



**Cell 1 Regional Coastal Monitoring Programme
Analytical Report 1: 'Full Measures' Survey 2009**

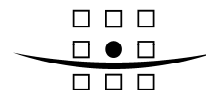
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**Northumberland County Council
& North Tyneside Council
Final Report**

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SUMMARY

The North East Coastal Monitoring Programme was established early in 2002 by the Northumbrian Coastal Authorities Group (NCAG) and is led by the Councils of Berwick-upon-Tweed¹, Alnwick¹, Castle Morpeth¹, Wansbeck¹, Blyth Valley¹ and North Tyneside.

Royal Haskoning has been commissioned by the Group to design and manage the monitoring programme and report annually on its findings.

The monitoring programme primarily comprises annual and biannual profile surveys of various sections of the coastline between Berwick-upon-Tweed and Tynemouth.

This report summarises the findings of the surveys undertaken in April 2008 and September/October 2008.

Analysis of the survey data has highlighted some areas of concern, including:

- There were low beach levels and a very notable (up to 2m) erosion of the dune face along the River Tweed inner estuary beaches (south bank).
- New record low beach levels were recorded along Spittal A, close to the estuary mouth
- Low beach levels were observed at Spittal B, the northern section of Goswick Sands, Beadnell Bay, Embleton Bay and High Hauxley.
- Continued changes were observed along the Alnmouth frontage, linked with changes in alignment of the channel of the River Aln estuary.
- Measurable retreat of shoreline position occurred along the northern part of Druridge Bay.
- There was erosion of the slag banks to the north of Lynemouth Power Station where they are exposed to marine process and there were severe beach width reductions where the slag banks are presently not exposed to marine processes.
- Roll back of the ridge to the south of Lynemouth Power Station continued.
- Measurable retreat of shoreline position occurred at Newbiggin Moor Golf Course
- Notable changes in the beaches within Newbiggin Bay were recorded following completion of the foreshore recharge scheme in 2007 (although beach volumes remain substantial).
- High rates of cliff erosion were recorded at the southern end of Sandy Bay Caravan Park.
- Erosion was observed at the toe of the cliffs at Cambois, caused by a more southerly alignment in the position of the channel of the River Wansbeck estuary.
- Measurable retreat of shoreline position occurred just north of the defended frontage of North Blyth.

¹ Part of Northumberland County Council since 1st April 2009.

- Continued seasonal behaviour occurred along the beaches at Blyth South Beach, with the ongoing lowering of dune crest level in the central bay (around profile BLY04) being a particular concern.
- There was erosion at the toe of the dunes to the north of Blyth South Beach, caused by a more northerly alignment of the outfall of Meggie's Burn.

In light of the above findings, ongoing monitoring and analysis is essential to inform coastal management throughout the NCAG frontage.

The programme should be enhanced through the inclusion of:

- More detailed topographic surveying in Newbiggin Bay to better inform volumetric analysis of changes since the foreshore recharge scheme was completed in 2007; and
- Clifftop monitoring along Cambois Bay to improve understanding of rates of change, assess erosion risk to fixed infrastructure and assets, assess breaching risk to the north of North Blyth and to inform land use plans for this area.

It is also recommended that discussions are held between the new unitary authority in Northumberland and owners of the Newbiggin Caravan Park and the Sandy Bay Caravan Park to discuss the findings from the cliff top monitoring presented in this report and the implications of the management policies recommended in the SMP2.

Funding for the North East Coastal Monitoring Programme has previously been allocated for financial year 2008/09. The activities covering by the present contract will be completed with the April 2009 'partial measures' survey and associated data processing and storage.

The next 'full measures' survey will be undertaken in September/October 2009 and this will be contracted and funded under the wider Cell 1 Regional Monitoring Programme, although its specification will remain unchanged.

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1 INTRODUCTION

As part of the North East Coastal Monitoring Programme, the Coastal Protection Authorities of Berwick-upon-Tweed Borough Council², Alnwick District Council², Castle Morpeth Borough Council², Wansbeck District Council², Blyth Valley Borough Council² and North Tyneside Council have commissioned beach profile surveys to be undertaken along various sections of their coastline. These commenced in April 2002, with a survey of eighty-six profile lines at various locations along the coast. These were fully repeated in September 2002, and since then annual surveys of all eighty-six profiles have been undertaken in September/October each year. This is known as the ‘full measures’ survey. In addition, surveys of twenty-nine selected profile lines have been repeated in April each year since 2003. This intermediate April survey is known as the ‘partial measures’ survey and is intended to show seasonal variations in selected coastal profiles.

During the full measures survey in September/October 2007, ten additional profile lines were added to capture additional information in locations that are known to be causing some concerns or where capital schemes had been implemented. These locations included Boulmer, Low Hauxley, Lynemouth and Newbiggin-by-the-Sea. These ten new lines have remained in both the full and partial measure surveys in subsequent years.

The following beach profile surveys have now been undertaken as part of the North East Coastal Monitoring Programme:

Year	Full Measures	No. Profiles	Partial Measures	No. Profiles
1 - 2001/2002	-	-	April 2002	86
2 - 2002/2003	Sept/Oct 2002	86	April 2003	29
3 - 2003/2004	Sept/Oct 2003	86	April 2004	29
4 - 2004/2005	Sept/Oct 2004	86	April 2005	29
5 - 2005/2006	Sept/Oct 2005	86	April 2006	29
6 - 2006/2007	Sept/Oct 2006	86	April 2007	29
7 - 2007/2008	Sept/Oct 2007	96	April 2008	39
8 - 2008/2009	Sept/Oct 2008	96	April 2009 *	39 *

* To be undertaken

This Analytical Report newly assesses the changes that have been measured by the April 2008 partial measures survey and the September/October 2008 full measures survey.

The locations of the recorded profiles are shown in Appendix A.

² Part of Northumberland County Council since 1st April 2009.

In addition to the surveys of cross-shore beach profiles, additional topographic surveys of the Holy Island causeway and Alnmouth beach have been undertaken.

The topographic survey for Holy Island was added to the programme in October 2004. The following surveys have now been undertaken:

- October 2004;
- October 2005;
- November 2006;
- October 2007; and
- October 2008.

The Alnmouth beach topographic survey was added to the April 2005 monitoring programme and the following surveys have now been undertaken:

- April 2005;
- October 2005;
- April 2006;
- November 2006;
- April 2007;
- October 2007;
- April 2008; and
- October 2008

Also, newly added in September/October 2007, were two topographic surveys of the sea cliff crest to improve understanding of recession rates. These cliff crest surveys were undertaken along an approximate length of 250m at Newbiggin Caravan Park and an approximate length of 400m in Cambois Bay at Sandy Bay Caravan Park. These are repeated as part of both the full measures and partial measures campaigns.

To date, the following Analytical Reports have been prepared and issued as part of the North East Coastal Monitoring Programme:

- October 2006 to October 2007 Monitoring Results (dated December 2007);
- October 2005 to October 2006 Monitoring Results (dated December 2006);
- October 2004 to October 2005 Monitoring Results (dated December 2005);
- September 2003 to October 2004 Monitoring Results (dated December 2004);
- April 2002 to April 2004 Monitoring Results (dated August 2004).

In addition, a walk-over survey is conducted every two years of the entire frontage, enabling inspections to be made of coastal defence structures and natural features such as beaches, dunes and cliffs. To date, the following Inspection Overview Reports have been prepared and issued as part of the North East Coastal Monitoring Programme:

- Defence Inspection Overview Report 2008 (dated September 2008);
- Defence Inspection Overview Report 2006 (dated June 2006);
- Defence Inspection Overview Report 2004 (dated May 2005);
- Defence Inspection Overview Report 2002 (May 2003).

The present report focuses on the changes observed between the October 2007, April 2008 and October 2008 surveys and is structured in the following manner:

- **Section 2** describes the changes observed in the beach profiles, based on the profile plots and the trend plots;
- **Section 3** provides a description and assessment of the additional Holy Island topographic surveys;
- **Section 4** provides a description and assessment of the additional Alnmouth topographic surveys;
- **Section 5** provides a description of the additional Newbiggin Caravan Park cliff crest surveys;
- **Section 6** provides a description of the additional Sandy Bay Caravan Park cliff crest surveys;
- **Section 7** collates these trends together and provides an overview of the behaviour of the coast; and
- **Section 8** highlights the main concerns arising from the monitoring in relation to notable or progressive beach changes.

The **Appendices** contain digital files that enable the profile locations and cliff-top survey lines to be viewed within Google Earth by following a set of simple instructions. Also included are plots of the topographic surveys covering Holy Island and Alnmouth.

The data gathered to date as part of the ongoing monitoring programme is providing valuable information, especially with regard to the short term trends in beach response. This is already assisting in the management of the coastline and formed a key aspect of the development of the Shoreline Management Plan 2.

2 DISCUSSION OF CHANGES IN BEACH PROFILES

This section discusses the changes that have been noted in the beach profiles following the April and September/October 2008 surveys. The description and interpretation of the profiles noted in the previous reports have also been included (*in italics*) for comparative purposes.

The analytical methodology has involved a plot of each profile being superimposed upon the upper and lower envelope recorded from previous surveys. This demonstrates how high or low the beach has been, based on all of the previous monitoring data. The Highest Astronomical Tide (HAT), Mean High Water Spring tide (MHWS), Mean Sea Level (MSL) and, where relevant, Mean Low Water Spring tide (MLWS) have been shown on each plot as guidance for considering the beach response to wave action in the analysis.

In addition, trend lines have separately been plotted for each profile line to show the pattern of erosion and/or accretion over previous years. The graphs plot the distance from the intersection of the beach with HAT, MHWS and MSL to a datum position, defined as the position of the beach in the first year data was taken. The location of the intersection point is plotted seaward of the datum (positive) to indicate accretion or landward of the datum (negative) to indicate erosion.

For purposes of relevance of discussion, the coast has been divided in a manner compatible with the SMP, enabling discussion of the results from a group of adjacent profiles. For each of these divisions, the following format has been adopted:

- Reiteration of the aims for the monitoring;
- A description of the changes that have occurred since the October 2007 survey, including where appropriate a description of change between six-monthly profiles – with a description of the previous survey(s) also repeated (*in italics*) as a reference;
- A general interpretation of the results, highlighting how information from each profile combines to give an understanding of how each frontage behaves - the interpretation of the previous survey(s) is also repeated (*in italics*);
- An identification of any concerns arising from the analysis;
- Recommended actions in relation to either coastal management approaches or the monitoring procedures;
- An assessment of whether the monitoring process is likely to address the aims of monitoring.

As noted in the previous report, the monitoring is still at a relatively early stage and with a maximum of six and a half years comparison possible, only an initial assessment and interpretation is possible. In some respects the interpretation is put forward as a working hypothesis, with the intention of highlighting this for discussion and refinement in future years when more than ten, etc. years data are available.

2.1 Spittal A (Profiles Berwick (BER) 01 - 10)

2.1.1 Aims

- Identify the transfer of material under differing wave and flow conditions.
- Test sensitivity of beaches.
- Monitor integrity of defences.

2.1.2 Description

04-2004 *Within the inner estuary there is little change in Profiles 1 to 3. There has been minor erosion to the upper beach (HAT) on Profiles 1 and 2 with some accretion at this level in Profile 3.*

On the front face of Spittal Beach (Profiles 7-10) there has been general accretion particularly on the intertidal beach below HAT.

Between these two sets of profiles, Profiles 4, 5 and 6, at the mouth of the River Tweed have shown significant variation since monitoring commenced. Profile 4 initially showed no channel separating Spittal Point to Sandstell Point. Since then, a channel developed some 200m offshore as noted in the 2003 surveys. The most recent survey shows that the channel is still present though the back face (western side) of Sandstell Point has eroded significantly to a level below the channel. Profile 5, at right angles to Profile 4, shows significant accretion on the front face of Spittal Point. Profile 6, across Sandstell Point, shows a progressive seaward movement of the crest of the sand island with erosion resulting on the back face, as shown in the Profile 4 survey.

10-2004 *There are generally only minor changes evident in Profiles 1 to 3 within the inner estuary. There has been minor erosion of the lower beach below HAT in Profiles 1 and 3. Profile 3 also shows slight accretion of the upper beach. There is an indication that Profile 1 is steepening.*

Profile 4 shows accretion above MSL (towards the sand island Sandstell Point) resulting in a flatter slope. Erosion at MSL and below MSL (as was observed in the previous year) resulted in a slightly increased channel depth.

There is very little change in Profile 5 since the previous monitoring in April 2004. Profile 6, oriented almost east-west on the sand island Sandstell Point has changed significantly since the previous monitoring in April 2004. The crest of the island, at the seaward end, has decreased in height. The sediment of the crest appears to have been redistributed over the inner and outer slope of the island.

The general pattern occurring in Profiles 7 to 10 is of significant erosion of the lower beach (around MSL) and significant accretion of the upper beach at high-tide level.

04-2005 *The minor erosion of the upper beach above HAT continues at Profile 2 within the inner estuary. The lower beach (between HAT and MHWS) has accreted slightly.*

The significant changes at Profiles 4, 5 and 6 continue with Profile 4 showing the channel has deepened and widened due to significant erosion below HAT. Profile 5 shows that there has been significant erosion of the estuary end of the profile with

negligible variation across Spittal Point. The island crest level on Profile 6 has continued to reduce significantly. The island has become flatter and wider with minor accretion around MSL.

10-2005 *The tidal zone of the inner estuary beach (Profiles 1 to 3) has generally retreated by 1 to 2m due to erosion. The erosion at Profile 4 has continued and is concentrated between MHWS and MSL. This has resulted in the channel deepening but the width has remained similar to April 2005. Erosion of the estuary side of Profile 5 continues. The crest of the island in Profile 6 has increased again in conjunction with material redistribution around MSL. The crest of the island is much narrower than in April 2005. The historic profiles show that the crest of the island is gradually moving in a southerly direction widening the main channel of the River Tweed. Profiles 7 to 10 have eroded significantly, with up to 20m retreat in the upper beach area (between HAT and MSL). There has been negligible change in the lower beach.*

04-2006 *There has been little change since October 2005 along the inner estuary (Profile 2), although some minor beach recovery occurred around HAT. The channel deepening previously observed at Profile 4 was followed during this period by shallowing and widening, with a notable landward movement of the edge of the beach slope. Profile 5 continued to exhibit notable erosion at its western (estuary) side, where the groynes are now starting to show above the sand, but the crest height of the bank increased over a length of around 50m. The redistribution of material from around MSL to the crest of the bank at Sandstell Point continued along Profile 6, illustrating its continued movement in a southerly direction.*

10-2006 *In the inner estuary, the notable erosion that was observed below HAT along Profile 1 between September 2004 and October 2005 had not worsened by October 2006, but some further erosion had occurred between HAT and the beach crest. No further changes of significance were noted along Profile 2. Around HAT, Profile 3 experienced some minor erosion, with material appearing to have been redistributed to the upper beach where it is building up around driftwood. The channel separating Spittal Point and Sandstell Point had continued to shallow to such an extent that pre-April 2005 levels were restored along Profile 4. There was no further landward migration of the beach face, however, and its position was very similar to that recorded in April 2006. Along Profile 5, some slight erosion had occurred between MHWS and MSL, with some deposition above HAT. A notable change occurred along Profile 6, which crosses Sandstell Point, demonstrating further migration to the south. At the northern end of the main beach frontage, Profiles 7-10 show a consistent, and continuing, behaviour of erosion/retreat of the upper inter-tidal zone.*

04-2007 *In the inner estuary, little change occurred along Profile BER02, although around HAT a very low level was locally recorded. At the estuary mouth, along BER04, the beach slope migrated significantly landward (approximately 40m) and new record low levels were recorded. Accompanying this was a landward migration of the MSL mark by some 130m. Along BER05, which runs perpendicular to BER04, the most notable change was an eastward shift in the western bank margin, suggesting some migration in the main river channel as it exits the mouth.*

10-2007 *In the inner estuary, the lowest ever recorded beach levels were observed along BER01 and (in places) along BER02 and along much of BER03.*

At the estuary mouth, the beach slope noted on BER04 migrated slightly further landward, but there was a substantial recovery of the low beach levels recorded on the previous survey. This was accompanied by a notable westward migration of the western bank margin along BER05 (i.e. the opposite movement to that identified in the April 2007 survey).

Along the open coast, Profiles BER07 to BER10 all uniformly showed a reduction in upper beach level, with material deposited lower down the profile between 1.5mODN and 0.5mODN.

04-2008 In the inner estuary, notable change occurred along BER02 above MHWS, with effectively a landward retreat of around 2m of the dune edge.

At Sandstell Point Profile BER04 exhibited a similar (but smaller scale) retreat above MHWS but more significantly the bed levels dropped by, in places, in excess of 1m seaward of 100m chainage.

There was a notable eastward migration of the western bank margin by up to 30m along BER05. This resulted in a new record eastward position. There was a modest accompanying accretion of sediment on the bank crest and eastern face.

Large scale changes also occurred along BER06, with a substantial volume of material eroded from the western slope of the bank crest and deposited on the lower western face of the bank and the eastern side of the crest.

10-2008 In the inner estuary, profile BER01 exhibited a notable retreat in the zone above MHWS, resulting in landward movement of the dunes by 1.3m and record low levels in this zone. This seems continuation of an ongoing landward trend. Whilst a similar landward trend was observed along BER02 between October 2007 and April 2008, the position stabilised to October 2008, with some minor accretion of sand evident on the upper beach above MHWS. Along BER03, landward retreat at the toe of the dunes by around 2m was observed and beach levels dropped by in excess of 0.5m.

At Spittal Point / Sandstell Point, BER04 exhibited some minor accretion, particularly above MHWS and between chainages 200-300m, but significant bed lowering (by up to 1m) occurred between chainages 100m and 200m and seaward of 300m. Profiles BER05 and BER06 run perpendicular to BER04 to capture changes in the banks and channel around Spittal Point / Sandstell Point. Whilst very modest accretion continued on the crest and eastern face of the bank, notable further eastward migration of the channel occurred, causing erosion of the western slope of the bank. Along BER06, the bank captured by the survey exhibited the smallest width and crest level recorded on all surveys.

Along the open coast profiles BER07 to BER10 all recorded the lowest ever levels in beaches, with reduction well in excess of 1m since the previous survey which itself recorded relatively low levels.

2.1.3 Interpretation

04-2004 *With the limited time span of data it is too early to come to any definite conclusions. There is an indication however that the behaviours of the spit strongly response in profiles on the open shore.*

The monitoring data analysed to date indicates that there has been a net transport of material from the back face of Sandstell Point to the front face and across the channel to Spittal Point. It is too early to say whether this is an established pattern of movement.

From the available data, the inner estuary beach appears to be relatively stable.

The accretion observed on the front face of Spittal Beach may also be attributed in part to calm sea conditions allowing offshore sand to be transported back onto the beach.

10-2004 *As noted in the previous analysis, there is still an indication that the spit influences the beach behaviour on the main frontage though the nature of this relationship still cannot be conclusively defined at this stage.*

The previous pattern of movement of material from the back face of Sandstell Point to the front face and across the channel to Spittal Point has not been seen in this summer survey period. In contrast to the previous results, the seaward crest has reduced in height and redistributed material over the front and back slopes of the island. This reversal of behaviour may be indicative of a seasonal variation.

The estuarine beaches inside the mouth of the River continue to be relatively stable.

The erosion occurring on the front face of the main beach is likely to be a reflection of increased wave activity in this period, compared to the previous period. The increased wave activity at this location is probably an indication of more east to south-east wave activity (as opposed to the north-east wave climate predominant over the winter period) to which this frontage is significantly more exposed.

It is interesting to see that the frontage covered by Profiles 7 – 10 does appear to act in a relatively consistent manner, with little evidence of differential change between profiles.

10-2005 *This is the first year that the inner estuary beaches have shown any significant change with erosion of the upper beach. This likely to be due to increased fluvial flows resulting from a number of significant rainfall events this year. Further monitoring will indicate whether this is a trend or an isolated occurrence.*

The patterns in the relationship between Sandstell Point and Spittal Point continue to develop. There is a trend of Sandstell and Spittal Points moving in a south-easterly direction. This survey shows that the channels (River Tweed and between the Points) are widening and becoming deeper. Again this is consistent with pressure from within the estuary.

At the northern end of the main beach frontage, Profiles 7 to 10 show a consistent behaviour of erosion/retreat of the upper tidal zone. Both the channel widening and the erosion of the northern frontage at Spittal Point are likely to be due to increased fluvial flows resulting from a number of significant rainfall events this year.

There is a possible correlation between changes in profiles 3, 4, 7, 8, 9 and 10. Growth, or movement, in the spit (profile 4) occurred in September 2003. At the same time there was accretion at profile 3 and significant accretion at MSL for profiles 7-10. Since 2003, there has been a retreat of profile 4. This is associated with loss at profile 3 and loss to the lower sections of profiles 7-10. Associated now with this loss to the southern sections is a loss of the mid beach to profiles 7-10.

Two processes may be happening. As the spit changes form, profile 3 is exposed to greater tidal flow causing erosion. Also as the spit curves more into the outer estuary it may set up a local gyre on the seaward side, tending to reduce lower beach levels. It may also act as a partial breakwater tending to draw material into its lee from the northern end of the open coast. Such behaviour is likely to be cyclic, balanced between the occurrence of river flow and wave action. This, if it is correct, will be significant to the management of defences at this northern section of open coast and may explain why there has been a need in the past to heavily defend this area of coast.

04-2006 *No further erosion of the inner estuary beaches was observed, thereby supporting the previous hypothesis that the erosion prior to the October 2005 survey was caused by high fluvial flows in the River Tweed.*

The behaviour of the beaches and banks around the mouth of the estuary are interrelated and the processes remain ongoing. The migration of the channels causes erosion of material from the western margins of Spittal Point and Sandstell Point and this material is then redistributed to the crests of these banks.

10-2006 *Southerly migration of the channel which separates Spittal Point and Sandstell Point has continued to occur, leading to greater exposure along the beach section covered by Profiles 7 to 10. This increased exposure has resulted in erosion/landward recession of the beach profiles along this section, demonstrating clear interaction between the beach, banks and channels at the estuary mouth.*

04-2007 *The inner estuary beach at BER02 remained stable. The landward migration and beach lowering along BER04 suggests that the estuary channel may have tended to drive a more easterly alignment at its outfall.*

10-2007 *The inner estuary beaches all experienced lowering to some of the lowest levels on record in this location. This, together with the recovery of the previously identified beach lowering along BER04, together with the westward migration of the western bank margin along BER05, suggest that the estuary channel may have migrated, causing more energy to impact closer to the shore along BER01 to BER03 (i.e. the main channel taking a more meandering form). On the open coast, uniform processes are governing behaviour causing lowering of the upper beach and accretion of the material released lower down the profile. This is uniformly occurring along all profiles between BER07 and BER10. As the responses here appear different to those further south (BER11 and beyond), it is suggested that they remain linked to channel and bank movements at the estuary mouth.*

04-2008	<i>The inner estuary beach is no longer stable but instead retreated landwards by a considerable rate. This appears to be linked to the banks and channels around Sandstell Point. The channel is continuing to migrate eastwards, eroding into the western face of</i>
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the sand bank. This increases exposure at the shoreline.

10-2008 Changes in the configuration of banks and channels around Spittal Point / Sandstell Point continue to have significant influence on shoreline response, both within the estuary and along the adjacent open coastline.

In the inner estuary, notable landward movement of the dunes and record low foreshore levels are significant 'step changes'. This seems to be a continuation of an ongoing longer term landward trend. It is possible that this step back occurred during a particular sequence of storms over the winter 2007/08 because BER02 did not exhibit further major change between the April 2008 and October 2008 surveys.

Along the open coast behaviour continues to be consistent along profiles BER07 to BER10, with the changes observed being significant.

2.1.4 Concerns

The lowering of the upper sections of beaches between Profiles BER07 and BER10 remains consistent and ongoing and is linked to the migration of the channel separating Spittal Point and Sandstell Point. The last survey recorded very low levels along all profiles and this could have implications for the future likely landward migration of the shore if the trend persists. Changes in the channel are also increasing exposure on inner estuary beaches (southern side) where the dunes have eroded markedly, with a landward retreat of up to 2m.

2.1.5 Actions

It will be important to continue monitoring the evolution of the channel and beaches, especially the beach levels along the Spittal frontage. Results from this latest survey should be fed to developers planning activities in the Spittal area.

2.1.6 Assessment Against Aims

The monitoring continues to suggest that the inner estuary and open coast beach behaviour is dependent upon the movement of banks and channels at the river mouth.

2.2 Spittal B (Profiles Berwick (BER) 11 - 14)

2.2.1 Aims

- Identify the transfer of material under differing wave and flow conditions.
- Test sensitivity of beaches.
- Monitor integrity of defences.

2.2.2 Description

04-2004 *The profiles along Spittal Beach show some change over this period.*

Profile 11 shows erosion of the upper beach (above MHWS) and accretion of the lower beach over the winter period (September 2003 to April 2004). Profile 12 shows general accretion for the period between April 2002 and September 2003. Profile 13 shows general erosion over the winter period (though not as low as the previous minimum levels) and Profile 14 shows general erosion between April 2002 and September 2003.

10-2004 *Profiles 11 to 13 show erosion at MSL and accretion above MSL. Profile 11 also shows some accretion on the lower beach slope, below MSL. Profile 14 shows general accretion of the upper slopes, and a berm of accretion just below MSL.*

04-2005 *Accretion of the upper beach, above HAT, is evident from this survey of Profile 11. Erosion continues between HAT and MSL with accretion occurring immediately below MSL. Further seaward the profile is eroding with the loss of the low ridge at -1m ODN.*

Further south the upper beach at Profile 13 eroded with the material being redistributed above MSL. There was minimal change below MSL.

