Overstrand to Walcott

Defence Condition Survey

Interim Report
October 2003

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Contract - Consultancy

This report describes work commissioned by North Norfolk District Council whose representative was Mr Peter Frew. The HR Wallingford job numbers were CDR3212 and CDR3214. The work was carried out by Mr Peter Lawton of St La Haye Consulting Engineers. The HR Wallingford project manager was Mr Paul Sayers.

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Summary

Overstrand to Walcott

Defence Condition Survey

Interim Report
June 2002

This report describes a survey of the coastal defences protecting towns, communities, and land from west of the coastal town of Overstrand to east of Walcott (i.e. Ostend). Visual inspections of the defences in the study area have led to initial assessments of their condition. These assessments were then reviewed, where appropriate, through ultimate and serviceability limit state calculations of the stability of various wall sections supported by simple geotechnical investigations.

Overstrand

The concrete seawalls in Overstrand are entirely dependent on the stability of the aprons and piles fronting them for their stability. For more than half of the frontage, the steel piles are very badly corroded and at the end of their useful life. Failure of these piles through buckling could lead to seawall failure by overturning. Also, few of the weep holes in the walls are functioning, and most joints in the concrete have lost their sealant or packing. This could affect the integrity of the walls and has been taken into account in the assessment of the defence condition rating. While the main groynes were found to be in good condition with few defects, the two shorter groynes have badly corroded steel components.

Sidestrand

This frontage is one of the few stretches of coast in the study area that has never been protected with coastal defences. At its western flank, on the outskirts of Overstrand, the cliffs are protected by a timber revetment in poor condition. The eastern flank sees the beginning of the Trimingham defences with the concrete sea wall and timber revetment. The predominately sandy beach is backed by cliffs rising up to fifty metres in height. These cliffs, which are part of a SSSI, are subject to very large failures and slumping.

Trimingham

The toe of the cliff fronting Trimingham is partially protected by a timber revetment, part of which was built on a concrete seawall. The revetment was built in stages between 1972 and 1975. The periodic failures of the cliffs continue to severely damage the timber revetment (which is in poor to very poor condition). The talus from cliff failures is, in places, placing considerable weight against the timber revetment. This will, in turn, cause further revetment failures. A 160m length of timber revetment was reconstructed in July 2003 using rock armour. The groynes on this frontage are typically permeable timber groynes in good condition. However, many of the seaward ends have failed and are in very poor condition. The beach is predominantly sandy but volatile.

Mundesley

The oldest sections of seawall are now in poor condition. While visual inspections indicate that the newer section is in good condition, its design provides poor resistance to sliding under serviceability limit loads. Thus, a defence condition rating of poor has been assigned to these. Despite their age the rest of the seawalls are in good to very good condition. The groynes are of mixed construction and are generally in fair to good condition with the seaward ends requiring attention. All promenades are in good condition. The retaining walls are also generally in good condition, with some exceptions.

Bacton

Timber revetments and timber groynes protect the western end of the Bacton frontage, while the remainder is protected by a seawall extending from Bacton to Ostend (again with timber groynes). The timber revetment in the west, contiguous with the Mundesley defences, primarily protects the economically significant Bacton Gas Site. The gas site is located on a clifftop that reduces in height towards the village of Bacton. The timber revetment was built in the 1960's and is in fair condition. The groynes are permeable, typically of timber construction, and are all in good condition. There are also a number of outfalls serving the gas site which tend to act as groynes. The beach is predominantly sandy in nature but volatile. At times of low beach levels, the temporary works structures associated with gas pipelines can often be seen. The concrete seawall with steel pile toe is generally in good condition. The steel piles have been assessed to be in good condition although there is a minor concern regarding the manner in which they have been anchored to the concrete apron in that there does not appear to be any tie bars. Almost all of the joints in the concrete wall require attention. The promenade formed by the apron varies in condition and is good where repairs have taken place, otherwise poor. The groynes are typically of timber, permeable construction and are in good condition. The wall protects a mixed community of residential and tourism-related property.

Walcott

The entire Walcott frontage is protected by a seawall that is contiguous with that fronting Bacton and Ostend. The concrete seawall with steel pile toe is generally in good condition. However, small sections of the wall exhibit spalling of the concrete, where maintenance works are required. The steel piles have been assessed to be in good condition although there is a minor concern regarding the manner in which they have been anchored to the concrete apron in that there does not appear to be any tie bars. Almost all of the joints in the concrete wall require attention. The promenade formed by the apron varies in condition and is good where repairs have taken place, otherwise poor. The groynes are typically of timber permeable construction and are in good condition. The wall protects a mixed community of tourism related and residential property as well as part of the coast road that runs immediately behind the wall for a distance of approximately 500m. This section is susceptible to overtopping.

Ostend

The village of Ostend is protected in part by a seawall (contiguous with that fronting Bacton and Walcott) and in other sections by a timber revetment. The concrete seawall with steel pile toe is generally in good condition. The steel piles

have been assessed to be in good condition although there is a minor concern regarding the manner in which they have been anchored to the concrete apron, in that there does not appear to be any tie bars. Almost all of the joints in the concrete wall require attention. The promenade formed by the apron is generally in poor condition, apart from repaired sections, which are in good condition. The groynes are typically of timber, permeable construction and are in good condition. The wall protects a mixed community of tourism related and residential property. A timber revetment built in the early 1990's protects the eastern part of the Ostend frontage. The revetment is in good condition, having recently been subjected to extensive maintenance works. A particular problem with this particular revetment is the narrow plank spacing that tends to trap mobile flints and cobbles. This, in turn , causes the revetment to act as a solid wall rather than a permeable structure (causing increased loading on the structure). The groynes are typically of timber permeable construction and are in good condition. The revetment protects a mixed community of tourism related and residential property.

Contents

Tables

Figures

1. INTRODUCTION

All of the defences in the study area have been visually inspected, enabling an initial defence condition rating to be applied. These assessments were then reviewed where appropriate to take account of ultimate and serviceability limit state calculations of the stability of the walls. In general terms, the integrity of a defence length depends on the condition of the weakest component in that length. Hence, for each section a combined defence condition rating has been determined as well as ratings for the individual components.

1.1 Methodology

The condition of coastal defences (i.e. both sea defences for flood defence and coast protection works for erosion protection) in the study area was assessed visually using the criteria shown in Table 1.2. This table is an adaptation of the condition descriptions that the Environment Agency developed for their Condition Assessment manual.

A number of trial holes were excavated adjacent to the defences to determine local ground conditions, to identify the geological platform for the beach and to allow an assessment of the condition of the defences below beach level. Given the very high level of water in the beach, it was found necessary to supplement the trial holes with a ground investigation technique called window sampling.

Using original drawings of the defences and the soil parameters obtained from the ground investigations, the structural stability of the walls has been calculated. Ultimate and serviceability limit state calculations were based on the criteria and mobilisation factors stated in BS 8002:1994 Code of practice for earth retaining structures. For every section of sea wall, the defence condition rating derived from the visual survey has been reviewed to take account of the results of these stability calculations.

Similarly, the groynes within the study area were the subjects of a detailed inspection. This inspection also included the excavation of trial holes to determine, if practicable, the construction of the groynes.

1.2 Residual life

As the residual life of the defences cannot be predicted with precision, the approach adopted in this study has been to categorise the residual life into bands. The banding is derived from the surveyed condition of the sea walls and groynes, taking into account the results of the structural stability calculations. The residual life bands, together with their corresponding defence condition rating, are given in Table 1.1. Furthermore, text providing definitions of defence conditions for various structures is provided in Table 1.2.

Table 1.1 Residual life bands and defence condition rating

Residual Life	Defence Condition Rating
20+ years	Very Good
10 to 20 years	Good
5 to 10 years	Fair
3 to 5 years	Poor
0 to 3 years	Very Poor

Table 1.2 Definitions of defence conditions

Grade	Defence Condition Rating	General	Concrete	Timber	Steel	Promenades	Slopes
1	**Very Good**	No significant defects. No maintenance required	No significant visible defects. Some hairline cracking permitted	No significant defects. No maintenance required	No visible defects	No significant defects. No maintenance required	Stable with no slumps, cracking makes or water and good vegetative cover
2	**Good**	Minor defects only. Minor maintenance required to no more than 5% of the structure	Cracks <0.5mm. Some honeycombing, flaking or loss of joint sealant	Slight loss of section. No movement of joints.	Localised surface erosion with loss of section. No physical deformation	Minor defects that can be solved by localised patching. Generally waterproof and safe for vehicle or pedestrians.	Minor departures from Grade 1
3	**Fair**	Significant defects. Major maintenance required to no more than 20% of the structure	Some rust staining or localised spalling, some loss of steel cover, cracking or movement or extensive honeycombing.	More significant loss of section. Some movement of joints. Occasional plank missing.	More significant loss of section. Impact damage or minor movement.	Significant defects that can only be solved by non-structural overlay. Loss of water proofing and a potential hazard for vehicle or pedestrians.	Minor slumps, cracks or makes of water
4	**Poor**	Structurally unsound. Major remedial works need within 5 years. Up to 50% affected	Extensive spalling exposed steel or extensive movement. Loss of joint sealant of other defect likely to affect structural integrity.	Severe loss of section. Movement of most joints. Several elements missing with structure severely weakened.	Severe loss of section affecting structural integrity. Severe impact damage or extensive movement	Major defects that can only be solved with a structural overlay / redecking. Dangerous to vehicles or pedestrians. Temporary closure necessary.	Larger slumps with cracking and significant flows of water
5	**Very Poor**	Totally failed or derelict. Require complete reconstruction	Derelict or complete failure. Beyond repair.	Totally failed. Requires reconstruction.	Derelict or beyond repair	Totally failed and requires reconstruction.	Total collapse

2. TRI 1 – CROMER TO OVERSTRAND CONDITION SURVEY

2.1 History

The first recorded works along this frontage stems from the late nineteenth century. The whole frontage was defended by a series of relatively close centred groynes. It is believed that these were built by the Cromer Protection Commissioners, the relevant authority at that time. By 1930, many of the original groynes had gone but the form of today's groynes has begun to appear. The present system is largely a reconstruction of the remnants of the original groyne field built between 1967 and 1976.

2.2 Summary

The land along this frontage is almost entirely given over to recreational use, mainly the Royal Cromer Golf Club. At the western end of the frontage, there is 350m long timber breastwork. Otherwise there are no other linear defences. The defences here can be summarised as being in fair to good condition.

2.3 Observations

2.2.3 Defence Length TRI 1.01

Location: Cromer to Overstrand	
Start / Finish NG Co-ordinates **Start** **Finish** **Easting:** 622762 623097 **Northing:** 341972 341800 **Length:** 377m	**Survey Date:** 13/03/03
Management Unit: TRI 1	**Defence Length Reference:** 1.01
Description of Defences and Beach Timber breastwork – 4 Timber groynes **Defences maintained by:** North Norfolk District Council	
Condition and Performance of Beach Wide expanse of beach, levels inshore partially controlled by stub groynes **Control Structures** Groynes: D1 – D4 (0A – 0D)	
Conditions and Performance of Backshore Defences **Type:** Timber breastwork **Built:** 1976 **Refurbished:** **Description:** **Defence Condition Rating:** Poor **Updates to CPSE (1997):** Unknown	
Description of Hinterland and Development Public open space	

Cause and Consequence of Failure	
Likely Failure Mechanism:	Deterioration of timber structures
Consequence of Failure:	Loss of public open space

Photograph Log	
Ref. No.	**Description of View**
P 22	View along beach to east showing groynes D2, D3, D4

Plate 2.1 Photo P22 View along beach to east showing groynes D2, D3, D4

2.2.3 Defence Length TRI 1.02

Location:	**Cromer to Overstrand**	
Start / Finish NG Co-ordinates		**Survey Date:** 13/03/03
	Start / **Finish**	
Easting:	623097 / 624320	
Northing:	341800 / 341257	
Length:	1338m	
Management Unit:	TRI 1	**Defence Length Reference:** 1.02

Description of Defences and Beach

No backshore defences

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Almost natural beach, levels influenced by three timber groynes

Control Structures

Groynes: D5 – D7 (0, W4 – W5)

Conditions and Performance of Backshore Defences

Type: **Built:** **Refurbished:**

Description:

Defence Condition Rating:

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

Golf course

Cause and Consequence of Failure

Likely Failure Mechanism: Damage to groynes by wave action and erosion.

Consequence of Failure: The beach naturalises, increased wave attack on the base of the cliff leading to failures damaging the golf course. Increased sediment supply.

Photograph Log

Ref. No.	Description of View
P 19	Groyne D7 (W5)
P 20	Groyne D5 (0)
P 21	Groyne D5 (0)

Plate 2.2 Photo P21 Groyne D5 (0)

2.2.3 Groynes in TRI 1

Management Unit	**TRI 1**		**Location: Groyne No. OD**
Start / Finish NG Co-ordinates			**Survey Date:** 13/01/03
	Root		
Easting:	622838	622860	
Northing:	341920	341979	
Length:	60m		
Management Unit:	TRI 1		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1976	**Refurbished:**	
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: No beacon			

Management Unit	**TRI 1**		**Location: Groyne No. OC**
Start / Finish NG Co-ordinates			**Survey Date:** 13/01/03
	Root		
Easting:	622913	622935	
Northing:	341873	341930	
Length:	60m		
Management Unit:	TRI 1		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1976	**Refurbished:**	
Defence Condition Rating: Good/Fair			
Updates to CPSE (1997): Unknown			
Comment: Some planks missing P22			

Management Unit	**TRI 1**		**Location: Groyne No. OB**
Start / Finish NG Co-ordinates			**Survey Date:** 13/01/03
	Root		
Easting:	622987	623012	
Northing:	341826	341879	
Length:	60m		
Management Unit:	TRI 1		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1976	**Refurbished:**	
Defence Condition Rating: Good/Fair			
Updates to CPSE (1997): Unknown			
Comment: No Beacon			

Management Unit	TRI 1	Location: Groyne No. OA
Start / Finish NG Co-ordinates		**Survey Date:** 13/01/03
	Root	
Easting:	623065 623087	
Northing:	341793 341842	
Length:	60m	
Management Unit:	TRI 1	**Defence Length Reference:** 01
Conditions and Performance of Groyne		
Type: Timber	**Built:** 1976	**Refurbished:**
Defence Condition Rating: Good		
Updates to CPSE (1997):	Unknown	
Comment: Beacon complete		

Management Unit	TRI 1	Location: Groyne No. W6/O
Start / Finish NG Co-ordinates		**Survey Date:** 13/01/03
	Root	
Easting:	623298 623338	
Northing:	341669 341810	
Length:	140m	
Management Unit:	TRI 1	**Defence Length Reference:** 02
Conditions and Performance of Groyne		
Type: Timber	**Built:** C. 1935	**Refurbished:**
Defence Condition Rating: Fair/Poor		
Updates to CPSE (1997):	Unknown	
Comment: Poor condition, no beacon – Planks missing P20 – Horizontal support P21		

Management Unit	TRI 1	Location: Groyne No. W5
Start / Finish NG Co-ordinates		**Survey Date:** 13/01/03
	Root	
Easting:	623684 623718	
Northing:	341484 341615	
Length:	130m	
Management Unit:	TRI 1	**Defence Length Reference:** 02
Conditions and Performance of Groyne		
Type: Timber	**Built:** 1984	**Refurbished:**
Defence Condition Rating: Good		
Updates to CPSE (1997):	Unknown	
Comment: Beacon complete		

Management Unit TRI 1			Location: Groyne No. W4
Start / Finish NG Co-ordinates			**Survey Date:** 13/01/03
	Root		
Easting:	624094	624120	
Northing:	341335	341436	
Length:	107m		
Management Unit: TRI 1			**Defence Length Reference:** 02

Conditions and Performance of Groyne

Type: Timber **Built:** 1967 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No beacon P19

3. TRI 2 – OVERSTRAND CONDITION SURVEY

3.1 History

The pattern of coastal defence construction at Overstrand is very similar to that at Mundesley. The first seawalls and groynes were built in the late nineteenth century, principally to protect private and commercial property. The exception here is that in 1881 Lord Suffield gave timber to the fishermen for the construction of a groyne at what is still the principal launching point for fishing boats.

Erpingham RDC (Regional District Council) built a seawall in the 1920's that linked the originally privately funded walls. Newspaper reports suggest that these walls were severely damaged in the 1940's and, despite reconstruction, were again all but destroyed in 1953. The post-1953 walls in Overstrand remain as the town's principal defence, although there has been a catalogue of repair and extension as late as 2000.

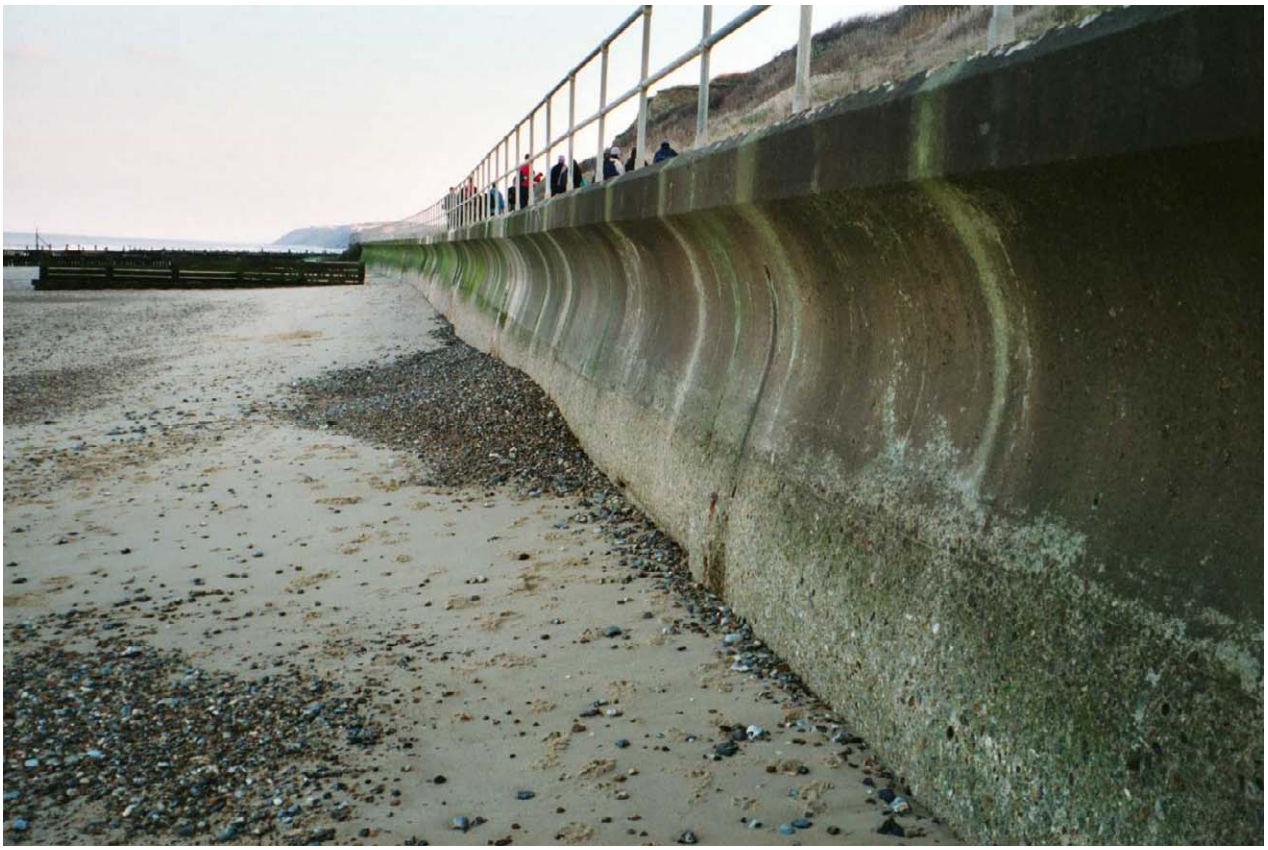


Figure 3.1 Seawall at Overstrand

In a similar pattern to Mundesley, the 1953 event also caused the RDC to build timber revetments at the flanks of the town. At this time, the RDC attempted to develop a coast protection strategy for the coast from Overstrand to Bacton. In fact, the construction of new defences for this stretch of coast continued on a piecemeal basis as the strategy could not be funded. There is evidence to suggest that defences continued to be built as a reaction to increased erosion downdrift of defences, and an almost continuous line of defence developed from Cromer to Happisburgh.

Overstrand's defences, despite limiting the damage caused by the sea, have had little effect on cliff stability. In 1952 the Eastern Daily Press (EDP) reported, "Great sections of the seawall at the east end have been undermined. Cracks in the promenade can be seen almost completely along its length and the cliff slopes above are, in places, a mass of slowly moving mud spilling onto the promenade itself." Similarly, earlier in 1951, the EDP reported of an application for an order to demolish the Overstrand

Hotel, which had become a victim of cliff failure. This situation is somewhat ironic, in that one of the first seawalls in Overstrand was built to protect the Hotel's grounds against the sea and provide beach side facilities for guests.

The combined action of the sea and cliff failure continues to be a problem at Overstrand. A feature of the defences in Overstrand is the incorporation, from quite an early date, of drains at the back of the wall, collecting water from field drains on the cliff itself. In the 1960's, there was a large cliff failure at the principal point of access onto the beach, at the junction of Pauls Lane and Cliff Road. This necessitated the building of a large gabion wall and realignment of one of the access paths.

Far more catastrophic was the series of cliff failures at Clifton Way, to the east of the town and just beyond the site of the ill-fated Overstrand Hotel. The first occurred in May 1990 and was followed by further failures in November 1992 and January 1994. Approximately 90m of land were lost as a result, threatening a large number of houses. A major cliff stabilisation and sea defence scheme was implemented, with the base of the cliff now protected by a large mass of granite.

Most recently in 2000, the western end of the seawalls failed, and the original nineteenth century wall (rehabilitated in the 1980's) had to be reconstructed. The failure appeared to be at the apron of the wall and was probably linked to the failure of tie bars supporting the steel sheet piles.

Figure 3.2 provides a summary timeline of the history of the defences at Overstrand in tabular form.

3.2 Summary

The stability of the concrete seawalls at Overstrand is entirely dependent on the stability of the aprons and piles fronting them. The steel piles forming part of Section 2, the ramps at the western end, and those in the adjacent Section 3 (i.e. 50% of the total frontage) are at the end of their useful life, having become very badly corroded. There is clear evidence that the fixings to the tie rod walings have failed through corrosion. Thus, the piles are inherently weak, unable to withstand serviceability limit state loading, and likely to buckle if the beach is lowered beyond 1.0m below the pile tops over a long length of frontage. Such significant beach lowering would potentially lead to seawall failure by overturning. The photograph in Figure 3.3 illustrates the above with a failure of the apron and steel pile toe that occurred in December 1997.

From general observations of the condition of the walls, it is apparent that few of the weep holes in the walls appear to be functioning, which may lead to excessive water pressures behind the walls. This has been taken into account in the serviceability limit state stability calculations. Furthermore, most joints in the concrete have lost their sealant or packing; this could affect the integrity of the walls and has been taken into account in the assessment of the defence condition rating.

The main groynes were found to be in good condition with few defects. However, the two shorter groynes have badly corroded steel components, leading to the condition rating of poor.

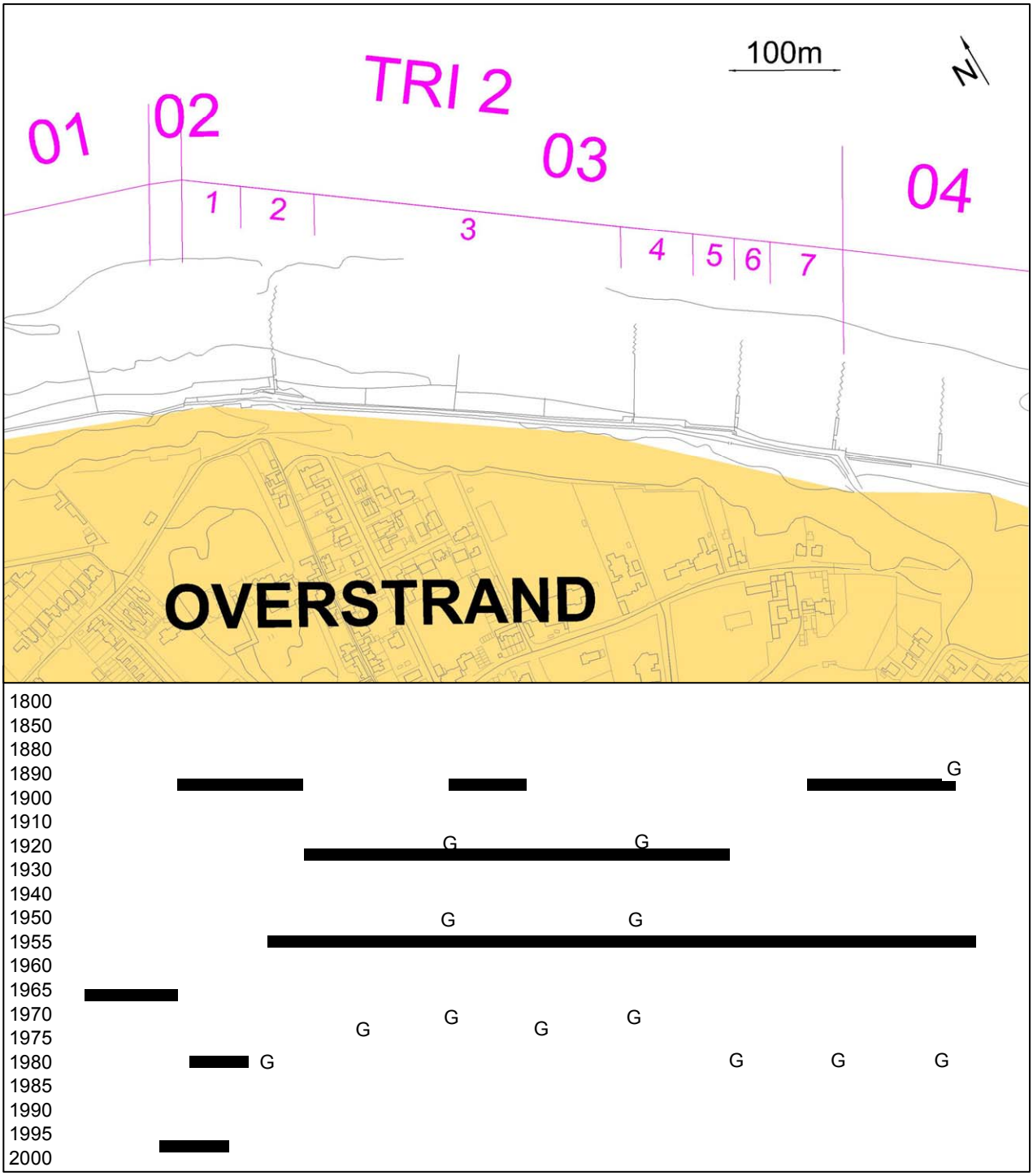


Figure 3.2 Timeline of Overstrand coastal defence construction

Figure 3.3 Failure of the apron and steel pile toe in December 1997 at Overstrand

3.3 Observations

3.2.3 Defence Length TRI 2.01

Location: Overstrand	
Start / Finish NG Co-ordinates **Start** **Finish** **Easting:** 624320 624734 **Northing:** 341257 341106 **Length:** 441m	**Survey Date:** 13/03/03
Management Unit: TRI 2	**Defence Length Reference:** 2.01
Description of Defences and Beach Timber revetment **Defences maintained by:** North Norfolk District Council	
Condition and Performance of Beach Beach levels controlled partially by groynes. Moderate amenity value **Control Structures** Groynes: D8, E1 – E2 (W1 – W3)	
Conditions and Performance of Backshore Defences **Type:** Timber revetment **Built:** 1967 **Refurbished:** **Description:** Some planks missing **Defence Condition Rating:** Poor **Updates to CPSE (1997):** Unknown	
Description of Hinterland and Development Open space and residential	

Cause and Consequence of Failure
Likely Failure Mechanism: Damage by cliff falls. Failure of toe due to low beach levels. Deterioration of timber structure
Consequence of Failure: Loss of open space and property

Photograph Log	
Ref. No.	**Description of View**
P 14	Blockwork revetment
P 15	General revetment view
P 16	Groyne E2 (w1)
P 17	Groyne E1 (W2)
P 18	Groyne D8 (W3)

Plate 3.1 Photo P15 General revetment view

Plate 3.2 Photo P18 Groyne D8 (W3)

3.2.3 Defence Length TRI 2.02

Location:	**Overstrand**	
Start / Finish NG Co-ordinates		**Survey Date:** 13/03/03
	Start / **Finish**	
Easting:	624734 / 624763	
Northing:	341106 / 341098	
Length:	30m	
Management Unit:	TRI 2	**Defence Length Reference:** 2.02

Description of Defences and Beach

Block revetment

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Beach levels controlled partially by groynes in adjacent defence lengths. Moderate amenity value

Control Structures

None

Conditions and Performance of Backshore Defences

Type: Block revetment **Built:** 1949 **Refurbished:**

Description: Substantial deterioration of vertical steel sheets supporting rubble, some timber split

Defence Condition Rating: Poor

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

Open space and residential

Cause and Consequence of Failure

Likely Failure Mechanism: Damage by cliff falls. Failure of toe due to low beach levels. Deterioration of timber/steel structure

Consequence of Failure: Loss of open space and property

Photograph Log

Ref. No.	Description of View
P 14	Blockwork revetment.

Plate 3.3 Photo P14 Blockwork revetment

3.2.3 Defence Length TRI 2.03

This defence length has been divided into sub-lengths as based on marked changes in condition grade and/or defence type. Where possible, information in the following tables has not been duplicated but is rather referenced back to the western-most sub-lengths 2.03.1 or 2.03.2.

Location:	**Overstrand**	
Start / Finish NG Co-ordinates		**Survey Date:** June 2002
	Start	**Finish**
Easting:	622846	622897
Northing:	342356	342349
Length:	51m	
Management Unit:	TRI 2	**Defence Length Reference:** 2.03.1

Description of Defences and Beach

A vertical sea wall toped with a promenade runs along the sea front. A concrete apron with a steel piled toe protects the base of the sea wall. In December 1997 the apron and steel pile toe failed, threatening imminent collapse of the sea wall. In May 1998 this section was refurbished and is presently in very good condition. To the western extreme of this section there is a timber groyne.

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is fair. In places it is uneven and rough with trips at the site of constructions joints. The concrete retaining wall is in good condition.

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Normally a thin veneer of sand over gravels and clay. Highly volatile.

