



**Cell 1 Regional Coastal Monitoring Programme
Coastal Walkover Inspections 2010**

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Abbreviations and Acronyms

Acronym / Abbreviation	Definition
CAM	Condition Assessment Manual
NFCDD	National Flood and Coastal Defence Database

Asset Condition Grades

Grade	Condition Description
1	Very Good
2	Good
3	Fair
4	Poor
5	Very Poor

Glossary of Terms

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

Preamble

The Cell 1 Regional Coastal Monitoring Programme covers approximately 300km of the north east coastline, from the Scottish Border (just south of St. Abb's Head) to Flamborough Head in East Yorkshire. This coastline is often referred to as 'Coastal Sediment Cell 1' in England and Wales (Figure 1). Within this frontage the coastal landforms vary considerably, comprising low-lying tidal flats with fringing salt marshes, hard rock cliffs that are mantled with glacial till to varying thicknesses, softer rock cliffs, and extensive landslide complexes.

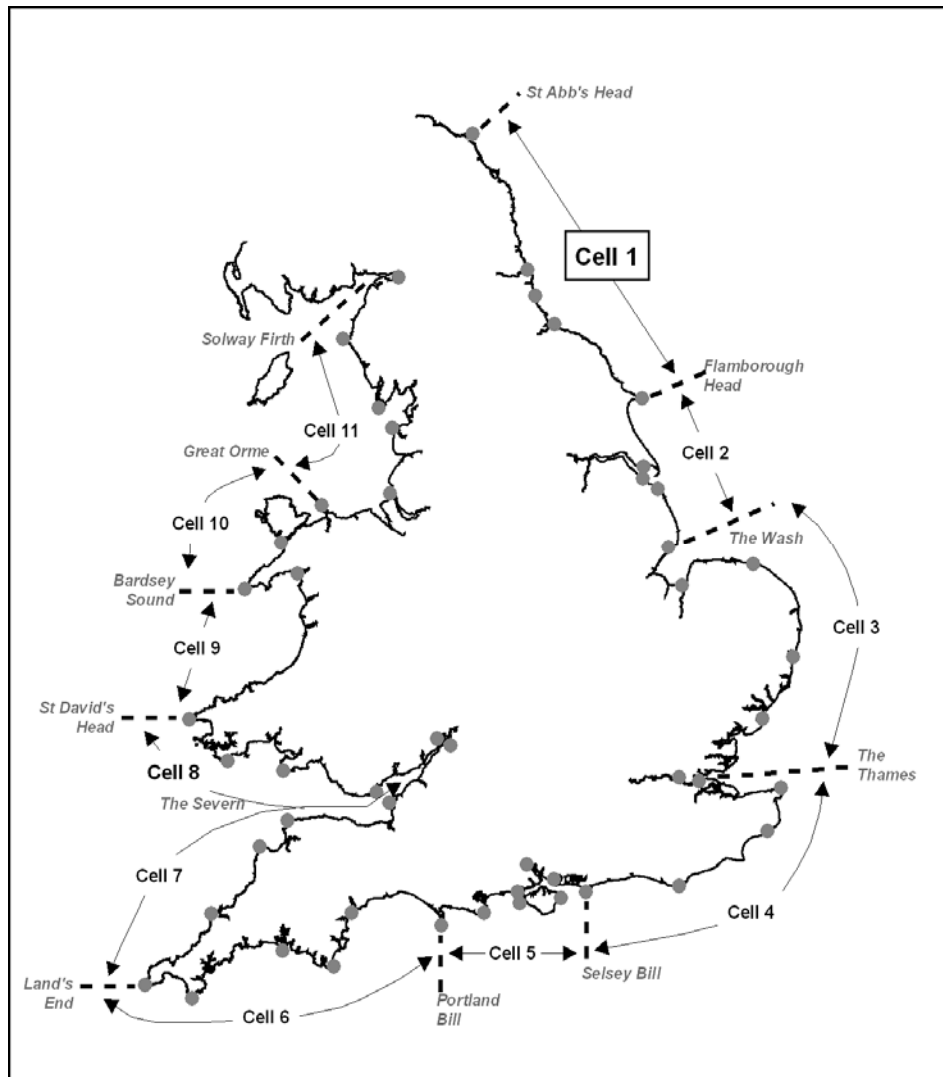


Figure 1 - Sediment Cells in England and Wales

The programme commenced in its present guise in September 2008 and is managed by Scarborough Borough Council on behalf of the North East Coastal Group. It is funded by the Environment Agency, working in partnership with the following organisations.



The data collection, analysis and reporting is being undertaken as a partnership between:



The main elements of the Cell 1 Regional Coastal Monitoring Programme involve:

- beach profile surveys
- topographic surveys
- cliff top recession surveys
- real-time wave data collection
- bathymetric and sea bed characterisation surveys
- aerial photography
- walk-over surveys

The present report is **Coastal Walkover Inspections 2010** and provides a summary of the main findings from the walkover inspections that are undertaken once every 2 years along the part of East Riding of Yorkshire Council’s frontage that is located within Cell 1 (Dulcey Dock to Flamborough Head).

In addition, separate reports are produced for other elements of the programme as and when specific components are undertaken, such as beach profile, topographic and cliff top surveys, wave data collection, bathymetric and sea bed sediment data collection, and aerial photography.

1. Introduction

1.1 Study Area

This report documents the condition of the coastal cliffs and assets along the part of East Riding of Yorkshire Council's frontage that is located within Cell 1, from just west of Dulcey Dock in the north to Flamborough Head in the south.

This area is characterised by high chalk cliffs with a till cap. The cliff elevation declines towards the south, with a reduced extent of chalk and increasing till cap thickness.

The cliff behaviour units (CBUs) previously mapped along this stretch of coast in 2008 were again used in this inspection, with adjustments made where units were found to deviate from the mapping.

The naming convention for CBUs along the study area is as follows; for CBU E110/14 the prefix relates to Futurecoast unit E110 and the suffix /14 relates to the specific area as defined in this case by the headlands at Gull Nook and Close Nooks (North of Flamborough village).

1.2 Methodology

This section presents the approach taken by the slope and asset inspectors respectively for the East Riding of Yorkshire Council coastal frontage.

Coastal Slope Condition Assessment

The cliff condition assessment was undertaken by systematic walk-over inspection of the whole coastline by a team of geomorphologists on 11th August 2010. Weather conditions during this time were generally warm and fair. The inspection involved visual assessment of cliff activity and noting specific areas of activity (e.g. landslides and tension cracks). All observations were documented with photographs and annotated field maps. Each unit was identified, photographed and classified according to the five point activity scale as defined in Table 1.1. This classification scheme is the same as that used in the Speeton to Flamborough Head assessment undertaken during the 2008 walkover survey. Brief descriptions of the condition of the cliffs were also entered into the National Flood and Coastal Defence Database (NFCDD) for all areas of undefended coastline.

Activity Class	Description
Totally Active	Retreating cliffline almost entirely affected by large-scale landsliding or intense erosion
Partly Active	Retreating cliffline with very common smaller-scale landslides or areas of intense erosion
Locally Active	Retreating cliffline with localised small landslides or areas of erosion
Inactive	Relict cliffs or landslides with vegetated slopes and localised erosion of the toe or failure of the headscarp
Dormant	Protected cliffline or landslide complex with no visible evidence of landslide activity

Table 1.1 - Cliff activity classes used in the August 2010 assessment

The inspection was primarily conducted from the cliff-top, due to access restrictions and health and safety concerns associated with the cliff toe and beaches along this stretch of coast. In the East Riding of Yorkshire, the coastline is followed for the most part by a cliff top footpath. Where the footpath moved inland the inspection kept to the cliff edge to ensure the whole coastline was observed and activity recorded.

Coast Protection Asset Condition Assessment

The visual assessment of built assets was carried out by a team of asset inspectors and structural engineers on 21st September 2010. The weather experienced during this period was of a mild nature, and was generally fair and dry. Assets were graded based on their condition (as defined in Table 1.2), residual life and urgency of repair work, following standard Environment Agency guidelines and the Condition Assessment Manual (CAM). This classification scheme is the same as that used during inspections in 2008 and that planned for future inspections. Inspections were made from both the seaward and landward side of defence where possible. Observations were photographed and all data were stored 'live' in the offline NFCDD Poweruser software using ruggedised laptops.

Asset descriptions provide an overview of findings, summarising each locality and identifying individual assets of poor condition, failing structures and assets that have the potential to fail. It is anticipated that this will help identify areas for investment, including repair work, replacement or the installation of a different asset type. This report will also highlight assets with a certain level of importance or interest.

Grade	Rating	Description
1	Very Good	Cosmetic defects that will have no effect on performance.
2	Good	Minor defects that will not reduce the overall performance of the asset
3	Fair	Defects that could reduce performance of the asset.
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation needed.
5	Very Poor	Severe defects resulting in complete performance failure

Table 1.2 - Condition assessment grading used in the 2010 assessment

North Landing was the only site visited along the East Riding of Yorkshire frontage that had coastal assets present. The asset descriptions provide an overview of findings, summarising this locality and identifying any assets of poor condition, failing structures and assets that have the potential to fail. It is anticipated that this will help identify areas for investment, including repair work, replacement or the installation of a different asset type.

2. Overview

2.1 Coastal Slope Condition Assessment

In total, 40 CBUs were observed during the 2010 walkover inspection of this area, of which the majority were classified as Locally Active (Figure 1). Assets along this stretch of coastline include occasional properties, the Lifeboat Station at North Landing, a golf course at Stottle Bank Nook and the Lighthouse at Flamborough Head. A footpath also follows the cliff top throughout the study area.

