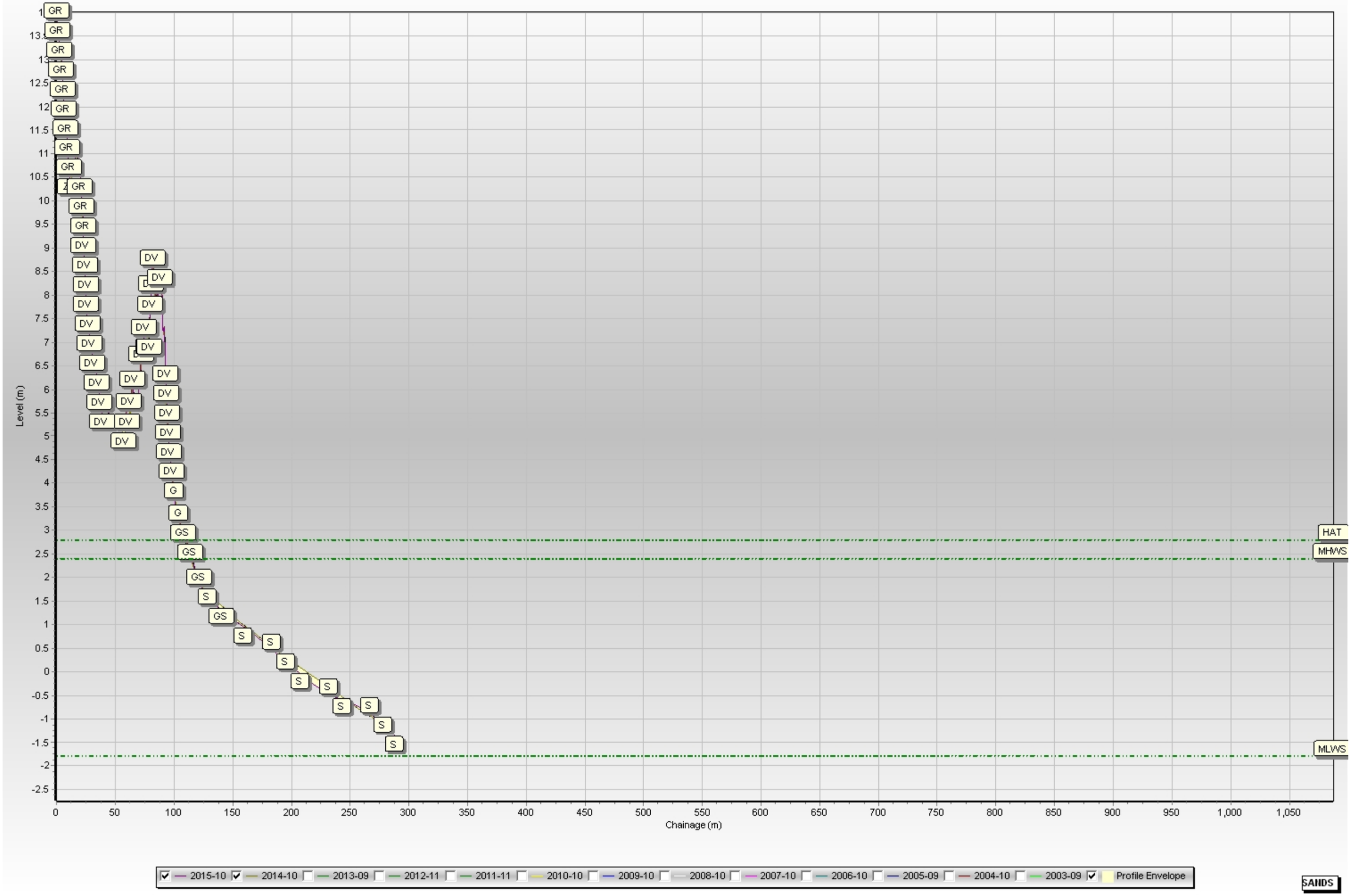

Profiles: 1aBTBC10
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS


Profiles: 1aBTBC11
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

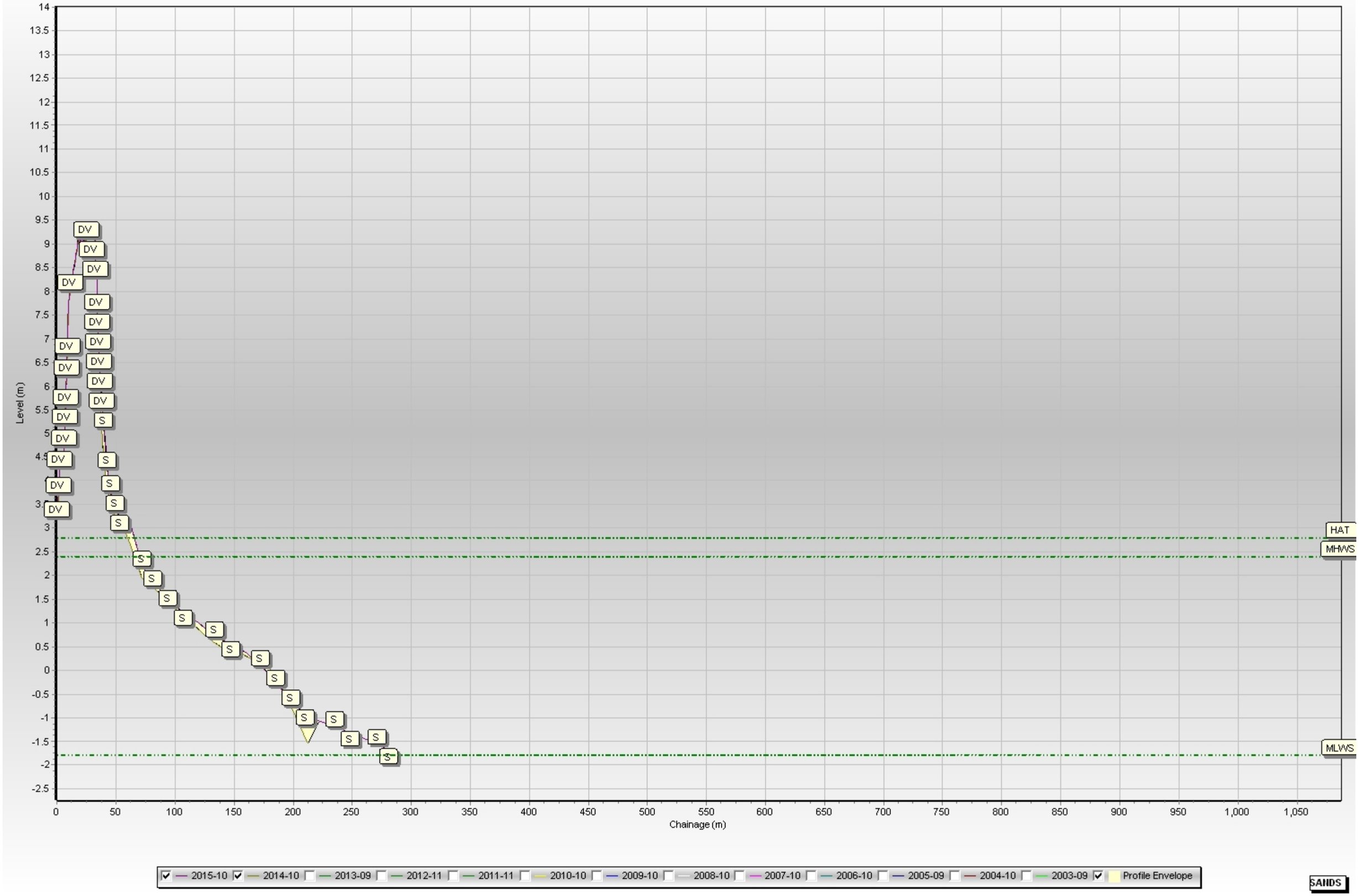

Profiles: 1aBTBC12
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SAIDS


Profiles: 1aBTBC13
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SAIDS


Profiles: 1aBTBC14
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS


Profiles: 1aBTBC15
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-10
2014-10
2013-09
2012-11
2011-11
2010-10
2009-10
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

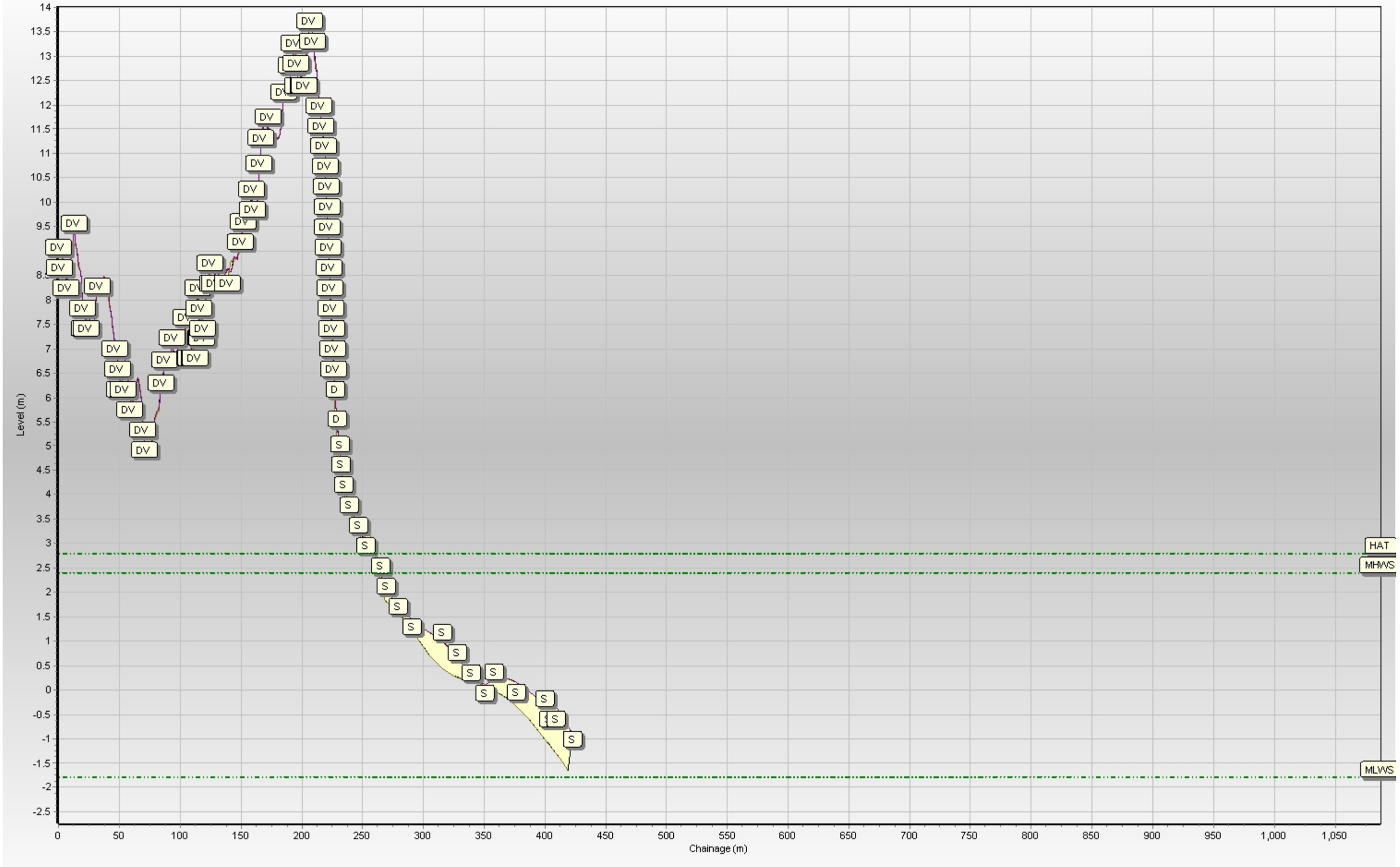
Profiles: 1aBTBC16




2015-10 | 2014-10 | 2013-09 | 2012-11 | 2011-11 | 2010-10 | 2009-10 | 2008-10 | 2007-10 | 2006-10 | 2005-09 | 2004-10 | 2003-09 | Profile Envelope

SANDS

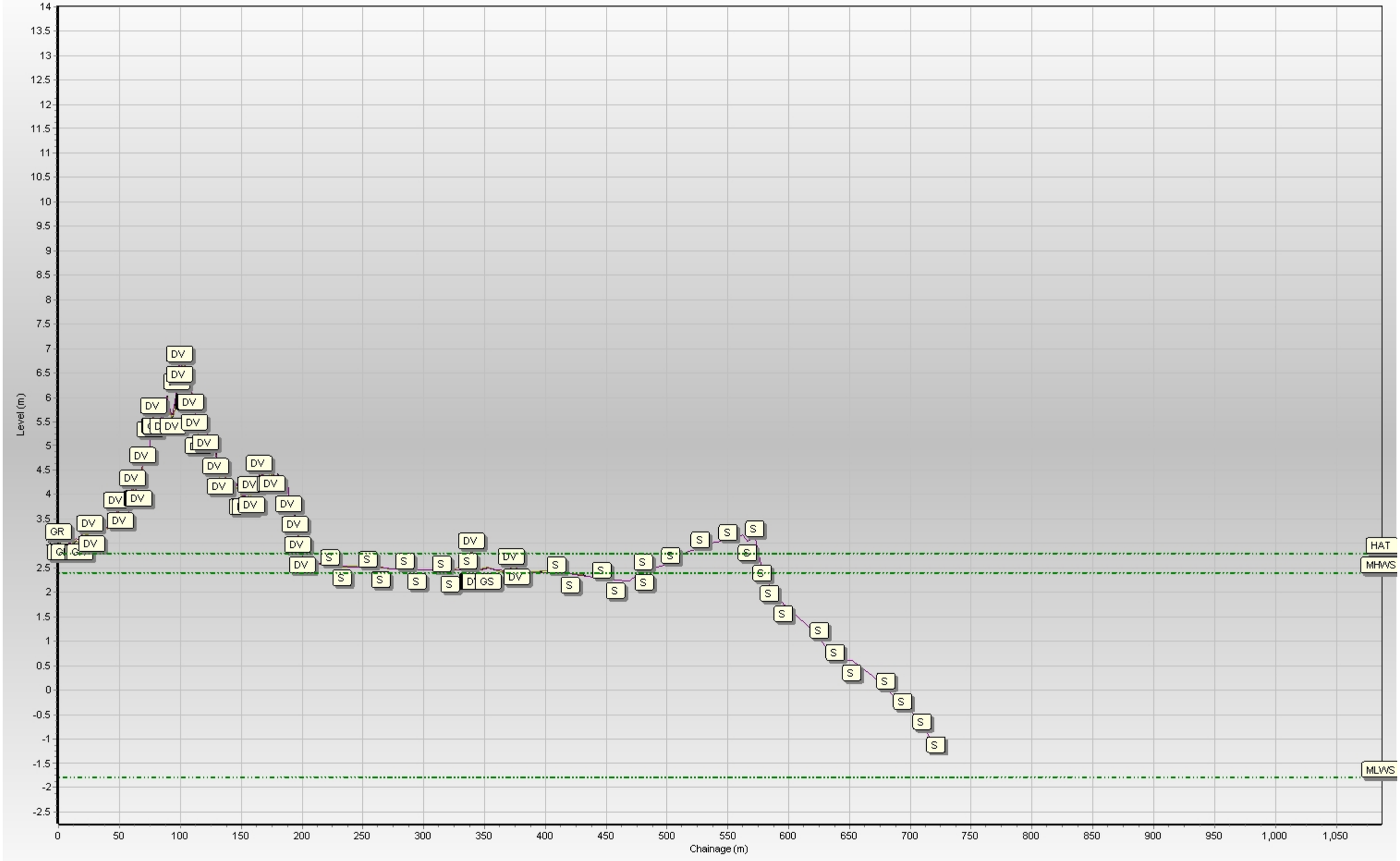
Profiles: 1aBTBC17




2015-10 2014-10 2013-09 2012-11 2011-11 2010-10 2009-10 2008-10 2007-10 2006-10 2005-09 2004-10 2003-09 Profile Envelope

SANDS

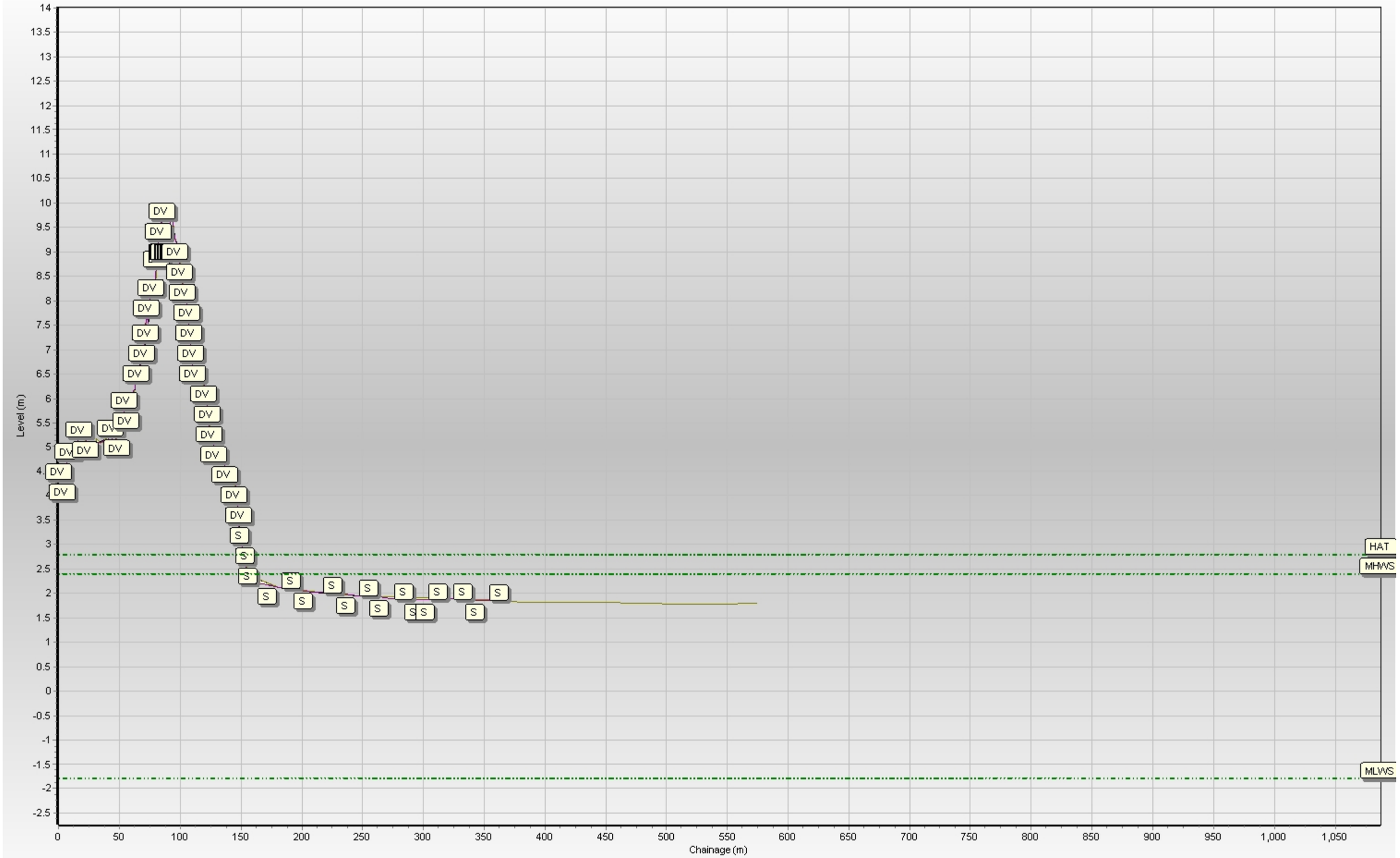
Profiles: 1aBTBC18




2015-10 | 2014-10 | 2013-09 | 2012-11 | 2011-11 | 2010-10 | 2009-10 | 2008-10 | 2007-10 | 2006-10 | 2005-09 | 2004-10 | 2003-09 | Profile Envelope

SANDS

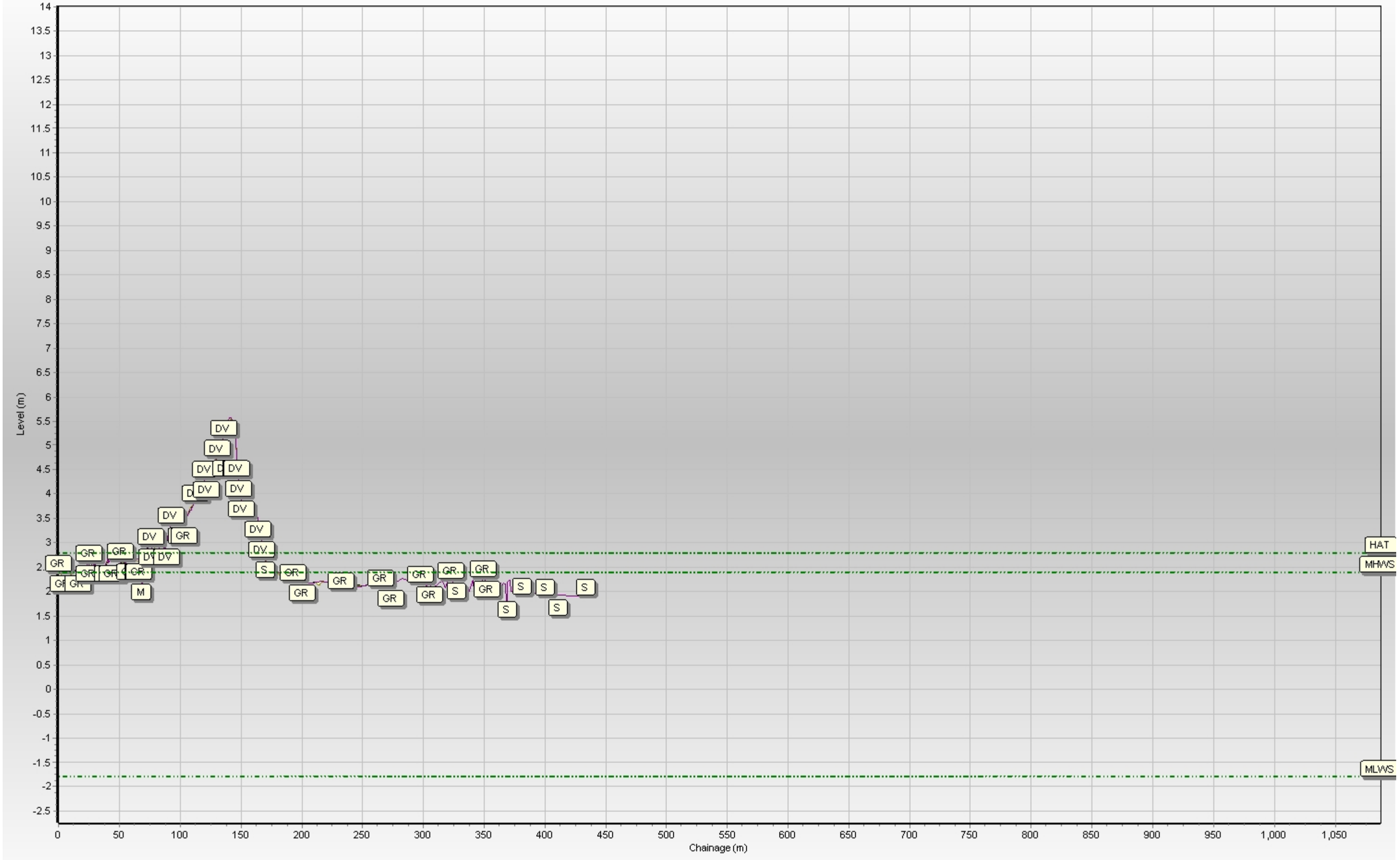
Profiles: 1aBTBC19




2015-10 | 2014-10 | 2013-09 | 2012-11 | 2011-11 | 2010-10 | 2009-10 | 2008-10 | 2007-10 | 2006-10 | 2005-09 | 2004-10 | 2003-09 | Profile Envelope

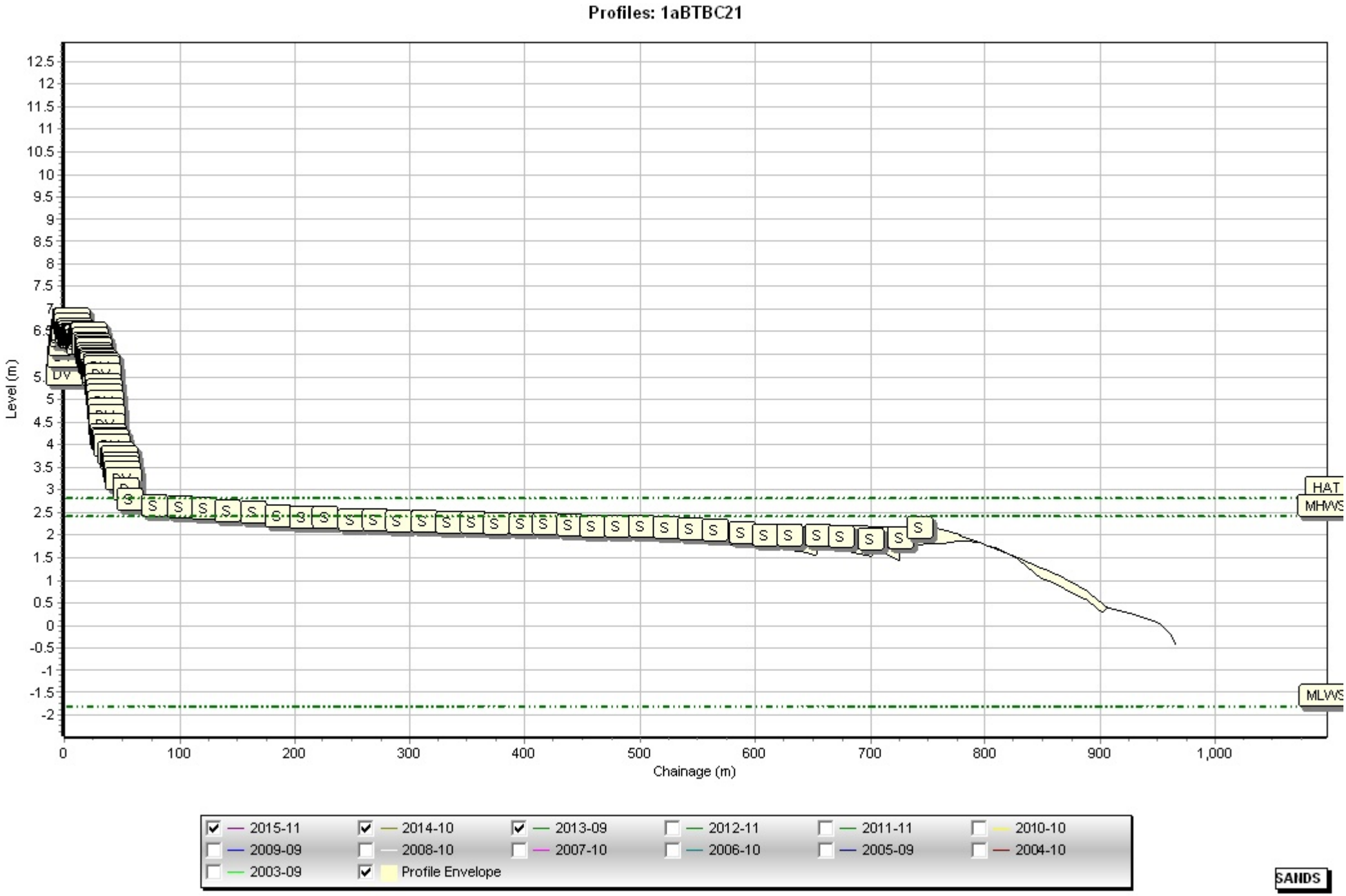
SANDS

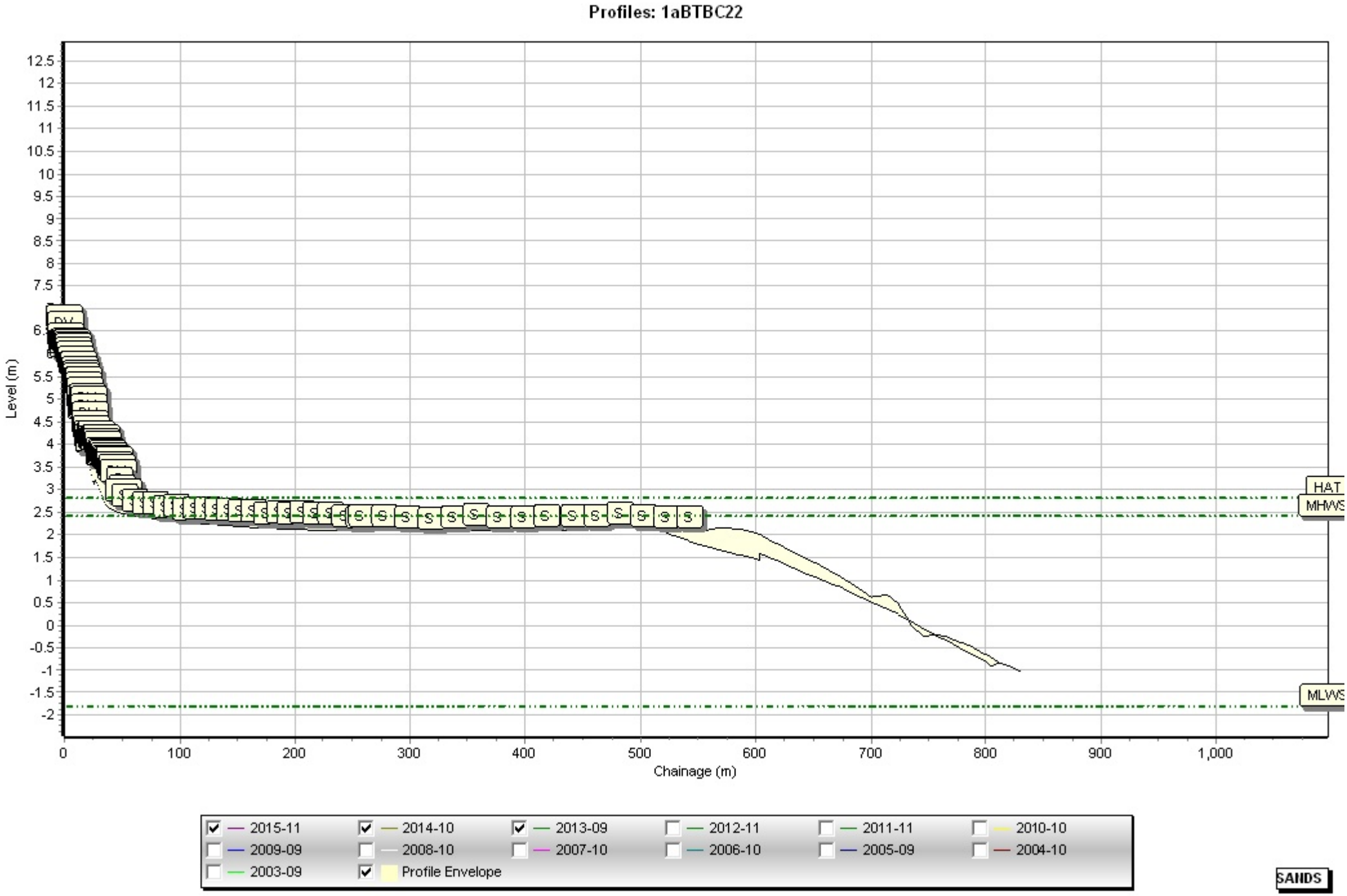
**Profiles: 1aBTBC20**

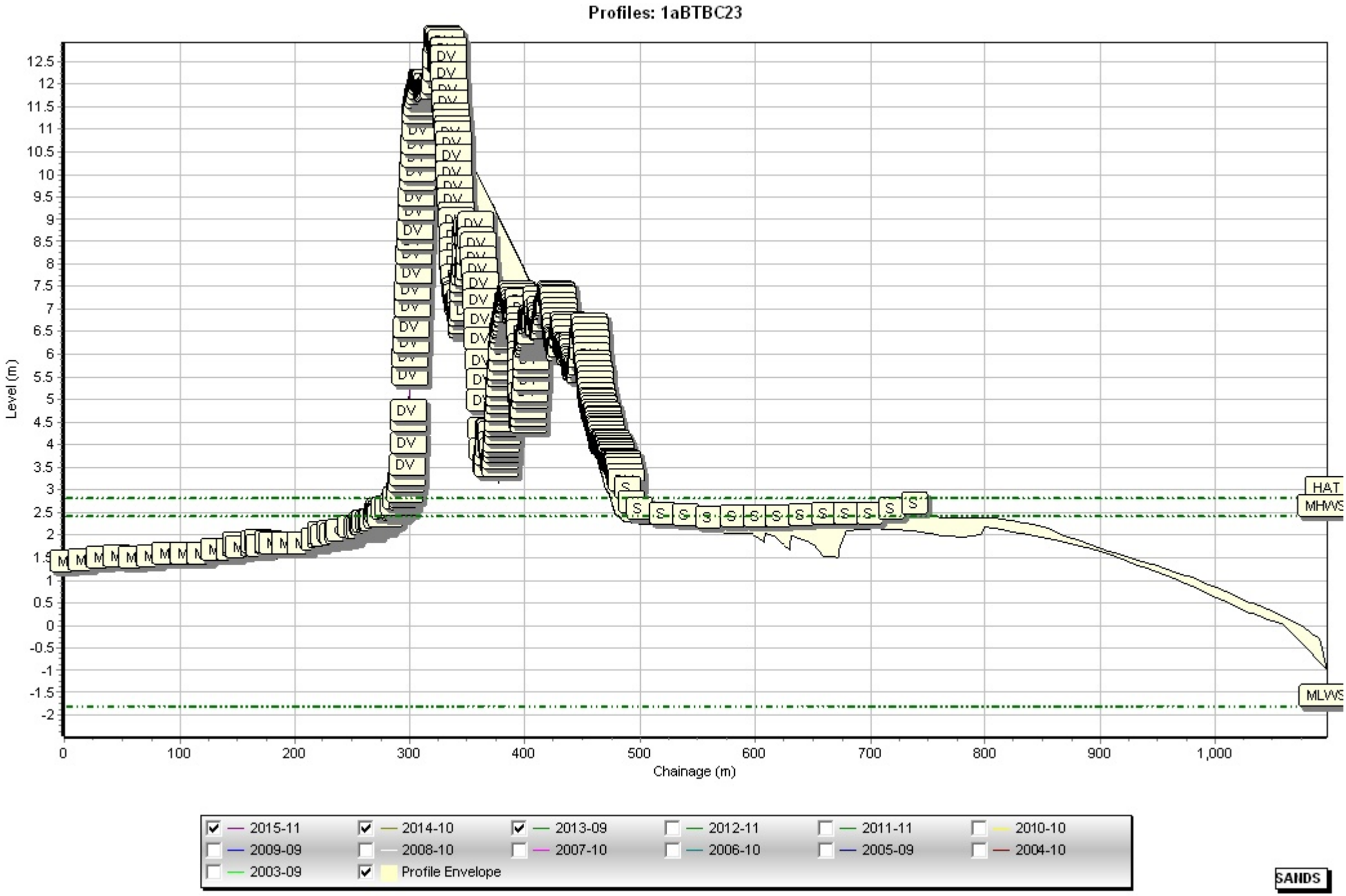


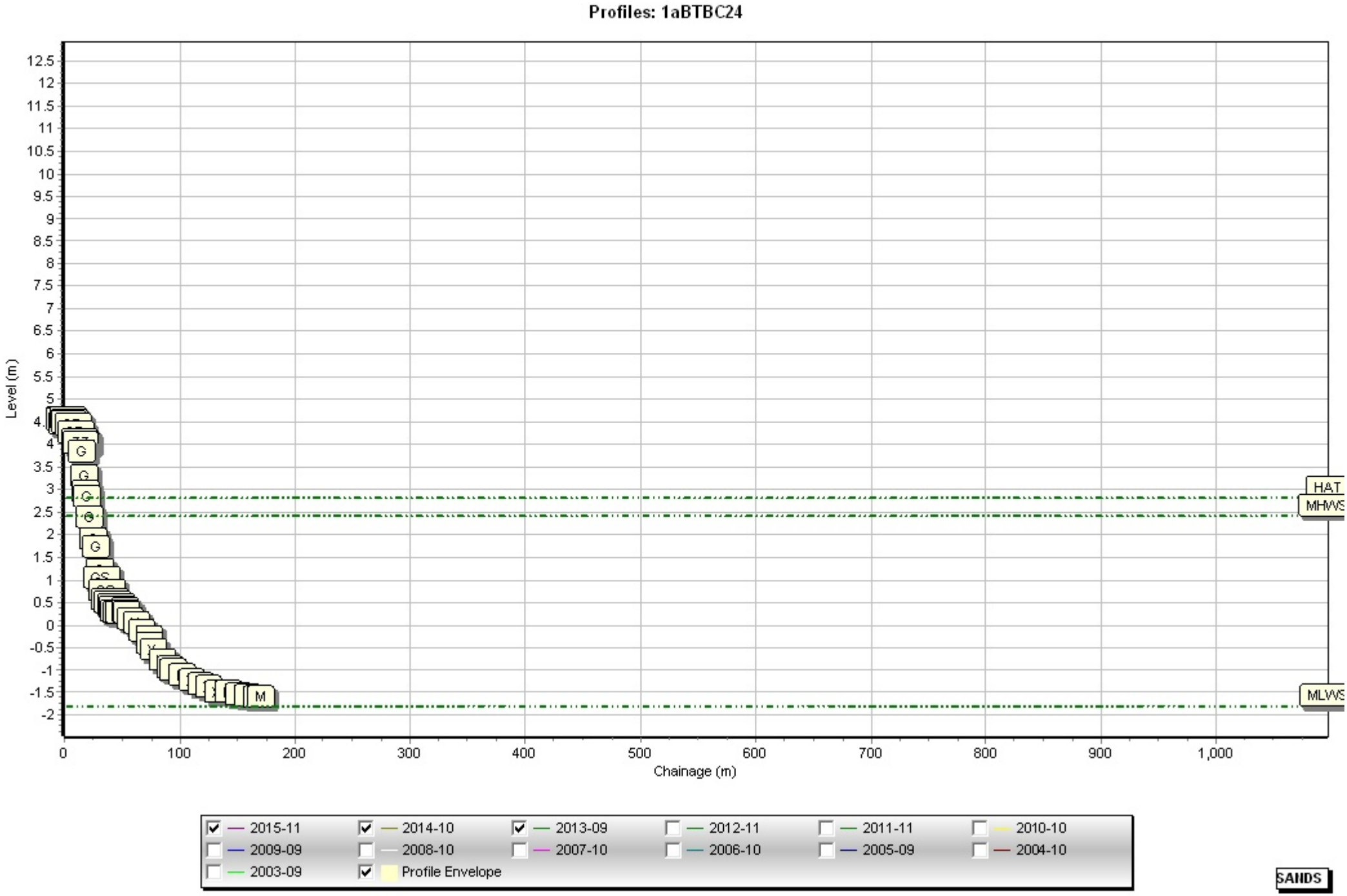

2015-10 | 2014-10 | 2013-09 | 2012-11 | 2011-11 | 2010-10 | 2009-10 | 2008-10 | 2007-10 | 2006-10 | 2005-09 | 2004-10 | 2003-09 | Profile Envelope

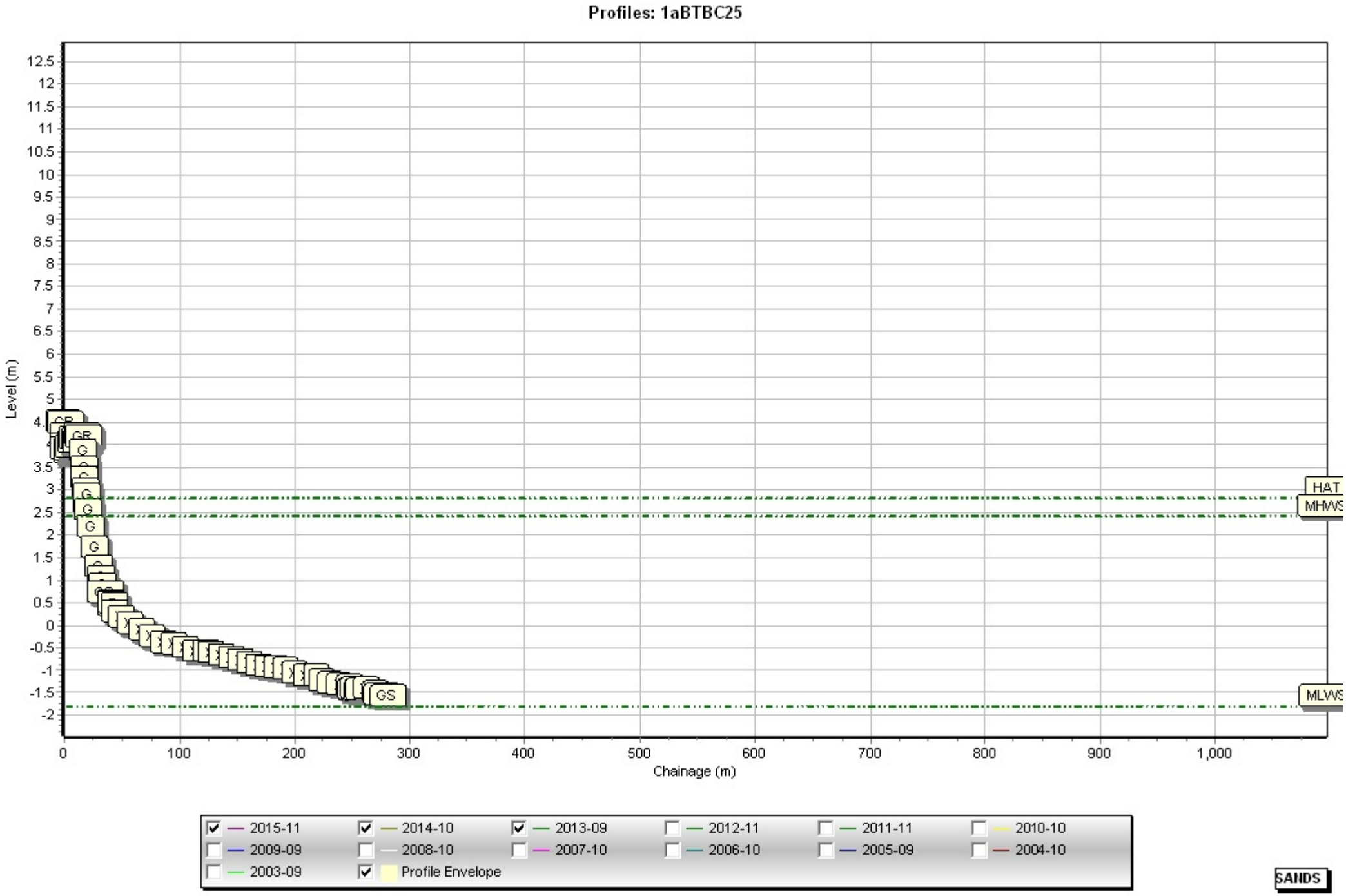
SANDS

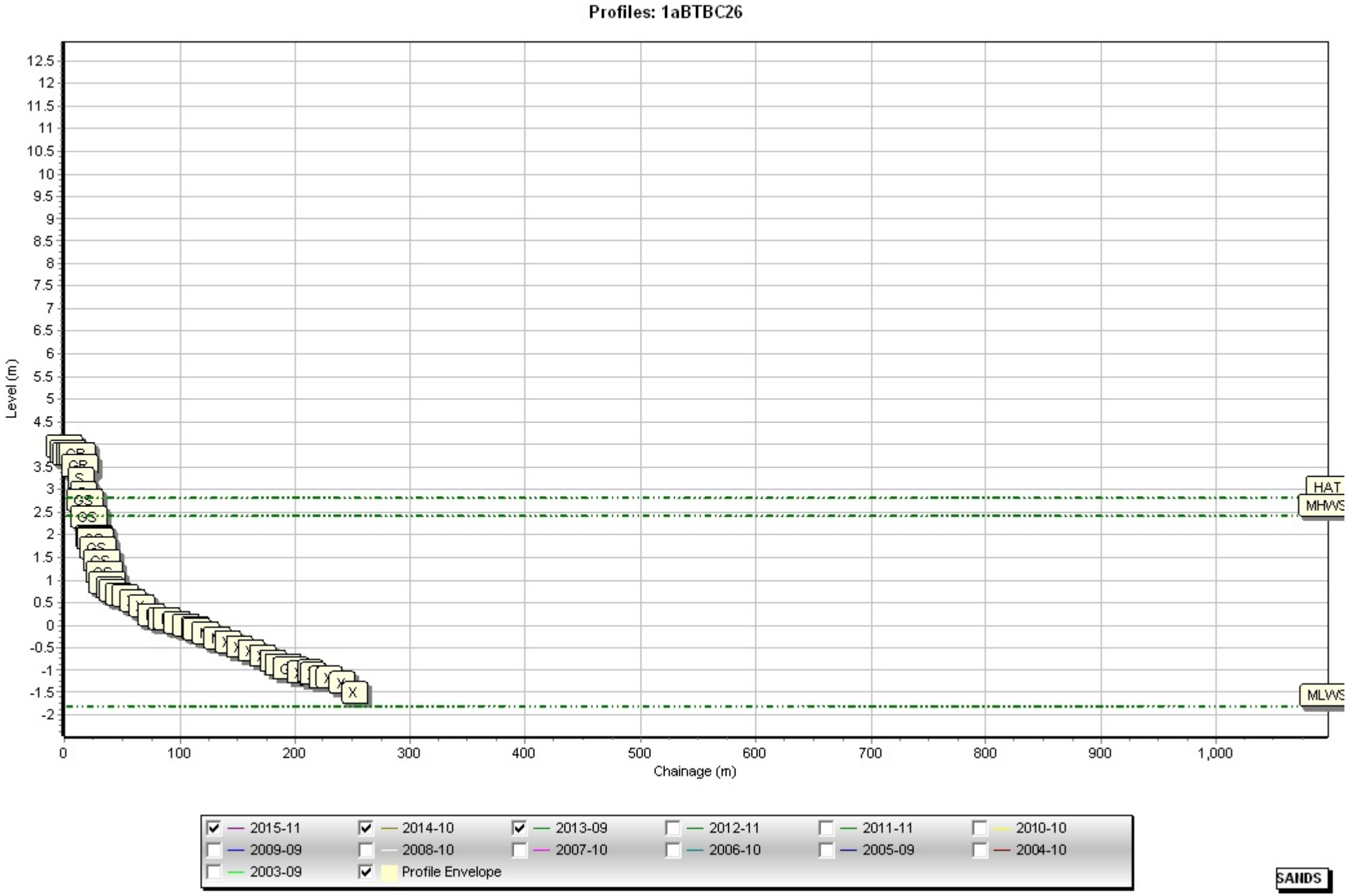

Profiles: 1aBTBC21
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-09
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

