

Scarborough Borough Council

Cayton Bay Coastal Strategy Study

Strategy Report (Final)

Technical Annexes

October 2002



Halcrow Group Limited

Halcrow

Scarborough Borough Council
Cayton Bay Coastal Defence Strategy Study
Strategy Report (Final)
Technical Annexes
October 2002

Halcrow Group Limited

Halcrow Group Limited
Burderop Park Swindon Wiltshire SN4 0QD
Tel +44 (0)1793 812479 Fax +44 (0)1793 812089
www.halcrow.com

Halcrow Group Limited has prepared this report in accordance with the instructions of their client, Scarborough Borough Council, for their sole and specific use. Any other persons who use any information contained herein do so at their own risk.

© Halcrow Group Limited 2002

Scarborough Borough Council
Cayton Bay Coastal Defence Strategy Study
Technical Annexes
Strategy Report (Final)

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
1	0	Draft (in 3 volumes)	June 2001	
2	0	Revised draft for consultation	Sept 2001	
3	0	Final	Oct 2002	

Contents

- A Bathymetric & Topographic Survey**
- B Summaries of Models Used**
- C Historic Cliff Recession Data**
- D Cliff Recession Database & Mapping**
- E Strategic Environmental Appraisal**
- F Economic Assessment**

Annex A
Bathymetric & Topographic Survey

To: Alison Atkinson, Halcrow Maritime, Swindon
From: Dominic Latham, Senior Surveyor, Halcrow Survey
Date: 29th November 2000
M Ref: HS2260
Y Ref: VVFBSS 11/25

REPORT OF SURVEY

Filey Bay Coastal Defence Strategy Study Topographic & Bathymetric Surveys Flamborough Head to Cayton Bay

1.0 Further to your commission dated 7th November 2000, enclosed are copies of the survey.

1.1 The survey covers the following areas:-

Flamborough Head to Cayton Bay including Filey Bay

1.2 The survey comprises data obtained by land and bathymetric survey methods.

1.3 The survey was undertaken in accordance with a scope of work requested by Halcrow Maritime.

2.0 CONTROL

2.1 Horizontal and vertical control was based on the National GPS Network.

National GPS Network - Information

The National GPS Network has been developed and implemented by the Ordnance Survey to provide precise and consistent positioning across the UK to centimetre accuracy and to promote good practice in the use of GPS allied to national mapping.

The network includes both 'passive' and 'active' layers, which ensure that GPS co-ordinates are consistent with European Terrestrial Reference System 1989 (ETRS89) a precise realisation of World Geodetic System 1984 (WGS84) Latitude and Longitude.

The ETRS89 co-ordinate reference system is used as a standard for precise GPS surveying throughout Europe. Using ETRS89 the effects of continental motion can be ignored – with respect to WGS84 Great Britain, in common with the rest of Europe, is moving at a rate of about 2.5 centimetres per year.

The Ordnance Survey has calculated two precise transformations to allow surveyors to convert ETRS89 positions to OSGB36 'National Grid'

Ordnance Survey Transformation 1997 (OSTN97) is the current version of the National Grid transformation. The current OS triangulation pillar network is being replaced by the National GPS Network. OSTN97 accurately converts any ETRS89 position into the equivalent National Grid co-ordinate and vice versa. This new realisation is designed to match the original to an accuracy better than 0.2m better than the most accurate OS mapping.

Ordnance Survey Geoid Model 1991 (OSGM91) is the current version of the National Geoid Model. Ordnance Datum Newlyn (ODN) is the vertical datum adopted for our national mapping 'height above mean sea level' and is realised by 75000 levelled bench marks. OSGM91 is a superior realisation, which consists of a single grid of height shift parameters representing the difference between ODN and ETRS89 ellipsoidal heights.

OSGM91 offers considerable benefit to surveyors who are concerned with accurate height differences across project areas. Unlike OS benchmarks, which are prone to damage, neglect settlement and are no longer maintained by Ordnance Survey, OSGM91 provides a consistent transformation from ETRS89 to ODN without the need to check between numerous benchmarks for agreement.

The agreement with benchmarks is better than 10cm (95% confidence) which is as good as the estimated accuracy of benchmark heights relative to Newlyn. *Source: Ordnance Survey "Improving access to the National Co-ordinate System 1999".*

OS benchmarks are no longer maintained and to provide positional consistency across the project area the National GPS Network with OSTN97 and OSTN91 was adopted for this project. Over the project area this will provide a greater consistency than conventional levelling.

Typical GPS system accuracy's for the equipment deployed on this project are given as 3mm +/- 0.5ppm. However we would advise that the achievable accuracy, relative to the control network, will be in the order of +/- 15(mm) in plan and +/- 20(mm) in height for stable ground surfaces and +/- 1.0(m) in plan and +/- 0.1m in depth for soundings.

ETRS89 was adopted as the co-ordinate reference system (datum) for the Filey Bay Coastal Defences Strategy Study and the National GPS Network was utilised with OSTN97 and OSGM91 to transform positions to OSGB36 and Ordnance Datum Newlyn (ODN).

2.2 Horizontal & Vertical Control – Methodology & Results – Beach Survey

A network of ten primary control stations was utilised throughout the project area. These included four stations established by Scarborough Borough Council (Department of Technical Services), and one Ordnance Survey “passive” station (Buckton Cliffs triangulation pillar T1TA1774).

Station CU29 was observed over a period of three days and was chosen as the reference station for the project (since it was located at the approximate centre of the survey area). Precise ETRS89 co-ordinates for this station were derived using data from the “active” Ordnance Survey GPS stations at Newcastle, Leeds and Flamborough covering the observation periods. This gave the following positional quality for CU29:

Position Quality	= 0.0034m
Height Quality	= 0.00125m
Position & Height (3D) Quality	= 0.0130m

A further nine primary control stations were observed over the same period (utilising shorter observation times – typically one hour) and the precise ETRS89 of these were computed from station CU29. Results were as follows:

Primary Control Network – ETRS89 Co-ordinates

<u>Station</u>	<u>Latitude ϕ</u>	<u>Longitude λ</u>	<u>Ellip. Hgt</u>	<u>3D Quality</u>
BUCKTONT	54 9 22.286939 N	0 12 29.467868 W	181.0659	0.0012
CU24	54 14 40.736290 N	0 21 50.478035 W	63.2829	0.0011
CU28	54 12 13.002111 N	0 17 5.246455 W	53.7566	0.0015
CU29	54 10 40.695857 N	0 16 14.308602 W	80.8144	0.0130
CU30	54 10 10.643235 N	0 15 21.487356 W	89.4619	0.0019
FLAMBH	54 6 58.854189 N	0 4 53.153928 W	87.0916	0.0014
FLBS	54 12 38.738585 N	0 17 0.216209 W	52.4669	0.0018
NORTHLNG	54 7 43.692387 N	0 6 21.366283 W	81.6048	0.0016
REIGHTON	54 10 14.047680 N	0 15 15.836311 W	68.5412	0.0021
RSPB	54 8 49.453702 N	0 10 3.419041 W	139.2473	0.0013

The primary control (in ETRS89) was then transformed (by OSTN97 and OSGM91) to give local co-ordinates in OSGB36 and Ordnance Datum Newlyn (ODN). This was then used to calculate a local transformation so that RTK detail could be collected for the beach profiles and cliff top survey. Results in OSGB36 were as follows:

Primary Control Network – OSGB36 Co-ordinates

<u>Station</u>	<u>Easting</u>	<u>Northing</u>	<u>Ortho. Hgt</u>	<u>3D Quality</u>
BUCKTONT	517108.7216	474855.6720	135.1900	0.0012
CU24	506705.3231	484450.3731	16.9694	0.0011
CU28	511978.6813	480007.3112	7.6609	0.0015
CU29	512971.3213	477177.2302	34.7687	0.0130
CU30	513951.7974	476272.0310	43.4575	0.0019

FLAMBH	525505.4085	470640.4435	41.5520	0.0014
FLBS	512050.4981	480804.8697	6.3707	0.0018
NORTHLNG	523866.8247	471982.8850	35.9966	0.0016
REIGHTON	514051.6661	476379.7674	22.5396	0.0021
RSPB	519784.0119	473908.9209	93.4764	0.0013

Location diagrams for all new survey stations are included in appendix I.

2.3 Comparison - New & Existing Control (New value – Existing Value)

The following results were obtained which compares the results obtained above (using values calculated from the ETRS89 reference datum) and existing control where re-occupation was undertaken (results in OSGB36):

<u>Station</u>	<u>Diff. Easting</u>	<u>Diff. Northing</u>	<u>Diff Ortho.Hgt</u>	<u>Source</u>
BUCKTONT	+ 0.005m	- 0.010m	- 0.042m	OS PASSIVE
CU29	+ 0.022m	- 0.131m	+ 1.218m	S.B.C
CU28	+ 0.042m	- 0.080m	+ 0.513m	S.B.C
CU30	+ 0.013m	- 0.147	+0.489m	S.B.C
CU27	<UNABLE TO OCCUPY DUE TO ENGINEERING WORKS>			
CU24	<S.B.C CO-ORDINATES NOT SUPPLIED>			

Whilst a favourable comparison was obtained to the OS passive station (Buckton Cliffs – T1TA1774) the results were less sympathetic with the S.B.C control. Halcrow Survey would be happy to discuss these findings should the need arise.

Computations for CU29 from the “active” stations is included in appendix II. Computations for the primary control is included in appendix III.

2.4 Independent Checks

A number of independent data checks were undertaken during the site work to verify the integrity of the GPS transformation to local (OSGB36) co-ordinates – this was especially true where height (to ODN) was concerned. The following results were obtained:

2.4.1 Level check OSBM TA 1201 8084 (W.C Building – Church Ravine, Filey) to stn FLBS

Spirit Height stn FLBS	= 6.351m (loop closure +0.001m)
GPS Height stn FLBS	= 6.371m
Difference	= -0.020m

2.4.2 RTK level check to stn BucktonT (O.S passive stn T1TA1774)

Height from RTK	= 135.168m
Height from Halcrow control	= 135.190m
Difference	= +0.022m

Height published by O.S = 135.232m
Difference (RTK) = +0.064m

2.4.2 RTK position check to stn BucktonT (O.S passive stn T1TA1774)

Easting diff. to Halcrow control = +0.004m
Northing diff. to Halcrow control = -0.002m

Easting diff. to O.S published value = +0.009m
Northing diff. to O.S published value = -0.012m

2.4.3 Level check – test points at stn CU28

Test1 height from RTK = 7.563m
Test2 height from RTK = 7.606m
Difference = 0.043m

Difference by spirit levelling = 0.053m

Checks to 0.010m

2.4.4 Level check – test point at stn Northlng

Height diff. Northlng to *Test4* by RTK = 0.881m

Height diff. Northlng to *Test4* by spirit levelling = 0.876m

Checks to 0.005m

The above verified that no gross errors were occurring during the data collection on site.

2.5 Design Co-ordinates – Survey Lines

Prior to commencing the fieldwork the location of the required survey lines were received from the client. The design co-ordinates were extracted from the drawing supplied and a schedule of setting out data was tabulated. The design co-ordinates for each survey line were uploaded into the field equipment for both the land and bathymetric surveys. The design co-ordinates are included in appendix IV.

2.5 Project Control – Bathymetry

Navigation was obtained using a Differential GPS system using the broadcast Trinity Lighthouse corrections. This was linked to a PC aboard the survey vessel. All data was logged in real-time to provide a both a depth and position for any one moment. Tide gauges were used at Scarborough Harbour and Bridlington Harbour. Tidal corrections were used to adjust the soundings to ODN through the establishment of control points at Scarborough Harbour and

Bridlington Harbour. The height of these control points was determined by converting their precise ETRS89 co-ordinates by the OSTN97 and OSGM91 transformations to OSGB36 and ODN. Details of these are included in appendix V.

3.0 METHOD OF SURVEY

3.1 Data Collection – Bathymetry

Sounding data was collected using a single frequency echo sounder linked to an on-board PC with data logging capabilities. All soundings were directly logged to the hydrographic software package. All survey information was processed using the dedicated hydrographic software package, and an output of XYZ co-ordinates was produced to link the data to the land survey element of the project.

The echo sounder was calibrated using the bar-check method prior to survey. This checks the accuracy of the echo sounder at known intervals throughout the water column.

3.2 Data Collection – Beach Survey

The position and extent of the required sections was input and overlaid onto the largest scale OS digital mapping and uploaded into the GPS field controllers (data loggers). The section lines were set out and data was recorded at the correct location in the field. Topographic information was coded directly in the field in order to provide output directly into dedicated land survey processing software. Cross sections were generated from the survey data at the required scales as defined in the contract specification. Typical accuracy attained in the field was less than 0.1m onto the design position of the survey lines.

3.3 Data Collection – Cliff Tops

A point was taken as near to the cliff edge as was safe to do so and the required sections were extended to include 10 - 15m back from the top of the cliff face and a permanent marker was installed and co-ordinated for future monitoring reference. Detail was also taken at breaks of slope where significant changes in the cliff profile occurred. A schedule of the PGM's established is included in appendix VI. These are also included on the layout drawings where background OS mapping is shown.

3.4 The equipment used to undertake the survey is as follows:

- Leica System 500 Dual Frequency GPS
- Wild NA24 automatic level
- Atlas Deso 14 Echo Sounder
- Trimble Ag132 Differential GPS
- Norcom Hydrographic Survey Software
- Landscape Land Survey Software

4.0 PRESENTATION

4.1 The survey is presented as follows:-

- (i) Topographical / Bathymetric survey lines (1:2500 scale) on 11 no. A0 paper sheets.
- (ii) Cross sections (1:500 natural scale) provided in digital format only (11 no. dwg files) plus 1 no. A0 paper proof plot.

4.2 Digital data is supplied as follows:-

- (i) AutoCAD r14 .DWG files.
- (ii) ASCII format XYZ file.

4.3 Appendices to this report: -

- I. Station witness diagrams – primary control.
- II. Computation data – active stations.
- III. Computation data- primary control.
- IV. Design co-ordinate schedule – survey lines
- V. Tide gauge control computations and control point witness diagrams
- VI. Schedule of cliff top permanent ground markers established.

5.0 LAND OWNERSHIP / LANDUSE DETAILS

5.1 Land ownership details were not required for this contract.

6.0 COMMENTS

6.1 It is understood that the survey is required to facilitate the study of a coastal defence strategy for the area.

7.0 PROBLEMS ENCOUNTERED

7.1 The bathymetric survey had to be cancelled on 22/11/00 due to adverse weather conditions.

7.2 It was not possible to survey the bathymetric section no.01 at Flamborough Head on 23/11/00 due to rough seas. The client has since indicated that this bathymetric section is no longer required due to existing survey data.

7.3 It was not possible to establish cliff top PGM's on cross section nos. 48 and 49 (Cayton Bay) due to dense woodland.

7.4 It was not possible to survey detail at the bottom of the cliffs on cross section nos. 07 and 06 due to general inaccessibility and safety considerations.

7.5 It was not possible to obtain an overlap of data between the land and bathymetric surveys for the following sections:

Section 36 – the depth of water on the beach was too shallow at high tide for the survey vessel (due to the surf) and too deep to wade at low tide by the land surveyor to provide an overlap.

Section 34 – the depth of water on the beach was too shallow at high tide for the survey vessel (due to the surf) and too deep to wade at low tide by the land surveyor to provide an overlap.

Section 32 – the depth of water on the beach was too shallow at high tide for the survey vessel (due to the surf) and too deep to wade at low tide by the land surveyor to provide an overlap.

Section 15 – the depth of water on the beach was too shallow at high tide for the survey vessel (due to the surf) and too deep to wade at low tide by the land surveyor to provide an overlap.

Section 10 – due to rocks at the cliff base.

Section 03 – due to a rock shelf extending out to sea and also because the design location of the section line passed through solid cliffs in the bay.

Signed..........

Dominic Latham.
Senior Surveyor.

Signed..........

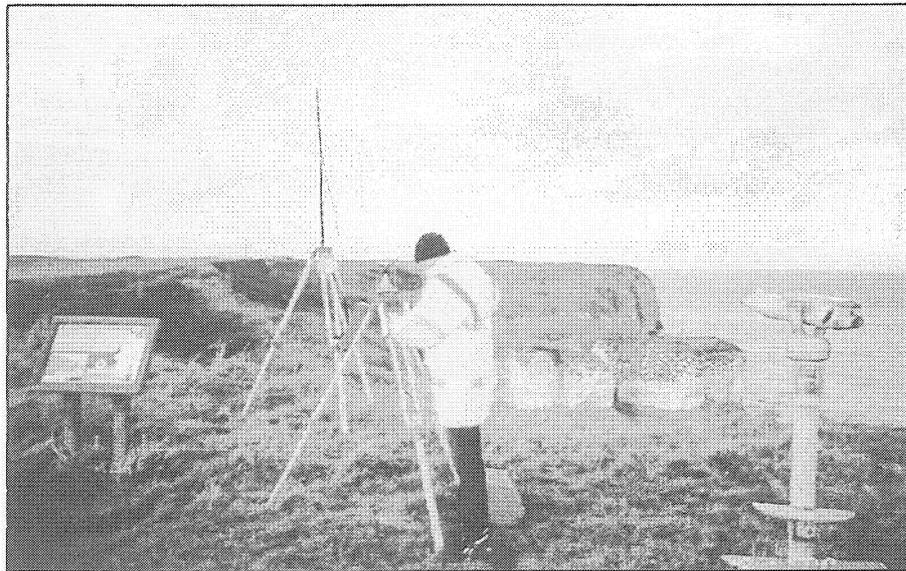
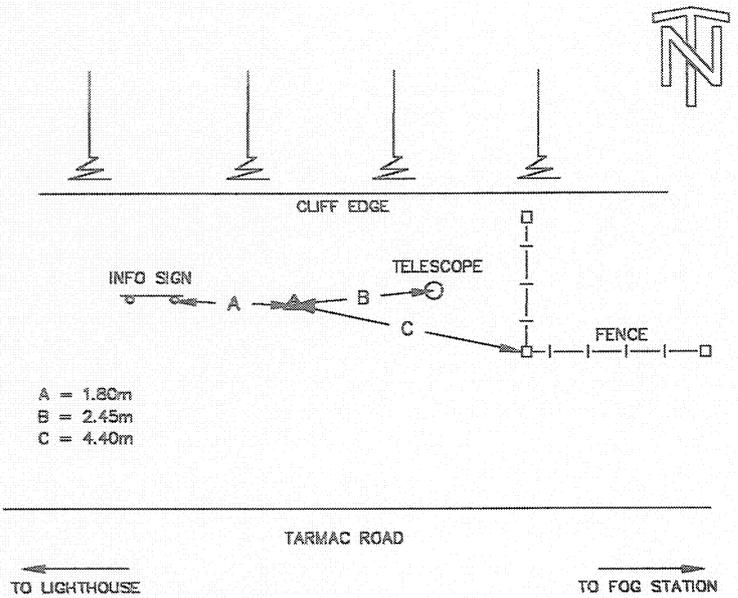
Steve Waggott.
Hydrographic Surveyor.

APPENDIX I

HORIZONS

STN. FLAMBH

WITNESS DIAGRAM



DESCRIPTION: PGM ON NORTH SIDE OF ACCESS ROAD TO FOG STATION.

EAST SIDE OF FLAMBOROUGH LIGHTHOUSE

STATION CO-ORDINATES: 525505.409 E

SURVEYED BY: HALCROW SURVEY

DATE: 08/11/00

JOB NO: HS 2260

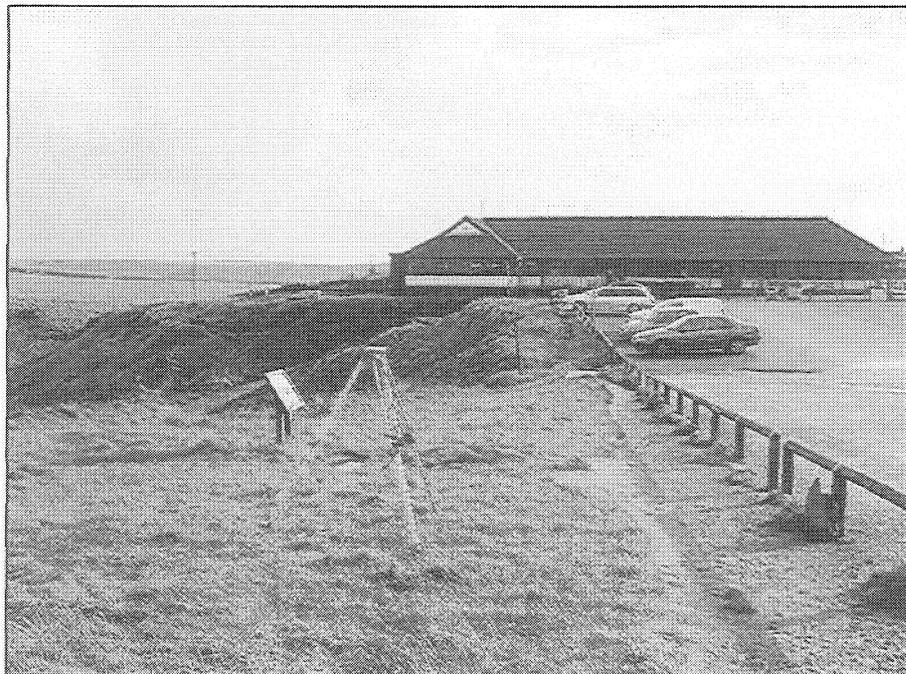
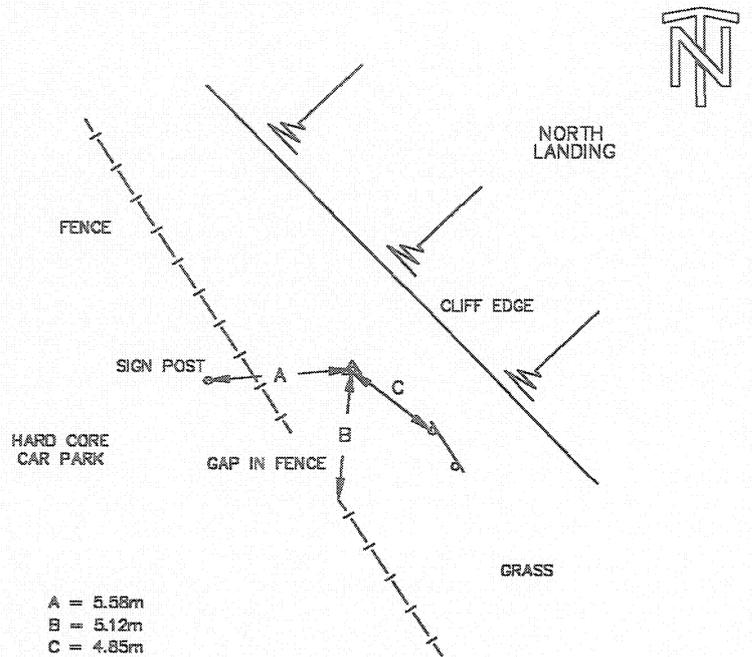
470640.444 N

HEIGHT: 41.552 metres O.D.N

HORIZONS

STN. NORTH LING

WITNESS DIAGRAM



DESCRIPTION: PGM AT EAST SIDE
OF CAR PARK, NORTH LANDING

SURVEYED BY: HALCROW SURVEY
DATE: 08/11/00
JOB NO: HS 2260

STATION CO-ORDINATES: 523866.825 E

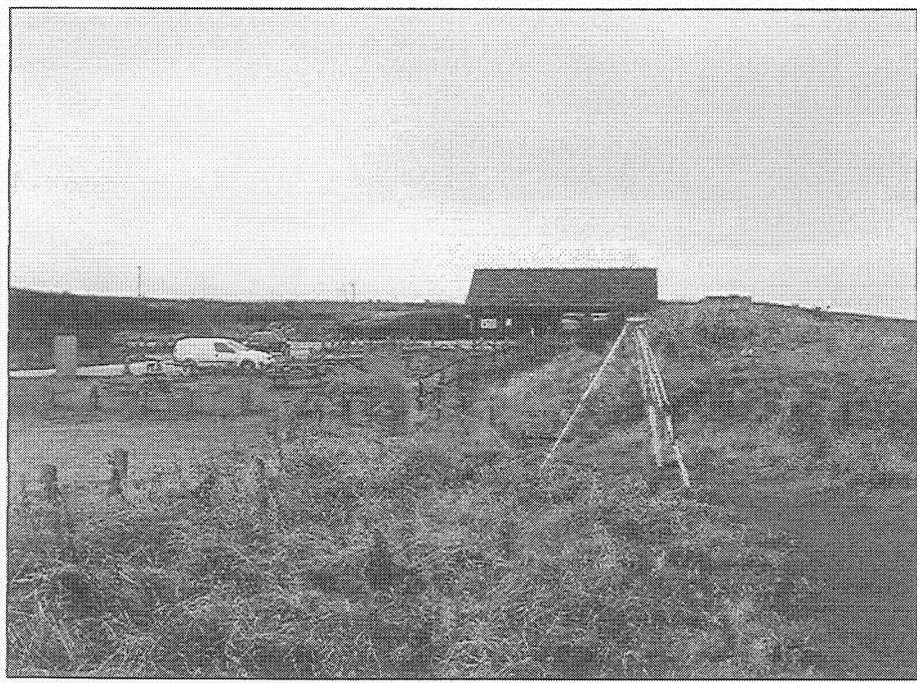
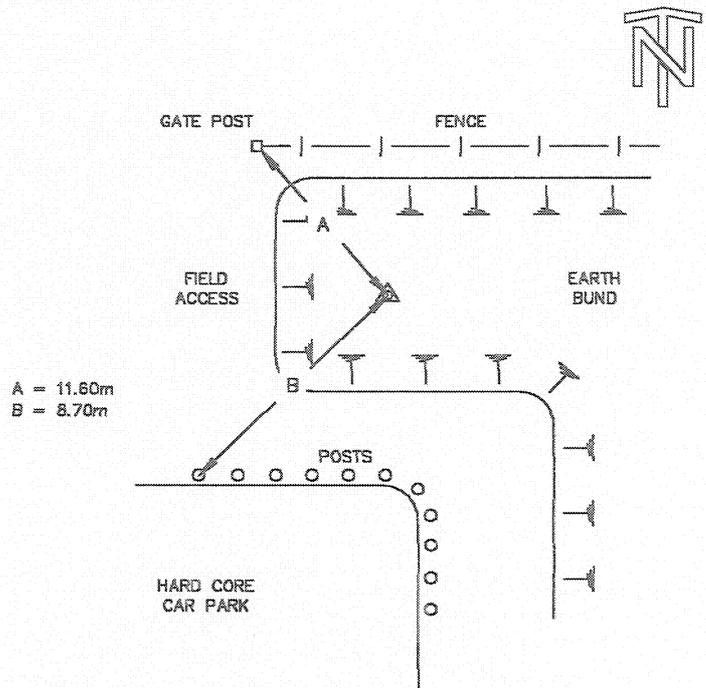
471982.885 N

HEIGHT: 35.997 metres O.D.N

HORIZONS

STN. RSPB

WITNESS DIAGRAM



DESCRIPTION: PGM IN TOP OF EARTH
BUND AT RSPB CENTRE, BEMPTON.
EAST SIDE OF CAR PARK.

SURVEYED BY: HALCROW SURVEY
DATE: 08/11/00
JOB NO: HS 2260

STATION CO-ORDINATES: 519784.012 E

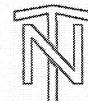
473908.921 N

HEIGHT: 93.476 metres O.D.N

HORIZONS

STN. BUCKTONT

WITNESS DIAGRAM



DUDLEY DOCK

CLIFF TOP

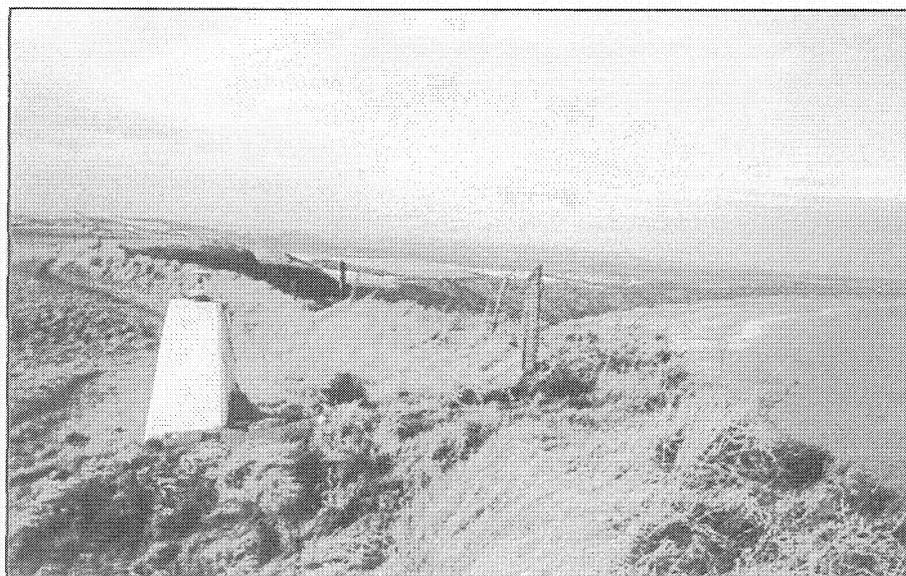


PASTURE

TO BUCKTON HALL

ARABLE

ARABLE



DESCRIPTION: OS TRIG' PILLAR T1TA1774
BUCKTON CLIFFS, SOUTH SIDE FILEY BAY.

SURVEYED BY: HALCROW SURVEY

DATE: 08/11/00

JOB NO: HS 2260

STATION CO-ORDINATES: 517108.722 E

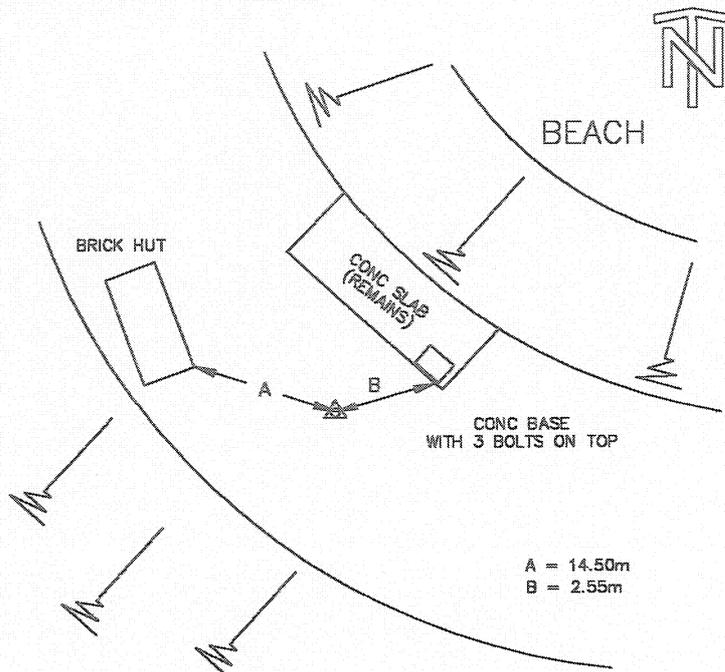
474855.672 N

HEIGHT: 135.19 metres O.D.N

HORIZONS

STN. REIGHTON

WITNESS DIAGRAM



DESCRIPTION: PGM AT BOAT CLIFF
NW SIDE OF FOOTPATH FROM
REIGHTON GAP HOLIDAY VILLAGE
STATION CO-ORDINATES: 514051.666 E

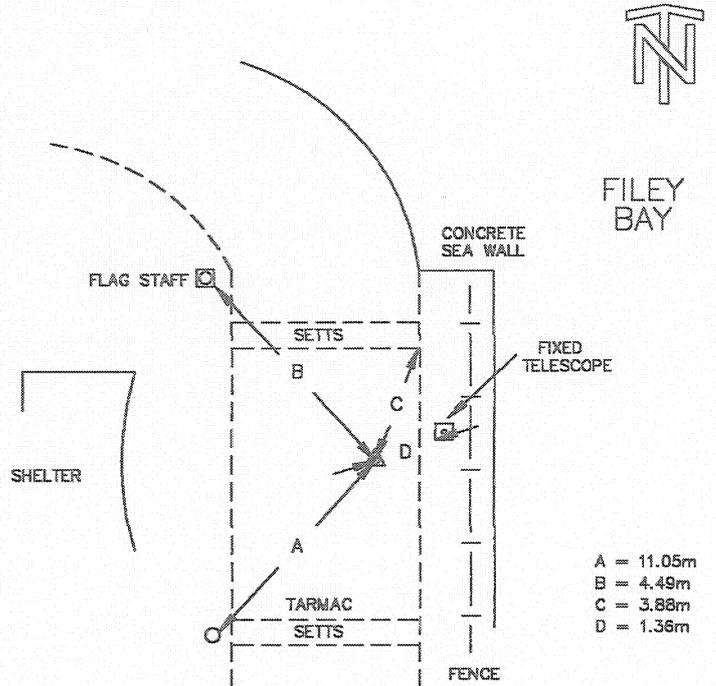
SURVEYED BY: HALCROW SURVEY
DATE: 08/11/00
JOB NO: HS 2260

476379.767 N HEIGHT: 22.540 metres O.D.N

HORIZONS

STN.FLBS

WITNESS DIAGRAM

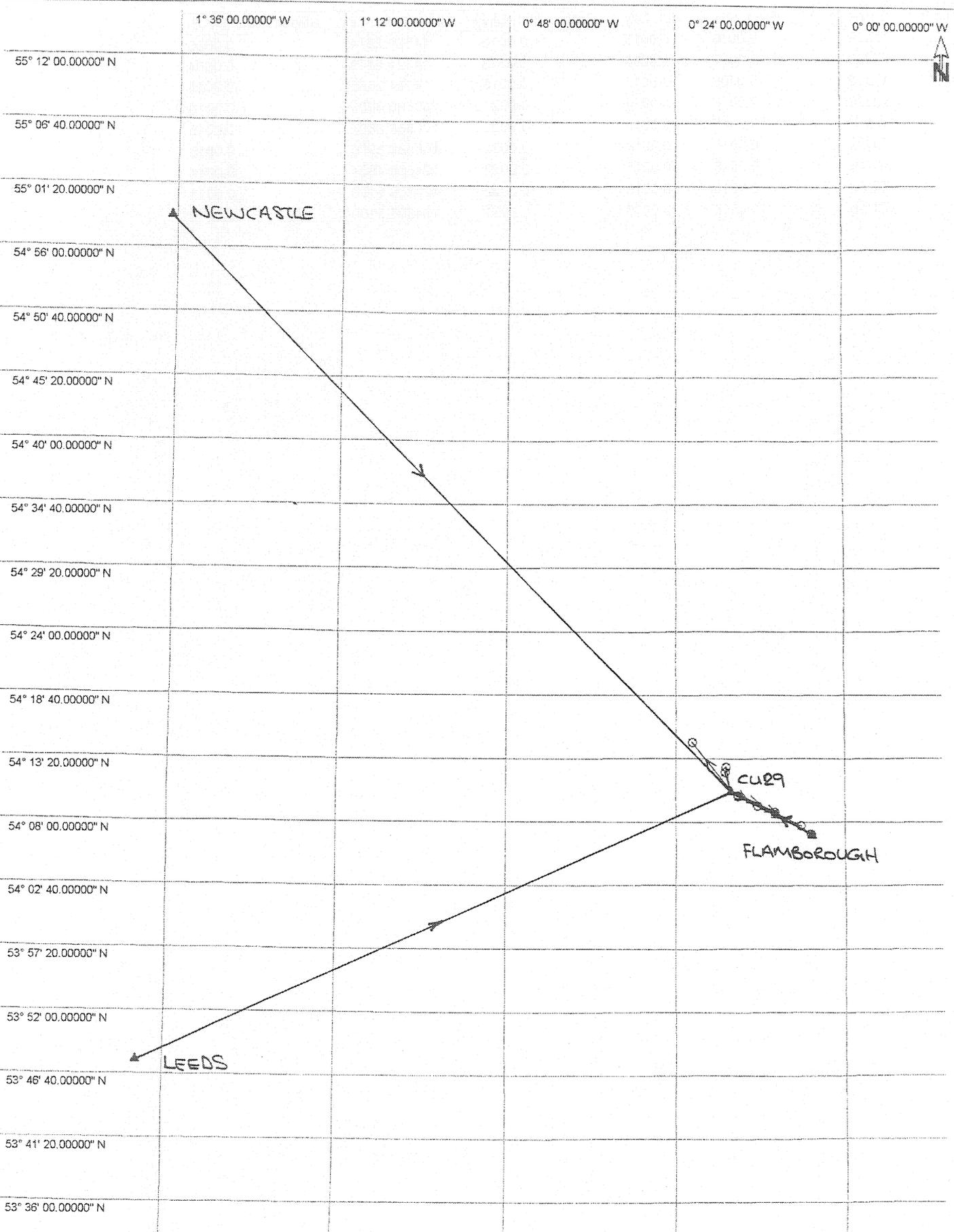


DESCRIPTION: PK NAIL & WASHER IN
 TARMAC AT EDGE OF SEA WALL.
 SOUTH OF SLIPWAY, FILEY LIFEBOAT STN.
 STATION CO-ORDINATES: 512050.498 E