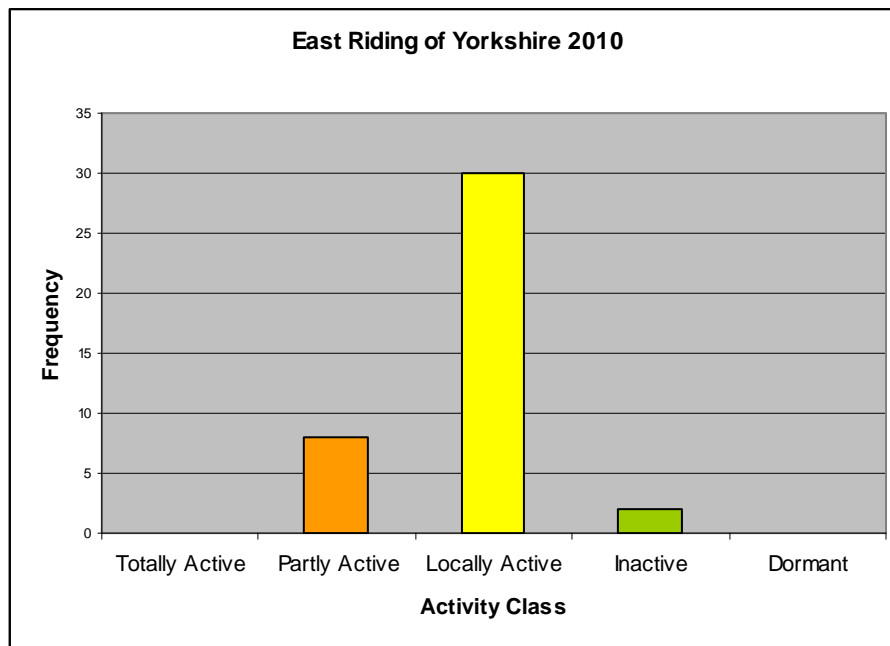


Figure 1 - Frequency of cliff activity along the East Riding of Yorkshire frontage in 2010

As in 2008, the majority of CBUs within this region are classified as Locally Active and pose little risk to the listed assets. The exceptions are still the Partly Active areas around Thornwick Nab and Stottle Bank Nook. At both locations diversion of the cliff top footpath has been necessary due to cliff top retreat, with the latter involving loss of land at the golf course. Continued monitoring of all units is recommended with more frequent inspection of the more active units at Thornwick Nab and especially Stottle Bank Nook.

Coast Protection Asset Condition Assessment






The only coast protection assets within this region are located at North Landing, and include the area around the Lifeboat station, a concrete revetment, a slipway and associated gabions. The revetment shows some minor cracking and corrosion and the gabions have undergone minor deformation and loss of rock packing in places. However, none of these defects are considered serious. It is recommended that continued monitoring of these assets is undertaken but no specific repair works are required.

3. Condition Assessment

3.1 Coastal Slope Condition Assessment

The section of coastline between Dulcey Dock and Flamborough Head is described as a whole, with specific reference to particularly active or inactive CBUs. The locations of all CBUs are shown in Appendix A (Maps 1 to 3) with areas of change highlighted in Appendix B (Maps 4 to 6).

Photographs in the following section have been bordered with colours in order to show their activity status, as follows:

	Totally Active
	Partly Active
	Locally Active
	Inactive
	Dormant

The majority of CBUs within the study area have been classified as Locally Active during the 2010 inspection. The chalk cliffs in this area are high and near vertical. They are capped by a layer of glacial sediment (till) which varies in thickness but is generally well vegetated with grasses and other small plants. In most places the till is stable; however there are localised landslides which are causing recession of the headscarp. In the south of the study area, where the cliffs are of lesser elevation, the till layer becomes thicker forming gently undulating slopes which overlie a thinner chalk layer. These probably represent relict mudslides.

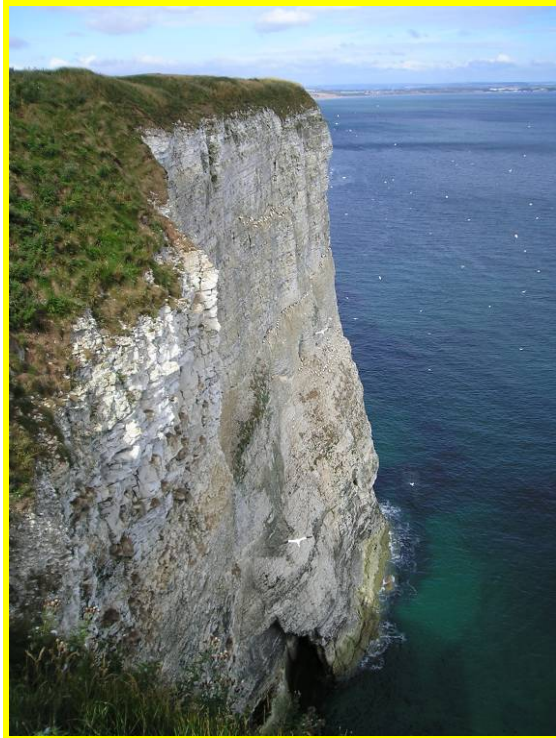
Within most units the lower chalk cliff face is heavily fractured and largely devoid of vegetation. The toe of the cliffs is subject to marine action but no major undercutting was observed. That said, stacks and arches have developed in some areas (such as within units E110/6 at Scale Nab, E111/11 just west of Breil Nook and E111/15b below the Lighthouse at Flamborough Head). There is also widespread evidence of episodic rockfall activity, occurring both prior to and since the 2008 walkover inspection. For example, recent rockfall activity has occurred within unit E108/2 near Dulcey Dock where a chalk pillar has collapsed. Consequently this unit has been upgraded from Locally to Partly Active. Recent rockfall is also evident within units E110/5 and E110/6 (Bempton Cliffs – both Locally Active), E110/10 (Dykes End – Locally Active), E110/14 and E111/1 (North Cliff – both Locally Active) and E111/10 (embayment east of North Landing – Partly Active).

The heavily fractured cliff rocks are susceptible to preferential erosion and weathering along their joints. This has resulted in the local formation of gully features and large tension cracks which cut inland from the cliff face (e.g. unit E109/4 at the east end of Buckton Cliffs, E110/4 at Crab Rocks and E111/13 near Cradle Head). These features are currently stable, but may become a focus for elevated rates of erosion and instability in the future.

As in 2008, there remain some areas of cliff which are much more heavily vegetated with very little evidence of instability, and are therefore classified as Inactive. These include CBU E110/13 near Gull Nook (just east of Danes' Dyke) and CBU E111/7 at Holmes Gut which stretches inland and is characterised by densely vegetated gentle slopes.

A number of units along this frontage have been classified as Partly Active. These units are on the whole located further south, where the exposures of till are much thicker. This includes the cliffs around Thornwick Nab (E111/2, E111/3, E111/4, E111/5a), where the till is undergoing failure, with consequent headscarp recession. Within Thornwick Bay

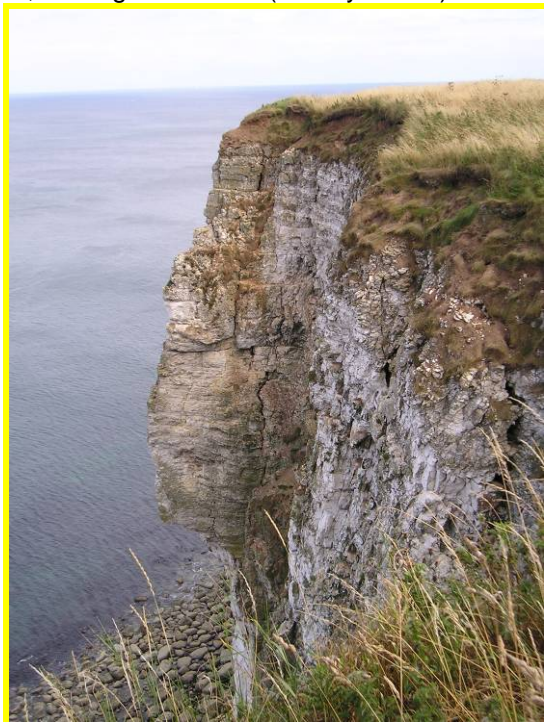
further change is brought about by marine action, and this is causing undercutting of the cliff toe and the formation of caves and small gullies. The till cliffs within unit E111/8a at North Landing are also largely affected by instability and are showing signs of active recession of the cliff top and instability at the toe. As in 2008, Partly Active cliffs were also recognised at Stottle Bank Nook (E111/14) where localised erosion and instability in the till is affecting the adjacent golf course and has led to diversion of the cliff top footpath.