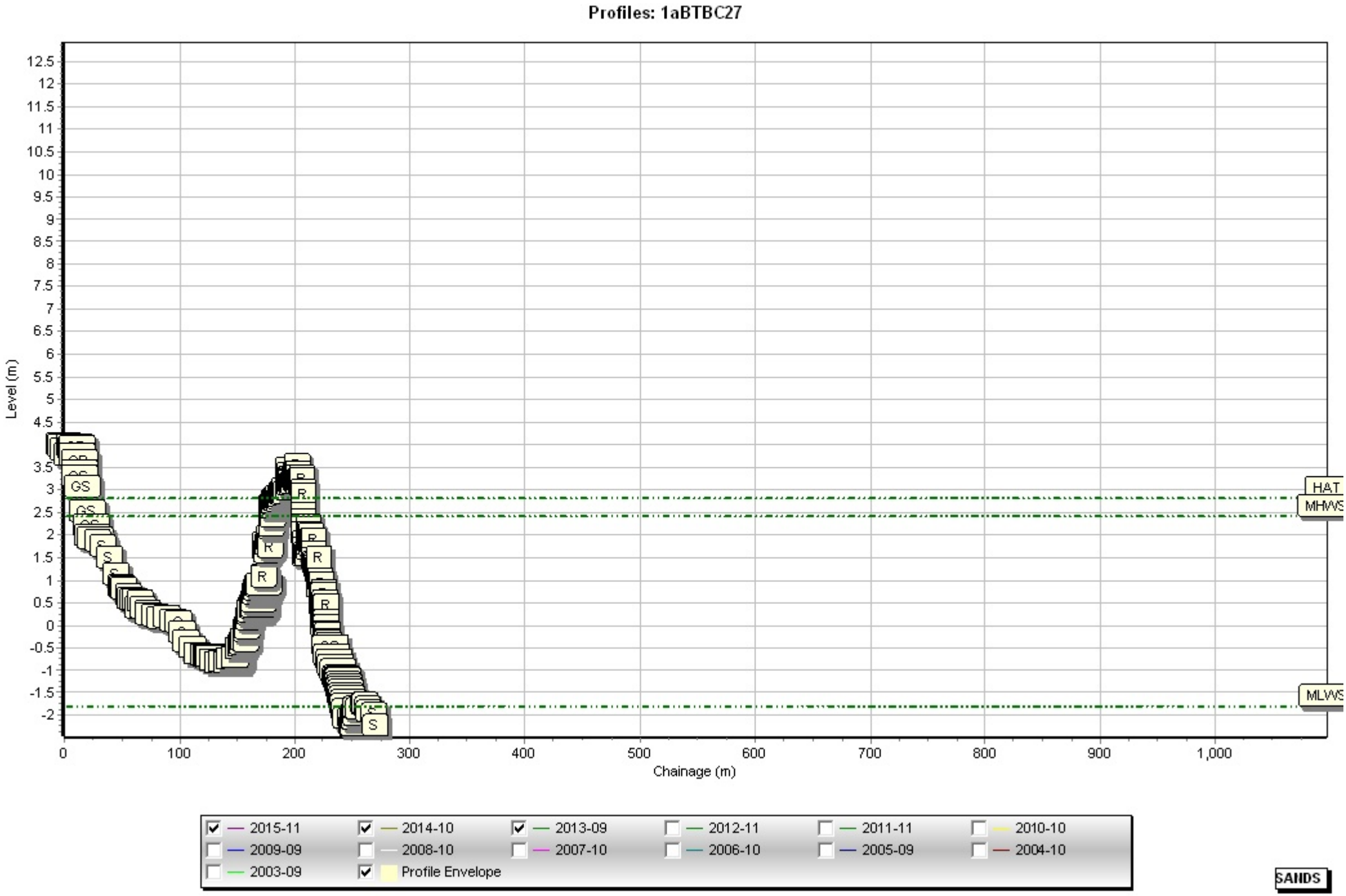

Profiles: 1aBTBC22
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-09
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

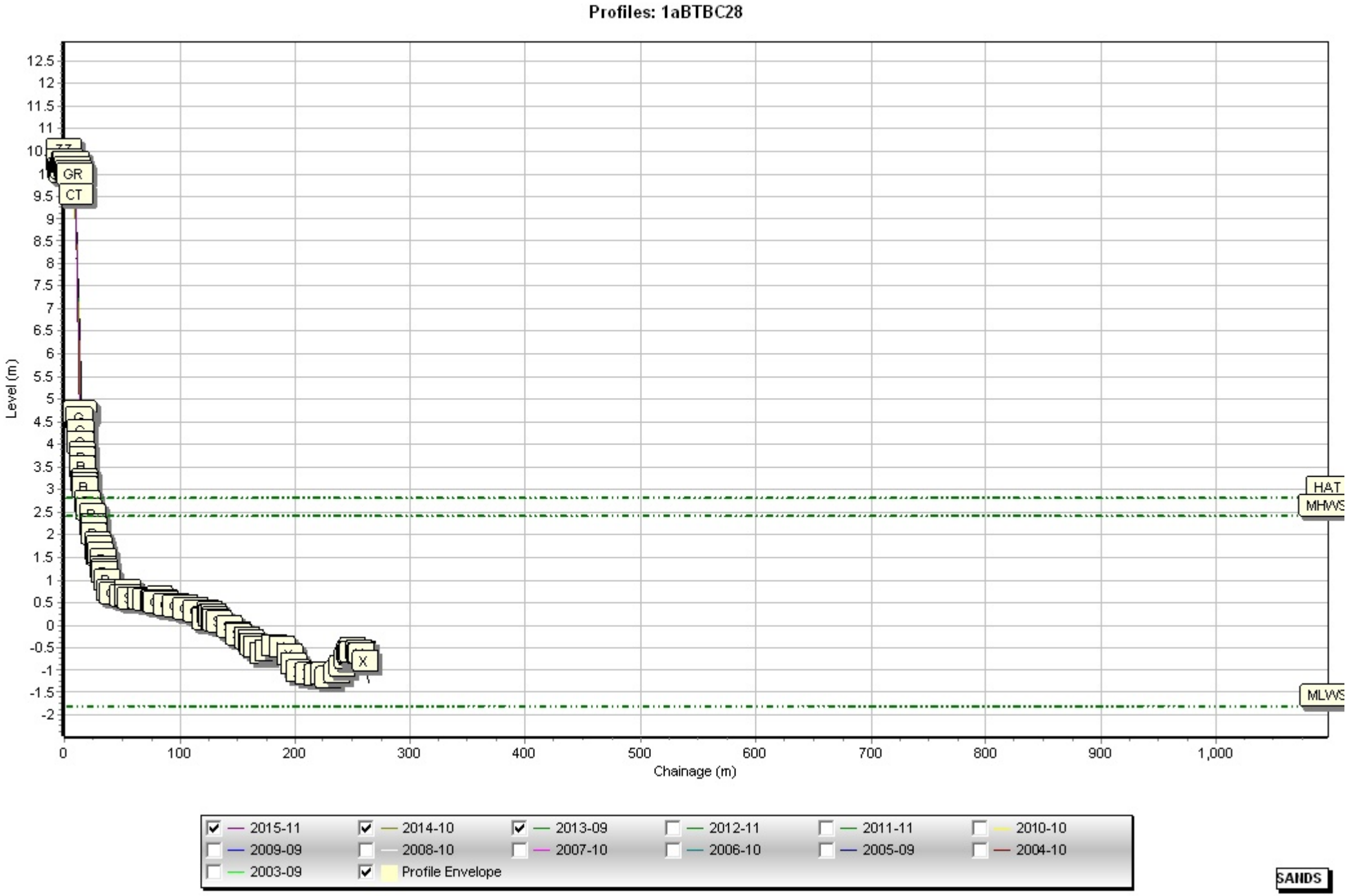

Profiles: 1aBTBC23
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-09
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

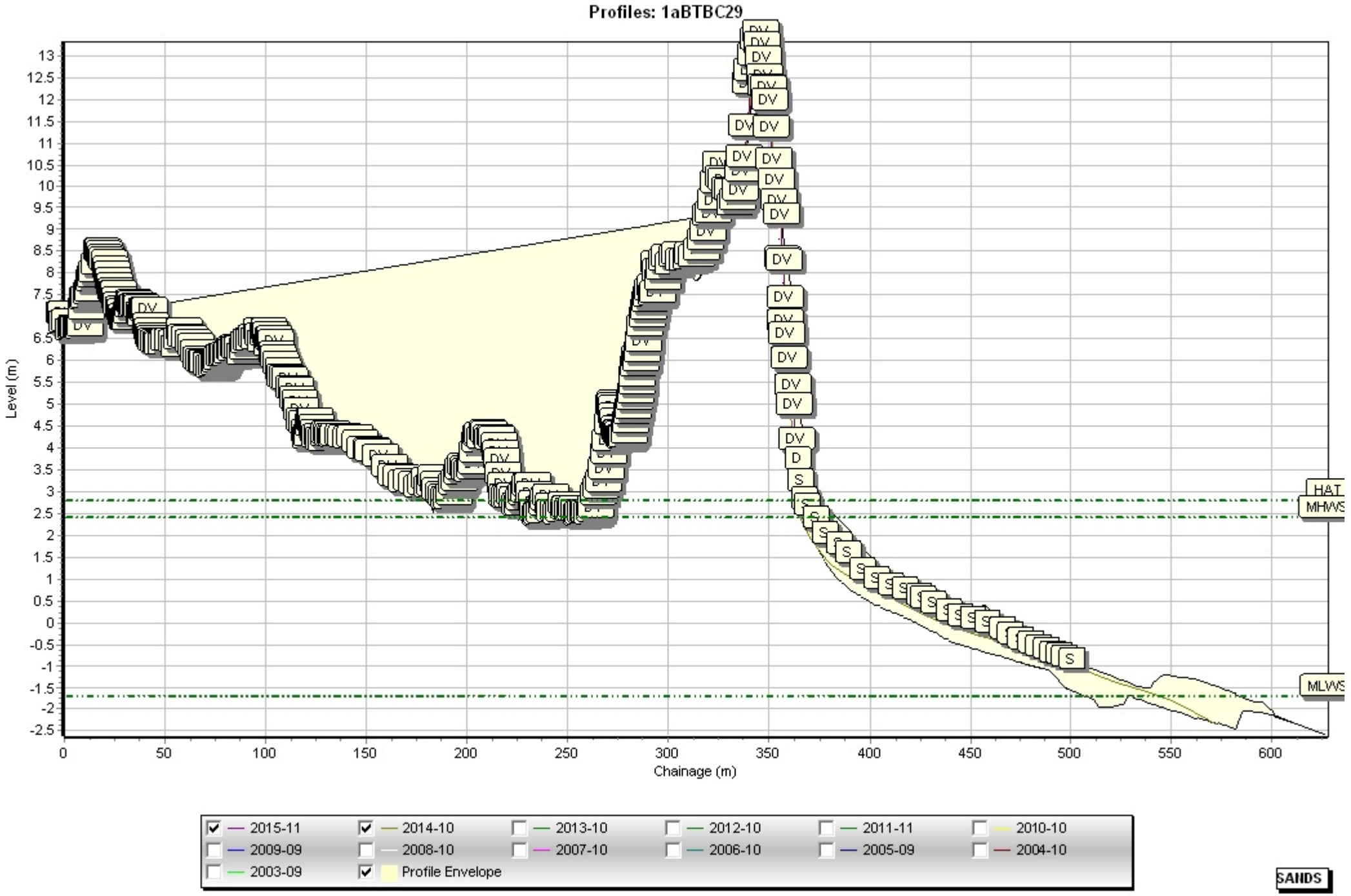

Profiles: 1aBTBC24
Level (m)
12.5
12
11.5
11
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
100
200
300
400
500
600
700
800
900
1,000
Chainage (m)
HAT
MHWS
MLWS
G
M
2015-11
2014-10
2013-09
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

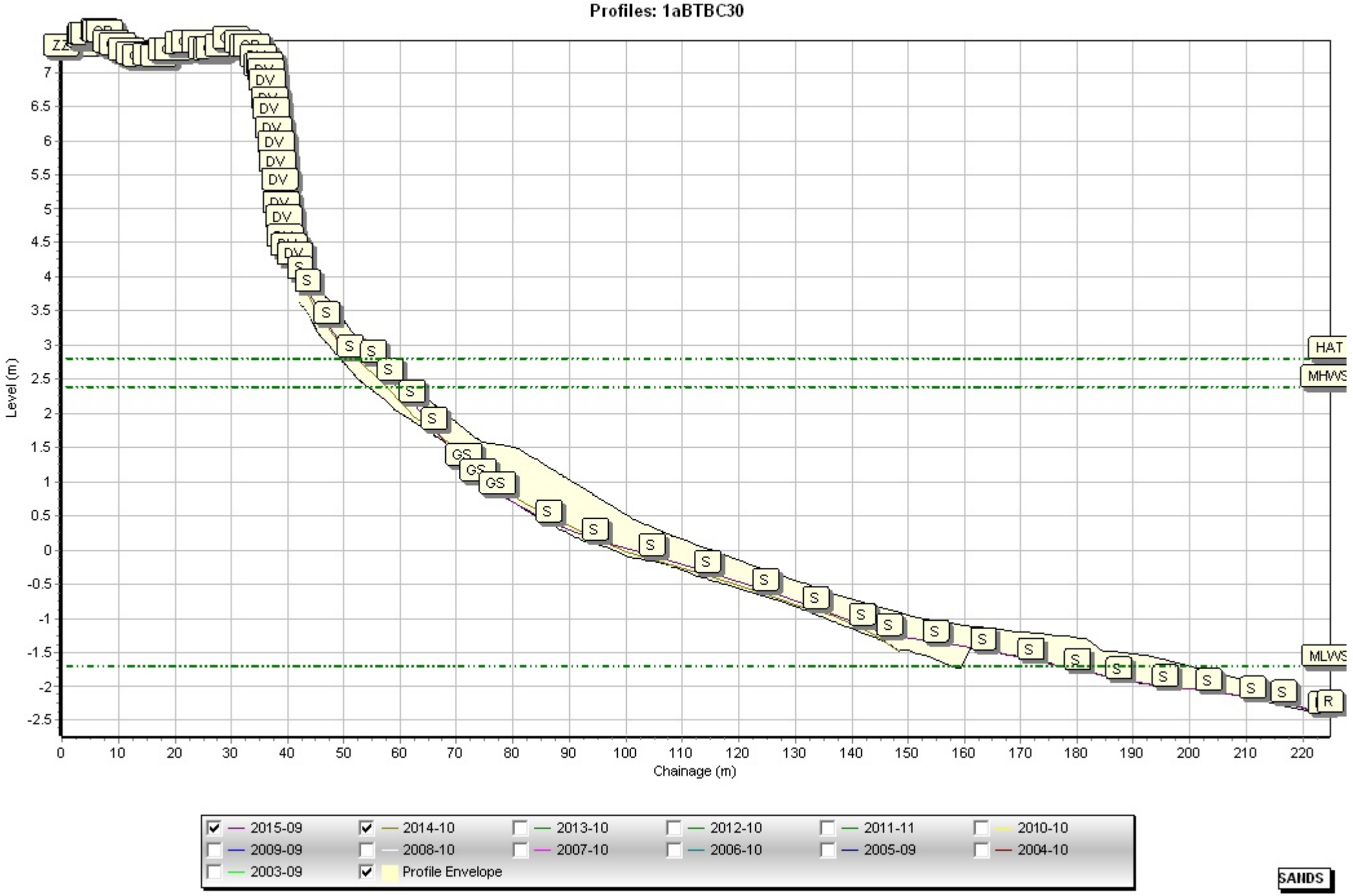

Profiles: 1aBTBC25
Level (m)
12.5
12
11.5
11
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
100
200
300
400
500
600
700
800
900
1,000
Chainage (m)
HAT
MHWS
MLWS
GS
2015-11
2014-10
2013-09
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

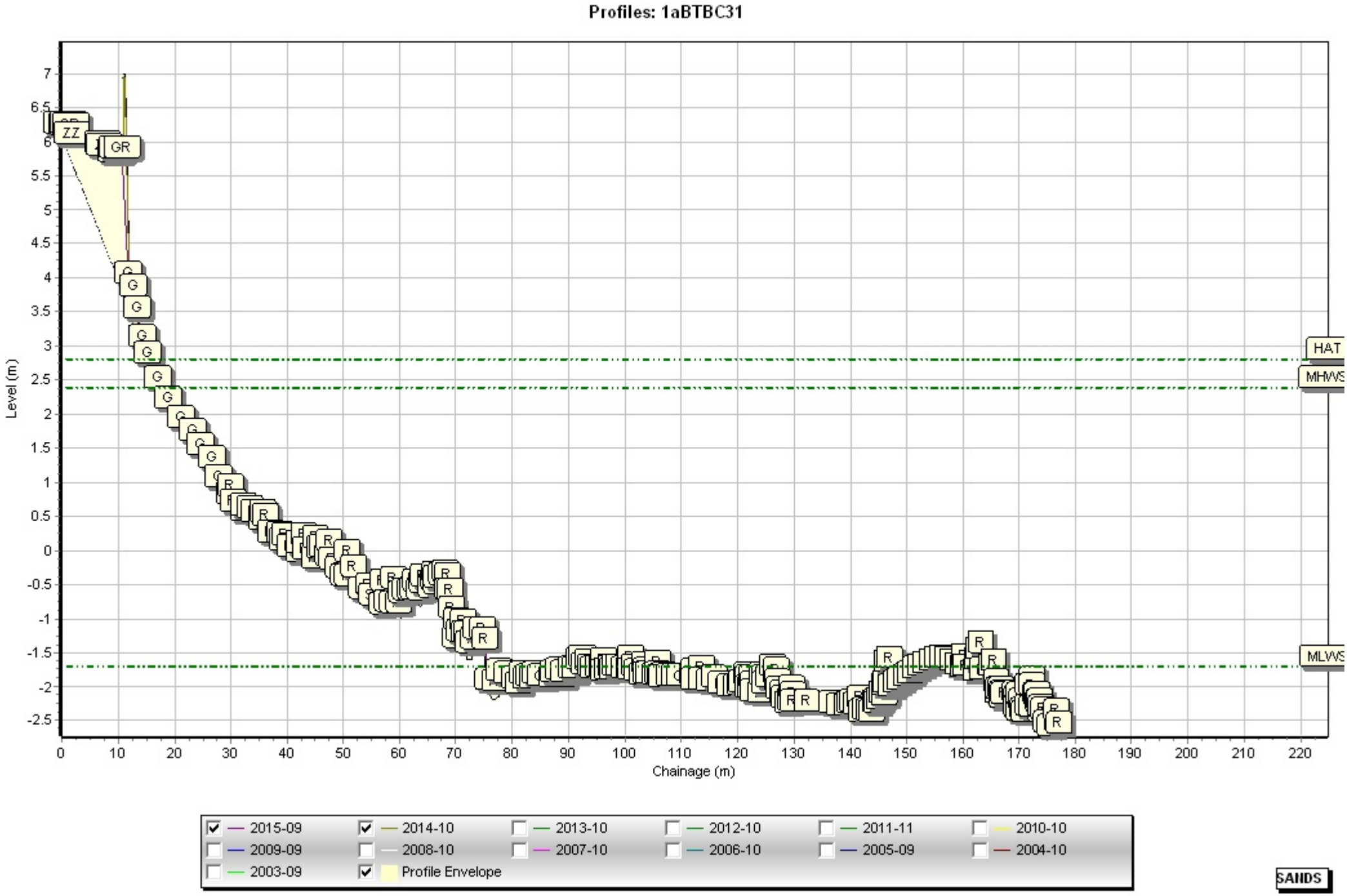

Profiles: 1aBTBC26
Level (m)
12.5
12
11.5
11
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
100
200
300
400
500
600
700
800
900
1,000
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-09
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SAIDS

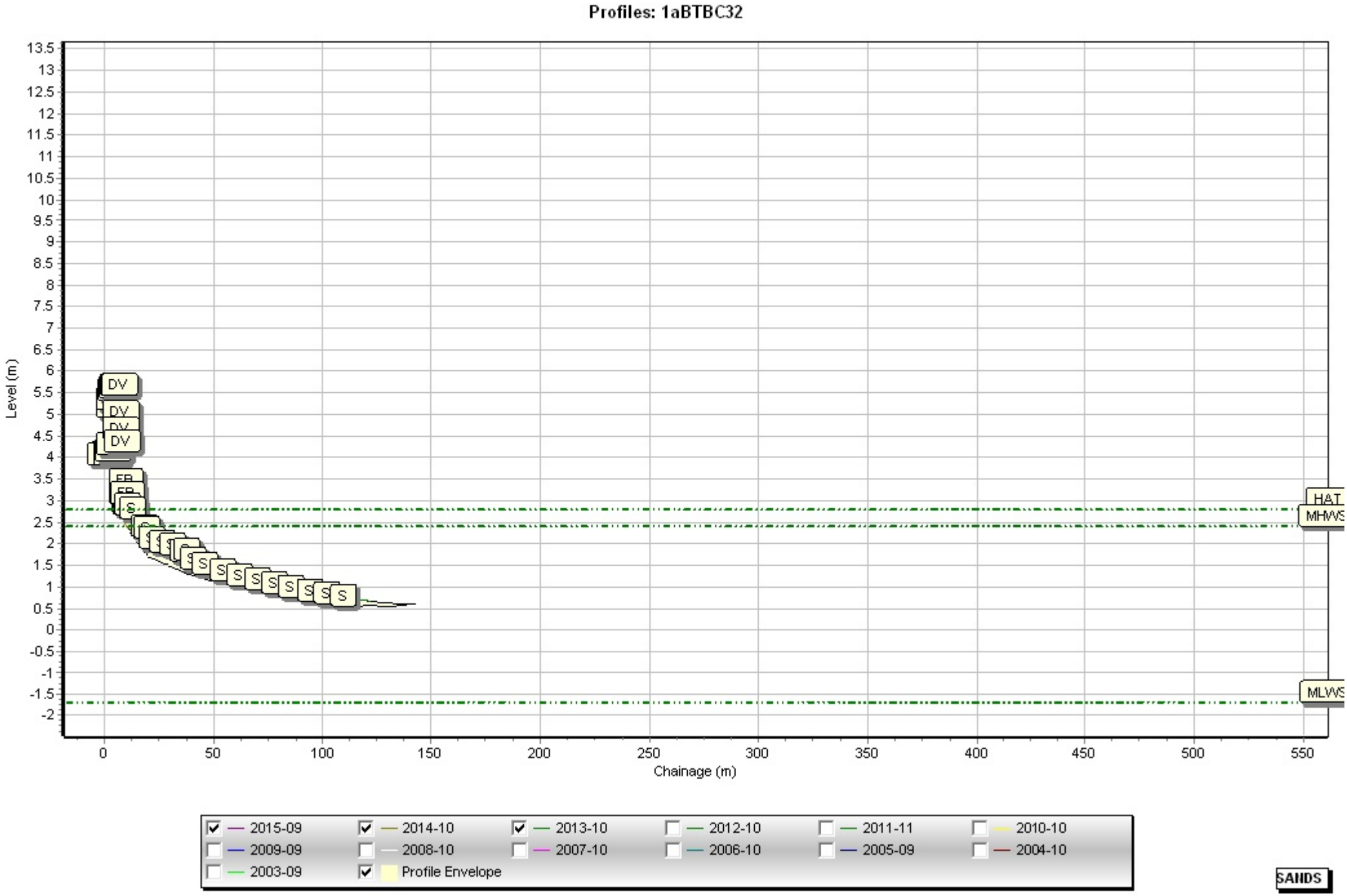

Profiles: 1aBTBC27
Level (m)
12.5
12
11.5
11
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
0
100
200
300
400
500
600
700
800
900
1,000
Chainage (m)
HAT
MHWS
MLWS
GS
S
R
2015-11
2014-10
2013-09
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

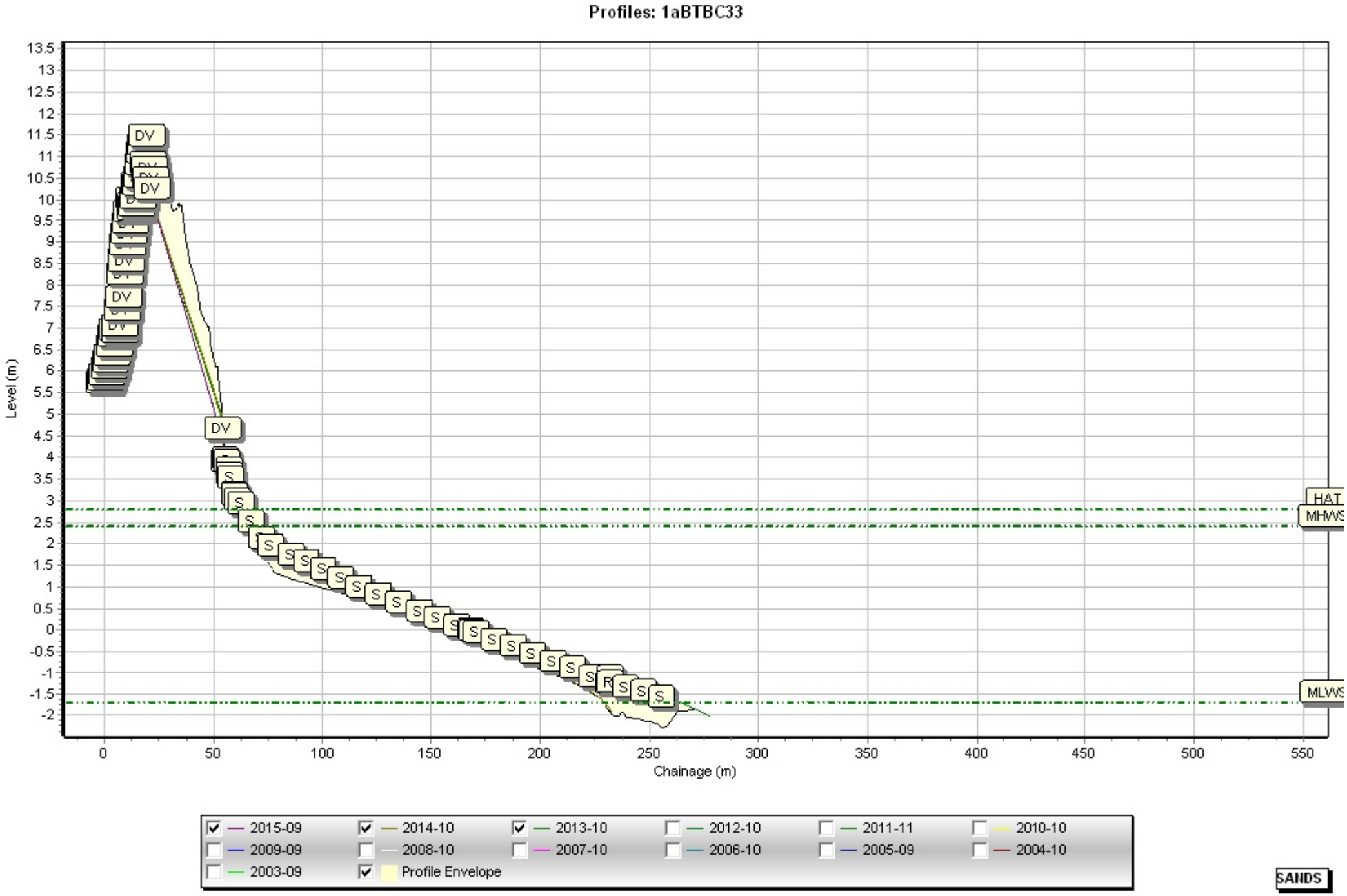

Profiles: 1aBTBC28
Level (m)
Chainage (m)
GR
CT
X
HAT
MHWS
MLWS
2015-11
2014-10
2013-09
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

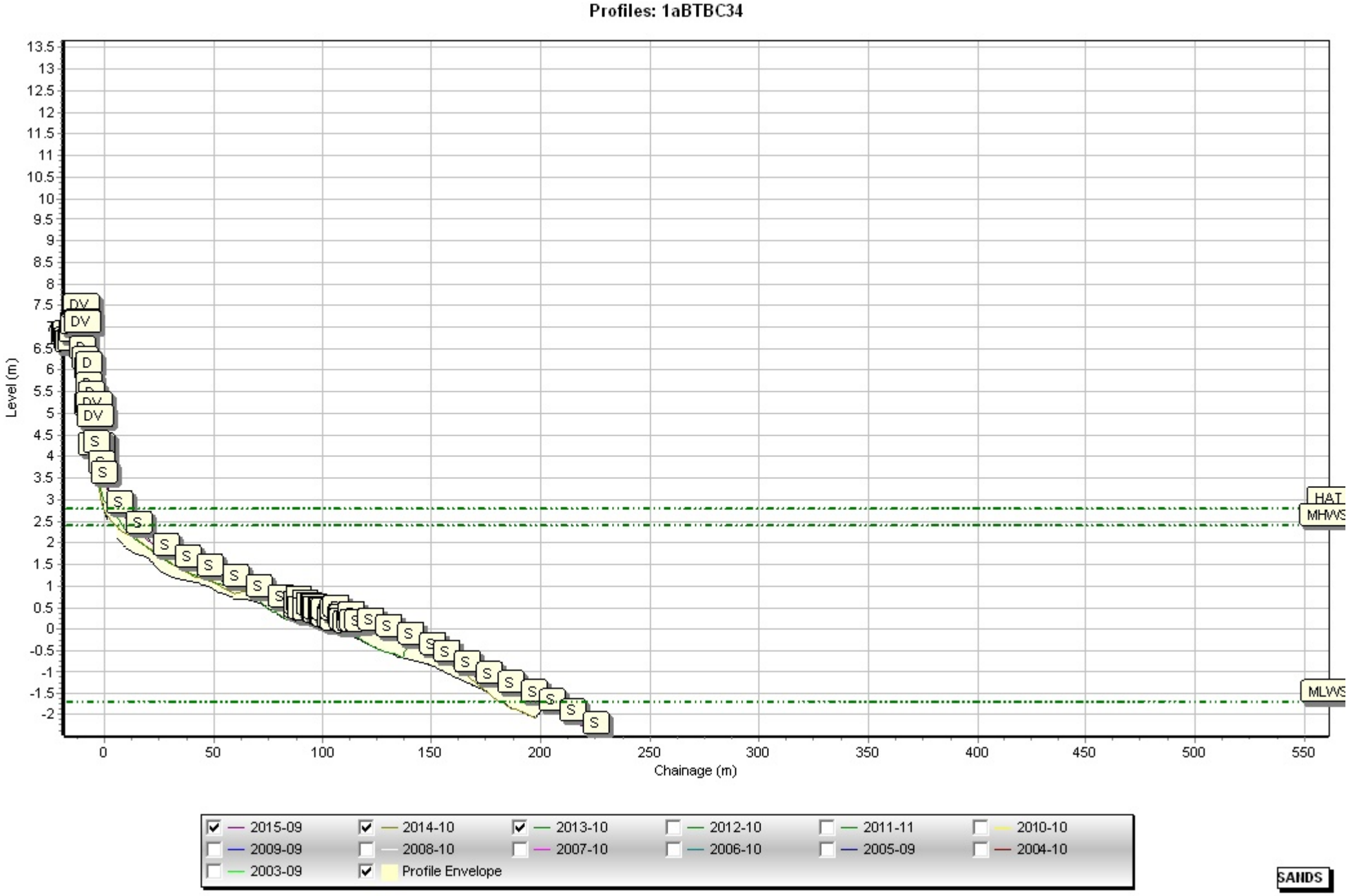

Profiles: 1aBTBC29
Level (m)
Chainage (m)
HAT
MHWS
MLWS
DV
D
S
2015-11
2014-10
2013-10
2012-10
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

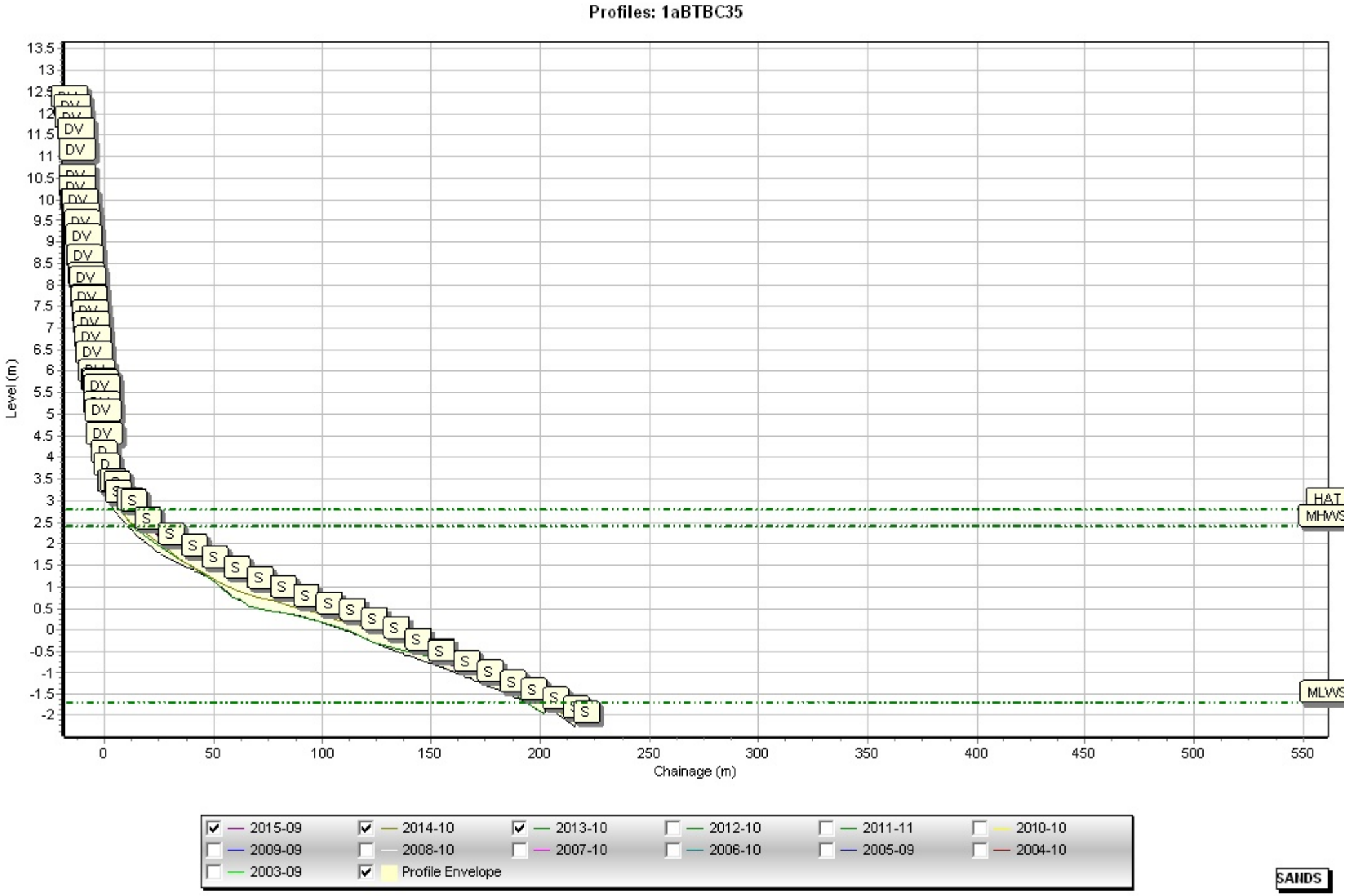

Profiles: 1aBTBC30
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-10
2012-10
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

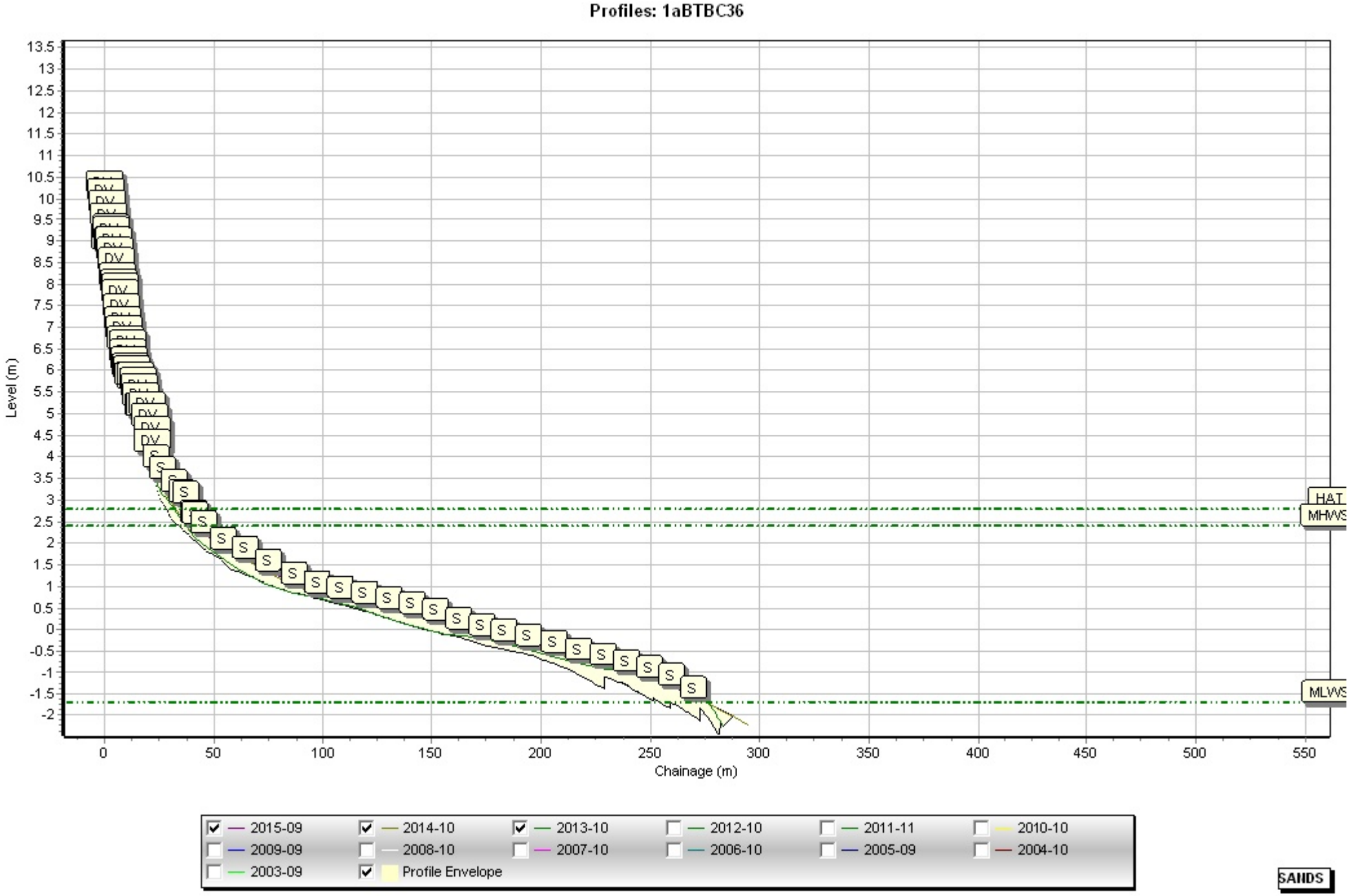

Profiles: 1aBTBC31
Level (m)
Chainage (m)
HAT
MHWS
MLWS
ZZ
GR
2015-09
2014-10
2013-10
2012-10
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

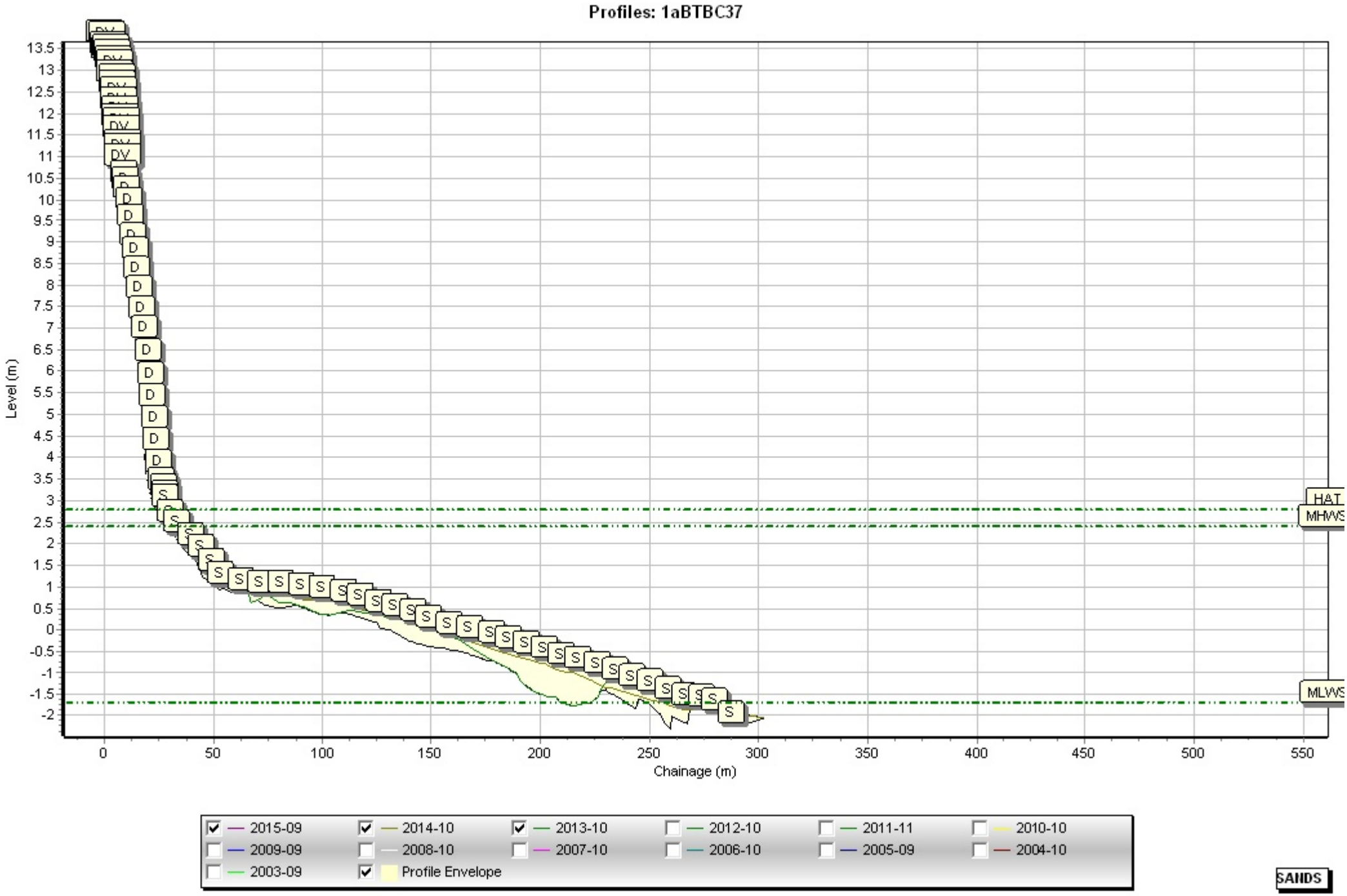

Profiles: 1aBTBC32
Level (m)
Chainage (m)
DV
HAT
MHWS
MLWS
2015-09
2014-10
2013-10
2012-10
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

