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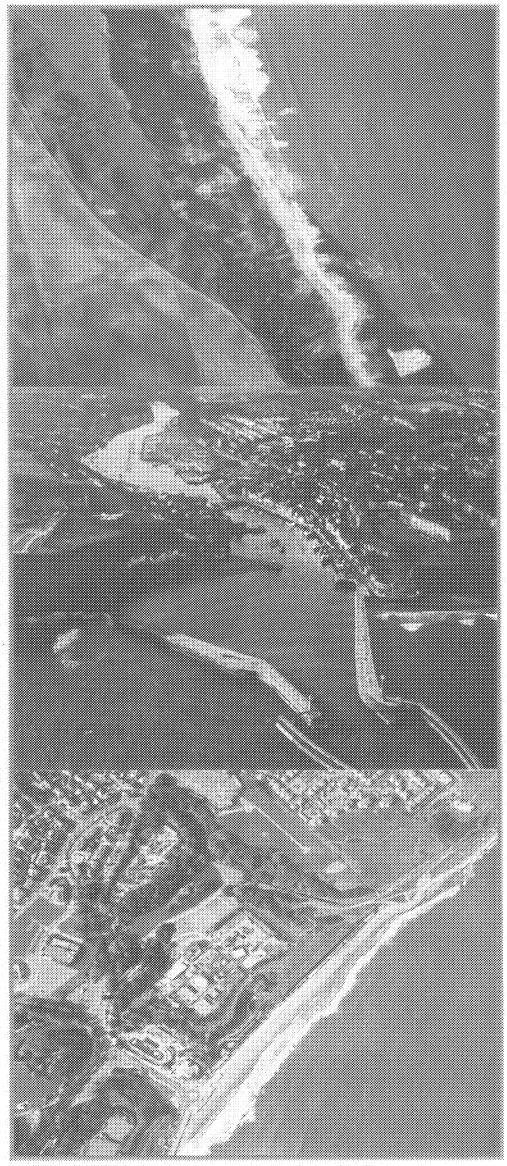
Scarborough Borough Council 1999 Aerial Photographs

Interpretative Report

October 2001



POSFORD HASKONING
A COMPANY OF
ROYAL HASKONING

Scarborough Borough Council

1999 Aerial Photographs
Interpretative Report

October 2001

PREPARED BY	*CHECKED BY*	*APPROVED BY*
Names: R J Grinham H Marshall J K Holliday	Names: S P Howard Dr N C Meakins M J Groves S Mayo	Names: J L Andrews
Signed:	Signed: pp M. Groves pp S. Mayo	Signed:
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Contents

PLEASE NOTE

- Posford Duvivier Ltd. are now Posford Haskoning Ltd.

- Ministry of Agriculture, Fisheries and Food (MAFF) are now Department for Environment, Food and Rural Affairs (DEFRA)

Section 1 INTRODUCTION

This report sets out to investigate the value of the 1999 aerial photographs for monitoring the shoreline in respect of natural processes, coastal defence structures and natural habitats. It also sets out to identify any other monitoring techniques necessary to make up for any deficiencies in the aerial photographs.

1.1 BRIEF

The brief is based upon the following documents:-

- Scarborough Borough Council – 1999 Aerial Coastal Photographs – Interpretative Report – Tender – January 2001.
- Posford Duvivier – 1999 Aerial Photographs – Interpretative Report Proposals – January 2001.
- Tender Correspondence:-

  15 January 2001
  17 January 2001
  2 February 2001
  13 February 2001
  20 February 2001
  March 2001

1.2 INPUT DATA

The input data is as follows:-

- 1:4000 Scale Stereoscopic Vertical Aerial Photographs (Prints)
- 1:10000 Scale Monoscopic Vertical Aerial Photographs (CD)
- Monoscopic Oblique Aerial Photographs (Prints)
- 1:50000 Scale OS Maps (CD)
- Shoreline Management Plan (1997)
- Annual Cliff Inspection Reports (2000)
  - Abbey & Spa Cliffs, Whitby
  - Scarborough Castle Cliffs
  - Holbeck Cliffs
  - Filey Brigg

1.3 BACKGROUND DATA

The main background data is as follows:-

- Scarborough Borough Council Flood & Coastal Action Plan – 2000/01
- MAFF High Level Targets for Flood and Coastal Defence
- Scarborough Borough Council Interpretative Report – Tender
- Posford Duvivier Interpretative Report - Proposal

1.4 OUTPUT DATA

Following discussions with the Council, the output data is summarised as follows:-

1.4.1 Standard of Assessment

Appropriate standards of assessment based upon good working practice and/or requirements of particular organisations.

1.4.2 General Assessments

Commentaries on the sufficiency of the input data to assess particular issues to the appropriate standard. Also identification of methods of addressing any deficiencies in the input data.

1.4.3 Full Assessments

Identification and assessment of all occurrences of a particular issue as far as the input data allows.

1.4.4 Issues

1. Natural Processes
2. Coastal Defence Structures
3. Natural Habitats

1.4.5 Natural Processes

1. Standard of Assessment

   - an indication of the scale, timing and context of the issue to allow the Council to make in-principle decisions in respect of planning matters, more detailed investigations, intervention, etc.

2. General Assessments

   - foreshore instability
   - current cliff instability

- future cliff instability
- historic cliff instability (geotechnical hot spots)
- cliff erosion rates (MAFF Target 13)
- effects of climate change

3. Full Assessments

- foreshore erosion rates (high/medium/low risk for coastal process unit)
- current cliff instabilities
- historic cliff instabilities
- cliff erosion rates (high/medium/low risk for coastal process unit)

1.4.6 Coastal Defence Structures

1. Standard of Assessment

- for natural processes and natural environment, as above.
- for coastal defence structures, in accordance with recent practice for MAFF returns and EA returns.

2. General Assessments

- description, situation and condition (MAFF Targets 4B and 6A)
- performance in terms of negative impacts on coastal erosion (MAFF Target 6B)
- performance in terms of other negative impacts on natural processes and natural environment

3. Full Assessments

- impacts of recent works on natural processes and natural environment (Runswick Bay, Robin Hood's Bay and Holbeck Landslide)

1.4.7 Natural Habitats

1. Standard of Assessment

- to Phase I Habitat Survey Standard as defined by the Nature Conservancy Council (now English Nature)

2. General Assessments

- types and extents
- health and damage
- gains and losses

3. Full Assessments

- comment only on benchmarking and enhancement

1.4.8 General Assessment Tables

The general assessments are recorded on standard General Assessment Tables. There is a separate table for each particular issue under consideration. The tables list a range of input data and for each assessment percentage values are inserted against relevant items within the list. The values represent the contributions made by the particular items towards a full assessment of the issue under consideration.

Section 2 NATURAL PROCESSES

2.1 PREAMBLE

2.1.1 GENERAL DISCUSSION

A single aerial photograph can provide a permanent record of the condition of a coastal slope at any particular moment in time. A series of aerial photographs taken within the same time can provide a large record in a short span of time.

A great deal of information with respect to coastal slope instability can be derived from the interpretation of aerial photographs by experienced geotechnical specialists. It therefore follows that aerial photography and its interpretation can provide an accurate and measurable record and very cost effective means of assessing coastal erosion processes. In addition, a series of aerial photographs taken at differing time intervals are capable of providing a record of changing slope conditions with time.

Aerial photographs have been examined to assess the impact of natural processes on coastal slopes with particular reference to coastal cliff and foreshore erosion. An assessment has been carried out considering past, present and future stability of cliffs on the North Yorkshire coast.

2.1.2 Standard of Assessment

General principles of aerial photograph interpretation are contained within standard texts, and methods of interpretation are not discussed here.

Provision and interpretation of aerial photography is an acceptable and commonly used method for assessing stability of slopes.

This assessment has been carried out in accordance with best practice using appropriately qualified geotechnical specialists. Reference has been made to guidance on the use of aerial photography for the interpretation of site features given in the British Standard for Site Investigations, BS5930:1999 (Section 1, Chapter 8).

Very detailed assessments have not been carried out here. A detailed assessment would require the use of more accurate forms of aerial photograph such as Orthophotos. Orthophotos are photographs from which height distortion has been removed and they are therefore especially useful for plotting in the field since it is possible to accurately measure horizontal distances from such a photograph. This type of photograph can form the basis of detailed contour plans and geomorphological/engineering maps and plans.

2.2 GENERAL ASSESSMENTS

General assessments have considered the sufficiency of the input data to assess past, present and future instability of cliffs along the North Yorkshire coast. A summary of the estimated percentage value of aerial photographs for use in this study and an appraisal of sufficiency of the input data is provided in the General Assessment Table 2.2.1 below.

