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HUNDALE POINT– SCALBY NESS COSTAL STRATEGY STUDY

EXECUTIVE SUMMARY

The Hundale Point to Scalby Ness coastal defence strategy study discusses the results and recommendations of the Shoreline Management Plan (SMP), which provides the basis for sustainable coastal defence policies along the North Yorkshire coastline. In addition to assessing the coastal processes operating in the Hundale Point – Scalby Ness area (Management Unit 19E), the study assesses the coastal and fluvial elements of Scalby Beck and the coastal regime upon the rock cliffs and the overlying glacial till slopes in proximity to the properties and amenities in the southern section of the study area and the remainder of the management unit. The aim of this strategy is to provide an environmentally and technically acceptable coastal defence strategy sustainable for the next 60 years. The study has been carried out in accordance with FCDPAG's 1 – 5.

The majority of the study area lies within the Heritage Coast Boundary (as far south as Scalby Ness Headland). The coastal frontage of the study area is a SSSI including the north bank of Scalby Beck. Scalby Beck to Long Nab is a Site of Nature Conservation Importance. Only the northern part of the study area lies within the North York Moors National Park.

The strategy study identifies the problems that are associated with the beck and coastal slopes and has determined that there is the potential for large-scale failure of the northeasterly and northwesterly facing slopes. Based on engineering judgement and slope stability analysis a do nothing scenario has identified that failure of these slopes is possible by Year 2 and that the consequences of stream flow being impounded following a major landslide into the beck will have detrimental effects to the slopes upstream.

It has been determined that toe erosion of the beck slopes is triggered by a combination of high sea levels, storminess and when the river is in flood. Insufficient data is available to model significant marine influence upstream, although it is considered to extend beyond the northeasterly facing slope.

It is considered that a do nothing strategy is acceptable for the coastal slopes north of Scalby Sands (ie no shoreline management activity required during the strategy period - assets are a distance greater than the predicted rates of recession for the strategy period). Cliff recession above Scalby Sands and the adjacent southwesterly facing beck slope has resulted in very steep, actively eroding glacial till slopes with a crest width of ~3m available for users of the Cleveland Way; low cost slope betterment works and minor maintenance will be required to maintain safe public access.

South of Scalby Sands and within the beck area the do nothing option is not acceptable. Analysis has shown that marine influence extends beyond the westerly turn of the Scalby Beck to the base of the northwesterly facing slope. High tides and high levels of the beck are detrimental to toe slope stability. Slope stability analysis has identified that some 30m of cliff top loss, which would involve significant losses of property, and the lower part of Scalby Mills Road.

The preferred coastal defence strategy developed for Scalby Ness – Hundale Point is described in detail and is discussed along with the adopted strategy (and preferred scheme) for the Management Sub Unit 20A (of the Holbeck – Scalby Mills Coastal Defence Strategy Study).

Given the rapidly deteriorating condition of the coastal and beck slopes it is recommended that a strategy involving toe protection and slope stabilisation of the northeasterly facing beck slope, together with a programme of regular inspection/ monitoring and maintenance are implemented to ensure that the current coastal defence policy for Scalby Ness outlined in the SMP remains sustainable over a 60 year period

The preferred strategy comprises:

- the construction of slope stabilisation measures (mechanical stabilisation by piling along with drainage) on the northeasterly facing beck slope along with a series of slope top betterment works to prevent progressive failure below the Scalby properties (the current minimum width is 8m from the cliff top edge to the properties),
- toe protection works (comprising a rock armour revetment which will dissipate wave/fluvial energy and weight the toe of the slope without hindering beck flow);
- Regular monitoring and inspection of the slopes above the beck, Scalby Sands and the Headland

- maintenance of the slopes as and when necessary following monitoring and inspection (including the removal of any slope debris falling into the beck); the construction of slope betterment works on the oversteepened northwesterly facing slope upstream of Scalby Beck; and, on the coastal and beck slopes at the pinch point above Scalby Sands. The latter will maintain public access along the Cleveland Way and delay Scalby Ness Headland from effectively becoming an island. These works are considered non-eligible for coastal protection works.

The PV Costs attributed to implementing the preferred coastal defence strategy have been assessed at **£1,811k**, of which it is considered **£1,614k** is grant eligible. Taking the PV Benefits derived by a probabilistic assessment of the likelihood of a failure event occurring by Year 2 (**£11,811k** – do nothing pv damages), it has been established that if the works associated with the preferred coastal defence strategy are implemented in Year 2, a benefit cost ratio of **6.6** is attainable. The estimated benefit to accrue from the scheme implementation in pv terms is **£11,683k**. Risk and sensitivity analyses of the residual damages, increases in costs of construction, no losses of tourism and delaying erosion losses demonstrates that the strategy is robust.

During the process of the strategy study a number of statutory and relevant local consultees were invited to comment on any issues of due concern regarding the strategy study area. No significant comments were made. It is anticipated that there will be some short term harm to the environment during the construction phase, thereafter the natural habitat will re-establish itself.

The DEFRA strategy prioritisation score is **16.54** based on the CBR (6.6) and 68 number residential units.

HUNDALE POINT TO SCALBY MILLS COASTAL DEFENCE STRATEGY STUDY

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1.0 OVERVIEW

1.1 Background

The study area, Scalby Mills to Hundale Point, is located immediately north of Scarborough's North Bay, on the North Yorkshire coastline. The study area is 4 km long and comprises steep coastal cliffs from Hundale Point to Scalby Mills, where at Scalby Mills a headland (Scalby Ness) is separated from the Scarborough's North Bay by Scalby Beck (see Figure 1.1). The ~30m high coastal cliffs have a near vertical lower part where they have formed from rock and a shallower angle upper section which is formed from glacial till. The study area is generally fronted by a rock platform and in places boulder, cobble and sand material. The majority of the coastline is used as agricultural land and apart from the southern bank of Scalby Beck, there are very few properties within the study area, all of which are some distance from the cliff top edge. A relatively recent housing development was built on the southern bank of the beck in the 1970's and is presently, at its closest point, some 8m from the bank top edge. A public house is also situated lower down the southern bank near the mouth of the beck. The study area is subject to direct wave action, as there are no coastal or fluvial defences.

Scalby Beck emerges from the River Derwent near Everley and runs a distance of approximately 8km in an easterly direction, through Scalby. Locally, at Scalby Mills, the Scalby Beck flows northeast and then turns sharply southeast at Scalby Ness to outfall to the sea between the Sea Life Centre and Scalby Ness headland. Scalby Beck acts as an overflow to the River Derwent. The River Derwent is prone to flooding, and the Scalby Beck acts as a relief channel during periods of flooding.

The river outfall is affected by marine influences. Observations on site indicate wave rush and backing up of the river during periods of high sea states. Tidal influence and storm surge significantly restrict the outfall characteristics of the river particularly during spring tides and strong southeasterly winds. The interaction of flood river water and tidal action during storm conditions adversely affects the toes of slopes associated with the beck and the adjacent coastal slopes. Part of the housing development at Scalby Mills, lies to the south and west of Scalby Beck at the top of the slopes. Existing slopes supporting the development have degraded with time and the crest of slopes is receding towards housing.

The coastal frontage is situated within the North Yorkshire and Cleveland Heritage Coast and is a Site of Special Scientific Interest.

Scarborough Borough Council wants to prevent further instability and the potential for large scale failures in order to protect properties and infrastructure of the Scalby area and feels that a coastal strategy study is essential in the process of achieving this.

1.2 Terms of Reference

High-Point Rendel were instructed to provide Scarborough Borough Council with a proposal for the Hundale Point to Scalby Ness Coastal Strategy Study in the Council's letter dated 23 April 2001. HPR replied to SBC with their proposal sent undercover of their letter dated 24 May 2002 (ref.1404/3.3/05). SBC accepted HPR's proposal and instructed them to proceed with the Hundale Point to Scalby Ness Coastal Strategy Study in their letter dated 28 January 2002 (ref.CJM/JM TLJ384 19/7/29).

1.3 Scope of this Report

The strategy study assesses the coastal processes operating in Management Unit 19E and the behaviour of the neighbouring coastal areas. An understanding of the prevailing coastal processes and the risk potential of cliff stability is essential if the preferred coastal defence strategy is to be sustainable over the next 60 years.

The aim of the strategy study is to identify appropriate and environmentally acceptable coastal defence management and outline scheme options for the Scalby Ness coastline, for a period of the next 60 years. Specific objectives that will be addressed include:

- division of the management unit into shorter management sub-units based upon common characteristics exhibited by discreet units of coastline (e.g. geology, geomorphology, coastal/fluvial processes, presence of existing defences, etc);
- definition of the nature and extent of the coastal erosion and cliff stability problems;
- collation and evaluation of existing information describing the discharge regime of Scalby Beck;
- characterisation of Scalby Beck fluvial processes and evolutionary trends;
- establish the tidal influences within Scalby Beck;
- assessment of the nature and condition of the existing coastal defences (seawalls, groynes, etc;
- review and analysis of historic, current and future coastal and beach processes to assess their significance for constraining/directing the choice of management and outline scheme options;
- develop a coastal sediment budget for the area;
- identification of the planning and environmental constraints which influence the choice of scheme options;
- identifying a range of scheme options;
- identify, quantify and, where possible, value the costs, benefits and uncertainties of main options;
- identify and provide budget estimates for the preferred options;
- undertake a preliminary environmental impact assessment for the preferred options;
- evaluation of the requirements for additional specialist studies to support the detailed design of the preferred option;
- early consultation with statutory consultees and interested parties; and
- develop a strategic approach for the area with identified priorities.

Furthermore, the strategy study identifies monitoring and maintenance programmes that require implementation to ensure that the long-term performance of the coastal slopes, beaches and environment are maintained.

The framework and approach of the strategy study, based on DEFRA's Flood and Coastal Defence Project Appraisal Guidance 1-5 documents, is intended to provide a broad overview of the problems and present a range of possible options for their solution and management. It is not intended to provide high levels of detail sufficient for the design of scheme options. Although preferred options are recommended they are based on current information. Further consideration should be given to the preferred options during the preparation of the Engineer's Report on the basis of further studies, investigations and monitoring.

This report incorporates work undertaken as part of the Scalby Ness Rapid Risk Assessment and Strategic Coastal Monitoring, Staithes to Scarborough reports both undertaken by High-Point Rendel on behalf of Scarborough Borough Council in 2002.

2.0 THE STRATEGIC APPROACH

2.1 Key Issues

The SMP Policy for the majority of the coastal frontage suggests do nothing, which is apparent from no shoreline assets to protect from Scalby Ness to Hundale Point. However, the problem of instability regarding the slopes of the beck and the assets that may be lost through failure require a thorough examination on a strategic level.

A strategic approach to determine a solution to the problems in this management subunit is desirable and the aim will be to determine a long-term plan to sustain the property and the infrastructure whilst providing options that will not be detrimental to the environment and enhance the economic potential of the area.

2.2 Shoreline Management Plan

The Shoreline Management Plan (SMP) for the Huntcliffe (Saltburn) to Flamborough Head (Sub Cell 1d) produced by Mouchel Consulting Limited, 1996 outlined the future objectives for the management of the shoreline and provides the basis for sustainable defence policies.

Consideration and comparison has been made with the policy options given in the SMP for each of the management units under consideration (Figure 2.1). The preferred coastal defence option for Management Unit 19E (between Hundale Point to Scalby Mills) as defined in the Shoreline Management Plan is, albeit somewhat ambiguous:

> *'... a composite system of management strategies producing a transition from do nothing to retreat the existing line.*
>
> *'This graduation of strategy moving southward through the unit achieves the transition between the Do Nothing option proposed for the majority of units, immediately to the north, to the Hold the Existing Defence lines strategies for Scarborough to the south.'*

The SMP identifies that the objectives for the retreat the existing defence line strategy are generally achieved, however for the majority of the unit from Hundale Point to Scalby Ness Sands the practicality and economics of such a strategy cannot be justified and the SMP states that a dual but complementary low/no maintenance management policy is required to achieve a balanced strategy for the unit.

The policy of this coastal strategy remains consistent with the current SMP policy option for the few isolated properties located some distance from the cliff line along the majority of the coastal management unit and for the concentrated location of properties along the southern bank of the beck. The recently constructed Yorkshire Water WWT works is set back from the cliff edge at a distance (>200m) considered greater than future cliff recession rates during the strategy period. Based on this it follows that any future coastal defence strategy must include:

- Maintain the line of the assets situated above the slopes of Scalby Beck in the vicinity of Scalby
- Maintain the existing access between Scalby Ness headland and the coastal frontage to the north
- routine monitoring of both the coastal slopes and foreshore
- routine maintenance of the coastal slopes

(Note the coastal defences south of Scalby Mills Pub are recognised to form part MU 20/A).

For the majority of the unit 'do nothing' is the most practical and economically justifiable management strategy. However complications occur at the southern end of the coast where Scalby Ness effectively provides a degree of protection to the buildings at Scalby Mills and the developed frontage of Scarborough North Bay. Consequently the SMP report recommended 'Hold the Existing Defence Line', whilst clearly inappropriate for the majority of the frontage does potentially offer benefits if applied to the Scalby Ness headland area.

2.2.1 Management Sub-Units

The SMP identifies the Hundale Point to Scalby Ness coastline as a separate Management Unit (19E). This unit is described as being characterised by unprotected steep cliffs fronted by pronounced rock platforms, boulders and large shingle. The cliffs comprise a steep lower section developed in bedrock, with an upper section developed in glacial till.

Cliff recession involves a variety of landslide forms, from mudslides and debris slides generated within the glacial tills that form the upper cliff sections, and rock falls from the lower bedrock sections. Although the recession process is driven by wave attack at the cliff foot, internal slope processes (e.g. weathering and high pore water pressures) are important in controlling much of the landslide activity, especially on the glacial till sections.

The Management Unit can be sub-divided into a number of sub-units as follows (see Figure 2.1):

1. *Hundale Point to Long Nab*; this sub-unit comprises a fringing boulder rampart backed by 30m high bedrock cliffs with a thin (<5m thick) mantle of till. Prominent rock ledges front much of the cliffline, developed in Scarborough and Scalby Formation rocks (Figure 2.2). A cobble and boulder beach occurs towards the southern end of this section.

   Typical cliff recession events include a combination of falls and translational slides from the rock cliff and small slumps of the till mantle.

2. *Long Nab to Cromer Point*; this sub-unit is dominated by a fringing shingle and cobble beach backed by high composite cliffs developed glacial till and bedrock. Between Long Nab and Crook Ness, the glacial till is generally less than 5m thick; beyond Crook Ness the till thickness increases to around 25m. Prominent rock

ledges front much of the cliffline, developed in Scarborough and Scalby Formation rocks (Figure 2.2).

Cliff recession is generally dominated by high-angled debris slides generated within the glacial tills and rockfalls from the lower seacliff.

3. *Cromer Point to Scalby Ness Sands*; this sub-unit comprises a series of small pocket shingle and cobble beaches retained within small, secondary headlands. The whole sub-unit is backed by high composite (glacial till over Scalby Formation bedrock) cliffs. Till thickness probably exceed 25m in places. Prominent rock ledges front much of the cliffline.

   Recession of the glacial till upper cliff involves a combination of high-angled debris slides and elongate mudslides. Small rockfalls occur from the lower seacliff.

4. *Scalby Ness Sands*; this sub-unit is dominated by a fringing shingle/cobble and sand beach backed by composite (glacial till over Scalby Formation bedrock) cliffs. Prominent rock ledges are a feature of this sub-unit.

   This section of cliff appears to have been fashioned by deeper-seated rotational and translational landslides, probably confined to glacial tills that form much of the cliff.

5. *Scalby Ness*; this near-detached headland is developed in Scalby Formation Moor Grits and Long Nab Member shales (Figure 2.2). The shoreline comprises a fringing boulder rampart and prominent rock ledges.

   The upper glacial till sections of the cliff appear to have failed as deeper-seated rotational slides, notably on the northern and southern sides of the headland. High angled debris slides and mudslides also have developed in places; rockfalls and topples have developed on the rock cliff.

6. *Scalby Beck*; this sub-unit comprises the banks of Scalby Beck from Whitby Bridge Road to the mouth of the beck into the North Bay. The slopes generally comprise glacial till, the northeasterly and southwesterly facing slopes have bedrock exposed at beck level.

   The glacial till slopes have failed by surface slumping and high angled debris slides.

The above slopes and coastal cliffs are discussed in more detail in Section 3.

2.3 Review of Current Data

The data used and a brief resume of the data can be observed in Appendix A.

The strategy will require integration with the preferred strategy of the Sea Life Centre Management Sub-unit of the Holbeck-Scalby Mills Coastal Strategy Study undertaken in 1999. The proposed strategy for the Sea Life Centre is discussed later within this report.

2.4 Environmental Considerations

Any future capital schemes must take into account the environmentally sensitive nature of the site and must utilise techniques which are sympathetic with the local environment. Full discussion and liaison with all interested parties including English Nature and North Yorks Moors National Park Authority must be held during the detailed design of any future capital scheme or improvement works. In all future circumstances it is likely that compromises will be required between engineering and environmental considerations in order to develop appropriate cost effective solutions that are in keeping with the environmentally sensitive locality.

The coastal frontage and hinterland areas of the SMP Management Unit 19E fall within the North Yorkshire and Cleveland Heritage Coast and partly within the North Yorkshire Moors and include :

Iron Scar & Hundale Point to Scalby Ness is a geological Site of Special Scientific Interest (SSSI), and site of national importance for its exposures of Jurassic succession, with rich fossil beds occurring at Cloughton Wyke and Scalby Ness. The SSSI includes strata exposed within coastal cliffs at Scalby Ness Rocks and slopes north of the Scalby Beck.

The site is identified in the SBC Local Plan adopted in April 1999 as containing a designated Site of Importance for Nature Conservation (SINC). It also borders a number of tourism / recreational developments in the form of the Sea Life Centre, a public house, camping and caravan parks.

An Environmental Scoping Document was produced regarding the early development of the strategy study and was issued to the relevant statutory consultees and third parties (see Appendix B for the list of Consultees and comments received). The document outlined the background to the coastal strategy and the rationale for undertaking an environmental overview of the strategy options that may evolve. All consultees were offered the opportunity to comment on the proposed scope and content of the document.

Following the submission of the draft strategy document to Scarborough Borough Council in September 2002, a three month period of consultation commenced in December 2002. The list and addresses of the statutory and non-statutory consultees consulted in December 2002 is given in Appendix B, along with the documentation provided by High-Point Rendel.

Comments received during the Consultation period December 2002 to February 2003 are discussed in Section 4.8.

2.5 Coastal and Fluvial Processes

2.5.1 Introduction

This section of the report reviews the wave and tidal climate of the Scalby Ness Coastal Strategy area, a geomorphological assessment of shoreline processes and preparation of a sediment budget.

Specific items that were highlighted in the brief were:

1. **wave and tidal climate:**
   - annual sea level maxima;
   - extreme water levels, including storm surges;
   - sea level changes over the next 60 years and their potential impact upon coastal erosion rates and slope instability processes.

2. **geomorphological assessment:**
   - the stability of the cliffs;
   - the significance of sediment supply from the cliffs on the integrity of other landforms on the neighbouring coast;
   - the possible impact of coast protection schemes on the longshore transport of sediment and the sediment budget within the coastal cell.

The following is based on a combination of walk-over inspection of the shoreline and a review of available reports and documents. Very little of the available information relates directly to the Hundale Point to Scalby Ness coastline. Reference is made, therefore, to information collected for nearby Scarborough.

2.5.2 Tides and Tidal Currents

The tides off the North Yorkshire coast are driven by the amphidromic system in the German Bight of the North Sea. Table 2.1, below, summarises the astronomical tide levels for nearby Scarborough.

Table 2.1 Astronomical tide levels: Scarborough

Condition	Water Level (m OD)	Water Level (m Chart Datum)
MLWS	-2.35	0.9
MLWN	-0.95	3.2
MHWN	1.35	4.6
MHWS	2.45	5.7
HAT	3.05	6.3

Extreme water levels can be generated by the passage of deep depressions across the North Sea. When the depression moves rapidly across the sea, the elevation of the water level moves correspondingly as a storm surge. The Proudman Oceanographic Laboratory (POL, 1995) has published extreme water level data for a number of sites round the UK coast, including Whitby and Immingham. Extremes for sites between these locations can be derived using data from POL's spatial tidal elevation model; Table 2.2 presents the extreme water levels estimated by HR Wallingford (1998) for Scarborough.

Table 2.2 Extreme water levels: Scarborough (from HR Wallingford 1998)

Return Period Water Level	Water Level (m OD)	Water Level (m Chart Datum)
10:1 year	3.0	6.25
1:1 year	3.35	6.6
1: 10 years	3.53	6.78
1:20 years	3.60	6.85
1:50 years	3.74	6.99
1:100 years	3.87	7.12

During each tidal period the flood-tidal stream enters the area from the north, flowing in a southerly direction parallel to the coast. After slack water the tide ebbs in the opposite direction. HR Wallingford (2001) present the results of hydrodynamic modelling of a mean spring tide along the Scarborough coastline (Figure 2.2). This work revealed a number of points that are probably applicable to the Scalby Ness to Hundale Point coast:

- nearshore peak tidal currents are likely to be weak, less than 0.2m/s;
- the establishment of clockwise tidal gyres between headlands, indicating that there is likely to be an ebb dominance to the tidal cycle, with residual currents producing a net weak northerly flow.

2.5.3 Waves

Waves are generated by winds moving across the open sea. Wind data can be used to generate a predicted *offshore wave climate.* HR Wallingford (2001) used wind data from October 1986 to May 2000 to produce an offshore wave climate for Scarborough. The results are summarised in Table 2.3 and reveal that waves up to 8.5m have been predicted for the sector 330-360°.

As waves travel into shallow water they are transformed by the nearshore bathymetry, resulting in changes to both wave height and direction. Figure 2.3 presents a typical wave rose for North Bay, Scarborough and highlights the dominance of waves from ENE to ESE; this plot is likely to be representative of conditions within the bays between the headlands on the Scalby Ness to Hundale Point coast.