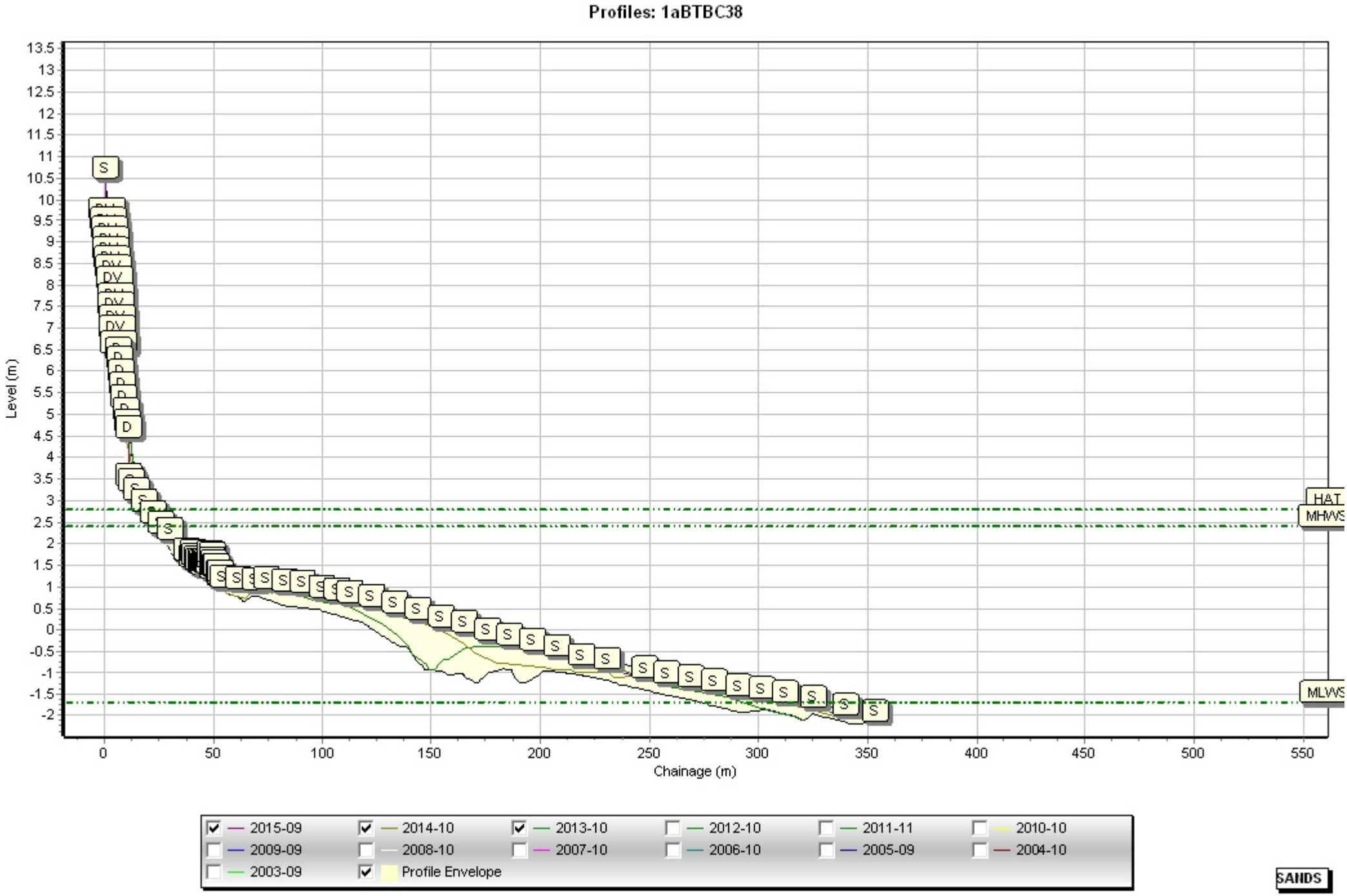

Profiles: 1aBTBC33
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-10
2012-10
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

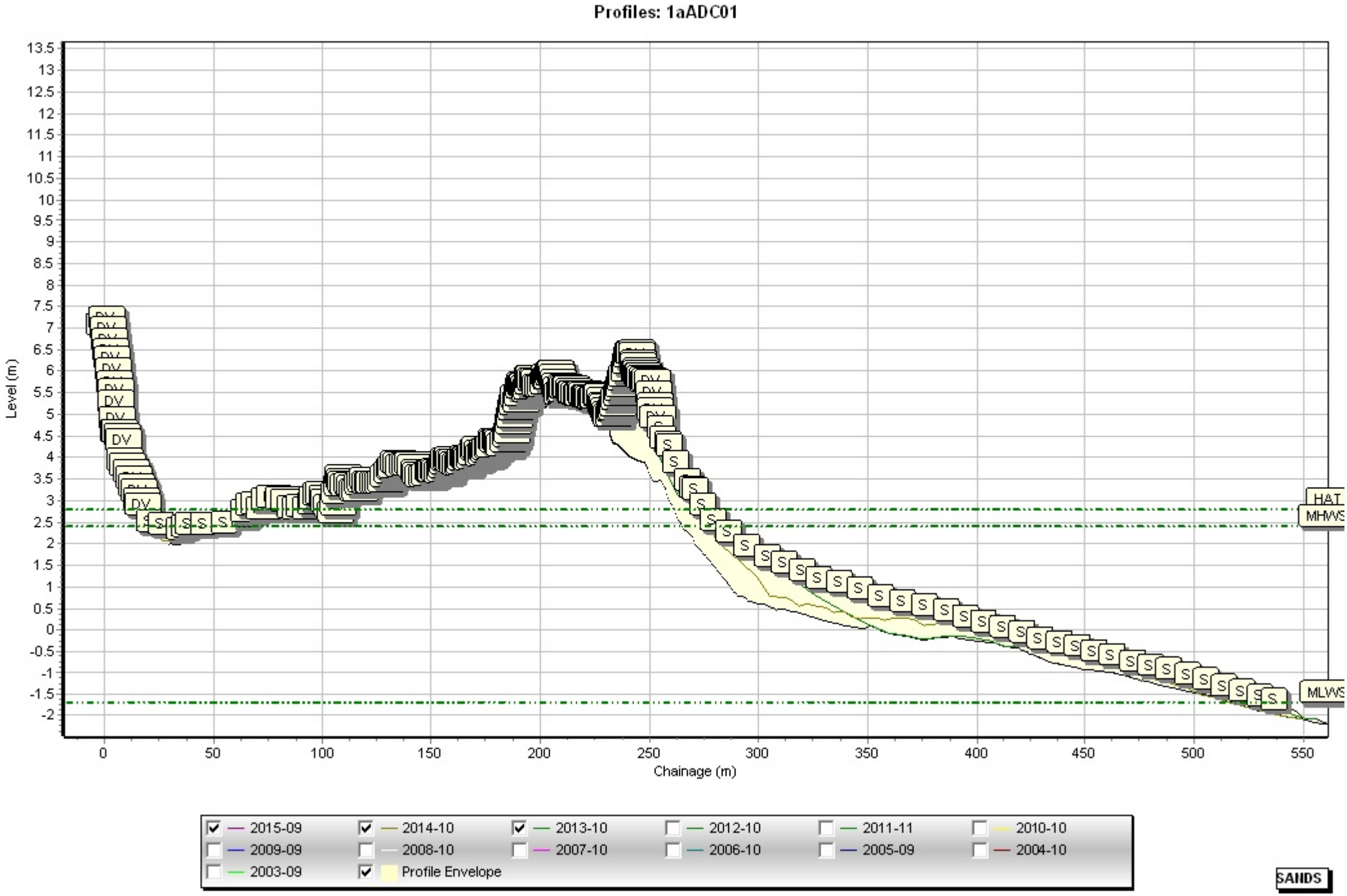

Profiles: 1aBTBC34
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-10
2012-10
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

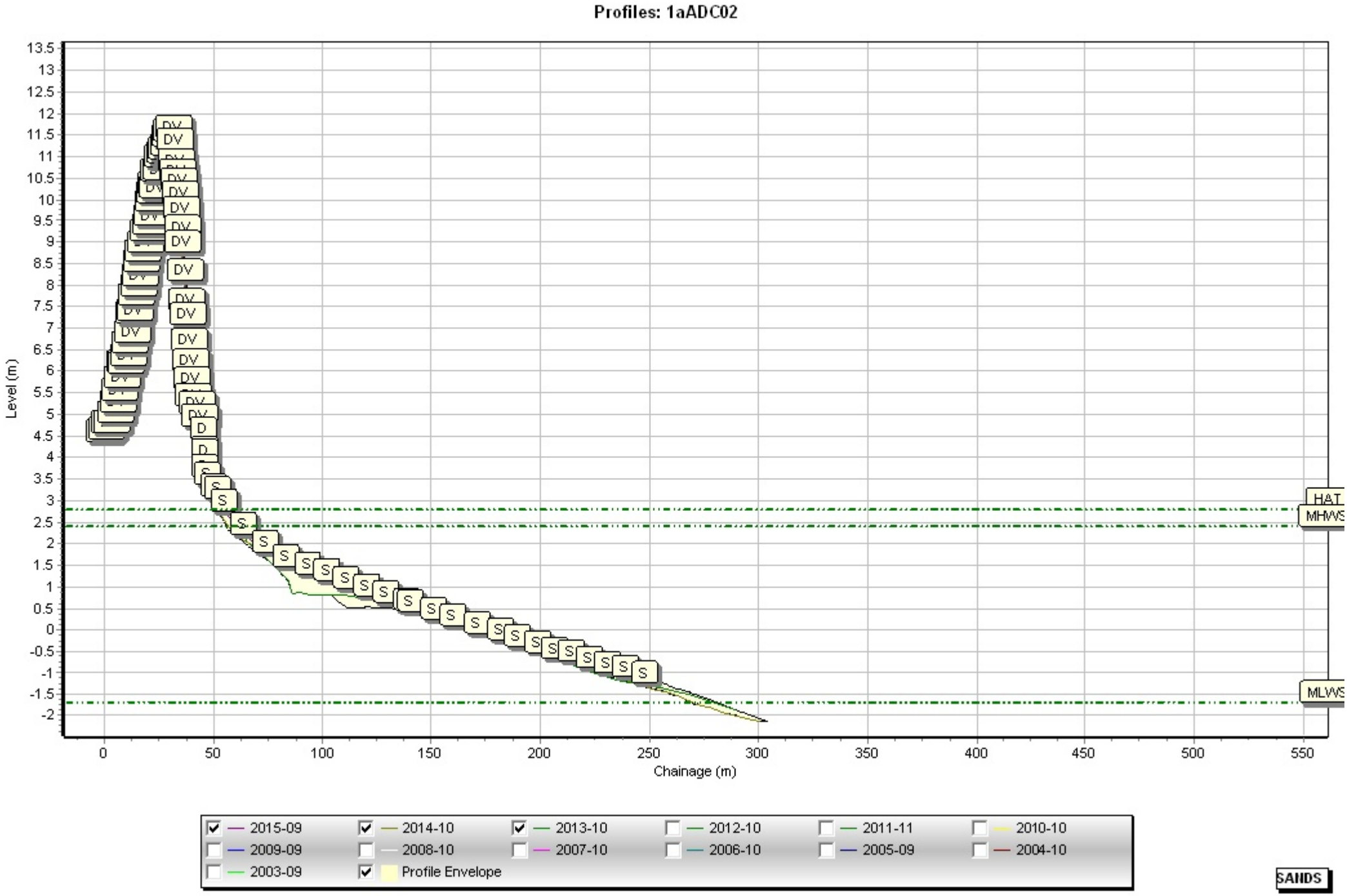

Profiles: 1aBTBC35
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-10
2012-10
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SAIDS

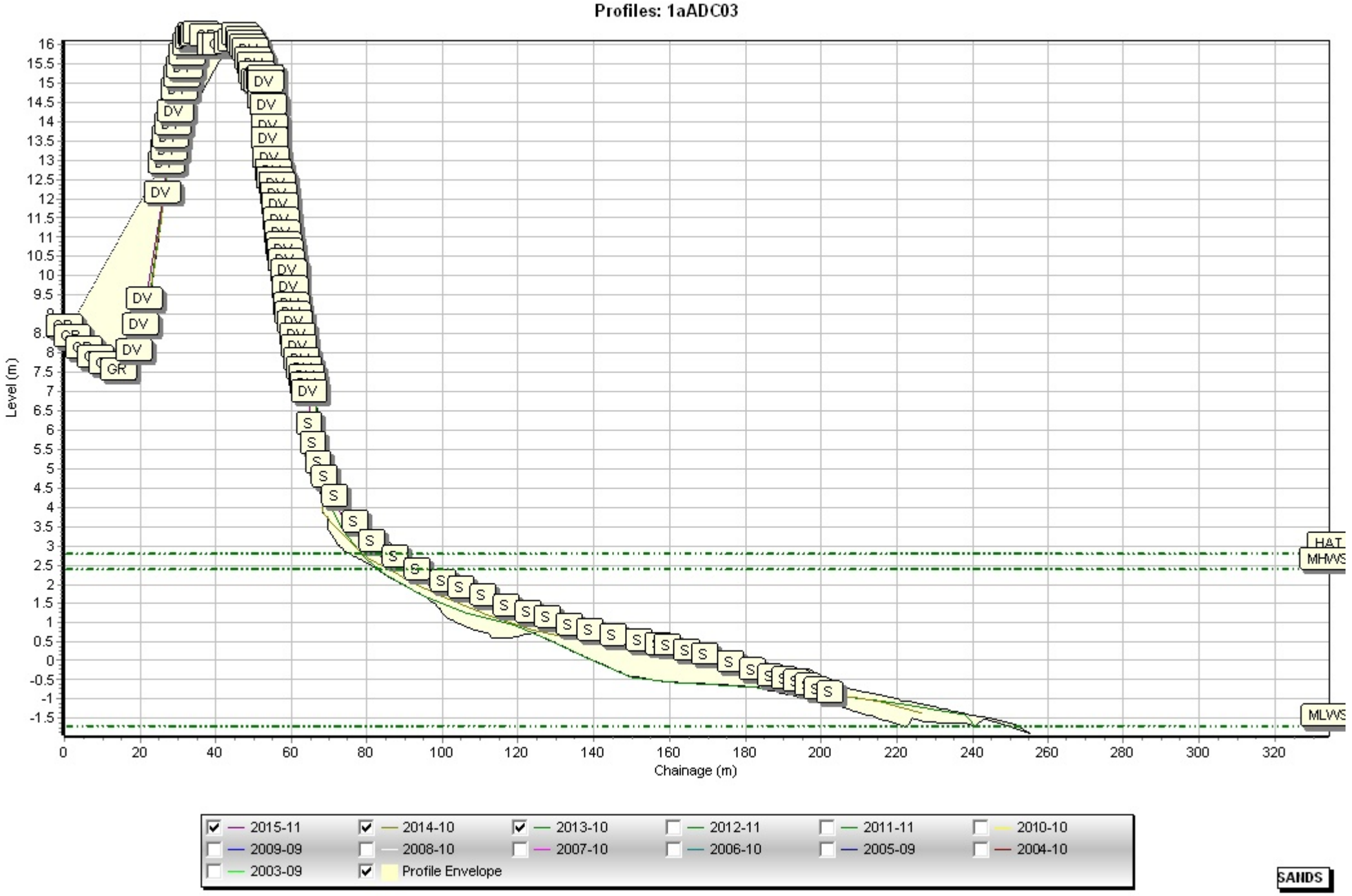

Profiles: 1aBTBC36
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-10
2012-10
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

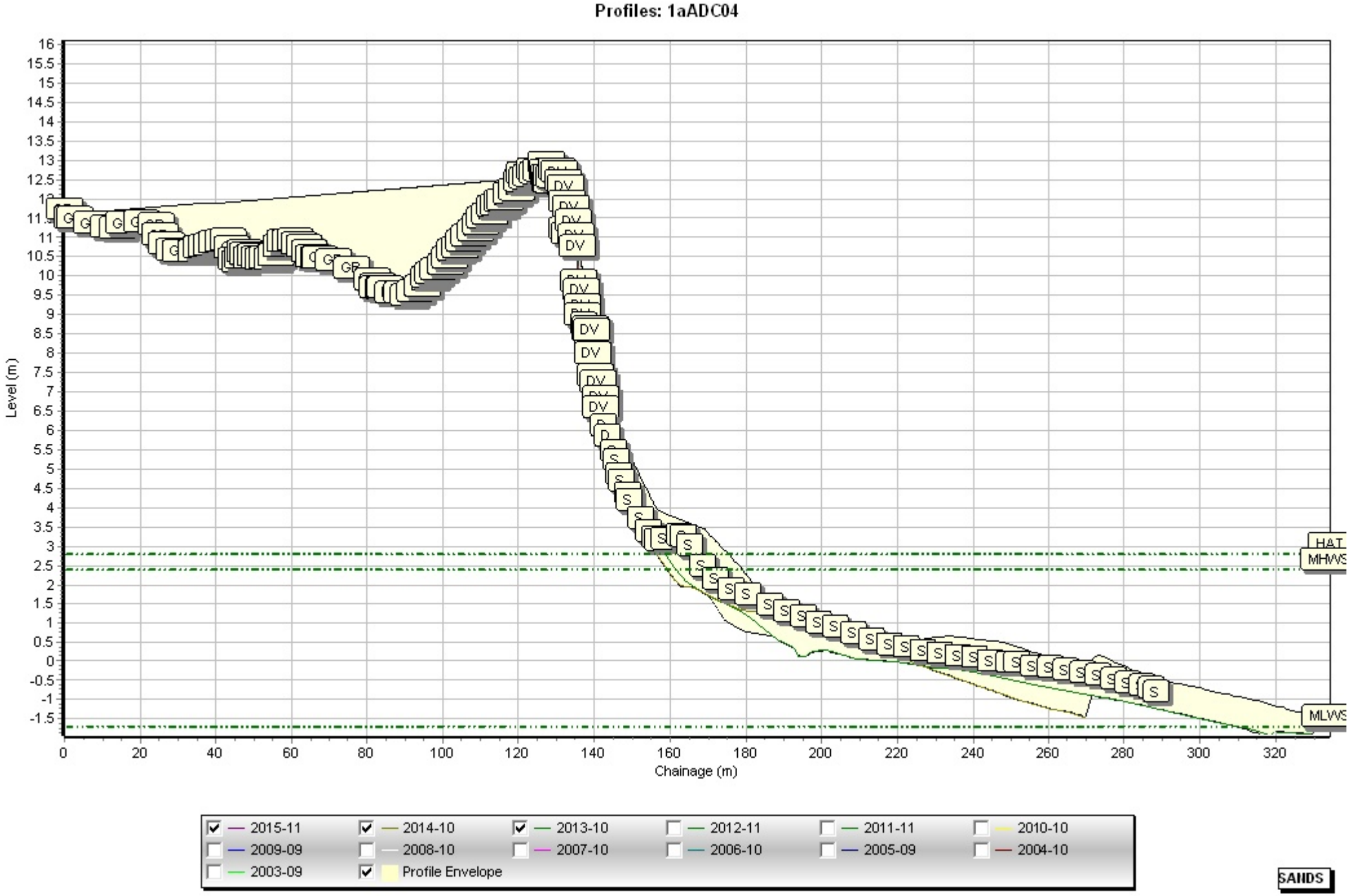

Profiles: 1aBTBC37
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-10
2012-10
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

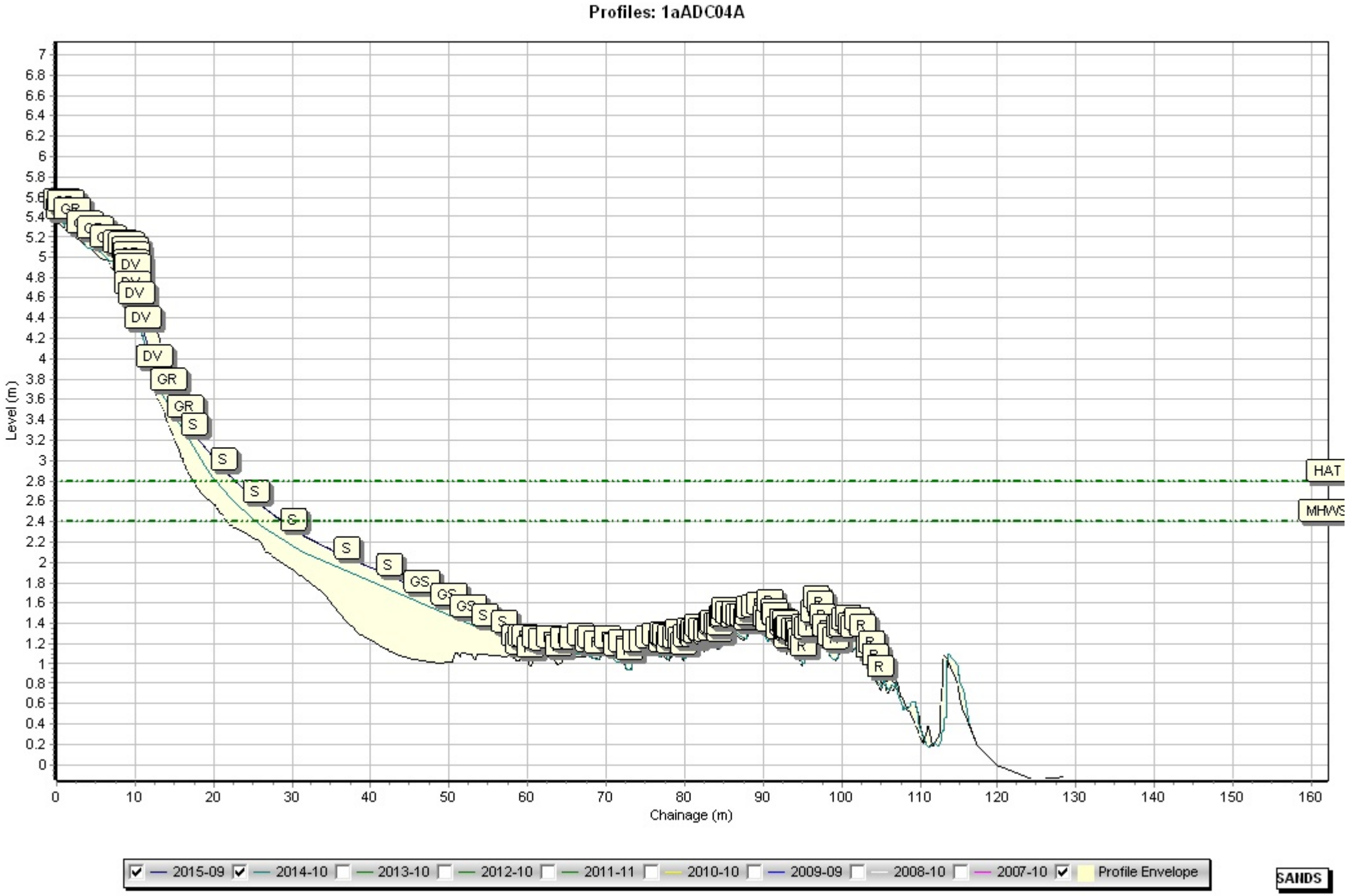

Profiles: 1aBTBC38
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-10
2012-10
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

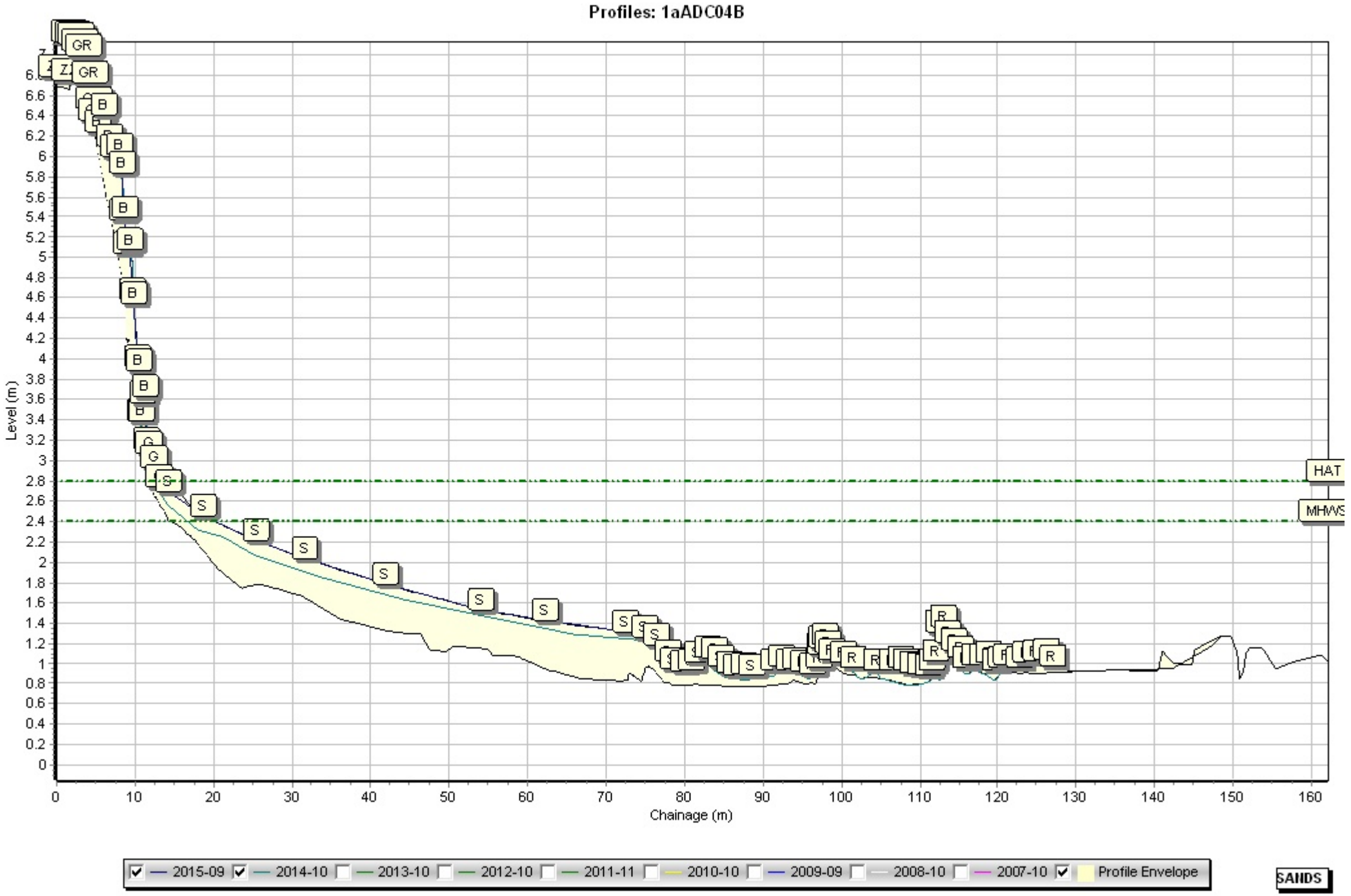

Profiles: 1aADC01
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-10
2012-10
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

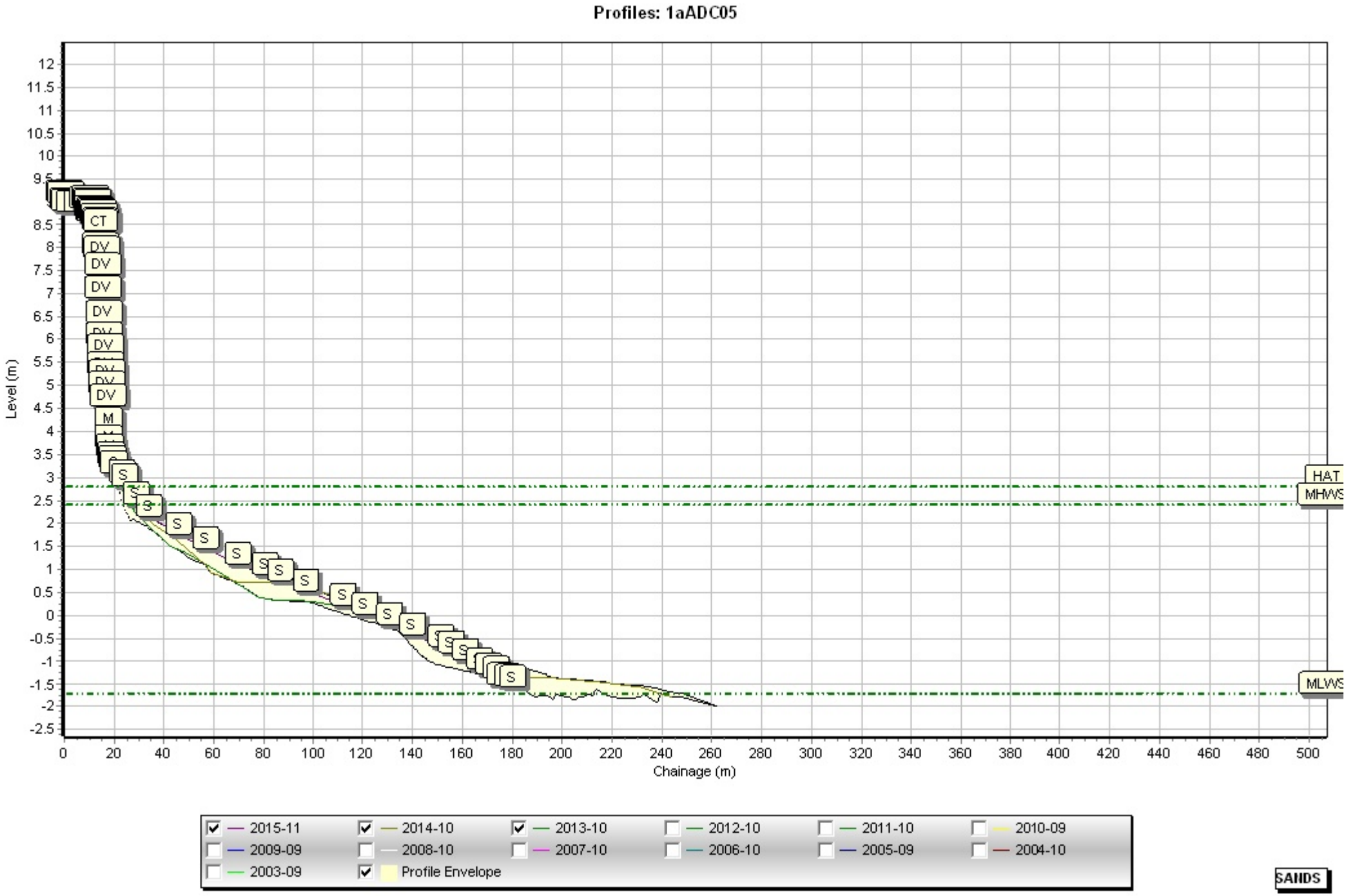

Profiles: 1aADC02
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-09
2014-10
2013-10
2012-10
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SAIDS

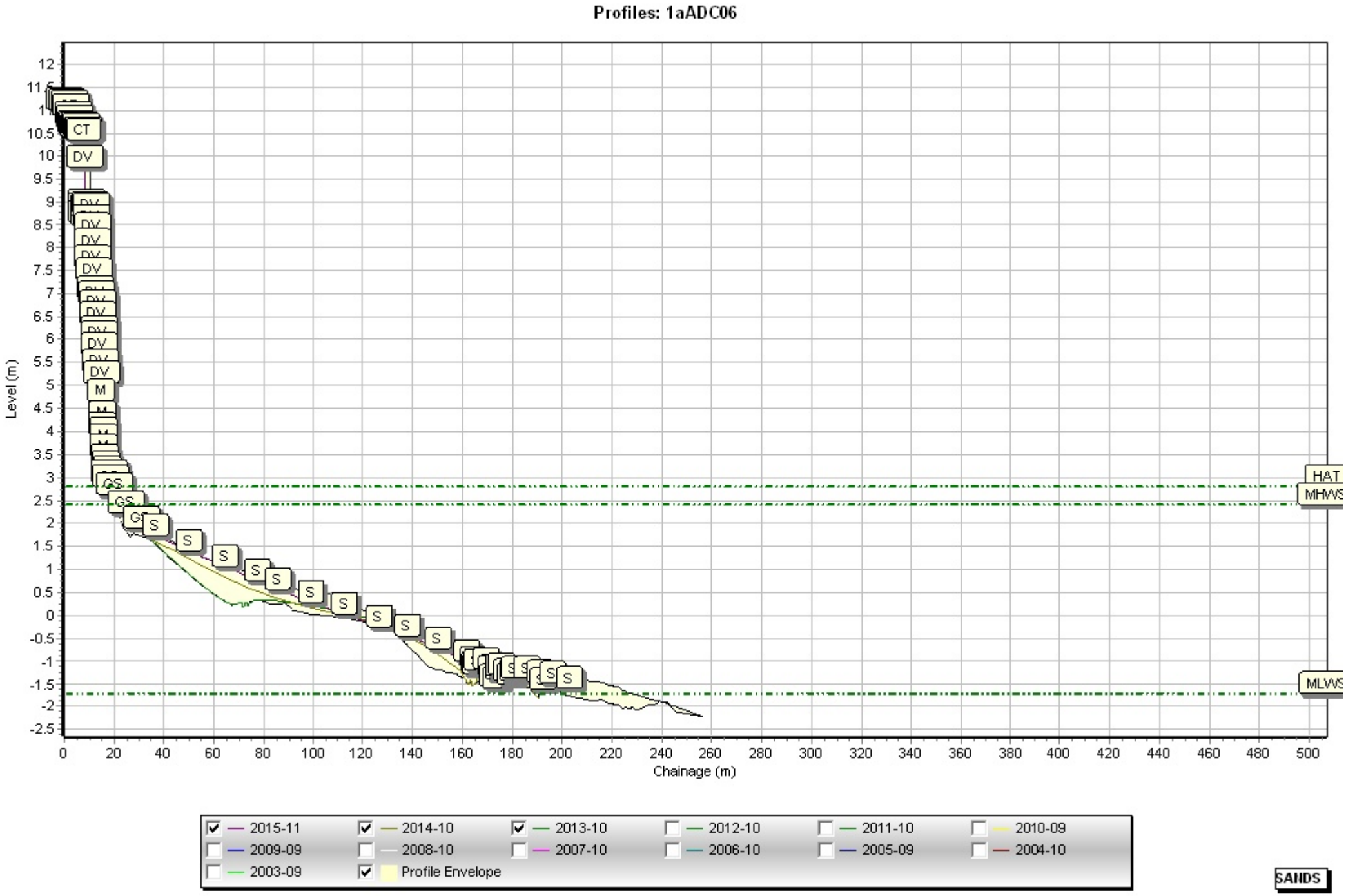

Profiles: 1aADC03
Level (m)
Chainage (m)
DV
GR
S
HAT
MHWS
MLWS
2015-11
2014-10
2013-10
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

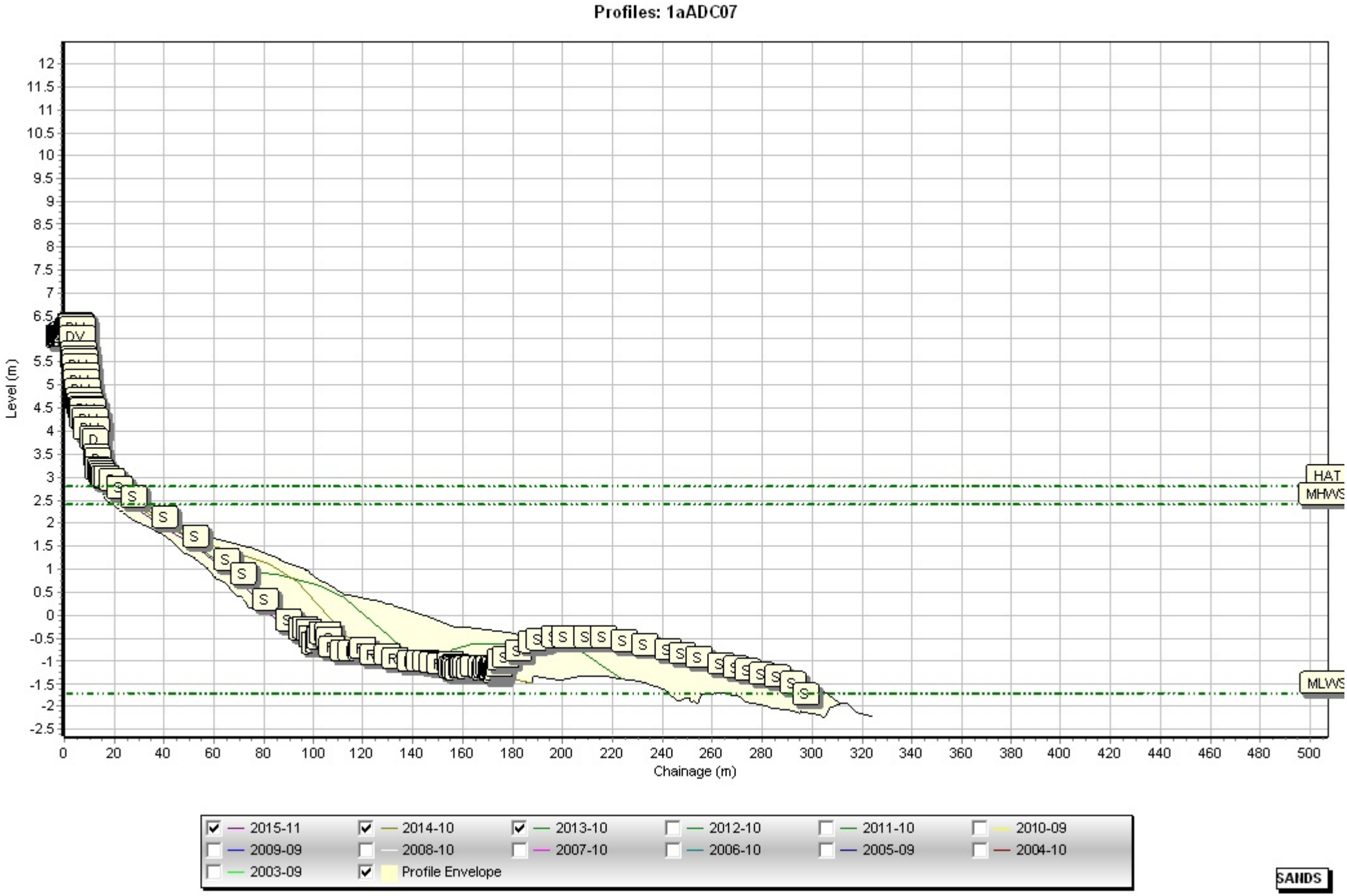

Profiles: 1aADC04
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-10
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

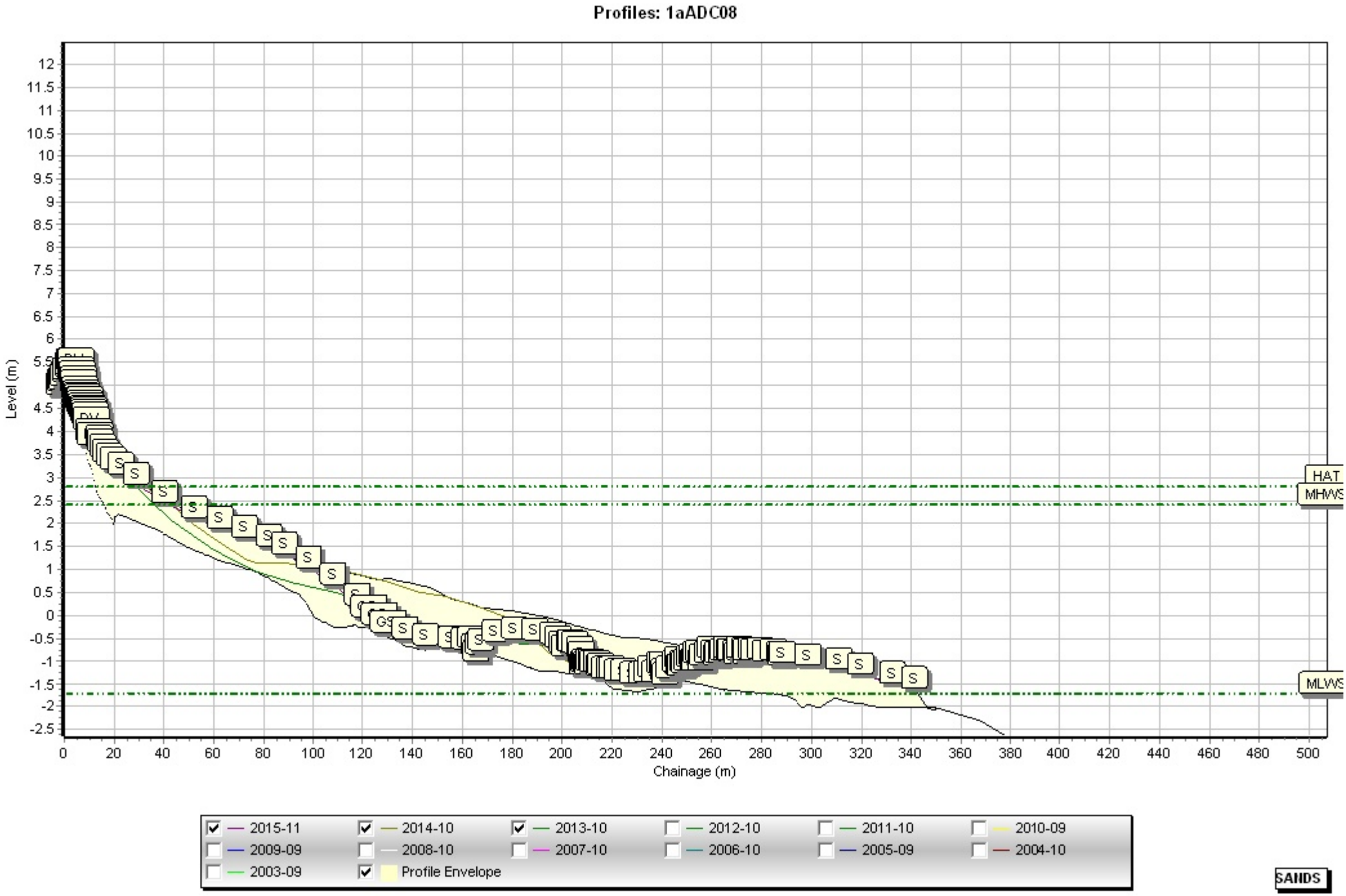

Profiles: 1aADC04A
Level (m)
Chainage (m)
HAT
MHWS
2015-09
2014-10
2013-10
2012-10
2011-11
2010-10
2009-09
2008-10
2007-10
Profile Envelope
SANDS

