



**Cell 1 Regional Coastal Monitoring Programme
Update Report 3: 'Partial Measures' Survey 2011**

Sunderland City Council

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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
m	metres
MHWN	Mean High Water Neap
MHWS	Mean High Water Spring
MLWS	Mean Low Water Neap
MLWS	Mean Low Water Spring
MSL	Mean Sea Level
ODN	Ordnance Datum Newlyn

Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (mODN)			
	River Tyne to Frenchman's Bay	Frenchman's Bay to Souter Point	Souter Point to Chourdon Point	Chourdon Point to Hartlepool Headland
1 in 200 year	3.41	3.44	3.66	3.91
HAT	2.85	2.88	3.18	3.30
MHWS	2.15	2.18	2.48	2.70
MLWS	-2.15	-2.12	-1.92	-1.90
Water Level Parameter	Water Level (mODN)			
	Hartlepool Headland to Saltburn Scar	Skinningrove	Hummersea Scar to Sandsend Ness	Sandsend Ness to Saltwick Nab
1 in 200 year	3.87	3.86	4.1	3.88
HAT	3.25	3.18	3.15	3.10
MHWS	2.65	2.68	2.65	2.60
MLWS	-1.95	-2.13	-2.15	-2.20
Water Level Parameter	Water Level (mODN)			
	Saltwick Nab to Hundale Point	Hundale Point to White Nab	White Nab to Filey Brigg	Filey Brigg to Flamborough Head
1 in 200 year	3.88	3.93	3.93	4.04
HAT	3.10	3.05	3.05	3.10
MHWS	2.60	2.45	2.45	2.50
MLWS	-2.20	-2.35	-2.35	-2.30

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

Glossary of Terms

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

Preamble

The Cell 1 Regional Coastal Monitoring Programme covers approximately 300km of the north east coastline, from the Scottish Border (just south of St. Abb's Head) to Flamborough Head in East Yorkshire.

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.

To date the following reports have been produced:

Table 1 Analytical, Update and Overview Reports Produced to Date

Year		Full Measures		Partial Measures		Cell 1 Overview Report
		Survey	Analytical Report	Survey	Update Report	
1	2008/09	Sep-Dec 08	May 09 ⁽⁺⁾	Mar-May 09	June 09	-
2	2009/10	Sep-Dec 09	Mar 10	Mar-Apr 10	May10	-
3	2010/11	Sep-Nov 10	Nov 10	Mar-May 11	June 11 ^(*)	July 2011

⁽⁺⁾ An Analytical Report was not produced in May 2009 for Sunderland City Council as part of the Cell 1 Regional Monitoring Programme because the survey data collection and reporting was coordinated under an existing 5-year local monitoring programme which Sunderland City Council had commissioned other consultants to undertake.

^(*) The present report is **Update Report 3** and provides an analysis of the 2011 Partial Measures survey for Sunderland City Council's frontage. It is intended as a brief update of the key findings from this survey to maintain an understanding of ongoing changes.

1. Introduction

1.1 Study Area

Sunderland City Council's frontage extends from The Bents to Ryhope Dene. For the purposes of this report, it has been sub-divided into three areas, namely:

- Whitburn Bay (also referred to as Sunderland North or 'SNN')
- Sunderland Harbour and Docks (also referred to as Sunderland Central or 'SNC')
- Hendon to Ryhope (also referred to as Sunderland South or 'SNS')

1.2 Methodology

Along Sunderland City Council's frontage, the following surveying is undertaken:

- Full Measures survey annually each autumn/early winter comprising:
 - 58 no. beach profile lines
 - Topographic survey at Whitburn Bay
 - Topographic survey at Hendon to Ryhope
- Partial Measures survey annually each spring comprising:
 - 14 no. beach profile lines
- Cliff top survey bi-annually at:
 - Hendon to Ryhope

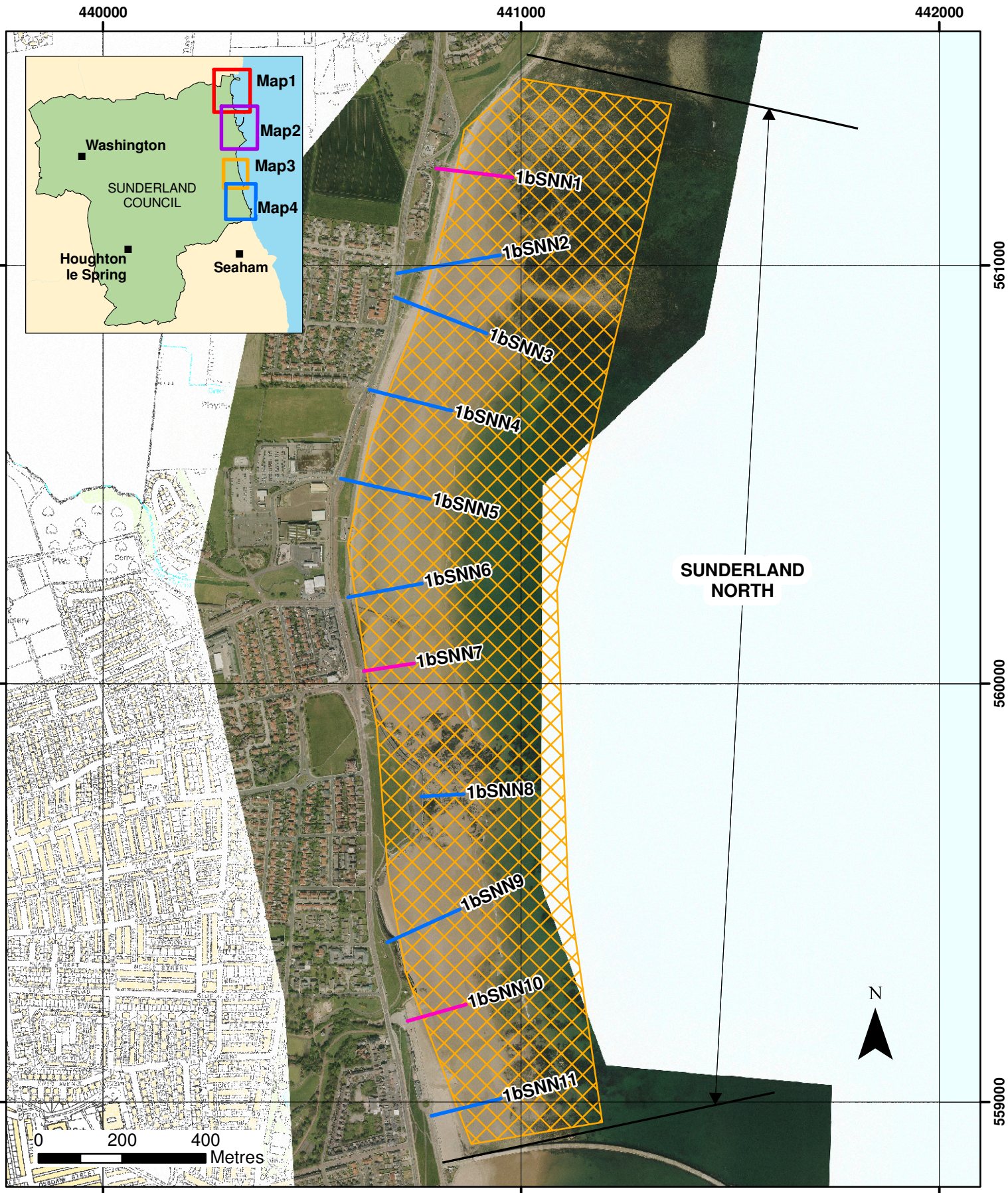
The location of these surveys is shown in Figure 1. They have also previously been provided on a digital file which can be opened in Google Earth showing the locations of the surveys.

The Partial Measures survey was undertaken along this frontage in March 2011, when weather conditions for the Sunderland North surveys were dry and breezy but the sea state was calm.

The Update Report presents the following:

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

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



TOPOGRAPHIC SURVEY LOCATIONS

- Annual Profile
 - Bi-Annual Profile
 - 6 monthly Survey
 - Yearly Survey
 - 5 yearly Survey
 - Cliff Top Survey @ 50 centres
 - Cliff Top Survey @ 100 centres
 - Cliff Top Survey @ 300 centres
- (Indicative Survey Extents shown)*

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

**Figure 1 - Map 1
 Sunderland
 Council Frontage**

Update Report 3
 'Partial Measures' Survey 2011

Drawing Scale 1:12,000 at A4



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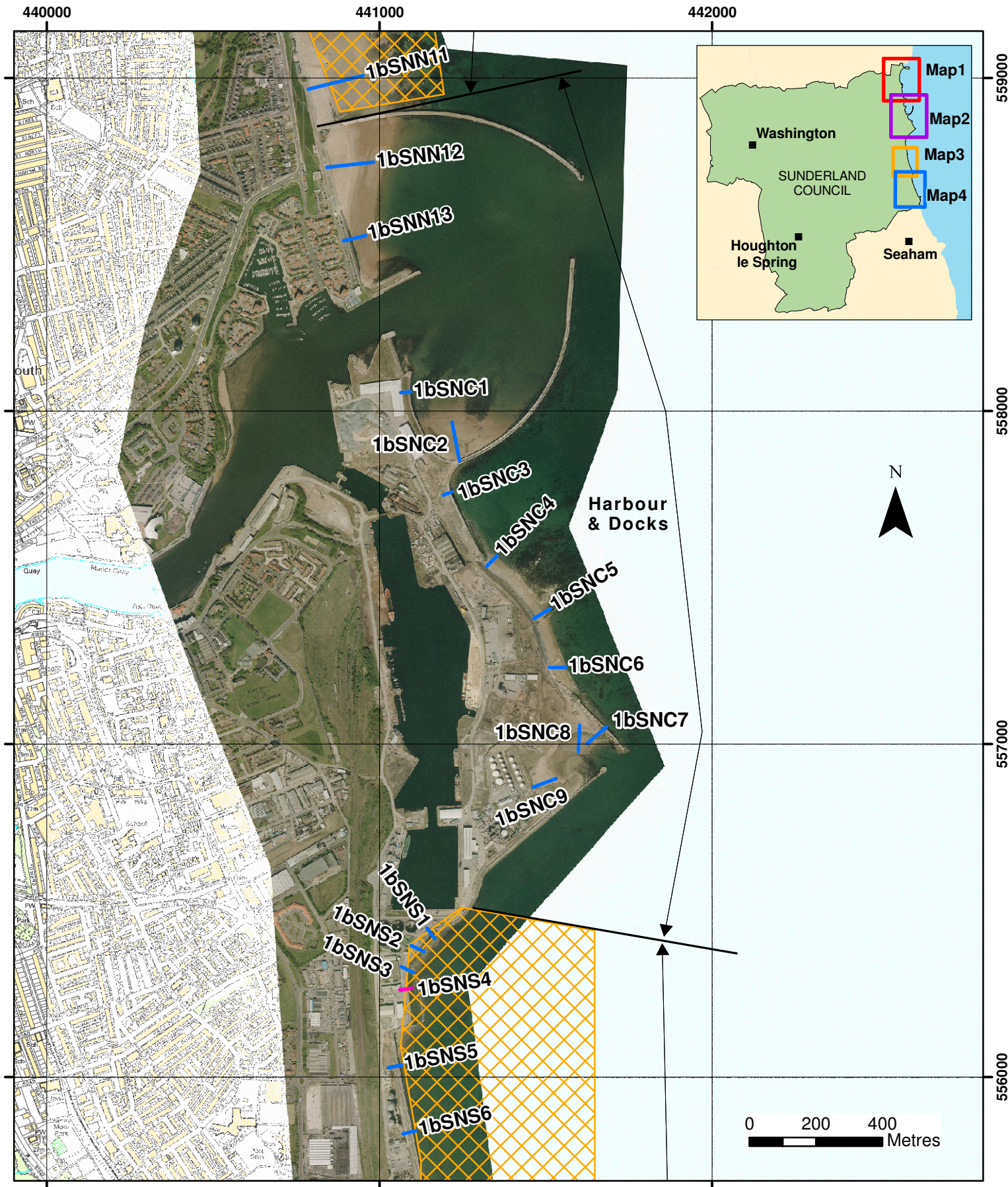


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 Checked by: MD Date: 12/05/2011
 Approved by: NC Date: 12/05/2011

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 North East Coastal Observatory
 www.northeastcoastalobservatory.org.uk



TOPOGRAPHIC SURVEY LOCATIONS

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- 6 monthly Survey
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- Cliff Top Survey @ 50 centres
- Cliff Top Survey @ 100 centres
- Cliff Top Survey @ 300 centres

(Indicative Survey Extents shown)

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

**Figure 1 - Map 2
 Sunderland
 Council Frontage**

Update Report 3
 'Partial Measures' Survey 2011

Drawing Scale 1:15,000 at A4



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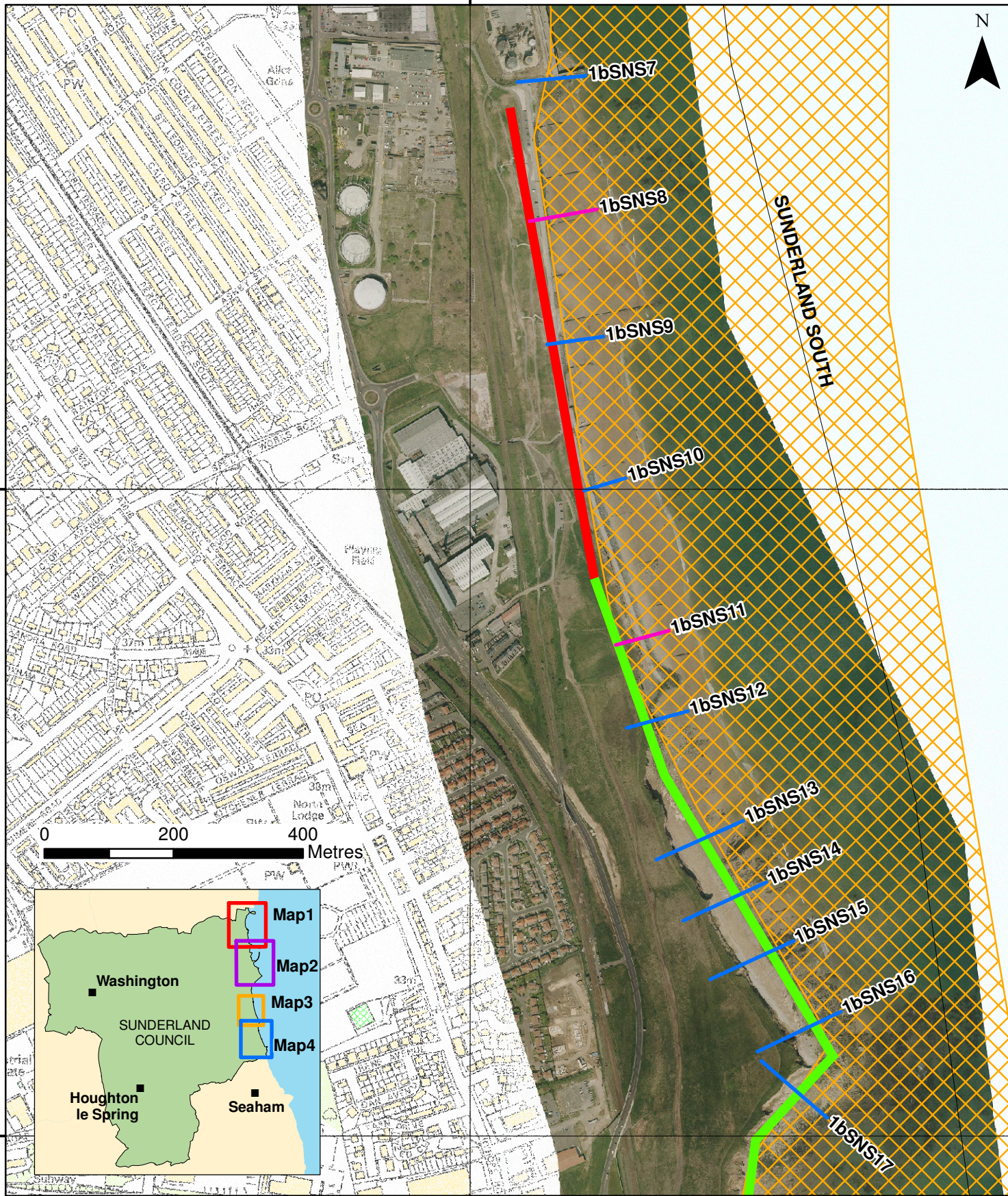