SURVEYED BY: HALCROW SURVEY
 DATE: 09/11/00
 JOB NO: HS 2260

480804.870 N HEIGHT: 6.371 metres O.D.N

APPENDIX II



50000.0 m

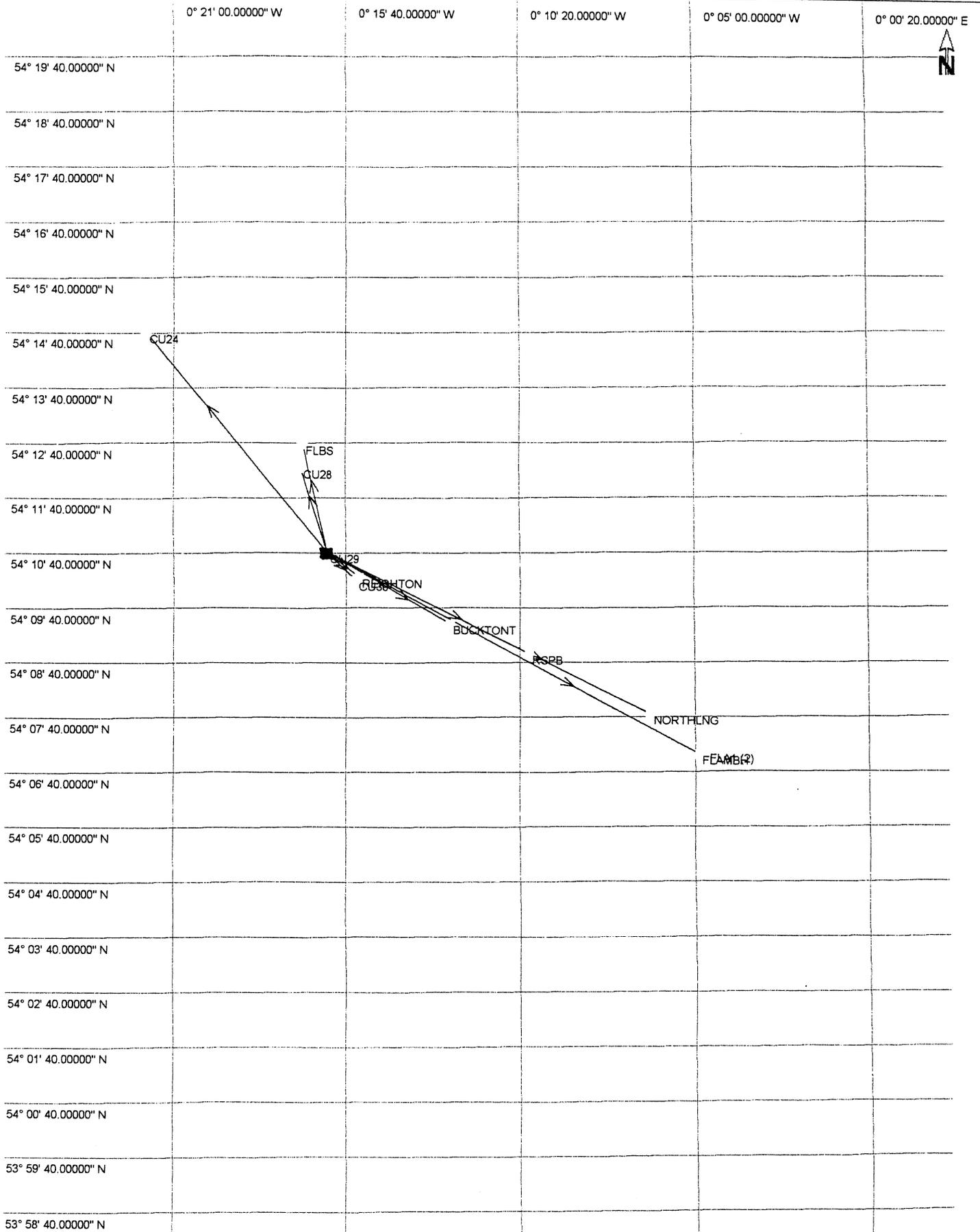
- Estimated
- Navigation
- GPP
- Measured
- Average
- Reference
- Adjusted
- Fixed Weighted
- Fixed Height
- Fixed Position
- Fixed Position and Height

Date: 12/01/2000 Time: 15:37:08

Reference Id	Rover Id	Posn. Qty	Hgt. Qty	Posn. + Hgt. Qty	Slope Distance	Slope Distance S.d.
FLA1	CU29	0.0009	0.0013	0.0015	14324.2974	0.0006
_A1	CU29	0.0007	0.0010	0.0012	14324.2869	0.0004
._A1	CU29	0.0008	0.0013	0.0015	14324.2886	0.0005
LEED	CU29	0.0016	0.0014	0.0021	100588.8900	0.0010
:ED	CU29	0.0015	0.0015	0.0021	100588.8867	0.0013
:ED	CU29	0.0015	0.0014	0.0021	100588.8906	0.0013
NEWC	CU29	0.0016	0.0015	0.0022	124606.4924	0.0014
NEWC	CU29	0.0016	0.0015	0.0022	124606.5193	0.0011
:EWC	CU29	0.0016	0.0015	0.0021	124606.5100	0.0010

Point Id	Latitude	Longitude	Height	Posn. Qty	Hgt. Qty	Posn. + Hgt. Qty
J29	54° 10' 40.69575" N	0° 16' 14.30895" W	80.7699	0.0009	0.0013	0.0015
J29	54° 10' 40.69560" N	0° 16' 14.30844" W	80.7832	0.0007	0.0010	0.0012
J29	54° 10' 40.69575" N	0° 16' 14.30840" W	80.7943	0.0008	0.0013	0.0015
J29	54° 10' 40.69626" N	0° 16' 14.30934" W	80.8050	0.0016	0.0014	0.0021
J29	54° 10' 40.69577" N	0° 16' 14.30917" W	80.8463	0.0015	0.0015	0.0021
J29	54° 10' 40.69596" N	0° 16' 14.30907" W	80.8111	0.0015	0.0014	0.0021
J29	54° 10' 40.69655" N	0° 16' 14.30866" W	80.8294	0.0016	0.0015	0.0022
J29	54° 10' 40.69584" N	0° 16' 14.30781" W	80.8669	0.0016	0.0015	0.0022
J29	54° 10' 40.69602" N	0° 16' 14.30825" W	80.8806	0.0016	0.0015	0.0021

APPENDIX III



Estimated
avigation
_PP
Measured
Average
Reference
_justed
_xed Weighted
Fixed Height
Fixed Position

Fixed Position and Height

Date: 11/30/2000 Time: 10:32:14

Reference Id	Rover Id	Posn. Qty	Hgt. Qty	Posn. + Hgt. Qty	Slope Distance	Slope Distance S.d.
CU29	CU28	0.0008	0.0013	0.0015	2999.9022	0.0006
A1	CU28	0.0013	0.0021	0.0025	16619.7447	0.0009
J29	FLBS	0.0010	0.0015	0.0018	3743.6201	0.0008
FLA1	FLBS	0.0024	0.0039	0.0046	17021.3596	0.0017
J29	CU24	0.0007	0.0009	0.0011	9602.2880	0.0005
A1	CU24	0.0052	0.0043	0.0068	23489.6084	0.0036
CU29	FLAMBH	0.0007	0.0012	0.0014	14139.1210	0.0004
FLA1	FLAMBH	0.0010	0.0017	0.0020	248.3689	0.0006
J29	NORTHLNG	0.0008	0.0014	0.0016	12072.8388	0.0004
A1	NORTHLNG	0.0017	0.0028	0.0033	2273.8634	0.0010
CU29	RSPB	0.0008	0.0011	0.0013	7557.9659	0.0006
A1	RSPB	0.0014	0.0020	0.0025	6770.6065	0.0011
J29	BUCKTONT	0.0006	0.0010	0.0012	4746.3561	0.0004
FLA1	BUCKTONT	0.0012	0.0019	0.0022	9585.8978	0.0007
J29	REIGHTON	0.0010	0.0018	0.0021	1343.1434	0.0007
A1	REIGHTON	0.0015	0.0028	0.0032	13001.7530	0.0009
CU29	CU30	0.0011	0.0016	0.0019	1334.7598	0.0009
FLA1	CU30	0.0020	0.0028	0.0034	13045.3209	0.0014

Point Id	Latitude	Longitude	Height	Posn. Qlty	Hgt. Qlty	Posn. + Hgt. Qlty
U28	54° 12' 13.00211" N	0° 17' 05.24645" W	53.7566	0.0008	0.0013	0.0015
RS	54° 12' 38.73859" N	0° 17' 00.21621" W	52.4669	0.0010	0.0015	0.0018
.24	54° 14' 40.73629" N	0° 21' 50.47804" W	63.2829	0.0007	0.0009	0.0011
AMBH	54° 06' 58.85419" N	0° 04' 53.15393" W	87.0916	0.0007	0.0012	0.0014
BRTHLNG	54° 07' 43.69239" N	0° 06' 21.36628" W	81.6048	0.0008	0.0014	0.0016
PB	54° 08' 49.45370" N	0° 10' 03.41904" W	139.2473	0.0008	0.0011	0.0013
CKTONT	54° 09' 22.28694" N	0° 12' 29.46787" W	181.0659	0.0006	0.0010	0.0012
UGHTON	54° 10' 14.04768" N	0° 15' 15.83631" W	68.5412	0.0010	0.0018	0.0021
JO	54° 10' 10.64324" N	0° 15' 21.48736" W	89.4619	0.0011	0.0016	0.0019
--						

Point Id	Easting	Northing	Height	Posn. Qty	Hgt. Qty	Posn. + Hgt. Qty
CU28	511978.6813	480007.3112	7.6609	0.0008	0.0013	0.0015
BS	512050.4981	480804.8697	6.3707	0.0010	0.0015	0.0018
J24	506705.3231	484450.3731	16.9694	0.0007	0.0009	0.0011
FLAMBH	525505.4085	470640.4435	41.5520	0.0007	0.0012	0.0014
NORTHLNG	523866.8247	471982.8850	35.9966	0.0008	0.0014	0.0016
SPB	519784.0119	473908.9209	93.4764	0.0008	0.0011	0.0013
JCKTONT	517108.7216	474855.6720	135.1900	0.0006	0.0010	0.0012
REIGHTON	514051.6661	476379.7674	22.5396	0.0010	0.0018	0.0021
J30	513951.7974	476272.0310	43.4575	0.0011	0.0016	0.0019

APPENDIX IV

Filey Bay Co-Ordinate Schedule

Section Number	Right Bank (Coastline)		Left Bank (To Sea)		Type
	Eastings	Northings	Eastings	Northings	
01	525490.64	470807.30	527421.22	471329.63	H/L
02	523865.64	472027.84	524053.81	472380.82	L
03	523859.18	472025.84	524564.88	473897.20	H/L
04	523845.69	472041.87	523957.68	472425.88	L
04A	521862.62	473029.01	522780.01	474806.20	H
05	520529.73	473717.05	521447.12	475494.24	H
06	518787.33	474538.64	519231.71	476488.65	H/L
07	518563.70	474598.81	518658.12	474987.50	L
08	517948.35	474752.71	518054.46	475138.38	L
09	517408.73	474882.95	517525.29	475265.59	L
10	516721.37	474989.52	517162.03	476940.37	H/L
11	516116.36	475159.68	516304.52	475512.66	L
12	515589.70	475397.85	515817.06	475726.94	L
13	515072.93	475685.27	515368.55	475954.73	L
14	514687.34	475970.48	514963.77	476259.60	L
15	514285.23	476284.91	515743.99	477653.13	H/L
16	514045.49	476501.87	514323.19	476789.75	L
17	513780.09	476710.71	515221.66	478097.03	H/L
18	513633.76	476809.65	513937.31	477070.14	L
19	513314.04	477144.80	513631.20	477388.54	L
20	513039.56	477398.21	514728.79	478468.97	H/L
21	512809.12	477675.80	513157.19	477872.90	L
22	512612.60	477936.00	514478.17	478685.58	H/L
23	512527.56	478108.72	512896.11	478264.18	L
24	512398.60	478380.87	512782.19	478494.26	L
25	512323.46	478579.34	514274.02	479021.29	H/L
26	512184.27	478900.64	512574.94	478986.52	L
27	512075.42	479258.65	514069.87	479407.64	H/L
28	512024.06	479501.70	512420.28	479556.53	L
29	511986.13	479910.05	513985.67	479953.16	H/L
31	512016.99	480268.50	512414.83	480227.03	L
32	512018.92	480512.83	514012.48	480352.44	H/L
33	512062.89	480656.00	512460.74	480614.54	L
34	512078.28	480782.72	514067.19	480572.40	H/L
35	512161.26	480975.84	512559.11	480934.38	L
36	512244.09	481147.71	514208.29	480771.01	H/L
37	512359.62	481374.54	512745.99	481271.00	L
38	513851.37	481343.13	515841.69	481146.62	H
39	511732.82	482164.23	512996.08	483714.77	H
40	510058.25	483011.87	511544.53	484350.14	H
41	507714.73	484017.41	507875.75	484383.57	L
42	507577.39	484058.97	508763.36	485669.39	H/L
43	507369.18	484146.22	507603.51	484470.40	L
44	507067.93	484308.27	507297.13	484636.10	L
45	506855.29	484403.84	508369.87	485710.00	H/L
46	506681.50	484523.60	507024.64	484727.43	L
47	506438.86	484802.73	506785.22	485002.81	L
48	506057.87	484885.84	507808.21	485853.46	H/L
49	506257.23	485168.38	506617.93	485341.27	L

APPENDIX V

Handwritten notes

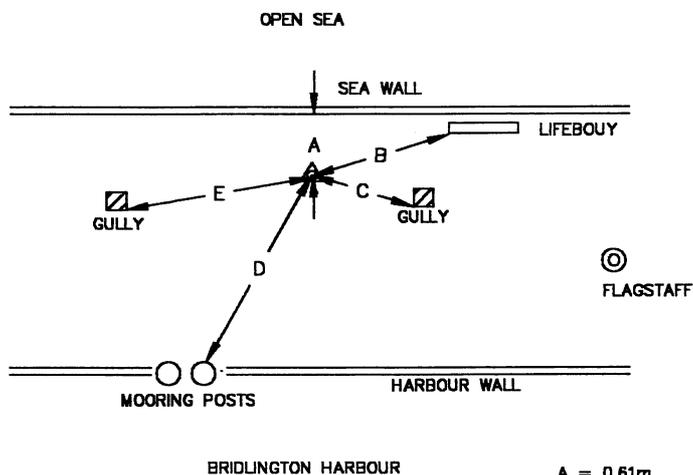
STATION DESCRIPTION

QAF GEN 18

HORIZONS

STN. BH01

WITNESS DIAGRAM



- A = 0.61m
- B = 5.39m
- C = 9.62m
- D = 6.05m
- E = 6.49m



DESCRIPTION: PK NAIL & YELLOW PLASTIC SURVEYED BY: HALCROW SURVEY
 DISK ON N SIDE OF HARBOUR WALL. DATE: 20/11/00

BRIDLINGTON HARBOUR. JOB NO: HS 2260

STATION CO-ORDINATES: 518731.428 E

466464.982 N HEIGHT: 5.811 metres O.D.N

Handwritten notes:
1. 10/11/00

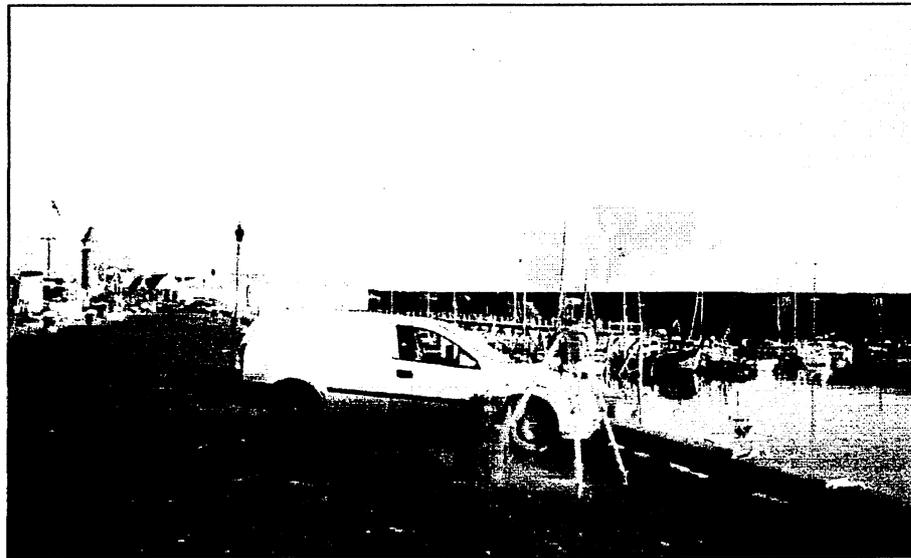
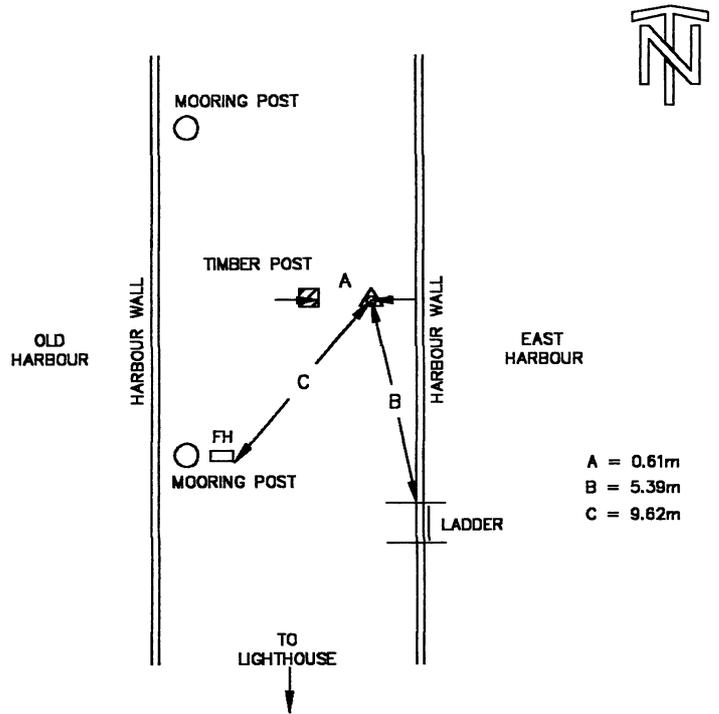
STATION DESCRIPTION

QAF GEN 18

HORIZONS

STN. SH01

WITNESS DIAGRAM



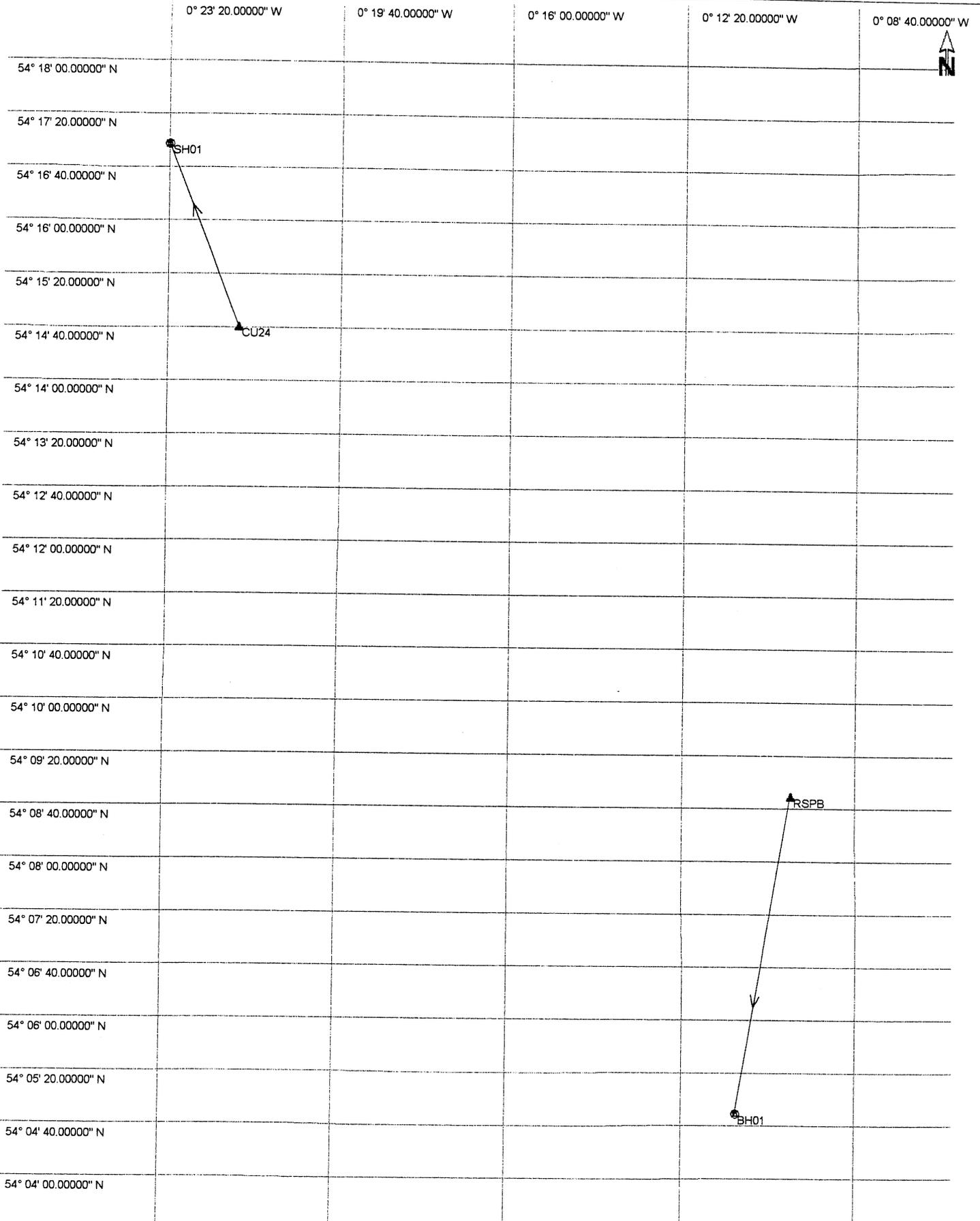
DESCRIPTION: PK NAIL & BLUE PLASTIC DISK ON SE SIDE OF ACCESS ROAD, TO SCARBOROUGH HARBOUR LIGHTHOUSE
STATION CO-ORDINATES: 504980.024 E

SURVEYED BY: HALCROW SURVEY
DATE: 20/11/00
JOB NO: HS 2260

488643.660 N

HEIGHT: 4.485 metres O.D.N

View/Edit of Project 2260 Tide Gauges



- Estimated
 - Navigation
 - SPP
 - Measured
 - Average
 - Difference
 - Adjusted
 - Fixed Weighted
 - Fixed Height
- Fixed Position
 - Fixed Position and Height

Date: 11/30/2000 Time: 09:55:41

Points of Project 2260 Tide Gauges (ETRS89)

Point Id	Point Class	Epoch	Latitude	Longitude	Ellip. Hgt.	Posn. + Hgt. Qlty
CU24	Control	11/20/2000 10:16:40	54° 14' 40.73629" N	0° 21' 50.47804" W	63.2829	0.0000
ISPB	Control	11/20/2000 13:00:30	54° 08' 49.45370" N	0° 10' 03.41904" W	139.2473	0.0000
JH01	Adjusted	11/20/2000 19:25:00	54° 04' 49.60581" N	0° 11' 11.91222" W	51.5282	0.0108
SH01	Adjusted	11/20/2000 19:25:00	54° 16' 57.63077" N	0° 23' 20.46778" W	50.9034	0.0116

Property	Value
Reference Id	CU24
Owner Id	SH01
Stored Status	yes
Ambiguity Status	yes
Start	11/20/2000 10:16:40
End	11/20/2000 12:17:10
Duration	2h 00' 30"
Type	STS
X	-3453.6274
Y	-1606.1854
Z	2462.1066
Sd. X	0.2926
Sd. Y	0.00000525
Sd. Z	-0.00000049
Corr. X	0.00000356
Corr. Y	0.00000125
Corr. Z	-0.00000044
Q33	0.00000911
Sd. X	0.0007
Sd. Y	0.0003
Sd. Z	0.0009
Corr. Qlty	0.0006
Obs. Qlty	0.0010
Corr. + Hgt. Qlty	0.0012
Wave Distance	4535.3437
Wave Distance S.d.	0.0005

Property	Value
Reference Id	RSPB
over Id	BH01
Stored Status	yes
Ambiguity Status	yes
start	11/20/2000 13:31:00
end	11/20/2000 15:30:10
Duration	1h 59' 10"
Type	STS
X	5952.9233
Y	-1262.6607
dZ	-4418.0942
0	0.2817
11	0.00000414
Q12	-0.00000038
^13	0.00000266
22	0.00000143
Q23	-0.00000069
Q33	0.00000903
d. X	0.0006
d. Y	0.0003
Sd. Z	0.0008
Posn. Qlty	0.0006
gt. Qlty	0.0009
Posn. + Hgt. Qlty	0.0011
Slope Distance	7520.0508
Slope Distance S.d.	0.0005

APPENDIX VI

FILEY BAY C.D.S.S - SCHEDULE OF CLIFF TOP PGM' s ESTABLISHED
OSGB36 CO-ORDINATES & ODN HEIGHT

PGM & SECTION NUMBER	POINT CLASS	EASTING (m)	NORTHING (m)	ORTHO. HEIGHT (m.ODN)	3D CO-ORD QUALITY (m)
STN01	Averaged	525319.8214	470761.1555	44.8191	0.0044
STN02	Averaged	523845.6653	471990.4968	36.9406	0.0029
STN03	SAME LOCATION AS STN02 (LINES CONVERGE)				
STN04	Averaged	523833.2100	471999.0877	37.2247	0.0038
STN04A	Averaged	521789.5903	472887.4806	84.6213	0.0026
STN05	Averaged	520482.2384	473624.9891	85.0694	0.0027
STN06	Averaged	518785.9977	474532.7064	103.1793	0.0036
STN07	Averaged	518560.4138	474585.3389	104.4243	0.0022
STN08	Averaged	517940.7126	474725.0031	111.7346	0.0085
STN09	Averaged	517388.8012	474817.4480	117.9847	0.0044
STN10	Averaged	516699.8071	474894.1748	124.0941	0.0033
STN11	Averaged	516014.8078	474969.1577	117.6215	0.0058
STN12	Averaged	515477.2858	475235.0965	71.1666	0.0043
STN13	Averaged	514892.6934	475521.0343	67.3881	0.0023
STN14	Averaged	514555.1615	475832.2526	55.3075	0.0042
STN15	Averaged	514170.9990	476177.7716	42.1502	0.0068
STN16	Averaged	513907.7525	476359.0081	49.4366	0.0034
STN17	Averaged	513682.3469	476616.6706	37.7429	0.0037
STN18	Averaged	513567.6747	476752.9748	34.4427	0.0084
STN19	Averaged	513222.1003	477074.1183	28.4143	0.0046
STN20	Averaged	512963.6527	477350.0953	32.0797	0.0034
STN21	Averaged	512758.6975	477647.2526	17.2599	0.0038
STN22	Averaged	512590.7815	477925.7093	14.5341	0.0105
STN23	Averaged	512393.4889	478052.2169	28.1401	0.0057
STN24	Averaged	512358.0496	478368.7941	15.7916	0.0033
STN25	Averaged	512210.9897	478553.8876	33.8086	0.0027
STN26	Averaged	512092.6282	478881.5922	30.2045	0.0024
STN27	Averaged	511968.1443	479250.6352	28.3413	0.0035
STN28	Averaged	511925.4360	479488.0592	38.5856	0.0021
STN29	Averaged	511887.3155	479907.9524	28.3471	0.0027
STN31	NOT REQUIRED - SEA WALL - FILEY TOWN				
STN32	NOT REQUIRED - SEA WALL - FILEY TOWN				
STN33	NOT REQUIRED - SEA WALL - FILEY TOWN				
STN34	NOT REQUIRED - SEA WALL - FILEY TOWN				
STN35	Averaged	512030.3915	480989.4956	33.6184	0.0062
STN36	Averaged	512110.9016	481173.2368	35.3064	0.0018
STN37	Averaged	512218.7845	481412.2630	37.2112	0.0026
STN38	NOT REQUIRED - BATHYMETRIC SURVEY ONLY				
STN39	NOT REQUIRED - BATHYMETRIC SURVEY ONLY				
STN40	NOT REQUIRED - BATHYMETRIC SURVEY ONLY				
STN41	Averaged	507701.5947	483987.5425	76.0246	0.0046
STN42	Averaged	507531.9652	483997.2778	71.7093	0.0045
STN43	Averaged	507323.9756	484083.6660	51.0669	0.0048
STN44	Averaged	506996.0291	484205.4229	39.3883	0.0034
STN45	Averaged	506783.4787	484341.9045	39.2646	0.0042
STN46	NOT REQUIRED - SEA WALL - PUMPING STATION AT CAYTON BAY				
STN47	Averaged	506387.4538	484773.0306	27.0382	0.0035
STN48	UNABLE TO ESTABLISH DUE TO WOODLAND				
STN49	UNABLE TO ESTABLISH DUE TO WOODLAND				

FILEY BAY C.D.S.S - SCHEDULE OF CLIFF TOP PGM's ESTABLISHED
ETRS89 CO-ORDINATES & ELLIPSOIDAL HEIGHTS

PGM & SECTION NUMBER	<u>Latitude Φ</u>	<u>Longitude λ</u>	<u>Ellip. Hgt</u>
STN01	54° 07' 02.92024" N	0° 05' 03.18895" W	90.3662
STN02	54° 07' 43.95685" N	0° 06' 22.52007" W	82.5496
STN03	SAME LOCATION AS STN02 (LINES CONVERGE)		
STN04	54° 07' 44.24544" N	0° 06' 23.19318" W	82.8341
STN04A	54° 08' 14.72837" N	0° 08' 14.42577" W	130.3115
STN05	54° 08' 39.68523" N	0° 09' 25.36522" W	130.8126
STN06	54° 09' 10.45859" N	0° 10' 57.51170" W	148.9907
STN07	54° 09' 12.34793" N	0° 11' 09.86541" W	150.2445
STN08	54° 09' 17.37715" N	0° 11' 43.81083" W	157.5788
STN09	54° 09' 20.82106" N	0° 12' 14.08959" W	163.8502
STN10	54° 09' 23.86655" N	0° 12' 51.94477" W	169.9860
STN11	54° 09' 26.84912" N	0° 13' 29.58390" W	163.5401
STN12	54° 09' 35.88469" N	0° 13' 58.83553" W	117.1080
STN13	54° 09' 45.60292" N	0° 14' 30.65718" W	113.3530
STN14	54° 09' 55.93853" N	0° 14' 48.83264" W	101.2869
STN15	54° 10' 07.41992" N	0° 15' 09.53397" W	88.1460
STN16	54° 10' 13.49116" N	0° 15' 23.79678" W	95.4429
STN17	54° 10' 22.00341" N	0° 15' 35.87131" W	83.7591
STN18	54° 10' 26.50264" N	0° 15' 42.00752" W	80.4639
STN19	54° 10' 37.16266" N	0° 16' 00.62284" W	74.4502
STN20	54° 10' 46.29233" N	0° 16' 14.49827" W	78.1265
STN21	54° 10' 56.06430" N	0° 16' 25.39766" W	63.3161
STN22	54° 11' 05.20203" N	0° 16' 34.28131" W	60.5978
STN23	54° 11' 09.44870" N	0° 16' 44.98984" W	74.2116
STN24	54° 11' 19.71464" N	0° 16' 46.51915" W	61.8660
STN25	54° 11' 25.81619" N	0° 16' 54.38044" W	79.8889
STN26	54° 11' 36.50710" N	0° 17' 00.46876" W	76.2907
STN27	54° 11' 48.53961" N	0° 17' 06.84031" W	74.4338
STN28	54° 11' 56.25136" N	0° 17' 08.87826" W	84.6804
STN29	54° 12' 09.86054" N	0° 17' 10.41936" W	74.4453
STN31	NOT REQUIRED - SEA WALL - FILEY TOWN		
STN32	NOT REQUIRED - SEA WALL - FILEY TOWN		
STN33	NOT REQUIRED - SEA WALL - FILEY TOWN		
STN34	NOT REQUIRED - SEA WALL - FILEY TOWN		
STN35	54° 12' 44.72513" N	0° 17' 01.07810" W	79.7153
STN36	54° 12' 50.60401" N	0° 16' 56.38954" W	81.4010
STN37	54° 12' 58.24920" N	0° 16' 50.11598" W	83.3026
STN38	NOT REQUIRED - BATHYMETRIC SURVEY ONLY		
STN39	NOT REQUIRED - BATHYMETRIC SURVEY ONLY		
STN40	NOT REQUIRED - BATHYMETRIC SURVEY ONLY		
STN41	54° 14' 25.01842" N	0° 20' 56.06110" W	122.2969
STN42	54° 14' 25.46138" N	0° 21' 05.41452" W	117.9883
STN43	54° 14' 28.41204" N	0° 21' 16.78750" W	97.3546
STN44	54° 14' 32.59638" N	0° 21' 34.73920" W	85.6892
STN45	54° 14' 37.16976" N	0° 21' 46.30102" W	85.5741
STN46	NOT REQUIRED - SEA WALL - PUMPING STATION AT CAYTON BAY		
STN47	54° 14' 51.40905" N	0° 22' 07.61950" W	73.3647
STN48	UNABLE TO ESTABLISH DUE TO WOODLAND		
STN49	UNABLE TO ESTABLISH DUE TO WOODLAND		

Annex B
Summaries of Models Used

MWAVE_REG: A REGIONAL WAVE MODEL

The MWAVE_REG wave model is based on a new formulation of the mild slope equation for water waves. The model is very computationally efficient, as well as being accurate, and can be applied to very large areas. MWAVE_REG includes wave refraction, diffraction, breaking and bottom friction. Results may be presented as wave heights or directions over the whole modelled area. The output may also be used in Halcrow's hydrodynamic modelling suite DAWN and wave-induced current model MWAVE_WIC to determine sediment transport trends.

DATE DEVELOPED

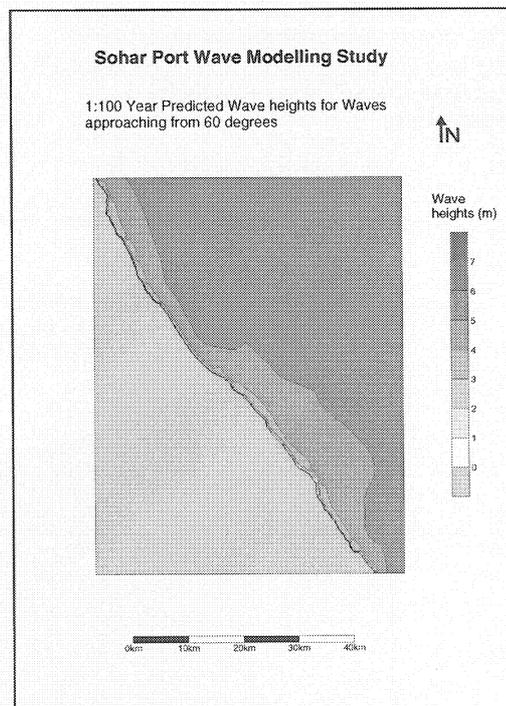
1994

MAJOR APPLICATIONS

West Bay Lagoon Wave Study - UAE
Zirku Island Wave Study - UAE
Das Island Wave Study - UAE
Ras Al Khaimah Reclamation Protection - UAE
Ilfracombe Harbour Development, UK
Happisburgh to Winterton Coastal Defences - UK
Chicago Beach - UAE
Dibba Beach Study - Oman
Jebel Ali Approach Channel Siltation Study - UAE
Al Mamzar Recreation Area Study - UAE
Uig Pier Upgrade Study - Scotland
Regis Harbour Development - Bognor, UK
Dabhol LNG Receiving Terminal - India
Sumaismah Jetty Study - Qatar
Diera Sea Corniche Study - UAE
Stochastic Methods for Long Term Prediction of Coastal Systems - UK
Benacre to Thorpeness Strategy Study - UK
Sovereign Harbour Siltation Study - UK
Oban Bay Wave Modelling - UK
Newton Shore Outfall Design, Ayr - UK

KEY WORDS

- Wave refraction and diffraction
- Non-linear shallow water effects
- Spectral and single frequency wave transformation
- Regional wave model
- Mathematical model



The wave model MWAVE_REG is based on a new formulation of the mild slope equation for water waves (Li, 1994. An evolution equation for water waves. Coastal Engineering, Vol 23, p227-242). The evolution equation is a time dependent parabolic equation and its solutions approach the results of the elliptic mild-slope equation as time increases.

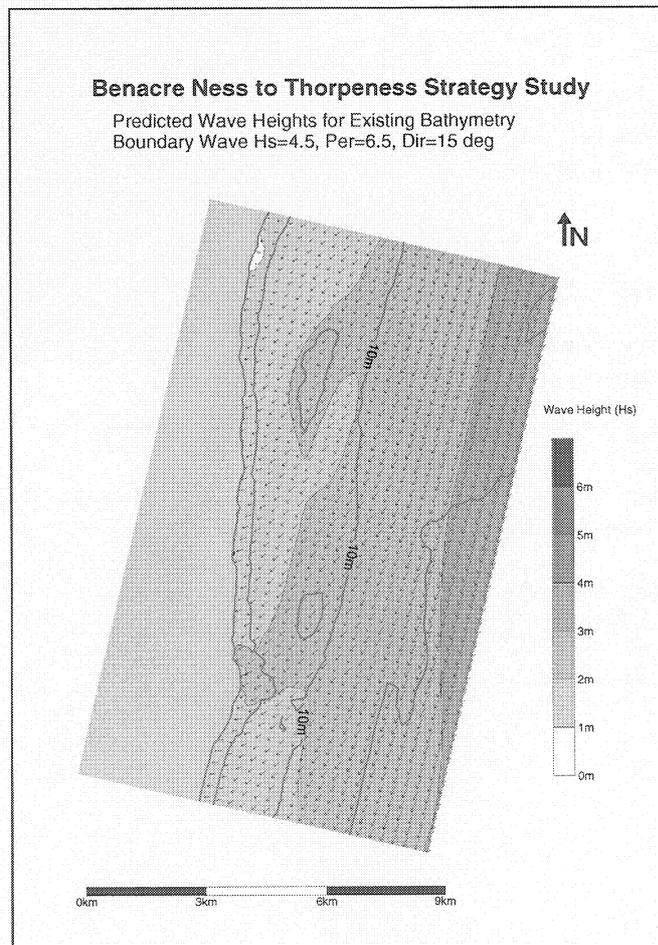
The solution method is based on solving for the wave amplitude and wave length. Because these parameters are slowly varying, the required number of grid points per wave length can be small, without adversely affecting accuracy or stability. As a result, MWAVE_REG can be used to calculate wave transformations over a large area. Typically, the calculation domain could be 50km by 50km.

The model has been compared against experimental data from Delft Hydraulics Laboratory and shown very good agreement.

The experiment was for wave propagation over an elliptical shoal on a sloping beach and is considered by researchers as standard data set for testing models.

MWAVE_REG may be run in either single frequency or spectral mode. In the latter case, the form of the offshore wave energy spectrum is specified by the user and non-linear shallow water processes are included through spectral saturation.

Results from MWAVE_REG may be used directly in MWAVE_WIC to determine the currents induced by the wave pattern, and they may also be used in DAWN, Halcrow's hydrodynamic modelling suite, to determine sediment transport trends.