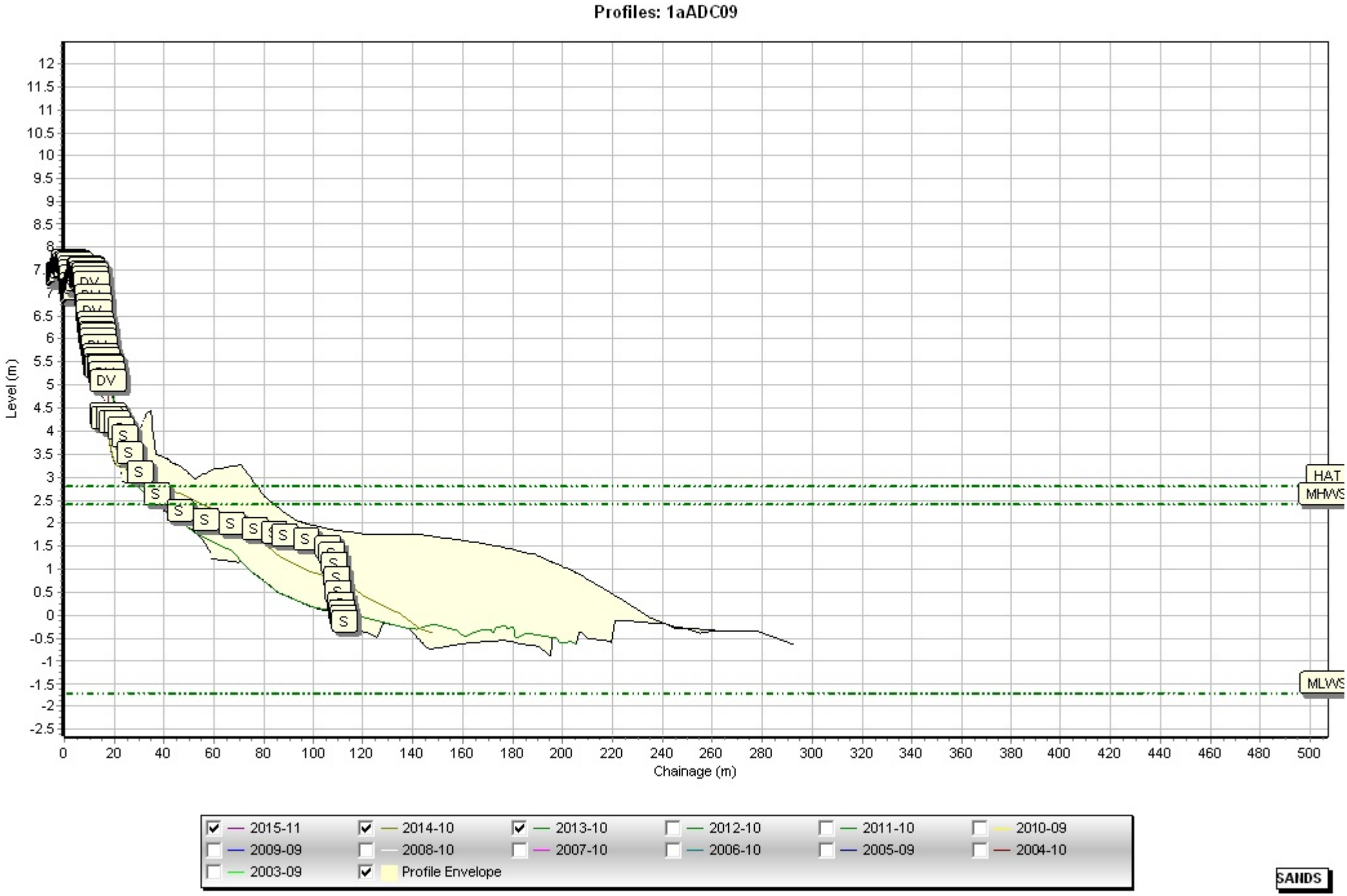

Profiles: 1aADC04B
Level (m)
Chainage (m)
HAT
MHWS
2015-09
2014-10
2013-10
2012-10
2011-11
2010-10
2009-09
2008-10
2007-10
Profile Envelope
SANDS

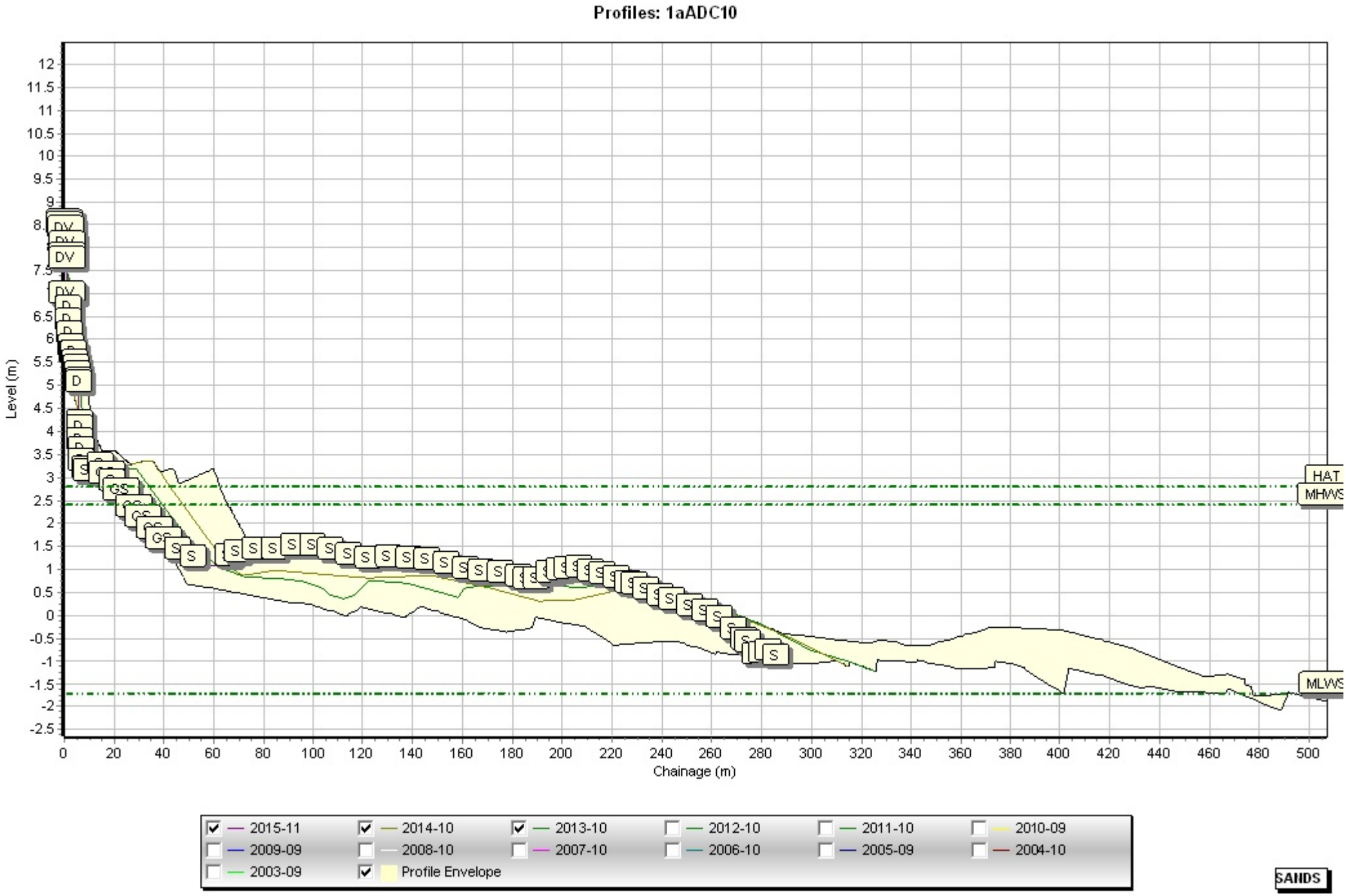

Profiles: 1aADC05
Level (m)
Chainage (m)
CT
DV
M
S
HAT
MHWS
MLWS
2015-11
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

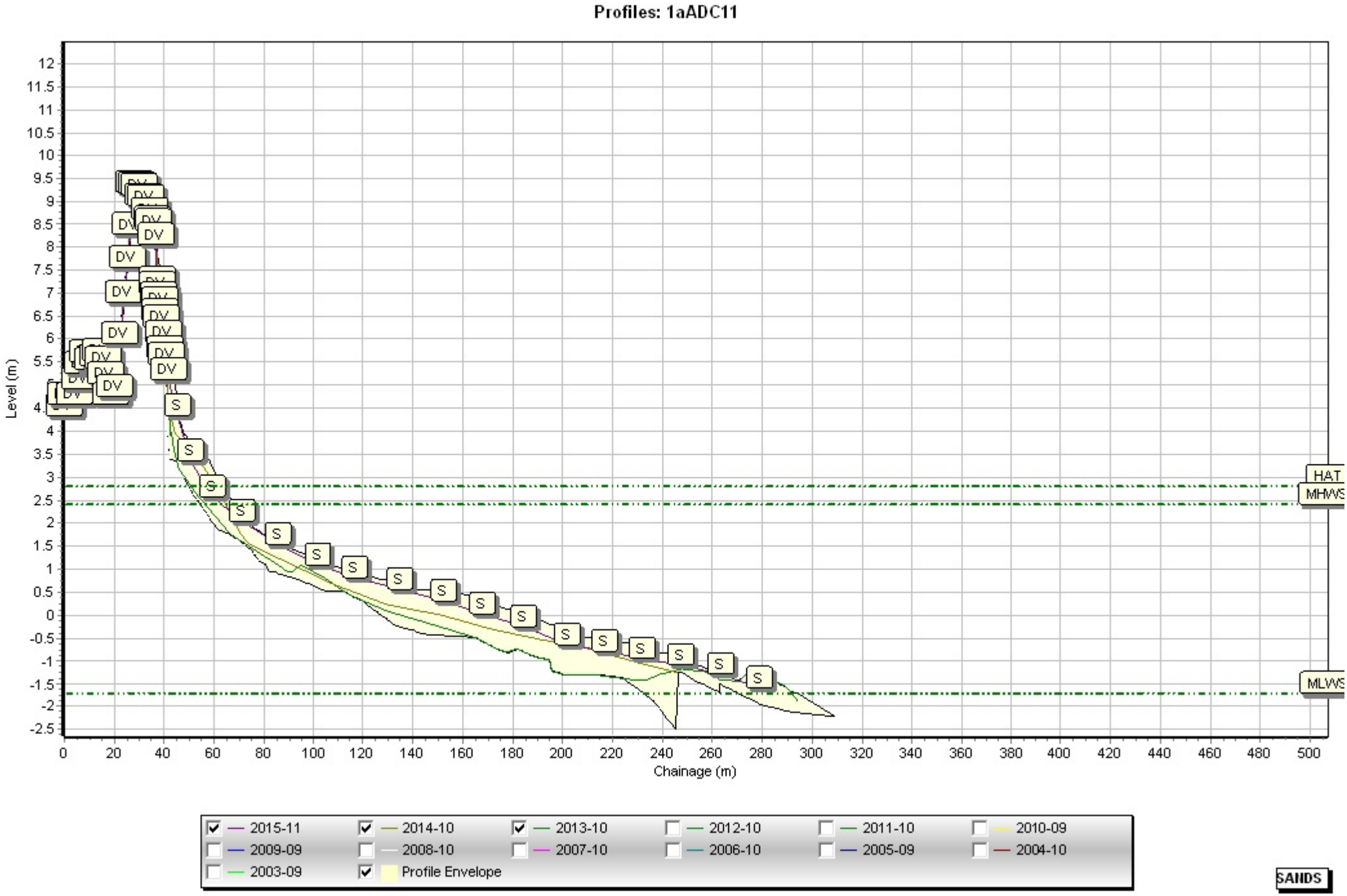

Profiles: 1aADC06
Level (m)
Chainage (m)
CT
DV
M
GS
S
HAT
MHWS
MLWS
2015-11
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

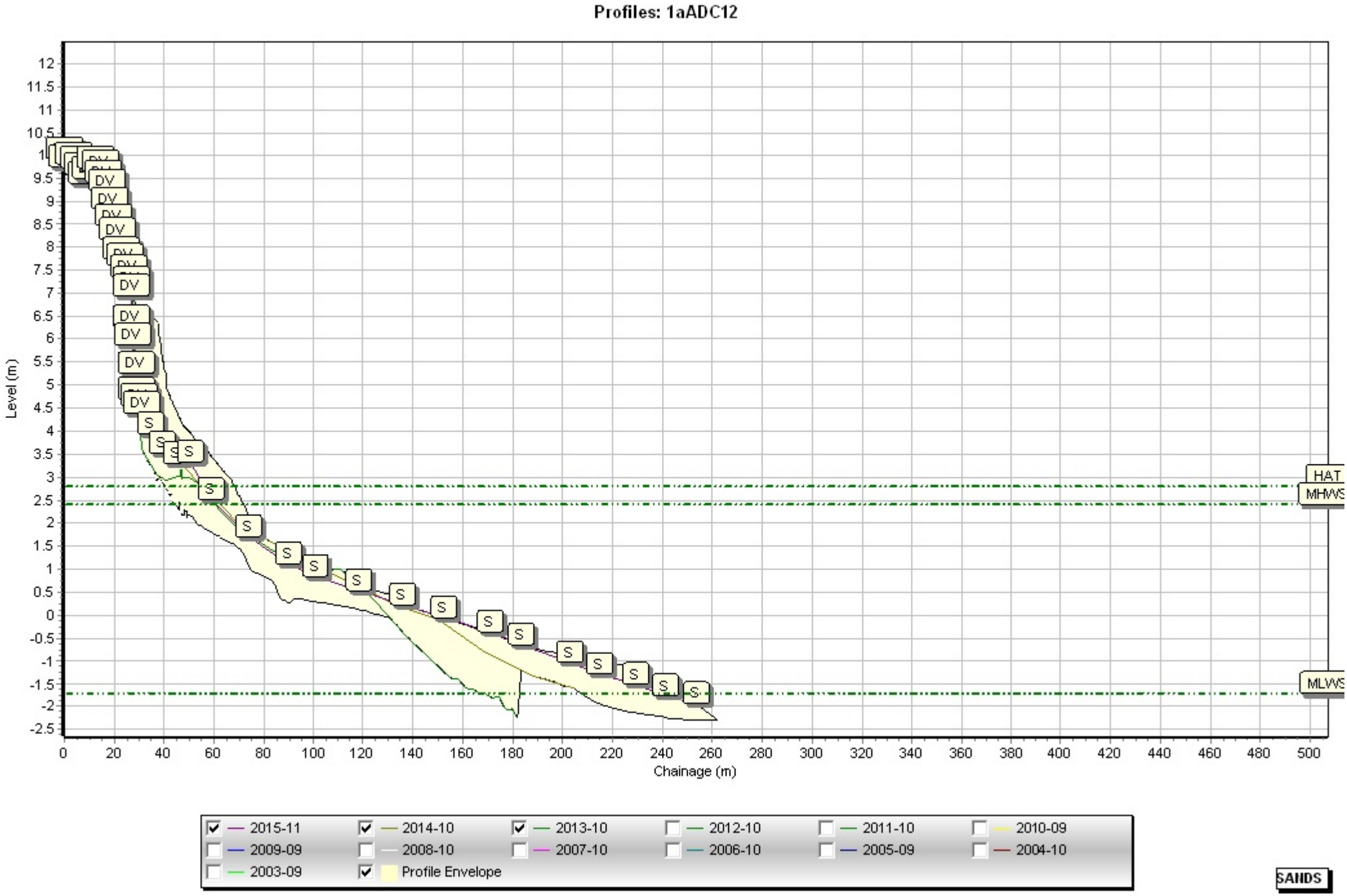

Profiles: 1aADC07
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

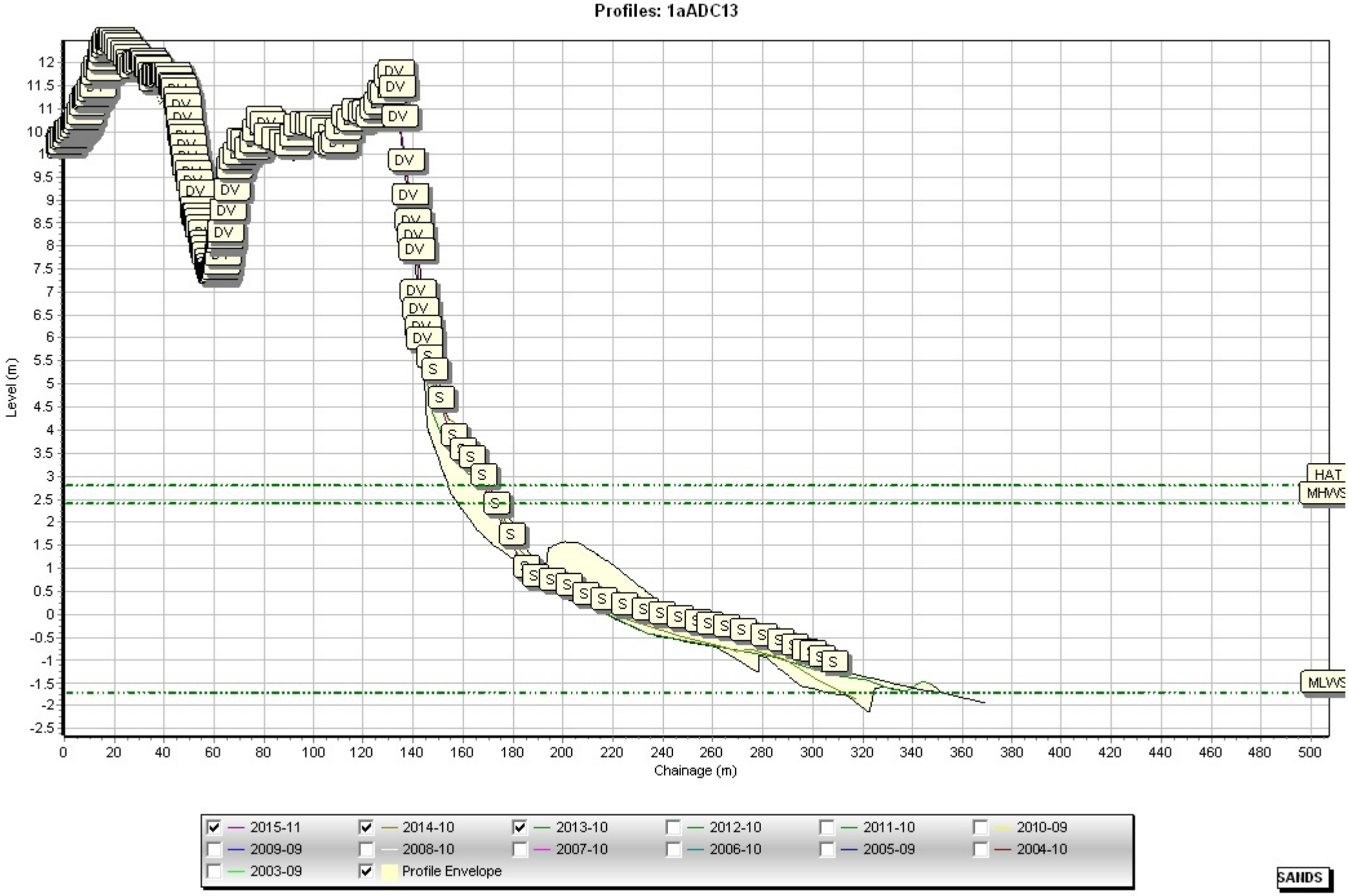

Profiles: 1aADC08
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

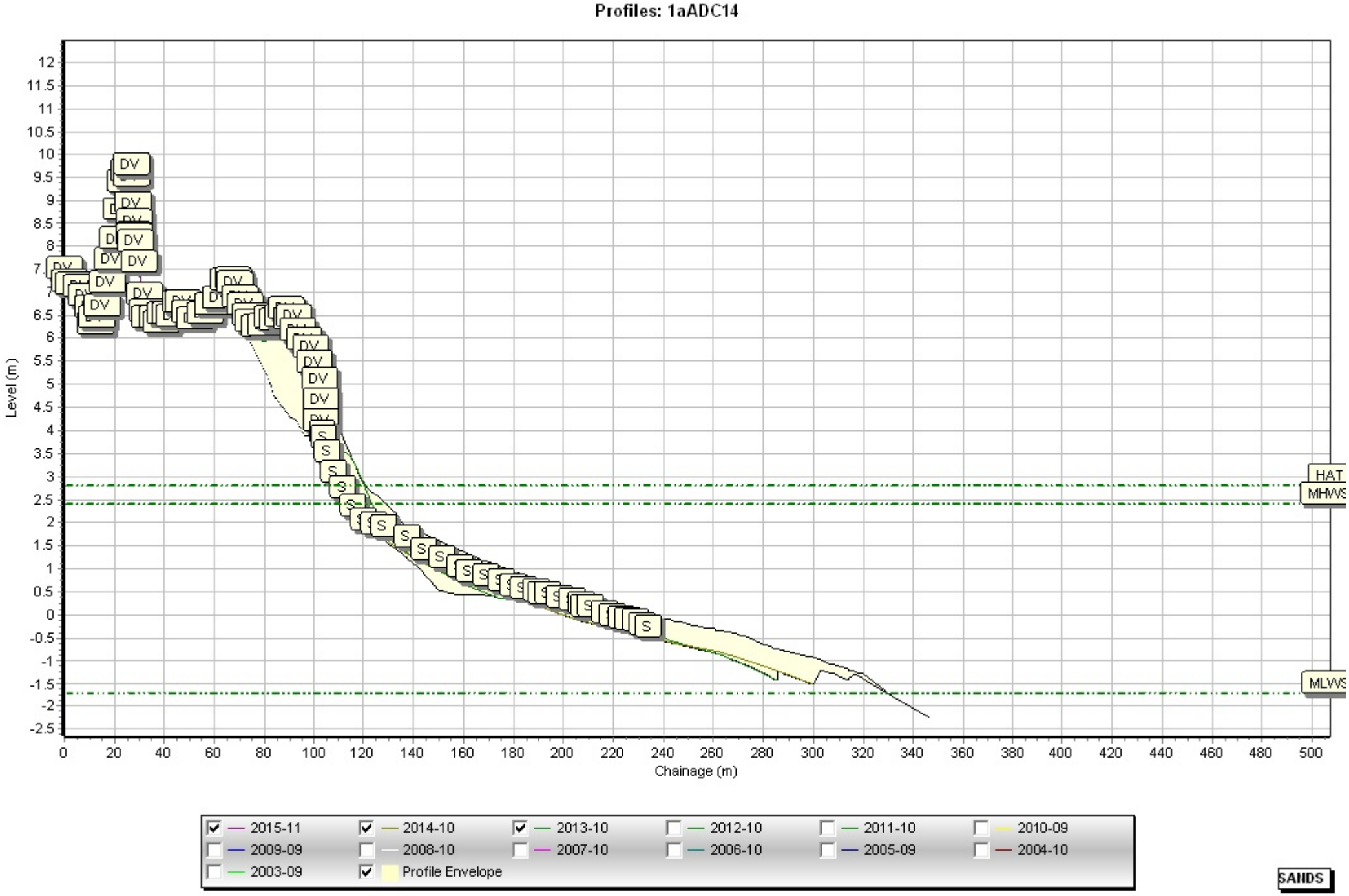

Profiles: 1aADC09
Level (m)
Chainage (m)
DV
S
HAT
MHWS
MLWS
2015-11
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

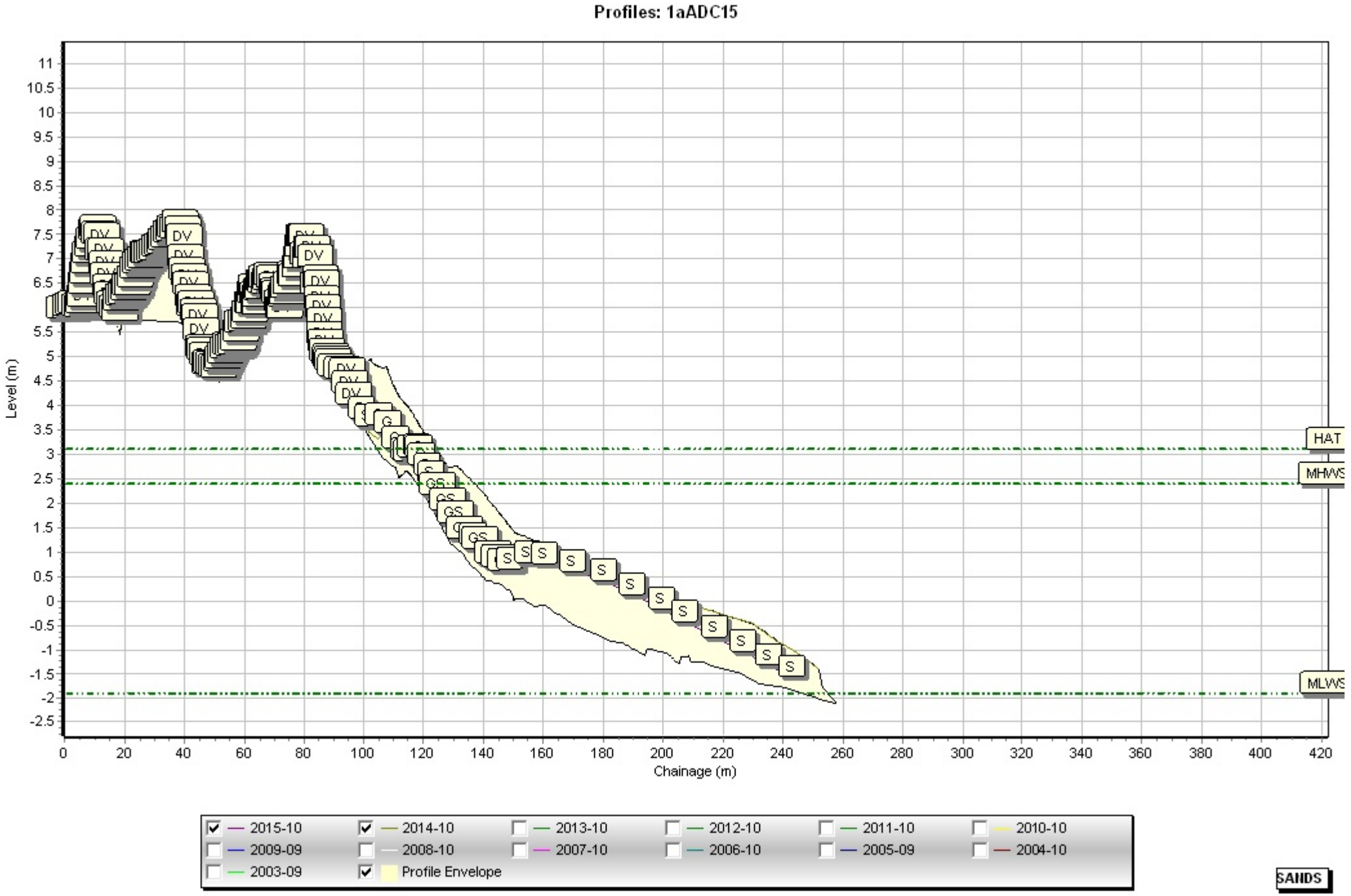

Profiles: 1aADC10
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

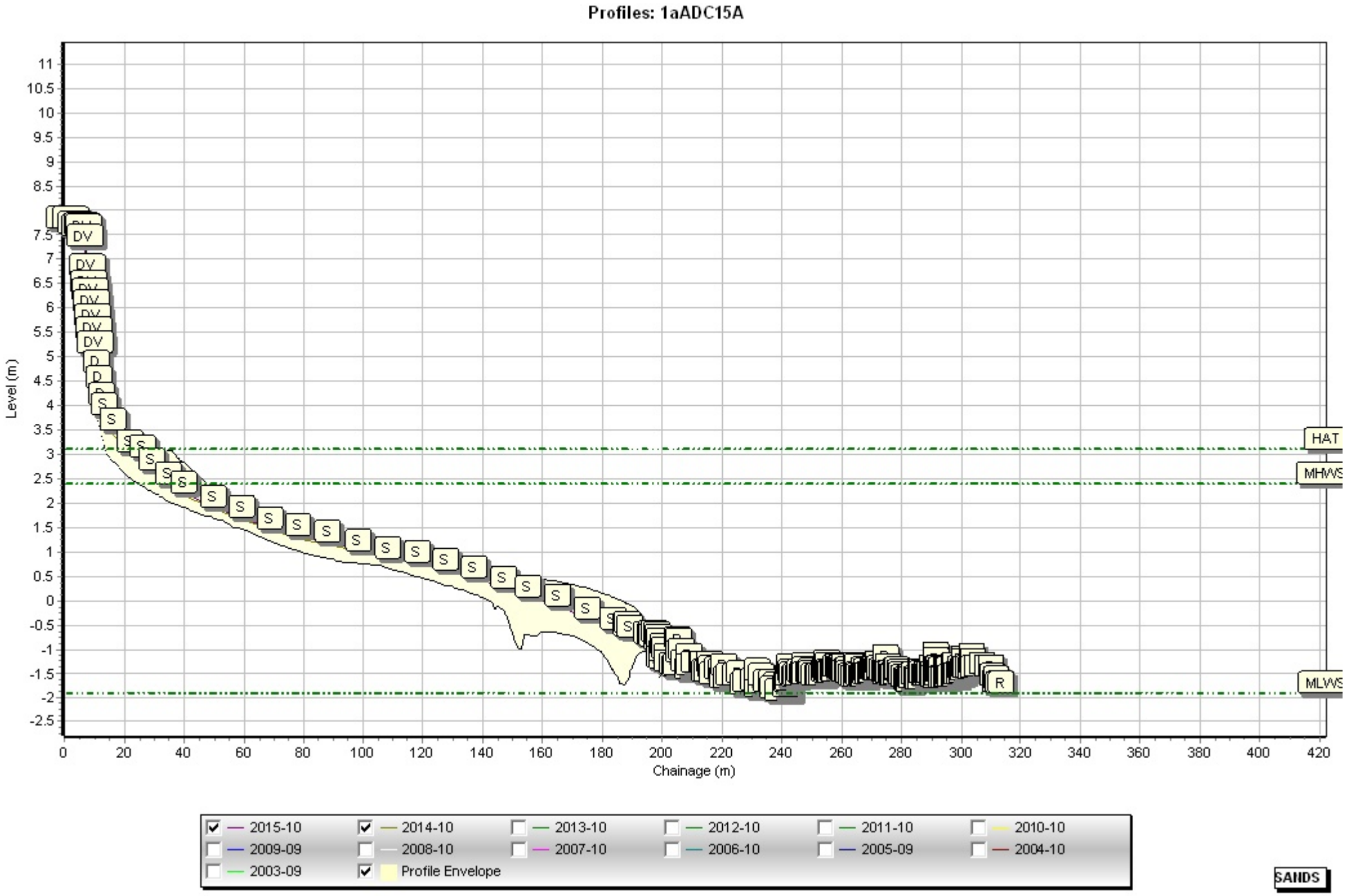

Profiles: 1aADC11
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

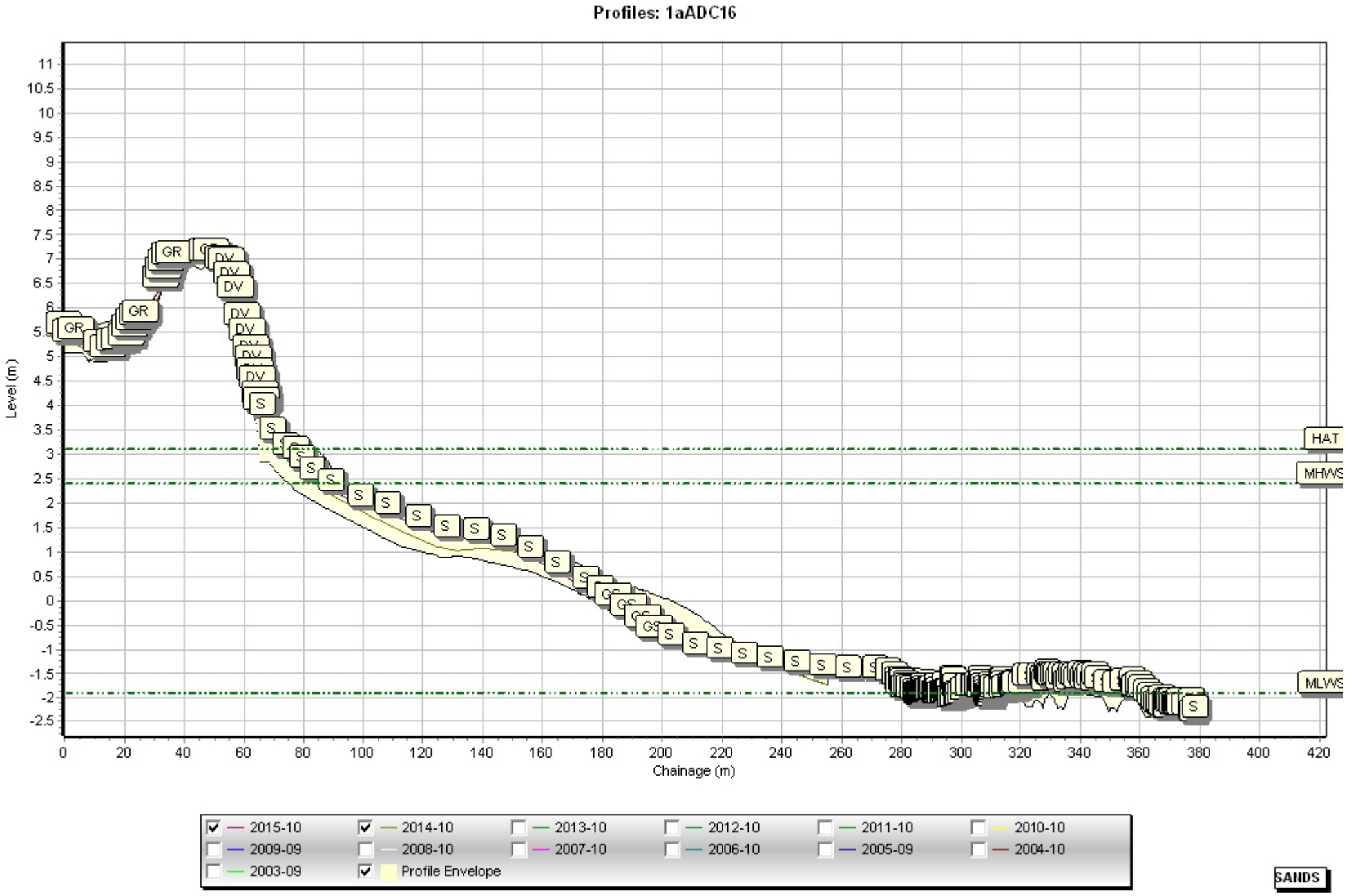

Profiles: 1aADC12
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

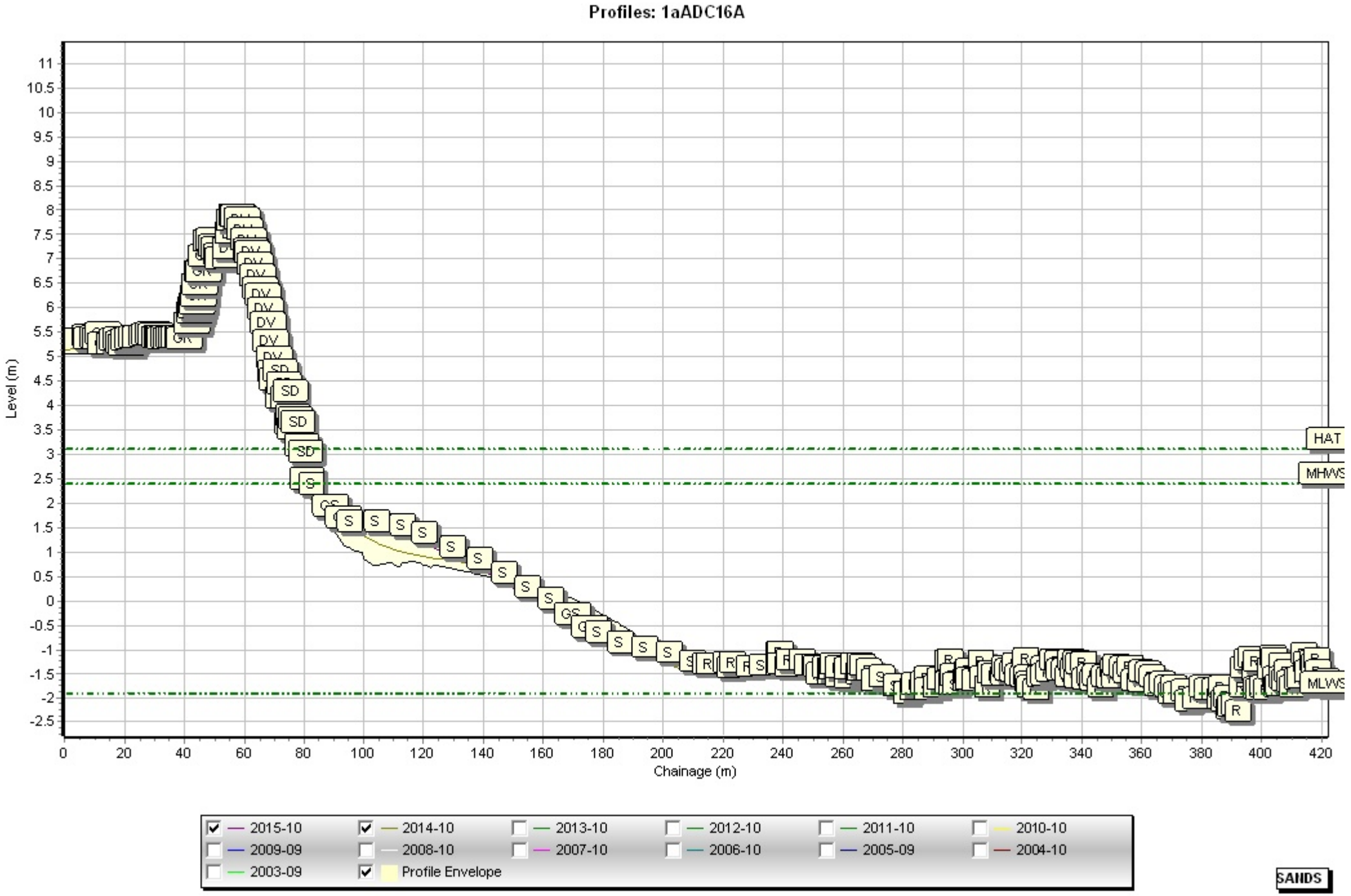

Profiles: 1aADC13
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SAINDS

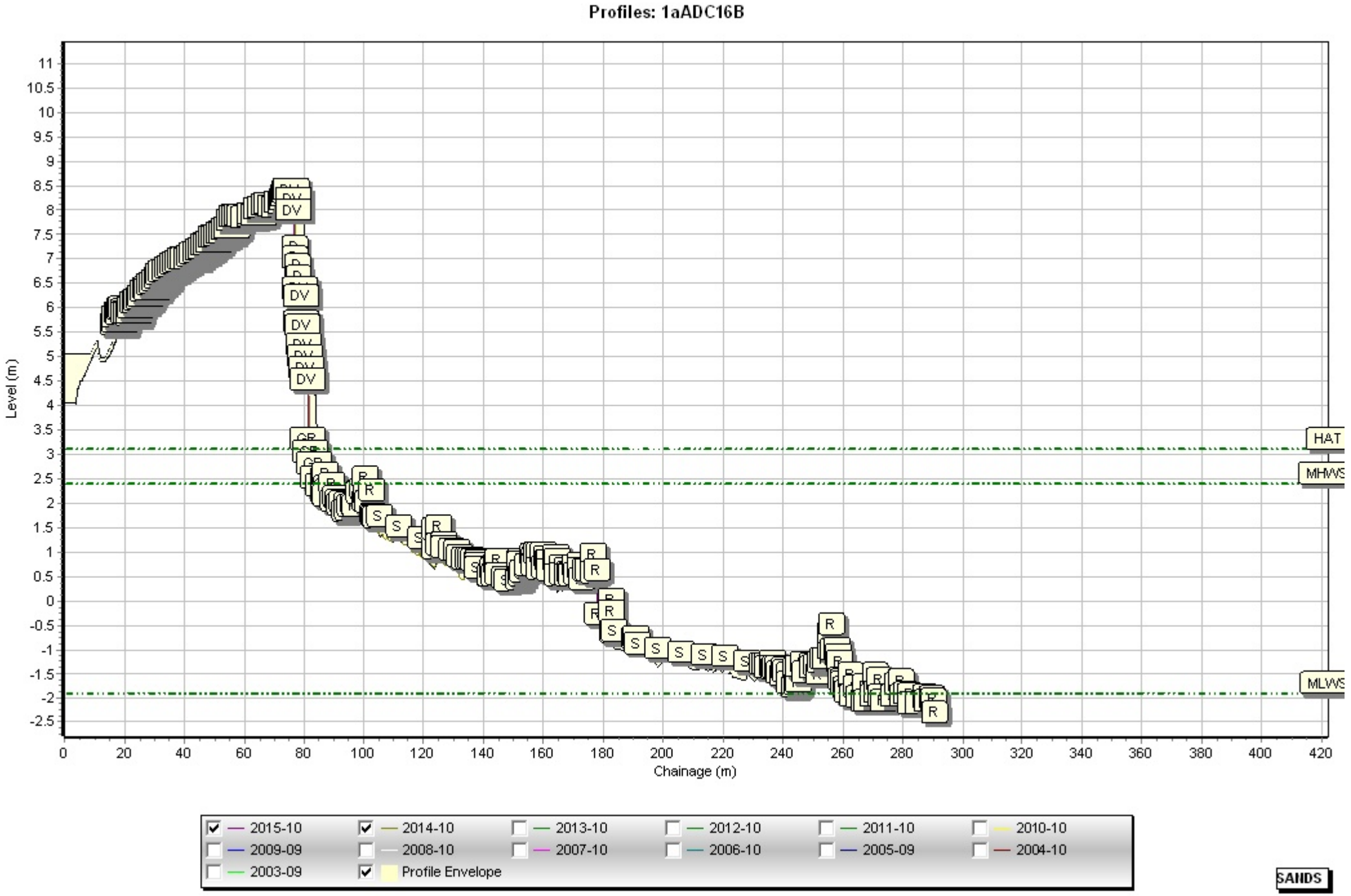

Profiles: 1aADC14
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

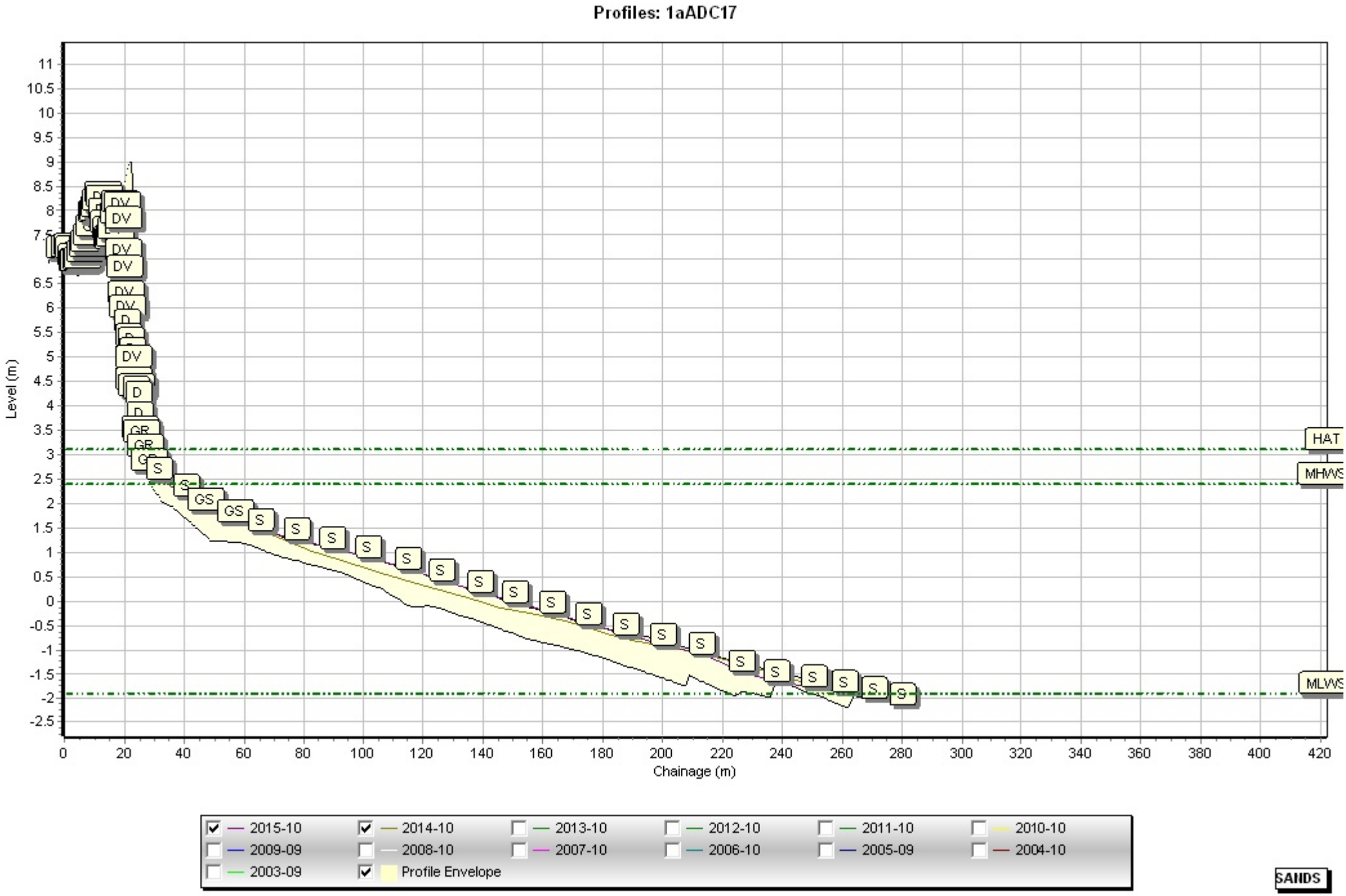

Profiles: 1aADC15
Level (m)
Chainage (m)
HAT
MHWS
MLWS
DV
GS
S
2015-10
2014-10
2013-10
2012-10
2011-10
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

