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

North Tyneside Council

North Tyneside Council
Final Report

February 2016

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Abbreviations and Acronyms

Acronym / Abbreviation	Definition
AONB	Area of Outstanding Natural Beauty
DGM	Digital Ground Model
HAT	Highest Astronomical Tide
LAT	Lowest Astronomical Tide
MHWN	Mean High Water Neap
MHWS	Mean High Water spring
MLWS	Mean Low Water Neap
MLWS	Mean Low Water spring
m	metres
ODN	Ordnance Datum Newlyn

Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (m AOD)
	River Tyne
1 in 200 year	3.7
HAT	3.1
MHWS	2.4
MLWS	-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.

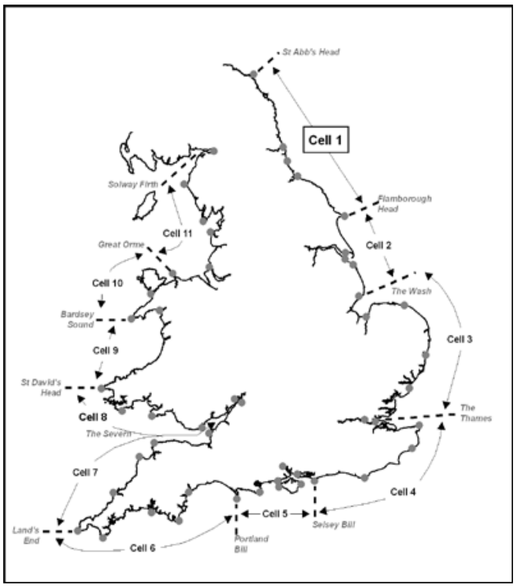


Figure 1 Sediment Cells in England and Wales

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:

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 to 2016.

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

(*) The present report is **Analytical Report 8** and provides an analysis of the 2015 Full Measures survey for North Tyneside Council's frontage.

In addition, separate reports are produced for other elements of the programme as and when specific components are undertaken, such as wave data collection, bathymetric and sea bed sediment data collection, aerial photography, and walk-over visual inspections.

For purposes of analysis, the Cell 1 frontage has been split into the sub-sections listed in the Table 2.

Table 2 Sub-divisions of the Cell 1 Coastline

Authority	Zone
Northumberland County Council	Spittal A
	Spittal B
	Goswick Sands
	Holy Island
	Bamburgh
	Beadnell Village
	Beadnell Bay
	Embelton Bay
	Boulmer
	Alnmouth Bay
	High Hauxley and Druridge Bay
	Lynemouth Bay
	Newbiggin Bay
	Cambois Bay
	Blyth South Beach
North Tyneside Council	Whitley Sands
	Cullercoats Bay
	Tynemouth Long Sands
	King Edward's Bay
South Tyneside Council	Littehaven Beach
	Herd Sands
	Trow Quarry (incl. Frenchman's Bay)
	Marsden Bay
Sunderland Council	Whitburn Bay
	Harbour and Docks
	Hendon to Ryhope (incl. Halliwell Banks)
Durham County Council	Featherbed Rocks
	Seaham
	Blast Beach
	Hawthorn Hive
	Blackhall Colliery
Hartlepool Borough Council	North Sands
	Headland
	Middleton
	Hartlepool Bay
Redcar & Cleveland Borough Council	Coatham Sands
	Redcar Sands
	Marske Sands
	Saltburn Sands
	Cattersty Sands (Skinningrove)
	Staithes
Scarborough Borough Council	Staithes
	Runswick Bay
	Sandsend Beach, Upgang Beach and Whitby Sands
	Robin Hood's Bay
	Scarborough North Bay
	Scarborough South Bay
	Cayton Bay
	Filey Bay

1. Introduction

1.1 Study Area

North Tyneside Council's frontage extends from Hartley (just south of Blyth) in the north, to the River Tyne in the south. For the purposes of this report and for consistency with previous reporting, it has been sub-divided into four areas, namely:

- Whitley Sands
- Cullercoats Bay
- Tynemouth Long Sands
- King Edward's Bay

1.2 Methodology

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

- Full Measures survey annually each autumn/early winter comprising:
  - Beach profile surveys along eight transect lines (commenced 2002)
  - Beach profile surveys along an additional two transects (commenced 2010)
  - Topographic survey along Whitley Sands (commenced 2010)
  - Topographic survey along Tynemouth Long Sands (commenced 2011)
- Partial Measures survey annually each spring comprising:
  - Beach profile surveys along all ten transect lines (commenced 2010)

The location of these surveys is shown in Figure 1. The beach profiles and topographic survey at Tynemouth Long Sands were undertaken on the 25th October 2015 and at Whitley Bay on the 26th November 2015. The weather conditions on these dates varied between sunny and overcast but on both the weather was dry, winds were Force 2 and the sea state was calm.

All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data collection approach and file format is comparable to that being used on other regional coastal monitoring programmes, such as in the South East and South West of England.

Upon receipt of the data from the survey team, they are quality assured and then uploaded onto the programme's website for storage and availability to others and also input to SANDS and GIS for subsequent analysis.

The Analytical Report is then produced following a standard structure for each authority. This involves:

- description of the changes observed since the previous survey and an interpretation of the drivers of these changes (Section 2);
- documentation of any problems encountered during surveying or uncertainties inherent in the analysis (Section 3);
- recommendations for 'fine-tuning' the programme to enhance its outputs (Section 4); and
- providing key conclusions and highlighting any areas of concern (Section 5).

Data from the present survey are presented in a processed form in the Appendices.

1.2 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.

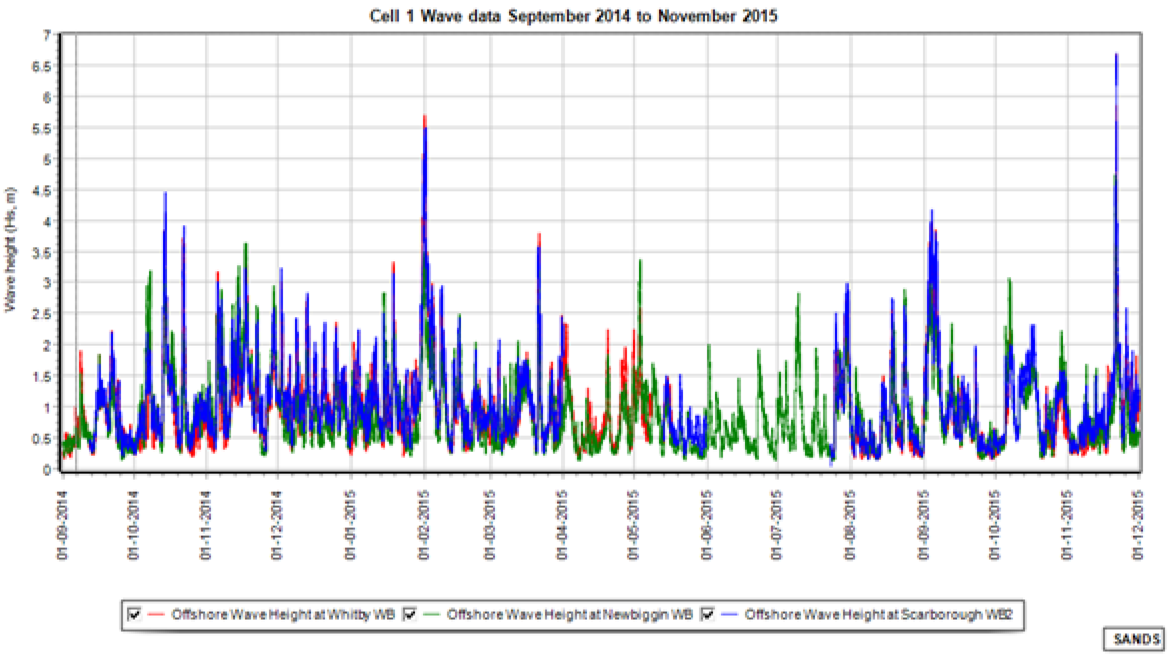


Figure 3 Wave monitoring data from the three Cell 1 wave buoys

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 2.1 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

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)
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
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. The Tynemouth Long Sands beach profile and topographic surveys were undertaken nearly two months after the 3rd/4th September 2015 storm, and well before the 21st November 2015 storm, therefore the latter of these storms could not have affected sediment redistribution evidenced in these surveys, and it is difficult to draw definitive conclusions about the influence of the earlier storm. However, the beach profiles and the short term difference plot at Tynemouth Long Sands do show a draw-down of material from the upper beach to the foreshore, which could be a lingering signature of the 3rd/4th September storm.