COSMOS: SEDIMENT TRANSPORT MODEL

A nearshore hydrodynamic sediment transport model has recently been developed which is operational in both two and three dimensions. The two dimensional model assumes a straight coastline with parallel depth contours, the three dimensional model deals with gently curved coastlines.

DATE DEVELOPED

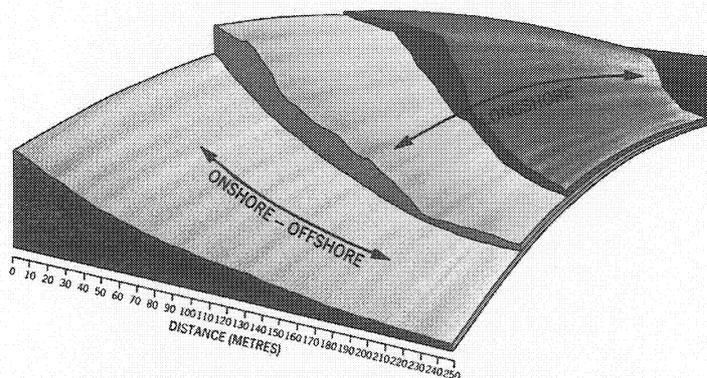
1990 (ongoing)

MAJOR APPLICATIONS

Anglian Sea Defence Management Study – UK
Happisburgh to Winterton Sea Defences – UK

KEY WORDS

- Two dimensional and three dimensional hydrodynamic models
- Cross-shore and longshore sediment transport
- Wave refraction
- Shoaling
- Doppler shifting
- Bottom friction
- Wave breaking
- Tidal and wave induced currents

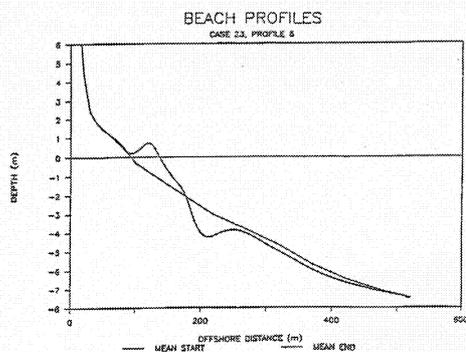


Beach Plan and Profile Development

Halcrow has recently developed a nearshore hydrodynamic sediment transport model of which there are two versions available.

The two dimensional nearshore model (two-dimensional in the vertical and cross-shore horizontal dimensions) assumes a straight coastline with parallel depth contours. This model has the following capabilities:

- wave transformation by refraction (by depth variations and currents), shoaling, Doppler shifting, bottom friction and wave breaking
- interacted longshore tidal and wave-induced currents
- cross-shore undertow velocities



- cross-shore and longshore sediment transport rates and downcutting of the cohesive profile (where present)
- depth profile changes due to (iv), including dune avalanching where appropriate.

The three dimensional model has been extended to deal with three-dimensional coastlines (ie with a gentle curvature and no prominent structures such as harbour breakwaters), and will consider beach elevation changes due to longshore sediment transport as well as cross-shore. Further developments to incorporate littoral barriers, ie groynes, are currently taking place.

Annex C
Historic Cliff Recession Data

CLIFF BEHAVIOUR UNIT	EROSION AVERAGE (m)	EROSION SHORT-TERM (m)	PERIOD	SITE	COUNTY	METHOD	SOURCE
2	1.12		1892-1960	Staithees, Penny Nab	Yorkshire	OS maps, survey	Agar 1960
2	1.12		1892-1960	Port Mulgrave	Yorkshire	OS maps, survey	Agar 1960
2	0.5		-	Whitby	Yorkshire	OS maps, data review	Clark & Guest 1991
2	0.31		1892-1960	Robin Hood's Bay, Mill Beck	Yorkshire	OS maps, survey	Agar 1960
2	0.28		1891-1960	Tees Estuary to Ravenscar	Yorkshire	OS maps, survey	Agar 1960, 1962
2	0.27		-	Runswick	Yorkshire	Historical review	Rozier & Reeves 1979
2	0.26		1892-1960	Upgang, near Whitby	Yorkshire	OS maps, survey	Agar 1960
2	0.19		1892-1960	Whitby, East Cliff	Yorkshire	OS maps, survey	Agar 1960
2	0.16		1892-1960	Robin Hood's Bay	Yorkshire	OS maps, survey	Agar 1960
2	0.1		1892-1960	Runswick	Yorkshire	OS maps, survey	Agar 1960
2	0.07		1892-1960	Robin Hood's Bay	Yorkshire	OS maps, survey	Agar 1960
2	0.05		1892-1960	Staithees, Cowbar Nab	Yorkshire	OS maps, survey	Agar 1960
2	0.03		1892-1960	Whitby, West Cliff	Yorkshire	OS maps, survey	Agar 1960
2	0.023		1971-1972	Whitby, Fourth Bight	Yorkshire	Micro-erosion meter	Agar 1960
3	0.94		-	Scarborough, South Bay	Yorkshire	OS maps, data review	Robinson 1977
3	0.53		1893-1912	Wheatcroft Cliff	Yorkshire	OS maps	Rendel Geotechnics 1994
3	0.38		1912-1928	White Nab	Yorkshire	OS maps	Rendel Geotechnics 1993
3	0.3		-	Seaham to Teesmouth	Yorkshire	Local records	Brooke et al. 1994
3	0.15		-	Dothor Pitts	Yorkshire	Historical review	Rozier & Reeves 1979
3	0.11		1892-1960	Black Nab	Yorkshire	OS maps, survey	Agar 1960
3	0.09		1891-1960	Tees Estuary to Ravenscar	Yorkshire	OS maps, survey	Agar 1960, 1962
3	0.05		1892-1960	Low Peak, The Dock	Yorkshire	OS maps, survey	Agar 1960
3	0.04		1892-1960	Huntcliff, Roman Signal Station	Yorkshire	OS maps, survey	Agar 1960
3	0.04		1892-1960	Saltwick Nab	Yorkshire	OS maps, survey	Agar 1960
3	0.036	70	1891-1960	Tees Estuary to Ravenscar	Yorkshire	OS maps, survey	Agar 1960, 1962
3		2	6/1993	Scarborough, Holbeck Hall	Yorkshire	Site survey	Rendel Geotechnics 1993
4			1993	Frank Cliff	Yorkshire	Site survey	Rendel Geotechnics 1993
4	1.11		1911-1938	Osgodby	Yorkshire	OS maps	Rendel Geotechnics 1993
4	0.5		1911-1922	Tennants Cliff	Yorkshire	OS maps	Rendel Geotechnics 1993
4	0.16		1893-1912	Frank Cliff	Yorkshire	OS maps	Rendel Geotechnics 1993

Annex D
Cliff Recession Database & Mapping

Upper Bound Evaluation of Cliff Recession Potential and Sediment Supply to Beaches

3D Correction Factor:	Composite Cliffs	Simple Cliffs	Simple Landslides	Complex Landslides
	80%	90%	70%	70%
CBU Type:	1	2	3	4

Notes: GT = Gtaseal Till
 OC = Oxford Clay
 LD = Landslide debris
 LCG = Lower Calcareous Grit (Middle Colite)
 IKSM = Interbedded mudrocks and sandstones (Middle Colite)
 IKSS = Interbedded mudrocks and sandstones (Scabby Formation)

RR = Killybeg Rock
 OO = Osmington Colite
 MCG = Middle Calcareous Grits

Map Ref	CBU Type	Geology	Rock Cliff Height (m)	Cliff Height (m)	Cliff Gradient (degrees)	CBU Section Length (m)	CBU Longshore Extent (m)	CBU Failure Depth (m)	CBU Sediment Storage (m ³)	CBU Activity	CBU Recession Potential (m)	Recession Frequency (years)	CBU Sediment Loss (m ³ /yr)	Sediment Grading %			Episodic supply to beach due to landslips (m ³ /yr)	Total average annual sediment supply (m ³ /yr)	Photo Ref																				
														Coarse	Medium	Fine																							
Map Sheet 007 - Cayton Bay																																							
Kilbray Point																																							
Cayton Bay - north																																							
A9	4	GT/IKSS	0	66	12	320	400	20.0	1832034	100%	0.5	1	2663	30%	40%	30%	0	2004	42.43																				
A8	1	GT/RR	6	25	32	30	120	0.5	2222	100%	0.5	1	402	24%	34%	42%	0	233	44																				
A7	1	GT/RR	2	65	38	80	45	3.0	12730	100%	0.5	1	125	40%	50%	10%	0	112	48.47,46.45																				
A	4	GT/LCG/OC	0	92	17	300	420	30.0	2766900	100%	60.0	50	653350	30%	40%	30%	0	7747																					
B	4	GT/LCG/OC	0	76	19	230	700	30.0	3575916	50%	60.0	50	466411	40%	50%	10%	0	8385																					
B1	2	LD	0	27	42	140	75	0.5	2543	75%	0.0	1	0	40%	50%	10%	0	419770																					
B2	3	LD	0	27	42	30	80	3.0	6752	100%	0.0	1	0	40%	50%	10%	0	0																					
B3	2	LD	0	27	42	30	40	2.0	2007	100%	0.0	1	0	40%	50%	10%	0	0																					
B4	2	LD	0	20	59	12	50	0.5	524	100%	0.0	1	0	40%	50%	10%	0	0																					
B5	3	LD	0	20	35	28	74	3.0	5312	100%	0.0	1	0	40%	50%	10%	0	0																					
B6	3	LD	0	19	47	18	20	2.0	739	100%	0.0	1	0	40%	50%	10%	0	0																					
B7	1	LD	0	19	30	20	54	1.0	1998	100%	0.0	1	0	40%	50%	10%	0	0																					
B8	2	LD	0	20	45	20	28	0.5	350	75%	0.0	1	0	40%	50%	10%	0	0	49																				
B9	2	LD	0	20	45	20	60	0.5	754	100%	0.0	1	0	40%	50%	10%	0	0																					
B10	2	LD	4	18	50	10	10	0.5	94	75%	0.0	1	0	40%	50%	10%	0	0	50																				
Pumping station																																							
C	3	GT	0	36	27	70	65	3.0	14023	100%	25.0	10	5068	24%	34%	42%	0	2965	54.51																				
D	3	GT	0	40	30	70	50	3.0	61023	100%	25.0	10	3031	24%	34%	42%	0	1758	55																				
E	3	GT	0	36	25	100	80	3.0	57695	100%	25.0	10	4498	24%	34%	42%	0	2609	57.96																				
F	3	GT	0	36	25	78	30	2.0	9645	100%	25.0	10	1436	24%	34%	42%	0	672																					
G	3	GT	0	44	26	90	28	2.0	3025	100%	25.0	10	1090	24%	34%	42%	0	632																					
Killybeg Ravine																																							
H	3	GT	0	18	27	36	260	2.0	15524	100%	25.0	10	10213	24%	34%	42%	0	5924	6.5																				
I	3	GT	0	40	23	95	170	15.0	184220	75%	50.0	20	72118	24%	34%	42%	0	42177	22.23																				
J	3	GT	0	42	22	105	70	5.0	27745	100%	25.0	10	6609	24%	34%	42%	0	2109																					
K	3	GT	0	43	26	88	20	3.0	4112	100%	25.0	10	1168	24%	34%	42%	0	3591	4.32																				
L	3	GT	0	46	30	30	50	3.0	9699	100%	25.0	10	3031	24%	34%	42%	0	58	4.32																				
M	3	GT	0	48	31	80	60	2.0	7940	100%	25.0	10	2450	24%	34%	42%	0	1758																					
N	3	GT	0	48	35	65	50	6.0	17306	100%	0.5	1	184	24%	34%	42%	0	1421																					
O	1	GT/LCG	15	51	28	68	55	3.0	12595	100%	0.5	1	184	30%	35%	35%	119	176																					
P	1	GT/LCG	22	59	27	75	75	3.0	1047	100%	0.5	1	965	30%	35%	35%	379	176																					
Q	1	GT/LCG	30	61	27	60	20	2.0	3736	100%	0.5	1	965	40%	40%	20%	724	724																					
R	1	GT/LCG	45	67	26	45	65	2.0	13989	75%	0.5	1	1617	35%	40%	25%	188	166																					
S	1	GT/LCG	55	72	21	45	55	1.0	7764	100%	0.5	1	1598	40%	40%	20%	1294	1294																					
High Red Cliff																																							
T	1	GT/LCG	60	73	18	40	80	1.0	13225	100%	0.5	1	2565	40%	40%	20%	0	2052	58.50																				
U	1	GT/LCG	65	81	15	60	200	0.5	21925	100%	0.5	1	8663	40%	40%	20%	0	6014	52																				
V	2	GT/LCG/OC	0	84	30	145	300	3.0	105482	100%	1.0	1	727	40%	50%	10%	0	6014	53.1																				
W	1	GT/IKSM	12	59	25	100	185	3.0	53897	100%	1.0	1	2760	35%	40%	25%	0	436	1																				
X	1	GT/IKSM	10	57	25	100	140	3.0	38366	100%	1.0	1	1784	35%	40%	25%	0	2069	24.25																				
Y	1	GT/IKSM	5	61	25	120	350	3.0	168014	100%	1.0	1	2633	35%	40%	25%	0	1345	24.25																				
SUB-TOTAL										1,155,434										871,501										40,604									

Longshore width of Killybeg Ravine is 50m. Instability of ravine sides over 260m length used to calculate sediment delivery to shoreline.

Lower Bound Evaluation of Cliff Recession Potential and Sediment Supply to Beaches

3D Correction Factor:	Composite Cliffs	Simple Cliffs	Simple Landslides	Complex Landslides
	80%	80%	50%	50%
CBU Type:	1	2	3	4

Notes: GT = Glacial Till
 CC = Oxford Clay
 LD = Landslide debris
 LCG = Lower Calcareous Grit (Middle Collie)
 IMSM = Interbedded mudrocks and sandstones (Middle Collie)
 IMSM = Interbedded mudrocks and sandstones (Starry Formation)

KR = Kellaway Rock
 CO = Osmington Collie
 MCG = Middle Calcareous Grits

Map Ref	CBU Type	Geology	Rock Cliff Height (m)	Cliff Height (m)	Cliff Gradient (degrees)	CBU Section Length (m)	CBU Longshore Extent (m)	CBU Failure Depth (m)	CBU Sediment Storage (m³)	CBU Activity	CBU Recession Potential (m)	Recession Frequency (years)	CBU Sediment Loss (m³/yr)	Sediment Grading %			Sediment supply to beach due to erosion (m³/yr)	Episodic supply to beach from landslips (m³/yr)	Total average annual sediment supply (m³/yr)	Photo Ref																			
														Coarse	Medium	Fine																							
Map Sheet 007 - Cayton Bay																																							
Kelpa Point																																							
A9	1	GT/MSM	0	68	12	320	400	10.0	654298	75%	0.1	1	153	30%	40%	30%	107	0	107	42.43																			
A8	1	GT/KR	6	25	32	30	120	0.3	1121	75%	0.1	1	57	24%	34%	42%	33	0	53	44																			
A7	1	GT/KR	2	65	39	80	45	1.5	6858	75%	0.1	1	12	40%	50%	10%	11	0	11	48.47.46.45																			
A	4	GT/LCG/CC	0	92	17	300	420	15.0	58959	75%	50.0	50	72392	30%	40%	30%	0	86466	1729																				
B	4	GT/LCG/CC	0	78	19	230	700	15.0	127107	25%	50.0	50	59405	40%	50%	10%	2	62468	1249																				
B1	3	LD	0	27	42	30	140	0.3	1130	50%	0.1	1	2	40%	50%	10%	2	0	2																				
B2	3	LD	0	27	42	30	80	1.5	2422	75%	0.1	1	3	40%	50%	10%	5	0	5																				
B3	2	LD	0	27	42	30	40	1.0	1253	75%	0.1	1	3	40%	50%	10%	3	0	3																				
B4	2	LD	0	20	59	12	50	0.3	233	75%	0.1	1	1	40%	50%	10%	1	0	1																				
B5	3	LD	0	20	33	28	74	1.5	1897	75%	0.1	1	5	40%	50%	10%	5	0	5																				
B6	3	LD	0	19	47	18	20	1.0	264	75%	0.1	1	1	40%	50%	10%	1	0	1																				
B7	1	LD	5	19	30	25	54	0.5	840	75%	0.1	1	23	40%	50%	10%	20	0	20																				
B8	2	LD	0	20	46	20	28	0.3	158	50%	0.1	1	0	40%	50%	10%	0	0	0	49																			
B9	2	LD	0	20	45	20	60	0.3	339	75%	0.1	1	0	40%	50%	10%	1	0	1																				
B10	2	LD	4	16	50	10	10	0.3	42	50%	0.1	1	2	40%	50%	10%	2	0	2	50																			
Pumping station																																							
C	3	GT	0	38	27	70	85	1.5	5008	75%	10.0	10	537	24%	34%	42%	0	311	31	53.51																			
D	3	GT	0	40	30	70	50	1.5	4031	75%	10.0	10	325	24%	34%	42%	0	188	19	55																			
E	3	GT	0	38	21	100	80	1.5	6427	75%	10.0	10	482	24%	34%	42%	0	280	28	57.56																			
F	3	GT	0	36	25	78	30	1.0	1291	75%	10.0	10	124	24%	34%	42%	0	72	7																				
G	3	GT	0	44	26	90	28	1.0	1402	75%	10.0	10	117	24%	34%	42%	0	68	7																				
Kellaway Ravine																																							
H*	3	GT	0	19	27	38	260	1.0	5544	75%	10.0	10	1054	24%	34%	42%	0	635	63	6.5																			
I	3	GT	0	40	23	95	170	7.5	65783	50%	25.0	20	8657	24%	34%	42%	0	5021	251	22.23																			
J	3	GT	0	42	22	105	70	2.5	9099	75%	10.0	10	708	24%	34%	42%	0	411	41																				
K	3	GT	0	43	26	88	20	1.5	1469	75%	10.0	10	125	24%	34%	42%	0	73	7	4.3.2																			
L	3	GT	0	46	30	80	50	1.5	3464	75%	10.0	10	325	24%	34%	42%	0	186	19	4.3.2																			
M	3	GT	0	48	31	80	60	1.0	2600	75%	10.0	10	282	24%	34%	42%	0	152	15																				
N	1	GT/LCG	2	48	35	65	50	3.0	6213	75%	0.1	1	15	30%	35%	35%	10	0	10																				
O	1	GT/LCG	15	61	28	68	55	1.5	4495	75%	0.1	1	67	35%	40%	25%	50	0	50																				
P	1	GT/LCG	22	59	26	75	59	1.5	7617	75%	0.1	1	131	35%	40%	25%	98	0	98																				
Q	1	GT/LCG	27	61	27	60	20	1.0	1354	50%	0.1	1	31	35%	40%	20%	23	0	23																				
R	1	GT/LCG	45	67	26	65	65	1.0	4863	75%	0.1	1	228	40%	40%	20%	162	0	162																				
S	1	GT/LCG	55	72	21	45	55	0.5	2773	75%	0.1	1	231	40%	40%	20%	185	0	185	59.58																			
High Road Cliff																																							
T	1	GT/LCG	60	73	18	40	80	0.5	4724	75%	0.1	1	369	40%	40%	20%	295	0	295	52																			
U	1	GT/LCG	65	81	15	60	200	0.3	7931	75%	0.1	1	995	40%	50%	10%	896	0	896	53.1																			
V	2	GT/LCG/CC	0	84	30	145	300	1.5	37672	75%	0.5	1	87	20%	40%	40%	58	0	58	1																			
W	1	GT/MSM	12	59	25	100	165	1.5	19249	75%	0.5	1	805	35%	40%	25%	679	0	679																				
X	1	GT/MSM	10	67	25	100	140	1.3	14070	75%	0.5	1	478	35%	40%	25%	433	0	433	24.25																			
Y	1	GT/MSM	5	61	25	120	350	1.5	37862	75%	0.5	1	775	35%	40%	25%	591	0	591	24.25																			
SUB-TOTAL										3,673										158,390										7,131									

* Longshore width of Kellaway Ravine is 50m; instability of ravine sides over 260m length used to calculate sediment delivery to shoreline.

Upper Bound Evaluation of Cliff Recession Potential and Sediment Supply to Beaches

3D Correction Factor:	Composite Cliffs	Simple Cliffs	Simple Landslides	Complex Landslides
	90%	80%	70%	70%
CBU Type:	1	2	3	4

Notes: GT = Glacial Till
 OC = Oxford Clay
 LD = Landslide debris
 LCG = Lower Calcareous Grit (Middle Coile)
 IMSM = Interbedded mudrocks and sandstones (Middle Coile)
 IMSS = Interbedded mudrocks and sandstones (Scalby Formation)
 KR = Kellaway Rock
 OO = Osmington Coille
 MCG = Middle Calcareous Grits

Map Ref	CBU Type	Geology	Rock Cliff Height (m)	Cliff Height (m)	Cliff Gradient (degrees)	CBU Section Length (m)	CBU Longshore Extent (m)	CBU Failure Depth (m)	CBU Sediment Storage (m ³)	CBU Activity	CBU Recession Potential (m)	Recession Frequency (years)	Sediment Loss (m ³ /yr)	Sediment Grading %			Sediment supply to beach due to erosion (m ³ /yr)	Episodic supply to beach from landslides (m ³ /yr)	Total average annual sediment supply (m ³ /yr)	Photo Ref					
														Coarse	Medium	Fine									
Map Sheet 007 - Cayton Bay																									
Kilbray Point																									
A9	4	GT/IMSS	0	69	12	320	400	20.0	1852034	100%	0.5	1	2883	30%	40%	30%	2004	0	2004	42,43					
A8	1	GT/KR	6	25	32	30	120	0.5	2522	100%	0.5	1	492	21%	34%	42%	233	0	233	44					
Cayton Bay - north																									
A7	1	GT/KR	2	95	39	80	45	3.0	12730	100%	0.5	1	125	40%	50%	10%	112	0	112	48,47,46,45					
A	4	GT/LCG/OC	0	82	17	300	420	30.0	276900	100%	60.0	60	65330	30%	40%	30%	2004	0	2004						
B1	2	GT/LCG/OC	0	79	19	230	700	30.0	3575816	50%	60.0	50	468411	40%	50%	10%	0	387366	7747						
B2	3	LD	0	27	42	30	140	0.6	2613	75%	0.0	1	0	40%	50%	10%	0	419770	8595						
B3	2	LD	0	27	42	30	30	0.0	6762	100%	0.0	1	0	40%	50%	10%	0	0	0						
B4	2	LD	0	27	42	30	40	2.0	2907	100%	0.0	1	0	40%	50%	10%	0	0	0						
B5	2	LD	0	27	42	30	12	0.0	524	100%	0.0	1	0	40%	50%	10%	0	0	0						
B6	3	LD	0	27	42	30	7	0.0	524	100%	0.0	1	0	40%	50%	10%	0	0	0						
B7	3	LD	0	27	42	30	19	0.0	524	100%	0.0	1	0	40%	50%	10%	0	0	0						
B8	2	LD	0	27	42	30	20	1.0	1856	100%	0.0	1	0	40%	50%	10%	0	0	0						
B9	2	LD	0	27	42	30	28	0.5	369	75%	0.0	1	0	40%	50%	10%	0	0	0	49					
B10	2	LD	4	16	50	10	10	0.5	94	75%	0.0	1	0	40%	50%	10%	0	0	0	50					
Pumping station																									
C	3	GT	0	38	27	70	85	3.0	14023	100%	25.0	10	5008	24%	34%	42%	0	2905	290	53,51					
D	3	GT	0	40	30	30	50	3.0	6467	100%	25.0	10	3031	24%	34%	42%	0	1758	178	55					
E	3	GT	0	38	21	100	80	3.0	17905	100%	25.0	10	4469	24%	34%	42%	0	2609	261	57,56					
F	3	GT	0	36	25	79	30	2.0	3615	100%	25.0	10	1169	24%	34%	42%	0	672	67						
G	3	GT	0	44	26	90	28	2.0	3825	100%	25.0	10	1090	24%	34%	42%	0	632	63						
Kilbray Ravine																									
H	3	GT	0	19	27	38	260	2.0	15224	100%	25.0	10	10213	24%	34%	42%	0	5924	592	6,5					
I	3	GT	0	40	23	95	170	15.0	184220	75%	50.0	20	72718	24%	34%	42%	0	42177	2109	22,23					
J	3	GT	0	42	22	105	70	5.0	27745	100%	25.0	10	6606	24%	34%	42%	0	3831	383	4,3,2					
K	3	GT	0	43	26	88	20	3.0	4112	100%	25.0	10	1168	24%	34%	42%	0	678	68	4,3,2					
L	3	GT	0	46	30	80	50	3.0	9099	100%	25.0	10	3031	24%	34%	42%	0	1758	178						
M	3	GT	0	48	31	80	60	2.0	7640	100%	25.0	10	2460	24%	34%	42%	0	1421	142						
N	1	GT/LCG	2	48	35	65	50	6.0	17366	100%	0.5	1	184	30%	35%	35%	119	0	119						
O	1	GT/LCG	15	51	28	68	55	3.0	12566	100%	0.5	1	605	35%	40%	25%	379	0	379						
P	1	GT/LCG	22	59	26	75	75	3.0	21047	100%	0.5	1	965	35%	40%	25%	724	0	724						
Q	1	GT/LCG	30	61	27	60	20	2.0	3736	75%	0.5	1	243	35%	40%	25%	186	0	186						
R	1	GT/LCG	45	67	21	45	65	2.0	13666	100%	0.5	1	1617	40%	40%	20%	1284	0	1284						
R	1	GT/LCG	55	72	21	45	55	2.0	7764	100%	0.5	1	1559	40%	40%	20%	1279	0	1279						
High Reef Cliff																									
T	1	GT/LCG	60	73	18	40	80	1.0	13228	100%	0.5	1	2595	40%	40%	20%	2052	0	2052	59,58					
U	1	GT/LCG	65	81	15	60	200	0.5	21228	100%	0.5	1	6663	40%	50%	10%	6014	0	6014	52					
V	2	GT/LCG/OC	0	84	30	145	300	3.0	105482	100%	1.0	1	797	20%	40%	40%	436	0	436	53,1					
W	1	GT/IMSM	12	69	25	100	185	3.0	63897	100%	1.0	1	2769	35%	40%	25%	2069	0	2069	1					
X	1	GT/IMSM	10	67	25	100	140	3.0	99568	100%	1.0	1	1794	35%	40%	25%	1345	0	1345	24,25					
Y	1	GT/IMSM	5	61	25	120	350	3.0	106014	100%	1.0	1	2833	35%	40%	25%	1975	0	1975	24,25					
SUB-TOTAL										4,509										20,223		571,501		40,694	

* Longshore width of Kilbray Ravine is 50m; instability of ravine sides over 260m length used to calculate sediment delivery to shoreline.

Lower-Bound Evaluation of Cliff Recession Potential and Sediment Supply to Beaches

3D Correction Factor:	Composite Cliffs	Simple Cliffs	Simple Cliffs	Simple Cliffs	Complex Landslides
	80%	85%	50%	50%	50%
CBU Type:	1	2	3	4	4

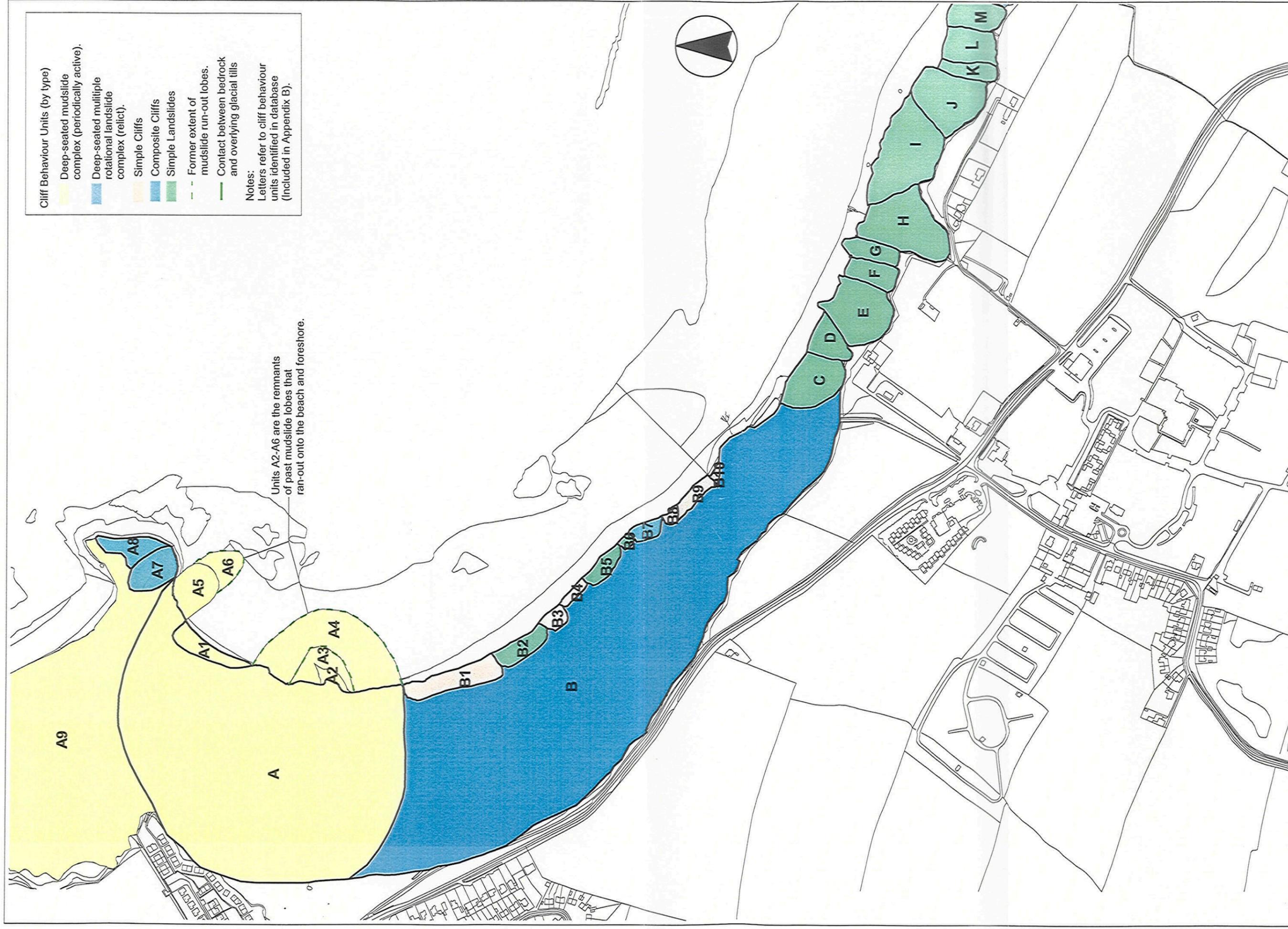
Notes: GT = Glacial Till
OC = Oxford Clay
LD = Landslide debris

LCG = Lower Calcareous Grit (Middle Colliie)
IMSM = Interbedded mudrocks and sandstones (Middle Colliie)
IMSS = Interbedded mudrocks and sandstones (Scaly Formation)

KR = Kellaway Rock
CO = Osmington Odliie
MCG = Middle Calcareous Grits

Map Ref	CBU Type	Geology	Rock Cliff Height (m)	Cliff Height (m)	Cliff Gradient (degrees)	CBU Section Length (m)	CBU Longshore Extent (m)	CBU Failure Depth (m)	CBU Sediment Storage (m ³)	CBU Activity	CBU Recession Potential (m)	Recession Frequency (years)	CBU Sediment Loss (m ³ /yr)	Sediment Grading %			Sediment supply to beach due to erosion (m ³ /yr)	Episodic supply to beach from landfills (m ³ /yr)	Total average supply to annual sediment supply (m ³ /yr)	Photo Ref	
														Coarse	Medium	Fine					
Map Sheet 007 - Cayton Bay																					
A9	4	GT/IMSS	0	68	12	320	400	10.0	564289	75%	0.1	1	153	30%	40%	30%	107	0	107	42.43	
A8	1	GTKR	6	25	32	30	120	0.3	1121	75%	0.1	1	57	24%	34%	42%	33	0	33	44	
A7	1	GTKR	2	65	38	80	45	1.5	5859	75%	0.1	1	12	40%	50%	10%	11	0	11	48.47.46.45	
B	4	GT/LCG/OC	0	92	17	300	420	15.0	984179	75%	50.0	50	123522	30%	40%	30%	0	89466	1728		
B1	4	GT/LCG/OC	0	76	19	230	700	15.0	1277077	75%	50.0	50	69406	40%	50%	10%	0	62466	1249		
B2	3	LD	0	27	42	30	140	0.3	1130	50%	0.1	1	2	40%	50%	10%	2	0	2		
B3	2	LD	0	27	42	30	80	1.5	2422	75%	0.1	1	5	40%	50%	10%	3	0	3		
B4	2	LD	0	27	42	30	40	1.0	1292	75%	0.1	1	3	40%	50%	10%	3	0	3		
B5	2	LD	0	20	59	12	50	0.3	243	75%	0.1	1	1	40%	50%	10%	1	0	1		
B6	3	LD	0	20	35	6	74	1.5	1997	75%	0.1	1	5	40%	50%	10%	1	0	1		
B7	3	LD	0	19	47	18	20	1.0	264	75%	0.1	1	1	40%	50%	10%	1	0	1		
B8	2	LD	5	19	30	25	54	0.5	840	75%	0.1	1	23	40%	50%	10%	20	0	20		
B9	2	LD	0	20	45	20	28	0.3	158	50%	0.1	1	1	40%	50%	10%	0	0	0		
B10	2	LD	0	20	45	20	60	0.3	339	75%	0.1	1	1	40%	50%	10%	1	0	1		
B10	2	LD	4	16	50	10	10	0.3	42	50%	0.1	1	2	40%	50%	10%	2	0	2		
Fluvial station																					
C	3	GT	0	35	27	70	85	1.5	5008	75%	10.0	10	537	24%	34%	42%	0	311	31		
D	3	GT	0	40	30	70	50	1.5	3031	75%	10.0	10	325	24%	34%	42%	0	168	19		
E	3	GT	0	38	21	100	80	1.5	6427	75%	10.0	10	462	24%	34%	42%	0	269	28		
F	3	GT	0	36	25	78	30	1.0	1261	75%	10.0	10	124	24%	34%	42%	0	72	7		
G	3	GT	0	44	26	90	28	1.0	1402	75%	10.0	10	117	24%	34%	42%	0	66	7		
Kilberby Ravine																					
H	3	GT	0	19	27	38	260	1.0	5544	75%	10.0	10	1094	24%	34%	42%	0	635	63		
I	3	GT	0	40	23	95	170	7.5	85763	50%	25.0	20	8657	24%	34%	42%	0	5021	261		
J	3	GT	0	42	22	105	70	2.5	9909	75%	10.0	10	708	24%	34%	42%	0	411	41		
K	3	GT	0	43	26	88	20	1.5	1463	75%	10.0	10	125	24%	34%	42%	0	73	7		
L	3	GT	0	46	30	80	50	1.5	3464	75%	10.0	10	325	24%	34%	42%	0	188	19		
M	3	GT	0	48	31	80	60	1.0	2800	75%	10.0	10	282	24%	34%	42%	0	152	15		
N	1	GT/LCG	2	48	35	65	50	3.0	6213	75%	0.1	1	15	30%	35%	35%	10	0	10		
O	1	GT/LCG	15	51	28	68	55	1.5	4485	75%	0.1	1	67	35%	40%	25%	60	0	60		
P	1	GT/LCG	22	53	26	75	75	1.5	7617	75%	0.1	1	131	35%	40%	25%	98	0	98		
Q	1	GT/LCG	30	61	27	60	20	1.0	1334	50%	0.1	1	31	35%	40%	25%	23	0	23		
R	1	GT/LCG	45	67	26	45	65	1.0	4963	75%	0.1	1	228	40%	40%	20%	182	0	182		
S	1	GT/LCG	55	72	21	45	55	0.5	2773	75%	0.1	1	231	40%	40%	20%	185	0	185		
High Rate Cliff																					
T	1	GT/LCG	60	73	18	40	60	0.5	4724	75%	0.1	1	369	40%	40%	20%	289	0	289		
U	1	GT/LCG	65	81	15	60	200	0.3	7631	75%	0.1	1	985	40%	50%	10%	880	0	880		
V	2	GT/LCG/OC	0	84	30	145	300	1.5	37672	75%	0.5	1	97	20%	40%	40%	68	0	68		
W	1	GT/IMSM	12	89	23	100	185	1.5	16249	75%	0.5	1	679	35%	40%	25%	679	0	679		
X	1	GT/IMSM	10	87	15	140	140	1.5	14070	75%	0.5	1	978	35%	40%	25%	433	0	433		
Y	1	GT/IMSM	5	81	23	120	120	1.5	37662	75%	0.5	1	775	35%	40%	25%	561	0	561		
SUB-TOTAL						4,359	4,359		3,186,791				210,363				3,673	156,339	7,141		

Longshore width of Kilberby Ravine is 50m. Instability of ravine sides over 260m length used to calculate sediment delivery to shoreline.



Cliff Behaviour Units (by type)

- Deep-seated mudslide complex (periodically active).
- Deep-seated multiple rotational landslide complex (relict).
- Simple Cliffs
- Composite Cliffs
- Simple Landslides
- - Former extent of mudslide run-out lobes.
- Contact between bedrock and overlying glacial tills

Notes:
 Letters refer to cliff behaviour units identified in database (Included in Appendix B).