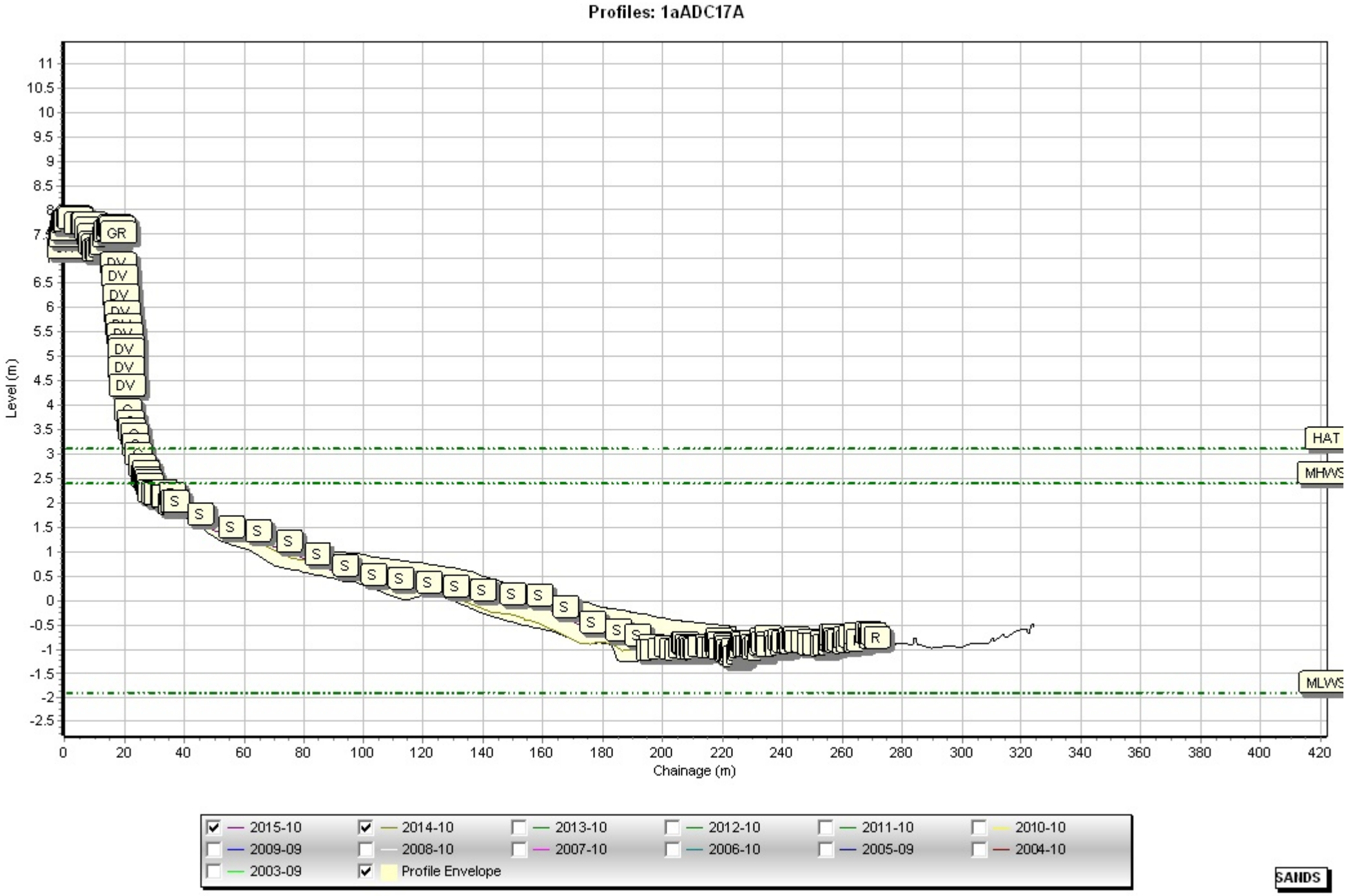

Profiles: 1aADC15A
Level (m)
Chainage (m)
HAT
MHWS
MLWS
DV
S
R
2015-10
2014-10
2013-10
2012-10
2011-10
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

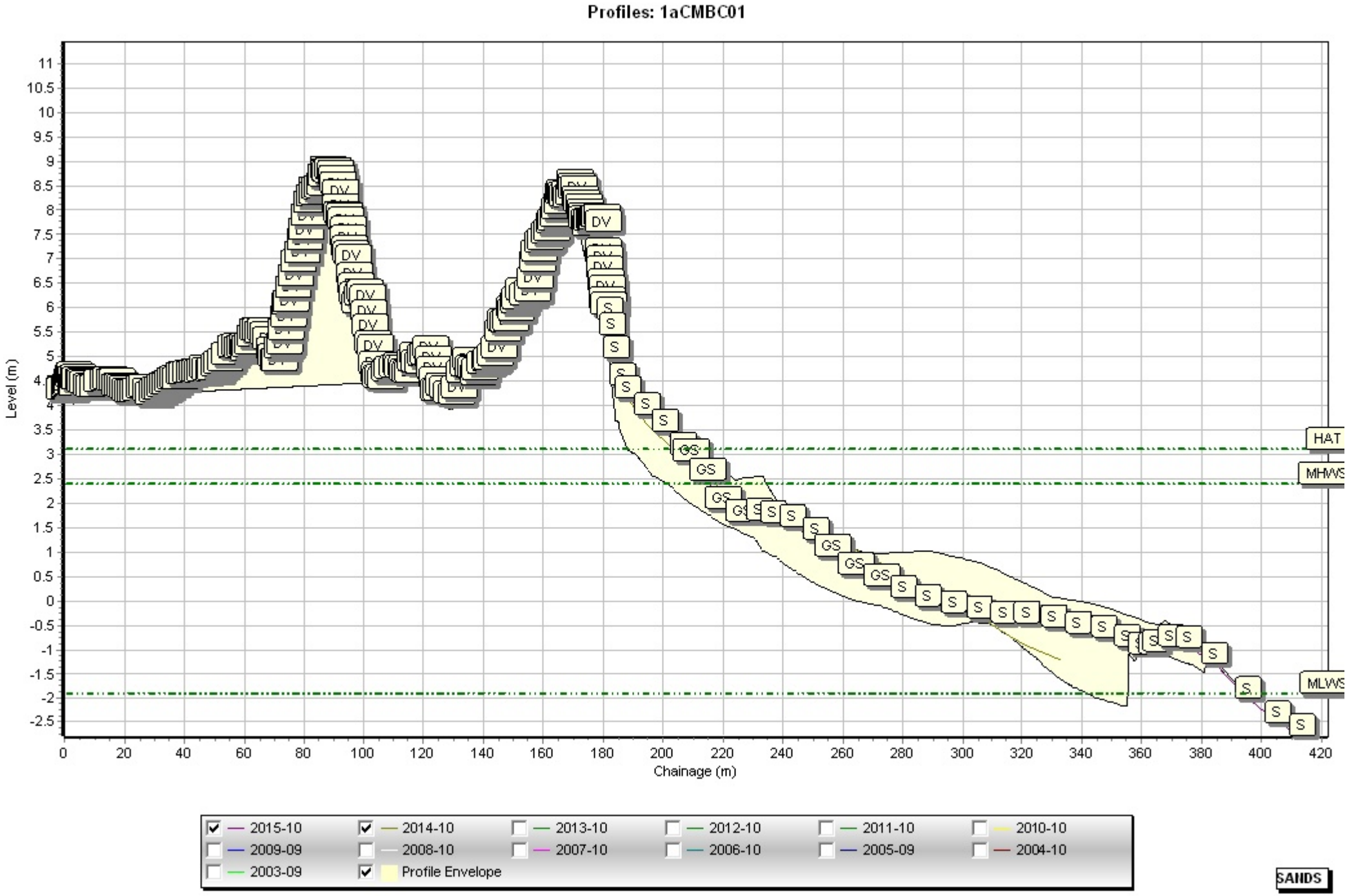

Profiles: 1aADC16
Level (m)
Chainage (m)
HAT
MHWS
MLWS
GR
DV
S
2015-10
2014-10
2013-10
2012-10
2011-10
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

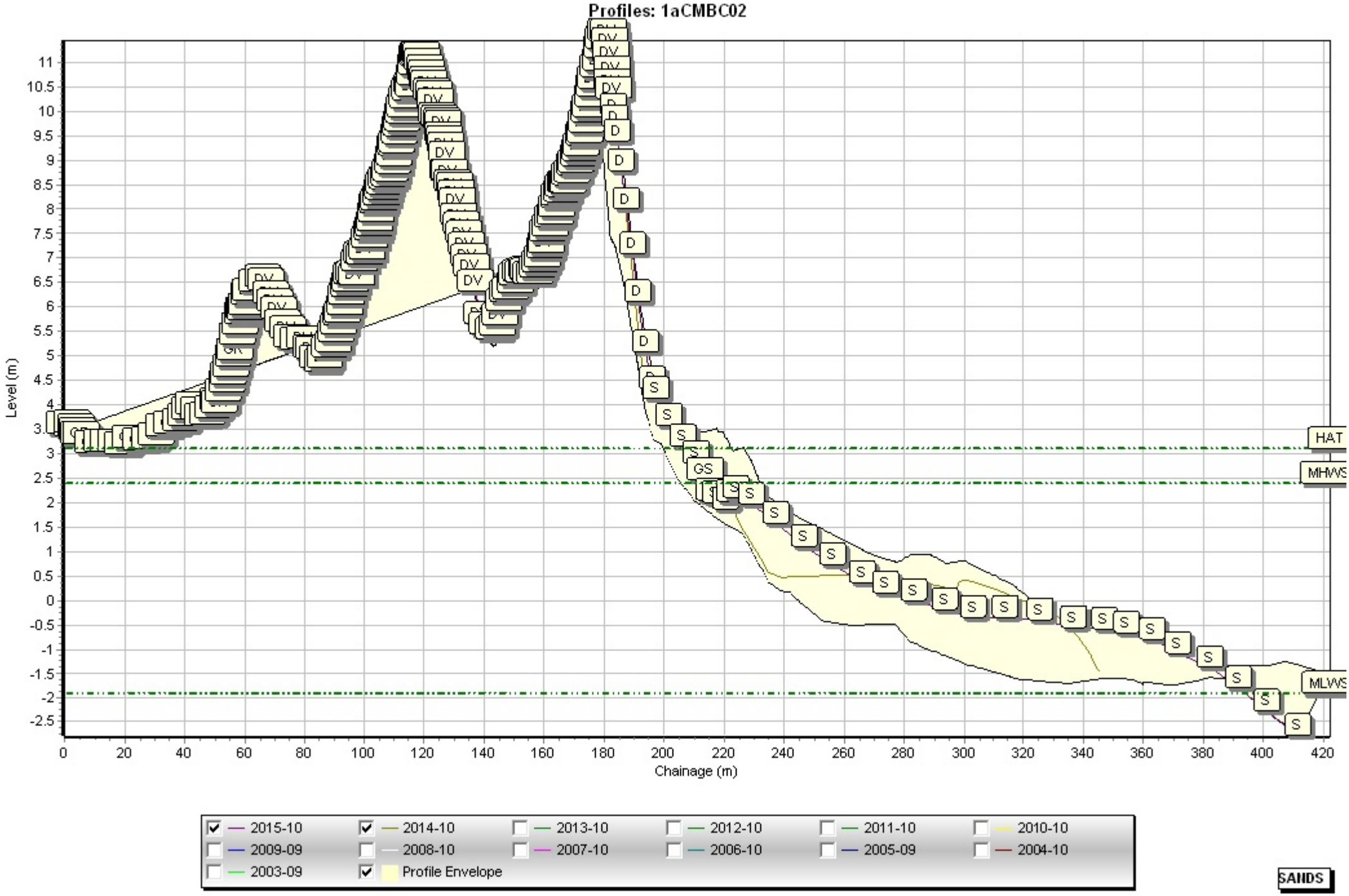

Profiles: 1aADC16A
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-10
2014-10
2013-10
2012-10
2011-10
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SAINDS

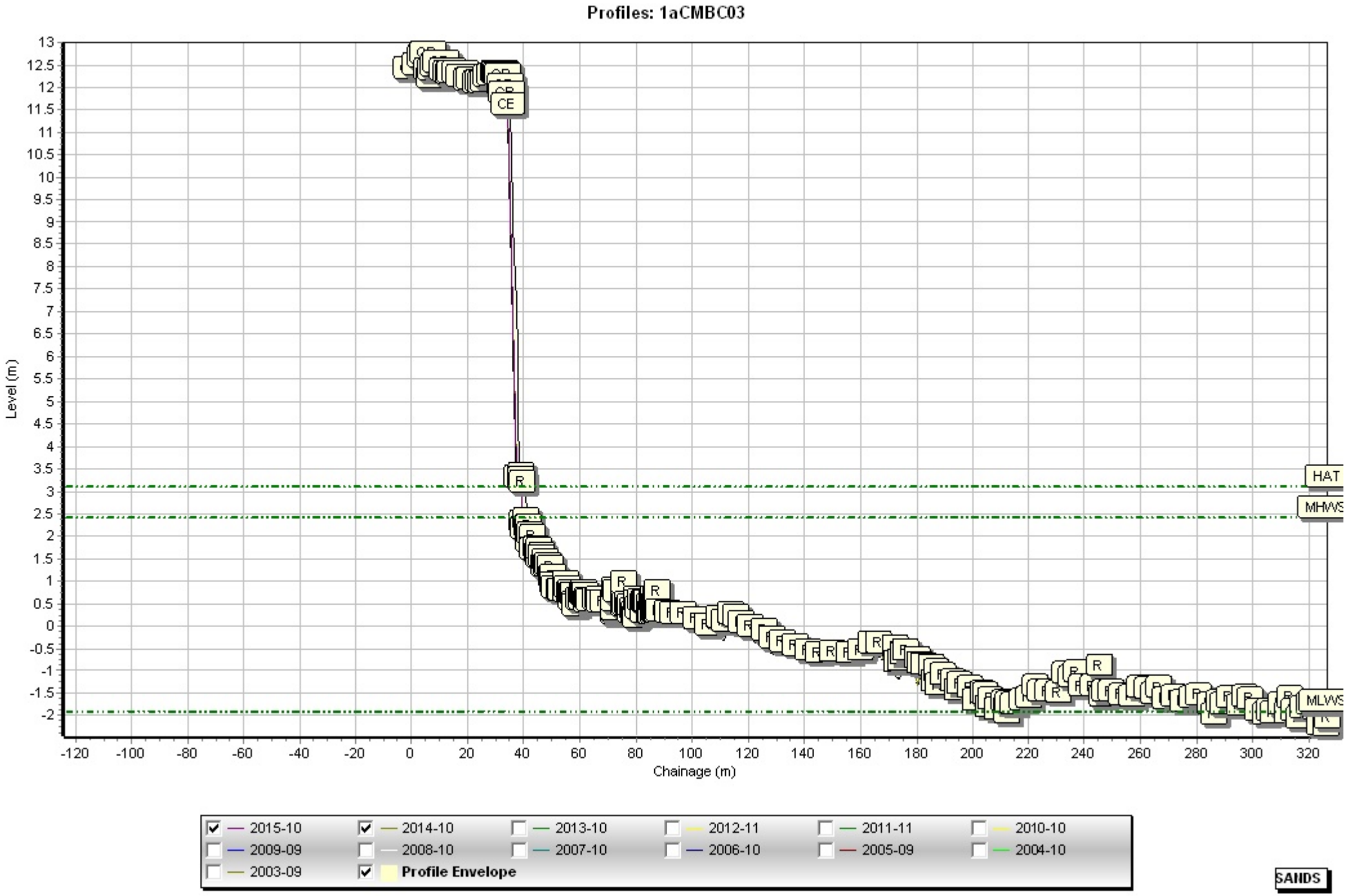

Profiles: 1aADC16B
Level (m)
Chainage (m)
HAT
MHWS
MLWS
DV
R
S
2015-10
2014-10
2013-10
2012-10
2011-10
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

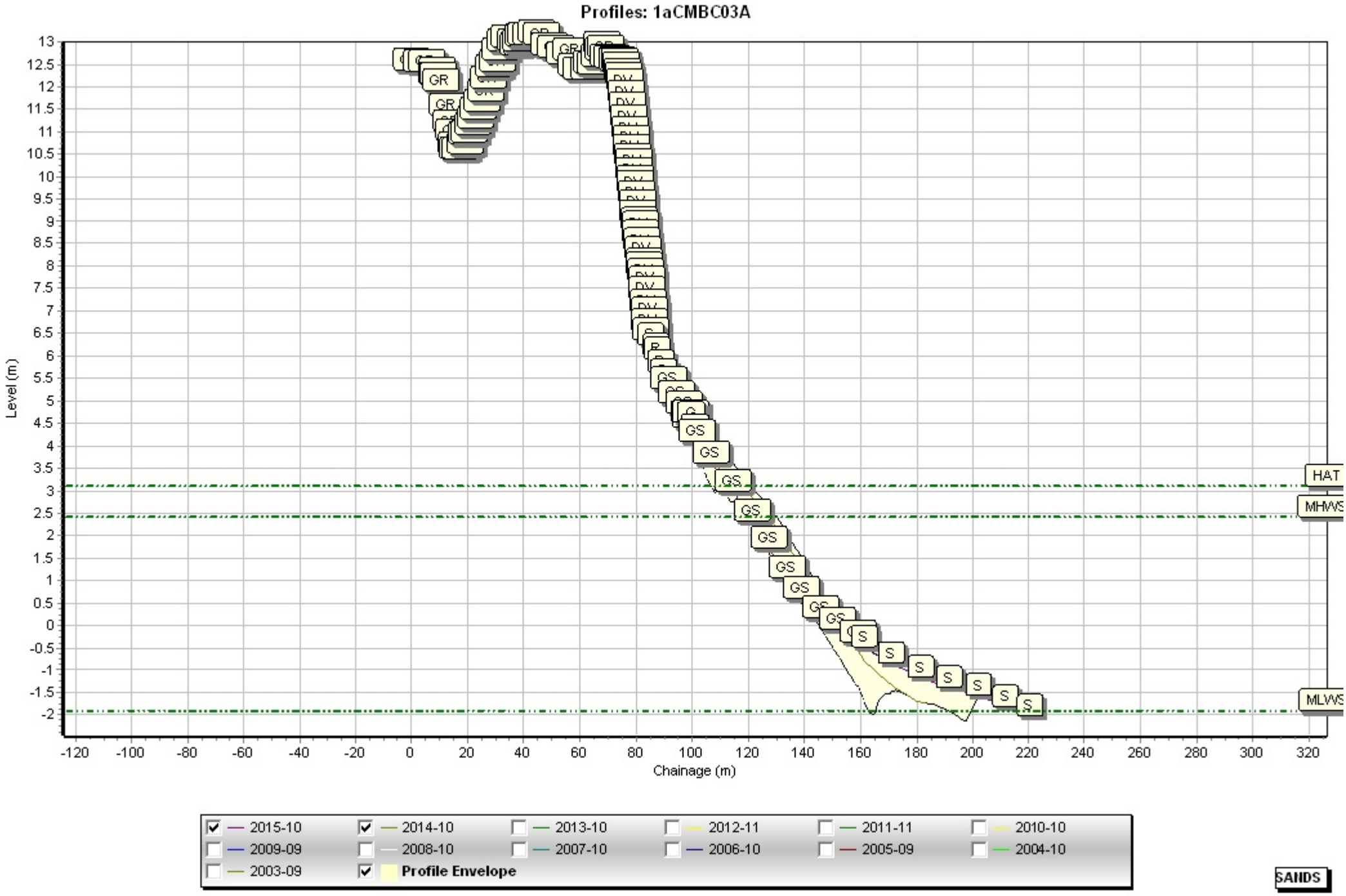

Profiles: 1aADC17
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-10
2014-10
2013-10
2012-10
2011-10
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SAINDS

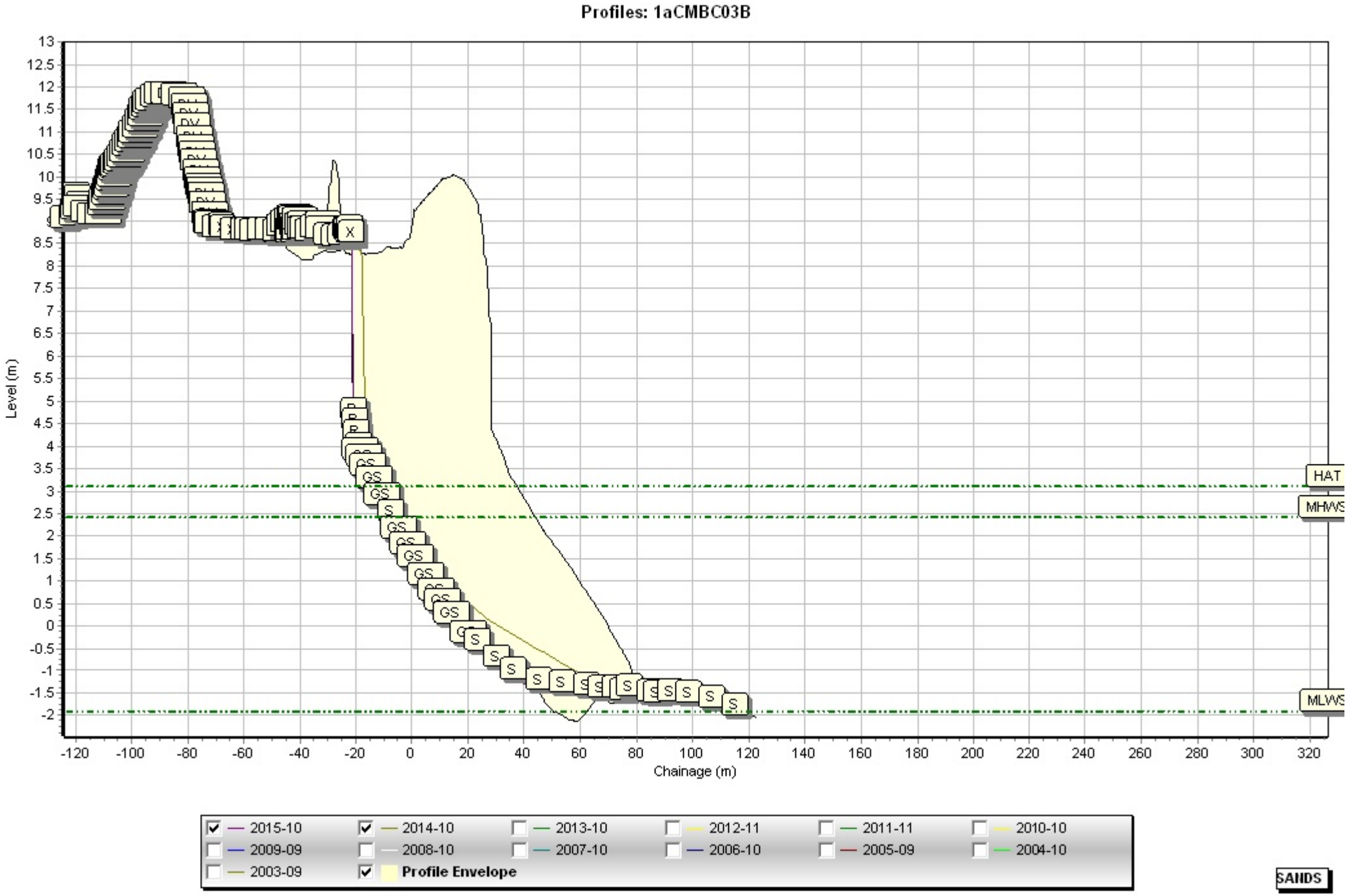

Profiles: 1aADC17A
Level (m)
Chainage (m)
GR
DV
S
R
HAT
MHWS
MLWS
2015-10
2014-10
2013-10
2012-10
2011-10
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

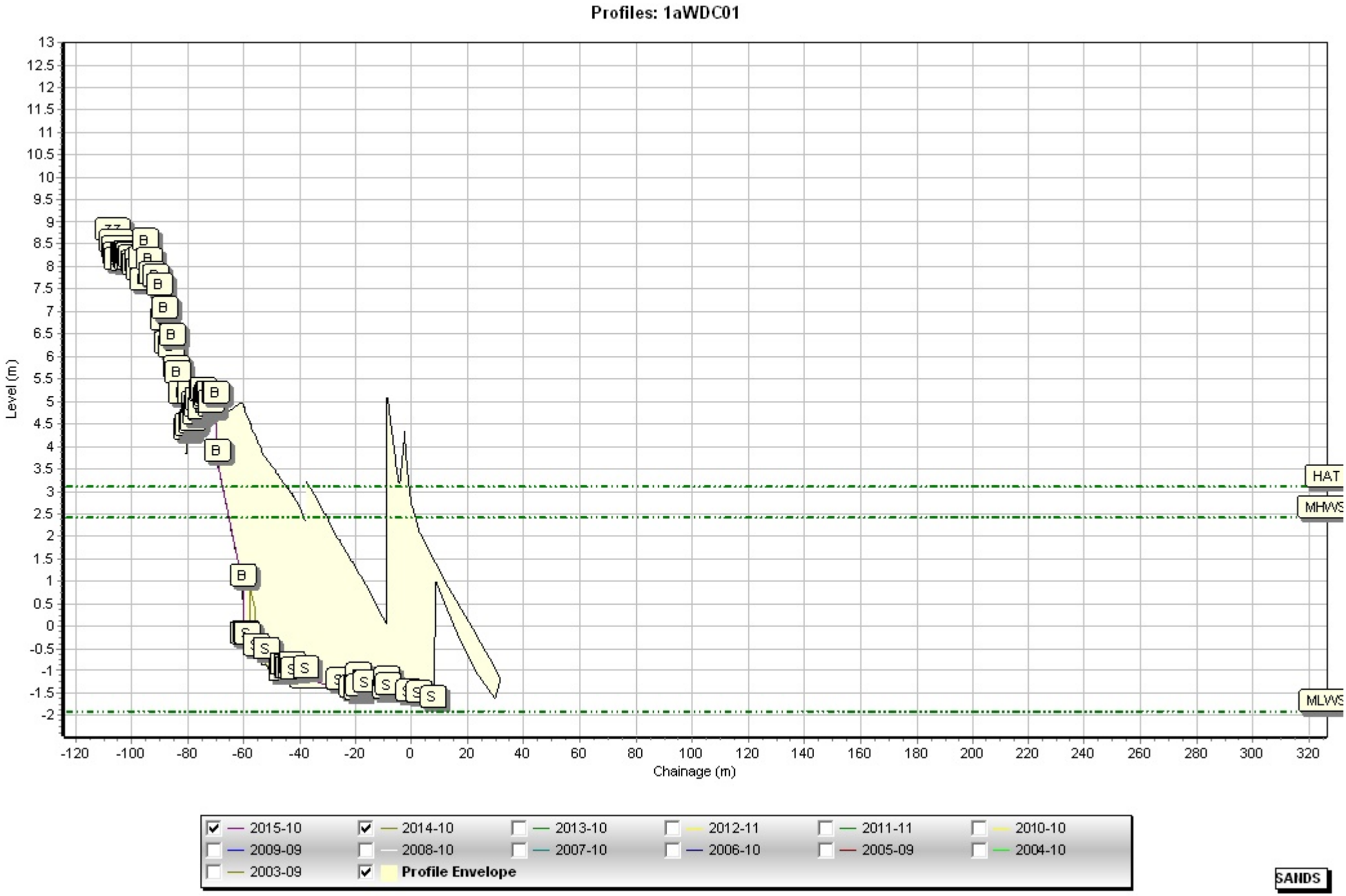

Profiles: 1aCMBC01
Level (m)
Chainage (m)
HAT
MHWS
MLWS
DV
S
GS
2015-10
2014-10
2013-10
2012-10
2011-10
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

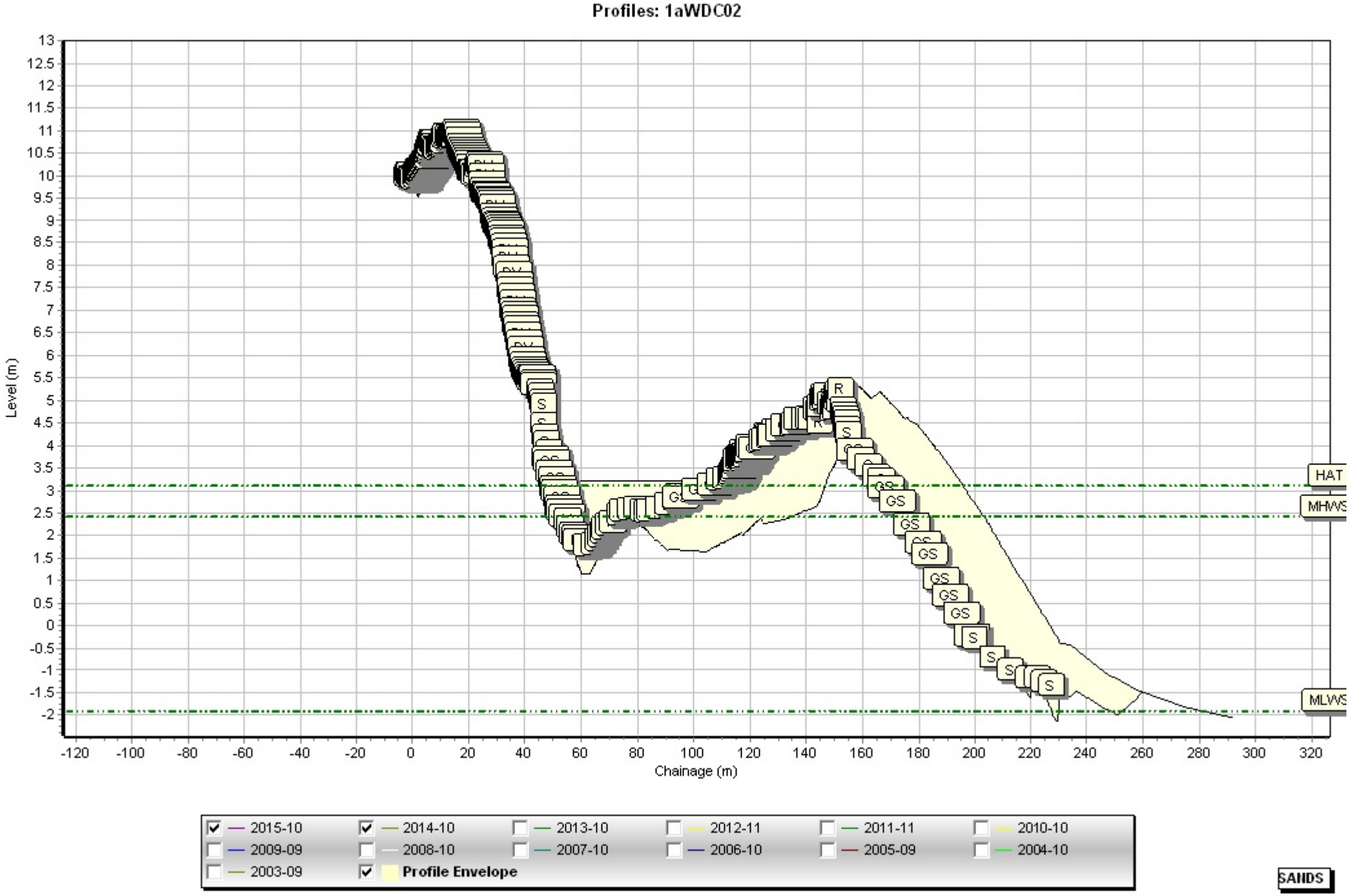

Profiles: 1aCMBC02
Level (m)
Chainage (m)
HAT
MHWS
MLWS
DV
D
S
GS
2015-10
2014-10
2013-10
2012-10
2011-10
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

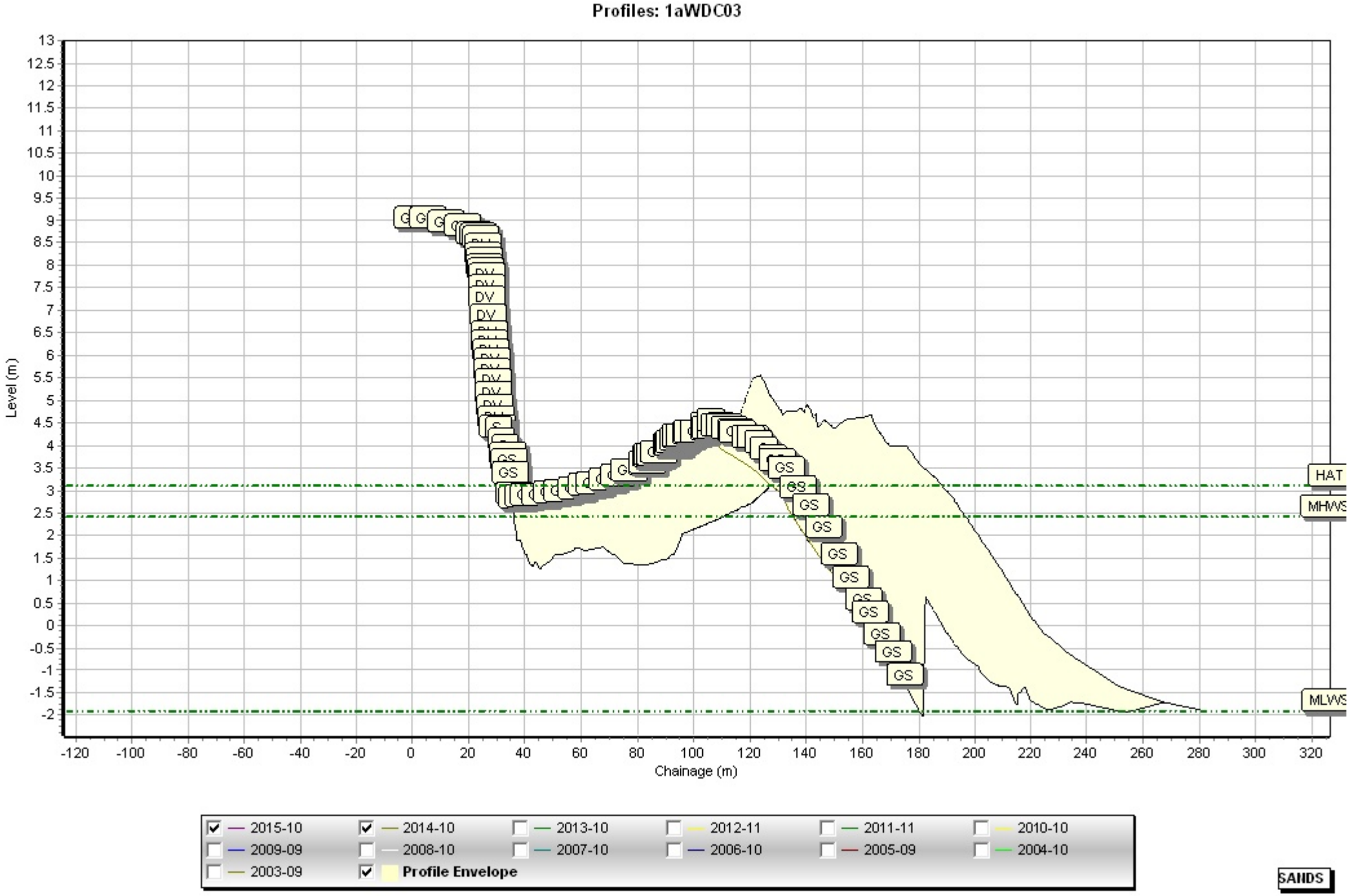

Profiles: 1aCMBC03
Level (m)
Chainage (m)
CE
R
HAT
MHWS
MLWS
2015-10
2014-10
2013-10
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SAIDS

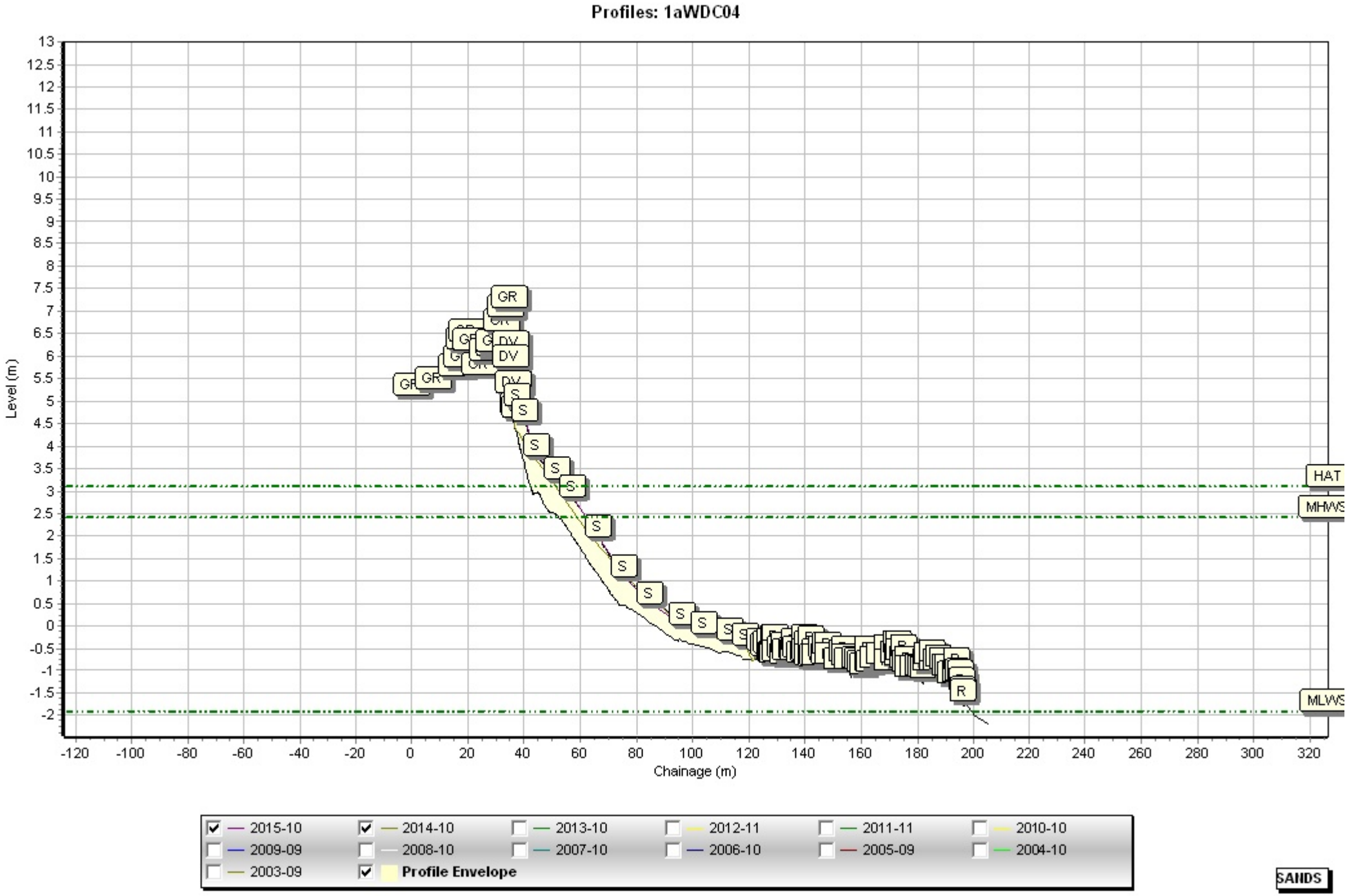

Profiles: 1aCMBC03A
Level (m)
Chainage (m)
GR
GS
S
HAT
MHWS
MLWS
2015-10
2014-10
2013-10
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

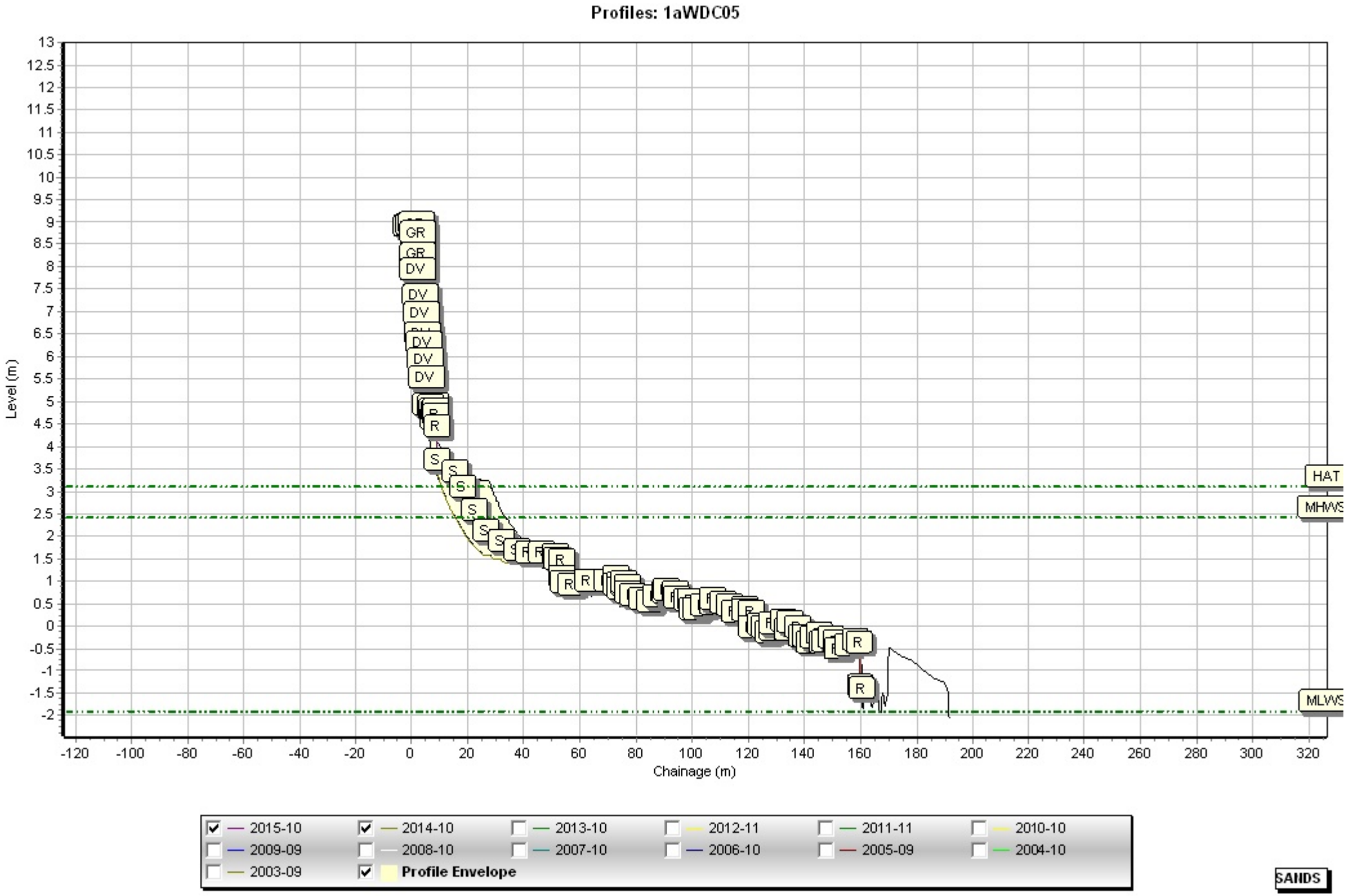

Profiles: 1aCMBC03B
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-10
2014-10
2013-10
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