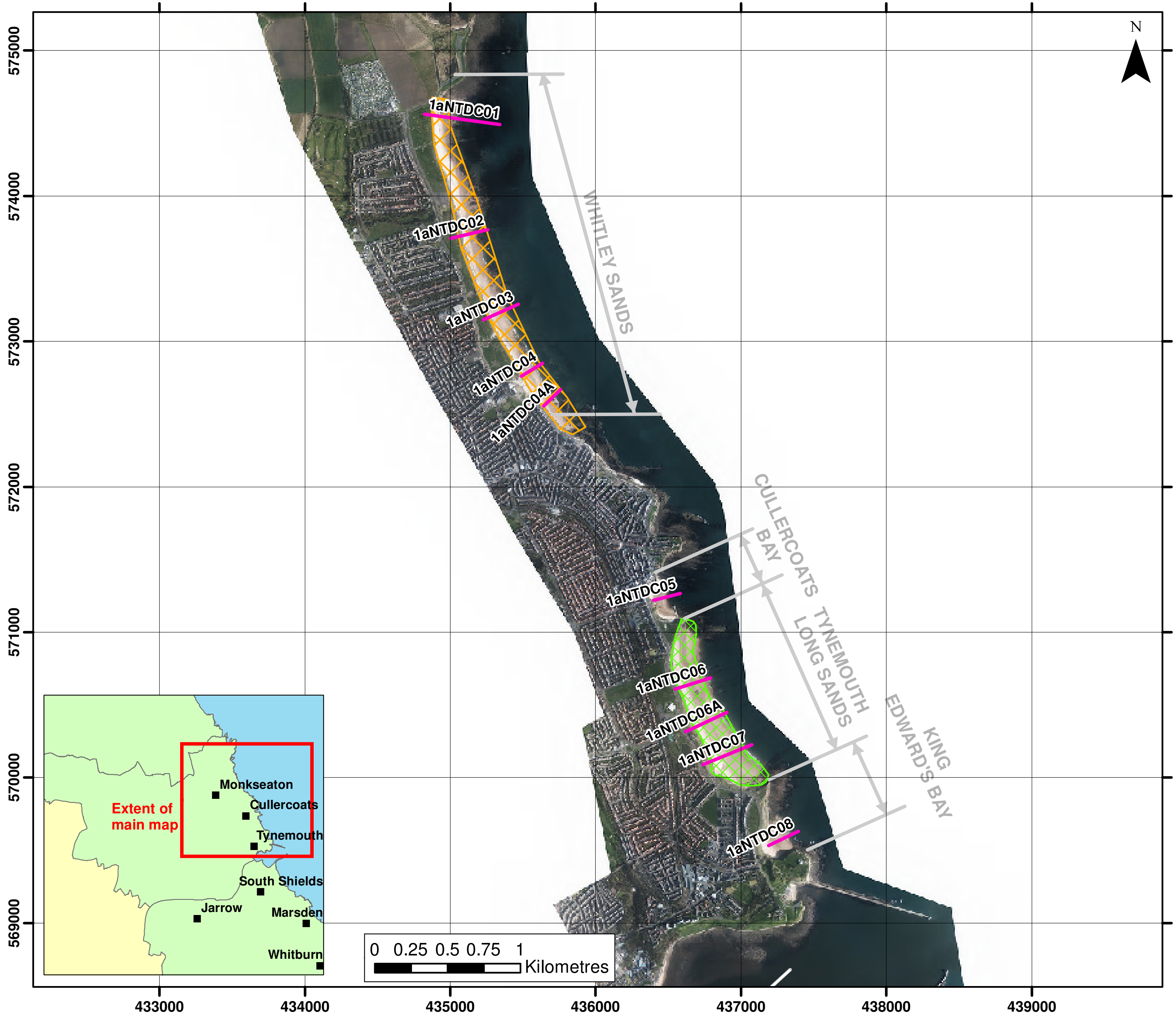
The beach profiles and topographic surveys in Whitley Bay were undertaken less than one week after the 21st September 2015 storm. The topographic survey in Whitley Bay shows erosion at the back of the beach, deposition in the foreshore and more accretion in the south of the bay than the north. As such, it is probable 21st November storm strongly influenced this redistribution of sediment, given its northerly (356°) peak wave direction.

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
Whitley Sands
to King Edward's Bay
North Tyneside Council

Analytical Report 8
Full Measures Survey
Autumn 2015

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

2. Analysis of Survey Data

2.1 Whitley Sands

<table>
<tr><th>Survey Date</th><th>Description of Changes Since Last Survey</th><th>Interpretation</th></tr>
<tr><td>Nov 2015</td><td> Beach Profiles:
Whitley Sands is covered by five beach profile lines for the Full Measures survey (Appendix A). Four of these (1aNTDC01 to 1aNTDC04) were initially surveyed in April 2002 and were surveyed annually to 2009 (Full Measures, autumn 2009) and bi-annually thereafter. From March 2010 (Partial Measures, spring 2010) onwards, an additional beach profile line (NTDC04A) has been surveyed at the southern end of the frontage. All profiles were last surveyed in March 2015 for the Partial Measures survey.
1aNTDC01 is located in the north of Whitley Sands, along the undefended cliffs immediately south of Trinity Road car park. A small depression present at the cliff toe during the last survey has infilled with c.0.5m of sediment, but seaward of here the beach level has fallen by up to 0.6m, as far as 110m chainage. Seaward of 110m chainage there has been very little change since the last survey. Beach levels are at medium to high level compared to earlier surveys.
Profile 1aNTDC02 is located in the northern part of Whitley Sands. A seawall is present at the back of the beach. Changes in beach elevation of up to 0.3m have occurred throughout the profile, with accretion between 60m and 70m chainage forming a berm in the upper beach, and accretion between 110m and 140m chainage forming a berm in the lower foreshore which extends the sand cover a further 5m seaward relative to the last survey, covering more of the rocky shore platform. Overall beach levels are at medium to high levels compared to earlier surveys, except in the lower foreshore where they are at their lowest on record.
Profile 1aNTDC03 is located at the centre of Whitley Sands. Beach levels have fallen by up to 0.5m between the seawall and 60m chainage but have increased seaward of here by up to 0.8m to bury the rocks that were exposed at c.90m chainage in the previous survey and form a berm with its crest at c.95m chainage in the foreshore. Survey photographs show exposed sand and gravel and some </td><td> Since the last survey, the profiles in the northern part of the frontage have experienced a limited movement of sediment towards the upper beach and the foreshore has remained low. This trend is reversed in the south of the bay where upper beach levels have tended to fall significantly and the foreshore has accreted, in some instances burying the shore platform.
Longer term trends: Beach levels are mostly within the range seen in earlier surveys. The exception is the north-central part of the bay around 1aNTDC02 where the lower foreshore is at its lowest level on record. </td></tr>
</table>

Survey Date	Description of Changes Since Last Survey	Interpretation
	standing water (see Plate 1) landward of this berm. Compared to earlier surveys, the upper beach is at a medium to low level and the lower foreshore is at a medium level. Profile **1aNDC04** is located in the southern part of Whitley Sands. Beach levels between the seawall and the exposed shore platform at 55m chainage have fallen by up to 0.7m to remove the sandy berm that was previously evident here and gravel-cobble storm deposits are now present in the upper beach (see Plate 2). Between 55m and 75m chainage the shore platform continues to be exposed (see Plate 3). However, seaward of 75m chainage to the end of the profile beach elevations have increased by up to 0.7m. Overall the upper beach is at medium to low level compared to earlier surveys and the lower foreshore is at a medium level. Profile **1aNTDC04a** is located towards the southern end of Whitley Sands. In front of the seawall, the upper beach has fallen by up to 0.8m as far as 12-13m chainage. Seaward of this the beach level has increased by up to 0.8m to bury all but the most prominent part of the shore platform. Despite this change, compared to earlier survey the profile remains only at medium-low levels throughout the vast majority of the profile.	
Nov 2015	**Topographic Survey:** Whitley Sands is covered by an annual topographic survey, which commenced in October 2010. 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 GIS. A difference plot has also been produced using the DGM (Appendix B – Map 1b) produced from the last produced topographic survey (Full Measures, autumn 2014) and the present survey. The difference plot shows a greater extent of erosion in the northern part of the bay, except in the upper beach where accretion has occurred. In the central and southern parts of the bay there is a continuous strip of erosion in the upper beach which is mirrored by a near-continuous band of accretion of up to c.1m in lower foreshore. Whilst this is a comparison of annual surveys, rather than a biannual comparison like the beach profiles, the changes observed in the detailed profiles support this pattern of change in the bay as whole, indicating that much of this change is likely to have happened in the last six months. **Longer Term Topographic Trends autumn 2010 to autumn 2015:**	The topographic survey indicates there to have been a movement of sediment towards the foreshore of the southern end of the bay. In the last Full Measures survey (autumn 2014), a northerly movement of sediment was recorded, suggesting beaches respond to storm directions that dominate over the monitoring period. **Longer term topographic trends autumn 2010 to autumn 2014:** The long term difference plot shows an increase in beach levels in the north of bay, a mixture of erosion and deposition in the central part of the bay and the most intense erosion on the foreshore and the southern part of the bay. This is different from the short term difference plot which indicates a movement of sediment towards the foreshore and the southern end of the bay. This

Survey Date	Description of Changes Since Last Survey	Interpretation
	The long term difference plot (Appendix B – Map 1c) shows the net change in beach levels between autumn 2010 and autumn 2014. Over the long term beach levels (particularly upper beach levels) are much higher (up to 2m) in the northern part of the bay, there is a mixture of erosion and deposition in the central part of the bay and the most intense erosion (up to 1m) is on the foreshore and at the southernmost end of the bay.	indicates significant interannual variation in beach form.

Plate 1 – Survey photograph 1aNTDC03_20151126_N6

Plate 2 – Survey photograph 1aNTDC04_20151126_N3

Plate 3 – Survey photograph 1aNTDC04_20151126_N8

2.2 Cullercoats Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2015	**Beach Profiles:** Cullercoats Bay is covered by one beach profile line for the Full Measures survey (Appendix A). This was surveyed annually each autumn between 2002 and 2009. From spring 2010 onwards, it has been surveyed bi-annually. At profile 1aNTDC05 the survey report notes '*cliff not measured at section 5 due to dangerous access*' as it has done in previous surveys. Only minimal changes (<0.2m) in beach elevation have occurred, with the beach between the cliff toe and 85m eroding slightly, and the foreshore seaward of this accreting slightly.	As in previous surveys access to the cliff has not been possible. The data shows only limited change, related to short-term patterns of sediment movement. **Longer term trends:** The amount of change is low and the profile is within the past range. The upper beach is currently high, whereas the lower beach is at its lowest level and a bar seen in earlier surveys is absent.