Control Structures

There is a timber groyne at the western extreme of the beach. This is in good condition with no planks missing

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1890 **Refurbished:** 1998

Description: The sea wall is in good condition with no visible signs of damage or movement since it was repaired and refaced

Defence Condition Rating: Very Good

Updates to CPSE (1997): Unknown

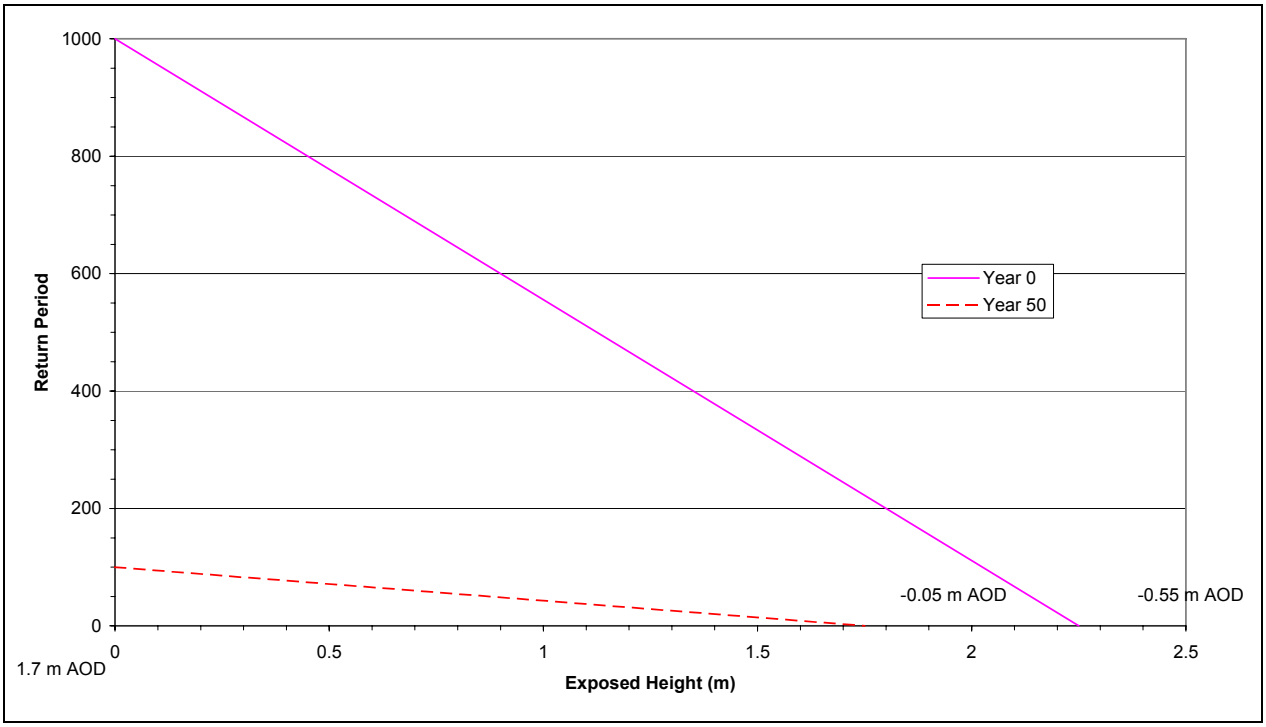
Description of Hinterland and Development

The town of Overstrand. Predominantly residential but having an important tourism based economy. The sewerage system serving the town is focussed on the cliff top site where a storage tank and pumping station is located at the rear of a car park.

Cause and Consequence of Failure

Likely Failure Mechanism: Slip circle failure of the cliff.

Consequence of Failure: Loss of sewerage infrastructure serving the town as well as residential and commercial property. Loss of access for the fishing community. Increased sediment supply to the beaches.



Fragility curve for Defence Length 2.03.1

Photograph Log	
Ref. No.	**Description of View**
OP1	East Elevation of Groyne 1
OP2	Western end of the Sea Wall
OP53	View along the base of the Sea Wall from the West

Plate 3.4 Photo OP1 East Elevation of Groyne 1

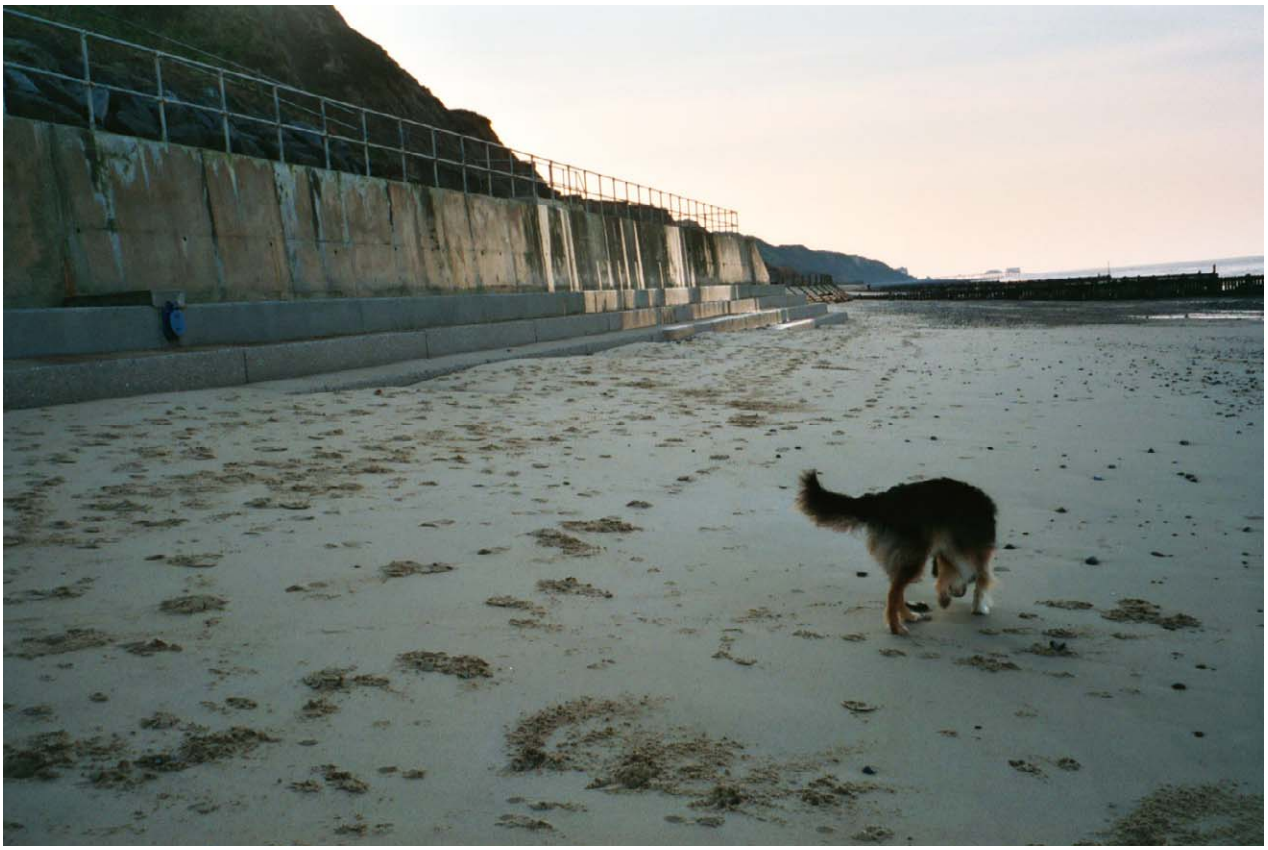


Plate 3.5 Photo OP53 View along the base of the Sea Wall from the West

Location:	Overstrand	
Start / Finish NG Co-ordinates		**Survey Date:** June 2002
	Start / **Finish**	
Easting:	622897 / 622961	
Northing:	342349 / 342349	
Length:	64m	
Management Unit:	TRI 2	**Defence Length Reference:** 2.03.2

Description of Defences and Beach

A vertical sea wall toped with a promenade runs along the sea front. A concrete apron with a steel piled toe protects the base of the sea wall. In the centre of the section is a ramp leading down to the beach. A timber groyne is also sited in the centre of this section to the east of the ramp.

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is fair. In places it is uneven and rough with trips at the site of constructions joints. The concrete retaining wall is in good condition.

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

As for Defence Length 2.03.1.

Control Structures

There is a timber groyne In the centre of the section. This is in good condition with no planks missing

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1953 **Refurbished:** N/A

Description: The apron and steel piles to the west of the ramp have been renewed or replaced, it is assumed, in association with the renewal of the wall in Section 1 and so is in good condition. To the east of the ramp the apron and piles are much older, probably from when the wall was rebuilt in 1953. The concrete apron is in fair condition but the steel piles are badly corroded and in very poor condition. It is very likely that the tie rod waling fixings have failed. A small section of original sea wall is located behind the eastern ramp. With extensive spalling and cracking and open construction joints it has been assessed to be in very poor condition.

Defence Condition Rating: Very Poor

Updates to CPSE (1997): Unknown

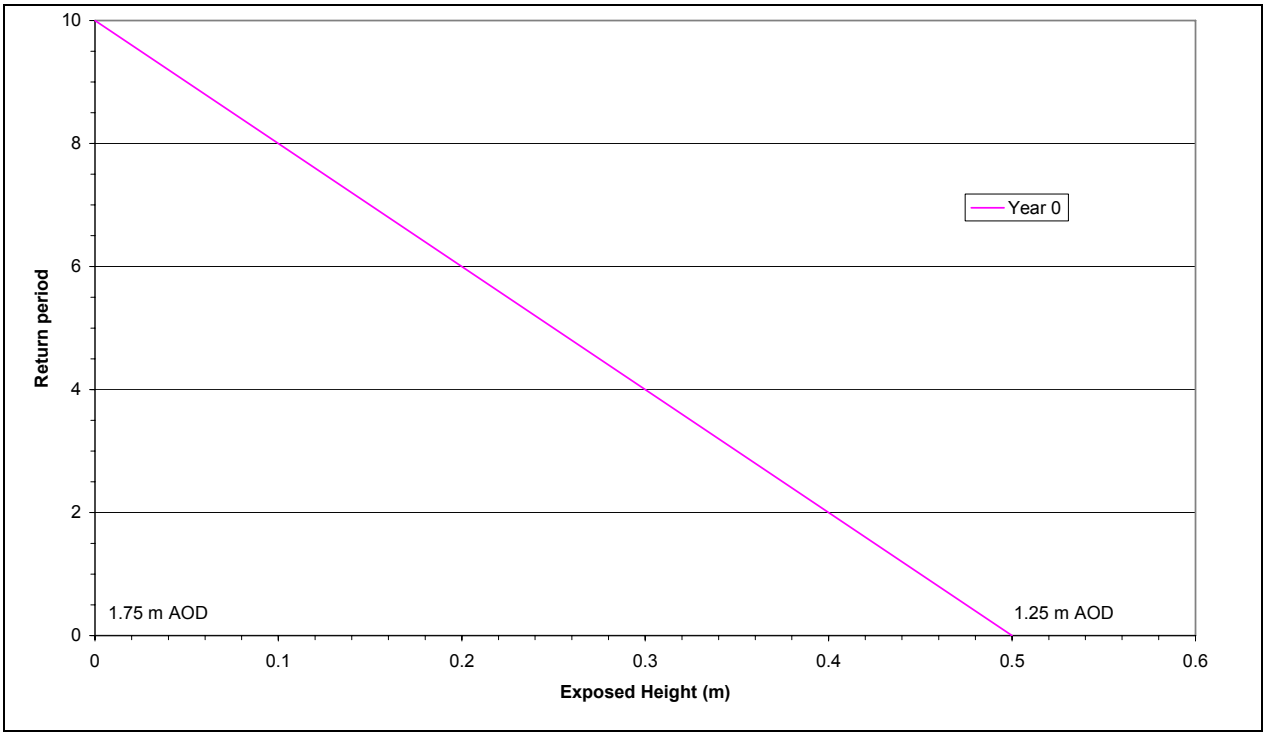
Description of Hinterland and Development

As for Defence Length 2.03.1.

Cause and Consequence of Failure

Likely Failure Mechanism: A review of the durability of the steel piles, using literature dating from when they were installed, suggests that they have reached the end of their useful life. The contemporary standard of a corrosion allowance of 0.09mm per year gives a calculated loss of 4.5mm, which is over half the original steel thickness. Imminent steel pile toe and apron failure followed quickly by failure of the seawall. This in turn leads to cliff instability.

Consequence of Failure: As for Defence Length 2.03.1 and loss of beach access.



Fragility curve for Defence Length 2.03.2

Photograph Log	
Ref. No.	**Description of Photograph**
OP3	Beacon at the end of Groyne 2
OP4	West Elevation of Groyne 2, looking towards the Sea Wall
OP5	Close up of Groyne 2 showing boards bolted to the groyne below the beach level
OP6	Close up of Groyne 2
OP7	Close up of Groyne 2
OP7a	View of Groyne 2 near the sea wall, showing steel piles
OP8	Steel Piling and Concrete Apron at the base of the Sea Wall
OP9	Close up of the Piling and Apron
OP10	Junction where Groyne 2 meets the Sea Wall
OP51	Poor condition of Sea Wall to the East of the ramp
OP52	Junction where Groyne 2 meets the Sea Wall

Plate 3.6 Photo OP6 Close up of Groyne 2

Plate 3.7 Photo OP8 Steel Piling and Concrete Apron at the base of the Sea Wall

Plate 3.8 Photo OP51 Poor condition of Sea Wall to the East of the ramp

Location:	Overstrand		
Start / Finish NG Co-ordinates			**Survey Date:** June 2002
	Start	**Finish**	
Easting:	622961	623237	
Northing:	342338	342306	
Length:	278m		
Management Unit:	TRI 2		**Defence Length Reference:** 2.03.3

Description of Defences and Beach

A vertical sea wall toped with a promenade runs along the sea front. A concrete apron with a steel piled toe protects the base of the sea wall. Behind the promenade at the western end of the section a gabion basket wall that was erected in the late sixties following a major slip protects the cliff. There are three groynes along this section of the beach, two of which are shorter than all the other groynes along the Overstrand beachfront.

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is fair. In places it is uneven and rough with trips at the site of constructions joints. The concrete retaining wall is in good condition.

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

As for Defence Length 2.03.1.

Control Structures

There are three groynes in this section of the beach. The two shorter groynes are labelled 2A and 3A on the map (Figure 2.3) and the longer groyne is labelled 3. The timber components for groynes 2A and 3A are sound, the steel piles below the timberwork exhibit a severe loss of section. The rating for these two groynes is therefore poor. Groyne 3 is in good condition.

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1920 **Refurbished:** 1955

Description: Examination of this stretch of wall, substantially repaired or renewed in the early fifties, revealed extensive wear due to abrasion at or about beach level, some loss of steel cover, loss of joint sealant and some cracking. There was also some local but severe damage at the roots of groynes 2A and 3A. Overall the initial assessment of the defence condition rating for this section was that it is in fair condition.

The concrete apron is in poor to fair condition unlike the steel piles, which have been assessed to be in very poor condition, beyond repair. The Frodingham piles are very badly corroded and the tie rod waling fixings have failed consequently. The piles would have failed in bending under ultimate limit state conditions. Hence, on review, the condition of the apron and piles has been confirmed as very poor condition with a residual life of 0 to 3 years.

The walls, when analysed in isolation are safe. Their stability is however entirely dependant on the serviceability of the apron and steel piles. If the piles fail the wall fails. Hence, the overall condition of the sea wall has been assessed, on review, to be very poor with a residual life of 0 to 3 years.

Defence Condition Rating: Very Poor

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

As for Defence Length 2.03.1.

Cause and Consequence of Failure

Likely Failure Mechanism: Limit state calculations indicate that the steel piles will fail in bending, without the tie rods, even if they had their original thickness of steel. Without any loss of section and with tie rod fixings intact, the serviceability limit state wall height exposure above the beach would have been 2.46m. The stability of the walls is entirely dependent on the serviceability of the apron and steel piles. If the piles fail the wall fails. Also failure of the gabion protection to part of the cliff is likely due to deterioration of the gabion baskets again leading to cliff instability.

Consequence of Failure: Loss of residential property. Damage limited by the extensive grounds of the Hotel.

Fragility curve – as for Defence Length 2.03.2

Photograph Log	
Ref. No.	**Description of View**
OP11	View of Groyne 2A towards the Sea Wall
OP12	Beacon at the end of Groyne 3
OP12a	Close up of Groyne 3
OP13	View of the West Elevation of Groyne 3, towards the Sea Wall
OP14	View of the East Elevation of Groyne 3, towards the Sea Wall
OP19	View along the front of the Sea Wall showing the poor Apron and Piling
OP20	Close up of poor Piling
OP21	Close up of poor Apron
OP33	View of Groyne 3A from Sea Wall
OP34	Close up of Groyne 3A
OP43	View or along the base of the Sea Wall, looking West
OP44	Close up of spalling about a joint at the base of the Sea Wall
OP46	View of the Sea Wall showing a Weep Hole and abrasion damage
OP47	View or along the base of the Sea Wall, looking East
OP48	View of the Sea Wall
OP49	Sealant loss in a joint of the Sea Wall
OP50	View along Sea Wall, looking East
OP54	Gabion Basket Slope Protection
OP55	Gabion Basket Slope Protection
OP56	Spillage from a damaged Gabion Basket Slope Protection
OP56a	Spillage from a damaged Gabion Basket Slope Protection
OP57	Elevation View of Gabion Basket Slope Protection, looking East

Plate 3.9 Photo OP13 View of the West Elevation of Groyne 3, towards the Sea Wall

Plate 3.10 Photo OP21 Close up of poor Apron

Plate 3.11 Photo OP56 Spillage from a damaged Gabion Basket Slope Protection

Location: Overstrand	
Start / Finish NG Co-ordinates **Start** **Finish** **Easting:** 623237 623301 **Northing:** 342306 342297 **Length:** 64m	**Survey Date:** June 2002
Management Unit: TRI 2	**Defence Length Reference:** 2.03.4

Description of Defences and Beach

A vertical sea wall toped with a promenade runs along the sea front. A concrete apron with a steel piled toe protects the base of the sea wall. At the western end of the section there is a timber groyne

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is fair. In places it is uneven and rough with trips at the site of constructions joints. The concrete retaining wall is in good condition.

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

As for Defence Length 2.03.1.

Control Structures

The timber groyne at the western extreme of the beach is in good condition with no planks missing

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1920 **Refurbished:** 1955

Description: The wall is similar in condition to that in Section 3 in that it has been assessed to be in fair condition. The apron and piles are in very good condition, about the root of groyne 4 there has been a massive renewal of the apron and steel piles, they have a residual life in excess of 20 years. Despite the initial assessment of the wall's residual life of 5 to 10 years, its life is likely to be extended by the massive apron. Hence on review, the wall, still only in fair condition, has been assessed to have a residual life of 10 to 20 years.

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

As for Defence Length 2.03.1.

Cause and Consequence of Failure

Likely Failure Mechanism: Wall instability precipitated by deep seated cliff failures

Consequence of Failure: Loss of residential and tourism property. Increased sediment supply

Fragility curve – as for Defence Length 2.03.1

Photograph Log

Ref. No.	Description of View
OP15	Beacon at the end of Groyne 4
OP16	Close up of Groyne 4 beneath the Beacon
OP17	Close up of Groyne 4

OP18	View along Groyne 4, from the Sea Wall
OP42	View of Sea Wall

Plate 3.12 Photo OP18 View along Groyne 4, from the Sea Wall

Plate 3.13 Photo OP42 View of Sea Wall

Location:	Overstrand	
Start / Finish NG Co-ordinates		**Survey Date:** June 2002
	Start / **Finish**	
Easting:	623301 / 623338	
Northing:	342297 / 342289	
Length:	38m	
Management Unit:	TRI 2	**Defence Length Reference:** 2.03.5

Description of Defences and Beach

A vertical sea wall toped with a promenade runs along the sea front. A concrete apron with a steel piled toe protects the base of the sea wall. The Defence Condition Rating of the Promenade that runs along the top of the sea wall is fair. In places it is uneven and rough with trips at the site of constructions joints. The concrete retaining wall is in good condition.

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

As for Defence Length 2.03.1.

Control Structures

None

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1920 **Refurbished:** 1955

Description: The inspection of this stretch of wall, substantially repaired or renewed in the early fifties, revealed extensive wear due to abrasion at or about beach level, some exposed steel, loss of joint sealant and some cracking. It was noted that the exposed steel is located in concrete at the base of the wall that has been placed there as a repair or local strengthening. Despite this repair, the wall was assessed to be in poor condition. The concrete apron is badly damaged by abrasion and is very rough. As such it is a danger to beach users. Thus the apron has been assessed to be in poor condition. The steel piles show no deformity and only a slight loss of section and these have been assessed to be in good condition with a residual life of 10 to 20 years.

Defence Condition Rating: Poor

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

As for Defence Length 2.03.1.

Cause and Consequence of Failure

Likely Failure Mechanism: Wall instability precipitated by deep-seated cliff failures and failure as a retaining wall.

Consequence of Failure: As for Defence Length 2.03.4.

Fragility curve – as for Defence Length 2.03.2

Photograph Log

Ref. No.	Description of View
OP40	View of the rough surface of the Apron and abrasion damage at base of seawall
OP41	View of the rough surface of the Apron along the base of the seawall

Plate 3.14 Photo OP40 View of the rough surface of the Apronand abrasion damage at base of seawall

Location:	Overstrand	
Start / Finish NG Co-ordinates		**Survey Date:** June 2002
	Start	**Finish**
Easting:	623338	623370
Northing:	342289	342279
Length:	33m	
Management Unit:	TRI 2	**Defence Length Reference:** 2.03.6

Description of Defences and Beach

A vertical sea wall toped with a promenade runs along the sea front. A concrete apron with a steel piled toe protects the base of the sea wall. At the western end of the section there is a timber groyne.

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is fair. In places it is uneven and rough with trips at the site of constructions joints. The concrete retaining wall is in good condition.

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

As for Defence Length 2.03.1.

Control Structures

The timber groyne at the western extreme of the beach is in good condition with no planks missing

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1955 **Refurbished:** N/A

Description: The initial defence condition rating for this section of wall is fair: This despite it being contiguous with Section 5. The surface of the apron is very rough and presents a hazard to beach users. The steel piles exhibit only a small loss of section and the tie bar fixings are not badly corroded. Hence the initial rating for the apron is poor and that for the piles good.

Defence Condition Rating: Fair

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

As for Defence Length 2.03.1.

Cause and Consequence of Failure

Likely Failure Mechanism: As for Defence Length 2.03.5.

Consequence of Failure: As for Defence Length 2.03.5.

Fragility curve – as for Defence Length 2.03.1

Photograph Log

Ref. No.	Description of View
OP22	View of Groyne 5
OP23	Close up of the end of Groyne 5
OP24	View of Groyne 5
OP25	Close up of base of Groyne 5
OP32	Close up of Steel Piling

OP38	View rough surface of the Apron along base of Sea Wall
OP38a	Damage about a joint in the Sea Wall
OP39	Close up of spalling about a joint in the base of the Sea Wall
OP42a	Close up of poor Apron and Piling

Plate 3.15 Photo OP23 Close up of the end of Groyne 5

Plate 3.16 Photo OP38 View rough surface of the Apron along base of Sea Wall

Location:	Overstrand	
Start / Finish NG Co-ordinates		**Survey Date:** June 2002
	Start	**Finish**
Easting:	623370	623436
Northing:	342279	342251
Length:	71m	
Management Unit:	TRI 2	**Defence Length Reference:** 2.03.7

Description of Defences and Beach

A vertical sea wall toped with a promenade runs along the sea front. A concrete apron with a steel piled toe protects the base of the sea wall. There is a timber groyne at the eastern extreme of this section.

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is fair. In places it is uneven and rough with trips at the site of constructions joints. The concrete retaining wall is in good condition.

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

As for Defence Length 2.03.1.

Control Structures

The is a timber groyne is in good condition with no planks missing

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1890 **Refurbished:** 1978

Description: This is the section of wall the forms the eastern limit of the concrete wall defences. The initial defence condition rating for this section of wall is good, there being only minor defects. The apron has been renewed in the past and has a rounded edge at the junction with the piles. The rating of the apron is, like the wall behind it, good. The steel piles, placed in 1978, show only a slight loss of section and the tie rod anchorages appear to be in good condition. The initial defence condition rating for the piles is very good with a residual life in excess of 20 years.

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

As for Defence Length 2.03.1.

Cause and Consequence of Failure

Likely Failure Mechanism: As for Defence Length 2.03.5.

Consequence of Failure: As for Defence Length 2.03.5.

Fragility curve – as for Defence Length 2.03.1

Photograph Log

Ref. No.	Description of View
OP27	View of Groyne 6
OP28	Close up of the end of Groyne 6

OP29	Close up of the end of Groyne 6
OP30	View of Groyne 6 halfway up the beach
OP31	Close up of Groyne 6
OP35	View of the Sea Wall
OP36	View of the Ramp leading down onto the beach
OP37	View of the Apron along the base of the Sea Wall

Plate 3.17 Photo OP27 View of Groyne 6

Plate 3.18 Photo OP37 View of the Apron along the base of the Sea Wall

3.2.3 Defence Length TRI 2.04

Location:	**Overstrand**	
Start / Finish NG Co-ordinates		**Survey Date:** 13/03/03
	Start / **Finish**	
Easting:	625257 / 625432	
Northing:	340764 / 340612	
Length:	232m	
Management Unit:	TRI 2	**Defence Length Reference:** 2.04

Description of Defences and Beach

Timber revetment and rock armour

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Control Structures

Groynes: E10 – E11 (7 – 8)

Conditions and Performance of Backshore Defences

Type: Timber revetment and rock armour **Built:** 1969 **Refurbished:** rock 1996

Description: Rock armour forms the toe of the works done to stabilize and defend Clifton Way, Overstrand following catastrophic cliff failure.

Defence Condition Rating: Rock armour – very good: Revetment - poor

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

Residential. Major beach access for maintenance purposes.

Cause and Consequence of Failure

Likely Failure Mechanism: Deterioration of timber revetment. Rock armour is extremely stable

Consequence of Failure: Loss of beach access. Damage to Clifton Way cliff protection works. Outflanking of sea wall in TRI 2.3. Damage to residential property

Photograph Log

Ref. No.	Description of View
X17	Intersection of Rock and Timber Revetments
X18	View of Timber Groyne
X19	Timber Revetment with Exposed Toe
X20	Intersection of Rock and Timber Revetments
X21	Timber Revetment with Exposed Toe
X22	View of the End of a Groyne
X23	View of the Timber Revetment and End of the Seawall (from section 2.03.7)

Plate 3.19 Photo X20 Intersection of Rock and Timber Revetments

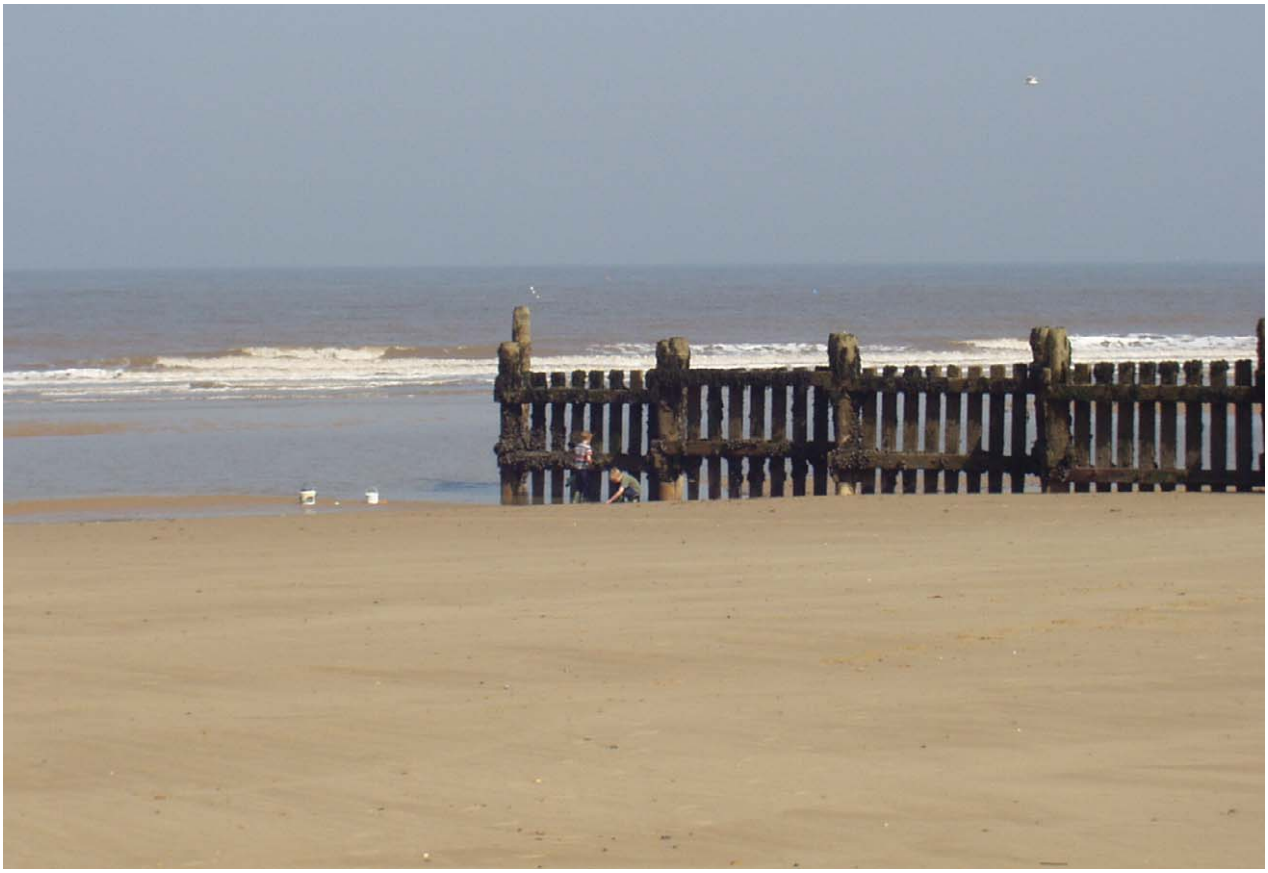


Plate 3.20 Photo X22 View of the End of a Groyne

3.2.3 Defence Length TRI 2.05

Location:	**Overstrand**	
Start / Finish NG Co-ordinates		**Survey Date:** 13/03/03
	Start / **Finish**	
Easting:	625432 / 625555	
Northing:	340612 / 340483	
Length:	178m	
Management Unit:	TRI 2	**Defence Length Reference:** 2.05

Description of Defences and Beach

A timber revetment forming the eastern flank of the Overstrand system. Contiguous with the timber revetment in TRI 3.01

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

The revetment is forward of the cliff and its level is partially controlled by groynes. It has low amenity value by virtue of very poor access.