E110/2 thin till layer above fractured high chalk cliff, looking westwards (Locally Active)



E108/2 recent rockfall and collapse of chalk pillar (Partly Active) (Note: this unit was previously classified as Locally Active in 2008)



E110/8 large vertical fractures in chalk (Locally Active)



E110/13 well vegetated cliff face (Inactive)



E111/2 Thornwick Nab (Partly Active)



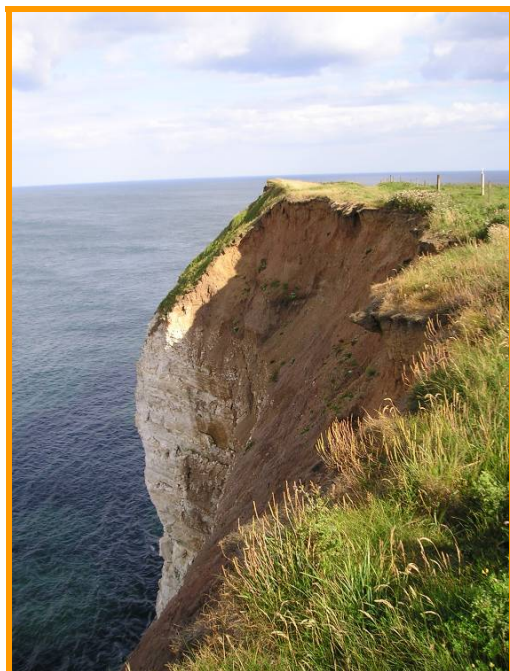
E111/4 landsliding in the till in Thornwick Bay (Partly Active)



E111/7 well vegetated slopes of Holmes Gut (Inactive)



E111/8a cliffs behind North Landing (Partly Active)



E111/14 till failure at Stottle Bank Nook (Partly Active)



E111/15b Flamborough Head (Locally Active)

Coast Protection Asset Condition Assessment

Descriptions and photographs are presented for key assets and those where there are significant defects or the condition has changed significantly since the previous inspection. Photographs have been bordered with colours in order to show their condition as follows:

	5 – Very poor
	4 – Poor
	3 – Fair
	2 – Good
	1 – Very good

The locations of all coast protection assets are shown in Appendix C (Map 7), while change is shown in Appendix D (Map 8). A full assessment of coast protection asset condition has been entered into NFCDD.

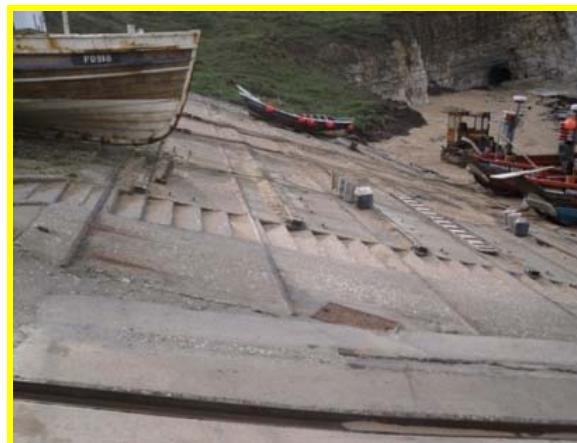
The only coastal assets within this area are located at North Landing and are associated with the Lifeboat Station. They include a concrete revetment (Asset Ref No. 1221D901D1803C02) and a slipway with associated gabions (Asset Ref. No. 1231D901D3201C03).

The concrete revetment, constructed with horizontal steel bars set approximately 1.5m apart, is located to the west of the Lifeboat Station. This structure features a set of steps on its eastern side, giving pedestrian access to the beach and is used for mooring boats. There are two full height cracks in the apron, which have been repaired in the past and no longer appear active. There is corrosion to the steel elements, and some erosion of an old repair near the manhole in the slipway. Immediately west of structure, there is evidence of recent large slip onto the beach.

The Lifeboat Station slipway is protected on the east side with a series of gabions, retaining the earth bank behind. There is some evidence of slipping at the lower end of the gabions. Several of the baskets show deformation and have been repaired in a make-shift fashion. Loss of rock packing seems to have occurred in places and there is evidence of earth from the bank behind slipping onto the gabions. The 450mm diameter clay service pipe exiting from the base of the slipway observed in 2008 was not visible, probably be due to beach level change.



Slipway and revetment at North Landing
(Asset Ref No. 1231D901D3201C02)



Slipway and revetment at North Landing
(Asset Ref No. 1231D901D3201C02)



Concrete revetment – showing crack
(Asset Ref No. 1221D901D1803C02)



Concrete revetment – showing crack
(Asset Ref No. 1221D901D1803C02)



Overview of slipway
(Asset Ref No. 1221D901D1803C02)



Failing repair around manhole
(Asset Ref No. 1221D901D1803C02)



Overview of gabions and patched repair
(Asset Ref No. 1231D901D3201C03)



Patched repair of gabion
(Asset Ref No. 1231D901D3201C03)

4. Comparison with Previous Assessments

Coastal Slope Condition Assessment

Previous cliff condition assessment data were available from the 2008 inspection. Comparison of 2008 and 2010 survey results indicate only one unit has experienced a change in activity status within the study area. This is unit E108/2 near Dulcey Dock, where the collapse of a chalk pillar and recent rockfall has led to an increase in activity status to Partly Active. The level of activity within all other units remains much the same as it was in 2008.

Coast Protection Asset Condition Assessment

Previous coast protection asset condition data was available from 2008 within NFCDD. The condition of neither asset had changed significantly enough for the condition grade to be improved or lowered, see Appendix D (Map 8).

5. Problems Encountered and Uncertainty in Analysis

Coastal Slope Condition Assessment

No significant problems were encountered in the cliff condition assessment. A limited view of the cliff was afforded at a small number of CBUs. In these cases, judgments about cliff behaviour activity status were made on the clearly visible sections of cliff and using the Cell 1 Aerial Survey oblique aerial images from 2010.

Coast Protection Asset Condition Assessment

No significant problems were encountered in the coast protection asset condition assessment. All assets were located in public spaces and were easily accessible. Local tide tables provided key information for the appropriate planning of the inspections. It would not be recommended to attempt further inspections during very high tides.

6. Conclusions and Recommended Actions

Most of the cliff units along this stretch of coastline are classified as Locally Active. Minor erosion is ongoing and is in line with the natural evolution of the coast. Greater levels of activity are observed in the units around Thornwick Nab and Stottle Bank Nook. At these locations there is active headscarp recession and consequent diversion of the cliff top footpath. It is recommended that continued monitoring of all units is undertaken, with more frequent consideration given to the more active locations.

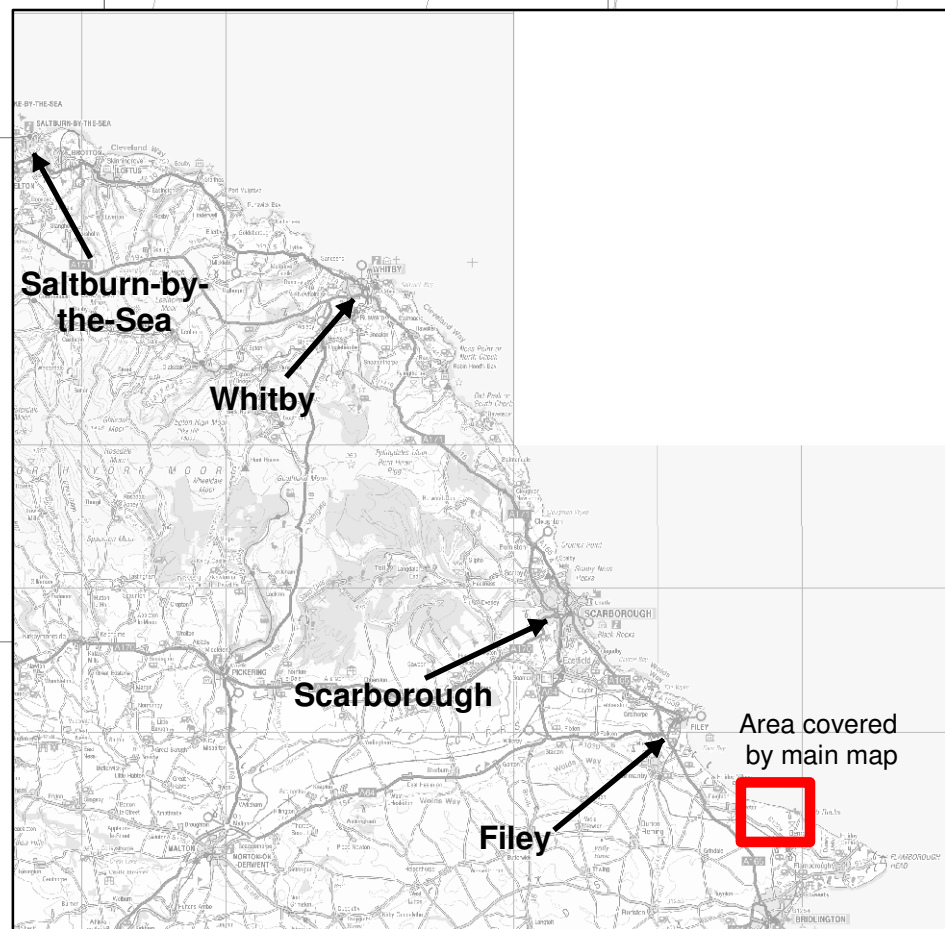
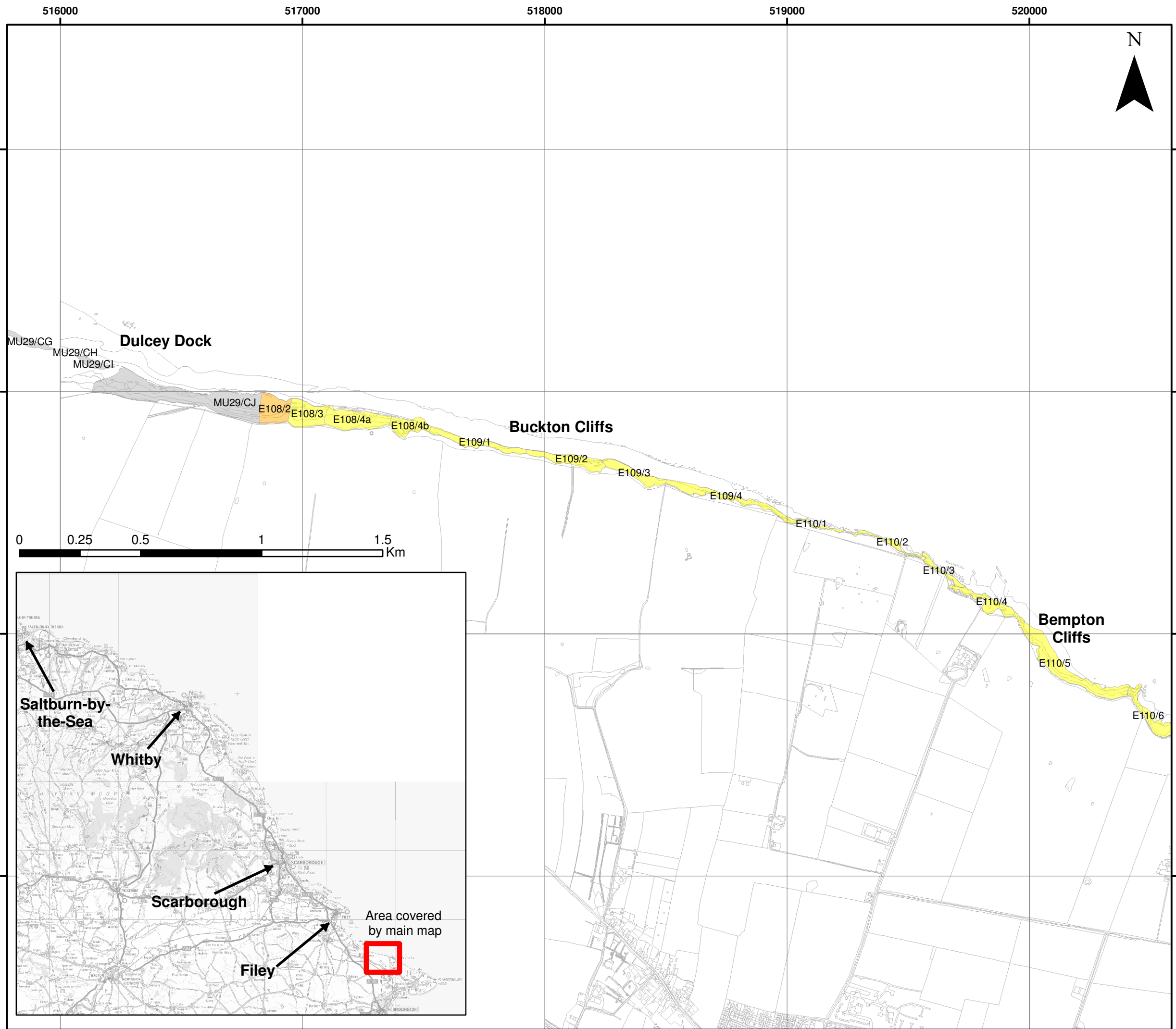
There are no specific repair works required to individual coastal assets. However, it is recommended that continued monitoring of coastal assets within the East Riding of Yorkshire area is undertaken.