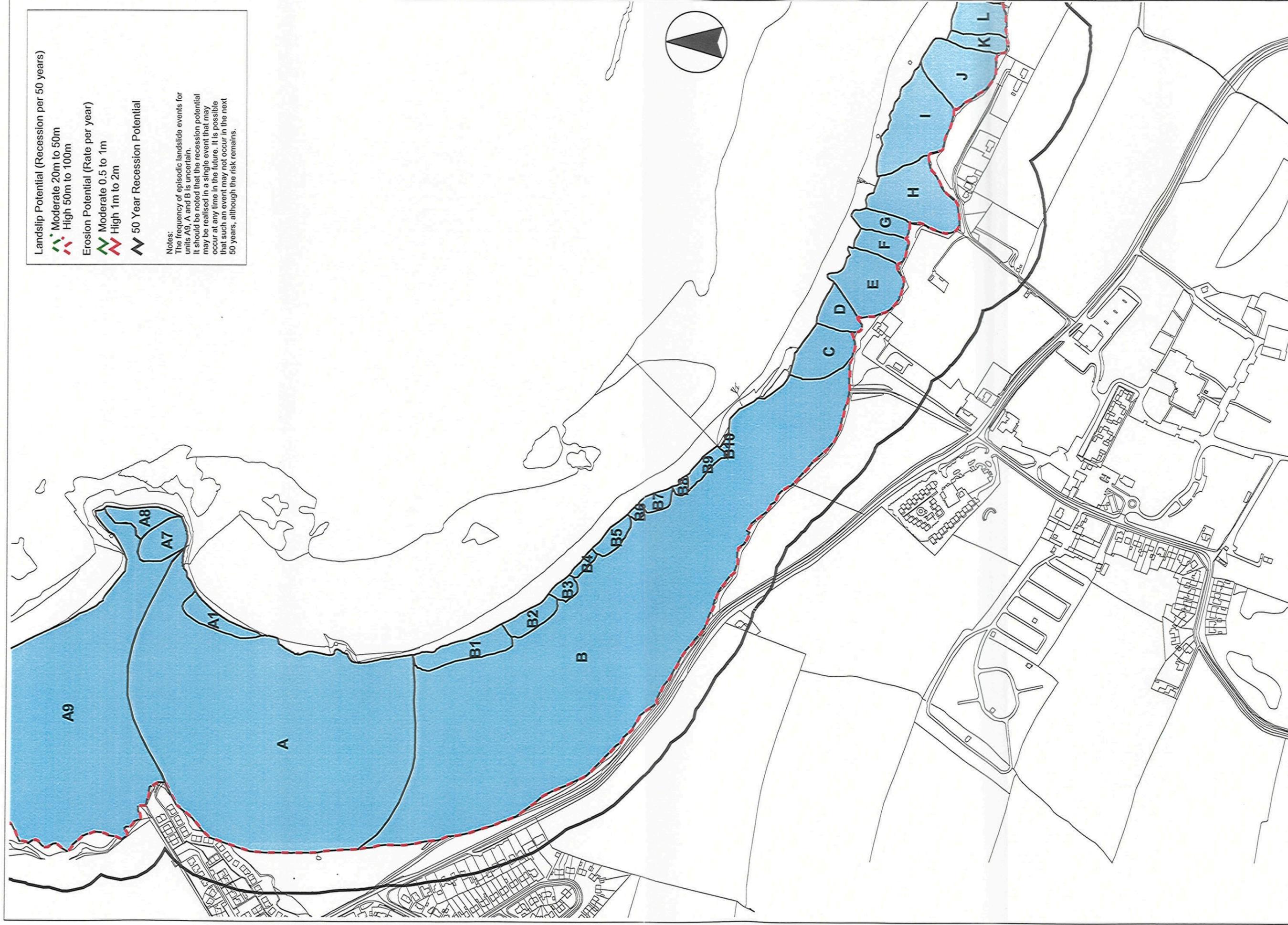
Units A2-A6 are the remnants of past mudslide lobes that ran-out onto the beach and foreshore.



Cliff Behaviour Units (by type)

- Deep-seated mudslide complex (periodically active).
- Deep-seated multiple rotational landslide complex (relict).
- Simple Cliffs
- Composite Cliffs
- Simple Landslides
- - Former extent of mudslide run-out lobes.
- Contact between bedrock and overlying glacial tills

Notes:
Letters refer to cliff behaviour units identified in database (Included in Appendix B).



Landslip Potential (Recession per 50 years)

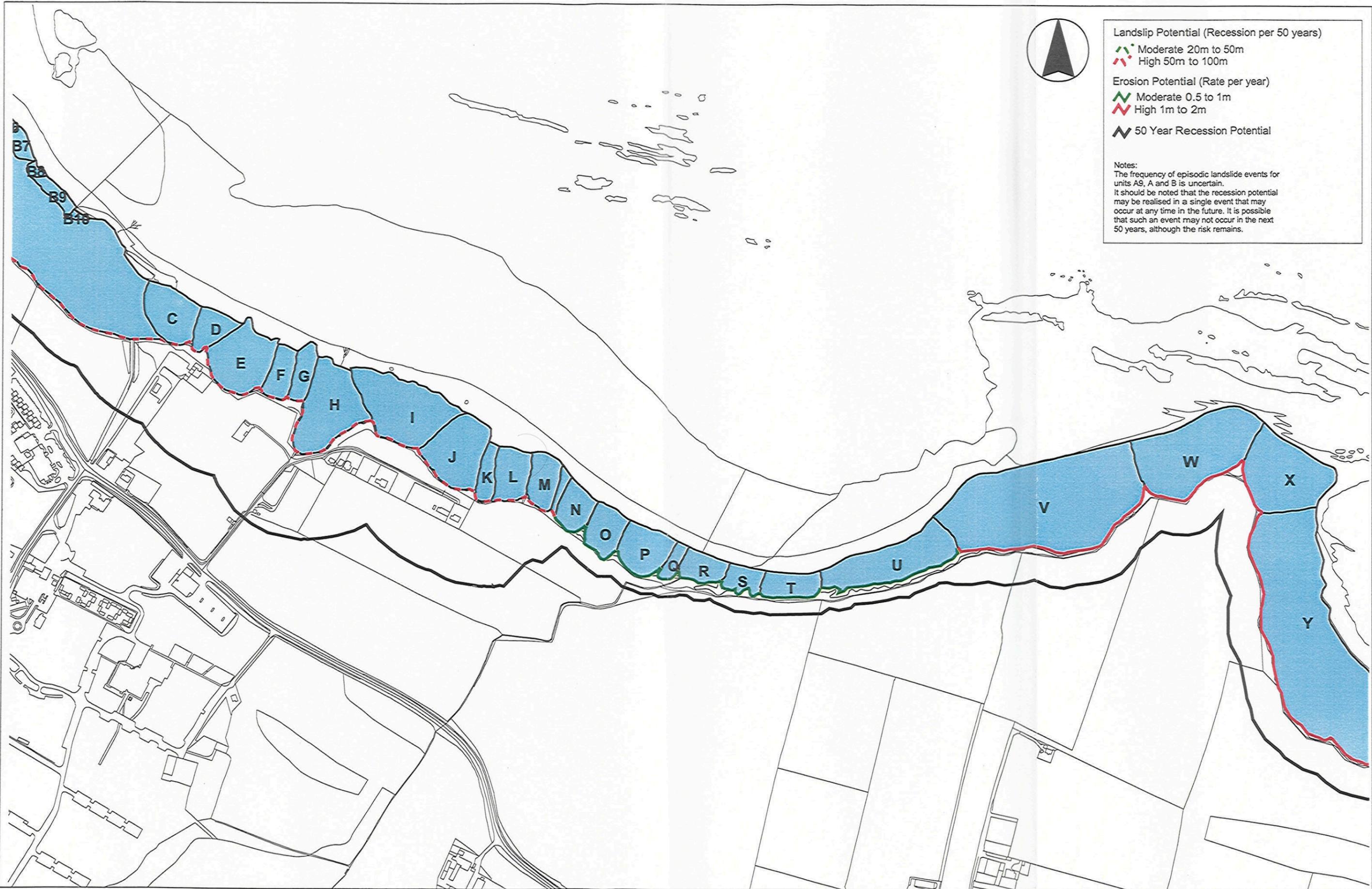
- Moderate 20m to 50m
- High 50m to 100m

Erosion Potential (Rate per year)

- Moderate 0.5 to 1m
- High 1m to 2m

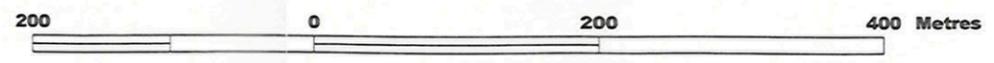
50 Year Recession Potential

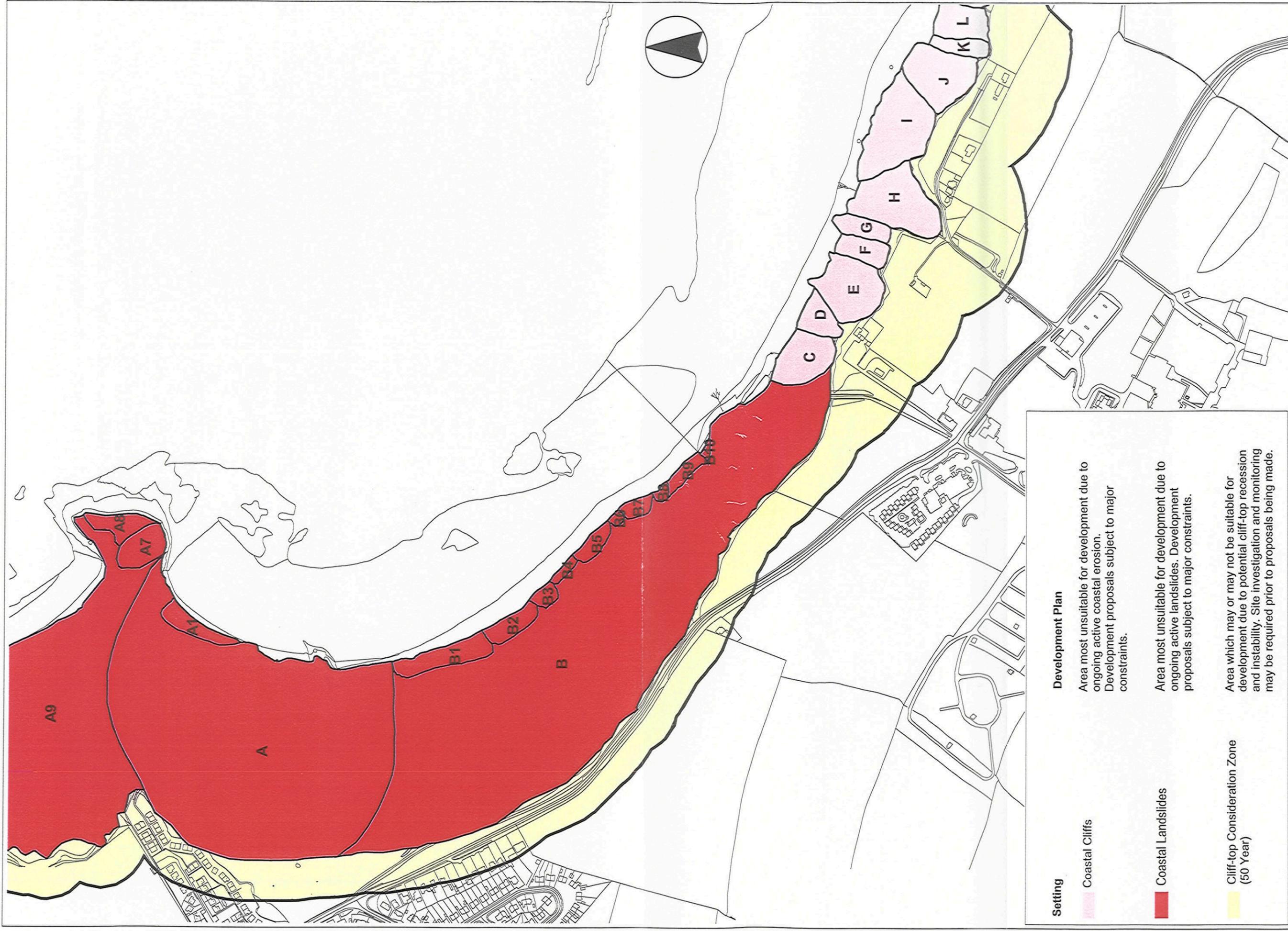
Notes:
The frequency of episodic landslide events for units A9, A and B is uncertain. It should be noted that the recession potential may be realised in a single event that may occur at any time in the future. It is possible that such an event may not occur in the next 50 years, although the risk remains.



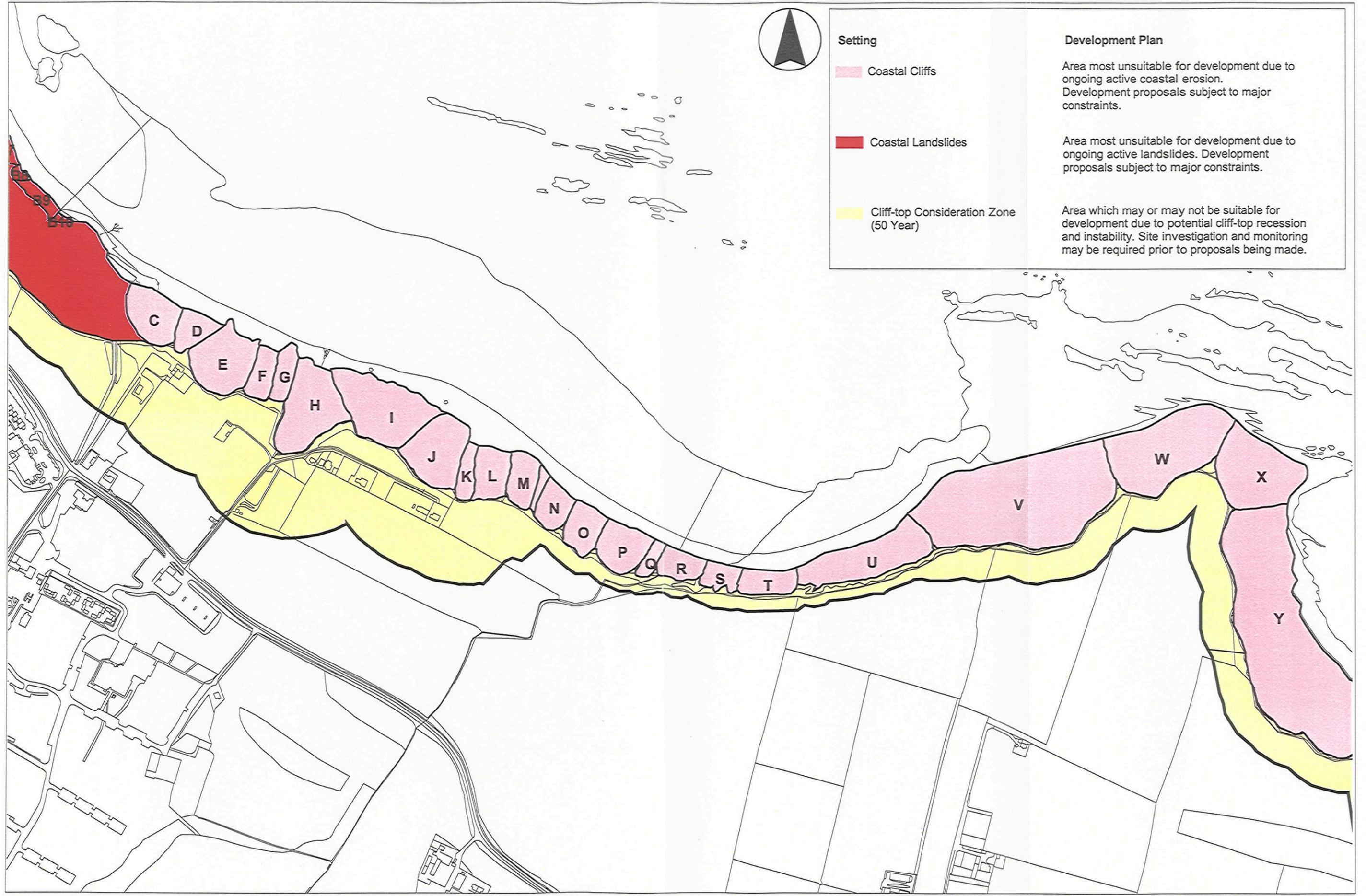
Reproduced from the Ordnance Survey mapping with the permission of the Controller of Her Majesty's Stationary Office (c) Crown Copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Scarborough Council. License No. LA 079251

Saturn\\d:\Projects\Fbss\arcview\cayton_geomorphology.apr





Setting	Development Plan
 Coastal Cliffs	Area most unsuitable for development due to ongoing active coastal erosion. Development proposals subject to major constraints.
 Coastal Landslides	Area most unsuitable for development due to ongoing active landslides. Development proposals subject to major constraints.
 Cliff-top Consideration Zone (50 Year)	Area which may or may not be suitable for development due to potential cliff-top recession and instability. Site investigation and monitoring may be required prior to proposals being made.



Annex E

Strategic Environmental Assessment

Scarborough Borough Council

Cayton Bay Coastal Defence Strategy Study

Annex E: Strategic Environmental Assessment

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
1	0	Draft Baseline SEA	02/2001	ECB
2	1	Final Draft	09/2001	ECB
3	1	Final	Oct 2002	

Contents

1	Introduction	1
	1.1 <i>General</i>	1
	1.2 <i>Approach</i>	1
	1.3 <i>Objectives</i>	2
	1.4 <i>Format</i>	2
2	Existing Environment	4
	2.1 <i>Sources of Information</i>	4
	2.2 <i>Location and Character</i>	4
	2.3 <i>Geology and Geomorphology</i>	4
	2.4 <i>Water and Aquatic Environment</i>	5
	2.5 <i>Ecology and Nature Conservation</i>	8
	2.6 <i>Landscape</i>	17
	2.7 <i>Land Use and Population</i>	19
	2.8 <i>Tourism and Recreation</i>	21
	2.9 <i>Fisberies</i>	25
	2.10 <i>Transport Network and Traffic</i>	27
	2.11 <i>Cultural Heritage</i>	28
	2.12 <i>Planning Issues</i>	31
3	Consultation	38
	3.1 <i>Introduction</i>	38
4	Environmental Objectives	44
	4.1 <i>General Issues</i>	44
	4.2 <i>Practicability, Sustainability and Economic Considerations</i>	44
5	Evaluation of Strategy Options	54
	5.1 <i>Introduction</i>	54
	5.2 <i>Unit 24A - Knipe Point to Clifton Crag</i>	54
	5.3 <i>Unit 24B - Clifton Crag to High Red Cliff</i>	61
6	Mitigation and Compensation	67
	6.1 <i>Introduction</i>	67
7	Conclusions	71

1 Introduction

1.1

General

Strategic Environmental Assessment is the formalised, systematic process of evaluating the environmental impact of a policy, plan, strategy or programme. It provides an environmental overview and establishes environmental objectives at the strategic level.

This Strategic Environmental Assessment comprises:

- A description of the baseline environment, concentrating on aspects of the environment that are relevant to, or may be affected by, coastal protection and flood defence plans.
- Consultation with relevant statutory bodies and other organisations with an interest in the coastal zone.
- Establishing specific environmental objectives that the adopted coastal management strategy should aim to fulfil.
- Appraisal of specific strategy options, to evaluate the types of environmental impacts and benefits that they will generate.
- Recommendation of the most acceptable strategy option(s).
- Conclusions as to the positive and negative environmental implications of the proposed option.
- Identification of environmental issues that need to be addressed (for example, generic mitigation measures) as part of the implementation of the preferred option.

1.2

Approach

Strategic Environmental Assessment (SEA) follows a similar approach to project-level environmental assessment, but differs from it in that it is a high level overview setting broad objectives and identifying generic approaches.

Consultation is undertaken with the aim of agreeing the objectives with a wide variety of stakeholders, and ensuring that the strategy is environmentally sustainable. The information necessary to complete a project level environmental assessment, such as engineering scheme design details, is not available at this stage. However, the SEA fulfils an important role in ensuring that the agreed strategy is, at least in outline, environmentally acceptable. By identifying and considering the most important environmental issues at this stage, it is intended to prevent a

situation in which detailed schemes are developed that subsequently have to be rejected or fundamentally re-designed to comply with legislation or other environmental requirements. By identifying strategic level issues that can be carried through to several projects or schemes, SEA also aims to minimise duplication of work later on. Hence, SEA occupies a central position in a hierarchy of studies, between shoreline management planning on the one hand and project environmental assessment on the other.

1.3

Objectives

The specific objectives of this Strategic Environmental Assessment are:

- Identification of nature conservation assets that may be lost or significantly affected by erosion or flooding, and an initial estimate to quantify the habitat changes expected;
- Identification of archaeological or other cultural heritage sites that may be affected by erosion or flooding, and recommendation of measures for recording them;
- Identification of any other environmental assets, including those relating to recreation and tourism, that may be affected by erosion or flooding;
- Development of environmental objectives for each unit of the frontage, to be used in developing and appraising strategy options;
- Review of Shoreline Management Plan policies, in relation to environmental assets, and identification of specific strategy options;
- Identification of legal issues and other constraints relating to strategy options (including the "do nothing" option);
- Contributing to the development of preferred strategic options for each unit of the frontage;
- Identification of significant environmental issues that are expected to arise in relation to the development of individual coastal defence or flood protection schemes, including recommending approaches to their assessment and mitigation.

1.4

Format

This SEA Report comprises:

- An account of existing environmental conditions that are relevant to coastal management in the study area (Section 2);
- A summary of consultation responses from interested organisations, together with comments (Section 3);

- Environmental objectives (Section 4);
- Evaluation of options (Section 5);
- Proposed approaches to mitigation and compensation (Section 6);
- Conclusions (Section 7).

2 Existing Environment

2.1 *Sources of Information*

Information on baseline conditions has been obtained from:

- previous reports on the study area;
- site visits;
- correspondence and meetings with consultees;
- statutory policies, plans and citations relating to environmental designations.

2.2 *Location and Character*

The strategy study area is situated on the coast of North Yorkshire, comprising approximately 2.5 km of coast (Figure 2.1). The area is bounded by the settlements of Osgodby to the north and Cayton to the west. The Bay is delimited by the relatively erosion-resistant rock outcrops of Osgodby or Knipe Point to the North and High Red Cliff to the South. The shoreline between comprises soft eroding boulder clay cliffs fronted by a wide sweeping sandy beach with considerable earthy loam deposits.

2.3 *Geology and Geomorphology*

The Bay is a particular feature formed by faulting, with the sweeping sandy beach which extends offshore backed by low slumping boulder clay cliffs formed in the underlying Jurassic Shales and sand stones overlain by Quaternary deposits. Landslips are common in the undercliff area, creating a characteristic series of terraces and seepage ponds with most recent slippages occurring in the ravine area of Killerby Cliff.

The whole area is affected by large volumes of ground water originating from the adjacent coastal margins. Some channels and surface water runoff can be seen down the cliff faces. The combination of groundwater and wave action at the base of the cliffs represents the main mechanism of coastal erosion and cliff instability and are chiefly the cause of considerable changes in cliff morphology in the short to medium term.

2.4

Water and Aquatic Environment

The quality of the coastal waters is dependent on a number of variables, including both natural effects, such as weather and ocean currents, as well as those due to human influences, such as the dumping and discharge of sewage, industrial waste and other pollutants. General concentrations of various pollutants can be identified from sources relating to the North Sea as a whole. Information has been obtained from the Flamborough Head Sensitive Marine Area Technical Report; the Esk and the Esk and Coast (Hartlepool to Filey Bay) Local Environment Agency Plan (LEAP).

There are no significant rivers or estuaries within the study area.

2.4.1

Oil Pollution

The increase of oil transport in the North Sea has resulted in a continuing pollution of the North East coast of England and makes the possibility of a major oil slick a constant hazard to the area. The NE coast of England has one of the worst oil pollution records in Britain and evidence points to an increasing problem.

Scarborough Borough Council and North Yorkshire County Council have prepared an oil spill contingency plan for the coast from Staithes Beck (north of the study area) to Speeton Cliffs (south of the study area). This distinguishes between three tiers of response: Tier 1 (a minor incident dealt with by the Borough Council), Tier 2 (a significant spill in which the County assists in clean up) and Tier 3 (a major pollution incident requiring a co-ordinated response from national and local authorities). The Plan identifies the roles of a wide range of organisations in the event of a Tier 3 incident, including the councils, RSPB, RSPCA, oil industry representatives, DETR, MAFF and the Department of Trade and Industry. As well as administrative arrangements, it also deals with technical approaches to containing or dispersing oil at sea and cleaning beaches if it comes ashore.

2.4.2

Litter

Litter is recognised to be a problem in the North Sea. The major sources of litter are disposal from ships, leisure activities on beaches and rivers and sewage discharges. Cayton Bay is surveyed as part of the Norwich Union Coastwatch UK initiative.

2.4.3

Nutrient Enrichment

Concentrations of nutrients originating from the land are also found near the coast in less saline waters. However, these sources of nutrients are being reduced due to the changes in practice that are required by European legislation. This includes the increased treatment of sewage effluent, as required by the Urban Waste Water Treatment Directive (EU Directive 91/271/EEC), and the protection of waters against pollution caused by nitrates from agricultural sources (EU Directive 91/676/EEC). Directive 91/676/EEC involves “vulnerable zones” being designated. In the case of coastal and marine waters, this designation is based on whether they “are found to be eutrophic or in the near future may become eutrophic” (Harding & Nichols, 1987 cited by English Nature, 1998).

2.4.4

Bathing Waters and Waste Water Treatment

The EU Bathing Water Directive (76/160/EEC) was agreed in Brussels on 8 December 1975 and imposes statutory objectives on bathing waters. Its two main objectives are:

- to improve or maintain the quality of bathing water for reasons of amenity; and
- to protect public health.

The Environment Agency carries out the monitoring and then reports to the Department of the Environment, which assesses compliance on a calendar year basis. The bathing season in England and Wales runs from 15 May to 30 September and sampling commences two weeks before the start of the season. Twenty samples are taken at regular intervals throughout the season at each site and these are analysed for total and faecal coliform bacteria. All samples are taken at predetermined points off the beach of the identified bathing water where the daily average density of bathers is at its highest (Environment Agency, 1999).

The mandatory coliform standards given in the Directive that are used to assess compliance are that 95% of samples meet the following:

6. a limit of 10,000 total coliforms per 100ml; and
7. no more than 2,000 faecal coliforms per 100ml.

The more stringent guideline values for coliform and faecal streptococci standards given in the Directive are that:

8. 80% of samples must not contain more than 500 total coliforms or 100 faecal coliforms per 100ml; and
9. 90% of samples must not contain more than 100 faecal streptococci per 100ml.

Cayton Bay is a designated Bathing Beach and its waters are tested on a regular basis by the Environment Agency to determine compliance. Data for samples taken in 1999 and 2000 at Cayton Bay are presented in Table 2.1. The Bay has met mandatory standards for total coliforms and faecal during both years, however it has failed to meet the more stringent guideline values for faecal coliforms in 1999 and faecal coliforms /faecal streptococci in 2000.

There are no designated Blue Flag award beaches within the study area, however, Cayton Bay has qualified for the Tidy Britain Group Seaside Award, achieving mandatory Bathing Water Directive Standards over the past six years. These awards are only given to beaches that are clean, safe and have water quality that meets European legislation. Applications for seaside awards are made on an annual basis and an announcement of qualifying sites is made in March.

Table 2.1 Bathing Water Quality at Cayton Bay

Units: bacteria per 100 ml sample

Criterion	Cayton Bay	
	1999	2000
Total Coliforms		
80 th Percentile (<i>Guideline</i>)	200	310
90 th Percentile	248	392
95 th Percentile (<i>Mandatory</i>)	306	420
Maximum	477	450
Faecal Coliforms		
80 th Percentile (<i>Guideline</i>)	102	216
90 th Percentile	109	300
95 th Percentile (<i>Mandatory</i>)	114	304
Maximum	114	324
Faecal Streptococci		
90 th Percentile (<i>Guideline</i>)	91	210
95 th Percentile	145	330
Maximum	250	360

Note: Results in shaded boxes represent exceedances of the corresponding standard in the EU Bathing Water Directive.

The Esk and Coast Local Environment Agency Plan (1999) identified the need for improvements in coastal water quality at various locations along the Yorkshire coast including the study area. The Agency monitoring highlighted relatively poor bathing water quality and a requirement for the installation of primary treatment by the end of 2000 at all coastal outfalls serving populations over 10,000 in order to comply with the requirements of the Urban Waste Water Treatment Directive (UWWT). This therefore applied to the industrial (McCain) pipeline and the storm/emergency discharges at Wheatcroft pumping station north of Cayton Bay that is classed as a major outfall as it is one of four pumping stations servicing the Scarborough area which intercepts the flow of wastewater from the town via the main drainage areas and pumps it to Scalby for treatment.

In addition, the Secretary of State for the Environment has decided that High Natural Dispersion Area (HNDA) status will no longer apply in the UK and therefore all significant outfalls such as Wheatcroft will require secondary treatment by December 2000. An activity table in the Esk and Coast LEAP identified the issue of threats to coastal water quality from permitted discharges. One of the actions identified in the table being for the Agency to ‘...ensure the delivery by YWS of secondary treatment..... by December 2000.’

Yorkshire Water Services has met this deadline and installed a new £30 million waste water treatment and disposal scheme as part of its Coast Care initiative, involving the development of a new treatment plant at Scalby Lodge providing screening, primary treatment and the latest UV disinfection. Sewage treatment infrastructure within the study area includes waste water pumping stations at Killerby Cliff (inland) and Knipe Point. There is also a long sea outfall (continuous discharge to 2km offshore) and short sea outfall discharging at MLWS immediately to the north of the study area in Cornelian Bay. A private septic tank discharges onto Cayton beach from a property at the base of Tenant’s Cliff adjacent to the disused water pumping station.

2.5

Ecology and Nature Conservation

Information on the ecology of the study area is based on information from:

- the Natural Area profile;
- citations provided by English Nature;
- discussions with ecologists from English Nature and Scarborough Borough Council;

- data supplied by the SINC Survey Steering Group and discussions with the County Ecologist;
- fisheries survey information provided by the North-Eastern Sea Fisheries Committee (as part of the Filey Bay strategy study) and discussions with MAFF District Fisheries Officer;
- Directory of the North Sea Coastal Margin (JNCC 1993);
- Marine Nature Conservation Review: Sector 5 - South-east Scotland and north-east England (JNCC, 1998);
- site visits by Halcrow scientists.

2.5.1

General Description

Cayton Bay falls within the Saltburn to Bridlington Maritime Natural Area (English Nature 1998b). The Natural Area extends inland to all habitats with a coastal influence and offshore to the 12 mile territorial limit. Significant features of nature conservation importance in the Bay are:

- Species rich coastal grasslands
- Cliff invertebrates
- Wading birds during winter months
- Exposures of Upper Jurassic strata with associated plant and animal fossil sites.

The Bay is composed of a suite of habitats, including terrestrial, semi-aquatic, freshwater/mildly brackish and marine all combining to form a stretch of open coast of great variety.

2.5.2

Nature Conservation Designations

There are no International or European sites of nature conservation interest lying within the study area. However, those national and local nature conservation designations in the study area are defined as follows:

- (a) Statutory, National Importance
 - Sites of Special Scientific Interest (SSSI) - Designated under the Wildlife and Countryside Act 1981, SSSIs represent some of the best examples of Britain's natural features. SSSIs are of national or regional nature conservation or geological importance.

- (b) Non Statutory, County Importance
 - County Wildlife Sites - These are sites of nature conservation interest identified as being of county importance to wildlife conservation.
 - Regionally Important Geological/Geomorphological Sites (RIGS) - These are identified by locally developed criteria, and are currently the most important places for geology and geomorphology outside statutorily protected land such as SSSIs. There are currently no RIGS within the study area as the Ryedale and Scarborough RIGS group has only recently formed and it is currently in the process of developing criteria against which to assess sites within their remit.

2.5.3

Designations in the Study Area

Figure 2.2 shows the existing nature conservation designations within the study area. The entire study area is covered by some form of designation, including two Sites of Special Scientific Interest (SSSIs) linked by a Site of Importance for Nature Conservation (SINC). The characteristics of these designated nature conservation sites are summarised below.

Both SSSI sites have been primarily designated for their geological interest and are of international importance in the Geological Conservation Review. High Red Cliffs and Red Cliff, and part of the Cayton, Cornelian and South Bays SSSI have been proposed as an international Stratotype by a sub-committee of the International Union of Geological Sciences. The Gristhorpe Plant Bed (immediately to the south of the study area) is included on the Global Indicative List of Geological Sites.

- (a) Cayton, Cornelian and South Bays SSSI

Parts of this SSSI (notably Cornelian and South Bays) lie to the north of the study area. All three bays are of biological and geological interest. Geologically the area is of importance for its exposures of the middle Jurassic, Callovian series from the Cornbrash to the Hackness Rock. It has a particularly well displayed junction of the Oxford Clay with the Callovian sequence for which it has been proposed as the type locality. Cliffs and foreshore exposure in Cayton Bay, at Tenants Cliff, expose the overlying Calcareous Grit formation and more specifically the type section of the Tenant's Cliff Member. The Member comprises sandstones with calcareous concretions, some of which yield an abundant fauna of ammonites, especially *Cardioceras*. It is also the type fauna of the Buckowskii Subzone (Codatum Zone, Lower Oxfordian) and therefore of international importance.

The steep slopes of the cliffs extending down to the beach support areas of species-rich grassland, including common spotted-orchid (*Dactylorhiza fuchsii*), twayblade (*Listera ovata*), glaucous sedge (*Carex flacca*), cowslip (*Primula veris*) and pignut (*Conopodium majus*). Semi natural woodland including alder and willow (*Salix alba*) by springs and damp hollows among planted sycamore, wych elm and ash, occupies the coastal slopes to the north of the bay. There is a rich dead wood invertebrate fauna and a variety of breeding birds including green woodpecker, and sparrowhawk. Frequent springs and open pools are found on the plateau of Tennant's Cliff supporting the locally scarce tubular water-dropwort (*Oenanthe fistulosa*) and Hemlock water dropwort (*Oenanthe crocata*) with grass of Parnassus (*Parnassia palustris*) and marsh arrowgrass (*Triglochin palustris*) growing in damp areas. Semi natural grassland and scrub predominate around the edge of the woodland.

The bare and eroding boulder clay on the more unstable areas of the cliff also supports a rich invertebrate assemblage of ground beetles and soldier flies, believed to be the richest in Northern England. Significant species include the nationally scarce shore ground beetle (*Nebria livida*), a high diversity of ground beetles of the genus *Bembidion*, including the nationally scarce *Bembidion saxatile* and the local species *Pterostichus macer* at its second most northern location in Britain. Seepages in the cliff grasslands support populations of local soldier flies (*Stratiomyidae*) as well as the nationally scarce weevil *Grypidius equiseti*. An invertebrate site register has been prepared by the Nature Conservancy Council that records red data book and notable species in Cayton Bay.

Intertidal areas support feeding and roosting waders and gulls, with nationally significant numbers of purple sandpiper (*Calidris maritima*) and turnstone (*Arenaria interpres*) during the winter months.

(b) Gristhorpe Bay and Redcliff SSSI

Gristhorpe Bay itself is immediately to the south of the study area, obscured by the headland of Red Cliff. High Red Cliff exposes a thick sequence of Callovian (Upper Jurassic) rocks from the Cornbrash to the Oxford Clay and is of great importance in interpreting the history of the Yorkshire area during this part of geological time.

The cliff sequence exposed here comprises the following:

Cornbrash
Cornbrash shales

Kellaways Rock (particularly well developed, exhibiting a rich fossil fauna)
Hackness Rock
Oxford Clay

This is a critical site for studies of Callovian palaeogeography and it is extensively used for geological study and research.

Coastal defence related operations identified by English Nature as likely to damage the features of special interest at these two sites include the following:

- Reclamation of land from the sea;
- Erection of sea defences or coast protection works, including cliff or landslip drainage or stabilisation measures;
- extraction of minerals including shingle, sand and gravel, topsoil, subsoil, shells and spoil;
- erection of permanent or temporary structures, or the undertaking of engineering works including drilling.
- Modification of natural features, clearance of boulders, large stones, loose rock or scree and battering, buttressing or grading rock faces.
- Use of vehicles or craft likely to damage or disturb features of interest.

(c) Lebberston and Gristhorpe Cliffs SINC

Parts of this SINC cover the southern area of Cayton Bay. Those habitats lying within the study area include coastal grassland, bare ground, intertidal boulders and rocks associated with the wave cut platform, hard cliff, continuous bracken and scattered bracken. Further SINC designations exist to the north and south of the study area, details of which are given in Fact Sheet 9 on Nature Conservation, produced by Scarborough Borough Council. However it has been agreed by the SINC Panel that the coastal cliffs and other maritime habitats are sufficiently important to warrant at least designation as a SINC along the full length of the coastline excepting the settlement areas. Existing national designations (SSSIs) within the study area preclude the need for further SINC designations within this area.

2.5.4

Freshwater and Brackish Habitats

There has been a history of pond formations along the perimeter of the descending cliff line at Cayton Bay. The freshwater ponds which received sea spray, located in the middle of the bay, formerly supported a rich and diverse fauna, comprising freshwater species such as the common frog (*Rana temporaria*),

some of coastal habit, fringed by marginal rushes and other marginal aquatic plants. Observed invertebrate taxa included adult winged species of Odonata (Damselflies & Dragonflies), Corixidae (Lesser Waterboatmen) and some small 'Gammarid' species. Vertebrate taxa included the common toad (*Bufo bufo*), Smooth Newt and Great Crested Newt. During the past 10-15yrs, these coastal freshwater ponds have all but disappeared, being swamped in excessive vegetative growth (caused by increased nutrient enrichment through groundwater runoff) resulting in a complete loss of habitat for these species.

At present, the last known coastal pond in Cayton Bay lies at the foot of the woodland located in the north of the bay, covering some 50m of open water with submerged and marginal aquatic vegetation. The pond receives freshwater drainage from the adjacent forest and some sea spray especially during E or SE storms (Hindley, J in correspondence). There are other seasonal/permanent pools mainly overgrown or filled with leaf litter.

Coastal water bodies, which receive a direct input of salt derived from the adjacent sea, are as such sometimes referred to as lagoon or lagoon-like habitats or saline ponds, and as such this site could be described in this way. The rarity of brackish water lagoons (and lagoon like bodies) on a national and European scale, particularly natural lagoons, has given the conservation of these habitats great importance. They are identified as priority habitats in the UK Biodiversity Action Plan and the Habitats Directive (85/338/EEC) (Smith & Laffoley, 1992).

2.5.5

Marine and Intertidal Ecology

In the marine ecotope, Cayton Bay demonstrates classic sandy beach, sub littoral reef, high and mid shore intertidal rocky shore and pools, along with more sheltered areas of beach of finer sediments and hence different benthic ecology. Rocky outcrops such as Calf Allen Rocks and the rocky platforms at Knipe Point extend out to sea, with the exposed, wave-battered rocky ledges forming a habitat for barnacles, limpets and mussels, and a more diverse marine fauna present, along with seaweeds, in reef sheltered areas and amongst boulders.

JNCC (1998) has mapped the intertidal and near-shore subtidal habitats of the study area using a system of biotope classification. This categorises the habitats according to their physical characteristic, dominant species and distinctive communities of plants and animals. The biotopes recorded in the study area are tabulated in Table 2.2.