10-2005 *Profile 11 accreted slightly between HAT and MHWS with significant erosion occurring between MHWS and MSL below MSL. Minor accretion in the form of the creation of a ridge occurred at MSL.*

Profile 13 has also accreted at the upper beach (above +1.0m ODN) with erosion occurring below this level to MSL. Beyond MSL the profile has accreted during the summer months (since April 2005).

The southern end of this frontage, Profile 14, also shows accretion of the upper beach. The accretion continued to below MSL with erosion of the lower beach.

04-2006 *Profile 11 showed erosion in the upper beach and some accretion below MSL. At MHWS level, the beach width reduced by some 20m. A similar pattern was observed along Profile 13, where the beach width at MHWS cut-back by some 15m.*

10-2006 *Profiles 11 to 14, along Spittal Beach, have shown considerable variability over time, and this continues to the present survey. Profiles 11 and 13 both showed accretion of material on the upper beach since the April 2006 survey, but October 2005 levels were not fully restored on either profile. Profiles 12 and 14 presently have upper beach levels that are lower than those recorded in October 2005, but are likely to have experienced similar seasonal changes to Profiles 11 and 13.*

04-2007 *BER11 and BER13 both returned to a similar profile shape as was observed in April 2006, although without the small berm present on that survey. Along both profiles, beach levels on the upper beach were relatively healthy.*

10-2007 *Along BER11, a classic summer profile shape was evident, but with two notable berms between MHWS and HAT. Overall, beach levels were healthy, but the profile quickly shelved into deeper levels. Similarly, along BER12, levels were relatively healthy, but the profile gradient abruptly steepened and shelved away to greater depths. BER13 was relatively healthy and mid beach levels were higher than ever previously recorded. BER14 exhibited a redistribution of sediment to the upper beach compared with the previous year's survey.*

04-2008 *BER11 exhibited a general reduction in levels of up to 0.7m around levels of 3.5mODN and 0.5mODN and seaward of around 140m chainage. Along this seaward section, record low levels were recorded. In between these zones modest accretion occurred and accretion was also noted on the upper most section of beach.*

Along BER13 universal beach lowering occurred, with levels dropping by up to 0.8m.

10-2008 *Beach lowering continued along most of BER11, with further drops of up to 0.7m resulting in new record low levels seaward of around 50m chainage. Modest accretion occurred at the crest of the beach. A similar trend was observed along BER12, with the berm previously observed being smoothed out resulting in a local beach level change of around 1.7m. Along BER13 beach lowering continued and record low levels were recorded along the lower profile, seaward of around 45m chainage. Little change was observed along profile BER14.*

2.2.3 Interpretation

04-2004 *Due to the limited timeframe it is too early to come to any conclusions about the long term trends on Spittal Beach. The recent trend is of erosion, with the exception of Profile 12 that accreted slightly. This erosion may be a reflection of the wave climate during the winter period of the monitoring.*

While the trends would indicate a general pattern of erosion in this area and accretion at Spittal Point to the north, it would be inaccurate to suggest a cause and effect regime.

10-2004 *The general trend along Spittal Beach is one of erosion on the lower slopes and accretion of the upper slopes. This is likely to be the result of onshore/offshore sediment transport due to wave action. The accretion observed in Profile 14 may be an indication of long-shore sediment transport from the northern end of the beach to the southern end. Certainly there would appear to be a difference in behaviour at the southern end compared to the profile further north!*

10-2005 *The Spittal frontage is showing significant fluctuations in beach levels indicating a lot of movement of beach material between the upper and lower beaches. Over the full year there has generally been accretion of the dry upper beach (above HAT) and some erosion of the lower beach (below MSL) and fluctuations in between. The accretion of material is likely to be due to the increased fluvial flows in the River Tweed resulting from a number of significant rainfall events this year. Material eroded from the estuary and the northern Spittal frontage may be deposited on this southern stretch of beach. The*

profiles that are monitored 6 monthly (Profiles 11 and 13) also show the upper beach material being drawn down to the lower beach over the winter months, and material being pushed back up onto the upper beach during the summer months.

This frontage continues to present evidence of typical seasonal variation due to wave activity and it is potentially susceptible to storms.

04-2006 *The beach profile changes observed along Profiles 11 and 13 (and assumed to have also occurred along other sections of Spittal Beach) are examples of the classic beach response to seasonal conditions, with a flatter, narrower profile during the stormier months (i.e. prior to the April 2006 survey) and a steeper, wider beach during calmer periods (i.e. built up prior to the October 2005 survey).*

10-2006 *The classic seasonal beach profile response continued to be observed in Profiles 11 and 13, with material moved back up the beach by the more constructive wave activity during the summer and early autumn to increase beach width and gradient around the MHWS and HAT marks. Longer term trends are more evident from Profiles 12 and 14, where surveys are undertaken annually in October. In both areas, the upper beach width reduced compared to the October 2005 data, but that survey did show an unusual volume of material around the MHWS mark.*

04-2007 *The classic seasonal beach profile behaviour is continuing to be observed.*

10-2007 *Seasonal trends are continuing, with the effect of the deeper water channel associated with one of the outfall channels of the Tweed being noted on profiles BER11 and BER12.*

04-2008	Reductions in beach level seem linked to reductions elsewhere, indicating profile response to a major storm or sequence of storms over the winter months.
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10-2008	Profiles BER11 to BER13 are relatively consistent and appear still linked with changes in channel configuration at the mouth of the River Tweed estuary.
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2.2.4 Concerns

The recording of low beach levels along BER11 to BER13 is of concern since continuation of such a trend could affect the stability of the Spittal sea defences.

2.2.5 Actions

There are no specific actions required at this stage.

2.2.6 Assessment Against Aims

The beaches are proven to be highly seasonally dependent in form and level.

2.3 Goswick Sands (Profiles Berwick (BER) 15 - 23)

2.3.1 Aims

- Provide key background information on changes in the areas in support of future investigation.
- Identify threat to Unit 13 and Unit H2.
- Identify sensitivity to wave direction.

2.3.2 Description

04-2004 *Along the frontage of Cheswick Sands there is little change in Profiles 15 and 17 with some erosion in Profile 16 generally over the whole beach face. Comparing this with earlier surveys suggests greater variation in Profile 16 with accretion during the first year and erosion over 2003 to 2004. Profiles 18, 19 and 20 in the Goswick Sands area also show little change though there is an indication of growth on Profile 18 at the crest of the seaward face of the beach. In relation to the area at the northern end of Holy Island, Profiles 21, 22 and 23 show little change with only minor erosion near MHWS level and minor accretion on the lower bed slope of Profile 21.*

10-2004 *The Cheswick Sands frontage (Profiles 15 to 17) has undergone very little change with some minor reshaping around mid-tide level. Profiles 18 to 20 in the Goswick Sands area also show little change. Profiles 17 and 18 do however have some typical post storm characteristics. Holy Island Sands, Profiles 21 to 23 show little change with a slight seaward movement of the forward crest in Profile 22.*

04-2005 *The beach face below HAT of Profile 16 eroded between the October 2004 and April 2005 surveys, which continue from the erosion noted in the April 2004 description. The area of significant change is generally around the MSL datum which can be seen in the trend pattern has been eroding since October 2003.*

Towards the centre of this frontage, Profile 19 has also eroded slightly immediately below the MHWS datum. Profiles 21 and 23, on the northern face of Holy Island, showed small changes during this period.

10-2005 *The beach level at Cheswick Sands (Profiles 15 and 17) has eroded slightly below MHWS between October 2004 and October 2005. Profile 16 shows continuous erosion with 20m retreat at MSL since October 2004.*

The crest of the ridge present at HAT during the 2004 survey of Profile 18 has reduced and moved further inland. Profile 18 shows significant historic changes with accretion between 2002 and 2004 with HAT returning to similar location as 2002 in 2005. The changes at Profiles 19 and 20, Goswick Sands continue to be minor. The northern end of Holy Island also follows the pattern of minor variations including the erosion of the low ridge above MHWS on Profile 22.

04-2006 *The upper beach along Profile 16 exhibited little change from the previous survey, but accretion was noted below MSL. Negligible change was noted along most of Profiles 19, 21 and 23, although the lower beach levels along Profile 19 (beyond a chainage of 600m) recorded a new minimum level.*

10-2006 Along Profile 15 the beach levels increased slightly between MHWS and MSL, but dropped to a new minimum below MSL. Profile 16 showed accretion along its entire length seaward of HAT. Profile 17 demonstrated a similar trend, with a channel feature appearing to have been created just below MHWS, with a ridge evident immediately seaward of this. Along Profile 18, the ridge that is present some 500m from the survey origin moved further inland, by some 35m. No change was evident along Profiles 19 or 23 compared with their respective April 2006 surveys. A small area of accretion was observed along Profile 20 just above MHWS, whilst small-scale profile lowering (below HAT) was the trend observed along Profile 21. Profile 22 demonstrated relatively little change.

04-2007 Foreshore levels reduced along profile BER16, but to within previously observed bands. Little change was noted along most of Profiles BER19, BER21 and BER23.

10-2007 Along BER15 little change was noted along most of the profile, but a reduction in level at a chainage of around 185m (around MSL) resulted in a new record low level. Little change was observed along BER16 between April and September 2007. Along BER17, beach levels fell to a record low just above MSL, but recovered further seaward. Along BER18 the ridge evident in previous surveys had all but disappeared. Low levels were recorded along BER19. The small area of accretion previously observed along BER20 had reduced, but little other change was evident. At Holy Island Sands, little change was evident.

04-2008 BER16 experienced beach lowering, including at the toe of the dunes although the seaward face of the dunes was unaffected. In places along the profile length, new record low levels were observed. Along BER19, BER21 and BER23 beach levels were marginally lower than recorded on the previous survey.

10-2008 Along BER15 beach levels were generally relatively low, but always within previously observed bands. Between MHWS and HAT some accretion had locally occurred, resulting in record high beach levels. Along BER16 levels recovered somewhat along the previous low sections, but new record low levels were recorded seaward of 125m chainage. Beach levels were also at a record low between MHWS and MSL on profile BER17 although elsewhere along the profile they remained within normal bands of behaviour.

Along BER18 some beach lowering just above MHWS resulted in record low beach levels here, but the mobilised sand was deposited on the flats between 300m and 450m chainage, resulting in record high levels here.

Record low levels were recorded along the lower portion of BER19, but little change was observed along the upper profile.

Negligible change was observed along BER20, BER21, BER22 and BER23.

2.3.3 Interpretation

04-2004 This area appears to be generally stable. The variation in Profile 16 would suggest local sensitivity to wave direction possibly relating to interaction with the rock outcrops. The growth of the crest of the seaward beach face at Profile 18 would be consistent with the general southern development of the outer dune along Cheswick Links.

10-2004 *The area appears to be generally stable. Profiles 17 and 18 have some minor reshaping with local scour above MSL and sediment deposition above and below this section.*

Goswick Sands and Holy Island Sands, both with broad plains (extending typically 200m.) at around MHWS, can show significant variation in chainage little change in level. Growth or reduction in level at the forward face of these sand flats can however result in major change to both the degree of tidal inundation and the pattern of flooding of the upper beach, which may create significant change in the nature of the upper foreshore.

10-2005 *Beaches along Cheswick Sands (profiles 15 to 18) are quite variable. There is general erosion in the tidal zone in the beaches at Profiles 15 and 16 with the largest movements in Profile 16. This further reinforces the idea that there is a local sensitivity to wave direction possibly relating to interaction with the rock outcrops near Profile 16. There is also significant flattening of the offshore dune at profile 18, as material is drawn seaward. In contrast, there is minimal change evident in profiles 19 to 23 on Goswick Sands and the northern face of Holy Island. The northern beaches of Holy Island are considered relatively stable.*

04-2006 *The area appears to be generally stable. Of the profiles surveyed in April 2006, it is Profile 16 that again demonstrates the greatest variability (this time lower beach accretion), supporting the earlier hypothesis of local sensitivity to wave climate.*

10-2006 *Beaches along Cheswick Sands (Profiles 15 to 18) remain quite variable, further supporting evidence of local sensitivity to wave climate. Goswick Sands and Holy Island Sands (Profiles 19 to 23) remain, in contrast, relatively stable.*

04-2007 *The area is generally stable and the few changes that did occur give little cause for concern.*

10-2007 *The area is generally stable and the few changes that did occur give little cause for concern despite the fact that in places some (marginally) record low levels were observed.*

04-2008	<i>The changes along this section were less than those observed along frontages further north, but still resulted in record low levels along some parts of BER16.</i>
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10-2008	<i>The southern section of this frontage remained generally stable, although further north (particularly around BER15 to BER17) the shoreline was clearly hit by a storm or sequence of storms that resulted in lower beach levels than previously observed bands of behaviour.</i>
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2.3.4 Concerns

Although some record low beach levels were recorded, there are no major concerns at the present time since this seems to be storm related rather than an ongoing trend.

2.3.5 Actions

There are no specific actions required at this stage other than ongoing monitoring of beach changes to see whether the levels recover.

2.3.6 Assessment Against Aims

Although it is too early to see any clear trends relating to sediment transportation, the monitoring is considered adequate to address the aims of the SMP.

2.4 Holy Island (Profiles Berwick (BER) 24 - 28)

2.4.1 Aims

- Establish rates and patterns of erosion.
- Monitoring of defences.

2.4.2 Description

04-2004 *Profiles 24 to 26 are taken within the bay to the east of the village. The profiles show little change.*

Profiles 27 and 28, to the west of the village, also show little change. The large change in the trend plot for Profile 27 results from a change in survey data establishing a new datum on the inner face of the channel.

10-2004 *Profiles 24 to 26, located within the bay on the southern side of Holy Island, show little change. Profiles 27 and 28, west of the village, also show minor changes with slight erosion of the crest in Profile 27.*

10-2005 *The Holy Island profiles (Profiles 24 to 28) continue to be stable with only very minor variations occurring on Profile 27 with a slight increase in crest level of the ridge.*

10-2006 *The Holy Island profiles (Profiles 24 to 28) continue to be very stable. Slight accretion has been observed along Profile 26 seaward to a chainage of 70m. Along Profile 27, it is assumed that the survey did not pick up data points along the bottom of the channel, leading to the 'apparent' siltation and levelling of the channel bedform, although this can be checked against the next survey.*

10-2007 *The Holy Island profiles continue to be stable with only very minor variations occurring over time.*

10-2008 *Very little change along profile BER24. Whilst the changes along BER25 and BER26 are modest, they have resulted in the lowest ever recorded levels along some sections of the foreshore. There were negligible changes along BER27 and BER28.*

2.4.3 Interpretation

04-2004 *The results indicate relatively stable frontages but with the limited time period it is too early to see any clear patterns.*

10-2004 *The beach profiles appear to be relatively stable. Note however that the monitoring programme is still at an early stage.*

10-2005 *The profiles around the south of Holy Island continue to show the area to be stable.*

10-2006 *The profiles around the south of Holy Island continue to show the area to be stable.*

10-2007 *The profiles around the south of Holy Island continue to show the area to be stable.*

10-2008 *Given the history of stability, the profiles are relatively well sheltered. Despite this, some*

were still affected by modest changes resulting in lowest ever recorded levels along some sections of the frontage. This indicates the severity of the storm (or sequence of storms) that has appeared to cause considerable beach lowering along the Berwick frontages.

Details of the topographic survey along the causeway can be found in Section 3.

2.4.4 Concerns

There are no concerns at this stage.

2.4.5 Actions

No actions are required.

2.4.6 Assessment Against Aims

The monitoring continues to show relatively stable areas, in which no significant erosion is taking place. Any change in these profiles may be very episodic and despite little change at present it is worthwhile maintaining the profiles to provide a baseline against response under a further severe storm in the region.

2.5 Bamburgh (Profile Berwick (BER) 29)

2.5.1 Aims

- Monitoring of defences.
- Establish sensitivity of dune system.

2.5.2 Description

04-2004 There has been slight erosion to the toe of the dune with possible accretion lower down the beach.

10-2004 Minor reshaping of Profile 29 has occurred with accretion at MSL and some minor erosion below.

10-2005 The upper profile continues to show minor reshaping variations rather than any significant changes. There is however, accretion occurring at MLWS with the formation and gradual seaward migration of a ridge.

10-2006 *The ridge present around MLWS in the previous survey was much reduced and the upper beach experienced accretion.*

10-2007 *Aside from a small runnel at a chainage of around 550m, which locally reduces beach level, the beach levels are relatively healthy.*

10-2008	Slight lowering between MHWS and MSL.
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2.5.3 Interpretation

04-2004 *It is too early to see any clear patterns. The changes are consistent with natural variations of the dune.*

10-2004 *It is still too soon to determine any long term trends. The changes are still consistent with natural variation and reshaping of the dune as sediment is pushed up the beach and drawn down by wave activity.*

10-2005 *The dunes and upper beach appear to be stable whilst accretion around MSL may reflect a net southerly drift of material, building up updrift of the Islestone rock outcrop.*

10-2006 *It is likely that the material accreting on the upper beach was moved from the ridge which appeared to be accreting around MLWS in the October 2005 survey.*

10-2007 *The dunes and upper beach appear to be stable while the lower beach appears to periodically be characterised by a ridge and runnel feature at the seaward end of the profile.*

10-2008	This section of coast appears to have been less affected by the lowering in beach level characteristically observed along frontages to the north.
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2.5.4 Concerns

There are no concerns at this stage.

2.5.5 Actions

No actions are required.

2.5.6 Assessment Against Aims

The monitoring data is consistent with the previous survey showing that the dunes are in a stable condition.

2.6 Beadnell (Profiles Berwick (BER) 30 - 31)

2.6.1 Aims

- Establish range of movement within bays.
- Monitor human use of areas.

2.6.2 Description

04-2004	<i>There has been no significant change in Profiles 30 and 31.</i>
10-2004	<i>Profile 30 shows a significant steepening of the upper beach with erosion of up to 5m. There is no apparent erosion, however, of the upper bank. Profile 31 shows little change.</i>
04-2005	<i>Profile 31 suffered very minor erosion particularly at MSL.</i>
10-2005	<i>The upper beach (HAT) of Profile 30 has continued to erode though only slightly, with general accretion below high water level.</i> <i>Profile 31 recovered from the minor erosion before April 2005 and accreted to return to levels of October 2004.</i>
04-2006	<i>Material was eroded from the upper beach (above MHWS) along Profile 31 and deposited in a mound just below MHWS. Further erosion took place seaward of this, with further deposition of eroded material below MSL.</i>
10-2006	<i>Profile 30 experienced accretion along its entire length seaward of HAT, with the levels attained between MSL and MHWS representing new a new maximum. The cross-shore shape along Profile 31 reverted to a more typical configuration, with the mound previously exhibited around MHWS becoming flattened and material infilling the upper beach once again to restore beach levels at that location. Mid-way between MSL and MHWS a new minimum beach level was recorded over a short distance (approximately 6m).</i>
04-2007	<i>Along BER31, beach levels generally lowered since the prior survey, resulting in some new record low levels in very localised and small areas. Otherwise, the profile fell within typically recorded levels and shape.</i>
10-2007	<i>BER30 exhibited material movement from the upper to lower beach profile, causing upper beach levels to drop below previously recorded low values in the process. Only slight moderation of profile BER31 occurred between April and September 2007.</i>
04-2008	<i>BER31 exhibited very modest lowering.</i>
10-2008	<i>Upper beach levels recovered along BER30. There was slight lowering of the lower profile, but to within previous bands of change. There were nominal changes along BER31.</i>

2.6.3 Interpretation

- 04-2004** *It is too early in the monitoring programme to see any patterns.*
- 10-2004** *Erosion of the beach face of Profile 30 could result in erosion to the upper slope. This may have consequences for the strategic approach to defences in this area and will require review as further monitoring data is obtained.*
- 10-2005** *The profile at Beadnell and just north of Beadnell indicate relatively stable beaches, with minor seasonal variations.*
- 04-2006** *The changes observed along Profile 31 are likely to be due to seasonal variations in wave climate, with the more destructive energy conditions following the October 2005 survey causing erosion and draw-down of beach material across the profile slope.*
- 10-2006** *The observed changes support the hypothesis that the beaches are relatively stable and subject to only minor seasonal variations in form.*
- 04-2007** *Behaviour is largely consistent with previous findings and low levels were only observed in very localised areas.*
- 10-2007** *Slight seasonal moderations are consistent with previous hypotheses.*
- 04-2008** *The profiles are relatively stable at present.*
- 10-2008** *The profiles are relatively stable at present.*

2.6.4 Concerns

There are no concerns at this stage.

2.6.5 Actions

No actions are required.

2.6.6 Assessment Against Aims

The monitoring is providing information on the range of movement within the bays.

2.7 Beadnell Bay (Profiles Berwick (BER) 32 - 38 and Alnwick (ALN) 01 - 02)

2.7.1 Aims

- Establish range of movement within bays and sensitivity to wave direction.
- Monitor human use areas.

2.7.2 Description

04-2004 *There has been little major change over the bay as a whole. Profiles 32 and 33 show very little movement which is consistent with their protected location in Beadnell Harbour. By contrast, Profile 34 shows erosion above MSL with accretion above 1m ODN and below MSL. This pattern is more pronounced over the winter period. Profile 35, shows a similar behaviour of lesser volumes but is assessed over merely the annual profiles. Profile 37 shows accretion at the toe of the dune and erosion on the lower slope at around MSL. Profile 38 similarly shows minor accretion at the toe of the dune and minor erosion below MSL. Profile 1 shows a similar pattern, and Profile 2 shows little change. Typically, greater movement occurs between the autumn survey of 2003 and the spring survey of 2004 i.e. the winter months, compared to movement between spring 2003 and autumn of 2003 i.e. the summer months, as is expected.*

10-2004 *Within Beadnell Harbour, Profile 32 has accreted slightly (back to the 2002 profile) and Profile 33 shows some accretion over the upper intertidal area but some minor erosion at MSL. There has been very little change along the northern frontage of Beadnell Bay (Profiles 34 to 38). In Profile 34, minor accretion has taken place at MSL and some erosion is observed at low tide level. Profile 35 shows minor erosion over the majority of the beach slope and Profiles 36 and 37 have some minor erosion at low tide level. The accretion at the toe of the dune on Profile 37 observed in April has been maintained through to September. Profile 38 shows significant erosion since the previous year but generally only cutting back to a position of the 2002 survey. Alnwick Profiles 1 and 2, along the southern frontage of Beadnell Bay, show for greater change than the profiles to the north with erosion above MSL and accretion below MSL.*

04-2005 *There have been no changes in Profiles 33 and 37 whilst Profile 34 has eroded slightly below MSL. Alnwick Profile 1 has eroded significantly during the winter months around MSL with the material being deposited between MSL and MHWS. Profile 2 indicates minor general accretion.*

10-2005 *Profile 32 has continued to accrete around MHWS with minor erosion occurring below MHWS. This has resulted in the upper profile steepening. Profiles 33 to 38 inclusive have generally remained stable during this year with minor erosion below MSL on Profile 34 and minor accretion below MHWS on Profile 35 and above HAT on Profile 37. The southern end of this frontage continues to be the most mobile. The ridge above MSL on Alnwick Profile 1 has been pushed further inland and the crest level has subsequently increased. Minor accretion has occurred between MHWS and MSL on Profile 2 but has generally remained unchanged.*

04-2006 *Profile 33 demonstrated little change on the seaward face, but some deflation in elevations was evident on the upper dunes. Minor lowering of the foreshore was noted along the length of Profile 34, while local cut-back occurred around HAT on Profile 37. Moving to the Alnwick section, Profile 1 experienced flattening of the beach berm and*

restoration of a similar beach form to that observed in April 2005, although beach levels in April 2006 were higher across the whole profile. The minor accretion previously observed along Profile 2 was removed from the mid to lower profile, but the resultant beach form was similar to pre-October 2005 surveys.

10-2006 Minor erosion was observed along Profile 32 below MHWS and minor accretion both above MHWS and lower on the profile (around a chainage of 40m). Some highly-localised lowering of the beach occurred along Profile 33 between HAT and MHWS, whilst the pre-April 2006 beach levels were restored along Profile 34 by the time of the October 2006 survey. No significant changes were observed along Profiles 35 to 38 despite local variations in some locations. At Profile (Alnwick) 1, the formation of a beach berm was observed just above MSL, following a similar pattern to previous years. Profile 2 experienced minor accretion at the toe of the dunes, between MHWS and HAT.

04-2007 Profile BER33 shows modest accretion on the foreshore, whilst BER34 shows a general reduction, resulting in new record low beach levels between chainages of 50m and 100m. Only very minor change is observed on BER37, mostly around HAT (slight lowering). ALN01 experienced a small degree of cut-back into the face of the dunes, with the resulting material being deposited just below MHWS. ALN02 experienced very minor flattening of the profile.

10-2007 Along BER32, the upper beach is remarkably similar to the previous survey in form and level, but below around 1.2mODN a new record low level is set. Similarly, low levels are observed at around this point on profile BER33. The previous lowering along BER34 is reversed and new record high beach levels are observed both at the upper beach and at just below MSL. There is little observed change along profiles BER35, 36 and 37. BER38 generally experienced accretion whilst ALN01 returned in shape and level to a profile resembling that previously recorded in October 2006, with a berm present just above MSL. ALN02 experienced minor accretion along its profile.

04-2008 Some slight cliffing at the dune toe and some local beach lowering to (just) new record low levels were recorded along BER33. Upper beach levels reduced along BER34, but to within previous bands of change. Slight lowering was observed along BER37. Along ALN01 beach levels increased along the upper section of beach but marginally decreased along ALN02.

10-2008 Upper beach levels dropped notably along both BER32 and BER33, creating a new record low in places. There was a notable increase in level along BER34 at the crest of the beach but a modest lowering elsewhere along the profile.