2.3 Tynemouth Long Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2015	**Beach Profiles:** Tynemouth Long Sands is covered by three beach profile lines for the Full Measures survey (Appendix A). Profiles 1aNTDC06 and 1aNTDC07 were initially surveyed annually each autumn between 2002 and 2009. A third profile, 1aNTDC06A, was then added in the centre of the frontage. From spring 2010 (Partial Measures) onwards, all profiles have been surveyed bi-annually. **1aNTDC06** is located approximately 150m south of the access ramp towards the north of the bay. The top of the cliff has not changed since the last survey, however, the remainder of the cliff profile cannot be reviewed due to lack of data points in the profile plot as the survey report notes '*no access to middle of section 6 due to seed protection fences*'. The beach profile starts at c.35m chainage and shows that a berm in the upper beach between 40m and 80m chainage has been eroded by up to 0.8m to produce a shallow angled, straighter profile. Other changes are minimal except for a slight depression between 170m and 190m chainage has been infilled with up to 0.3m of sand to flatten the profile. In general the profile is relatively high compared to earlier surveys. At profile **1aNTDC06A**, the dune-cliff face has not significantly changed in form or position. As with section 6, the survey report notes '*no access to middle of section 6a due to seed protection fences*'. Between 80m chainage and 120m chainage beach levels have fallen by 0.3m to remove a subtle berm in the upper beach around HAT and MHWS. Seaward of this, the beach has accreted slightly with minimal change as far as 230m chainage, but up to 0.6m of accretion in lowermost extent of the foreshore. Profile **1aNTDC07** is located approximately 50m south of the access route through the dunes towards the southern end of the bay. The dune-cliff has not significantly changed in form or position since the last survey. As with section 6 and 6a, the survey report notes '*no access to middle of section 7 due to seed protection fences*'. Beach levels have changed little with all change <0.2m and the vast majority <0.1m.	Since the last survey the dunes have retained the same form and position with limited change on the beach **Longer term trends:** Overall, the beaches have retained a similar form but are towards the upper bound of the range of previous surveys, particularly in the foreshore.

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2015	**Topographic Survey:** The first survey was undertaken for the Full Measures survey in October 2010. Data from the current topographic survey have been used to create a digital ground model (DGM) (Appendix B – Map 2a) using a Geographical Information System (GIS). A difference plot has also been produced by comparing the current DGM (Appendix B – Map 2b) with that produced from the last topographic survey. The difference plot shows that change since the last survey (Partial Measures, spring 2015) is limited to <1m. There is a continuous strip of erosion at the back of the beach, fronted by near continuous strip of accretion in the middle beach and a more broken pattern of erosion and deposition in the lower foreshore. **Longer Term Topographic Trends autumn 2011 to autumn 2015:** The long term difference plot (Appendix B – Map 2c) shows the net change in beach levels between autumn 2011 and autumn 2015. The plot shows erosion across of <1m across the majority of the beach with shore-parallel, discontinuous strips of accretion in the middle foreshore, the upper beach in the south of the bay, at the back of the beach in the north-central part of the bay and in the lower foreshore in the north of the bay, where the accretion exceeds 1m.	The pattern shown in the difference plot corroborates the patterns identified in the profiles, and shows that sediment has been eroded from the upper beach and deposited lower down in the foreshore. Exceptions are two arcuate areas of erosion in the foreshore at the northern and southern ends of the bay, which are most likely subtle runnels which have developed as indicated in Plate 4. **Longer term topographic trends autumn 2011 to autumn 2014:** The plot shows a general reduction in beach elevation of up to 1m, with accretion concentrated in shore-parallel strips. This indicates movement of sediment across the beach as bars. Accretion of up to 1m has also occurred on the foreshore in the north of the bay. Together these patterns indicate a net drift of sediment towards the north of the bay and the lower beach. All changes are limited and inter-annual variability is large.

Plate 4 – Survey photograph 1aNTDC07_20151025_Up4

2.4 King Edward's Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2015	**Beach Profiles:** King Edward's Bay is monitored by one beach profile line for the Full Measures survey (Appendix A). This was surveyed annually between 2002 and 2009. From spring 2010 onwards, it has been surveyed bi-annually. At profile **1aNTDC08** between a chainage of 15m and 70m the beach level has fallen by up to 0.5m, reducing the prominence of a berm that was present here in the previous survey. Seaward of this, the foreshore has accreted by up to 0.9m, increasingly so towards the toe of the profile.	Since the last survey, the beach at King Edward's Bay has attained a shallower gradient as material has been redistributed towards the lower beach. **Longer term trends:** The profile is mostly within the range of previously observed profiles at this location, with the exception of that part of the profile between 150m and 175m chainage where the profile is at its highest on record. The magnitude of change in the lower foreshore suggests that additional material usually stored below MLWS may have moved to the foreshore.

3. Problems Encountered and Uncertainty in Analysis

Individual Profiles

- At profile 1aNTDC05 the cliff was not measured due to access problems. Access to this profile is noted to have been dangerous in the previous Partial Measures and Full Measures reports, and is recommended that the beach profile should start at the cliff toe and that the cliff be monitored using the aerial survey data.
- At Tynemouth Long Sands (profiles 1aNTDC06, 1aNTDC06A and 1aNTDC07) there was no access to the dunes in the middle of the profile due to seed protection fences. This means it has not yet been possible to monitor the effectiveness of the dune stabilisation scheme

Topographic Survey

At Tynemouth Long Sands, the topographic survey report notes:

- Construction work is still ongoing at the northern beach ramp.

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

It is recommended that access to the stabilised dunes at Tynemouth Long Sands be attempted in future surveys in order to monitor the effectiveness of the stabilisation fences.

5. Conclusions and Areas of Concern

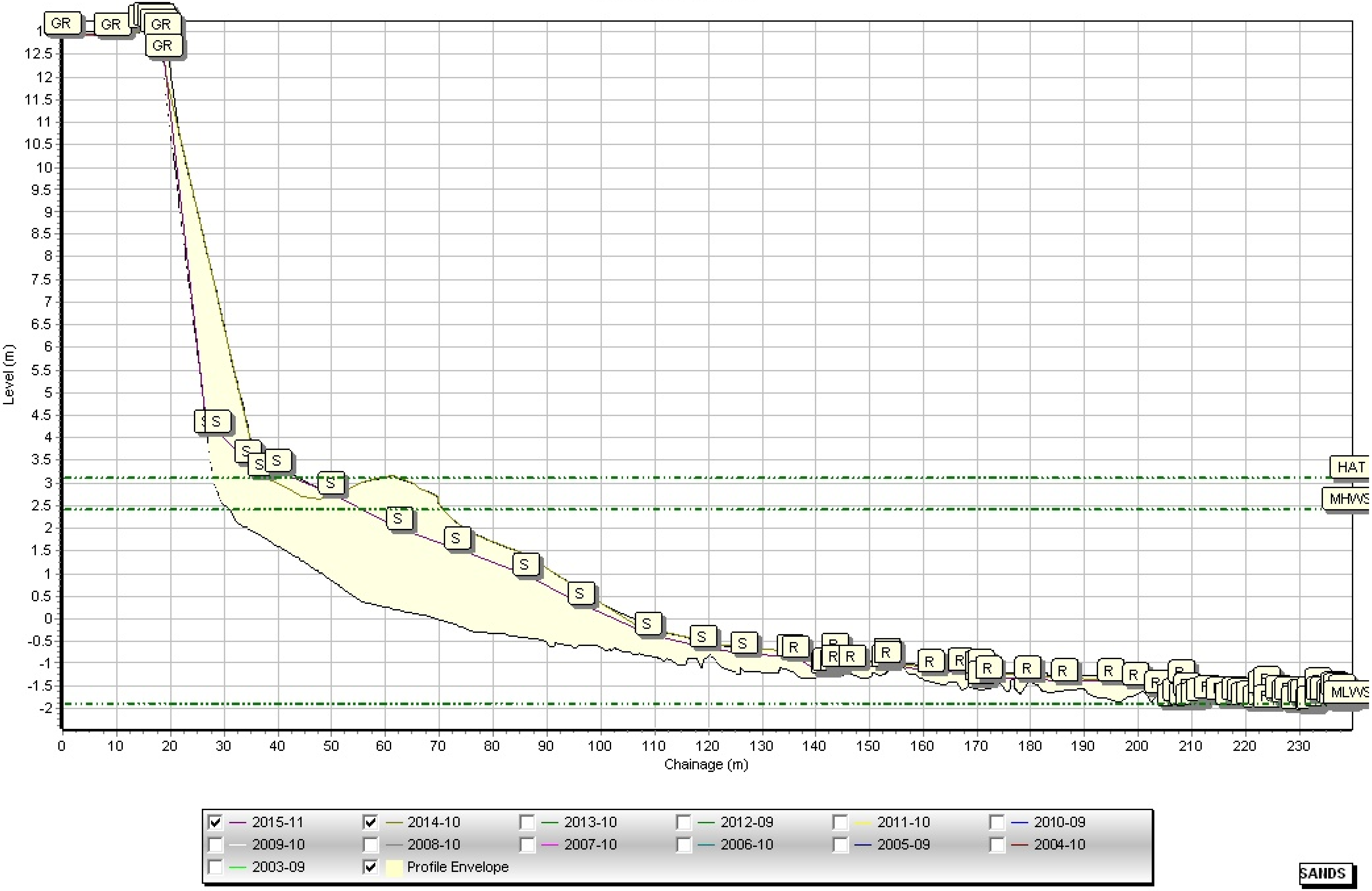
- The lower foreshore at profile 1aNTDC02 is at its lowest level on record. This is not a concern in itself but should be monitored in future reports to understand whether it represents a persistent or accelerating trend of sediment removal from this part of the bay.
- At Whitley Sands, observations have previously been made that the movement of shingle material onto/off the beach over various seasons could be cyclical. This time the shingle is not present. Whilst this is not a cause for concern, these occurrences should be monitored in future reporting to help clarify/confirm the interpretations and conclusions drawn from the beach profile analysis.
- Elsewhere along Whitley Sands, the recorded profiles present no causes for concern.
- The topographic survey indicates that sediment movements in Whitley Bay have, in general terms, 'reverted to type' with apparent sediment movement being towards the southern end of the bay.
- At Cullercoats Bay, at profile 1aNTDC05, the cliff was not measured due to dangerous access. Access to this profile is noted to have been dangerous in the previous Partial Measures and Full Measures reports, and is recommended that the beach profile should start at the cliff toe and that the cliff be monitored using the aerial survey data
- Also at profile 1aNTD05 at Cullercoats Bay the lower part of the foreshore is at its lowest level on record, but absolute elevation change between the highest and lowest beach levels is very limited here and this is not a cause for concern.
- At Tynemouth Long Sands, the recorded profiles and topographic survey show only limited change and present no cause for concern.
- At King Edward's Bay, there has been a significant increase in the elevation of the lower foreshore, possibly as a result of sediment usually stored below MLWS welding to the shoreline, as well as the drawdown of some sediment from the upper beach.