Table 2.2 Biotopes of Cayton Bay (and Leberston Cliff)

Biotope Code	Description
Littoral Gravels and Sands	
LGS.S.AEur	Burrowing amphipods and <i>Eurydice pulchra</i> in well-drained clean sand shores
LGS.S.AP.P	Burrowing amphipods and polychaetes (often with <i>Arenicola marina</i>) in clean sand shores
LGS.S.AP.Pon	Burrowing amphipods <i>Pontocrates spp.</i> and <i>Bathyporeia spp</i> in lower shore clean sand
Moderately exposed littoral rock	
MLR.Eph.Ent	<i>Enteromorpha spp</i> on freshwater influenced or unstable upper eulittoral rock
MLR.BF.Fser.Fser.Bo	<i>Fucus serratus</i> and under-boulder fauna on lower eulittoral boulders
Sheltered littoral rock	
SLR.F.Fspi	<i>Fucus spiralis</i> on moderately exposed to very sheltered upper eulittoral rock
SLR.F.Fves	<i>Fucus vesiculosus</i> on sheltered mid eulittoral rock
Exposed Littoral rock	
ELR.MB.Bpat.Sem	<i>Semibalanus balanoides</i> on exposed or moderately exposed, or vertical sheltered, eulittoral rock
Littoral Rock (Other)	
LR.Rkp.FK	Fucoids and kelps in deep eulittoral rockpools
Moderately exposed infralittoral rock	
MIR.KR.Ldig.Ldig.Bo	<i>Laminaria digitata</i> and under-boulder fauna on sublittoral fringe boulders
Moderately exposed circalittoral rock	
MCR.GzFa.FaAIC	Faunal and algal crusts, <i>Echinus esculentus</i> , sparse <i>Alcyonium digitatum</i> and grazing-tolerant fauna on moderately exposed circalittoral rock
Circalittoral muddy sands	
CMS.Abr.Nuc.Cor	<i>Abra alba</i> , <i>Nucula nitida</i> and <i>Corbula gibba</i> in circalittoral muddy sand or slightly mixed sediment

2.5.6

Biodiversity Action Plan

The second tranche of UK Biodiversity Action Plans (UK Biodiversity Group 1999) cover two habitats of which there are significant resources in the study area:

- Maritime cliff and slopes
- Soft cliffs such as those found in Cayton Bay are significant for their vegetation, invertebrate communities, seepages, springs and pools. Factors affecting these

habitats are construction of coastal defences, squeeze of cliff-top habitats between eroding cliff faces and cultivated land, agricultural intensification and built development close to the cliff top. The BAP sets targets to retain the UK maritime cliff resource, increase the area of semi-natural cliff-top habitat, retain or increase the area unaffected by coastal defences and improve management of the resource. A national inventory of maritime cliff and slope vegetation is being prepared by English Nature.

- Saline Lagoons

There are brackish water pools within Cayton Bay that may be considered as being saline lagoons. There are several different types of lagoon, one described in the BAP as being 'ponded waters in depressions on soft sedimentary shores'. The flora and invertebrate fauna present can be divided into those that are essentially freshwater in origin, those that are marine/brackish species and those that are more specialist lagoonal species. Factors affecting these habitats are changes in salinity regimes, pollution (in particular nutrient enrichment), construction of coastal defence, sea level rise and infilling or land claim. The BAP sets targets to maintain/enhance the current number, area and distribution of coastal lagoons, and to create by the year 2010, sufficient lagoon habitat to offset losses over the last 50 years. Future losses should be compensated for where feasible as and when they arise.

Preparation of a Local Biodiversity Action Plan by Scarborough Borough Council is due to commence shortly.

2.5.7

Main Nature Conservation Issues

The Natural Area Profile (English Nature 1998b) identifies the following main issues relating to nature conservation that may affect the study area:

- loss of semi-natural habitats
- natural coastal processes
- coastal protection schemes, managed retreat
- management conflicts
- sediment movement and diminishing supply
- mineral workings
- gas and oil industries/exploration
- catastrophic pollution events (e.g. oil spills)
- offshore waste disposal
- water quality and sewage outfalls

- agricultural events, such as runoff and encroachment onto the coast
- development and disturbance
- complex ownership and legislation
- impact of dredging
- offshore aggregate extraction
- fishing and potting industries
- over-collecting of shellfish
- recreational pressures e.g. caravan sites
- extension of heritage coast
- lack of education and interpretation facilities e.g. geology trails
- fossil collecting
- vegetation obscuring geological faces and neglect of geological faces
- possible conflict between nature conservation/geology

English Nature has also put forward three objectives for the Natural Area:

- (a) Manage characteristic wildlife habitats and associated species in a sustainable way, and restore these where appropriate and where they have been lost from the Natural Area. Key components of relevance are:
- sea cliffs and cliff vegetation - including maintenance of natural processes of erosion and buffer strips of semi-natural vegetation along cliff tops to protect coastal habitats from agricultural impacts.
 - sandy and muddy shores - including maintenance of natural processes, improvement of water quality and taking account of the needs of wading birds.
 - shingle and rocky shores
 - offshore subtidal habitats and open sea - including sediment processes
- (b) Maintain characteristic and rare species populations, whilst maintaining natural processes. Key components are:
- shoreline and intertidal birds (relevant species include turnstone and purple sandpiper)
 - rare invertebrate populations characteristic of soft cliffs (notable species of relevance include soldier flies and ground beetles)
 - plants and animals associated with base-rich coastal grasslands
 - species associated with rocky shores

- (c) Maintain the diversity of geological interest found in the area. Key components are:
- maintenance of natural processes, with active management where necessary
 - raising the profile by better interpretation and education
 - maintaining access to all exposed sites
 - responsible fossil collection
 - local conservation strategies such as a RIGS group
 - serious consideration of geological interest in determining planning applications
 - international designations for geological sites should be encouraged.

2.6

Landscape

Landscape information has been obtained from field visits, Scarborough Borough Council's Landscape Appraisal (Local Plan Fact Sheet No 7), Proposed Extension to the North Yorkshire and Cleveland Heritage Coast (May 1996) and the Shoreline Management Plan.

2.6.1

Landscape Setting of the Coast

Cayton Bay is a self-contained landscape enclosed by the relatively hard headlands of Knipe Point to the north and Red Cliff to the south. The coastal character of the bay is strongly influenced by its underlying geology with tree covered slopes extending from Knipe Point to Tenants Cliff giving way to more unstable eroding boulder clay cliffs with sparse vegetation cover. The wide sandy sweep of the beach extends around the bay from Johnny Flints Harbour in the north before giving way to the bedrock at the base of Red Cliff to the south.

The north of the bay contains a variety of landscape features including managed and replanted woodlands, pools, scrub, semi-improved grassland and floristically rich cliff slopes. Panoramic views around Cayton Bay can be obtained from the beach, cliff top path and from sections of Osgodby Hill road. The cliff top residences of Killerby Cliff and the Cayton Bay holiday park are clearly visible from the beach due to a lack of extensive woodlands or hedgerows, thus detracting from the overall landscape quality of the area. Developments closer to the shore include the old pumping station and kiosk located on the edge of lower lying cliffs towards the centre of the bay. Second World War pill boxes line the beach at periodic intervals in varying states of repair with other Second World War

structures found along the Killerby cliff top. Much of the cliff base, particularly to the north, is fronted by large boulders that have eroded out of the cliff face.

Within the study area significant landscape features are:

- The distinctive promontory of Knipe or Osgodby Point;
- The soft cliffs within much of the Bay, which include areas of extensive vegetation and other sections exhibiting recent erosion and cliff falls;
- The uninterrupted sandy beach stretching from Knipe Point around the Bay;
- Individual developments along the cliff-top such as Knipe Point residential complex overlooking the northern section of the Bay, the pumphouse station at the base of the cliff, tourist developments such as the Beach View Caravan Park and various residential properties at Killerby Cliff;
- Pill boxes lying at various intervals along the beach foreshore.

The coastal landscape of Cayton Bay contains numerous signs of the effects of coastal erosion and cliff slumping including recent landslides onto the beach, blocked access routes to the beach at Killerby Cliff and the exposed areas of clay on the cliffs. In places drainage structures have also been eroded out of the cliff face and are largely redundant. Some second world war pill boxes now lie on the beach. Small-scale coastal defences such as rock gabions have been installed in a few locations to protect discharge pipes at the cliff toe.

2.6.2

Landscape Setting of the Hinterland

The landscape quality is generally much lower than that of the coast being largely a result of human activity and dominated by tourism related infrastructure including caravan sites and touring parks. A large car park at Killerby Cliff is well frequented during the summer months. The main A165 coast road demarcates the boundary with the residential settlements of Osgodby and Cayton that lie to the west. The remainder of the hinterland is largely agricultural with a modified enclosure landscape bounded by hedges but few trees and predominantly in arable use with some stock grazing, particularly on National Trust land at Tenants Cliff.

2.6.3

Views towards the Frontage

Visually, one of the most striking aspects of the Cayton Bay coastline is the sweeping view, obtained from almost all parts of the Bay, giving a semi-enclosed aspect to the coastline. The topography of the frontage means that the beach is not visible from far into the hinterland, however, some cliff top developments such as that at Knipe Point and Killerby Cliff are clearly visible from the beach. From Filey Road and footpaths crossing the land there are magnificent views out to sea, however vistas along the coast towards Scarborough or Filey are blocked by the headlands of the bay.

2.6.4

Landscape Designations

Cayton Bay forms part of a stretch of coastline between Scarborough and Filey Brigg that is currently located between two separate heritage coast designations, the North Yorkshire and Cleveland Heritage Coast to the north, and the Flamborough Headland Heritage Coast to the south. The North Yorkshire and Cleveland Heritage Coast partnership has put forward a proposal for the extension of the Heritage Coast to include this area (Figure 2.2). The proposed area is subject to assessment against criteria established by the 1970 Heritage Coast report that indicates that a Heritage Coast should:

- a) comprise a coastline of exceptionally fine scenic quality;
- b) exceed one mile in length;
- c) be substantially undeveloped;
- d) contain features of special significance and interest, whether natural or man-made.

The proposal is presently with the Countryside Agency for consideration.

2.7

Land Use and Population

The main land uses within the study area include agriculture, tourism, leisure and recreation, with fishing along the coast.

2.7.1

Agriculture

Agricultural land is classified by MAFF into five grades. The Provisional Agricultural Land Classification (Figure 2.3) shows that all of the land within the

study area is classified as Grade 3. More detailed work for this area has not been undertaken to date.

There is one Countryside Stewardship Scheme, funded by MAFF, in place within the study area at Killerby Cliff. Another scheme is also in place immediately to the north of the study area. The locations of these, including those that provide within the agreement for public access, are also shown in Figure 2.3. The scheme aims through the payment of grants to improve the natural beauty and diversity of the countryside, enhance, restore and recreate targeted landscapes, their wildlife habitats and historical features, and to improve opportunities for public access. Farmers and land managers enter 10-year agreements to manage land in an environmentally beneficial way in return for annual payments.

2.7.2

Conservation Land Holdings

The National Trust owns approximately 36 ha of land within the study area, specifically the area from Knipe Point to the boundary of Tenant's Cliff fields with the A165 comprising parts of the cliff, undercliff and beach. This land has been in National Trust ownership since 1984. The National Trust has statutory powers to protect its property, under an Act of Parliament (1907) by declaring its holdings of land and buildings inalienable; these properties cannot be sold or mortgaged. The area of land held by the National Trust is shown on Figure 2.3.

The Trust's cliff top grassland is actively managed through the stock grazing of highland cattle that help to reduce the dominance of coarse grasses and enhance the floristic diversity of the habitat. Public access is permitted across the Trust's landholding.

2.7.3

Settlements and Population

Settlements in close proximity to the study area include those of Cayton and Osgodby. Cayton has experienced substantial housing growth since the 1960s and some further residential expansion has been identified at Osgodby with provision made for the development of 53 new dwellings made in the Local Plan (1999). Smaller coastal developments south of Scarborough, within the study area, such as Killerby Cliff and Knipe Point, originated before the advent of planning control, many as holiday accommodation. Over the years this accommodation has become permanent residential. There are also several large caravan parks, most notably, Cayton Bay Holiday Centre.

There are no specific population figures for the settlements of Osgodby and Cayton, however, in terms of parish, the 1991 census figures for Cayton and Osgodby were 2,529 and 1,241 respectively (Scarborough Borough Council 1993).

In terms of demography, Osgodby has a particularly low proportion of children aged under 16 years old (11.5%) compared to 20% nationally. In contrast, Osgodby has a particularly high concentration of pensioners (32.8%) compared to a national average of 21.1%.

2.8

Tourism and Recreation

Tourism plays an important role within the study area, but formal tourist facilities are largely limited to those associated with the various caravan parks within the study area. However, there are numerous opportunities for informal recreation that allow enjoyment and appreciation of the natural assets of the coast (Figure 2.4).

2.8.1

Walking

The Cleveland Way, a national trail and long distance footpath, follows the cliff top from Saltburn to Carr Naze, Filey where it joins the Wolds Way. This footpath also networks with a number of local footpaths within the study area.

2.8.2

Water Sports

Cayton Bay is a very popular venue for watersports enthusiasts with activities including surfing, windsurfing, canoeing, diving, sea angling and swimming. A surf centre based at Killerby Cliff has hosted top national surfing competitions since 1989 with the Quicksilver event. Between 1990 and 1996 the Cayton Bay Surf Challenge was held and in 1995 Surfers Against Sewage participated, putting Cayton Bay on the environmental circuit. It is hoped that the Surf Challenge will be held again this year following abandonment during recent years due to a lack of funding. Since 1996 a residential surf school has been in operation, manned by a level 2 surf instructor.

Regular visits are made to the bay by canoeist and surfer groups from Liverpool and London. The beach does not have a manned lifeguard station at the present time and it is felt by some local residents that there is a need for this during the summer months.

2.8.3

Cycling

A cycling study has recently been carried out by Sustrans for North Yorkshire County Council and Scarborough Borough Council, with the aim of investigating the most appropriate route for the national cycle network within the area. A report has been produced, proposing an "East Coast Cycle Route". This would form a vital link in the National Cycle Network Route 1, which runs from the Channel Ports in Kent through East Anglia and Lincolnshire, across the Humber Bridge into Yorkshire, north through Tyneside and Northumberland and into Scotland as far as Inverness.

Within the study area, the proposed cycle route crosses the River Hertford to the south, passing due north to reach Cayton Village where three options are considered between here and Scarborough, designed to fit in with the Scarborough Cycling Strategy. One route passes through Cayton Village and Osgodby, joining the Filey Road Corridor (A165) at Cayton Cliff for which traffic calming measures are recommended for main street, Cayton. Alternative routes passing further inland include the Seamer Road Corridor following quiet roads, Eastway and Westway from Eastfield west to the A64, and the Deepdale Route which follows a bridle path north from Overdale in Eastfield.

The Filey Road corridor is the recommended route in the Scarborough Cycling Strategy for the National Cycle Network. However, the development of this route is connected to the construction of a new section of the A165 road avoiding Osgodby.

2.8.4

Access to the Beach and Coastal Area

The beach at Cayton Bay is a major attraction with both local residents and tourists using it for recreational purposes, predominantly in the summer season (June to September). Public pedestrian access to the northern part of the bay is gained via woodland paths maintained by the National Trust. The Trust also permits access across its land along the cliff top. A private road provides access to housing and the pumping station located at the base of Tenants cliff in the centre of the bay. The public are permitted to use this as a pedestrian access route to the beach at their own risk. A further public right of way providing access down through Killerby Cliff to Cayton Sands is temporarily prohibited to pedestrian use due to a recent land slippage that has blocked the path. This path is due to be restored by Easter 2001. Slippage is a major and perennial problem in retaining coastal paths and routes down to the beach.

There is no official access to the beach at the Haven holiday village further to the south at Gristhorpe Cliff, therefore many visitors come to Cayton Bay.

A privately owned 2 acre car park at Killerby Cliff is open to the public at a cost of £2 per day servicing approximately 8,000 cars per annum. It provides a range of facilities including toilets, shop, picnic area and free hot showers. Further parking facilities within the study area are associated with the Holiday Village and there is some informal parking provision along the road leading to Cayton Village.

2.8.5

Accommodation

There is no hotel accommodation within the immediate vicinity of Cayton Bay, however there are several large caravan/camping sites and holiday villages, notably the Beach View Caravan Park and Cayton Bay Holiday Park where the emphasis is on self-contained sport and entertainment facilities. Data on these sites are given in Table 2.3.

Table 2.3 Caravan Sites and Facilities at Cayton Bay

	Capacity				Facilities on Site							
	Touring Caravans	Tents	Static Caravans	Chalets	Electricity to pitches	Toilet Blocks	Laundry Facilities	Shop	Restaurant/Cafe	Licensed club/bar	Entertainments	Indoor Swimming Pool
Brown's Caravan Park	35	-	-	-	Y	Y	Y					
Cayton Village Caravan Park	200	-	-	-	Y	Y	Y	Y				
Cayton Bay Holiday Centre	-	-	300	24	Y		Y	Y	Y	Y	Y	Y

Source: Tourist Information Centre Fact Sheets.

2.8.6

Tourism and the Local Economy

The tourist market plays an important role in the local economy, both in terms of visitor spending and by providing employment. Visitors staying in tents, caravans and chalets made up around 24% of total visitor days in the Borough in 1993 and are valued as making a significant contribution to the local economy. The settlements of Osgodby and Cayton have few employment opportunities and those that exist are largely tourist related, notably the caravan sites.

There are no specific figures for the settlements of Cayton and Osgodby which are incorporated into the 'southern rural' area which is defined as the area around Filey and Scarborough extending from Reighton in the South to Staintondale in the North (excluding the town of Scarborough). In 1998, approximately 4 million tourist days were spent in Filey and the surrounding rural area, generating an estimated £90 million for the local economy and sustaining approximately 2,400 full-time equivalent (FTE) jobs. A breakdown of these figures is given in Table 2.4. Figures for the southern rural area are based on an apportionment of the total rural area.

Table 2.4 The Impact of Tourism in the Rural South of Scarborough, 1998

	Rural South ⁽⁴⁾
Tourist Days (000s)¹	3871
Staying in serviced accommodation	112
Staying in non-serviced accommodation	3335
Staying with friends and relatives	126
Day visitors	298
Tourist Numbers (000s)	877
Staying in serviced accommodation	53
Staying in non-serviced accommodation	487
Staying with friends and relatives	39
Day visitors	298
Economic Impact (£m)²	85.3
Staying in serviced accommodation	7.3
Staying in non-serviced accommodation	71.8
Staying with friends and relatives	2.6
Day visitors	3.6
Direct	-
Indirect	-
Employment³	2179
Direct	-
Indirect	-

Sources: Scarborough Tourism Economic Activity Monitor

Notes:

¹ Tourist Days are calculated by multiplying the number of visitors by the number of days spent in the area.

² Economic Impact relates to overall expenditure in the region, including direct expenditure by visitors and indirect expenditure (e.g. supplies, employees' wages).

³ Employment = average employment supported by direct and indirect revenue throughout the year.

Tourism in the Rural South is highly seasonal as shown in Table 2.5 overleaf. This seasonality and the relatively high reliance of the local economy on the tourist

industry can create problems, however this is more pronounced outside the study area, with some traders in Filey and Scarborough having to adapt their businesses to seasonal fluctuations and often closing during the winter period.

Table 2.5 Tourist Days Spent in the Rural South by Season, 1998

	Rural South
January- March	6%
April-June	34%
July-September	49%
October-December	11%

Source: Filey and the South

Scarborough Borough Council has recently produced its tourism strategy for 2000-2005. In terms of strategy development, the Borough has been divided into three areas, Scarborough Town, Whitby and the Rural North and Filey and the South. Key issues have been developed relating to the future tourism development and marketing of Filey, largely in terms of the surrounding area, as follows:

- Viability of future facilities. The limited resident population and increasing investment and competition from surrounding caravan parks represents both an opportunity and a threat to Filey's tourism industry, which is facing a downward spiral of lack of visitor demand for facilities leading to facility closure. Maintaining existing facilities and developing new ones is viewed as a key challenge.
- Maximising the synergy between Filey and the surrounding accommodation. Research suggests that the majority of visitors to the surrounding caravan parks do visit Filey. However, opportunities to maximise their spend in the town need to be explored, such as increased accessibility by public transport.

2.9

Fisheries

Information on fishing activities within the study area was obtained through consultation with the North Eastern Sea Fisheries Joint Committee (NESFC) and MAFF District Fisheries Officer.

There are no indigenous fleets of vessels within Cayton Bay, however, sizeable fleets located at Scarborough and Filey, lying immediately to the north and south of the Bay respectively, work Cayton Bay. Shellfishing is undertaken within the bay by approximately six small vessels (under 12 metres) laying pots for crab and

lobster. A further six trawlers also operate within the bay focusing on cod, whiting and all flat fish. Fishing for Dover Sole is prohibited between the months of January and April. Juvenile fish are found within the study area and there are small nursery grounds to the south at Filey Brigg although these are not significant.

Fishing activity along the Yorkshire coast can be classified into inshore or offshore with trawlers up to 18.6 m permitted to fish within six miles of the coast. Most of the catch is sold on UK markets at Scarborough, Hull and Grimsby. Shellfish is sold to merchants who supply UK and Continental buyers. The main commercial fish species found around the study area are listed in Table 2.6.

Table 2.6 Commercial Fish Species around the Study Area

PELAGIC SPECIES		
Mackerel	<i>Scomber scombrus</i>	
Herring	<i>Clupea harengus</i>	
Sprat	<i>Sprattus sprattus</i>	
DEMERSAL SPECIES		
Elasmobranchs		
Thornback ray	<i>Raja clavata</i>	
Lesser spotted dogfish	<i>Scyliorbinus canicula</i>	
Gadoids (cod family)		
Cod	<i>Gadus morhua</i>	Spawning peaks during February
Whiting	<i>Merlangius merlangus</i>	
Ling	<i>Molva molva</i>	Locally distributed, found especially around areas of stony ground, reefs and wrecks
Pollack	<i>Pollachius pollachius</i>	Locally distributed, found especially around areas of stony ground, reefs and wrecks
Flatfish		
Plaice	<i>Pleuronectes platessa</i>	Found over sandy sea bed. Spawns Jan to June
Dab	<i>Limanda limanda</i>	Found over sandy sea bed. Spawns Jan to June
Dover sole	<i>Solea solea</i>	More common where bottom temp higher. Spawns April to June
Lemon sole	<i>Microstomus kitt</i>	More common further north.
Turbot	<i>Scophthalmus maximus</i>	
Brill	<i>Scophthalmus rhombus</i>	
Flounder	<i>Platichthys flesus</i>	

Table 2.6 Commercial Fish Species around the Study Area Cont'd

Other demersal fish		
Bass	<i>Dicentrarchus labrax</i>	
Mulletts	<i>Chelon labross, Liza ramada, L aurata</i>	
Monkfish (Angler)	<i>Lophius piscatorius</i>	Spawns March to June
Sandeels	<i>Ammodytes spp</i>	
Gurnards	<i>Triglidae spp</i>	
Wrasse	<i>Labridae spp</i>	
MIGRATORY SPECIES		
Atlantic salmon	<i>Salmo salar</i>	Spawns freshwater, matures sea water
Sea trout	<i>Salmo trutta</i>	Spawns freshwater, matures sea water
Eel	<i>Anguilla anguilla</i>	Spawns sea water, matures freshwater
SHELLFISH		
Lobster	<i>Homarus gammarus</i>	
Crab	<i>Cancer pagurus</i>	
Velvet swimming crab	<i>Liocarcinus puber</i>	

A variety of fishing gear is used including pots, gill and trammel nets, longline and salmon 'T' and 'J' nets. The main fishing methods are:

- Demersal fish (cod, whiting, haddock, saithe, lemon sole, plaice, dab, sole, turbot, brill, ray and dogfish): gill and trammel nets, longlines, trawling and tangle nets.
- Pelagic fish (herring, sprat and mackerel): drift nets and also handlines.
- Shellfish (lobsters and brown crabs): potting.

Year-round fishing activity is maintained through the exploitation of several seasonal fisheries. Longlines and nets are mainly used for cod from autumn to spring, but a decline in this fishery during the 1980s had a serious impact on the longline fishery. Between spring and autumn, pots are more important and up to 650 lobster pots may be set by each coble. Netting for demersal fish such as sole is important from April to June. From June to August shore nets are set for salmon and sea trout.

2.10

Transport Network and Traffic

The study area is relatively remote from the national road network. The principal road connections are:

- The A165 Filey coast road connecting Cayton Bay to Filey and Scarborough;
- The B1261 connecting Cayton Bay and Lebberston with the A64 (T) to York and the A1

These main routes are served by regular bus services. The coastal road, comprising the A165 to East Yorkshire and the Humber ports is a designated priority route. The A165 Filey Road is one of the main radial routes into Scarborough and suffers congestion at peak times and during the summer months due to tourist traffic. A highway scheme is proposed for the Scarborough to Lebberston diversion in addition to a link road to the A64 (T) through the Middle Deepdale / High Eastfield area. Park and ride facilities will also be provided adjacent to the proposed Scarborough to Lebberston diversion.

Rail services are limited and pass inland of the study area, with the Scarborough to Hull line servicing Filey. However, regular bus services link Cayton to Filey, Scarborough and further afield.

Traffic in the study area is strongly seasonal, as much of it is generated by the tourist industry. The Local Transport Plan notes that the area is relatively remote and inaccessible, so reducing visitor dependence on car use is difficult. Prime objectives set by the Plan for Scarborough Borough are as follows:

- minimising the need to travel;
- where travel is necessary, to provide for the safe, speedy, and efficient movement of people and goods into and out of town centres, prime holiday destinations and major employment sites;
- minimising the negative impact of transport systems on the local and global environment.

2.11

Cultural Heritage

Information on the historic environment, including archaeology and built historical interest, within the study area has been obtained from North Yorkshire County Council Heritage Unit, Humber Archaeology Partnership, English Heritage, the Defence of Britain and Defence of Yorkshire Groups.

2.11.1

Archaeology

There is limited information on the Cayton Bay area as no survey work has been undertaken in this area. However, there is considerable potential for foreshore archaeology such as manmade ruts that would have been cut for the transportation of minerals from the North York Moors. Evidence of a donkey road exists that has been cut up through the cliff, immediately to the north of Knipe Point.

Various dykes, barrows and tumuli are located along the ridge of the cliff backing the bay. The tumuli would have been placed here deliberately in good areas of visibility at the time of the Roman conquest forming part of the defensive network including the signal stations at Filey and Scarborough. There are no settlements close to the shore, however it is possible human settlements may have been lost to erosion as it is believed that the coastline in Roman times was probably much further east of where it is today.

Osgodby is a medieval settlement and archaeological work has been undertaken where new development has taken place.

The Defence of Yorkshire project has surveyed the Cayton Bay beach defence system which was sited during the second world war. The system consisted of the following elements:

- Minefields
- Dannert Wire entanglements
- Weapon pits
- Permanent Pillboxes
- Anti-Tank Blocks

The Cayton Bay system is now unique along the North East coast in that it is the only site with an existing complex of pillboxes of this size. However, it is clear that some have moved from an original position due to the action of tides coupled with earth movement. There are six pillboxes to be found at Cayton Bay, four of which are typical of a variant of the Type 24 design of pillbox, with the other two typical of the linear 'concrete trench' type. The linear type is normally found on the cliff edge.

One of the type 24 pillboxes fronting Killerby Cliff is now at beach level and upside down having slipped down the cliff face. Immediately behind the pillbox to the north of the bay (at the base of Tenants cliff) lies a string of anti-tank blocks,

certainly in their original position. English Heritage considers that these structures should be protected in some manner, possibly through listing or scheduling, as complete pill boxes are quite rare and these form part of a longer and more elaborate chain of defence. However, no decision has yet been made with regard to their future protection.

2.11.2

Archaeological Sites

There are no Scheduled Monuments located within the study area, however records of non-scheduled sites have been obtained from North Yorkshire County Council (31 sites in the study area). The site locations are mapped in Figure 2.5. North Yorkshire County Council notes that the unknown archaeological resource is likely to be greater than that which is known and suggests that detailed assessments and field visits are needed to provide up to date comprehensive information. Whilst it is agreed that there are likely to be many unknown sites, detailed investigations of this kind are beyond the scope of a strategy study. It is recommended that consideration be given to further research and field investigations in relation to any proposed specific coastal defence schemes that may affect known or potential archaeological sites.

A number of excavations have been undertaken within the study area in the past in relation to other planning applications. The most significant finds being that of a medieval shrunken village at Osgodby, including housing, roads, buildings and pits excavated during the mid 1950/60s. Monitoring of groundworks associated with expansion of 'the Barn' public house in Osgodby during 1997/8 and construction of drainage works/a new garage at Manor Farm, Osgodby during 1997 did not reveal any new information on the poorly understood complex of buildings.

2.11.3

Conservation Areas

A Conservation Area is an area of special architectural or historic interest, the character or appearance of which it is desirable to preserve or enhance. There are no designated Conservation Areas within the study area, although one does exist in the nearby settlement of Cayton.

2.11.4

Wreck Sites

There is a number of wreck sites out beyond the headland, the accurate positioning of which is in some doubt. Considerable maritime traffic passed in and out of Scarborough so there is great potential for numerous wreck sites within the Cayton Bay area. Five records are recorded on the National Monuments Record maritime database, only one of which details actual located vessel remains. The remaining

four are casualty records which are know documented shipping losses whose remains have not been located and whose precise position of loss is not known. However, original documentary sources described these vessels as being lost in the vicinity of Cayton Bay. Therefore the co-ordinates contained in the records below (Table 2.7) are for Cayton Bay itself, and therefore do not tell us anything about what is currently known to occupy the seabed, they do provide an indication of the archaeological potential of the area.

Table 2.7 Wreck Site Details for Cayton Bay

NMR No	Name	Period	Craft Type	Material	Propulsion
TA 08 NE 138/133752 3	Isabella	Post Medieval (1851)	English Schooner	Wood	Sail
TA 08 NE 38/973026	Fly	Post Medieval (1880)	English Schooner	Wood	Sail
TA08NE 130/ 1303795	Centurion	Post Medieval (1828)	English Cargo Vessel	Wood	Sail
TA08NE 133/ 1306462	Unknown	Post Medieval (1824)	Dutch cargo vessel	Wood	Sail
TA18NW 3/909138	Eli	Modern (1914)	Norwegian cargo vessel		Steam

2.12

2.12.1

Planning Issues

Relevant Planning Guidance

Planning Policy Guidance Notes (PPGs) and Minerals Planning Guidance (MPGs) are prepared by the Government, after public consultation, to provide guidance to local authorities and others on policies and the operation of the planning system. National Planning Policy Guidance Note 20 on Coastal Planning is perhaps the most relevant to this study as it covers planning policy for the coastal areas of England and Wales. It identifies key planning policy issues for the coast as being: conservation of the natural environment, development and risks (including flooding, erosion and land instability). As many of the issues which need to be addressed in planning the coast also apply inland, other PPG's of relevance include those on countryside, green belts, nature conservation, ancient monuments, sport and recreation and development in areas subject to risk of flooding.

Regional Planning Guidance for Yorkshire and the Humber (RPG12) is currently undergoing revision. The preparation of draft revised guidance produced in October 1999 by the Regional Assembly for Yorkshire and Humberside (RAYH), was followed by public consultation in Dec/Jan and an examination in public by an independent panel who submitted their report to the Secretary of State in October 2000. Following consideration of this report and representations from the public consultation, the Secretary of State has published his proposed changes which are subject to further public consultation until June 2001. This version of RPG12 looks forward to 2016 and replaces the guidance issued in 1996 which covered the period to 2006.

One significant change of relevance to this study is a revised policy on development and flood risk and an additional map indicating flood risk areas that are proposed in order to ensure a more rigorous approach in the region. The policy sets out a systematic approach and requires liaison with the Environment Agency at all stages of the planning process.

The revised RPG sets out the following broad objectives for the area:

- Maintenance of high and stable levels of economic growth and employment;
- Social progress which recognises the needs of everyone;
- Effective protection of the environment;
- Prudent use of natural resources.

Site-specific statutory planning guidance is contained in the North Yorkshire County Structure Plan and the Scarborough Borough Local Plan that set out more detailed policies and specific proposals to guide development in their areas. The Shoreline Management Plan and Local Environment Agency Plan are also relevant.

The Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 (SI 293 of 1999) implement the European Union Directives on EIA (Directive 85/337/EEC as amended by Directive 97/11/EC) for those projects that require planning permission in England and Wales. This includes coastal defences proposed by local authorities. Sea defences proposed by flood defence authorities such as the Environment Agency do not generally require planning permission, but the requirement for EIA is implemented through the Environmental Impact Assessment (Land Drainage Improvement Works) Regulations 1999 (SI 1783 of 1999).

2.12.2

North Yorkshire County Structure Plan

The third Alteration to the original 1980 County Structure Plan was adopted by North Yorkshire County Council in October 1995 and its provisions have been incorporated into the document, which constitutes the adopted North Yorkshire County Structure Plan for the period to 2006. The role of the Structure Plan is to set out key strategic policies as a framework to feed into local planning by District Councils. The Structure Plan does not refer to specific sites or locations.

Priority is placed on the conservation of the landscape and general amenity areas of importance, such as the Flamborough Head Heritage Coast. Within such areas there is a strong presumption against new development or major extensions to existing development. When development is permitted, high standards of design are required and measures taken to protect and enhance the landscape, important buildings and other heritage feature. In addition, development will not normally be permitted within national nature reserves, local nature reserves and sites of special scientific interest, or in adjoining locations where development would have an adverse effect on such sites.

The Plan contains specific policies restricting the development of roads, caravan, chalet, camping and other recreational developments (including the provision of car parking) to areas that can absorb the development and visitors without suffering environmental damage, and where they will not adversely affect areas of nature conservation or archaeological significance. The Plan also contains a policy for the maintenance, review and upgrading of footpaths and bridleways where the need for recreational or visitor management is greatest, including national parks and heritage coasts.

The Joint Structure Plan is currently being reviewed so it looks ahead to 2016. A consultation report has been produced with supporting documentation outlining possible development strategies and stating nine key aims that have been developed representing a broad statement of what the four authorities want to achieve and how development should take place through to 2016. A deposit draft of the Joint Structure Plan is due to be published shortly followed by an examination in public in Autumn 2001 and subsequent adoption.

2.12.3

Scarborough Borough Local Plan

The Scarborough Borough Local Plan was adopted by Scarborough Borough Council on 3 April 1999 and, together with the North Yorkshire County Structure Plan, deals with strategic issues and is the main policy document referred to by the

Borough Council when determining planning applications. The two main purposes of the Plan are:

- to set out the Borough Council's policies for the control of development; and
- to make proposals for the development and use of land and to allocate land for specific purposes.

The Plan's environmental strategy sets out policies that are intended to contribute to meeting several environmental objectives, including:

- To encourage development which contributes to the improvement of the character of the area, both urban and rural, and enhances its physical beauty;
- To work towards sustainable development;
- To protect air and water quality, and land resources and infrastructure;
- To encourage the diversification of the economy while protecting the natural beauty and environmental quality of the countryside;
- To prevent development that would harm the character and appearance of the area's landscape, and seek further improvements to that landscape;
- To protect the landscape of the Coastal Zone and Heritage Coasts and seek the improvement and restoration of those parts and adjacent areas that have been degraded by past development;
- To protect sites specifically identified for their nature conservation value and wherever possible to enhance the ecological richness of the Local Plan area;
- To preserve and enhance the historic qualities of the area's environment;

Specific environment policies relevant to the study area include:

Policy E.2 The Coastal Zone

Development within the defined coastal zone will be strictly limited to that for which a coastal location is essential and where it will enhance the open, expansive character of the coastal landscape. Proposals for new development will be required to demonstrate that they cannot be

located elsewhere. Where development is permitted, appropriate mitigation measures will be required to redress any potential harm to the landscape or nature conservation interests.

The Cayton Bay study area lies within the defined coastal zone as outlined on the proposals map of the Local Plan. Proposals are now being considered for an extension of the North Yorkshire and Cleveland Heritage Coast to include the coastline south of Scarborough to Filey Brigg that will encompass land within the Study Area.

E.8 National Nature Conservation Sites

Proposals which are likely to adversely affect, directly or indirectly, the nature conservation interest of a Site of Special Scientific Interest, National Nature Reserve, or other statutorily designated nature conservation site will be subject to special scrutiny, and will only be permitted if harm to the interest can be overcome by conditions or planning obligations, or if there are special reasons for granting the permission, which outweigh the national importance of the site.

E.16: Development on Unstable Land

Applications for the development of land which may potentially be unstable should be accompanied by a site survey undertaken at the developer's expense. The Local Plan area contains extensive stretches of cliff top areas and cliff slopes overlain by boulder clay which is potentially unstable. This is true of the whole Study Area.

E.17 Coastal Protection Works

Coast protection works will only be permitted where they accord with an approved shoreline management plan. In advance of an approved shoreline management plan, coastal protection measures will only be permitted where they are essential to protect the life or important natural or man-made assets at imminent risk and are technically, environmentally and economically sound and sustainable.

E.18 Development Close to Coastal and Other Cliff Edges

Development would not be permitted where its design life would be limited by projected rates of cliff retreat.

E.19 Flooding and Coastal Erosion

Development which is likely to lead to an increase in flooding or coastal erosion will not be permitted.

E.27 The Protection of Significant Views

Subject to compliance with other plan policies, development will be permitted provided that views of and from the area's important landscape and townscape features will not be adversely affected.

Special scrutiny will be applied to proposals affecting views of and from the North York Moors fringe, the Wolds, the coastal zone, Oliver's Mount and the designated conservation areas.

E.28 Archaeology

There is a presumption in favour of the physical preservation of nationally important archaeological remains, whether or not scheduled. Developments that would damage the site, detract from its archaeological quality and importance, adversely affect its setting or prejudice its future investigation will not be permitted.

L.6 Caravan Site Provision

The development of new caravan/ chalet sites will not be permitted. The extension of existing sites, or alterations to their boundaries will only be permitted where (f) the site is not within the defined coastal zone.

T.1 Highway Schemes

Where necessary land will be safeguarded for the construction of the following highway Schemes; (A) A165 Scarborough to Lebberston.

T.5 Park and Ride

Facilities for park and ride will be provided in the following locations in Scarborough: (B) A165 (South of Town), adjacent to the proposed Scarborough to Lebberston diversion.

R.1 Public Open Space Allocations

The following sites are allocated for the provision of public open space: between proposed A165 diversion and Filey Road, Scarborough; between proposed A165 diversion and Osgodby.