Appendices

Appendix A

Coastal Slope Condition

Maps 1 – 3



- Legend**
- Cliff Activity Status 2010**
- Dormant
 - Inactive
 - Locally Active
 - Partly Active
 - Totally Active
 - Not inspected in 2010



Client: Cell One (East Riding of Yorkshire Council)

Project: Cell One Coastal Slope Condition Analysis 2010

Map 1 - Dulcey Dock to Bempton Cliffs

Coastal Slope Condition 2010

Drawing Scale 1:15,000 at A3

Drawn by: AW	Date: Nov 2010
Checked by: PRF	Date: Nov 2010
Approved by: PRF	Date: Nov 2010



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Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

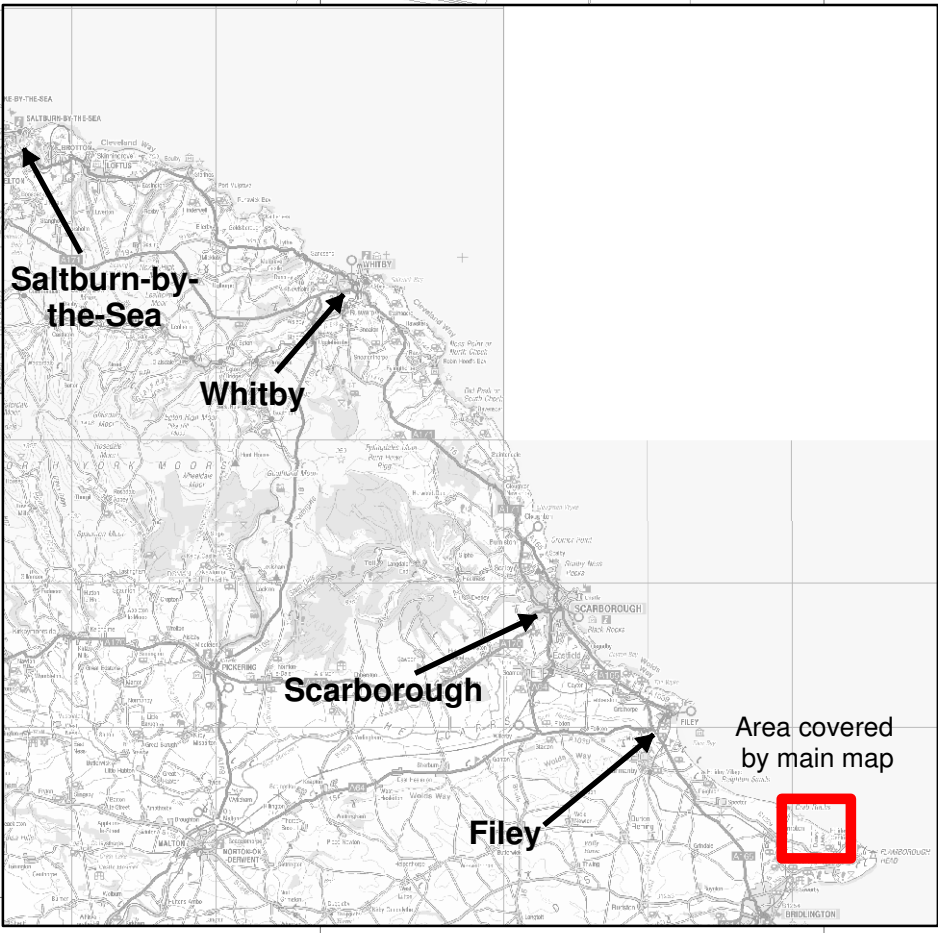
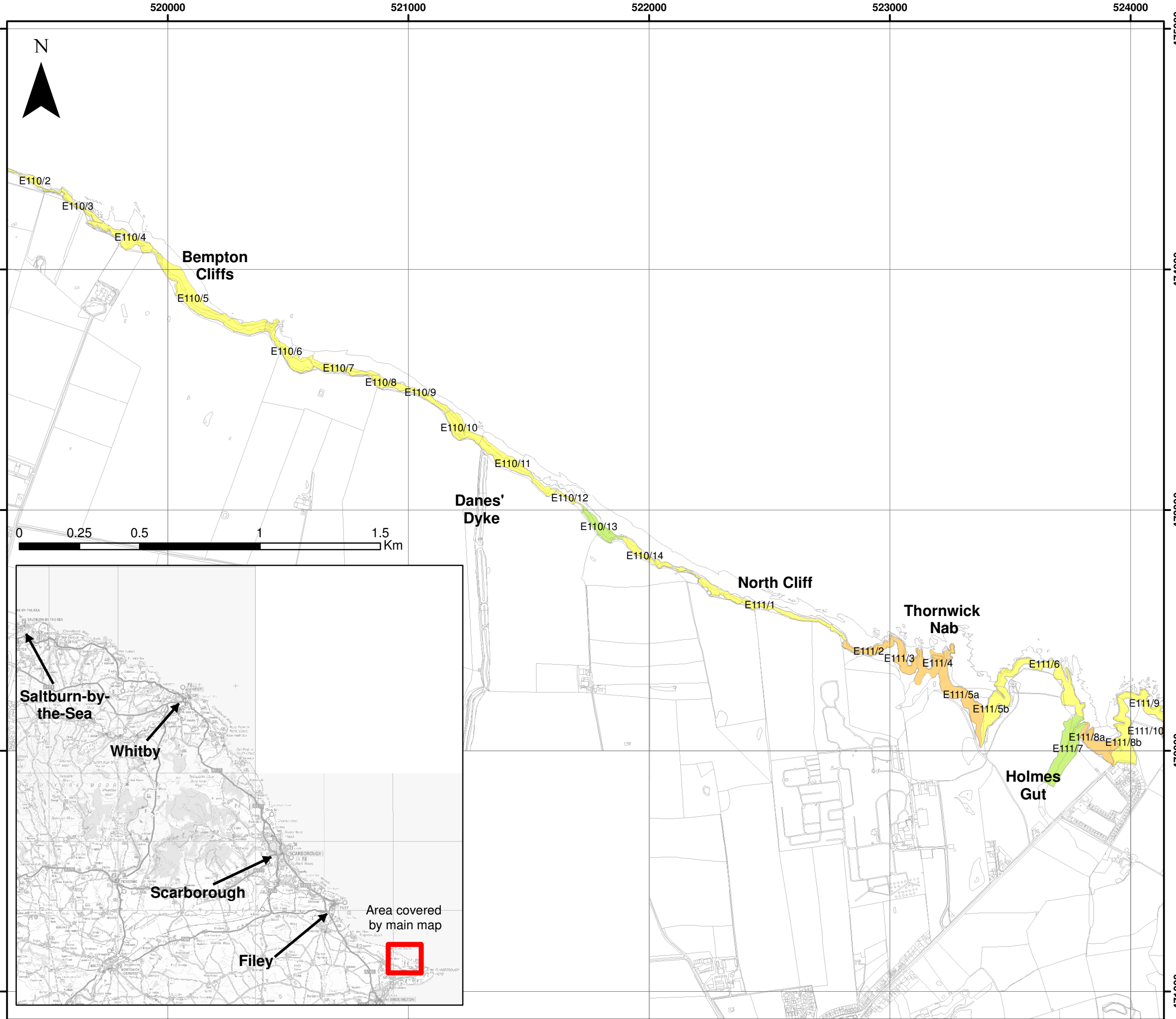


Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE

Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoning.com

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
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Legend

Cliff Activity Status 2010

- Dormant
- Inactive
- Locally Active
- Partly Active
- Totally Active



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Client: Cell One (East Riding of Yorkshire Council)

Project: Cell One Coastal Slope Condition Analysis 2010

Map 2 - Bempton Cliffs to Holmes Gut

Coastal Slope Condition 2010

Drawing Scale 1:15,000 at A3

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Approved by: PRF	Date: Nov 2010



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NE1 4EE

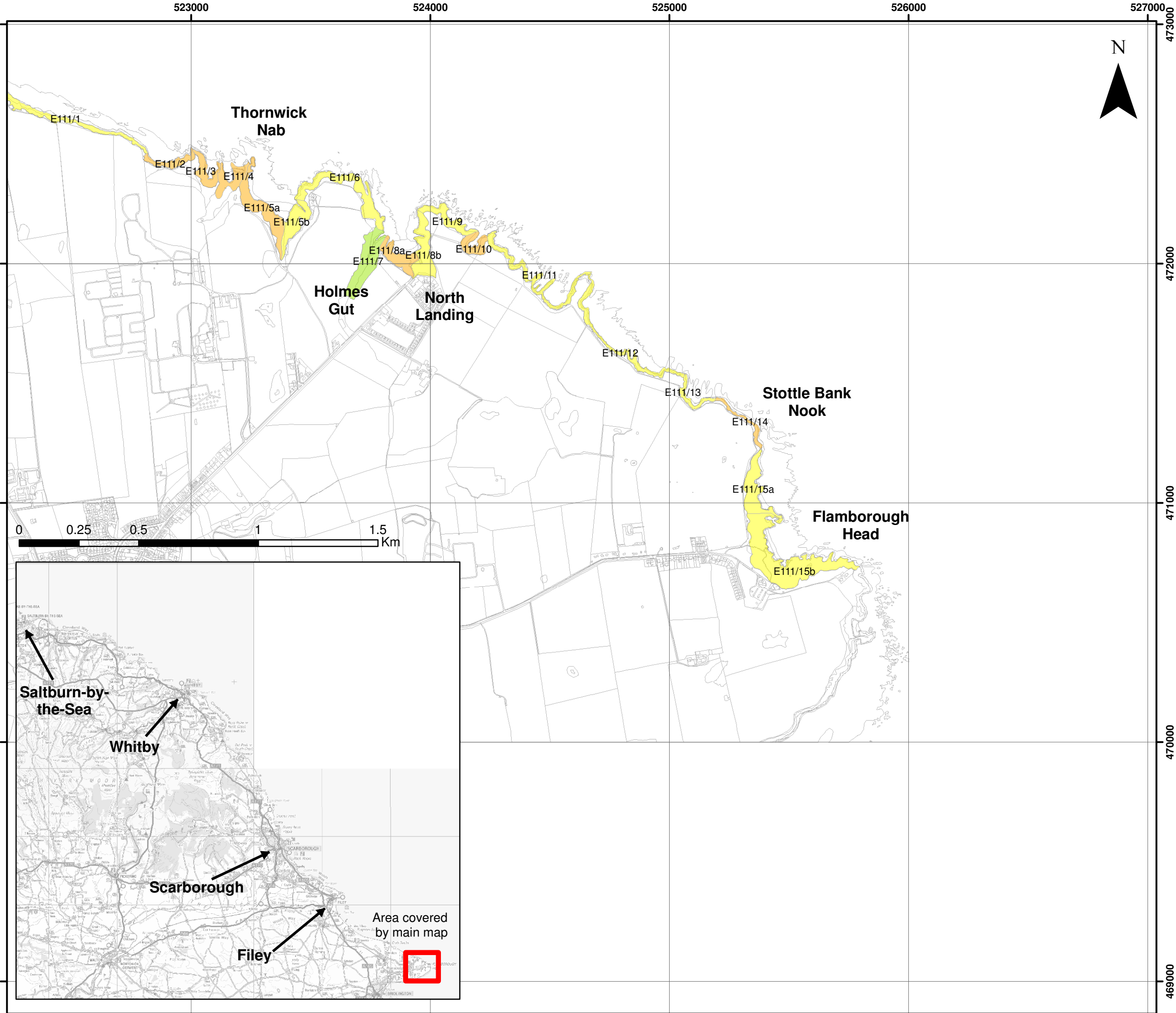


Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE

Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoning.com

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Legend

Cliff Activity Status 2010

- Dormant
- Inactive
- Locally Active
- Partly Active
- Totally Active



Client: Cell One (East Riding of Yorkshire Council)