Control Structures

Timber groynes E12-E13 (9-10)

Conditions and Performance of Backshore Defences

Type: Timber revetment **Built:** 1975 **Refurbished:**

Description:

Defence Condition Rating: poor

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

Rural, residential

Cause and Consequence of Failure

Likely Failure Mechanism: Failure of the timber components through physical damage (cliff failure) or loosening of joints.

Consequence of Failure: Increased cliff erosion leading to the loss of a small number of homes.

Photograph Log

Ref. No.	Description of View
X14	Badly Damaged Wooden Revetment
X15	Badly Damaged Wooden Revetment
X16	View South East Along the Revetment

Plate 3.21 Photo X14 Badly Damaged Wooden Revetment

Plate 3.22 Photo X16 View South East Along the Revetment

3.2.3 Groynes in TRI 2

Management Unit	**TRI 2**		**Location: Groyne No. W3**
Start / Finish NG Co-ordinates			**Survey Date:** 13/01/03
	Root		
Easting:	624387	624412	
Northing:	341249	341318	
Length:	76		
Management Unit:	TRI 1		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1967		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Beacon complete			

Management Unit	**TRI 2**		**Location: Groyne No. W2**
Start / Finish NG Co-ordinates			**Survey Date:** 13/01/03
	Root		
Easting:	624544	624559	
Northing:	341186	341258	
Length:	76m		
Management Unit:	TRI 2		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1967		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Beacon missing P17			

Management Unit	**TRI 2**		**Location: Groyne No. W1**
Start / Finish NG Co-ordinates			**Survey Date:** 13/01/03
	Root		
Easting:	624693	624715	
Northing:	341131	341202	
Length:	76m		
Management Unit:	TRI 2		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1967		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Beacon head missing – Slight deterioration of verticals P16			

Management Unit	TRI 2	Location: Groyne No. 2
Start / Finish NG Co-ordinates		**Survey Date:** 13/01/03
	Root	
Easting:	624841	624889
Northing:	341068	341148
Length:	95m	
Management Unit:	TRI 2	**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber/SSP/ZZ **Built:** 1967 **Refurbished:**

Defence Condition Rating: Good/Fair

Updates to CPSE (1997): Unknown

Comment: Zig-zag Beacon complete – Secondary OK – Poles OK –Occasional timber deterioration – Zig-zag panelling broken

Management Unit	TRI 2	Location: Groyne No. 2A
Start / Finish NG Co-ordinates		**Survey Date:** 13/01/03
	Root	
Easting:	624904	624912
Northing:	341016	341029
Length:	15m	
Management Unit:	TRI 2	**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber/SSP **Built:** 1972 **Refurbished:**

Defence Condition Rating: Poor

Updates to CPSE (1997): Unknown

Comment:

Management Unit	TRI 2	Location: Groyne No. 3
Start / Finish NG Co-ordinates		**Survey Date:** 13/01/03
	Root	
Easting:	624971	625015
Northing:	340972	341034
Length:	88m	
Management Unit:	TRI 2	**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber **Built:** 1981 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete

Management Unit	TRI 2	Location: Groyne No. 3A
Start / Finish NG Co-ordinates		**Survey Date:** 13/01/03
	Root	
Easting:	635038 625047	
Northing:	340927 340940	
Length:	15m	
Management Unit: TRI 2		**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber/SSP **Built:** 1972 **Refurbished:**

Defence Condition Rating: Poor

Updates to CPSE (1997): Unknown

Comment: Significant deterioration of sheet piling for 3 sections

Management Unit	TRI 2	Location: Groyne No. 4
Start / Finish NG Co-ordinates		**Survey Date:** 13/01/03
	Root	
Easting:	625105 625150	
Northing:	340881 340958	
Length:	85m	
Management Unit: TRI 2		**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber **Built:** 1981 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete

Management Unit	TRI 2	Location: Groyne No. 5
Start / Finish NG Co-ordinates		**Survey Date:** 13/01/03
	Root	
Easting:	625180 625226	
Northing:	340830 340896	
Length:	90m	
Management Unit: TRI 2		**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber/SSP/ZZ **Built:** 1980 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Zig-zag – No beacon – Secondary OK – Single plank missing and some erosion of sheet piling

Management Unit	TRI 2	Location: Groyne No. 6
Start / Finish NG Co-ordinates		**Survey Date:** 12/01/03
	Root	
Easting:	625249	625296
Northing:	340772	340834
Length:	90m	
Management Unit: TRI 2		**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber/SSP/Z **Built:** 1980 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Zig-zag – Beacon in place

Management Unit	TRI 2	Location: Groyne No. 7
Start / Finish NG Co-ordinates		**Survey Date:** 12/01/03
	Root	
Easting:	625323	625368
Northing:	340710	340778
Length:	90m	
Management Unit: TRI 2		**Defence Length Reference:** 04

Conditions and Performance of Groyne

Type: Timber/SSP/Z **Built:** 1980 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Zig-zag – No beacon

Management Unit	TRI 2	Location: Groyne No. 8
Start / Finish NG Co-ordinates		**Survey Date:** 12/01/03
	Root	
Easting:	625397	625438
Northing:	340643	340711
Length:	90m	
Management Unit: TRI 2		**Defence Length Reference:** 04

Conditions and Performance of Groyne

Type: Timber/SSP/ZZ **Built:** 1980 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Zig-zag – No beacon

Management Unit	TRI 2	Location: Groyne No. 9
Start / Finish NG Co-ordinates		**Survey Date:** 12/01/03
	Root	
Easting:	625464 625505	
Northing:	340584 340568	
Length:	76m	
Management Unit:	TRI 2	**Defence Length Reference:** 05

Conditions and Performance of Groyne

Type: Timber **Built:** 1970 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon OK

Management Unit	TRI 2	Location: Groyne No. 10
Start / Finish NG Co-ordinates		**Survey Date:** 12/01/03
	Root	
Easting:	625529 625568	
Northing:	340504 340568	
Length:	76m	
Management Unit:	TRI 2	**Defence Length Reference:** 05

Conditions and Performance of Groyne

Type: Timber **Built:** 1970 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No beacon top

4. TRI 3 – SIDESTRAND CONDITION SURVEY

4.1 History

4.2 This frontage is almost unique in the study area in that it does not have a history of extensive defence works. Historical maps show that there were two groynes built by 1892 towards the east of the management unit but by 1908, these had gone. The western part of the unit is protected by a timber revetment built by NNDC in 1987 as an extension to, and contiguous with, Overstrand's defences. Summary

The cliffs, which are part of a SSSI designated for its geological characteristics, reach up to 64 metres in height. They are prone to massive failures. Given the low level of intervention in the past, the beach here is, arguably, the most natural beach in the study area. The timber revetment is in poor condition.

4.3 Observations

4.2.3 Defence Length TRI 3.01

Location: Sidestrand	
Start / Finish NG Co-ordinates **Start** **Finish** **Easting:** 625551 626152 **Northing:** 340487 340043 **Length:** 747m	**Survey Date:** 13/03/03
Management Unit: TRI 3	**Defence Length Reference:** 3.01

Description of Defences and Beach

A timber revetment forming the eastern flank of the Overstrand system. Contiguous with the timber revetment in TRI 2.05

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

The revetment is forward of the cliff and its level is partially controlled by groynes. It has low amenity value by virtue of very poor access.

Control Structures

Timber groynes F1-F5, (11-15)

Conditions and Performance of Backshore Defences

Type: Timber revetment **Built:** 1975 **Refurbished:**

Description:

Defence Condition Rating: poor

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

Rural: Agricultural with a small number of homes and the large residential Sidestrand Special School

Cause and Consequence of Failure

Likely Failure Mechanism: Failure of the timber components through physical damage or loosening of joints.

Consequence of Failure: Increased cliff erosion leading to the loss of agricultural land, playing fields and a small number of homes.

Photograph Log

Ref. No.	Description of View
X1	Termination of Wooden Revetment
X2	Rear View of Wooden Revetment
X3	View of the End of a Groyne
X4	Front View of Wooden Revetment
X5	View of a Groyne

X6	View of a Wooden Revetment with Boards Missing
X7	View of a Groyne
X8	View of a Wooden Revetment with Boards Missing
X9	View of a Wooden Revetment with Boards Missing
X10	Wooden Revetment with Exposed Sheet Pile Toe
X11	Close up of Corrosion of Sheet Pile Toe
X12	View of Join Between Groyne and Revetment
X13	Badly Damaged Wooden Revetment

Plate 4.1 Photo X1 Termination of Wooden Revetment

Plate 4.2 Photo X8 View of a Wooden Revetment with Boards Missing

Plate 4.3 Photo X10 Wooden Revetment with Exposed Sheet Pile Toe

4.2.3 Defence Length TRI 3.02

Location:	**Sidestrand**		
Start / Finish NG Co-ordinates			**Survey Date:** 13/03/03
	Start	**Finish**	
Easting:	626152	627781	
Northing:	340043	339129	
Length:	1868m		
Management Unit:	TRI 3		**Defence Length Reference:** 3.02

Description of Defences and Beach

No defences

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Excellent beach. Low amenity value by virtue of the extremely difficult access

Control Structures

None

Conditions and Performance of Backshore Defences

Type: **Built:** **Refurbished:**

Description:

Defence Condition Rating:

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

Agricultural land, no property

4.2.3 Groynes in TRI 3

Management Unit	TRI 3		Location: Groyne No. 11
Start / Finish NG Co-ordinates			**Survey Date:** 12/01/03
	Root		
Easting:	625616	625655	
Northing:	340438	340499	
Length:	75m		
Management Unit:	TRI 3		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1970		**Refurbished:** 1987
Defence Condition Rating: Good			
Updates to CPSE (1997):	Unknown		
Comment: Beacon OK			

Management Unit	TRI 3		Location: Groyne No. 12
Start / Finish NG Co-ordinates			**Survey Date:** 12/01/03
	Root		
Easting:	625725	625761	
Northing:	340330	330392	
Length:	75m		
Management Unit:	TRI 3		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1987		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997):	Unknown		
Comment: Beacon OK			

Management Unit	TRI 3		Location: Groyne No. 13
Start / Finish NG Co-ordinates			**Survey Date:** 12/01/03
	Root		
Easting:	625853	625890	
Northing:	340249	340315	
Length:	75m		
Management Unit:	TRI 3		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1987		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997):	Unknown		
Comment: Beacon OK			

Management Unit	TRI 3	Location: Groyne No. 14
Start / Finish NG Co-ordinates		**Survey Date:** 12/01/03
	Root	
Easting:	635980 626017	
Northing:	340169 340232	
Length:	75m	
Management Unit:	TRI 3	**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber **Built:** 1987 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: None

Management Unit	TRI 3	Location: Groyne No. 15
Start / Finish NG Co-ordinates		**Survey Date:** 12/01/03
	Root	
Easting:	626106 626149	
Northing:	340088 340148	
Length:	75m	
Management Unit:	TRI 3	**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber **Built:** 1987 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon OK

Management Unit	TRI 3	Location: Groyne No. 16
Start / Finish NG Co-ordinates		**Survey Date:** 17/01/03
	Root	
Easting:	627850 627882	
Northing:	339111 339179	
Length:	72m	
Management Unit:	TRI 3	**Defence Length Reference:** 02

Conditions and Performance of Groyne

Type: Timber **Built:** 1975 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment:

5. TRI 4 – TRIMINGHAM CONDITION SURVEY

5.1 History

The continuing mass movement of the cliffs at Trimingham caused landowners to build defences there well before those at Overstrand and Mundesley. Before any seawalls were built at Overstrand and Mundesley, the community of Trimingham made many attempts to prevent erosion by the sea. As early as 1844 William Hewitt mentions a groin at Trimingham, erected "a few years hence." Extending to or beyond low water, the groyne was destroyed by heavy seas. There were a series of such groynes built below Trimingham in the nineteenth century; all of these had been destroyed by 1900.

In the 1970's, Erpingham RDC and NNDC invested large sums of capital in the construction of a timber revetment and groynes along the Trimingham frontage. The works were fraught with difficulty as cliff failures severely damaged the defences under construction. Since then the revetment has been persistently damaged by cliff failures. All that is left of the western extremities of this defence is the skeleton of the revetment and its concrete apron.

Figure 5.1 Erpingham Type Groyne at Overstrand

There has been a long history of defence works along this frontage. Initially solely for the protection of landowners' interests, they were later constructed in attempts to attenuate the devastating effects of erosion and cliff instability on communities. Much of the work was very traditional in concept, featuring hard seawalls and groyne fields, built with little consideration for the environment and drift regime, although the potentially damaging effects of groynes was recognised by Erpingham RDC. Throughout the frontage from Overstrand to Walcott permeable groynes can be seen. These groynes are built with the intention of only partially retaining drift materials, while still allowing some movement of sand along the beach.

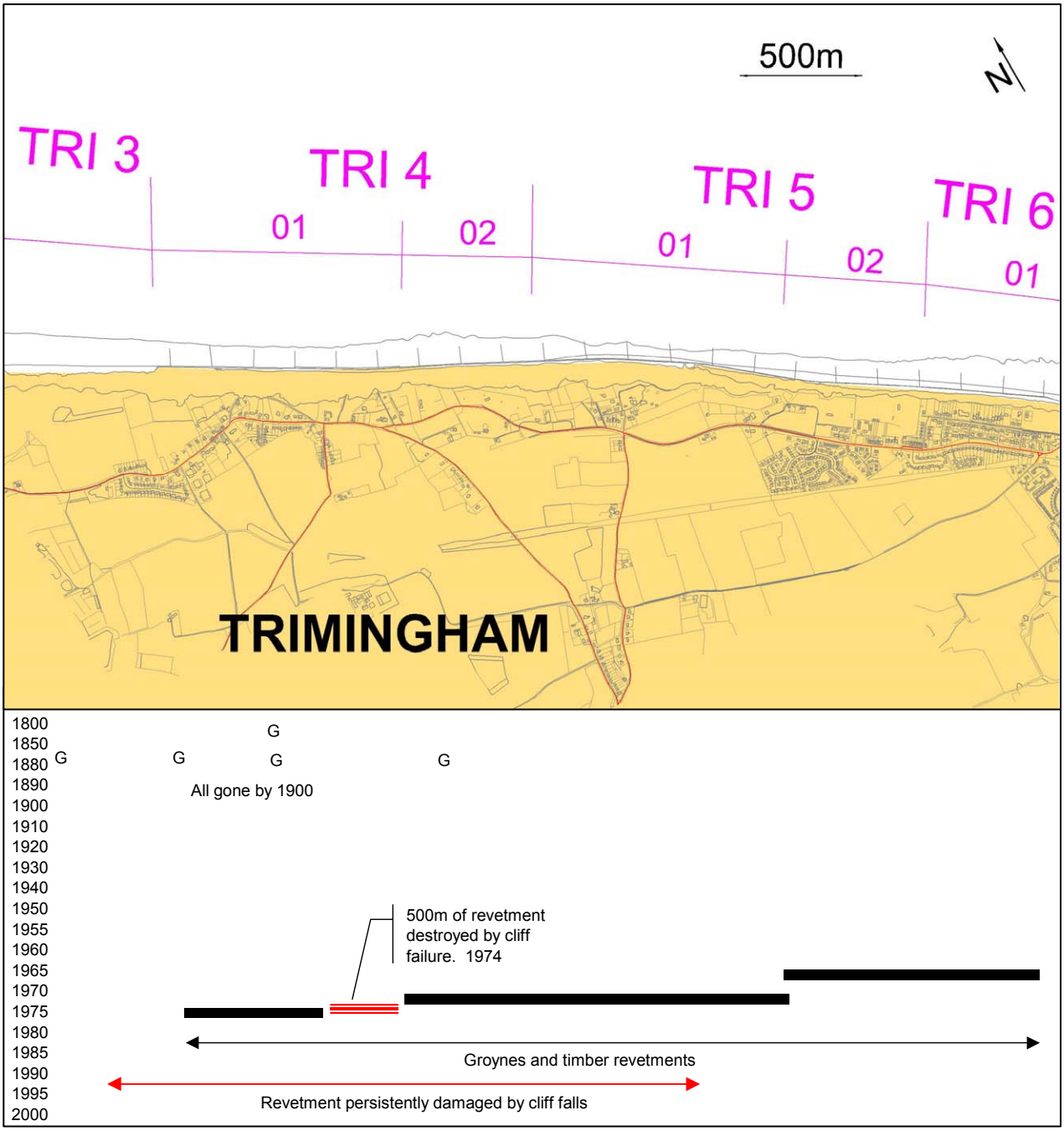


Figure 5.2 Timeline of Trimingham coastal defence construction

5.2 Summary

The timber revetment along the length of the frontage has been damaged by periodical cliff failures and is in very poor condition, while the concrete elements of the western section (TRI 4.01) in fair condition. In places, significant quantities of talus (material generated by cliff failure and lying at the base of the cliff) bear upon the rear of the revetment, pushing through the timber breastworks and severely damaging the steel pile toe.

The nine groynes in this Management Unit were found to be mainly in good condition, though three are in fair / poor condition. The seaward ends of six of these are in very poor condition or require works, and the beacons of two of the groynes are missing altogether.

5.3 Observations

5.2.3 Defence Length TRI 4.01

Location:	**Trimingham**		
Start / Finish NG Co-ordinates			**Survey Date:** 17/01/03
	Start	**Finish**	
Easting:	627781	628660	
Northing:	339129	338641	
Length:	1006m		
Management Unit:	TRI 4		**Defence Length Reference:** 4.01

Description of Defences and Beach

Timber revetment and massive concrete apron, timber groynes

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

A volatile beach that benefits from the adjacent undefended management unit (TRI 3.02)

The distance away from the nearest access point limits the amenity value of this beach. Nevertheless, it is quite popular with visitors prepared to walk along the beach or follow a moderately hazardous path down the cliff.

Control Structures

Groyne numbers F6, G1-G5 (11-16)

Conditions and Performance of Backshore Defences

Type: Timber revetment & conc. apron **Built:** 1975 **Refurbished:**

Description: A timber revetment with a substantial concrete wall and steel pile toe as its foundation. Built in this manner in acknowledgment of the damage likely to be caused by cliff failures. The slumped material from the cliff is resting on and pushing through the timber revetment.

Defence Condition Rating: Timber revetment – very poor. Concrete wall - fair

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

The village of Trimingham and agricultural land.

Cause and Consequence of Failure

Likely Failure Mechanism: Damage or destruction of the timber revetment from cliff failure. Less probable damage to the revetment by the action of the sea. The substantial base is unlikely to fail.

Consequence of Failure: Increased wave attack on the cliff leading to an acceleration of the slip/erosion failure cycle. Severe damage to the village of Trimingham and the threat of closure of the coast road.

Photograph Log	
Ref. No.	**Description of View**
PT16	Seawall and derelict revetment.
PT17	Ditto, root of groyne G5 (11)
PT18	Seawall, derelict revetment.
PT19	Ditto
PT20	Ditto
PT21	Ditto, note pile condition
PT22	Apron to wall
PT23	Ditto
PT24	Revetment on seawall
TG1	Ditto, cliff fall debris on revetment
TG2	Western end of wall
TG3	Ditto
TG4	Groyne F6
TG5	Groyne G1
TG6	Groyne G2
TG7	Groyne G3
TG8	Groyne G4
TG9	Groyne G5

Plate 5.1 Photo PT16 Seawall and derelict revetment

Plate 5.2 Photo PT23 Apron to wall

Plate 5.3 Photo TG3 Western end of wall

Plate 5.4 Photo TG7 Groyne G3

5.2.3 Defence Length TRI 4.02

Location:	**Trimingham**		
Start / Finish NG Co-ordinates			**Survey Date:** 17/01/03
	Start	**Finish**	
Easting:	628660	629138	
Northing:	338641	338391	
Length:	539m		
Management Unit:	TRI 4		**Defence Length Reference:** 4.02

Description of Defences and Beach

Timber revetment contiguous with TRI 5.01

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Revetment forward of the cliff. The rear of the revetment is a mixture of beach and talus. Seaward the beach is sandy controlled by groynes. Moderate amenity value.

Control Structures

Groynes G6 –G8 (8 – 10)

Conditions and Performance of Backshore Defences

Type: Timber revetment **Built:** 1975 **Refurbished:**

Description: Timber revetment with steel sheet pile toe. Timber revetment in vey poor condition with its steel pile toe being severely damaged by mass movements from the cliff: (Steel piles physically detached from the revetment.

Defence Condition Rating: Very poor

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

High cliffs, (SSSI) Rural, smallholdings and RAF radar station. Coast road

Cause and Consequence of Failure

Likely Failure Mechanism: Low beach causing instability of the steel pile toe. Cliff failures damaging both the timber and steel components of the structure

Consequence of Failure: Increased wave attack on the cliff leading to an acceleration of the slip/erosion failure cycle. Loss of smallholdings and limited number of residential properties. Threat of severance of the coast road with the loss of the radar station.

Photograph Log

Ref. No.	Description of View
PT8	Breach in revetment.
PT9	Revetment damaged by cliff falls
PT10	Revetment, note damaged piles
PT11	Ditto, with missing piles
PT12	Ditto
PT13	Damaged revetment.

PT14	Skeletal revetment, no piles
PT15	Revetment, missing timbers
TG10	Groyne G6
TG11	Groyne G7
TG12	Root groyne G7
TG14	Groyne G8

Plate 5.5 Photo PT10 Revetment, note damaged piles

Plate 5.6 Photo PT14 Skeletal revetment, no piles

Plate 5.7 Photo TG11 Groyne G7

5.2.3 Groynes in TRI 4

Management Unit	TRI 4		Location: Groyne No. 15
Start / Finish NG Co-ordinates			**Survey Date:** 17/01/03
	Root		
Easting:	627995	628032	
Northing:	339029	339110	
Length:	72m		
Management Unit:	TRI 4		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber		**Built:** 1975	**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Generally good but seaward end missing			

Management Unit	TRI 4		Location: Groyne No. 14
Start / Finish NG Co-ordinates			**Survey Date:** 17/01/03
	Root		
Easting:	628142	628175	
Northing:	338941	338998	
Length:	69m		
Management Unit:	TRI 4		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber		**Built:** 1975	**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Generally good but seaward end missing			

Management Unit	TRI 4		Location: Groyne No. 13
Start / Finish NG Co-ordinates			**Survey Date:** 17/01/03
	Root		
Easting:	628288	628320	
Northing:	338855	338911	
Length:	66m		
Management Unit:	TRI 4		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber		**Built:** 1974	**Refurbished:**
Defence Condition Rating: Good/Fair			
Updates to CPSE (1997): Unknown			
Comment: V Poor at seaward end, beacon complete			

Management Unit	TRI 4	Location: Groyne No. 12
Start / Finish NG Co-ordinates		**Survey Date:** 17/01/03
	Root	
Easting:	628436 628467	
Northing:	338769 338827	
Length:	69m	
Management Unit: TRI 4		**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber **Built:** 1974 **Refurbished:**

Defence Condition Rating: Good/Fair

Updates to CPSE (1997): Unknown

Comment: Generally good but seaward end panel missing, beacon complete

Management Unit	TRI 4	Location: Groyne No. 11
Start / Finish NG Co-ordinates		**Survey Date:** 17/01/03
	Root	
Easting:	628582 628617	
Northing:	338681 338750	
Length:	72m	
Management Unit: TRI 4		**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber **Built:** 1974 **Refurbished:**

Defence Condition Rating: Fair/Poor

Updates to CPSE (1997): Unknown

Comment: None

Management Unit	TRI 4	Location: Groyne No. 10
Start / Finish NG Co-ordinates		**Survey Date:** 17/01/03
	Root	
Easting:	628733 628762	
Northing:	338605 338673	
Length:	72m	
Management Unit: TRI 4		**Defence Length Reference:** 02

Conditions and Performance of Groyne

Type: Timber **Built:** 1972 **Refurbished:**

Defence Condition Rating: Fair/ Poor

Updates to CPSE (1997): Unknown

Comment: Generally Fair/Poor but seaward end Poor/V Poor

Management Unit	TRI 4	Location: Groyne No. 9
Start / Finish NG Co-ordinates		**Survey Date:** 17/01/03
	Root	
Easting:	628887 628915	
Northing:	338526 338596	
Length:	72m	
Management Unit:	TRI 4	**Defence Length Reference:** 02

Conditions and Performance of Groyne

Type: Timber **Built:** 1972 **Refurbished:**

Defence Condition Rating: Fair/ Poor

Updates to CPSE (1997): Unknown

Comment: Generally Fair/Poor but seaward end V Poor

Management Unit	TRI 4	Location: Groyne No. 8
Start / Finish NG Co-ordinates		**Survey Date:** 17/01/03
	Root	
Easting:	628887 628915	
Northing:	338526 338596	
Length:	72m	
Management Unit:	TRI 4	**Defence Length Reference:** 02

Conditions and Performance of Groyne

Type: Timber **Built:** 1972 **Refurbished:**

Defence Condition Rating: Good/Fair

Updates to CPSE (1997): Unknown

Comment: Beacon complete

6. TRI 5 – TRIMINGHAM TO MUNDESLEY CONDITION SURVEY

6.1 History

No defences were in place within this management unit until 1967, when the timber revetment and groyne system was built as a westerly extension of the Mundesley system and part of a scheme to protect the Trimingham frontage. Vale Road, the only safe access to the entire Trimingham frontage, is included in this unit.

6.2 Summary

The timber revetment is in fair to good condition with small elements damaged by cliff falls. The groynes are generally in good condition. The access road down the cliff is built on ground that tends to be unstable. This is evidenced by the cracking in the surfacing, the repairs done to date and anomalies in the kerb lines.

6.3 Observations

6.2.3 Defence Length TRI 5.01

Location:	**Trimingham to Mundesley**	
Start / Finish NG Co-ordinates		**Survey Date:** 17/01/03
	Start	**Finish**
Easting:	629138	629988
Northing:	338391	337829
Length:	1019m	
Management Unit: TRI 5		**Defence Length Reference:** 5.01

Description of Defences and Beach

Timber revetment with steel pile toe. Contiguous with TRI 4.02

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Revetment forward of the cliff. The rear of the revetment is a mixture of beach and talus. Seaward the beach is sandy controlled by groynes. High amenity value given the proximity to the Vale Road access. Used by visitors and for boat launching. Has, in the past, been an important access for small inshore fishing boats. None are believed to be operating now.

Control Structures

Groynes H1 – H6 (2 –7)

Conditions and Performance of Backshore Defences

Type: Timber revetment **Built:** 1972 **Refurbished:**

Description: **Timber revetment with steel pile toe.**

Defence Condition Rating: Fair

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

High cliffs (SSSI) Caravan park, residential and small holdings. Includes the seaward end of the important beach access off Vale Road

Cause and Consequence of Failure

Likely Failure Mechanism: Low beach causing instability of the steel pile toe. Cliff failures damaging both the timber and steel components of the structure

Consequence of Failure: Increased wave attack on the cliff leading to an acceleration of the slip/erosion failure cycle. Loss of important beach access. Loss of residential buildings. Forced relocation of caravan park. Severe loss of amenity in the tourism context.

Photograph Log

Ref. No.	**Description of View**
PT1	Groyne H4
PT1A	Ditto
PT2	Revetment.

PT4	Groyne H3
PT5	Revetment
PT6	Groyne H2
PT7	Groyne H1
TG15	Revetment.

Plate 6.1 Photo PT4 Groyne H3

Plate 6.2 Photo PT5 Revetment

6.2.3 Defence Length TRI 5.02

Location:	**Trimingham to Mundesley**		
Start / Finish NG Co-ordinates			**Survey Date:** 17/01/03
	Start	**Finish**	
Easting:	629988	630474	
Northing:	337829	337499	
Length:	587.4m		
Management Unit:	TRI 5		**Defence Length Reference:** 5.02

Description of Defences and Beach

Timber revetment contiguous with TRI 5.01, TRI 6.01

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Revetment forward of the cliff. The rear of the revetment is a mixture of beach and talus. Seaward the beach is sandy controlled by groynes. High amenity value given the proximity to the Vale Road access.

Control Structures

Groynes H7 – H11 (1, W5 – W7)

Conditions and Performance of Backshore Defences

Type: Timber revetment **Built:** 1967 **Refurbished:**

Description: Timber revetment local damage close to Vale Road access

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

High cliffs, Caravan sites, residential

Cause and Consequence of Failure

Likely Failure Mechanism: Low beach causing instability of the steel pile toe. Cliff failures damaging both the timber and steel components of the structure

Consequence of Failure: Increased wave attack on the cliff leading to an acceleration of the slip/erosion failure cycle. Loss of important beach access. Loss of residential buildings. Forced relocation of caravan park. Severe loss of amenity in the tourism context.

Photograph Log

Ref. No.	Description of View
M7	Groyne I1, surface water outfall
M8	Groyne H9
M9	Groyne H8, surface water outfall
M10	Local damage to revetment
TG17	General view of revetment
TG18	Groyne H7
TG19	Local damage to revetment as M10

TG20	General view of revetment
TG22	General view of revetment.