Beach lowering occurred almost universally along BER35 and BER36, with new record lows recorded along part of the profiles, although the form of the profile was similar to previous surveys. Levels remained low along BER37, while reductions were also noted along BER38.

There was considerable accretion on the seaward face of the dunes around and above MHWS along ALN01, with the rest of the profile remaining stable. Along ALN02 levels recovered along the upper beach.

2.7.3 Interpretation

- 04-2004** *The general pattern from the trend lines is one of movement onshore and offshore on profiles, with evidence that material lost or gained at MHWS is distributed up the beach to HAT or drawn down the beach to mid tide level. Although there is clear differential movement between profiles, no clear trend is yet obvious.*
- 10-2004** *The general trend still appears to be one of sediment movement onshore and offshore. A degree of interaction between the profiles is also suggested, but not able to be clearly defined at this early stage. The rock platform outcrops in front of the northern frontage appear to provide some protection to this area, and may also provide an effective physical boundary within which the sediments transported off the beach are prevented from further offshore movement. Profile 1, on the southern frontage appears to have the most exposure to wave activity and sediment transport mechanisms within Beadnell Bay.*
- 10-2005** *The area in the lee of the harbour has a general pattern of accretion between MHWS and MSL which may imply some northerly movement of material being trapped by the harbour. The beach fronting Swinhoe Links (Profiles 35 to 38) is also showing relative stability, reflecting the protection afforded by the northern headland and the offshore rock platforms. The southern part of Beadnell Bay has continued to be relatively stable, with seasonal fluctuations evident just south of the Brunton Burn (Profile 1) with a berm forming during summer and beach flattening occurring during winter.*
- 04-2006** *Although changes occurred on most profiles, they were local and relatively minor, indicating a degree of stability in Beadnell Bay between October 2005 and April 2006. Profile (Alnwick) 1 at the southern end of the frontage continues to be the most mobile, exhibiting seasonal trends where, during calmer months (i.e. prior to the October surveys), a beach berm forms just above MSL and then, during stormier months (i.e. prior to the April surveys), the profile flattens, with the material contained within the berm pushed up the beach.*
- 10-2006** *The profiles continued to exhibit a general stability of form up to October 2006, although local variations in response to forcing conditions were observed. The seasonal variations are most marked in Profile 1 and are continuing to be observed.*
- 04-2007** *At present, observed changes seem to be small, localised and seasonally influenced.*
- 10-2007** *The beaches appear to be relatively stable with seasonal fluctuations about a relatively steady state configuration. Whilst some record low levels have been recorded at times, it is expected that the beach form will return to a state that generally extends between the previous envelopes of change and is unlikely to exhibit a long-term unidirectional change at present.*

04-2008	Modest changes caused by winter storms.
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10-2008	The form of the profile remains constant, but the levels exhibit variability. The present low levels are in keeping with changes observed elsewhere along the coast during this survey.
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2.7.4 Concerns

There are no concerns at this stage.

2.7.5 Actions

No actions are required other than ongoing monitoring to see if low beach levels recover.

2.7.6 Assessment Against Aims

The monitoring is providing information on the range of movement within bays.

2.8 Embelton Bay (Profiles Alnwick (ALN) 03 - 04)

2.8.1 Aims

- Establish range of movement within bays and sensitivity to wave direction.
- Monitor human use of areas.

2.8.2 Description

04-2004 *Profile 3 shows erosion between MSL and MHWS, with corresponding increase above MHWS and towards mid tide level. Profile 4 shows general erosion on the profile.*

10-2004 *Profile 3 shows a general reshaping or smoothing of the profile with erosion at mid tide level and some accretion up to MHWS. Profile 4 similarly shows minor erosion around mid tide level with accretion above.*

10-2005 *Profile 3 has accreted slightly below MHWS whilst Profile 4 has accreted below HAT.*

10-2006 *Profile 3 has accreted slightly above MHWS and eroded slightly below this level. Generally, the lower profile is similar to that recorded in October 2004, prior to the accretion observed by October 2006. Profile 4 has experienced a redistribution of material across the profile, with low levels recorded below MSL and some cut-back evident at the base of the dunes.*

10-2007 *ALN03 showed little change in the dunes and minor 'smoothing' of the accretion previously identified in October 2006, located just above HAT. Beach levels between MSL and MHWS were healthier than previously recorded along this profile. A similar pattern was observed along ALN04, with particularly healthy beach levels seaward of MHWS. Just below HAT, however, the beach level dropped very locally at the base of the dunes.*

10-2008 *Along ALN03 the levels at the dune toe and along the upper beach lowered notably after the relatively healthy levels recorded the previous year, tending towards the previous lowest levels recorded. It is known that slightly to the north of this profile some anti-tank blocks at the toe of the dunes, which were previously buried by beach sand for several years, became exposed. In contrast, there was slight accretion at the toe of the dunes above HAT and along the upper beach along ALN04.*

2.8.3 Interpretation

04-2004 *The northern section of the bay appears to be responding in a manner similar to that in Beadnell Bay, with a pattern of general onshore/offshore movement. To the south there is an overall loss of beach.*

10-2004 *The changes in the profiles in Embleton Bay appear to be natural fluctuations and reshaping due to normal wave and tide activity. The overall losses noted in previous surveys were not evident this time, and it is too early in the monitoring programme to conclude any clear trends in sediment movement.*

10-2005 *Embleton Bay profiles are showing a good degree of stability with a small amount of accretion on the beaches. It would appear that while the distribution of beach material*

has fluctuated in the past in response to wave activity, this frontage is generally stable. The two profiles indicate opposite changes. While the upper beach at profile 3 accreted generally to October 03, profile 4 eroded. Since then profile 3 has shown slight erosion with profile 4 showing slight accretion. In all cases movement is slight.

10-2006 *The natural reshaping of the profiles in response to changing wave climate appears to be continuing, with no changes of major concern. The slight erosion at the dune toe along Profile 4 needs to be further assessed at the time of the next survey to determine whether it is a minor fluctuation or the start of an erosive trend.*

10-2007 *Embleton Bay was exhibiting extremely healthy beach levels in this survey. ALN04 had some very localised lowering at the dune toe which may be a continuation of the previously identified changes and, if continuing, may require some very local scale intervention.*

10-2008 The general position of the dune crest has remained relatively stable since the first survey in 2002, but there have been periods of both modest erosion and modest accretion along the measured profiles at the dune toe and there has been some variability in beach levels along the foreshore. Overall, the northern section appears to experience onshore-offshore movement of sediment during storms and subsequent slow return of sediment during calmer conditions. Over the short duration of the monitoring, the observed changes to date are largely due to local reshaping of beach profiles and the dune toe in response to wave events.

2.8.4 Concerns

There are no concerns at this stage, with seasonal variations dominating behaviour within previously recorded bands. However, with sea level rise in the medium to long term the sheltering effect of the protective foreshore rock outcrops will lessen, leading to more exposure of the upper beach and dune toe and likely landward movement of the dune crest.

2.8.5 Actions

No actions are required, although a watching brief is needed at the toe of the dunes.

2.8.6 Assessment Against Aims

More monitoring data is needed to identify any clear trends in sediment movement and sensitivity to wave direction.

The data from 2002 to 2008 were used, with permission from Alnwick District Council, in a Rapid Geomorphological Assessment at Low Newton and Embleton Links for The National Trust to inform its management decisions relating to leases of the bungalows along the dune crest of Chuck Bank.

2.9 Boulmer (Profiles Alnwick (ALN) 04A – 04B)

2.9.1 Aims

- Establish erosion rates of the foreshore that is fronting cliff-top assets at Boulmer.

2.9.2 Description

Note: *These profile lines were newly-added to the North East Monitoring programme in the full measures survey of 2007.*

10-2007 *ALN04A and ALN04B show a coastal cliff fronted by a beach that slopes down to a rocky shore platform.*

04-2008	Slight accretion on the upper beach along ALN04A, with a redistribution of sediment from just below MHWS to a slight berm located towards the rock platform. Very notable reduction in beach levels along ALN04B but no changes in cliff position.
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10-2008	Redistribution of sediment from previous berm to upper beach along ALN04A with high beach levels at cliff toe. Accretion of sand along whole beach section, especially notable between MHWS and around 1mODN.
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2.9.3 Interpretation

Note: *These profile lines were newly-added to the North East Monitoring programme in the full measures survey of 2007.*

10-2007 *This survey provides a baseline against which future survey will be compared.*

04-2008	No changes in position of rock platform or cliff, but changes in levels of sand beaches.
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10-2008	Apparent accretion of sediment along both profiles, especially ALN04B.
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2.9.4 Concerns

There are no concerns at this stage.

2.9.5 Actions

Monitor future profile lines against the newly-established baseline.

2.9.6 Assessment Against Aims

More monitoring data is needed to identify any clear trends and rates in beach behaviour.

2.10 Alnmouth (Profiles Alnwick (ALN) 05 - 14)

2.10.1 Aims

- Establish interaction at the mouth of the River Aln and the rate of erosion of management Unit 27.
- Identify sensitivity of Unit 29 to wave action.
- Establish interactions at Warkworth Harbour.
- Monitor defences.

2.10.2 Description

04-2004 *The northern bay between Seaton Point and Marden Rocks (Profiles 5 and 6) shows little change, with slight accretion above MSL and slight erosion below MSL. The Alnmouth frontage north of the mouth of the River Aln has experienced notable change between autumn 2003 and spring 2004. Profile 7 shows general accretion at mid-tide level and minor erosion above (up to MHWS). Profile 8 shows a similar pattern. Profile 9 shows accretion of up to 1m depth around MHWS and little change below. The first two profiles on the main beach between Alnmouth and Amble (Profiles 10 and 11) show erosion just below MHWS and accretion above and below this area. Over the central section of the main beach, Profiles 12 and 13, there has been general accretion. Profile 14 shows accretion above MHWS and erosion below.*

10-2004 *Profiles 5 and 6 continue to show some little change, with some minor erosion observed at the toe of the beach and some minor accretion below MSL in Profile 6. Profiles 7 to 9 north of the River Aln show significant changes compared to the last survey (6 months ago). In Profile 7 erosion has taken place at the toe of the beach (around MLWS) and at mid tide level (MSL). Minor accretion is evident on the upper beach and a berm has accreted between the low tide level and mid tide level. A similar pattern is seen in Profile 8, located just north of the mouth of the River Aln with the erosion of the lower beach starting at higher level (MSL) and the accretion being more significant between MSL and MHWS. Profile 9, located at the mouth of the River Aln shows erosion above MSL level with some accretion at MSL level, in contrast to the general accretion noted in the previous survey. At Profile 10, south of the mouth of the River Aln, there has been erosion at MSL with minor accretion above and below this level. Minor erosion has also occurred at high tide level with an accreted ridge forming at HAT. Further south of the River Aln, Profiles 11 and 12 show slight erosion at mid tide level and minor accretion on the lower slopes. In Profile 13 and 14 there is some accretion evident above MSL and erosion below this level.*

04-2005 *Profile 7 eroded significantly between HAT and MSL with areas of accretion below MSL and erosion above MLWS. Profile 8 has accreted significantly between HAT and MSL. Below MSL the profile has eroded slightly. Further south Profile 9 has eroded between HAT and MHWS and accreted below MHWS. The location of the MSL datum has also retreated slightly.*

10-2005 *The northern end of the frontage (Profiles 5 and 6) has eroded slightly around MSL with deposition of this material on the lower beach during the last year. Profiles 7 to 9 inclusive continue to be the most variable along the frontage. Profile 7 is the most variable profile along the frontage with accretion above +1.25m ODN, erosion of the toe of the dune above +0.25m ODN, accretion of the beach at the toe of the dunes, erosion*

around MSL and accretion between MSL and MLWS. There seems to be a trend whereby movement at MSL is reflected in opposite movement of MHWS. Profile 8 exhibits accretion above HAT, however, has eroded between HAT and MSL. Accretion has occurred again at the seaward end of the profile above MLWS. This may show the redistribution of material along the profile following storm events. The upper beach of Profile 9 has accreted whilst the lower beach has eroded. This again may be due to material being pushed up the profile by wave action. Both profiles 8 and 9 act differently to 7. On these two profiles generally loss at MSL is associated with loss further up the beach. Profiles 10 to 14 inclusive, show minor erosion of the face of the dunes. Profile 10 accreted at the toe of the dune and the ridge which was present in the 2004 survey has been eroded. Profile 11 has eroded significantly below MSL. Profile 14 has accreted slightly below MHWS. Profile 12 has eroded significantly on the upper beach, with a retreat of about 20m at the high water level and an associated steepening of the dune slope. Profile 13 and 14 acted similarly but to a lesser extent.

04-2006 Profile 7 continued to exhibit considerable change, with the berm formed around MSL in October 2005 being redistributed across the upper profile, resulting in increased beach levels here. Below MSL, however, the profile lowered as the overall shape altered. Along Profile 8 some slight erosion of the upper beach was more than offset by the accretion that occurred over about 100m around the MSL mark. Profile 9 experienced notable accretion along the entire profile length.

10-2006 Profiles 5 and 6 showed only minor redistribution of sediment across the profile since the October 2005 survey. In contrast, Profile 7 showed further change since April 2006, with yet more redistribution of the material contained within the berm on the beach face. This resulted in an increase in beach levels above 1mODN and a decrease in levels between here and MSL. Along Profile 8, the beach form was notably different to all preceding surveys, with a notable channel (or runnel) and berm formation present. The material which had accumulated, relatively evenly, across the whole length of Profile 9 at the time of the previous survey had been redistributed by the time of the present survey. This involved material from the lower beach being transported up the beach and forming a berm between just below MHWS and just above HAT. A consequence of this was that the lower beach experienced relatively low levels at around 1mODN. Profiles 10 to 12 inclusive all showed signs of ongoing erosion of the upper beach face and/or dune toe, with an increase in beach levels around the 1mODN level. In contrast to this, Profiles 13 and 14 showed stability or accretion of material at the dune toe and upper beach face.

04-2007 ALN07 showed considerable variability, with a reduction in level of up to 1m on the lower beach (around a chainage of 180m). Whilst there was a short section where levels increased (around 100m to 150m chainage), the upper profile also lowered, although by a smaller amount. Along ALN08 the previously formed berm had apparently been pushed landward, resulting in some flattening out and infilling of the backing runnel. Whilst this increased the previously low beach levels in the (former) runnel by up to 1m, it also resulted in the beach width at MSL reducing by around 20m. Profile ALN09 also showed change, with the previously identified berm being flattened and the material released being deposited on the beach lower down the profile.

10-2007 In the northern bay, between Seaton Point and Marden Rocks, both profiles ALN05 and ALN06 show a low beach level at around midway between MSL and MLWS, but elsewhere the profiles generally fall within previously recorded values.

The Alnmouth Bay frontage to the north of the river outfall continues to show considerable variability. Along ALN07 the beach width at MSL reduced by around 15m and relatively low levels were recorded on the lower profile. A small berm at chainage 75m locally increased levels here, and some accretion occurred at the very top of the beach. Along ALN08 the berm and runnel previously identified in October 2006, but flattened out by April 2007 had reformed, but was considerably less pronounced. The newly reformed berm crest was around 0.8m lower than that observed in the previous year, peaking at a level just above MSL. Upper beach levels were relatively healthy. Along ALN09, considerable accretion occurred between MSL and MHWS and beach levels along the entire profile were relatively healthy.

South of the River Aln estuary, profile ALN10 also showed variability, with material pushed up the beach to form multiple berms. The most landward berm, peaking above HAT, resulted in a notable increase in beach width above HAT and MHWS. The most seaward berm, at a chainage of around 225m, was separated from the adjacent berm by a small runnel (at chainage 200m).

Moving further south, ALN11 showed notable cut-back at the base of the dune, with some of the eroded material deposited on the lower foreshore. On a smaller scale, this process was also noted at ALN12, but at the very south of Alnmouth Bay, profiles ALN13 and ALN14 were showing healthy and accreting beach levels.

04-2008 Along ALN07 beach levels lowered along the upper beach (MSL and above), and although the berm previously recorded at about 75m chainage remained present, it reduced in volume. Beach levels along the lower beach, however, increased notably. A similar trend (of upper beach lowering and mid beach accretion) was noted along ALN08 with the resultant profile being relatively featureless and exhibiting no berms or runnels. ALN09 was relatively stable along the upper beach, but the previously formed berm had flattened, with sand accreting along the lower profile section.

10-2008 Between Seaton Point and Marden Rocks, both profiles ALN05 and ALN06 show a low beach level, being close to the lowest levels recorded along this section. This includes very low levels at the toe of the cliffs where new record low levels are recorded locally. Whilst this has not caused any change in the cliff position, it could lead to oversteepening of the cliff and subsequent local failures unless beach levels recover.

Generally, ALN07 exhibited considerable accretion, resulting in the previous low levels being restored to healthy values down to about MSL. However, the lower beach (seaward of about -1mODN) exhibited record low levels. Along ALN08 more modest accretion or stability was recorded on the upper beach, with again very low levels seaward of around -1mODN. ALN09 exhibited little change along the upper-most section of beach but below HAT beach levels dropped dramatically.

South of the River Aln there was a very mixed response. Along ALN10 upper beach levels reduced very notably, creating new record low levels just above MSL and around MHWS. Seaward of MSL, however, notable increases in beach level were recorded, with a notable berm created at around 400m chainage. Although there was notable cliffing at the dune toe along ALN11, cutting back to record low levels most of the upper beach accreted with material. There was, however, a more widespread beach lowering of around 0.5m seaward of around 80m chainage, with record low levels recorded around MSL. A broadly similar pattern was observed along ALN12, with cliffing at the dune toe

reaching record low levels and widespread lowering seaward of around 80m chainage. Again, record low beach levels were recorded along this section at around MSL. Along ALN13 cut back at the dune toe reached record low levels, leading to a steep low cliff being formed at the base. A modest volume of accretion occurred just landward of MSL, but in the main an erosional trend was observed and record low levels were reached around 300m chainage. ALN 14 exhibited different behaviour, with accretion of sand (and observed fresh vegetation growth) above HAT. Even along this profile, however, the beach lowered between HAT and MSL, although it remained stable further seaward.

2.10.3 Interpretation

04-2004 *Given the low degree of change in Profiles 5 and 6 and the considerable accretion on Profile 7, it seems reasonable to conclude that there is little direct interaction between the northern bay and the Alnmouth frontage. The accretion observed to the north of the River Aln mouth is therefore likely to be contributed to by a combination of sand movement from the upper beach slope to the lower beach slope in addition to deposition of sediments transported by from the River Aln. It will be important to confirm with future monitoring whether material from south of the estuary mouth progresses further north or whether material tends to be recycled within the estuary influence of the Aln.*

Over many of the sections, particularly to the main Alnmouth to Amble Beach there is persistent evidence of erosion at the high tide level. This suggests a relatively high energy storm on a relatively low water level. Classically, during such an event, material is moved away from the still water level to be pushed up the beach as a ridge and to be drawn down the beach to form a berm or bank. Profiles 12, 13 and 14 do not conform to this pattern, and show general accretion suggesting the north to south littoral sediment transport mechanisms are active, confirming the analysis of the SMP.

Any interpretation at this stage has to be considered tenuous.

10-2004 *The results further reinforce the notion that there is little direct interaction between the northern bay and the Alnmouth frontage. Profiles 5 and 6 continue to be fairly stable as was noted in the previous survey.*

Profile 7, at the northern end of the bay, is afforded some protection from wave activity emanating from the north east by Marden Rocks. It is interesting to note that this profile had accreted relatively uniformly over the previous survey period (April 2003 to April 2004), indicating typical beach recovery during calmer periods, but in the most recent survey period (April 2004 to September 2004) this profile has undergone some significant erosion and reshaping. It is likely that this is the result of more wave activity from the south east over the summer months, which the northern end of the beach is more exposed to.

Significant changes are noted in Profiles 8 to 10, near the mouth of the River Aln. Due to the complexity of change it is difficult to establish any specific patterns of behaviour.

Whilst it is still early in the monitoring programme it is felt that single profiles may not be adequate to properly define detail behaviour.

The erosion above MSL, noted along the southern frontage (Profiles 11 to 13) in the previous survey, has continued to persist, with an associated minor accretion below this level.

Profile 14 is the only exception, with accretion near the high tide level. This is likely to be a reflection of the degree of protection from south-eastern waves afforded to the southern end of the frontage by the North Pier.

10-2005 The beach to the north of the Aln River (between the river entrance and Marden Rocks) is quite dynamic with significant fluctuations in level, particularly at the northernmost profile. These beach movements do appear to be fluctuating though, maintaining a general overall balance in the medium term (of the 3.5 years of survey to date). The fluctuations are likely to be the result of wave driven sediment transport, during storms, which redistributes the sand over the profiles either pushing sand up the beach or dragging it seaward to form berms, that are then flattened or redistributed with the next event or input of wave energy. Within this semi-confined frontage, any weather emanating from the southeastern sector would tend to push material up into the shelter of Marden rocks at Profile 7. Profile 9 shows some movement in the river entrance location, with a possible shift of over 100m to the south between April 2005 and October 2005. This variance is also likely to have an impact on the beach to the north. The profile in front of the car park (profile 8), shows a stable dune and accretion of the upper beach. The behaviour of the profiles changes to the south of the River Aln where the dunes have accreted and the upper beaches have generally eroded during this year. Further information on the River Aln and Alnmouth area is available in Section 4 which describes the results from the topographic survey. There is no obvious explanation for the sudden erosion at profile 12.

04-2006 The beach appears to have been affected by the preceding wave conditions, since all three measured profiles are showing signs of change. Profiles 7 and 8 appear to have experienced a cross-shore redistribution of sediment, whereas Profile 9 has experienced an influx of sediment since the trend of accretion is uniform across the entire profile.

10-2006 The hypothesis that the beaches either side of Marden Rocks are relatively independent of each other is further supported by these survey data, which indicate relative stability to the north (Profiles 5 and 6) and some considerable redistribution of sediment along Profile 7. Some of the dynamism previously noted along Profiles 8 and 9 is apparent in the present data, with a very different beach form to all previous surveys noted at these locations. Due to this, it appears likely that the channel of the River Aln may have migrated, resulting in changes in the beach form along beaches near the river mouth. The ongoing erosion of the upper beaches and/or dunes immediately south of the River Aln continued, although not across the entire frontage. Erosion was evident along Profiles 10 to 12 inclusive, with some of the material eroded from the dune and upper beach being deposited lower down the profiles. At Profiles 13 and 14, the accretion that was experienced may in part be due to material eroded from beaches further to the north becoming transported to this southern frontage, where some of it tends to accumulate due to different exposure to the wave climate created by the concave nature of the bay and the (partial) 'barrier' presence of the North Pier at the entrance to the River Coquet. The continued bypassing of the North Pier by some remaining sediment results in an increasing siltation problem with the river entrance. This issue is soon to be investigated as part of a separate study commissioned by Warkworth Harbour Commissioners.

04-2007 *In the northern portion of Alnmouth Bay, all three profiles monitored during this survey continued to show considerable variability. The general trend was for the seaward cross-shore movement of sediment along the profile. Along ALN08 and ALN09 this resulted in the redistribution of sediment from storage in a well-defined berm on the upper profile, but along ALN07 the berm was less well defined and therefore upper foreshore levels were stripped more generally.*

10-2007 *In the northern portion of Alnmouth Bay, the berm feature reformed but along ALN08 this feature was less pronounced than in the preceding year. Whilst levels along ALN09 were relatively healthy, beach levels along the lower sections of ALN08 remained relatively low. The section of beach continues to show high variability that is analysed further in Section 4.*

The Alnmouth Bay frontage to the south of the river outfall also showed variability, but this decreased with progression south away from the river mouth. Nearest the river, profile response is likely to be associated with channel movements, but further south there appears to be some connectivity between the erosion along profiles ALN11 and (to a lesser extent) ALN12 and the accretion at profiles ALN13 and ALN14, indicating that both onshore-offshore processes and longshore (southerly) operate in the southern section of Alnmouth Bay.

04-2008 The changes observed to the north of Alnmouth Bay primarily relate to a flattening out of the previous berm and runnel features, probably due to more quiescent conditions leading up to the survey.

10-2008 The changes observed to the north of Alnmouth Bay appear to be related to changes in the channel of the River Aln, with a suggestion that it has migrated closer to the shore. This is confirmed by the topographic survey described in Section 4 of this report.

To the south of the River Aln, the beach appears to have been severely affected by storm damage, with notable lowering of levels and cliffing at the toe of the dunes.

2.10.4 Concerns

Continued changes have been observed along the Alnmouth frontage. There are notable beach profile changes:

- immediately north of the River Aln due to apparent changes in the river channel; and
- immediately to the south of the River Aln where the dunes and/or upper beach continue to erode.

The above changes demonstrate how complex and dynamic the processes are at the interaction of coasts and estuaries.

2.10.5 Actions

The additional monitoring data collected along the northern (most dynamic) section of Alnmouth beach has been analysed and is presented in Section 4.

2.10.6 Assessment Against Aims

As noted above, monitoring is now being carried out in greater detail in order to address the issues noted in the strategy report.

The current beach monitoring continues to provide long term information on general overall change and remains of considerable value.

2.11 High Hauxley to Druridge Bay (Profiles Alnwick (ALN) 15 - 17 and Castle Morpeth (CM) 01 and 02)

2.11.1 Aims

- Potential impacts of subsidence on the dune frontage.
- Impact of cessation of sand mining.
- Potential long term supply to south.
- Potential closure of dune to Cresswell Ponds.
- Impact of change in feed to Lynemouth Bay.
- Erosion of Snab Point.
- Integrity of defences.