Project: Cell One Coastal Slope Condition Analysis 2010

Map 3 - Holmes Gut to Flamborough Head

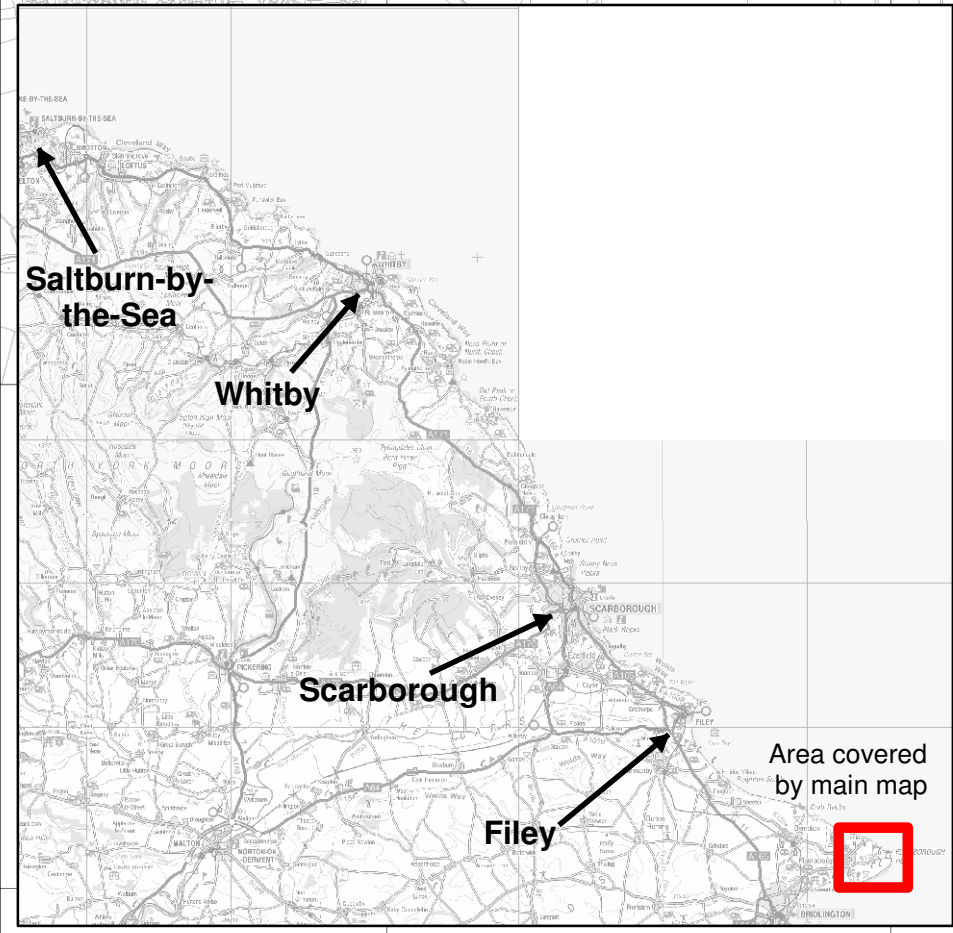
Coastal Slope Condition 2010

Drawing Scale 1:15,000 at A3

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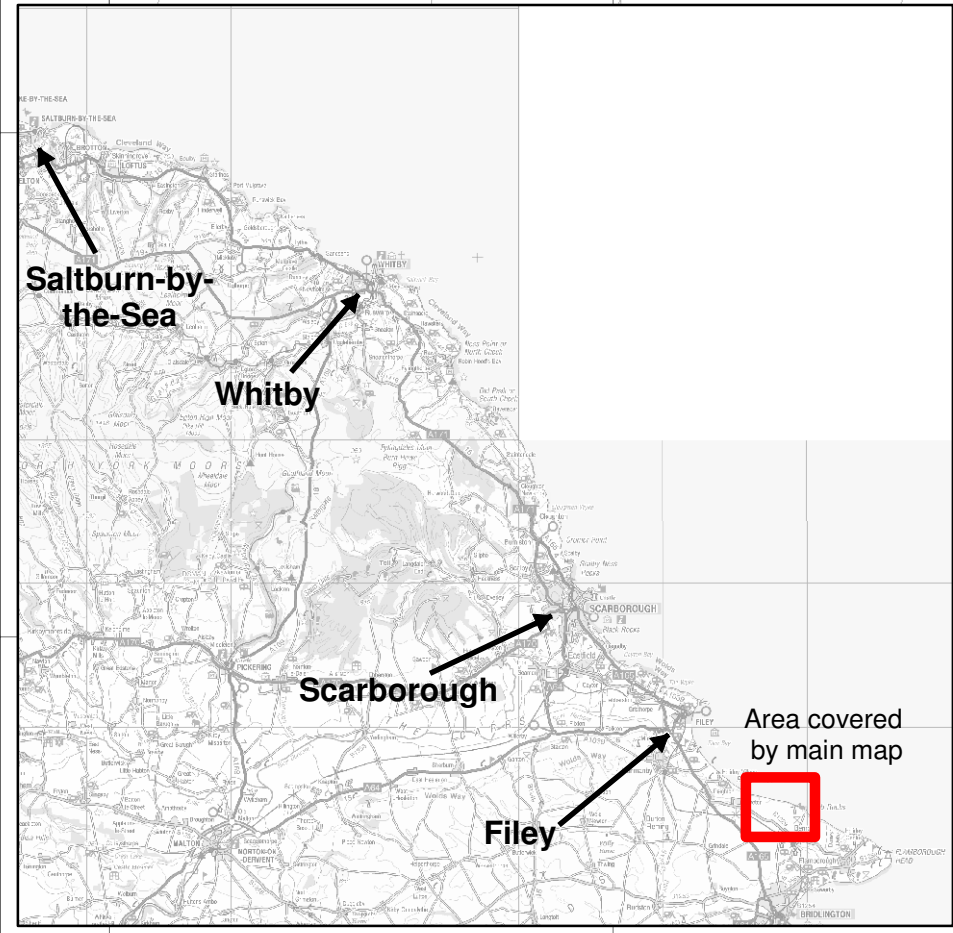
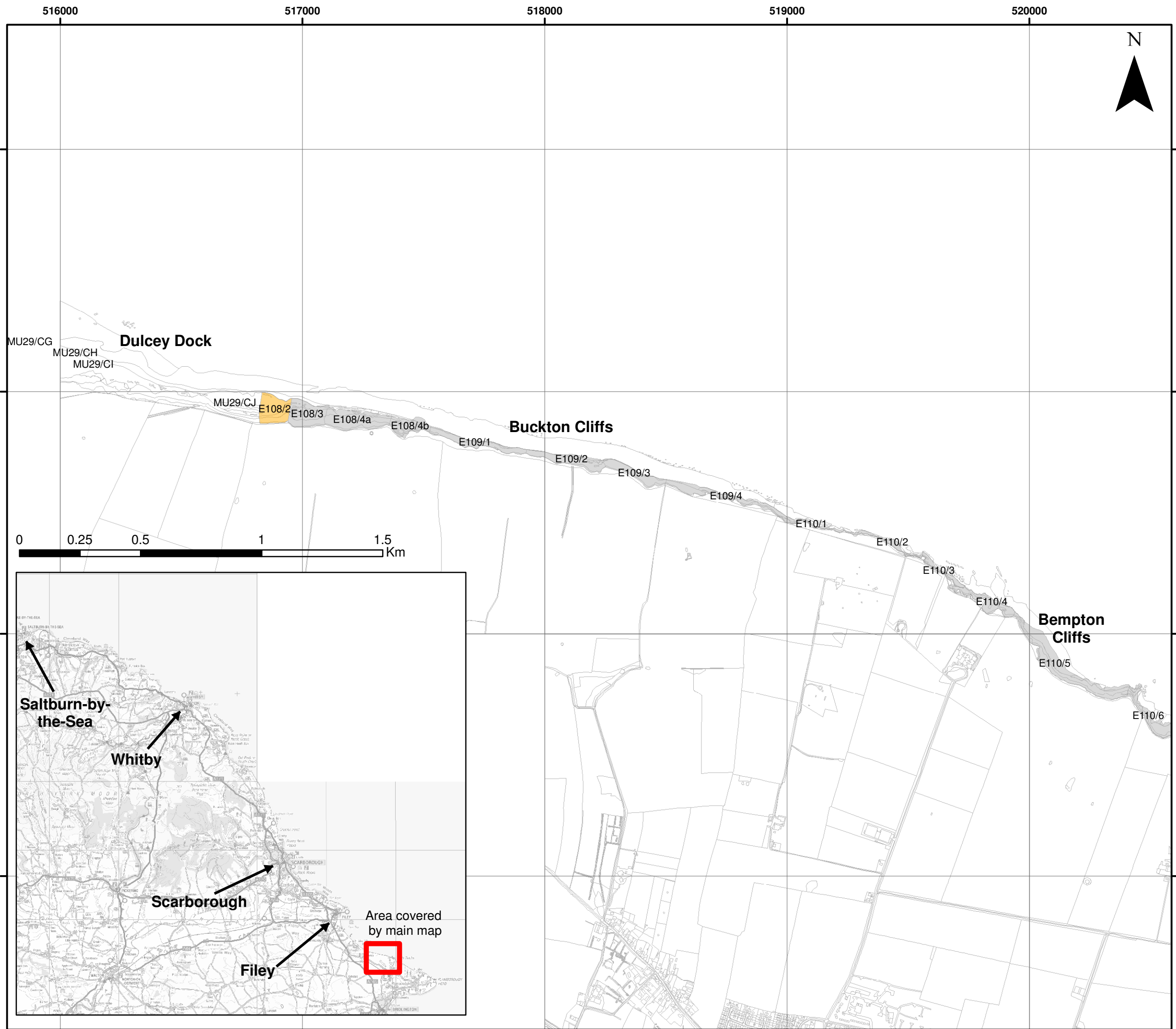
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Appendix B

Coastal Slope Condition Change Analysis

Maps 4 – 6



- Legend**
- Cliff Activity Status 2010**
- Major increase in activity
 - Minor increase in activity
 - No change
 - Minor decrease in activity
 - Major decrease in activity



Client: Cell One (East Riding of Yorkshire Council)

Project: Cell One Coastal Slope Condition Analysis 2010

Map 4 - Dulcey Dock to Bempton Cliffs

Coastal Slope Condition Change Analysis 2008 to 2010

Drawing Scale 1:15,000 at A3

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Approved by: PRF	Date: Nov 2010



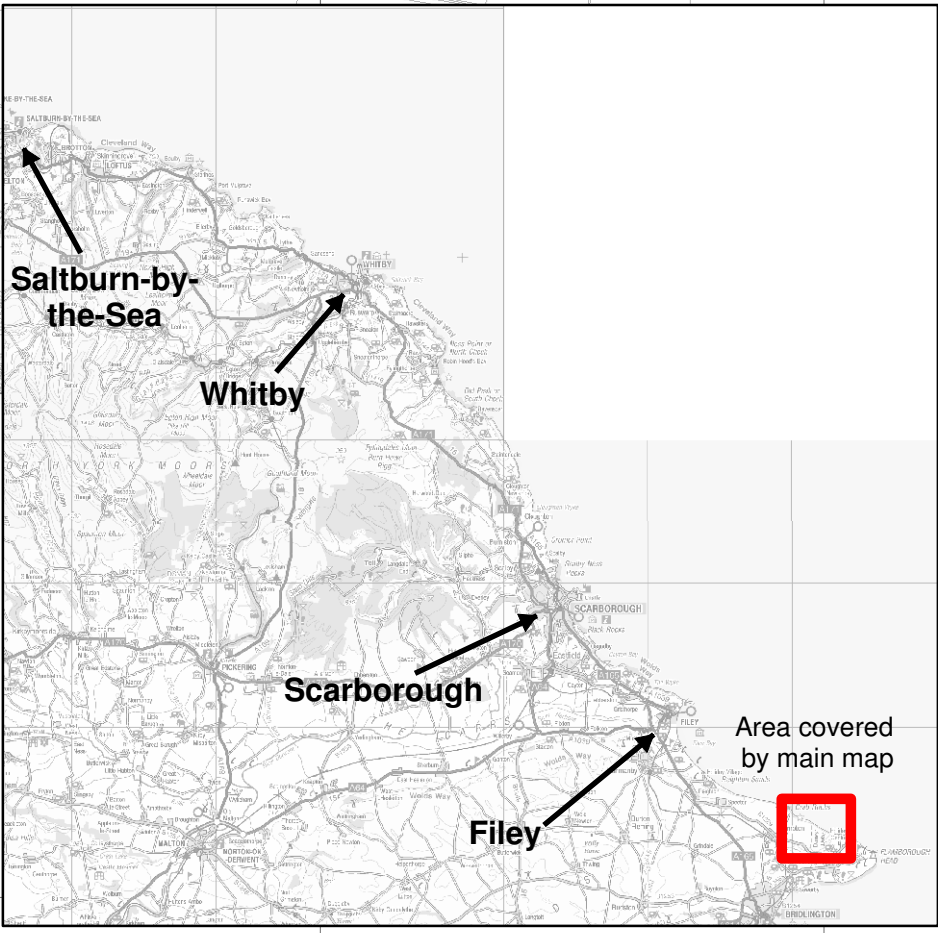
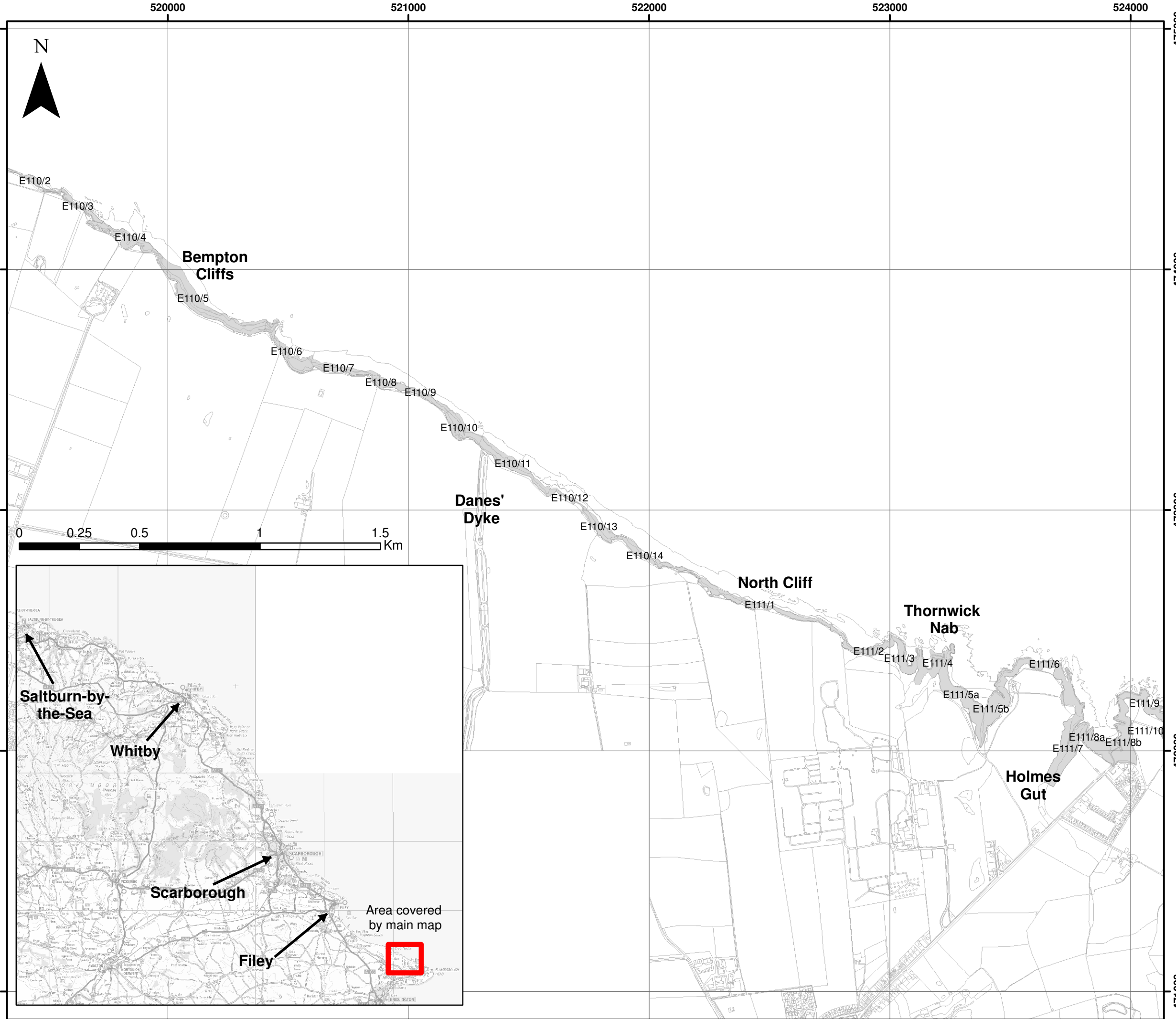
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Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE