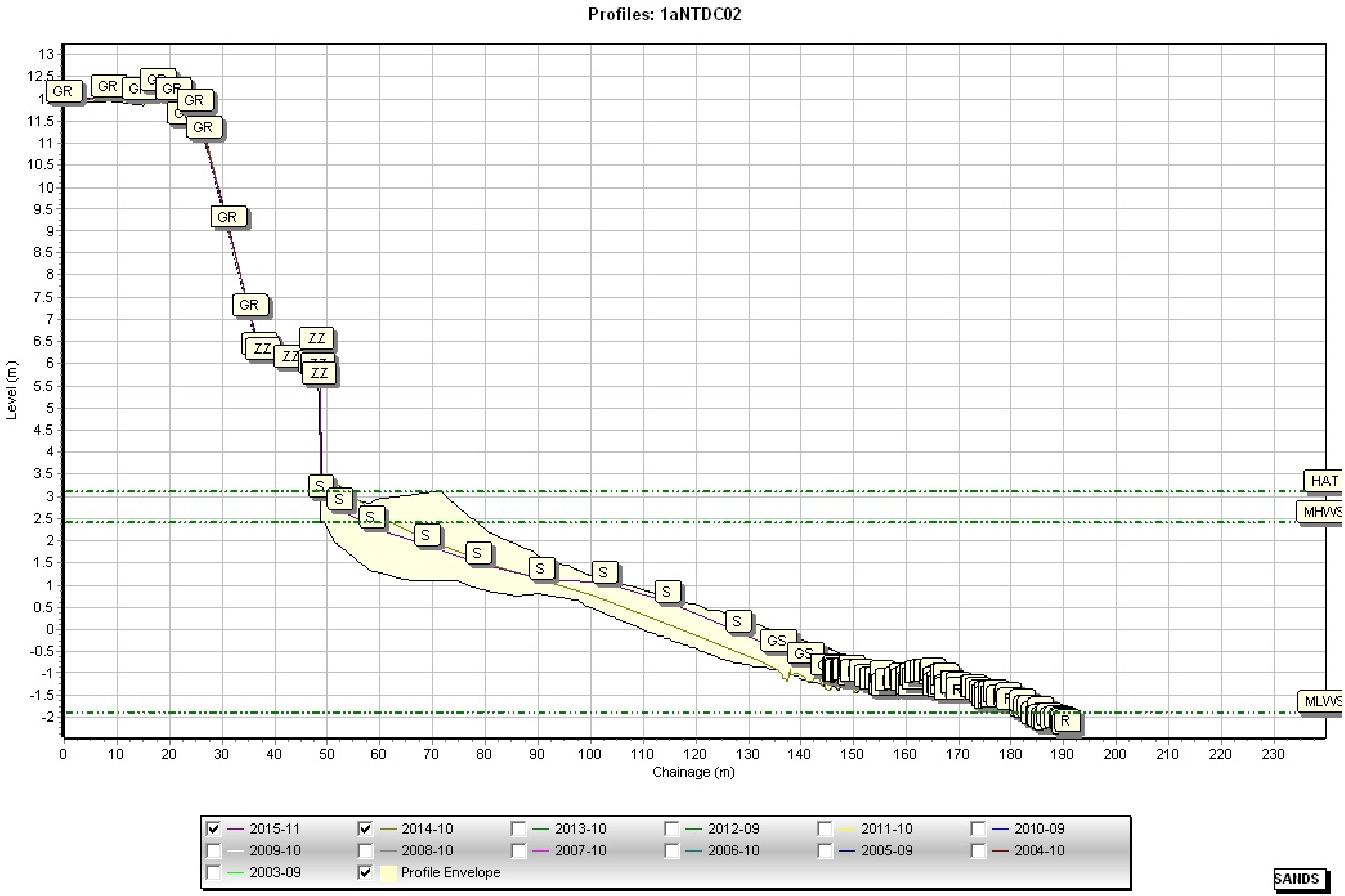
Appendices

Appendix A

Beach Profiles

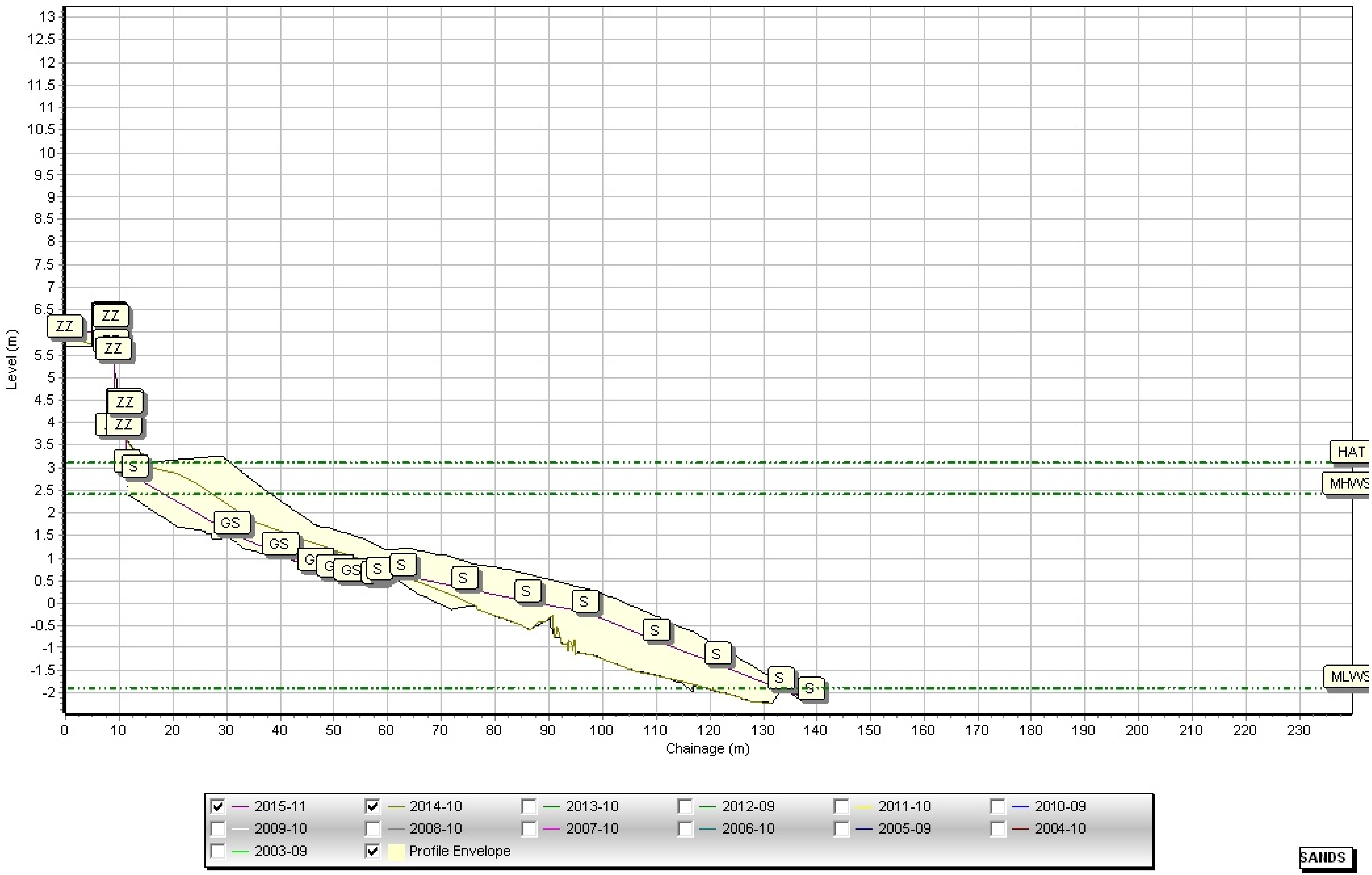
Profiles: 1aNTDC01

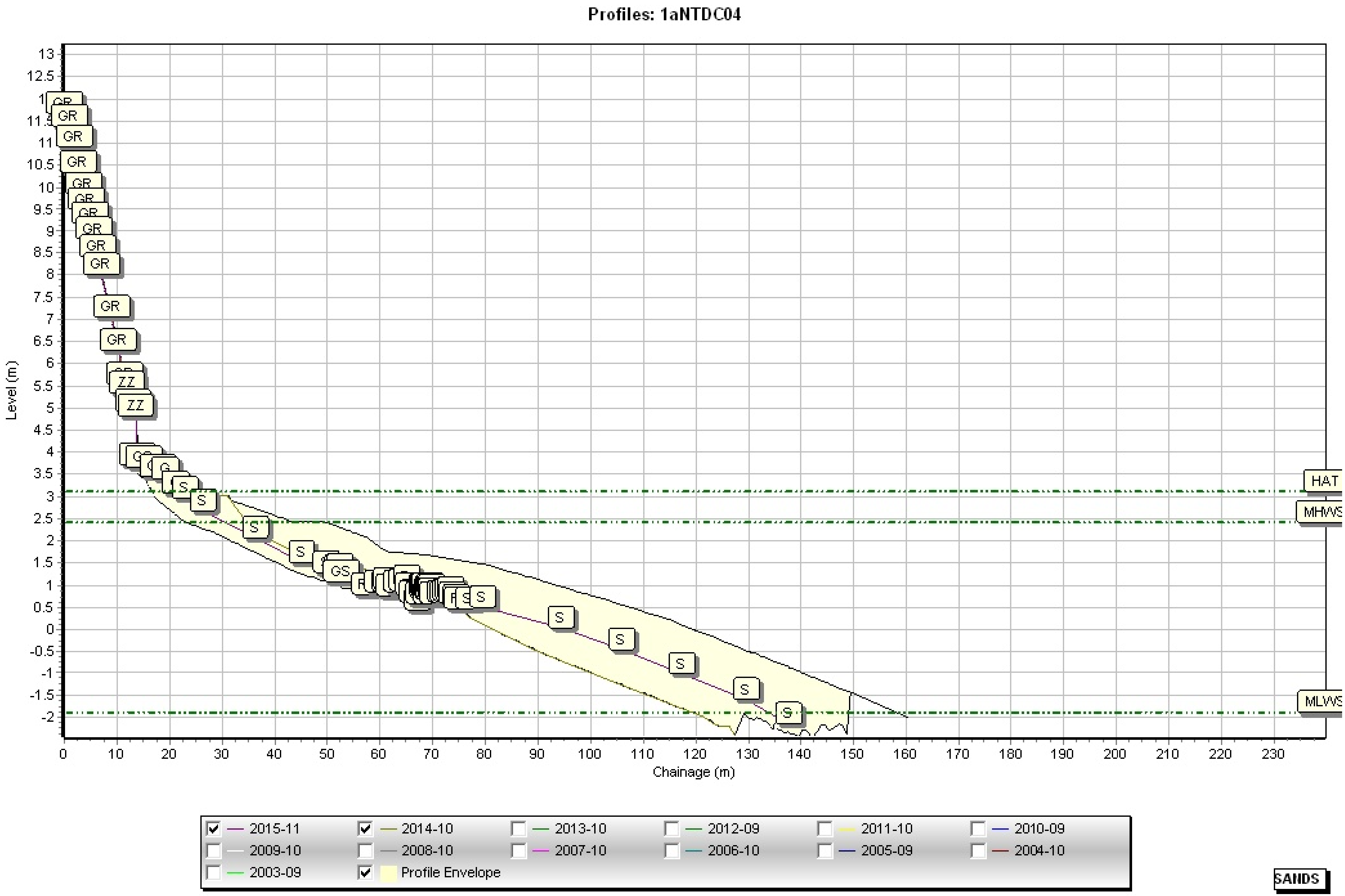