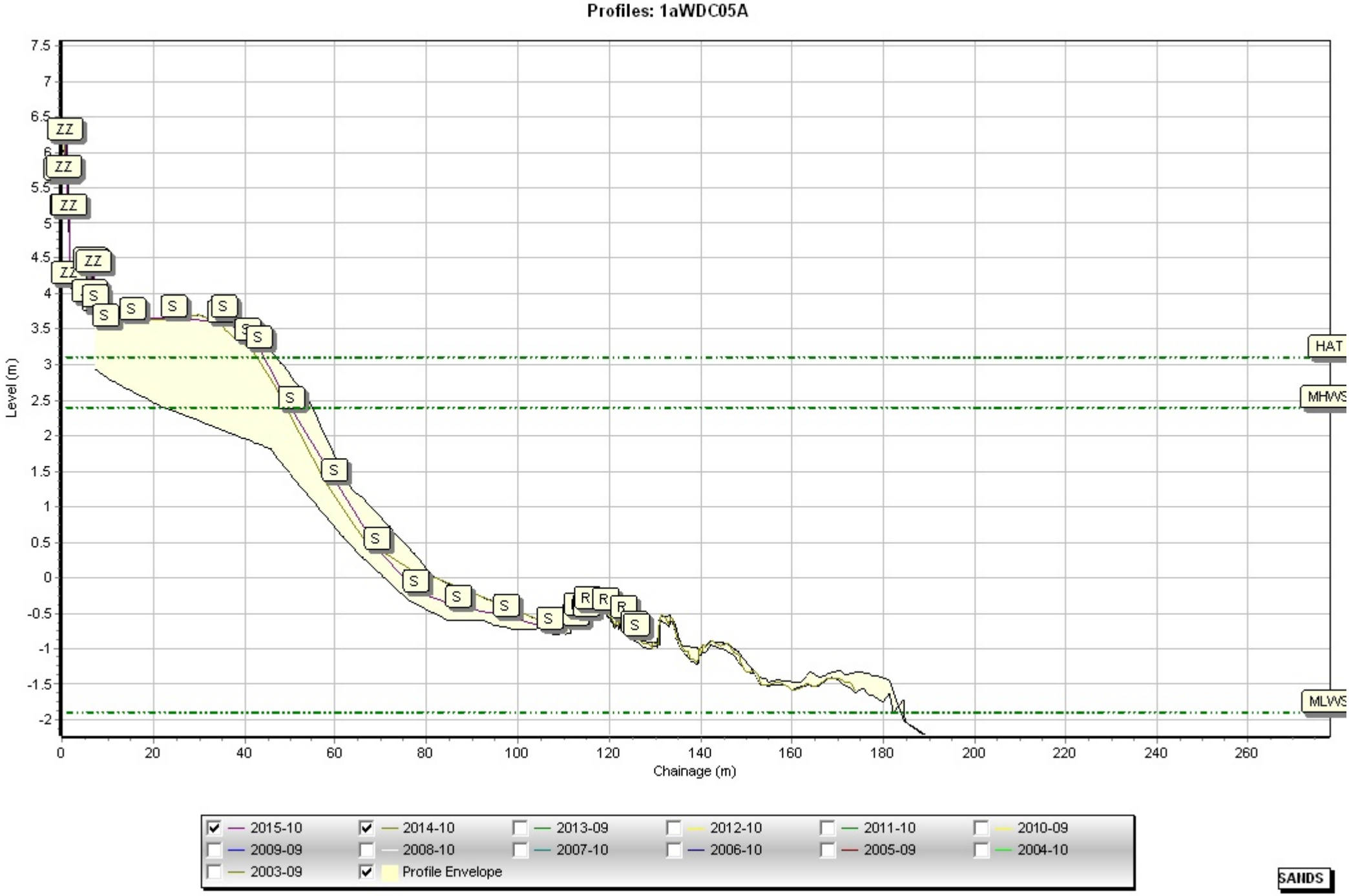

Profiles: 1aWDC01
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-10
2014-10
2013-10
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

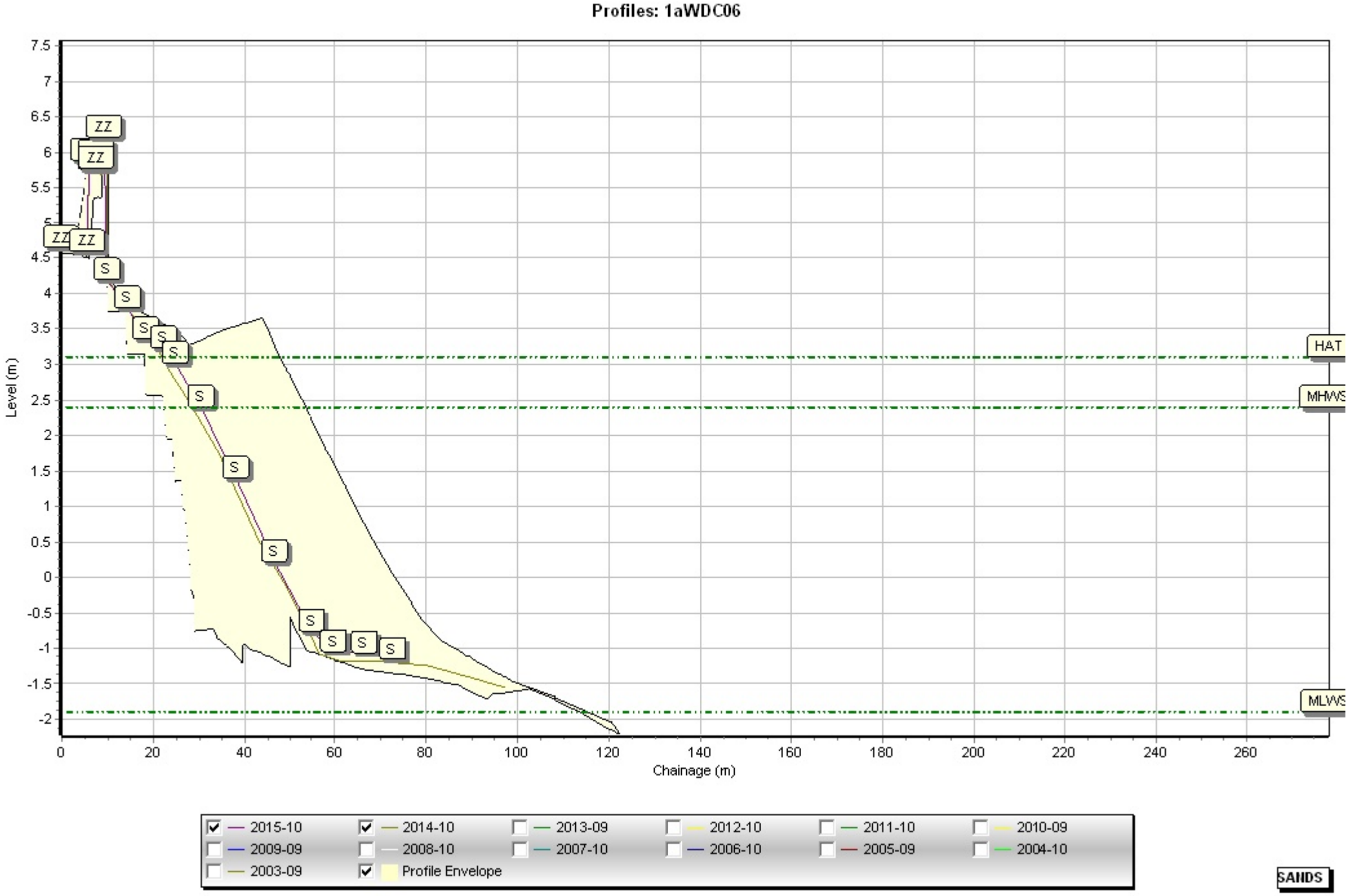

Profiles: 1aWDC02
Level (m)
Chainage (m)
HAT
MHWS
MLWS
R
S
GS
2015-10
2014-10
2013-10
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SAIDS

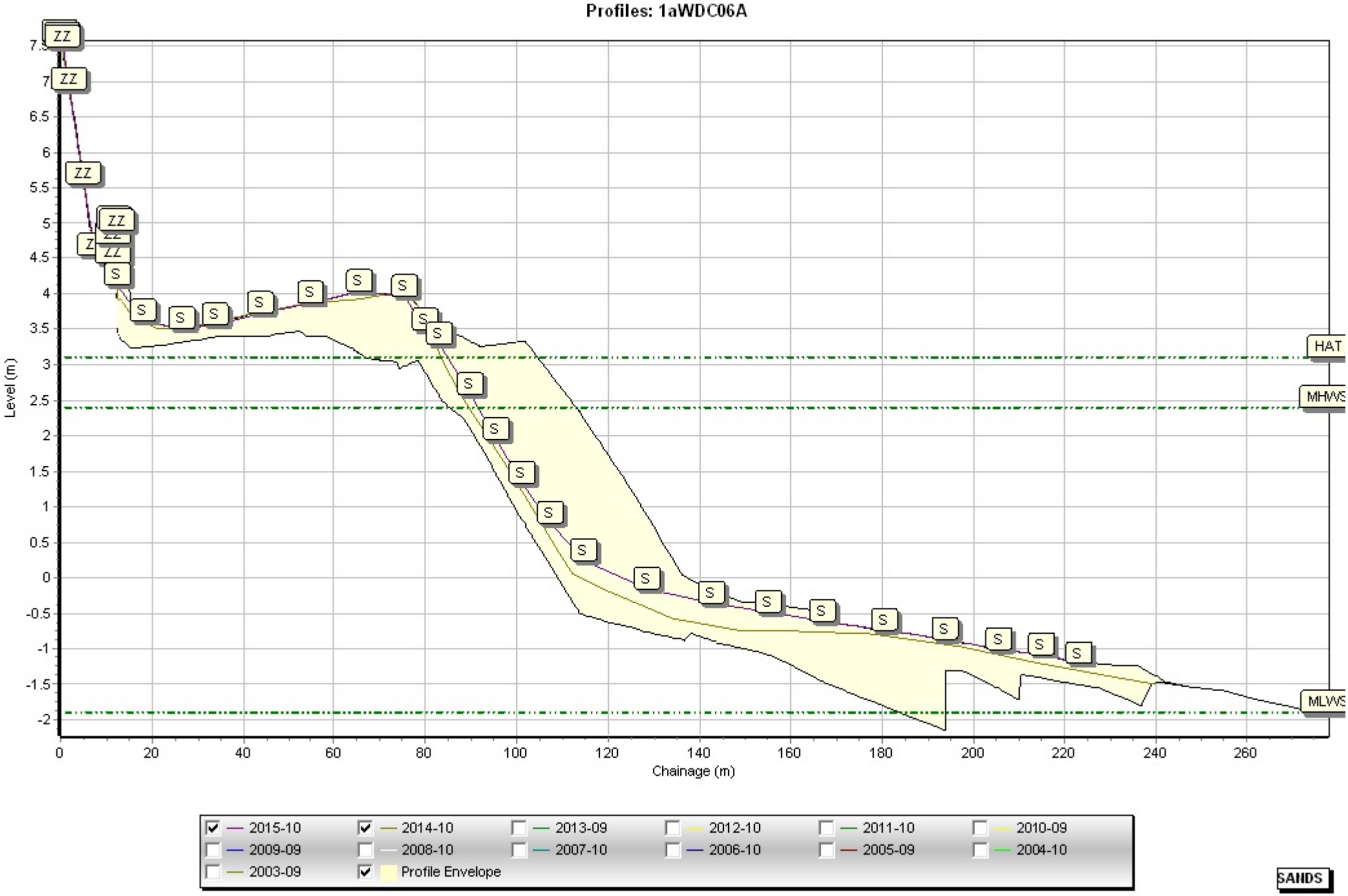

Profiles: 1aWDC03
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-10
2014-10
2013-10
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

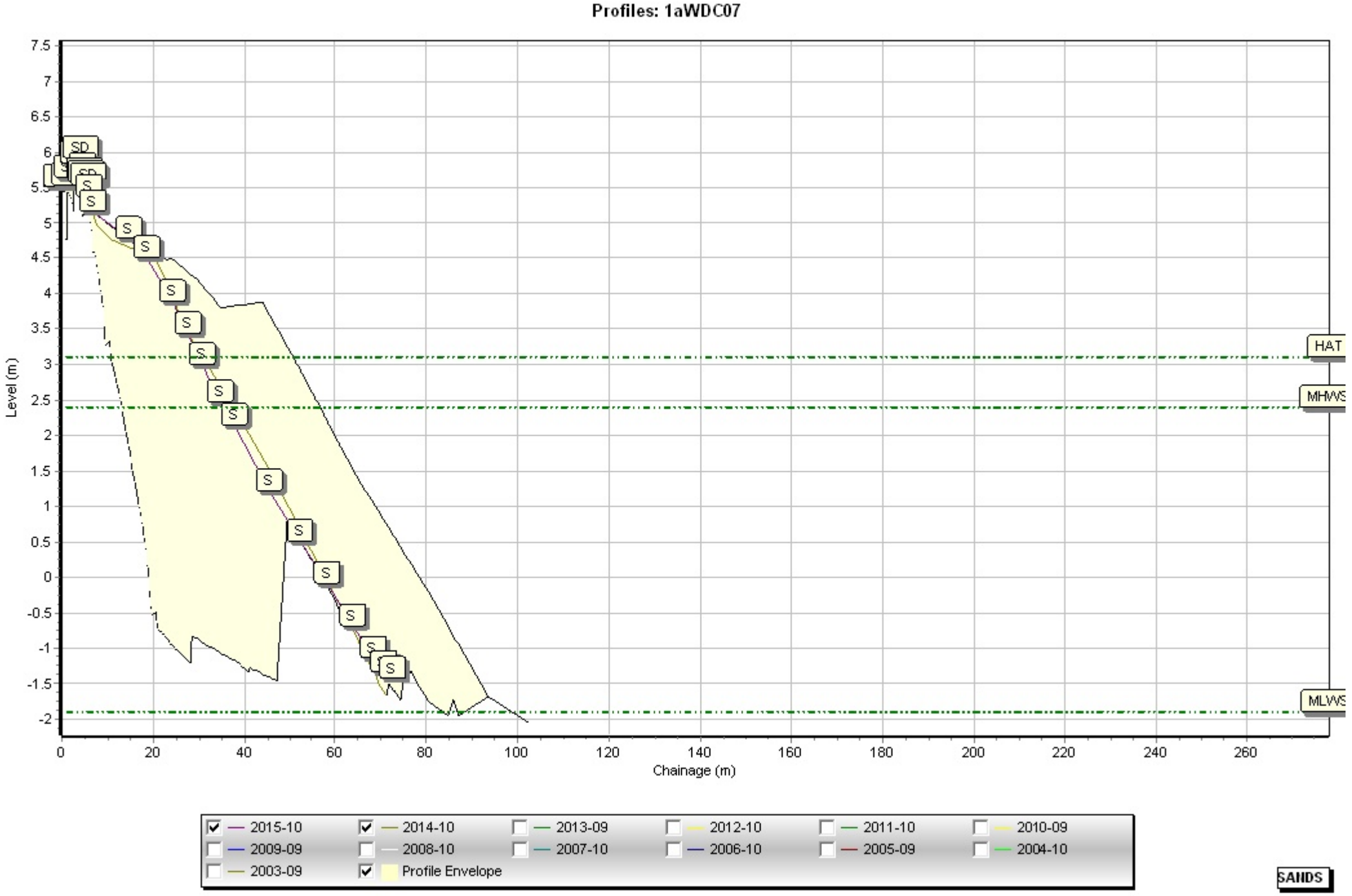

Profiles: 1aWDC04
Level (m)
Chainage (m)
HAT
MHWS
MLWS
GR
DV
S
R
2015-10
2014-10
2013-10
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

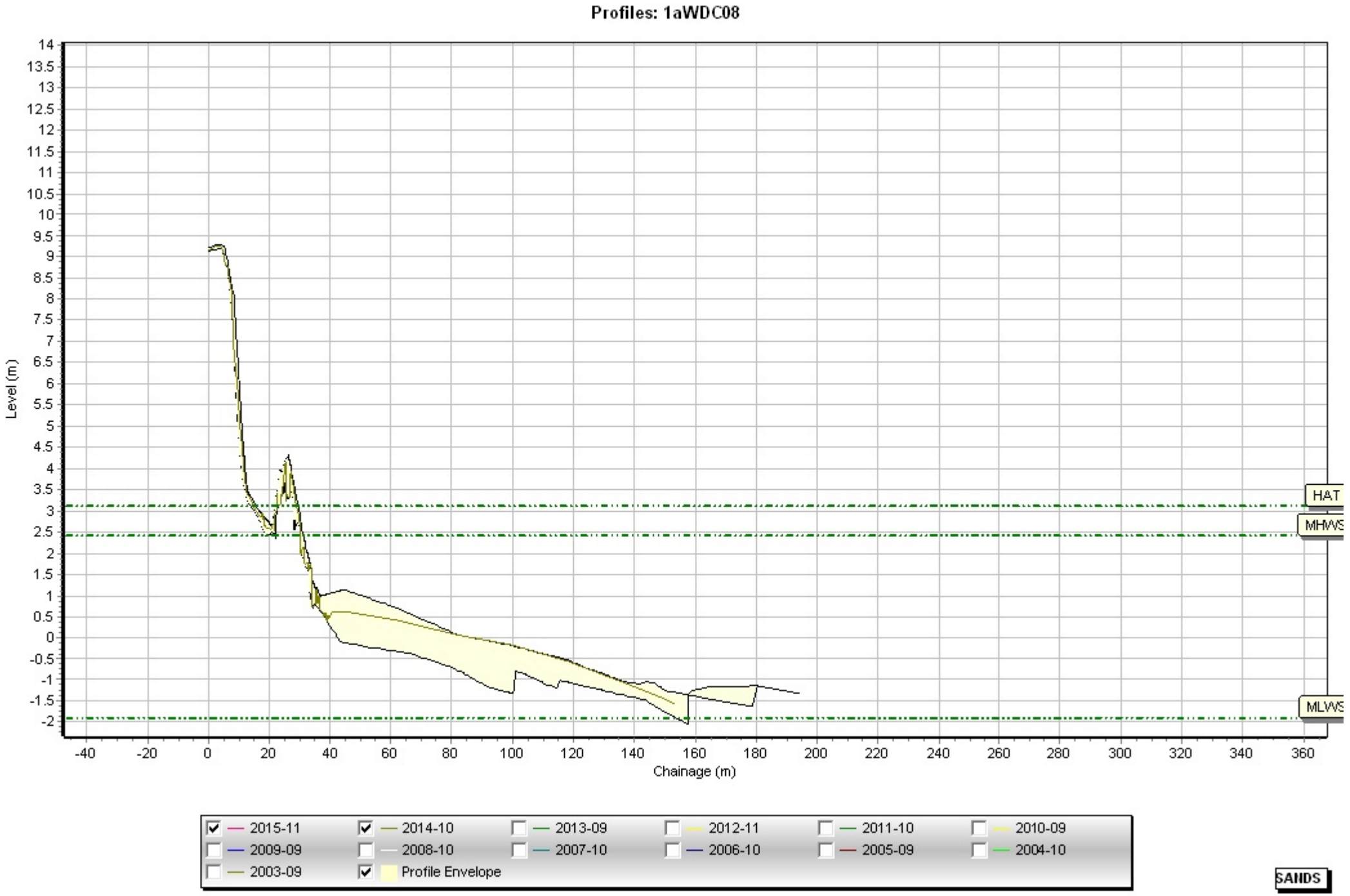

Profiles: 1aWDC05
Level (m)
Chainage (m)
HAT
MHWS
MLWS
GR
DV
R
S
2015-10
2014-10
2013-10
2012-11
2011-11
2010-10
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

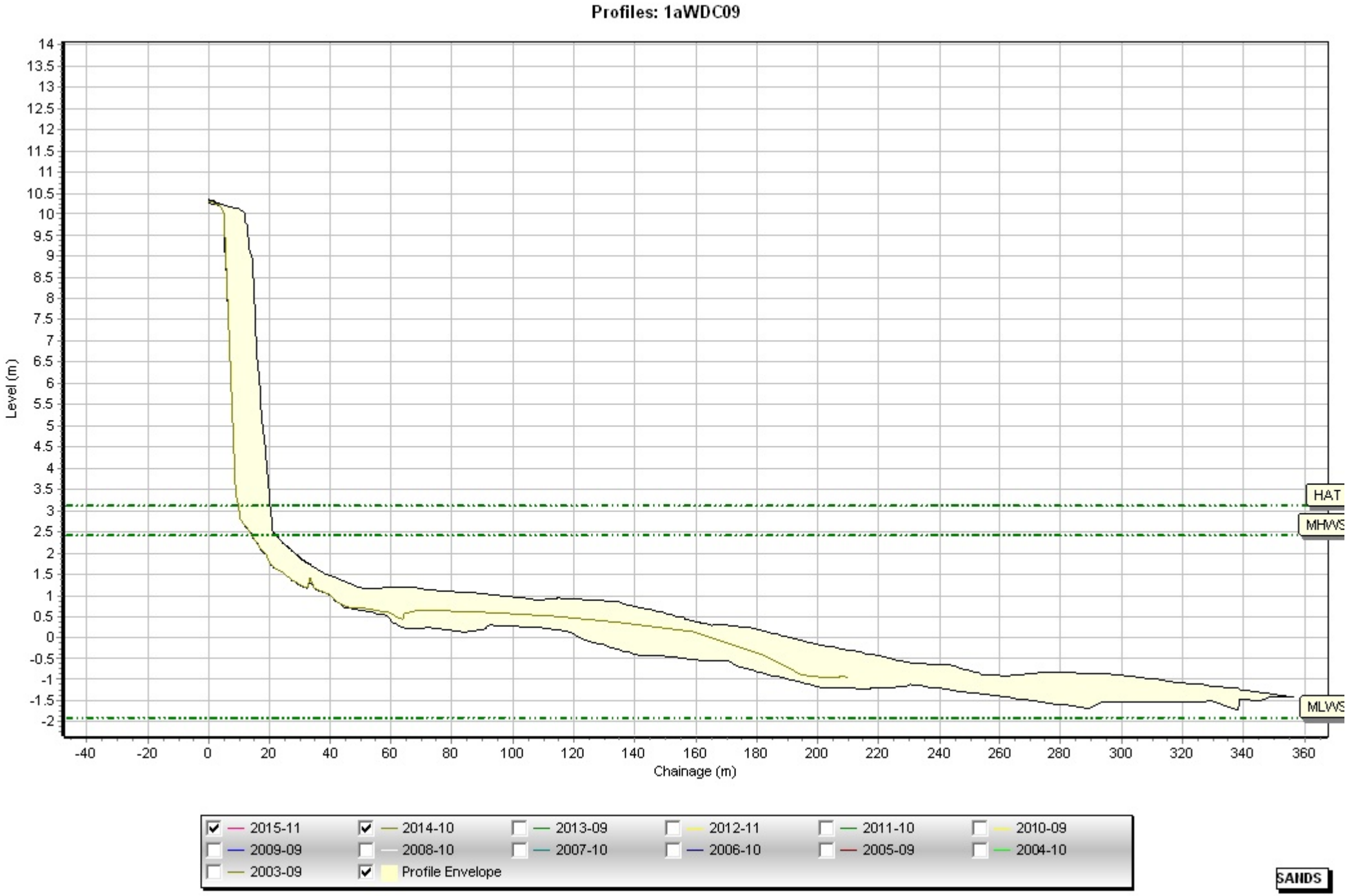

Profiles: 1aWDC05A
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-10
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

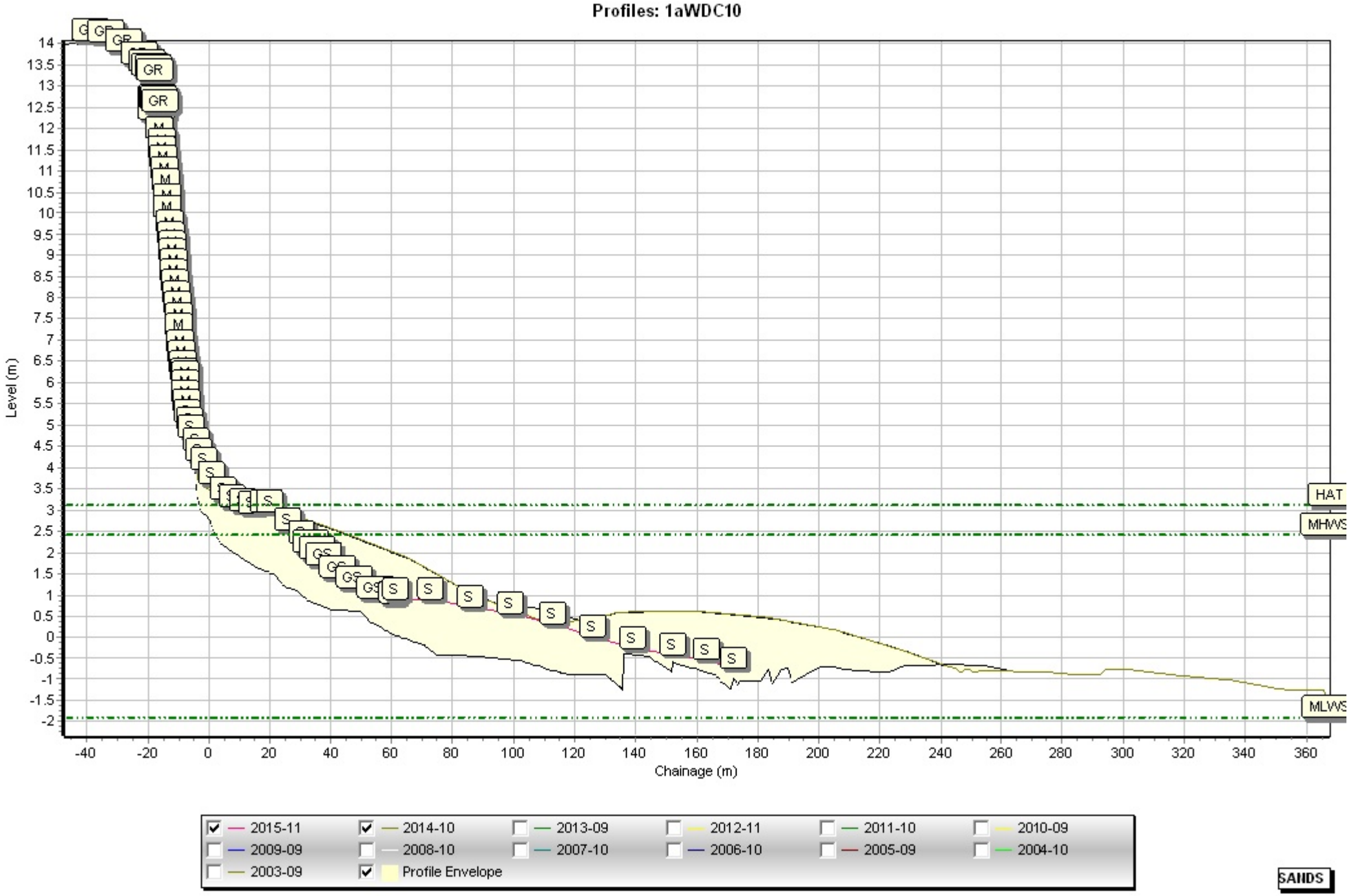

Profiles: 1aWDC06
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-10
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

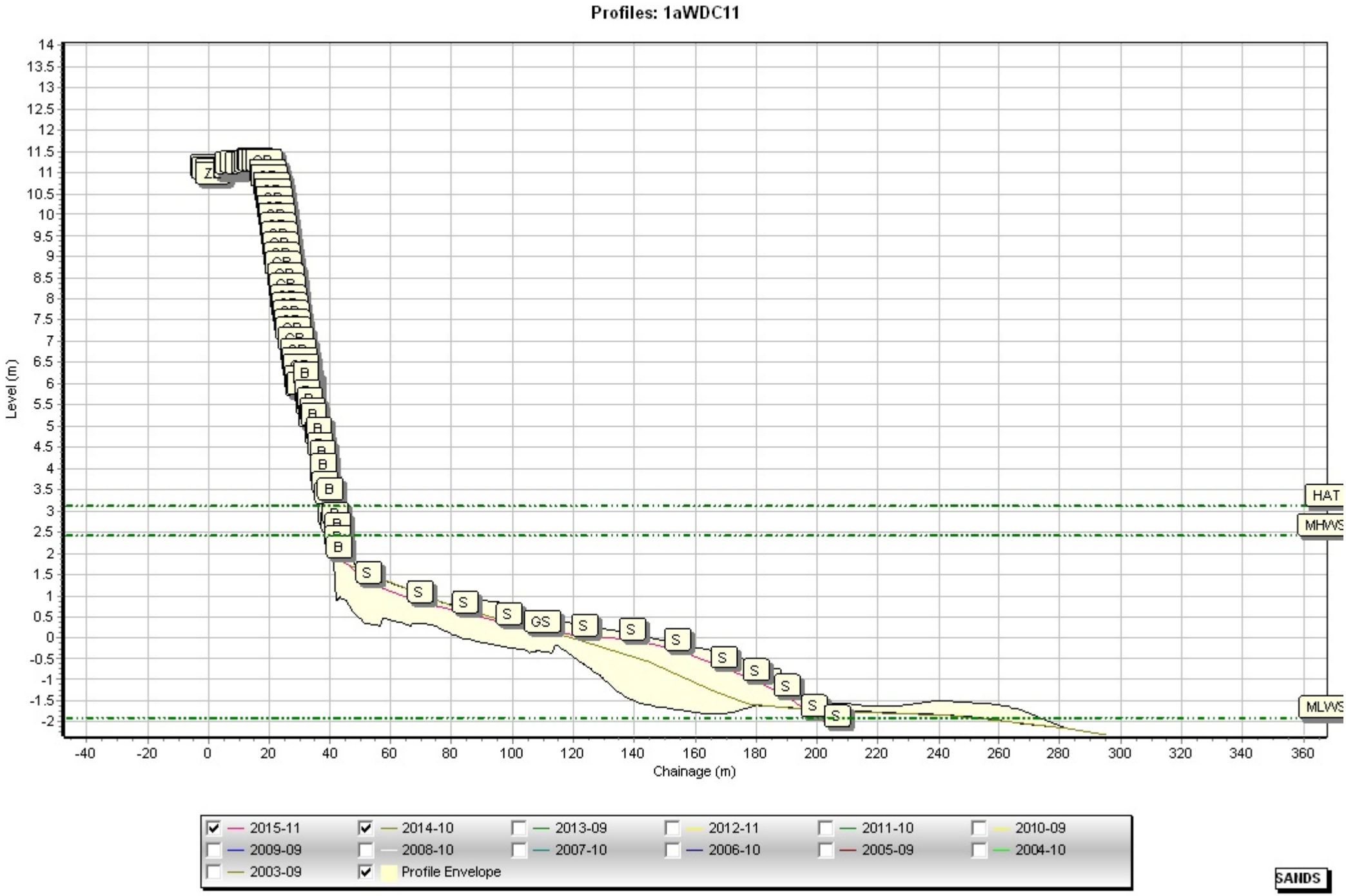

Profiles: 1aWDC06A
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-10
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

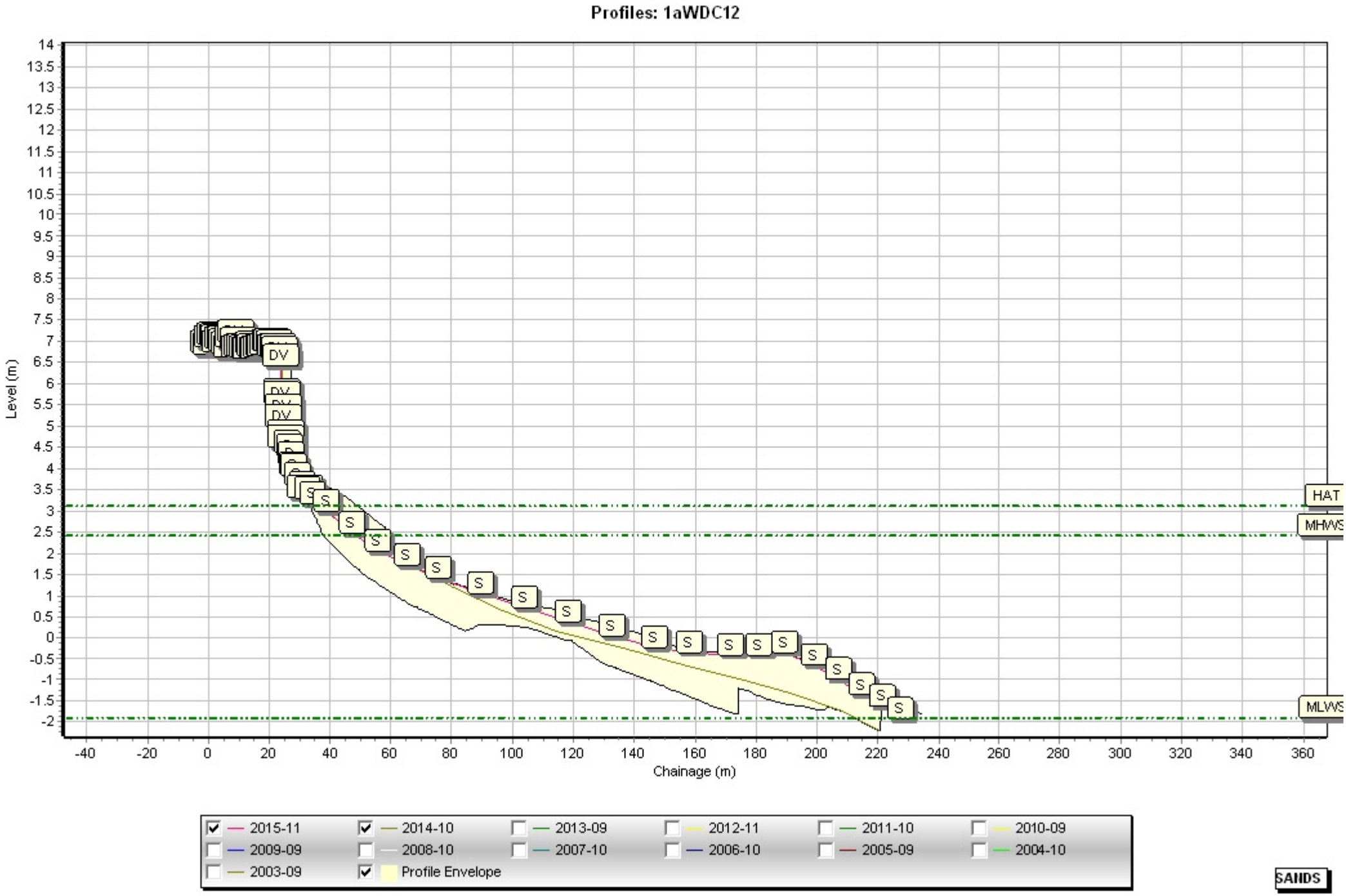

Profiles: 1aWDC07
Level (m)
Chainage (m)
HAT
MHWS
MLWS
SD
S
2015-10
2014-10
2013-09
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

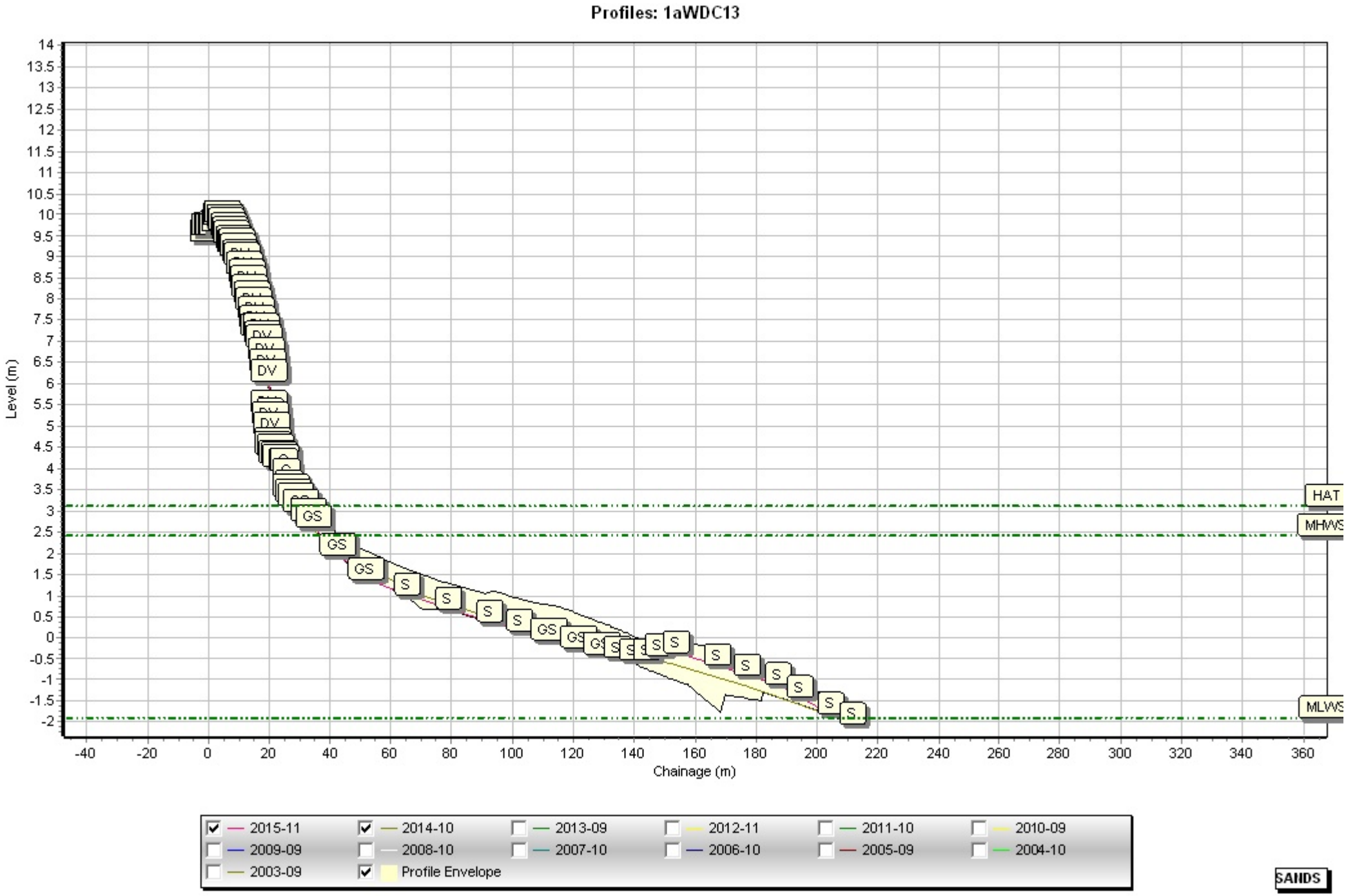

Profiles: 1aWDC08
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-09
2012-11
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

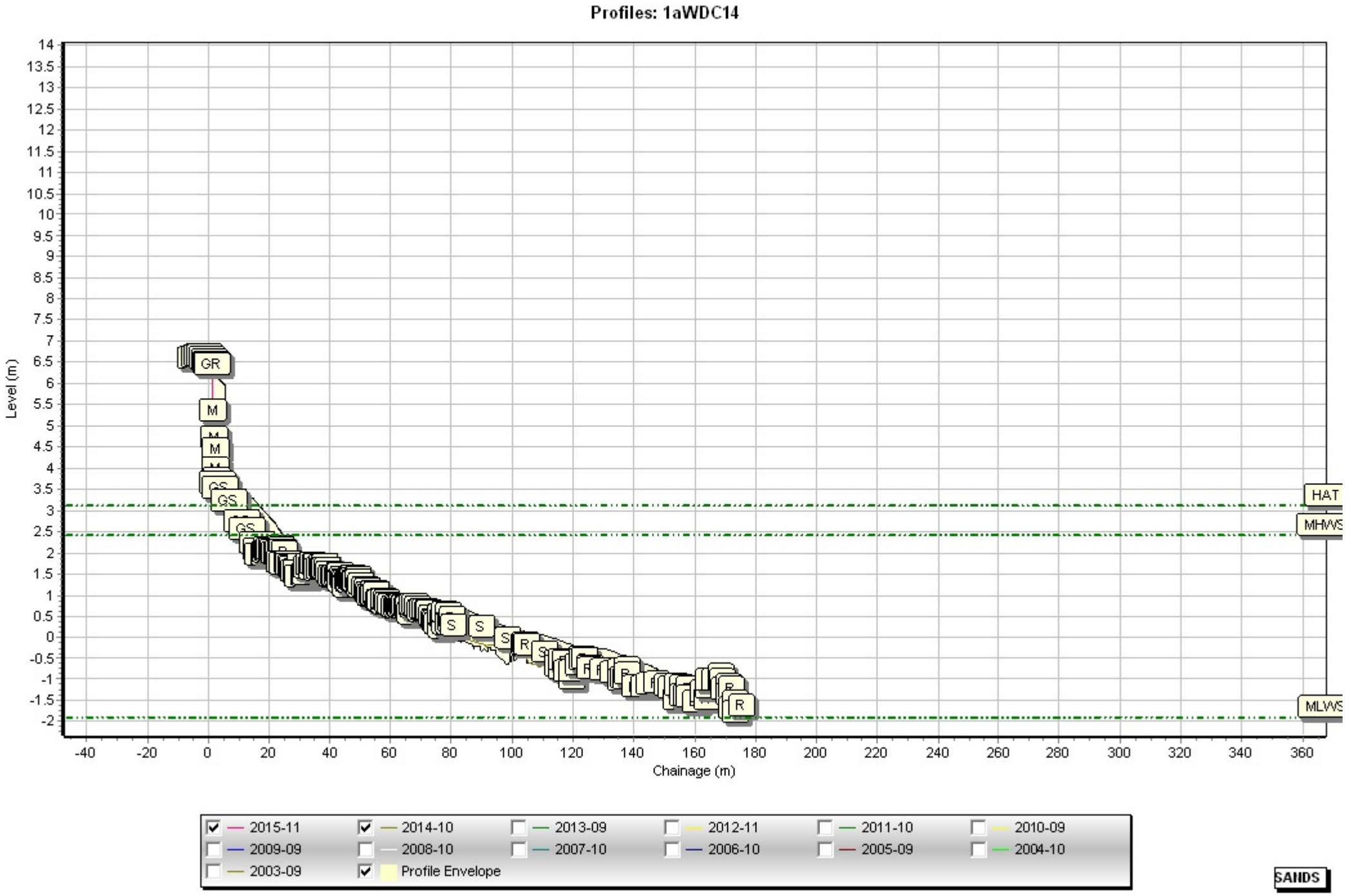

Profiles: 1aWDC09
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-09
2012-11
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

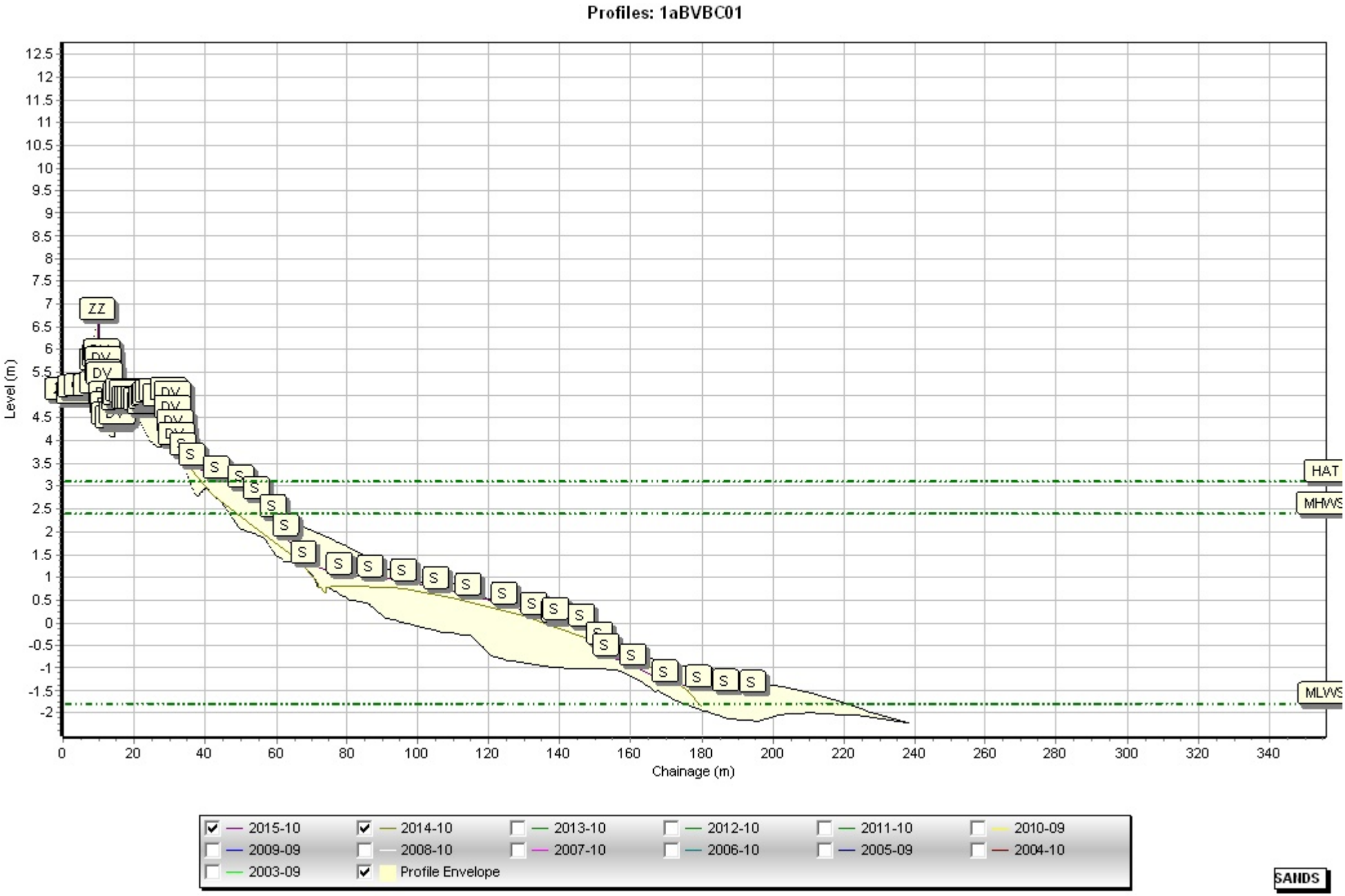

Profiles: 1aWDC10
Level (m)
Chainage (m)
HAT
MHWS
MLWS
GR
S
2015-11
2014-10
2013-09
2012-11
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