Table 2.3 Scatter diagram for offshore wave climate: Scarborough (from HR Wallingford 2001)

Total number of hours = 119808
Based on HINDWAVE predictions for October 1986 - May 2000

H1	To H2	P(H>H1)	Wave direction in degrees North											
			0 30	30 60	60 90	90 120	120 150	150 180	180 210	210 240	240 270	270 300	300 330	330 360
0.00	0.50	0.96037	1656	1129	1228	1375	1763	2061	2191	2255	2170	2065	1896	1725
0.50	1.00	0.74523	1335	855	887	1356	1693	2910	3262	2335	2811	3812	1941	1664
1.00	1.50	0.49661	1425	665	711	848	1492	3433	2587	2146	2715	3685	3067	1943
1.50	2.00	0.24942	511	163	235	293	771	2027	1179	437	1248	2128	1590	691
2.00	2.50	0.13672	191	51	56	254	830	819	179	63	260	570	970	1346
2.50	3.00	0.08083	750	493	559	346	409	280	3	13	28	152	533	645
3.00	3.50	0.03870	404	208	260	386	184	36	5	3	12	80	193	433
3.50	4.00	0.01667	44	19	7	39	73	10	0	0	0	11	48	283
4.00	4.50	0.01133	119	95	130	139	10	0	0	0	0	0	2	110
4.50	5.00	0.00528	73	6	1	67	0	0	0	0	0	0	3	90
5.00	5.50	0.00287	7	24	114	10	0	0	0	0	0	0	0	21
5.50	6.00	0.00111	16	0	17	18	0	0	0	0	0	0	0	8
6.00	6.50	0.00053	6	6	7	0	0	0	0	0	0	0	0	7
6.50	7.00	0.00028	0	0	0	0	0	0	0	0	0	0	0	6
7.00	7.50	0.00022	0	0	0	0	0	0	0	0	0	0	0	18
7.50	8.00	0.00004	0	0	0	0	0	0	0	0	0	0	0	0
8.00	8.50	0.00004	0	0	0	0	0	0	0	0	0	0	0	4
Parts per thousand for each direction			68	39	44	53	75	121	98	75	96	130	107	94

Table 2.4 presents the results of an assessment of extreme wave conditions for the Scarborough Sealife Centre, immediately south of Scalby Ness (HR Wallingford 1998).

Table 2.4 Extreme wave conditions for the Scarborough Sealife Centre (HR Wallingford 1998).

Return Period (years)	Northerly		Easterly	
	Hs (m)	Tm (s)	Hs (m)	Tm (s)
0.1	1.80	4.58	4.51	7.93
1	2.51	5.41	4.51	10.03
10	3.14	6.05	4.51	11.68
50	3.55	6.43	4.51	12.68
100	3.71	6.58	4.51	13.08

Notes: Hs is the significant wave height (the mean of the highest third of waves in the modelled series). Tm is the mean wave period (the time taken for 2 successive wave crests to pass a point).

This suggests that within the bays nearshore waves are probably limited to a maximum height of around 4.5m by the seabed bathymetry. Larger waves could be expected at the headlands where refraction will tend to increase the nearshore wave height (modelling of extreme waves at Scarborough suggests that waves up to 4.92m could be experienced at Castle Headland).

The most severe sea conditions occur when high waves coincide with extreme water levels. HR Wallingford (1998) estimated the joint probability of waves and water levels for the Scarborough coast. The results for the Sealife Centre are presented in Table 2.5; these are likely to be broadly representative of conditions along the Scalby Ness to Hundale Point coast. For a given return period, any of the listed combinations of water level and waves (either Easterly or Northerly) may be the worst case.

Table 2.5 Joint probability of water levels and wave height for the Scarborough Sealife Centre (from HR Wallingford 1998).

Joint Return Period	Water Level (m)	Northerly Wave (Hs)	Easterly Wave (Hs)
10	3.0	3.0	4.8
	13.35	2.5	5.0
	3.45	2.0	5.1
	3.53	2.0	4.0
20	3.0	3.3	4.8
	3.35	2.7	5.0
	3.45	2.3	5.1
	3.53	2.0	5.1
	3.6	1.8	4.5
50	3.35	3.0	5.0
	3.45	2.6	5.1
	3.53	2.4	5.1
	3.6	2.3	5.1
	3.74	2.9	4.5
100	3.35	3.3	5.0
	3.45	2.9	5.1
	3.53	2.7	5.1
	3.6	2.5	5.1
	3.74	2.3	5.2
	3.87	2.1	5.0

2.5.4 Sediment Budget

To understand the development of the beaches along this shoreline it is useful to consider the beach as a store of gravel and sand supplied from source areas on the adjacent coastline or offshore. Thus, the beaches can be viewed as parts of a larger system (a "coastal cell" or "sediment transport cell") within which a range of sediment transfers takes place (Figure 2.5). Beach building material might be supplied from the seabed, moved onshore by wave energy, or from rivers and eroding cliffs. This material is then redistributed along the shoreline by waves ("longshore drift"), unless prevented by barriers such as headlands or breakwaters (e.g. Cromer Point). Although these barriers might prevent longshore drift, some of the material can still be "lost" to the system around the seaward end of the barriers or offshore, particularly during large storms.

Sediment inputs and longshore drift are not necessarily constant over time and so it is important to consider the current beach behaviour within the context of the changes that might have occurred over the period of the historical record. Over time, the balance between sediment inputs and outputs (i.e. the sediment budget) within the system will determine whether the beach experiences growth, decline or has remained constant in overall size.

It is estimated that the glacial tills within the cliffs deliver around 17,000m^3 per metre of cliff recession of potential beach-building material (i.e. sand, gravel and cobbles) to the shoreline (Table 2.6; assuming average coarse sediment content of 25% of the glacial till and that the bedrock lower cliffs do not supply significant quantities of coarse material).

Table 2.6 Estimated sediment yield from the Scalby Ness to Hundale Point Cliffs

Cliff Section	Cliff Length (m)	Estimated Average Till Thickness (m)	Estimated Coarse Sediment Proportion	Potential Coarse Sediment Yield m^3/m recession
Hundale Point – Long Nab	900	5	0.25	1125
Long Nab – Crook Ness	600	5	0.25	750
Crook Ness – Cromer Point	700	15	0.25	2625
Cromer Point – Scalby Ness	2500	20	0.25	12500
			TOTAL	17000

Only the coarser till debris and rockfall boulders appears to be retained within each sub-unit, where it forms the fringing and pocket beaches described earlier. These are lag deposits. All the fines, sand, much of the gravel and some cobbles is removed offshore by wave action. Only in more sheltered sites, such as Scalby Ness Sands are the waters calm enough to allow sand to remain on the foreshore.

Extensive spreads of sand are reported to lie off the North Yorkshire coast, in water depths of between 5-15m. It is estimated that some 20-40Mm^3 of sediment may be held in this store (assuming an average thickness of 1-2m and an area of 2000ha). Individual pocket sand beaches on the North Yorkshire coast, such as those at Runswick Bay and Whitby/Sandsend, are connected to this sand sheet by sand-filled channels that run normal to the shoreline, between the rock shore platforms. Although this material is probably suspended in waters off the shoreline, transported by the tidal currents, it does not settle because of the very high turbulent wave velocities across the rock ledges that front much of this shoreline.

Within each of the sub-units there appears to be limited southwards longshore redistribution of the coarse sediment, under wave action. This has lead to the tendency for the fringing beaches to be larger towards the southern end of each sub-unit. However, the presence of prominent headlands suggests that it is unlikely that any material is exchanged between the sub-units through longshore transport.

It is difficult to quantify the sediment budget for this coastline. However, it is clear that the bulk of the material supplied to the foreshore by cliff instability will be removed offshore by wave action. This material probably contributes to the relatively large spreads of sand known to exist on the seabed in depths of 5-15m of water.

A summary of the key sediment budget issues for each sub-unit is presented in Table 2.7. Although relatively large quantities of sediment are released from the eroding cliffs it is likely that this represents only a minor contribution to the offshore stores of sediment. Other than being important for maintaining the fringing and pocket within each of the sub-units, the sediment yield from the cliffs is unlikely to be critical for maintaining the integrity of the beaches of the adjacent Scarborough coastline. These beaches are more likely to be dependent on the regional offshore sand stores. It follows that the sediment budget related impacts of coast protection schemes are likely to be localised (i.e. within sub-unit), rather than regional.

Table 2.7 A summary of the key sediment budget issues for each sub-unit

Sub-Unit	Sediment Inputs	Sediment Transport	Sediment Outputs
Hundale Point – Long Nab	Cliff recession inputs of c.1125m^3/m recession.	Longshore redistribution of shingle and cobbles within the sub-unit.	Offshore removal of all fines, sand and much of the gravel/cobble component. No longshore exchanges with adjacent sub-units.
Long Nab – Cromer Point	Cliff recession inputs of c.3375m^3/m recession.	Longshore redistribution of shingle and cobbles within the sub-unit.	Offshore removal of all fines, sand and much of the gravel/cobble component. No longshore exchanges with adjacent sub-units.
Cromer Point – Scalby Ness Sands	Cliff recession inputs of c.7500 m^3/m recession.	Coarse material retained within pocket beaches.	Offshore removal of all fines, sand and much of the gravel/cobble component. No longshore exchanges with adjacent sub-units.
Scalby Ness Sands	Cliff recession inputs of c.2500 m^3/m recession.	Longshore redistribution of shingle and cobbles within the sub-unit.	Offshore removal of all fines, some sand and gravel/cobble component. No longshore exchanges with adjacent sub-units.
Scalby Ness	Cliff recession inputs of c.2500 m^3/m recession.	Limited longshore redistribution of cobbles within the sub-unit.	Offshore removal of all fines, sand and much of the gravel/cobble component. No longshore exchanges with adjacent sub-units

2.5.5 Mean Sea Level Rise and Climate Change

Evidence from tide gauge records around Britain has indicated that sea level has been rising over the last 100 years or so (Table 2.8). It is likely that the Hundale Point– Scalby Ness coast has experienced sea level rise in the order of 0.5 to 1.1mm/year over this period. It is possible that the coastline has responded to this rise through accelerated recession rates, although there is little clear evidence to support this view.

Table 2.8 A summary of the recorded sea-level changes at North Shields and Immingham (from Woodworth et al 1999).

Location	Period	Mean sea-level trend	Mean sea-level rise relative to Newlyn	Land submergence rate (approx.)	Relative sea-level rise	Acceleration in trend
North Shields	1901-1996	1.86mm/year ± 0.15	0.26mm/year ± 0.15	0.08mm/year	1.14mm/year ± 0.13	0.8mm/year/century
Immingham	1960-1995	1.11mm/year ± 0.52	Not available	Not available	0.51mm/year ± 0.69	Not available

The predicted climate changes, as a result of human activity, expected over the next century are expected to increase risks from cliff recession. Mean sea-level on the north-east coast is expected to rise by up to 0.3m over the next 50 years (Table 2.9), probably resulting in increased frequency of wave attack at the cliff foot and more efficient debris removal from the foreshore. The predicted changes would result in more rapid rates of sea-level rise than those that have been recorded for England and Wales over the past 5000-6000 years.

By the 2050s, the rise in mean sea-level is predicted to increase the frequency of extreme high water levels from once a century to, typically, once a decade. Recent modelling by the Hadley Centre (1998) suggests that an increase in the frequency of extreme high water levels arising as a result of a combination of high tides and storms. For example, for North Shields it has been estimated that, with an effective mean sea-level rise of 0.2m, the current 100 year water level would, by 2050, be the equivalent of a 20 year return period water level. This situation would be further exacerbated if storminess were to increase (Hadley Centre 1998).

DEFRA recommend an allowance for future mean sea level rise (relative to the land) of 4mm per year for this area (MAFF 1999), implying a sea level rise of 24cm over the next 60 years.

Recent modelling by the Hadley Centre (e.g. Hulme et al 1998) has predicted climatic changes that are likely to have a marked impact on cliff stability. For example these changes include:

- an increase in average summer temperatures by around 2.5°C;
- an increase in the average winter rainfall (December, January, February), by around 0.5mm/day;

The implications of the predicted increase in winter rainfall on slope stability are likely to be potentially serious, given the sensitivity of many glacial till cliffs to groundwater.

Table 2.9 Changes in the return period of the current 100-year water level with predicted sea-level rise data for various locations in Britain (after the Hadley Centre 1998).

Port	Effective sea-level rise	Approximate return period for the current 100 year water level by 2050s
North Shields	20cm	20 years
Harwich	31cm	20 years

2.6 Summary of Coastal Processes

Unprotected steep cliffs fronted by pronounced rock platforms, with discontinuous boulder, cobble and shingle beaches, dominate the stretch of coastline between Scalby Ness and Hundale Point. The cliffs comprise a steep lower section developed in bedrock, with an upper section developed in variable thicknesses of glacial till. The shoreline is exposed to large waves (extreme nearshore waves are probably in the order of 4.5m high), particularly from the eastern sector. Storm surges can generate water levels in excess of 1.5m higher than the predicted highest astronomical tide levels. The tidal flow is probably ebb-dominant, producing a relatively weak residual northerly flow.

The coastline can be sub-divided into a number of sub-units as follows:

1. *Management Subunit 19E/I Hundale Point to Long Nab*;
2. *Management Subunit 19E/II Long Nab to Cromer Point*;
3. *Management Subunit 19E/III Cromer Point to Scalby Ness Sands*;
4. *Management Subunit 19E/IV Scalby Ness Sands*;
5. *Management Subunit 19E/V Scalby Ness;*
6. *Management Subunit 19E/VI Scalby Beck.*

Cliff recession involves a variety of landslide forms, from mudslides and debris slides generated within the glacial tills that form the upper cliff sections, and rock falls from the lower bedrock sections. Although the recession process is driven by wave attack at the cliff foot, internal slope processes (e.g. weathering and high pore water pressures) are important in controlling much of the landslide activity, especially on the glacial till sections.

It is estimated that the glacial tills within the cliffs deliver around 17,000m^3 per metre of cliff recession of potential beach-building material (i.e. sand, gravel and cobbles) to the shoreline. Only the coarser till debris and rockfall boulders appears to be retained within each sub-unit, where it forms fringing and pocket beaches. All the fines, sand, much of the gravel and some cobbles is removed offshore by wave action. Only in more 'sheltered' sites, such as Scalby Ness Sands where there is also protection from Scalby Ness Headland from longshore drift, are the waters calm enough to allow sand to remain on the foreshore.

Within each of the sub-units there appears to be limited southwards longshore redistribution of the coarse sediment, under wave action. This has lead to the tendency for the fringing beaches to be larger towards the southern end of each sub-unit. However, the presence of prominent headlands suggests that it is unlikely that any material is exchanged between the sub-units through longshore transport.

The bulk of the material supplied to the foreshore by cliff instability is removed offshore by wave action. This material probably contributes to the relatively large spreads of sand known to exist on the seabed in depths of 5-15m of water.

Other than being important for maintaining the fringing and pocket within each of the sub-units, the sediment yield from the cliffs is unlikely to be critical for maintaining the integrity of the beaches of the adjacent Scarborough coastline. These beaches are more likely to be dependent on the regional offshore sand stores. It follows that the sediment budget related impacts of coast protection schemes are likely to be localised (i.e. within sub-unit), rather than regional.

Sea-level on this coast is expected to rise by up to 0.24m over the next 60 years, probably resulting in increased frequency of wave attack at the cliff foot and more efficient debris removal from the foreshore. The predicted increase in winter rainfall is also likely to have an effect on the stability of the glacial till portions of the cliffs, as they are sensitive to changes in groundwater.

3.0 THE PROBLEM

3.1 Coastal & Beck Slope Stability Assessment

3.1.1 Introduction

In order to provide a sustainable integrated coastal defence strategy for the study area, it is essential to establish the mechanism of potential landslip and the effects of coastal erosion within the study area. It is apparent that the coastal slopes and the lower reaches of the beck are subject to marine action, and, therefore, coastal erosion has the potential to induce slope instability. In addition to the effects of coastal erosion and the solutions to any problems identified it is necessary to determine and prioritise the most appropriate and cost effective slope/cliff management programmes.

3.1.2 Engineering Geology Assessment of the Coastal Slopes – Management Sub-Units 19E/I to V

The coastal slopes comprise a varying height of sandstone and shale (7 to 15m thick) capped by a glacial till layer (15 to 4m), typical of the North Yorkshire coastline. The cliffs are recessing due to wave attack at the toe of the cliffs which results in an oversteepening of these cliffs and the subsequent failure through a toppling-like motion or in a translational slide. Lower rock cliff failures undermine the overlying glacial till, which along with high groundwater levels, results in the following types of failures.

- Deeper-seated rotational slides which has resulted in the scallop-like scars remaining along the cliff top, at an angle lying between 30° and 50 °
- high-angled debris slides with up to 1m vertical backscars
- elongated mudslides.

The angle at which the glacial till fails is subject to the composition of the material (clay/sand ratio) and its fabric. Other factors which affect the stability of the glacial till include the rate of the lower rock recession and the groundwater level. The stability of the slopes are a function of the groundwater level resulting from the quantity of rainfall in the catchment area and the potential for porewater pressures to build up which reduces the strength of the material and the holding properties binding the material together. Where failures have occurred a glacial till scar has resulted which is likely to accelerate weathering and erosion to these areas where vegetation cover has been lost.

A summary of the engineering assessment and the consequences of potential failure (ie risks and losses during the strategy period) of the coastal slopes is presented in Table 3.1.

It is evident that cliff top recession will continue and that the existing alignment of the Cleveland Way will be lost. It is not expected that any cliff top assets (ie properties, including the new Yorkshire Water WWTW) will be lost during the strategy period.

3.1.3 Engineering Geology Assessment of Scalby Beck Slopes – Management Sub-Unit 19E/VI

The beck has been given the Management Sub-unit designation of 19E/VI and comprises the beck and its slopes from the mouth of the beck upstream to the weir downstream of Whitby Bridge Road, which marks the limit of marine influence, see Figure 2.1 (EA, 2002). Although, it is considered that *significant* marine influence extends the approximate length of the northeasterly facing beck slope.

The beck slopes are approximately 30m high and comprise glacial till overlying, in parts, Jurassic Sandstones and Shales (see Plates). From the western end of the study area the beck runs east-north-east where on the slope top to the south of the beck the hamlet of Scalby Mills is situated. The beck turns southeast before the Scalby Ness headland where it flows to the shore between the Sea Life Centre promenade and the Scalby Ness Headland.

A summary of the engineering assessment and the consequences of potential instability (ie risks and losses during the strategy period) for the beck slopes can be observed in Table 3.2.

Coastal erosion will result in the loss of the toe of the northeasterly and northwesterly facing slopes. This will ultimately result in major slope instability and the potential loss of cliff top assets. The beck will be impounded from landslip debris and beck levels are likely to increase upstream in the short term. This is likely to affect toe stability of the slopes upstream (ie towards the weirs) and create instability upslope along Scholes Park Drive.

It has been determined that up to 68 residential properties could be lost over the next 60 years should no coast protection and slope stabilisation works be undertaken.

3.2 Present Ground Movement – Scalby Beck

Visual observations and results of monitoring on site by SBC and HPR confirm ground movements continue to affect the northeast and northwest facing slopes at Scalby Ness. Monitoring of groundwater and ground movement instrumentation has been carried out in conjunction with SBC Technical Services.

Ground movements have been monitored using a combination of the following methods :

i) Geomorphological mapping, visual observations and photographs of slope condition of the slip faces and backscars of slip areas jointly carried out by HPR and SBC (see Figure 3.1 & Plates 1 to 7);
ii) Monitoring of 8 No. survey pins along the edge of the existing slips and 9 No. pins installed within the slip by SBC using theodolite equipment to establish a three dimensional topographic survey of the slips.
iii) Commissioning and monitoring of inclinometers in boreholes (SN1 & SN3) has been carried out by Soil Mechanics Ltd, under contract to SBC, on 12 October, 23 November 2001 and 31 January 2002 (see Figures 3.2a & b).

A summary of the results of the inclinometer monitoring is given in the following table.

Date of reading	Inclinometer SN1 Lateral Movement	Inclinometer SN3 Lateral Movement
Maximum Total Movement	13 mm	144 mm
Ground Movement Profile	Abrupt translational movement from a depth of 11.75m bgl	Abrupt translational movement from a depth of 6.7m bgl
Average Rates of Movement for the following periods in mm/month		
Oct – Nov 2001	0.7	3.0
Nov 01 - Jan 02	0	3.0
Jan – Mar 02	2.0	8.0
Mar – Jul 02	0	2.0
Jul – Sept 02	0	11.0
Sep – Nov 02	4.0	33.0

Data for the lower section of the northeast facing slopes (Inclinometer SN3) confirms the cumulative lateral displacement of up to 144mm has occurred since October 2001. A distinctive "spike" in the depth profile indicates movement is occurring over a depth of up to 6.5mbgl. Average monthly rate of displacement of between 2mm to 8mm is indicated with the greatest movement recorded during the period September to November 2002. Initially, the data suggested a trend for continuous movement of around 3mm/month increasing to 8mm/month during the winter months, however, since the summer of 2002 the rate of movement has increased over and above the trends established for winter and summer movement.

In contrast, data for the mid-height plateau of the northeast facing slope (Inclinometer SN1) indicates smaller displacements of up to a total of 13mm have occurred since October 2001. The profile of this inclinometer suggests movement is occurring to a depth of up to 11mbgl. These measurements confirm deep-seated progressive movements are affecting the main body of the slope.

3.3 Influence of stream and marine erosion.

Observations have confirmed the level in the beck at any time is controlled in part by natural drainage and base flows, storm discharges from the River Derwent and high sea states effectively impounding and restricting the outfall of the river. No data is available of stream discharge flows, other than water levels at the weir and much further upstream; without suitable geometry data of the stream channel these cannot be used for, say, backwater curves etc.