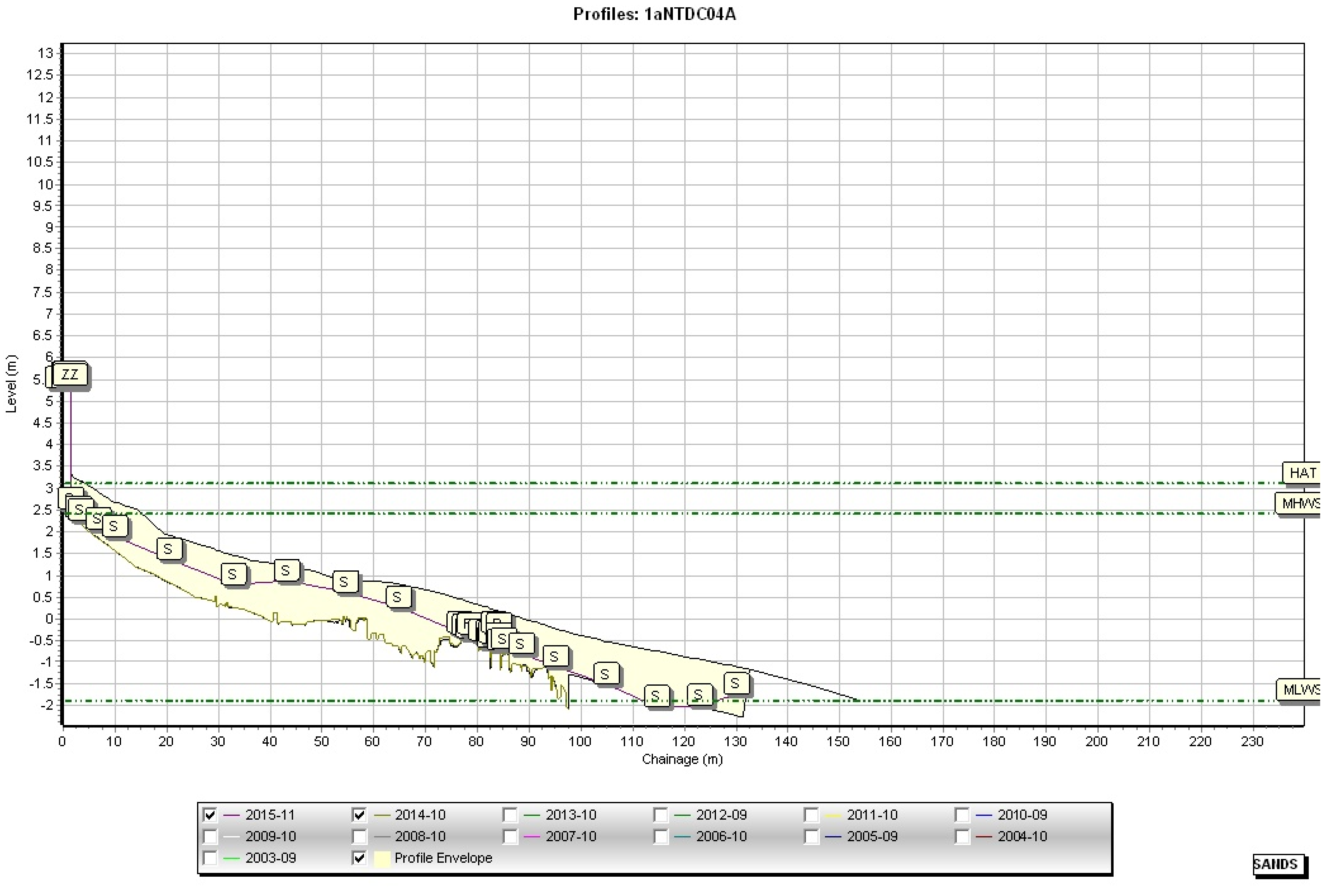
Profiles: 1aNTDC02
Level (m)
Chainage (m)
HAT
MHWS
MLWS
GR
ZZ
S
GS
R
2015-11
2014-10
2013-10
2012-09
2011-10
2010-09
2009-10
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