Plate 6.3 Photo M7 Groyne I1, surface water outfall

Plate 6.4 Photo M10 Local damage to revetment

Plate 6.5 Photo TG17 General view of revetment

6.2.3 Groynes in TRI 5

Management Unit	TRI 5		Location: Groyne No. 7
Start / Finish NG Co-ordinates			**Survey Date:** 17/01/03
	Root		
Easting:	628887	628915	
Northing:	338526	338596	
Length:	72m		
Management Unit:	TRI 5		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1972		**Refurbished:**
Defence Condition Rating: Fair/Poor			
Updates to CPSE (1997): Unknown			
Comment: Generally Fair/Poor but seaward end V Poor			

Management Unit	TRI 5		Location: Groyne No. 6
Start / Finish NG Co-ordinates			**Survey Date:** 17/01/03
	Root		
Easting:	629342	629369	
Northing:	338289	338357	
Length:	72m		
Management Unit:	TRI 5		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1972		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Beacon complete			

Management Unit	TRI 5		Location: Groyne No. 5
Start / Finish NG Co-ordinates			**Survey Date:** 17/01/03
	Root		
Easting:	629491	629520	
Northing:	338205	338269	
Length:	72m		
Management Unit:	TRI 5		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1972		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Beacon head missing			

Management Unit	TRI 5	Location: Groyne No. 4
Start / Finish NG Co-ordinates		**Survey Date:** 17/01/03
	Root	
Easting:	629637 629667	
Northing:	338105 338170	
Length:	72m	
Management Unit:	TRI 5	**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber **Built:** 1972 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete

Management Unit	TRI 5	Location: Groyne No. 3
Start / Finish NG Co-ordinates		**Survey Date:** 17/01/03
	Root	
Easting:	629776 629812	
Northing:	338010 338070	
Length:	72m	
Management Unit:	TRI 5	**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber **Built:** 1972 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete

Management Unit	TRI 5	Location: Groyne No. 2
Start / Finish NG Co-ordinates		**Survey Date:** 17/01/03
	Root	
Easting:	629910 629947	
Northing:	337901 337955	
Length:	72m	
Management Unit:	TRI 5	**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber **Built:** 1972 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon missing

Management Unit	TRI 5		Location: Groyne No. W 7
Start / Finish NG Co-ordinates			**Survey Date:** 14/01/03
	Root		
Easting:	630177	630210	
Northing:	337692	337750	
Length:	67m		
Management Unit:	TRI 5		**Defence Length Reference:** 02
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1967		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Beacon complete outfall groyne			

Management Unit	TRI 5		Location: Groyne No. W 6
Start / Finish NG Co-ordinates			**Survey Date:** 14/01/03
	Root		
Easting:	630323	630323	
Northing:	337600	337658	
Length:	67m		
Management Unit:	TRI 5		**Defence Length Reference:** 02
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1967		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Beacon head missing			

Management Unit	TRI 5		Location: Groyne No. 1
Start / Finish NG Co-ordinates			**Survey Date:** 17/01/03
	Root		
Easting:	630043	630080	
Northing:	337792	337850	
Length:	72m		
Management Unit:	TRI 5		**Defence Length Reference:** 02
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1972		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Beacon head missing			

7. TRI 6 – MUNDESLEY CONDITION SURVEY

7.1 History

In his 1844 "Essay on the Encroachment of the German Ocean," William Hewitt wrote:

> Mister Wheatley of Mundesley had the hulls of old vessels placed upon the shore at the base of the cliffs adjoining his property; They were filled with large stones, secured by piles and chains but a few years hence, they were entirely removed by the sea.

This was one of the more extreme examples of landowners striving to protect their property against the actions of the sea in the late eighteenth and early nineteenth centuries. Dating from circa 1880, the earliest seawalls to be built along the frontage were in Mundesley, as shown in Figure 7.1. These seawalls were built to protect hotels as well as provide beach side facilities for the embryonic tourist trade. Although in very poor condition, these walls are still in service today.

The first publicly funded seawall in Mundesley was built circa 1905. This wall protected the heart of the town, and for the first time Mundesley had a continuous defence. The extensions to the sea defences at the flanks of the seawalls then followed the growth of the town. Erpingham RDC (Regional District Council) extended the seawall to the west in the late 1940's. After the catastrophic event of 1953, timber revetments were built westwards towards Trimingham and eastwards towards Bacton.

Figure 7.2 provides a summary timeline of the history of the defences at Mundesley in tabular form.

Figure 7.1 Seawall in Mundesley c 1880

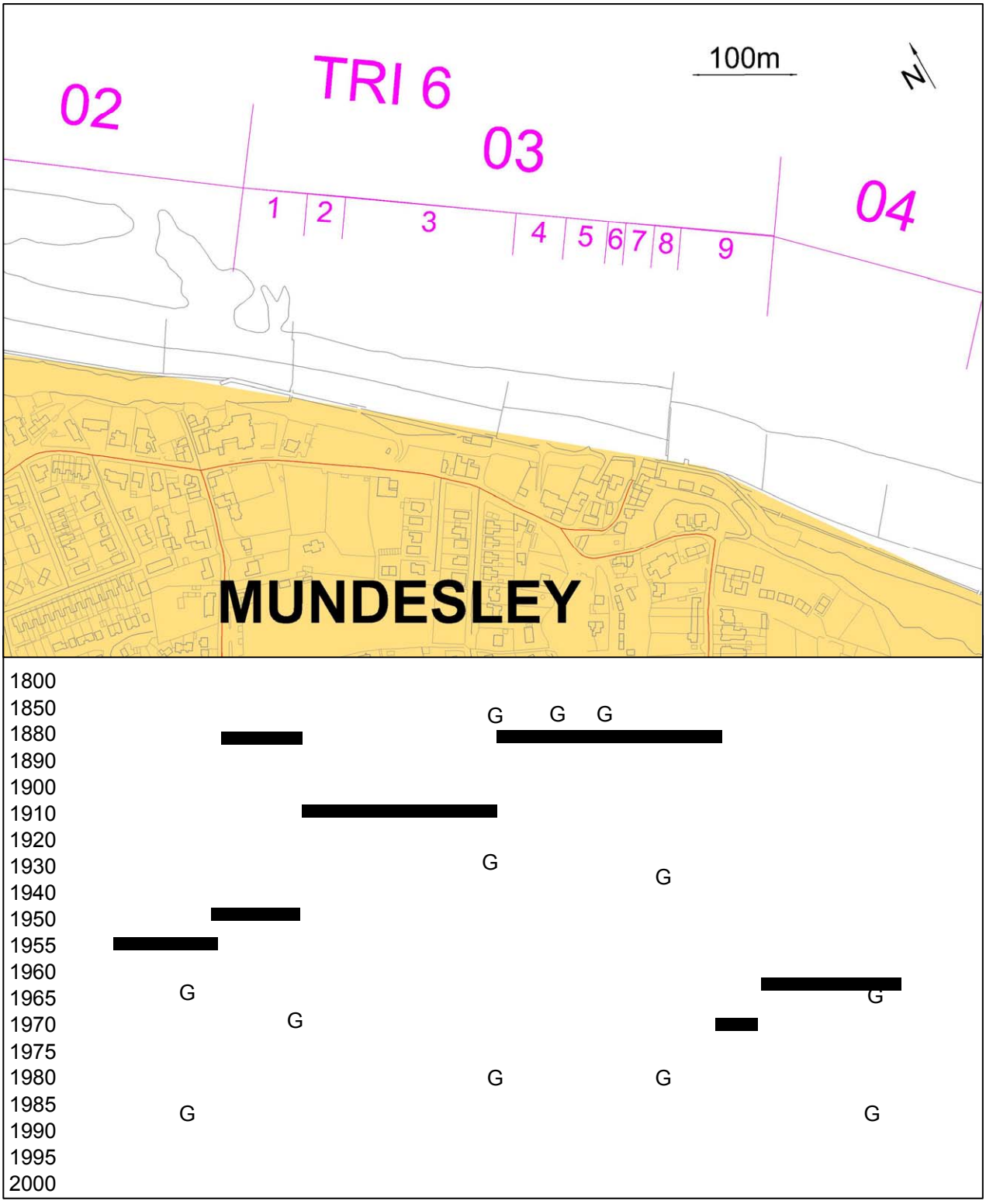


Figure 7.2 Timeline of Mundesley coastal defence construction

7.2 Summary

The nine different types of construction of Mundesley's seawalls reflect the evolution of the system over time. A concrete apron and a steel pile embedded wall front all of the seawalls. The seawalls rely on the embedded wall for stability such that, once a section of embedded wall fails, the seawall behind it fails in rotation or sliding. The oldest sections of seawall east of groyne 4 are now in poor condition. While the seawall section west of groyne 3 is, on inspection, in good condition, its design provides for poor

resistance to sliding under serviceability limit loads. Thus, this section has been given a poor defence condition rating. Despite their age, the remaining seawalls are in good to very good condition.

Stability analysis of the embedded walls show that typically the limit state beach level is at approximately 0.8m AODN. Furthermore, the steel piles have a residual life of 40 to 45 years.

The groynes are of mixed types of construction, the oddest being groyne 6, which has three types of construction and, in part, is reinforced by the outfall of the River Mund. The groynes are generally in fair to good condition with the seaward ends generally requiring attention.

All of the promenades and retaining walls are generally in good condition. The exceptions to this are the retaining walls in Sections 4, 5, and 6, which are quite old and heavily damaged by cracking.

7.3 Observations

7.2.3 Defence Length TRI 6.01

Location:	**Mundesley**		
Start / Finish NG Co-ordinates			**Survey Date:** 14/01/03
	Start	**Finish**	
Easting:	630474	630973	
Northing:	337499	337130	
Length:	620m		
Management Unit:	TRI 6		**Defence Length Reference:** 6.01

Description of Defences and Beach

Timber revetment contiguous with TRI 5.02

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Revetment forward of the cliff. The rear of the revetment is a mixture of beach and talus. Seaward the beach is sandy controlled by groynes. Moderate amenity value

Control Structures

Groynes 12 –14 (W2 – W4)

Conditions and Performance of Backshore Defences

Type: Timber revetment **Built:** 1967 **Refurbished:**

Description: Some planks missing M11

Defence Condition Rating: fair

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

High cliffs, residential.

Cause and Consequence of Failure

Likely Failure Mechanism: Low beach causing instability of the steel pile toe. Cliff failures damaging both the timber and steel components of the structure

Consequence of Failure: Loss of residential property

Photograph Log

Ref. No.	Description of View
M3	General view of revetment
M5	Ditto
M6	Ditto
M7	Groyne I1
M11	Revetment showing missing panels.

Plate 7.1 Photo M11 Revetment showing missing panels

7.2.3 Defence Length TRI 6.02

Location:	**Mundesley**	
Start / Finish NG Co-ordinates		**Survey Date:** 14/01/03
	Start / **Finish**	
Easting:	630973 / 631320	
Northing:	337130 / 336850	
Length:	446m	
Management Unit:	TRI 6	**Defence Length Reference:** 6.02

Description of Defences and Beach

Concrete block revetment at the base of the cliff

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Moderate amenity beach levels partially controlled by groynes

Control Structures

Groynes 15 – 17 (W1, 1 – 2)

Conditions and Performance of Backshore Defences

Type: Concrete block revetment **Built:** 1955 **Refurbished:**

Description: Steel supports & rock fill beginning to suffer

Defence Condition Rating: Fair

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

High cliffs, residential

Cause and Consequence of Failure

Likely Failure Mechanism: Corrosion of steelwork, displacement of structure following a cliff failure

Consequence of Failure: Loss of residential property

Photograph Log

Ref. No.	Description of View
M1	Groyne I5
M2	Blockwork revetment
M12	Groyne I6
M13	Blockwork revetment.
M14	Blockwork revetment.
M15	Blockwork revetment.

Plate 7.2 Photo M12 Groyne I6

Plate 7.3 Photo M14 Blockwork revetment

7.2.3 Defence Length TRI 6.03

This defence length has been divided into sub-lengths as based on marked changes in condition grade and/or defence type. Where possible, information in the following tables has not been duplicated but is rather referenced back to the western-most sub-lengths 6.03.1 or 6.03.2.

Location:	**Mundesley**	
Start / Finish NG Co-ordinates		**Survey Date:** June 2002
	Start / **Finish**	
Easting:	631115 / 631183	
Northing:	336782 / 336775	
Length:	69m	
Management Unit:	TRI 6	**Defence Length Reference:** 6.03.1

Description of Defences and Beach

The western end of the sea wall is in this section. The sea wall carries on from a low rubble armour revetment which runs to the western end of the section. There are also two groynes in this section. The sea wall is topped by a promenade.

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is good. It is safe for pedestrians and where indicated for vehicles as well. The concrete retaining wall is in good condition.

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Predominantly sandy beach which tends to be relatively stable.

Control Structures

Groyne 3 is a permeable hardwood timber groyne approximately 70m in length. It is unusual in that the seaward end is offset by 2m following reconstruction. The groyne was built using 250mm x 250mm piles, 225mm x 100mm walings and 225mm x 100mm vertical timber sheet piles. The timbers of the seaward end show a severe loss of section with several elements missing. The navigation beacon is also missing. The defence condition rating for the seaward end is assessed to be poor.

The rest of the groyne, protected by the normally high beach levels, shows only a slight loss of section with little or no movement of joints. The defence condition rating for the rest of the groyne is good.

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1880 **Refurbished:** 1950

Description: This section forms the western limit of the concrete seawalls protecting Mundesley. Its design and form suggest that it is of a later construction than the majority of the seawalls in Mundesley even though it was built in the fifties. The packing or sealant to the joints has been eroded and there are minor patches of efflorescence. High beach levels and access difficulties prevented inspection of the apron and steel piles. The initial assessment of the defence condition rating is that it is good. The stem of the wall is however rather slim for a mass concrete wall. Stability calculations show that it can resist overturning but its ability to resist sliding under serviceability limit conditions is poor. On review, the defence condition rating has been revised to that of poor.

Steel Pile Embedded Walls

The original Mobbs and English drawings for Mundesley's defences indicate that the apron and

embedded steel pile walls are similar in design for the entire frontage except for those in Section 9. The trial holes dug at in front of the piles tends to substantiate this. The piles are rarely exposed for any length of time because of the high beach levels. Hence there is little corrosion about the tie bar fixings. The analysis of the stability of these embedded walls shows that the typical critical beach level is, for the serviceability limit state, 1.8m below the top of the pile. (Approximately 0.8m AOD) All of the piles are in good condition.

The embedded wall in Section 9 was built in the late 1970's. The limit state safe beach level is only 0.75m below pile top. (0.78m AOD) The residual life of this embedded wall is 45 years.

Defence Condition Rating: Poor

Updates to CPSE (1997): Unknown

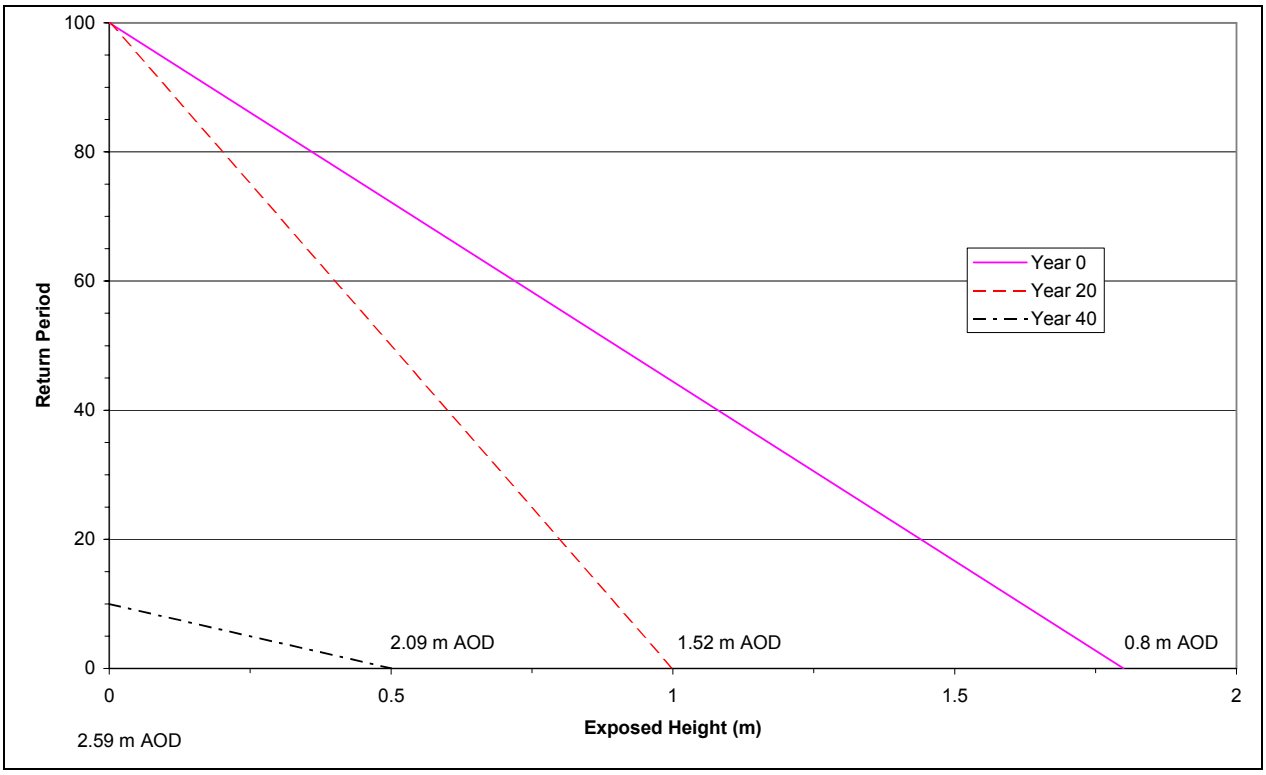
Description of Hinterland and Development

Urban, residential and tourism related commercial property.

Cause and Consequence of Failure

Likely Failure Mechanism: The original design life of the piles was 85 years. As most of them were placed in the fifties, the residual life of the piles is 40 years approximately. (The permissible loss of section of these piles is 6.1mm. On the basis of 0.09mm per year, the likely loss of section is 4.14mm to date.). It seems more likely that as the stem of the wall is rather slim for a mass concrete wall the most likely cause of failure is the collapse of the wall. Stability calculations show that it can resist overturning but its ability to resist sliding under serviceability limit conditions is poor.

Consequence of Failure: Loss of substantial commercial property and residential property. Increased sediment supply.



Fragility curve for Defence Length 6.03.1

Photograph Log	
Ref. No.	**Description of View**
MP40	View along Sea Wall
MP41	View along Sea Wall
MP42	Construction Joint in Sea Wall
MP43	Western termination of Sea Wall
MP44	Steps in Rubble Armour
MP45	Promenade along top of Sea Wall
MP46	Rubble Armour
MP47	End of Groyne 3
MP48	Close up of end of Groyne 3
MP49	Side view of end of Groyne 3
MP50	Close up of Groyne 3
MP51	Close up of Groyne 3
MP75	View of Groyne 3
MP76	Close up of Groyne 3
MP77	View of Groyne 3
MP78	Close up of Groyne 3
MP79	Close up of Groyne 3
MP80	View of Groyne 3
MP92	End of Groyne 2
MP93	Junction of Groyne 2 and Rubble Armour
MP94	Junction of Groyne 2 and Rubble Armour
MP95	End of Groyne 2
MP96	Close up of Groyne 2

Plate 7.4 Photo MP43 Western termination of Sea Wall

Plate 7.5 Photo MP96 Close up of Groyne 2

Plate 7.6 Photo MP80 View of Groyne 3

Location:	Mundesley		
Start / Finish NG Co-ordinates			**Survey Date:** June 2002
	Start	**Finish**	
Easting:	631183	631220	
Northing:	336775	336768	
Length:	38m		
Management Unit:	TRI 6		**Defence Length Reference:** 6.03.2

Description of Defences and Beach

The base of the cliffs is protected by a sea wall that runs for the entire length of the section. There is a promenade, which runs along the top of the sea wall. There are no groynes or other control structures in this section. A set of steps descends to the beach at the western edge of this section.

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is good. It is safe for pedestrians and where indicated for vehicles as well. The concrete retaining wall is in good condition.

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

As for Defence Length 6.03.1.

Control Structures

None

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1910 **Refurbished:** N/A

Description: The seawalls in Sections 2 and 3 have the same profile and were built to the same design. However, by inspection it is clear that differing qualities of finish were achieved. The construction joints are evident and there are some minor cracks. The initial defence condition rating was assessed as good.

The defence condition rating of the apron concrete is good and that of the steel piles is very good.

Defence Condition Rating: Very Good

Updates to CPSE (1997): Unknown

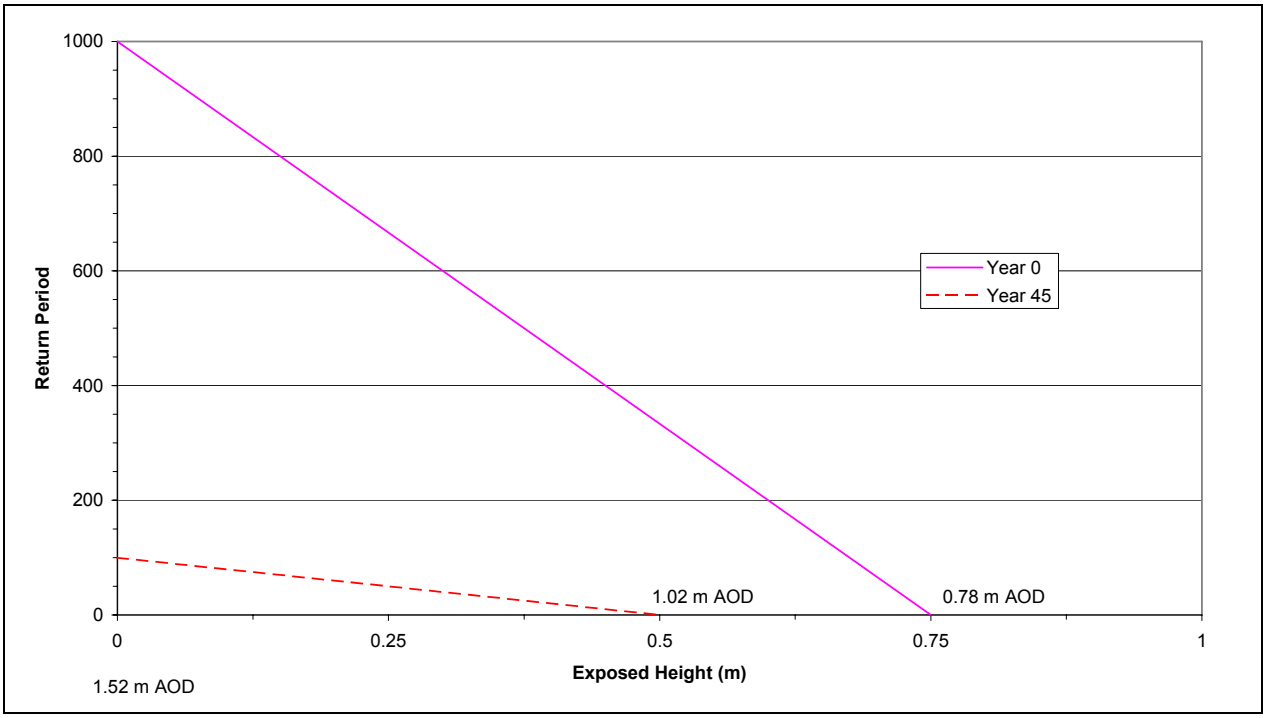
Description of Hinterland and Development

As for Defence Length 6.03.1.

Cause and Consequence of Failure

Likely Failure Mechanism: Ultimate and serviceability limit state calculations show that the sea wall could fail by sliding if there was excess hydrostatic pressure behind the wall. The calculations also show that the stability of the wall is otherwise dependant on the stability of the apron and steel piles.

Consequence of Failure: Loss of property. Increased sediment supply



Fragility curve for Defence Length 6.03.2

Photograph Log	
Ref. No.	**Description of View**
MP36	View of Sea Wall
MP37	Close up of crack in the Sea Wall
MP38	View of Sea Wall
MP39	View of Sea Wall

Plate 7.7 Photo MP39 View of Sea Wall

Location:	Mundesley		
Start / Finish NG Co-ordinates			**Survey Date:** June 2002
	Start	**Finish**	
Easting:	631220	631384	
Northing:	336768	336740	
Length:	117m		
Management Unit:	TRI 6		**Defence Length Reference:** 6.03.3

Description of Defences and Beach

The base of the cliffs is protected by a sea wall which runs for the entire length of the section. There is a promenade which runs along the top of the sea wall. There are no groynes or other control structures in this section.

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is good. It is safe for pedestrians and where indicated for vehicles as well. The concrete retaining wall is in good condition.

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

As for Defence Length 6.03.1.

Control Structures

None

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1910 **Refurbished:** N/A

Description: The condition of the wall in this section is only slightly worse than that in Section 2, with construction joints being more evident. Otherwise the comments are as in Section 2.

Defence Condition Rating: Very Good

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

As for Defence Length 6.03.1.

Cause and Consequence of Failure

Likely Failure Mechanism: This section of the sea wall is to be considered identical to the sea wall in section 2

Consequence of Failure: Loss of public open space and commercial property. In the nedium term closure of the coast road.

Fragility curve – as for Defence Length 6.03.2

Photograph Log

Ref. No.	Description of View
MP27	View of Sea Wall
MP28	Promenade along top of Sea Wall
MP29	View of Sea Wall
MP30	View of Sea Wall
MP31	View of Sea Wall

MP32	Close up of crack in Sea Wall
MP33	View of Ramp in Sea Wall
MP34	Promenade along top of Sea Wall
MP35	Promenade along top of Sea Wall

Plate 7.8 Photo MP30 View of Sea Wall

Plate 7.9 Photo MP35 Promenade along top of Sea Wall

Location:	Mundesley	
Start / Finish NG Co-ordinates		**Survey Date:** June 2002
	Start / **Finish**	
Easting:	631384 / 631433	
Northing:	336740 / 336738	
Length:	48m	
Management Unit:	TRI 6	**Defence Length Reference:** 6.03.4

Description of Defences and Beach

The base of the cliffs is protected by a sea wall that runs for the entire length of the section. There is a promenade, which runs along the top of the sea wall. There is a timber groyne at the western end of this section. A wide set of steps descends to the beach at the eastern end of this section.

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is good. It is safe for pedestrians and where indicated for vehicles as well. The retaining wall exhibits the same characteristics as the seawall in front of it. There are extensive cracks, some quite old, and there is evidence of slight movement in the past. The retaining walls this section is rated as poor

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

As for Defence Length 6.03.1.

Control Structures

This timber groyne has a permeable seaward end, built to the same design as groyne 4, whilst the inshore length is impermeable built using closely fixed 225mm x 100mm timber sheets. The piles in the inshore end also have diagonal bracing on both sides. The timbers at the seaward end show a significant loss of section whereas the timbers in the impermeable section show only a slight loss of section. The bracing to the piles in the impermeable inshore section have suffered a severe loss of section, worn right through in places. The defence condition of the seaward end is rated to be fair. The rest of the groyne, the impermeable length, is rated to be good.

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1880 **Refurbished:** N/A

Description: This section is located immediately east of groyne 3. It is a section of sea wall that has been rendered in the past. The rendering has failed revealing the original wall. There are very large cracks in the wall, some associated with construction joints but others running diagonally down the wall. There is also a suggestion of minor movement in the past. The retaining wall to the rear of the promenade is similarly distressed. Although protected by a high beach, the cracks are likely to affect the structural integrity of the seawall. The defence condition rating for this stretch is assessed to be poor.

Defence Condition Rating: Poor

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

As for Defence Length 6.03.1.

Cause and Consequence of Failure

Likely Failure Mechanism: Structural failure of the seawall acting as a retaining wall

Consequence of Failure: Limited property damage

Fragility curve – as for Defence Length 6.03.1.

Photograph Log	
Ref. No.	**Description of View**
MP21	View of Sea Wall
MP22	Steps leading down from the Sea Wall
MP23	Close up of cracks in the Sea Wall
MP24	View of the rough surface of the Sea Wall
MP25	Junction of Groyne 4 and the Sea Wall
MP26	Promenade along top of Sea Wall
MP67	End of Groyne 4
MP68	View of Groyne 4
MP81	End of Groyne 4
MP82	End of Groyne 4
MP83	Close up of Groyne 4
MP84	Close up of Groyne 4
MP85	Close up of Groyne 4
MP86	View of Groyne 4
MP87	Close up of Groyne 4
MP88	Close up of Groyne 4
MP89	Close up of Groyne 4
MP90	Close up of Groyne 4
MP91	End of Groyne 4

Plate 7.10 Photo MP22 Steps leading down from the Sea Wall

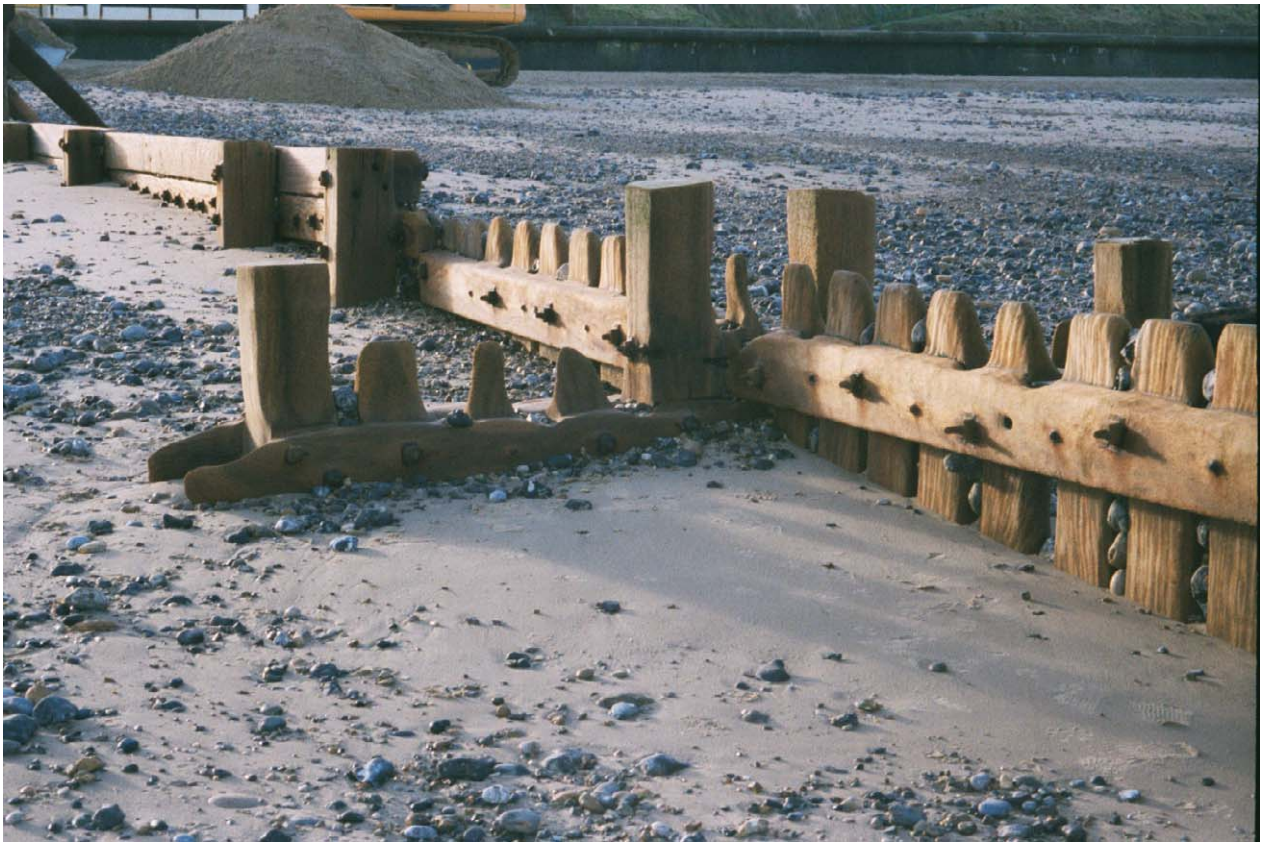


Plate 7.11 Photo MP84 Close up of Groyne 4

Location:	Mundesley		
Start / Finish NG Co-ordinates			**Survey Date:** June 2002
	Start	**Finish**	
Easting:	631433	631490	
Northing:	336738	336725	
Length:	41m		
Management Unit:	TRI 6		**Defence Length Reference:** 6.03.5

Description of Defences and Beach

The base of the cliffs is protected by a sea wall that runs for the entire length of the section. There is a promenade, which runs along the top of the sea wall. There are no groynes or other control structures in this section.