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555000

554000

TOPOGRAPHIC SURVEY LOCATIONS

- Annual Profile
 - Bi-Annual Profile
 - ▨ 6 monthly Survey
 - ▨ Yearly Survey
 - ▨ 5 yearly Survey
 - Cliff Top Survey @ 50 centres
 - Cliff Top Survey @ 100 centres
 - Cliff Top Survey @ 300 centres
- (Indicative Survey Extents shown)*

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

**Figure 1 - Map 3
 Sunderland
 Council Frontage**

Update Report 3
 'Partial Measures' Survey 2011

Drawing Scale 1:8,000 at A4



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441000

442000



TOPOGRAPHIC SURVEY LOCATIONS

- Annual Profile
 - Bi-Annual Profile
 - ▨ 6 monthly Survey
 - ▨ Yearly Survey
 - ▨ 5 yearly Survey
 - Cliff Top Survey @ 50 centres
 - Cliff Top Survey @ 100 centres
 - Cliff Top Survey @ 300 centres
- (Indicative Survey Extents shown)*

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

**Figure 1 - Map 4
 Sunderland
 Council Frontage**

Update Report 3
 'Partial Measures' Survey 2011

Drawing Scale 1:10,000 at A4



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2. Analysis of Survey Data

2.1 Whitburn Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2011	<p>Beach Profiles:</p> <p>Whitburn Bay is covered by three beach profile lines during the Partial Measures survey (Appendix A).</p> <p>SNN1 is just to the south of Sunderland City Council's northerly boundary of jurisdiction. A berm is present along the profile at a chainage of around 100m. Seaward of this point, the foreshore levels are very high, although the rock on the lower foreshore remains exposed.</p> <p>SNN7 is at Seaburn, just to the north of Parson's Rock. The profile extends across the crest of the sea wall, which is at an elevation of 5.6mODN, and down the vertical face to the toe. The foreshore levels are relatively high.</p> <p>SNN10 is located approximately mid-way between Parson's Rock and Roker Pier. The profile shows relatively high beach levels at the toe of the wall and along the upper foreshore, with a berm present at a chainage of around 85m.</p>	<p>Beach levels along Whitburn Bay were high at the time of the survey, with a berm notable along all three transects at a chainage of around 100m.</p>

2.2 Hendon to Ryhope

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2011	<p>Beach Profiles:</p> <p>Hendon to Ryhope is covered by twelve beach profile lines during the Partial Measures survey (Appendix A). Eight of these are closely spaced and located at Halliwell Banks to specifically monitor erosion rates along the cliffs fronting the former landfill area.</p> <p>SNS4 crosses the concrete boundary wall of the Hendon Sewage Treatment Works, which has an elevation in excess of 7.0mODN, and extends a further 5m across the concrete deck to the edge of the near vertical wall face. The profile then crosses the fronting rock revetment until it intercepts water. There is very little foreshore exposed along the frontage as the profile soon extends into deeper water, but the short length of foreshore that is present at the toe of the revetment did exhibit erosion between September 2010 and March 2011 to reach quite low values.</p> <p>SNS8 and SNS11 both start at the coastal slope/cliff backing the Hendon Sea Wall and extend across the wall and fronting rock armour before reaching sand levels and then extending down to low water. SNS8 experienced accretion of the beach profile between the toe of the revetment and a chainage of around 75m. SNS11 also experienced accretion since September 2010 but levels remained moderate.</p> <p>SNS20 is located at Shirley Banks. The profile extends across the cliff top, which is at an elevation in excess of 25mODN, and drops over 21m in height down the steeply-sloping cliff face to the toe. The profile then extends across the foreshore down to low water, with some rock outcrops captured towards the landward end. There was no significant change in position of the cliff top, face or toe along this profile, and the foreshore levels remained stable.</p>	<p>There seems to be alternating patterns of erosion and accretion, typically within bounds of previous observations, along SNS4, SNS8 and SNS11.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>Profiles SNS26 to SNS33 are all located at close spacings at Halliwell Banks. Each profile exhibits a broadly similar form, with a gentle downward slope across the first 50m or so of cliff top followed by a slightly steeper upward slope to around 10m or so from the cliff edge. The profile then has a near-horizontal or very gently downward sloping form to the very cliff edge, which generally is around 26.8mODN, although slightly lower in elevation at SNS31, SNS32 and SNS33. There is then a drop of around 22-24m down the steep cliff face to the upper foreshore. Each profile then extends a short distance across the gravelly foreshore to low water.</p> <p>All profiles previously exhibited measurable erosion from September 2009 to March 2010, with some continuation of this process to March 2011 along SNS28, SNS30, SNS31, SNS32 and SNS33. All profiles exhibited very low foreshore levels at the toe of the cliffs. The surveyors' notes record that <i>"There have been some large retreats in the cliff top. The layer of sandy soil above the lower rock strata is in a very poor state. Large holes are visible [in places at the toe of the cliffs] and a number of landslips were observed in site"</i>.</p>	<p>The low foreshore level at the toe of the cliffs is likely to be the cause of ongoing erosion in the cliff face. This is because the toe of the cliff is subject to greater wave activity if it is less protected by foreshore sediments.</p>
03-2011	<p>Cliff Top Survey:</p> <p>Thirty-five ground control points have been established along the cliff top between Hendon and Ryhope (Appendix B, Figure B1). [Note: the numbering of control points is <u>not</u> intended to correlate with that of the beach profile lines and reference should be made to Figure B1 for locations of control points].</p> <p>Measurements are taken from each ground control point along a fixed bearing to the edge of the cliff top. These cliff top surveys are undertaken bi-annually and are intended to inform on erosion rates of the sea cliffs extending from the defended industrial areas at Hendon southwards along the undefended cliffs to Ryhope Dene.</p> <p>Points 1 to 3 have been affected by cliff landscaping works that were undertaken in 2009 and early 2010. With a baseline re-established in October 2010, all three points have seen a degree of change since.</p> <p>Points 4 to 23 are located along the undefended sea cliffs extending from the end of the Hendon Seawall south to Ryhope Burn (sometimes known as Ryhope Beach Road), which separates Shirley Banks from Halliwell Banks. Here, the changes recorded to date have generally been within the bands of accuracy of the surveying technique, so no net trends have been identified along most of the frontage. However, there do appear to be two sections where erosion has occurred. Between points 9 and 11 and between points 19 and 21 the cliffs have cut back measurably. At some of these points, the erosion occurred between October 2010 and March 2011, although the process seems to have been initiated earlier.</p>	<p>The changes along the re-landscaped area covered by points 1-3 may be due to settlement rather than erosion.</p> <p>There are two sections of cliff along the undefended frontage between the end of the Hendon Seawall and Ryhope Burn where measurable erosion has occurred.</p>

<p>03-2011</p>	<p>Points 24 to 32, which extend along Halliwell Banks to Ryhope Dene, have generally experienced changes greater than the accuracy of the surveying technique and therefore must be considered as true records of recession. In some cases, such as at points 24, 25, 27, 28, 31 and 32, the recession has been of the order of metres since the first survey in March 2009. The recession is also approaching 1m along two of the additional points introduced in September 2009 (namely 28A and 28B).</p>	<p>Recession rates along the undefended cliffs at Halliwell Banks (which fronts the former land fill) and immediately south of Pincushion appear high. At the most extreme (point 25), the cliff top has eroded 5.7m between March 2009 and March 2011, giving rise to concern about the integrity of the rock barrier which retains the waste within the land fill.</p>
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3. Problems Encountered and Uncertainty in Analysis

Cliff Top Surveys

Surveying any cliff top is difficult due to the safety risks posed to surveyors, especially during adverse weather, and the 'apparent' changes that can arise due to surveyors interpreting different points as the cliff edge on successive surveys (Plate 1). This has previously been identified as affecting most of the cliff top surveys and demonstrates the importance of a long term record.

Plate 1 – Cliff Top Surveying



In addition to surveyor interpretation, cliffs along this frontage have a characteristic tendency to heave seawards prior to a toppling failure, leading to apparent discrepancies in the data.

It is also known that along cliff top monitoring points 1 – 3 the cliff top was re-landscaped in late 2009 and early 2010 behind the coastal defences, giving rise to the apparent massive increase in distance to the cliff edge recorded in the September 2009 survey. The baseline was therefore re-set in October 2010 to the new re-landscaped cliff form.

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

No changes are recommended at the present time.

5. Conclusions and Areas of Concern

- Whitburn Bay had high beach levels at the time of the March 2011 surveys, with a berm recorded at a chainage of around 85-100m.
- There appear to be alternating patterns of erosion and accretion, typically within bounds of previous observations, along the Hendon frontage.
- Shirley Banks (as measured by profile SNS20) remained stable since the previous survey.
- The sections of undefended cliff along Halliwell Banks appear to be eroding quite rapidly, with several sections remaining active. There are numerous areas where the cliffs are undercut at their toe (see below), which is likely to lead to further collapses.



- A concerning feature from the March 2011 survey, was the very low foreshore levels fronting the Halliwell Banks cliffs. This, together with the current condition of some cliff sections, is likely to result in yet further erosion along this frontage.
- It was noted that work on beach access and a new outfall at Ryhope is complete.