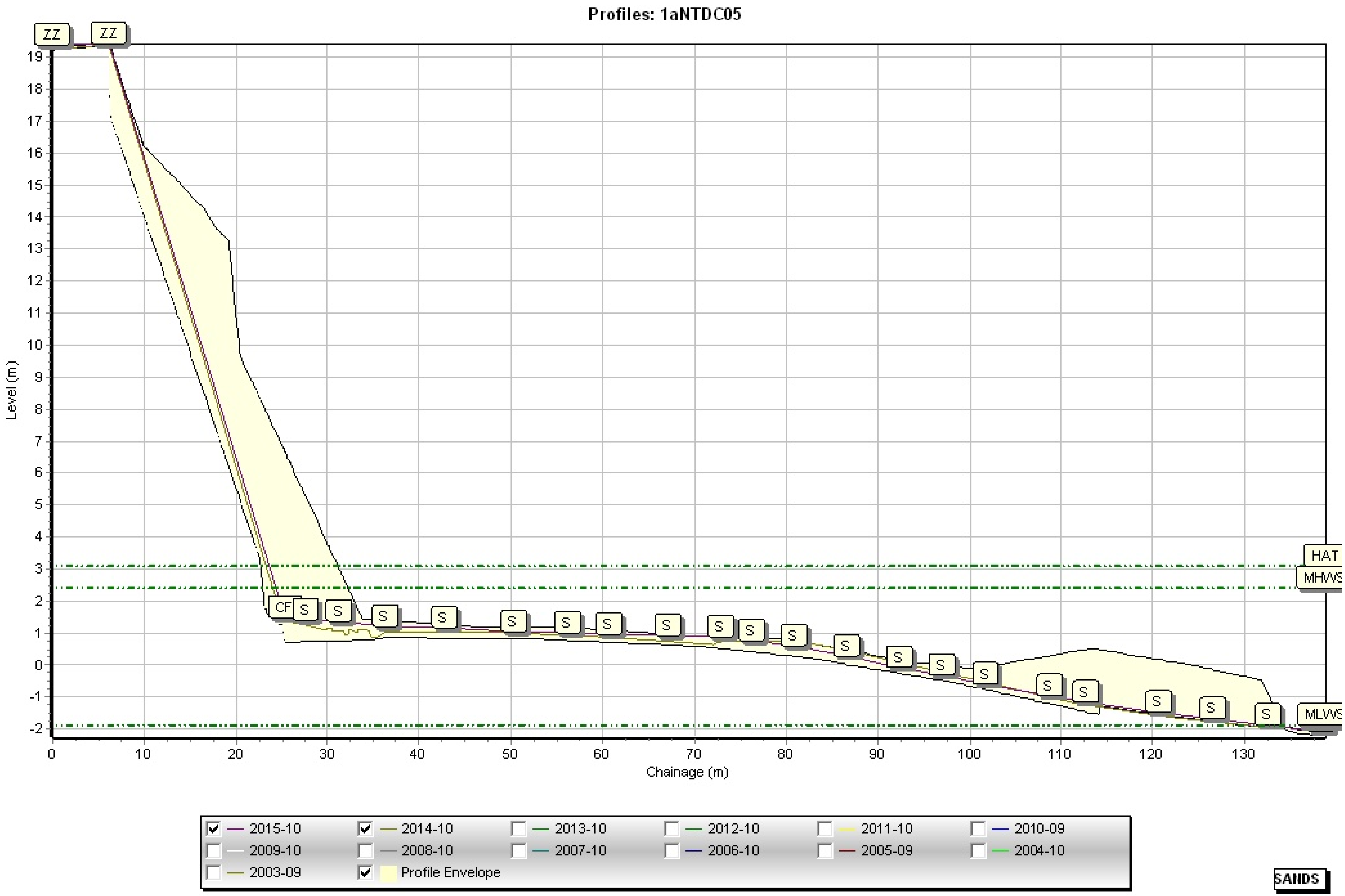
Profiles: 1aNTDC03



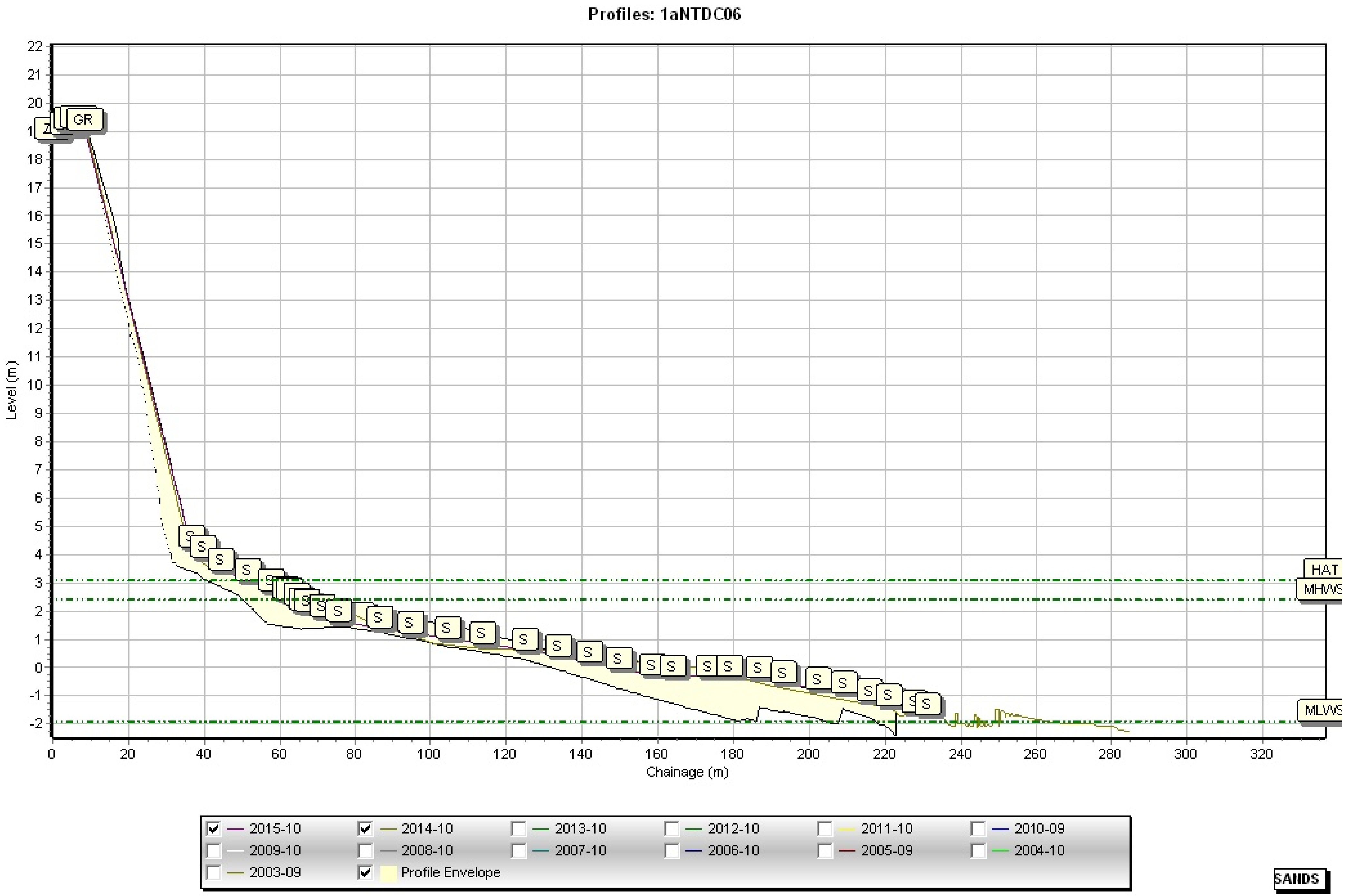


Profiles: 1aNTDC04
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-11
2014-10
2013-10
2012-09
2011-10
2010-09
2009-10
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

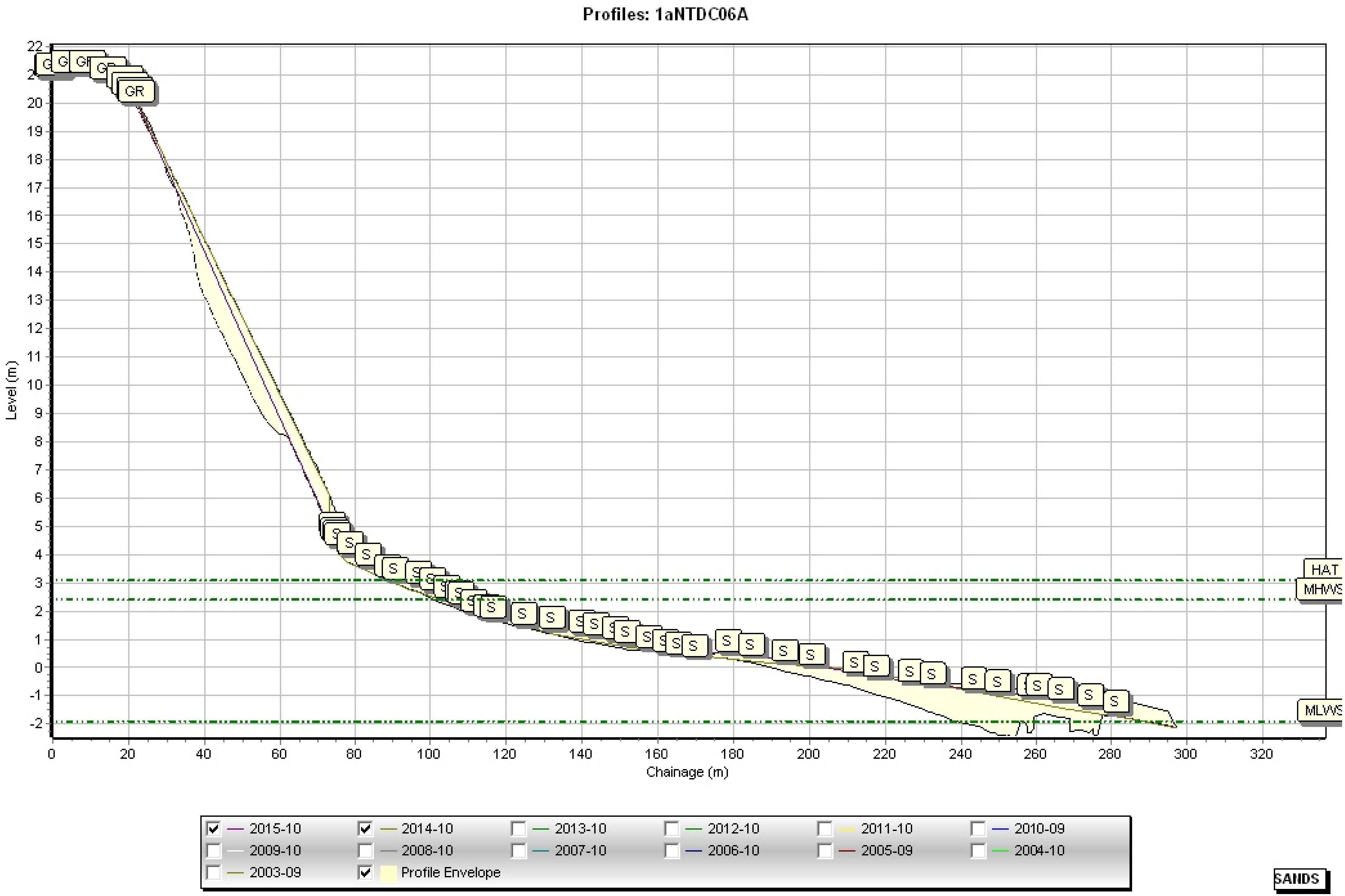

Profiles: 1aNTDC04A
Level (m)
Chainage (m)
HAT
MHWS
MLWS
ZZ
S
2015-11
2014-10
2013-10
2012-09
2011-10
2010-09
2009-10
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS



Profiles: 1aNTDC05
ZZ
ZZ
Level (m)
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Chainage (m)
HAT
MHWS
MLWS
CF
S
2015-10
2014-10
2013-10
2012-10
2011-10
2010-09
2009-10
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