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is good. It is safe for pedestrians and where indicated for vehicles as well. The retaining wall exhibits the same characteristics as the seawall in front of it. There are extensive cracks, some quite old, and there is evidence of slight movement in the past. The retaining walls this section is rated as poor

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

As for Defence Length 6.03.1.

Control Structures

None

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1880 **Refurbished:** N/A

Description: This section of seawall has been rendered in the past. The surface cracking seems to reflect the likely pattern of cracking of the original wall. Whilst the render is intact it is protecting the wall from deterioration similar to that in Section 4. The defence condition rating for this section is therefore fair.

Defence Condition Rating: Fair

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

As for Defence Length 6.03.1.

Cause and Consequence of Failure

Likely Failure Mechanism: Structural failure of the seawall acting as a retaining wall

Consequence of Failure: Limited property damage

Fragility curve – as for Defence Length 6.03.1

Photograph Log

Ref. No.	Description of View
MP17	Corner of Sea Wall
MP18	View of Sea Wall
MP19	Close up of cracks in the Sea Wall

MP20	Promenade along top of Sea Wall

Plate 7.12 Photo MP17 Corner of Sea Wall

Location:	Mundesley		
Start / Finish NG Co-ordinates			**Survey Date:** June 2002
	Start	**Finish**	
Easting:	631490	631497	
Northing:	336725	336728	
Length:	20m		
Management Unit:	TRI 6		**Defence Length Reference:** 6.03.6

Description of Defences and Beach

The base of the cliffs is protected by a sea wall that runs for the entire length of the section, at the end of the section there is a gap in the sea wall where a ramp descends down to the beach. There is a promenade, which runs along the top of the sea wall. There are no groynes or other control structures in this section.

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is good. It is safe for pedestrians and where indicated for vehicles as well. The retaining wall exhibits the same characteristics as the seawall in front of it. There are extensive cracks, some quite old, and there is evidence of slight movement in the past. The retaining walls this section is rated as poor

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

As for Defence Length 6.03.1.

Control Structures

None

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1880 **Refurbished:** N/A

Description: This section of wall may be of the same type of construction as that in Section 5. The very extensive and large cracks indicate defects that are likely to affect its structural integrity. Hence the defence condition rating is assessed to be poor.

Defence Condition Rating: Poor

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

As for Defence Length 6.03.1.

Cause and Consequence of Failure

Likely Failure Mechanism: Structural failure of the seawall acting as a retaining wall

Consequence of Failure: property damage in oldest part of Mundesley

Fragility curve As for Defence Length 6.03.1

Photograph Log

Ref. No.	Description of View
MP13	Promenade along top of Sea Wall
MP14	Cracks in the Sea Wall next to an access ramp
MP15	Close up of cracks in the Sea Wall

MP16	Close up of Cracks in the Sea Wall

Plate 7.13 Photo MP14 Cracks in the Sea Wall next to an access ramp

Location:	Mundesley	
Start / Finish NG Co-ordinates		**Survey Date:** June 2002
	Start	**Finish**
Easting:	631497	631518
Northing:	336728	336728
Length:	20m	
Management Unit:	TRI 6	**Defence Length Reference:** 6.03.7

Description of Defences and Beach

The base of the cliffs is protected by a sea wall that runs between two ramps which descend to the beach at either end of the section. There is a promenade, which runs along the top of the sea wall. There are no groynes or other control structures in this section.

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is good. It is safe for pedestrians and where indicated for vehicles as well. The concrete retaining wall is in good condition.

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

As for Defence Length 6.03.1.

Control Structures

None

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1880 **Refurbished:** N/A

Description: This is a short length of seawall whose deck is almost inaccessible to pedestrians. There are few defects other than loss of joint sealant/packing except for some vertical cracking at the north west corner. There is no corresponding displacement of the coping of the wall. This section of wall is in good condition.

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

As for Defence Length 6.03.1.

Cause and Consequence of Failure

Likely Failure Mechanism: Structural failure of the seawall acting as a retaining wall

Consequence of Failure: property damage in oldest part of Mundesley

Fragility curve – as for Defence Length 6.03.2

Photograph Log

Ref. No.	Description of View
MP9	Corner of Sea Wall
MP10	Close up of Sea Wall
MP11	Corner of Sea Wall
MP12	Promenade along top of Sea Wall

Plate 7.14 Photo MP9 Corner of Sea Wall

Location:	Mundesley		
Start / Finish NG Co-ordinates			**Survey Date:** June 2002
	Start	**Finish**	
Easting:	631527	631543	
Northing:	336727	336727	
Length:	17m		
Management Unit:	TRI 6		**Defence Length Reference:** 6.03.8

Description of Defences and Beach

The base of the cliffs is protected by a sea wall that runs from the ramp at the western end of the section all the way to a set of steps that descend to the beach at the eastern end of the section. There is a promenade, which runs along the top of the sea wall. There are no groynes or other control structures in this section.

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is good. It is safe for pedestrians and where indicated for vehicles as well. The concrete retaining wall is in good condition.

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

As for Defence Length 6.03.1.

Control Structures

None

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1880 **Refurbished:** N/A

Description: This length of wall once protected Mundesley's sewer outfall storage tanks. The layers of the construction joints can be seen clearly but there are no significant defects. Hence its defence condition rating has been assessed to be good.

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

As for Defence Length 6.03.1.

Cause and Consequence of Failure

Likely Failure Mechanism: Structural failure of the seawall acting as a retaining wall

Consequence of Failure: property damage in oldest part of Mundesley**.** Potential loss of sewerage infrastructure

Fragility curve – as for Defence Length 6.03.2

Photograph Log

Ref. No.	Description of View
MP6	Steps in Sea Wall
MP7	Corner of Sea Wall
MP8	Corner of Sea Wall

MP8a	Promenade along top of Sea Wall

Plate 7.15 Photo MP6 Steps in Sea Wall

Location:	Mundesley		
Start / Finish NG Co-ordinates			**Survey Date:** June 2002
	Start	**Finish**	
Easting:	631543	631632	
Northing:	336727	336701	
Length:	93m		
Management Unit:	TRI 6		**Defence Length Reference:** 6.03.9

Description of Defences and Beach

The base of the cliffs is protected by a sea wall that runs from the western end of the section up to a ramp for pedestrian and vehicular access to the beach. To the east of the ramp there is a wooden revetment which protects the base of the cliff. There is a promenade, which runs along the top of the sea wall. There are two timber groynes in this section, groyne 6 and groyne 7.

The Defence Condition Rating of the Promenade that runs along the top of the sea wall is good. It is safe for pedestrians and where indicated for vehicles as well. The concrete retaining wall is in good condition.

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

As for Defence Length 6.03.1.

Control Structures

Groyne 6 is unusual in that on the eastern side, it has the reinforced concrete outfall for the River Mund built immediately next to it and over some of the pile frames. The outfall structure now acts partially as the groyne with the timber components of the groyne, alongside the concrete being in poor condition although the crest is higher than the outfall. However, the groyne crest rises well above the outfall at the inshore end. The outfall also stops 30m short of the end of the groyne.

Groyne 6, seaward of the outfall consists of three types of construction. There is a short length of impermeable groyne built using 225mm x 100mm timber sheet piles. There is then a length of permeable groyne and the seaward end consists of steel sheet piles. Taken as a whole, the seaward end timbers suffer from a slight loss of section whereas the steel piles are very badly corroded and holed. The seaward end is rated to be poor. At the inshore end the timber structure is in fair condition. That portion of the groyne that runs alongside of the outfall is in poor condition.

Groyne 7 is a permeable groyne whose root is now 25.5m out from the seawall. There is only a slight loss of section in the timbers. Therefore its defence condition is rated as good.

Conditions and Performance of Backshore Defences

Type: Sea Wall **Built:** 1880 **Refurbished:** 1970

Description: The wall in Section 9 is more modern in construction relative to the rest of Mundesley's defences having been built in the late seventies. The only defect is that the sealant to the joints needs to be renewed. The wall has a stepped apron fronted by steel piles. The wall was built over an old derelict timber revetment that was left in place. The condition of the wall is very good, as is the condition of the piles and apron concrete.

Defence Condition Rating: Very Good

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

As for Defence Length 6.03.1.

Cause and Consequence of Failure

Likely Failure Mechanism: Structural failure of the seawall acting as a retaining wall following excessive surcharge and/or cliff failure

Consequence of Failure: property damage in oldest part of Mundesley**.** Loss of the sewerage outfall headworks and pumping station. Loss of the long sea treated effluent outfall

Fragility curve – as for Defence Length 6.03.2

Photograph Log	
Ref. No.	**Description of View**
MP1	Access ramp to beach and promenade
MP2	Promenade along top of Sea Wall
MP3	View of Sea Wall
MP4	Close up of Sea Wall
MP5	View of sea Wall
MP60	End of Groyne 7
MP61	Close up of end of Groyne 7
MP62	View of Sea Wall
MP63	Close up of Apron at base of Sea Wall
MP64	Close up of Sea Wall
MP65	Junction of Groyne 6 and the Sea Wall
MP66	View of Groyne 6
MP69	End of Groyne 6
MP70	End of Groyne 6
MP71	View of Groyne 6
MP72	View of Groyne 6
MP72a	View of Groyne 6
MP73	View of Groyne 6
MP74	Close up of Groyne 6

Plate 7.16 Photo MP1 Access ramp to beach and promenade

Plate 7.17 Photo MP66 View of Groyne 6

Plate 7.18 Photo MP61 Close up of end of Groyne 7

7.2.3 Defence Length TRI 6.04

Location:	**Mundesley**	
Start / Finish NG Co-ordinates		**Survey Date:** 15/01/03
	Start / **Finish**	
Easting:	631711.4 / 631813.6	
Northing:	336486.1 / 336357.8	
Length:	164m	
Management Unit:	TRI 6	**Defence Length Reference:** 6.04

Description of Defences and Beach

Timber revetment, east of Mundesley sea walls. Includes the boat park at the base of the access road, behind the revetment. Contiguous with BAC 1.01. Reinforced concrete boat park on steel sheet pile foundation at the base of the cliff.

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Timber revetment forward of the cliffs. Stable beach with dune building at the rear of the revetment. High amenity value given its proximity to the centre of Mundesley and the private access ramp

Control Structures

Groynes: I12 (8)

Conditions and Performance of Backshore Defences

Type: Timber revetment **Built:** 1958 & 1964 **Refurbished:**

Description: Some splitting verticals around bolt holes but less deterioration than previous

Defence Condition Rating: Revetment – Fair. Boat park - good

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

Residential on moderately high cliffs. Boat park at base of cliff

Cause and Consequence of Failure

Likely Failure Mechanism: Low beach-causing instability of the structure. Loose joints in timber components. Damage due to cliff failure.

Consequence of Failure: Accelerated cliff erosion leading to the loss of residential property. The boat park is not at risk. Damage/disruption to the access road serving the pumping station and RNLI facilities located in TRI 6.3

Photograph Log

Ref. No.	Description of View
M17	Groyne I11
M18	Revetment
M20	General view

Plate 7.19 Photo M20 General view

7.2.3 Groynes in TRI 6

Management Unit	TRI 6		Location: Groyne No. W 5
Start / Finish NG Co-ordinates			**Survey Date:** 14/01/03
	Root		
Easting:	630465	630496	
Northing:	337506	337568	
Length:	67m		
Management Unit:	TRI 6		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1967		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Beacon complete, outfall groyne			

Management Unit	TRI 6		Location: Groyne No. W 4
Start / Finish NG Co-ordinates			**Survey Date:** 14/01/03
	Root		
Easting:	630608	630638	
Northing:	337413	337469	
Length:	67m		
Management Unit:	TRI 6		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1967		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Some planks missing			

Management Unit	TRI 6		Location: Groyne No. W 3
Start / Finish NG Co-ordinates			**Survey Date:** 14/01/03
	Root		
Easting:	630747	630786	
Northing:	337313	337372	
Length:	67m		
Management Unit:	TRI 6		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1967		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Beacon top missing			

Management Unit	TRI 6	Location: Groyne No. W 2
Start / Finish NG Co-ordinates		**Survey Date:** 14/01/03
	Root	
Easting:	630887 630917	
Northing:	337217 337272	
Length:	67m	
Management Unit:	TRI 6	**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber **Built:** 1967 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete

Management Unit	TRI 6	Location: Groyne No. W 1
Start / Finish NG Co-ordinates		**Survey Date:** 14/01/03
	Root	
Easting:	631014 631048	
Northing:	337104 337157	
Length:	67m	
Management Unit:	TRI 6	**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber **Built:** 1967 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon head missing, otherwise complete

Management Unit	TRI 6	Location: Groyne No. 1
Start / Finish NG Co-ordinates		**Survey Date:** 14/01/03
	Root	
Easting:	631145 631179	
Northing:	336996 337041	
Length:	63m	
Management Unit:	TRI 6	**Defence Length Reference:** 02

Conditions and Performance of Groyne

Type: Timber **Built:** 1988 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete

Management Unit	TRI 6	Location: Groyne No. 2
Start / Finish NG Co-ordinates		**Survey Date:** 14/01/03
	Root	
Easting:	631279 631307	
Northing:	336889 336932	
Length:	60m	
Management Unit:	TRI 6	**Defence Length Reference:** 02
Conditions and Performance of Groyne		
Type: Timber	**Built:** 1964	**Refurbished:** 1988
Defence Condition Rating: Good		
Updates to CPSE (1997):	Unknown	
Comment: Beacon head poor		

Management Unit	TRI 6	Location: Groyne No. 3
Start / Finish NG Co-ordinates		**Survey Date:** 14/01/03
	Root	
Easting:	631379 631409	
Northing:	336813 336866	
Length:	62m	
Management Unit:	TRI 6	**Defence Length Reference:** 02
Conditions and Performance of Groyne		
Type: Timber	**Built:** 1970	**Refurbished:**
Defence Condition Rating: Good		
Updates to CPSE (1997):	Unknown	
Comment: No beacon		

Management Unit	TRI 6	Location: Groyne No. 4
Start / Finish NG Co-ordinates		**Survey Date:** 14/01/03
	Root	
Easting:	631524 631560	
Northing:	336677 336713	
Length:	70m	
Management Unit:	TRI 6	**Defence Length Reference:** 03
Conditions and Performance of Groyne		
Type: Timber	**Built:** c. 1930	**Refurbished:**
Defence Condition Rating: Good		
Updates to CPSE (1997):	Unknown	
Comment: Beacon complete – SSP heads showing corrosion		

Management Unit	TRI 6	Location: Groyne No. 6
Start / Finish NG Co-ordinates		**Survey Date:** 15/01/03
	Root	
Easting:	631656 631703	
Northing:	336577 336642	
Length:	93m	
Management Unit: TRI 6		**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Composite **Built:** 1935 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete – various forms of construction – outfall built into groyne – tatty appearance

Management Unit	TRI 6	Location: Groyne No. 7
Start / Finish NG Co-ordinates		**Survey Date:** 15/01/03
	Root	
Easting:	631718 631751	
Northing:	336499 336546	
Length:	46m	
Management Unit: TRI 6		**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber **Built:** 1964 **Refurbished:** 1988

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete

Management Unit	TRI 6	Location: Groyne No. 8
Start / Finish NG Co-ordinates		**Survey Date:** 14/01/03
	Root	
Easting:	631791 631826	
Northing:	336403 336449	
Length:	65m	
Management Unit: TRI 6		**Defence Length Reference:** 04

Conditions and Performance of Groyne

Type: Timber **Built:** 1964 **Refurbished:** 1988

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete

8. BAC 1 – MUNDESLEY TO BACTON CONDITION SURVEY

8.1 History

Historical Ordnance Survey plans show that there were no defences built along this frontage until 1964 to 1966. In 1964, work began on a timber revetment and groyne field that was to become contiguous with Mundesley TRI 6) and Bacton (BAC2)

8.2 Summary

The timber revetment was assessed to be in fair condition whilst the groynes are generally in good condition but with works required to the seaward ends.

8.3 Observations

8.2.3 Defence Length BAC 1.01

Location:	**Mundesley to Bacton**	
Start / Finish NG Co-ordinates		**Survey Date:** 15/01/03
	Start	**Finish**
Easting:	631813.6	632869
Northing:	336357.8	335376
Length:	1441m	
Management Unit: BAC 1		**Defence Length Reference:** 1.01

Description of Defences and Beach

Timber revetment Contiguous with TRI 6.04 and BAC 2.01

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Timber revetment forward of the cliffs. Stable beach with dune building at the rear of the revetment.

Control Structures

Groynes: J1 – J8 (9, 1 – 7)

Conditions and Performance of Backshore Defences

Type: Timber revetment **Built:** 1964/6 **Refurbished:**

Description: Inundated with sand

Defence Condition Rating: Fair

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

Predominantly agricultural, holiday camp on top of moderately high cliffs.

Cause and Consequence of Failure

Likely Failure Mechanism: Low beach-causing instability of the structure. Loose joints in timber components. Damage due to cliff failure.

Consequence of Failure: Increased erosion of the cliff. Loss of agricultural land and damage to a moderately sized holiday facility.

Photograph Log

Ref. No.	Description of View
M21	Groyne J 2, failed seaward end
M22	View of cliffs
M23	Groyne J 3
M24	Groyne J4
M25	Revetment
M26	Groyne J6
M27	Groyne J7

Plate 8.1 Photo M25 Revetment

Plate 8.2 Photo M23 Groyne J3

8.2.3 Groynes in BAC 1

Management Unit	BAC 1		Location: Groyne No. 9
Start / Finish NG Co-ordinates			**Survey Date:** 15/01/03
	Root		
Easting:	631864	631916	
Northing:	336301	336362	
Length:	65m		
Management Unit:	BAC 1		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber	**Built:** 1964		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Beacon missing – inundated with sand			

Management Unit	BAC 1		Location: Groyne No. 1
Start / Finish NG Co-ordinates			**Survey Date:** 15/01/03
	Root		
Easting:	631968	632014	
Northing:	336189	336265	
Length:	90m		
Management Unit:	BAC 1		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber SSP	**Built:** 1964		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Beacon complete			

Management Unit	BAC 1		Location: Groyne No. 2
Start / Finish NG Co-ordinates			**Survey Date:** 15/01/03
	Root		
Easting:	632092	632134	
Northing:	336071	336143	
Length:	90m		
Management Unit:	BAC 1		**Defence Length Reference:** 01
Conditions and Performance of Groyne			
Type: Timber SSP	**Built:** 1964		**Refurbished:**
Defence Condition Rating: Good			
Updates to CPSE (1997): Unknown			
Comment: Beacon complete – seaward end loss of horizontals			

Management Unit	BAC 1	Location: Groyne No. 3
Start / Finish NG Co-ordinates		**Survey Date:** 15/01/03
	Root	
Easting:	632229 632283	
Northing:	335946 336019	
Length:	90m	
Management Unit: BAC 1		**Defence Length Reference:** 01
Conditions and Performance of Groyne		
Type: Timber SSP	**Built:** 1966	**Refurbished:**
Defence Condition Rating: Good		
Updates to CPSE (1997): Unknown		
Comment: Beacon missing – as 2		

Management Unit	BAC 1	Location: Groyne No. 4
Start / Finish NG Co-ordinates		**Survey Date:** 15/01/03
	Root	
Easting:	632373 632428	
Northing:	335823 335892	
Length:	90m	
Management Unit: BAC 1		**Defence Length Reference:** 01
Conditions and Performance of Groyne		
Type: Timber SSP	**Built:** 1966	**Refurbished:**
Defence Condition Rating: Good		
Updates to CPSE (1997): Unknown		
Comment: Beacon complete – SSP heads showing corrosion		

Management Unit	BAC 1	Location: Groyne No. 5
Start / Finish NG Co-ordinates		**Survey Date:** 15/01/03
	Root	
Easting:	632541 632588	
Northing:	335672 335746	
Length:	90m	
Management Unit: BAC 1		**Defence Length Reference:** 01
Conditions and Performance of Groyne		
Type: Timber SSP	**Built:** 1966	**Refurbished:**
Defence Condition Rating: Good		
Updates to CPSE (1997): Unknown		
Comment: Beacon missing – SSP's slightly worse than 4		

Management Unit	BAC 1	Location: Groyne No. 6
Start / Finish NG Co-ordinates		**Survey Date:** 15/01/03
	Root	
Easting:	632710	632757
Northing:	335525	335596
Length:	90m	
Management Unit: BAC 1		**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1966 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete –apparently recently constructed buttressing

Management Unit	BAC 1	Location: Groyne No. 7
Start / Finish NG Co-ordinates		**Survey Date:** 15/01/03
	Root	
Easting:	632865	632921
Northing:	335383	335456
Length:	90m	
Management Unit: BAC 1		**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1966 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Outfall

9. BAC 2 – BACTON, WALCOTT AND OSTEND CONDITION SURVEY

9.1 History

In 1845 the parish of Bacton was described as a collection of hamlets from Bacton to Keswick. There is a long history of erosion along this frontage with references to "great encroachments" in 1836 and 1845 and the loss of the medieval church in Keswick after 1382. Despite the continuous history of erosion, defences were not built until 1954, when the seawall from Bacton to Keswick (Ostend) was constructed. This was later supplemented by the timber revetment built in 1964 to the west of the village of Bacton.

The community is now predominantly residential with a strong tourism input. The west of the frontage is dominated by the Bacton Gas Site, the landfall for most of the natural gas won from the North Sea gas fields. The gas site itself is of major economic importance to the nation.

9.2 Summary

The timber revetment fronting the gas site varies in condition from fair to good. Overall, it has been assessed to be in fair condition. This revetment has been reconstructed in small sections by the various gas pipeline operators as pipelines were brought ashore. Between the timber revetment and concrete seawall is a relatively short cliff base breastwork, part of which has been newly constructed using steel sheet piles. Protected by the timber revetment, the breastwork is in two parts, with the older section in very poor condition and the new, piled section in very good condition.

The seawall that runs from Bacton to Walcott can best be described by its components. While visual inspection of the steel pile toe indicates good condition with no signs of distress, this assessment has to be qualified to a degree. Original drawings show that there are no tie rods supporting the piles. Theoretically, calculations show that under service condition loading, the piles could fail by overturning. This qualification has to be tempered by the longevity and condition of the piles.

The apron to the wall has been assessed to be in fair condition overall. This is despite the extensive remedial works that have already been done raising the condition of those sections to good. The concrete revetment and wave wall has been assessed to be in fair condition overall with occasional poor elements. Almost all of the joints require attention and there are a number of panels exhibiting extensive spalling.

The timber groynes along the entire frontage are of permeable construction, generally dating from the 1970's and 1980's (when the original 1954 groynes were reconstructed). The groynes are all in good condition.

9.3 Observations

9.2.3 Defence length BAC 2.01

Location: Bacton	
Start / Finish NG Co-ordinates **Start** **Finish** **Easting:** 632869 633776 **Northing:** 335376 334585 **Length:** 1204m	**Survey Date:** 15/01/03
Management Unit: BAC 2	**Defence Length Reference:** 2.01
Description of Defences and Beach Timber revetment contiguous with BAC 1.01 **Defences maintained by:** North Norfolk District Council	
Condition and Performance of Beach Timber revetment forward of the cliffs. Stable beach with dune building at the rear of the revetment. **Control Structures** Groynes: GA, GB, K1 – K6 (8 – 13) Outfalls from the Gas site	
Conditions and Performance of Backshore Defences **Type:** Timber revetment **Built:** 1966 **Refurbished:** **Description:** Almost totally inundated with sand, in places only pile tops visible **Defence Condition Rating:** Ranging from fair to good, overall grade fair **Updates to CPSE (1997):** Unknown	
Description of Hinterland and Development Bacton Gas Site	

Cause and Consequence of Failure
Likely Failure Mechanism: Low beach-causing instability of the structure. Loose joints in timber components. Damage due to cliff failure, reducing in likelihood moving from west to east as cliff height lowers. **Consequence of Failure:** Increasing erosion of the cliff, damage to gas industry facilities generally but initially a threat of damage to the many shallow gas pipelines that come ashore here and are located across the beach and rise close to the cliff edge.

Photograph Log	
Ref. No.	**Description of View**
M28	Revetment
M29	Groyne J8
M30	Groyne 9A outfall
M31	Groyne k2
M32	Groyne K1

M33	Outfall
M34	Ditto
M35	General view
W1	General view
W2	General view
W3	General view
W4	General view
W6	Groyne K3
W7	Outfall adjacent to K5
W8	Groyne K6
W11	Outfall
W13	Groyne K4
W14	Outfall
W15	Groyne K2, failed seaward end
W16	Groyne K1

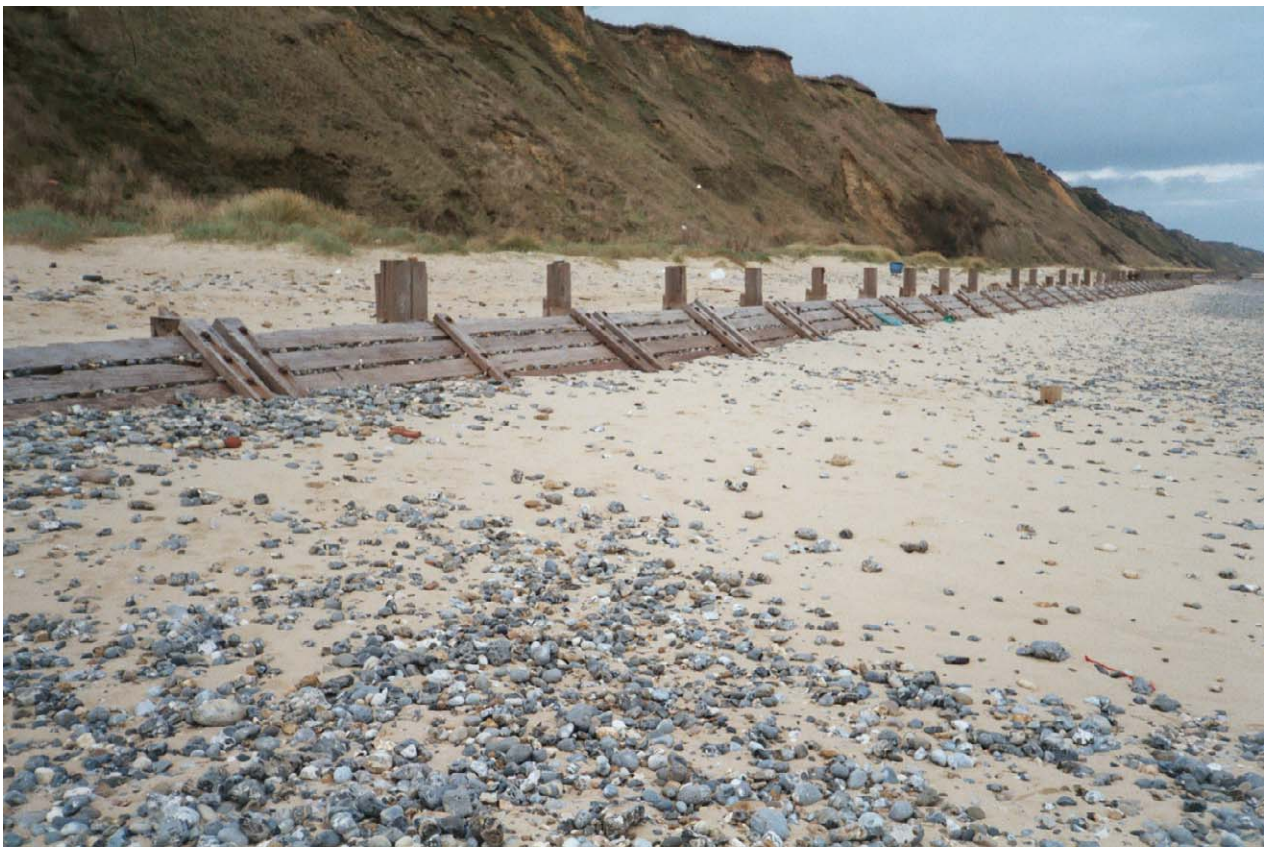


Plate 9.1 Photo M28 Revetment

Plate 9.2 Photo W1 General view

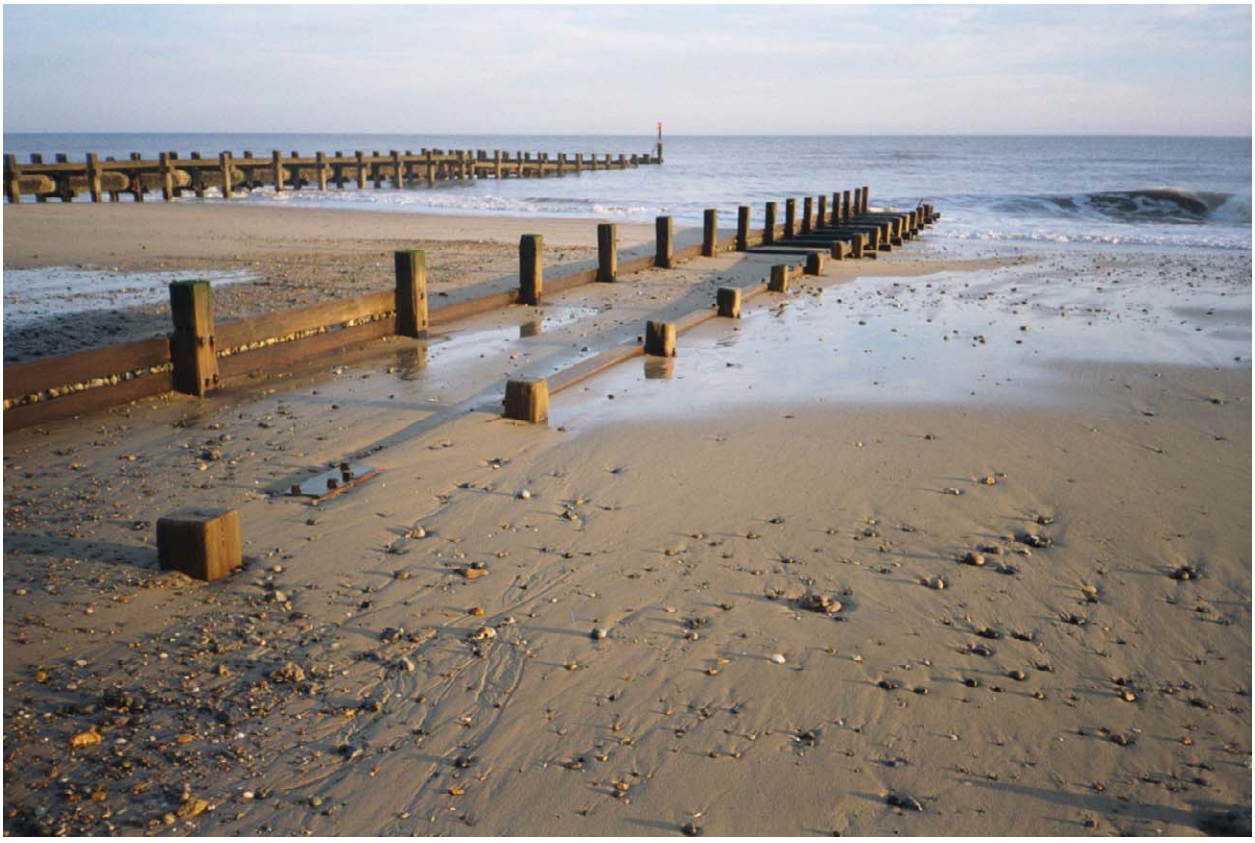


Plate 9.3 Photo W16 Groyne K1

9.2.3 Defence length BAC 2.02

Location:	**Bacton**	
Start / Finish NG Co-ordinates		**Survey Date:** 27/01/03
	Start / **Finish**	
Easting:	633776 / 633963	
Northing:	334585 / 334445	
Length:	233m	
Management Unit:	BAC 2	**Defence Length Reference:** 2.02

Description of Defences and Beach

Timber revetment, steel and concrete breastwork, timber breastwork

Defences maintained by: North Norfolk District Council. Breastwork may be in private ownership.