A comparison of site photography taken in 1998 and 2002 has demonstrated the variable and turbulent nature of flow in the Scalby Beck. Further photography has shown the tidal influence of impeding flows from the Beck at the outfall during high spring tides and confirmed wave overtopping of the sea wall (+5.8mAOD) adjacent to the Sea Life Centre.

The interaction of marine influence impounding the outfall together with the nature and extent of the stream channel geometry and flows is considered one of the main causes for an evident increase in active erosion of the existing slope toes and banks by both fluvial activity and marine influences. It is shown in the section dealing with Stability Analyses (Section 3.5) that the current instability of the toe of the slopes is intimately related to the reactivation of slippage of the lower and upper slopes of both the northeast and northwest facing slopes.

To date, a review has been carried out to assess marine influence by the following sources.

- Limited topographical survey data from the ground investigation at Scalby Beck giving bed, bank and water levels at section points A' and C'. Note these sections have been used in stability analyses (see Figure 3.1).
- Commentary on Coastal and Beach Processes.
- Report by HR Wallingford, EX3782, dated June 1999 entitled Holbeck to Scalby Mills Coastal Defence Strategy Study – Hydrodynamic Assessment.

No flow rates and suitable cross sections are available for Scalby Beck and, therefore, it has not been possible to determine backwater curves for the extent of marine influence from MHWS. Any simple backwater curve analysis would require a number of assumptions, which are likely to render any calculations inaccurate. The hydraulic modelling of extreme wave heights, undertaken for the Sea Life Centre as part of the Holbeck – Scalby Mills Coastal Strategy, cannot be extrapolated for the beck due to the shallow beck levels being restrictive in generating such wave levels. However, MHWS and HAT levels are shown in Figure 3.3 and it can be assumed that storms and high sea states along with high levels of the beck are likely to significantly increase water level of the beck over the entire north-south stretch. It is considered that significant marine influence will be reduced upstream beyond this location. The extent of sea water ingress into the beck has been observed by seaweed becoming caught upon the rocks beneath the northeasterly facing slope.

These factors are the main causes for an evident increase in active erosion of the toe by both river and marine influences. The increased instability of the toe of the slopes has reactivated slippage of the lower and upper slopes of both the northeast and northwest facing slopes.

TABLE 3.1 SUMMARY TABLE OF COASTAL SLOPES, FAILURE TYPES AND CONSEQUENCES (INCL. ASSETS LOST) OVER THE NEXT 60 YEARS

Management SubUnit	Failure Type	Consequence
19E/I *Hundale Point to Long Nab*	Typical cliff recession events include a combination of falls and translational slides from the rock cliff and small slumps of the till mantle.	Failure events that could result in a gradual cliff top recession and periodic failures of up to 3m of cliff top loss resulting in the loss of the present alignment of the Cleveland Way
19E/II *Long Nab to Cromer Point*	Cliff recession is generally dominated by high-angled debris slides generated within the glacial tills and rockfalls from the lower sea cliff.	Failure events that could result in a gradual cliff top recession and periodic failures of up to 3m of cliff top loss resulting in the loss of the present alignment of the Cleveland Way
19E/III *Cromer Point to Scalby Ness Sands*	Recession of the glacial till upper cliff involves a combination of high-angled debris slides and elongate mudslides. Small rockfalls occur from the lower sea cliff.	Failure events that could result in a gradual cliff top recession and periodic failures of up to 3m of cliff top loss resulting in the loss of the present alignment of the Cleveland Way
19E/IV *Scalby Ness Sands*	This section of cliff appears to have been fashioned by deeper-seated rotational and translational landslides, probably confined to glacial tills that form much of the cliff.	A pinchpoint is evident in this section which lies adjacent to the southwesterly facing slope above Scalby Beck; the width of this pinchpoint is presently 3m. Further failure of the cliff top from either a gradual cliff top recession will result in the loss of the present access between Scalby Ness Headland and the cliff top to the north in the next 5 years. A failure event of 3m or more, at the pinchpoint, would sever the present access. This may occur following the next period of heavy rainfall. The Cleveland Way, on its present alignment, would be lost without intervention. *On a longer timescale (more than likely greater than the strategy period) this section of cliff line could possibly be breached and result in wave overtopping/ infiltration into the beck*
19E/V *Scalby Ness*	The upper glacial till sections of the cliff appear to have failed as deeper-seated rotational slides, notably on the northern and southern sides of the headland. High angled debris slides and mudslides also have developed in places; rockfalls and topples have developed on the rock cliff.	Further failures will result in the loss of the present line of footpath from/to the footbridge across Scalby Beck to the North Bay. The Cleveland Way on its present alignment, would be lost

TABLE 3.2 SUMMARY TABLE OF BECK SLOPES, FAILURE TYPES AND CONSEQUENCES (INCL. ASSETS LOST) OVER THE NEXT 60 YEARS*

Slope/ MSu	Failure Type	Consequence
Northwest facing slopes *19E/VI*	Superficial movement of shallow surface layers – slumping - weakened by the infiltration of rainfall which has caused existing scars at the crest of the slope scarp to extend and deepen. Failure of a rotational nature has occurred where a drainage outfall is present at the cliff top. Erosion of the base of the slope by fluvial/ marine action has resulted in translational / slumping movement of the lower beck slope. This has translated upslope as failure expands.	The scarp is a distance of approximately 8m from the nearest property in Scholes Park Road. The potential slippage area is 110m long in front of the properties. Although it is considered a lower risk upstream past the new properties where tree vegetation offers some stabilising force. Further slump failures of those already present may extend and deepen, and further undermine the slope top. Further expansion of the drainage induced failure will encroach the properties on the cliff top. Reactivation of shallow slips caused by the removal of toe weight by erosion of the lower slopes by fluvial/ marine action in addition to the additional weight of water resulting from high rainfall may result in major deeper-seated failures of the slope. Major failure will almost certainly result in the damming of the beck from failed debris material and the possible accelerated erosion of the slopes due to impounded waters. Further failure of this slope will result in the cliff top encroaching within 5m of the properties along Scholes Park Road within the next 5 years.
Southeast facing slope *19E/VI*	Superficial movement of shallow surface layers – slumping - weakened by the infiltration of rainfall which has caused existing scars at the crest of the slope scarp to extend and deepen. Erosion of the base of the slope by fluvial/ marine action has resulted in translational/ slumping movement of the lower beck slope. This has translated upslope as failure expands; this is particularly evident on this slope where a failure has translated from beck level to slope top.	There are no properties along the top of this slope. Further slump failures of those already present may extend and deepen, and further undermine the slope top. Reactivation of shallow rotational slips caused by the removal of toe weight by erosion of the riverbank by fluvial/ marine action in addition to the additional weight of water resulting from high rainfall may result in major deeper-seated failures of the slope. Major failure will almost certainly result in the damming of the beck from failed debris material and the possible accelerated erosion of **both** the northwesterly facing slope and this slope due to impounded waters.

TABLE 3.2 SUMMARY TABLE OF BECK SLOPES, FAILURE TYPES AND CONSEQUENCES (INCL. ASSETS LOST) OVER THE NEXT 60 YEARS (CONTINUED)

Northeast facing slopes *19E/VI*	The dominant feature of the northeast facing slopes is a large previously failed back rotated slip block. The slopes generally comprised a steep rear scarp and shallower front slopes separated by a sub-horizontal plateau. Lower slope - erosion and removal of support to the slope toe during flooding and impounding by softening and undercutting from fluvial/marine action. Failure occurs more commonly as a shallow rotational type movement of soft, saturated clay. Upper slope – slumping and translational movement reactivating existing scars at the crest of the slope. Tension cracks and scaring over much of the rear slopes suggesting large scale translational slope movements resulting from the release of toe weighting by movement of the main slip block and from softening of shallow soil layers by rainfall. The evidence of groundwater emerging from the sand / gravel horizons removes fine sand by seepage erosion and softens clays below; mudflows result and local failures in the sand/soft clay interface will remove support to the upper slopes. Movement of the main slip block resulting from infiltration of standing water from the sub-horizontal plateau into an existing shear surface, weight of rainfall and the release of toe weight at Scalby Beck.	The slope top is a distance of approximately 12m from the nearest property in Scholes Park Road- where the properties follow the line of the slope top. The potential slippage area is 150m long in front of the properties. The Scalby Mills public house is situated to the south of this slope near the mouth of the beck. Further failures on the lower front slopes resulting from the removal of toe weight by erosion of the lower beck slope. Progressive failure of the lower slope: by removal of the toe of the slope by wave attack/ fluvial action and high groundwater levels and surface water ingress into slip planes. The upper slope suffers progressive failure by steepening of the slope, development of tension scars and slip surface/s within the back slopes will result in slope top recession encroaching the properties along Scholes Park Road. Movement of the previously failed back rotated block at mid slope is likely to be the result of softening of the existing shear surfaces due to groundwater issues in granular layers. Surface water runoff from the upper slopes would exacerbate this situation. The mid-height plateau is supported by the lower slopes and therefore the current stability is intimately related to the unweighting and reduction in support of the lower slope due to erosion of the beck slopes as well as pore water pressures on slip surfaces. Reactivation of the tilted block resulting from lower slope failure and/or high groundwater levels is likely to result in the unloading of the whole slope system and potentially large scale failure would result potentially sever stream flow damming the beck and progressive failures upslope and laterally, including severing Scalby Mills Road. *Further failures of this slope will increase the rate of cliff top recession and threaten property at the top of this slope; a major failure could result in 10's of metres of cliff top loss which could also include the loss of Scalby Mills Road; damming the beck will have consequences upstream of accelerating erosion and threaten the properties on the northwesterly facing slope.*
Southwest facing slope *19E/VI*	Superficial movement of shallow surface layers – slumping - weakened by the infiltration of rainfall which has caused existing scars at the crest of the slope scarp to extend and deepen. Erosion of the base of the slope by fluvial/ marine action is a magnitude of order less than the glacial till banks due to rock exposure in the lower sections of this slope.	A pinchpoint is evident on this slope which lies adjacent to the coastal slope of Scalby Sands; the width of this pinchpoint is presently 3m. Further failure of the cliff top from either a gradual cliff top recession or a rotational failure will result in the loss of the present access between Scalby Ness Headland and the cliff top to the north in the next 5 years. A failure event of 3m or more, at the pinchpoint, would sever the present access. This may occur following the next period of heavy rainfall. *Cliff top access along The Cleveland Way, on its present alignment, would be lost between Scarborough's North Bay and Scalby Sands.*

3.4 Calculation of Cliff Recession Rates

3.4.1 Cliff Top Recession – Coastal Cliffs

The Strategic Coastal Monitoring Cliff Condition Survey Report from Staithes to Scarborough, undertaken by High-Point Rendel in May 2002 identifies an average cliff top recession rate between 1 and 9 cm/yr and cliff foot recession between 1 and 13cm/yr for Management Unit 19E. The slopes at Scalby Ness Headland were recognised as an active retreating composite cliff and the slopes of Scalby Sands as an unstable till slope; the remainder of the coastal frontage was classified as an actively retreating till-capped rock cliff.

3.4.2 Cliff Top Recession – Scalby Beck Slopes

A judgement has been made on the frequency of different types of landslide failure occurring at each of the slopes under consideration for the next 60 years. These judgements are based upon the assumption that a "do nothing" scenario is adopted and the evidence provided by the engineering geological assessment and slope stability analysis.

The average cliff top annual recession rate considering all the measured sections is calculated to be 0.134m/year for the northeasterly facing slope (see Appendix C for the method of calculation).

However, it has been demonstrated by slope stability analyses that there is the potential for failures involving the loss of up to 30m of cliff top in a single event.

Bearing a large scale landslip in mind and the possible rise in beck levels from the impounded waters, there will a detrimental effect on the beck slopes upstream. Therefore, for the do nothing scenario it has been estimated that a recession rate of 0.3m/ yr should be used along the slope top.

3.5 Slope Stability Analyses

Stability analyses have been undertaken to quantify the current stability of the slopes above Scalby Beck thus providing a better understanding of the potential for future instability. The form of analysis cannot be regarded as being rigorous because of the lack of reliable long term data.

Two ground models have been established for the northeast and northwest facing slopes respectively based on the available topographic, geomorphological, borehole and groundwater data. However, uncertainty remains with respect to the details such as groundwater conditions in the slopes prior to previous incidents of major instability, and the detailed geological and geomorphological conditions that prevailed at those times.

Parameters used in the analysis are the same as those established from back analysis in a previous report for Holbeck Gardens (HPR, 1999). These parameters are shown in Appendix D. Characteristic soil parameters adopted for Holbeck Gardens are considered valid for the site since the glacial strata exhibit similar lithological descriptions and compositions.

A series of stability analyses were carried out using the Bishop and Morgenstern and Price Methods incorporated within the *Oasys* and *SLOPE/W* computer programs. The analyses considered the following:

- Assessment of the existing landslide areas to determine the potential for reactivation or renewal of instability.
- Assessment of the stability of the current intact slopes.
- Assessment of a number of recession scenarios modelling the effects of loss of support from the existing landslide areas and reduction in soil strength with progressive failure.

A number of parametric and sensitivity analyses were carried out to assess the impact of rising groundwater as a result of the natural variability of rainfall.

3.5.1 Assessment of Existing Landslide Areas

Back analysis of the existing landslide systems was carried out to determine the likely strength parameters applicable for detailed analysis of the landslides at Scalby Ness.

The analysis assessed a number of existing predicted slip surfaces. It assumed slopes to be at marginal stability (i.e. Factors of Safety (FOS) marginally in excess of 1.0) with current measured groundwater conditions and a cohesion intercept (c') of zero to derive the average effective angle of shearing resistance, ϕ' of the predicted failure surface.

The tills at this site are of low plasticity (PI<20) with a significant proportion of granular content. For this reason it was considered unlikely that any first time failures would fully reduce the strength of the tills to the residual value.

A back analysis indicated the average effective angle of shearing resistance, ϕ' mobilised along the pre-existing shear surfaces was approximately 25°. This value (referred to here as the softened strength) was generally consistent with field observations and the expected reduction in peak without full reduction to the residual value.

3.5.2 Stability of Intact Slopes

Several different slip surfaces were analysed under varying ground water conditions for the two landslide systems adopting both peak and softened strength parameters for intact (first time) and existing failed slopes respectively.

A summary of the results of the analyses of **existing landslide areas** and intact slopes is summarised in Table 3.6.

TABLE 3.6 SUMMARY OF SLOPE STABILITY ANALYSES OF EXISTING LANDSLIDE AREAS.

Assessed Section	Slope Description	Groundwater conditions	Design parameters and critical surfaces	Calculated lowest FOS
A – A1	Upper (intact) slope (overall slope 1:2)	Fully drained	First time slide using peak strengths for interpreted critical surface	1.14
	Previously failed back tilted mid height combined with lower slope	Highest recorded level	Softened parameters used to assess pre-existing critical failure surfaces	1.45
	Lower (failing) slope	Highest recorded level	Softened parameters used to assess pre-existing critical failure surfaces	1.02 *
	Existing overall (intact and failing) slopes i.e. upper, mid and lower sections combined	Highest recorded level	Softened parameters used throughout for intact (upper) and (lower) failed sections of slope	1.38
	Existing overall (intact and failed) slopes i.e. upper, mid and lower sections combined	High predicted groundwater level	Softened parameters used throughout for intact (upper) and (lower) failed sections of slope	0.88 +
C – C1	Existing overall (failed) slope	Highest recorded level	Softened parameters used throughout for critical failed section of slope	1.03 to 1.08

NOTES:* In many cases, loss of toe support indicated by FOS less than 1.0.
+ This value is on the conservative side since softened strength parameters have been assumed for the upper intact materials.

The analyses of the lower slopes (Section A – A1) clearly models the present state of instability at the toe with development of tension cracking due to removal of support by ravelling at the toe from erosion by the fluvial/marine action. The analyses of Section C – C1 demonstrates the marginal stability of the existing landslide areas. The marginal FOS will decrease further as the toe becomes eroded and the slopes become increasingly exposed to surface and groundwater ingress.

These analyses confirmed the sensitivity of stability of all slopes to slight variations in groundwater levels and that existing slopes are currently in a state of marginal stability.

Inclinometers confirm total lateral displacements of the lower slope and are occurring at the toe of the slope and within the main body (mid section) of the landslip respectively. The magnitudes of displacement are considered sufficient to reduce the strength along the failure surface to a value between the softened and residual strengths. In addition, the depths and levels at which displacements are being recorded indicate large-scale mass movements are developing in a manner that is characteristic of large scale progressive failure.

3.5.3 Recession Scenarios

A number of scenarios have been developed to predict possible future cliff top recession and likely outcomes affecting the slopes and cliff top assets.

Sensitivity analyses were carried out to assess the effects of successive removal of support to the slope through failure of the lower, middle and upper slopes sections of the slope. The analyses also considered the effects of variation of soil strength to simulate the effect of progressive failure.

The analyses were based on a range of existing groundwater levels together with variations of the strength parameter (effective angle of shearing resistance, ϕ'). The assessed strengths were for the granular sand layers ϕ_{cv}' = 30° (critical state strength), and for the cohesive glacial tills values ranging between ϕ_p' = 27° (peak strength), ϕ_s' = 25° (softened strength), and ϕ_r' = 22° (residual strength), and effective cohesion, c' = 0, 2.5, 5, and 7 kN/m^2.

Results of these analyses are summarised below:

- North East Facing Slopes

  The results indicate that the Factor of Safety (FOS) against failure of the existing north east facing slope is very marginal and lies between 1.10 and 0.957 for the fully softened and residual strength conditions respectively, assuming the highest recorded groundwater level of +17.5mOD.

  It can be seen that the FOS reduces to a value below 1.0 where a series of recession scenarios unfold following removal of the slope toe and mid slope.

  The FOS for subsequent large scale failure resulting in 15m to 30m recession following recession of the currently intact slope lies between 1.2 to 0.9.

- North West Facing Slopes

  The results indicate that the Factor of Safety (FOS) against failure of the existing north west facing slope is at or below 1.0 for all cases of strength and groundwater.

  The FOS for subsequent large scale failure resulting in 15m to 30m recession of the currently intact slope lies between 1.4 to 0.8.

  These analyses clearly demonstrate the sensitivity of the strength parameter and influence of groundwater level and recession scenario on the stability and consequence of failure of the existing slopes.

3.5.4 Modelling Effects of Present Climate Variability/ Climate Change

Stability analyses have been based on highest recorded groundwater levels encountered during the period of the ground investigation and subsequent monitoring of piezometers since August 2001. To this point, the models have not attempted to predict extreme events experienced during very wet periods such as the winter of 2000/2001.

There is a widely recognised difficulty in accurately predicting the seasonal level and future fluctuation of groundwater applicable to stability analyses, and this difficulty is particularly pertinent to these slopes. The effects of present and future variability in climate is likely to result in accelerated slope and toe erosion. In addition, the effects of climate change will impact significantly on other factors that control the stability of slopes at this site in a number of ways including:

- Increased storminess and levels of rainfall frequency and duration with consequent rise in groundwater levels and surface water infiltration.

- Increased frequency, magnitude and duration of flood water released into the Scalby Beck from the River Derwent.

- A rise in sea levels with consequent landward extension of the levels of marine influence.

- A rise in the magnitude, frequency and duration of impounding of the Scalby Beck likely to result from slope and bank failures.

There is little guidance in available literature on quantifying the rise in groundwater level in response to changes in rainfall events. Therefore, stability analyses has attempted to identify present and future variability's in climate by the rise of groundwater levels in terms of the pore pressure ratio, r_u. Previous analyses were undertaken using specific groundwater levels based on the results of monitoring piezometer boreholes. The highest recorded groundwater levels corresponded to an r_u value of approximately 0.25. It is proposed that for high rainfall periods, r_u values will increase above this r_u value of 0.25.

The stability analyses models considered the case of first time failures of the existing (intact) slopes using predicted r_u values of 0.3, 0.4 and 0.5, and a cliff recession of 30m occurring in a single event in less than 2 years. The results indicate that for an r_u value of 0.5, the FOS for 30m recession of the existing intact north east and north west slopes is at or just above 1.0 (1.03 and 1.003 respectively). Any removal of toe support during or prior to this condition would lower the FOS to below 1.0 resulting in major large scale failure threatening cliff top assets and inhabitants.

Using the same climate change parameters, additional stability analyses were carried out for Sections X-X' and Y-Y' (see Figure 3.1 for location) to assess the extent and probability of failure affecting both cliff top assets and the road and public house beyond the cliff toe. These analyses confirmed significant major large scale first time failures will occur where an r_u value of between 0.4 to 0.5 is operative. In this condition the slope failures would result in complete loss of the road serving the Sea Life Centre and the public house together with recessions of up to 30m affecting cliff top assets. It is also considered that this section of the slope is at threat from progressive upslope failure should reactivation of the rotated block above the beck occur.

3.5.5 Summary of Stability Analyses

Slope stability analyses is shown in Appendix D.

Results of site observations, analyses and monitoring of ground movements confirm these slopes to be marginally stable under present conditions of predicted soil strength and known slope geometries and groundwater levels. Current FOS for existing landslide areas are marginally above 1.0 (1.02 to 1.03).

Analyses indicate the stability of the north east and north west slopes is intimately related to factors such as the current support of the slopes by the toe weighting; slight variations in groundwater levels; the rates of lateral displacements affecting the slopes and development of progressive failure. These factors in turn will be influenced by the present variability in climate and future climate change scenarios.

Results of monitoring inclinometers confirm large-scale mass movements are affecting the toe of the slope and the main body (mid section) of the landslide under present conditions.

Recession modelling of the north east slope has confirmed that loss of the toe accelerated by bank erosion would result in major slope failures with cliff top recessions up to **30m**. Increased storminess is very likely to promote failure of the toe within a very short period of time and probably less than 2 years. Similarly, the FOS of the existing north west slope is marginally above 1.0 (1.03 to 1.08) and for a 15m recession under current conditions is 1.06 to 1.13. This type of failure and the subsequent failures progressing upslope will inevitably result in loss of assets including properties and Scalby Mills Road.