A number of factors are thought to control the stability of coastal cliffs. These factors may be observed in single or time series aerial photographs.

The main factors contributing to overall slope stability in this study are :

Geology

The type and extent of solid and superficial geological formations and their structural relationship are found to be major controls on the magnitude and rate of cliff erosion.

Records of the British Geological Survey (BGS) such as geological maps and memoirs have been used to determine the solid and superficial geological formations and structural relationships present within the study area.

Glacial Till forms the main superficial formation. This is invariably a stiff fissured clay which typically forms oversteep unstable cliff slopes when present.

Slope Morphology

Slope morphology encompasses slope height, angle and aspect. These factors are important elements in formal analyses and have been recognised as important factors in controlling stability of highway earthworks in the UK .

Slope factors have been assessed by direct measurement from 1:50,000 and 1:2500 scale Ordnance Survey (OS) maps and from scaled aerial photographs.

Vertical photographs of steep sided coastal cliffs in particular were found to be of limited value when attempting detailed geological and slope assessments because of the lack of visible detail. In these situations, oblique aerial photographs were particularly useful to confirm geological formations, where exposed, the nature and extent of slope failures, slope morphology and vegetation on slopes.

2.2.1 Foreshore Instability

Foreshore instability is generally dependent on factors such as geological formation, slope aspect and exposure to weathering, and the prevailing wave and tidal regime. Its assessment in aerial photographs has been considered in terms of the nature and extent of protection to the foreshore from erosion.

General assessments have considered : solid/superficial formations from BGS maps; slope aspect in relation to exposure to weathering and incidence of wave attack from OS maps and vertical photographs; the presence or absence of natural debris fans, protective headlands or foreshore rock shelves from OS maps and photographs; and the type and extent of any formal coast defence structures.

2.2.2 Current Cliff Instability

Current cliff instability is generally dependent on factors such as geological formations present; cliff height, slope and aspect; presence or absence of vegetation and surface and groundwater behaviour.

Areas of current cliff instability are clearly visible from single and stereo pairs of aerial photographs. Oblique photographs can refine interpretation particularly in areas of steep cliffs.

2.2.3 Future Cliff Instability

Future cliff instability has been simply assessed by considering existing foreshore and cliff instability and predominant failure mechanisms together with a prediction of the effects of climate change. Generally, the extent and mechanisms of failure of existing cliffs are likely to continue at a rate similar to the present day unless there is intervention.

2.2.4 Historic Cliff Instability

Records of historic cliff instability are held by both the highway and coast defence authorities. Historical cliff instability is also recorded within the relevant Shoreline Management Plans (SMP).

Aerial photographic interpretation can assist in identifying areas of historic cliff instability.

A database of aerial photography has been available since the 1940's and use of such existing sources could assist in examining the nature and extent of historic instability affecting cliffs within the study area when compared with recent photography. Such a study would also supplement existing assessments in a cost effective manner.

2.2.5 Cliff Erosion Rates

Cliff erosion rates cannot be estimated from a single photograph without the benefit of comparison with previous time series (historical) aerial photographic data.

Traditionally, cliff erosion rates have been estimated by comparison and measurement of cliff line recession from time series (historical) OS maps. Time series aerial photography is potentially capable of providing a far greater scope of detail that may be used for estimation of erosion rates by direct measurement of relevant measurable features.

For this study, cliff erosion rates have been assessed from visual observations of features described in the assessments of foreshore and cliff instability taken from the 1999 series of aerial photographs.

2.2.6 Effects of Climate Change

The effects of climate change are difficult to quantify for the immediate future. It is generally accepted that global sea levels are rising albeit at a very slow rate and that increased storminess will increase the risk of extreme climatic events affecting the stability of coastal cliffs.

Sea level rise will generally increase risk of slope instability by increased erosion of the foreshore and toe ultimately resulting in the accelerated erosion of cliffs. Increased storminess will also increase the frequency of slope instability by increasing surface and groundwater influence in slopes and softening exposed strata.

2.3 FULL ASSESSMENTS

A simple hazard zonation scheme has been produced to enable a subjective and detailed assessment of stability of the coastal cliffs. The scheme provides a basis for subjective assessment of risk of slope instability. It can be used as a basis for decision making in coast defence planning and coastal risk management.

The scheme is based on looking at two critical areas, slope crest and slope toe, which exhibit and are affected by several factors. These areas are key in considering property within public or third party ownership. A reasonable risk rating is given as follows :

High risk is defined as areas where the slope crest and/or slope toe are within 50 metres of existing habitable property boundaries.

Moderate risk is defined as areas where the slope crest and/or slope toe are within >50 metres to <100 metres of existing habitable property boundaries.

Low risk is defined as areas where the slope crest and/or slope toe are >100 metres of existing habitable property boundaries.

Properties have been selected as the main indicator of risk to the human and built environment which would include people and infrastructure. However, where appropriate isolated roads or areas where people visit have also been taken into account.

The hazard zonation scheme has been refined based on the number of factors discussed in the general assessment. These factors have been linked to the stability of existing cliffs and categorised in order of degree of risk. The proposed risk categorisations are presented in Tables 2.3.1 and 2.3.2 below.

Rapid assessment techniques and experience of detailed assessments from similar coastal stability studies have been applied to aerial photographs by specialist geotechnical engineers to allow cost effective interpretations of both current and historical stability of cliffs.

The principle of rapid assessment using aerial photography has been shown to be an effective means both in time and money to assess cliff and foreshore instability. In this case, a set of aerial photographs can cover a large area of land and be taken in one day .

In general the risk of slope instability has been assessed as high for predominantly cohesive materials and low from non-cohesive granular rock and soil lithologies.

The presence or absence of glacial till is a significant factor in assessment of instability. High and low risk has been attached to slopes with and without glacial tills respectively to reflect the influence of this factor.

Slope morphological factors have been assessed in terms of their influence and a risk categorisation has been established.

GENERAL ASSESSMENT TABLE 2.2.1 Natural Processes – All Aspects

Information Category	Single Data Set				Time Series Data Set				Total % Value
	Existing Specification		Improved Specification		Existing Specification		Improved Specification		
	Description	% value	Description	% value	Description	% value	Description	% value	
Specified Input Data	1:4000 Scale Monoscopic Vertical Aerial Photographs (Prints)	5	1:2500 scale and Time of Photography	(10)	12 Monthly	5	1:2500 scale and Time of Photography	(10)	10
	1:4000 Scale Stereoscopic Vertical Aerial Photographs (Prints)	5				15			20
	1:10000 Scale Monoscopic Vertical Aerial Photographs (CD)								
	Monoscopic oblique Aerial Photographs (Prints)	5				5			10
	1:50000 Scale OS Maps								
	Shoreline Management Plan (1997)	5				5			10
	Annual Cliff Inspection Reports (2000)	5				5			10
Specified SMP Monitoring	Visual inspection of coastal defence structures only (6 or 12 monthly)								
	Visual inspection of foreshore, defences, backshore and cliff (1/2, 1 or 5 yearly)	5				5			10
	Foreshore profile survey only (selected areas/6 monthly/manually)	5				5			10
	Cliff top location survey only (6 or 12 monthly/manually or aerial photos)								
	Foreshore, defences, backshore and cliff profile survey (selected areas/yearly/aerial photos)								
	Bathymetric survey and sediment analysis (5 yearly)	5				5			10
	Coastal water level records (ongoing)								
	Coastal wind records (ongoing)								
	Offshore wave climate records (ongoing)								
Other Sources	1:2500 Scale OS Maps	5							5
	Geological Maps	5							5
	Admiralty Charts								
	Existing surveys, records, studies, reports, etc (e.g. Section 8 of Tender)								
	Trial Excavations								
	Ground Investigation								
	Quantitative Ecological Survey								
	Coastal defence structure profile survey only								
Total % values		50				50			100

Notes Bracketed values represent separate assessments to demonstrate improved value.

In assessment of cliff instability, a simple assessment of failure mechanisms has been carried out. Risk has been assessed in subjective terms on the basis of relative scale and activity of instability observed. High, moderate and low risk are attached to slopes indicating active, semi-active and dormant (stable) states of instability respectively.

Detailed assessments have been carried out for the Coastal Process Units 4 to 10.

Results of the full assessments are summarised in Tables 2.3.3 to 2.3.9 below. The results are discussed with reference to foreshore and cliff erosion rates and current cliff instability as follows :

2.3.1 Foreshore and Cliff Erosion Rates

Foreshore erosion rates have been assessed in terms of available protection from erosion. A number of factors were proposed that control erosion of the foreshore.