Appendices

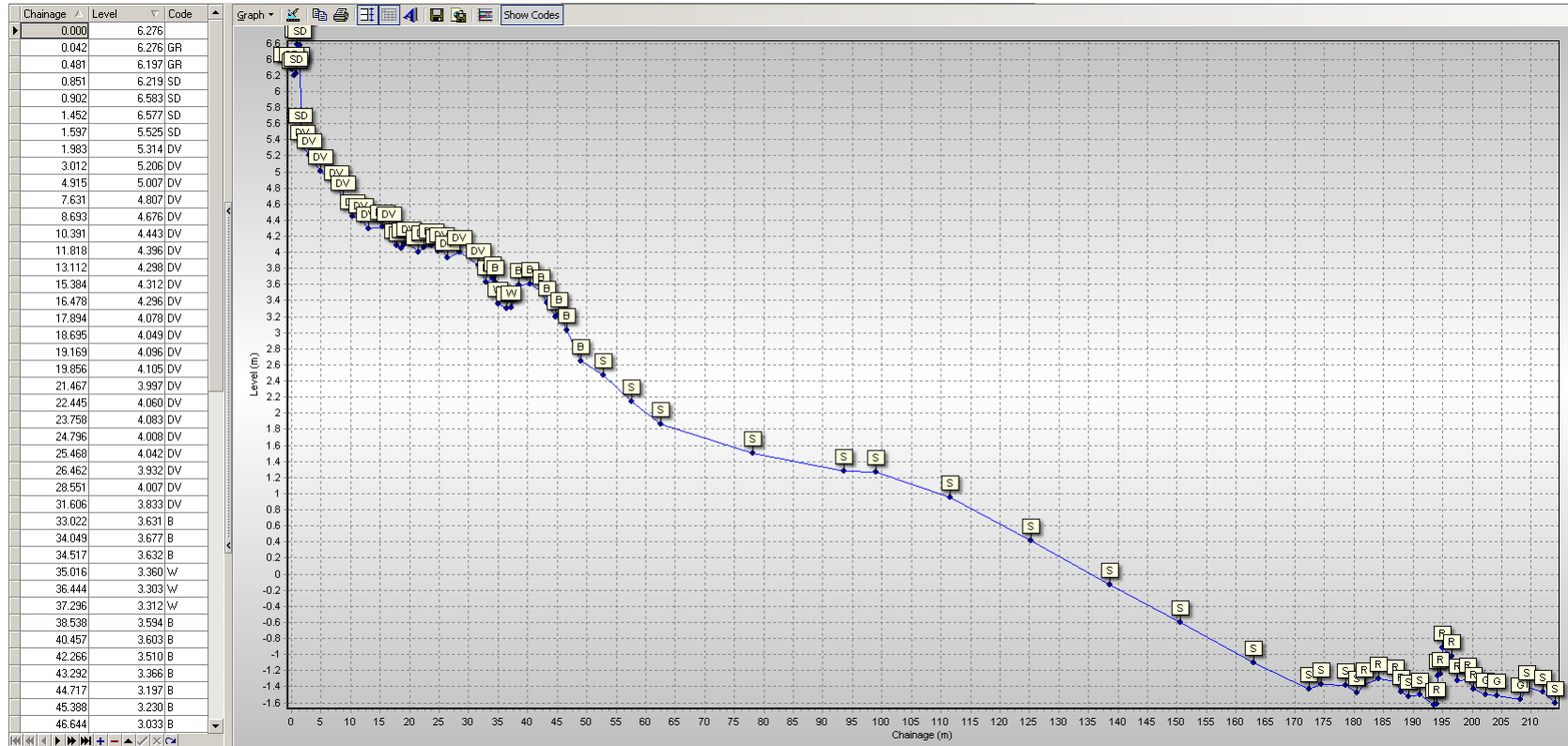
Appendix A
Beach Profiles

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

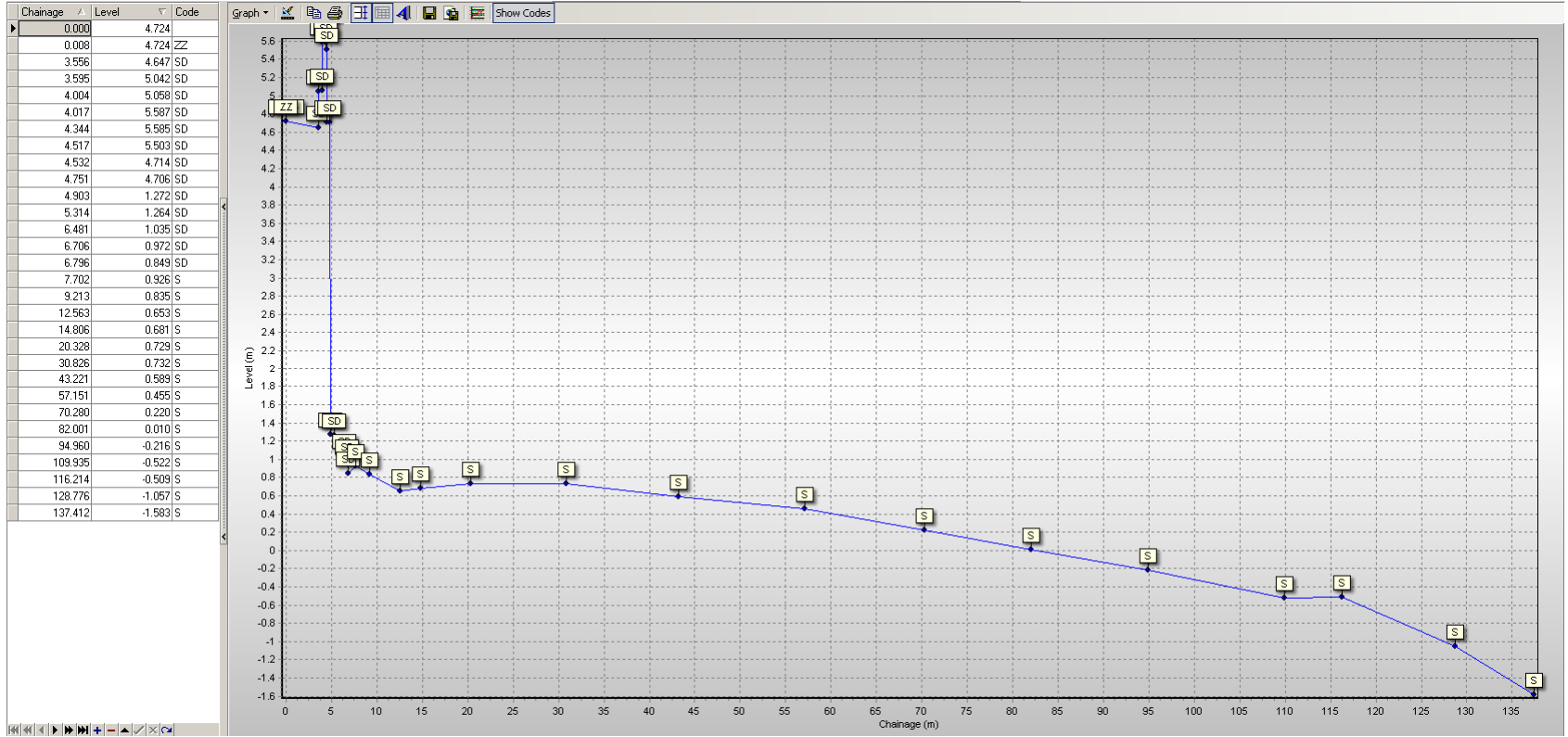
Code	Description
M	Mud
S	Sand
G	Gravel
GS	Gravel & Sand
GM	Gravel & Mud
MS	Mud & Sand
B	Boulders
R	Rock
SD	Sea Defence
SM	Salt Marsh
GR	Grass
D	Dune (non-vegetated)
DV	Dune (vegetated)
F	Forested
X	Mixture
FB	Obstruction
CT	Cliff Top
CE	Cliff Edge
CF	Cliff Face
SH	Shell
W	Water Body
ZZ	Unknown

Sunderland North

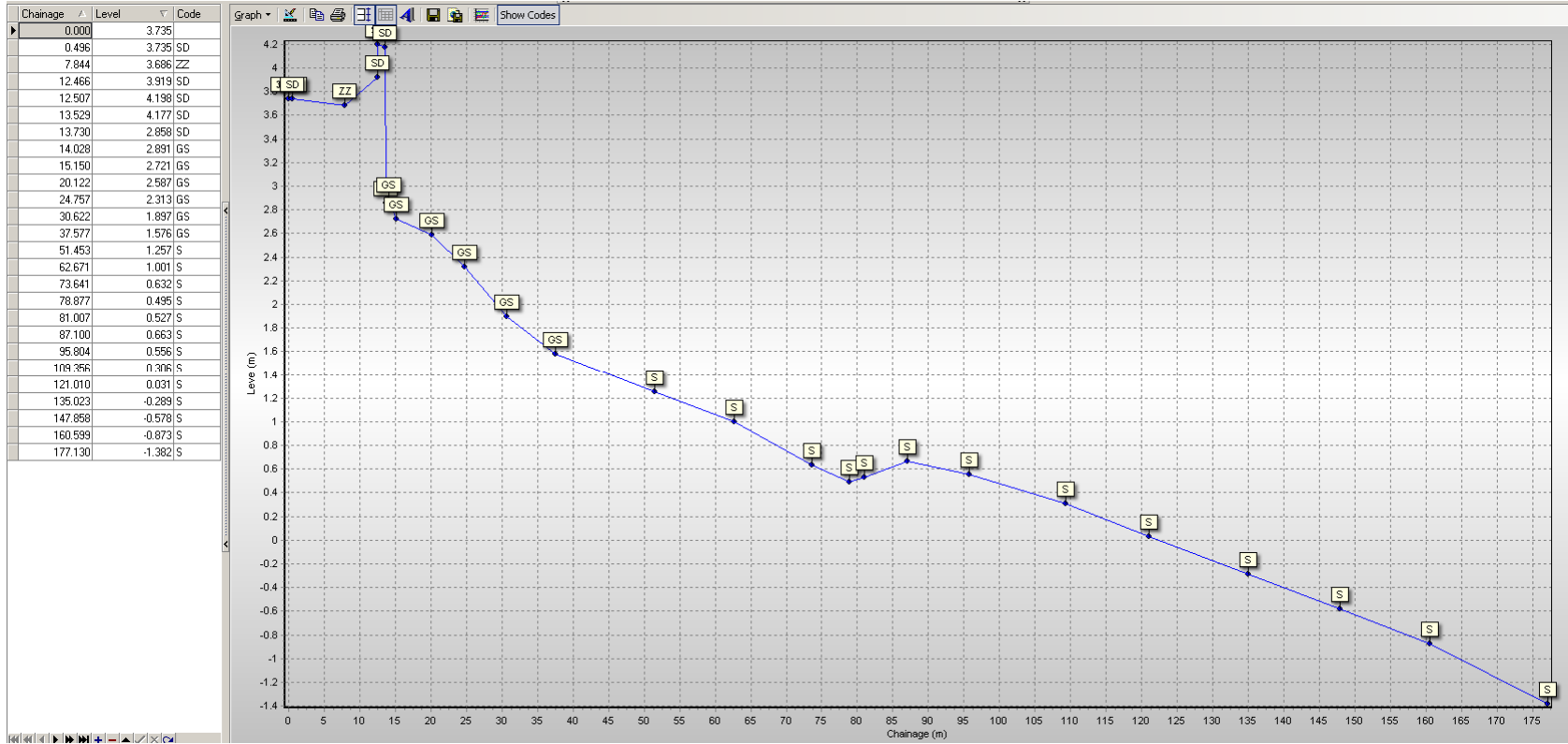
1bSNN1 - 10/03/2011



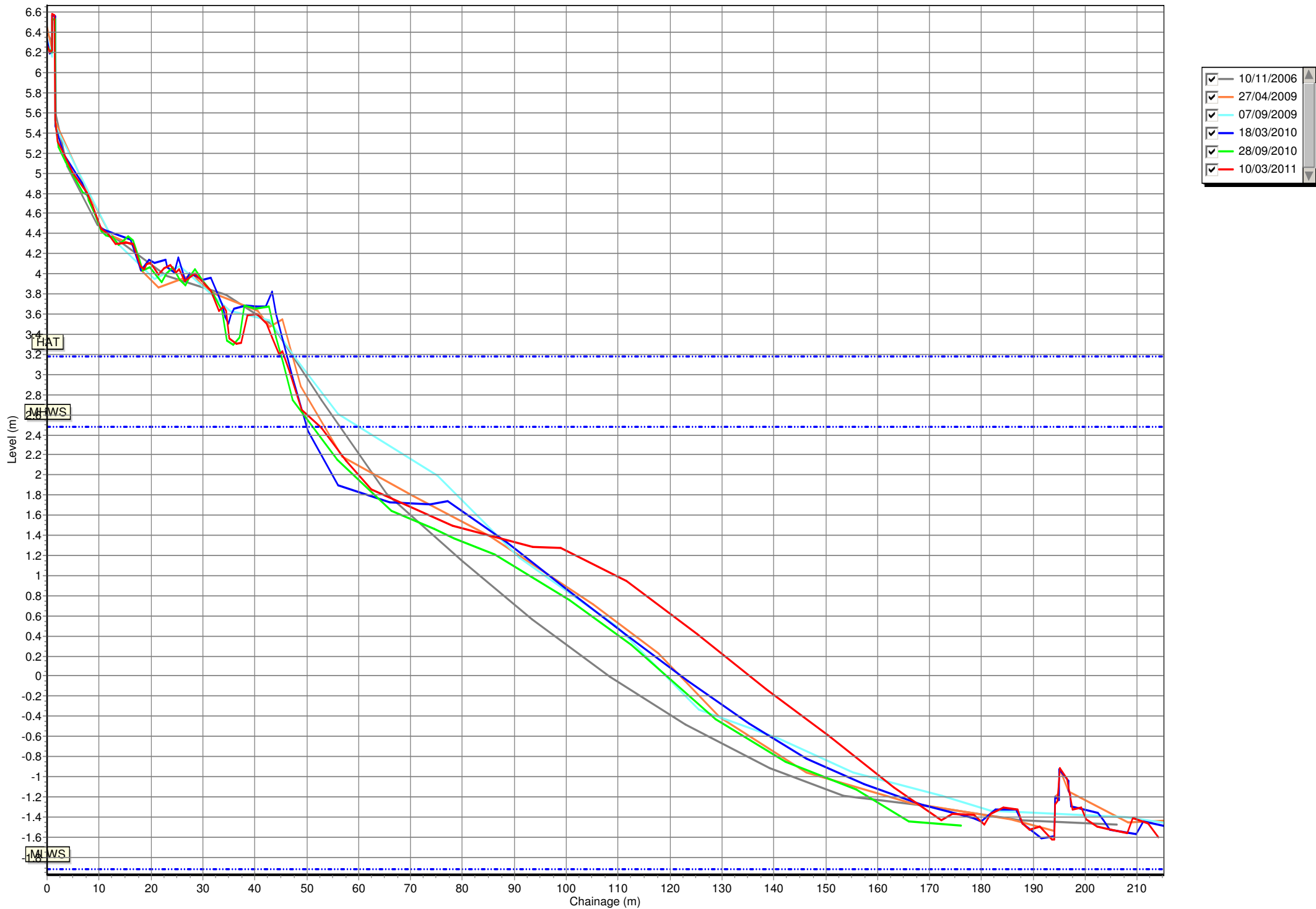
1bSNN7 - 10/03/2011



1bSNN10 - 10/03/2011



Beach Profiles: 1bSNN1



Beach Profiles: 1bSNN7



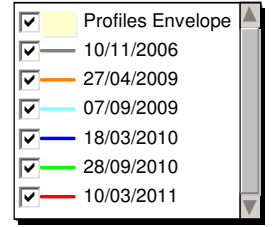
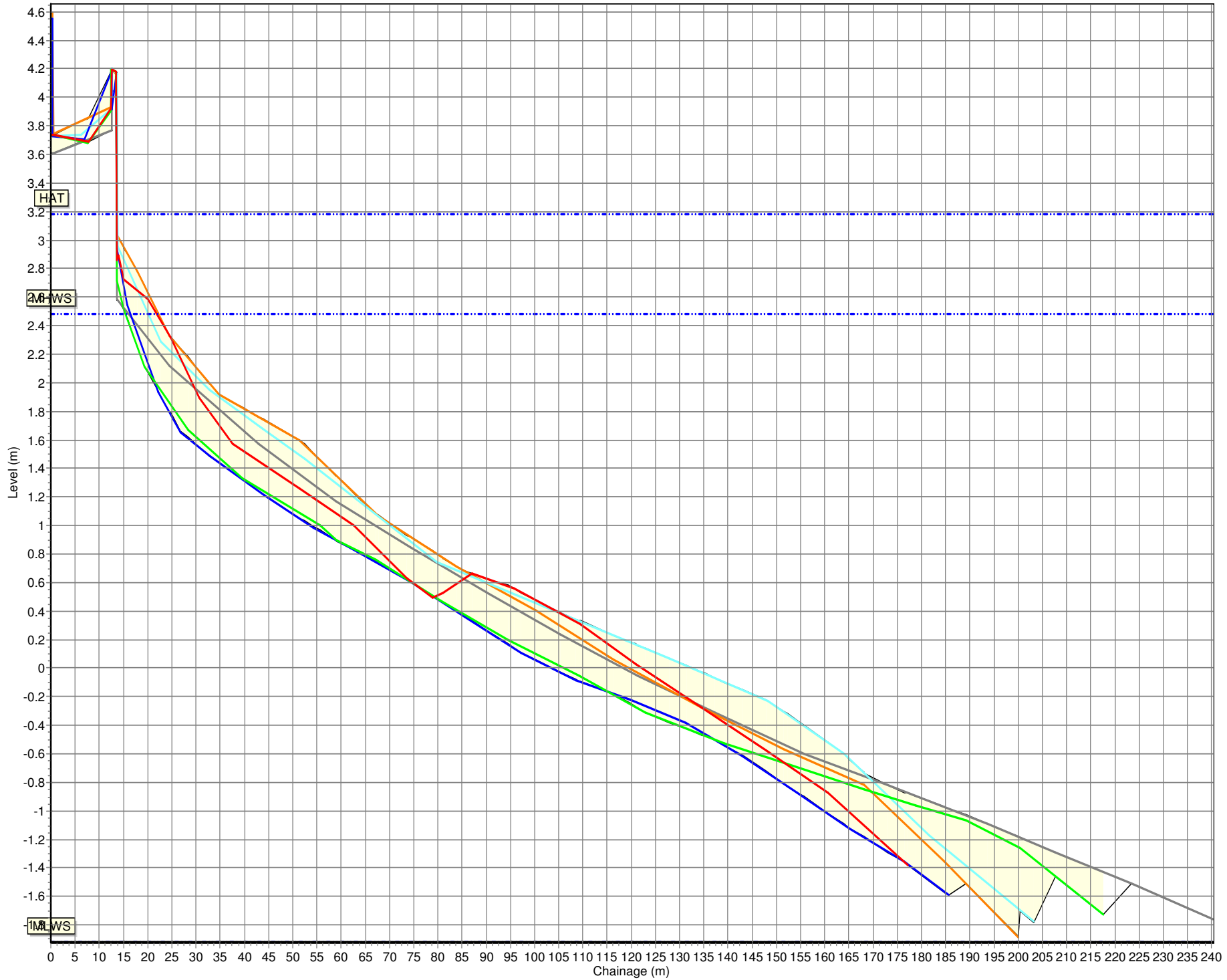
- Profiles Envelope
- 10/11/2006
- 27/04/2009
- 07/09/2009
- 18/03/2010
- 28/09/2010
- 10/03/2011