2.11.2 Description

04-2004 *Profile 15, between Wellbaugh Point and Beacon Hill, shows general accretion. Profile 16, at Hauxley Haven, shows similar accretion over the first year but with some erosion over the summer of 2003 and into 2004. Profile 17, at Togston Links, shows only minor change.*

At the southern end of Druridge Bay, Profile 1 shows significant erosion over the upper beach (below the previous minimum profile level), and some erosion of the top of the frontal dune.

Further south, Profile 2 shows some erosion above the high tide level and significant accretion of the upper beach (MSL to MHWS).

10-2004 *In contrast to the previous survey, Profile 15, between Wellbaugh Point and Beacon Hill, shows significant erosion (up to 1m deep) below HAT. Some of this material has been moved up the beach but the majority is no longer evident on the profile. Profiles 16 and 17 show very little change with only minor erosion below MSL in Profile 17. Both these profiles, however, are still low. Profile 1 in Druridge Bay, shows some accretion above MSL with some toe erosion below MSL. Further south in Druridge Bay significant erosion (up to 1m deep) is observed in Profile 2 with some accretion above HAT.*

04-2005 *Accretion has occurred at the toe of the rock revetment on Profile 16. The toe of the dunes and the beach face at Profile 17 eroded slightly between the October 2004 and April 2005 surveys though the beach has been generally stable. Profiles 1 and 2 accreted between HAT and MHWS with erosion occurring above HAT. Profile 1 also eroded above the MSL datum.*

10-2005 *The beach along the whole frontage has eroded. Profiles 1 and 2 of the Castle Morpeth frontage, Druridge Bay, continue to be the most variable. Profile 1 eroded between MHWS and MSL with the material being deposited around MSL. The erosion occurred at MSL on Profile 2 with the material being pushed up the beach to accrete above MSL.*

04-2006 *Profile 16 showed signs of erosion between MHWS and HAT and accretion lower down the profile. Very little change was observed along Profile 17. The profiles in Druridge Bay continued to show variability, with material moved from the upper beach and deposited on the lower beach along (Castle Morpeth) Profile 1. At Profile 2, in contrast, net accretion was observed along the profile.*

10-2006 *Profile 15 showed little change in beach form between October 2005 and October 2006, although slight accretion was observed around MSL. Profile 16 showed accretion along almost its entire length while very minor accretion was observed below MHWS over a length of around 40m along Profile 17. Variability continued in Druridge Bay where Profile 1 experienced movement of material from the mid beach to the upper beach where levels increased at the toe of the dunes. Along Profile 2, the material which had accumulated prior to the previous survey was eroded and some of this became deposited lower on the beach, around a level of 1mODN.*

04-2007 *Profile ALN16 showed erosion between MSL and just above HAT and minor accretion lower down the profile. Beach levels at the toe of the dune were low, but the main dune face was unaffected. Profile ALN17 showed beach lowering between MHWS and a chainage of around 80m, and minor accretion lower down the profile and immediately at the toe of the dunes.*

Profile CM01 showed erosion around MHWS, but considerable deposition in a previous hollow at around 250m chainage. In comparison, Profile CM02 showed relatively little change since the previous survey.

10-2007 *Landward retreat of the whole profile above MSL was observed along Profile ALN15, extending up to and including the seaward margin of the dunes. This meant that beach levels within this zone were lower than ever previously recorded. The main dune field remained unaffected.*

Profile ALN15A was recorded for the first time during this survey. It shows a steep, high dune backing a relatively featureless foreshore, with a small channel noted at a chainage of around 150m.

Profile ALN16 had a relatively healthy beach level at the dune toe and along much of the profile down to around MSL.

Profile ALN16A was recorded for the first time during this survey. It shows a high dune and a foreshore with a small berm at a chainage of around 120m.

Profile ALN16B was recorded for the first time during this survey. It shows a high (8mODN) and wide dune field with a very steep coastal margin. This fronts a foreshore upon which rocky outcrops can be noted at chainages of around 100m and 150–175m.

Profile ALN17 showed notable accretion seaward of chainage 70m, but notable lowering landward of this limit, including some cut-back of the dune face.

Profile ALN17A was recorded for the first time during this survey. It shows a steep, high dune backing a relatively featureless foreshore.

Profile CM01 showed its most varied form yet. A large berm was formed at around 250-350m chainage, causing a channel to form to landward and the highest ever beach levels to be recorded around 300m chainage. Levels on the upper beach, extending above HAT, were very healthy compared to most recent surveys. This included a small section around 210m chainage where the previous record high levels were matched.

Profile CM02 showed considerable lowering on the lower profile, at around 250-350m but accretion between 200-250m chainage. Minor lowering was also noted at the dune toe.

04-2008 The second survey of ALN15A shows widespread accretion of beach sand across the profile, including infilling of the small channel noted on the previous survey. Profiles ALN16 and ALN16A show similar accretion on the lower profile, but general flattening of previous berms along the mid beach and cliffing at the toe of the dunes.

Along ALN16B at the northern end of Druridge Bay, beach levels along the upper beach dropped, including directly at the toe of the dunes, with material being moved to just landward of the rocky outcrops. Seaward of these outcrops, beach levels accumulated. ALN17 also exhibited cut back at the toe of the dunes but elsewhere along the profile levels were midway between previous bands. Along ALN17A universal profile lowering was observed, including directly at the dune toe.

The berm previously identified along CM01 was flattened and the area of accretion around MHWS was depleted. Along CM02 the previously recorded low beach levels had recovered.

10-2008 Following the behaviour of the previous year, landward retreat of the whole profile above MSL was observed along Profile ALN15, extending up to and including the seaward margin of the dunes. This meant that beach levels within this zone were lower than ever previously recorded. The main dune field remained unaffected.

Along ALN15A accretion continued above MHWS, resulting in very healthy beach levels at the dune toe. Accretion was also observed at the dune toe along both ALN16 and ALN16A, although immediately seaward of this zone slight reductions in levels occurred along both profiles. Seaward of around 150m chainage, beach levels remained stable.

Along ALN16B beach levels were restored to autumn 2007 values, with no change in position of the dunes or the rocky outcrops. ALN17 exhibited continued cut-back and cliffing at the dune toe, but no changes in the seaward face of the dune or its crest position. Beach levels remained stable along the section down to around MSL, and seaward of there record high levels were observed. Accretion was observed at the upper section of ALN17A and around MSL, but a degree of this was redistribution from the mid beach and lower beach berm.

There was little change along CM01 from the April 2008 survey, but a berm had developed along CM02 at a chainage of around 300m.

2.11.3 Interpretation

04-2004 *At present no obvious pattern of change has emerged for the isolated beaches between rock platforms in Amble (Profiles 15 to 17).*

The Druridge Bay profiles currently indicate significant storm erosion in the mid-section of the bay, and possible littoral transport of this material to the southern end of the beach.

10-2004 *Profiles Alnwick 15 and Castle Morpeth 2 show similar significant net loss of material over the profile with minor gain as material is driven up the beach. Castle Morpeth 1 shows similar characteristics, but with less overall loss.*

Whether material is taken into the sub tidal area or along the beach is uncertain. However, Profiles 16 and 17 show net accretion, failing to show any indication of direct linkage. Indeed the trend plots for both these profiles suggest a general trend of erosion over the year.

10-2005 *Profile 15 has eroded in the upper beach area for the first time in this monitoring programme, previously it has been relatively stable. This may be an isolated response to a storm or extreme tide. Further judgement can be made next year. The tidal zone of Profile 15 has continuously eroded since 2003.*

Profiles 16 and 17 have been generally stable over the period of the last 3 surveys, though there was some erosion noted prior to 2004. The southern end of Druridge Bay, (Profiles 1 and 2) show fluctuations with beach material being moved up and down the slope. This is to be expected along this exposed frontage susceptible to the predominant weather emanating from the northern sector. Both profiles have eroded beyond the previous envelope of minimum level. I.e. lower than historically seen since the monitoring began. This erosion is generally occurring at mean sea level.

04-2006 *Druridge Bay remains an area sensitive to seasonal wave and wind climate. The accretion experienced along Profile 2 may be a result of cessation of sand-winning, but further data would be needed to confirm this.*

10-2006 *Profile 15 was relatively stable compared with the previous survey, suggesting that the erosion observed between October 2004 and October 2005 may have been storm related rather than a continuous ongoing net process.*

The seasonal vulnerability of Druridge Bay was emphasised again during this period, but it is unclear why the changes were not consistent across each profile within the Bay. The accretion previously observed along Profile 2 was removed by October 2006 and future survey analysis will need to assess whether the April 2006 levels were anomalous or whether they were indeed related to cessation of sand-winning.

04-2007 *There appeared to be an offshore process operating along Profiles 16 and 17 whereby material was re-distributed from the upper to lower beach. This is an expected typical beach profile response over winter months.*

It is unclear why CM01 showed much more notable changes than CM02, given that both have roughly similar exposure conditions.

10-2007 *The frontage was storm-damaged in places, including most notably along ALN15 and on the dune face of ALN17. However, this process was not universal along the frontage, suggesting that some areas were not as damaged by the storms at the end of September 2007, or that some material eroded from the beaches and dunes fed other areas along the frontage, helping them to recover quicker.*

The significant berm formation recorded along CM01 had previously been recorded on occasions, but was at its most pronounced form during this survey. Erosion at a similar

location on the profile of CM02 would have released some material but it is unlikely that this would have contributed to the berm formation along the profile to the north. The complexity of the behaviour within Druridge Bay remains.

04-2008	There is local redistribution of sediment along and possibly between adjacent profiles.
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10-2008	There appear to be no major changes to date in the seaward face or crest of the dunes, but considerable variability in the form of the fronting beaches occurs, with berms developing and demising as sediment is re-distributed and prevailing conditions change.
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2.11.4 Concerns

The storm-related beach lowering along ALN15 and the dune face erosion along ALN17 need to be carefully observed on the next survey to ensure that recovery is attained. The behaviour of Profiles CM01 and CM02 is not yet fully understood as there seems to be no consistent pattern or inter-linkages in behaviour.

2.11.5 Actions

There are no specific actions required at this stage.

2.11.6 Assessment Against Aims

The general assumption of a net southerly drift is not evident at present and there is little evidence of major growth of Profile CM02 following cessation of sand winning.

2.12 Lynemouth (Profiles Castle Morpeth (CM) 03 - 03B and Wansbeck (WAN) 01 - 03)

2.12.1 Aims

- Establish erosion rates and changes in patterns of erosion and accretion.
- General monitoring conditions of defences.

2.12.2 Description

04-2004 *Castle Morpeth Profile 3 shows little change. Wansbeck Profile 1 shows general accretion. Wansbeck Profiles 2 and 3 show some erosion, particularly over the crest of the outer beach.*

10-2004 *No significant change is evident in Castle Morpeth Profile 3 as was observed in the previous survey.*

Wansbeck Profile 1 shows significant erosion (up to 1.5 m in depth) in contrast to the significant accretion noted in the previous survey. Wansbeck Profile 2 shows significant erosion of the front face of the crest of the beach as was observed in previous survey. Some accretion has taken place behind the dune crest. The crest of the beach in Wansbeck Profile 3 has eroded significantly with some accretion of the upper slope (most likely transported from the crest).

10-2005 *Castle Morpeth Profile 3 generally continues to be stable. Wansbeck Profile 1 has eroded significantly since October 2004 resulting in a retreat of approximately 15m of the whole profile. Wansbeck Profiles 2 and 3 have accreted on the front face of the ridge with minor erosion on the back face above HAT.*

10-2006 *Castle Morpeth Profile 3 remains extremely stable. Wansbeck Profile 1 has been translated landward by about 4m whilst maintaining the same form and gradient. Profiles 2 and 3 have eroded on their seaward faces and experienced deposition on the crest and backward face of the ridge.*

10-2007 *Profile CM03 shows little change. Profiles CM03A and CM03B have been newly added and, when analysed together with Profiles WAN01-03, can be used to help inform on the performance of the revetment coastal defence, which was completed in March 2006.*

Profile CM03A extends a considerable distance across former slag heaps. Profile CM03B is similar but here the width of slag is considerably less. At Profile WAN01 the former slag embankment has now been removed and the revetment is observed from the survey, located higher up the profile.

Profiles WAN02 and WAN03 have eroded on their seaward faces and experienced deposition on the crest and backward face of the ridge. WAN03 now has the lowest crest level recorded to date. During the survey, both WAN02 and WAN03 had experienced overtopping of the crest and flooding of the area behind.

04-2008	<i>The slag bank along CM03A is located above the limit of tidal and surge action at present and therefore all changes are seaward of around 85m chainage. Beach lowering of up to 0.45m occurred universally along the beach profile. In contrast, the slag bank along</i>
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CM03B is located within the influence of marine process and exhibited landward retreat of up to 4m and foreshore lowering of up to 0.9m.

10-2008 Profile CM03 shows no change. The foreshore levels along CM03A continued to lower, by around 0.6m, resulting in a reduction in beach width at MHWS since the first survey of some 10m. Along CM03B foreshore lowering continued, but at a much reduced rate. Along the slag bank, continued erosion at the toe resulted in around 2m landward retreat here, although the crest of the bank remained in position. The effect is that a much steeper seaward face to the slag bank now exists.

Along WAN01 the 2008 profile of the revetment extension is similar in form and gradient to that recorded in 2007, although located very slightly further landward in position. This suggests that either the previous survey was undertaken just before the armourstone was placed on the profiled slope or that there has been minor settlement of the armourstone.

South of Lynemouth Power Station, along both WAN02 and WAN03 there was modest redistribution of sediment from the seaward face of the berm to its crest and landward face. This particularly resulted in improved crest levels along WAN03 where record low levels were recorded on the previous survey.

2.12.3 Interpretation

04-2004 *The accretion seen in Wansbeck Profile 1 is most likely explained by further placement of colliery material on the existing embankment in front of the Lynemouth Power Station rather than any natural processes. The erosion occurring further south along the beach may be influenced by the rock revetment structure in front of the power station. This structure may effectively be directing some wave energy southward along the beach as the defence is in advance of the adjacent beach.*

It should also be noted that the beach state in this location is not always natural, as regrading of portions of the back beach were evident at the time of the inspections. This may explain the erosion evident in the southern-most Profile 3 surveys.

It is our understanding that this beach has previously been 'nourished' by colliery waste material and that this has ceased in recent years. The beaches subsequent erosion is therefore not an unexpected outcome

The length of monitoring time is too short to really establish any trend.

10-2004 *The man-made spoil embankment providing protection to the power station infrastructure at the location of Profile 1 has eroded significantly. The changes observed in Profiles 1 to 3 are likely to again be the result of human intervention as well as natural processes. The crest of the beach in Profiles 2 and 3 appear to be decreasing in height with material redistributed in front or behind the crest. The sediment movement is likely to be explained by movement of machinery associated with the power station and other human intervention. However, quite evidently a significant volume of material is lost to the beach and fed into the shoreline system.*

10-2005 *The dramatic erosion and retreat seen in front of Lynemouth Power Station is due to the cessation of tipping of colliery waste for coastal protection in mid 2005. The stockpile of*

colliery waste material has since eroded rapidly due to its advanced position on the foreshore and the unconsolidated nature of the material. An extension of the existing revetment fronting the Power Station is currently under construction to prevent further erosion of this coal stocking yard area. The accretion seen in the beach to the south of the Power Station would most likely be the result of deposition of the colliery waste material that has been eroded from the Power Station frontage.

10-2006 Profile 1 is on the northern corner of the recent revetment extension. The works were undertaken between October 2005 and March 2006 so the rapid erosion over the preceding monitoring period (as described above) may reflect the excavations that took place during the works. The more minor erosion that has occurred since April 2006 probably reflects the adjustment of the shoreline following the construction. Along both Profiles 2 and 3, the ridge has experienced 'roll-back', with material eroded from the seaward face being deposited on the crest, or transported over the crest and deposited on the landward slope of the ridge.

10-2007 Since completion of the revetment scheme, the fronting beach has, as expected, continued to erode. Further south, the ridge has experienced roll-back with material eroded from the seaward face being deposited on or over the crest to landward.

04-2008	Where slag banks are within the limits of tidal, surge or wave activity, they are eroding quite rapidly. Where they are above the limits of marine processes they remain stable, but ongoing erosion along the fronting beach could soon initiate erosion along these sections also.
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10-2008	<p>CM03 is very stable. Along CM03A, the net effect of the retreat is that the beach width at MHWS and HAT has retreated by 10m in the space of one year. Should this rate continue, the slag bank erosion will become activated, as is currently occurring along CM03B.</p> <p>There may be some minor revetment settlement along the extension fronting the coal storage yard.</p> <p>Processes of roll-back on the ridge south of the Power Station are continuing, with material eroded from the seaward face being deposited on or over the crest to landward.</p>
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2.12.4 Concerns

It will be important to continue monitoring Profile WAN01 for ongoing minor erosion as the beach in front of the revetment continues to cut back and for evidence of settlement of the rock armourstone. The newly added profiles CM03A and CM03B will also be useful in understanding slag deposit recession rates further north. Roll-back of the ridge along profiles WAN02 and 03 will also need to be observed as this process will ultimately be inhibited by the higher ground to landward.

2.12.5 Actions

Despite construction of the revetment it will be important to continue monitoring this location to assess how quickly the beach erodes without colliery waste protection.

2.12.6 Assessment Against Aims

Ongoing monitoring of existing and newly added profile lines will assist in understanding recession rates along this frontage.

2.13 Newbiggin-by-the-Sea (Profiles Wansbeck (WAN) 04 - 07)

2.13.1 Aims

- Establish erosion rates and changes in pattern of erosion and accretion.
- General monitoring of condition of defences.

2.13.2 Description

04-2004 *There has not been any significant change in the dunes adjacent to Newbiggin Moor Golf Links, in Profile 4. Minor general erosion is evident on the upper beach slope. Profile 5, in front of the Newbiggin Caravan Park, shows some possible slumping/failure of the cliff as there is a slight landward movement evident at the crest of the cliff and a slight seaward movement at the base of the cliff. Profile 6, is a transect through the stepped concrete defence structure backed by a curved concrete wave deflection seawall in Newbiggin Bay. The structure itself is stable with no movement evident and the sand level directly in front of the structure has increased, associated with a slightly steeper bed slope. Profile 7, through the rock revetment at Newbiggin Bay shows little change in the revetment slope and a slight lowering of the level of the toe material.*

10-2004 *Profiles 4 and 5 are located between rocky outcrops. Profile 4 is continuing to erode slowly above MSL level along with some accretion below MSL. No significant changes have occurred in Profile 5. Profile 6, consisting of a stepped concrete defence structure, in the north of Newbiggin Bay, shows no change except for a drop in the sand level at the toe and a general flattening of the sand slope at the base of the structure. Profile 7 at the rock revetment, shows a stable slope with accretion at the toe of the structure, back up to the 2002 profile.*

10-2005 *Profile 4 has generally remained unchanged apart from a small area of accretion below MSL. Profile 5 has accreted above MHWS with negligible variation below. The beach level at the toe of the stepped revetment (Profile 6) has increased during the last year. The rock revetment of Profile 7 appears to have slumped slightly at HAT. The beach at the toe of the revetment has accreted in the order of 0.5m.*

10-2006 *The changes observed along Profile 4 are relatively minor and in line with previously observed profile behaviour. The accretion previously observed along the upper section of Profile 5 has been removed, with very little change observed across the lower rock platform. The accreted material previously observed in October 2005 at the toe of the stepped revetment at Profile 6 has been reduced, but levels still remain healthy with respect to the minimum observed levels along this profile. The beach levels immediately at the toe of the revetment along Profile 7 have reduced notably, although the general beach level appears reasonably healthy.*

10-2007 *Profile WAN04 has eroded back to a new record low level just above HAT, but the steep coastal margin remains unaffected. Profile WAN05 shows a minor redistribution of material from above HAT to below MHWS.*

Profile WAN05A has been added to help inform assessments of the performance of the beach recharge and offshore breakwater at Newbiggin Bay. It shows a healthy beach volume extending from the coastal margin seaward to the rocky foreshore outcrops. Profile WAN06 shows a massive increase in beach levels and width associated with the

beach replenishment scheme. Profile WAN06A has also been added to help inform assessments of the performance of the scheme and shows a wide beach above HAT extending some 100m from the seawall, with a slope down to MLWS. Profile WAN07 similarly shows a massive increase in beach level and width.

04-2008 Along WAN05A beach levels increased substantially, increasing the beach width at MHWS by around 12m. In contrast beach width reduced along WAN06A by around 20m at MHWS. There remained, however, a substantial width of beach in advance of the sea wall and promenade.

10-2008 WAN04 showed cut-back at the toe and seaward face of the cliffs and beach levels above MSL remained relatively low. Along WAN05 a berm formed above MHWS resulting in record high beach levels at this location.

In Newbiggin Bay, WAN05A experienced further increase in levels above MSL, widening the beach at MHWS. Along WAN06 the previous massive increase in volume due to the replenishment had cut back substantially, by around 18m. The beach volume remained very healthy, however. WAN06A experienced a recovery in beach levels, whilst maintaining a constant profile gradient between MSL and HAT. Along WAN07 the seaward gradient of the replenished beach remained constant, with a landward movement of around 13m. Some of the material was deposited well above HAT, raising levels at the toe of the beach.

2.13.3 Interpretation

04-2004 *The possible slumping/failure indicated at Profile 5 are consistent with observations of general erosion and failure of the cliff slope fronting the caravan park in this area.*

The defence structures in Newbiggin Bay to the south appear generally stable though some settlement of the toe of the revetment may be occurring.

Due to the limited timeframe it is much too early to come to any conclusion about the trends of Newbiggin.

10-2004 *There is no further evidence of the slumping/failure at Profile 5 that was noted previously. This however should be continued to be monitored. The structures surveyed in Profiles 6 and 7 in Newbiggin Bay appear relatively stable with some minor changes in the sand profile at the toe of each structure. Previous erosion of the toe of the revetment has reversed to slight accretion.*

It will be important to continue to measure and access the sand behaviour at the toe of these structures.

10-2005 *The beaches fronting Newbiggin Moor Golf Course Links (Profiles 4 and 5) appear to have stabilised over the last year, and previous erosion trends seem to have halted. This is most likely to indicate calmer weather conditions. The beach level at the toe of the defence structures in Newbiggin Bay has accreted, resulting in a steepening of this beach slope. This again, is indicative of calmer, depository weather conditions.*

10-2006 *The erosion previously identified at Profiles 4 and 5 remains abated. The lowering of beach levels at the toe of the revetment within the Bay could lead to defence undermining.*

10-2007 *The Newbiggin Bay coast protection scheme has resulted in massive increases in beach level and width. A wide, healthy beach now extends some considerable distance from the seawall, and is at a level above HAT.*

04-2008	Replenishment material appears to have been redistributed somewhat from south to north.
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10-2008	<p>The frontage of Newbiggin Moor Golf Course appears to experience successive periods of retreat and relative stability, with the most recent trend in the north resulting in erosion of the cliff face.</p> <p>The beaches within Newbiggin Bay are still adjusting to the forcing conditions following the replenishment scheme in 2007.</p>
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2.13.4 Concerns

The previous concerns have been abated due to the construction of the Newbiggin Bay coast protection scheme. Monitoring of the effectiveness of the breakwater in retaining the imported beach volume will be an important future component of the monitoring programme.

2.13.5 Actions

Details of the newly-commenced cliff crest survey along the Newbiggin Caravan Park can be found in Section 5.

2.13.6 Assessment Against Aims

The monitoring is currently adequate to address the aims of the SMP, but could be enhanced yet further (e.g. full topographic survey of the beach and volumetric analysis) to provide useful scheme-related data associated with the recently completed coastal defence scheme.

2.14 Cambois (Profiles Wansbeck (WAN) 08 - 14)

2.14.1 Aims

- Establish erosion rates and changes in pattern of erosion and accretion.
- General condition of defences.

2.14.2 Description

04-2004 *Profile 8, at the northern end of Sandy Bay Caravan Park, shows general accretion. Profiles 9 to 14, along Cambois Links, show a general pattern of erosion/scouring at the base of the cliffs/dunes and accretion seaward of this area. Where there are dunes backing the beach along Cambois Links (Profiles 10, 12 and 13) there is also some accretion of the front face of the dune.*

10-2004 *Profile 8, located at the northern end of Sandy Bay Caravan Park, shows the opposite pattern to the last survey with general erosion. Profile 9, north of the mouth of the River Wansbeck, shows some accretion between MHWS and MSL and erosion around MSL. Some erosion of the cliff is also evident.*

Profile 10, south of the mouth of the River Wansbeck shows significant erosion over the majority of the profile, with the exception of a small section of accretion at MSL. Profile 11 shows general erosion over the whole beach. In Profile 12 erosion is evident over most of the beach with the exception of the area just below MHWS. Profile 13 similarly shows general erosion. Profile 14 shows very little change with minor erosion of the dune face (above HAT) and above MSL, with some accretion observed below MSL.

10-2005 *Profile 8 has remained stable in the upper beach zone and beach material has generally redistributed to form a flatter profile below MSL. Material has similarly been drawn down from below MHWS and deposited at MSL on Profile 9 with a general flattening of the profile resulting. Significant accretion has occurred along the majority of Profile 10 during the last 12 months. Minor erosion has occurred below MSL.*

Profile 11 has accreted between MHWS and MSL with the formation of a low ridge above MSL. Below MSL the profile has eroded slightly. The upper beach of Profile 12 (between HAT and MHWS) has accreted slightly. Between MHWS and MSL the profile response has been very varied with small areas of minor accretion and erosion. Below MSL the profile has accreted. There has been very little change in Profile 13 during this monitoring year. Above MHWS, Profile 14 has accreted whilst between MHWS and MSL, the profile has generally eroded slightly. MSL and below the profile has accreted including the formation of a ridge at MSL.