High risk was assessed in areas of little or no protection where softer (cohesive) rock or soil types occur (including glacial tills), where undercutting of cliffs and steep foreshore shelves are visible, and there is little natural rock or soil debris on the foreshore to protect the toe of cliffs.

Moderate risk was assessed in areas where there was some protection from resistant rock or soil types, and some shelf protection and debris at the toe of cliffs.

Low risk areas were assessed where there was greatest protection from resistant rock types, significant debris at the toe of cliffs and features such as bluffs, headlands or formal coast defence structures that afford protection to the cliffs.

2.3.2 Current Cliff Instabilities

Risk has been assessed in subjective terms depending on the observable extent and frequency of instability being high (active), moderate (semi-active) or low (dormant).

2.3.3 Historic Cliff Instabilities

Information on historic cliff instability is contained within the SMP. Detailed assessment of aerial photographs of areas of historic cliff instability require time series photography to determine the current state of stability.

Previous detailed studies of areas of historic cliff instability have suggested that the centres, timing and extent of instability affecting coastal cliffs may migrate with time in local areas in response to more complex behaviour and environmental factors such as bed load, sediment supply, storm frequencies and duration etc . Again, time series aerial photography taken at suitable scale and time frequency can provide a useful and measurable record of such behaviour.

2.3.4 Cliff Erosion Rates

Cliff erosion rates have been assessed in terms of current cliff instability from 1:2500 scale observed features in photography. Areas of current cliff instability are clearly visible in both single and stereo pairs of aerial photographs and oblique photographs enhance the interpretation of mechanism of failure especially for typically steep cliffs.

FULL ASSESSMENT TABLE 2.3.1

Overall Risk Categorisation for Coastal Process Units 4 to 31

Factor	Hazard	Description	Relative risk	Risk rating
Geology	Solid geology	(see Table 2.3.2)	Table 2.3.2	Table 2.3.2
	Superficial geology	Present	H	10
		Absent	L	1
Slope	Slope height	>100m	H	10
		50-100m	M	5
		<50m	L	1
	Slope angle	>50°	H	10
		25-50°	M	5
		<25°	L	1
	Slope aspect	South facing	H	10
		East facing	M	5
		North facing	L	1
Instability	Foreshore protection	None	H	10
		Some	M	5
		Significant	L	1
	Current cliff instability	Active	H	10
		Semi-Active	M	5
		Dormant	L	1
	Future cliff stability	Summation of foreshore and current cliff instabilities	H	10
			M	5
			L	1
Erosion Rates	Foreshore	No protection	H	10
		Some protection	M	5
		Greatest protection	L	1
	Cliff	Based on observable number, extent and frequency of instabilities	H	10
			M	5
			L	1
Urban/Rural	Risk to people/property	<50m	H	10
		>50m-<100m	M	5
		>100m	L	1

FULL ASSESSMENT TABLE 2.3.2

Risk Categorisation of Geological Formations For Coastal Process Units 4 to 31

Age	Group	Formation	Typical lithologies	Risk rating
Upper Cretaceous	Chalk Group	Ferriby Chalk	Marly soft chalk without flint	L
Lower Cretaceous		Speeton Clay	Grey clay with phosphatic nodules.	M
Upper Jurassic		Kimmeridge Clay	Bituminous mudstone with limestone nodules	H
		Oxford Clay	Grey-green mudstone	H
Middle Jurassic		Osgodby (Kellaways)	Yellow sandstone, limestone and siltstone	L
	Ravenscar Group	Scalby Scarborough Cloughton Eller Beck Saltwick	Mudstone, sandstone Calc sandstone, limestone Sandstone, mudstone Limestone Sandstone, mudstone	M
		Dogger	Ironstone, siltstone	L
Lower Jurassic	Lias Group	Whitby Mudstone	*Upper Lias* - bituminous mudstone, siltstone, Alum shales and limestone	H
		Cleveland Ironstone	*Middle Lias* - ironstone and yellow grey sandstone	L
		Redcar Mudstone	*Lower Lias* - grey mudstone with siderite and pyrite, beds of sandstone	H

FULL ASSESSMENT TABLE 2.3.3

Coastal Process Unit No.4 – Staithes Cowbar to Penny Nab Coastguard Lookout.

Factor	Field	Description/Comments	Risk
GEOLOGY	Lithology – solid	Middle Lias – ironstone, sandstones. Estimate up to 30m thick.	L
	Lithology –superficial	Glacial Till – stiff clays. Estimate up to 20m thick.	H
SLOPE	Slope height	50m – 100m	M
	Slope angle	≥ 70° in sandstones. Up to 45°(1:1) in till (scaled from photographs horiz=27m, vert=25m).	H
	Slope aspect	North	L
INSTABILITY	Foreshore	Eroding foreshore with little protection from wave action. Active undercutting of sandstone cliffs with formation of blow holes and caves.	H
	Current cliff	Active erosion of glacial tills over rock. Lack of vegetation protection.	H
	Future	Greatest risk of erosion of tills adjacent to housing.	H
	Historic	Assumed similar modes of failure evident from photographs.	
EROSION RATES	Foreshore	Relatively stable resistant rock at toe. Slow recession.	L
	Cliff	Active erosion of glacial tills and lack of vegetation protection. Moderate recession.	M
URBAN / RURAL	Risk to people/property	Locally, high risk due to proximity of properties near the edge of actively eroding cliffs. Nearest edge of cliffs measured to be ≤10m.	H
OVERALL ASSESSMENT			6.3 (M)

Assessment

The overall assessment indicates **moderate** risk of cliff instability (6.3). The area is predominantly rural and therefore risk and consequences of slope instability affecting rural property is considered to be **low**.

Locally, **high risk** occurs where actively eroding cliffs threaten housing and roads within 50m distance.

FULL ASSESSMENT TABLE 2.3.4

Coastal Process Unit No.5 – Staithes Penny Nab Coastguard Lookout to Old Nab.

Category	Factor	Description/Comments	Risk
GEOLOGY	Lithology - solid	Upper Lias – mudstone, siltstones.	H
	Lithology -superficial	absent	L
SLOPE	Slope height	50m - 100m	M
	Slope angle	Composite slopes. Steep ≥ 50° in mud/siltstones. Estimate up to 35°(1:1½) weathered upper layers.	H
	Slope aspect	East	H
INSTABILITY	Foreshore	Actively eroding foreshore with little protection from wave action. Scour and undercutting of cliffs evident.	H
	Current cliff	Areas where current cliffs stable (little sign of instability, slopes protected by vegetation). Instability in steeper cliffs with absence of vegetation.	M
	Future	Greatest risk of erosion in steep, unprotected weathered layers.	M
	Historic	Assumed similar modes of failure evident from photographs.	
EROSION RATES	Foreshore	Relatively stable resistant rock at toe. Slow recession.	L
	Cliff	Semi-active erosion of upper weathered layers in areas with lack of vegetation protection. Moderate recession.	M
URBAN / RURAL	Risk to people/property	Locally, moderate risk due to proximity of properties near the edge of semi-active eroding cliffs. Nearest edge of cliffs measured to be ≤20m.	M
OVERALL ASSESSMENT			6.2 (M)

Assessment

The overall assessment indicates **moderate** risk of cliff instability (6.2). The area is predominantly rural and therefore risk and consequences of slope instability affecting surrounding property is considered to be **low**.

Locally, **moderate risk** occurs where semi-active eroding cliffs are within 50m distance to nearest housing and roads.

FULL ASSESSMENT TABLE 2.3.5

Coastal Process Unit No. 6a – Port Mulgrave Old Nab to Beacon Hill

Category	Factor	Description/Comments	Risk
GEOLOGY	Lithology - solid	Upper Lias – mudstone, siltstones.	H
	Lithology -superficial	absent	L
SLOPE	Slope height	50m - 100m	M
	Slope angle	Steep ≥ 50° in mud/siltstones..	H
	Slope aspect	East (varies). Structural/aspect control on instability apparent. Instability in north facing steep slopes exposed to wave attack producing active erosion. Relative stability in east facing slopes protected by vegetation cover.	M
INSTABILITY	Foreshore	Actively eroding foreshore to north facing slopes with recent falls producing rock debris fans. East facing slopes protected by vegetation cover.	M
	Current cliff	North faces currently actively eroding. East facing slopes currently stable and protected by vegetation.	M
	Future	Continued instability in north facing slopes anticipated.	M
	Historic	It is apparent that east facing slopes have in the past experienced large scale mass instability (currently stable).	
EROSION RATES	Foreshore	Moderate recession of north facing cliff toe. Slow recession of east facing cliff toe.	M
	Cliff	Moderate recession of north facing cliff edge. Slow recession of east facing cliff edge.	M
URBAN / RURAL	Risk to people/property	Locally, moderate risk due to proximity of properties near the edge of semi-active eroding cliffs. Nearest edge of cliffs measured to be ≤20m.	M
		OVERALL ASSESSMENT	5.6 (M)

Assessment

The overall assessment indicates **moderate** risk of cliff instability (5.6). The area is predominantly rural and therefore risk and consequences of slope instability affecting surrounding rural property is considered to be **low**. Locally, **moderate risk** occurs where semi-. active eroding cliffs are within 50m distance to nearest housing and roads.