Finally, analyses have made provision for the occurrence of extreme events due to the present variability of the climate, assuming r_u values of between 0.4 to 0.5 being realistic in the absence of scientific evidence. Under these conditions, the analyses confirm major large scale first time failures would occur and result in up to 30m recession of the cliff top. In addition, major large scale failures involving mass movement of the cliff toe would result in substantial damage to the road serving the Sea Life Centre (Scalby Mills Road), the public house and possibly sections of the adjoining Yorkshire Water's underground waste water treatment works.

A plan showing the predicted extent of cliff top assets affected by a 30m recession occurring within the next 2 years is presented in Figure 3.4. It is difficult to determine the exact timing of any failure as failure will be determined by the rate of toe erosion and duration and intensity of any rainfall. It will be necessary to monitor the inclinometers and piezometers on a regular basis to identify any trend of further instability.

3.6 Evaluation of Do Nothing

3.6.1 Do Nothing – Coastal Frontage: MSU's 19E/I to V

The consequences of 'do nothing' would involve further failures of the coastal cliff and slope between Hundale Point and Scalby Ness Headland. This will result in the loss of cliff top land, some 18m width over the next 60 years. Given the historic rate of cliff top recession, and even allowing for accelerated rates of erosion due to sea level rise and foreshore lowering, it is not anticipated that any cliff top property will be lost within the strategy period (see Figure 2.1). However, it is expected that the entire length of the present alignment of the Cleveland Way will be lost and some 5 km of this pathway will have to be realigned inland to allow continued safe public access. The current practise following failure of the Cleveland Way is to move the Cleveland Way footpath inland as and when required. This is presently undertaken by the Heritage Coastline/ NYMNP.

There is potential for a breach in the cliff at Scalby Sands, albeit a longer term issue. The cliff is this section (MSu 19E/IV) comprises mainly glacial till. Should a breach occur there is the potential that direct wave action will affect Scalby Beck from a northerly direction. Possible timing for any breach is considered greater than the strategy period.

Yorkshire Water's WWTW an associated shaft is situated some 60m from the coastal cliff edge (see Figure 3.5) and it is not anticipated to be affected by cliff top recession in the next 60 years.

Cliff top recession of the slopes at Scalby Ness Sands and Headland will continue by wave attack eroding the cliff toe and undermining the glacial till slopes above. This will result in the loss of access between Scalby Ness Headland and coastal frontage to the north. Failure of the slope on the coastal side will result in the Cleveland Way footpath being abandoned and diverted inland across the Whitby Bridge Road. This would have the effect of taking passing trade from the North Bay, Scarborough, depending upon the diverted route and potentially reducing the number of people able to walk along this section of the coastline.

The Headland will effectively become an island and further erosion at the mouth of the beck and the slopes around the Headland will prevent foot access and damage to the footbridge.

3.6.2 Do Nothing – MSU 19E/VI

The consequences of 'Do Nothing' would be as follows:

- The toes of Scalby Beck slopes will continue to be removed by marine and fluvial erosion (Figure 3.6 – Mechanism 1). This will remove support to the upper slopes and reduce stability further (Figure 3.6 – Mechanism 2).

- The bench of the northeasterly facing slope is presently moving and calculations have identified that there is the potential for up to 30m of cliff top to be lost in one event. The potential for an event of this magnitude will inevitably include the loss of properties above this slope and possibly those on the northwesterly facing slope; and, the loss of the lower part of Scalby Mills Road (as progressive failure upslope occurs). This will culminate in damage to the first row of properties, the evacuation and demolition of adjoining properties (as a Health & Safety requirement). In addition access to the Sea Life Centre will be lost for vehicles and there will also be a loss of revenue from Scalby Mills Car Park.

- Slope failures and cliff recession will continue at both the north east and north west facing slopes. The slope crest will continue to recede towards the properties.

- The rate and magnitude of slope failure and cliff recession is difficult to predict with any accuracy but both are likely to increase as a result of:

  i) increased storminess and exposure to inclement weather;
  ii) decreased protection to the slopes with increased loss of vegetation cover;
  iii) elevated groundwater levels within the slopes and surface water infiltration due to increased rainfall events;
  iv) reduced support to the lower and mid slopes of the beck by increased erosion of the toe.

- The maximum water levels and flows in the Scalby Beck are likely to increase steadily in the long term (<50 years) as a result of climate change and sea level rise. However, present climate variability is likely to increase levels dramatically in the short term as a result of flash flooding and prolonged rainfall events producing increased peak discharges combined with backing up of the river from high water springs and storm surges at the sea outfall. This will result in increased erosion of the beck banks and removal of support to the landslide systems.

- There will be an increased risk of the Scalby Beck being temporarily impounded by large scale landsliding of the northeasterly slope into the confined channel of the Scalby Beck. This would increase the probability of further slope failures and extend the boundaries of the present 'at risk' properties and infrastructure upstream of the northwest facing slopes.

- Slope failures and instability will have an environmental impact by the temporary loss of habitats, amenity and recreation.

- No data on the depth of Yorkshire Water's tunnel below the beck has been made available. Although, it is understood to lay beneath rock head and below the slip surfaces identified within this report.

4.0 STRATEGY DEVELOPMENT

4.1 Strategy Aims and Objectives

The primary objective of the Hundale Point to Scalby Ness Coastal Strategy is to provide an environmentally and technically acceptable coastal defence plan that is sustainable over the next 60 years.

The specific objectives of the Strategy Study are detailed below:

- to identify the coastal defence Management Units (within the existing SMP framework);
- to assess the nearshore wave climate;
- to assess the historic rates of coastal erosion and identify instability problems associated with the cliffs and coastal slopes;
- to review the coastal processes and historic beach behaviour in order to assess how these may affect the coastline in the future;
- to develop a preliminary sediment budget;
- to identify coastal defence strategies, alternative options and opportunities for environmental improvement for each Management Unit;
- to identify planning and environmental constraints for each Management Unit;
- to identify and evaluate the costs, benefits and uncertainties of each option;
- to prepare preliminary budget estimates for the preferred options;
- to undertake preliminary environmental appraisal of the preferred strategies and options;
- to prioritise the works of each Management Unit on the basis of condition, performance and consequences of failure of the existing slopes and defences;
- to develop a programme of works for the monitoring, maintenance and improvement options and associated timescale for expenditure;
- to provide recommendations for further studies required to support the implementation and design of preferred options.

4.2 Identification of Options

A range of generic options were considered to manage the risk in each management sub-unit, namely:

- Do nothing (no active intervention)
- Limited intervention
- Managed realignment
- Advance the existing defence line
- Hold the existing defence line

Options have been identified that could deliver sustainable solutions for the strategy period. The generic options for each management subunit were evaluated based on technical feasibility, environmental acceptability and economic viability, together with issues of sustainability and climate change/sea level rise. During the evaluation of these options it was apparent that some options were considered not viable in some management subunits and were not assessed any further.

The following options were considered:

- Do nothing (no active intervention) for Management subunits 19E/I to III based on no shoreline management activity at risk from cliff recession during the strategy period. This is considered unacceptable for Management Subunits 19E/IV to VI.
- Limited intervention is not considered appropriate;
- Managed realignment is not viable in areas where there is risk to assets, as there are no options for defining a defence line further inland because of the proximity of the assets to the cliff top.
- Advance the existing defence line is not viable.
- Hold the existing defence line is technically feasible and consistent with the SMP for management subunits 19E/IV to VI. However, the do minimum option (i.e. maintenance and monitoring) also requires consideration for these subunits.

In order to assess the most suitable strategy option for study area it is necessary to consider all realistic alternative options. These options are

- **Do nothing (Strategy Option 1)**

  The consequences of the do nothing option were discussed in Section 3.6.

  This report concurs with the SMP and identifies that the 'do nothing' option for the majority of this section is the preferred management strategy for MSu's 19E/I to III.

  With regard to MSu's 19E/IV to VI it is considered, that in order to maintain access between Scarborough North Bay and the coast to the north the 'do nothing' option is not acceptable. A do nothing strategy would result in a decline of the socio-economic benefits for the Scalby area.

  (NB. Designated Strategy Option 1 to maintain continuity when assessing the economics later within this report).

- **Do minimum - monitoring and inspection**

  A Do Minimum approach should be considered as a short-term measure in an attempt to "observe and maintain the current situation". The Do Minimum option should include the following elements :

  - A programme of regular monitoring of the slopes in respect of assets identified within this report. A procedure to review the results and an agreed action plan to be established to formally manage the identified risks at the site.

  The management subunits which specifically require this option are:

- MSu's 19E/IV to VI - Monitoring of the beck slopes (especially the northeasterly and northwesterly facing beck slopes) and the coastal slopes at Scalby Sands pinchpoint and Scalby Ness Headland.

The do minimum option is not sustainable in MSu's 19E/IV to VI for the duration of the strategy, other than in the short term (ie less than 2 years) and has not been assessed as a viable strategy option alone.

- **Do minimum – periodic works/ emergency works as and when necessary (Strategy Option 2)**

  In order to achieve sustainability of the MSu's 19E/IV to VI over the strategy period it will require a programme of works or a practise of reactive management to slope failures (i.e. emergency works). Other options include phasing each element of work within the first five years: toe protection, slope stabilisation, drainage, etc. However, by phasing the toe protection and slope stabilisation works during the course of the strategy there remains a high risk of landslide to the sections of the site yet to be treated. Furthermore, with limited funds for each tranche of work, it is unlikely that realistic acceptable standards of stabilisation could be undertaken without the risk of landslide affecting adjacent sites and damage of work undertaken. Additionally, and possibly more applicable to emergency works, health and safety issues must be considered which would increase the costs of the works both by risk to the Contractor and costs of clearing up.

  The risk of major landslip by year 2 is such that the 'do minimum and works' would be unacceptable in terms of cost effectiveness. However, such a strategy may result in the assets at risk from slope failure surviving 60 years, albeit at a cost.

  Therefore, the do minimum option with periodic works and, emergency works as and when necessary, should include the following:

  - A prioritised schedule of cliff top stabilisation and toe protection works of the northeasterly facing beck slope.
  - A schedule of cliff top stabilisation and management including Scalby Sands pinchpoint and Scalby Ness Headland.
  - A schedule of cliff top stabilisation and management including the possible narrowing of Scholes Park Drive, reprofiling, drainage and mechanical stabilisation *(non-coast protection related work)*.
  - A contingency for 'Emergency Response' procedures in order to establish and assess technical, economic and social responses to consequences should each hazard occur. This may include emergency works as and when required.

  The works for this option have been based on phasing the works described in Option 3 over the strategy period.

- **Do something – proactive intervention (Strategy Option 3)**

It is considered that the do minimum option alone (i.e. monitoring and inspection) and the 'do minimum with works' for MSu's 19E/IV to VI is not sufficient to sustain property and infrastructure within the strategy period and that the do something option is analysed as part of the strategy.

The do something strategy will prevent major landslide and the subsequent impounding of the beck upstream. It is recognised that the Scholes Park Drive area is outside what can be considered grant eligible coast protection works. However, should the northeasterly facing slope fail as a result of coastal erosion, the accelerated erosion rates upstream and the potential loss of property and infrastructure could be argued a consequence of the initial coastal induced major landslide.

Prior to selection and finalisation of the scheme, elements will need to be considered further with respect to technical, economic and environmental suitability.

This report has identified the main causes of instability as follows:

- Erosion and removal of toe support in Scalby Beck,
- Lack of support to the beck and coastal slopes
- Over steep slopes
- Lack of drainage
- Lack of slope protection / vegetation cover

From the problems described within the study area it is evident that pro-active intervention is required as part of the strategy. Any proposed scheme options and their evaluation are based on the review of current data and knowledge and take into account the following:

- Technical suitability and purpose.
- Buildability.
- Long term environmental impact.
- Disruption during construction.
- Maintenance requirements.
- Potential contribution to funding.

Modelling of the fluvial and marine interaction has been considered at this level of the strategy development, but it is unlikely that sufficient data will be presented that will aid design and scheme considerations.

Such measures to maintain the present alignment of MSu's19E/IV to VI would comprise:

- Construction of a toe protection scheme along the northeasterly and part of the northwesterly facing beck slopes to prevent toe erosion by fluvial and marine attack (MSu's19E/VI only).

- In-situ reinforcement of slopes by mechanical stabilisation (MSu's19E/IV to VI)

- Drainage measures throughout the slopes at appropriate depths and spacing (northeasterly facing slope only) including the slopes immediately above and below the bend in the lower part of Scalby Mills Road.

- A schedule of cliff top stabilisation and management including Scalby Sands pinchpoint and Scalby Ness Headland,

A number of stabilisation options have been considered to manage the causes of instability. These options are presented in Tables 4.1 and 4.2. The options considered have either been accepted or not for various reasons which are detailed within the tables.

A 'composite' form of construction has been identified for the northeast (and part of the northwesterly) facing slope – MSu 19E/VI based on options identified in Table's 4.1 and 4.2:

- Construct a rock revetment at slope of 1:2 to height at least 3m above bed level or alternatively highest recorded flood level plus 450mm freeboard as appropriate. The revetment is intended to protect the banks from current scour and wave erosion.

- Excavate toe of slip and replace with rock revetment or granular crushed rock blanket to stabilise the toe.

- Install bored reinforced concrete stabilising piles to the mid height plateau. Piles to be approximately at 5m centres in 3 rows parallel to slope contours. Preliminary assessment suggests pile lengths to range between 10m to 16mbgl, of nominal 600mm diameter, and designed to stabilise the main slip block for both short term and long term conditions.

- Excavate slip materials of the lower slope in successive stepped excavations from the toe and recompact. Work to be carried out in benches of limited bay widths (say 20m maximum) to maintain stability during construction.

- Install drainage blanket during recompaction of the lower slope to outfall to the rock revetment.

- The lower slope to be reinstated at 1:3 (v:h) with drainage and toe support measures. Reuse topsoil and grass seed all slopes to provide long term protection against run off erosion.

- Install counterfort drainage with slotted pipe from the base to the cliff top. Counterfort drainage to outfall to the drainage blanket installed in the lower slope.

The general arrangement of this option is presented in Figures 4.1a & b.

A key to the effective control of stability of these slopes will involve appropriate drainage measures able to intercept and remove significant quantities of surface water and groundwater emerging from the permeable granular layers.

Uncontrolled groundwater and surface water is recognised as one of the main factors contributing to instability of the glacial till slopes. Clearly a practical and effective means of controlling groundwater within slopes is a minimum requirement to stabilise existing landslides. Drainage measures to the slopes comprising a counterfort drainage system should be designed to support and buttress the slopes and improve stability by maintaining groundwater and surface water levels to safe levels within the slopes. Counterfort drainage would typically comprise 1m wide trenches excavated throughout the full height and constructed parallel to the slope gradient to a minimum depth of 3-4m. The drains would be spaced at approximately 10m and backfilled with a slotted pipe at the base surrounded by an imported free draining granular material. The drainage media would be encapsulated by a filter geosynthetic to prevent silting up of the filter system. The use of a drainage blanket as an integral element of the earthworks option has the advantage of effectively intercepting all groundwater seepage and transmitting these to the outfall.

There will be temporary environmental impact involving removal of existing vegetation. However, the topsoil can be reused to preserve the local soil chemistry and selected seeding and planting can be carried out to maintain the local flora.

- **Do something – Proactive intervention - a partial scheme (Strategy Option 4)**

The alternative option to the composite scheme discussed above includes undertaking the main elements of the works described in Strategy Option 3. The works required would be prioritised to reduce the most immediate risk of a major landslide, which would result in the loss of the cliff top properties and infrastructure. The works required are based on similar construction methods described in Strategy Option 3 and comprise the following:

- Stabilisation of the slope by piles situated along the mid-slope plateau.
- Drainage of the slope by maintaining groundwater levels to a safe level by counterfort drains.
- Slope top betterment works using geomaterials and soil nails to prevent progressive cliff top recession
- Toe protection works to prevent toe erosion by wave/ fluvial attack.

The works included in this option do not comprise the entire package of the 'full scheme' described in Option 3 (ie. the excavation and recompaction of the lower slope and reinstatement of the lower slope at 1:3 has been omitted from this option) and hence the requirement for an increased programme of periodic maintenance. The general arrangement of this option is shown in Figures 4.1c & d. Small-scale superficial slides of the slopes are likely to continue and in order that these are not allowed to expand and potentially trigger larger landslides, pre-emptive remedial maintenance will have to be undertaken. In addition, maintaining drainage outfalls from fine blockages will also be required.

- **Support to Cliff Tops : Scalby Beck (NE & NW Facing Slope) and Scalby Sands Pinchpoint (NON COAST PROTECTION WORKS)**

It is considered that the line demarcating significant marine action is the limit of coast protection works. Works upstream form this area will fall outside coast protection related works.

In order to prevent progressive cliff top recession of the northeasterly and northwesterly facing slopes and the cliff top above Scalby Sands it is necessary to undertake cliff top stabilisation works.

It is necessary to emphasise that the rates of recession used for the do nothing scenario (Figure 3.4) are based on accelerated erosion rates following impounding of the beck and subsequent raised beck levels. Should toe protection and slope stabilisation works be undertaken on the northeasterly and northwesterly facing slopes, cliff top recession rates upstream would not be as significant and losses are anticipated to be less during the strategy period.

In the vicinity of the pinchpoint above Scalby Sands, stabilisation work will be required on both sides of the pinchpoint.

The limited width between the cliff top and properties above Scalby Beck (~8m) reduces the number of options that can be used to maintain access. Failure of the upper slope is triggered by toe erosion of the cliff and the subsequent failure of the glacial till above. In addition high groundwater levels reduce the strength binding the clay/sand particles together. The width is such that major reprofiling, drainage and piling, etc are not feasible. It is considered that the most suitable option would be to place a geomaterial secured by soil nails on the cliff top in these locations.

For the pinchpoint above Scalby Sands (minimum width of ~3m) it is considered that works will be required on both sides of the upper 5m of cliff top over a length of 100m secured to the slope by soil nails. By undertaking this work the public can gain safe access above Scalby Sands to the Headland and into Scarborough's North Bay. It is expected that any works along the cliff top will be undermined from cliff recession and therefore, provision has been made within the Strategy period to undertake a series of cliff top betterment programmes. These works are intended to delay the onset of cliff recession and the loss of the coastal footpath in this area until the end of the strategy period.

Reinforcement of these slopes can be undertaken using a combination of geomaterial and soil nails. The geomaterial, such as Macmat-R or similar, will provide tensile strength to the slopes and through which vegetation can grow maintaining the landscape in the area.

Soil nailing has the advantage of minimising large scale disruption to the site by locally installing drilled and grouted reinforcing bar to the slopes.

4.3 Summary of Realistic Options for Each Management Sub-unit

The options considered in this strategy report for each management sub-unit are as follows:

Option No.	Option	Description	Management Sub-Unit
Option 1	Do Nothing*	No active intervention	19E/I - Hundale Point to Long Nab 19E/II - Long Nab to Cromer Point 19E/III - Cromer Point to Scalby Ness Sands
Option 2	Do Minimum	Monitoring and Inspection	19E/IV to VI
		Periodic works	19E/IV to VI
Option 3	Do Something	Full stabilisation scheme	19E/VI - Scalby Beck
Option 4		Stabilisation scheme (partial)	19E/VI - Scalby Beck

* Monitoring/ inspections will be required as a Health & Safety issue regarding public safety along the coastal footpath and to assess any acceleration in cliff recession rates

4.4 Preferred Strategy for the Sea Life Centre - MU 20A (Scarborough North Bay)

The details of the preferred strategy for the Sea Life Centre (MSu 20A/1) are described in the Holbeck – Scalby Mills Coastal Defence Strategy Study (HPR, 1999).

The recommended strategy is a 50m wide low level rock revetment (see Figure 4.2) situated along the length of the management subunit. The alternative options discussed in Table 4.2 have not only been dismissed on engineering buildability and feasibility (ie options that do not address the problems of the slopes in the Scalby area) but also because of the lack of integration with the adopted preferred scheme recommended for the Sea Life Centre (MU 20A).