10-2006 *Profiles 8 and 9 exhibited minor erosion along much of their lengths following the previous survey, although below MSL Profile 9 demonstrated some accretion also. Profile 10 was considerably more variable, with the material that had accreted between October 2004 and October 2005 becoming redistributed along the profile by the time of the present survey, although the overall volume appeared to remain intact. Profiles 11 and 14 showed signs of erosion at the base of the cliffs and minor redistribution around, or just above MSL, whilst Profiles 12 and 13 showed only relatively minor changes.*

10-2007 *Profile WAN08, at the northern end of the Sandy Bay Caravan Park, showed relatively*

low beach levels around and below MSL, but a stable rock berm at the cliff toe. At the southern end of the caravan park, Profile WAN09 exhibited a low level at the cliff toe, but healthy levels lower down the profile.

Profile WAN10 appeared relatively healthy, with record high beach levels recorded at the upper beach, and a large berm located around 75-130m chainage.

At Profile WAN11, the cliff line was unchanged, but the foreshore had a berm located at around 60-100m chainage, resulting in a runnel feature formed close to the cliff toe. This feature was not evident in Profile WAN12, which despite having low foreshore levels throughout did not exhibit significant change in the cliff. Beach levels along Profile WAN13 were, in contrast, higher than ever previously recorded. Profile WAN14 was relatively unchanged. The particularly low water level during this survey enabled some of the rocky outcrops to be captured in the dataset for the first time.

10-2008	<p>WAN08 shows that the rock berm (breakwater) remains stable and helps to stabilise the cliffs behind, with changes confined to the beach levels in front of this defence. Beach levels between MSL and the rock berm recovered, but record low values were recorded between 50m and 90m chainage. Along WAN09, at the southern end of the caravan park, beach levels were relatively similar to the previous survey, and although some cut-back was observed directly at the cliff toe this was very localised and upper beach levels increased marginally elsewhere.</p> <p>The previous high beach levels recorded along WAN10 dropped by well in excess of 1m, matching or setting new record low values along much of the cross-shore length. The berm previously identified along WAN11 was flattened, with material infilling the runnel. Beach levels were low on the lower sections of profile, including a short section around MSL where record low values were set.</p> <p>Along WAN12 material was eroded from the lower profile, which was already relatively low, and pushed up the beach to improve levels at the toe of the low cliff/dune. The previous high beach levels along WAN13 were reduced but remained reasonably healthy, except for at the dune toe where some cut-back occurred.</p> <p>Along WAN14, which is just to the north of the defended section at North Blyth, the cliff has cut-back and beach levels at the toe have increased down to around MHWS. On the lower profile a runnel and ridge feature has developed.</p>
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2.14.3 Interpretation

04-2004 *The pattern of scour at the base of the cliffs/dunes and deposition further down the beach slope is indicative of typical storm erosion. The reason for the accretion at the northern end of the beach is not evident at this stage.*

10-2004 *The erosion and accretion noted in Profiles 9 and 10 and to a lesser extent Profile 11, is likely to be related to sediment transport mechanisms influenced by the River Wansbeck. The pattern of storm erosion noted in the previous survey is still evident along the Cambois Links (Profiles 12 to 14) and also to the north of the River Wansbeck (Profile 8). The full extent of the influence of the River Wansbeck entrance is not entirely clear at this early stage in the monitoring process.*

10-2005 *The trend for this frontage continues to indicate that the beaches are dynamic in response to storm events with beach material being redistributed up and down the slope, but generally fluctuating within a stable range. The on-shore/off-shore transportation of material at various levels implies the profiles are sensitive to storms during low and high tides. The majority of the upper beach along this frontage has remained stable over the last year. The southern shore of the River Wansbeck and the area south of the outfall at Cambois have shown instability in previous years. The profile to the south of River Wansbeck eroded significantly during the 2003-2004 monitoring year. This may have been due to increased flows down the river and the response at the estuary mouth to this. It would appear that change in the channel position is critical to the spates of erosion and periods of recovery in this area. The Cambois profile also eroded significantly during the 2003-2004 monitoring year, and shows signs of very minor recovery however not as noticeable as the River Wansbeck area. The orientation of the localised area is similar to the River Wansbeck profile and therefore the response of the Cambois profile may also be due to increased storms from the north-east prior to October 2004. Significant variations in level have occurred in the lower beach area along the whole frontage, which is a continuation of the storm response identified previously.*

10-2006 *The changes observed are in line with previous hypotheses which suggest higher variability of the beach close to the mouth of the River Wansbeck and cross-shore redistribution of sediment in response to predominant wave conditions.*

10-2007 *Over the monitoring year, the beaches have remained relatively stable along this section. The most notable change was the presence of a berm along profiles WAN10 and WAN11, but this had disappeared by WAN12, suggesting it was a local feature. This could be evidence of 'in progress' post-storm recovery along these sections, with material that had previously been removed from the profile being returned during relatively calmer conditions.*

10-2008 Beach response continues to be linked to changes in forcing conditions, with ridge and runnel features being formed and subsequently flattened.

Along WAN10 the dropping in beach levels appears linked with changes in alignment of Wansbeck channel. This has taken a more southerly alignment over the past year, increasing exposure of the shore to the south of the mouth and starting to initiate erosion at the toe of the cliffs.

To the north of the defence protecting North Blyth, a notable cut-back in dune/low cliff position has occurred. With this change, there has been around a 1m cut-back since the 2004 survey (i.e. an average rate of around 0.2 m per year).

2.14.4 Concerns

The erosion observed along WAN10 and WAN14 could, if continuing at the same rates into the future, have implications for built assets at Cambois Farm and North Blyth in the mid term.

2.14.5 Actions

Details of the newly-commenced cliff crest survey along the Sandy Bay Caravan Park can be found in Section 6.

It is recommended that the rate of recession of the cliffs between the River Wansbeck estuary and the River Blyth estuary are monitored through cliff top surveys. This will have three benefits:

- i. It will improve knowledge of the rates of recession of the cliffs and dunes to better understand erosion risks to built assets;
- ii. It will appropriately inform development proposals for Cambois;
- iii. It will inform understanding of the risk of breaching through the thin isthmus of land at North Blyth.

2.14.6 Assessment Against Aims

The importance of cliff-top assets such as Sandy Bay Caravan Park and Cambois House means that continued monitoring remains important.

2.15 Blyth (Profiles Blyth (BLY) 1 – 6)

2.15.1 Aims

- Establish pattern of sediment movement.
- Clarify understanding of beach loss in the centre of bay.
- Identify potential future vulnerability of dune frontage.
- Monitor defence integrity.

2.15.2 Description

04-2004 *Following the summer period of 2003, Profiles 1 to 6 generally had a typical post storm shape with erosion of the upper beach, and associated deposition forming a seaward berm and a landward ridge in the dune. Following the winter 2003/4 period, the beach generally has a smoother reshaped profile where the berm and ridge have been flattened out and the eroded dune base has been filled in.*

10-2004 *Profiles 1 to 6 show a similar pattern compared to the profiles observed in the summer period of 2003. The smooth shape achieved during the winter period of 2003/2004 has been replaced by general post storm shape with erosion of the upper beach and associated deposition forming a seaward berm and landward ridge in the dune.*

04-2005 *The pattern of smoothing of the profiles during the summer months has generally not continued. The April 2005 profiles are smoother and have shallower slopes, imply that the months between October 2004 and April 2005 were relatively calm in terms of storm events.*

10-2005 *The development of ridges above HAT on all profiles except 2 and 3 between the April and October 2005 surveys is apparent. Profile did develop such a ridge in 2004. The central Profiles, 2 to 5, show erosion of the upper beach around high water level, with deposition of material seaward at MSL and below. Profile 3 also shows significant erosion of the face of the dune.*

04-2006 *The ridge that had previously formed around HAT became smoothed along all profiles. Particularly low beach levels were noted along Profiles 2, 3 and 4, but all profiles showed signs of variability. Profile 1 experienced accretion on the dune face.*

10-2006 *All profiles demonstrated a degree of accretion since the April 2006 survey. Along Profiles 1, 5 and 6, there appears to have been largely a redistribution of sediment across the profile, while Profiles 2, 3 and 4 seem to have experienced an input of sediment since accretion is relatively uniform across the entire profile length.*

04-2007 *BLY01 exhibited a notable redistribution of sediment from the upper beach to between 0.5m and 1.5mODN. Along BLY02 upper beach levels were relatively healthy, but material was moved from 40-60m chainage and deposited in a large berm, peaking at around 80m chainage. Along BLY03, beach levels reduced marginally compared to the previous survey, but remained well above the previous minimum. Along BLY04, beach levels were very healthy. BLY05 exhibited a notable redistribution of sediment from the upper beach to between 0.5m and 1.5mODN, but lowering again further seaward. Along Profile BLY06, the previous ridge around chainage 125m had reduced in significance, but was still evident and beach levels were relatively healthy.*

10-2007 *BLY01 had a notable lower beach berm and 'restored' upper beach levels. The large berm identified at around 80m chainage in the previous survey along BLY02 had become flattened, but the sediment had infilled upper beach levels, resulting in the most healthy levels for some time. Beach levels were also healthy along BLY03, but Profile BLY04 was severely altered, presumably by storm damage/blow-outs. Here the dunes had cut-back markedly and the dune crest had lowered to a new minimum. Foreshore levels were very low, especially around 75-100m chainage. Along BLY05, some recovery of level was noted between MLWS and around 1.5mODN, but levels at the dune toe were relatively low. BLY06 exhibited now-total flattening of the former crest around 125m chainage and redistribution of that sediment down the profile to MSL.*

04-2008 BLY01 showed notable lowering at the toe of the dunes and along most of the profile down to MSL and steepening of the seaward face of the dunes, although changes were within previous bands of change. The lower beach berm recorded on the previous survey was totally flattened.

Previous healthy beach levels along BLY02 dropped by around 0.3m at the toe of the seawall and promenade, and new record low levels set just below MHWS. The small berm remained at around chainage 80m, but levels seaward of this point also dropped to new record low values.

Material stored above MSL along BLY03, where record high levels were set on the previous survey, was moved up the beach to provide the healthiest beach levels for some time at the toe of the defence. This redistribution did however reduce levels between MHWS and MSL to match previous record low levels.

Along BLY04 lowering of the beach by up to 0.6m occurred at the toe of the dunes. Between MHWS and MSL, however, beach levels were at their healthiest for some time. Below MSL levels were relatively low but a berm had formed at around 170m chainage. The dune crest, which already was low, further reduced slightly in height.

The seaward face of the dunes remained very similar to previous surveys along BLY05, although a slight reduction in beach level occurred right down the profile to around 140m chainage. Seaward of here, however, beach levels were healthy and a berm had formed at around 200m chainage.

Along BLY06 upper beach levels reduced slightly, but a notable volume of material accreted on the mid and lower profile, creating record high levels between MHWS and MSL. The main dune ridge accreted slightly on its upper seaward face.

10-2008 On BLY01 material previously stored on the profile at around the level of 1mODN was eroded and moved up the profile to increase beach levels around MHWS and above, including establishment of a small berm above HAT.

Material stored in the berm at around 80m chainage along BLY02 was pushed up the profile to restore healthy beach levels at the toe of the seawall and promenade and down to around 40m chainage. Seaward of here, however, dramatic reductions in beach level were observed and new record low values were recorded around MSL. Seaward of MSL, levels remained low, but within previous bands of change.

Whilst beach levels remained high beyond MHWS along BLY03, some material was drawn down from this upper section of the profile. In contrast to previous seasonal changes, however, this was not deposited on the lower beach and instead there seemed to be a net loss of sediment from the profile as lowering occurred along almost the entire length, resulting in lowest ever recorded levels between just below MHWS and MSL.

Along BLY04 the dune crest appeared to reduce further still. Beach levels at the toe of the dunes and along the upper beach were much improved. A considerable volume of material was removed from the profile between MHWS and MSL and the berm identified on the lower profile in the previous survey was flattened.

The berm previously identified on the lower profile along BLY05 migrated landward by around 15-20m and a new berm formed above HAT, restoring upper beach levels to healthy values.

Material was redistributed from the lower and mid beach along BLY06 and deposited in the form of a berm above HAT creating healthy levels at the dune toe. Slight accretion continued on the seaward face of the high dune ridge.

2.15.3 Interpretation

04-2004 *The current pattern evident indicates erosive conditions during the summer months and recovery during the winter months. With the limited time period it is too early to establish this as a typical pattern.*

The monitoring shows some indication of patterns of movement with the northern section of the beach (Profiles 2 and 3) responding differently to profiles to the south. This is anticipated but it is too early to draw substantial conclusions.

10-2004 *The current pattern indicates that erosive conditions have again been prevalent in the summer period as was the case in 2003. The northern section of the beach (Profiles 1 to 3) has again responded slightly differently to profiles in the south, with accretion at high tide level and erosion at MSL in the north, and the opposite occurring in the south.*

The accretion on the upper beach at Profile 2, backed by a vertical wall, demonstrates the ability of the section to recover despite the structure. This observation was made in the recent strategy study.

10-2005 *The differences between the April and October 2005 profile appear to exhibit typical beach building response with material moving from the lower beach. The profiles have areas of accretion and erosion indicating the redistribution of material along the profile rather than significant losses of material. Despite the recovery in October 2005, generally over the full year there has been erosion of the high water zone and deposition on the lower beach slope over most of this beach.*

Looking at the trend plots there may be some indication that profiles 4 and 6 show some linkage. Accretion at 4 is associated with erosion at 6 and erosion at 4 with accretion at 6. The behaviour of profile 2 clearly demonstrates the sensitive position of the defence. While with other profiles there is width for material berms to develop, at 2 no width exists. Profile 1 continues to accrete and there is no obvious close association with change at 2.

This is tending to support the idea that offshore onshore supply is important to the frontage.

04-2006 *The change in profiles appears to tie in with expected beach response to stormier wave conditions experienced between October 2005 and April 2006, with the 'summer berm' previously identified in October 2005 becoming flattened and the material being redistributed across the profiles.*

10-2006 *The profiles exhibit continuing variability in response to changes in wave climate. The erosion of the dunes previously observed at Profile 3 appears to have been an isolated event, likely to have been storm-driven.*

04-2007 *Typically the trend along this section was for the redistribution of sediment from the upper to lower beach, as expected as a natural response to seasonal forcing.*

10-2007 *Mostly, seasonal beach profile responses were observed, but along BLY04, major storm-related damage occurred.*

04-2008 The northern and mid sections of Blyth South Beach continue to show the greatest changes, with the southern end appearing less volatile. BLY04 continues to be a particularly vulnerable section of frontage, with continued lowering of the dune crest despite dune management activities. Some record low levels were recorded along several profiles, indicating the vulnerability of the beaches to winter storms.

10-2008 The previous low levels on the upper beach recorded along many profiles were mostly restored by this survey, indicating the seasonal behaviour along this frontage, with draw-down of material during winter months and slow return of sediment during the summer.

Changes along BLY03 were different to this trend, however, and from the summer 2008 inspections appear to be more directly linked with Meggie's Burn outfall. When the channel changes its configuration it can both directly cause erosion of the beach and dune toe and also changes energy patterns impinging on the foreshore.

Along BLY04 the dune crest continued to lower, despite the restoration of improved beach levels at the toe of the dunes.

2.15.4 Concerns

The main concern is the ongoing erosion and lowering of the crest of the dunes along profile BLY04. Changes in the outfall of Meggies Burn also appear to influence behaviour of the beaches and dunes along adjacent frontages, including the profile measured at BLY03.

2.15.5 Actions

The section of dunes covered by BLY04 would benefit from regular inspection and ongoing maintenance, especially over winter months and pre- and post-storm events. This section appears to have been particularly vulnerable over recent years.

2.15.6 Assessment against Aims

In this period, the monitoring has identified one particularly sensitive area of the dunes, as exemplified by the changes along BLY04. It has also identified the linkages between Meggie's Burn and the behaviour of adjacent shores.

2.16 Whitley Sands (Profiles North Tyneside (NTY) 01 - 04)

2.16.1 Aims

- Monitor integrity of defences.
- Identify sensitivity and trends in beach movement.

2.16.2 Description

04-2004 *Profile 1, at the northern end of Whitley Sands, shows general accretion, particularly at the base of the cliff. Profiles 2 and 3 also show general accretion on the upper beach with some minor erosion below the mid-tide level. Profile 4 in contrast shows general erosion.*

10-2004 *Profile 1 shows erosion at the base of the cliff on the upper slope of the beach (between HAT and MSL). Profiles 2 and 3 show accretion at high tide level and erosion below this level. Profile 4 shows uniform accretion across the beach slope.*

04-2005 *The beach levels at the toe of the cliffs to the north and defences slightly further south have eroded. The southern end of the frontage has accreted below MHWS.*

10-2005 *Profile 1 eroded at the base of the cliff to its lowest level since the monitoring programme started in 2002. This is not seen as being critical at this point given the nature of the land behind. Profiles 2 and 3 have eroded at the toe of the defence between HAT and MHWS. The material at the toe of the defence on Profile 3 has been deposited below MHWS. The profile is also at its lowest level since the start of monitoring between HAT and MHWS. Look at photo to see impact on defence. Profile 4 has accreted significantly below MHWS.*

10-2006 *At Profile 1, accretion was recorded at the toe of the cliffline, restoring the profile level from a minimum in October 2005 to a similar position as that observed during the 2003 survey. Little change was noted across the lower foreshore. At Profile 2, erosion continued across the profile above a level of around 0.5mODN. The beach here remains above the previous critical low, however. There was no significant change on the lower profile. Profile 3 exhibited a redistribution of material from the berm just below MHWS (as recorded in October 2005) to infill the hollow previously created by erosion at the toe of the defence. Whilst levels were not restored to 2004 values, the present beach levels are significantly improved compared to the previous survey. Profile 4 experienced a net lowering of levels across the whole cross-section, but levels remain notably above the previous minima.*

10-2007 *NTY01 recorded very low beach levels at the toe of the undefended cliffs, setting new record low levels since monitoring began. A similar pattern was observed at NTY02 and NTY03, where levels at the toe of the defences were record low values. At NTY03 a large wide berm formed at a chainage of around 55-100m, establishing new record high levels at this section of the profile. This meant that small rocky foreshore outcrops identified on previous surveys were buried by sand. This berm was already less evident by Profile NTY04, but here again record low levels were recorded at the toe of the defences.*

10-2008 Along NTY01 beach levels on the upper beach recovered slightly from the previous record low values, but remained relatively low. There was, however, no change in position of the seaward face or crest of the undefended cliffs.

NTY02, NTY03 and NTY04 exhibited much better recovery from the previous record low levels, particularly at the toe of the promenade. Along NTY03 the berm previously identified had migrated landward by around 20m and became less pronounced but still evident.

2.16.3 Interpretation

04-2004 *The increasing degree of erosion from the north to the south is likely to be a reflection of the level of exposure of the various profile locations to waves emanating from the north eastern sector. The northern profiles (1 and 2) are afforded significant protection from the rock platform headland forming St Mary's Island to the north.*

With the limited data available it is too early to see any clear patterns.

10-2004 *Long shore sediment transport directed from the north to the south is likely to be active, though it is still too early in the monitoring programme to come to any definite conclusions. Previous accretion in Profile 1 has eroded slightly, while Profiles 2 and 3 have maintained a trend of steepening (growth of the upper beach and loss lower down the profiles). The erosion of Profile 4 has changed to slight overall accretion. To a degree the pattern of change over the bay is opposite to what had been seen previously. This might suggest an adjustment of the bay as a whole to short term change in wave climate.*

This possible seasonal variation in prevailing wind should become clearer with further monitoring.

10-2005 *Most of Whitely Sands frontage has suffered from erosion of the upper slopes at the base of the cliffs or the defences, with the exception of Profile 4 which has accreted on the lower beach. This may be the result of storm activity eroding the upper slopes and a net southerly drift depositing the material on the southern part of the beach.*

10-2006 *A complex response was observed along the profiles within Whitley Bay, in that no consistent trend was observed across all four locations. Profiles 1 and 3 exhibited recovery from the previous erosion episodes, but Profiles 2 and 4 showed continuing foreshore lowering. It appears that much of the material eroded previously from the toe of the defence at Profile 3 remained on the profile and was subsequently redistributed to fill the eroded hollows, rather than being washed offshore or transported significantly alongshore.*

10-2007 *In contrast to the previous year, a consistent trend was noted across all four profile lines: erosion due to storms that occurred at the end of September 2007. These storms resulted in record low beach levels at the toe of the defences (or undefended cliffs).*

10-2008 The record low beach levels previously recorded in October 2007 had recovered, suggesting that the previous lows were storm-related.

2.16.4 Concerns

The previous concerns have been alleviated as the beach has recovered from the previous low levels.

2.16.5 Actions

Ongoing inspection of beach condition at the toe of defence structures.

2.16.6 Assessment against Aims

The monitoring identified that the severe storms at the end of September 2007 caused considerable beach changes.

2.17 Cullercoats Bay and Tynemouth Long Sands (Profiles North Tyneside (NTY) 05 - 07)

2.17.1 Aims

- Monitor integrity of defences.
- Identify sensitivity and trends in beach movement.

2.17.2 Description

04-2004 *Profile 5, in Cullercoats Bay, shows erosion of up to 2m landward at the base of the cliff. There has not been any significant change in Profiles 6 and 7.*

10-2004 *No significant change is observed in Profiles 5 to 7. There is some minor erosion at the top of the cliff noted in Profile 5, Cullercoats Bay.*

10-2005 *Profile 5 has accreted slightly at the toe of the cliff and above MLWS with a localised area of minor erosion in between. The beach level at the toe of the cliff at Profile 6 has eroded slightly with accretion occurring around MHWS. Significant erosion has occurred around MSL. Profile 7 has shown minimal change.*

10-2006 *Profiles 5 and 7 show very little change in beach form or level. Profile 6 is more dynamic, however, and experienced erosion around and above MHWS, including at the cliff toe. Accretion was observed lower down this profile, around and below MSL.*

10-2007 *No notable change was recorded along NTY05 or NTY07. Along NTY06, however, beach levels at the toe of the dunes were very low following the September 2007 storms, although material eroded from the upper beach appeared to have fed the lower beach.*

<p>10-2008</p>	<p>In Cullercoats Bay NTY05 experienced little change, except at the toe of the defence where beach levels dropped by around 0.5m to locally attain new record low values. Along Tynemouth Long Sands NTY06 experienced upper beach accretion beyond MHWS but lowering of levels seaward of this elevation. Negligible change was observed along NTY07.</p>
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2.17.3 Interpretation

04-2004 *Review of the data and visual inspection indicates that the survey results in this area are very sensitive to the location of the surveyed points. The 2m landward movement of the base of the cliff shown in the plot therefore does not reflect actual erosion. There is some undercutting of the cliffs occurring due to wave action at high tide levels, though it is not as dramatic as indicated in the plot. The soft foreshore within this area is the more important aspect of the coastal monitoring.*

10-2004 *As noted previously, there does not appear to be any dramatic changes taking place to the cliffs in Cullercoats Bay. No long term trends can yet be identified.*

10-2005 *Long Sands continues to be stable with only minor fluctuations in beach levels. This likely to be a reflection of the relatively protected aspect of the bay, with sheltering provided by rock outcrops at the northern and southern ends. Cullercoats Bay is also very stable, as it is protected by the two breakwaters across the bay.*

10-2006 *Cullercoast Bay and the southern end of Long Sands were extremely stable, and the dynamism towards the north and centre of Long Sands is in alignment with previous rates and scales of change.*

10-2007 *Profile NTY06 was affected by storms at the end of September 2007.*

10-2008 Changes are generally within previous bounds of change.
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2.17.4 Concerns

There are no concerns at this stage.

2.17.5 Actions

Ongoing inspection of beach condition at the toe of the dunes.

2.17.6 Assessment against Aims

The monitoring is continuing to build up a clearer picture of the beach behaviour and indicate the integrity of defences, thus addressing the aims of the SMP.

2.18 King Edward's Bay (Profile North Tyneside (NTYN) 08)

2.18.1 Aims

- Monitor integrity of defences.
- Identify sensitivity and trends in beach movement.

2.18.2 Description

- 04-2004** *The 2002 survey of Profile 8, in King Edward's Bay, showed a distinct ridge at high tide level. The subsequent annual survey in 2003 showed a general reshaping of the beach involving erosion of the ridge and filling in of the lower beach to create a smoother bed profile shape.*
- 10-2004** *Profile 8 in King Edward's Bay has eroded above MSL and accreted below MSL.*
- 04-2005** *The erosion noted previously has been concentrated above MHWS with material being drawn down the profile and deposited between MHWS and MSL.*
- 10-2005** *Profile 8 shows erosion of the upper beach above high water level and accretion below. The erosion above MHWS has resulted in the profile retreating the most since monitoring started in 2002. However, this erosion appears to be removal of an upper beach berm, the mid beach remaining healthy.*
- 10-2006** *The form of Profile 8 changed considerably. Erosion just below MSL resulted in a new minimum beach level, whilst accretion between MHWS and HAT resulted in a new maximum upper beach level. The profile gradient between these two limits became considerably steeper.*
- 10-2007** *The berm present in 2006 remained identifiable and beach levels generally were relatively healthy across the profile, except for at the toe of the defences, where they were very low in a localised zone.*
- | | |
|----------------|---|
| 10-2008 | <i>NTY08 experienced general accretion across most of its length, with the exception of a small zone around chainage 75m to 125m which experienced a slight lowering.</i> |
|----------------|---|

2.18.3 Interpretation

- 04-2004** *The ridge observed in the upper beach is likely to have been the result of wave activity associated with storms where material is moved away from the still water level to be pushed up the beach as a ridge (and often also drawn down the beach to form a berm, though this is not evident in this case). The 2003 shape is likely to be the result of a period of recovery where calmer conditions allow for the reshaping of the beach profile.*
- 10-2004** *Sediment is redistributed from the upper beach to the lower beach. This reshaping may be further beach recovery taking place since the distinct post storm profile of 2003, though it is too early in the monitoring process to know what the equilibrium profile of the beach looks like.*
- 10-2005** *The redistribution of material up and down the profile continues. Recovery following the 2003 storm event however does not appear to be occurring as it is continuing to erode.*

The high rate of erosion on the upper beach is matched by accretion on the main beach face. At present it seems likely that there would be adequate bulk in the beach for the frontage to respond to a storm.