Condition and Performance of Beach

Volatile beach. High amenity value

Control Structures

Groynes: K7 –K8 (14 –15)

Conditions and Performance of Backshore Defences

Type: Timber revetment **Built:** 1966 **Refurbished:**

steel and concrete breastwork, timber breastwork at base of cliff.

Description:

Defence Condition Rating: Revetment – good. Steel pile breastwork – very good. Timber breastwork - poor

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

Low cliffs. Caravan site and residential property

Cause and Consequence of Failure

Likely Failure Mechanism: Low beach-causing instability of the structure. Loose joints in timber components. Steel pile ties to revetment failing.

Consequence of Failure: Loss of tourism facilities.

Photograph Log

Ref. No.	Description of View
W10	Groyne K7
W10A	Revetment and breastwork

Plate 9.4 Photo W10 Groyne K7

Plate 9.5 Photo W10A Revetment and breastwork

9.2.3 Defence length BAC 2.03

Location:	**Bacton**	
Start / Finish NG Co-ordinates		**Survey Date:** 27/01/03
	Start / **Finish**	
Easting:	633963 / 635348	
Northing:	334445 / 333322	
Length:	1783m	
Management Unit:	BAC 2	**Defence Length Reference:** 2.03

Description of Defences and Beach

Concrete seawall with apron and steel sheet pile toe contiguous with BAC 2.04

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Volatile beach, levels partially controlled by groynes. High amenity value.

Control Structures

Groynes: K9 – K21 (15 – 25)

Conditions and Performance of Backshore Defences

Type: Seawall **Built:** 1978 **Refurbished:**

Description: Seawall with a steel sheet pile toe, concrete apron, sloping concrete revetment wall topped by small wave wall.

Defence Condition Rating: Piles – good, Apron – fair, Revetment and wave wall – fair, occasionally poor.

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

Low cliff entirely protected by the seawall. Residential

Cause and Consequence of Failure

Likely Failure Mechanism: Steel pile failure due to low beach levels. Sloping apron failure resulting from undermining due to washout through weak joints and cracking along top edge.

Consequence of Failure: Property damage

Photograph Log

Ref. No.	Description of View
WB14	Groyne K 21
WB15	Seawall, sand covered
WB16	Ditto
WB17	Groyne K20
WB18	Seawall
WB19	Groyne K19
WB20	Groyne k18
WB21	Seawall
WB22	Ditto

WB23	Groyne K16
WB24	Groyne k15
WB25	Seawall
WB26	Groyne k14
WB27	Seawall
WB28	Groyne K13
WB29	Joints in seawall
WB30	Seawall
WB31	Groyne K11
WB32	Groyne K9
WB33	Seawall
WB34	Groyne K8
WB35	Junction of seawall and revetment
WB36	Seawall.

Plate 9.6 Photo WB17 Groyne K20

Plate 9.7 Photo WB18 Seawall

Plate 9.8 Photo WB36 Seawall

9.2.3 Defence length BAC 2.04

Location:	**Walcott**		
Start / Finish NG Co-ordinates			**Survey Date:** 28/01/03
	Start	**Finish**	
Easting:	635348	636003	
Northing:	333322	332894	
Length:	783m		
Management Unit:	BAC 2		**Defence Length Reference:** 2.04

Description of Defences and Beach

Concrete seawall with apron and steel sheet pile toe contiguous with BAC 2.03 and BAC 2.05

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Volatile beach, levels partially controlled by groynes. High amenity value.

Control Structures

Groynes: K22 – K26 (26 – 29)

Conditions and Performance of Backshore Defences

Type: Seawall **Built:** 1954 **Refurbished:**

Description: Seawall with a steel sheet pile toe, concrete apron, sloping concrete revetment wall topped by small wave wall.

Defence Condition Rating: Piles – good, Apron – fair, Revetment and wave wall – fair, occasionally poor.

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

Low cliff entirely protected by the seawall. Residential. Coast road immediately behind seawall

Cause and Consequence of Failure

Likely Failure Mechanism: Steel pile failure due to low beach levels. Sloping apron failure resulting from undermining due to washout through weak joints and cracking along top edge.

Consequence of Failure: Loss of residential and tourism facilities. Severe disruption to local communications if them coast road is damaged.

Photograph Log

Ref. No.	Description of View
WE7	Seawall
WE8	Groyne K25
WE9	Groyne K24
WE10	Seawall
WE11	Groyne K23
WE12	Seawall
WE13	Groyne K22
WE18	Groyne K26

XW3	Minor Spalling at Construction Joint in Sea Wall
XW4	View of Sea Wall and Ramp on to Beach
XW5	View of Sea Wall and Steps on to Beach
XW6	View of Groyne meeting Sea Wall
XW7	View of End of Groyne

Plate 9.9 Photo WE9 Groyne K24

Plate 9.10 Photo WE12 Seawall

Plate 9.11 Photo XW6 View of Groyne meeting Sea Wall

9.2.3 Defence length BAC 2.05

Location:	**Ostend**	
Start / Finish NG Co-ordinates		**Survey Date:** 28/01/03
	Start / **Finish**	
Easting:	636003 / 636476	
Northing:	332894 / 332584	
Length:	565m	
Management Unit:	BAC 2	**Defence Length Reference:** 2.05

Description of Defences and Beach

Concrete seawall with apron and steel sheet pile toe contiguous with BAC 2.04

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Volatile beach, levels partially controlled by groynes. High amenity value.

Control Structures

Permeable groynes: K27 – K29 (30 – 32)

Conditions and Performance of Backshore Defences

Type: Seawall **Built:** 1954 **Refurbished:**

Description: Seawall with a steel sheet pile toe, concrete apron, sloping concrete revetment wall topped by small wave wall.

Defence Condition Rating: Piles – good, Apron – fair, Revetment and wave wall – fair, occasionally poor.

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

Low cliff entirely protected by the seawall. Residential.

Cause and Consequence of Failure

Likely Failure Mechanism: Steel pile failure due to low beach levels. Sloping apron failure resulting from undermining due to washout through weak joints and cracking along top edge.

Consequence of Failure: Loss of residential property

Photograph Log

Ref. No.	Description of View
WE4	Seawall
WE5	Ditto
WE6	Ditto
WE19	Groyne K27
WE20	Groyne K28
XW1	Sloping Concrete Sea Wall with Exposed Sheet Pile Toe
XW2	Significant Spalling Damage to Sea Wall

Plate 9.12 Photo WE6 Seawall

Plate 9.13 Photo WE19 Groyne K27

Plate 9.14 Photo XW2 Significant Spalling Damage to Sea Wall

9.2.3 Defence length BAC 2.06

Location:	**Ostend**	
Start / Finish NG Co-ordinates		**Survey Date:** 28/01/03
	Start / **Finish**	
Easting:	636476 / 636918	
Northing:	332584 / 332294	
Length:	529m	
Management Unit:	BAC 2	**Defence Length Reference:** 2.06

Description of Defences and Beach

Timber revetment, end of seawall

Defences maintained by: North Norfolk District Council

Condition and Performance of Beach

Volatile beach, levels partially controlled by groynes. High amenity value.

Control Structures

Permeable groynes: K30 – K33 (33 – 36)

Conditions and Performance of Backshore Defences

Type: Timber revetment **Built:** 1961 **Refurbished:** 1994

Description: Being repaired at time of survey

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Description of Hinterland and Development

Holiday accommodation, residential tending towards rural/agricultural. This defence length includes the important Ostend Gap beach access ramp

Cause and Consequence of Failure

Likely Failure Mechanism: Storm damage to timber structure stemming from the narrowness of the gaps between planking. (Effectively a solid and highly reflective structure) The lack of a steel pile toe enables water to push up behind the revetment, lifting the planking.

Consequence of Failure: Loss of residential and holiday property

Photograph Log

Ref. No.	Description of View
WE1	Groyne K33
WE2	Revetment planks missing
WE3	Groyne L1
WE4	Seawall
WE5	Seawall
WE21	Groyne K30
WE22	Revetment, note stones clogging “permeable” structure
WE23	Revetment

WE24	Groyne k31
WE25	Revetment
WE26	Revetment

Plate 9.15 Photo WE3 Groyne L1

Plate 9.16 Photo WE22 Revetment, note stones clogging “permeable” structure

Plate 9.17 Photo WE26 Revetment

9.2.3 Groynes in BAC 2

Management Unit	BAC 2	Location: Outfall (Groyne No. 8)
Start / Finish NG Co-ordinates		**Survey Date:** 15/01/03
	Root	
Easting:	632997 633090	
Northing:	335262 335388	
Length:	156m	
Management Unit:	BAC 2	**Defence Length Reference:** 01
Conditions and Performance of Groyne		
Type: Timber & SSP	**Built:** 1966	**Refurbished:**
Defence Condition Rating: Good		
Updates to CPSE (1997):	Unknown	
Comment: Totally Inundated with sand		

Management Unit	BAC 2	Location: Groyne No. 8
Start / Finish NG Co-ordinates		**Survey Date:** 27/01/03
	Root	
Easting:	633020 633074	
Northing:	335241 335314	
Length:	90m	
Management Unit:	BAC 2	**Defence Length Reference:** 01
Conditions and Performance of Groyne		
Type: Timber SSP	**Built:** 1966	**Refurbished:**
Defence Condition Rating: Good		
Updates to CPSE (1997):	Unknown	
Comment: Very close to gas site outfall		

Management Unit	BAC 2	Location: Groyne No. 9
Start / Finish NG Co-ordinates		**Survey Date:** 27/01/03
	Root	
Easting:	633173 633224	
Northing:	335102 335171	
Length:	90m	
Management Unit:	BAC 2	**Defence Length Reference:** 01
Conditions and Performance of Groyne		
Type: Timber SSP	**Built:** 1966	**Refurbished:**
Defence Condition Rating: Good		
Updates to CPSE (1997):	Unknown	
Comment: Slight deterioration of seaward end		

Management Unit	BAC 2	Location: Outfall (Groyne No. 9A)
Start / Finish NG Co-ordinates		**Survey Date:** 27/01/03
	Root	
Easting:	633223 633310	
Northing:	335057 335173	
Length:	90m	
Management Unit:	BAC 2	**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1966 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Outfall to gas site

Management Unit	BAC 2	Location: Groyne No. 10
Start / Finish NG Co-ordinates		**Survey Date:** 27/01/03
	Root	
Easting:	633303 633352	
Northing:	334978 335051	
Length:	90m	
Management Unit:	BAC 2	**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1966 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No beacon

Management Unit	BAC 2	Location: Groyne No. 11
Start / Finish NG Co-ordinates		**Survey Date:** 27/01/03
	Root	
Easting:	633437 633490	
Northing:	334855 334925	
Length:	90m	
Management Unit:	BAC 2	**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1966 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Totally inundated with sand at landward end

Management Unit	BAC 2	Location: Outfall (Groyne No. 12)
Start / Finish NG Co-ordinates		**Survey Date:** 27/01/03
	Root	
Easting:	633571 633642	
Northing:	334745 334843	
Length:	121m	
Management Unit:	BAC 2	**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1964 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Outfall to gas site

Management Unit	BAC 2	Location: Groyne No. 12
Start / Finish NG Co-ordinates		**Survey Date:** 27/01/03
	Root	
Easting:	633579 633632	
Northing:	334740 334813	
Length:	90m	
Management Unit:	BAC 2	**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1966 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment:

Management Unit	BAC 2	Location: Groyne No. 13
Start / Finish NG Co-ordinates		**Survey Date:** 27/01/03
	Root	
Easting:	633723 633775	
Northing:	334633 334705	
Length:	90m	
Management Unit:	BAC 2	**Defence Length Reference:** 01

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1966 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No beacon - inundated with sand at landward end

Management Unit	BAC 2	Location: Groyne No. 14
Start / Finish NG Co-ordinates		**Survey Date:** 27/01/03
	Root	
Easting:	633866 633915	
Northing:	334521 334593	
Length:	90m	
Management Unit: BAC 2		**Defence Length Reference:** 02
Conditions and Performance of Groyne		
Type: Timber SSP	**Built:** 1966	**Refurbished:**
Defence Condition Rating: Good		
Updates to CPSE (1997): Unknown		
Comment: No beacon		

Management Unit	BAC 2	Location: Groyne No. 15
Start / Finish NG Co-ordinates		**Survey Date:** 27/01/03
	Root	
Easting:	633000 634039	
Northing:	334375 334445	
Length:	80m	
Management Unit: BAC 2		**Defence Length Reference:** 03
Conditions and Performance of Groyne		
Type: Timber SSP	**Built:** 1978	**Refurbished:**
Defence Condition Rating: Good		
Updates to CPSE (1997): Unknown		
Comment: Beacon complete		

Management Unit	BAC 2	Location: Groyne No. 16
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	634122 634160	
Northing:	334296 334365	
Length:	85m	
Management Unit: BAC 2		**Defence Length Reference:** 03
Conditions and Performance of Groyne		
Type: Timber SSP	**Built:** 1974	**Refurbished:** 1980's
Defence Condition Rating: Good		
Updates to CPSE (1997): Unknown		
Comment: Beacon complete		

Management Unit	BAC 2	Location: Groyne No. 16A
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	634188	634202
Northing:	334247	334272
Length:	30m	
Management Unit:	BAC 2	**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber **Built:** 1983 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No beacon

Management Unit	BAC 2	Location: Groyne No. 17
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	634253	634290
Northing:	334194	334261
Length:	84m	
Management Unit:	BAC 2	**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1974/6 **Refurbished:** 1983

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete

Management Unit	BAC 2	Location: Groyne No. 18
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	634376	634415
Northing:	334086	334086
Length:	84m	
Management Unit:	BAC 2	**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1974/6 **Refurbished:** 1983

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No beacon

Management Unit	BAC 2	Location: Groyne No. 19
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	634520 634553	
Northing:	333994 334052	
Length:	84m	
Management Unit: BAC 2		**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1974/6 **Refurbished:** 1983

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon gone

Management Unit	BAC 2	Location: Groyne No. 20
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	634653 634695	
Northing:	333890 333948	
Length:	85m	
Management Unit: BAC 2		**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1974 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete landward end inundated

Management Unit	BAC 2	Location: Groyne No. 21
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	634780 634818	
Northing:	334790 333852	
Length:	85m	
Management Unit: BAC 2		**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1974 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No beacon

Management Unit	BAC 2	Location: Groyne No. 22
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	634927	634964
Northing:	333685	333748
Length:	85m	
Management Unit:	BAC 2	**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber SSP ZZ **Built:** 1974 **Refurbished:** 1981/3

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete beginning to deteriorate

Management Unit	BAC 2	Location: Groyne No. 22A
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	634982	634989
Northing:	333650	333617
Length:	23m	
Management Unit:	BAC 2	**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber **Built:** 1984 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No Beacon

Management Unit	BAC 2	Location: Groyne No. 22B
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	635033	635056
Northing:	333613	333645
Length:	23m	
Management Unit:	BAC 2	**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber **Built:** 1984 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No Beacon

Management Unit	BAC 2	Location: Groyne No. 23
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	635080 635125	
Northing:	333569 333629	
Length:	80m	
Management Unit: BAC 2		**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1974 **Refurbished:** 1978/81

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon gone, end of groyne gone

Management Unit	BAC 2	Location: Groyne No. 24
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	635212 635255	
Northing:	333450 333513	
Length:	78m	
Management Unit: BAC 2		**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber SSP ZZ **Built:** 1974 **Refurbished:** 1981

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete

Management Unit	BAC 2	Location: Groyne No. 25
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	635344 635393	
Northing:	333325 333408	
Length:	100m	
Management Unit: BAC 2		**Defence Length Reference:** 03

Conditions and Performance of Groyne

Type: Timber SSP ZZ **Built:** 1974 **Refurbished:** 1981

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: ZZ inundated with sand

Management Unit	BAC 2	Location: Groyne No. 26
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	635496 635528	
Northing:	333226 333307	
Length:	88m	
Management Unit: BAC 2		**Defence Length Reference:** 04

Conditions and Performance of Groyne

Type: Timber SSP ZZ **Built:** 1974 **Refurbished:** 1984

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No Beacon

Management Unit	BAC 2	Location: Groyne No. 27
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	635633 635673	
Northing:	333143 333226	
Length:	83m	
Management Unit: BAC 2		**Defence Length Reference:** 04

Conditions and Performance of Groyne

Type: Timber SSP ZZ **Built:** 1974 **Refurbished:** 1981/4

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No Beacon

Management Unit	BAC 2	Location: Groyne No. 28
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	635775 635814	
Northing:	333053 333136	
Length:	74m	
Management Unit: BAC 2		**Defence Length Reference:** 04

Conditions and Performance of Groyne

Type: Timber SSP ZZ **Built:** 1974 **Refurbished:** 1981

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No Beacon

Management Unit	BAC 2		Location: Groyne No. 28A
Start / Finish NG Co-ordinates			**Survey Date:** 02/02/03
	Root		
Easting:	635875	635876	
Northing:	332994	333016	
Length:	30m		
Management Unit:	BAC 2		**Defence Length Reference:** 04

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1981 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No Beacon

Management Unit	BAC 2		Location: Groyne No. 29
Start / Finish NG Co-ordinates			**Survey Date:** 02/02/03
	Root		
Easting:	635954	635983	
Northing:	332933	332989	
Length:	70m		
Management Unit:	BAC 2		**Defence Length Reference:** 04

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1981/87 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete

Management Unit	BAC 2		Location: Groyne No. 30
Start / Finish NG Co-ordinates			**Survey Date:** 02/02/03
	Root		
Easting:	636073	636108	
Northing:	332843	332905	
Length:	80m		
Management Unit:	BAC 2		**Defence Length Reference:** 05

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1981/7 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No Beacon – some splitting of verticals

Management Unit	BAC 2	Location: Groyne No. 31
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	636212 636249	
Northing:	332749 332815	
Length:	75m	
Management Unit:	BAC 2	**Defence Length Reference:** 05

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1981/7 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No Beacon - some splitting of verticals

Management Unit	BAC 2	Location: Groyne No. 32
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	636367 636407	
Northing:	332655 332726	
Length:	80m	
Management Unit:	BAC 2	**Defence Length Reference:** 05

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1974 **Refurbished:** 1981

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No Beacon - some splitting of verticals

Management Unit	BAC 2	Location: Groyne No. 33
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	636517 636562	
Northing:	332551 332617	
Length:	60m	
Management Unit:	BAC 2	**Defence Length Reference:** 06

Conditions and Performance of Groyne

Type: Timber **Built:** 1987 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete

Management Unit	BAC 2	Location: Groyne No. 34
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	636634 636682	
Northing:	332470 332538	
Length:	65m	
Management Unit: BAC 2		**Defence Length Reference:** 06

Conditions and Performance of Groyne

Type: Timber **Built:** 1987 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No Beacon – slight deterioration of seaward end

Management Unit	BAC 2	Location: Groyne No. 35
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	636797 636846	
Northing:	332358 332426	
Length:	70m	
Management Unit: BAC 2		**Defence Length Reference:** 06

Conditions and Performance of Groyne

Type: Timber **Built:** 1987 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: No Beacon as G 34

Management Unit	BAC 2	Location: Groyne No. 36
Start / Finish NG Co-ordinates		**Survey Date:** 02/02/03
	Root	
Easting:	636922 636955	
Northing:	332290 332364	
Length:	90m	
Management Unit: BAC 2		**Defence Length Reference:** 06

Conditions and Performance of Groyne

Type: Timber SSP **Built:** 1961 **Refurbished:**

Defence Condition Rating: Good

Updates to CPSE (1997): Unknown

Comment: Beacon complete – slight splitting of verticals

10. SUMMARY

10.1 Table summaries of defence condition

Tables 10.1 and 10.2 summarise the visual observations from the defence condition surveys for linear defences (i.e. seawalls and revetments) and groynes, respectively. The observations are referenced to the relevant management unit and defence length, as given in Figure 10.1.

10.2 Source-Pathway-Receptor-Consequence diagrams

As a graphical display of the processes involved in coastal erosion and flooding, Source-Pathway-Receptor-Consequence (SPRC) diagrams have been produced for given Management Units and, in some cases, Defence Lengths. Figures 10.2 to 10.14 provide these graphical representations from Management Unit TRI 1 to Defence Length BAC 2.06, respectively.

Table 10.1 Defence condition survey summary – linear defences by Management Unit (MU) and Defence Length

MU	Defence Length	Type	Condition
TRI 1	1.01	Timber breastwork	Poor
	1.02	None	
TRI 2	2.01	Timber revetment	Poor
	2.02	Blockwork revetment	Poor
	2.03.1	Seawall	Very Good
	2.03.2	Seawall	Very Poor
	2.03.3	Seawall	Very Poor
	2.03.4	Seawall	Good
	2.03.5	Seawall	Poor
	2.03.6	Seawall	Fair
	2.03.7	Seawall	Good
	2.04	Rock armour/timber revetment	Very Good/Poor
	2.05	Timber revetment	Poor
TRI 3	3.01	Timber revetment	Poor
	3.02	None	
TRI 4	4.01	Timber revetment/Concrete wall	Very poor/Fair
	4.02	Timber revetment	Very Poor
TRI 5	5.01	Timber revetment	Fair
	5.02	Timber revetment	Good
TRI 6	6.01	Timber revetment	Fair
	6.02	Blockwork revetment	Fair
	6.03.1	Seawall	Poor
	6.03.2	Seawall	Very Good
	6.03.3	Seawall	Very Good
	6.03.4	Seawall	Poor
	6.03.5	Seawall	Fair
	6.03.6	Seawall	Poor
	6.03.7	Seawall	Good
	6.03.8	Seawall	Good
	6.03.9	Seawall	Very Good
	6.04	Timber revetment/Steel sheet piles	Fair/Good
BAC 1	1.01	Timber revetment	Fair
BAC 2	2.01	Timber revetment	Fair
	2.02	Timber revetment / Steel breastwork / timber breastwork	Good/Good/Fair
	2.03	Seawall	Fair
	2.04	Seawall	Fair
	2.05	Seawall	Fair
	2.06	Timber revetment	Good

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154

CDR3214 07/01/2004 17:58:00

Table 10.2 Defence condition survey summary – groynes by Management Unit (MU) and Defence Length

MU	Defence Length	Reference (Old)	Reference (New)	Type*	Condition	Seaward end works needed	Beacon missing
TRI 1	1.01	0D	D1	timber	good		X
		0C	D2	timber	fair		
		0B	D3	timber	fair		X
		0A	D4	timber	good		
	1.02	0	D5	timber	poor		X
		W5	D6	timber	good		
		W4	D7	timber	good		X
TRI 2	2.01	W3	D6	timber	good		
		W2	E1	timber	good		X
		W1	E2	timber	good		X
	2.02	None					
	2.03	2	E3	timber/SSP	fair		
		2A	E4	timber/SSP	poor		
		3	E5	timber/steel z	good		
		3A	E6	timber/SSP	poor		
		4	E7	timber/steel z	good		
		5	E8	timber/steel z	good		X
		6	E9	timber/steel z	good		
	2.04	7	E10	timber/steel z	good		X
		8	E11	timber/steel z	good		X
	2.05	9	E12	timber	good		
		10	E13	timber	good		X
TRI 3	3.01	11	F1	timber	good		
		12	F2	timber	good		
		13	F3	timber	good		
		14	F4	timber	good	X	
		15	F5	timber	good	X	
	3.02	16	F6	timber	good	X	
TRI 4	4.01	15	G1	timber	good	X	
		14	G2	timber	good	X	X
		13	G3	timber	good	X	X
		12	G4	timber	good	X	
		11	G5	timber	fair		
	4.02	10	G6	timber	fair	X	
		9	G7	timber	good	X	
		8	G8	timber	good		

* SSP refers to construction using steel sheet piling, while steel z refers to steel piling with a z plan-shape.

Table 10.2 Defence condition survey summary – groynes by Management Unit (MU) and Defence Length (continued)

MU	Defence Length	Reference (Old)	Reference (New)	Type*	Condition	Seaward end works needed	Beacon missing
TRI 5	5.01	7	H1	timber	fair	X	
		6	H2	timber	good		
		5	H3	timber	good		X
		4	H4	timber	good		
		3	H5	timber	good		
		2	H6	timber	good		X
	5.02	1	H7	timber	good		X
		W7	H8	timber	good		
		W6	H9	timber	good		X
TRI 6	6.01	W5	I1	timber	good		
		W4	I2	timber	good		
		W3	I3	timber	good		X
		W2	I4	timber	good		
		W1	I5	timber	good		X
	6.02	1	I6	timber	good		
		2	I7	timber	good		
	6.03	3	I8	timber	good		X
		4	I9	timber	good		
		6	I10	composite (outfall)	good	X	
	6.04	7	I11	timber	good		
		8	I12	timber	good		
BAC 1	1.01	9	J1	timber	good		X
		1	J2	timber/SSP	good		
		2	J3	timber/SSP	good	X	
		3	J4	timber/SSP	good	X	X
		4	J5	timber/SSP	good		
		5	J6	timber/SSP	good		X
		6	J7	timber/SSP	good		
		7	J8	timber/SSP	good		

* SSP refers to construction using steel sheet piling, while steel z refers to steel piling with a z plan-shape.

Table 10.2 Defence condition survey summary – groynes by Management Unit (MU) and Defence Length (continued)

MU	Defence Length	Reference (Old)	Reference (New)	Type*	Condition	Seaward end works needed	Beacon missing
BAC 2	2.01	8	K1	timber/SSP	good		
		9	K2	timber/SSP	good		
		9A		timber (outfall)	good		
		10	K3	timber/SSP	good		X
		11	K4	timber/SSP	good		
		12	K5	timber/SSP	good		
		13	K6	timber/SSP	good		X
	2.02	14	K7	timber/SSP	good		X
	2.03	15	K8	timber/SSP	good		
		16	K9	timber/SSP	good		
		16A	K10	timber	good		X
		17	K11	timber/SSP	good		
		18	K12	timber/SSP	good		X
		19	K13	timber/SSP	good		X
		20	K14	timber/SSP	good		
		21	K15	timber/SSP	good		X
		22	K16	timber/SSP	good		
		22A	K17	timber	good		X
		22B	K18	timber	good		X
		23	K19	timber/SSP	good	X	X
		24	K20	timber/SSP	good		
		25	K21	timber/SSP	good		
	2.04	26	K22	timber/SSP	good		X
		27	K23	timber/SSP	good		X
		28	K24	timber/SSP	good		X
		28A	K25	timber/SSP	good		X
		29	K26	timber/SSP	good		
	2.05	30	K27	timber/SSP	good		X
		31	K28	timber/SSP	good		X
		32	K29	timber/SSP	good		X
	2.06	33	K30	timber/SSP	good		
		34	K31	timber/SSP	good		X
		35	K32	timber/SSP	good		X
		36	K33	timber/SSP	good		

* SSP refers to construction using steel sheet piling, while steel z refers to steel piling with a z plan-shape.