FULL ASSESSMENT TABLE 2.3.6

Coastal Process Unit No. 7a – Runswick Bay Upgarth Hill to Nettle Dale

Category	Factor	Description/Comments	Risk
GEOLOGY	Lithology - solid	absent	L
	Lithology -superficial	Glacial Till	H
SLOPE	Slope height	Up to 50m	L
	Slope angle	Moderate 25° to 50° in mud/siltstones. Estimate up to 35°(1:1½) in Glacial Tills.	M
	Slope aspect	East.	M
INSTABILITY	Foreshore	Little sign of foreshore instability. Foreshore protected by supply of sand from active erosion of surrounding hills.	L
	Current cliff	East facing slopes relatively stable and protected by vegetation.	L
	Future	Effectiveness of remedial works in progress at 1999 will affect any possibility of future instability affecting Runswick Bay.	L
	Historic	Runswick Bay is located on east to south facing slopes. The form of the slopes suggest the area may possibly have been affected in the past by mass instability.	
EROSION RATES	Foreshore	Anticipate moderate recession of east facing cliff toe. Local erosion of foreshore in areas of river tributaries.	M
	Cliff	Slow recession of east facing cliff edge	L
URBAN / RURAL	Risk to people/property	Work in progress to stabilise Runswick Bay anticipated to reduce risk of instability affecting properties.	L
		OVERALL ASSESSMENT	3.1 (L)

Assessment

The overall assessment indicates **low** risk of cliff instability (3.1). The area is both urban and rural. The risk and consequences of slope instability affecting urban property would be assessed as high, however, it is assumed that work in progress at the time of photography would substantially reduce that risk.

FULL ASSESSMENT TABLE 2.3.7

Coastal Process Unit No. 8a – Kettle Ness Claymore Bank to Kettle Ness

Category	Factor	Description/Comments	Risk
GEOLOGY	Lithology - solid	Predominantly Upper Lias – Alum Shales capped by sandstones of the Inferior Oolite Fm.	H
	Lithology -superficial	absent	L
SLOPE	Slope height	50m to 100m	M
	Slope angle	Steep > 50° in shales and sandstones.	H
	Slope aspect	East (varies).	M
INSTABILITY	Foreshore	Some instability. Resistant Alum Shales at toe forming effective rock shelf protection with some rock debris. Some undercutting and caving at toe.	L
	Current cliff	Semi-active erosion of cliffs from undermining and steepening of shale cliffs.	M
	Future	Steady erosion of type described above.	M
	Historic	Extensive former workings of Kettle Ness and Scratch Alley dominate the landscape.	
EROSION RATES	Foreshore	Anticipate moderate recession of east facing cliff toe with protection from debris fans, resistant rock type and rock shelves.	M
	Cliff	Slow recession of east facing cliff edge	L
URBAN / RURAL	Risk to people/property	There is no property within at least 100m from the nearest cliff edge (except Sandsend which is assessed separately).	L
		OVERALL ASSESSMENT	4.4 (M)

Assessment

The overall assessment indicates **moderate** risk of cliff instability (4.4). The area is rural. The risk and consequences of slope instability affecting rural property would be assessed as **low**.

FULL ASSESSMENT TABLE 2.3.8

Coastal Process Unit No. 9a – Sandsend Mast Hill Sandsend to Sandsend Beck

Category	Factor	Description/Comments	Risk
GEOLOGY	Lithology - solid	absent	L
	Lithology -superficial	Glacial Till	H
SLOPE	Slope height	<50m	L
	Slope angle	Moderate 25° – 50°. Estimate 1:1.5 (35°) in Glacial Tills.	M
	Slope aspect	North	L
INSTABILITY	Foreshore	Little foreshore instability with significant formal coast defence measures.	L
	Current cliff	Semi-active erosion of oversteep glacial clay cliffs.	M
	Future	Steady erosion of type described above.	L
	Historic		
EROSION RATES	Foreshore	Anticipate low erosion rates as result of existing coast defences.	L
	Cliff	Low cliff erosion rates as result of low to moderate slope heights and angles and vegetation cover.	L
URBAN / RURAL	Risk to people/property	The area is predominantly urban. There is a low risk to properties and A174 road assuming existing coast defences are constructed to adequate standard with acceptable residual life.	L
OVERALL ASSESSMENT			2.7 (L)

Assessment

The overall assessment indicates **low** risk of cliff instability (4.4). The area is mainly urban. The risk and consequences of slope instability affecting urban property would be assessed as **low**.

FULL ASSESSMENT TABLE 2.3.9

Coastal Process Unit No. 10 – Whitby Raithewaite Gill to Upgang Beck

Category	Factor	Description/Comments	Risk
GEOLOGY	Lithology - solid	absent	L
	Lithology -superficial	Glacial Till	H
SLOPE	Slope height	<50m (i.e. estimate ≤30m).	L
	Slope angle	Moderate 25° – 50°. Estimate 1:1.5 (35°) in Glacial Tills.	M
	Slope aspect	North	L
INSTABILITY	Foreshore	Active instability of unprotected cliff toes in glacial clays. Little foreshore protection from sandy beach.	H
	Current cliff	Active instability of cliffs.	H
	Future	Continued instability of foreshore and cliffs as described above.	H
	Historic		
EROSION RATES	Foreshore	Anticipate moderate to high erosion rates of unprotected foreshore.	M
	Cliff	Anticipate moderate to high erosion rates of unprotected cliffs.	M
URBAN / RURAL	Risk to people/property	The area is predominantly rural. The only affected property are buildings belonging to the golf club which are in the region of 100m from the cliff edge. There is therefore currently a low risk to properties.	L
OVERALL ASSESSMENT			5.4 (M)

Assessment

The overall assessment indicates **moderate** risk of cliff instability (5.4). The area is mainly rural. The risk and consequences of slope instability affecting urban property would be assessed as **low**.

Section 3 COASTAL DEFENCE STRUCTURES

3.1 PREAMBLE

3.1.1 General Discussion

A general assessment of the coastal defence structures has been divided into 4 areas:-

Description
Situation
Condition
Performance

The description of structures covers their general location, type and geometry together with background information such as ownership, age and replacement costs. The information involved changes little with time.

The situation in which the structures operate refers to the sea conditions, shoreline conditions and the land and properties protected by the defences. The information can vary with time, especially in respect of the shoreline conditions.

The condition of the structures deals with their basic integrity and residual life, and examines the operational significance of these issues. Such information changes from year to year.

The performance of the coastal defence structures considers their standard of protection and any negative impacts they may have on their natural surroundings. Although performance may only change slowly, say with annual sea level rise, regular monitoring is necessary to measure impacts.

A full assessment of all of the coastal defence structures has been limited to looking at the impacts of the recent works.

3.1.2 Standard of Assessment

The standard of assessment, both in terms of extent and detail, is based upon the Coast Protection Survey of England as developed by the Ministry of Agriculture, Fisheries and Food and upon the Asset Management Survey as developed by the Environment Agency. The assessment is primarily a visual examination of what is on view without routinely uncovering buried structures.

Where an insufficient amount of the structure is on view, or where there are other difficulties with a purely visual examination, a confidence rating can be applied to the assessment of condition. Also, where there are serious questions about the condition of a structure, a recommendation can be made for a more detailed investigation.

3.2 GENERAL ASSESSMENTS

3.2.1 Description

With reference to Table 3.2.1A it can be seen that aerial photographs only play a minor role (20%) in describing coastal defence structures. Collection of most of the data requires a visual inspection on site supported by information such as OS Maps and profile surveys.

Although aerial photographs help to reduce the amount of time spent on other data collection, they are not indispensable for this exercise.

3.2.2 Situation

From Table 3.2.2A it can be seen that aerial photographs make a 30% contribution to determining the situation in which the coastal defence structures operate. Half of that value in derived from a time series data set which helps to detect changes, such as in foreshore levels and cliff positions.

However, there is still a need for visual inspections and profile surveys and therefore, although helpful, aerial photographs are not essential.