HAT

MWS

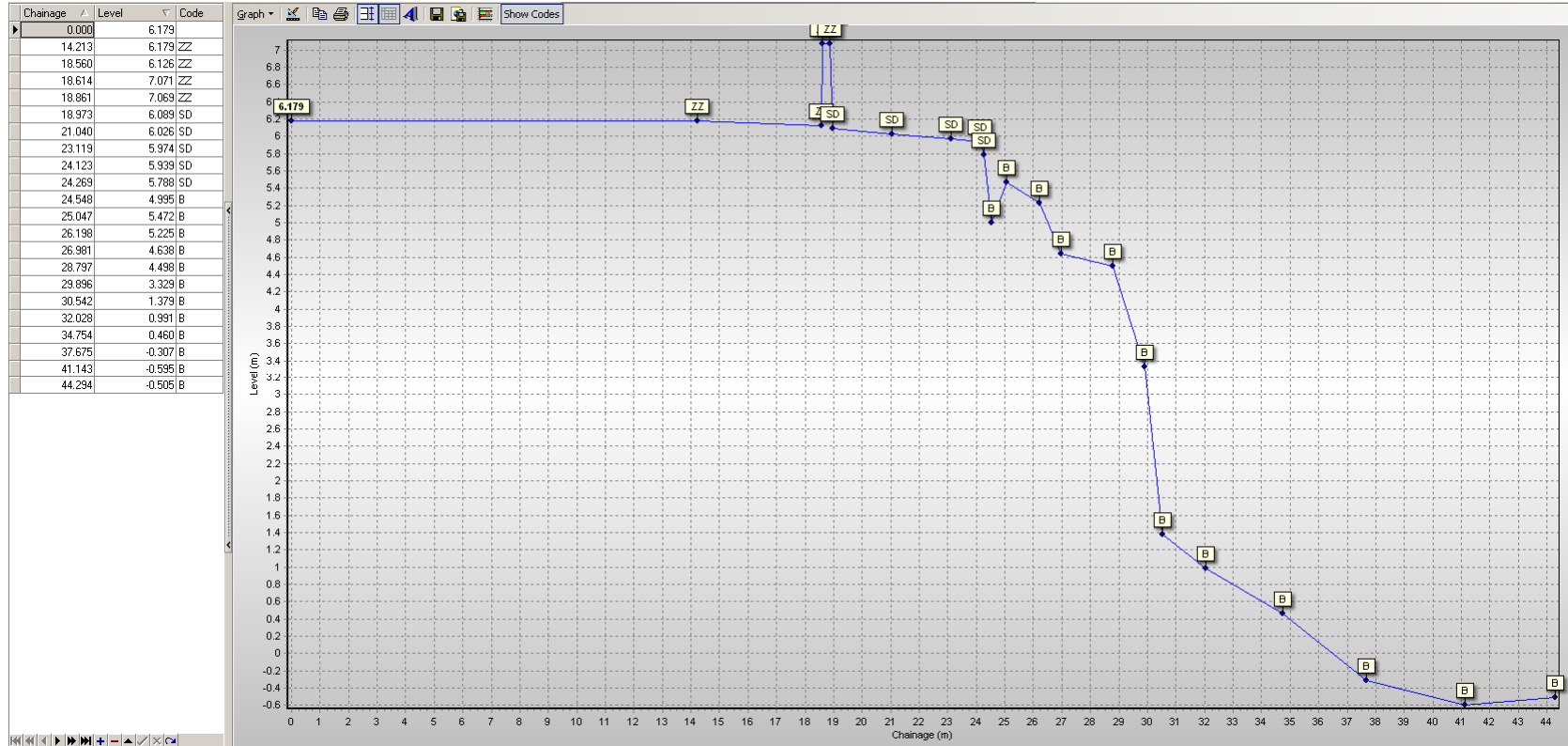
MLWS

Beach Profiles: 1bSNN10

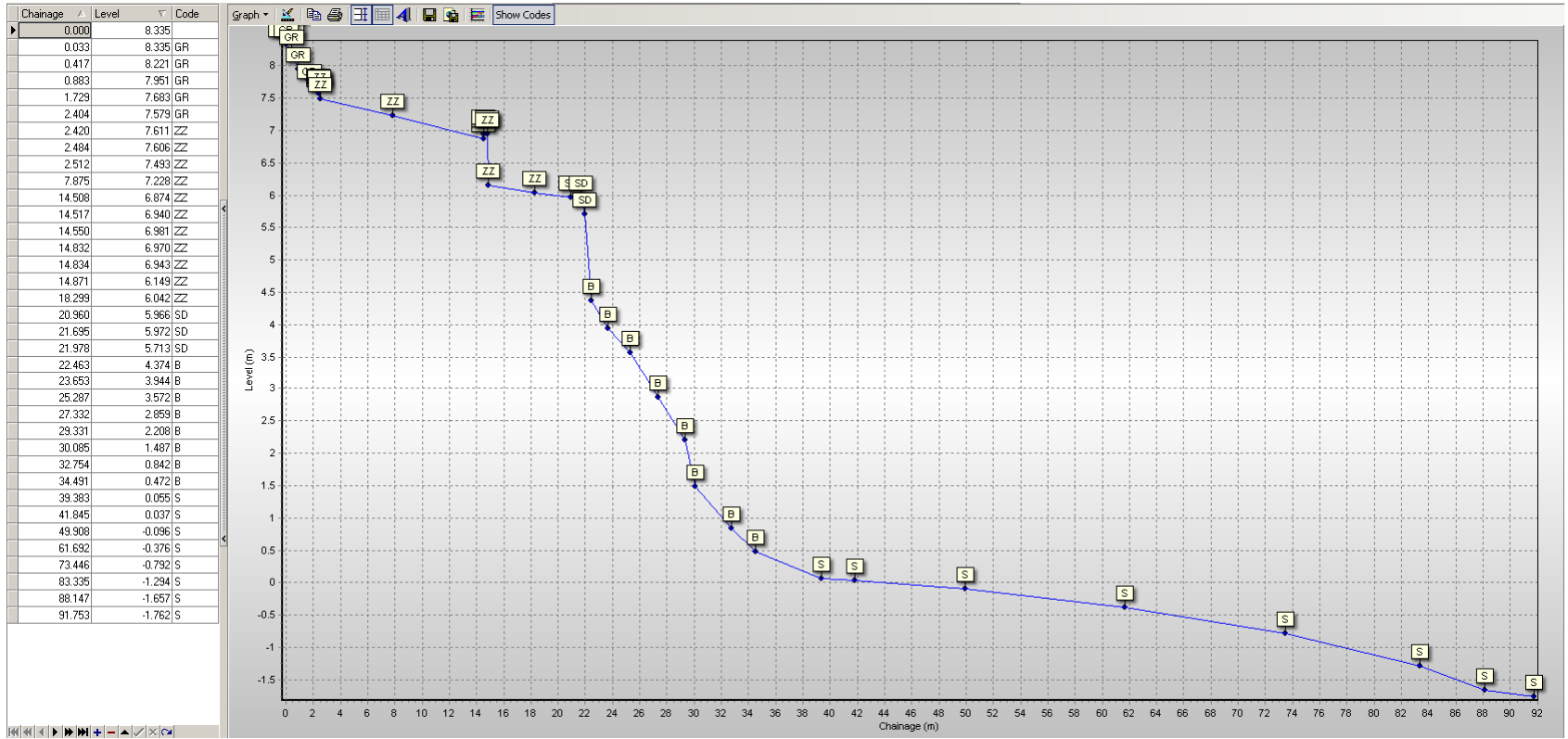


Sunderland South

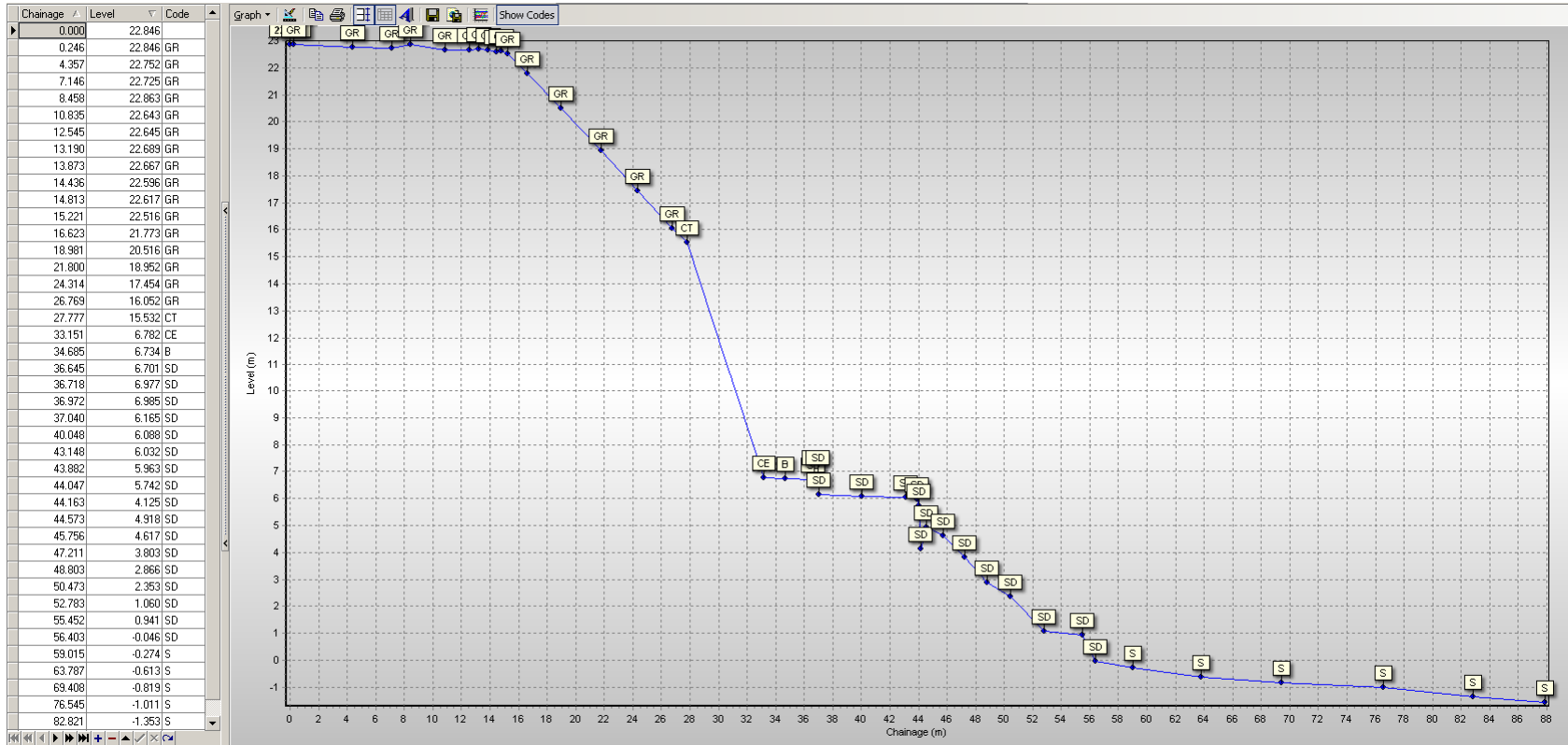
1bSNS4 - 04/04/2011



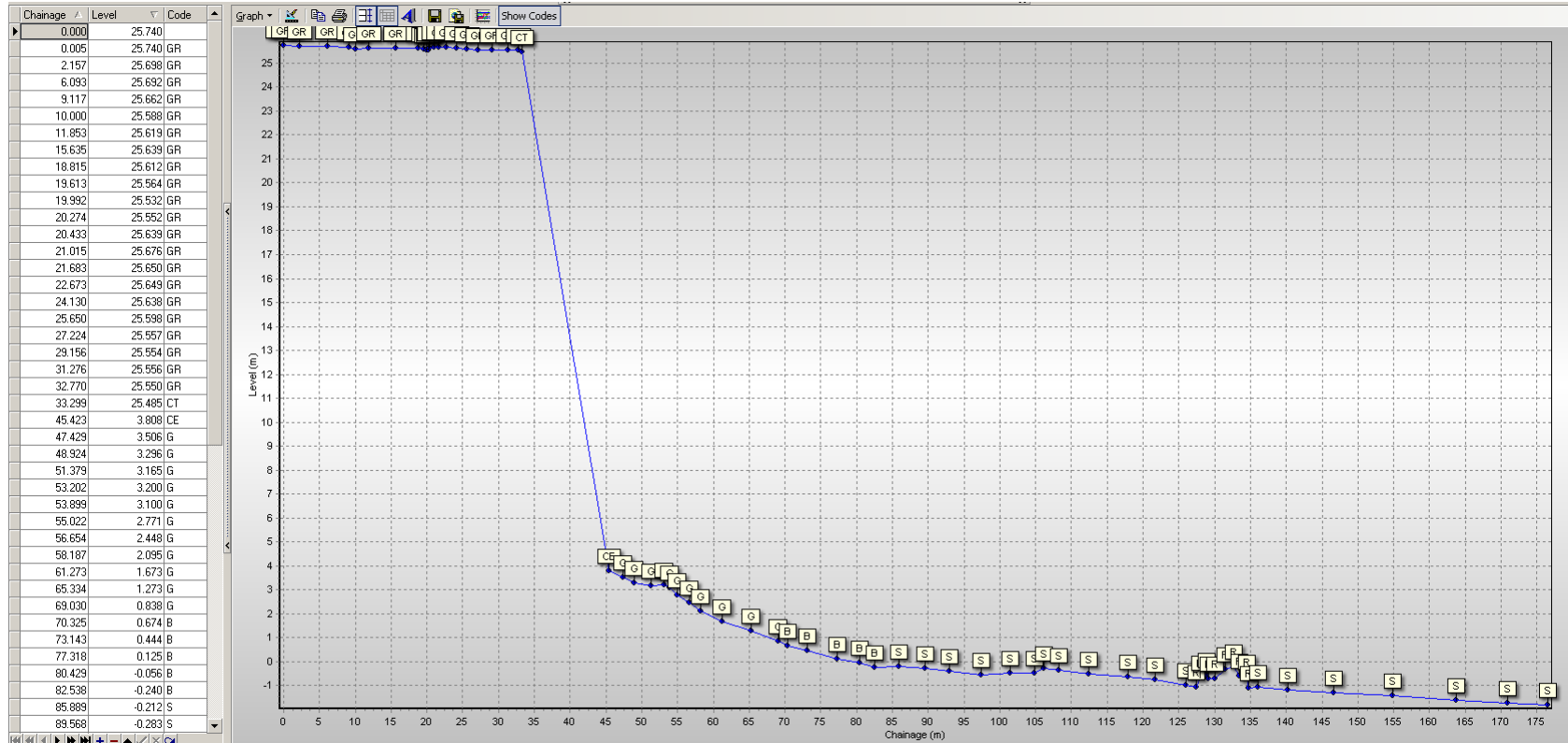
1bSNS8 - 04/04/2011



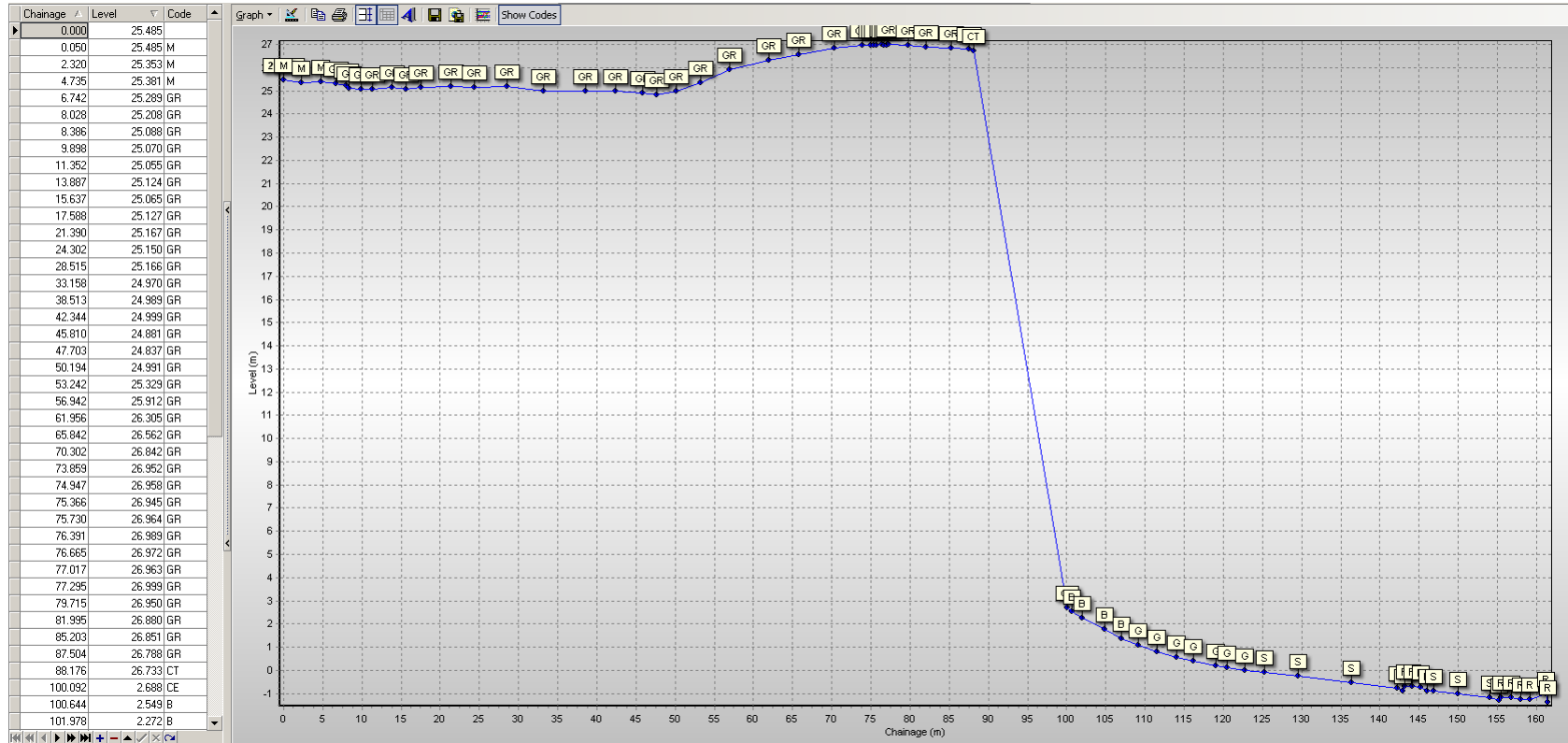
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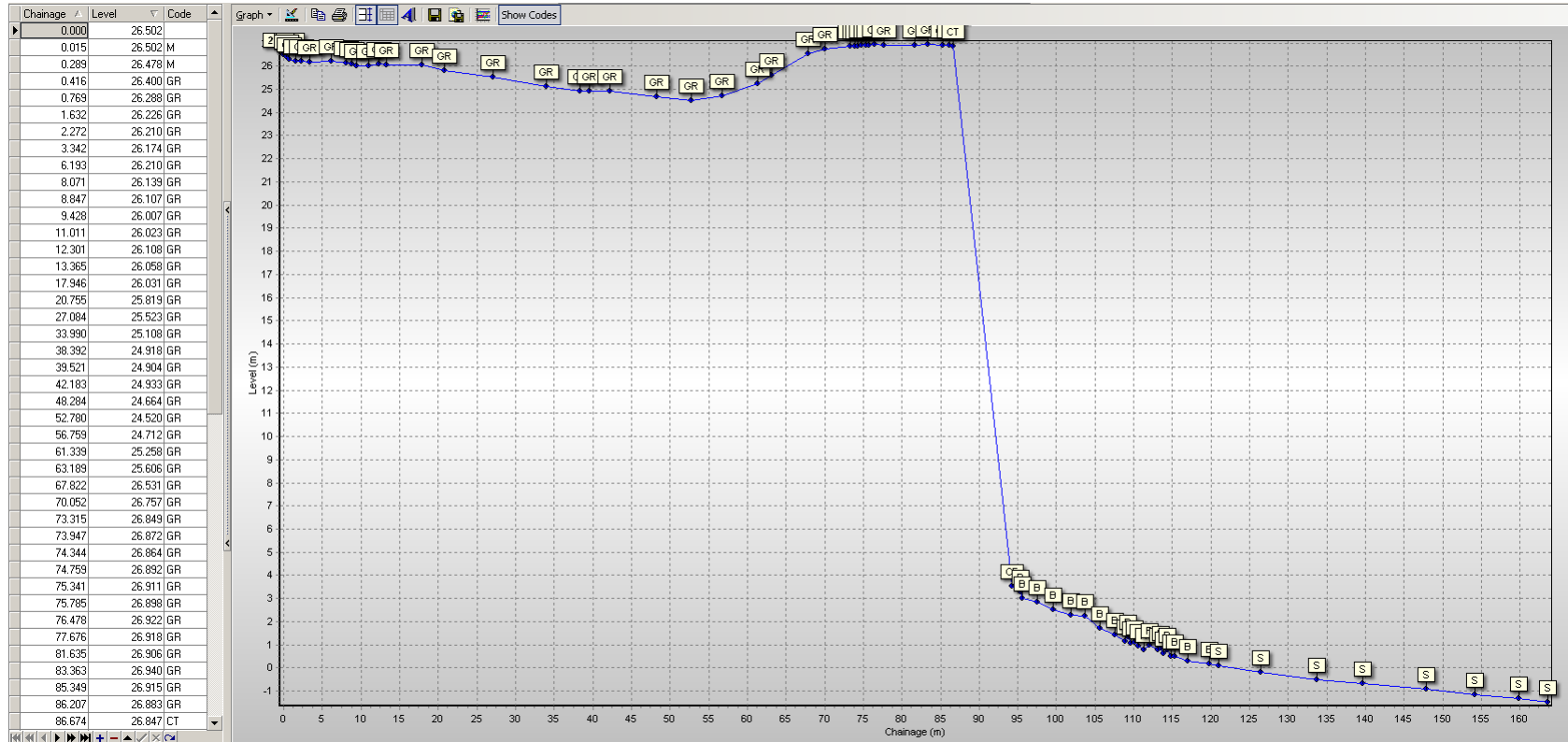
1bSNS20 - 04/04/2011