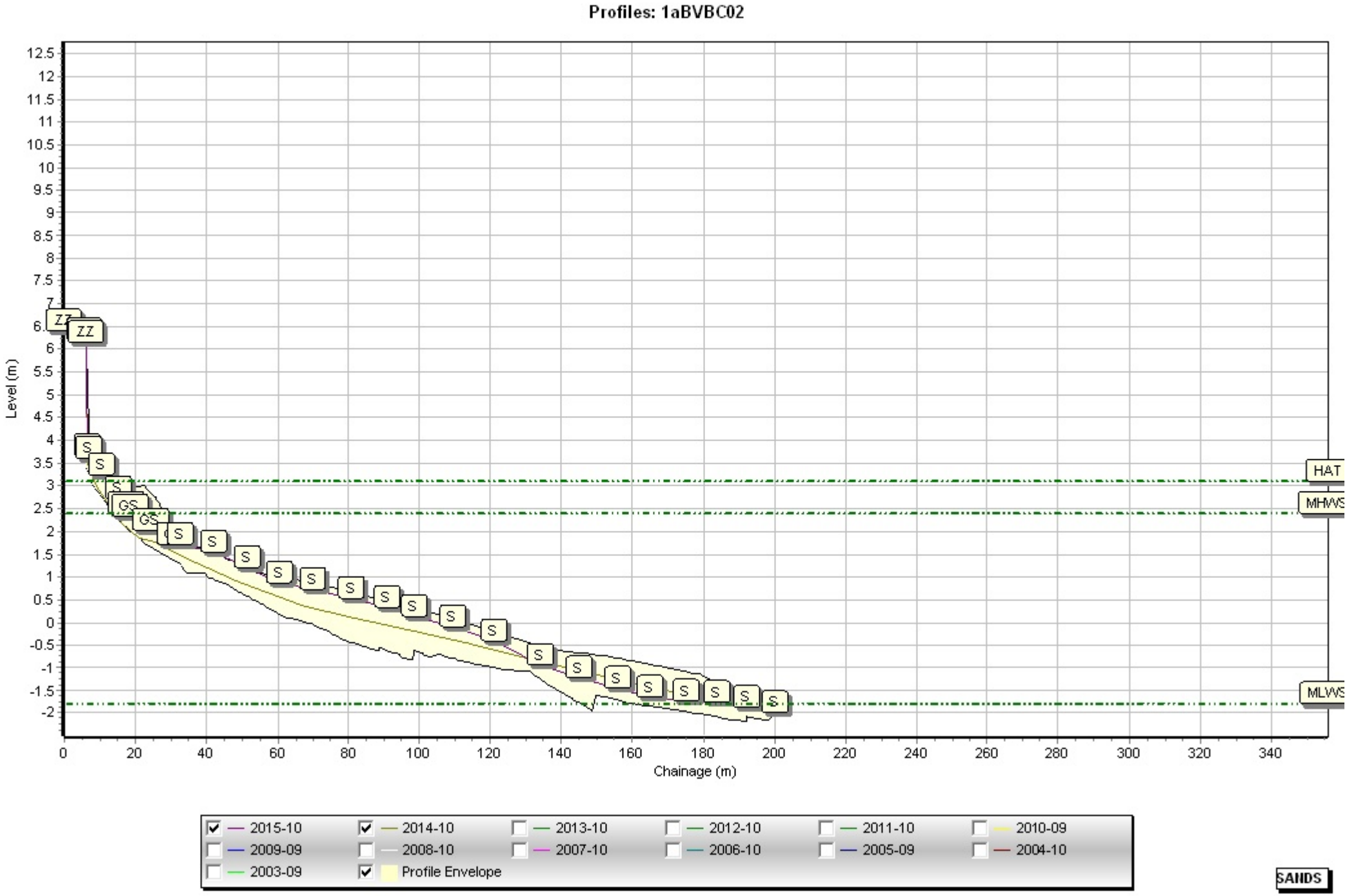

Profiles: 1aWDC11
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-09
2012-11
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

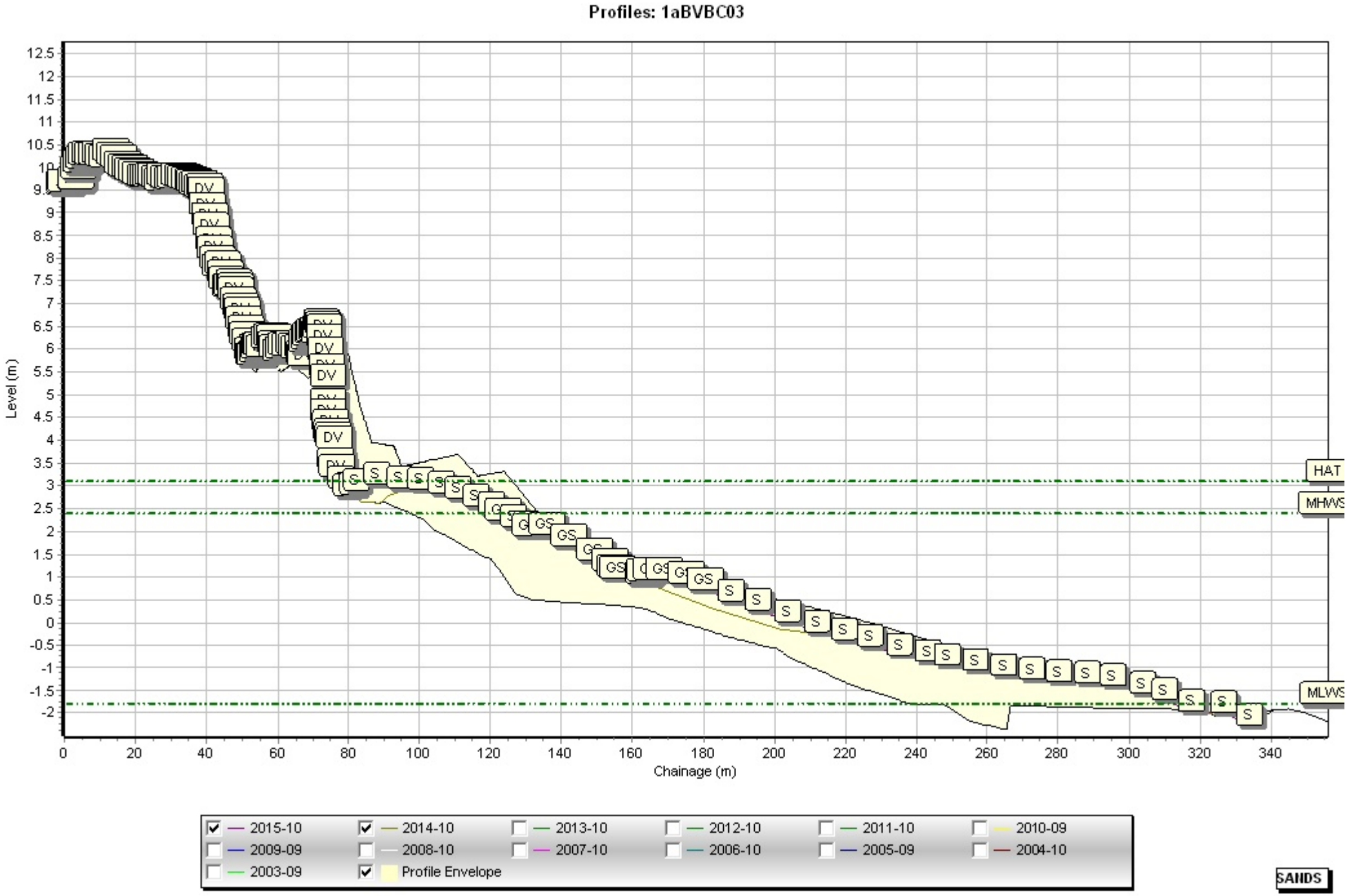

Profiles: 1aWDC12
Level (m)
Chainage (m)
DV
S
HAT
MHWS
MLWS
2015-11
2014-10
2013-09
2012-11
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

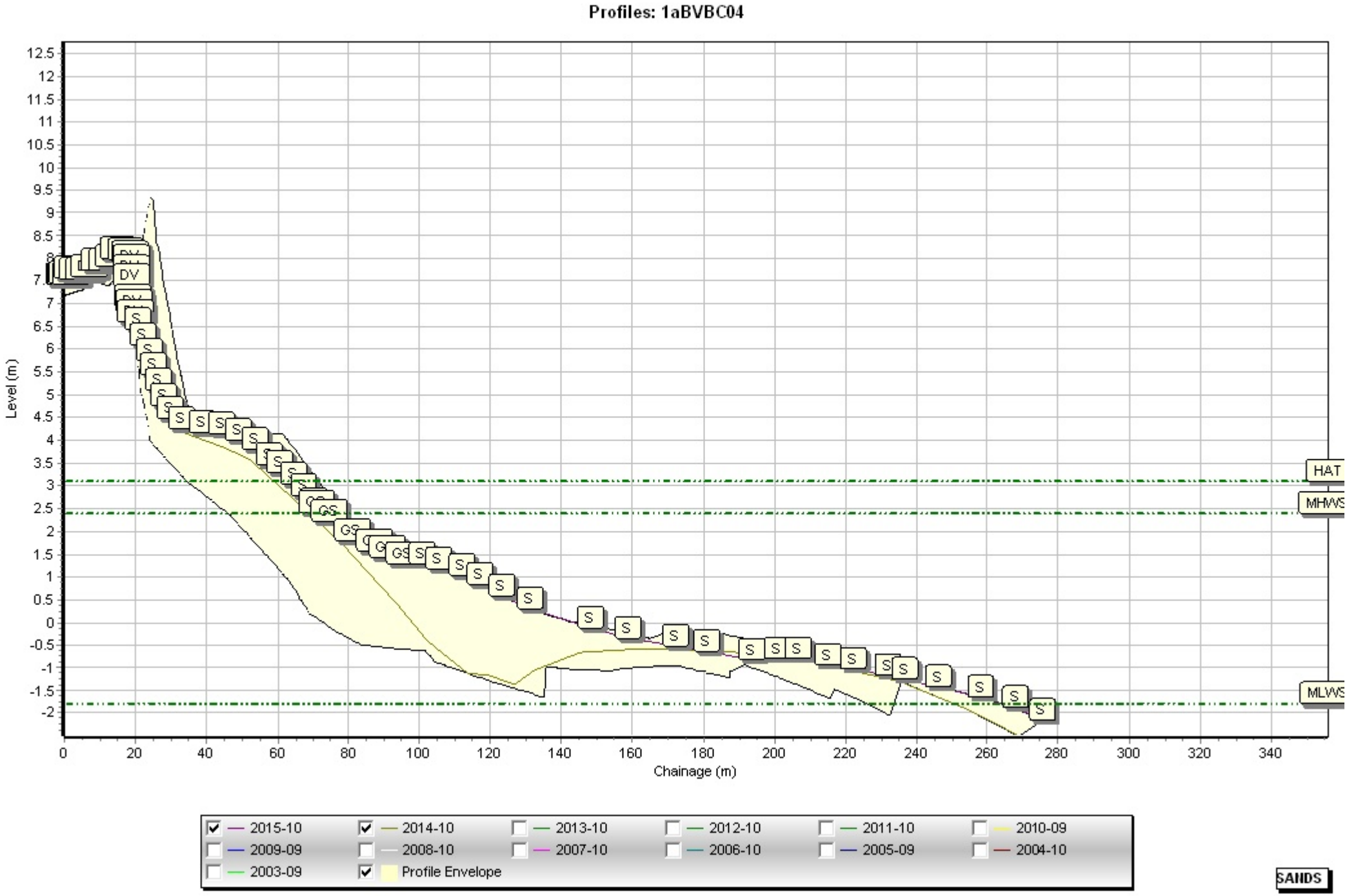

Profiles: 1aWDC13
Level (m)
Chainage (m)
HAT
MHWS
MLWS
DV
GS
S
2015-11
2014-10
2013-09
2012-11
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

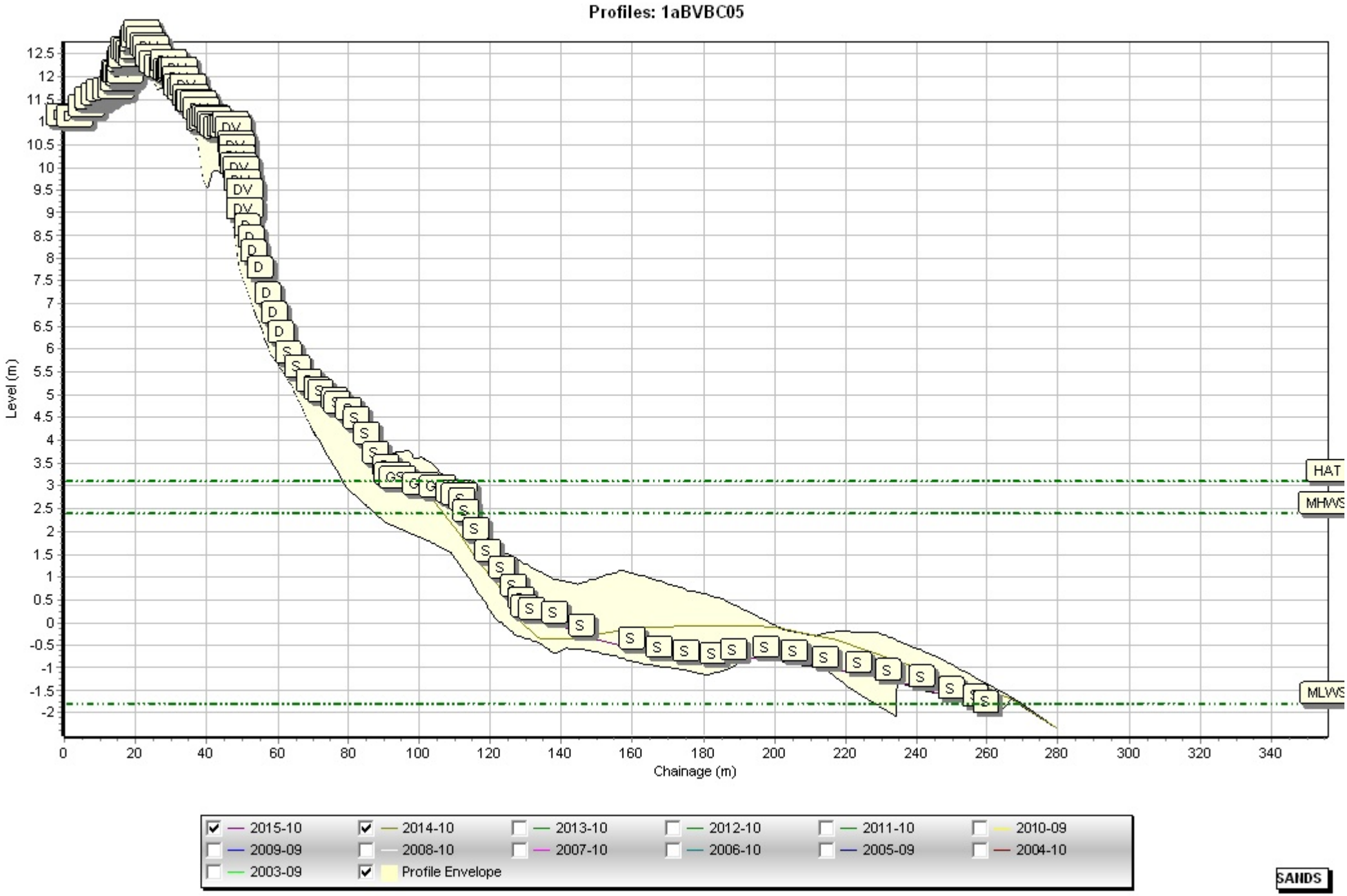

Profiles: 1aWDC14
Level (m)
Chainage (m)
HAT
MHWS
MLWS
GR
M
GS
S
R
2015-11
2014-10
2013-09
2012-11
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

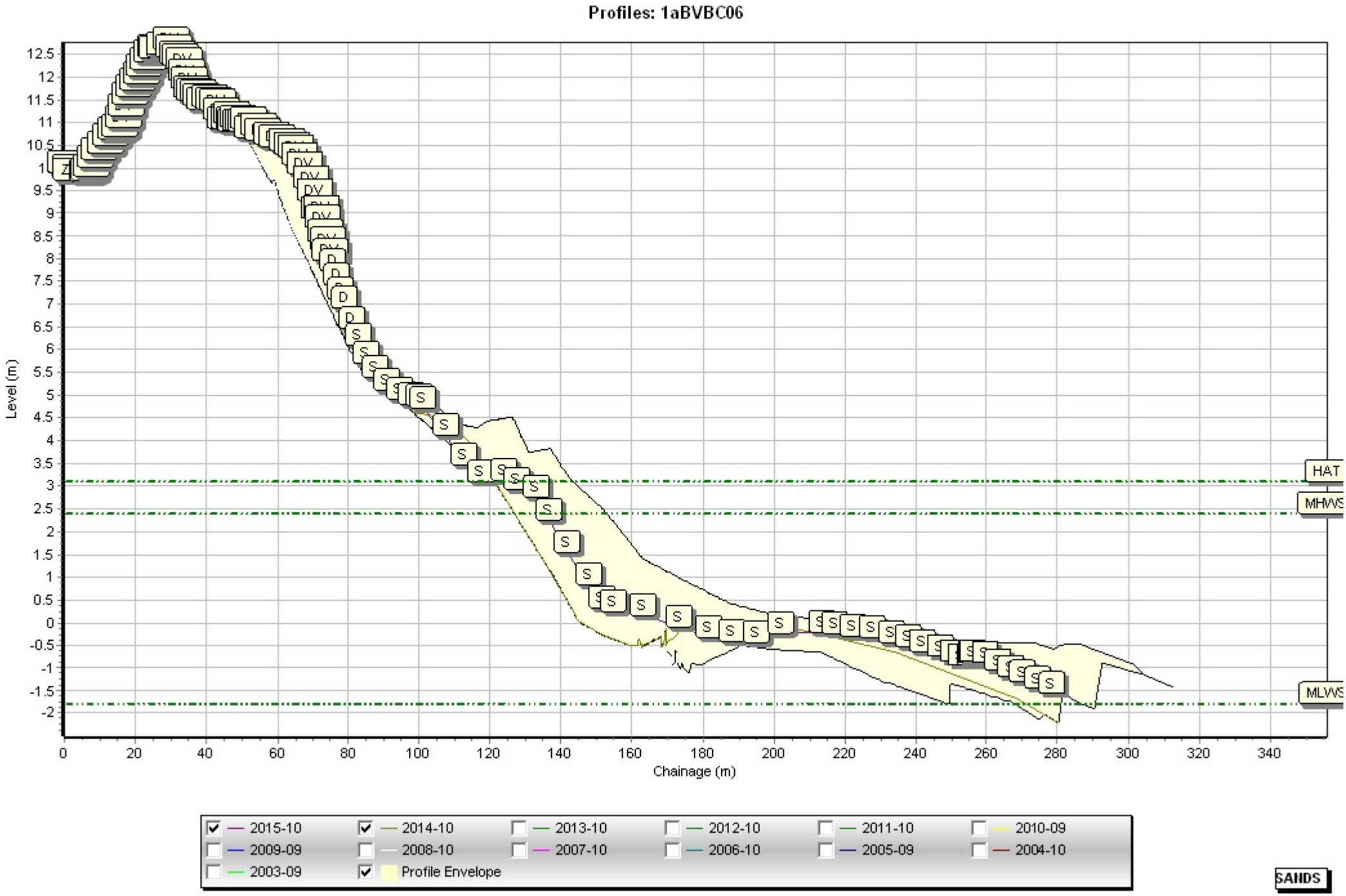

Profiles: 1aBVBC01
Level (m)
Chainage (m)
ZZ
DV
S
HAT
MHWS
MLWS
2015-10
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS


Profiles: 1aBVBC02
Level (m)
Chainage (m)
HAT
MHWS
MLWS
ZZ
S
GS
2015-10
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS


Profiles: 1aBVBC03
Level (m)
Chainage (m)
HAT
MHWS
MLWS
DV
GS
S
2015-10
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS


Profiles: 1aBVBC04
Level (m)
Chainage (m)
HAT
MHWS
MLWS
DV
S
GS
2015-10
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS


Profiles: 1aBVBC05
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-10
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

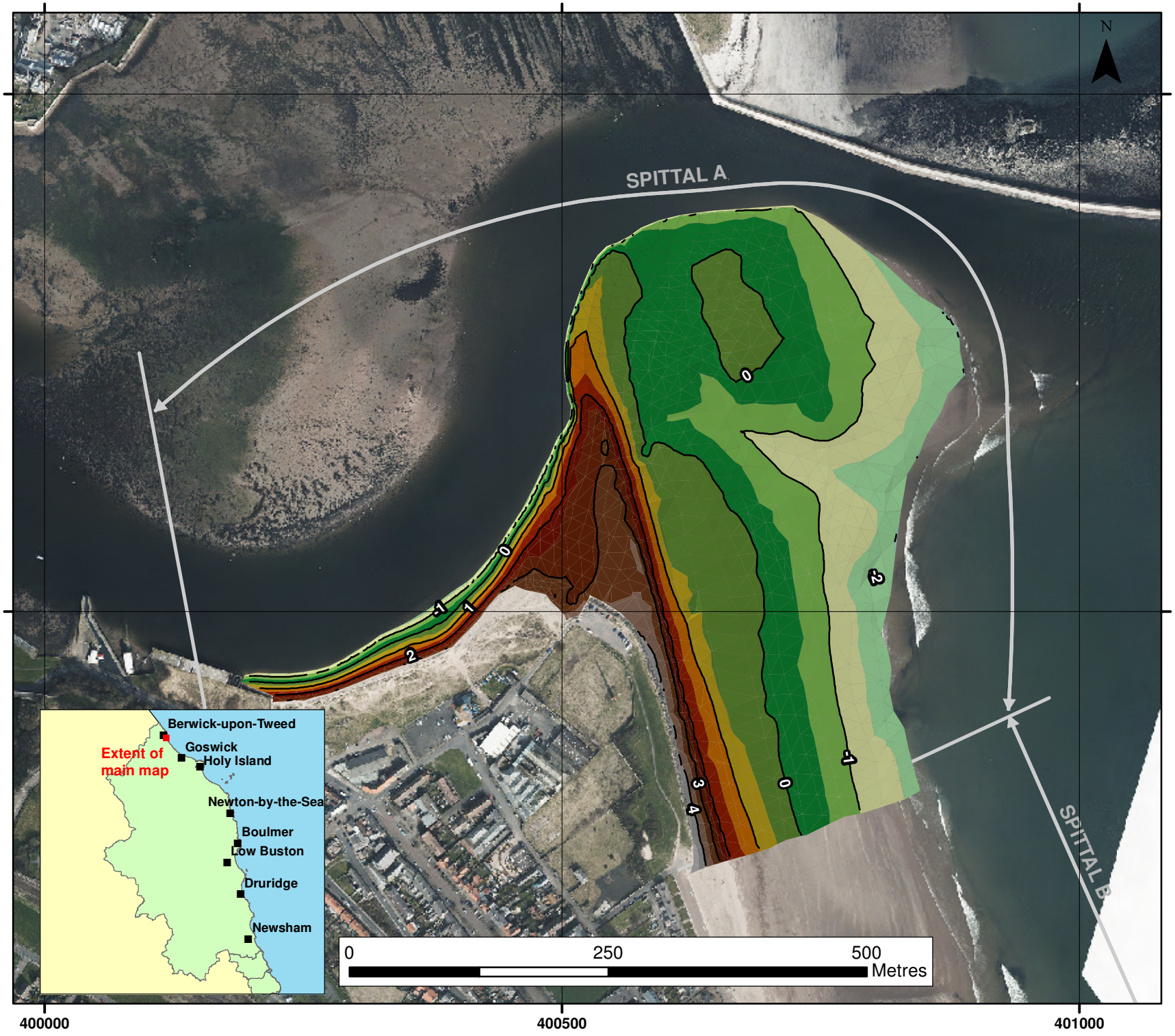

Profiles: 1aBVBC06
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-10
2014-10
2013-10
2012-10
2011-10
2010-09
2009-09
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

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 |

# Appendix B

# Topographic Survey




**KEY**

**Elevation (m OD)**

- 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

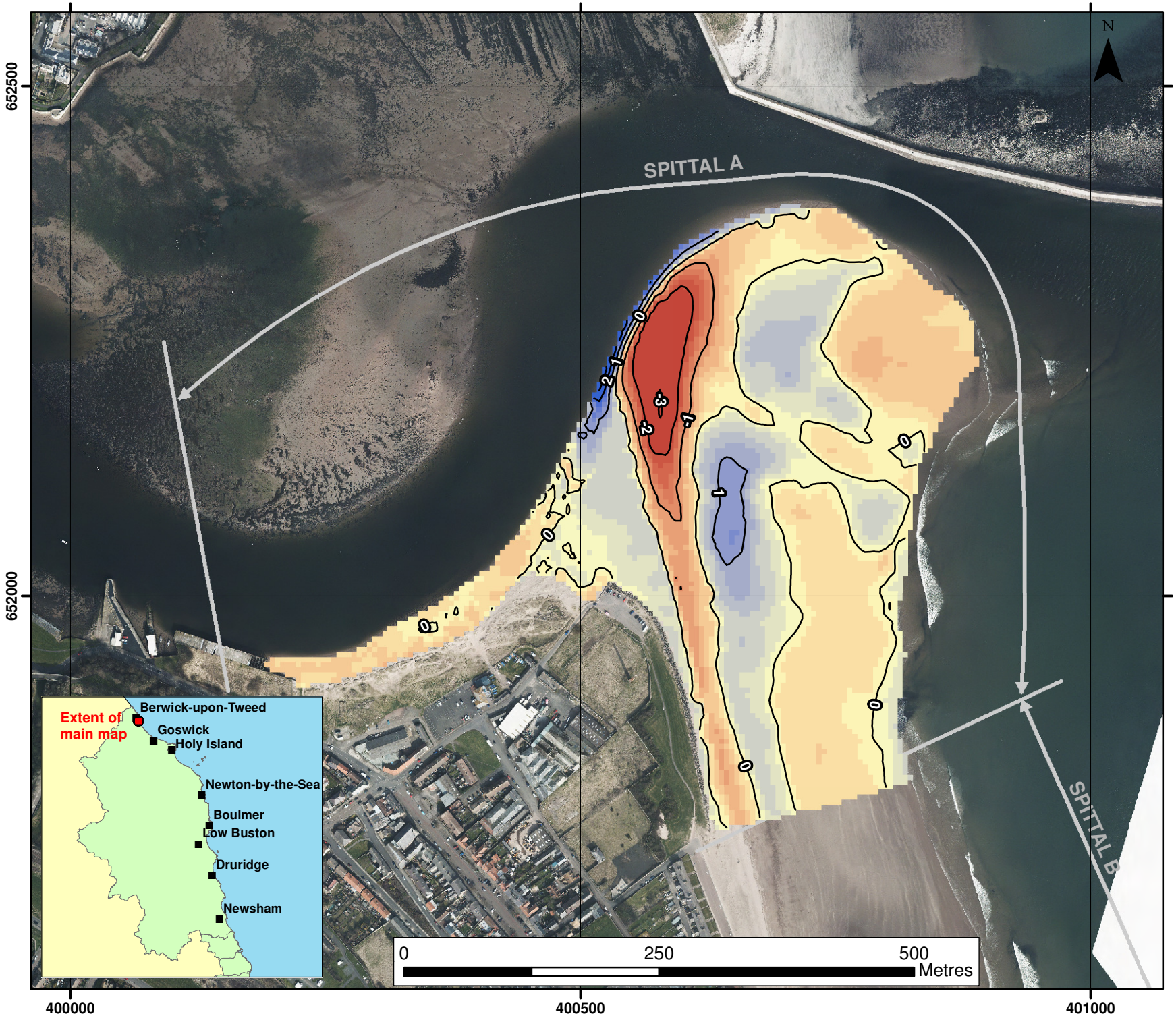
# Appendix B - Map 1a
# Topographic Survey
# Sandstell Point (Spittal A)
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015


ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




**KEY**

**Spring 2015 and Autumn 2015**
**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 1b
# Short-term Elevation Change
# Berwick
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015

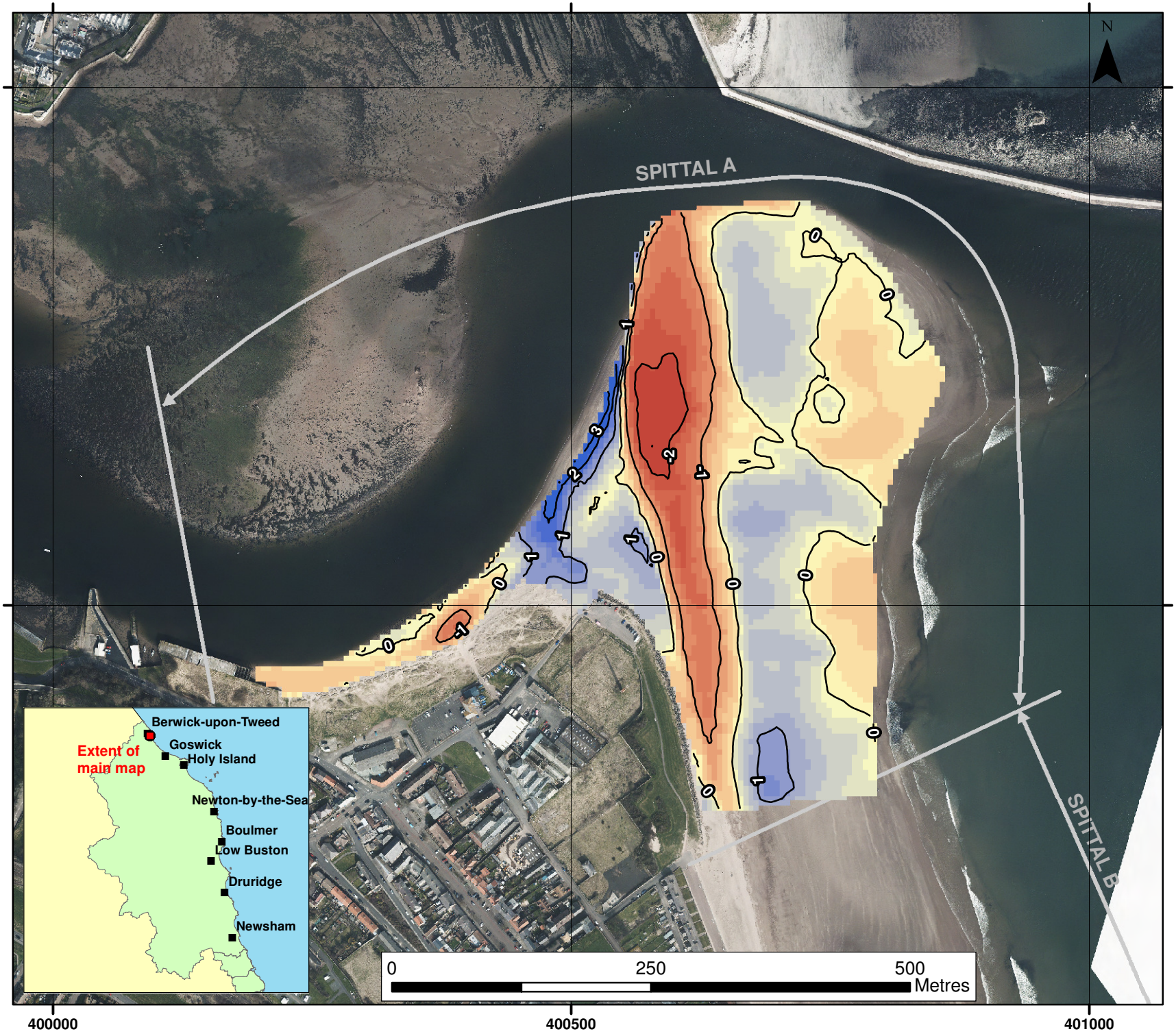

ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com



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




**KEY** Autumn 2011 and Autumn 2015
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

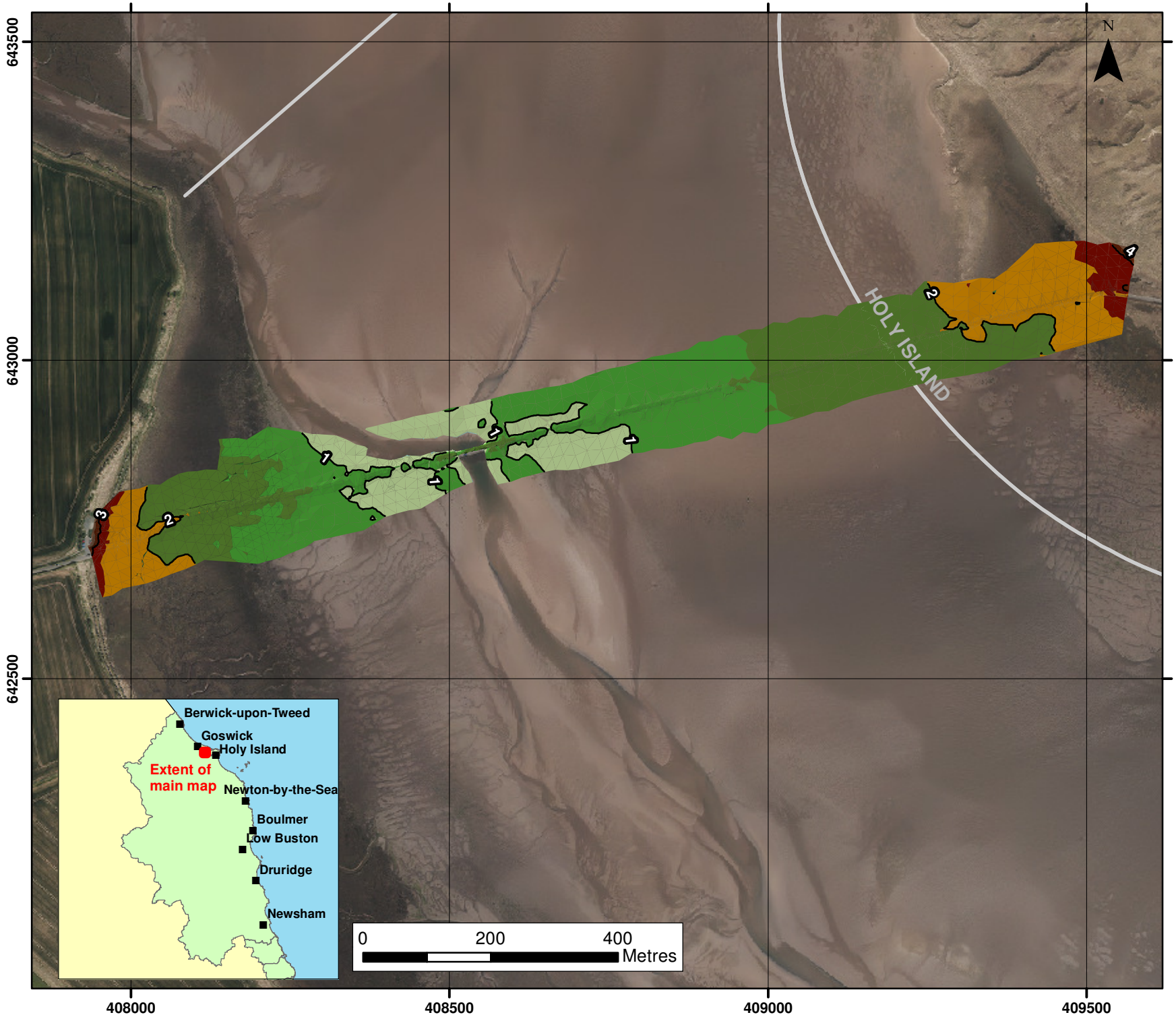
Client: North East Coastal Group
Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

# Appendix B - Map 1c
# Long-term Elevation Change
# Berwick
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




**KEY**

**Elevation (m OD)**

- 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
- Contour 1m

Client: North East Coastal Group

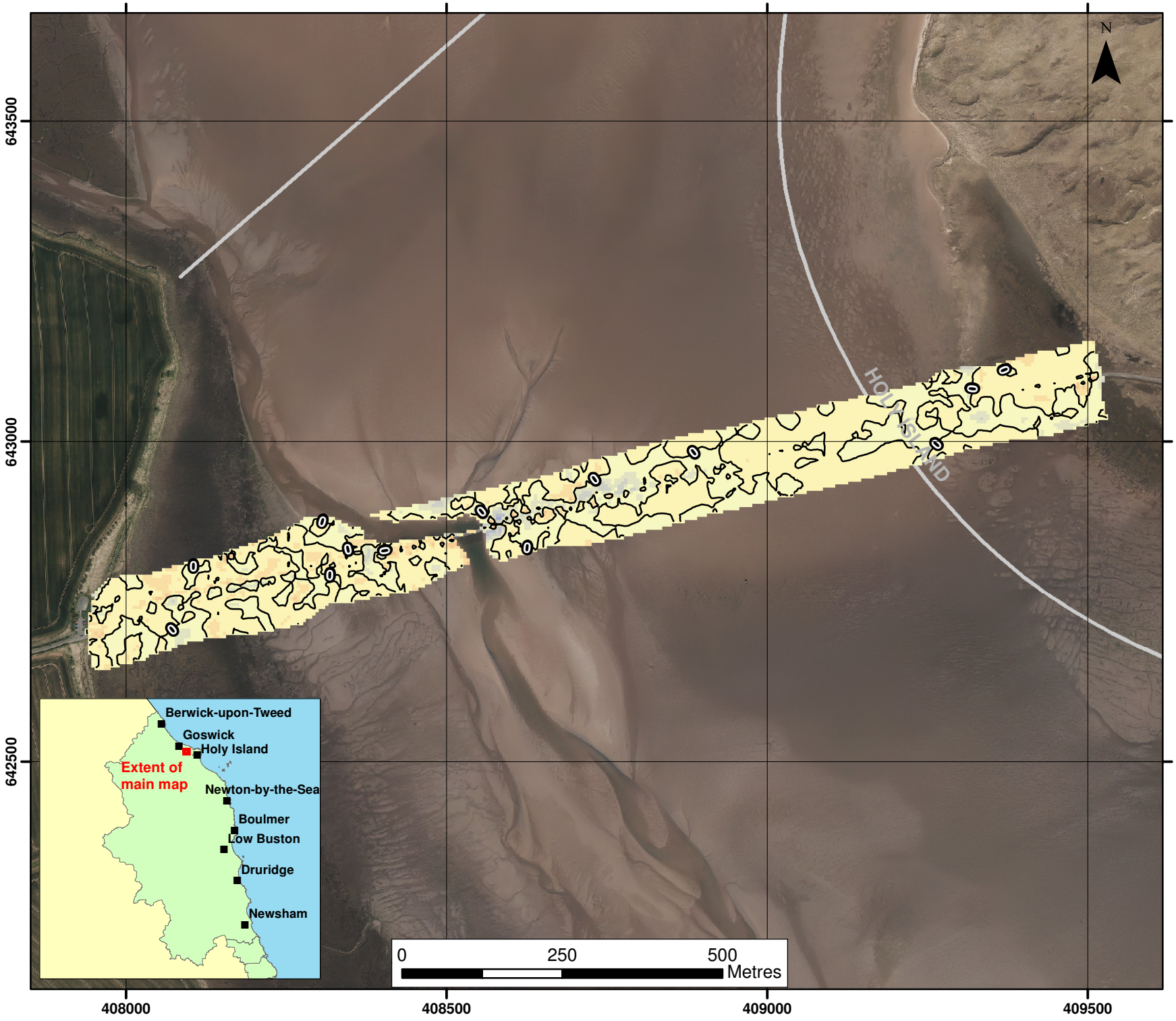
Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

# Appendix B - Map 2a
# Topographic Survey
# Holy Island
# Northumberland
# County Council

Analytical Report 8
Full Measures Survey
Autumn 2015

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




**KEY** Autumn 2014 and Autumn 2015 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

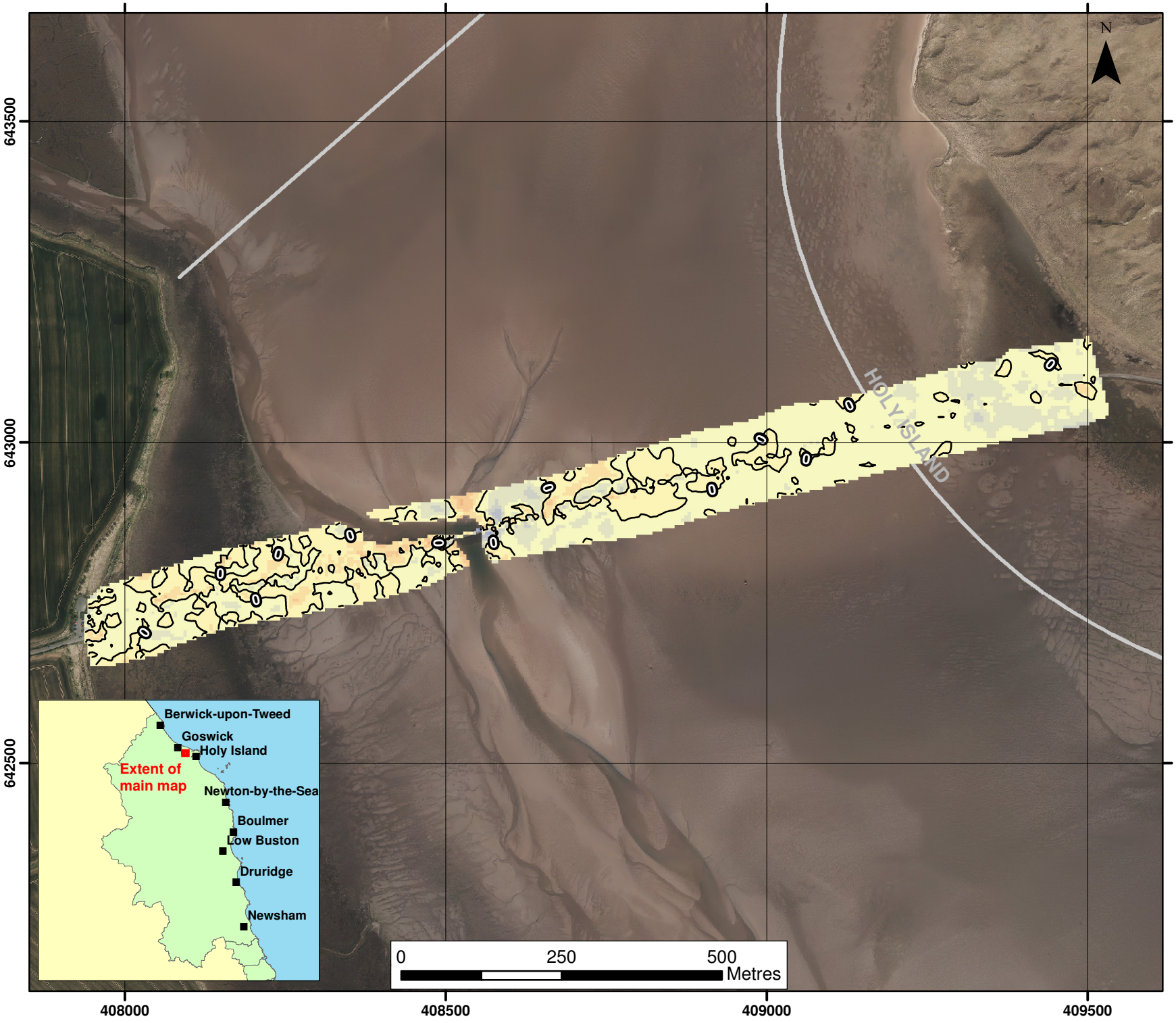
Client: North East Coastal Group
Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