Figure 10.1 Management Units and Defence Lengths for the study area

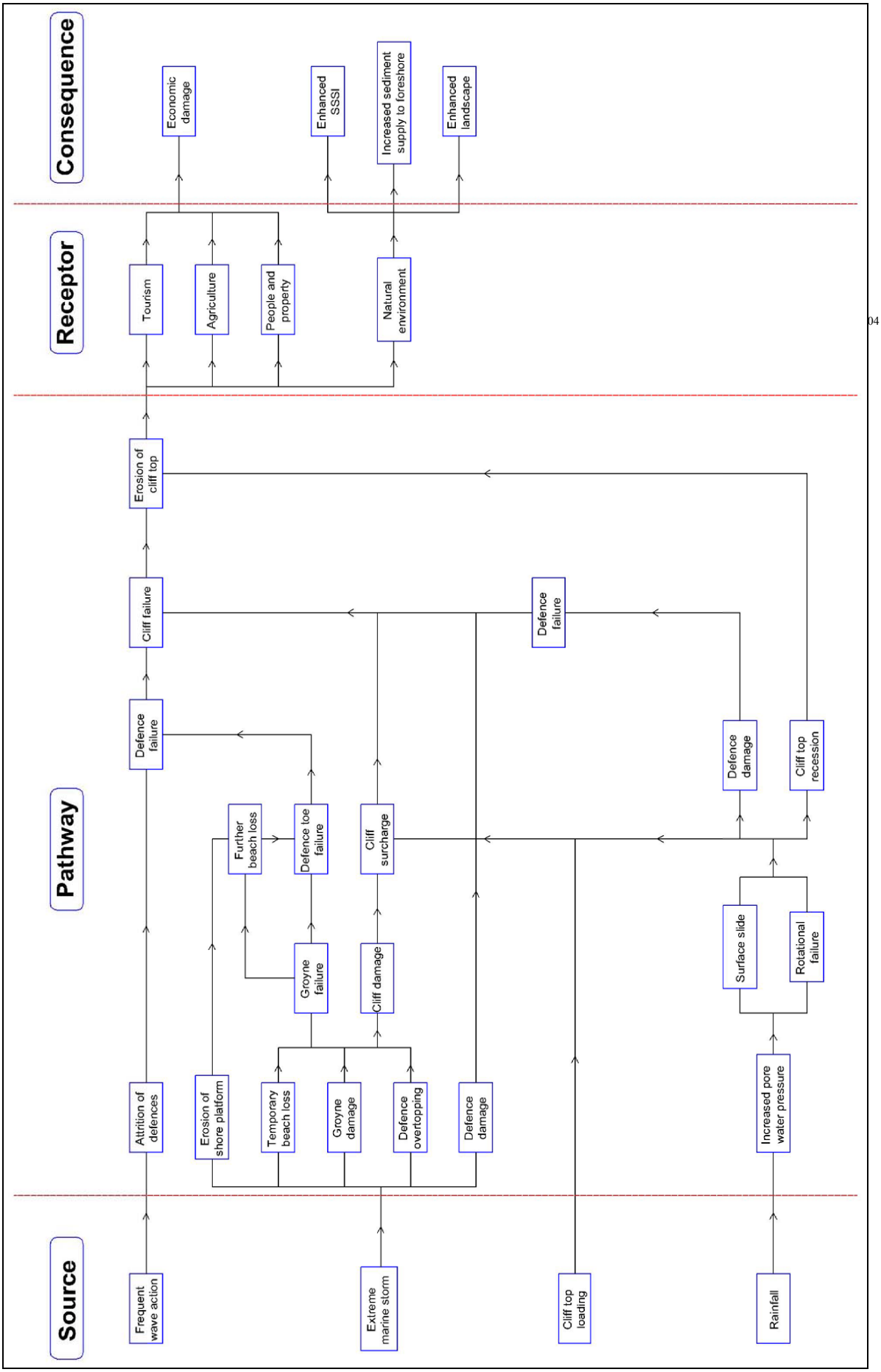

Figure 10.2 SPRC diagram – TRI 1

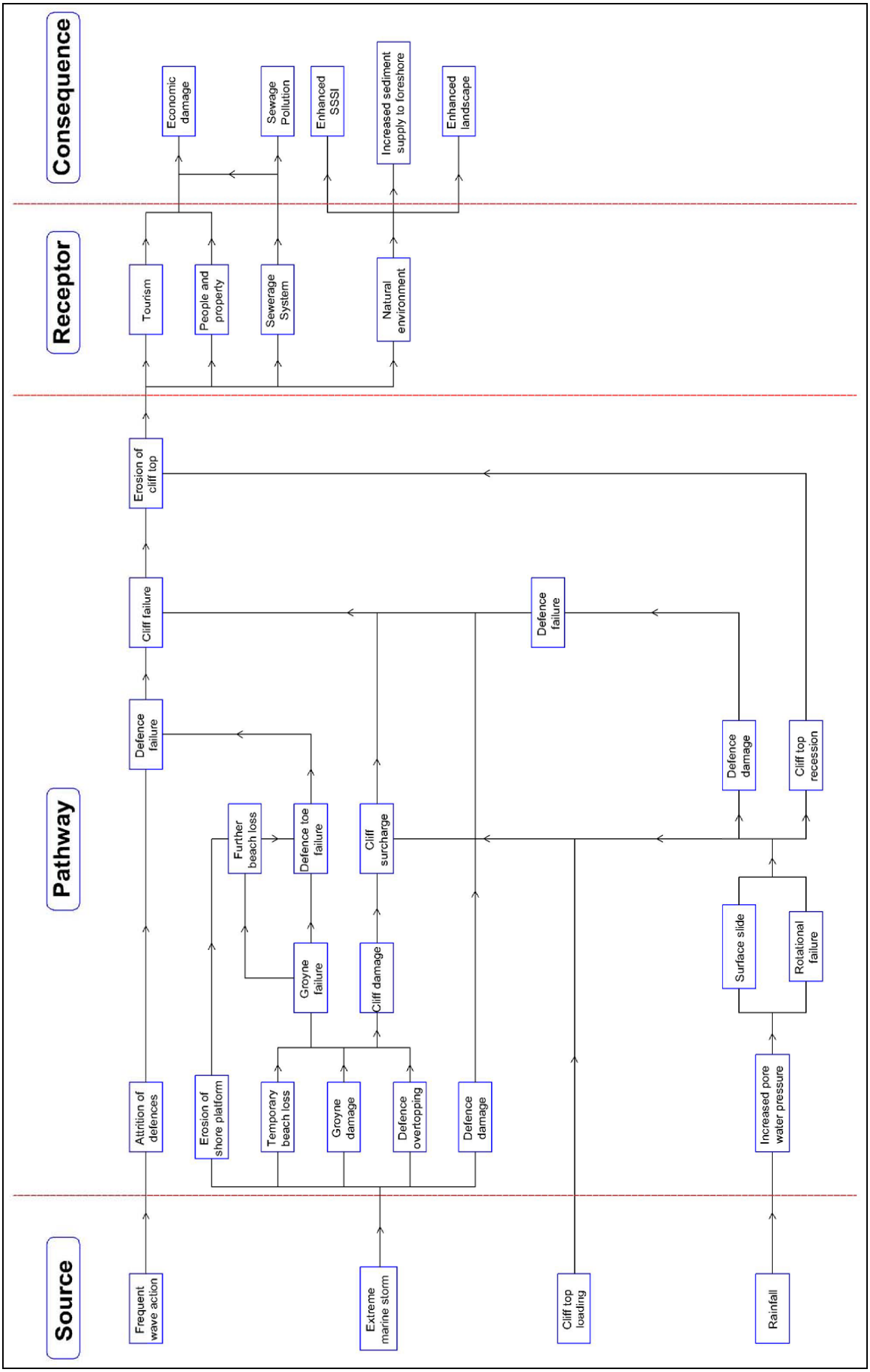

Figure 10.3 SPRC diagram – TRI 2

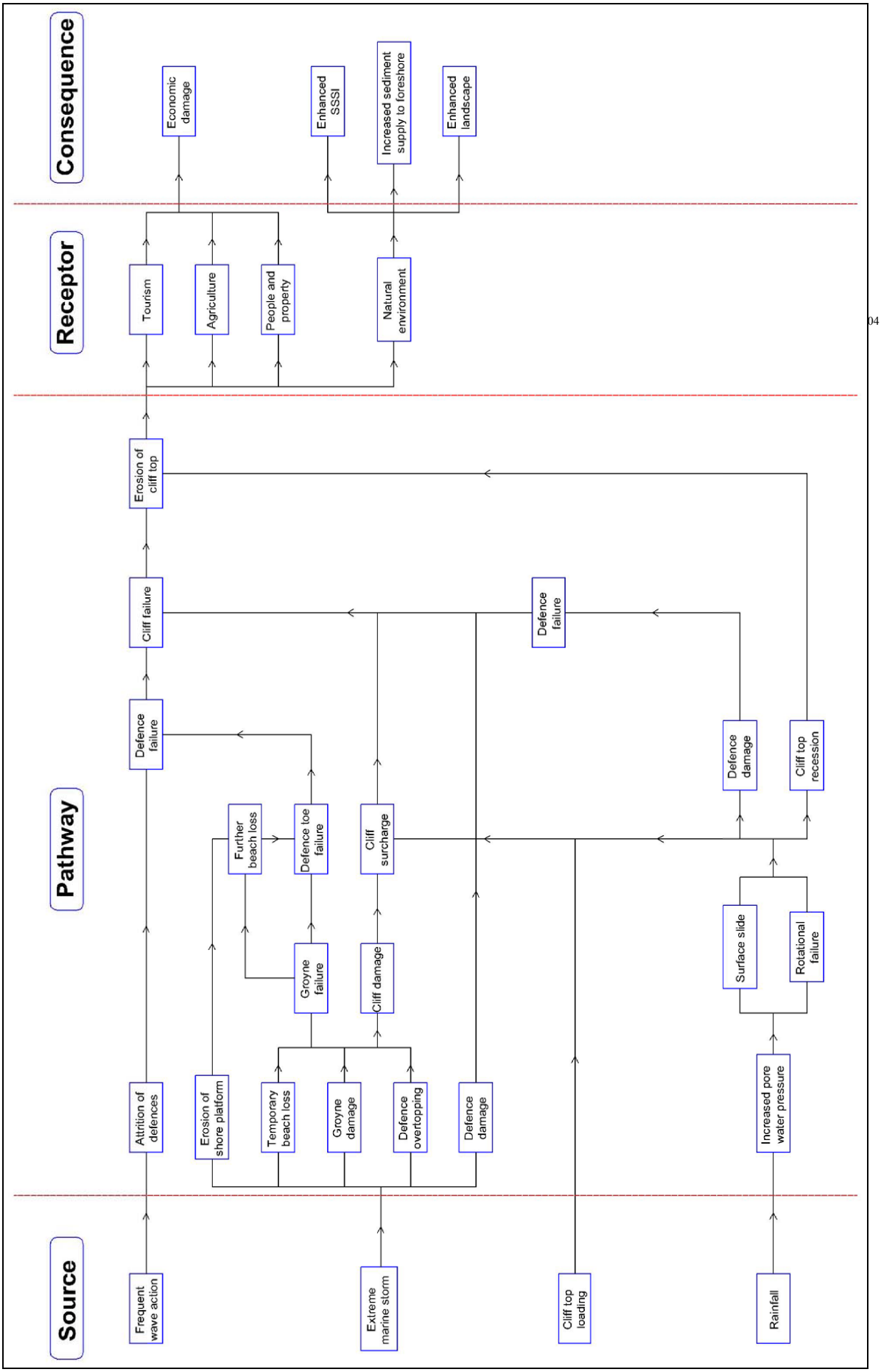

Figure 10.4 SPRC diagram – TRI 3

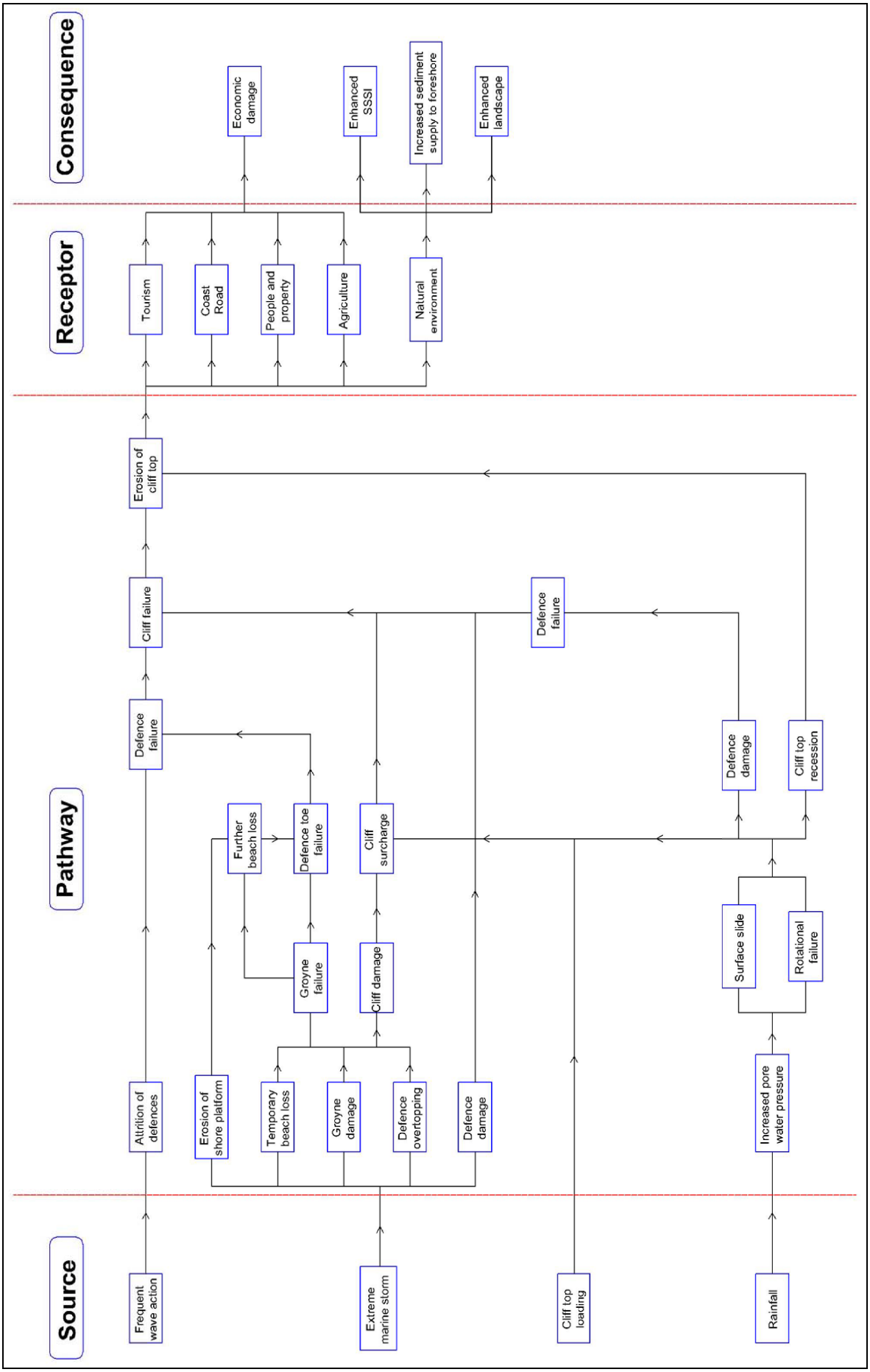

Figure 10.5 SPRC diagram – TRI 4.01

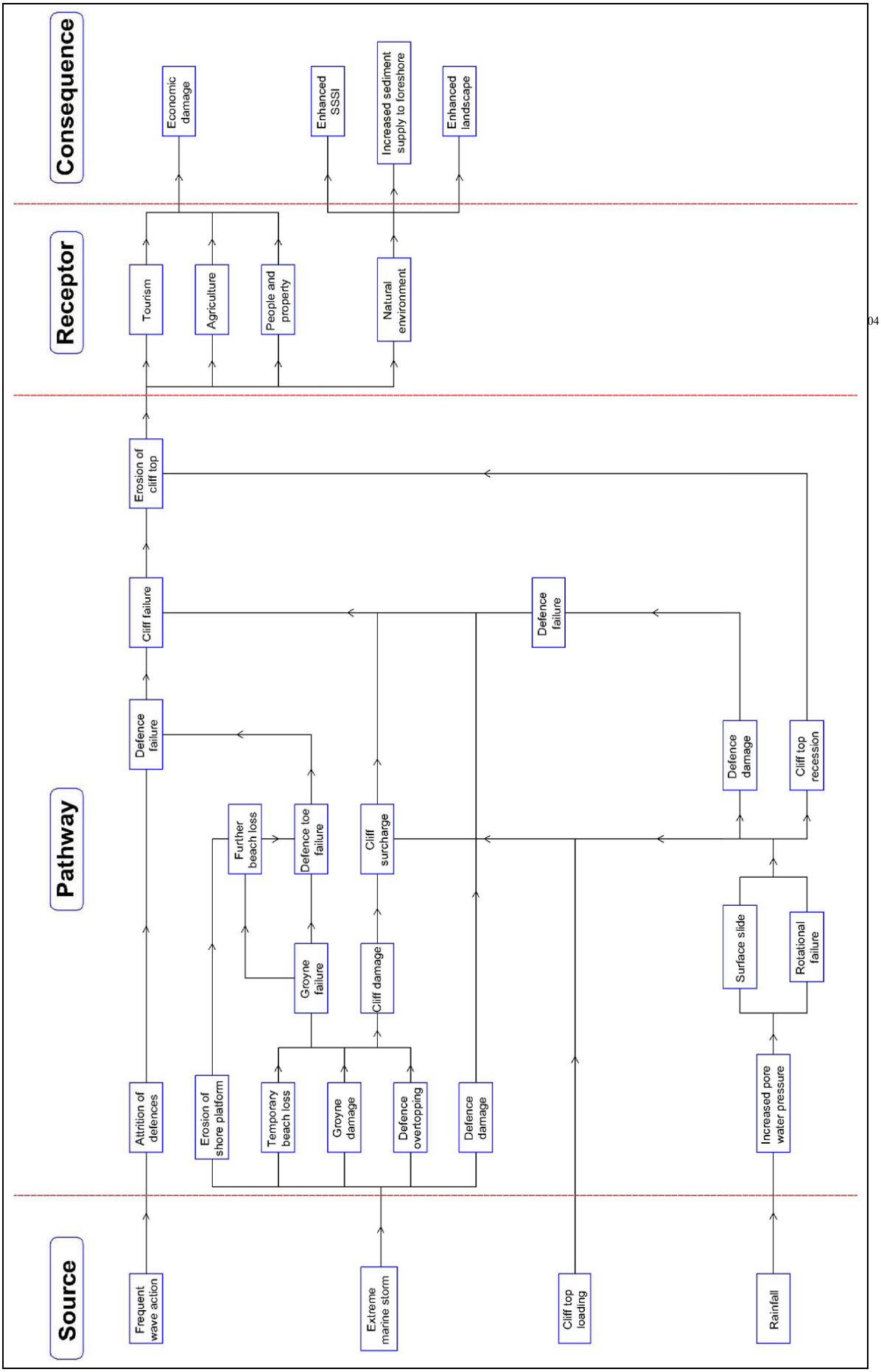

Figure 10.6 SPRC diagram – TRI 4.02 & TRI 5

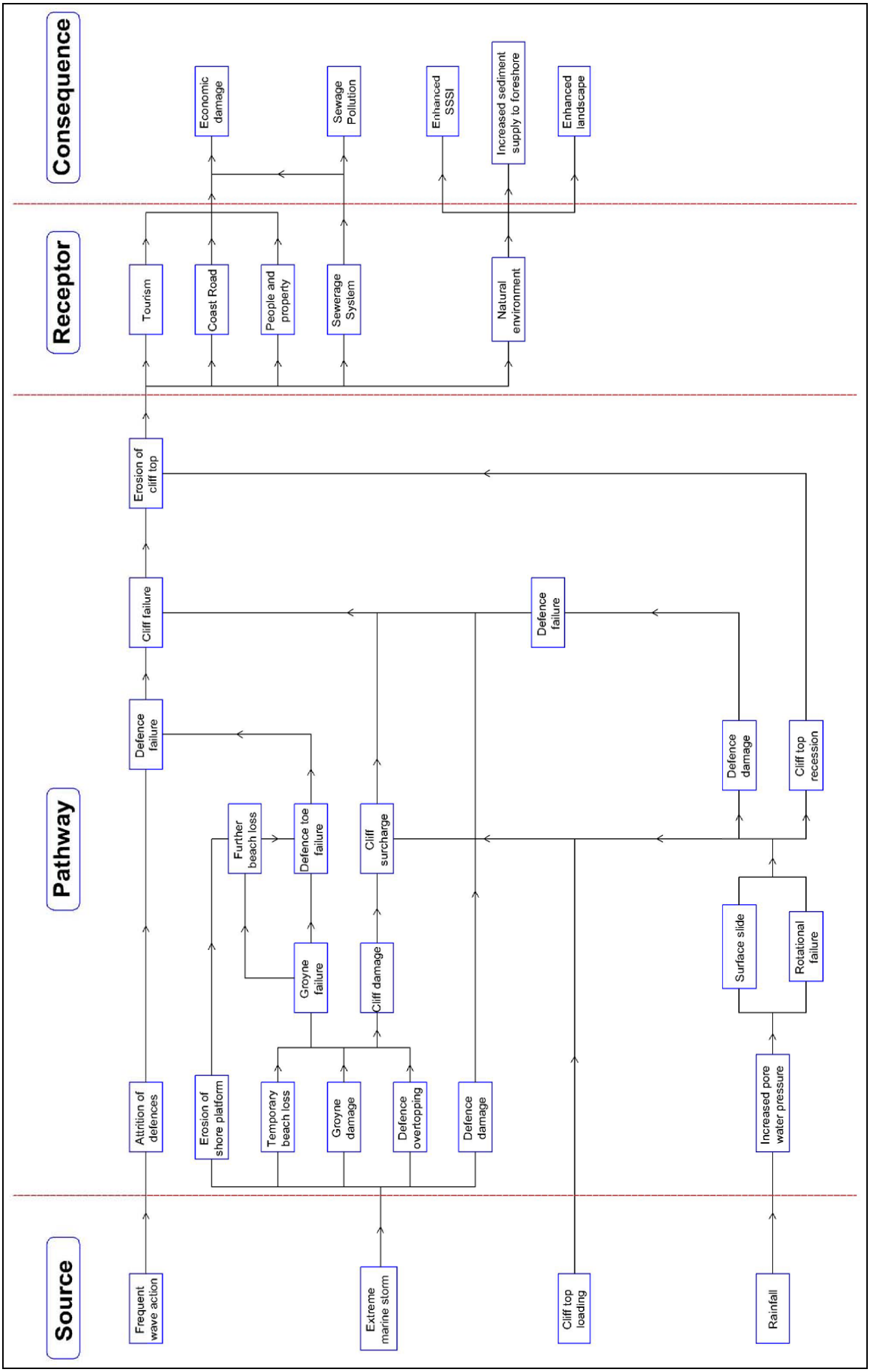

Figure 10.7 SPRC diagram – TRI 6

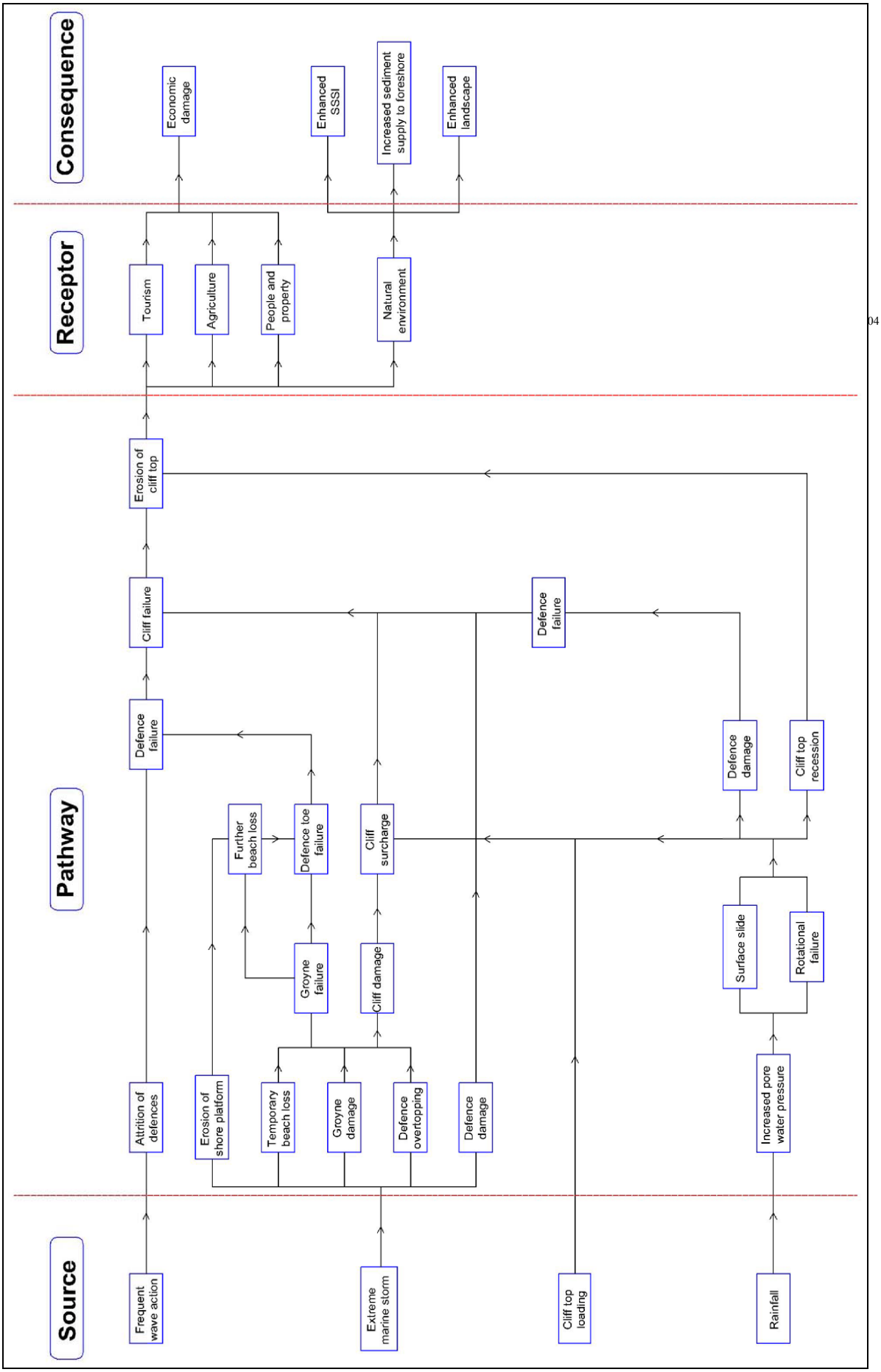

Figure 10.8 SPRC diagram – BAC 1

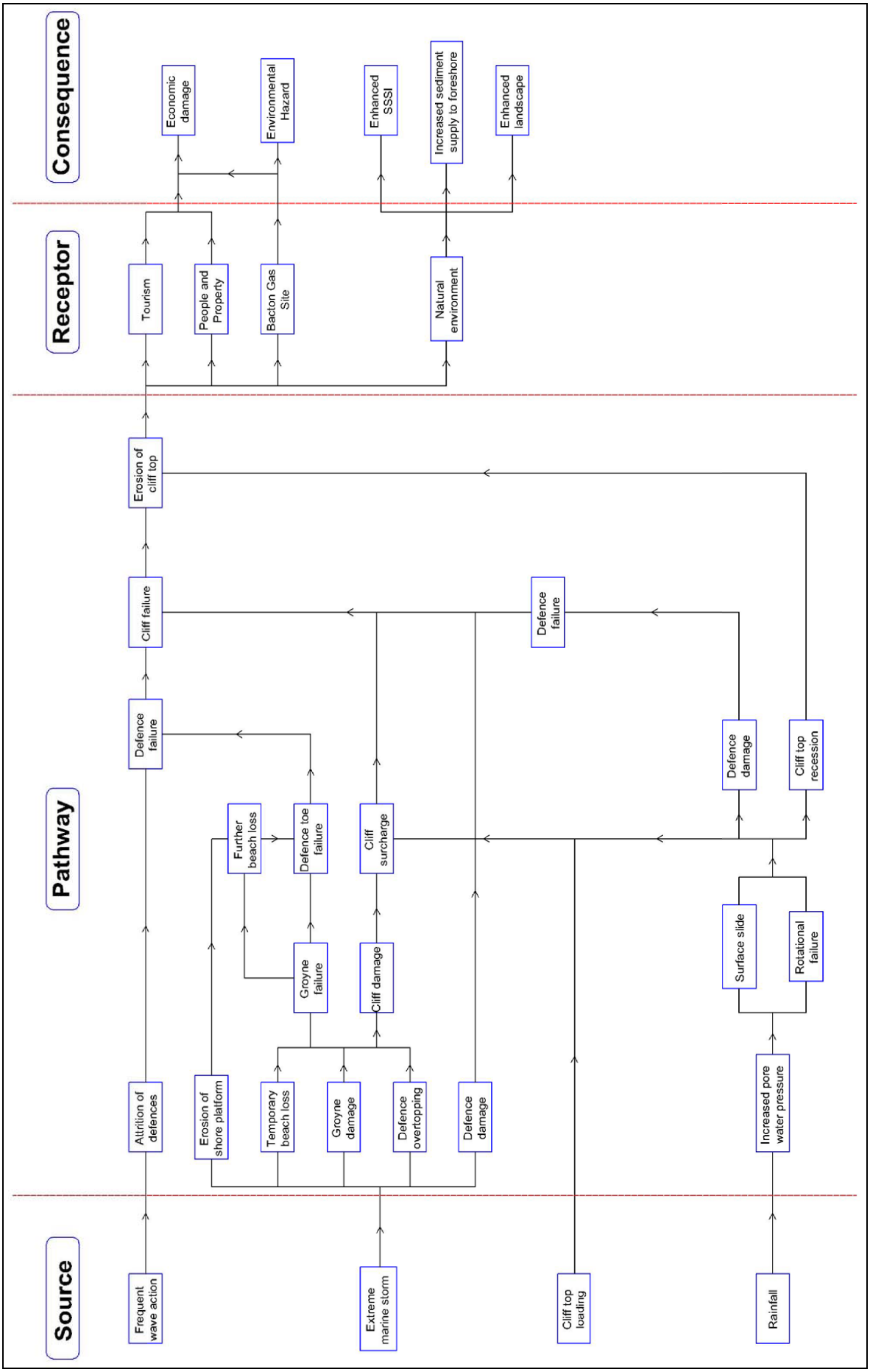

Figure 10.9 SPRC diagram – BAC 2.01

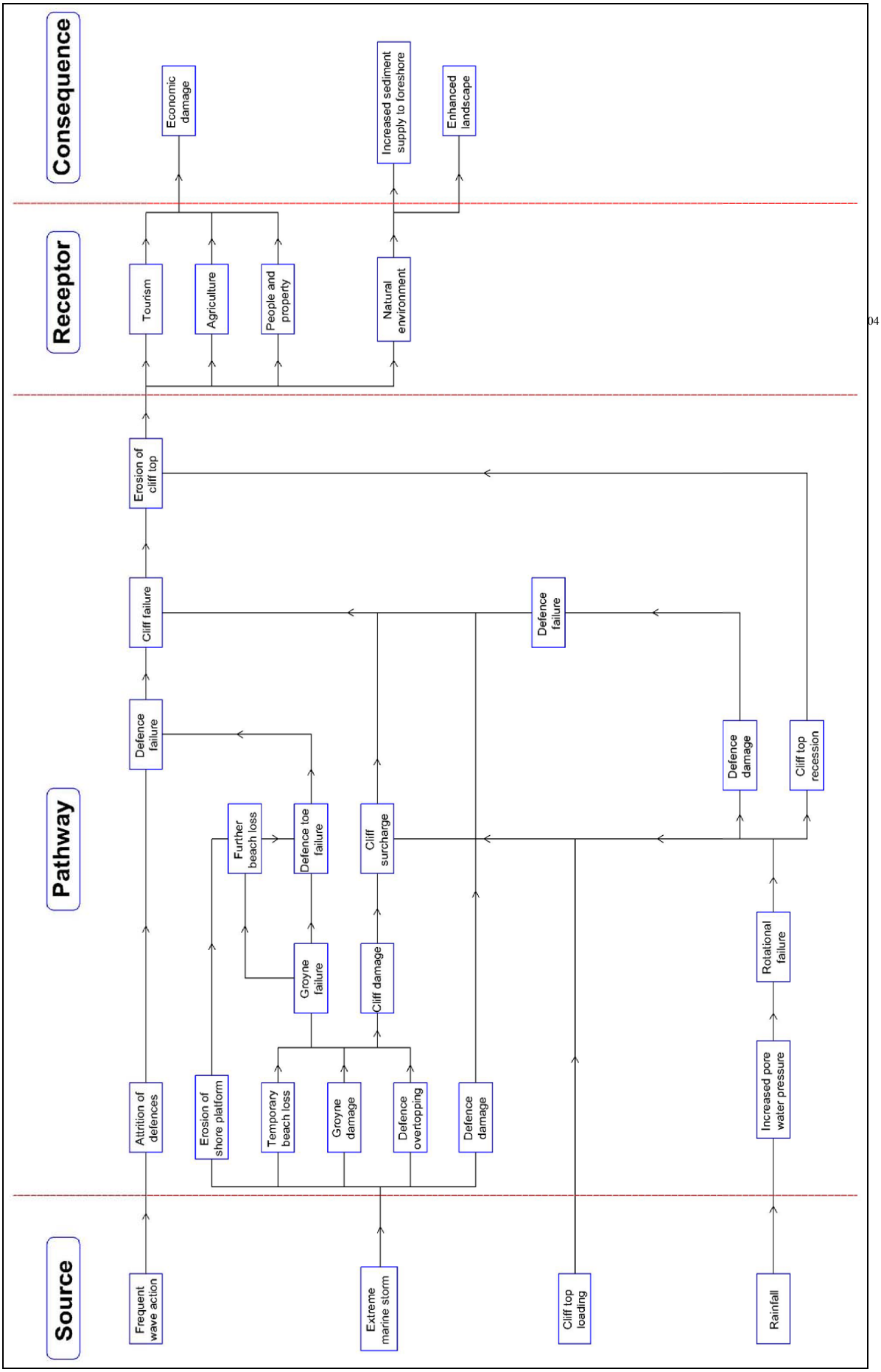

Figure 10.10 SPRC diagram – BAC 2.02 & BAC 2.03

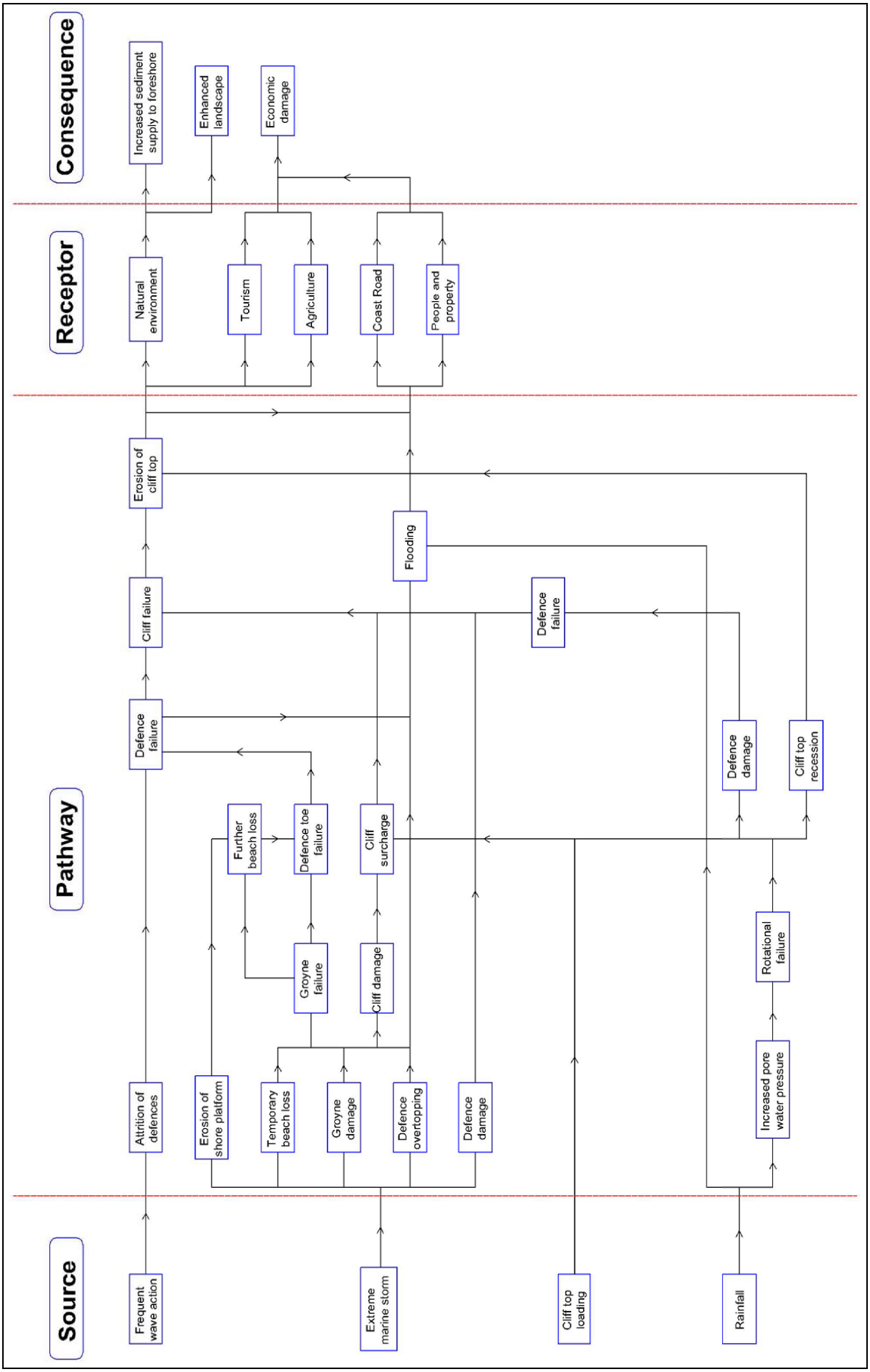

Figure 10.11 SPRC diagram – BAC 2.04

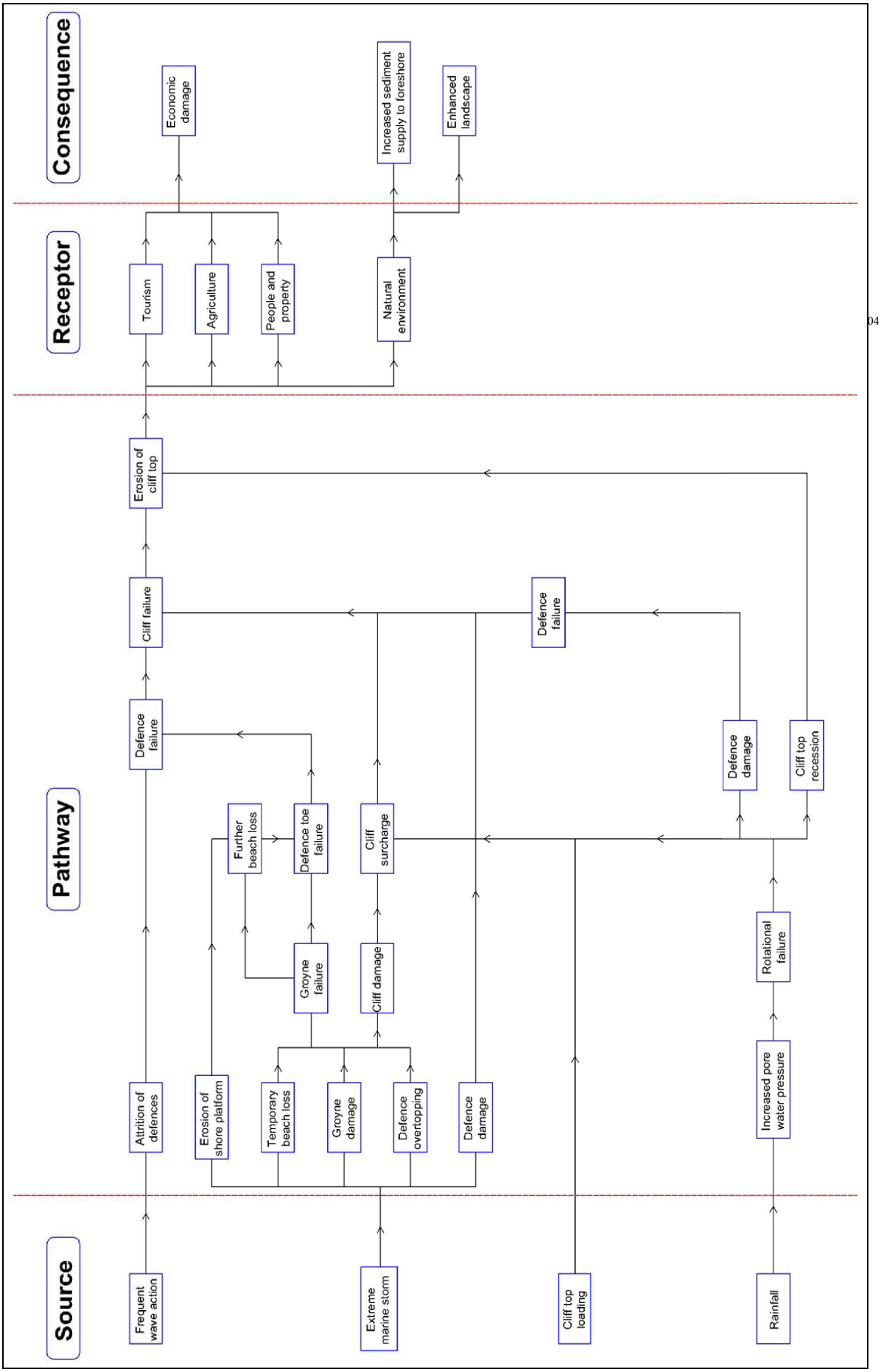

Figure 10.12 SPRC diagram – BAC 2.05 & BAC 2.06

11. INDEX OF PHOTOGRAPHS

Ref. No.	Description of View	Defence Length	Page #
Cromer to Overstrand Photos			
P 22	View along beach to east showing groynes D2, D3, D4	TRI 1.01	17
P 19	Groyne D7 (W5)	TRI 1.02	
P 20	Groyne D5 (0)	TRI 1.02	
P 21	Groyne D5 (0)	TRI 1.02	19
Overstrand Photos			
P 15	General revetment view	TRI 2.01	25
P 16	Groyne E2 (w1)	TRI 2.01	
P 17	Groyne E1 (W2)	TRI 2.01	
P 18	Groyne D8 (W3)	TRI 2.01	26
P 14	Blockwork revetment.	TRI 2.02	28
OP1	East Elevation of Groyne 1	TRI 2.03.1	30
OP2	Western end of the Sea Wall	TRI 2.03.1	
OP53	View along the base of the Sea Wall from the West	TRI 2.03.1	31
OP3	Beacon at the end of Groyne 2	TRI 2.03.2	
OP4	West Elevation of Groyne 2, looking towards the Sea Wall	TRI 2.03.2	
OP5	Close up of Groyne 2 showing boards bolted to the groyne below the beach level	TRI 2.03.2	
OP6	Close up of Groyne 2	TRI 2.03.2	34
OP7	Close up of Groyne 2	TRI 2.03.2	
OP7a	View of Groyne 2 near the sea wall, showing steel piles	TRI 2.03.2	
OP8	Steel Piling and Concrete Apron at the base of the Sea Wall	TRI 2.03.2	35
OP9	Close up of the Piling and Apron	TRI 2.03.2	
OP10	Junction where Groyne 2 meets the Sea Wall	TRI 2.03.2	
OP51	Poor condition of Sea Wall to the East of the ramp	TRI 2.03.2	35
OP52	Junction where Groyne 2 meets the Sea Wall	TRI 2.03.2	
OP11	View of Groyne 2A towards the Sea Wall	TRI 2.03.3	
OP12	Beacon at the end of Groyne 3	TRI 2.03.3	
OP12a	Close up of Groyne 3	TRI 2.03.3	
OP13	View of the West Elevation of Groyne 3, towards the Sea Wall	TRI 2.03.3	38
OP14	View of the East Elevation of Groyne 3, towards the Sea Wall	TRI 2.03.3	
OP19	View along the front of the Sea Wall showing the poor Apron and Piling	TRI 2.03.3	
OP20	Close up of poor Piling	TRI 2.03.3	
OP21	Close up of poor Apron	TRI 2.03.3	39
OP33	View of Groyne 3A from Sea Wall	TRI 2.03.3	
OP34	Close up of Groyne 3A	TRI 2.03.3	
OP43	View or along the base of the Sea Wall, looking West	TRI 2.03.3	
OP44	Close up of spalling about a joint at the base of the Sea Wall	TRI 2.03.3	
OP46	View of the Sea Wall showing a Weep Hole and abrasion damage	TRI 2.03.3	
OP47	View or along the base of the Sea Wall, looking East	TRI 2.03.3	
OP48	View of the Sea Wall	TRI 2.03.3	
OP49	Sealant loss in a joint of the Sea Wall	TRI 2.03.3	
OP50	View along Sea Wall, looking East	TRI 2.03.3	
OP54	Gabion Basket Slope Protection	TRI 2.03.3	

Ref. No.	Description of View	Defence Length	Page #
OP55	Gabion Basket Slope Protection	TRI 2.03.3	
OP56	Spillage from a damaged Gabion Basket Slope Protection	TRI 2.03.3	39
OP56a	Spillage from a damaged Gabion Basket Slope Protection	TRI 2.03.3	
OP57	Elevation View of Gabion Basket Slope Protection, looking East	TRI 2.03.3	
OP15	Beacon at the end of Groyne 4	TRI 2.03.4	
OP16	Close up of Groyne 4 beneath the Beacon	TRI 2.03.4	
OP17	Close up of Groyne 4	TRI 2.03.4	
OP18	View along Groyne 4, from the Sea Wall	TRI 2.03.4	42
OP42	View of Sea Wall	TRI 2.03.4	42
OP40	View of the rough surface of the Apron and abrasion damage to the base of the Sea Wall	TRI 2.03.5	45
OP41	View of the rough surface of the Apron along the base of the Sea Wall	TRI 2.03.5	
OP22	View of Groyne 5	TRI 2.03.6	
OP23	Close up of the end of Groyne 5	TRI 2.03.6	48
OP24	View of Groyne 5	TRI 2.03.6	
OP25	Close up of base of Groyne 5	TRI 2.03.6	
OP27	View of Groyne 6	TRI 2.03.6	51
OP28	Close up of the end of Groyne 6	TRI 2.03.6	
OP29	Close up of the end of Groyne 6	TRI 2.03.6	
OP30	View of Groyne 6 halfway up the beach	TRI 2.03.6	
OP31	Close up of Groyne 6	TRI 2.03.6	
OP32	Close up of Steel Piling	TRI 2.03.6	
OP38	View rough surface of the Apron along base of Sea Wall	TRI 2.03.6	48
OP38a	Damage about a joint in the Sea Wall	TRI 2.03.6	
OP39	Close up of spalling about a joint in the base of the Sea Wall	TRI 2.03.6	
OP42a	Close up of poor Apron and Piling	TRI 2.03.6	
OP35	View of the Sea Wall	TRI 2.03.7	
OP36	View of the Ramp leading down onto the beach	TRI 2.03.7	
OP37	View of the Apron along the base of the Sea Wall	TRI 2.03.7	51
X17	Intersection of Rock and Timber Revetments	TRI 2.04	
X18	View of Timber Groyne	TRI 2.04	
X19	Timber Revetment with Exposed Toe	TRI 2.04	
X20	Intersection of Rock and Timber Revetments	TRI 2.04	53
X21	Timber Revetment with Exposed Toe	TRI 2.04	
X22	View of the End of a Groyne	TRI 2.04	54
X23	View of the Timber Revetment and End of the Seawall (from section 2.03.7)	TRI 2.04	
X14	Badly Damaged Wooden Revetment	TRI 2.05	56
X15	Badly Damaged Wooden Revetment	TRI 2.05	
X16	View South East Along the Revetment	TRI 2.05	57
X1	Termination of Wooden Revetment	TRI 3.01	61
X2	Rear View of Wooden Revetment	TRI 3.01	
X3	View of the End of a Groyne	TRI 3.01	
X4	Front View of Wooden Revetment	TRI 3.01	
X5	View of a Groyne	TRI 3.01	
X6	View of a Wooden Revetment with Boards Missing	TRI 3.01	
X7	View of a Groyne	TRI 3.01	
X8	View of a Wooden Revetment with Boards Missing	TRI 3.01	62
X9	View of a Wooden Revetment with Boards Missing	TRI 3.01	

Ref. No.	Description of View	Defence Length	Page #
X10	Wooden Revetment with Exposed Sheet Pile Toe	TRI 3.01	63
X11	Close up of Corrosion of Sheet Pile Toe	TRI 3.01	
X12	View of Join Between Groyne and Revetment	TRI 3.01	
X13	Badly Damaged Wooden Revetment	TRI 3.01	
Trimingham Photos			
PT16	Seawall and derelict revetment.	TRI 4.01	70
PT17	Ditto, root of groyne G5 (11)	TRI 4.01	
PT18	Seawall, derelict revetment.	TRI 4.01	
PT19	Ditto	TRI 4.01	
PT20	Ditto	TRI 4.01	
PT21	Ditto, note pile condition	TRI 4.01	
PT22	Apron to wall	TRI 4.01	
PT23	Ditto	TRI 4.01	70
PT24	Revetment on seawall	TRI 4.01	
TG1	Ditto, cliff fall debris on revetment	TRI 4.01	
TG2	Western end of wall	TRI 4.01	
TG3	Ditto	TRI 4.01	71
TG4	Groyne F6	TRI 4.01	
TG5	Groyne G1	TRI 4.01	
TG6	Groyne G2	TRI 4.01	
TG7	Groyne G3	TRI 4.01	71
TG8	Groyne G4	TRI 4.01	
TG9	Groyne G5	TRI 4.01	
PT8	Breach in revetment.	TRI 4.02	
PT9	Revetment damaged by cliff falls	TRI 4.02	
PT10	Revetment, note damaged piles	TRI 4.02	74
PT11	Ditto, with missing piles	TRI 4.02	
PT12	Ditto	TRI 4.02	
PT13	Damaged revetment.	TRI 4.02	
PT14	Skeletal revetment, no piles	TRI 4.02	74
PT15	Revetment, missing timbers	TRI 4.02	
TG10	Groyne G6	TRI 4.02	
TG11	Groyne G7	TRI 4.02	75
TG12	Root groyne G7	TRI 4.02	
TG14	Groyne G8	TRI 4.02	
Trimingham to Mundesley Photos			
PT1	Groyne H4	TRI 5.01	
PT1A	Ditto	TRI 5.01	
PT2	Revetment.	TRI 5.01	
PT4	Groyne H3	TRI 5.01	79
PT5	Revetment	TRI 5.01	79