3.2.3 Condition

From Table 3.2.3A it can be seen that aerial photographs make a minimal contribution to the assessment of the condition of the coastal defence structures. The majority of the assessment is based upon visual inspections and these cannot be replaced by aerial photography.

3.2.4 Performance

With reference to Table 3.2.4A, aerial photographs make up 30% of the assessment of the performance of the coastal defence structures. Half of that figure relates to a time series data set which is necessary to determine the ongoing nature of the various impacts.

Although visual inspections and surveys are also required, the aerial photographs provide a valuable qualitative assessment of impacts and make a contribution to quantitative assessments.

GENERAL ASSESSMENT TABLE 3.2.1A Coastal Defence Structures - Description

Information Category	Single Data Set				Time Series Data Set				Total % Value
	Existing Specification		Improved Specification		Existing Specification		Improved Specification		
	Description	% value	Description	% value	Description	% value	Description	% value	
Specified Input Data	1:4000 Scale Monoscopic Vertical Aerial Photographs (Prints)	10							10
	1:4000 Scale Stereoscopic Vertical Aerial Photographs (Prints)								
	1:10000 Scale Monoscopic Vertical Aerial Photographs (CD)								
	Monoscopic oblique Aerial Photographs (Prints)	10							10
	1:50000 Scale OS Maps								
	Shoreline Management Plan (1997)	10							10
	Annual Cliff Inspection Reports (2000)								
Specified SMP Monitoring	Visual inspection of coastal defence structures only (6 or 12 monthly)	30			12 monthly	10			40
	Visual inspection of foreshore, defences, backshore and cliff (1/2, 1 or 5 yearly)								
	Foreshore profile survey only (selected areas/6 monthly/manually)								
	Cliff top location survey only (6 or 12 monthly/manually or aerial photos)								
	Foreshore, defences, backshore and cliff profile survey (selected areas/yearly/aerial photos)								
	Bathymetric survey and sediment analysis (5 yearly)								
	Coastal water level records (ongoing)								
	Coastal wind records (ongoing)								
	Offshore wave climate records (ongoing)								
Other Sources	1:2500 Scale OS Maps	10							10
	Geological Maps								
	Admiralty Charts								
	Existing surveys, records, studies, reports, etc (e.g. Section 8 of Tender)	10							10
	Trial Excavations								
	Ground Investigation								
	Quantitative Ecological Survey								
	Coastal defence structure profile survey only	10							10
Total % values		90				10			100

Notes For details included in Description of Coastal Defence Structures see Table 3.2.1B

COMMENTARY TABLE 3.2.1B Description of Coastal Defence Structures - Details and Data Sources

Details	Data Sources
General Location	SMP/OS Map
OS Grid References	OS Map
Type	SMP/Aerial Photographs / Visual Inspection
Materials	SMP/Visual Inspection
Length	SMP/OS Map / Visual Inspection
Cross-section/Crest Levels	SMP/Visual Inspection / Profile Survey
Close-up Photograph	Visual Inspection
Owner/Maintenance Responsibility	Records
Year of Construction	Records
Replacement Value	Records
Special Details	Visual Inspection / Records

GENERAL ASSESSMENT TABLE 3.2.2A Coastal Defence Structures - Situation

Information Category	Single Data Set				Time Series Data Set				Total % Value
	Existing Specification		Improved Specification		Existing Specification		Improved Specification		
	Description	% value	Description	% value	Description	% value	Description	% value	
Specified Input Data	1:4000 Scale Monoscopic Vertical Aerial Photographs (Prints)	10			12 monthly	10			20
	1:4000 Scale Stereoscopic Vertical Aerial Photographs (Prints)								
	1:10000 Scale Monoscopic Vertical Aerial Photographs (CD)								
	Monoscopic oblique Aerial Photographs (Prints)	5			12 monthly	5			10
	1:50000 Scale OS Maps	5							5
	Shoreline Management Plan (1997)	10							10
	Annual Cliff Inspection Reports (2000)								
Specified SMP Monitoring	Visual inspection of coastal defence structures only (6 or 12 monthly)								
	Visual inspection of foreshore, defences, backshore and cliff (1/2, 1 or 5 yearly)	10			12 monthly	10			20
	Foreshore profile survey only (selected areas/6 monthly/manually)								
	Cliff top location survey only (6 or 12 monthly/manually or aerial photos)								
	Foreshore, defences, backshore and cliff profile survey (selected areas/yearly/aerial photos)	10			12 monthly	10			20
	Bathymetric survey and sediment analysis (5 yearly)								
	Coastal water level records (ongoing)	5			Ongoing	5			10
	Coastal wind records (ongoing)								
	Offshore wave climate records (ongoing)								
Other Sources	1:2500 Scale OS Maps								
	Geological Maps								
	Admiralty Charts								
	Existing surveys, records, studies, reports, etc (e.g. Section 8 of Tender)	5							5
	Trial Excavations								
	Ground Investigation								
	Quantitative Ecological Survey								
	Coastal defence structure profile survey only								
Total % values		60				40			100

Notes For details of Situation for Coastal Defence Structures see Table 3.2.2B

COMMENTARY TABLE 3.2.2B Situation for Coastal Defence Structures - Details and Data Sources

Details	Data Sources
Tide Levels	SMP / Records / Monitoring
Inshore Wave Climate	SMP / Records / Monitoring
Degree of Exposure to Wave Action	SMP / OS Map / Aerial Photographs / Records / Visual Inspection
Type, Level & Condition of Foreshore	SMP / Aerial Photographs / Profile Survey / Visual Inspection
Dependency on Foreshore Levels	Aerial Photographs / Visual Inspection / Records
Erosion Rate of Coastal Slope	Aerial Photographs / Cliff Top Survey / Visual Inspection
Land Type	SMP / Aerial Photographs / OS Map
Properties at Risk	SMP / Aerial Photographs / Visual Inspection
Special Details	Visual Inspection / Records

GENERAL ASSESSMENT TABLE 3.2.3A Coastal Defence Structures - Condition

Information Category	Single Data Set				Time Series Data Set				Total % Value
	Existing Specification		Improved Specification		Existing Specification		Improved Specification		
	Description	% value	Description	% value	Description	% value	Description	% value	
Specified Input Data	1:4000 Scale Monoscopic Vertical Aerial Photographs (Prints)								
	1:4000 Scale Stereoscopic Vertical Aerial Photographs (Prints)								
	1:10000 Scale Monoscopic Vertical Aerial Photographs (CD)								
	Monoscopic Oblique Aerial Photographs (Prints)								
	1:50000 Scale OS Maps								
	Shoreline Management Plan (1997)	20							20
	Annual Cliff Inspection Reports (2000)								
Specified SMP Monitoring	Visual inspection of coastal defence structures only (6 or 12 monthly)	25			12 monthly	45			70
	Visual inspection of foreshore, defences, backshore and cliff (1/2, 1 or 5 yearly)								
	Foreshore profile survey only (selected areas/6 monthly/manually)								
	Cliff top location survey only (6 or 12 monthly/manually or aerial photos)								
	Foreshore, defences, backshore and cliff profile survey (selected areas/yearly/aerial photos)								
	Bathymetric survey and sediment analysis (5 yearly)								
	Coastal water level records (ongoing)								
	Coastal wind records (ongoing)								
	Offshore wave climate records (ongoing)								
Other Sources	1:2500 Scale OS Maps								
	Geological Maps								
	Admiralty Charts								
	Existing surveys, records, studies, reports, etc (e.g. Section 8 of Tender)	5			12 monthly	5			10
	Trial Excavations								
	Ground Investigation								
	Quantitative Ecological Survey								
Total % values		50				50			100

Notes: For details of Condition of Coastal Defence Structures see Table 3.2.3B

COMMENTARY TABLE 3.2.3B Condition of Coastal Defence Structures - Details and Data Sources

Details	Data Sources
General State of Repair	SMP/Visual Inspection
Worst Case State of Repair	Visual Inspection
Defects	Visual Inspection
Residual Life	SMP/Visual Inspection
Maintenance Importance	Land Type/Visual Inspection
Maintenance Urgency	Land Type/Residual Life
Special Details	Visual Inspection