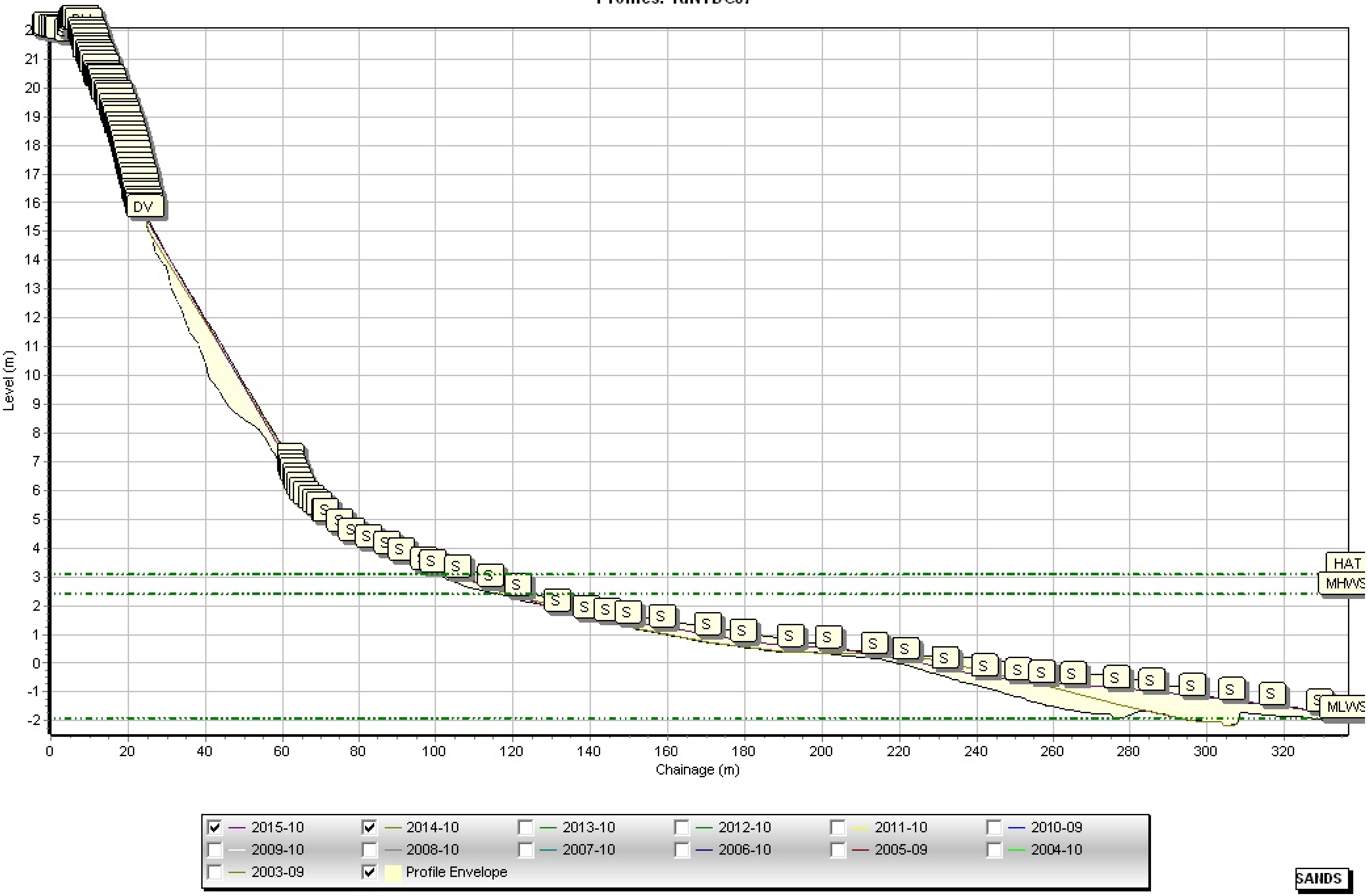


Profiles: 1aNTDC06
Level (m)
Chainage (m)
GR
S
HAT
MHWS
MLWS
2015-10
2014-10
2013-10
2012-10
2011-10
2010-09
2009-10
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

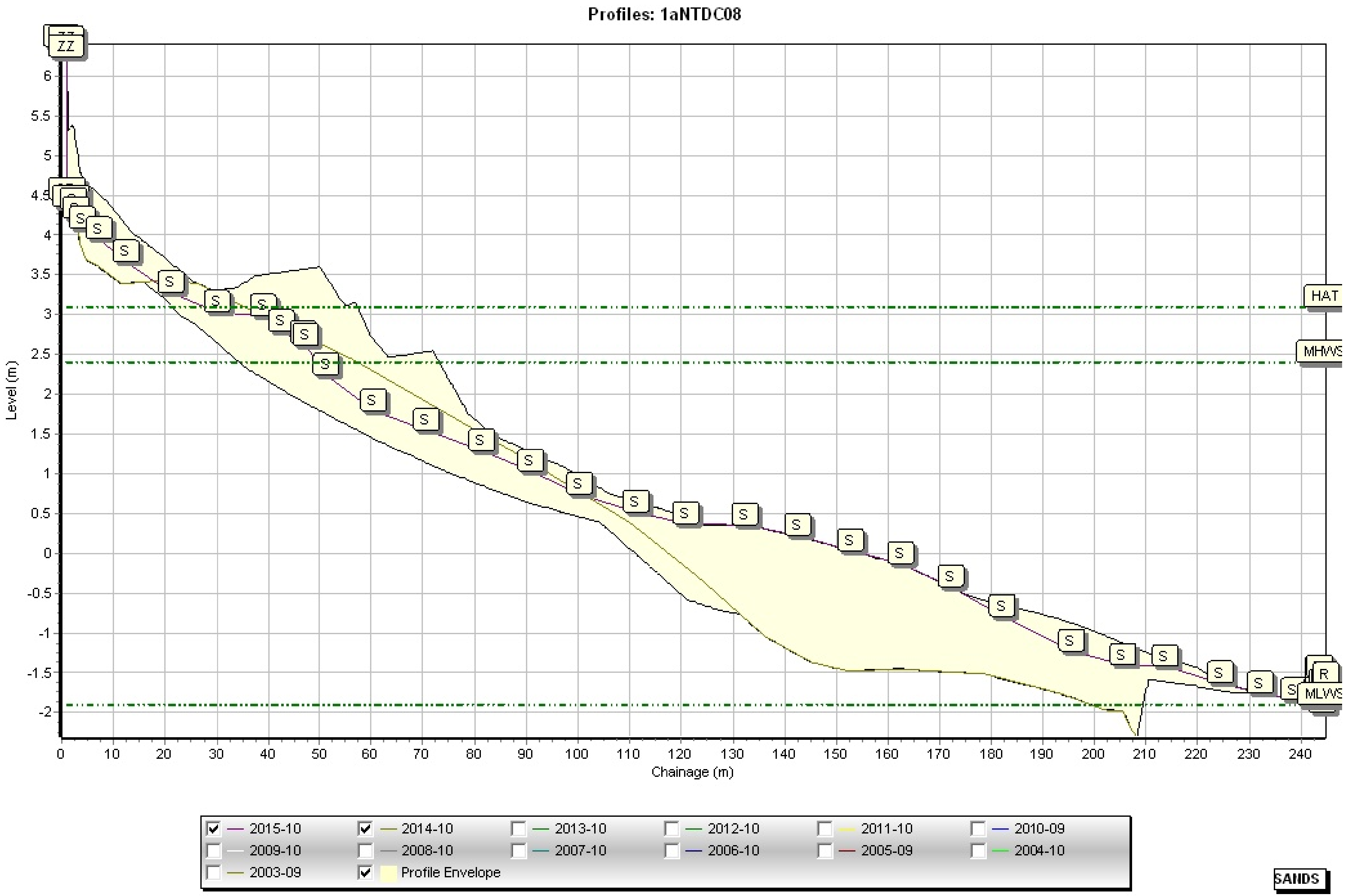


Profiles: 1aNTDC06A
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-10
2014-10
2013-10
2012-10
2011-10
2010-09
2009-10
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

Profiles: 1aNTDC07



SANDS



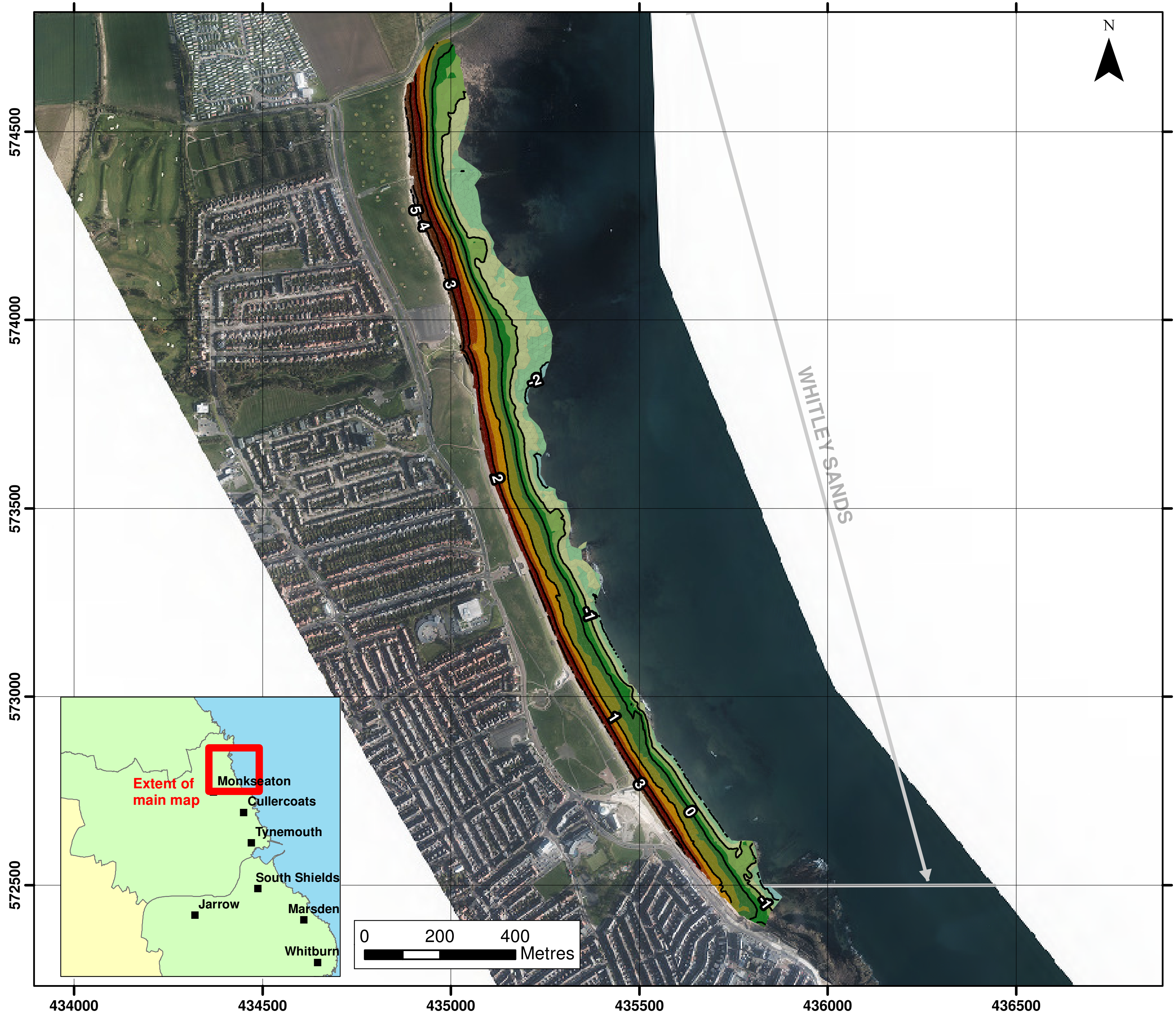
Profiles: 1aNTDC08
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2015-10
2014-10
2013-10
2012-10
2011-10
2010-09
2009-10
2008-10
2007-10
2006-10
2005-09
2004-10
2003-09
Profile Envelope
SANDS