10-2006 *The observed patterns of erosion and accretion are in-keeping with the movement of material from the lower to upper beach. The berm created above MHWS was last observed in the 2002 survey.*

10-2007 *Little change was observed along this profile.*

10-2008	<i>There was a net influx of sediment to enable the accretion along most of the profile. Some accretion was due to redistribution of sediment from the mid beach, resulting in lowering in that section.</i>
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2.18.4 Concerns

There are no major concerns at this stage.

2.18.5 Actions

No actions are required.

2.18.6 Assessment against Aims

It is too early in the monitoring programme to see any clear patterns of erosion.

3 HOLY ISLAND

3.1 Background Information

The topographic surveying along the Holy Island causeway was included in the annual monitoring programme in October 2004. The surveys completed to date are:

- October 2004;
- October 2005;
- November 2006;
- October 2007; and
- October 2008.

Plots of the original survey data and plots showing the differences between the 2004, 2005, 2006, 2007 and 2008 surveys have been produced and can be viewed in Appendix B. Positive values on the level difference plots indicate accretion.

The purpose of the monitoring is to assess the effects that of raising the causeway has on the adjacent sandflats.

3.2 Description of Original Survey Plots

- 10-2004** *The topography plots show that the main flow route is adjacent to a shallower channel located further north-east. This secondary channel flows along the northern edge of the causeway for a short distance and the traverses the causeway.*
- 10-2005** *The main channel is slightly shallower than the 2004 levels and the flow path appears to have re-orientated slightly further round to the north (from 290°N in 2004 to 305°N in 2005). The profile of the main channel is shallower along the northern boundary. The secondary channel has deepened for a short section as it flows along the northern edge of the causeway with a small corresponding deeper area on the southern edge. The remainder of the secondary channel is shallower than in 2004 particularly to the south of the causeway. This maybe due to the flow path being blocked by the causeway and therefore the channel is gradually filling.*
- 11-2006** *The main channel has once again adopted an alignment tending towards the north-west, resulting in some sand flat material being cut through and moved.*
- 10-2007** *The main channel remains aligned along a north-west trend. Some sand flat material on the north east side of the channel has been removed. This removal is to a lesser extent than in previous years.*

10-2008 *The main channel remains along a similar alignment, with a slight sinuosity developing.*

3.3 Description of Level Variations

- 10-2005** *The level difference plots show that the channel depth adjacent to the northern boundary has increased by approximately 0.35m. The adjacent area of erosion is due to the re-orientation of the main channel.*

Adjacent to the causeway there are localised areas of erosion along the northern edge. These areas show a reduction in level of between 0.5m and 0.8m. There is an area of accretion on the eastern side of the channel to the north of the causeway. The levels in this area have increased by more than 0.3m.

The edges of the main channel exhibit areas of accretion where the levels have raised by up to 0.8m and surrounding an area of erosion where levels have reduced by approximately 0.4m. These areas again are likely to be due to the marginal re-alignment of the channel.

11-2006 *Adjacent to the main channel, there are localised areas of deposition. These are particularly evident along the northern edge of the causeway, but some local patches also exist to the south. Over most of the survey area, levels have generally ranged $\pm 0.1m$ of the October 2005 survey.*

10-2007 *As in previous years, the majority of sediment movement is localised around the main channel (South Low). Up to 0.3m of accretion have occurred on the north western side of the channel and up to 0.2m of erosion have occurred to the east of the channel on the north of the road.*

10-2008 *Once again the majority of change is close to the main channel of South Low, although erosion of up to 0.2m does extend slightly further east along the causeway.*

3.4 Interpretation

10-2005 *The main and secondary channels are the most mobile areas of the survey. The areas of accretion on the western edge of the main channel are adjacent to areas of erosion. This pattern indicates that the main channel is gradually re-orientating further round to the north, however, it is too early in the monitoring programme to determine whether this is a long term trend.*

The western side of the surrounding area has localised areas of minor erosion and accretion ($\pm 0.1m$). The eastern side of the channel appears to have remained relatively stable with patches of minor accretion ($\leq 0.1m$).

11-2006 *The re-orientation of the South Low channel has reversed and the channel alignment is now back towards the north-east. This indicates a degree of mobility in the channel that will be important to continue to monitor. Areas of accretion close to the channel are likely to be the results of material mobilised from the re-orientation of the channel becoming deposited locally.*

The small scale changes across the remainder of the survey area suggest that no long-term persistent trend is yet observable, but instead that minor re-working of material has occurred across the sand flats.

10-2007 *The continued erosion on the eastern side of the main channel, and accretion on the western side illustrate that there is still a degree of mobility within the channel. However, both the quantity and area over which erosion and accretion are occurring have reduced from recent years which suggest that the sand flats may becoming increasingly stable following the raising of the causeway, but are not yet considered stable.*

10-2008 There is greater erosion to the east of the main channel than previously observed, in terms of both the magnitude of bed level changes (up to 0.3m in spots) and the extent of effect. However, there is not a universal trend along the whole causeway and therefore these changes are interpreted as relating to the storm damage that has occurred along the Berwick frontage (observed along other profile lines) and changes in the main channel of South Low rather than a widespread response to causeway raising.

3.5 Concerns

Increasing erosion to the north east of the main channel may become of concern if the pattern continues.

3.6 Actions

No actions are required immediately, but it will be interesting to continue to observe the behaviour of the South Low channel.

4 ALNMOUTH

4.1 Background Information

A topographic survey of the coastline to the north of the mouth of River Aln, including the main channel, was incorporated into the monitoring programme in April 2005. The following surveys have been completed to date:

- April 2005;
- October 2005;
- April 2006;
- November 2006;
- April 2007;
- September 2007;
- April 2008;
- October 2008.

The key objectives for this additional monitoring are:

- Improving the understanding of process interaction between the estuary and the open coast;
- Confirming erosion and accretion rates;
- Establishing the interaction between upper and lower foreshore;
- Maintain a watch on assets at risk, confirming the direct threat to the car park area and the threat of a breach through to the golf course.

Plots of the original survey data and plots showing the differences between the surveys have been produced and the most recent data can be viewed in Appendix C. Positive values on the level difference plots indicate accretion.

4.2 Description of Level Variations

10-2005 *The level difference plots show a number of different features in the surveyed area. There are a number of areas where runnels have developed with levels decreasing by approximately 0.6m. These runnels are generally parallel to the coastline with areas of accretion between them. The ridges have increases in crest levels of between 0.4m and 0.7m.*

Profile 7 of the survey is located at the southern end of Marden Rocks. In April 2005 the whole profile eroded with the HAT datum retreating approximately 5m. By October 2005 the front face of the dune recovered and accreted resulting in a shallower slope. The upper beach accreted between the April and October 2005 surveys, however did not recover to the level of October 2004.

The upper beach of Profile 8, which starts on the dunes in the centre of the car park frontage, has accreted significantly since October 2004. By April 2005 HAT had advanced by more than 20m. The accretion continued with a further advance of approximately 2m. The dune ridge itself has remained stable.

Profile 9 is located on the northern shore of the mouth of River Aln. By October 2005 the profile was smoother than the previous two surveys with very minor erosion occurring at

the toe of the dunes and minor accretion to the crest of the dunes. To the south of the River AIn, the dunes at Profile 10 have accreted since October 2004.

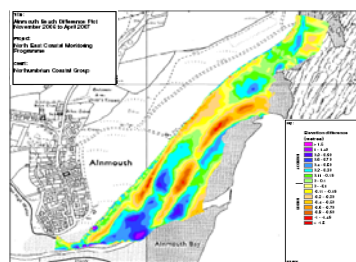
04-2006 The accretion over the upper shore identified along Profile 7 was clearly widespread from the topographic survey. There was a general accretion in the area of the groynes, with the levels increasing by up to 1m. This area of accretion is centred behind Marden Rocks, with a mid beach ridge of accretion running south to the centre of the frontage. This ridge is associated with an area of slight erosion over the central section against the upper beach.

At the southern end, there has been significant general accretion (as reported along Profile 9) in the area of the dunes at the mouth to the AIn, but also extending north over part of the car park area. Part of this is in the form of a ridge running north over the lower section of the beach.

11-2006 Over this period, as recorded by the profile lines, there has been a general onshore movement of material over virtually the whole frontage. This has had the affect of redistributing some of the material accreted lower on the beach up to the dune face. There has also been some further accretion at mid-beach level. Both areas of accretion are quite uniform over the length of the beach, in comparison with the separation of change seen in the previous 6 months.

To the southern end of the area, the growth of the dunes, in effect as a nose developing just outside the entrance to the estuary, has suffered significant erosion. While there has been some movement of material up the beach (as recorded for Profile 9), this cross-shore movement does not appear to be the most significant change. Associated with the loss of the nose has been continued growth of the whole beach profile slightly further north; this linking with the change along the main part of the beach.

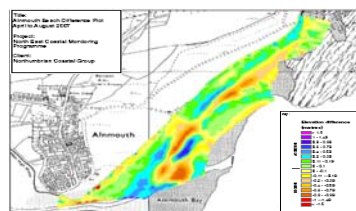
04-2007



During this period there was some general erosion of upper beach with material tending to be drawn down the beach to the mid-beach area and evidence of growth to the area of dunes at the southern end of the frontage. Some of this material would appear to have been carried as a bank extending along the northern bank of the river channel. The most vulnerable section of the beach has been in the area extending some

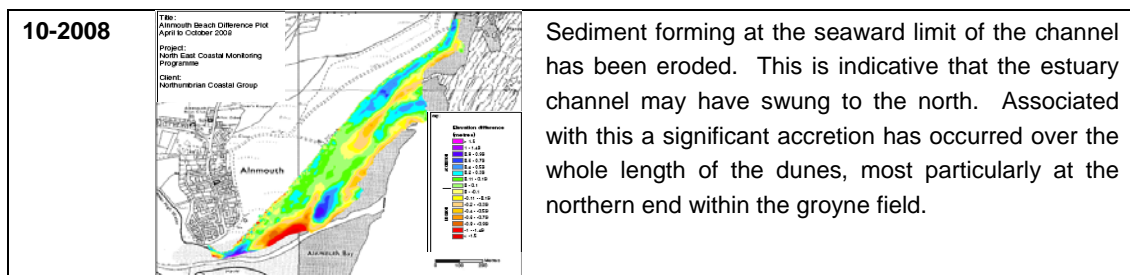
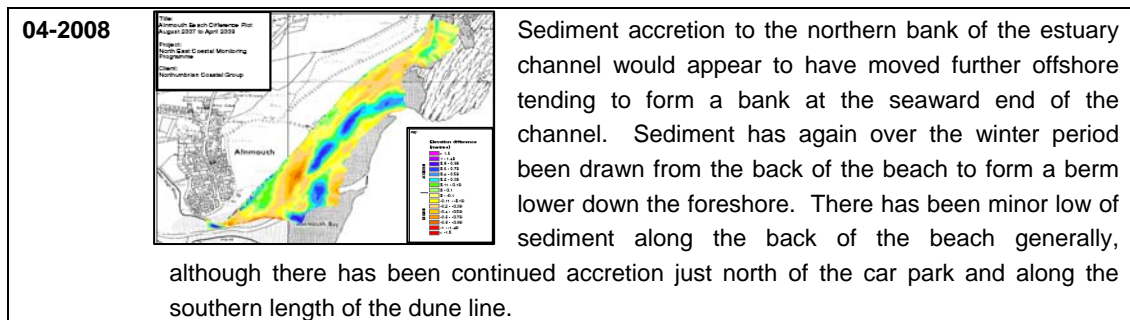
200m north of the access to the car park. No damage was reported to the new regarding works in this area.

09-2007



Material drawn down the beach between November 2006 and April 2007 has tended to be moved up the beach by the time of this latest survey. There has been further increase of the dunes although associated with slight erosion at the mouth of the river as the channel is pushed further south by the growth of the nose of dunes. The area of major erosion to the

north of the car park has accreted but the area of erosion has moved south, putting pressure on the car park frontage.



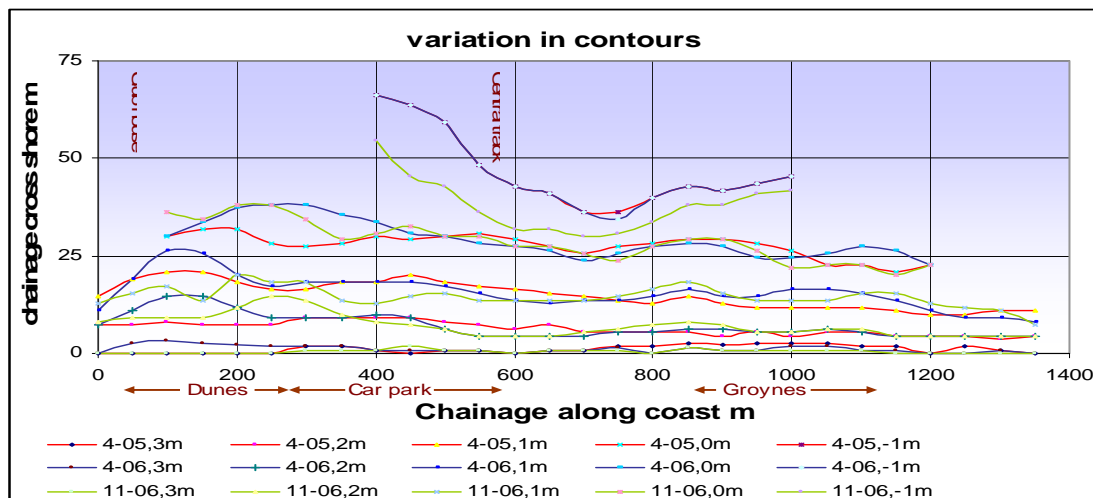
4.3 Interpretation

10-2005 *The survey data available at this early stage of the monitoring shows that the dunes and beach are generally accreting, despite the longer term evidence that the front face of the dune has eroded. The topographic survey of the whole area shows that it is very mobile with the formation of ridges and trenches. The current survey shows that the mouth of the River Aln has eroded in the middle of the main channel with reductions in levels of up to 0.8m.*

Even though detailed monitoring of the frontage is in its very early stages certain points may be made.

- *There is strong evidence of a ridge and runnel formation. This is typical of a system with good sediment supply.*
- *The frontage appears to behave as three interactive zones; the estuary mouth where there is typically growth, the car park frontage; which appears to be strongly influenced by the channel position, and the groyned area which response more as open coast.*
- *The river channel would appear to form a slight bank to its northern side which then creates a tendency for an inner channel to form. This could result in lowering of the beach in front of the car park.*
- *The photographs show significant variation in the beach levels and in the general shape of the beach. While these are very preliminary findings, they do indicate that the erosion problem on the frontage may be of a relatively local scale. This would influence the manner in which appropriate management could be developed for the frontage.*

04-2006 *To assist interpretation of the beach performance, a graphical plot is provided below. This presents a normalised (in effect straightening the frontage) view of the beach contours. Comparison is made of the contours over the first year (April 2005 to April 2006) and for the most recent survey in November 2006.*



Comparison of surveys, plotted as contours along a straightened frontage

The growth in the beach (as shown by the 2m contour) is obvious in the area of the groynes. This is strongly linked to the presence of the Marden rocks. These act as a breakwater and were effective even given the higher water level storms recorded during March 2006. This effect may have led to some loss of material from the upper beach over the central section of the frontage. The impression is that material is moved from the centre, to both north and south, with pressure on the central frontage to erode.

This erosion of the central beach area appears, in addition to feeding the area in the vicinity of the groynes to the north, to have fed down to the dunes at the southern end. The ebb flow of the AIn constrains further movement south, leading to the development of the nose in front of Marine Road. This growth is shown in the 1m and 2m contours, and even the 0m contour, moving the channel offshore some 10m.

11-2006 Over this period the beach has tended to act far more a single unit with material being moved back against the dune line in a uniform manner. The erosion behind Marden Rocks would indicate that there was significant wave energy from a more south to southeast direction. This has also caused a movement onshore of the -1m contour over the whole frontage.

The most notable change has been the erosion of the nose at the southern end. From the graphical plot below, it may be seen that in addition to erosion there has been a movement of material slightly further north, possibly providing slightly better protection to the southern section of the car park.

Overall, the frontage appears to be very sensitive to water levels and wave direction; at times with the beach working almost as different sections and at times as a whole unit. The areas where pressure develops for erosion similarly varies. There is a consistent area where there is pressure, that being just to the north of the central track; where recent matting has been undertaken. In other areas the erosion would appear to be far more intermittent.

04-2007 The variation previously noted over the frontage is again highlighted with then erosion to the north of the car park. There is, however, further indication that sediment is re-

distributed along the frontage and over the beach as a whole, rather than being lost to the system.

09-2007 *An overall assessment has been carried out of data so far collected as part of the SMP2 analysis. Changes occurring between surveys are presented in Figure A, shown together with the trend analysis for the three profiles AL 07 to 09.*

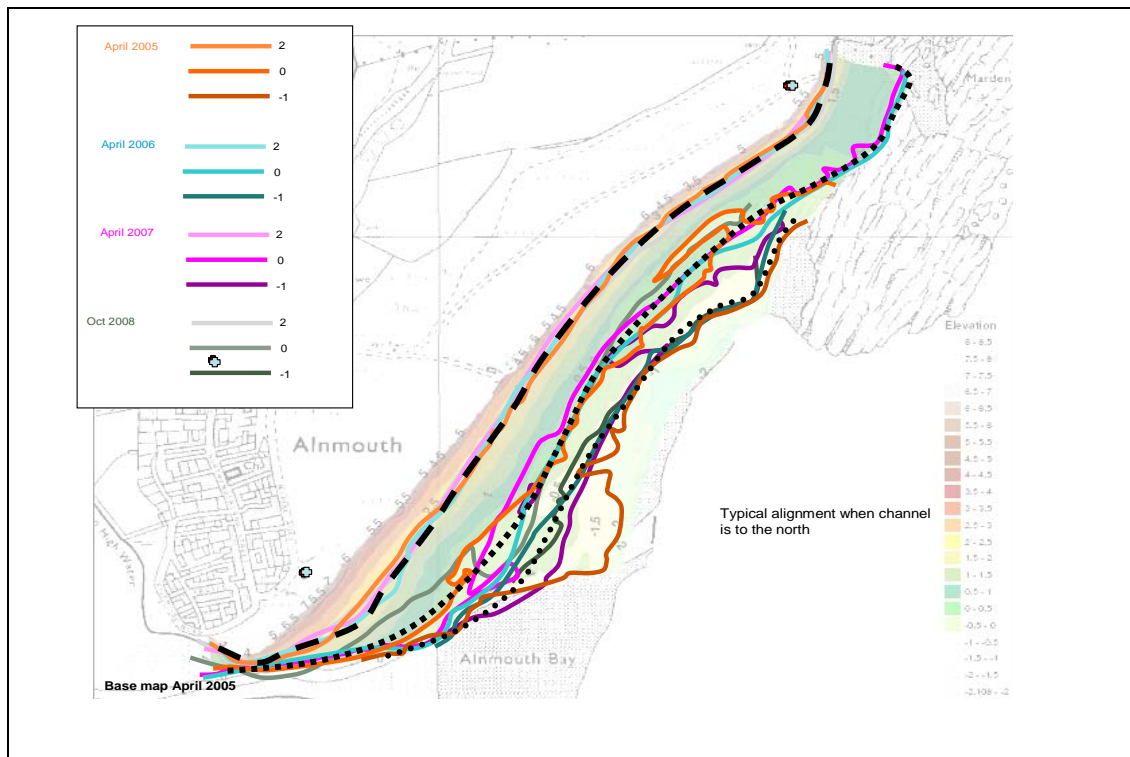
Although there is considerable variation certain points may be made:

- *During the Spring to Autumn period there tends to be movement of sediment from the mid-beach area to the upper beach. During the Autumn to Spring period sediment tends to be drawn down the beach with bands of accretion tending to develop within the mid-beach zone. This seasonal behaviour is most evident over the northern section (Al 07) where the forward and backward movement of the MHWS contour is out of phase with movement of the MSL contour.*
- *Over the central frontage, the area of erosion during the spring to autumn period there tends to be erosion to the section of coast to the north of the car park. During the autumn to spring, this erosion tends to focus more on the car park area.*
- *There is an indication that, as this central section suffers erosion, the areas to the south, in particular, but also to the north tends to benefit.*
- *When there is erosion of the dunes section to the south, the central area tends to benefit.*
- *In general the change in the nose of the dunes tends to influence most directly the mouth of the river. As the nose grows to the south, there tends to be erosion further in towards the narrows of the mouth.*
- *Erosion at the mouth tends then to result in material being deposited further north at the channel edge. This material potentially being pushed back on to the main beach.*
- *Finally, over the period of monitoring, since 2002, there has been a trend of growth on all profiles over the upper beach. These trends have to be treated with caution; based as they are on only a limited period of data.*

Overall, the frontage has been relatively stable and is considered to be part of a larger system extending across the mouth of the Aln; forming in effect a relatively stable corner in the larger bay extending down towards Amble. This corner is cut through by the river, rather than being dominated by the river; the river resulting in a recirculation of sediment.

Within the stable bay, the central frontage remains vulnerable to local erosion. When erosion occurs, this can remove sections of the car park frontage, which is not then replaced; although accretion of beach material can then rebuild in front of the areas of erosion.

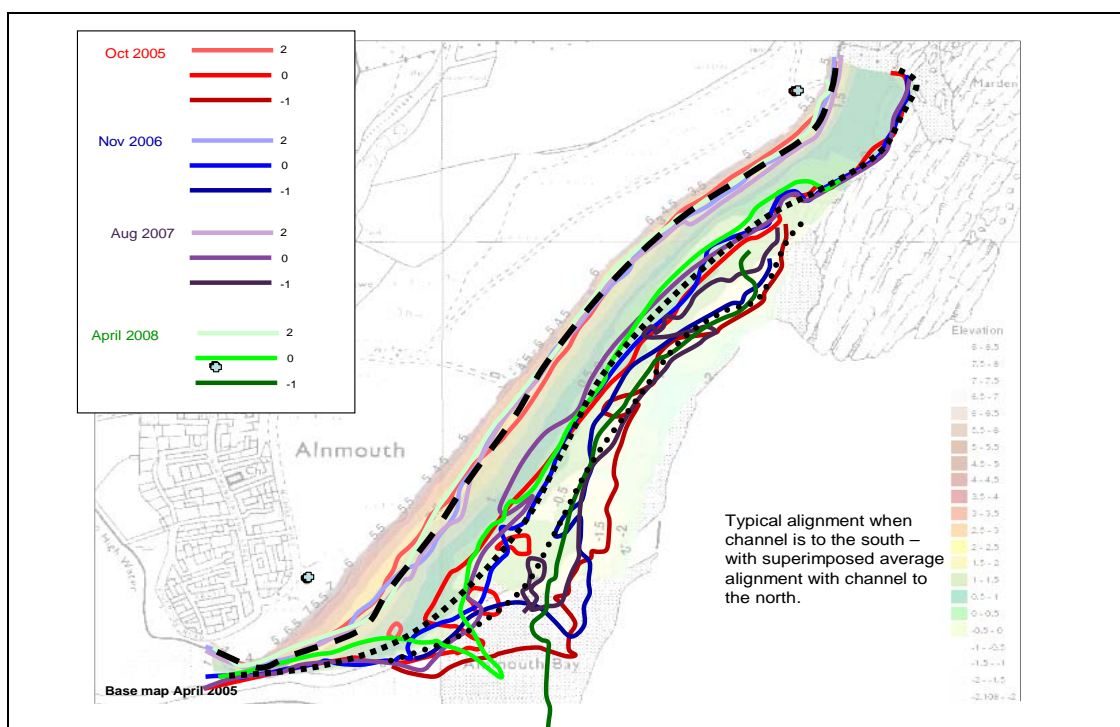
2008 *A further general review has been undertaken of the behaviour of the area. This includes both the April 2008 data and that for October 2008. It has been noted previously that at times the estuary channel tends to swing to a more northerly position. The effect of this the main beach is considered. This swing in the channel has occurred in April 2005, 2006, 2007 and October 2008. A plot has been produced of the contours at 2m, 0m and -1m OD for these surveys. This is shown below.*



Typical lines have been plotted representing an average alignment of the three contours. The lower contours show considerable variation, most notably:

- On the Oct 2008 survey the 0m contour cuts back further than noted previously, but does not appear to have significantly affected the position of the back dune.
- The -1m contour is closer inshore at the northern end of the site during the April 2007 survey and the 0m contour is relatively inshore. Again there is no significant set back of the dune line as a result of this.
- The inclusion of the October 2008 survey within this group of surveys would suggest that there is not necessarily any seasonable pattern to the position of the channel.

A further plot, below, shows surveys when there has been a seaward development of the beach at the southern end of the site. This includes surveys from Oct 2005, Nov 2006, Aug 2007 and April 2008. The typical alignment of the contours from the previous plot is shown superimposed on the survey lines.