GENERAL ASSESSMENT TABLE 3.2.4A Coastal Defence Structures - Performance

Information Category	Single Data Set				Time Series Data Set				Total % Value
	Existing Specification		Improved Specification		Existing Specification		Improved Specification		
	Description	% value	Description	% value	Description	% value	Description	% value	
Specified Input Data	1:4000 Scale Monoscopic Vertical Aerial Photographs (Prints)	10			12 Monthly	10			20
	1:4000 Scale Stereoscopic Vertical Aerial Photographs (Prints)								
	1:10000 Scale Monoscopic Vertical Aerial Photographs (CD)								
	Monoscopic Oblique Aerial Photographs (Prints)	5			12 Monthly	5			10
	1:50000 Scale OS Maps								
	Shoreline Management Plan (1997)								
	Annual Cliff Inspection Reports (2000)								
Specified SMP Monitoring	Visual inspection of coastal defence structures only (6 or 12 monthly)	10			12 monthly	10			20
	Visual inspection of foreshore, defences, backshore and cliff (1/2, 1 or 5 yearly)								
	Foreshore profile survey only (selected areas/6 monthly/manually)								
	Cliff top location survey only (6 or 12 monthly/manually or aerial photos)								
	Foreshore, defences, backshore and cliff profile survey (selected areas/yearly/aerial photos)	10			12 Monthly	10			20
	Bathymetric survey and sediment analysis (5 yearly)	10			5 Yearly	10			20
	Coastal water level records (ongoing)								
	Coastal wind records (ongoing)								
	Offshore wave climate records (ongoing)								
Other Sources	1:2500 Scale OS Maps								
	Geological Maps								
	Admiralty Charts								
	Existing surveys, records, studies, reports, etc (e.g. Section 8 of Tender)	5			12 monthly	5			10
	Trial Excavations								
	Ground Investigation								
	Quantitative Ecological Survey								
Total % values		50				50			100

Notes: For details of Performance of Coastal Defence Structures see Table 3.2.4B

COMMENTARY TABLE 3.2.4B Performance of Coastal Defence Structures - Details and Data Sources

Details	Data Sources
Standard of Defence	Records/Aerial Photographs/Profile Survey/Visual Inspection
Negative Impact on Coastal Erosion	Aerial Photographs/Profile Survey/Visual Inspection
Negative Impact on Natural Processes	Aerial Photographs/Visual Inspection/Bathymetric Survey
Negative Impact on Natural Environment	Aerial Photographs/Visual Inspection/Records
Special Details	Visual Inspection

3.3 FULL ASSESSMENTS

The full assessments relate to the impact of recent coastal defence works on coastal erosion, natural processes and the natural environment. Coastal erosion includes cliffs and foreshore, and natural processes include local wave climate, tidal currents and sediment transport. Impacts on the natural environment consider any other issues that might be evident such as appearance, amenity, habitats, etc.

The impacts have been classified as high, medium or low.

Assessments have been carried out at 3 sites and the results are given in Tables 3.3.1 to 3.3.3 below.

FULL ASSESSMENT TABLE 3.3.1

Coastal Process Unit No. 7 – Runswick Bay Built Settlement – Impacts of New Southern Rock Revetment

Category	Factor	Description/Comments	Impact
COASTAL EROSION	Updrift	none – protected frontage to the north	L
	At Defences	none at present	L
	Downdrift	none at present	L
NATURAL PROCESSES	Waves	temporary rock stockpiles on lower foreshore providing some attenuation at shoreline	M
	Currents	possibly some local changes in vicinity of temporary rock stockpiles	M
	Sediment Transport	some disturbance due to construction activities on the beach	M
NATURAL ENVIRONMENT	Nearshore	no signs of any disturbance	L
	Foreshore/Backshore	general disturbance of beach due to construction activities	M
	Cliff	access track to construction site	M
	Cliff Top Area	no information – outside area of photographs	-
		OVERALL ASSESSMENT	M/L

Assessment The present assessment indicates a medium/low impact overall. This should reduce on completion of the construction works.

FULL ASSESSMENT TABLE 3.3.2

Coastal Process Unit No. 16 – Robin Hood's Bay Village – Existing Impacts at Site of Proposed Works

Category	Factor	Description/Comments	Impact
COASTAL EROSION	Updrift	cliff erosion to north of defences and natural promontory	M
	At Defences	some lowering of foreshore levels	M
	Downdrift	cliff erosion to south of defences	M
NATURAL PROCESSES	Waves	possibly some local diffraction	L
	Currents	possibly some local affects	L
	Sediment Transport	existing walls discouraging build up of beach levels	M
NATURAL ENVIRONMENT	Nearshore	nothing evident	L
	Foreshore/Backshore	apart from erosion, nothing evident	L
	Cliff	apart from erosion, nothing evident	L
	Cliff Top Area	no adverse affects evident	L
OVERALL ASSESSMENT			M/L

Assessment There are a number of existing impacts at the site. The proposed works will be addressing the cliff erosion.

FULL ASSESSMENT TABLE 3.3.3

Coastal Process Unit No. 22 – Holbeck Landslide – Impacts of New Rock Revetment

Category	Factor	Description/Comments	Impact
COASTAL EROSION	Updrift	none – protected frontage to the north	L
	At Defences	none at present	L
	Downdrift	early signs of possible accelerated erosion	L
NATURAL PROCESSES	Waves	slight concentration of wave action to north and south of revetment	L
	Currents	likely to be slight changes around revetment but nothing particularly evident	L
	Sediment Transport	likely to have local influence but nothing particularly evident at present	L
NATURAL ENVIRONMENT	Nearshore	nothing evident	L
	Foreshore/Backshore	possibly slightly lower beach levels in front of revetment	L
	Cliff	no adverse affects evident	L
	Cliff Top Area	no adverse affects evident	L
		OVERALL ASSESSMENT	L

Assessment In terms of providing cliff protection, the rock revetment appears to be performing well. Otherwise, its impacts on the area are low.

Section 4 NATURAL HABITATS

4.1 PREAMBLE

4.1.1 General Discussion

In order to make informed decisions about the impacts of flood and coastal defence works on natural habitats and to adhere to MAFFs high level targets relating to the natural environment, it is important to have a detailed knowledge of the coastal environment. The traditional method of obtaining such information would be by a search of available literature and, if necessary, completing a walkover ecological survey. Both remain valuable methods of gaining detailed information and, as shown below, are still required in many circumstances. However, a walkover ecological survey is often labour intensive, time consuming and difficult to carry out along some stretches of coastline. This section of the report looks at the ability of aerial photographs to replace ecological walkover surveys in providing this information.

4.1.2 Standard of Assessment

In order to meet MAFF high level target 9, regarding biodiversity, it is essential to have a detailed knowledge of the natural habitats within a catchment area. The Nature Conservancy Council (now English Nature) developed the Phase I Habitat Survey as a standard method by which the nature, location, extent and distribution of habitats can be determined. The Phase I Habitat Survey is a useful standard of assessment providing sufficient information for a coastal defence authority to make strategic decisions regarding the coast. This section of the report, therefore, is concerned with the provision of sufficient information to enable a Phase I Habitat Survey to be undertaken. More detailed survey work would, nevertheless be required for specific schemes where more detailed information is necessary.

The habitat types defined by the Phase I Habitat Survey are shown in Table 4.1.1. below, those relevant to the Scarborough Borough Council coastline are shaded in grey. Habitat types are broadly defined and do not identify species type.

Table 4.1.1 Phase I Habitat Survey Recommended Grouping of Habitats for Area Measurement

Woodland and scrub	Semi-natural broadleaved woodland Semi-natural coniferous woodland Semi-natural mixed woodland Plantation woodland Dense/continuous scrub Recently-felled woodland
Grassland	Acid grassland Neutral grassland Calcareous grassland Improved & poor semi-improved grassland Marsh/marshy grassland
Tall herb and fern	Continuous bracken All other tall herb and fern habitats
Heathland	Acid & basic dry dwarf shrub heath & lichen/bryophyte heath & montane heath/dwarf forb Wet dwarf shrub heath
Mire	Blanket bog Raised bog Modified bog (wet and dry) Acid & basic flush Fen
Swamp, marginal and inundation	All types should be combined
Open water	Standing water Running water
Coastland	Intertidal mud/sand Intertidal shingle/cobbles & boulders/rocks Dense/continuous saltmarsh Shingle & boulders/rocks above high tide mark & strandline vegetation All sand dune habitats All maritime cliff and slope habitats
Rock exposure	All natural types, except limestone pavement Limestone pavement All artificial and waste types
Miscellaneous	All cultivated/disturbed land All built up areas

Habitats relevant to Scarborough Borough Council are shaded in grey

While developing this methodology for a Phase I Habitat Survey, a comparison was made by the Nature Conservancy Council with the use of aerial photography. This comparison between the techniques is summarised in Table 4.1.2 below.