# Appendix B- Map 2b Short-term Elevation Change Holy Island Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




**KEY** Autumn 2010 and Autumn 2015
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

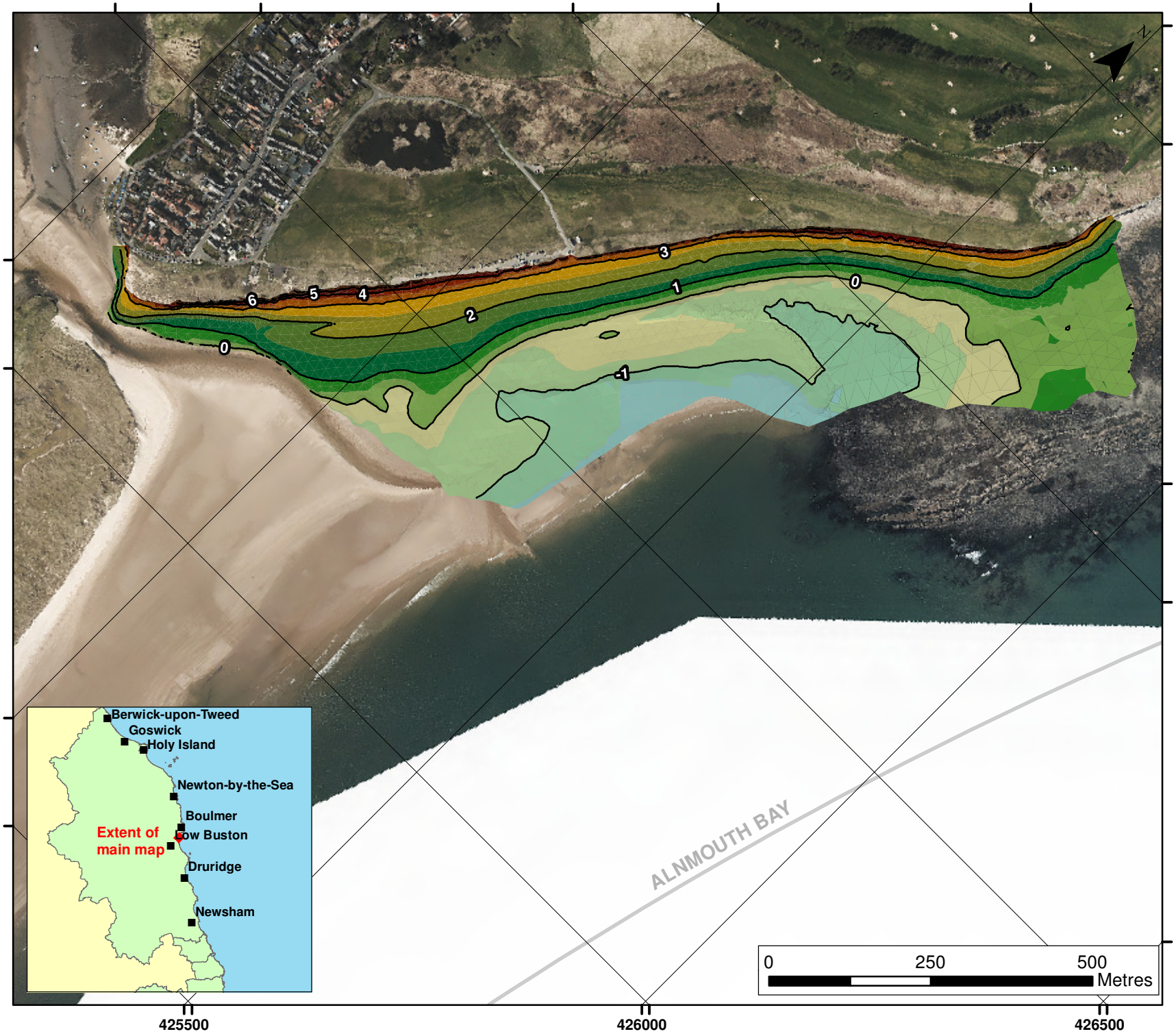
Client: North East Coastal Group
Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

# Appendix B- Map 2c
# Long-term Elevation Change
# Holy Island
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




**KEY**

**Elevation (m OD)**

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

Contour 1m

Client: North East Coastal Group

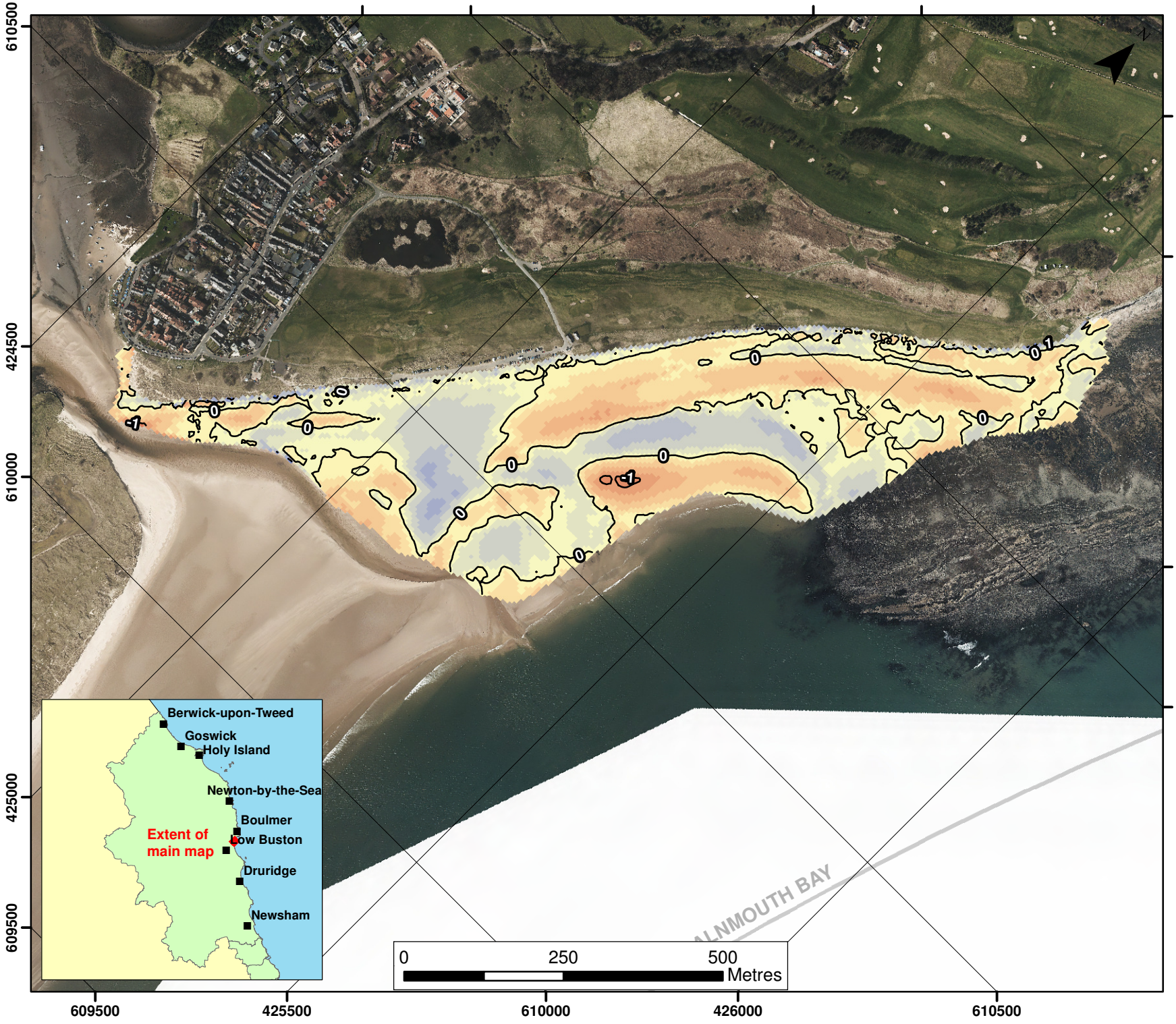
Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

# Appendix B - Map 3a
# Topographic Survey
# Alnmouth Bay
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015


Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




**KEY** Spring 2015 and Autumn 2015
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

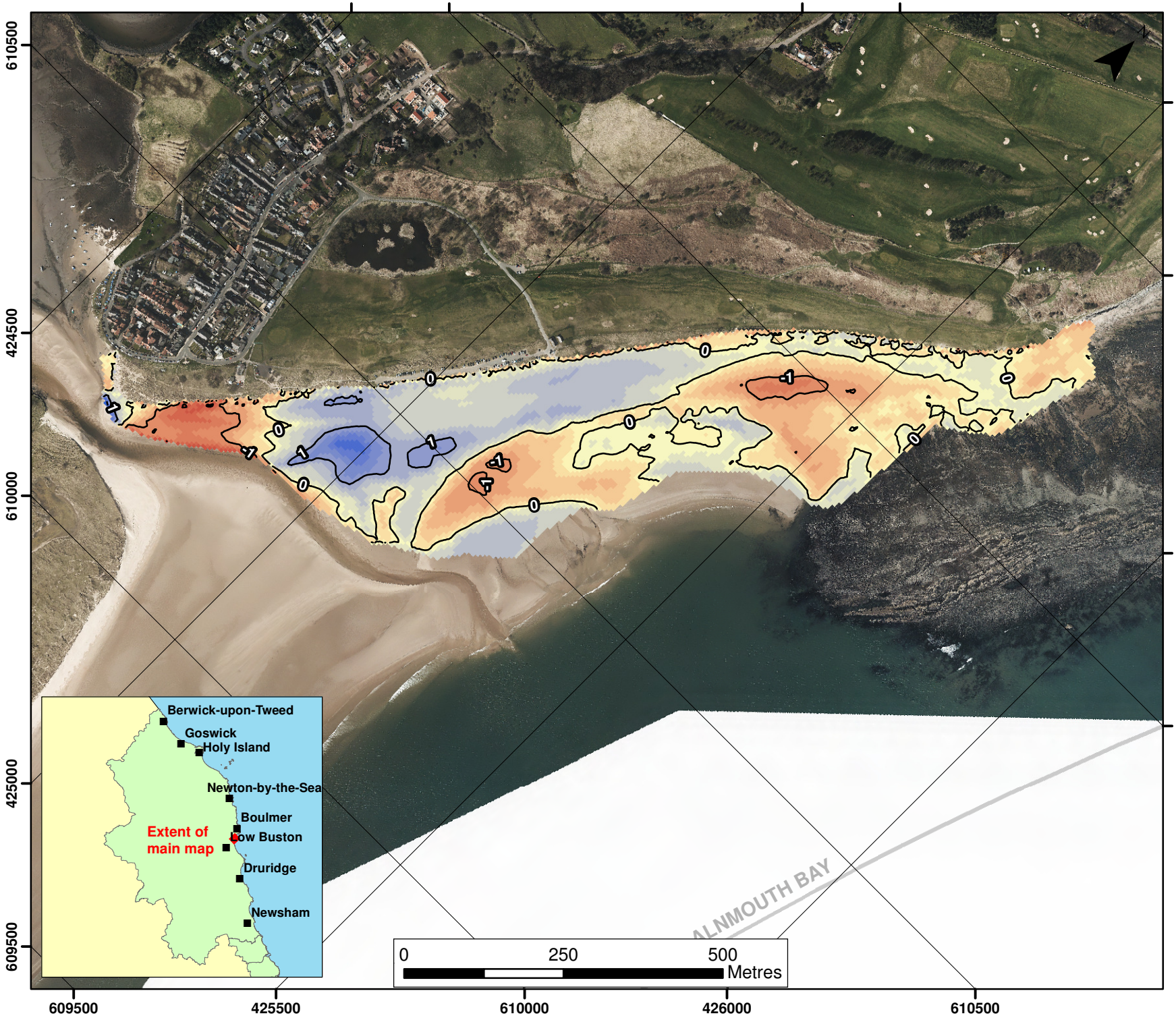
# Appendix B- Map 3b
# Short-term Elevation Change
# Alnmouth
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com

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




**KEY** Autumn 2011 and Autumn 2015
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

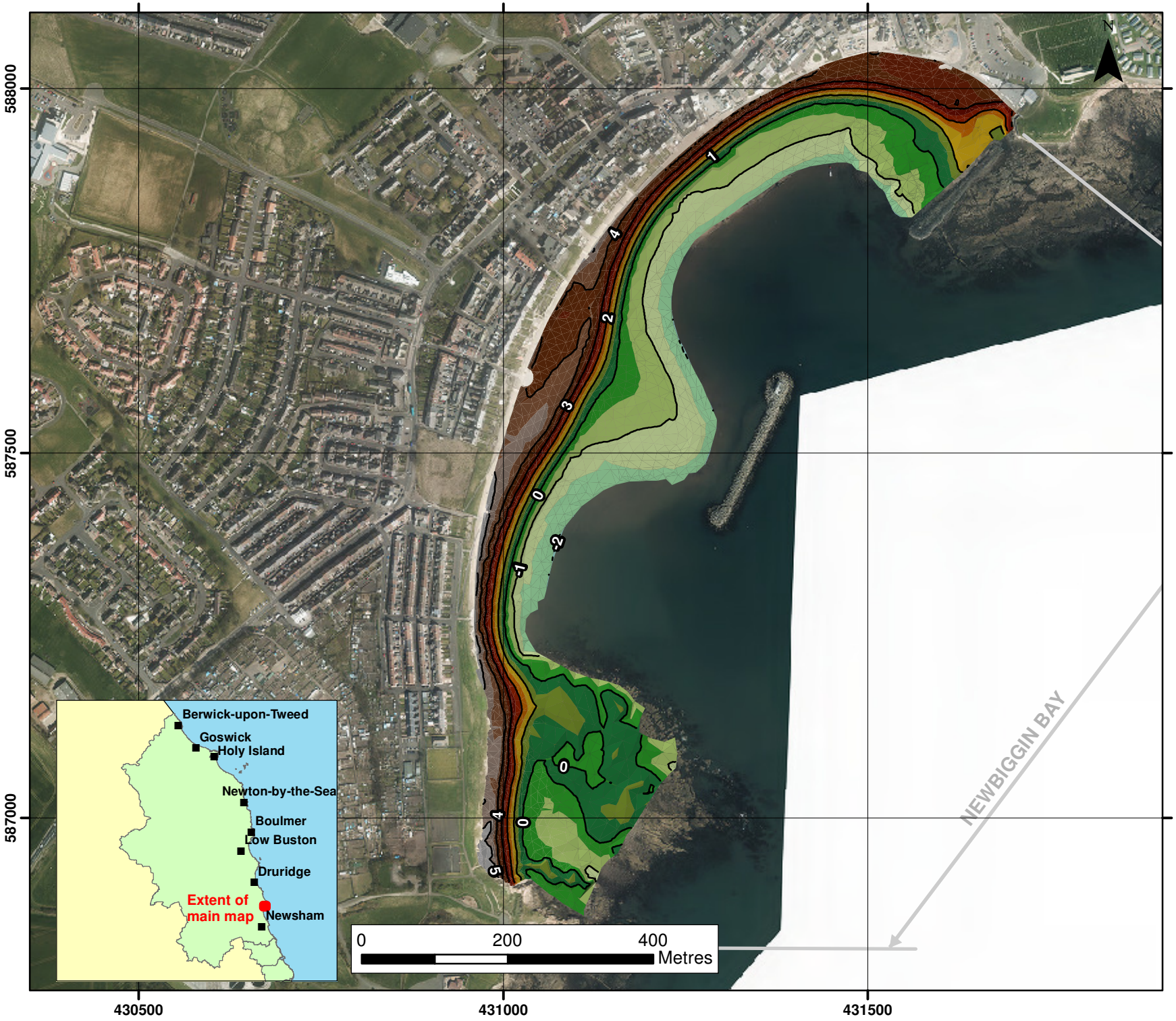
# Appendix B- Map 3c Long-term Elevation Change Alnmouth Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015

ch2m.

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




**KEY**

**Elevation (m OD)**

- 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

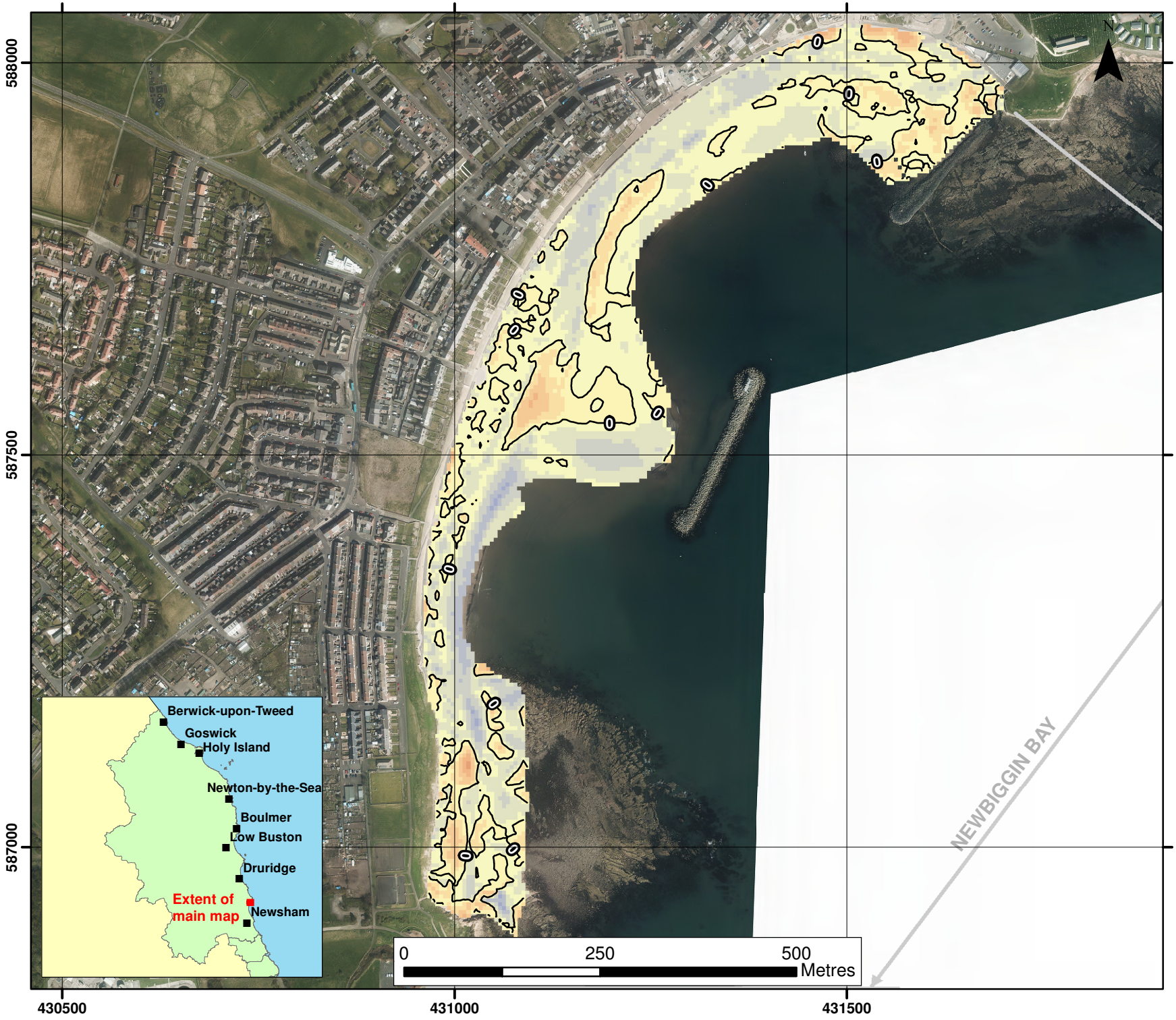
# Appendix B - Map 4a
# Topographic Survey
# Newbiggin Bay
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015


ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




**KEY** Spring 2015 and Autumn 2015 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

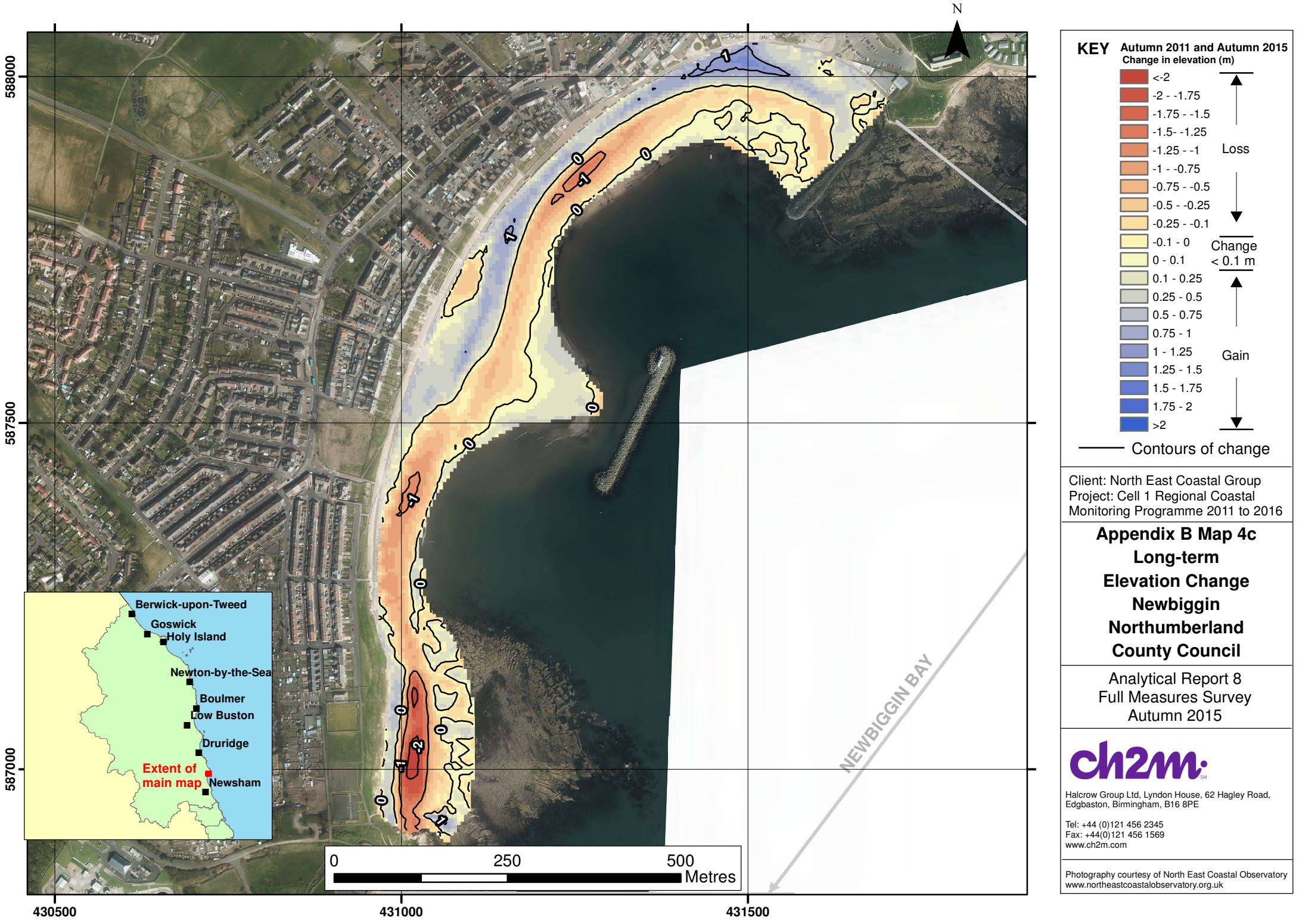
# Appendix B Map 4b Short-term Elevation Change Newbiggin Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015

ch2m.

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




**KEY** Autumn 2011 and Autumn 2015
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 4c
# Long-term Elevation Change
# Newbiggin
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015

ch2m

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com

# Appendix C

# Cliff Top Survey

## Cliff Top Survey

### Lynemouth Bay

Three ground control points have been established at Lynemouth Bay (Map 1). The maximum separation between any two points varies along the coast, reflecting the erosion risk.

The cliff top surveys at Lynemouth Bay are undertaken bi-annually. Measurements are taken along a fixed transect from the landward datum to the surveyed cliff top position.

Table C1 provides baseline information about these ground control points and results from the 2008 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the transect. 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 Lynemouth Bay**

| Ground Control Point Details | | Distance to Cliff Top (m) | | | Total Erosion (m) | | Erosion Rate (m/year) |
|---|---|---|---|---|---|---|---|
| Ref | Type | Baseline Survey (Oct 2008) | Previous Survey (Apr 2015) | Present Survey (Nov 2015) | Baseline (Oct 2008) to Present (Nov 2015) | Previous (Apr 2015) to Present (Nov 2015) | Baseline (Oct 2008) to Present (Nov 2015) |
| 1 | Cliff | 80.6 | 79.4 | 79.4 | -1.3 | 0.0 | -0.2 |
| 2 | Defended | 88.9 | 88.7 | 88.8 | -0.1 | 0.0 | 0.0 |
| 3 | Cliff | 80.2 | 80.4 | 80.3 | 0.0 | -0.2 | 0.0 |

## Cliff Top Survey

### Cambois Bay (north)

Five ground control points have been established at Cambois Bay (north) (Map 2). The maximum separation between any two points varies along the coast, reflecting erosion risk.

The cliff top surveys at Cambois Bay (north) 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 C2 provides baseline information about these ground control points and results from the 2008 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

**Table C2 – Cliff Top Surveys at Cambois Bay (north)**

| Ground Control Point Details | | Distance to Cliff Top (m) | | | Total Erosion (m) | | Erosion Rate (m/year) |
|---|---|---|---|---|---|---|---|
| Ref | Easting | Baseline Survey (Oct 2008) | Previous Survey (Apr 2015) | Present Survey (Nov 2015) | Baseline (Oct 2008) to Present (Nov 2015) | Previous (Apr 2015) to Present (Nov 2015) | Baseline (Oct 2008) to Present (Nov 2015) |
| 1 | Cliff | 125.47 | 125.0 | 125.2 | -0.3 | 0.2 | 0.0 |
| 2 | Defended | 146.01 | 145.6 | 145.9 | -0.1 | 0.3 | 0.0 |
| 3 | Defended | 116.4 | 116.1 | 116.8 | 0.4 | 0.6 | 0.1 |
| 4 | Cliff | 114.44 | 114.4 | 114.9 | 0.4 | 0.5 | 0.1 |
| 5 | Cliff | 110.04 | 107.3 | 107.2 | -2.9 | -0.2 | -0.4 |

## Cliff Top Survey

### Cambois Bay (south)

36 ground control points have been established at Cambois Bay (south) (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 at Cambois Bay (south) are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top.

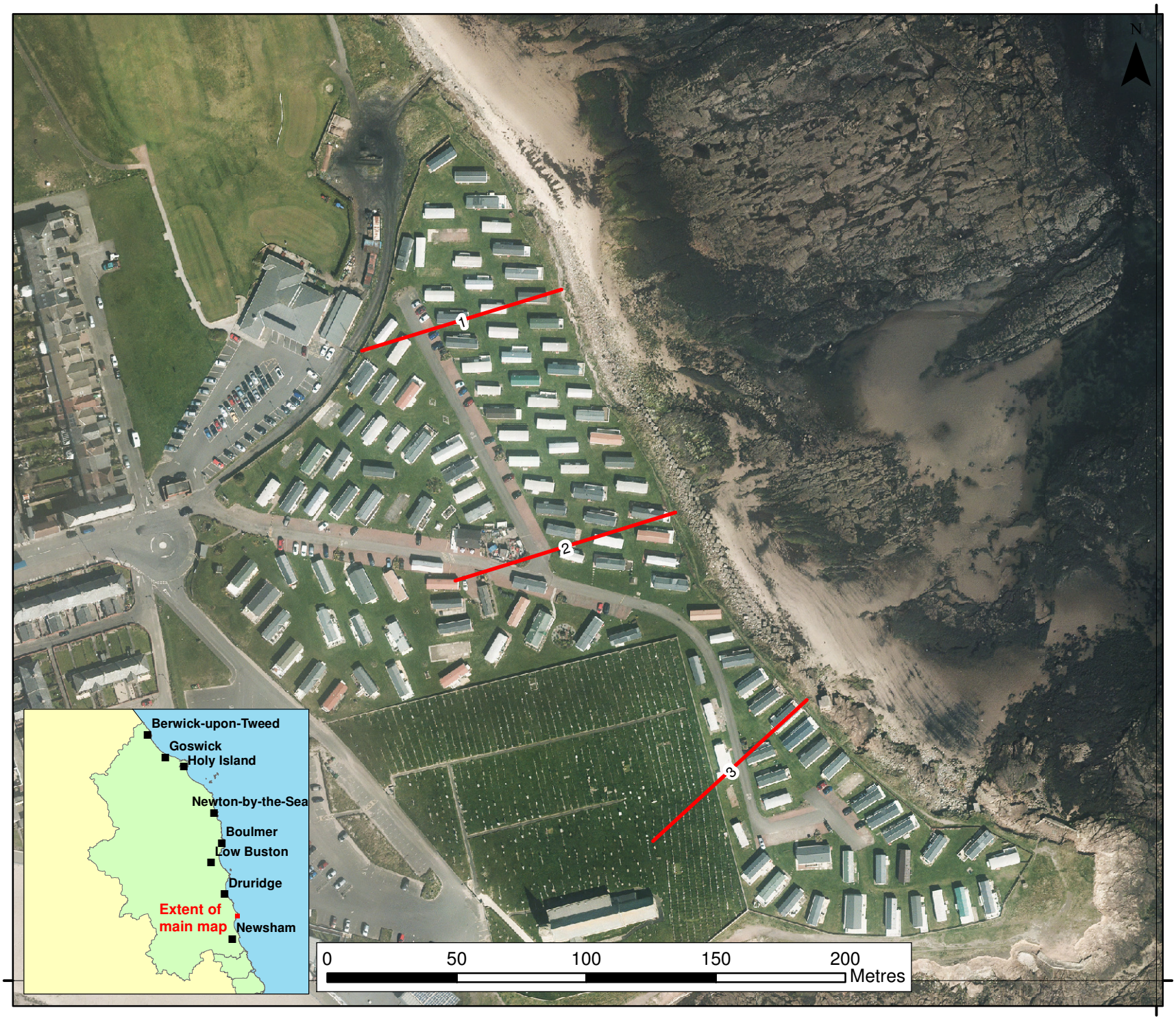
Table C3 provides baseline information about these ground control points and results from the 2008 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

**Table C3 – Cliff Top Surveys at Cambois Bay (south)**

| Ground Control Point Details | | Distance to Cliff Top (m) | | | Total Erosion (m) | | Erosion Rate (m/year) |
|---|---|---|---|---|---|---|---|
| Ref | Type | Baseline Survey (May 2009) | Previous Survey (Apr 2015) | Present Survey (Sept 2015) | Baseline (May 2009) to Present (Sept 2015) | Previous (Apr 2015) to Present (Sept 2015) | Baseline (May 2009) to Present (Sept 2015) |
| 6* | Dune | 74.5 | 75.2 | 85.0 | 10.5 | 9.8 | 1.6 |
| 7** | Cliff | 80 | No Data | No Data | No Data | No Data | No Data |
| 8 | Cliff | 82.62 | 80.6 | 80.7 | -1.9 | 0.1 | -0.3 |
| 9 | Cliff | 76.91 | 77.0 | 76.8 | -0.1 | -0.1 | 0.0 |
| 10 | Defended | 94.47 | 93.7 | 93.8 | -0.7 | 0.1 | -0.1 |
| 11 | Defended | 90.65 | 90.4 | 90.4 | -0.3 | 0.0 | 0.0 |
| 12 | Defended | 83.25 | 82.4 | 81.4 | -1.8 | -1.0 | -0.3 |
| 13 | Defended | 87.72 | 87.0 | 87.3 | -0.4 | 0.3 | -0.1 |
| 14 | Defended | 80.09 | 79.8 | 79.7 | -0.4 | -0.2 | -0.1 |
| 15 | Defended | 81.24 | 78.5 | 79.0 | -2.2 | 0.6 | -0.3 |
| 16 | Cliff | 71.65 | 69.9 | 69.7 | -1.9 | -0.2 | -0.3 |
| 17 | Cliff | 81.5 | 78.9 | 78.4 | -3.1 | -0.5 | -0.5 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18 | Cliff | 85.72 | 84.0 | 84.0 | -1.8 | 0.0 | -0.3 |
| 19 | Cliff | 81.48 | 79.8 | 79.9 | -1.6 | 0.1 | -0.3 |
| 20 | Dune | 71.04 | 69.2 | 68.8 | -2.3 | -0.4 | -0.4 |
| 21 | Dune | 75.11 | 69.8 | 69.8 | -5.3 | 0.0 | -0.8 |
| 22 | Dune | 78.69 | 72.0 | 72.0 | -6.6 | 0.0 | -1.0 |
| 23 | Dune | 86.59 | 75.9 | 75.8 | -10.8 | -0.1 | -1.7 |
| 24 | Dune | 87.99 | 79.4 | 78.5 | -9.4 | -0.8 | -1.5 |
| 25 | Dune | 78.24 | 76.6 | 80.1 | 1.8 | 3.5 | 0.3 |
| 26 | Dune | 67.08 | 63.8 | 63.9 | -3.2 | 0.0 | -0.5 |
| 27 | Dune | 61.31 | 62.2 | 62.2 | 0.9 | -0.1 | 0.1 |
| 28 | Dune | 55.83 | 55.7 | 55.8 | 0.0 | 0.1 | 0.0 |
| 29 | Dune | 57.66 | 55.6 | 55.7 | -2.0 | 0.1 | -0.3 |
| 30 | Dune | 56.66 | 56.6 | 56.3 | -0.3 | -0.2 | 0.0 |
| 31 | Dune | 63.03 | 64.6 | 64.6 | 1.6 | 0.0 | 0.3 |
| 32 | Dune | 68.35 | 67.5 | 67.5 | -0.9 | 0.0 | -0.1 |
| 33 | Dune | 65.17 | 63.6 | 63.3 | -1.9 | -0.3 | -0.3 |
| 34 | Dune | 60.34 | 59.2 | 59.1 | -1.2 | -0.1 | -0.2 |
| 35 | Cliff | 42.21 | 40.2 | 40.1 | -2.1 | -0.1 | -0.3 |
| 36 | Defended | 129.88 | 129.9 | 129.9 | 0.0 | 0.0 | 0.0 |
| 37 | Defended | 113.71 | 113.7 | 113.8 | 0.0 | 0.0 | 0.0 |
| 38*** | Defended | 101.81 | No Data | No Data | No Data | No Data | No Data |
| 39 | Defended | 111.71 | 111.7 | 111.7 | 0.0 | 0.0 | 0.0 |
| 40 | Defended | 109.02 | 109.0 | 108.9 | -0.1 | -0.1 | 0.0 |
| 41 | Defended | 94.35 | 94.4 | 94.3 | -0.1 | -0.1 | 0.0 |

* Apparent advance at transect 6 likely attributable to difficulty identifying true cliff edge.
** No data at transect 7 due to gap in cliffline.
*** Baseline for transect 38 is October 2010.




**KEY**

Transects

Client: North East Coastal Group

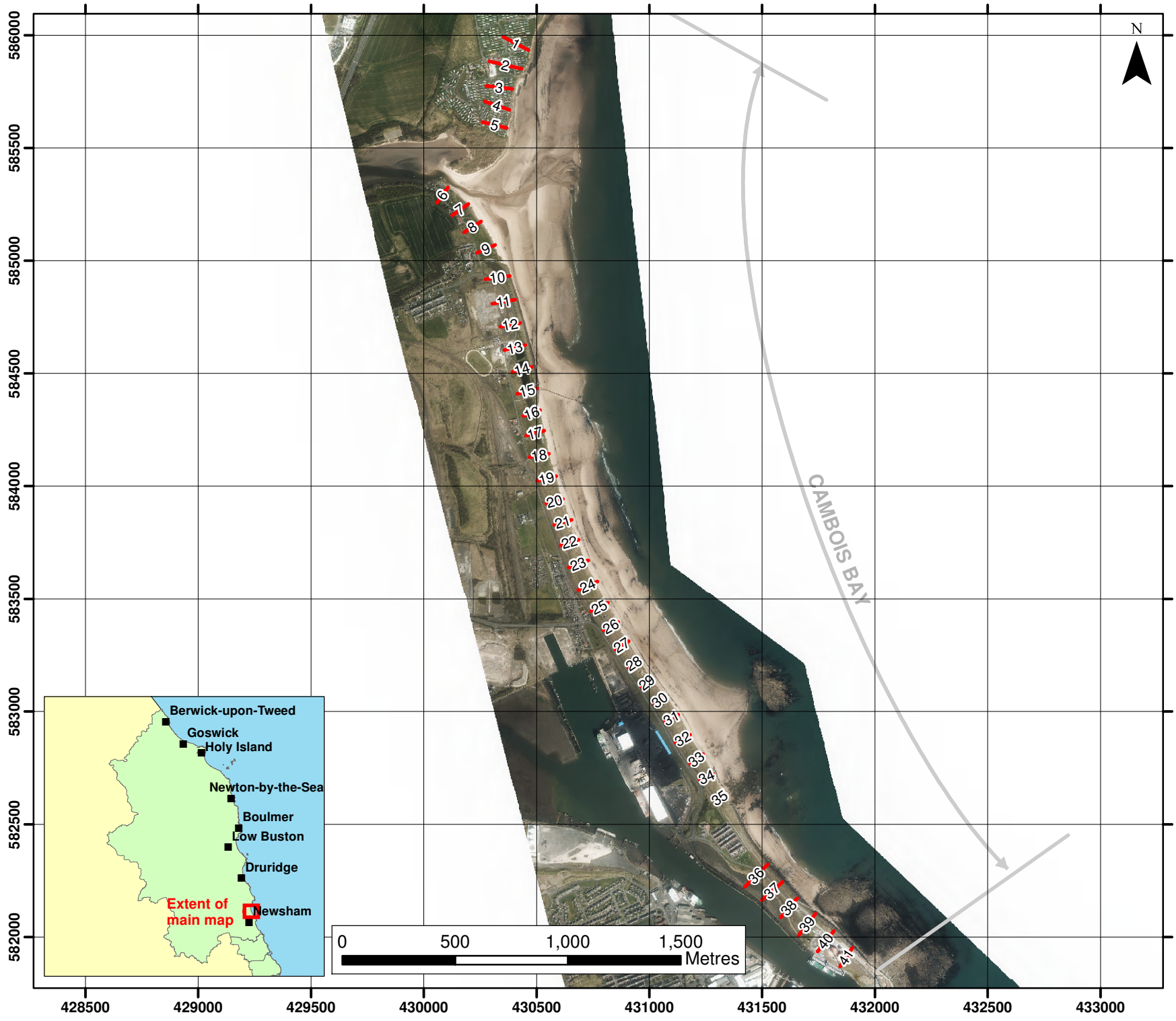
Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

**Appendix C - Map 1**
**Cliff Top Survey**
**Lynemouth Bay**
**Northumberland**
**County Council**

Analytical Report 8
Full Measures Survey
Autumn 2015


Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com




**KEY**

Transects

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

**Appendix C - Map 2**
**Cliff Top Survey**
**Cambois Bay**
**Northumberland**
**County Council**

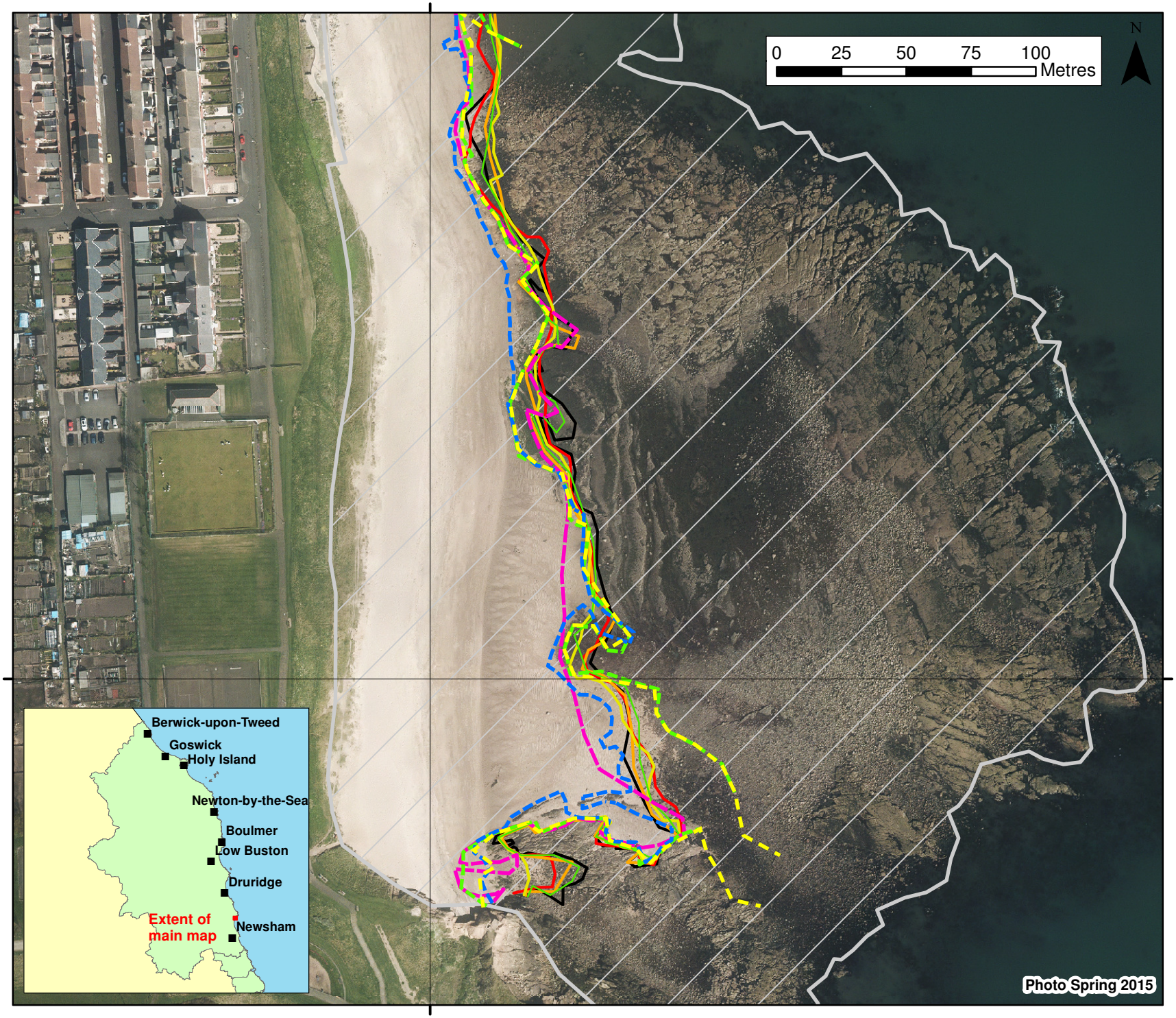
Analytical Report 8
Full Measures Survey
Autumn 2015


Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com

# Appendix D

# Sand Extent Survey




**KEY**

- Extent of sand (Autumn 2011)
- Extent of sand (Spring 2012)
- Extent of sand (Autumn 2012)
- Extent of sand (Spring 2013)
- Extent of sand (Autumn 2013)
- Extent of sand (Spring 2014)
- Extent of sand (Autumn 2014)
- Extent of sand (Spring 2015)
- Extent of sand (Autumn 2015)
- Extent of SSSI

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

# Appendix D- Map 1
# Sand Extent Survey
# Newbiggin Bay
# Northumberland County Council

Analytical Report 8
Full Measures Survey
Autumn 2015

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.ch2m.com

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