TABLE 4.1 SUMMARY TABLE OF OPTIONS FOR PROACTIVE INTERVENTION FOR CLIFF STABILISATION

	ENGINEERING CONSIDERATIONS		FEASIBILITY	ENVIRONMENTAL CONSIDERATIONS				
OPTIONS CONSIDERED	STABILITY	BUILDABILITY	WITH RESPECT TO EXISTING ACCESS	SCALE OF WORKS	IMPACT ON FLORA AND FAUNA	AESTHETIC VALUE	COST	SUMMARY
DO NOTHING/ - Option 1 Short Term Medium Term	DETERIORATES FAILS	N/A	N/A	N/A	NIL MAJOR	N/A UNACCEPTABLE	NIL UNACCEPTABLE	UNACCEPTABLE
DO MINIMUM – Option 2 Short Term Medium Term	DETERIORATES FAILS	EASY DIFFICULT	FEASIBLE	MINOR INTERMEDIATE	NIL MAJOR	GOOD UNACCEPTABLE	LOW UNACCEPTABLE	UNACCEPTABLE
SHALLOW DRAINAGE	POOR	EASY	FEASIBLE	MINOR	MINOR	GOOD	LOW	NOTE 1
DEEP DRAINAGE	MODERATE	MEDIUM	FEASIBLE	MINOR	MINOR	GOOD	LOW	NOTE 1
SHEAR KEYS	GOOD	V HARD	UNFEASIBLE	MODERATE	MODERATE	MODERATE	MODERATE	UNACCEPTABLE
TOE REPLACEMENT	MODERATE	HARD	FEASIBLE	MAJOR	MAJOR	POOR	HIGH	NOTE 1 & 3
REINFORCED EARTH	MODERATE	MEDIUM	FEASIBLE	MODERATE	MODERATE	MODERATE	MODERATE	NOTE 1
BORED PILES	GOOD	MEDIUM	FEASIBLE	MODERATE	MINOR	GOOD	MODERATE	ACCEPTABLE
SLOPE REPROFILING	MODERATE	HARD	FEASIBLE	MODERATE	MAJOR	MODERATE	MODERATE	NOTE 1

NOTES:
1 NOT A FEASIBLE SINGLE OPTION SHOULD BE USED IN CONJUNCTION WITH OTHER TECHNIQUES
2 VIABLE FOR TILL COBVER LESS THAN 8M DEEP
3 WOULD HAVE TO BE PHASED IN SMALL BAYS TO AVOID TRIGGERING LANDSLIDE
4 LABOUR INTENSIVE – WOULD REQUIRE LOCAL SOURCE OF STONE TO MAKE VIABLE (IE FROM THE BECK)

TABLE 4.2 SUMMARY OF TOE PROTECTION OPTIONS CONSIDERED FOR PROACTIVE INTERVENTION

OPTIONS CONSIDERED	ENGINEERING			BUILDABILITY/ FEASIBILITY	ENVIRONMENTAL			COST	SUMMARY
	TOE PROTECTION	STRUCTURE STABILITY	HYDRAULIC PERFORMANCE		SCALE OF WORKS	IMPACT ON FLORA AND FAUNA	AESTHETIC VALUE		
DO NOTHING **Short Term** **Medium Term**	DETERIORATES FAILS	N/A	DETERIORATES	N/A	N/A	NIL MAJOR	N/A UNACCEPTABLE	NIL UNACCEPTABLE	UNACCEPTABLE
DO MINIMUM **Short Term** **Medium Term**	DETERIORATES FAILS	DETERIORATES FAILS	DETERIORATES	EASY DIFFICULT	MINOR INTERMEDIATE	NIL MAJOR	GOOD UNACCEPTABLE	LOW UNACCEPTABLE	ACCEPTABLE UNACCEPTABLE
OFFSHORE BREAKWATERS	OPTIONS DO NOT INTEGRATE WITH HOLBECK-SCALBY MILLS COASTAL DEFENCE STRATEGY FOR THE SEA-LIFE CENTRE MANAGEMENT SUBUNIT(20A/1) (THE PREFERRED OPTION FOR MSU20A/1 IS A 50M WIDE ROCK ARMOUR REVETMENT)								UNACCEPTABLE
BEACH NOURISHMENT									UNACCEPTABLE
HEADLAND EXTENSION GROYNES									UNACCEPTABLE
STRONGPOINTS									UNACCEPTABLE
TOE PROTECTION STRUCTURES									
ROCK ARMOUR	GOOD	GOOD	V GOOD	HARD	MODERATE	MODERATE	MODERATE	MODERATE	ACCEPTABLE NOTE 1
MASS CONCRETE	GOOD	MODERATE	POOR	MEDIUM	MODERATE	MAJOR	POOR	MODERATE	UNACCEPTABLE
REINFORCED EARTH	GOOD	GOOD	POOR	MEDIUM	MODERATE	MODERATE	MODERATE	LOW	UNACCEPTABLE
ARMOURLOC	GOOD	POOR	GOOD	EASY	MODERATE	MODERATE	MODERATE	LOW	UNACCEPTABLE
GABION	GOOD	GOOD	GOOD	MEDIUM	MODERATE	MODERATE	GOOD	MODERATE	NOTE 2

NOTES
1 COSTS MAY BE REDUCED IF UNDERTAKEN WITH SCARBOROUGH COASTAL WORKS
2 LABOUR INTENSIVE – REQUIRES LOCAL SOURCE OF STONE (BECK?) TO BECOME ATTRACTIVE

4.5 Evaluation of Option Costs

The costs evaluated are based on design at strategic level and competitive rates used for recent works along the Scarborough coastline. Any associated risks, due the nature of the work in tidal/fluvial areas, have been incorporated into preliminaries and contingencies and also into rates where applicable.

4.5.1 Do Minimum: Monitoring & Inspection

Inspection costs of **£3000/yr** have been assessed by estimating the cost of routine inspection of the slopes twice per year and once following the abatement of significant storm force sea conditions. This estimate includes the reporting associated with the findings of the inspections, but does not allow for costs associated with further recommendations, assessments or studies which may arise from these inspections.

4.5.2 Do Minimum: Periodic and Emergency Works - OPTION 2

This option has been included as a 'realistic option' although it is considered as the least cost-effective. The costs for this option **(for MSu19E/VI –the northeasterly facing slope)** have simply spread the costs for a full capital scheme over seven phases of work for the duration of the strategy. In addition given that failures are likely to occur throughout the strategy period until all works are complete (ie Year 60) it has been estimated that there will be six occasions when emergency works will be required (ie 1 event/10yrs). It is considered that each set of work will not reduce the probability of failure along the slope line (ie the risk of major landslide remains until all work is complete).

The cost of the periodic works has been estimated to be **£308k** every 7 years for the duration of the strategy. A nominal cost of **£100k/event** has been attributed to emergency works. This amount includes for any damage to existing work and clearing up of any debris. It is not expected to contribute to reductions of any future work costs.

4.5.3 Do Something -Capital Scheme Costs – OPTION 3

The costs of constructing the **composite scheme** has been quantified using simplified bills of quantities for the scheme and typical cross section drawings for the proposed works. The outlined cost of the capital schemes scheduled for construction in year 2 **(£2156K)** are based upon, competitive bill rates, tendered by Contractors for similar works undertaken on the North Yorkshire coastline in 2001/2. Preliminary costs, mobilisation costs, method related charges, specified requirements, overheads and profit associated with the construction contract have been applied as a percentage of the overall construction costs. A percentage value of 30% has been used for preliminary items, based on the average of received tenders for previous works and a contingency of 20% has been applied to construction costs. Details of the cost of the preferred capital works scheme are presented in Table 4.3.

An allowance for maintenance during the strategy period has been budgeted for on annual basis.

In addition, contingency works required during the scheme have been estimated at £250k in Years 20 and 40.

4.5.4 Do Something - Partial Scheme Costs – OPTION 4

This option identifies that **partial works** comprising mechanical stabilization, drainage and toe protection can be undertaken primarily on the northeasterly facing beck slope. These works have been provisionally costed at **£1438K for Year 2**. It has been considered phasing the works over the first 10 years of the strategy, however, this will result in greater design costs and the risk to any contractor will be increased given that the likelihood of toe erosion will be greater (see Table 4.4b).

Although the scheme suggested for Option 4 will provide suitable protection against a major landslide it is likely that there will be higher maintenance costs due to the scheme not being the 'full scheme' described in Option 3. Therefore, an allowance of **£2000/year** up to year 20 has been allowed for maintenance of the northeasterly and northwesterly facing slopes within coast protection limits. Thereafter, (ie Year 20) it has been assumed that the cost of undertaking maintenance will increase to **£5000/year** over the remaining duration of the strategy. It is likely that maintenance works will be required periodically rather than annually; the costs have been spread on an annual basis for ease of budgeting. Details of the cost of the capital works option are presented in Table 4.4a. The costs of phasing the toe protection works are presented in Table 4.4b.

In addition, contingency works required during the scheme have been estimated at £250k in Years 20 and 40.

4.5.5 Other Costs

Included within this category are:

Further Studies:

Topographic survey for detailed design	est **£5k**
Environmental Study	est **£20k**
Engineer's Report	est **£20k**

Consultancy Costs for Project Management of the strategy and its implementation have been estimated at **£1k/yr**. This does not include for analysis and any presentation of data following other studies, monitoring, etc.

4.5.6 Consultancy Costs

Consultancy costs attributed to the writing of grant application reports and the procurement of planning consents and all other necessary legislation under the Coast Protection Act 1949 have been estimated as a percentage of the construction costs. The applied percentage being dependent on the estimated magnitude of the final construction costs. For the scheme presented in Tables 4.3 and 4.4; the total Consultant's fees have been assessed ranging from **£172k to £232k**.

Design costs attributed to detailed design, preparation of tender documentation and tender assessment services have also been estimated as a percentage (4-5%) of the construction costs – these range from **£63k to £77k**. These costs have been estimated based on the magnitude of construction works and tender preparation.

Construction supervision costs have also been applied on a percentage basis, although these percentages may vary depending on the duration of the construction contracts. The Consultant's head office supervision and administration costs were applied at 2%. Likewise, site office supervision costs were applied at 5%.

4.5.7 Council Costs

Estimates have been made on the level of expenditure attributed to Council Costs based on past spending. A judgement has been made to assign Council Costs at 2% of the total scheme costs. Council costs attributed to future administration of monitoring and maintenance works have been built into the strategy costs. A judgement has been made as to the extent and cost of any future emergency works, supplementary works, and further liaison based on the probability of such events occurring.

It has been identified that works may have to be taken on the slopes adjacent to Scholes Park Drive, upstream of the limit of the grant eligible coast protection works. It will be necessary for the Council to undertake cliff top works as and when necessary following a programme of regular monitoring. It is anticipated that costs for the monitoring (say three visits a year plus initial set up costs) will be in the order of **£1000/yr**. It is expected that initial maintenance works may commence as soon as Year 3. The costs have been estimated over sections of road being lost at predicted cliff top recession rates and have been determined for the first 10 years (future monitoring will determine further works):

- Year 3 80m @ £500/m £40,000
- Year 10 120m @ £500/m £60,000

The costs of maintaining access between the pinchpoint at Scalby Ness Headland and Scalby Sands **(MSu's IV & V)** will require a number of phases of cliff top betterment works. It is considered that the first phase of works be undertaken in Year 1 (while there is still sufficient cliff top to work with); any

Hundale Point To Scalby Ness Coastal Strategy Study

Scalby Beck Northeasterly Facing Slope - OPTION 3

Full Scheme Arrangement
1) Toe Protection
2) Slope Stabilisation

TABLE 4.3 - BILL OF QUANTITIES - PRELIMINARY ESTIMATE OF COST OF WORKS

Item	Description	Dimensions L (m)	D (m)	W (m)	Nr	Unit	Quantity	Rate	Price
1	**General Items**	1	1	1	1	Sum	1	}	
1.1	Contractual Requirements	1	1	1	1	Sum	1	}	
1.2	Site Establishment	1	1	1	1	Sum	1	}	£384,967.50
1.3	Method Related Charges	1	1	1	1	Sum	1	}	
1.4	Dayworks	1	1	1	1	Sum	1	}	
1.5	Specified Requirements	1	1	1	1	Sum	1	}	
2	**Toe Protection**								
2.1	Excavate & double handle earth	350	3	3	1	m3	3150	£34.00	£107,100.00
2.2	Rock Armour (1-5 tonne)	350	3	3	1	m3	3150	£55.00	£173,250.00
2.3	Ancillaries related to RA						50%	£173,250.00	£86,625.00
3	**Slope Stabilisation**								
3.1	Supply & installation of ~15m length piles	25	-	-	150	m2	150	£1,250.00	£187,500.00
3.2	Drainage - deep counterforts	75	5	1	10	Nr	10	£7,000.00	£70,000.00
3.3	Reprofiling Works	150	1	45	1	m3	6750	£65.00	£438,750.00
3.4	Cliff Top Stabilisation - Geomat & Soil Nails	220	20	1	1	m2	4400	£50.00	£220,000.00
4	**Contingency @20%**								£256,645.00
								Preliminaries	£384,967.50
								Construction	£1,283,225.00
								Contingency	£256,645.00
								GRAND TOTAL	£1,924,838

TABLE 2 - ESTIMATE OF CONSULTANTS FEE

Item	Project Stage	Estimate of Works Value	Fee % of Works Value	Specialist Studies	Cost
		1,924,838			
1	**Design Stage**		4%		£76,994
1.1	**Environmental Impact Study**			£20,000	£20,000
2	**Site supervision/Project Management** (incl expenses)		5%		£96,242
3	**Head Office Supervision**		2%		£38,497
Total Consultants Fee Estimate					£231,732

TABLE 3 - SCHEME COST ESTIMATE

Item	Estimate
Cost of Works	£1,924,838
Consultants Fees	£231,732
TOTAL	£2,156,570

Note
1. Estimated duration of works 6 months
2. Preliminaries 30% of Construction costs
3. Design stage allows for 6 weeks design and tender preparation

Hundale Point To Scalby Ness Coastal Strategy Study

Scalby Beck Northeasterly Facing Slope - OPTION 4

Scheme Arrangement
Do Something - Partial Works
2) Slope Stabilisation
3) Toe Protection

TABLE 4.4a - BILL OF QUANTITIES - PRELIMINARY ESTIMATE OF COST OF WORKS

Item	Description	Dimensions			Nr	Unit	Quantity	Rate	Price
		L (m)	D (m)	W (m)					
1	**General Items**	1	1	1	1	Sum	1	}	£253,342.50
2	**Slope Stabilisation**								
2.1	Supply & installation of ~15m length piles	25	-	-	150	m2	150	£1,250.00	£187,500.00
2.2	Drainage - deep counterforts & earthworks	75	5	1	10	Nr	10	£7,000.00	£70,000.00
2.3	Cliff Top Stabilisation - Geomat & Soil Nails	220	20	1	1	m2	4400	£50.00	£220,000.00
3	**Toe Protection**								
3.1	Excavate & double handle earth	350	3	3	1	m3	3150	£34.00	£107,100.00
3.2	Rock Armour (1-5 tonne)	350	3	3	1	m3	3150	£55.00	£173,250.00
3.3	Ancillaries related to RA						50%	£173,250.00	£86,625.00
3	**Contingency @20%**								£168,895.00
								Preliminaries (30% Construction Costs)	£253,342.50
								Construction	£844,475.00
								Contingency	£168,895.00
								GRAND TOTAL	£1,266,713

Item	Project Stage	Estimate of Works Value	Fee % of Works Value	Specialist Studies	Cost
		1,266,713			
1	**Design Stage**		5%		£63,336
1.1	**Environmental Impact Study**			£20,000	£20,000
2	**Site supervision/Project Management** (incl expenses)		5%		£63,336
3	**Head Office Supervision**		2%		£25,334
Total Consultants Fee Estimate					£172,006

Item	Estimate
Cost of Works	£1,266,713
Consultants Fees	£172,006
GRAND TOTAL	£1,438,718

1. Estimated duration of works 4 months
2. Design stage allows for 4 weeks design and tender preparation

Hundale Point To Scalby Ness Coastal Strategy Study

Scalby Beck Northeasterly Facing Slope - OPTION 4

Scheme Arrangement
Do Something - Phased Partial Works
2) Slope Stabilisation
3) Phased Toe Protection

TABLE 4.4b - BILL OF QUANTITIES - PRELIMINARY ESTIMATE OF COST OF WORKS

Item	Description	Dimensions L (m)	D (m)	W (m)	Nr	Unit	Quantity	Rate	Price
1	General Items	1	1	1	1	Sum	1	}	£143,250.00
2	Slope Stabilisation								
2.1	Supply & installation of ~15m length piles	25	-	-	150	m2	150	£1,250.00	£187,500.00
2.2	Drainage - deep counterforts & earthworks	75	5	1	10	Nr	10	£7,000.00	£70,000.00
2.3	Cliff Top Stabilisation - Geomat & Soil Nails	220	20	1	1	m2	4400	£50.00	£220,000.00
3	Contingency @20%								£95,500.00
								Preliminaries (30% Construction Costs)	£143,250.00
								Construction	£477,500.00
								Contingency	£95,500.00
								TOTAL	£716,250

Phased Toe Protection Works

Item	Description	L (m)	D (m)	W (m)	Nr	Unit	Quantity	Rate	Price
A	Toe Protection								
B	Preliminaries								£146,790.00
B1	Excavate & double handle earth	350	3	3	1	m3	3150	£34.00	£107,100.00
B2	Rock Armour (1-5 tonne)	350	3	3	1	m3	3150	£55.00	£173,250.00
B3	Ancillaries related to RA						50%	£173,250.00	£86,625.00
C	Contingency @30%								£110,092.50
								Preliminaries (40% Construction Costs)	£146,790.00
								Construction	£366,975.00
								Contingency	£110,092.50
								TOTAL	£623,857.50

GRAND TOTAL	£1,340,107.50

Item	Project Stage	Estimate of Works Value	Fee % of Works Value	Specialist Studies	Cost
		1,340,108			
1	Design Stage		6%		£80,406
1.1	Environmental Impact Study			£20,000	£20,000
2	Site supervision/Project Management (incl expenses)		5%		£67,005
3	Head Office Supervision		2%		£26,802
Total Consultants Fee Estimate					£194,214

Item	Estimate
Cost of Works	£1,340,108
Consultants Fees	£194,214
GRAND TOTAL	£1,534,321

Note
1. Estimated duration of works 4 months
2. Preliminaries 30% of Construction costs for slope work & 40% for toe protection works (to account for double mobilisation etc)
3. Contingency 20% for slope works and 30% for phased work (based on delayed work and potential higher risl of toe erosion)
4. Increased design costs due to phased work and two tender preparations etc

other works will be determined following periodic monitoring of the strategy. However, for the purposes of budgeting two other phases have been programmed for Years 20 and 40. The costs for each phase of work have been estimated at **£100k.** This has been estimated on engineering experience that geofabric and soil nailing works (say on a 2m^2 grid) cost approximately £50/m^2, the total area is some 100m long by 10m deep over two slopes (this work at the pinchpoint is not considered coast protection works and therefore non grant eligible).

4.5.8 Direct Losses: Properties at risk during the strategy period.

Properties at risk of total loss from erosion are valued at year 2002 expected market value. There is potential for recession of the existing backscar and instability developing within the oversteep slopes adjacent to and above the Scalby Mills Road. The predicted recession is shown on the Cliff Recession Plan, Figure 3.4.

It is assumed that properties 'at risk' will be written off, where property is less than a reasonable safe distance of the eroding cliff edge. It is assumed that the safe distance, following activation of a major landslide, from the cliff edge to existing properties is 10m. This is based on engineering judgement following stability analyses. The recommended safe distance provides a factor of safety against the recurrence of the predicted single event failure within the next 2 years. It is intended to allow adequate planning and timing of appropriate emergency responses. The existing minimum distances to the cliff edge are between 8m to 10m.

The direct losses have been assessed should the do nothing scenario occur. It has been determined that during the do nothing scenario a major landslip will occur and progressive failure upslope will continue throughput the strategy period. Furthermore, there is the potential for the beck to be impounded from the failed material and a subsequent rise in levels of the beck. This will ultimately result in slope degradation upstream and an increased rate of cliff top recession (see Section 3.4). Although the properties along Scholes Park Drive appear to be well away from significant marine influence, it is the consequence of marine erosion down stream that has established that these properties be included as benefits during the strategy period. Should works be undertaken to prevent major landslip of the northeasterly facing beck slope, recession rates will be significantly less than those presented in Figure 3.4 and, therefore, the risk of property loss. Having said this, it has been recognised that any work in these upstream areas will not be coast protection grant eligible (see Section 4.5.7).

Assuming a large scale slope failure within the next 2 years, the properties and infrastructure at risk during the term of the strategy are presented in Table 4.5. The direct losses are evaluated in Tables 4.6a b & c.

TABLE 4.5 ASSETS LOST DURING STRATEGY PERIOD

Event & Time	Property	Actual Costs
Major Landslide of Northeasterly Facing Slope *Within 2 years*	Flats Nos 169 to 223 & 138 to 148 Houses Scalby Mills Road No 78 Scholes Park Rd 45 to 59 Old Scalby Mills PH (43 Properties) YW Road sewage system Footbridge Clearance to YW UWWT Works	} } } £3571k } £320k £25k £25k
Progressive Failure along Northwesterly facing beck slope as beck becomes impounded *Year 5*	Commencement of loss of parts of Scholes Park Drive – Services 80m @ £300/m Scalby Mills Road No 80	£24k £278k
Progressive Failure along Northwesterly facing beck slope *Year 15*	Scholes Park Drive Nos 11-13 Scholes Park Rd No 165-7 (4 Properties) Scholes Park Drive – Services 120m @ £300/m	} } £366k £36k
Progressive Failure along Northwesterly facing beck slope *Year 30*	Scholes Park Drive Nos 15 & 49 (2 Properties) Scholes Park Drive – Services 50m @ £300/m	£240k £15k
Progressive Failure along Northwesterly facing beck slope *Year 45*	Scholes Park Drive Nos 21,23,25,27,29,35,37,39 & 47 (9 Properties)	£673k
Progressive Failure along Northwesterly facing beck slope *Year 60*	Scholes Park Drive Nos 31,33,41,43 & 45 Scholes Park Rd No 134,149,151,159,157 (10 Properties)	£657k

Note: Properties and infrastructure 'at risk' assuming a large scale failure within the next 2 years and/ or steady recession between 2 to 60 years (assuming 0.3m/year recession x 58 years = 17.4m recession + 10m safe distance = 18.4m following 30m cliff top failure).
Loss of services only for those properties still viable.
Total number of properties 69.

4.5.9 Indirect Losses: Damage to Scalby Mills Road, Yorkshire Water's Underground Wastewater Treatment Tunnel, Loss of Business at Scalby Mills Car Park and Sea Life Centre

It is considered that a potential failure of the slopes above Scalby Mills Road will result in the loss of access and superficial damage to Yorkshire Water's underground waster water treatment works in Scalby Mills Car Park. It has been assumed that the costs to repair any superficial damage will be in the region **£25k - £100k**. For the purposes of this report a figure of **£62.5k** has been used for assessment.

It has also been identified that Yorkshire Water's main sewage system assets cost **£320k** in addition to the sections of pipe accountable to the value of the properties. This figure has been used to replace/ realign a substantial part of the ring system following a 30m failure severing the ring system in Scalby Mills Road and between the Scalby properties; this includes for temporary works and clearing up costs as not all the system is likely to be damaged.