Table 4.1.2 – Comparison of Phase I Habitat Survey Techniques with Aerial Photography

Phase I survey	Aerial Photography
Complete ground cover possible if accessible on foot	Complete ground cover possible
Direct recording in the field	Relies on tone and pattern of spectral reflectance
Accuracy depends on skill of field surveyors; few problems of interpretation	Image accurate but interpretation variable and difficult
Can be used to standardise other methods	Should be calibrated by field survey
No sophisticated or expensive equipment needed	Needs complicated and expensive equipment (unless photographs are already available)
Yields complete set of Phase I habitat categories	Yields limited set of habitat categories
Yields maps, descriptive notes and statistical data	Can yield maps and statistical data
Gives information on dominant and other plant species	Little species information
Gives information on canopy and groundlayer	Information on canopy only (unless repeated at different seasons)
Data gathering slow, interpretation rapid	Data gathering rapid, interpretation laborious
Target notes give site related information on species, communities, management, threats etc. for a large number of sites	Site-related information limited; no target notes
Can be used for conservation evaluation	Limited use for conservation evaluation

Adapted from Handbook for Phase 1 Habitat Survey. A technique for Environmental Audit NCC, 1990.

Bearing the results of Table 4.1.2 in mind, Scarborough Borough Council's aerial photographs have been analysed to see if they can provide information to the Phase I Habitat Survey standard on:

- Habitat types and extent
- Habitat health and damage
- Habitat gains and losses.

The references to quantitative ecological surveys include Phase II Surveys, Phase III Surveys or National Vegetation Classification (NVC), for example.

4.2 GENERAL ASSESSMENTS

4.2.1 Types and Extents

The aerial photographs at their existing specification (1:4,000) provide approximately 70 % of the information required to carry out a Phase I habitat survey (particularly the habitat type and extent). However, data on smaller areas habitat types, such as, grassland bordering fields; the boundaries between intertidal and subtidal habitats; and the differences between the varieties of woodland may be more difficult to obtain at the existing specification. Photographs of improved specification (i.e. 1:2000) would provide more detail on these smaller areas, similarly photographs taken during the autumn/winter months (as opposed to the spring/summer months) would enable habitats with seasonal variations (i.e deciduous woodland, heathland) to be better defined. The 1:10,000 photographs produced on CD provide a method of accurately measuring distances (to within several metres). Finally a quantitative walkover ecological survey at targeted locations would provide any additional data required.

With respect to calculating the extent of these habitats, care should be taken on sloping surfaces. It is necessary to groundtruth the photographs or use orthophotos (see paragraph 2.1.2) to get an accurate estimate of size, this can be done with specialised computer packages. In most cases the boundary of the habitat can be easily determined from the photographs, however certain boundaries, for example between maritime and woodland cliff and slope habitats can be obscure. In such cases a walkover survey would be necessary to confirm the extent.

The SMP is a useful document and should be used for reference during the above process as it may be used to confirm habitats of note along the coastal frontage.

4.2.2 Health and Damage

The health of a habitat can be described by the diversity of the species that it supports and by its productivity, i.e. the vegetation cover and whether it is propagating and flowering successfully. Damage to a habitat may indicate a reaction to stress, which can take place for a variety of reasons (for example, pollution, erosion, tourism).

It is not possible to easily ascertain the health of a habitat in terms of diversity from aerial photographs, however productivity and damage may be seen to a limited degree. Very small scale damage (e.g. erosion from footpaths) won't be detectable, but larger scale impacts such as land slips should be seen easily.

Repeated analysis of aerial photographs on an annual basis over several (>5) years should give a good indication of the changing health and any larger scale damage to the habitats in question. It is important that these photographs are taken in summer in order to show the vigour of the vegetation growth.

Following the analysis of the aerial photographs, a brief visual inspection of the foreshore, defences, backshore and cliff by an ecologist will provide a significant amount of additional data (approximately 35%) that would support the findings from inspecting the photographs. It is important to note that the ecologist will need to be a specialist in the habitat that is being analysed and such a broadbrush study will not be able to accurately quantify diversity. A quantitative ecological study is necessary to provide this data and should be repeated annually to provide a full indication of the health of a particular habitat.

4.2.3 Gains and Losses

There are two methods to assess gains and losses in natural habitats; changes in the presence of species and changes in the overall size of habitats. Aerial photographs are only useful when assessing the physical change in habitat size as it would not be possible to determine the often subtle changes in species present.

Providing the borders of habitats can be accurately determined (as discussed in 4.2.1) then gains and losses can be calculated by groundtruthing a time series of photographs taken at similar times of year. It is important to treat such results with caution as habitats do change naturally often cyclically and therefore a temporary loss in habitat may not always be detrimental. For this reason, it is worth comparing data sets for at least 5 years to get a more accurate result.

The accuracy of such calculations will also be limited by the scale of the photographs being analysed but will be to within several metres. A quantitative ecological survey using GPS (Global Positioning System) can be used, along with, the analysis of aerial photographs to increase the accuracy of this analysis. The further benefit of walkover surveys is that they can also quantify changes in species diversity.

GENERAL ASSESSMENT TABLE 4.2.1 Natural Habitats: Types and Extents

Information Category	Single Data Set				Time Series Data Set				Total % Value
	Existing Specification		Improved Specification		Existing Specification		Improved Specification		
	Description	% value	Description	% value	Description	% value	Description	% value	
Specified Input Data	1:4000 Scale Monoscopic Vertical Aerial Photographs (Prints)	70	1:2,000 scale photographs	10	6 Monthly	10			90
	1:4000 Scale Stereoscopic Vertical Aerial Photographs (Prints)								
	1:10000 Scale Monoscopic Vertical Aerial Photographs (CD)	5							5
	Monoscopic oblique Aerial Photographs (Prints)								
	1:50000 Scale OS Maps								
	Shoreline Management Plan (1997)								
	Annual Cliff Inspection Reports (2000)								
Specified SMP Monitoring	Visual inspection of coastal defence structures only (6 or 12 monthly)								
	Visual inspection of foreshore, defences, backshore and cliff (1/2, 1 or 5 yearly)								
	Foreshore profile survey only (selected areas/6 monthly/manually)								
	Cliff top location survey only (6 or 12 monthly/manually or aerial photos)								
	Foreshore, defences, backshore and cliff profile survey (selected areas/yearly/aerial photos)								
	Bathymetric survey and sediment analysis (5 yearly)								
	Coastal water level records (ongoing)								
	Coastal wind records (ongoing)								
	Offshore wave climate records (ongoing)								
Other Sources	1:2500 Scale OS Maps								
	Geological Maps								
	Admiralty Charts								
	Existing surveys, records, studies, reports, etc (e.g. Section 8 of Tender)								
	Trial Excavations								
	Ground Investigation								
	Quantitative Ecological Survey	5							5
Total % values		80		10		10			100

GENERAL ASSESSMENT TABLE 4.2.2 Natural Habitats: Health and Damage

Information Category	Single Data Set				Time Series Data Set				Total % Value
	Existing Specification		Improved Specification		Existing Specification		Improved Specification		
	Description	% value	Description	% value	Description	% value	Description	% value	
Specified Input Data	1:4000 Scale Monoscopic Vertical Aerial Photographs (Prints)	10			Anually	10			20
	1:4000 Scale Stereoscopic Vertical Aerial Photographs (Prints)								
	1:10000 Scale Monoscopic Vertical Aerial Photographs (CD)								
	Monoscopic oblique Aerial Photographs (Prints)								
	1:50000 Scale OS Maps								
	Shoreline Management Plan (1997)	5							5
	Annual Cliff Inspection Reports (2000)								
Specified SMP Monitoring	Visual inspection of coastal defence structures only (6 or 12 monthly)								
	Visual inspection of foreshore, defences, backshore and cliff (1/2, 1 or 5 yearly)	35							35
	Foreshore profile survey only (selected areas/6 monthly/manually)								
	Cliff top location survey only (6 or 12 monthly/manually or aerial photos)								
	Foreshore, defences, backshore and cliff profile survey (selected areas/yearly/aerial photos)								
	Bathymetric survey and sediment analysis (5 yearly)								
	Coastal water level records (ongoing)								
	Coastal wind records (ongoing)								
	Offshore wave climate records (ongoing)								
Other Sources	1:2500 Scale OS Maps								
	Geological Maps								
	Admiralty Charts								
	Existing surveys, records, studies, reports, etc (e.g. Section 8 of Tender)								
	Trial Excavations								
	Ground Investigation								
	Quantitative Ecological Survey	20			Annually, preferably over 5 years	20			40
Total % values		70				30			100