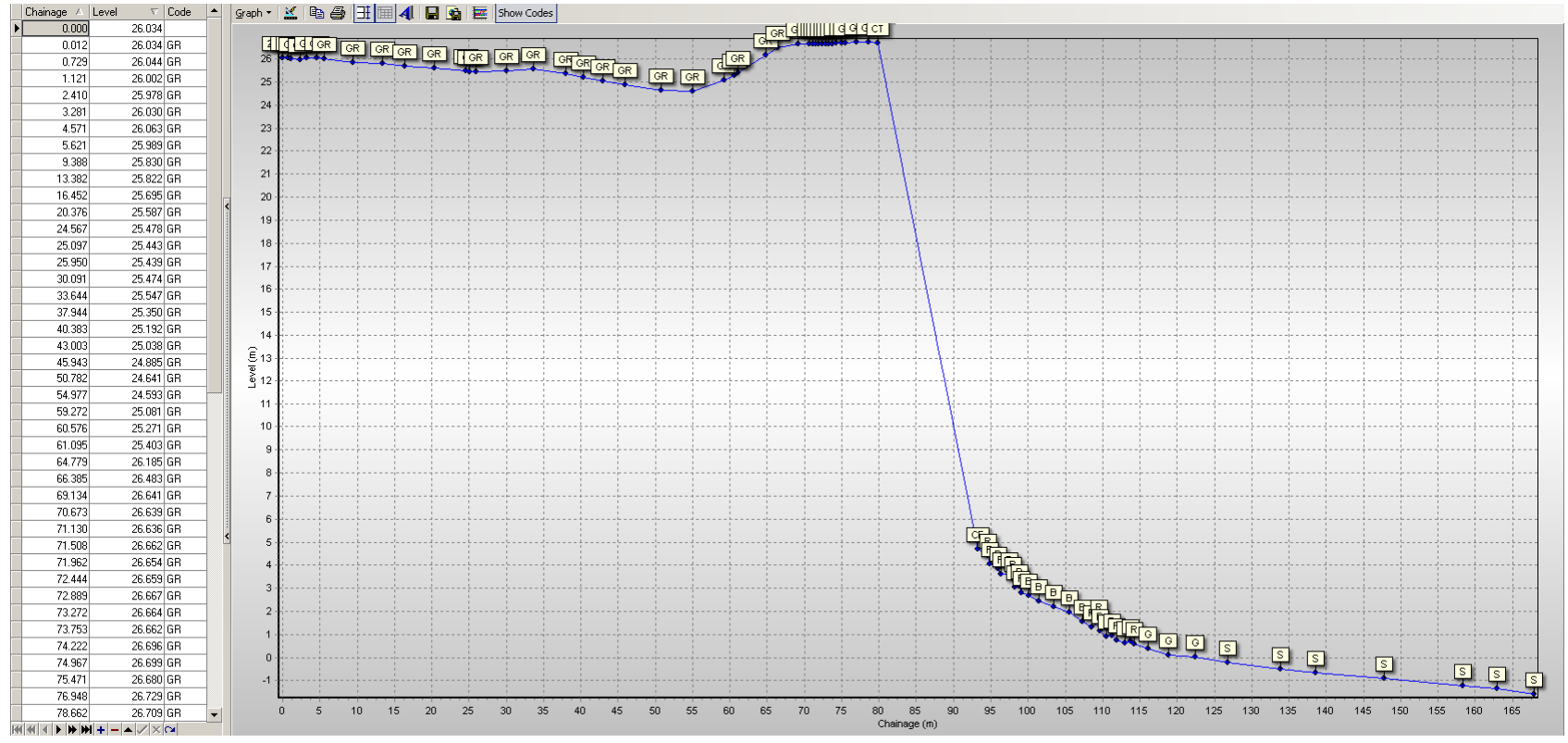
1bSNS26 - 04/04/2011



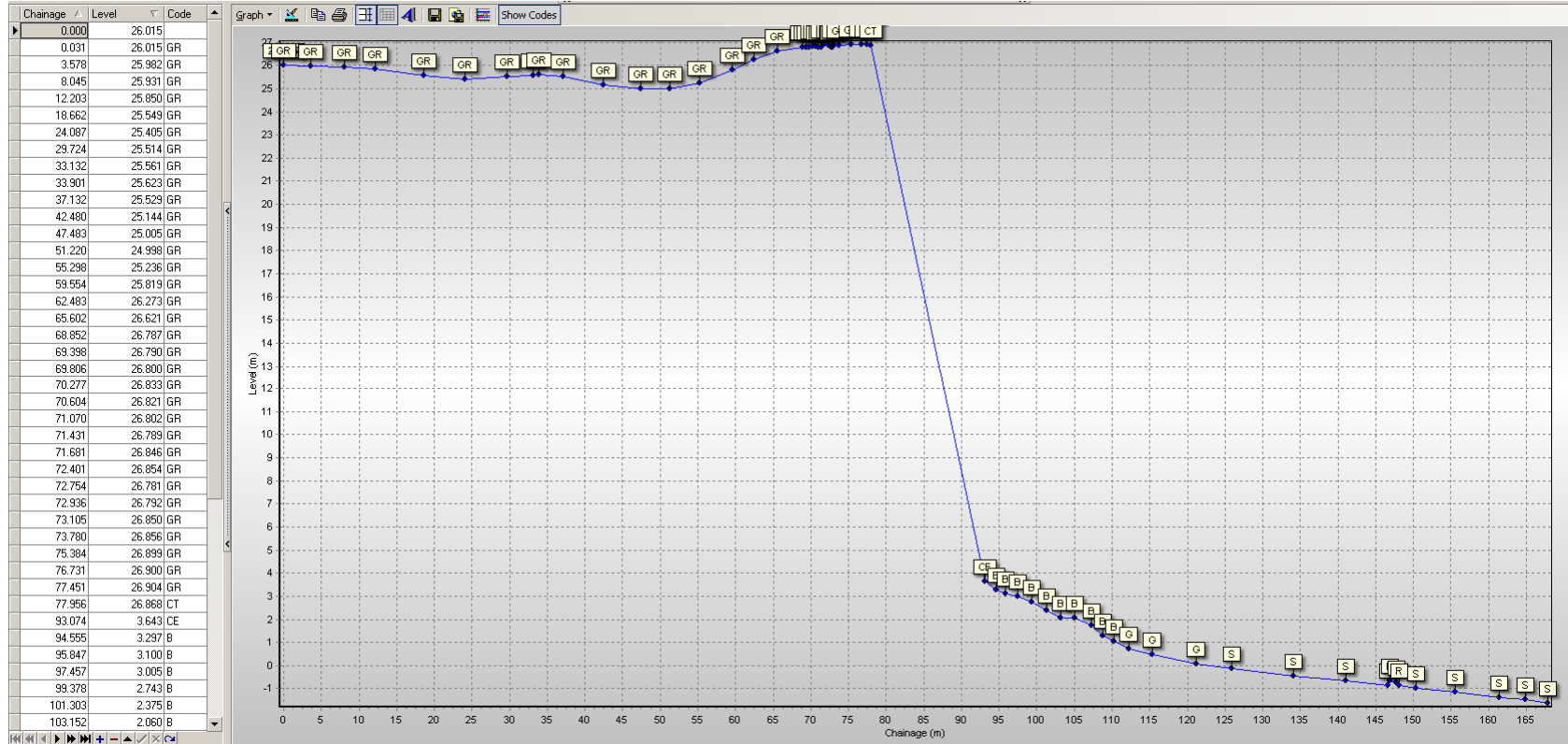
1bSNS27 - 04/04/2011



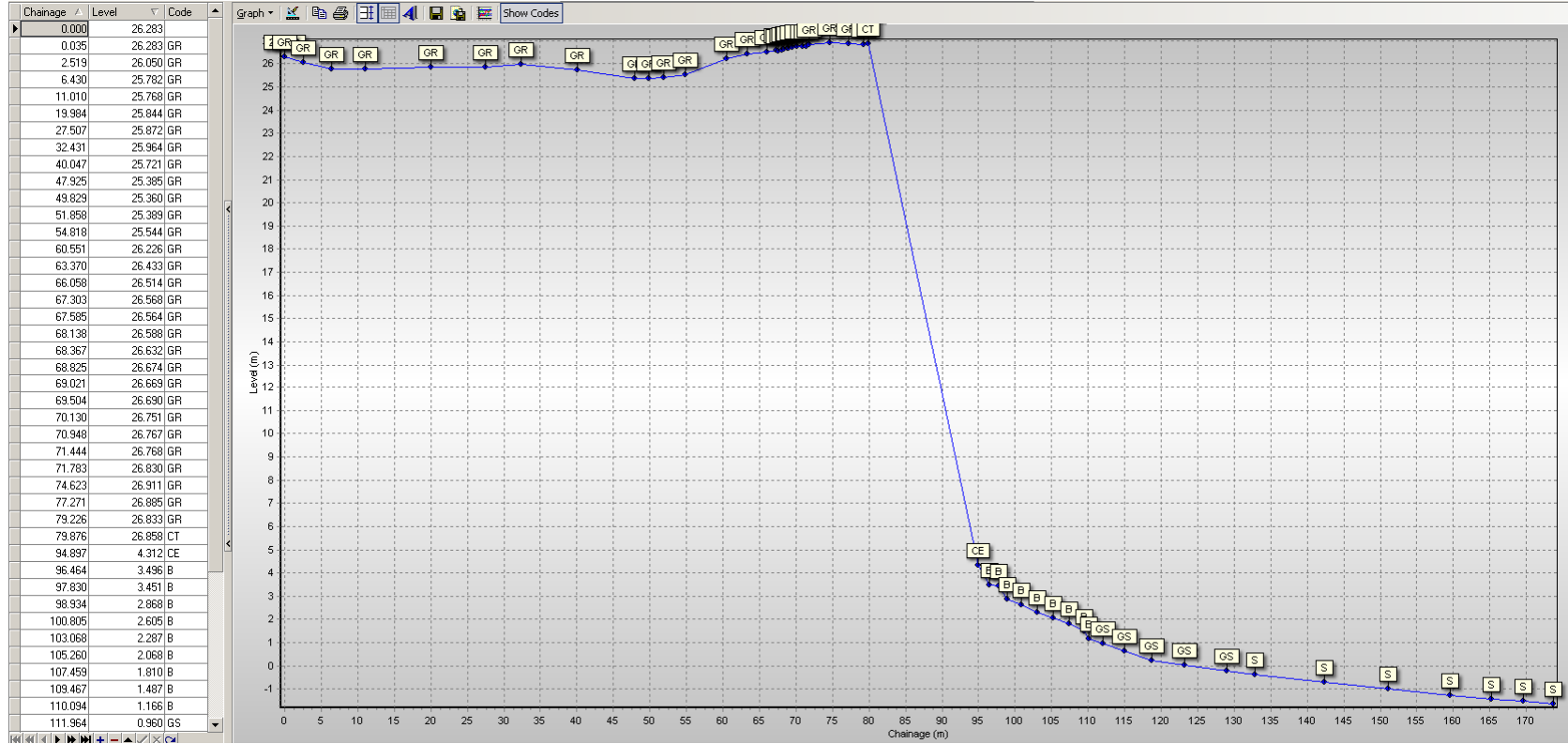
1bSNS28 - 04/04/2011



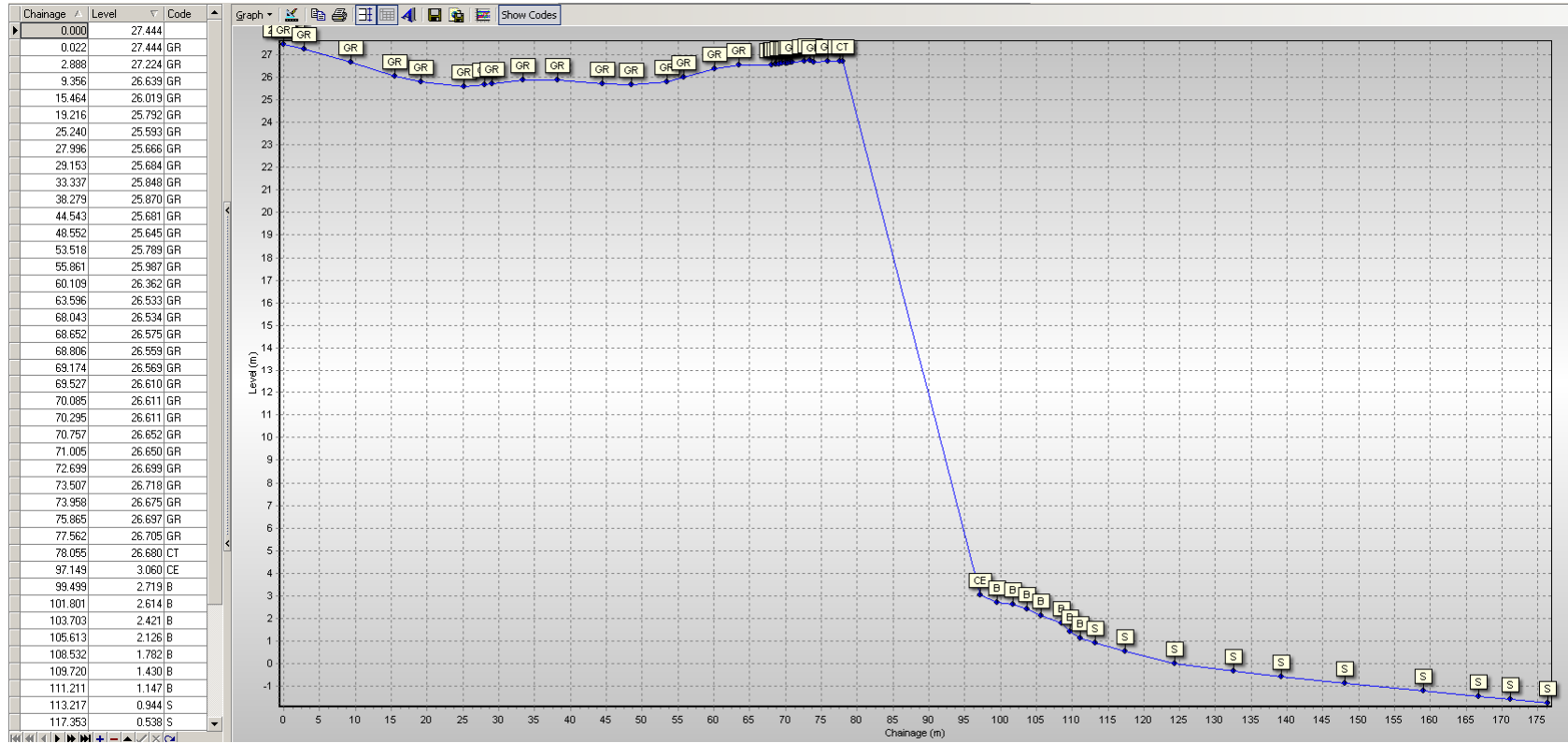
1bSNS29 - 04/04/2011



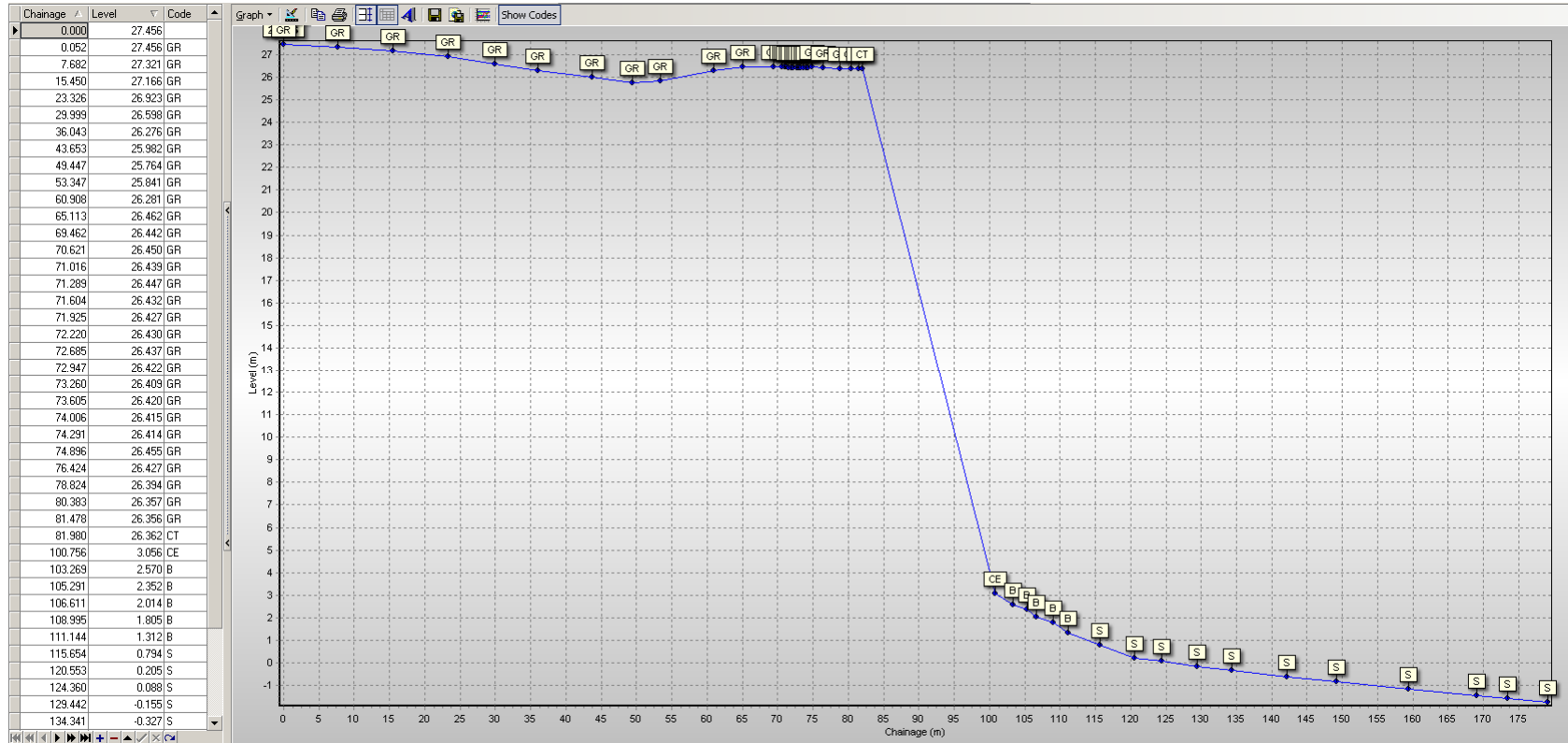