There is similar wide variation in contours at 0m and -1m. The following points are noted:

- There is an indication that there is advance of the dune line at the southern end (2006 and 2007) but that this is not always the case (2005 and 2008).
- There tends to be greater erosion in the area of the car park (2006, 2007, 2008) but not in 2005.
- There is some increased accretion at the northern end (2006, and 2007).

Overall there is an indication that sediment is redistributed along the frontage, with erosion in the central area associated with accretion to north and south, associated also with the growth of the seaward bank at the entrance to the estuary. This is seen as being quite weak, suggesting other factors affect the frontage. There does seem, however, to be greater variation in the dune line when the channel lies more to the south; when to the north, the 2m contour was in a more consistent position. Potentially, when the banks are higher in the south, the frontage acts more as a bay and is more susceptible to variation as a result of wave action. When the channel lies to the north, flows tend to create a more uniform open beach acted upon more uniformly by waves.

4.4 Concerns

There is a continuing threat of erosion to the back defence of the frontage during more major storms, despite the overall stability that appears to exist over the frontage as a whole. The area of erosion varies. At present the re-profiling and matting provides sufficient resistance to counteract normal periodic erosion. The car park frontage, however, will tend to continue to erode but episodically. There is no evidence from the current monitoring that the river channel is threatening to seriously cut further north, although the October 2008 survey shows the channel further north than previously. Further development of the channel in this position may create conditions for more persistent erosion to the main frontage.

There continues to be little evidence of any long term loss of sediment. As such management of the frontage needs to focus on retaining upper beach sediment rather than any overall pressure for retreat. There will be increased pressure on the frontage as sea levels increase and this has been considered in the SMP.

Against this background, it is felt that the groynes to the north of the frontage are acting beneficially in tending retain sediment, without significant detrimental impact on the rest of the frontage.

The control of access across the dunes has shown significant benefit and this is highlighted in the comparison of photographs presented below. It should be noted, however, that this control, while improving retention of available sediment, will have only limited benefit if the frontage is subject to a major storm.



4.5 Actions

No immediate actions are required.

5 NEWBIGGIN CARAVAN PARK CLIFF CREST SURVEYS

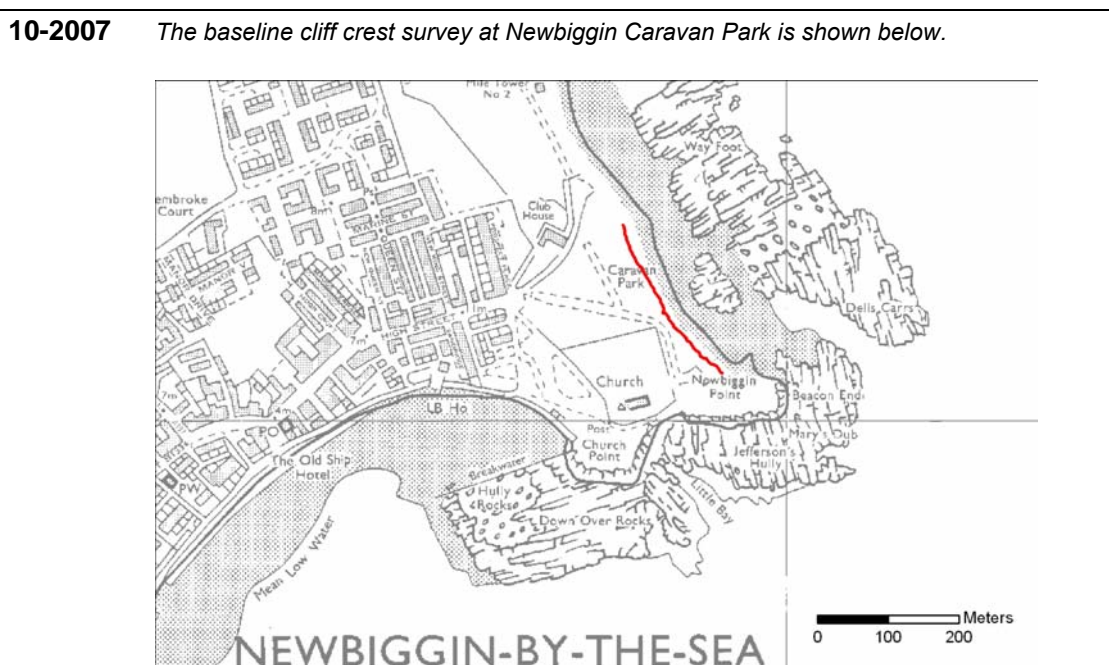
5.1 Background Information

The cliff crest position surveying in front of Newbiggin Caravan Park was included in the annual monitoring programme in October 2007.

The purpose of the monitoring is to assess the rates and locations of cliff top retreat at this location.

5.2 Description of Baseline Survey

Note: *This cliff crest survey was newly-added to the North East Monitoring programme in October 2007.*



5.3 Interpretation of Changes

Note: *This cliff crest survey was newly-added to the North East Monitoring programme in October 2007.*

10-2007 This survey provides a baseline against which future survey will be compared.

04-2008 The northern part of this frontage (approximately 70m in length) is unprotected by defences and many short individual sections, ranging from 1.5m to 10m in length and totalling around 35m, i.e. half the overall frontage section), are actively eroding at rates of between 0.2 and 0.4m over the six months, with one section having eroded by 0.6m between surveys. There is a marked step-back in cliff position at the junction between this undefended frontage and the protected length immediately to the south.

The middle section of frontage (approximately 125m) is protected by concrete blocks and rubble and was considerably more stable between the surveys, with only around three

lengths of cut-back noted reaching changes of around 0.4m at most over the six months.

The southern section of surveyed cliff (around 80m) is fronted by rocky shore platform and again only a very small number of relatively short lengths (from 2m to 6m) were affected by erosion, typically of around 0.2 to 0.4m but locally up to 0.55m over the six months.

10-2008

The cliff top position eroded landwards along the entire length of unprotected cliff at the north of the frontage between April 2008 and September 2008. Typically, the recession was of the order of 0.25m to 0.3m over the six months, but locally it was up to 0.6m between surveys. In total, the most rapidly eroding sections have retreated by up to 0.85m since the October 2007 survey.

The protected central section remains relatively stable, although two notable slippages have occurred. One of these occurred over a length of about 7m and at its maximum has cut the cliff crest back by 1m close to a caravan. The other is over a length of about 4m where around 0.6m of cut-back has occurred. Elsewhere, erosion is only localised and around 0.1m to 0.2m at most over the six months.

The southern section remained relatively stable, with erosion of around 0.15m observed locally, but not extensively.

5.4 Concerns

Erosion along the undefended length at the northern end of the surveyed frontage is extensively occurring, and at reasonably high rates. The frontages further south, which are defended by concrete blocks, rocky platforms and, in places, tipped rubble, are somewhat more stable along much of their lengths, but locally still eroding. There is a notable step-back in cliff-top position at the junction between the undefended and protected sections of coast.

5.5 Actions

There are no actions at this stage, but ongoing monitoring should provide further information on rates and locations of change. As recommended in the SMP2, information about the ongoing monitoring should be shared by the new unitary authority in Northumberland with the owners of the Newbiggin Caravan Park so they can start longer term adaptive planning of their plot locations.

6 SANDY BAY CARAVAN PARK CLIFF CREST SURVEYS

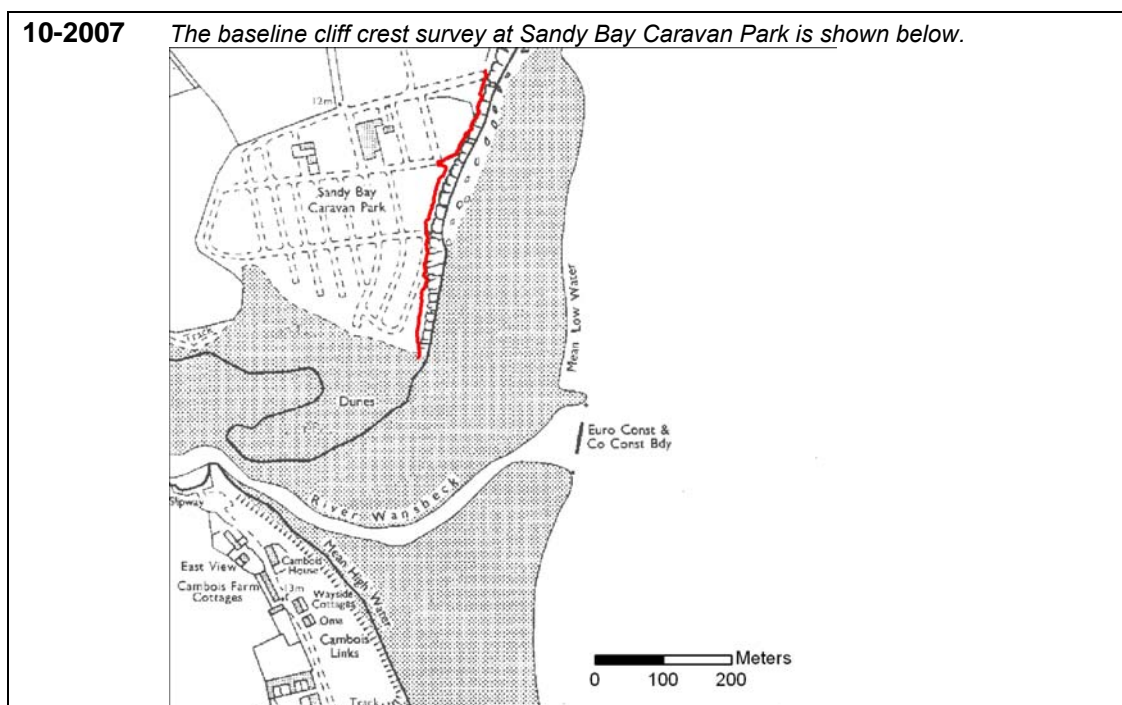
6.1 Background Information

The cliff crest position surveying in front of Sandy Bay Caravan Park was included in the annual monitoring programme in October 2007.

The purpose of the monitoring is to assess the rates and locations of cliff top retreat at this location.

6.2 Description of Baseline Survey

Note: *This cliff crest survey was newly-added to the North East Monitoring programme in October 2007.*



6.3 Interpretation of Changes

Note: *This cliff crest survey was newly-added to the North East Monitoring programme in October 2007.*

10-2007 *This survey provides a baseline against which future survey will be compared.*

04-2008 In the main, the cliff top position has remained relatively constant. Differences between the October 2007 and April 2008 surveys suggest that the accuracy of this technique of monitoring is around $\pm 0.15\text{m}$. With this in mind, the erosion over six different lengths, ranging from 1.5m to 4.75m and totalling less than 20m of frontage was between 0.1m and 0.2m over the six months. This suggests that much of the frontage was stable but that where erosion was occurring it was generally local and small scale. At the southern end of the frontage, however, close to the five southerly-most caravans, erosion was occurring over greater individual lengths (ranging from 5m to 13m) and at greater rates

(between 0.6m and 1.5m over the six months).

10-2008 In the northern section of frontage, changes are within the limits of accuracy of the surveying technique, but highly detectable changes remain ongoing towards the southern end. Immediately south of the three rock berms (breakwaters) ongoing 'trimming' of the cliff edge has caused up to 1m erosion over the six months, but this remains relatively local and over relatively short lengths of frontage only. The area of greatest concern, however, is where a row of five caravans is located at the south-eastern tip of the park. Here erosion has continued along several (relatively short) frontages where erosion has reached around a further 0.85m over the six months. Directly in front of one of these caravans, and over a length of some 15m, an area of cliff has eroded by a further 1.85m since the previous survey. The clifftop position here is now some 3m landward of the position recorded in October 2008. At its closest point, the second caravan in this row (from the north) is now only 1.25m from the cliff edge (assuming it has not been moved since the Google Earth imagery).

6.4 Concerns

The main concern relates to the high rates of erosion at the southern end of the frontage, particularly with respect to the safety of the parked caravans and public access.

6.5 Actions

Ongoing monitoring should provide further information on rates and locations of change. As recommended in the SMP2, information about the ongoing monitoring and SMP policies should be shared by the new unitary authority in Northumberland with the owners of the Sandy Bay Caravan Park so they can start longer term adaptive planning of their plot locations.

7 OVERVIEW

There is now six and a half years of survey data collected for the coastline between Berwick-upon-Tweed and Tynemouth as part of the North East Coastal Monitoring Programme. From these data significant knowledge has been gained of the short-term changes in profile form on the coast and we have begun to interpret and refine hypotheses for the observed changes.

The April 2008 'partial measures' survey has been used to identify the changes over the winter of 2007/08 along 39 profile lines, while the September/October 2008 'full measures' survey has indicated the changes over summer leading through to autumn 2008.

Some of the most notable changes along the whole coastal frontage changes continue to be observed along the beaches and sand banks around the mouth of the River Tweed estuary. Ongoing easterly migration of the channel separating the Spittal Point and Sandstell Point sand banks alters exposure conditions at the shore. Within the inner estuary low beach levels were recorded and a very notable 2m erosion of the dune face occurred. Along the open coast (Spittal A) running south of the estuary mouth, new record low beach levels were set. Both of these findings have important implications for development proposals in this area.

Elsewhere, low beach levels were recorded in places at Spittal B, the northern section of Goswick Sands, Beadnell Bay, Embleton Bay and High Hauxley. More modest changes were recorded at Holy Island, Bamburgh and Beadnell. This suggests that this northern section of frontage suffered the consequences of a storm, or succession of storms, prior to the surveys, causing low beach levels to be observed.

At Alnmouth changing beach levels to the north of the River Aln estuary appear linked to changes in alignment of the channel, with a northerly swing noted in the most recent survey.

Whilst previous surveys have revealed sometimes quite major changes in beach levels, there has not to date been significant change in the seaward face and crest position of most dunes or cliffs along the frontage. Following the most recent surveys, however, erosion has been notable and caused a retreat of shoreline position along the northern part of Druridge Bay, at Newbiggin Moor Golf Course and just north of the defended frontage of North Blyth.

The slag banks to the north of Lynemouth Power Station are eroding rapidly where they are exposed to marine process. Where they remain located above the limit of marine activity, beach changes are quite rapid, causing lowering of levels and reductions in beach width. If continuing, the presently stable slag banks will become subject to marine conditions in the mid term. South of the Power Station, the ridge continues to roll back, with material eroded from its seaward side and deposited on the crest of landward face.

Beaches within Newbiggin Bay are still adjusting to prevailing tidal and wave conditions following completion of the foreshore recharge scheme in 2007. From the beach profiles there appears to be measurable redistribution of sediment from south and

central sections to the north of the bay, and more detailed topographic surveying as part of the post-project evaluation is recommended to provide further insight.

At Sandy Bay Caravan Park, cliff erosion has occurred at high rates, cutting back to a position very close to caravan standings. Also in this vicinity, changes in the position of the channel of the River Wansbeck estuary, creating a more southerly alignment, seem to have initiated erosion at the toe of the cliffs at Cambois. Further cliff-top position surveying is recommended along Cambois Bay to better inform ongoing trends.

The seasonal behaviour of the beaches at Blyth South Beach remains evident, but the ongoing lowering of dune crest level in the central bay (around profile BLY04) remains of concern, especially as remedial works have been attempted there over recent years. Also along Blyth South Beach, a more northerly alignment of the outfall of Meggie's Burn has initiated erosion at the toe of the dunes to the north.

Along North Tyneside's frontage, the previous record low levels from October 2007 have been restored, confirming the view held at the time that the frontage was storm-affected. Changes during the present survey were comfortably within previous bands of change.

8 CONCERNS AND RECOMMENDATIONS

The areas of concern are listed below, although some are more severe than others:

- There were low beach levels and a very notable (up to 2m) erosion of the dune face along the River Tweed inner estuary beaches (south bank).
- New record low beach levels were recorded along Spittal A, close to the estuary mouth
- Low beach levels were observed at Spittal B, the northern section of Goswick Sands, Beadnell Bay, Embleton Bay and High Hauxley.
- Continued changes were observed along the Alnmouth frontage, linked with changes in alignment of the channel of the River Aln estuary.
- Measurable retreat of shoreline position occurred along the northern part of Druridge Bay.
- There was erosion of the slag banks to the north of Lynemouth Power Station where they are exposed to marine process and there were severe beach width reductions where the slag banks are presently not exposed to marine processes.
- Roll back of the ridge to the south of Lynemouth Power Station continued.
- Measurable retreat of shoreline position occurred at Newbiggin Moor Golf Course
- Notable changes in the beaches within Newbiggin Bay were recorded following completion of the foreshore recharge scheme in 2007 (although beach volumes remain substantial).
- High rates of cliff erosion were recorded at the southern end of Sandy Bay Caravan Park.
- Erosion was observed at the toe of the cliffs at Cambois, caused by a more southerly alignment in the position of the channel of the River Wansbeck estuary.
- Measurable retreat of shoreline position occurred just north of the defended frontage of North Blyth.
- Continued seasonal behaviour occurred along the beaches at Blyth South Beach, with the ongoing lowering of dune crest level in the central bay (around profile BLY04) being a particular concern.
- There was erosion at the toe of the dunes to the north of Blyth South Beach, caused by a more northerly alignment of the outfall of Meggie's Burn.

In light of the above findings, ongoing monitoring and analysis is essential to inform coastal management throughout the NCAG frontage.

The programme should be enhanced through the inclusion of:

- More detailed topographic surveying in Newbiggin Bay to better inform volumetric analysis of changes since the foreshore recharge scheme was completed in 2007; and

- Clifftop monitoring along Cambois Bay to improve understanding of rates of change, assess erosion risk to fixed infrastructure and assets, assess breaching risk to the north of North Blyth and to inform land use plans for this area.

It is also recommended that discussions are held between the new unitary authority in Northumberland and owners of the Newbiggin Caravan Park and the Sandy Bay Caravan Park to discuss the findings from the cliff top monitoring presented in this report and the implications of the management policies recommended in the SMP2.

Funding for the North East Coastal Monitoring Programme has previously been allocated for financial year 2008/09. The activities covering by the present contract will be completed with the April 2009 'partial measures' survey and associated data processing and storage.

The next 'full measures' survey will be undertaken in September/October 2009 and this will be contracted and funded under the wider Cell 1 Regional Monitoring Programme, although its specification will remain unchanged.

Appendices

Appendix A

Profile Locations

NCAG Profile Locations

The locations of the 96 beach profiles surveyed across the Northumbrian Coastal Authority Group (NCAG) frontage can be viewed superimposed on aerial imagery of the coastline using Google Earth.

To install Google Earth on your computer visit the Google Earth website <http://earth.google.com/> and download Google Earth.

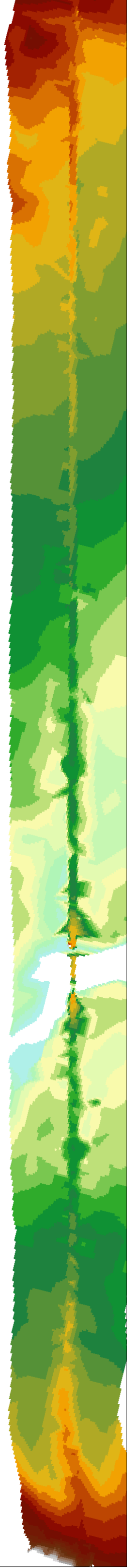
To view the profile locations open Google Earth and go the File Menu and select Open, then navigate to where the 'NCAG_coastal_monitoring.kmz' file (provided on attached CD) is saved.

Appendix B

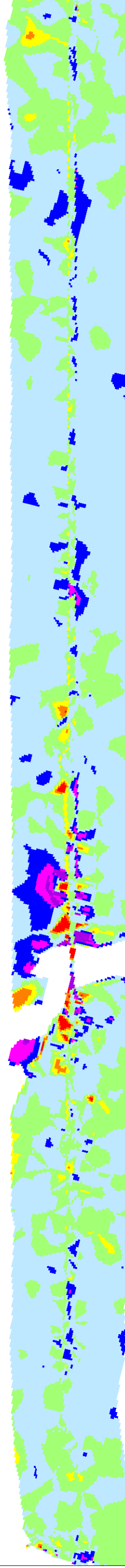
Alnmouth

Topographic Surveys

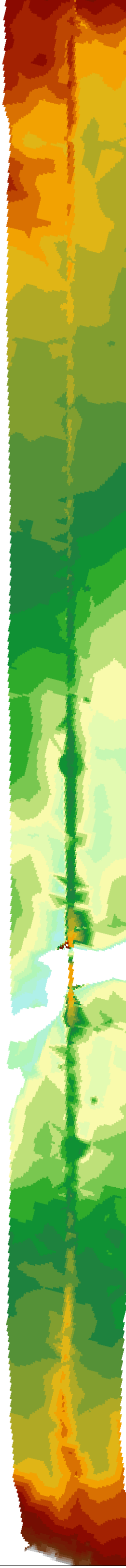
Plot A: Topographic Survey - October 2004



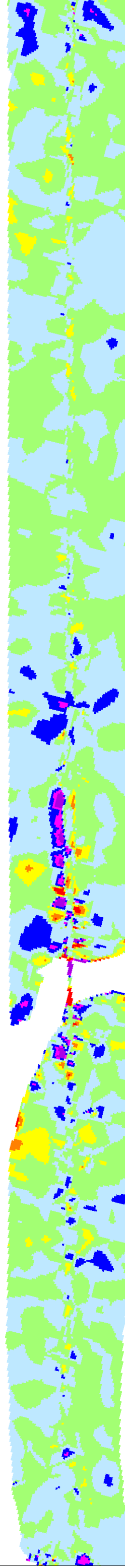
Plot B: Difference between October 2005 and 2004



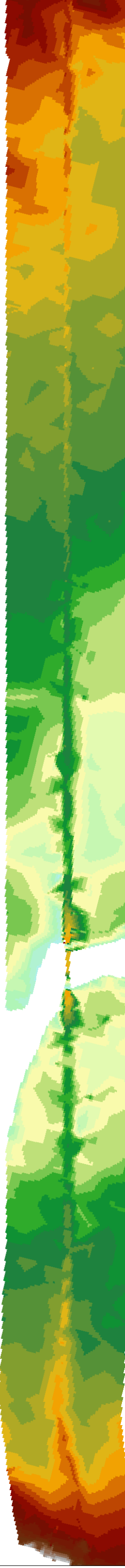
Plot C: Topographic Survey - October 2005



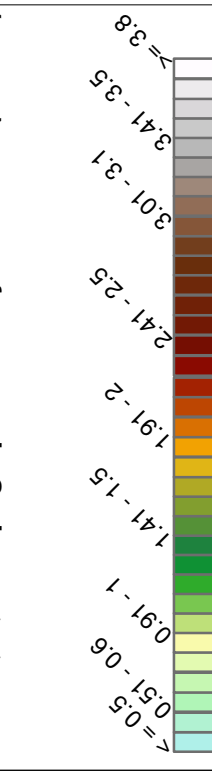
Plot D: Difference between November 2006 and October 2005



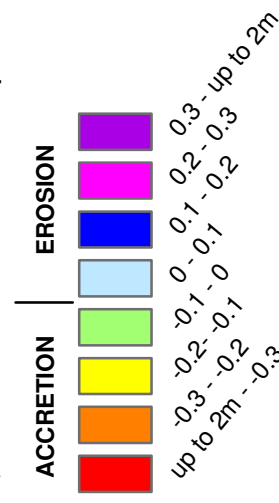
Plot E: Topographic Survey - November 2006



Plots A, C, E: Topographic Survey Elevation (metres)



Plots B, D: Difference in Elevation (metres)



Title:
Holy Island Causeway
Topographic Survey
+ Difference Plots

Project:
North East Coastal Monitoring
Programme

Date:
December 2008

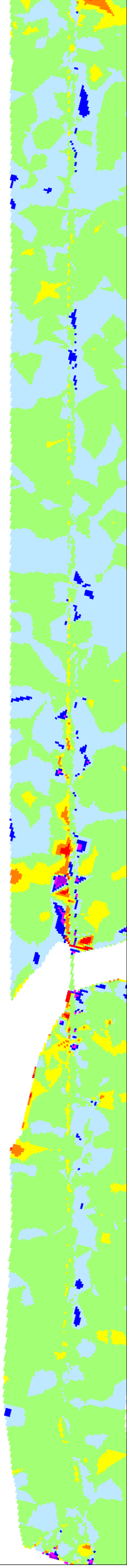
Scale:
1 : 4,000

Client:
Northumbrian Coastal Group

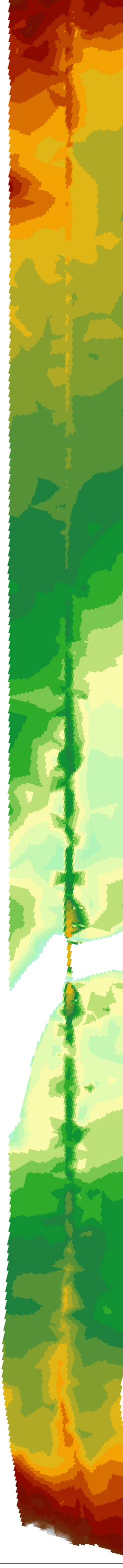


ROYAL HASKONING

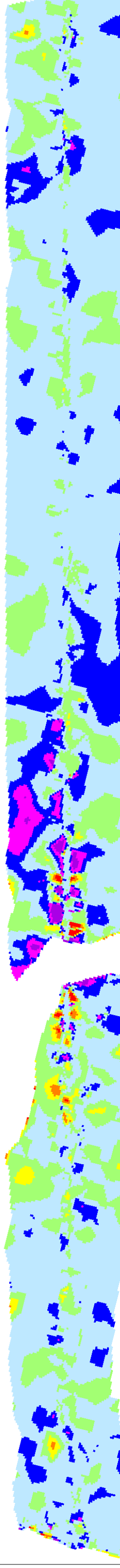
Plot F: Difference between October 2007 and November 2006