GENERAL ASSESSMENT TABLE 4.2.3 Natural Habitats: Gains and Losses

Information Category	Single Data Set				Time Series Data Set				Total % Value
	Existing Specification		Improved Specification		Existing Specification		Improved Specification		
	Description	% value	Description	% value	Description	% value	Description	% value	
Specified Input Data	1:4000 Scale Monoscopic Vertical Aerial Photographs (Prints)				6 Monthly	70	1:2,000	10	80
	1:4000 Scale Stereoscopic Vertical Aerial Photographs (Prints)								
	1:10000 Scale Monoscopic Vertical Aerial Photographs (CD)					5			5
	Monoscopic oblique Aerial Photographs (Prints)								
	1:50000 Scale OS Maps								
	Shoreline Management Plan (1997)								
	Annual Cliff Inspection Reports (2000)								
Specified SMP Monitoring	Visual inspection of coastal defence structures only (6 or 12 monthly)								
	Visual inspection of foreshore, defences, backshore and cliff (1/2, 1 or 5 yearly)								
	Foreshore profile survey only (selected areas/6 monthly/manually)								
	Cliff top location survey only (6 or 12 monthly/manually or aerial photos)								
	Foreshore, defences, backshore and cliff profile survey (selected areas/yearly/aerial photos)								
	Bathymetric survey and sediment analysis (5 yearly)								
	Coastal water level records (ongoing)								
	Coastal wind records (ongoing)								
	Offshore wave climate records (ongoing)								
Other Sources	1:2500 Scale OS Maps								
	Geological Maps								
	Admiralty Charts								
	Existing surveys, records, studies, reports, etc (e.g. Section 8 of Tender)								
	Trial Excavations								
	Ground Investigation								
	Quantitative Ecological Survey					15			15
Total % values						90		10	100

4.3 FULL ASSESSMENTS

4.3.1 Comment on Benchmarking and Enhancement

MAFF Target 9A

In order to meet MAFFs high level targets it is important to have a baseline understanding of the environment in question. The information gained from Sections 4.2.1 to 4.2.3 provides an initial model of the presence, extent and health of different habitats within the area. By making comparisons with this baseline any damage to environmental interests, or loss to habitats, included with Biodiversity Action Plans can be avoided when carrying out flood and coastal defence work.

With respect to seeking opportunities for environmental enhancement when selecting flood and coastal defence options, the aerial photographs can provide around 70% of the required information. They can highlight low lying agricultural land that may be used for managed realignment and intertidal habitat creation, for example. However used on their own they cannot provide the detailed investigative information required to inform such a decision making process.

MAFF Target 9B

Following the establishment of a baseline, MAFF target 9B can be met efficiently since larger scale physical habitat losses and gains can be calculated by comparison with the baseline data. As described in Section 4.2.3 this should be supplemented with an analysis of species diversity using a quantitative ecological survey.

Section 5 SUMMARY AND CONCLUSIONS

5.1 NATURAL PROCESSES

The proposed hazard zonation scheme is simple and could be improved in an extended scheme. It could be tested against known data (e.g., frequencies of failures or known areas of at risk).

A study to acquire and compare available historical aerial photography for the study area should be carried out. Rapid assessment of time series (historical) aerial photographs should be evaluated. It is expected that this method of study will give more accurate information on rates of erosion and areas of former erosion.

The type and scale of photograph is important for accurate measurement of slope features. Accurate topographical maps and plans can be produced from ortho-photographs and for very detailed assessments a scale of 1:500 to 1:1000 may be required. For general assessments, the currently assessed scale of 1:4000 is considered to be satisfactory although a scale of 1:2500 would be preferred.

Oblique photography was found to enhance the interpretation of stereo pairs of vertical photographs and is recommended to supplement vertical aerial photographs.

The time of photography was considered to be important particularly for the assessment of foreshore conditions. The timing of photography should therefore be planned to coincide with low spring tides wherever possible.

The frequency of photography is difficult to predict without the benefit of comparison with other time series information. A one year frequency could be a reasonable time period between photography.

Advanced horizontal photogrammetric techniques have also been used to assess accurate measurement of actual cliff recession with time. The firm has experience of a number of techniques applied to several case histories to assess recession of cliffs. A common survey station located in front of the cliffs would be required for these methods and may be limited by the stability and available space within the foreshore for these methods to be practical.

5.2 COASTAL DEFENCE STRUCTURES

In terms of the base-line description of the coastal defence structures and their condition, aerial photographs have little or no role to play. However, in terms of assessing the situation in which the defences operate and their performance, aerial photographs can make a valuable contribution. Owing to the dynamic nature of the shoreline time series photographs are necessary.

5.3 NATURAL HABITATS

The aerial photographs have been shown to be a thorough and relatively quick means of gaining habitat data for strategic reviews of large areas such as Scarborough Borough Council's coastline. They do not, however, provide enough information to carry out detailed analysis of specific areas such as would be required when investigating impacts of smaller coastal defence schemes, for example. As a first stage in the review of available information and assessment they should prove to be a valuable tool.

5.4 OVERALL CONCLUSIONS

5.4.1 1999 Single Data Set

Taking into account all of the objectives for the monitoring of natural processes, coastal defence structures and natural habitats, the 1999 aerial photographs provide overall approximately 20% of the information required.

The actual contribution towards each individual objective varies from zero to around 85%.

The percentage contributions are measured against the standards set by good working practice and by relevant organisations.

The majority of the information is derived from the 1:4000 scale monoscopic vertical aerial photographs supplied as prints.

The oblique aerial photographs, because of their different view point, are useful in providing some clarification.

The 1:4000 scale stereoscopic vertical aerial photographs are also useful in providing three dimensional images which are of particular benefit in the assessment of natural processes.

The 1:10000 monoscopic vertical aerial photographs supplied on CD have the facility for measuring distances electronically on screen. This is especially helpful in measuring habitat areas.

5.4.2 Time Series Data Set

A time series data set doubles the amount of information that can be gained from the aerial photography to approximately 40% of the total data required.

Typically, a frequency of 12 months is appropriate although 6 months would be useful in monitoring some aspects of natural habitats.

Timing is critical both in terms of seasons, say for habitat monitoring, and tide levels for natural processes and coastal defence structures. Also, daylight conditions are important.

5.4.3 Improved Specification

Although the existing specification is generally satisfactory, a number of improvements would increase the amount of information that could be extracted from the photographs.

The main improvement is one of scale and there is a case in some areas for the use of a scale more detailed that 1:4000. It is understood that scales of 1:500 are feasible but something of the order of 1:2500 may be more realistic. A recommendation for further investigation into this matter is given in paragraph 5.4.6 below.

5.4.4 Inspection Methods

The percentage values assigned to the aerial photographs are based upon the assumption that they are inspected by specialists in their respective fields, namely geotechnical engineers and geomorphologists, coastal engineers and environmental scientists. It is also assumed that, as far as possible, the same specialists would undertake repeat inspections in order to develop local knowledge and provide consistency of judgement.

It is understood that computer techniques are, or will be, available which enhance the amount of information that can be read from aerial photographs. For the purposes of this report this matter has not been investigated further. However, recommendations are given in paragraph 5.4.6 below to pursue this matter further.

5.4.5 Other Methods of Monitoring

In order to meet the desired standard of monitoring aerial photography has to be combined with other monitoring methods such as visual inspections and profile surveys.

In some situations the aerial photography can reduce the amount of additional monitoring required and in other situations the additional monitoring will tend to override the value of the photography.

Also there are circumstances where aerial photography can be tied-in with other monitoring methods such as photogrametric profile surveys.

As discussed below it is recommended that complementary methods of monitoring are investigated further.

5.4.6 Optimum Aerial Photography

A decision on the most appropriate aerial photography (type, scale, frequency, timing, inspection etc.) needs to be set in the context of the following:-

- The Council's total coastal management needs covering all aspects of monitoring including any actual or potential provision of information to other authorities.

- A very precise identification of exactly what information is required with a view to its end use.
- The overall package of data collection methods to be used, thereby allowing the aerial photography to be seen in its complete context.
- A benefit-cost analysis of the various methods and combinations of data collection available to help identify best value overall.

It is recommended that a further study is undertaken in respect of the above issues, in particular the last one concerning a benefit-cost analysis. This would involve looking in more detail at the different possible specifications for the aerial photography and complementary methods of monitoring with a view to establishing the most cost efficient way of gathering and processing the required data. This work lends itself to being carried out as a variation to the original brief.

In the meantime, with the exception of the benefit cost analysis, this report goes a long way in addressing the coastal aerial photography and monitoring needs of Scarborough Borough Council.

Appendix A
INPUT DATA

1:4000 Vertical Aerial Photographs

Oblique Aerial Photographs

1:50000 OS Maps

Shoreline Management Plan Extracts

(Refer to 2 No. Separate A3 Files)