1bSNS30 - 04/04/2011



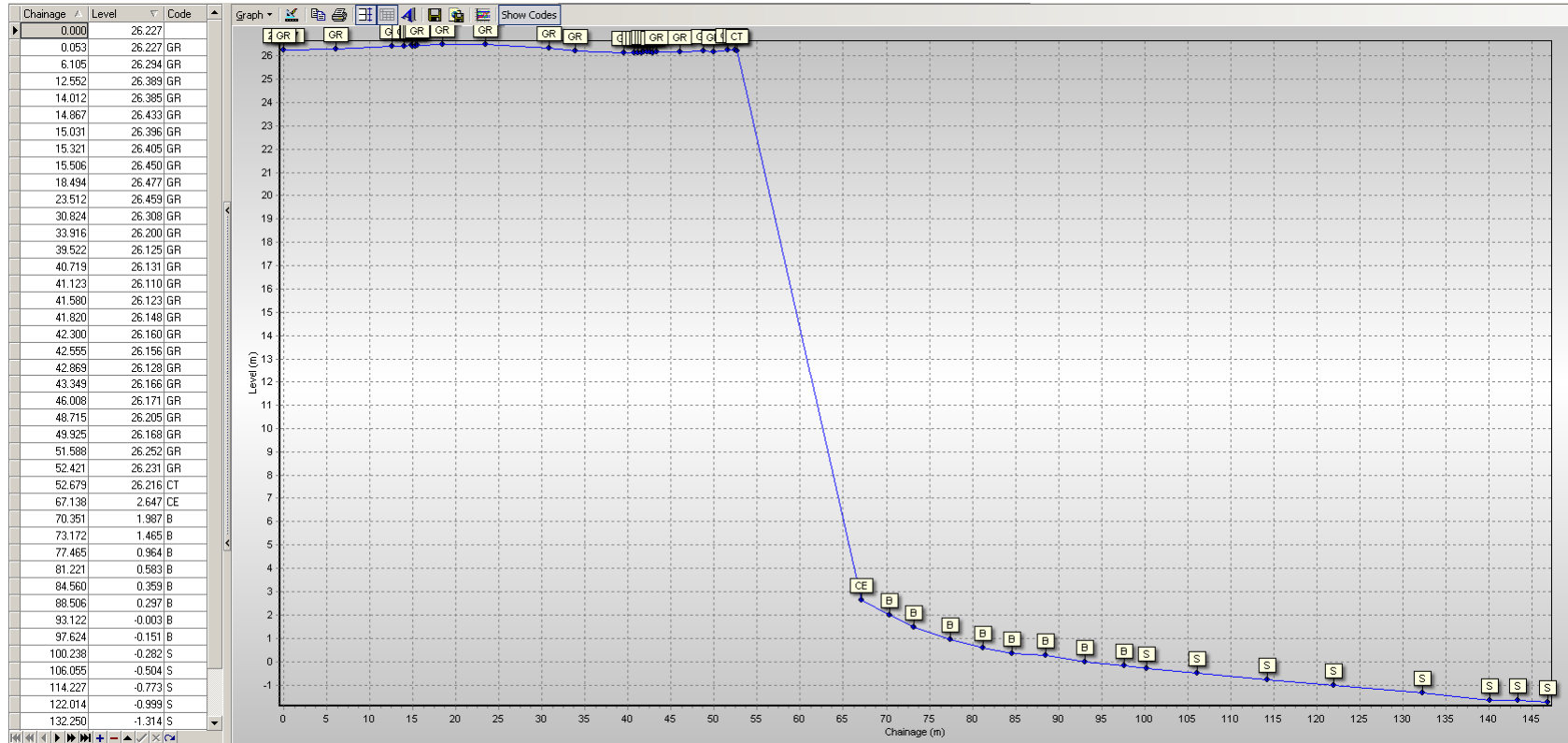
1bSNS31 - 04/04/2011



1bSNS32 - 04/04/2011



1bSNS33 - 04/04/2011



Beach Profiles: 1bSNS4



- Profiles Envelope
- 10/11/2006
- 25/03/2009
- 16/09/2009
- 18/03/2010
- 06/10/2010
- 04/04/2011