2.12.4

Shoreline Management Plan

The need to develop strategic management plans for the coastline of England and Wales is recognised and the first step has been to produce a series of Shoreline Management Plans based on recognised cells and sub-cells of sediment movement around the coast. The adopted Shoreline Management Plan for Huntcliffe (Saltburn) to Flamborough Head was completed in 1997.

The specific policies recommended for each section of coast are summarised in Table 2.8. There are only two Management Units falling within the Cayton Bay Study Area.

Table 2.8 Policies for the Cayton Bay Study Area Recommended in the Shoreline Management Plan

SMP Management Unit	Frontage	Policy
24A	Knipe Point to Clifton Crag	Retreat the existing defence line
24B	Clifton Crag to High Red Cliff	Do Nothing

2.12.5

Local Environment Agency Plans

The Local Environment Agency Plan (LEAP) covering the study area is the Esk and Coast (Hartlepool to Filey Bay) LEAP. The Esk and Coast LEAP Consultation Report, produced by the Environment Agency North East Region, was primarily a descriptive document. It contained a description of the area; reviewed the state of the local environment; identified the environmental issues that need to be addressed and made proposals for action to address them. Following its publication, a three-month period of consultation with external organisations and the general public was undertaken.

In April 1999, the Esk and Coast Action Plan was produced. This document includes activity plans that address identified issues for the management of the environment, which were proposed to address the issues raised both in the Consultation Report and through the consultation process. Amongst the eleven issues identified, the following are the most relevant to this study:

- Protect, maintain and enhance biodiversity;
- Risk of flooding to people and property;
- Promotion of sustainable recreation; and
- Threats to coastal water quality from permitted discharges.

3 Consultation

3.1

Introduction

Consultation was undertaken with a range of both statutory and non-statutory organisations with interests in the study area in January 2001, to ascertain their general concerns. A summary of the responses obtained is given in Table 3.1. Some information obtained as part of the Filey Bay Strategy Study was also of relevance and consequently the number of consultees was reduced accordingly to reflect this.

Table 3.1 Summary of Consultees' Responses

Organisation	Name & Telephone	Response
Association of Countryside Rangers		No response
Beach View Caravan Park	Mr King	Telecom received 19/02/01. He noted the problems of surface water in the area.
British Holiday & Home Park Association	Mrs D Brown	Telecom received 30/01/01 – not going to respond to letter as SBC will provide the same information. Commented on the state of access to the beach. She would like to see access maintained.
Cayton Bay Holiday Park		No Response
Cayton Parish Council	Mrs M Welsh	No Response
Cayton Bay Surf Shop and School	Mr J Hindley	Provided information regarding biological surveys undertaken within Bay
Cliffdene, Killerby Cliff	Mrs J Ashford	No information supplied
Council for the Protection of Rural England	Mr Geoff Mackley	No Response
Council for British Archaeology		No Response

Organisation	Name & Telephone	Response
Country Landowners' Association	Mr I R Kibble	No response
Countryside Agency	Phil Cookson 0113 246 9222	Telecom received 12/02/01. There is no plan for an extension to the Heritage Coast although proposals are being considered. There are still concerns over maintaining the character of the area and he referred to information previously sent through for the Filey Bay SS, Countryside Character Descriptions No's 25 and 26.
Crown Estate Commissioners	Mrs J Gray	No Response
District Inspector of Fisheries	Brian Meggett 01723 361 703	Provided verbal information re fisheries resource and activity within the Bay. Information sent as part of Filey Bay study also relevant.
Duchy of Lancaster	A N Argyle 01609 788455	As far as the Duchy is aware they do not own any of the foreshore along Cayton Bay
English Heritage Regional Office	Keith Emerick 01904 601988	EH does not hold details of SMR at their regional office. EH would aim to preserve the WWII defences on the beach as intact pillboxes are quite rare. Perhaps use as an educational resource.
English Nature	Mr David Clayden 01904 435 500	Documents supplied by Kimmo Evans include relevant SSSI citation sheets for the study area. Supplied CD-ROM for all England's Natural Areas
Environment Agency	Mr Jim Lancaster	Relevant bathing information obtained from EA Website

Organisation	Name & Telephone	Response
Floraville, Killerby Cliff	Mr & Mrs Jackson	Major cliff slippages (2 in last 6 months) are taking place immediately in front of the properties. Reports that undirected surface drainage is believed to be a contributory factor. ¹
Forest Authority	Mr R Smith	No Response
FRCA	Mr D Carter Lawnswood, Otley Road, Leeds. LS16 5QT 0113 261 333	Maps provided showing environmental designations, agricultural land grades and hard and soft geology
HM Coastguards	Mr RMC Young	No Response
Heritage Coast Project Office		No Response
Heritage Coast Forum	Mr T Badman	No Response
Humber Archaeology Partnership	Mr D Evans 01482 217 466	Awaiting Response
Killerby House	Mr D R Hindley 01723 585899	Has anecdotal evidence as to the drainage problems & rates of cliff erosion in the Bay for 70 yrs. Can also provide frequency of wave data over the last 10 yrs. ²
National Trust	Mel Cunningham 01723 870423	Information sent regarding National Trust Biological Survey of land in their ownership at Cayton Bay
National Farmers Union		No Response
National Federation of Fishermen's Organisations	Mr Barrie Deas	No Response

¹ Scarborough BC believes slips are activated by groundwater and not surface water referred to in consultation response.

² Scarborough BC reports that evidence of drainage problems has not been adequately substantiated.

Organisation	Name & Telephone	Response
North East Static Trawlers Society	D W Horsley	No Response
Natural Environment Research Council		No Response
North Yorkshire County Council	Mr J H Edwards Head of Heritage Service 01609 780 780 ext 2452	Provided various County planning documents
	Ms L E Smith SMR Officer Heritage Unit 01609 532 331	Concerned over lack of up to date and comprehensive information- advise desk top study and field visits to be carried out by archaeological consultants. Documents supplied: Archaeological sites on North Yorkshire SMR; 20 th Century Military Sites
	Kirsty Maddocks, Ecologist, Heritage Unit 01609 780 780 ext 2376	Provided details of SINC surveys & SSSI citation sheets. Issues identified include protection of designated conservation interests 'in situ', ID all important nature conservation areas; ID presence of any legally protected species; ID UK /local priority habitats and/or species; ID of appropriate mitigation measures.
North East Sea Fisheries Committee	Mr P Smith Tim Dapling 01262 422 522	No Response to Cayton Bay Consultation Details of shellfisheries (important), trawling (restricted), commercial fish species present. Concerns include sedimentation and effects of structures on currents. Copies of following documents supplied: fisheries byelaws; annual shellfish statistics 1999; summary of fishing effort 1999 (Filey Bay study)
Scarborough Harbour Users Association	Mr G B Hill	No Response

Organisation	Name & Telephone	Response
Scarborough Inshore Fishermen's Association	Mr F G Normandale	No Response
Scarborough Borough Council	Mark Kibblewhite Dept of Tourism and Leisure Services 01723 232 578	Information supplied for Filey Bay study includes: Borough of Scarborough Tourism Strategy; Scarborough Summary - Scarborough Tourism and Economic Activity Monitor 1990-1999; Filey and the South - A management document which looks at tourism in Filey and its immediate hinterland
	Bob Missin Countryside Management Project Officer	Details of nature conservation sites provided by telcom and further comments provided on SEA.
	Dave Williams Forward Planning	Documents purchased for Filey study: Fact Sheets 1 (Economy) and 5 (Population). Provided comments on SEA. Noted a European phone line comes ashore at Killerby.
	Mr J Riby Department of Technical Services 01723 232 461	Contacted for Filey study. Provided document: East Coast Cycle Route Report.
Seafish Industry Authority	M Jackin	No Response
Sports Council	Mr J A Copeland	No Response
University of Newcastle	Dr Jeremy Lowe	No Response

Organisation	Name & Telephone	Response
University of Hull	Mr N Cutts Institute of Estuarine and Coastal Studies 01482 465 667	Highlighted the following issues: The potential for maintenance /improvement of natural processes within the embayment (re sediment budget) Removal of hard defences where possible/utilisation of soft defences/managed realignment Improvements to water quality Impacts to nearshore seabed communities Disturbance to wintering seabird flocks & damage to coastal habitat
Yorkshire Water	The Planning Liaison Manager	Meeting held on 2 March 2001
Yorkshire Wildlife Trust		Telecom received 02/02/01. Any information supplied would be charged.
Yorkshire & Humberside Tourist Board	Mr Lawrence Wilson 01904 773381	Enclosed the following documents: Regional Tourism Strategy for Yorkshire (1998-2003); Visitor numbers to attractions in Yorkshire/North Lincolnshire Region; YTB Caravan & Camping Occupancy (Regional)
Defence of Britain Project Co- ordinator	Mr William Foot	Has records of seven anti-invasion sites along Cayton Bay.
Defence of Yorkshire Project	Mr John Harwood	Provided details of the survey of the Cayton Bay Beach Defence System

4

Environmental Objectives

4.1

General Issues

On the basis of the environmental baseline information (Section 2) and the views expressed by consultees (Section 3), environmental objectives were defined for the frontage. These provide a basis for the evaluation of strategic options put forward. The inclusion of a particular objective does not mean that it will necessarily be met by the strategy; indeed a number of objectives conflict with each other.

Due to the relatively small nature of the study area, the majority of objectives are general (those applying to all or much of the study area, Table 4.1) with some specific objectives (those applying to individual coastal sections, Table 4.2) identified where necessary. Where there may be a conflict between objectives this has been identified in the Tables.

In formulating the objectives, account has been taken of the recommended policies in the adopted Shoreline Management Plan (SMP). However, the present study is much more detailed than the SMP and has undertaken extensive coastal modelling. Accordingly, the SMP policies have been re-visited to take account of this new information.

Objectives for nature conservation assets generally have been framed in terms of habitats, rather than species. This is because, as a coastal defence strategy, the study is concerned with defining areas of land for management with respect to coastal and flood defences.

4.2

Practicability, Sustainability and Economic Considerations

Objectives have been formulated to take account of practical as well as legal constraints. Objectives are only put forward where an initial screening indicates that the types of actions required to meet them are likely to be technically feasible and environmentally sustainable, which as a minimum is taken to mean that:

- interventions would have a reasonable chance of being successful over a fifty year time scale;
- interventions would not interfere with natural processes in such a way as to bring about loss or damage to other statutorily designated sites, other nationally important features or local/county interest sites;

- there would not be a requirement for continued, excessive and increasing input of natural and financial resources.

It is considered that any actions that did not pass these tests would be very unlikely to be implemented, even if there were a *prima facie* requirement.

In the case of some objectives, an additional criterion is applied that they should only be implemented if an economic case can be made. This means at a minimum that there should be a cost-benefit ratio exceeding 1, but in practice a scheme would have to pass MAFF priority scoring to be implemented.

Table 4.1 General Environmental Objectives for the Whole Study Area

Assets	Objectives	Specific targets
Geomorphology		
Beach material	Any proposal for dredging marine aggregates should be rigorously assessed and only permitted if it can be shown that there would be no significant effect on beaches, coastal defence, the environment and other assets within Cayton Bay.	There should be no interference with the submarine pipeline that comes ashore at Killerby and wreck sites within the area.
Nature Conservation		
Sites of Special Scientific Interest	Habitats cited in or that support species cited in SSSI citations should be maintained where environmentally sustainable and technically possible. If this cannot be achieved, habitat should be maintained until compensation habitat has been re-created elsewhere.	<p>Cayton, Cornelian & South Bays SSSI:</p> <ul style="list-style-type: none"> • Composite section through rocks of Middle to early Upper Jurassic • Type fauna <u>Cardioceras</u> of the Buckowskii subzone • Species rich grassland, semi-natural woodland with frequent springs & open pools • Invertebrate assemblages of ground beetles & soldier flies • Intertidal area supporting purple sandpiper & turnstone <p>Gristhorpe Bay and Red Cliff SSSI:</p> <ul style="list-style-type: none"> • Exposures of Callovian (Upper Jurassic) rocks important in interpreting the history of the Yorkshire area • Middle Jurassic plant bed exposures at Gristhorpe
Sites of Importance for Nature Conservation	Characteristic habitats and species should be maintained <i>in situ</i> if environmentally sustainable, technically possible and consistent with other objectives, or otherwise provision made to re-create them elsewhere	<p>Provision should be made for landward migration of cliff top habitats, including species-rich coastal grassland, bracken and bare cliff faces, as the cliff line recedes; There may be a need to facilitate re-creation of freshwater and brackish pools lost to erosion;</p> <p>Re-creation should only be undertaken in areas of low wildlife value, e.g. agricultural land;</p> <p>Overall objective should be to ensure no net loss of significant habitats.</p> <p>A BAP is currently being produced which covers the area. UK BAP targets of relevance:</p>
Characteristic habitats	Conserve, within the study area if possible, the existing area and quality of habitats covered in the Biodiversity Action Plan (BAP). Where feasible a contribution should be made to meeting BAP enhancement targets.	<p>Maintain and where possible enhance existing area and quality of:</p> <ul style="list-style-type: none"> • Maritime Cliff and Slopes (including through use of mechanisms such as Countryside Stewardship) • Saline Lagoons

Assets	Objectives	Specific targets
	Conserve and contribute to sustainable management of characteristic wildlife habitats listed in Natural Area Profile	<ul style="list-style-type: none"> • Maintain natural processes of cliff erosion • Maintain or create buffer strips of semi-natural vegetation along cliff tops • Maintain natural processes, water quality and habitat value to birds of sandy and muddy shores • Maintain shingle and rocky shores
Characteristic species	Conserve, within the study area if possible, the existing area and quality of habitats supporting species covered in the Biodiversity Action Plan (BAP). Where feasible a contribution should be made to meeting BAP enhancement targets.	<p>Maintain present population and encourage sympathetic land management for:</p> <ul style="list-style-type: none"> • Skylark • Song thrush <p>Local BAP targets may be set for nationally scarce invertebrates associated with cliff seepages in the study area by the local BAP that is currently under production.</p> <p>Key components are:</p> <ul style="list-style-type: none"> • Intertidal bird species (turnstone/purple sandpiper) • Invertebrates associated with soft cliffs (ground beetles / soldier flies) • Plants and animals of base-rich coastal grasslands • Species associated with rocky shores • Species characteristic of sublittoral sediments
Geological interest	<p>Conserve and contribute to sustainable management of populations of characteristic and rare wildlife species listed in Natural Area Profile</p> <p>Maintain the diversity of geological interest listed in the Natural Area Profile</p> <p>Prevent physical damage to or obscuring of geological exposures that are designated as SSSIs</p> <p>Ensure the possibility for use of geological sites for research and educational proposes.</p>	<ul style="list-style-type: none"> • Maintain natural coastal processes • Maintain access to all recognised geological exposures • Gristhorpe and Redcliff SSSI (see 1 above) • Cayton, Cornelian and South Bays SSSI (see 1 above) • Studies of Callovian palaeogeography (High Red Cliff)
Landscape		
Coastal Landscape	Maintain, and where appropriate enhance, the character of the local landscape	<ul style="list-style-type: none"> • Sea Cliffs • Slumping boulder clay slopes with characteristic vegetation • Ravines and associated vegetation • Wave cut beach platform with boulders and associated flora and fauna • Geological features such as strata, sequences, faults, folds, fossils and features associated with glaciation • wildlife features such as wading birds, cliff slope/woodland flora and littoral habitats

Assets	Objectives	Specific targets
Coastal Landscape	<p>Avoid the construction of sea defences or coastal protection that would adversely impact on landscape quality</p> <p>Protect important landscape elements from adverse coastal change or adverse impacts of coastal erosion, where environmentally sustainable, practicable and economic</p> <p>Enhance or mitigate the effects of adverse landscape elements in the coastal zone, as part of implementing policies for coastal defence or managed realignment</p>	<p>There should be a presumption against visually intrusive hard defences to presently undefended cliff sections. Any proposed cliff protection must be assessed for its visual and landscape impact and the visual intrusion minimised.</p> <p>Significant features to which this should apply include:</p> <ul style="list-style-type: none"> • Osgodby / Knife Point and wave cut platform • Soft cliffs of Cayton Bay • Promontory of High Red Cliff and wave cut platform <p>Significant elements to which this applies include caravan parks, which should be set back from the coastline where possible, especially where threatened by coastal erosion, and accommodated in less visually intrusive locations and screened by existing landforms, woodland or appropriate tree planting</p>
Recreation and Tourism		
Coastal Paths	<p>The integrity of the existing Cleveland Way coastal path should be secured where feasible, sustainable and economic. Where coastal erosion or setback makes the existing route impracticable, it should be pro-actively diverted using relevant legal procedure, before it is lost.</p> <p>Opportunities should be sought to create new or extended Public Rights of Way in conjunction with appropriate coastal management projects such as cliff setback or protection</p>	<p>Need to define mechanism and responsibility (Borough and County Councils, role of Countryside Agency and others)</p> <p>Need to define mechanism and responsibility (Borough and County Councils, role of Countryside Agency and others). Role of Countryside & Rights of Way Act 2000.</p> <p>Need to take account of wildlife protection and controlling disturbance on sensitive sites.</p>
Public access	<p>Maintain existing public access to the beach for pedestrians and water sports and seek opportunities to create new access points where appropriate.</p>	<p>Key access points at the base of Killerby Cliff, Cayton Cliff and Tenants Cliff should be maintained.</p>
Recreational resources and visitor attractions	<p>Protect significant visitor attractions and recreational resources in the coastal zone that are threatened by coastal change, where environmentally sustainable, practicable and economic. Otherwise provide for relocation of these assets to sustainable locations.</p>	<ul style="list-style-type: none"> • Beach Cliff Kiosk • Car Park at Killerby Cliff • Caravan sites • Surf Shop and School at Killerby Cliff

Assets	Objectives	Specific targets
Bathing Water Quality	Achieve compliance of designated bathing beaches with mandatory, and if possible with guideline, water quality standards	<ul style="list-style-type: none"> Maintain existing mandatory standards at Cayton Bay and aim to improve to guideline standards
Fisheries		
Access to the sea	Maintain access to the shoreline for sea anglers within the Bay	
Fish stocks	Avoid adverse impact on fishing areas, including areas used for potting, fixed nets and trawling, and fish nursery areas from coastal defence works, including any barge deliveries and recharge activities	
Cultural Heritage		
Non-scheduled known archaeological sites	Provide mitigation in the form of a watching brief, excavation and recording of known sites affected by coastal erosion, or retreat of the defence line, where appropriate.	In particular World War II defence system.
Undiscovered archaeology	Consider providing mitigation in the form of assessment, excavation and recording within areas of high archaeological potential that would be affected by proposed sea defence or coastal protection schemes.	
Listed Buildings	Protect Listed Buildings from erosion or flooding where environmentally sustainable, feasible and economic.	
Wreck Sites	Avoid adverse impact on wreck sites from any coastal defence works, including any barge deliveries and recharge activities	
Land Uses		
Commercial and residential property	Protect buildings from erosion or flooding where environmentally sustainable, feasible and economic.	Residential properties and Caravan Site at Killerby Cliff and Tenants Cliff.
Road Infrastructure	Avoid new development in areas prone to erosion or flooding risk during the lifetime of this Plan Protect A165 road corridor	Consideration of policies for diversion of A165 Scarborough to Leeberton.
Agricultural land	Protect agricultural land from erosion or flooding where environmentally sustainable, feasible and economic.	National Trust grazing land and arable land at Killerby Cliff.

Assets	Objectives	Specific Targets
Economy and Community		
Economic Assets	Protect physical assets that provide a significant base for the local economy, including recreational resources, where environmentally sustainable, feasible and economic. Where this is not possible, provide for re-creation elsewhere.	Caravan Parks Yorkshire Water Pumping Station
Social assets	Protect physical assets that provide a significant base for local communities, including villages, where environmentally sustainable, feasible and economic. Where this is not possible, provide for re-creation elsewhere.	Infrastructure

Table 4.2 Specific Environmental Objectives for each section of coast (based on management units from SMP)

Management Unit (Fig 2.1)	Proposed Objectives	Implications of Proposed Objectives
24 A Cayton Bay (Knipe Point to Clifton Crag)	24.A.1 Maintain open sandy beach	Avoid constructing groynes
	24.A.2 Maintain pedestrian access to Cayton Cliff Woodlands	Potential conflict with objectives 24.A.3 and 24.A.4
	24.A.3 Maintain existing extent and quality of exposures of type localities of Tenants Cliff Member and type fauna of Buckowskii subzone (SSSI)	No active intervention appropriate
	24.A.4 Facilitate conservation or, if lost to cliff erosion, the re-creation of freshwater pool supporting tubular water-dropwort & possible populations of great crested newt	Limited intervention needed
	24.A.5 Avoid disturbance to World War II defence system remains on beach	Keep watching brief. Potential conflict with 24.A.9
	24.A.6 Protect cliff top property threatened by erosion and cliff slumping, if feasible, economic and sustainable	Potential conflict with objectives 24.A.3
	24.A.7 Maintain road infrastructure of A165 and proposed diversion	Potential conflict with objectives 24.A.3
	24.A.8 Maintain bathing water quality to comply with EU directive mandatory level	No implication for coastal defence policy
	24.A.9 Maintain recreational value of beach	Potential conflict with 24.A.6
24 B Cayton Bay (Clifton Crag to High Red Cliff)	24.B.1 Maintain open sandy beach	Avoid constructing groynes
	24.B.2 Avoid interference with intertidal habitat and characteristic biotopes of Lebborston & Gristhorpe (SNCI)	Potential conflict with objectives 24.B.3
	24.B.3 Create or maintain vegetated soft cliffs, allowing for landward migration as cliff recedes	No active intervention appropriate
	24.B.4 Avoid interference with intertidal and subtidal sandy and rocky habitat	No active intervention appropriate
	24.B.5 Protect cliff top property threatened by erosion and cliff slumping, if feasible, economic and sustainable	Potential conflict with objectives 24.B.2 and 24.B.3
	24.B.6 Maintain existing extent and quality of exposures of Callovian rocks and Gristhorpe Plant Beds (SSSI)	No active intervention appropriate
	24.B.7 Maintain bathing water quality to comply with EU directive mandatory level	No implication for coastal defence policy
	24.B.8 Maintain pedestrian access points to Killerby Cliff	Potential conflict with objectives 24.B.6
	24.B.9 Avoid disturbance to World War II defence system remains on beach	Keep watching brief
	24.B.10 Maintain road infrastructure of A165 and proposed diversion	Potential conflict with objectives 24.B.6
	24.B.11 Maintain Cleveland Way footpath along Killerby Cliff	Potential conflict with objective 24.B.6
	24.B.12 Maintain recreational value of beach	Potential conflict with 24.B.9
	24.B.13 Protect submarine cable that comes ashore at Killerby Cliff	Potential conflict with 24.B.6 & 24.B.8

5 Evaluation of Strategy Options

5.1

Introduction

A range of generic options for coastal management were considered in the Huntcliffe (Saltburn) to Flamborough Head Shoreline Management Plan. The options considered were:

- Do nothing;
- Hold the line;
- Retreat the line;
- Advance the line.

The benefits and constraints of implementing each option were considered by the SMP, and the most appropriate options for the coastline of Cayton Bay identified as 'Managed Retreat' and 'Do Nothing' for units 24A Knipe Point to Clifton Crag, and 24B Clifton Crag to High Red Cliff respectively. The strategy has reviewed these options and recommends the policy be changed to 'limited intervention' to allow the continuation of natural processes, while limiting the associated risks to property and infrastructure. There are various options considered for implementing these policies as outlined below. A detailed technical description of the coastal defence options is given in the Strategy Report. However, environmental appraisal plays a fundamental role in the development of the generic options. The environmental impacts and potential benefits of the proposed options are described in section 5.2 and 5.3. These are also assessed against the option of doing nothing for completeness.

5.2

Unit 24A - Knipe Point to Clifton Crag

5.2.1

Do Nothing

There are two major landslide complexes within the unit, notably Cayton Cliff at the northern end and Tenant's Cliff at the southern end. At Cayton Cliff there is likely to be localised settlement of cliff top land and run out of debris onto the beach. The risk of major landsliding exists that would involve rapid loss of cliff top land due to continued steepening and loss of stability within the lifetime of the strategy. The probability of landsliding is likely to increase with time.

At Tenant's Cliff there is likely to be continued erosion of the sea cliffs but relative inactivity within the relict landslide. Small scale cliff failures of 2m or less may occur to the rear scarp from time to time resulting in some loss of cliff top properties. Unless mitigated against, loss of properties over the cliff could pose a serious health and safety hazard whilst also detracting from the largely natural landscape of the bay.

The continuation of natural cliff slumping processes would ensure continued support for assemblages of ground beetles and soldier flies dependent on the associated habitats and important geological exposures. However, continued erosion of the cliff would result in a reduction of other habitats such as woodlands and species rich grassland as the cliff recedes.

Although little is known of the archaeological resource of the area, it may be possible that archaeological remains could erode out of the cliff face, including cliff top remains from World War II defences. Those on the foreshore are likely to be affected by erosion and decisions would have to be made by English Heritage to determine the future of these structures.

5.2.2

Limited intervention

Limited intervention will allow the continuation of natural processes, while reducing the associated risks to assets, either by slowing the rate of recession or providing warning of ground movements. This will be necessary in order to manage erosion as it principally affects residential properties / holiday development at Knipe Point with implications for beach access through National Trust owned woodland cliff slopes, the Cleveland Way national trail and A165 running parallel to the cliff top. However, the future recession of the coastline is recognised in the plans for landward realignment of the A165, which runs along the cliff top.

The various options available for limited intervention are as follows:

- Installation of a rapid response monitoring system, to warn of potential landslip events that may endanger properties;
- Re-grading of coastal slopes;
- Toe protection;
- Improved drainage of coastal slopes;
- Planning to identify timescale for relocation of residents on cliff top properties;

- Monitoring of the beach and coastal slopes, to assist in prediction of future behaviour.

The various options for retreating the line have been assessed against the specific environmental objectives identified for the management unit (Table 5.1) with a more detailed description of each option given below, grouped in terms of stabilisation and monitoring works.

5.2.3

Stabilisation Works

(a) Re-grading of coastal slopes

Stabilisation of coastal slopes through re-grading would provide some form of temporary protection to the cliff top properties at Knipe Point, the A165 coast road (this is being relocated inland) and the Cleveland Way cliff top footpath. It would also help to minimise landslips and associated issues such as slumping of material onto the open sandy beach affecting beach use, possible obscuration of parts of the WWII defence system lying at the cliff base and use of the woodland path at Cayton Cliff down to the beach foreshore.

The northern part of Cayton Bay (Cayton Cliff) supports areas of species rich grassland and semi-natural woodland that would benefit from cliff stabilisation measures, however the more unstable parts of the cliff also support a rich invertebrate fauna with a variety of assemblages associated with wet grassland, cliff seepages and bare and eroding boulder clay respectively. These naturally disturbed open wetland habitats and associated species could be significantly affected by re-grading of the coastal slopes. However, re-grading would probably help to stabilise the cliffs and therefore maintain the open pools on Tenant's Cliff in which the rare tubular water-dropwort grows, subject to continued provision of natural water supplies through cliff seepages.

Re-grading of the coastal slopes will assist in achieving a more stable slope, and therefore reduce the likelihood of landslips occurring. However, the vegetated nature of the slopes, notably the species rich grassland, would mean that this would have a significant environmental impact, and would therefore not be a preferred option.

(b) Toe protection

Rock protection at the foot of the coastal slopes would provide protection against erosion of the toe that may induce slope instability. Such an option might delay

cliff recession but will not halt it completely as in the event of a massive landslide it is likely the toe protection would be overwhelmed by the ground movement.

Stabilisation of the toe would prevent natural slippages from occurring and therefore alter the natural environment of the lower cliff slopes which support assemblages of rare species such as soldier flies and ground beetles associated with the cliff seepages, dislodged boulder clay blocks and bare earth resulting from the natural slumping process.

(c) Improved drainage of coastal slopes

Drainage works to coastal slopes would also provide temporary stabilisation to the cliffs in the short term and therefore provide temporary protection to the assets described in (a) above. However, the drainage works would help impede the natural cliff slumps and cliff seepages, therefore altering the habitat of ground beetles and soldier flies that colonise these areas for which the SSSI was partly designated.

Provision of drainage ditches for the coastal slopes at Cayton Cliff is recommended as an option. The ditches could be dug on the wooded coastal slopes to control groundwater and surface water. Ground movements are likely to continue so annual maintenance of the ditches should be undertaken to ensure that the ditches are kept in good repair and any blockages are removed.

Improved drainage may also lead to vegetation of the cliff face and therefore obscure geological exposures, notably the Bathonian and entirely non-marine Scalby formation that is present from the southern part of South Bay southwards. The most important geological interest is the Knipe Point headland as these cliffs together with those to the north contain a complete section through the Callovian rocks of the Upper Jurassic and has been recommended as the type locality of the for the base of the Oxfordian stage. It is therefore of great importance in the study of geological history of this part of geological time. The process of installing drainage improvement measures could also potentially damage the geological exposures discussed above.

The impacts of drainage work are, however, largely dependent on the degree of sophistication employed. The proposed drainage improvements to control and redirect surface water are not expected to have significant adverse impacts.

Monitoring Systems

(a) Early warning system

The early warning system would warn of ground movements and landslips that may lead to dangerous conditions or endanger properties but it would not prevent loss of housing as a result of landslips, therefore it is likely the loss of some housing during the lifetime of the strategy may result. Other assets would also be at risk including the Cleveland Way clifftop footpath. The A165 coast road is due to be relocated further inland, although the timing of this relocation is not yet known, so there remains a risk to this route until it is relocated. The current footpath access through the National Trust owned woodland from the cliff top down to the beach may have to be relocated as and when its present location becomes unsustainable. Such measures would need to be agreed between the National Trust as landowner and the local authority, possibly with the assistance of DEFRA funding under the Countryside Stewardship Scheme. Dangerous structures should be removed as and when required.

The installation of ground movement sensors is unlikely to have any environmental impacts. The natural processes of cliff slumping would continue to support assemblages of ground beetles and soldier flies, however, there may be some loss of species rich grassland and other undisturbed semi-natural habitats such as flush communities, pools, scrub and woodland. Consequently, there would be a need for compensation habitats to be produced further inland where possible.

(b) Planning

Planning to identify a timescale for relocation of residents on cliff top properties would not in itself present any environmental impacts to the study area, although there will be loss of properties within the lifetime of the strategy. A slope stability study would enable the production of objective guidance for planning, development and slope management for the area, and allow management of the evacuation of properties.

This should include for the complete removal of properties as and when they become at severe risk from landslip activity where practical. This would help prevent risks to the general public from falling debris and the health and safety implications of such structures, particularly should they fall onto the foreshore and present a hazard to beach users. The same applies to any World War II defences that occur along the cliff top, although consultation with English Heritage and the County Archaeologist would be required to determine any appropriate mitigation measures.

There are also aesthetic considerations of such debris detracting from the largely natural environment of the bay. Should the coastal footpath become at risk from landslip activity this should be relocated further inland as it forms part of an important network.

(c) Monitoring of beach and coastal slopes

In order to improve long term understanding of shoreline evolution, a programme of monitoring beach levels and recession of coastal slopes would provide useful data for future modelling of behaviour. While this will not delay loss of property, however it will help to quantify the rate at which the coastline is retreating and help with future management.

There are no environmental impacts associated with the monitoring of beach and coastal slopes to assist in the prediction of future behaviour as natural processes will continue and slumping habitats will be maintained. However, the need for compensation habitats is likely due to the potential loss resulting from cliff slumping and erosion. Mechanisms for demolition and removal of properties at risk as discussed in (b) above and potential relocation of the coastal footpath also apply.

Table 5.1 Management Unit 24A - Knife Point to Clifton Crag

Policy Description	FULFILMENT OF ENVIRONMENTAL OBJECTIVES									CONCLUSIONS
	24A.1	24A.2	24A.3	24A.4	24A.5	24A.6	24A.7	24A.8	24A.9	
Do Nothing	N	N	N	N	N	N	N	n/a	N	
Retreat the Line										
(a) Early warning system	n/a	N	Y	N	Y	N	Y	n/a	n/a	Monitoring alone may not meet all objectives.
(b) Re-grading of coastal slopes	Y	Y	N	N ^P	Y	Y	Y	n/a	N ^P	
(c) Toe protection	Y	Y	P	N	P	P	Y	n/a	P	
(d) Improved drainage of coastal slopes	Y	Y	N	*	Y	Y	Y	n/a	Y	
(e) Planning to identify timescale for relocation (policy)	n/a	n/a	Y	n/a	n/a	N	Y	n/a	n/a	
(f) Monitoring of beach and coastal slopes	Y	N	Y	N	Y	N	Y	n/a	N	

Key to Table:

- Y** Yes, the option fulfils the objective
- N** No, the option is in conflict with the objective
- P** Partially meets the objective
- *** The option will not fulfil the objective alone, another mechanism is needed in addition
- ?** Not certain at this stage whether the objective will be met
- n/a** Objective not applicable

5.3

Unit 24B - Clifton Crag to High Red Cliff

5.3.1

Do Nothing

Continued cliff recession will occur with risk to cliff top properties, particularly at Killerby Cliff which are at risk within the latter part of the strategy lifetime, as are properties at the seaward limits of the Beach View Caravan Park. The disused pumping station will also be at risk following continued deterioration of the defences at the base of Tenant's Cliff. Unless mitigated against, the loss of these properties over the cliff will pose a serious health and safety hazard whilst also detracting from the largely natural landscape of the bay. The properties of the Beach View Caravan Park will also become more prominent along the cliff top in the centre of the bay as the cliff recedes.

Beach access will be severely affected by cliff slumping, particularly at Killerby Cliff where the public footpath to the beach has recently been repaired following a recent landslip. The Cleveland Way is also subject to localised erosion, particularly at Killerby Cliff where it passes close to the cliff top.

Natural cliff slumping processes operating in the bay will ensure continued support for assemblages of ground beetles and soldier flies dependent on the associated habitats. However, continued erosion of the cliff would result in a reduction of other habitats such as species rich grassland as the cliff recedes back towards hard features, causing a squeeze of these habitats.

Although little is known of the archaeological resource of the area, it may be possible that archaeological remains could erode out of the cliff face, including cliff top remains from World War II defences. Those on the foreshore are likely to be affected by erosion and decisions would have to be made by English Heritage to determine the future of these structures.

5.3.2

Limited Intervention

The recommended policy change for this unit is to 'limited intervention' and a number of options exist for limited intervention to the coastline between Clifton Crag and High Red Cliff, as follows:

- Improved drainage both of the cliffs and of surface water at Killerby;
- Re-grading of coastal slopes, particularly adjacent to footpath;
- Removal of concrete defences as they become dangerous/obsolete and replacement with more flexible systems to provide access, that can be relocated as coastline recedes e.g. geogrids;

- Planning to identify timescale for relocation of residents on cliff top properties;
- Monitoring of the beach and coastal slopes, to assist in prediction of future behaviour.

In order to assess the potential impacts of the defence options, and to ensure full consideration of the strategic objectives, a matrix showing the environmental impact of options followed by a more detailed description is given overleaf.

The recommended management policy for this unit as proposed in the SMP is “Do nothing”. The SMP also notes that this is the preferred centrally funded option and that the ‘retreat the existing defence line’ policy may require further consideration, subject to economic appraisal. It is recommended that the policy be revised to “limited intervention”. Key interventions required will be management of beach access given the tourism value of the beach and management of the Cleveland Way, with realignment as required due to cliff recession. Landward relocation of the caravan park should also be considered as the coastline retreats. Options considered for this unit are:

5.3.3

Stabilisation Works

(a) Improved cliff drainage at Killerby

Improvements in drainage may be carried out with the intention of controlling groundwater within the cliffs to varying degrees of sophistication. This may comprise improvements in the surface drainage network, controlling run off from agricultural land, properties and paved areas, and continued maintenance of existing drainage ditches. Provision of a cut off surface drain landward of the bund to the rear of the properties may help to delay cliff recession by collecting and draining water which may otherwise lead to erosion. Improved drainage would help to stabilise the cliffs and therefore make them more resilient to coastal erosion at the cliff toe. This may therefore provide temporary protection to the assets described in section 5.3.1.

However, the drainage works would help impede the natural cliff slumps and cliff seepages, that could potentially alter the habitat of ground beetles and soldier flies that tend to colonise bare earth and seepages for which the SSSI was partly designated. Consultation would be required with English Nature to determine the nature of works to be employed and their location. A brief ecological survey of the area would also be recommended to determine if indeed, the proposed area has

been colonised and if so, consultation with English Nature would determine whether compensation habitat should be provided elsewhere within the bay.

(b) Periodic re-grading of coastal slopes, adjacent to footpath at Killerby
The footpath at Killerby is located in a gully with very steep side slopes. Landslips, such as occurred during winter 2000-2001, blocking the path are likely to reoccur. Routine maintenance would allow for periodic re-grading of these slopes. Stabilisation of these slopes may also help to provide temporary protection to some of the cliff top properties at Killerby and the Cleveland Way.

It would also help to minimise landslips and associated issues such as slumping of material onto the open sandy beach affecting beach use, possible obscuration of parts of the WWII defence system lying at the cliff base.

The unstable parts of the cliff support a rich invertebrate fauna with a variety of assemblages associated with wet grassland, cliff seepages and bare and eroding boulder clay respectively. These naturally disturbed open wetland habitats and associated species could be affected by re-grading of the coastal slopes, although this will only be carried out within a localised area.

(c) Removal of existing defences at Tenant's Cliff
The defences protecting the disused water pumping station and residential property at the base of Tenant's Cliff have suffered significant damage and are in a poor state of disrepair, presenting a safety hazard to beach users, particularly given the close proximity to beach access points. As the defences become dangerous/obsolete, replacement with more flexible systems has been recommended to provide access that can be managed as the coastline recedes. This will help to maintain public access to the beach and prevent outflanking which could otherwise alter the landscape of the bay. Replacement will also significantly enhance the aesthetic quality of the area as installation of geogrids and removal of the current concrete defences would be more in keeping with the nature of the bay.

This section of the bay has been subject to previous human intervention and consequently any geological and biological interest is likely to be minimal and restricted to the cliff and backing land of the residential property. The proposed interventions will have no significant adverse effects on landscape.