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

Tel: +44 (0)191 211 1300	Tel: +44 (0)121 456 2345
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Legend

Cliff Activity Status 2010

- Major increase in activity
- Minor increase in activity
- No change
- Minor decrease in activity
- Major decrease in activity

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Map 5 - Bempton Cliffs to Holmes Gut

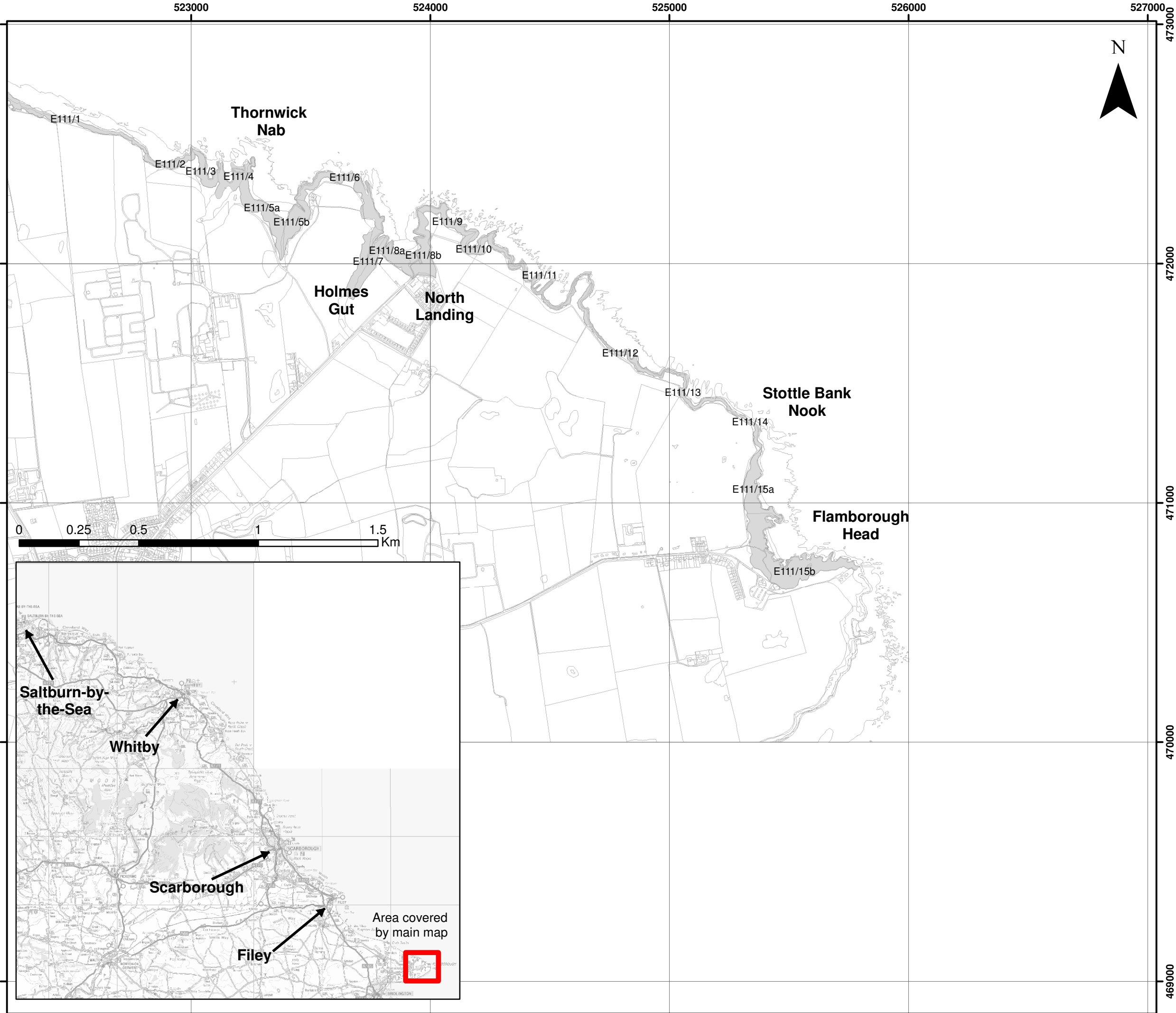
Coastal Slope Condition Change Analysis 2008 to 2010

Drawing Scale 1:15,000 at A3

Drawn by: AW	Date: Nov 2010
Checked by: RJ	Date: Nov 2010
Approved by: PRF	Date: Nov 2010

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Legend

Cliff Activity Status 2010

- Major increase in activity
- Minor increase in activity
- No change
- Minor decrease in activity
- Major decrease in activity

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Project: Cell One Coastal Slope Condition Analysis 2010

Map 6 - Holmes Gut to Flamborough Head

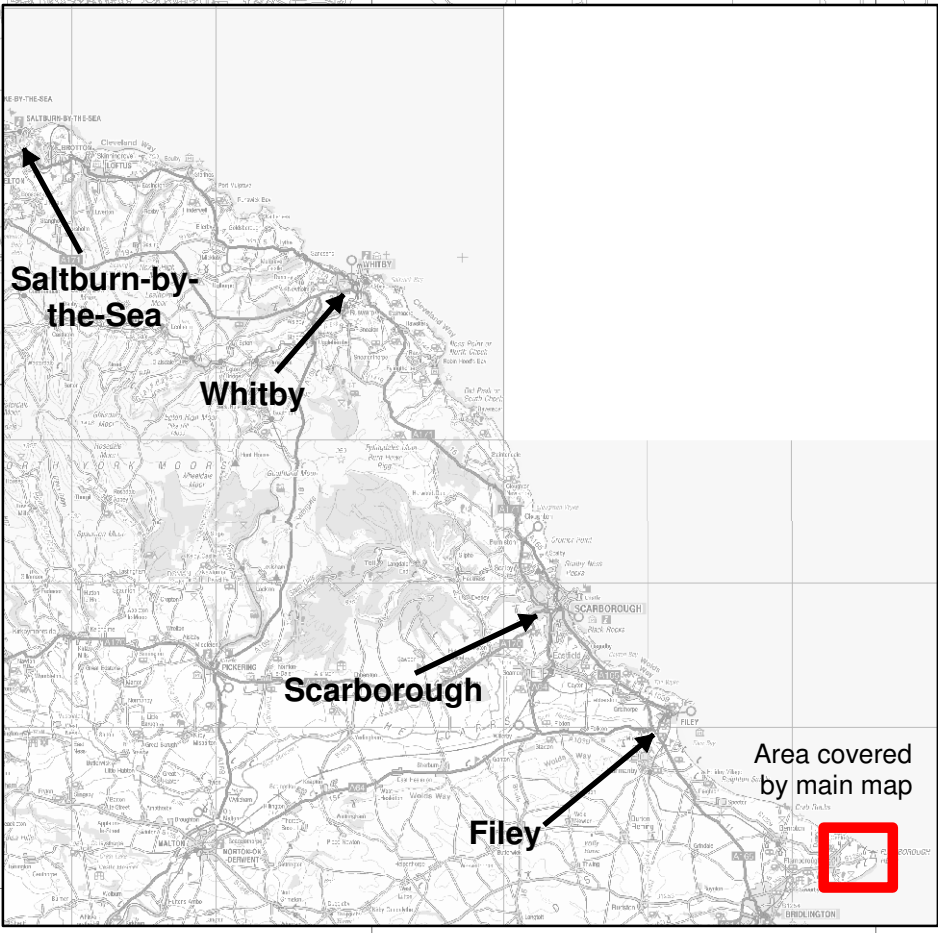
Coastal Slope Condition Change Analysis 2008 to 2010