PT6	Groyne H2	TRI 5.01	
PT7	Groyne H1	TRI 5.01	
TG15	Revetment.	TRI 5.01	
M7	Groyne I1, surface water outfall	TRI 5.02	81
M8	Groyne H9	TRI 5.02	
M9	Groyne H8, surface water outfall	TRI 5.02	
M10	Local damage to revetment	TRI 5.02	82

Ref. No.	Description of View	Defence Length	Page #
TG17	General view of revetment	TRI 5.02	82
TG18	Groyne H7	TRI 5.02	
TG19	Local damage to revetment as M10	TRI 5.02	
TG20	General view of revetment	TRI 5.02	
TG22	General view of revetment.	TRI 5.02	
Mundesley Photos			
M3	General view of revetment	TRI 6.01	
M5	Ditto	TRI 6.01	
M6	Ditto	TRI 6.01	
M7	Groyne I1	TRI 6.01	
M11	Revetment showing missing panels.	TRI 6.01	87
M1	Groyne I5	TRI 6.02	
M2	Blockwork revetment	TRI 6.02	
M12	Groyne I6	TRI 6.02	89
M13	Blockwork revetment.	TRI 6.02	
M14	Blockwork revetment.	TRI 6.02	90
M15	Blockwork revetment.	TRI 6.02	
MP40	View along Sea Wall	TRI 6.03.1	
MP41	View along Sea Wall	TRI 6.03.1	
MP42	Construction Joint in Sea Wall	TRI 6.03.1	
MP43	Western termination of Sea Wall	TRI 6.03.1	93
MP44	Steps in Rubble Armour	TRI 6.03.1	
MP45	Promenade along top of Sea Wall	TRI 6.03.1	
MP46	Rubble Armour	TRI 6.03.1	
MP47	End of Groyne 3	TRI 6.03.1	
MP48	Close up of end of Groyne 3	TRI 6.03.1	
MP49	Side view of end of Groyne 3	TRI 6.03.1	
MP50	Close up of Groyne 3	TRI 6.03.1	
MP51	Close up of Groyne 3	TRI 6.03.1	
MP75	View of Groyne 3	TRI 6.03.1	
MP76	Close up of Groyne 3	TRI 6.03.1	
MP77	View of Groyne 3	TRI 6.03.1	
MP78	Close up of Groyne 3	TRI 6.03.1	
MP79	Close up of Groyne 3	TRI 6.03.1	
MP80	View of Groyne 3	TRI 6.03.1	94
MP92	End of Groyne 2	TRI 6.03.1	
MP93	Junction of Groyne 2 and Rubble Armour	TRI 6.03.1	
MP94	Junction of Groyne 2 and Rubble Armour	TRI 6.03.1	
MP95	End of Groyne 2	TRI 6.03.1	
MP96	Close up of Groyne 2	TRI 6.03.1	94
MP36	View of Sea Wall	TRI 6.03.2	
MP37	Close up of crack in the Sea Wall	TRI 6.03.2	
MP38	View of Sea Wall	TRI 6.03.2	
MP39	View of Sea Wall	TRI 6.03.2	96
MP27	View of Sea Wall	TRI 6.03.3	
MP28	Promenade along top of Sea Wall	TRI 6.03.3	
MP29	View of Sea Wall	TRI 6.03.3	
MP30	View of Sea Wall	TRI 6.03.3	99

Ref. No.	Description of View	Defence Length	Page #
MP31	View of Sea Wall	TRI 6.03.3	
MP32	Close up of crack in Sea Wall	TRI 6.03.3	
MP33	View of Ramp in Sea Wall	TRI 6.03.3	
MP34	Promenade along top of Sea Wall	TRI 6.03.3	
MP35	Promenade along top of Sea Wall	TRI 6.03.3	99
MP21	View of Sea Wall	TRI 6.03.4	
MP22	Steps leading down from the Sea Wall	TRI 6.03.4	102
MP23	Close up of cracks in the Sea Wall	TRI 6.03.4	
MP24	View of the rough surface of the Sea Wall	TRI 6.03.4	
MP25	Junction of Groyne 4 and the Sea Wall	TRI 6.03.4	
MP26	Promenade along top of Sea Wall	TRI 6.03.4	
MP67	End of Groyne 4	TRI 6.03.4	
MP68	View of Groyne 4	TRI 6.03.4	
MP81	End of Groyne 4	TRI 6.03.4	
MP82	End of Groyne 4	TRI 6.03.4	
MP83	Close up of Groyne 4	TRI 6.03.4	
MP84	Close up of Groyne 4	TRI 6.03.4	102
MP85	Close up of Groyne 4	TRI 6.03.4	
MP86	View of Groyne 4	TRI 6.03.4	
MP87	Close up of Groyne 4	TRI 6.03.4	
MP88	Close up of Groyne 4	TRI 6.03.4	
MP89	Close up of Groyne 4	TRI 6.03.4	
MP90	Close up of Groyne 4	TRI 6.03.4	
MP91	End of Groyne 4	TRI 6.03.4	
MP17	Corner of Sea Wall	TRI 6.03.5	104
MP18	View of Sea Wall	TRI 6.03.5	
MP19	Close up of cracks in the Sea Wall	TRI 6.03.5	
MP20	Promenade along top of Sea Wall	TRI 6.03.5	
MP13	Promenade along top of Sea Wall	TRI 6.03.6	
MP14	Cracks in the Sea Wall next to an access ramp	TRI 6.03.6	106
MP15	Close up of cracks in the Sea Wall	TRI 6.03.6	
MP16	Close up of Cracks in the Sea Wall	TRI 6.03.6	
MP9	Corner of Sea Wall	TRI 6.03.7	108
MP10	Close up of Sea Wall	TRI 6.03.7	
MP11	Corner of Sea Wall	TRI 6.03.7	
MP12	Promenade along top of Sea Wall	TRI 6.03.7	
MP6	Steps in Sea Wall	TRI 6.03.8	110
MP7	Corner of Sea Wall	TRI 6.03.8	
MP8	Corner of Sea Wall	TRI 6.03.8	
MP8a	Promenade along top of Sea Wall	TRI 6.03.8	
MP1	Access ramp to beach and promenade	TRI 6.03.9	113
MP2	Promenade along top of Sea Wall	TRI 6.03.9	
MP3	View of Sea Wall	TRI 6.03.9	
MP4	Close up of Sea Wall	TRI 6.03.9	
MP5	View of sea Wall	TRI 6.03.9	
MP60	End of Groyne 7	TRI 6.03.9	
MP61	Close up of end of Groyne 7	TRI 6.03.9	114
MP62	View of Sea Wall	TRI 6.03.9	
MP63	Close up of Apron at base of Sea Wall	TRI 6.03.9	
MP64	Close up of Sea Wall	TRI 6.03.9	

Ref. No.	Description of View	Defence Length	Page #
MP65	Junction of Groyne 6 and the Sea Wall	TRI 6.03.9	
MP66	View of Groyne 6	TRI 6.03.9	114
MP69	End of Groyne 6	TRI 6.03.9	
MP70	End of Groyne 6	TRI 6.03.9	
MP71	View of Groyne 6	TRI 6.03.9	
MP72	View of Groyne 6	TRI 6.03.9	
MP72a	View of Groyne 6	TRI 6.03.9	
MP73	View of Groyne 6	TRI 6.03.9	
MP74	Close up of Groyne 6	TRI 6.03.9	
M17	Groyne I11	TRI 6.04	
M18	Revetment	TRI 6.04	
M20	General view	TRI 6.04	116
Mundesley to Bacton			
M21	Groyne J 2, failed seaward end	BAC 1.01	
M22	View of cliffs	BAC 1.01	
M23	Groyne J 3	BAC 1.01	120
M24	Groyne J4	BAC 1.01	
M25	Revetment	BAC 1.01	119
M26	Groyne J6	BAC 1.01	
M27	Groyne J7	BAC 1.01	
Bacton, Walcott and Ostend			
M28	Revetment	BAC 2.01	124
M29	Groyne J8	BAC 2.01	
M30	Groyne 9A outfall	BAC 2.01	
M31	Groyne K2	BAC 2.01	
M32	Groyne K1	BAC 2.01	
M33	Outfall	BAC 2.01	
M34	Ditto	BAC 2.01	
M35	General view	BAC 2.01	
W1	General view	BAC 2.01	124
W2	General view	BAC 2.01	
W3	General view	BAC 2.01	
W4	General view	BAC 2.01	
W6	Groyne K3	BAC 2.01	
W7	Outfall adjacent to K5	BAC 2.01	
W8	Groyne K6	BAC 2.01	
W11	Outfall	BAC 2.01	
W13	Groyne K4	BAC 2.01	
W14	Outfall	BAC 2.01	
W15	Groyne K2, failed seaward end	BAC 2.01	
W16	Groyne K1	BAC 2.01	125
W10	Groyne K7	BAC 2.02	127
W10A	Revetment and breastwork	BAC 2.02	128
WB14	Groyne K 21	BAC 2.03	
WB15	Seawall, sand covered	BAC 2.03	
WB16	Ditto	BAC 2.03	
WB17	Groyne K20	BAC 2.03	131
WB18	Seawall	BAC 2.03	131

Ref. No.	Description of View	Defence Length	Page #
WB19	Groyne K19	BAC 2.03	
WB20	Groyne K18	BAC 2.03	
WB21	Seawall	BAC 2.03	
WB22	Ditto	BAC 2.03	
WB23	Groyne K16	BAC 2.03	
WB24	Groyne K15	BAC 2.03	
WB25	Seawall	BAC 2.03	
WB26	Groyne K14	BAC 2.03	
WB27	Seawall	BAC 2.03	
WB28	Groyne K13	BAC 2.03	
WB29	Joints in seawall	BAC 2.03	
WB30	Seawall	BAC 2.03	
WB31	Groyne K11	BAC 2.03	
WB32	Groyne K9	BAC 2.03	
WB33	Seawall	BAC 2.03	
WB34	Groyne K8	BAC 2.03	
WB35	Junction of seawall and revetment	BAC 2.03	
WB36	Seawall.	BAC 2.03	132
WE7	Seawall	BAC 2.04	
WE8	Groyne K25	BAC 2.04	
WE9	Groyne K24	BAC 2.04	135
WE10	Seawall	BAC 2.04	
WE11	Groyne K23	BAC 2.04	
WE12	Seawall	BAC 2.04	135
WE13	Groyne K22	BAC 2.04	
WE18	Groyne K26	BAC 2.04	
XW3	Minor Spalling at Construction Joint in Sea Wall	BAC 2.04	
XW4	View of Sea Wall and Ramp on to Beach	BAC 2.04	
XW5	View of Sea Wall and Steps on to Beach	BAC 2.04	
XW6	View of Groyne meeting Sea Wall	BAC 2.04	136
XW7	View of End of Groyne	BAC 2.04	
WE4	Seawall	BAC 2.05	
WE5	Ditto	BAC 2.05	
WE6	Ditto	BAC 2.05	138
WE19	Groyne K27	BAC 2.05	139
WE20	Groyne K28	BAC 2.05	
XW1	Sloping Concrete Sea Wall with Exposed Sheet Pile Toe	BAC 2.05	
XW2	Significant Spalling Damage to Sea Wall	BAC 2.05	139
WE1	Groyne K33	BAC 2.06	
WE2	Revetment planks missing	BAC 2.06	
WE3	Groyne L1	BAC 2.06	141
WE4	Seawall	BAC 2.06	
WE5	Seawall	BAC 2.06	
WE21	Groyne K30	BAC 2.06	
WE22	Revetment, note stones clogging “permeable” structure	BAC 2.06	142
WE23	Revetment	BAC 2.06	
WE24	Groyne k31	BAC 2.06	
WE25	Revetment	BAC 2.06	
WE26	Revetment	BAC 2.06	142