There may be some short term impacts associated with the removal of the redundant defences and their replacement with geogrids. This will include a lack of

beach access down Tenant's Cliff and localised restrictions to public use of the beach foreshore in the vicinity of works. There is also likely to be localised elevated noise levels and a reduction in air quality. Plant access to the beach may also be problematical down the cliff. If any materials need to be brought ashore via barge the impacts/ disturbance to maritime archaeology e.g. wreck sites, fisheries and beach users, particularly surfers should be minimised. There are no intertidal habitats near the redundant structures, however any barge activities should be aware of those intertidal rock platforms within the bay.

5.3.4

Monitoring Systems

(a) Policy for developed areas

Planning to identify a timescale for relocation of residents on cliff top properties would not in itself present any environmental impacts to the study area, although there will be loss of properties within the lifetime of the strategy. A slope stability study would enable the production of objective guidance for planning, development and slope management for the area, and allow management of the evacuation of properties.

This should include for the complete removal of properties as and when they become at severe risk from landslip activity where practical. This would help prevent risks to the general public from falling debris and the health and safety implications of such structures, particularly should they fall onto the foreshore and present a hazard to beach users. The same applies to any World War II defences that occur along the cliff top, although consultation with English Heritage and the County Archaeologist would be required to determine any appropriate mitigation measures.

There are also aesthetic considerations of such debris detracting from the largely natural environment of the bay. Should the coastal footpath become at risk from landslip activity this should be relocated further inland as it forms part of an important network.

(b) Monitoring of beach and coastal slopes

In order to improve longer term understanding of the shoreline evolution, a programme of monitoring of beach levels should be continued, using the survey completed in 2000 as a baseline. This will provide useful data for future modelling of behaviour. While this will not delay loss of property, it will help to quantify the rate at which the coastline is retreating and help with future management.

There are no environmental impacts associated with the monitoring of beach and coastal slopes to assist in the prediction of future behaviour as natural processes will continue and slumping habitats will be maintained. However, the need for compensation habitats is likely due to the potential loss resulting from cliff slumping and erosion. Mechanisms for demolition and removal of properties at risk as discussed in (a) above and potential relocation of the coastal footpath also apply.

Table 5.2 Management Unit 24B - Clifton Crag to High Red Cliff

Policy Description	FULFILMENT OF ENVIRONMENTAL OBJECTIVES												CONCLUSIONS
	24B.1	24B.2	24B.3	24B.4	24B.5	24B.6	24B.7	24B.8	24B.9	24B.10	24B.11	24B.12	
Limited Intervention													
(a) improved drainage of cliffs & surface water at Killerby	Y	?	N	Y	*	n/a	n/a	*	Y	n/a	*	P	Potential localised impact on semi natural habitats
(b) Re-grading of coastal slopes, particularly adjacent to footpath	Y	P	N	Y	*	n/a	n/a	Y?	Y	P	P	Y	
(c) Planning to ID timescales for relocation of residents	n/a	Y	P	n/a	N	Y	n/a	N	Y	N	N	n/a	
(d) Monitoring of beach & coastal slopes	N	Y	P	Y	N	Y	n/a	N	Y	n/a	*	*	

Key to Table:

- Y** Yes, the option fulfils the objective
- N** No, the option is in conflict with the objective
- P** Partially meets the objective
- *** The option will not fulfil the objective alone, another mechanism is needed in addition
- ?** Not certain at this stage whether the objective will be met
- n/a** Objective not applicable

6

Mitigation and Compensation

6.1

Introduction

Where significant impacts have been identified, mitigation is proposed, where feasible, to reduce the impacts. Proposed mitigation and monitoring activities have been identified and summarised below as follows:

6.1.1

Nature Conservation

It has been identified that there are opportunities for recreation of vegetated cliff-top and cliff-face habitats, including freshwater pools, to replace those lost to erosion. There will be a need for proactive policies to ensure this habitat recreation and avoid squeezing of habitats between the receding cliff line and the boundaries of holiday parks and other developed areas. This may be achieved by:

- (a) land acquisition in the set-back zone by nature conservation bodies, including local authorities and the Yorkshire Wildlife Trust (It should be noted that some areas of land in the setback zone are already in Local Authority / National Trust ownership);
- (b) bringing agricultural land under more sympathetic conservation management through stewardship funding or similar initiatives (this does not include land owned by the National Trust); and
- (c) adoption and implementation of appropriate planning policies by local planning authorities, including the prohibition of any new building or extensions to existing buildings, for land in the set-back zone and exploration of possibilities to relocate the caravan park further inland.

No recent surveys have been undertaken of the main habitat types within the bay, notably species rich grassland, semi natural woodland, springs, open pools and bare ground, intertidal boulders and wave cut platform. Existing Sites of Importance to Nature Conservation (SINCs) cover the southern extremities of Cayton Bay that were surveyed in 1998, however the SINC Panel has recently agreed that the coastal cliffs and other maritime habitats in the bay are sufficiently important to warrant at least designation as a SINC along the full length of the coastline excepting the settlement areas. Existing national designations (SSSIs) within the study area preclude the need for further SINC designations within this area. A national inventory of maritime cliff and slope vegetation is also being prepared by English Nature. It is recommended that liaison with English Nature, the

Scarborough Borough Council ecologist, County Ecologist and the National Trust is undertaken to progress:

- a comprehensive habitat / species survey of the bay
- seed collection from SSSIs and other semi-natural habitat sites of interest to be grown on for future inoculation of replacement habitats.

The survey will provide important data for the maritime cliff and slope inventory operated by English Nature and for land owned by the National Trust, enabling informed sustainable management of their land as the previous biological evaluation and associated management suggestions for this land was last undertaken in 1987.

It is unlikely that any works would impact on the intertidal area. However, should any works require the movement of material by barge then intertidal habitats to the north and south of the bay should be avoided due to the nature conservation interests that exist. Also, works should not interfere with populations of purple sandpiper and turnstone that exist in nationally significant numbers during the winter months.

6.1.2

Landscape

The process of erosion will bring existing development such as houses and caravan parks closer to the cliff edge at Killerby and Knipe Point before they are eventually lost, resulting in increased prominence of intrusive landscape features along the cliff top and shoreline. Mitigating this impact will be difficult as there are no established powers that can require structures to be removed because of their landscape impacts, in advance of erosion making them unsafe. However, should opportunities arise to negotiate large-scale removal and relocation of existing facilities such as caravan parks to more sustainable and less visually intrusive locations, rather than waiting for piecemeal loss at the cliff top, it is recommended that the Local Authority should pursue them. Opportunities to screen existing or new sites with tree planting should also be followed up where possible.

6.1.3

Agriculture

There may be some minor losses of grazing land owned and managed by the National Trust within the study area and consequently further areas of agricultural land should be acquired on the open market and/or brought into conservation management to offset losses to cliff recession.

6.1.4

Tourism and Recreation

Parts of the Cleveland Way are likely to be lost due to erosion, therefore provision should be made for this to be re-routed where necessary. This responsibility should be shared between North Yorkshire County Council (as footpaths authority) and Scarborough Borough Council (as coastal protection authority). Intervention to re-route footpaths at Cayton Cliff is at the discretion of the National Trust who are the landowner of this section of the bay.

Where any works may impact on beach access or beach usage, either through the use of heavy machinery to replace defences at Tenant's Cliff or replacement of access at Killerby Cliff, this should not be undertaken during the summer months, particularly during peak holiday months so as to minimise adverse effects on tourism and recreation. However, there will inevitably be some impact on surfers whose activities are only reliant on surf conditions and therefore use the beach throughout the year.

6.1.5

Fisheries

If barge deliveries are required for any materials due to the steepness of the access road at Tenants Cliff, mitigation in the form of seasonal control of the working period would not necessarily enable any impacts to be avoided altogether as fishing effort is all year round. However, details of controls, such as barge access routes and delivery points, could be agreed with local fishermen when the requirements for any materials are determined.

6.1.6

Cultural Heritage

Parts of the WWII defence structure complex on both the cliff top and the foreshore could be liable to damage through cliff slumping. Excavation and recording is proposed to mitigate the loss of any sites expected to be lost within the lifetime of the strategy. Mitigation in respect of sites expected to be lost to erosion should be commissioned and co-ordinated by the archaeological unit of North Yorkshire County Council. It is not anticipated that any known archaeological sites will be adversely affected by coastal defence/stabilisation interventions. If, however, a need for archaeological mitigation were identified during the development of specific schemes, this would be the responsibility of the coastal defence operating authority commissioning the works.

6.1.7

Air Quality

The strategy will have no significant effects on the atmospheric environment. The potential for construction works to release dust will be limited by the damp nature

of materials in the intertidal zone, and it is not expected that any specific mitigation measures would be needed over and above normal good working practice.

7

Conclusions

Erosion will need to be managed in some form at the northern end of the study area (Unit 24A) as it principally affects residential properties / holiday development at Knipe Point with implications for beach access through National Trust owned woodland cliff slopes, and the Cleveland Way national trail and A165 running parallel to the cliff top.

Re-grading of coastal slopes and /or improved drainage would aid stabilisation of the coastal slopes and although helping to protect infrastructure in the short term, landslip drainage or stabilisation measures are operations identified by English Nature that would be likely to damage the special features of the SSSI. Therefore, if either of these two options are to be implemented it should only be following discussion with English Nature to establish those areas where such options are recommended to determine whether there are likely to be any impacts on the qualifying features of the SSSI. It may be that proposed stabilisation works could be modified to minimise their impact or installation in areas that do not represent a threat to the geological exposures or habitats.

Limited intervention options above (Unit 24B) will meet coastal defence objectives and will avoid damage to vegetated cliffs and intertidal habitats. It would, however, be preferable to incorporate proactive management of the coastal habitats through creation of a vegetated buffer strip along the cliff top, to act as a reservoir for colonisation of new areas of cliff fall. Such measures would need to be agreed between the landowner (National Trust) and the local authority, possibly with assistance of DEFRA funding under the Countryside Stewardship scheme.

References

East of England Tourist Board: A Strategy for Developing Tourism in the East of England 2000-2010

English Nature, 1998a, Flamborough Head SMA Technical Report.

English Nature, 1998b, Saltburn to Bridlington Natural Area profile

Environment Agency, 1999, Esk and Coast Action Plan Local Environment Agency Plan

Environment Agency, 1999, Bathing Water Quality in England and Wales 1999, A Summary Report

Hindley, J (2001) Cayton Bay Coastal Strategy – Ecology and Nature Conservation

Joint Nature Conservation Committee, 1998, Marine Nature Conservation Review Sector 5: South-East Scotland and North-East England.

Mouchel Consulting Ltd., 1997, Huntcliffe to Flamborough Head Shoreline Management Plan

North Yorkshire County Council, 1996, North Yorkshire County Structure Plan Written Statement (approved October 1995)

North Yorkshire County Council, Scarborough Borough Council and Sustrans, 2000, East Coast Cycle Route, Route 1 North Yorkshire to Scarborough Borough Route Study

Ottaway, P, undated, Romans of the Yorkshire Coast

Scarborough Borough Council, 1999, Scarborough Borough Local Plan

Scarborough Borough Council, 1999, Scarborough Borough Local Plan, Fact Sheet No 7, Landscape Appraisal

Scarborough Borough Council, 1999, Scarborough Borough Local Plan, Fact Sheet No 9, Nature Conservation

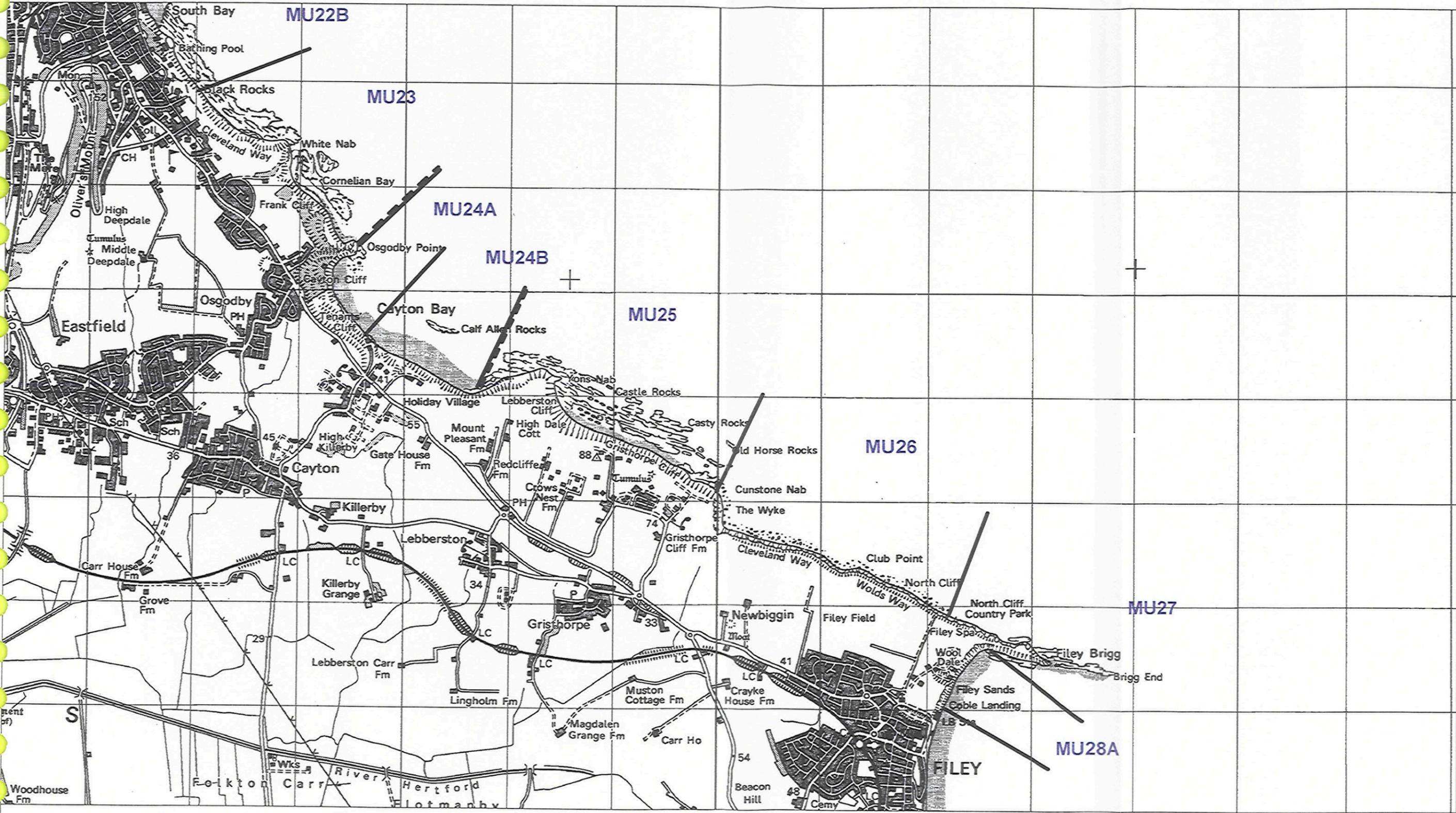
Scarborough Borough Council, Department of Tourism and Leisure Services,
2000, Scarborough Tourism Economic Activity Monitor, Scarborough Summary
1990-1999.

Scarborough Borough Council, Filey and the South

Scarborough Borough Council, 1996, Proposed Extension of North Yorkshire and
Cleveland Heritage Coast - South of Scarborough to Filey.

Smith, B.P & Laffoley, D. (1992). A Directory of Saline Lagoons and Lagoon like
Habitats in England, Peterborough, English Nature

Yorkshire Tourist Board Commitment to Quality: Regional Tourism Strategy for
Yorkshire 1998-2003



Management Units
Study Area Boundaries

Reproduced from the Ordnance Survey mapping with the permission of the controller of Her Majesty's Stationary Office (c) Crown Copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings.
Scarborough Borough Council. License No. LA 079251

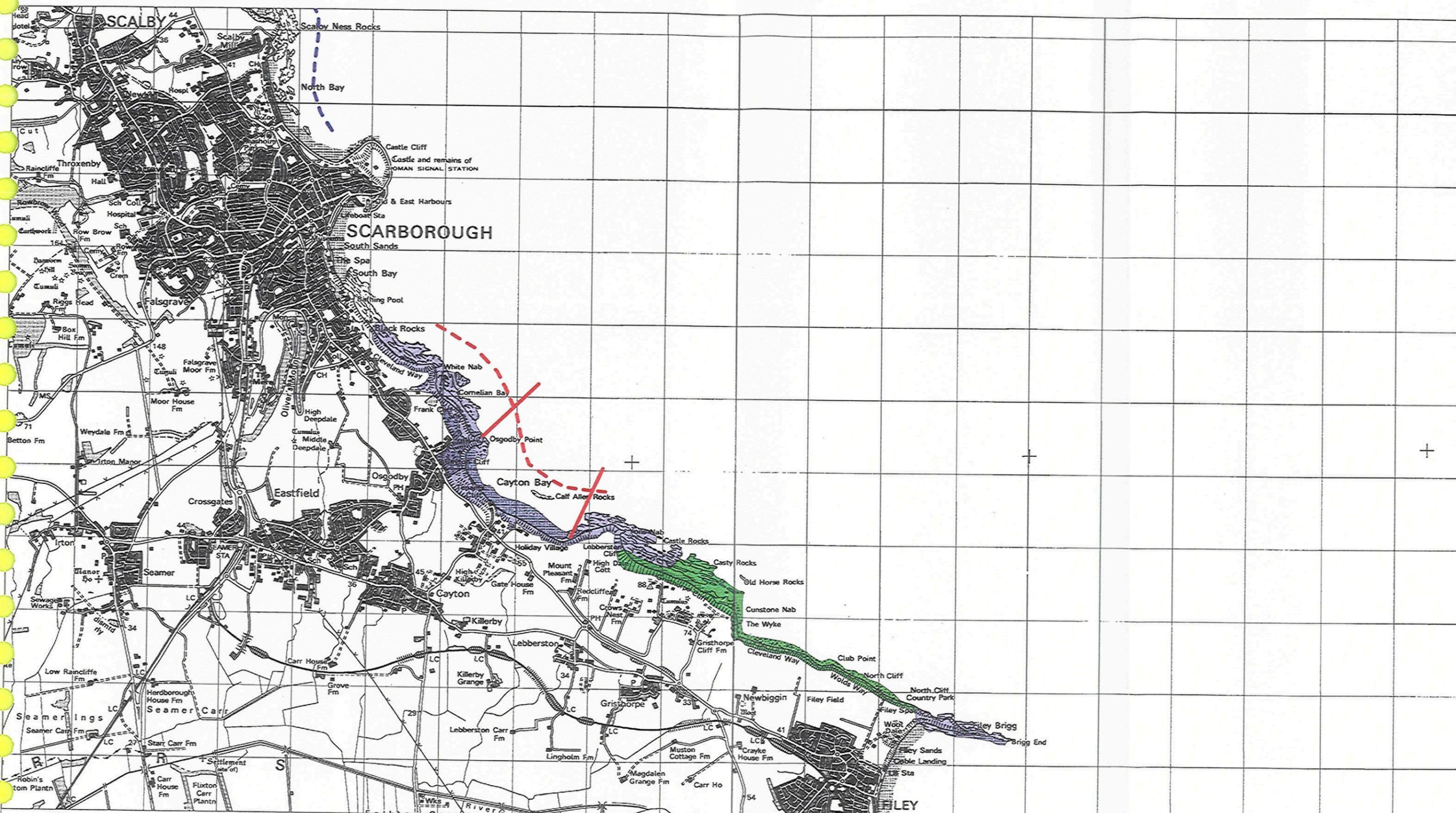
Location of Study Area

0 1 2 3 Kilometres

Figure 2.1

N





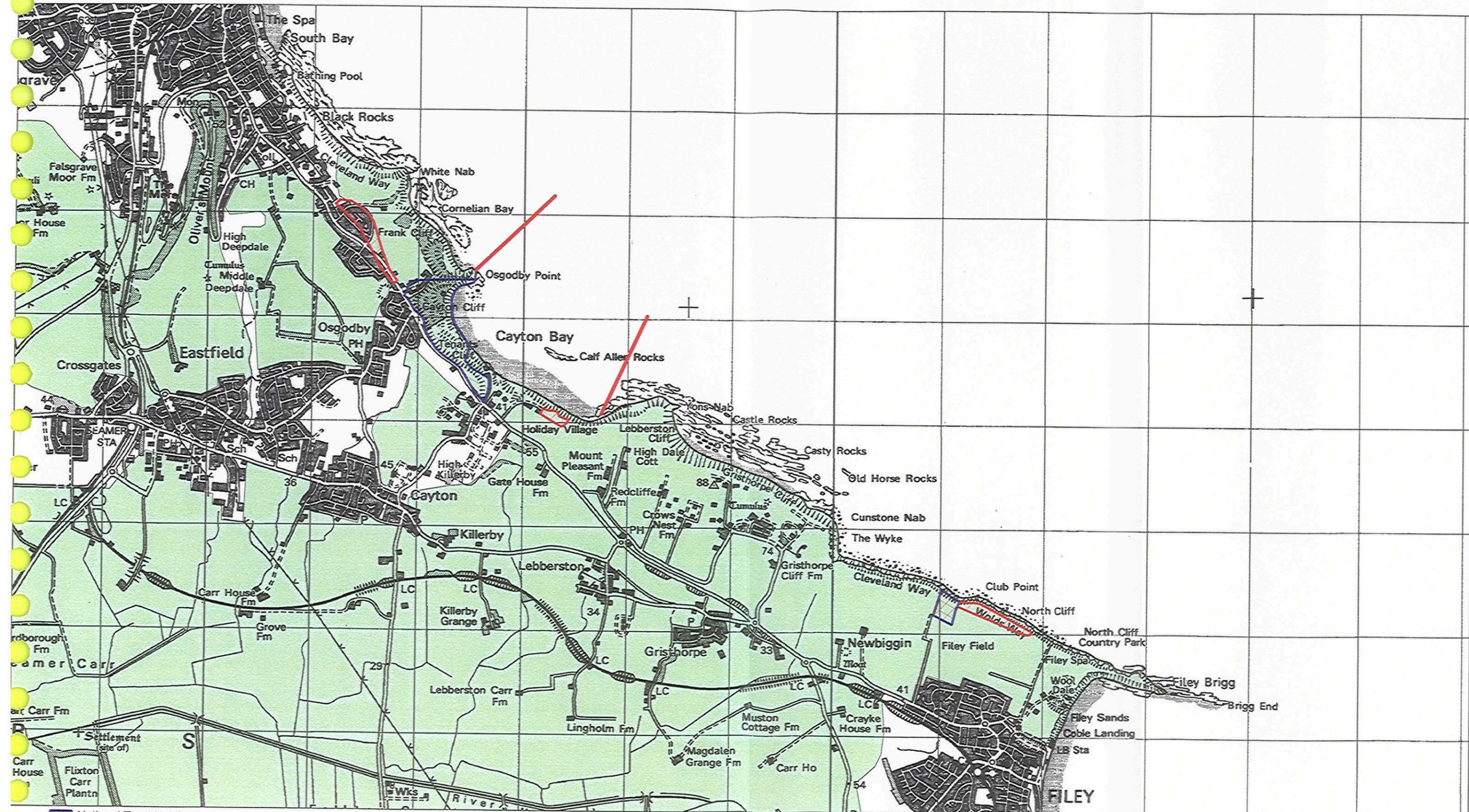
- Sites of Special Scientific Interest (SSSIs)
- Sites of Importance for Nature Conservation (SINCs)
- Existing Heritage Coast (Outside Study Area)
- Proposed Heritage Coast Extension
- Study Area Boundaries

**Statutory and Non Statutory Nature
Conservation and Landscape Designations**

Figure 2.2
N



Reproduced from the Ordnance Survey mapping with the permission of the controller of Her Majesty's Stationary Office (c) Crown Copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Scarborough Borough Council. License No. LA 079251



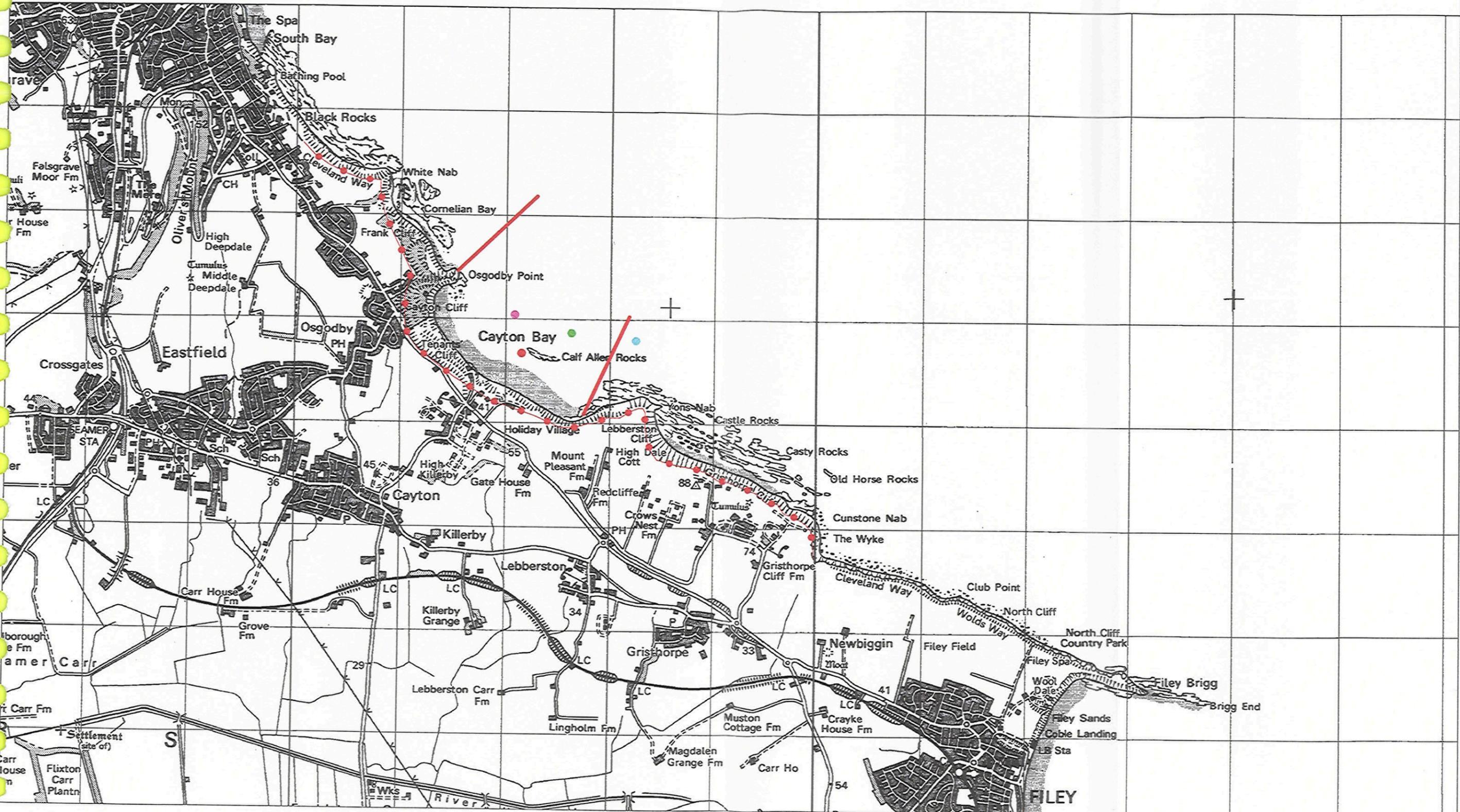
Agricultural Land Classification Grades, Countryside Stewardship Schemes and National Trust Landholdings

Figure 2.3

N



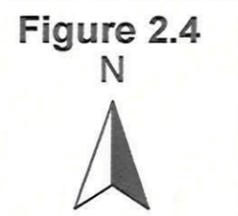
Reproduced from the Ordnance Survey mapping with the permission of the controller of Her Majesty's Stationary Office (c) Crown Copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Scarborough Borough Council. License No. LA 079251

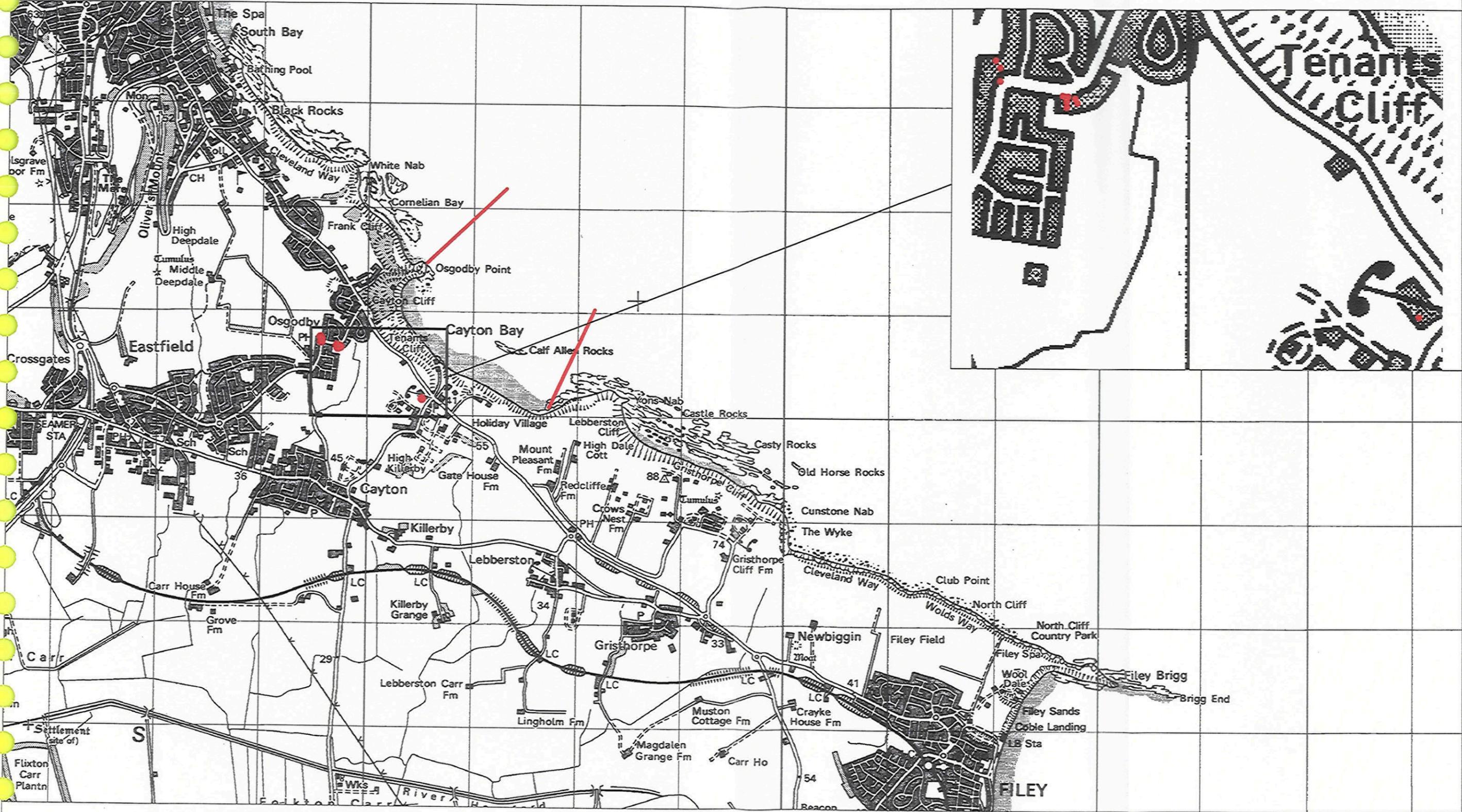


Tourism/Recreational Activities

- Designated Bathing Waters
- Windsurfing
- Scuba Diving
- Sea Canoeing
- Surfing
- Cleveland Way
- Study Area Boundaries

Reproduced from the Ordnance Survey mapping with the permission of the controller of Her Majesty's Stationary Office (c) Crown Copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Scarborough Borough Council. License No. LA 079251





● Non Scheduled Archaeological Sites
 Study Area Boundaries

Non Scheduled Archaeological Sites

Figure 2.5
 N

Reproduced from the Ordnance Survey mapping with the permission of the controller of Her Majesty's Stationary Office (c) Crown Copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings.
 Scarborough Borough Council. License No. LA 079251



Annex F
Economic Assessment

Scarborough Borough Council
Cayton Bay Coastal Strategy Study
Annex F: Economics Report (Final)
October 2002

Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
1	0	Draft	July 2001	KMcC
1	1	Revised draft	Sept 2001	KMcC
2	1	Final	Oct 2002	

Contents

1	Background	1
2	Sources of Economic Data	3
	2.1 <i>Property Values</i>	3
	2.2 <i>Infrastructure and Services</i>	3
	2.3 <i>Intangible Benefits</i>	3
3	Do Nothing	5
	3.1 <i>Failure Scenarios</i>	5
	3.2 <i>Predicted Losses</i>	5
	3.3 <i>Cost of Losses</i>	6
	3.4 <i>Constraints</i>	6
4	Intervention Options	7
	4.1 <i>Introduction</i>	7
	4.2 <i>Assessment of Options</i>	7
	4.3 <i>Constraints</i>	9
5	Residual Damages	11
	5.1 <i>Introduction</i>	11
	5.2 <i>Limited Intervention</i>	11
6	Benefit Cost Assessment	15
	6.1 <i>Cayton Cliff (MU24A)</i>	15
	6.2 <i>Tenant's Cliff (MU24B)</i>	15
	6.3 <i>Killerby Cliff (MU24B)</i>	16
	6.4 <i>Constraints</i>	16
7	Recommendations	19
	7.1 <i>Conclusions</i>	19
8	References	21

APPENDICES

Appendix A – Council Tax Banding

Appendix B – Breakdown of Cost of Loss of Residential Properties

Appendix C – Option Costs

Appendix D - FCDPAG3 Sheets

1

Background

This Annex presents the work undertaken in the economic appraisal of coastal defence options for Cayton Bay in Yorkshire. The prime concern of the Client Scarborough Borough Council, as Coast Protection Authority, is to ensure continued coast protection for Cayton and its environs, however a number of other issues will have to be considered. These include ensuring the continued amenity value of the beach in Cayton Bay, in particular to the local tourist industry, as well as maintaining the Cleveland Way footpath and minimising impacts on natural habitats.

The appraisal seeks to determine the most efficient option taking into account value for money and environmental considerations. In order to achieve this, a 'Do Nothing' scenario in terms of alleviation of cliff recession and instability was evaluated to provide a basis for comparison of all possible future defence options.

Much of the frontage of Cayton Bay is in its natural state. The only defences are located at the foot of Tenant's Cliff and comprise a masonry and concrete seawall and apron protecting a disused pumping station and a single residential property.

For evaluation purposes, the study area has been divided into Management Units (MUs), each of which has been considered in detail. MU24B has been further split into two sections, as different options are considered at discrete locations within this unit, at the existing defences at Tenant's Cliff and at Killerby Cliff.

The economic benefits of various intervention options for each management unit have been calculated following the procedures recommended in DEFRA's (previously MAFF's) Flood and Coastal Defence Project Appraisal Guidance - FCDPAG3 (MAFF, 1999). The benefit of cliff erosion and landslip alleviation measures has been calculated as the value of the damage or losses averted through implementation of a scheme. The cost has been calculated to be the price of implementing that particular alleviation measure.

2 Sources of Economic Data

2.1 *Property Values*

Damage or loss of property could either be as a result of cliff erosion, which is gradual or alternatively through landslip, which can occur suddenly. Either way if the property is lost the capital value of that property is taken as the value of the loss. This value is assumed to include the loss of all individual services for that property such as water supply, wastewater, and connections to gas, electric and telephone facilities.

Maps detailing the potential upper limit extent of cliff erosion and landslips over the 50-year strategy timescale were produced following detailed field reconnaissance. These are contained in Annex D of the Strategy Report. From these maps areas 'at risk' were identified. Scarborough Borough Council provided rateable values for the houses within the Council's ownership areas and from this a cost was associated with the loss of a specific property. These values only reflect the Council Tax band that the housing falls under and are not actual selling prices, however for the purposes of this assessment, this was deemed acceptable. The commercial rateable values were then multiplied by a factor, based on information on regional house price increases obtained from the Council of Mortgage Lenders, to give the capital value of the property. Appendix A details the classification.

Tables detailing the individual residential and commercial property capital damage values are contained within Appendix B.

2.2 *Infrastructure and Services*

The only services identified within the 'at risk' areas for Cayton Bay comprised the Pumping Station at the foot of Tenant's Cliff. Consultation with Yorkshire Water (YW) has confirmed that this pumping station is no longer in service, (believed to be abandoned) and is now in private ownership. Based on this, no monetary value has been assigned to the building.

2.3 *Intangible Benefits*

The beach at Cayton Bay provides an important recreational asset attracting visitors to the area. The loss of this resource through a 'do-nothing' strategy would result in a significant economic loss to the local community. Quantifying this loss has been estimated as follows:

The approximate number of visitors to the local area is 104,000 per year (based on 1998 figures provided by regional tourist board) predominately for the purpose of visiting the sea front and clifftop walks. The revenue generated from these visitors was £5.6M in 1998. Assuming: approximately 15 percent of these visitors come to enjoy the facilities in Cayton Bay particularly; that the Do Nothing scenario would result in the beach access being restricted; and the removal of this access would result in a 40 percent drop in the number of visitors, a value of £336,000 can be calculated as Loss of Amenity. This figure is calculated as 40 percent of the visitors to Cayton, (15% of 104,000) which gives a number of visitors lost, multiplied by the revenue spent per visitor.

Cayton Bay falls within the Saltburn to Bridlington Maritime Natural Area and contains a number of internationally and locally recognised habitats including Cayton, Cornelian & South Bays SSSI, Gristhorpe Bay & Red Cliff SSSI and Lebberston and Gristhorpe Cliffs SINC.

The loss of these areas would be detrimental to the locality in terms of tourism and ecological diversity. However it is extremely difficult to quantify this effect especially as the implementation of certain erosion alleviation measures could be equally harmful to the sites mentioned above. Therefore, assuming any losses could be credited as gains elsewhere, no monetary value has been assigned to this particular topic.

As this appraisal deals with coastal erosion, public safety is a significant issue. The nature of cliff instability could bring the lives of people living within the 'at risk' areas into danger. The continued use of cliff top footpaths at risk from cliff recession could also be detrimental to public safety. Reduction or eradication of these dangers through the implementation of a management or defence scheme is again extremely difficult to quantify. At present no monetary value has been assigned to this area.