It is unlikely that there will be any detrimental effects to the serviceability of the underground wastewater tunnel passing below the main slip block in the beck slopes.

Failure of the northeasterly facing slope has shown, through stability analysis, to affect Scalby Mills Road. Given that vehicular access will be lost to Scalby Mills car park, and for reasons that will be discussed later on within this section, it is necessary to account for the losses associated with: 1) the loss of income to the Sea Life Centre and the car park; 2) costs of constructing a car park within walking distance of the Sea Life Centre; and, 3) the 'total loss' of the Sea Life Centre due to the economic unviability should failure of Scalby Mills Road prevent parking facilities.

The Sea Life Centre and Scalby Mills Car Park should be considered special cases which satisfy three conditions set out in PAG 3 (p 26) that *losses of trade ..... result in real losses if the consumer cannot obtain an equivalent good at the same time and at the same cost.* The case for this argument is presented below.

During the tourist season it is well known that there is a serious shortage of car parking facilities near the Scarborough frontage. This is particularly true in North Bay where the three, quite small car parks near the swimming pools and bowling centre are frequently filled to capacity by users of these particular leisure facilities. The somewhat larger Burniston Road car park is also very often full to capacity throughout the day. None of these car parks offer quick and easy pedestrian access to the Sea Life Centre. This is clearly apparent, particularly since the funicular railway was dismantled, and the fact that the miniature railway, which is only operable during the peak holiday season, is an entertainment ride rather than an efficient mode of public transport. The park and ride scheme does not have set down locations in North Bay, and the scheme is only reluctantly used, usually after family cars have made several circuits whilst looking for parking opportunities.

Presently, there is little scope to create more car park spaces in and around North Bay and it is quite likely that the shortage of parking will become more acute year by year. This situation is equally, if not more acute at the neighbouring coastal resorts of Filey, Robin Hood's Bay, Whitby, Runswick Bay, and Staithes. So there is little opportunity or choice for day-trippers travelling from say Middlesborough or Stockton to visit this part of the coast during the Summer and to find convenient parking, unless they deliberately arrive early in the morning before the places reach saturation.

Clearly, in the context of the above, the road access leading to the car park immediately adjacent to the Sea Life Centre is essential for the continued popularity of this leisure/educational amenity. If vehicular access to the car park were to be lost then attendance figures to the Centre would be significantly reduced and it is extremely unlikely that a percentage of the prospective visitors to the Centre would visit the swimming pools, the Bowling Centre or the amusement arcades instead. There are seven Sea Life Centres in UK (aswell as other aquariums), the nearest to Scarborough being Blackpool and Birmingham. The others are at Brighton, Gt Yarmouth, Bray and Weymouth. In the event of closure of the Scarborough Centre there is no similar, alternative nearby venue for school parties nor holidaymakers and day-trippers. Therefore the loss of the car park access road would result in the loss of the Sea Life Centre amenity to the nation, albeit the northeast.

It is understood that one of the principal factors in locating the Sea Life Centre at Scalby was the existing car park adjacent to the site. Even though there are no figures identifying the number of visitors who solely use Scalby Mills car park for the Sea Life Centre, there can be no question that a high number of car park users visit the Sea Life Centre.

Although no figures for visitors have been provided by the Sea Life Centre it is conceivable that some 300,000 people may visit the centre each year. For the purposes of this study it has been assumed from car park income that half the users of the car park can be attributed to visitors of the Sea Life Centre. For the given cars said to be visiting the Sea Life Centre an average number of people per car and coach has been estimated. Based on these figures and on the average entrance price, the annual total loss for the Sea Life Centre has been estimated to be **£369k**, see Table 4.6c (equivalent to approximately 20% of the estimated visitors to the Sea Life Centre). Should 50% of visitors be deterred from attending and visit no other attraction the annual total loss would be £813k (at average ticket costs).

Assessment of visitors deterred from visiting the Sea Life Centre takes into account that if the Sea Life Centre could no longer be accessed by car and coach a large proportion of visitors requiring car access would visit attractions elsewhere. Given the educational value of the Sea Life Centre and the number of school visits, a large number of people are expected to visit Scarborough for the sole purpose of visiting the Sea Life Centre. This would be significantly detrimental to the economy of the Sea Life Centre and Scarborough's tourism.

It has been assessed that there will ultimately be a loss of vehicular access to Scalby Mills car park and therefore a loss of revenue to the Council which is unlikely to be retrieved from any other pay-per-car-parking scheme in the environs of Scarborough. Based on figures presented by SBC the total income for 2001/02 was **£53k**. It has been assumed that this income will be lost following a major failure and the loss of Scalby Mills Road which is the only vehicular access to the car park.

Even though the do nothing scenario could argue that these losses would be experienced every year for the duration of the strategy, it has been assumed that after 10 years that vehicular access to Scalby Mills Car Park would be an accepted loss and, accordingly, no further costs attributable to the Sea Life Centre have been used in the economic analysis after this period. The loss of revenue may be such that the Sea Life Centre considers relocating before this 10 year period.

Therefore, economic analysis has considered relocation of the Sea Life Centre within the Scarborough area. As part of the practicalities of relocating the Sea Life Centre it is necessary to consider the costs of closing down the present Sea Life Centre, loss of tourism during the intervening period between closing down and opening the new Centre, the cost of constructing a new centre. Table 4.6d identifies the costs associated with this option. The costs of relocating the Sea Life Centre have been estimated to be **£9028k**.

Another approach to assess the benefits would be relocating the car park. The only area suitable for car park construction, which has reasonable proximity to the Sea Life Centre, would be the ground above the existing car park (ie Scalby Golf Course). It is considered that this would be an unrealistic option given that: 1) the golf course would lose 18 Hole status (there is no additional land that could be used to expand the course landwards of the Whitby Road); 2) It is likely that the Golf Course would oppose any such idea, and time and cost in preventing purchase of a section of the golf course may be such that failure could occur in the intervening period; 3) Stabilisation works would also be required to prevent progressive upslope failure occurring from Scalby Mills Road; and, 4) Construction and maintenance of the pathway from the car park to the Sea Life Centre would have to be suitable for emergency services, given that the only other access along the promenade may be closed due to high seas.

The costs of relocating the car park have been estimated to be **£1431k** (see Table 4.6e).

The assumptions in assessing this approach of losses can be identified in the introduction to Appendix E, which also contains the spreadsheets for the various options and economic approaches. In addition, a cost estimate has been made of the Health & Safety requirements following a failure (ie fencing the area off and making safe, slope inspection and betterment works, etc). This has been estimated at £250k as an erosion loss.

4.5.10 Loss of amenity and habitats

It is likely that a do nothing scenario will result in significant environmental impact within the area. Impounding and flooding of Scalby Beck will promote large scale landsliding and may result in loss of amenity and habitats.

4.5.11 Unvalued Benefits and Consequences

If a do nothing scenario is adopted for Management Sub-unit 19E/I to VI there are intangible losses associated with the reduced facility of the level of amenities along the Yorkshire coastline. Other intangible losses associated with the stress and trauma caused by a failure event have not been quantified

TABLES 4.6 Losses over Strategy Period

A

Year 2 Direct Losses

Year	Property	Number	Cost	Total
Year 2	*Scalby Mills Road*			
	78	1	325,000	325,000
	Scholes Park Road			
	Nos 138 to 150	8	85,000	680,000
	Nos 213 to 223	6	82,000	492,000
	Nos 205 to 211	4	78,000	312,000
	Nos 189 to 203	8	78,000	624,000
	Nos 181 to 187	4	72,000	288,000
	Nos 169 to 177	6	72,000	432,000
	55	1	90,000	90,000
	53	1	65,000	65,000
	51	1	68,000	68,000
	Old Scalby Mills PH	1	170,000	170,000
			TOTAL	**3,546,000**
	Scalby Beck Footbridge	1	25,000	25,000
			TOTAL	**25,000**
			GRAND TOTAL	**3,571,000**

B

Year 5, 15, 30, 45 & 60 Losses

Year	Property	Number	Cost	Total
	Scholes Park Drive			
5	Road Services	80	300	24,000
	Scalby Mills Road			
	80	1	278,000	278,000
			Total	302,000
	Scloes Park Road/Drive			
15	13	1	74,000	74,000
	11	1	70,000	70,000
	7	1	92,000	92,000
	165-167	2	65000	130,000
	Road Services	120	300	36,000
			Total	402,000
	Scloes Park Drive			
30	15	1	78,000	78,000
	49	1	70,000	70,000
	7 Scoles Park Cliff	1	92,000	92,000
	Road Services	50	300	15,000
			Total	255,000
	Scloes Park Drive			
45	47	1	64,000	64,000
	39	1	73,000	73,000
	37	1	72,000	72,000
	35	1	66,000	66,000
	29	1	84,950	84,950
	27	1	84,950	84,950
	25	1	73,000	73,000
	23	1	72,000	72,000
	21	1	83,000	83,000
			Total	672,900
	Scloes Park Drive			
60	134	1	72,000	72,000
	149	1	55,000	55,000
	151	1	55,000	55,000
	159	1	65,000	65,000
	157	1	65,000	65,000
	45	1	66,000	66,000
	43	1	62,000	62,000
	41	1	73,000	73,000
	33	1	72,000	72,000
	31	1	72,000	72,000
			TOTAL	657,000

C

Year 2 Indirect Losses

Year	Ratio Of Cars: Coaches	Person per Vehicle	Number of Vehicles/ Persons	Ticket Prices for Car Park and Sea Life Centre	Total (£)
Car Park Revenue					53,270
Average Ticket Price				2.55	
Av Number of Vehicles			20890		
Vehicles visiting Sea Life Centre (Say 50%)			10445		
Ratio of Cars: Coaches (Say 10:1)					
Average Number of Persons/ Vehicle — Cars	9445	3	28335	5.88	166,610
Coaches	1000	30	30000	5.88	176,400
				Total	**396,280**

1. No actual figures provided by the Sea Life Centre - all visitor figures estimated
3. Av number of vehicles = CP Revenue/ Av ticket price
4. Persons per vehicle = 3pp car and 30pp coach - assumed
5. Av Ticket prices = sum of car park tarrifs/ no. of tarrifs (£2.55); ditto for Sea Life Centre (£5.42)

D

Relocation of Sea Life Centre

Item	Estimated Costs (£)
Closing out, demolition, temporary animal rehousing, say	£500,000
Loss of tourism [1]	£3,528,000
Construction of new Sea Life Centre[2]	£5,000,000
TOTAL	£9,028,000

1. Loss of tourism = 300,000 people @ £5.88 entrance fee over 2 years
2. Estimated cost based on discussion with SLC representative

E

Relocation of Car Park

Item	Description	Cost (Estimated)
1	**Detailed Design** (incl allowance for a ground investigation)	**£40k**
2	**Land Acquisition** (incl legal fees, planning etc)	**£30k**
3	**Costs to Convert new land bought into Golf Course Quality**	**£100k**
4	**Council Costs** (incl site supervision)	**£10k**
5.1	Site Establishment (20% of Construction costs & Ancillaries)	£99k
5.2	Excavation of existing golf course and for new car park and	£88k
5.3	Preparation & Placement of sub-base, base course and wearing course + kerb edging, landscaping Ancillaries: Fencing, ticket machines, painting boxes etc	£375k
5.4	**Pathway** 3m wide suitable for emergency services – 300m2	£30k
	Construction Sub Total	**£592**
6	**Slope Stabilisation** along Scalby Mills Road Slope	**£300k**
7	**Maintenance** (£0.5k/yr) & Rebuilding every 10 years	**£120k**
	Total	**£1,192k**
	Contingency 20%	**£239k**
	GRAND TOTAL	**£1,431k**

and are therefore not considered in the economic evaluation for the proposed strategy.

The cost of rebuilding the Scalby Mills Road (probably in the region of £250-500k) or costs attributable to traffic disruption have not been costed. The costs of demolition and removal of abandoned properties has also not been costed, nor has the loss of business to the public house.

The consequences of toe, bank and slope failures are likely to include the loss of access to the cliff top walk at Scalby Ness and the loss of habitat and walking, picnic areas along the banks of Scalby Beck.

4.6 Estimate of Benefits

Principles relating to the economic evaluation of coast protection strategies or schemes are presented in MAFF's (now DEFRA) Project Appraisal Guidance Note 3 (1999). In line with FCDPAG3 a probabilistic approach been used: where there is an annual probability of a single unrepeated failure leading to subsequent damages. The probabilistic analysis involves estimating both the levels of damages/losses that could result from a particular event (i.e. slope failure) and the probability that this event occurs in a particular year. Thus, the present value (PV) of the losses associated with the event affecting the site in a particular year (year i) were calculated as follows:

PV losses (Year i) = Prob. (event, Year i) x damages x discount factor (Year i). The PV of losses associated with the event over a 60-year period is the sum of the annual losses (Year 1 – 60). This approach expresses the results as the PV damages resulting from a cliff top failure event (i.e. without project).

The equivalent of the range of estimated years when failure might occur used in the deterministic analysis (see above) is the use of a range of annual probabilities of failure. Instead of assuming that failure will occur in a particular year, it was assumed that there would be a 95% probability that failure will have occurred by the time (i.e. the cumulative probability by year i = 0.95). For example, a 95% chance of occurrence by year 5 corresponds with an annual probability of 0.45. Similarly, a 95% chance of occurrence by year 10 corresponds with an annual probability of 0.25.

The estimated annual probability, cumulative probability and the time by which an event is almost certain to have occurred are related as follows, assuming a normal distribution:

Probability of Occurrence in x years = 1 - (1 - annual probability)^x

For example, for an event with an estimated 95% chance of occurrence in years 50, 10, 5, 2 and 1 the cumulative probability of an event occurring in any given year are presented in Table 4.7:

Table 4.7 CUMULATIVE PROBABILITY

Year	Cumulative Probability				
1	0.06	0.25	0.45	0.65	0.95
2	0.12	0.43	0.70	0.95	
5	0.26	0.76	0.95		
10	0.46	0.95			
50	0.95				

Table 4.8 presents a summary of the results obtained for the various options considered for different timing scenarios and changing probabilities of failure.

Full details of the derivation of the PV erosion losses, benefits and benefit:cost ratios are to be found in Appendix E.

4.7 Risk and Sensitivity Analysis

4.7.1 Risks and Uncertainties

A number of risks have been identified during the Strategy Study. Amongst the greatest risks are:

- Slope instability and potential deep-seated failures of the glacial till cliffs, particularly the northwesterly and northeasterly facing slopes, which threaten the cliff top assets and present a risk to public safety. The timing of these one-off events is extremely difficult to predict and attempts to address these risks have been made in the probabilistic approach of the economic evaluation. Nevertheless, the potential for a significant deep-seated failure during the course of the strategy, over the next 60 years or so, has been recognised.

- The loss of slope top along Scholes Park Drive during the Strategy period. It is considered that higher beck levels will almost certainly result in an increase in slope failures; beck levels will increase as a result of slope failure and damming of the beck downstream and/or more frequent discharging of the River Derwent into the beck.

- The possibility that failure could occur prior to the scheme being implemented. It would be preferable to construct the scheme as soon as possible; in the mean time frequent and regular monitoring of the borehole instrumentation should be undertaken to assess any trends in further instability.

- Loss of Scalby Mills Road as a result of slope failure. It is anticipated that this would lead to significant loss of revenue to the Council (car park tariffs) and the Sea Life Centre. Given the difficulties in assessing the consequences of the loss of Scalby Mills Road, the benefits and losses for all scenarios assessed in Section 4.5.9 have been appraised.

TABLE 4.8 BENEFIT COST RATIO SUMMARY TABLE FOR DEFERRED EROSION LOSSES

	TIMING OF FAILURE															
	YEAR 2				YEAR 5				YEAR 7				YEAR 10			
Assets include Sea Life Centre & Car Park Losses	DO NOTHING (OPTION 1)	DO MINIMUM + Phased Works (Option 2)	DO SOMETHING (OPTION 3)	DO SOMETHING (OPTION 4)	DO NOTHING (OPTION 1)	DO MINIMUM + Phased Works (Option 2)	DO SOMETHING (OPTION 3)	DO SOMETHING (OPTION 4)	DO NOTHING (OPTION 1)	DO MINIMUM + Phased Works (Option 2)	DO SOMETHING (OPTION 3)	DO SOMETHING (OPTION 4)	DO NOTHING (OPTION 1)	DO MINIMUM + Phased Works (Option 2)	DO SOMETHING (OPTION 3)	DO SOMETHING (OPTION 4)
PV COSTS (£k)	0.0	1,143.0	2,415.8	1,769.4	0.0	1,143.0	2,415.8	1,769.4	0.0	1,143.0	2,415.8	1,769.4	0.0	1,143.0	2,415.8	1,769.4
PV LOSSES (£k)	6,871.7	6,169.5	74.5	74.5	5,723.0	5,138.3	62.0	62.0	5,093.5	4,573.0	55.2	55.2	4,283.7	3,846.0	46.4	46.4
TOTAL PV BENEFITS (£K)	-	702.1	6,797.2	6,797.2	-	584.8	5,661.0	5,661.0	-	520.4	5,038.3	5,038.3	-	437.7	4,237.3	4,237.3
NET PRESENT VALUE NPV	-	-440.9	4,381.4	5,027.8	-	-558.3	3,245.3	3,891.6	-	-622.6	2,622.5	3,268.8	-	-705.3	1,821.5	2,467.8
BENEFIT/COST RATIO	-	0.6	2.8	3.8	-	0.5	2.3	3.2	-	0.5	2.1	2.8	-	0.4	1.8	2.4
Assets include Relocation of Car Park	DO NOTHING (OPTION 1)	DO MINIMUM + Phased Works (Option 2)	DO SOMETHING (OPTION 3)	DO SOMETHING (OPTION 4)												
PV COSTS (£k)	0.0	1,143.0	2,415.8	1,769.4												
PV LOSSES (£k)	5,481.3	4,921.2	59.4	59.4												
TOTAL PV BENEFITS (£K)	-	560.1	5,421.9	5,421.9												
NET PRESENT VALUE NPV	-	-583.0	3,006.1	3,652.4												
BENEFIT/COST RATIO	-	0.5	2.2	3.1												
Assets include total Sea Life Centre Loss	DO NOTHING (OPTION 1)	DO MINIMUM + Phased Works (Option 2)	DO SOMETHING (OPTION 3)	DO SOMETHING (OPTION 4)												
PV COSTS (£k)	0.0	1,143.0	2,415.8	1,769.4												
PV LOSSES (£k)	11,811.2	10,604.4	128.0	128.0												
TOTAL PV BENEFITS (£K)	-	1,206.8	11,683.2	11,683.2												
NET PRESENT VALUE NPV	-	63.8	9,267.4	9,913.7												
BENEFIT/COST RATIO	-	1.1	4.8	6.6												

TABLE 4.11 BENEFIT COST RATIO SUMMARY TABLE FOR NO INDIRECT LOSSES AND INCREASED CONSTRUCTION COSTS

	No Indirect Losses				+25% Construction Costs				+50% Construction Costs			
	DO NOTHING (OPTION 1)	DO MINIMUM + Phased Works (Option 2)	DO SOMETHING (OPTION 3)	DO SOMETHING (OPTION 4)	DO NOTHING (OPTION 1)	DO MINIMUM + Phased Works (Option 2)	DO SOMETHING (OPTION 3)	DO SOMETHING (OPTION 4)	DO NOTHING (OPTION 1)	DO MINIMUM + Phased Works (Option 2)	DO SOMETHING (OPTION 3)	DO SOMETHING (OPTION 4)
PV COSTS (£k)	0.0	1,143.0	2,416.4	1,770.1	0.0	1,143.0	2,870.2	2,089.8	0.0	1,143.0	3,324.4	2,367.6
PV LOSSES (£k)	4,160.4	3,735.3	45.1	45.1	6,871.7	6,169.5	74.5	74.5	6,871.7	6,169.5	74.5	74.5
TOTAL PV BENEFITS (£K)	-	425.1	4,115.3	4,115.3	-	702.1	6,797.2	6,797.2	-	702.1	6,797.2	6,797.2
NET PRESENT VALUE NPV	-	-718.0	1,698.9	2,345.2	-	-440.9	3,927.0	4,707.4	-	-440.9	3,472.8	4,429.6
BENEFIT/COST RATIO	-	0.4	1.7	2.3	-	0.6	2.4	3.3	-	0.6	2.0	2.9

- The length that the preferred scheme will function for. It is recognised that the scheme presented as Option 3 is likely to function for 60 years. However the scheme presented in Option 4 identifies and allows for annual significant maintenance throughout the strategy period. It is unlikely that money will be required every year, but for budgetary purposes an annual allowance has been made.

- Costs of the scheme may be incorrect. This is unlikely due to the costs being calculated on recent northeast coastal works. It is possible that Contractor's may place a greater risk on working on an active unstable slope and in tidal/ fluvial waters. In addition, the timing of the works may have an undesirable effect on any predicted cost of works.

Key areas of uncertainty associated with the identification of suitable strategies for risk reduction are summarised in Table 4.9. These uncertainties generally relate to the need to base many aspects of the appraisal on expert judgement of the current and future risks and, in the absence of reliable information, the need to make assumptions about the anticipated consequences of particular events. Clearly these uncertainties need to be further addressed in scheme appraisal and/or in subsequent reviews of the Strategy.

4.7.2 Sensitivity

The sensitivity of the preferred strategy for each section has been tested against variations in the following areas:

- The level of risk reduction likely to be provided by Options 2 to 4; in the analysis the implementation of the strategy is assumed to reduce the residual losses to 5% of the 'do nothing' losses. The implications of a range of risk reduction levels are presented in Table 4.10 – from 5% to 75% residual risk). This reveals that for Options 3 & 4 the BCR remains above 1.0 even if the options only deliver 50% of the 'do nothing' damages (i.e. 50% residual damages).