Drawing Scale 1:15,000 at A3

Drawn by: AW	Date: Nov 2010
Checked by: RJ	Date: Nov 2010
Approved by: PRF	Date: Nov 2010

 ROYAL HASKONING Royal Haskoning Marlborough House Marlborough Crescent Newcastle upon Tyne NE1 4EE	 Halcrow Halcrow Group Ltd Lyndon House 62 Hagley Road Edgbaston Birmingham B16 8PE Tel: +44 (0)191 211 1300 Fax: +44 (0)191 211 1313 www.royalhaskoning.com
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Appendix C

Coast Protection Asset Condition

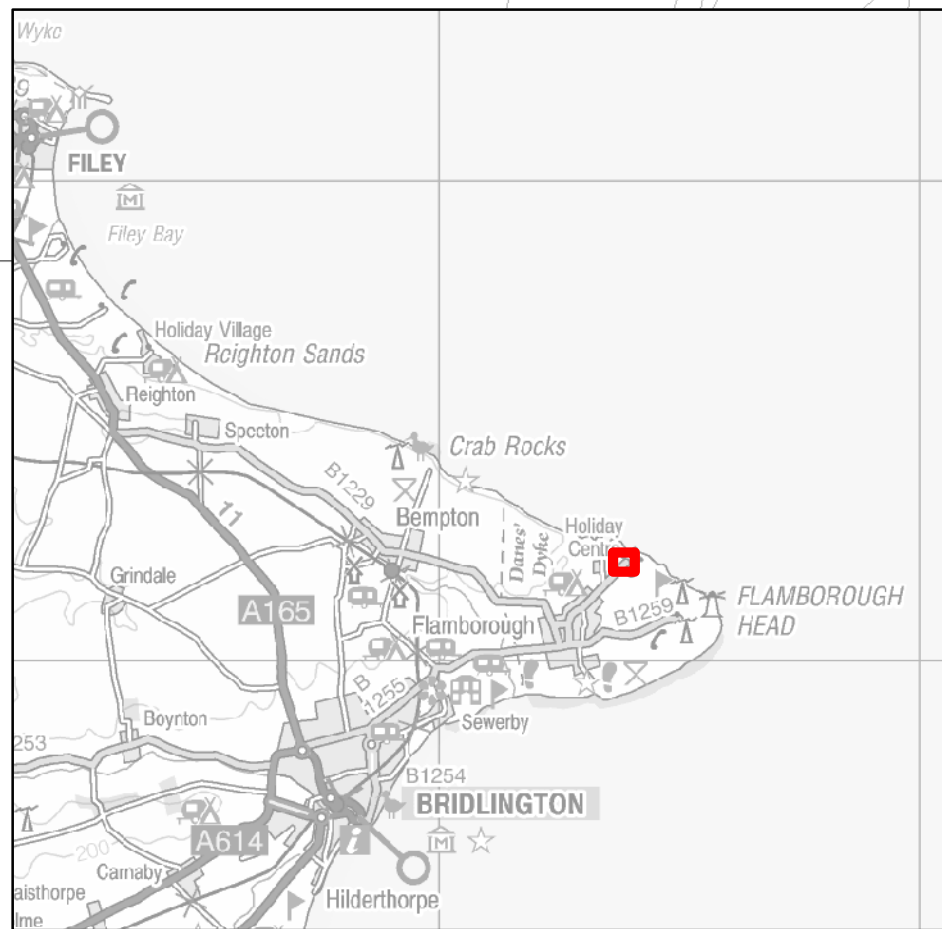
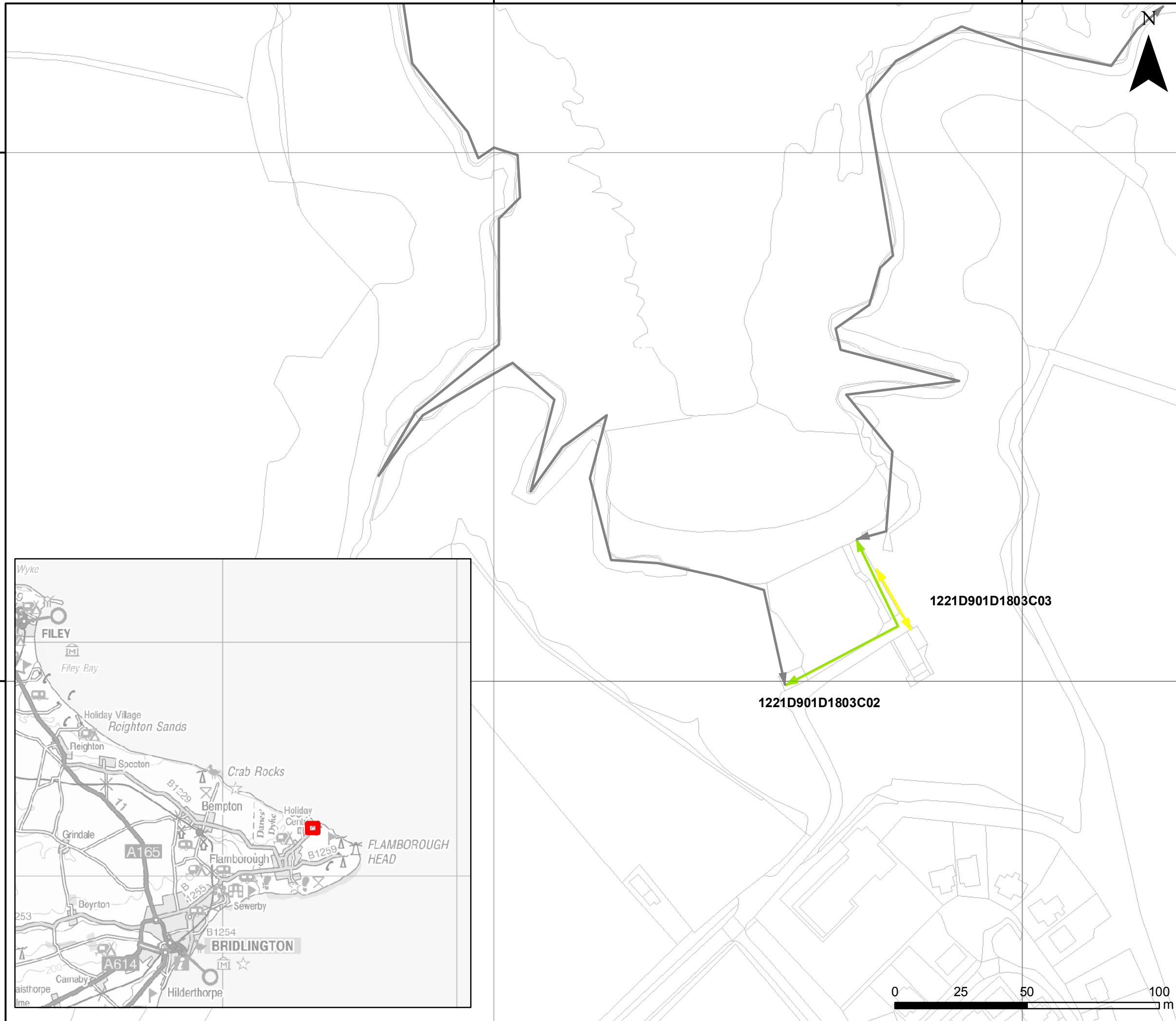
Maps 7

523800

524000

472200

472000



Legend

Overall Condition

- ← Not inspected
- ↔ Condition Grade 1 - Very Good
- ↔ Condition Grade 2 - Good
- ↔ Condition Grade 3 - Fair
- ↔ Condition Grade 4 - Poor
- ↔ Condition Grade 5 - Very Poor



Client: North East Coastal Authorities Group

Project: Cell One Coastal Monitoring 2010

Map 7 - Flamborough

Coast Protection Asset Condition 2010

Drawing Scale 1:15,000 at A3

Drawn by: RA	Date: Oct 2010
Checked by: NP	Date: Nov 2010
Approved by: NP	Date: Nov 2010



Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

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

Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoning.com

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

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Appendix D

Coast Protection Asset Condition Change Analysis

Map 8

523800

524000



472200

472000

Legend

Defence_ERY_2010_polyline Chge_08_10

- Major improvement
- Minor improvement
- No change
- Minor deterioration
- Major deterioration



Client: North East Coastal Authorities Group

Project: Cell One Coastal Monitoring 2010

Map 8 - Flamborough

Coastal Slope Condition
Change Analysis 2008 to 2010

Drawing Scale 1:15,000 at A3

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Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

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

Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoning.com

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

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