Plot G: Topographic Survey - October 2007



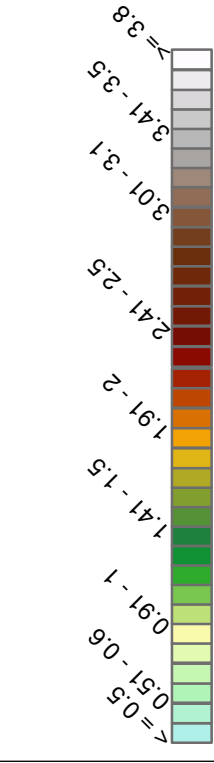
Plot H: Difference between October 2008 and October 2007



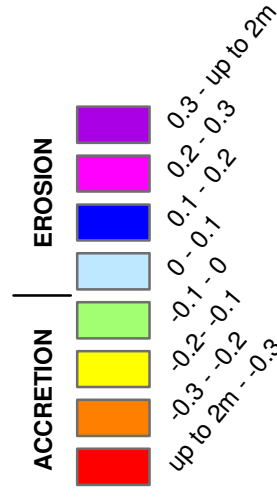
Plot I: Topographic Survey - October 2008



Plots G and I: Topographic Survey Elevation (metres)



Plots F and H: Difference in Elevation (metres)



Title:
Holy Island Causeway
Topographic Survey
+ Difference Plots

Project:
North East Coastal Monitoring
Programme

Date:
December 2008

Scale:
1 : 4,000

Client:
Northumbrian Coastal Group



ROYAL HASKONING

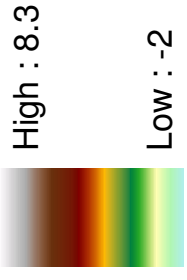
Appendix C

Holy Island

Topographic Surveys

Key:

Elevation (metres)



Contour intervals 0.5m

Title:
Alnmouth Beach - Digital Ground Model of Topographic Survey, August 2007

Project:
North East Coastal Monitoring Programme

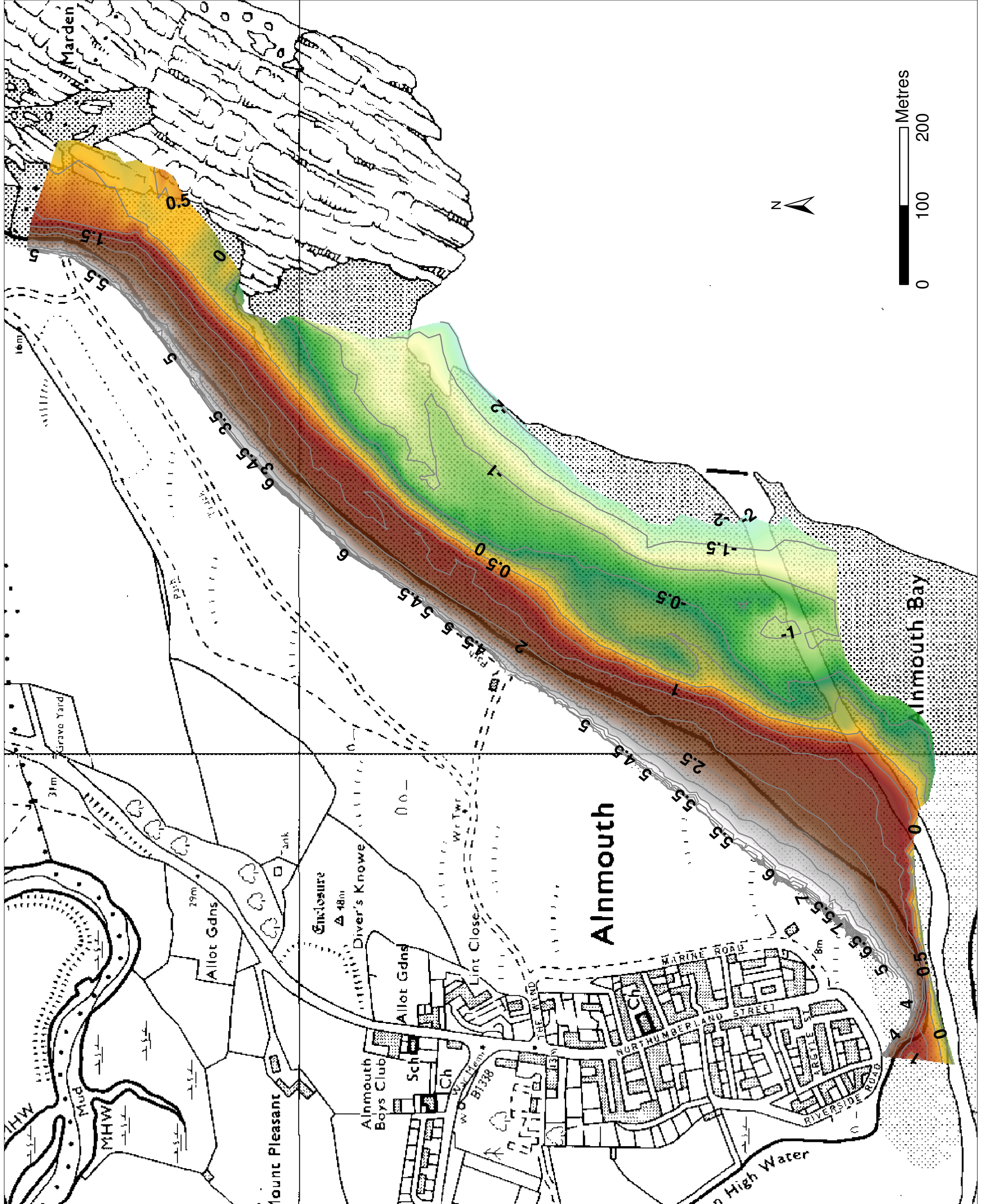
Client:
Northumbrian Coastal Group

Date:
December 2007

Scale:
1 : 4,500

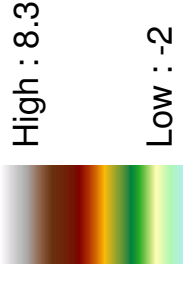


ROYAL HASKONING



Key:

Elevation (metres)



Contour intervals 0.5m

Title:
Alnmouth Beach - Digital Ground Model of Topographic Survey, April 2008

Project:
North East Coastal Monitoring Programme

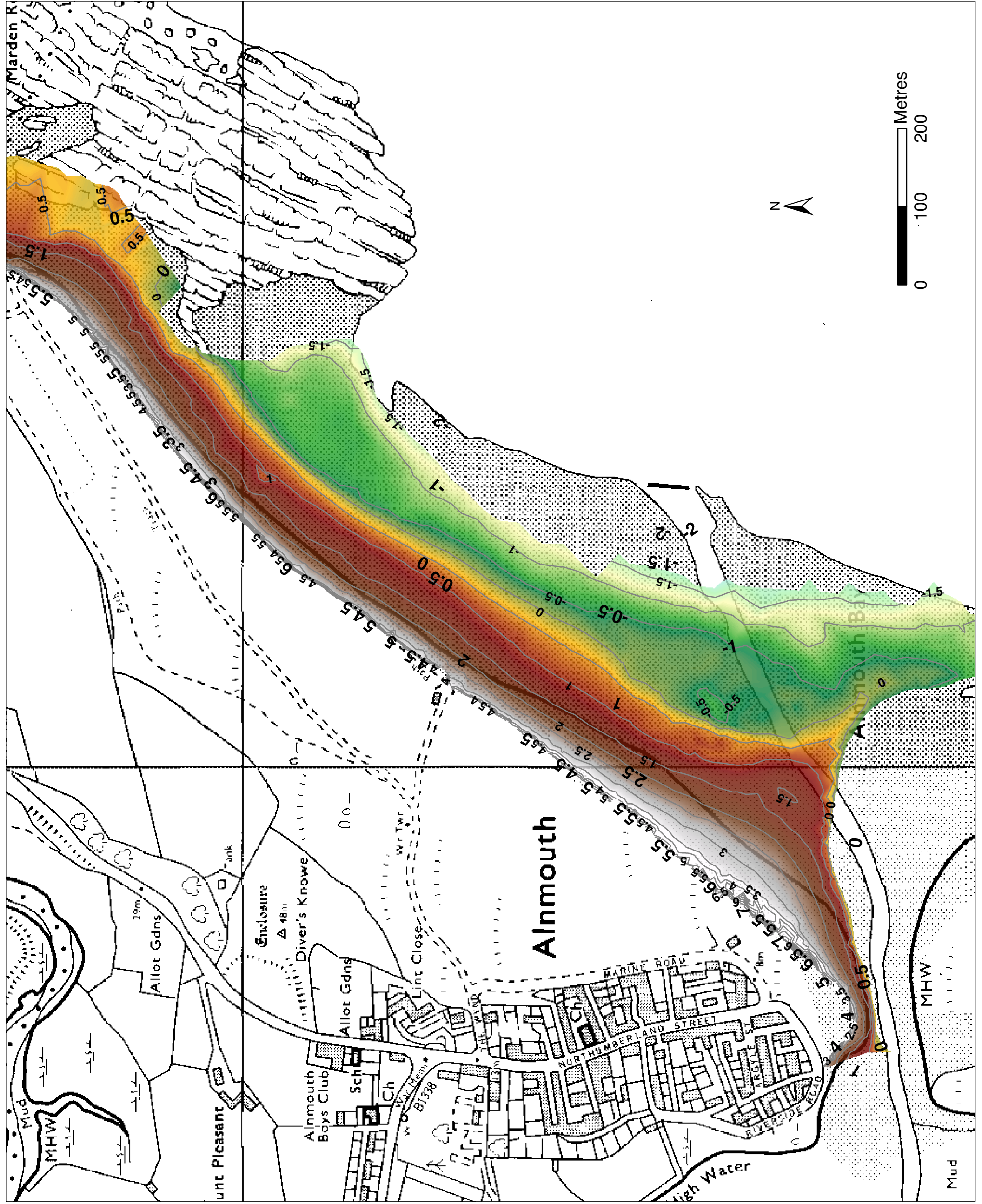
Client:
Northumbrian Coastal Group

Date:
June 2008

Scale:
1 : 4,500



ROYAL HASKONING



1:9507761 Technical Data\gsm\2008\Alnmouth\Alnmouth_Beach_042008.mxd
 Marden Rd
 MHW
 29m
 Allot Gdns
 Enclosure
 Diver's Knowe
 Allot Gdns
 Lint Close
 Wr Twr
 THE WIND
 B138
 Ch
 Alnmouth Boys Club
 Sch
 Ch
 MARINE ROAD
 NORTHUMBERLAND STREET
 ARGYLE ST
 RIVERSIDE ROAD
 High Water
 Mud
 MHW
 0 100 200 Metres
 N

Key:

Contour intervals 0.5m

Elevation (mOD)

High : 8.57514

Low : -2.02867



Title:

Alnmouth Beach - Digital Ground Model of Topographic Survey, October 2008

Project:

North East Coastal Monitoring Programme

Client:

Northumbrian Coastal Group

Date:

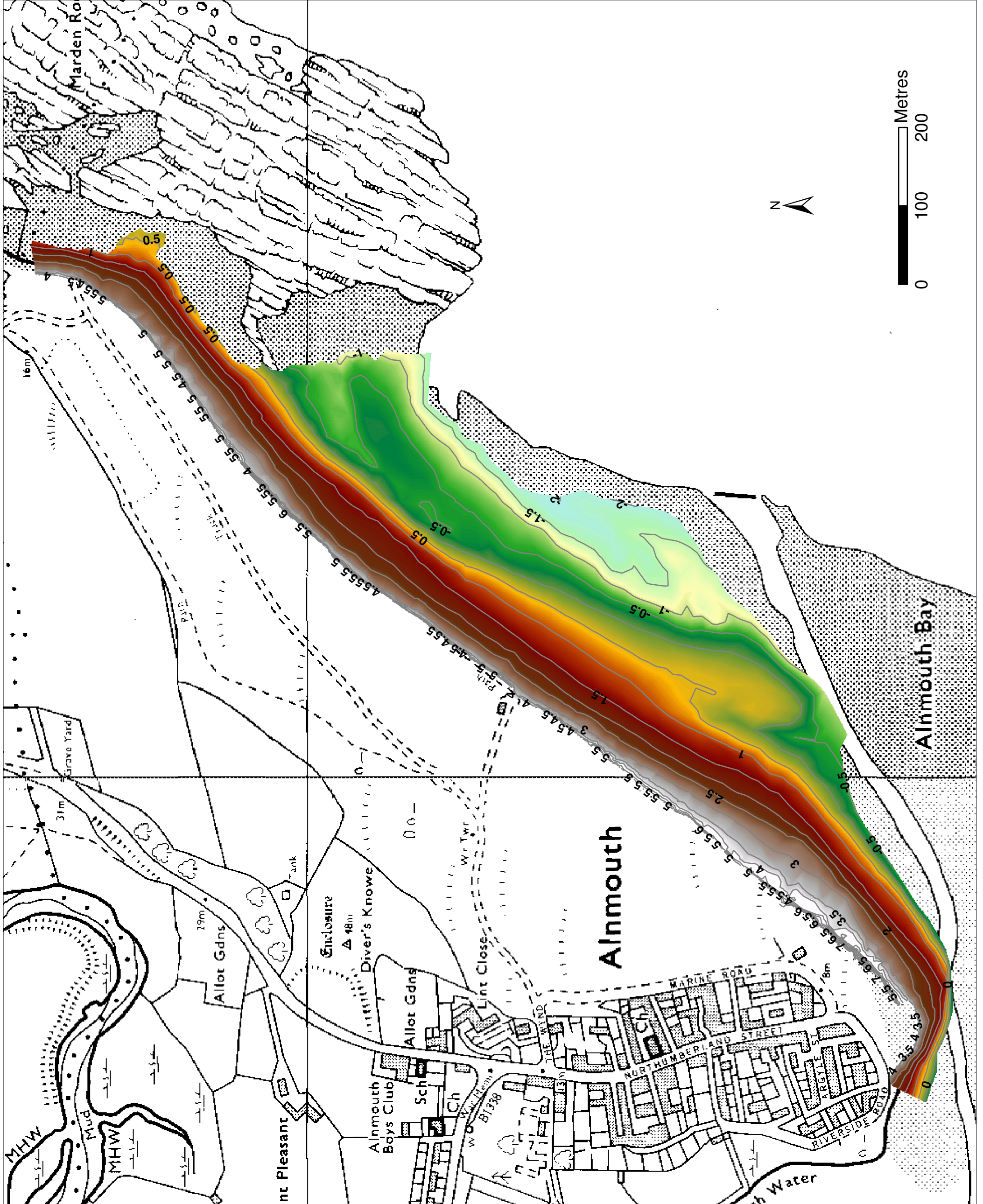
December 2008

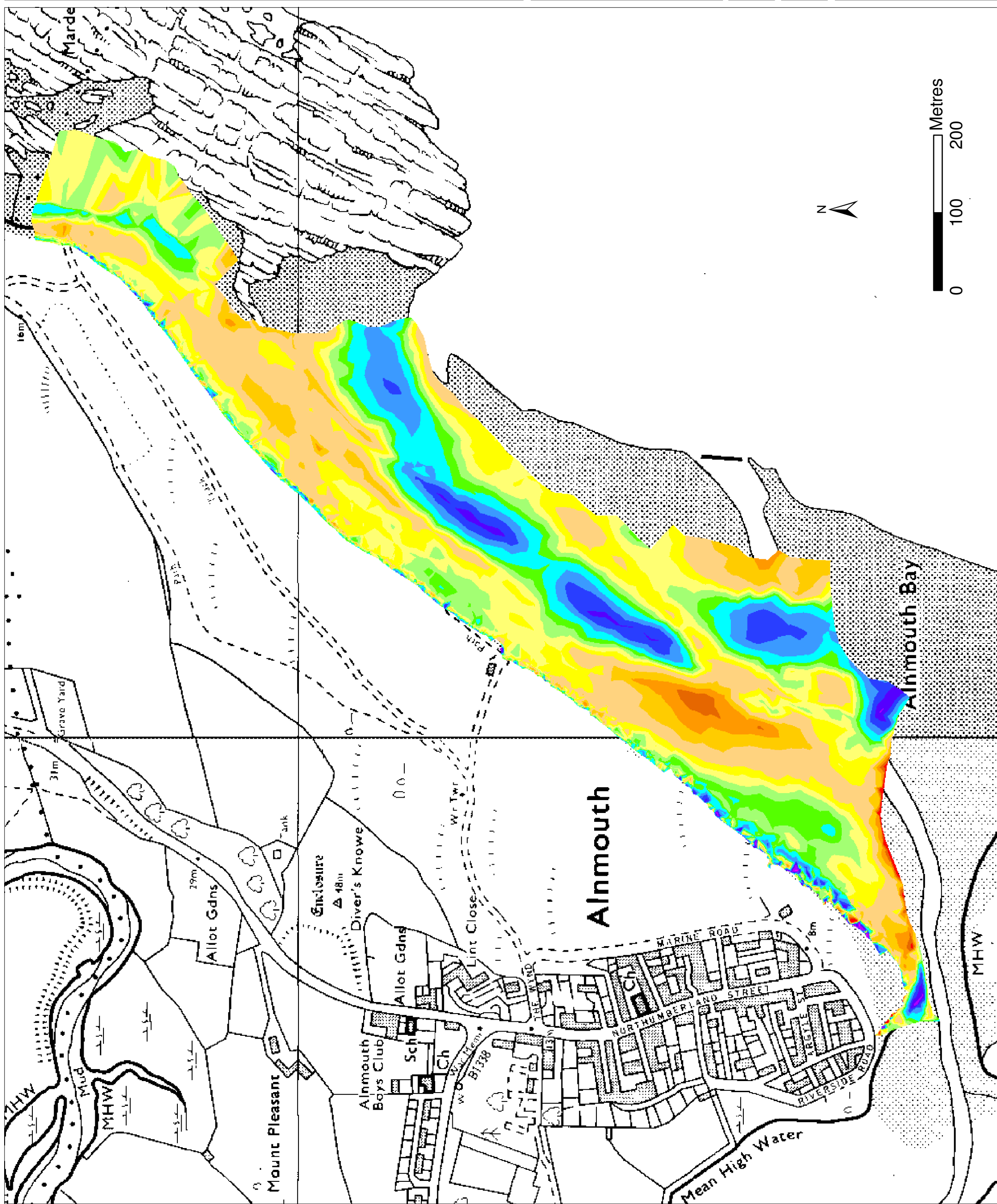
Scale:

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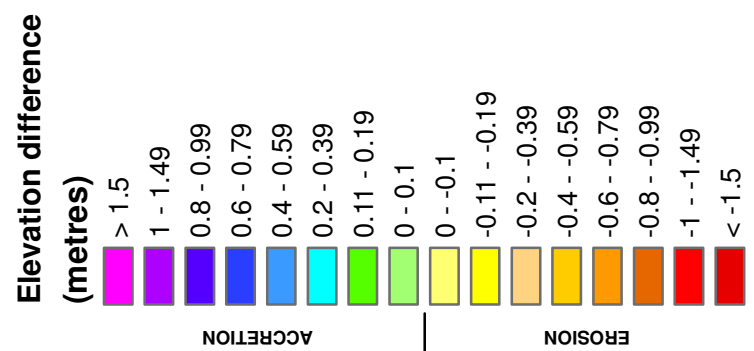


ROYAL HASKONING





Key:



Title:
Almouth Beach Difference Plot
August 2007 to April 2008

Project:
North East Coastal Monitoring
Programme

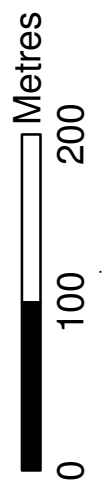
Client:
Northumbrian Coastal Group

Date:
June 2008

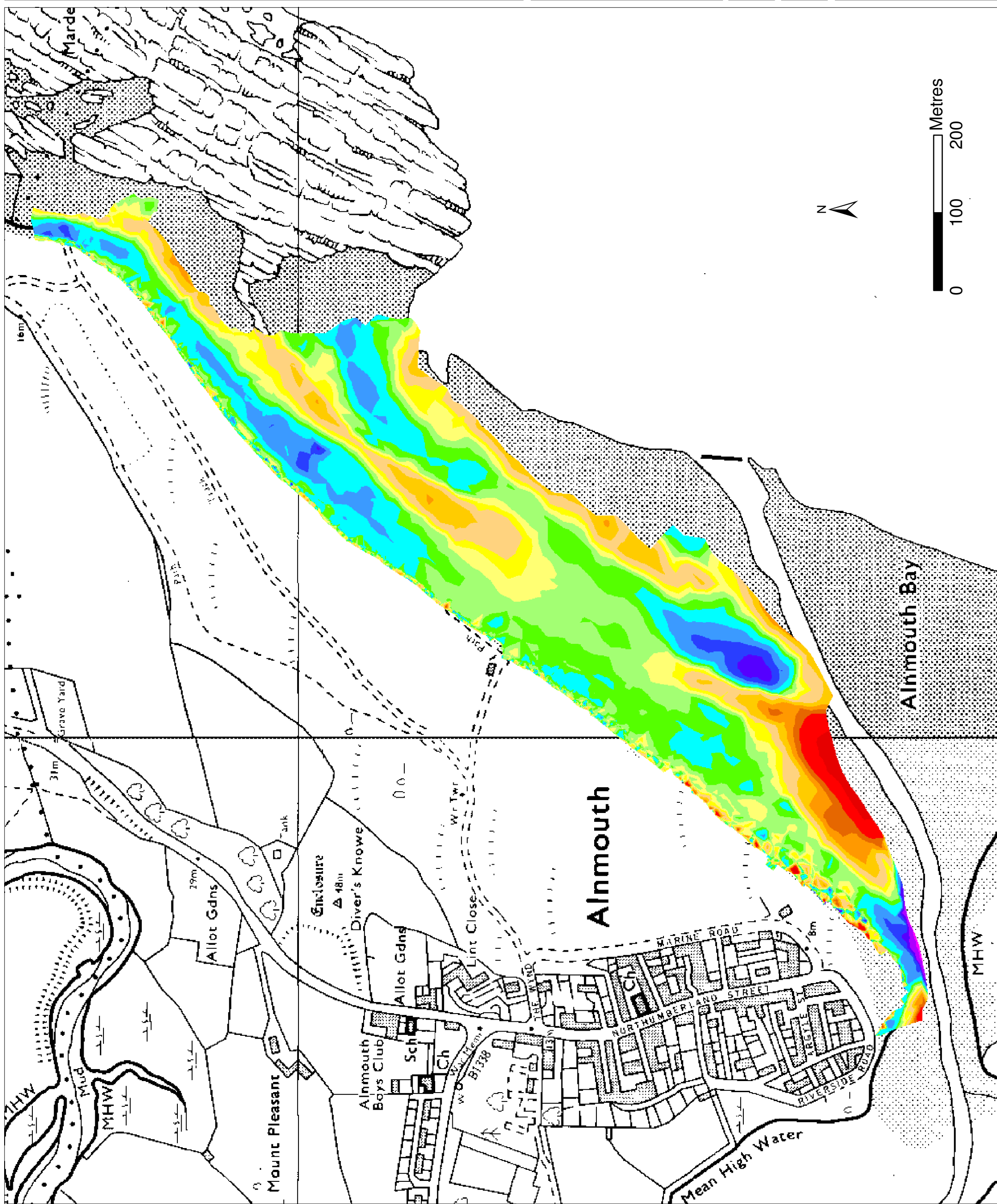
Scale:
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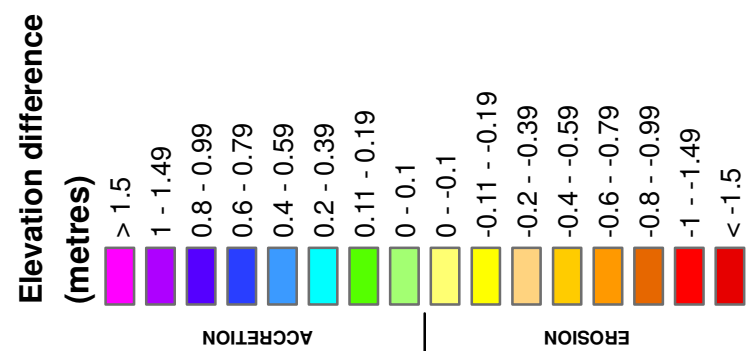
ROYAL HASKONING



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Key:



Title:
Almouth Beach Difference Plot
April to October 2008

Project:
North East Coastal Monitoring
Programme

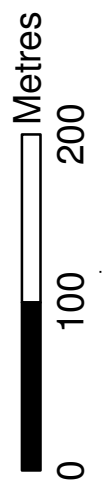
Client:
Northumbrian Coastal Group

Date:
December 2008

Scale:
1 : 4,500



ROYAL HASKONING



Appendix D

Newbiggin Caravan Park and Sandy Bay Caravan Park

Cliff Top Surveys

Newbiggin Caravan Park and Sandy Bay Caravan Park - Cliff Top Surveys

The cliff top survey lines surveyed at Newbiggin Caravan Park and Sandy Bay Caravan Park can be viewed superimposed on aerial imagery of the coastline using Google Earth.

To install Google Earth on your computer visit the Google Earth website <http://earth.google.com/> and download Google Earth.

To view the cliff top survey lines open Google Earth and go the File Menu and select Open, then navigate to where the 'NCAG_coastal_monitoring.kmz' file (provided on attached CD) is saved.

Once loaded, navigate to the desired location (Newbiggin Caravan Park or Sandy Bay Caravan Park) to view the different survey lines. Different survey lines can be clicked on/off as layers to provide a clearer picture of changes over time.