- The effects of no indirect losses (ie to the Sea Life Centre and loss of revenue to Scalby Mills Car Park) have been assessed. In addition, analysis on the increased costs of the works at 25% and 50% have also been assessed. The implications of these effects have been summarised in Table 4.11. The analysis reveals that for Options 3 & 4 the BCR remains above 1 even if costs for the works return at above 50% of those estimated and no losses of revenue for car parking and the Sea Life Centre are included.

TABLE 4.10 THE SENSITIVITY OF BCR OF THE OPTIONS WITH VARYING RISK REDUCTION EFFECTIVENESS

Notes:

1. the effectiveness of risk reduction is indicated by the level of residual damages after the scheme has been implemented.
2. 5% residual damage implies that the scheme is effective in preventing 95% of the "do nothing" damages, and so on.
3. the shaded cells indicate situations where the BCR for a section falls below 1.0

Option	PV Do Nothing Damages £K	PV Costs £K	5% Residual Damage	BCR (5% residual damage)	10% Residual Damage	BCR (10% residual damage)	25% Residual Damage	BCR (25% residual damage)	50% Residual Damage	BCR (50% residual damage)	75% Residual Damage	BCR (75% residual damage)
Option 2	1207	1143	1146.7	1.0	1086.3	1.0	905.3	0.8	603.5	0.5	301.8	0.3
Option 3	11683	2416	11098.9	4.6	10514.7	4.4	8762.3	3.6	5841.5	2.4	2920.8	1.2
Option 4	11683	1769	11098.9	6.3	10514.7	5.9	8762.3	5.0	5841.5	3.3	2920.8	1.7

TABLE 4.9 AREAS OF UNCERTAINTY

Area of Uncertainty	Issue
Problem Definition	Reliance on expert judgement to assess the likelihood/timing of slope failure and renewal of erosion; Future cliff recession rates are based on simple extrapolation of historical rates, with allowance for sea-level rise. Uncertainty over the effect of present variability of climate, climate change and sea-level rise on the level of risks. Uncertainty as to whether all potential failure modes (ie slope) have been identified.
Appreciation of Processes	The interaction between beach levels and slope performance; The interaction between fluvial and marine influences; The significance of internal slope processes (e.g. weathering, groundwater levels) and the role of drainage failure in promoting landslide events; The potential for small slides to expand and trigger large, deep-seated landslides.
Economic evaluation	The impact of damaging landslide/erosion on tourism and amenity and, hence, the local economy; The impact of Scalby Mills Road on car parking and the Sea Life Centre; The levels of residual risk associated with strategy implementation. Health & Safety implications for construction on an active landslide
Environmental	The impact on flora and fauna following of possible scheme options on habitats and protected sites
Timing and Planning	The prioritisation of urgent works is based on a current (year 2002) survey of slope condition and performance and assessment of the associated economic risks. Either or both of these factors could change in the future.

4.8 Consultation and Environmental Appraisal at the Strategic Level

Comments made by Statutory Consultees and third parties related to environmental matters should be incorporated, as far as possible and as required by the Planning Authority, into the detailed design and construction contract to reduce any unfavourable effects in the short term.

The following comments have been identified as being of particular concern to the implementation of the strategy and will have to be taken account of:

English Nature stated that otters (*Lutra lutra*) have been recorded in the lower part of Scalby Beck. Otters are fully protected under the Wildlife and Countryside Act 1981. It is likely that a license would be required from DEFRA given that any scheme in the beck may adversely affect any otters.

English Nature have no specific records of Salmonids using the beck, however, the North Eastern Sea Fisheries Committee state that Scalby Beck contains significant populations of sea trout.

An environmental appraisal at the strategic level has been undertaken in accordance with FCDPAG5. The environmental appraisal is presented in Appendix F. It is considered that the options that have been discussed above will not have a long-term detrimental effect on the habitats of flora and fauna in the Scalby area. However, any future works must take into account the environmentally sensitive nature of the site and must utilise techniques which are sympathetic with the local environment. Full discussion and liaison with all interested parties (namely English Nature and the Planning Department of Scarborough Borough Council) will be undertaken at initial detailed design stage.

5.0 DECISION ON PREFERRED OPTIONS

5.1 Determining the Preferred Management Strategy

Based on the economic assessment it is apparent that Option 4 offers the best cost-benefit ratio of 3.1.

Therefore, on economic criteria it provides the best value for money and it is considered that Option 4 is sustainable for the strategy period of 60 years as long as the regular maintenance allowed for is undertaken.

5.1.1 Preferred Strategy: Coastal Slopes – MSu's 19E/I to V

The preferred strategy, Option 4, has to establish the most appropriate measures in order that the SMP policy can remain effective throughout the 60 year life of the strategy.

It is considered that no coastal frontage activity management is required for the duration of the strategy in Management Sub-units 19E/I to III. The strategy concurs with the SMP policy of do nothing. However, a policy of monitoring and inspection should be undertaken to assess cliff recession during the strategy period.

In Management Sub-unit 19E/IV there is a practical need to maintain the current line of the slopes to prevent Scalby Ness Headland becoming cut off from the mainland and to prevent a decline in business and amenity value of the surrounding area. Therefore, in order that the strategy plan can concur with the SMP policy of **hold the existing line** in the Management Sub-unit 19E/IV and V a programme of monitoring and maintenance as and when necessary is required.

The principal elements of the preferred coastal cliff management strategy are summarised as follows for Management Sub-unit 19E/IV & V:

- To monitor and inspect on a periodic basis and immediately following heavy and prolonged rainfall signs of further deterioration of the coastal cliffs.

- Undertake initial low cost cliff top stabilisation works at Scalby Sands Pinchpoint/ Scalby Ness Headland. Then following a review of the strategy in 5 years and following monitoring/ inspections maintenance works as and when necessary.

- The footpaths leading to the Cleveland Way should be sign posted warning of the dangers of landslip.

If these elements are implemented it is envisaged that the present cliff line in Management Sub-unit 19E/I - V will remain sustainable up until a further strategy review, say in 5 years.

5.1.2 Preferred Strategy: Beck Slopes MSu 19E/VI

In Management Sub-unit 19E/VI there is a practical need to maintain the current line of the cliff top to prevent further failure of the slopes adjacent to Scalby Beck. Therefore, in order that the strategy plan can concur with the SMP policy of hold the existing line in the Management Sub-unit 19E/VI a phased scheme is required and a programme of maintenance.

The principle elements of the preferred beck slope management strategy are summarised as follows:

- A partial scheme that would prevent failure of the northeasterly facing slope below the Scholes Park Road properties; this would consist of slope stabilisation and toe protection works.

- To monitor ALL slopes twice annually and immediately following heavy and prolonged rainfall.

- A schedule and implementation of programmed maintenance works as and when required in accordance with the findings of the monitoring. The maintenance works have been based on envisaged preventative action to avoid small scale failures, given that this is not a full capital scheme. It is important that the beck is cleared of any landslide debris in order to prevent hindrance to beck flow.

If these elements are implemented it is envisaged that the present slope line in Management Sub-unit 19E/VI will remain sustainable throughout the proposed design life of the strategy plan.

5.2 Future Monitoring Programme

It is recommended that the coastal and beck slopes are monitored every March and October and following heavy periods of rainfall and storm events by means of walk over surveys in Management Subunits 19E/IV to VI. The coastal cliffs in Management Sub-units 19E/I to III should be inspected once every year by means of a walkover study.

Walk over surveys should be carried out by a suitably qualified geotechnical engineer and or maintenance inspector to determine the extent of any future damage and signs of deterioration to the coastal and beck slopes. In particular the inspection team should assess in detail the following:

- Extent and magnitude of failures
- The location of these failures
- The effects of these failures on the environment
- The beach levels in Scalby Sands
- The requirement to amend the strategy
- Recommendations for maintenance and of change of frequency of monitoring

- Recommendations for the preventative maintenance required to sustain the capital works over the strategy design life following unforeseen events

5.3 Future Maintenance Programme

It will be necessary for Scarborough Borough Council to initiate a programme of routine and preventative maintenance throughout the design life of the capital works scheme. Elements of the scheme that will require future maintenance by the Council include the slopes adjacent to the scheme, coastal footpaths and reprofiled slopes. Elements of the scheme that will require future maintenance by third parties include the cliff top pathway of the Cleveland Way, and the access steps and possibly the footbridge to the Scalby Ness Headland

The failures which have occurred along the cliff top frontage of management Sub-unit 19E/I to III are generally a result of the glacial till being undermined from below. In addition, high groundwater levels can trigger failure of these comparatively stable slopes. The location of these failures can be found in geomorphological low points along the cliff top and in areas where drainage from the fields on the cliff top have not been able to cope with heavy and prolonged rainfall. These isolated failures need to be monitored.

The drainage within the area of the properties in management Sub-unit 19E/VI and the possible soakaway drains below the recently constructed flats at Scalby Mills should also be inspected and where necessary improved or diverted away from the slope faces. In the event that significant seepage is observed in the future, following prolonged periods of wet weather, consideration should be given to constructing isolated stone filled counterfort drains to reduce the groundwater levels. These counterfort drains should be constructed in such a manner that they connect up to the existing property/ field drainage and across the face of the scarp developed along the cliff top. Furthermore additional topsoil and grassing may be required to repair areas that have been susceptible in the past to localised shallow failures and surface water erosion.

The controlled flow of the beck is important. If the capacity of the beck is compromised through the accretion of sediment on the stream bed from failure of the slopes above, there is a risk that the beck will flood following prolonged periods of heavy rain. This would effect the stability of the beck slopes and potentially along with high water and storm levels threaten the pub and the foundations of the bridge at the mouth of the beck.

5.4 Management Strategy Implementation Costs

This section of the report outlines the estimated cost associated with implementing the preferred strategy options identified for each individual Management sub-unit defined in Section 2 of the report. The preferred management strategy detailed in Section 5.0 has been costed over the next 60 years for 5 year periods 0-5, 5-10 and thereafter 10 year periods 10-20, 20-30, 30-40, 40-50 and.50-60 A detailed breakdown of the cash costs apportioned to implementing the preferred strategy **(£2374k)** are presented in Table 5.1. It is considered grant eligible costs are **£1974k**.

All the costs described below have been based on current rates applicable over the past few years. The costs, even for those schemes and strategy elements required in the long term, have not been inflated to reflect potential increases in future costs. The accuracy and appropriateness of these figures will be checked in future strategy reviews leading up to the longer term scheme recommendations, and when information from further studies is available and the Engineers Reports are prepared.

The PV costs associated with implementing the preferred strategy have been calculated at **£1810k** **(£1614k** grant eligible). These pv costs are presented in Table 5.2.

5.5 DEFRA Prioritisation Score

Based on the cost: benefit ratio obtained for Strategy Options 2 to 4 in Section 4.9, Option 4 offers the highest CBR of ranging from **3.1 to 6.6** dependant upon the consequences of losing Scalby Mills Road.

This rating suggests there are significant benefits associated with Option 4 to consider further study. Based on the new system of DEFRA scoring (LDW 14 – 4/02) the scheme prioritisation has been calculated as follows:

Scenario of Losses	Economic Score	People Score	Environmental Score	Total
Sea Life Centre and Car Park Losses over 10 years	7.6	3.34	0	10.94
Relocation of Car Park	6.2	3.34	0	9.54
Relocation of Sea Life Centre	13.2	3.34	0	16.54

The prioritisation score under the new DEFRA system has been identified as ranging from 9.54 to 16.54. Following the potential failure of the Scalby Mills Road it is likely that the Sea Life Centre will become economically unviable, therefore, it has been determined that the prioritisation score for the scheme is 16.54.

TABLE 5.1 CASH COSTS ASSOCIATED WITH STRATEGY OPTION 4 IMPLEMENTATION

		Year						
	TOTAL COSTS	0-5	5-10	10-20	20-30	30-40	40-50	50-60
Capital Scheme Costs								
Engineer's Report & Environmental Study	**£40,000**	£40,000						
Design	**£63,336**	£63,336						
Construction - Scalby Beck (19E/VI)	**£1,766,713**	£1,266,713			£250,000		£250,000	
Construction - Scalby Sands (19E/IV & V)	**£300,000**	£100,000			£100,000		£100,000	
Construction - Scholes Park Dr (19E/VI)	**£100,000**	£40,000		£60,000				
Supervision (Site & HO)	**£88,670**	£88,670						
SBC Direct Costs	**£25,334**	£25,334						
Cliff Strategy								
Monitoring/Inspection	**£180,000**	£15,000	£15,000	£30,000	£30,000	£30,000	£30,000	£30,000
Maintenance	**£240,000**	£10,000	£10,000	£20,000	£50,000	£50,000	£50,000	£50,000
Emergency Repairs	**Spread as part of maintenance**							
Other Costs								
Topographic Surveys for detailed design	**£5,000**	£5,000						
Strategy Implementation Project Management, client liaison,emergency reponses etc	**£30,000**	£2,500	£2,500	£5,000	£5,000	£5,000	£5,000	£5,000
TOTAL	**£2,839,053**	**£1,656,553**	**£27,500**	**£115,000**	**£435,000**	**£85,000**	**£435,000**	**£85,000**
Grand Total (Grant Eligible)	**£2,439,053**							

Notes:
1. Costs are based on present day prices and have not been inflated up to the year of implementation
2. Construction for Scalby Sands and Scholes Park Drive considered non-coast protection works

TABLE 5.2 PV COSTS ASSOCIATED WITH STRATEGY OPTION 4 IMPLEMENTATION

		Year						
	TOTAL COSTS	0-5	5-10	10-20	20-30	30-40	40-50	50-60
Capital Scheme Costs								
Engineer's Report & Environmental Study	**£40,000**	£40,000						
Design	**£59,751**	£59,751						
Construction - Scalby Beck (19E/VI)	**£1,292,377**	£1,190,120			£77,951		£24,306	
Construction - Scalby Sands (19E/IV & V)	**£129,902**	£89,000			£31,180		£9,722	
Construction - Scholes Park Dr (19E/VI)	**£67,088**	£33,585		£33,504				
Supervision (Site & HO)	**£83,651**	£83,651						
SBC Direct Costs	**£23,900**	£23,900						
Cliff Strategy								
Monitoring/Inspection	**£51,410**	£13,400	£10,010	£13,070	£7,300	£4,080	£2,280	£1,270
Maintenance	**£49,170**	£8,930	£6,670	£8,710	£12,160	£6,790	£3,790	£2,120
Emergency Repairs	**Spread as part of maintenance**							
Other Costs								
Topographic Surveys for detailed design	**£5,000**	£5,000						
Strategy Implementation Project Management	**£8,566**	£2,233	£1,668	£2,178	£1,216	£679	£379	£212
TOTAL	**£1,810,815**	**£1,549,569**	**£18,348**	**£57,462**	**£129,808**	**£11,549**	**£40,477**	**£3,602**
Grand Total (Grant Eligible)	**£1,613,824**							

1. Costs are based on present day prices and have not been inflated up to the year of implementation
2. Construction for Scalby Sands and Scholes Park Drive considered non-coast protection works

6.0 THE STRATEGY PLAN

6.1 Strategy Implementation

A strategy implementation plan has been developed as part of the coastal defence strategy study. The plan is presented in Table 6.1 and has been scheduled for the duration of the strategy, however the plan should be subject to revision at 5 year intervals. The works that have been recommended are those that are considered necessary during the next 10 years in order that the policies stated in the SMP can be maintained.

6.2 Prioritisation of the Preferred Scheme

It is recommended that prioritisation is given to constructing the preferred scheme by Year 2, Table 6.1 identifies that a fast track programme is feasible to allow construction of the scheme by the summer 2004. The works should be scheduled for construction during the spring/summer months, when beck levels are at their lowest. It is envisaged that subject to project approval being granted by the Planning Authority each of the proposed works could be designed, and tender documentation returned within 12 weeks of authorisation to proceed being received. It is recommended that a 4 month summer contract period be set for construction and that all materials and plant deemed necessary to complete the scheduled Permanent Works be mobilised to site by land.

Low cost slope betterment works comprising soil anchors and earthworks should be undertaken as soon as possible to prevent progressive cliff top recession on the coastal and beck slopes. It is envisaged that the proposed works could be completed within a period of one month.

6.3 Prioritised Programme of Monitoring, Maintenance Works and Further Studies

It is recommended that the strategy be implemented by Spring 2003, in order that monitoring and inspections can commence to form suitable baseline data.

It is recommended that the following monitoring regime be implemented from year 1.

MSU 19E/I to III	Once every year prior to the peak use of the Cleveland Way (say March)
MSU's 19E/IV to VI	Twice every year, say March and September or following period of heavy or prolonged rainfall

The findings of the monitoring programme should be used to determine the scope and frequency of any ad-hoc maintenance and slope stabilisation works at the site.

The most likely maintenance works required during the strategy period are:

- Clearing debris from superficial failures from the beck

- Maintaining public access along cliff top pathways as a health and safety requirement
- Necessary footpath closure signs in regard to public safety
- Maintaining drainage outfalls
- Maintaining toe protections works following storms
- Assessing the slope stabilisation works at Scalby Sands pinchpoint

Further studies into the environmental impact of each of the proposed capital schemes will be required prior to an Engineer's Report being submitted to DEFRA in support of an application for grant aid.

HUNDALE POINT TO SCALBY NESS COASTAL STRATEGY STUDY

TABLE 6.1 STRATEGY IMPLEMENTATION PROGRAMME

ITEM Year	0	1				2				3	4	5	6	7	8	9	10	11	12	13	14	15	30	60
Month		3	6	9	12	3	6	9	12															
Strategy Agreement																								
SBC/ DEFRA Approval																								
Proceed with Engineer's Report																								
Environmental Study (Provisional)																								
Consultation Period																								
SBC Adoption and implementation																								
Detail Design																								
Monitoring [1]																								
Topographical Survey																								
Design																								
Tender Period & Award																								
Construction																								
Mobilisation																								
Scalby Beck Works - Slope Stabilisation																								
Scalby Beck Toe Protection																								
Scalby Sands Cliff Top Works								x									x					x	x	x
Maintenance																								
Coastal Strategy																								
Beach Monitoring																								
Cliff Monitoring/ Inspection																								
Project Management																								
Review of Strategy												>					>					>	>>>>>>	>>>>>>
Agreement/ Approval																								
Implemention of Management/works																								

Year 1 = 2003

x To be determined following monitoring/inspection surveys and periodic reviews of strategy

> Periodic reviews at 5 year intervals

1 Regular monitoring prior to and post construction should borehole instrumentation not be lost during construction

7.0 CONCLUSIONS

Based on recommendations of this report the preferred strategy option for each management subunit is the following:

Management Subunit	Location	Preferred Option
MSU 19E/I	Hundale Point to Long Nab	Do nothing
MSU 19E/II	Long Nab to Cromer Point	Do nothing
MSU 19E/III	Cromer Point to Scalby Sands	Do nothing
MSU 19E/IV	Scalby Ness Sands	Do something – low cost cliff top stabilisation works; monitoring/ inspection; beach monitoring
MSU 19E/V	Scalby Ness Headland	
MSU 19E/VI	Scalby Beck	Do something - Slope stabilisation of the northeasterly and toe protection works by Year 2; low cost cliff top stabilisation works; monitoring/ inspections; beach monitoring.

The details of the preferred option are discussed in sections 4 and 5. The study has identified elements of work that are non-eligible for coast protection grant aid.

The findings of the Holbeck-Scalby Mills Coastal Strategy Study (primarily for the Sea Life Centre – Management Sub-unit 20A) and the proposed scheme for this site have been considered with integration for the preferred scheme at Scalby Mills.

As part of the strategy is will be necessary to undertake regular monitoring/ inspections of the cliff top recession and magnitude and frequency of any failures. In addition monitoring of beach levels in the Scalby Sands area is recommended for the possible long-term breach of this section of the cliff.

It is also recommended that monitoring and inspection be undertaken prior to every periodic review of the strategy in MSU's 19E/I to III to assess if acceleration of cliff top recession is occurring.

It is considered that should further investigation of the beck be required, for instance backwater curves, this can be undertaken during the Engineer's Report in Application for Grant Aid. Experienced engineering judgement is likely to be sufficient to design a toe protection structure without hydraulic modelling being required.

Section 6 identifies the strategy plan and the programme for the strategy. It is recommended that construction for the preferred scheme commences as soon as possible. Maintenance/ inspections should commence Spring 2003.

In order to achieve commencement of the strategy by Spring 2003, at the latest, agreement and approval of the strategy will be required by as soon as possible, in order that design, planning and consultation with various statutory consultees can be agreed.

The first review of the strategy should be in 2007.

REFERENCES

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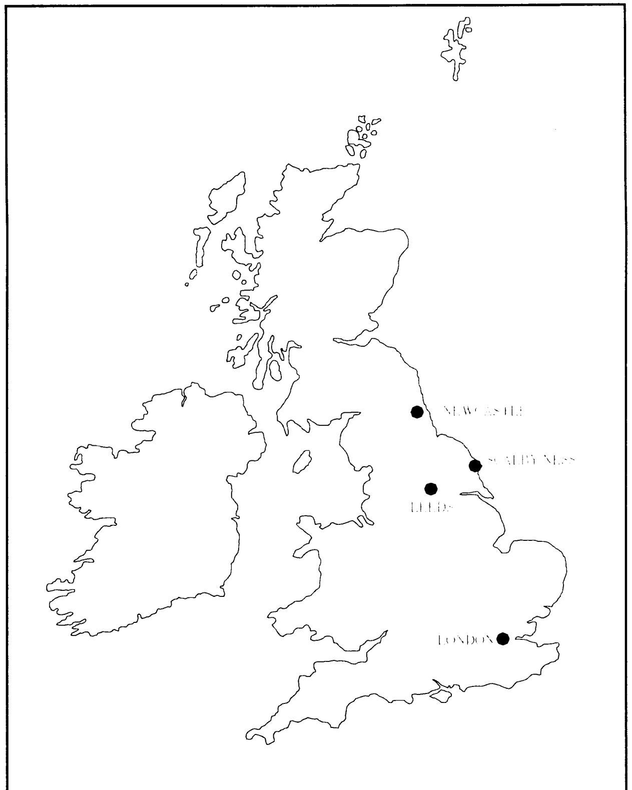
Hulme M, Barrow E M, Jenkins G J, New M, Osborn T J and Viner D 1998. Climate change scenarios for the UK Climate Impacts Programme. UKCIP Technical Report. Norwich: Climatic Research Unit.