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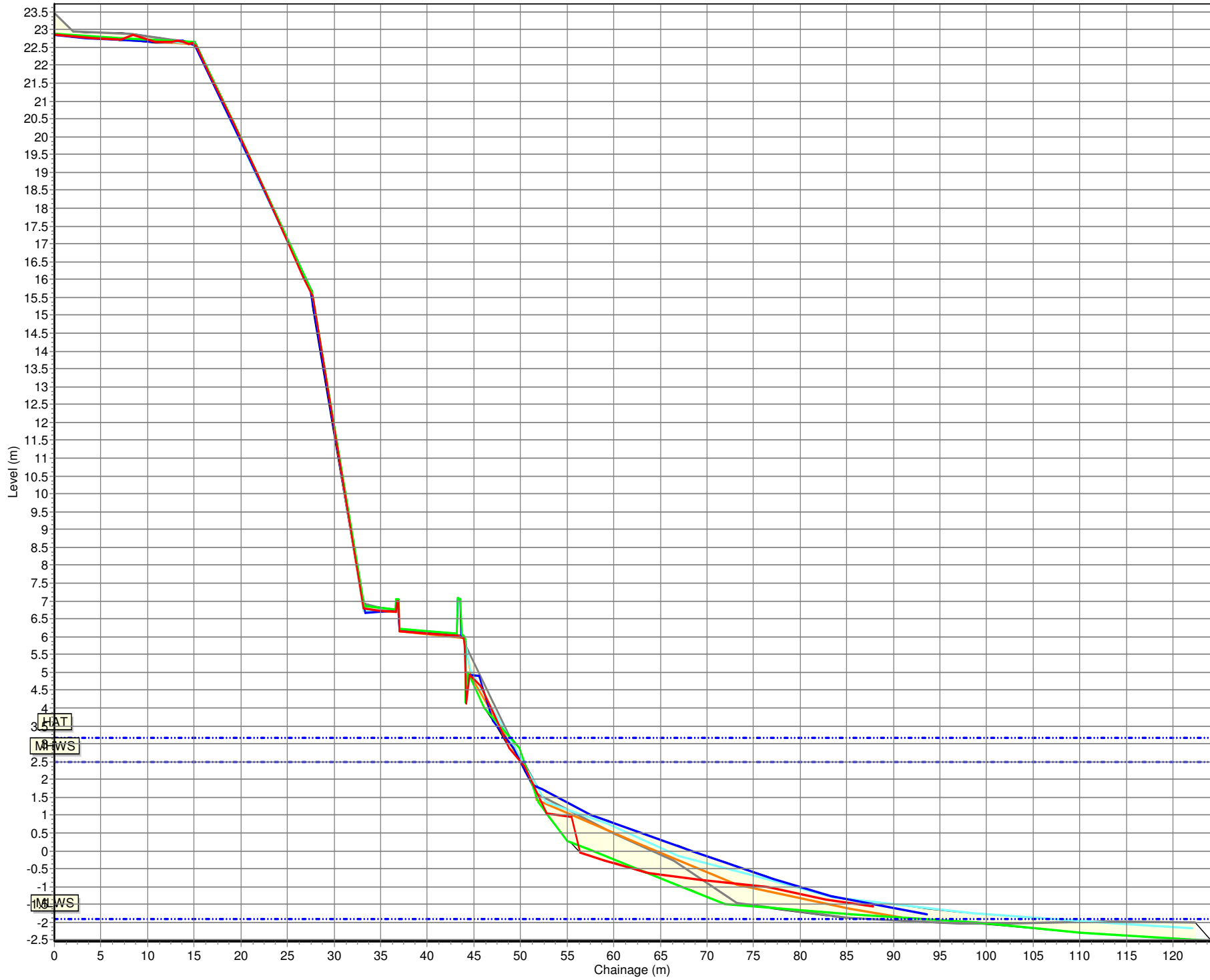
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HAT

MWS

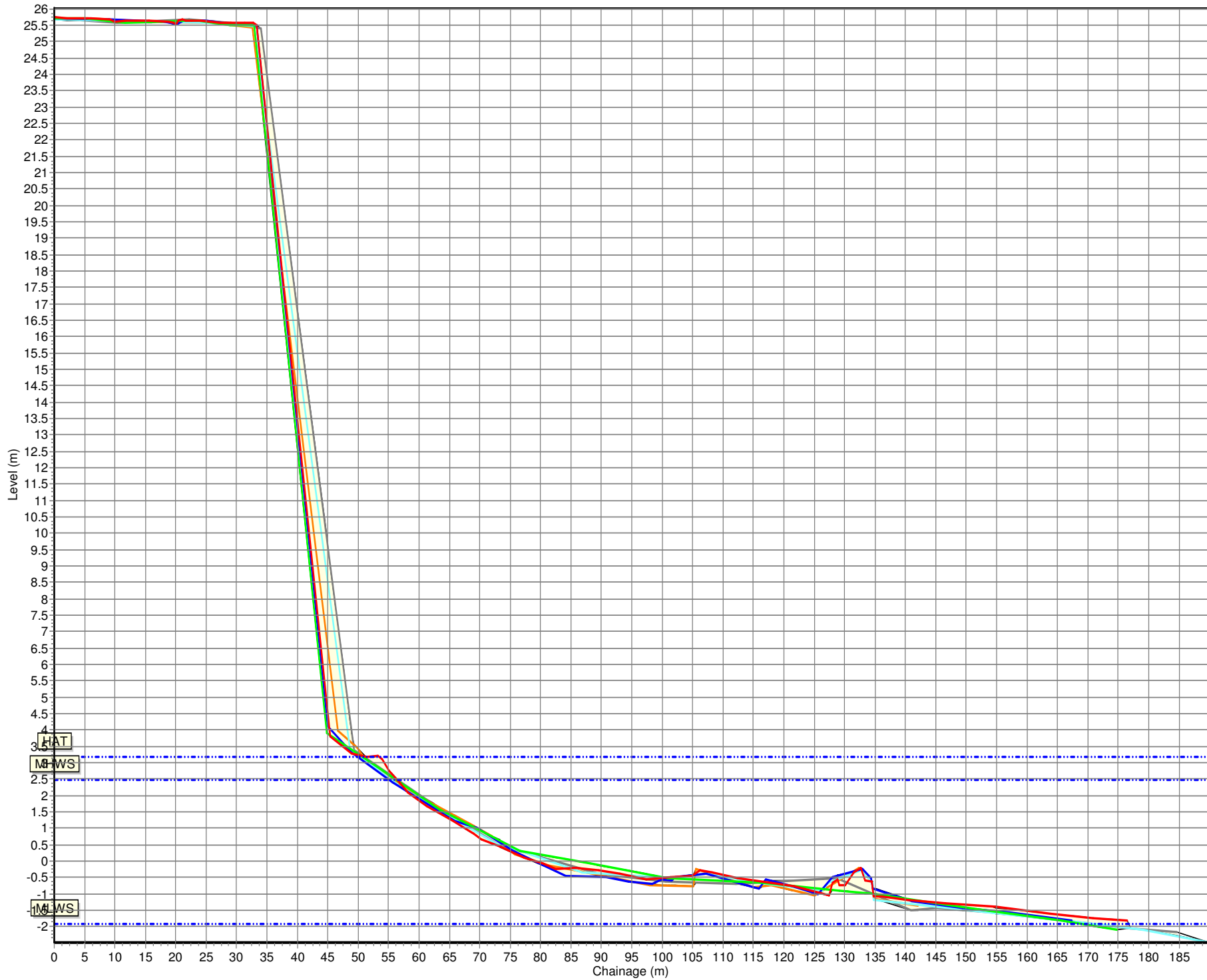
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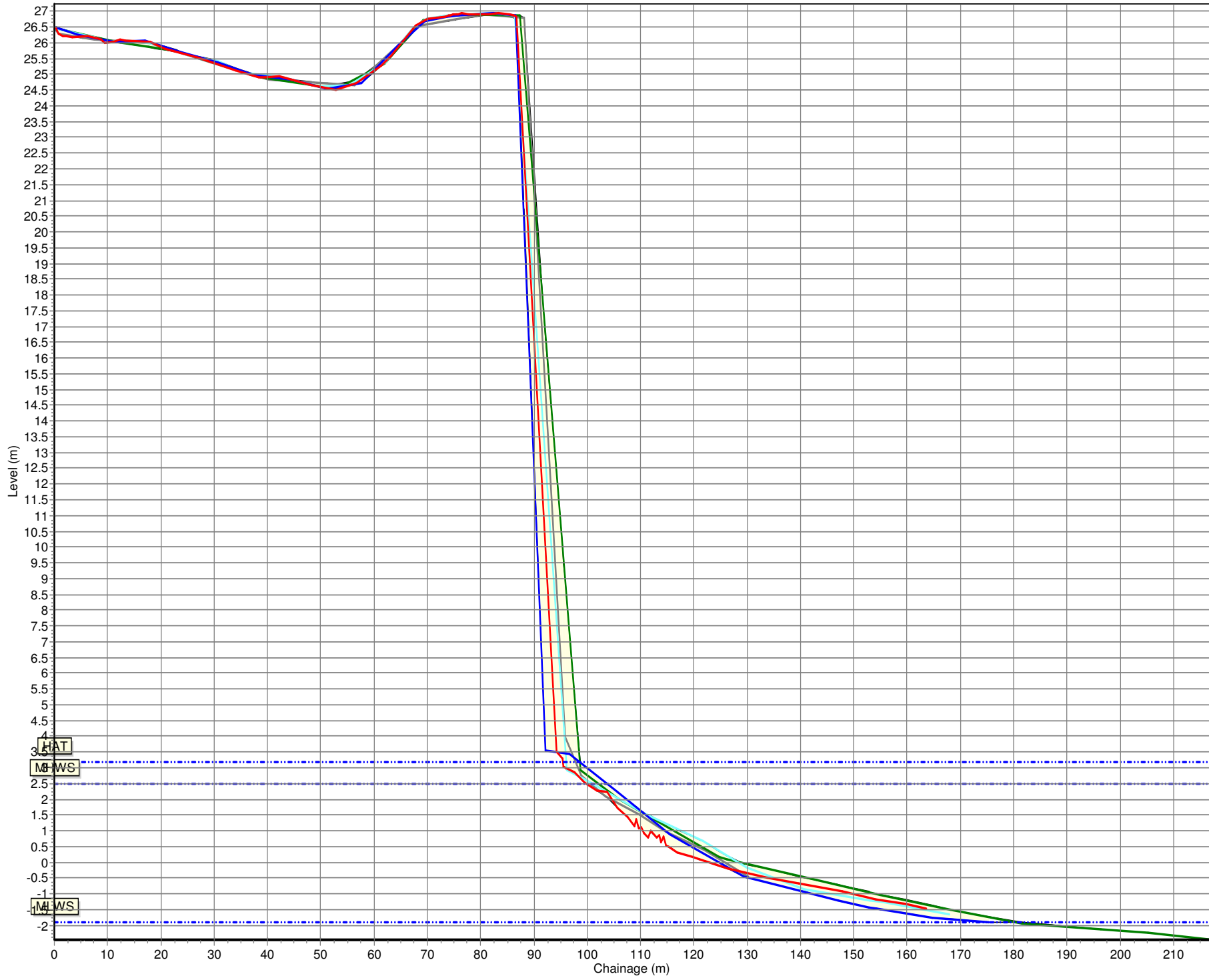
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Beach Profiles: 1bSNS26



- Profiles Envelope
- 25/03/2009
- 16/09/2009
- 18/03/2010
- 06/10/2010
- 04/04/2011

Beach Profiles: 1bSNS27



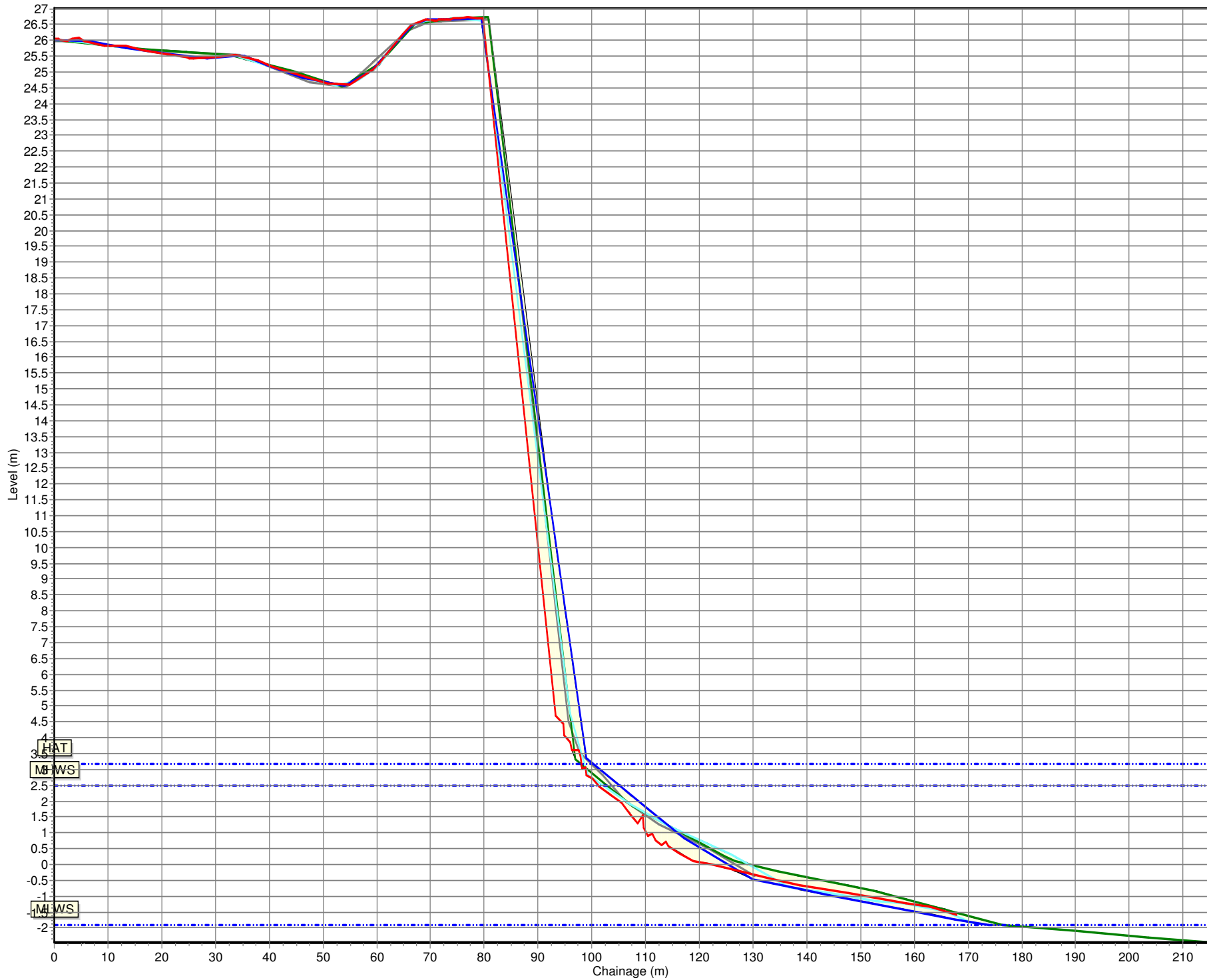
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- 06/10/2010
- 04/04/2011

F.A.T.

M.W.S.

L.W.S.