Appropriately designed rapid response monitoring systems can provide warning of ground movements and allow the evacuation of properties and removal of possessions, fixtures and fittings, thus reducing the cost associated with the loss of the building. The benefit of this early warning has been quantified using methods for the evaluation of flood damage given in Penning-Rowse et al (1992). The cost of replacing the contents of a domestic property has been assumed to be the benefit of the monitoring system.

3 Do Nothing

3.1 *Failure Scenarios*

Two main mechanisms of cliff failure are considered:

- cliff toe erosion and cliff top recession, occurring on a gradual basis and generally well described by average annual erosion rates;
- large scale landslide/mudslide movements result in significant loss of cliff top as a result of individual events.

Areas of potential cliff erosion and landslide have been determined for each Management Unit (MU) (see cliff recession potential maps in Strategy Report Annex D). Probabilities of occurrence have also been assigned for each area.

Where cliff instability is predicted to lead to landslip, it is likely that this will be episodic in nature with one or more large events occurring leading to the loss of a substantial width of the cliff top. For this circumstance a probability distribution has been assumed over the 50 years.

3.2 *Predicted Losses*

3.2.1 *Knipe Point to Clifton Crag (MU24A)*

The cliffs along this management unit are at risk from mudslide and landslip, (based on the cliff mapping, Strategy Report Annex D). Residential properties in the Knipe Point development at Osgodby Point, some properties adjacent to the A165 at Osgodby, and a single property at Clifton Crag, are at risk from landslide/mudslide over the 50-year period.

3.2.2 *Clifton Crag to High Red Cliff (MU24B)*

The cliffs at the northern end of MU24B are protected by concrete and masonry defences in various states of repair. A single residential property and a disused pumping station are protected by these defences. Access to the beach is gained along this stretch of coastline. Implications of loss of beach access could lead to significant reductions in visitors and therefore revenue to the locality. Immediately to the south of the defences a single residential property is at risk at the seaward limit of the Beach View Caravan Park, which will experience some loss of land.

Further south within MU24B, at Killerby Cliff, there is a risk of cliff recession, due to landslip. There are a number of residential properties along the cliff top that are estimated to be lost within the strategy lifetime.

3.3

Cost of Losses

The detailed calculation of costs associated with the loss of property and amenity are shown in Appendix B. These values assume a 'Do nothing' scenario. Table 3.1 below summarises the totals.

Area	Management Unit	Present Value Damages (£k)
Cayton Cliff	MU24A	£389
Tenant's Cliff	MU24B	£140
Killerby's Cliff	MU24B	£135

Table 3.1 Total Costs of Losses to Coastal Erosion

3.4

Constraints

A number of constraints have been identified in the evaluation of the 'Do-nothing' scenario. These are as follows:

- The loss of services associated with properties has been included in the cost of the loss of the properties they service. For example, sewers/drains serving a house will not require to be replaced if the property no longer exists;
- There is scope for miscalculation of the losses in the residential areas of Cayton Bay as small changes in the 'at-risk' area could incur significant differences in the estimated damage;
- Using Council Tax valuation bands is not an accurate method of assessing the value of a property, (although these have been adjusted based on data on house prices from the Council of Mortgage Lenders);
- It was not possible to identify some properties/businesses through the Council Tax valuation and these were therefore given assumed values;
- The value attributed to the loss of access to the beach in Cayton Bay, as a recreational asset is approximate as there is no means of accurately predicting the likely impact of such a loss.

4 Intervention Options

4.1

Introduction

The following sections identify and cost those defence intervention options that are considered to be technically and environmentally sustainable for this frontage (as described in the Chapter 9 of the Strategy Report). The strategic policies are:

- **Limited intervention** by working with the natural processes to reduce risks whilst allowing natural coastal change;
- **Hold the existing defence line** by maintaining or enhancing the standard of protection;
- **Advance the existing defence line** by constructing new defences seaward of the existing structures; and
- **Managed realignment** by identifying a new line of defence and where appropriate constructing new defences landward of the original defences.

Each policy may be achieved by a number of alternative options. The options for each management unit are discussed in detail in Chapter 9 of the Strategy Report. Those options discussed below are those for which economic assessment was undertaken. Full details of the economic assessment are given in the DEFRA (previously MAFF) FCDPAG3 sheets in Appendix D.

4.2

Assessment of Options

4.2.1

Unit Costs

The costs of the various options (detailed in Appendix C) have been based on standard rates associated with coastal works as shown in Table 4.1. These rates are based on rates provided by Scarborough Borough Council and from SPON's 1st Stage Estimating Handbook.

Work	Rate
3-6 tonne rock armour (including placement, trimming and provision of filter fabric)	£70/m ³
Excavation*	£4/m ³
Rapid response monitoring system :installation :maintenance	£30,000 £800
Labour*	£8/hr
Plant Hire*	£250/day

* - based on prices from Spons 1st Stage Estimating Handbook

Table 4.1 – Construction Rates

4.2.2

Cayton Cliff (MU24A) - Policy: Limited Intervention

A policy of Limited Intervention has been proposed for this unit. Presently there are no man-made defences in the area but the option of providing toe protection to the cliffs between Knipe Point and Tenant's Cliff was also considered. The following are the feasible options and associated costs for MU24A; (other options are discussed in Chapter 9 of the Strategy Report, Table 4.2 only details the options deemed feasible to take forward to a Benefit – Cost evaluation).

Option	Work	PV costs (£k)
Toe protection	Provision of rock armour, filter fabric and associated works	£416
Rapid response monitoring system	Installation of ground movement sensors, monitoring system and maintenance programme.	£52
Improvements to cliff drainage	Provision and maintenance of drainage ditches to reduce ground water.	£52

Table 4.2 PV Costs – Cayton Cliff (MU24A)

4.2.3

Tenant's Cliff (MU24B) – Policy: Limited Intervention

Limited Intervention is again recommended for this area. Part of the existing seawall and apron are damaged and failure is expected within the strategy lifetime, therefore replacement of these hard defences with a more flexible solution will allow management of beach access as the coastline retreats.

A typical approach involving the grading of the lower slope beneath the access road and placement of geogrids or a similar product to provide pedestrian access with erosion control is considered. It has been assumed that the defences immediately beneath the pumping station will not require removal, however this may require further review at later stages of the strategy. Again further options are discussed in Chapter 9 of the Strategy Report:

Option	Work	PV costs (£k)
Provision of alternative beach access	Regrading of coastal slope and provision of geogrids to pathway, removal of existing defences (not beneath pumping station) in year 15.	£23

Table 4.3 PV Costs – Tenant’s Cliff (MU24B)

4.2.4

Killerby Cliff – Policy: Limited Intervention

At Killerby Cliff improved drainage has been considered to prolong the life of the cliff top properties.

Option	Work	PV costs (£k)
Improvements to cliff drainage	Provision and maintenance of drainage ditches to control surface ground water and delay cliff recession	£18

Table 4.4 PV Costs – Killerby Cliff (MU24B)

4.3

Constraints

A number of assumptions were made in the calculation of expected costs of the intervention options. Scarborough Borough Council were able to provide standard cost rates for repair and provision of new works. It must be noted, however that the rates used (as summarised in Table 4.1) may not necessarily be representative of costs specifically in Cayton Bay and may be subject to variation in the future.

5 Residual Damages

5.1

Introduction

The damages that occur with an intervention option in place are referred to as 'residual damages'. The difference between these damages and the damages sustained under a do-nothing strategy are termed the 'damage avoided', effectively valuing the benefit that the scheme will bring.

Following the implementation of the various intervention options, there remains the possibility of damage (FCDPAG3 sheets in Appendix D). This damage will be reduced from the baseline conditions but no option completely protects the coastal assets of Cayton Bay. The implementation of the defence strategy is intended to delay the coastal erosion, not prevent it.

5.2

Limited Intervention

The implementation of this policy was recommended at three locations within the Bay, within management units 24A and 24B. This option will not stop coastal erosion, but may delay cliff recession, provide occupants of property at risk with prior warning of possible danger or limit the negative effects on the locality. It also aims to ensure the essential sediment supply and on-going natural processes prevail as far as possible.

Damage limitation as a result of the Limited Intervention policy includes:

- Rapid response monitoring system – allows residents of 'at risk' properties to remove their belongings including household contents before the property is destroyed;
- Improvements to cliff drainage – controls groundwater and therefore aids in stabilising the cliff; and
- Replacement of existing defences with regraded slopes and maintained footpath – will ensure the amenity value of the area is not lost.

Table 5.1 below summaries the damages avoided.

Unit	Option	Delay (yrs)	PV damages avoided (£k)
MU24A Cayton Cliff	Toe protection	15	£227
	Rapid response monitoring system	0	£39
	Improvements to drainage	10	£172
MU24B Tenant's Cliff	Provision of alternative beach access	0	£82 (based on recreational benefits)
MU24B Killerby Cliff	Improvements to drainage	10	£60

Table 5.1 – Damages Avoided (Limited Intervention)

The above damage assessments were based on a probability of failure and an estimate of the delay in cliff recession. As such these values vary if the probability of failure or the delay is varied.

5.2.1

Probability

Where occurrence of a landslide is the principal mechanism that will lead to losses, PV Damages have been calculated based on an assumed distribution of probability of occurrence of the landslide over the 50-year lifetime of the strategy.

At Cayton Cliff, the cliff assessment has identified that there is a small risk of a significant landslide event within the strategy lifetime, so a low probability has been assumed through much of the strategy lifetime, increasing towards the end of the 50 year period.

At Tenant's Cliff Killerby Cliff and the highest probability of losses are estimated at approximately half way through the strategy lifetime.

Earlier occurrence of damages compared to these estimates will increase the Cost Benefit ratios for each option.

5.2.2

Delay

The above PV Damages in Table 5.1 are based on specific delays in erosion or instability rather than prevention. In the cases of Cayton Cliff and Killerby Cliff, it is assumed that intervention works will result in a delay of 10 years due to drainage improvements and 15 years when toe protection is provided. The losses will still

occur under these options, however varying the delay values can affect the damages avoided and therefore the B-C ratio. Increasing the delay increases the damages avoided. If a delay of less than estimate results, then there will be a reduction in the damages avoided.

For the Limited Intervention option to manage the deteriorating defences at the foot of Tenant's Cliff, it is not expected that this will delay property losses incurred, but the amenity value of the beach will not be lost.

6

Benefit Cost Assessment

The following tables show the Present Value (PV) Benefit Cost (B-C) ratios for the options in Cayton Bay based upon the tangible and intangible benefits.

6.1

Cayton Cliff (MU24A)

The results for MU24A in Table 6.1 show that improvements of cliff drainage is the most economically viable option, with a Net Present value of £119,810 and a benefit cost ratio of 3.29.

Cayton Cliff	Costs and benefits £k			
	Do nothing	Rapid response monitoring	Toe protection	Improvements to cliff drainage
PV costs	389.6	45.6	415.6	52.3
PV damage		350.7	162.6	217.6
PV benefits		39.0	227.1	172.1
NPV		-6.7	-188.5	119.8
Benefit/cost ratio		0.85	0.55	3.29
Incremental b/c ratio				0.15

Table 6.1 Cayton Cliff (MU24A) – Cost Benefit Analysis

This analysis was undertaken on the basis of the potential property losses as it was understood that the A165 was due to be relocated and was therefore not included in the economic analysis. However as the timing of the A165 relocation is uncertain, there will be clear economic benefits in provision of a rapid response monitoring system to warn of ground movements that may compromise the road in the interim period before relocation. It is therefore recommended that the Highways Authority consider implementation of such a system.

6.2

Tenant's Cliff (MU24B)

Table 6.2 summarises the results for Tenant's Cliff, part of MU24B. Only one option was deemed feasible for this management unit and as Table 6.2 shows the benefit cost ratio is 3.59, which indicates that removal of deteriorating defences and provision of alternative beach access is economically viable.

Tenant's Cliff	Costs and benefits £k	
	Do Nothing	Provision of alternative beach access to replace deteriorating defences
PV costs	140.73	22.9
PV damage		58.5
PV benefits		82.2
NPV		59.3
Benefit/cost ratio		3.59
Incremental b/c ratio		

Table 6.2 Tenant's Cliff (MU24B) – Cost Benefit Analysis

6.3

Killerby Cliff (MU24B)

Table 6.3 details the option of improving cliff drainage in at Killerby Cliff. The PV of the scheme is £41,600 and the benefit cost ratio is 3.31. This indicates that improving the cliff drainage is an economically viable option.

Killerby Cliff	Costs and benefits £k	
	Do Nothing	Improvement to cliff drainage
PV costs	135.0	18.0
PV damage		75.4
PV benefits		59.6
NPV		41.6
Benefit/cost ratio		3.31
Incremental b/c ratio		

Table 6.3 Killerby Cliff (MU24B) – Cost Benefit Analysis

In addition to the provision of drainage it is recognised that there is a continuing cost to SBC for maintenance of the beach access at Killerby Cliffs. This access is frequently blocked by landslips, particularly following prolonged periods of wet weather. It is therefore recommended that regrading works be undertaken on the slopes of the gully where the footpath is located, early in the strategy lifetime. This will improve stability and reduce the need for maintenance.

6.4

Constraints

There are many variables used in the calculation of both costs and benefits associated with the intervention options, explored in detail in Chapter 4. This section will seek to identify the relative impact that changes to the costs and damages would have on the status of these preferred options.

6.4.1

Cost Variations

As mentioned in Section 4.4, changes from the assumed costs to the actual costs could significantly alter the B-C ratio. Values for rock armour and placement were assumed from a recent Scarborough Borough Council project. It would however require a significant reduction in rock armour rates to make rock toe protection economically viable.

Unforeseen construction limitations like undesirable ground conditions, bad weather or underestimated structural stability could lead to higher costs and therefore a lower B-C ratio for the option of improving drainage. For the simple land-based construction activities anticipated, it is not however considered that these risks will have a significant impact of costs.

Under- or over-prediction of the potential cliff recession is possible, resulting in a miscalculation of the losses. The upper estimate of cliff recession and hence of likely losses has been used in the calculations (discussed further in Chapter 4 of the Strategy Report).

Intervention options may not lead to the delay in erosion potential estimated in the Benefit Cost analysis, which would alter the economics, with a lower than estimated delay reducing the Cost-Benefit.

6.4.2

Benefit Variations

Small variations in the residual losses have a minimal impact on the level of damages for each of the intervention options. Only major changes to the damages incurred would result in significant differences to the benefit values. The more critical factor is the 'do-nothing' damage value. Variations in these values affect the viability of all the intervention options.

The timing of losses of individual properties is based on estimates of occurrence of landslip events. Uncertainty in the actual timing of losses could lead to varying damage values.

For the defences at Tenant's Cliff, the economic damage incurred is only based on the amenity value of the beach, as intervention options do not bring about any benefit in terms of delaying losses.

7 Recommendations

7.1 *Conclusions*

Using the information and Benefit Cost (B-C) ratios and Present Value Costs (PV) derived in the previous Chapters, conclusions based on economical viability can be made.

7.1.1 *Cayton Cliff (MU24A)*

Of the options considered for Cayton Cliff, improving cliff drainage has been identified as the recommended option, this is based on a B-C ratio of 3.29. This option has a Net PV of £119,810. It has been estimated that such an intervention will delay recession by 10 years.

7.1.2 *Tenant's Cliff (MU24B)*

The Limited Intervention option of providing continued beach access has a B-C ratio of 3.59 and a Net PV of £59,320, justified by maintaining the amenity value of beach access at this location.

7.1.3 *Killerby Cliff (MU24B)*

The option recommended for MU24B is improvements to cliff drainage, a Net PV of £41,600 has been calculated for this option and a B-C ratio of 3.31. This option is therefore deemed as economically viable.

8

References

Ministry of Agriculture, Fisheries and Food (1999): *Flood and Coastal Defence Appraisal Guidance, Economic Appraisal* (FCDPAG3).

Middlesex University Flood Hazard Research Centre (1990) *FLAIR (Flood Loss Assessment Information Report)*.

Penning-Rowsell E C, Green C H, Thompson P M, Coker A M, Tunstall S M, Richards C and Parker D J (1992) *The Economics of Coastal Management, A Manual of Benefit Assessment Techniques* (The Yellow Manual).

Parker D J, Green C H, and Thompson P M (1987) *Urban Flood Protection Benefits: A Project Appraisal Guide* (The Red Manual), Gower.

Spon (2000) *First Stage Estimating Handbook*, Spon Press

Appendix A
Scarborough Borough Council's
Valuation List

Scarborough Borough Council

Department of Corporate Services

Town Hall
St Nicholas Street
Scarborough
YO11 2HG

Director of Corporate Services:
P.J. Barton, LL.B.
Solicitor



Telephone: (01723) 232323 Fax: (01723) 500636 DX: 719232 Scarborough 5
E-mail: dcs@scarborough.gov.uk

If calling, please ask for Mrs Deighton Direct Line 232378

All correspondence to be addressed to the Director

Your Ref:

Our Ref: JD/PJM

15 January 2001

Alison Atkinson
Halcrow Maritime
Burderop Park
Swindon
Wiltshire
SN4 0QD

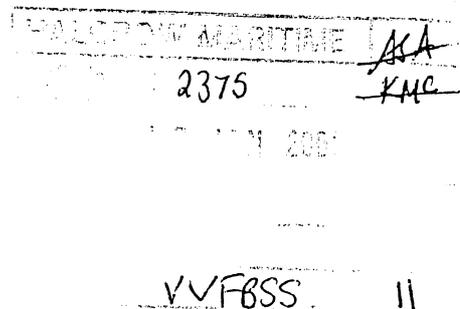
Dear Madam

I thank you for your letter received 4 December 2000. I apologise for the delay in my reply.

Please find enclosed a copy of the Valuation List which shows the property band assigned, for the relevant addresses, for each property. As I receive a valuation band and not an actual valuation, I can only provide you with a band for these properties.

The District Valuer assigns each band depending on its value at the 1 April 1991, therefore, a band may not indicate the true current value of the property. The District Valuer uses the following criteria to assign a band.

Band	Value (£)
A	up to 40,000
B	40,001-52,000
C	52,001-68,000
D	68,001-88,000
E	88,001-120,000
F	120,001-160,000
G	160,001-320,000
H	320,001 and over



Awarded for Excellence
Refuse Collection and
Recycling Services



Awarded for Excellence
Leisure Services

2

15 January 2001

Alison Atkinson

Any addresses which were on your original list, which do not appear on this valuation list, will either be Non-Domestic or not on our records.

I hope I have been of assistance in this matter.

Yours faithfully



Miss E Rhodes
Local Taxation and Recovery Manager

Scarborough Borough Council

Department of Technical Services

Town Hall
St Nicholas Street
Scarborough
YO11 2HG

Director of Technical Services:
Derek Rowell, BSc, ARICS



Telephone: (01723) 232323 Fax: (01723) 503826 Direct Line: 232464
E-mail: dts@scarborough.gov.uk

If calling, please ask for **Mr. M.D. Close**
All correspondence to be addressed to the Director

Your Ref: VV FBSS 25/038
Our Ref: MDC/EM TLEB551 V.732

20th February, 2001

Dear Mrs. Atkinson,

Cayton Bay – Coastal Strategy Study

HALCROW MARITIME	R/SJB
1314	KJMCC
23 FEB 2001	
VV/FBSS/11	

Thank you for your letter of 11th January 2001.

I attach for your information a copy of the rateable values as taken from the rating list. I also attach a copy of a plan showing the Council's ownership in the study area.

Please let me know if I can be any further assistance.

Yours sincerely

M.D. Close
Principal Valuer

Mrs. A. Atkinson,
Halcrow Maritime,
Burderop Park,
Swindon,
WILTSHIRE.
SN4 0QD

Encs.

Awarded for Excellence
Refuse Collection and
Recycling Services



Awarded for Excellence
Leisure Services



Reference Number	Address	Valuation Band	Effective Date
	Postal Town SCARBOROUGH, NORTH YORKSHIRE		
SC118125050024	47, FIELDSTEAD CRESCENT	YO12 6TH C	01-APR-1993
SC153025400012	CLIFTON CRAGG, FILEY ROAD, CAYTON	YO11 3NH E	01-APR-1993
SC108039250004	FERN BANK, FILEY ROAD, CAYTON	YO11 3NP D	01-APR-1993
SC153025400001	FINLANDIA, FILEY ROAD, CAYTON	YO11 3NH D	01-APR-1993
SC153025400004	LYNDALE, FILEY ROAD, CAYTON	YO11 3NH E	01-APR-1993
SC153025400005	NEWSTEAD, FILEY ROAD, CAYTON	YO11 3NH D	01-APR-1993
SC153025400006	SAN REMO, FILEY ROAD, CAYTON	YO11 3NH D	01-APR-1993
SC153025400007	SEACLIFFE, FILEY ROAD, CAYTON	YO11 3NH D	01-APR-1993
SC153025400008	SUNCLIFFE LODGE, FILEY ROAD, CAYTON	YO11 3QE E	01-APR-1993
SC108039250006	THE BEACH HOUSE, FILEY ROAD, CAYTON	YO11 3NR E	01-APR-1993
SC153025400002	THE FIRS, FILEY ROAD, CAYTON	YO11 3NH E	01-APR-1993
SC153025400003	THE HEIGHTS, FILEY ROAD, CAYTON	YO11 3NH E	01-APR-1993
SC153025400009	TWIN PEAKS, FILEY ROAD, CAYTON	YO11 3NH E	01-APR-1993
SC153025400010	WEST HALLAM, FILEY ROAD, CAYTON	YO11 3NH E	01-APR-1993
SC153025400011	WOODRISE, FILEY ROAD, CAYTON	YO11 3NH D	01-APR-1993
SC108039250002	FLAT AT BEACH VIEW STORES, FILEY ROAD, CAYTON BAY	YO11 3NP C (comp)	01-APR-1993
SC104025410001	1, FILEY ROAD, FLIXTON	YO11 3UF B	01-APR-1993
SC104025410002	2, FILEY ROAD, FLIXTON	YO11 3UF B	01-APR-1993
SC104025410003	3, FILEY ROAD, FLIXTON	YO11 3UF B	01-APR-1993
SC104025410004	4, FILEY ROAD, FLIXTON	YO11 3UF B	01-APR-1993
SC104025410005	5, FILEY ROAD, FLIXTON	YO11 3UF B	01-APR-1993
SC104025410006	6, FILEY ROAD, FLIXTON	YO11 3UF B	01-APR-1993
SC104025410007	7, FILEY ROAD, FLIXTON	YO11 3UF A	01-APR-1993
SC104025410008	8, FILEY ROAD, FLIXTON	YO11 3UF A	01-APR-1993
SC104025410009	9, FILEY ROAD, FLIXTON	YO11 3UF A	01-APR-1993
SC104025410010	10, FILEY ROAD, FLIXTON	YO11 3UF A	01-APR-1993
SC104025410011	11, FILEY ROAD, FLIXTON	YO11 3UF A	01-APR-1993
SC104025410012	12, FILEY ROAD, FLIXTON	YO11 3UF B	01-APR-1993
SC104025410013	13, FILEY ROAD, FLIXTON	YO11 3UF B	01-APR-1993
SC104025410014	14, FILEY ROAD, FLIXTON	YO11 3UF B	01-APR-1993
SC104025410015	15, FILEY ROAD, FLIXTON	YO11 3UF B	01-APR-1993
SC104025410016	16, FILEY ROAD, FLIXTON	YO11 3UF B	01-APR-1993
SC104025410017	17, FILEY ROAD, FLIXTON	YO11 3UF B	01-APR-1993
SC104025410018	18, FILEY ROAD, FLIXTON	YO11 3UF B	01-APR-1993
SC104025410019	19, FILEY ROAD, FLIXTON	YO11 3UF B	01-APR-1993
End of Page Number 454.			

Reference Number	Address	Valuation Band	Effective Date
	Postal Town SCARBOROUGH, NORTH YORKSHIRE		
SC172025600100	256, FILEY ROAD	YO11 3AQ F	01-APR-1993
SC171725450048	257, FILEY ROAD	YO11 3AE D	01-APR-1993
SC171725450049	259, FILEY ROAD	YO11 3AF D	01-APR-1993
SC171725450050	261, FILEY ROAD	YO11 3AF D	01-APR-1993
SC172025600101	264, FILEY ROAD	YO11 3AQ E	01-APR-1993
SC171725450051	275, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450052	277, FILEY ROAD	YO11 3AF F	01-APR-1993
SC171725450053	279, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450054	281, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450055	283, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450056	285, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450057	287, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450058	289, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450059	291, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450060	293, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450061	295, FILEY ROAD	YO11 3AF E	01-APR-1993
SC172025600102	296, FILEY ROAD	YO11 3AG F	01-APR-1993
SC171725450062	297, FILEY ROAD	YO11 3AF E	01-APR-1993
SC172025600103	298, FILEY ROAD	YO11 3AG F	01-APR-1993
SC171725450063	299, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450064	301, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450065	303, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450066	305, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450067	307, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450068	309, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450069	311, FILEY ROAD	YO11 3AF E	01-APR-1993
SC171725450070	313, FILEY ROAD	YO11 3JG D	01-APR-1993
SC171725450071	315, FILEY ROAD	YO11 3JG E	01-APR-1993
SC171725450072	325, FILEY ROAD	YO11 3JG E	01-APR-1993
SC171725450073	327, FILEY ROAD	YO11 3JG E	01-APR-1993
SC171725450074	329, FILEY ROAD	YO11 3JG E	01-APR-1993
SC171725450075	331, FILEY ROAD	YO11 3JG E	01-APR-1993
SC171925550181	FLAT 3 HARTFORD COURT 33, FILEY ROAD	YO11 1TB C	30-NOV-1998
SC171725450076	333, FILEY ROAD	YO11 3JG E	01-APR-1993
SC171725450077	335, FILEY ROAD	YO11 3JG D	01-APR-1993
SC171725450078	337, FILEY ROAD	YO11 3JG B	01-APR-1993

Reference Number	Address	Valuation Band	Effective Date
	Postal Town SCARBOROUGH, NORTH YORKSHIRE		
SC171725450079	339/341, FILEY ROAD	YO11 3JG E	15-AUG-1996
SC172025600104	340, FILEY ROAD	YO11 3JQ E	01-APR-1993
SC171725450081	343, FILEY ROAD	YO11 3JG C	01-APR-1993
SC171725450082	345, FILEY ROAD	YO11 3JG C	01-APR-1993
SC171725450093	347, FILEY ROAD	YO11 3JG E	01-JAN-1998
SC171725450085	351, FILEY ROAD	YO11 3JG D	01-APR-1993
SC153025350013	352, FILEY ROAD	YO11 3JQ E	01-APR-1993
SC171725450086	353, FILEY ROAD	YO11 3JG E	01-APR-1993
SC153025350003	355A, FILEY ROAD	YO11 3JG E	01-APR-1993
SC153025350002	355, FILEY ROAD	YO11 3JG D	01-APR-1993
SC153025350004	361, FILEY ROAD	YO11 3JG C	01-APR-1993
SC153025350005	363, FILEY ROAD	YO11 3JG B	01-APR-1993
SC153025350006	365, FILEY ROAD	YO11 3JG D	01-APR-1993
SC153025350007	367, FILEY ROAD	YO11 3JG D	01-APR-1993
SC153025350008	369, FILEY ROAD	YO11 3JG E	01-APR-1993
SC153025350009	375, FILEY ROAD	YO11 3JG D	01-APR-1993
SC153025350010	377A, FILEY ROAD	YO11 3JG D	03-JUL-1995
SC153025350011	379, FILEY ROAD	YO11 3JG E	01-APR-1993
SC172025600029	HYLANDS, FILEY ROAD	YO11 3BJ G	01-APR-1993
SC172025600030	HYLANDS COTTAGE, FILEY ROAD	YO11 3AY D	01-APR-1993
SC172025600002	NORTH RIDING COLLEGE OF EDUCATION, FILEY ROAD	YO11 3AZ H (comp)	01-APR-1993
SC153025350012	OSGODBY LODGE, FILEY ROAD	YO11 3JG E	01-APR-1993
SC172025600031	TANGLEWOOD, FILEY ROAD	YO11 3AY D	01-APR-1993
SC172025600001	CARETAKERS FLAT AT SCARBOROUGH COLLEGE, FILEY ROAD	YO11 3AZ A (comp)	01-APR-1994
SC171925550030	WILLERSLEY HOUSE AT SCARBOROUGH COLLEGE, FILEY ROAD	YO11 2TP G	01-APR-1993
SC171925550179	FLAT 1, HARTFORD COURT, FILEY ROAD	YO11 2TP B	01-SEP-1995
SC171925550180	FLAT 2, HARTFORD COURT, FILEY ROAD	YO11 2TP D	06-NOV-1995
SC171925550182	FLAT 4, HARTFORD COURT, FILEY ROAD	YO11 2TP C	01-SEP-1995
SC171925550183	FLAT 5, HARTFORD COURT, FILEY ROAD	YO11 2TP C	01-SEP-1995
SC171925550184	FLAT 6, HARTFORD COURT, FILEY ROAD	YO11 2TP C	01-SEP-1995
SC171925550185	FLAT 7, HARTFORD COURT, FILEY ROAD	YO11 2TP C	18-AUG-1995
SC171925550186	FLAT 8, HARTFORD COURT, FILEY ROAD	YO11 2TP C	25-AUG-1995
SC171925550187	FLAT 9, HARTFORD COURT, FILEY ROAD	YO11 2TP C	01-SEP-1995
SC171925550188	FLAT 10, HARTFORD COURT, FILEY ROAD	YO11 2TP C	10-FEB-1995

Reference Number	Address	Valuation Band	Effective Date
	Postal Town SCARBOROUGH, NORTH YORKSHIRE		
SC118239000033	33, KELD CLOSE	YO12 6UF A	18-AUG-1993
SC118239000034	34, KELD CLOSE	YO12 6UF A	18-AUG-1993
SC118239000035	35, KELD CLOSE	YO12 6UF A	18-AUG-1993
SC118239000036	36, KELD CLOSE	YO12 6UF A	18-AUG-1993
SC118239000037	37, KELD CLOSE	YO12 6UF A	18-AUG-1993
SC118239000038	38, KELD CLOSE	YO12 6UF A	18-AUG-1993
SC118239000039	39, KELD CLOSE	YO12 6UF A	18-AUG-1993
SC109139030001	1, KESTREL VIEW, CROSSGATES	YO12 4TN D	01-APR-1993
SC109139030002	2, KESTREL VIEW, CROSSGATES	YO12 4TN B	01-APR-1993
SC109139030003	3, KESTREL VIEW, CROSSGATES	YO12 4TN B	01-APR-1993
SC109139030004	4, KESTREL VIEW, CROSSGATES	YO12 4TN C	01-APR-1993
SC109139030005	5, KESTREL VIEW, CROSSGATES	YO12 4TN B	01-APR-1993
SC109139030006	6, KESTREL VIEW, CROSSGATES	YO12 4TN B	01-APR-1993
SC108039200007	2 KILLERBY LODGE, KILLERBY, CAYTON	YO11 3TW C	01-APR-1993
SC108039200001	BARNGATES, KILLERBY, CAYTON	YO11 3TW C	01-APR-1993
SC108039200002	GLENRIDDING, KILLERBY, CAYTON	YO11 3TW C	01-APR-1993
SC108039200003	KILLERBY CROFT, KILLERBY, CAYTON	YO11 3TW G	01-APR-1993
SC108039200005	KILLERBY HALL, KILLERBY, CAYTON	YO11 3TW G	01-APR-1993
SC108039200006	KILLERBY LODGE, KILLERBY, CAYTON	YO11 3TW C	01-APR-1993
SC108039200015	KILLERBY OLD HALL, KILLERBY, CAYTON	YO11 3TW G	04-JAN-1998
SC108039200009	LEAFIELD, KILLERBY, CAYTON	YO11 3TW C	01-APR-1993
SC108039200012	OAK LEA, KILLERBY, CAYTON	YO11 3TW C	01-APR-1993
SC108039200010	RYECROFT, KILLERBY, CAYTON	YO11 3TW G	01-APR-1993
SC108039200011	TUDOR LODGE, KILLERBY, CAYTON	YO11 3TW E	01-APR-1993
SC108039200016	BIELBYS FOLLY AT KILLERBY OLD HALL, KILLERBY, CAYTON	YO11 3TW A	01-DEC-1997
SC108039250001	ANCHORAGE, KILLERBY CLIFF, CAYTON BAY	YO11 3NR D	01-APR-1993
SC108039250015	CARAVAN ADJ PEARL BUNGALOW, KILLERBY CLIFF, CAYTON BAY	YO11 3NR A	01-APR-1993
SC108039250010	CHALK HALL, KILLERBY CLIFF, CAYTON BAY	YO11 3NR B	01-APR-1993
SC108039250003	FAIRWAYS, KILLERBY CLIFF, CAYTON BAY	YO11 3NR B	01-APR-1993
SC108039250011	FLORAVILLE, KILLERBY CLIFF, CAYTON BAY	YO11 3NR D	01-APR-1993
SC108039250008	KILLERBY HOUSE, KILLERBY CLIFF, CAYTON BAY	YO11 3NR E	01-APR-1993
SC108039250009	PEARL BUNGALOW, KILLERBY CLIFF, CAYTON BAY	YO11 3NR A	01-APR-1993
SC108039250005	THE HEADLANDS, KILLERBY CLIFF, CAYTON BAY	YO11 3NR B	01-APR-1993

Project Summary Sheet					
Client/Authority Scarborough Borough Council			Prepared (date)		11/01/2001
Project name Cayton Bay - Killerby Cliff (MU24B)			Printed		20/09/2001
Project reference Base date for estimates (year 0)			Prepared by		GM
Scaling factor (e.g. £m, £k, £)			Checked by		
Principle land use band			Checked date		
Discount rate					
Costs and benefits of options					
			Costs and benefits £k		
	No Project	Option 1			
PV costs PVc	-	18.01	-	-	-
PV damage PVd	135.00	75.38			
PV damage avoided		59.62			
PV assets Pva					
PV asset protection benefits		-	-	-	-
Total PV benefits PVb		59.62			
Net Present Value NPV		41.60			
Average benefit/cost ratio		3.31			
Incremental benefit/cost ratio					
Highest b/c					
Brief description of options:					
Option 1	Improve Cliff Drainage				
Notes:					
1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting					
2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option) PV asset protection benefits are calculated as PVa (Option) - PVa (No Project) PV benefits calculated as PV damage avoided + PV asset protection benefits					
3) Incremental benefit/cost ratio is calculated as: (PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))					

Erosion Loss Calculation Sheet with delay options							Sheet Nr.	3
Client/Authority Scarborough Borough Council								
Project name Cayton Bay - Killerby Cliff (MU24B)		Option: Option 1 Improve Cliff Drainage		Delay (yrs) 10		Prepared (date) 09/05/2001		
Project reference Base date for estimates (year 0) Scaling factor (e.g. £m, £k, £) Discount rate		VVFBS Sep-2001 £k 6%				Printed Prepared by Checked by Checked date 20/09/2001 GM		
Ref	Asset Description	MV £k	Year	Prob of loss without project in year	Without Project	Option 1	Expected Present Value of asset losses £k	
0	Properties @ Killerby	537.56	1	0.0050	2.54	1.42		
1		537.56	2	0.0050	2.39	1.34		
2		537.56	3	0.0050	2.26	1.26		
3		537.56	4	0.0050	2.13	1.19		
4		537.56	5	0.0050	2.01	1.12		
5		537.56	6	0.0050	1.89	1.06		
6		537.56	7	0.0050	1.79	1.00		
7		537.56	8	0.0050	1.69	0.94		
8		537.56	9	0.0050	1.59	0.89		
9		537.56	10	0.0050	1.50	0.84		
10		537.56	11	0.0050	1.42	0.79		
11		537.56	12	0.0050	1.34	0.75		
12		537.56	13	0.0069	1.74	0.97		
13		537.56	14	0.0069	1.64	0.92		
14		537.56	15	0.0080	1.79	1.00		
15		537.56	16	0.0100	2.12	1.18		
16		537.56	17	0.0120	2.40	1.34		
17		537.56	18	0.0150	2.82	1.58		
18		537.56	19	0.0200	3.55	1.98		
19		537.56	20	0.0297	4.98	2.78		
20		537.56	21	0.0400	6.33	3.53		
21		537.56	22	0.0640	9.55	5.33		
22		537.56	23	0.0724	10.19	5.69		
23		537.56	24	0.0750	9.96	5.56		
24		537.56	25	0.0758	9.49	5.30		
25		537.56	26	0.0745	8.80	4.92		
26		537.56	27	0.0720	8.03	4.48		
27		537.56	28	0.0647	6.80	3.80		
28		537.56	29	0.0545	5.41	3.02		
29		537.56	30	0.0428	4.01	2.24		
30		537.56	31	0.0310	2.74	1.53		
31		537.56	32	0.0262	2.18	1.22		
32		537.56	33	0.0200	1.57	0.88		
33		537.56	34	0.0152	1.13	0.63		
34		537.56	35	0.0120	0.84	0.47		
35		537.56	36	0.0110	0.73	0.41		
36		537.56	37	0.0100	0.62	0.35		
37		537.56	38	0.0075	0.44	0.25		
38		537.56	39	0.0069	0.38	0.21		
39		537.56	40	0.0060	0.31	0.18		
40		537.56	41	0.0050	0.25	0.14		
41		537.56	42	0.0050	0.23	0.13		
42		537.56	43	0.0050	0.22	0.12		
43		537.56	44	0.0050	0.21	0.12		
44		537.56	45	0.0050	0.20	0.11		
45		537.56	46	0.0050	0.18	0.10		
46		537.56	47	0.0050	0.17	0.10		
47		537.56	48	0.0050	0.16	0.09		
48		537.56	49	0.0050	0.15	0.09		
49		537.56	50	0.0050	0.15	0.08		
50				1.0000	-	-		
Totals		537.56			135.00	75.38		
Notes								
Make one entry in the description column for each property (or group of properties) as this determines subsequent calculation								
MV = risk free market value at base date for estimate - must be entered on each line when probability distribution is used								
Equivalent annual value = MV x discount rate (assumes infinite life)								
Year is year in which there is the probability of loss shown, years must be entered consecutively for each property or group								
If no distribution is used enter year of expected year of loss and enter 1.0 in probability column								
Columns G to K show expected present values of asset losses with each option, assuming extensions of life entered above								
The loss is calculated using the formula PV loss = MV * Prob of loss * (1 - (1 - 1/((1+r)^(Year of loss))) = MV * Prob of loss / ((1+r)^(Year of loss))								
Additional properties can be entered by inserting lines above line 62 and copying all formulae, including hidden calculation in column C								
Asset value in subsequent years for each property is additional value for that property if life extended								