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 - 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 1a
Topographic Survey
Whitley Sands
North Tyneside Council

Analytical Report 8
Full Measures Survey
Autumn 2018

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www.ch2m.com

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

KEY Autumn 2014 and Autumn 2015
Change in elevation (m)

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 1b
Short-term Elevation Change
Whitley Sands
North Tyneside Council

Analytical Report 8
Full Measures Survey
Autumn 2015

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

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	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 Whitley Sands North Tyneside Council

Analytical Report
Full Measures Survey
Autumn 2015

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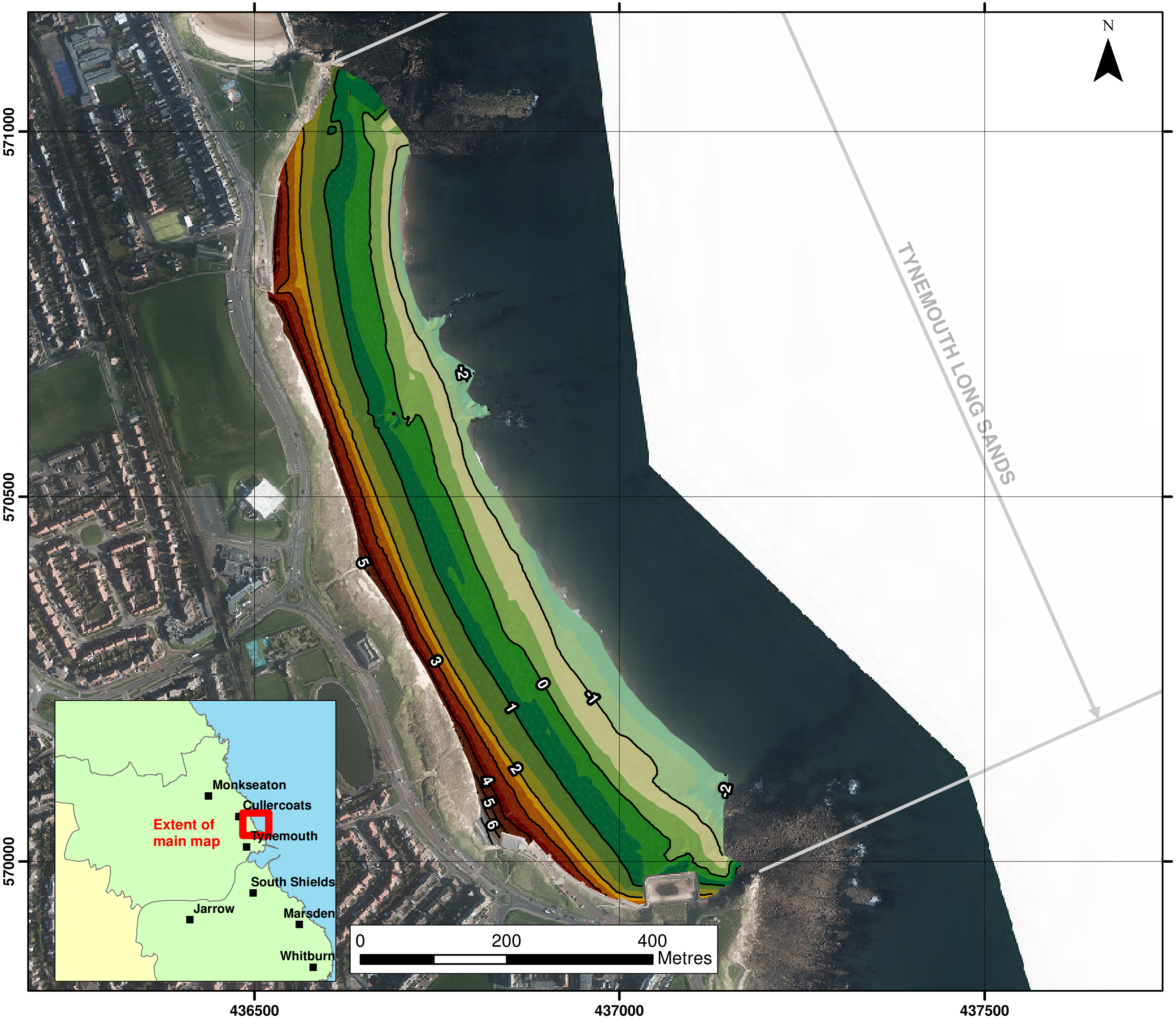
Photography courtesy of North East Coastal Observatory
www.northeastcoastalobservatory.org.uk



KEY
Elevation (m OD)

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

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B - Map 2a
Topographic Survey
Tynemouth Long Sands
North Tyneside Council

Analytical Report 8
Full Measures Survey
Autumn 2015

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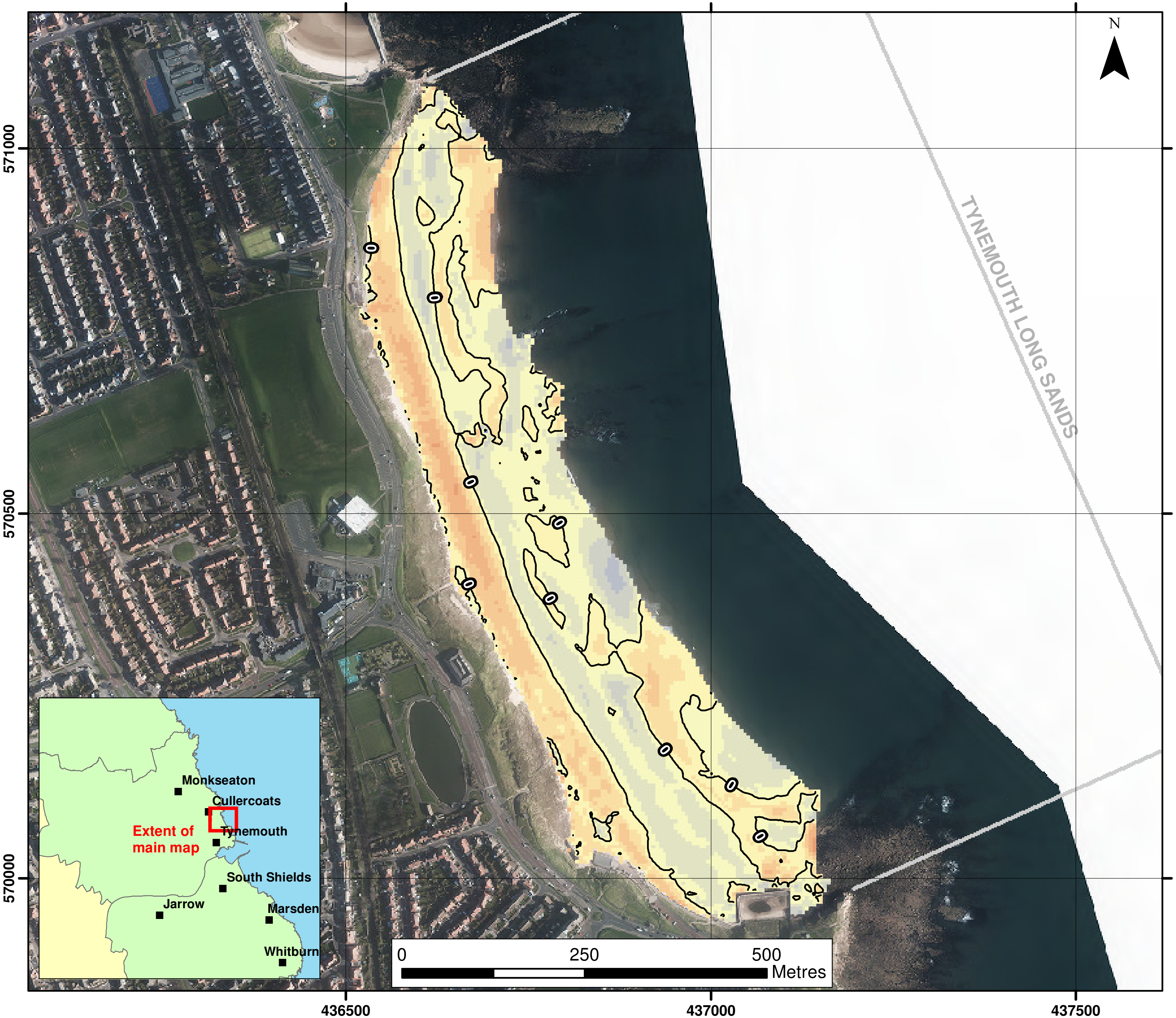

KEY

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 2b
Short-term Elevation Change
Tynemouth Long Sands
North Tyneside Council

Analytical Report 8
Full Measures Survey
Autumn 2015

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

KEY Autumn 2011 and Autumn 2015
Change in elevation (m)

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

Contours of change

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

Appendix B - Map 2c
Long-term Elevation Change Tynemouth Long Sands North Tyneside Council

Analytical Report 8
Full Measures Survey
Autumn 2015

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