Beach Profiles: 1bSNS28



- Profiles Envelope
- 25/03/2009
- 16/09/2009
- 18/03/2010
- 06/10/2010
- 04/04/2011

Beach Profiles: 1bSNS29



- Profiles Envelope
- 25/03/2009
- 16/09/2009
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- 06/10/2010
- 04/04/2011

Beach Profiles: 1bSNS30



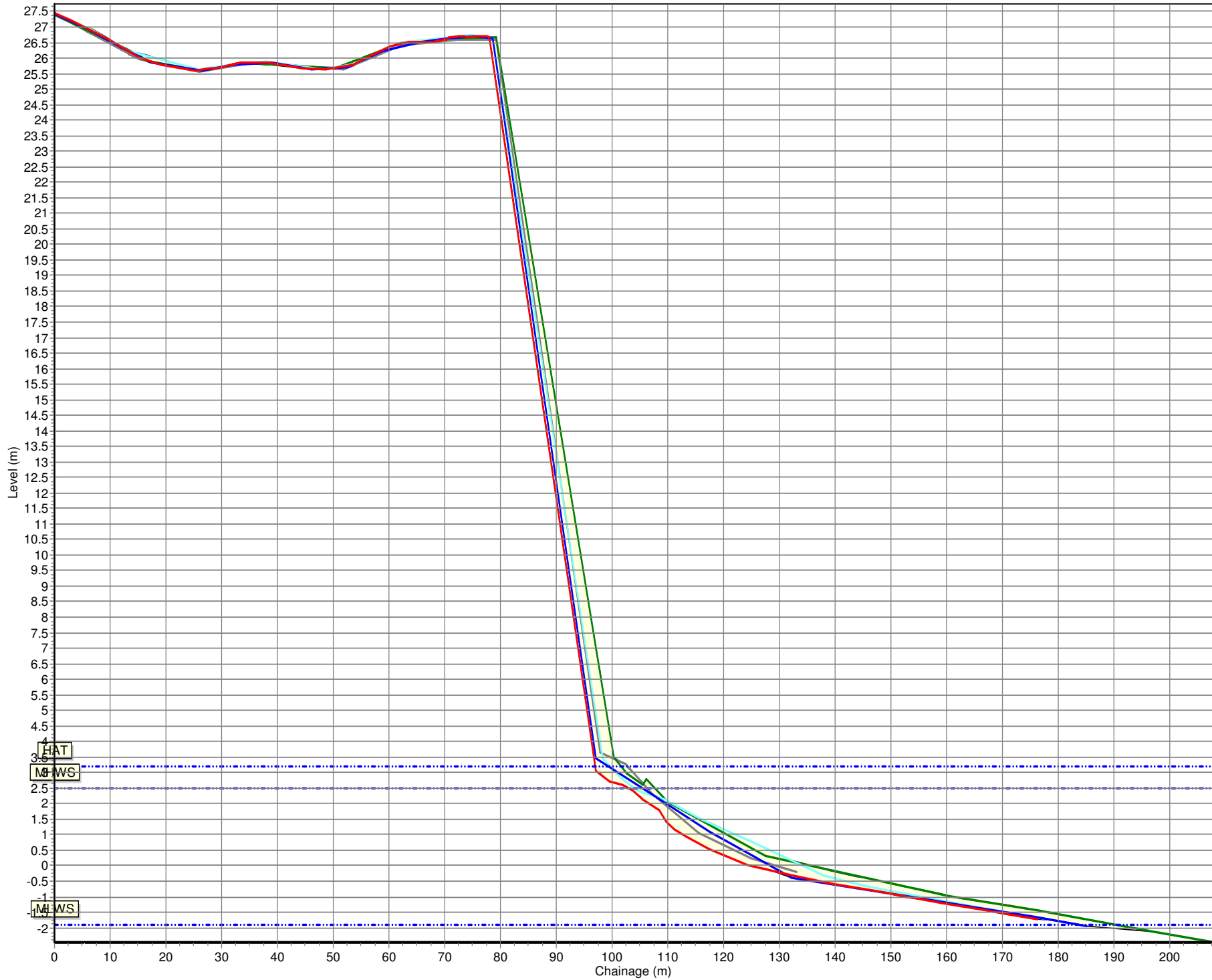
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- 04/04/2011

HAT

MHW

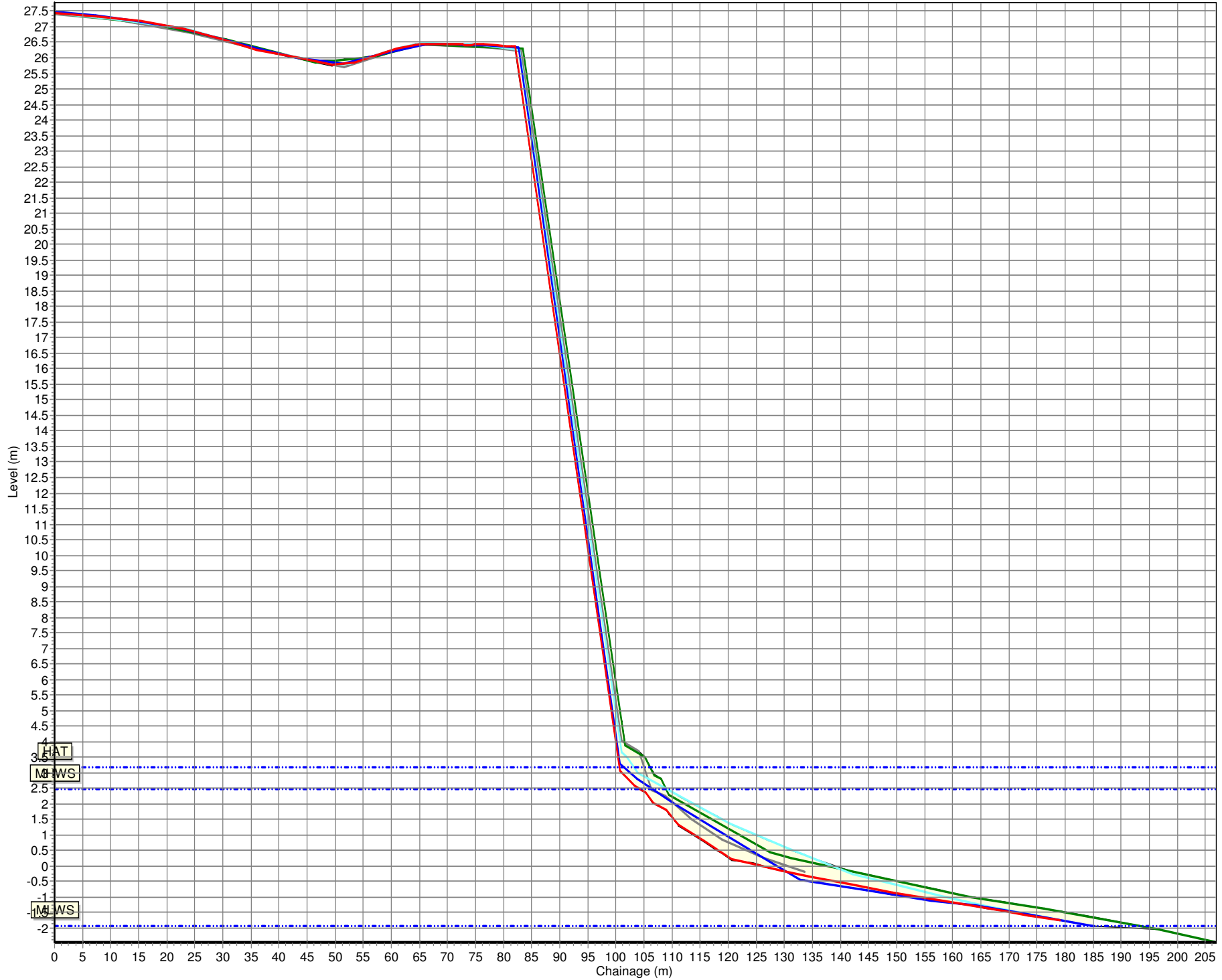
MLW

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- 06/10/2010
- 04/04/2011

Beach Profiles: 1bSNS32



- Profiles Envelope
- 25/03/2009
- 16/09/2009
- 18/03/2010
- 06/10/2010
- 04/04/2011

Beach Profiles: 1bSNS33



- Profiles Envelope
- 10/11/2006
- 16/09/2009
- 18/03/2010
- 06/10/2010
- 04/04/2011

Appendix B
Cliff Top Survey

Cliff Top Survey

Hendon to Ryhope

Thirty-five ground control points have been established between Hendon and Ryhope (Figure C1). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion.

The cliff top surveys between Hendon and Ryhope are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top. It is assumed that the accuracy of cliff top monitoring using this technique is $\pm 0.2\text{m}$. Therefore this should be taken into account when considering the calculated erosion rates in the table below.

Table B1 provides information about these ground control points and results from the baseline, previous and present cliff top surveys 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.

Notes:

- Points 1, 2 and 3 – baseline re-established in October 2010 due to slope landscaping works
- Points 28A, 28B and 28C – added in September 2009
- All other Points – baseline was March 2009

Table B1 – Cliff Top Surveys between Hendon and Ryhope

Ground Control Point Details					Distance to Cliff Top (m)			Total Erosion (m) Negative values = retreat Positive values = advance (heave prior to collapse)		Erosion Rate (m/year)
Ref	Easting	Northing	Level (mODN)	Bearing (°)	Baseline Survey (Mar 2009 unless stated)	Previous Survey (Oct 2010)	Present Survey (Mar 2011)	Baseline (Mar 2009 unless stated) to Present (Mar 2011)	Previous (Oct 2010) to Present (Mar 2011)	Baseline (Mar 2009 unless stated) to Present (Mar 2011)
1	441026	555571	18.9	75	8.9 (Oct 2010)	8.9	8.5	0.4 (Oct 2010)	-0.3	0.2 (Oct 2010)
2	441064	555355	17.3	85	6.8 (Oct 2010)	6.8	6.0	-1.1 (Oct 2010)	-0.9	-0.6 (Oct 2010)
3	441098	555124	17.9	82	10.6 (Oct 2010)	10.6	10.5	0.5 (Oct 2010)	-0.1	0.2 (Oct 2010)

Ground Control Point Details					Distance to Cliff Top (m)			Total Erosion (m) Negative values = retreat Positive values = advance (heave prior to collapse)		Erosion Rate (m/year)
Ref	Easting	Northing	Level (mODN)	Bearing (°)	Baseline Survey (Mar 2009 unless stated)	Previous Survey (Oct 2010)	Present Survey (Mar 2011)	Baseline (Mar 2009 unless stated) to Present (Mar 2011)	Previous (Oct 2010) to Present (Mar 2011)	Baseline (Mar 2009 unless stated) to Present (Mar 2011)
4	441174	554939	17.0	65	10.3	10.6	10.6	0.3	0.0	0.2
5	441199	554861	20.0	65	7.7	7.9	7.7	0.0	-0.1	0.0
6	441224	554774	22.4	71	10.8	10.8	10.9	0.0	0.1	0.0
7	441248	554690	22.8	74	10.2	10.4	10.4	0.2	0.0	0.1
8	441259	554597	22.5	101	10.1	10.0	10.4	0.3	0.4	0.2
9	441276	554513	23.0	66	10.5	7.0	6.7	-3.9	-0.4	-1.9
10	441309	554421	22.0	58	8.8	6.5	6.5	-2.3	0.0	-1.1
11	441354	554346	19.9	68	8.2	8.2	6.8	-1.4	-1.4	-0.7
12	441400	554248	20.5	56	6.2	6.1	6.2	0.0	0.1	0.0
13	441452	554175	22.9	63	11.6	11.8	12.0	0.3	0.2	0.2
14	441472	554081	23.3	127	7.3	7.2	7.6	0.3	0.4	0.1
15	441413	554005	22.9	122	7.8	7.9	8.0	0.2	0.1	0.1
16	441385	553913	23.6	90	9.9	9.9	10.0	0.1	0.1	0.1
17	441404	553815	21.2	93	6.3	6.4	6.5	0.2	0.1	0.1
18	441404	553724	24.6	119	8.1	7.9	8.2	0.1	0.2	0.0
19	441398	553633	25.4	78	8.2	6.2	6.2	-2.0	0.1	-1.0
20	441438	553453	26.8	71	10.1	7.6	6.9	-3.2	-0.7	-1.6
21	441506	553256	27.7	62	8.6	7.7	4.7	-3.9	-3.0	-2.0
22	441550	553159	26.5	103	6.6	6.6	6.8	0.2	0.2	0.1
23	441585	553076	18.7	64	8.1	8.2	8.1	0.0	-0.1	0.0

Ground Control Point Details					Distance to Cliff Top (m)			Total Erosion (m) Negative values = retreat Positive values = advance (heave prior to collapse)		Erosion Rate (m/year)
Ref	Easting	Northing	Level (mODN)	Bearing (°)	Baseline Survey (Mar 2009 unless stated)	Previous Survey (Oct 2010)	Present Survey (Mar 2011)	Baseline (Mar 2009 unless stated) to Present (Mar 2011)	Previous (Oct 2010) to Present (Mar 2011)	Baseline (Mar 2009 unless stated) to Present (Mar 2011)
24	441624	552871	28.1	69	7.5	5.7	5.3	-2.3	-0.4	-1.1
25	441689	552758	28.0	70	14.6	9.3	8.9	-5.7	-0.3	-2.8
26	441715	552713	28.0	54	12.9	12.8	12.9	0.0	0.0	0.0
27	441749	552674	27.4	62	14.6	10.7	10.8	-3.8	0.1	-1.9
28	441777	552630	26.9	57	8.6	4.8	4.8	-3.9	-0.1	-1.9
28A	441799	552586	26.8	56	13.6 (Sep 2009)	13.0	12.8	-0.9 (Sep 2009)	-0.2	-0.6 (Sep 2009)
28B	441817	552542	26.5	64	12.3 (Sep 2009)	12.0	11.4	-0.9 (Sep 2009)	-0.6	-0.6 (Sep 2009)
28C	441852	552503	26.3	52	13.1 (Sep 2009)	13.0	13.1	0.0 (Sep 2009)	0.1	0.0 (Sep 2009)
29	441880	552472	26.1	83	15.5	15.4	15.4	-0.1	-0.1	-0.1
30	441921	552269	25.1	97	8.6	7.9	8.1	-0.4	0.2	-0.2
31	441853	552094	26.4	75	11.2	8.7	8.0	-3.2	-0.7	-1.6
32	441883	551988	27.4	96	9.8	7.6	7.5	-2.3	0.0	-1.1

440000

441000

442000



South West Breakwater

Hendon to Ryhope

Salterfen Rocks

0 200 400 Metres



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● Cliff Top Monitoring Points

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

Appendix B - Map 1 Sunderland Council Frontage

Update Report 3
'Partial Measures' Survey 2011

Drawing Scale 1:15,000 at A4



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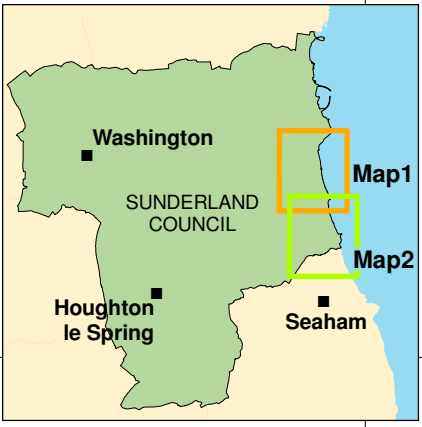
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Checked by: MD Date: 12/05/2011
Approved by: NC Date: 12/05/2011

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441000

442000

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● Cliff Top Monitoring Points

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

**Appendix B - Map 2
 Sunderland
 Council Frontage**

Update Report 3
 'Partial Measures' Survey 2011

Drawing Scale 1:15,000 at A4



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