Ministry of Agriculture Fisheries and Food 1999. FCDPAGN 1, 2, 3, 4 & 5.

Rawson P K and Wright J K 2000. The Yorkshire Coast. Geologists Association Guide No. 34.

Woodworth P L, Tsimplis M N, Flather R A and Shennan I, 1999. A review of trends observed in British Isles mean sea level data measured by tide gauges. Geophys. J. Int., 136, 651-670.

FIGURES

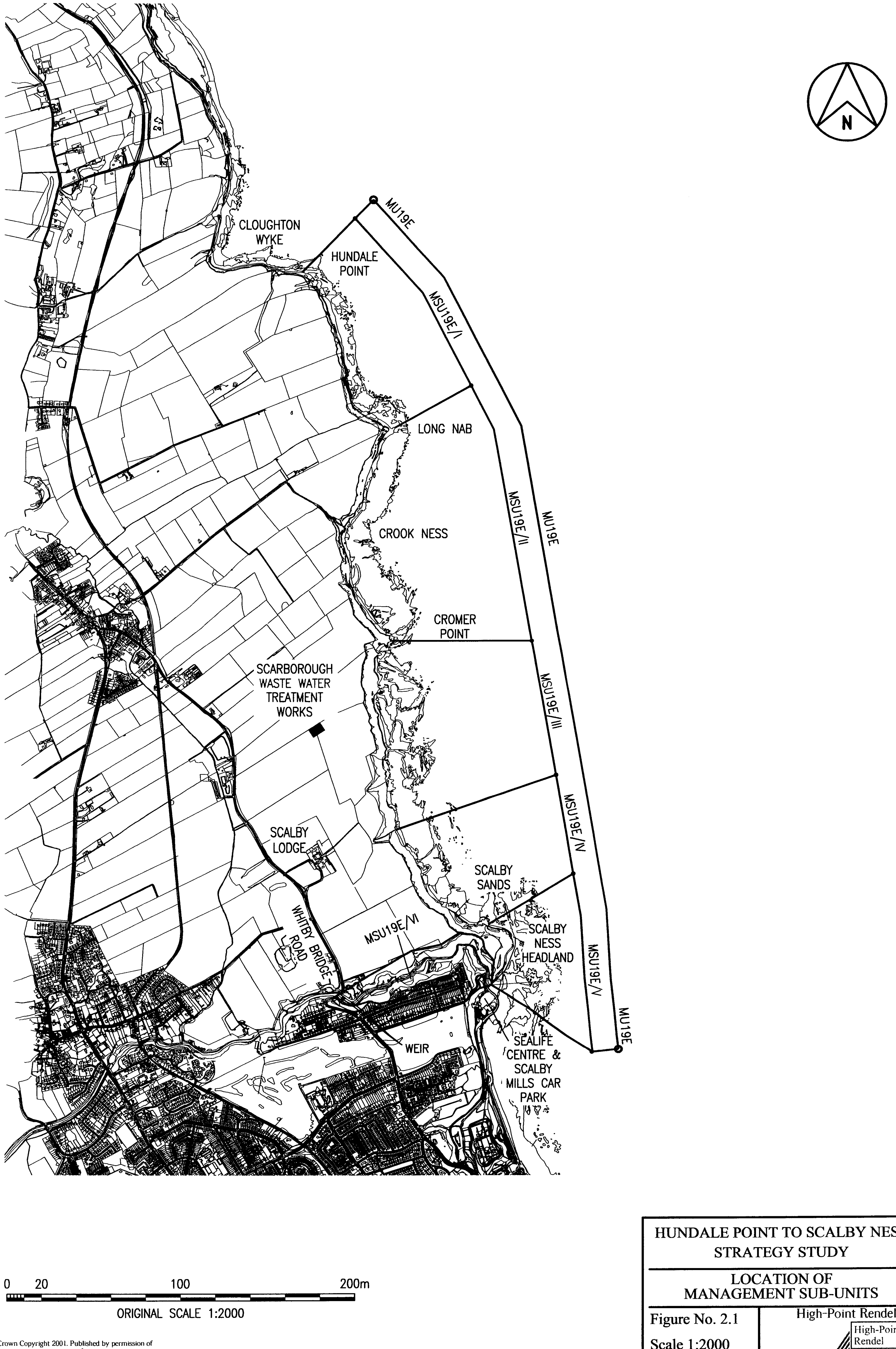


HUNDALE POINT TO SCALBY NESS STRATEGY STUDY

STUDY AREA LOCATION MAP

Figure 1.1
Not to Scale

High-Point Rendel



HUNDALE POINT TO SCALBY NESS STRATEGY STUDY	
LOCATION OF MANAGEMENT SUB-UNITS	
Figure No. 2.1	High-Point Rendel
Scale 1:2000	High-Point Rendel

CAD FILE 1404-P-Fig2.1

Figure 2.2 Geological Section: Scalby Ness to Hundale Point (source: Rawson and Wright 2000)

Age	Stage	Lithostratigraphic Division		Description	Thickness
160M	Bathonian	Ravenscar Group	Scalby Formation	**Long Nab Member**; alternations of fine alluvial clays and siltstones with occasional sand-filled channels. Includes the Burniston Footprint Bed. Cross-bedded sandstone to the base (the Meander Bed Unit). **Moor Grit Member**; cross-bedded sandstone, alternating with and passing into off-bank laminated siltstones and crevasse-splay sand sheets.	60m
	Upper Bajocian		Scarborough Formation	**Bogmire Gill Member**; siltstone passing up into fine grained sandstone (marginally marine). **White Nab Ironstone Member**; sulphurous grey sandy shales with iron-rich concretions. **Ravenscar Shale Member**; grey sandy shales **Spindle Thorne Limestone Member**; alternations of sandy shales and argillaceous limestone; **Hundale Sandstone Member**; massive sandstone over a thin-bedded flaggy, argillaceous sandstone, separated by a thin pink-weathering sideritic limestone resting on shale. **Hundale Shale Member**; silty sandstone passing up into argillaceous sandy limestone. **Helwath Beck Member**; shaly siltstones passing up to massive convoluted sandstone.	30m

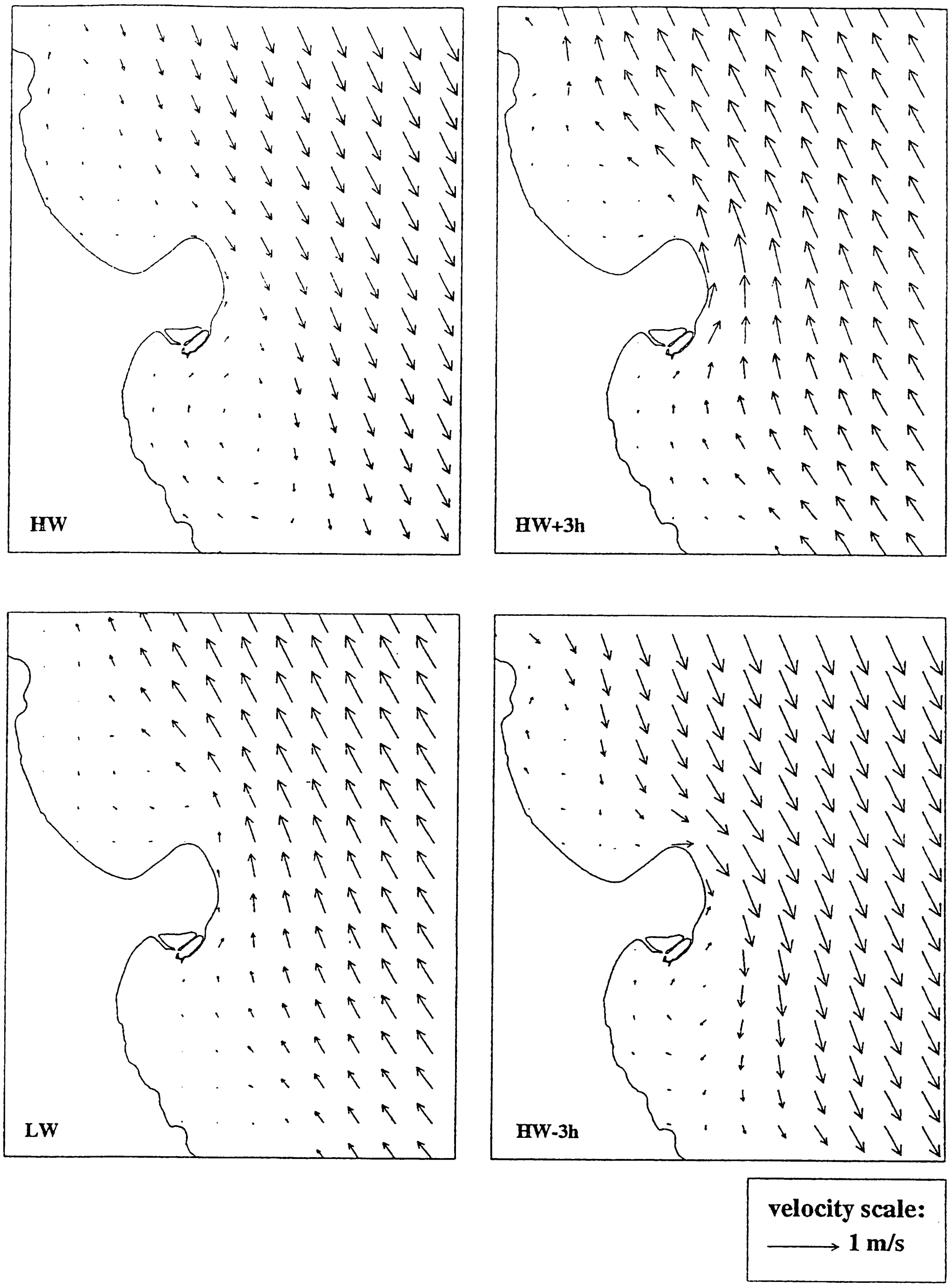


Figure 2.3 Flow vectors at four states of the tidal cycle, Scarborough (from HR Wallingford, 2001)

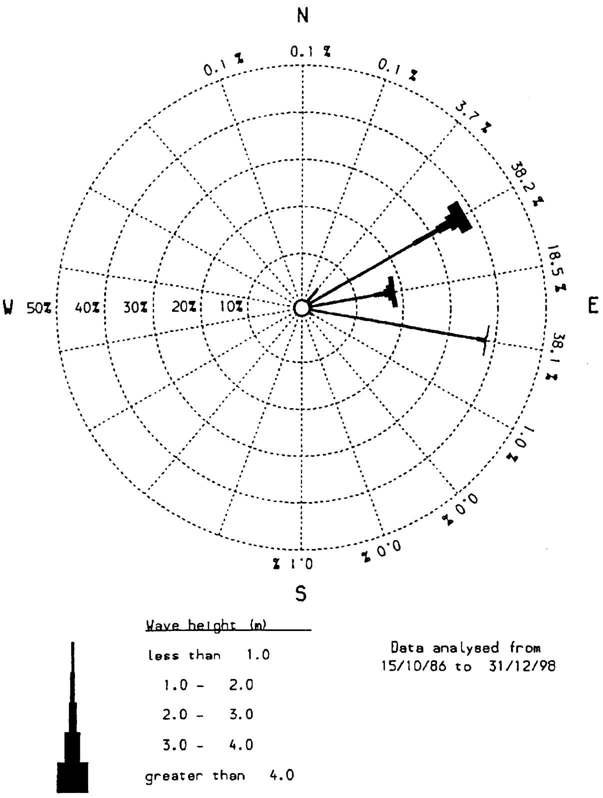


Figure 2.4 Nearshore wave rose diagram, North Bay Scarborough (from HR Wallingford 2001)

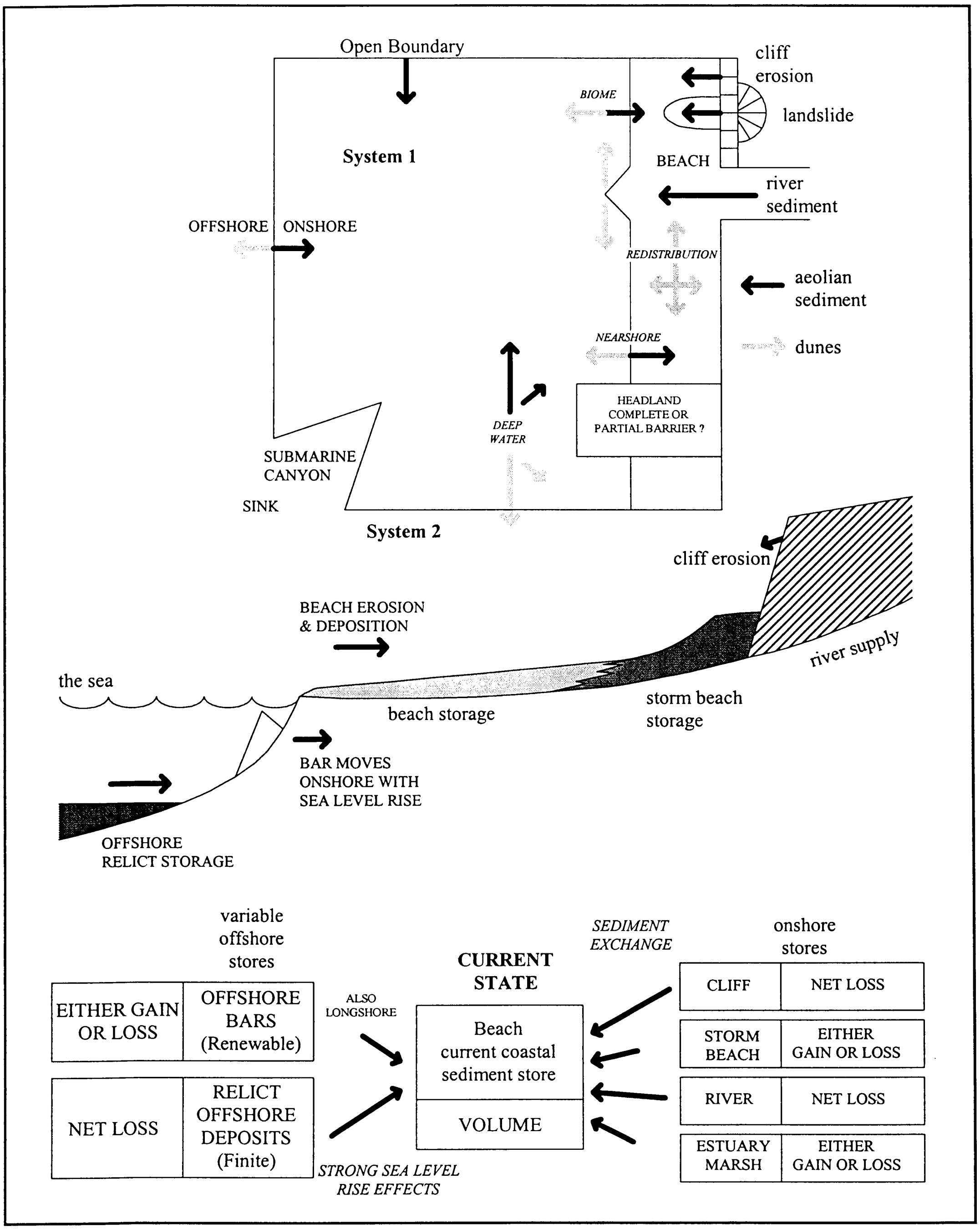
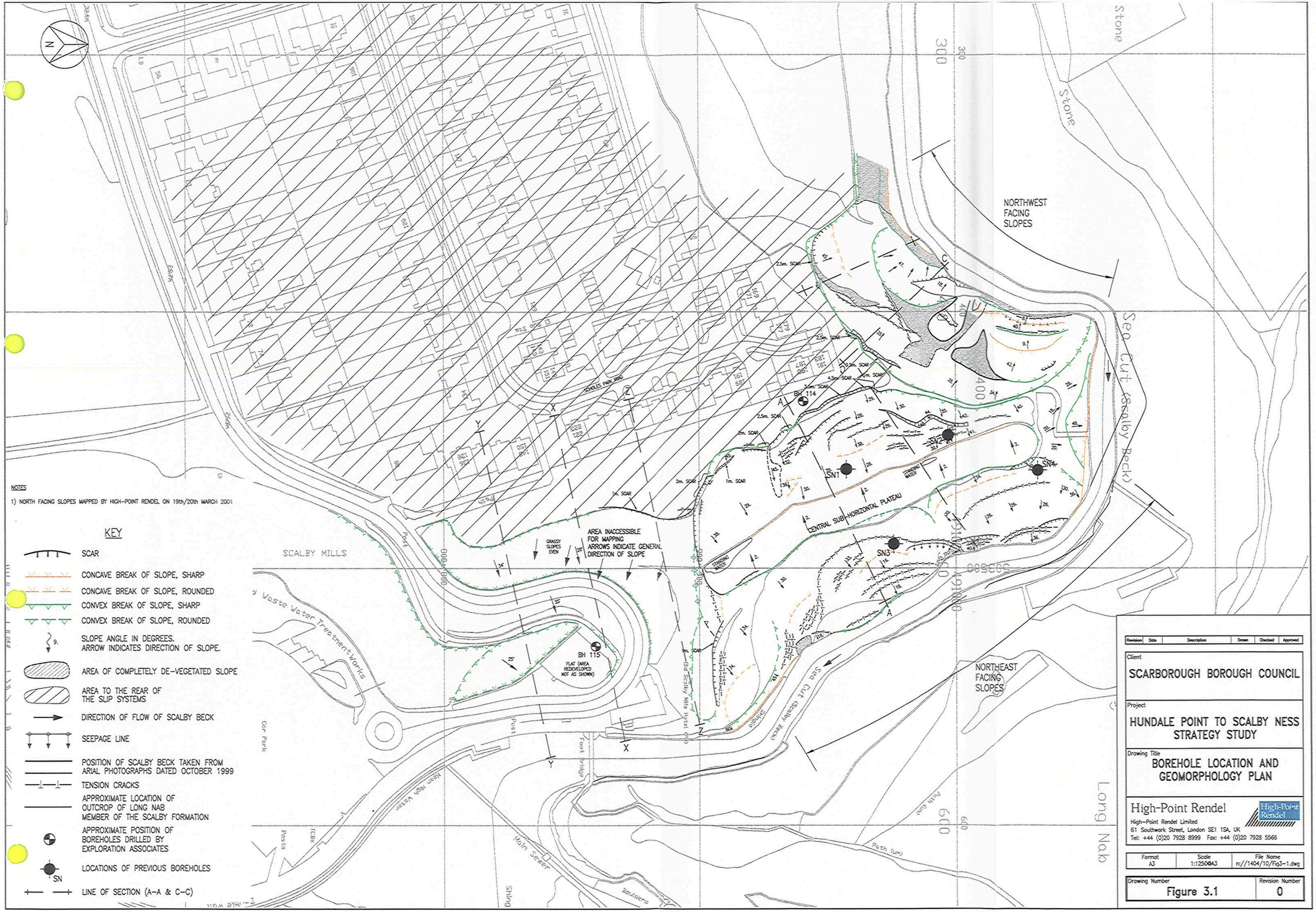


Figure 2.5 Sediment transfers within a coastal cell


NORTHWEST FACING SLOPES
NORTHEAST FACING SLOPES
CENTRAL SUB-HORIZONTAL PLATEAU
AREA INACCESSIBLE FOR MAPPING ARROWS INDICATE GENERAL DIRECTION OF SLOPE
GRASSY SLOPES EVEN
STANDING WATER
FLAT (AREA REDEVELOPED NOT AS SHOWN)
SCALBY MILLS
Scholes Park Road
Sea Cut (Scalby Beck)
Waste Water Treatment Works
Old Scalby Mills Hotel
Long Nab
Stone
Car Park
Foot Bridge
Main Sewer
Mean High Water
Boulders
BH 114
BH 115
SN1
SN2
SN3
SN4
NOTES
1) NORTH FACING SLOPES MAPPED BY HIGH-POINT RENDEL ON 19th/20th MARCH 2001
KEY
SCAR
CONCAVE BREAK OF SLOPE, SHARP
CONCAVE BREAK OF SLOPE, ROUNDED
CONVEX BREAK OF SLOPE, SHARP
CONVEX BREAK OF SLOPE, ROUNDED
SLOPE ANGLE IN DEGREES. ARROW INDICATES DIRECTION OF SLOPE.
AREA OF COMPLETELY DE-VEGETATED SLOPE
AREA TO THE REAR OF THE SLIP SYSTEMS
DIRECTION OF FLOW OF SCALBY BECK
SEEPAGE LINE
POSITION OF SCALBY BECK TAKEN FROM ARIAL PHOTOGRAPHS DATED OCTOBER 1999
TENSION CRACKS
APPROXIMATE LOCATION OF OUTCROP OF LONG NAB MEMBER OF THE SCALBY FORMATION
APPROXIMATE POSITION OF BOREHOLES DRILLED BY EXPLORATION ASSOCIATES
LOCATIONS OF PREVIOUS BOREHOLES
LINE OF SECTION (A-A & C-C)
Revision | Date | Description | Drawn | Checked | Approved
Client
SCARBOROUGH BOROUGH COUNCIL
Project
HUNDALE POINT TO SCALBY NESS STRATEGY STUDY
Drawing Title
BOREHOLE LOCATION AND GEOMORPHOLOGY PLAN
High-Point Rendel
High-Point Rendel Limited
61 Southwark Street, London SE1 1SA, UK
Tel: +44 (0)20 7928 8999 Fax: +44 (0)20 7928 5566
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Scale 1:1250@A3
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Drawing Number Figure 3.1
Revision Number 0

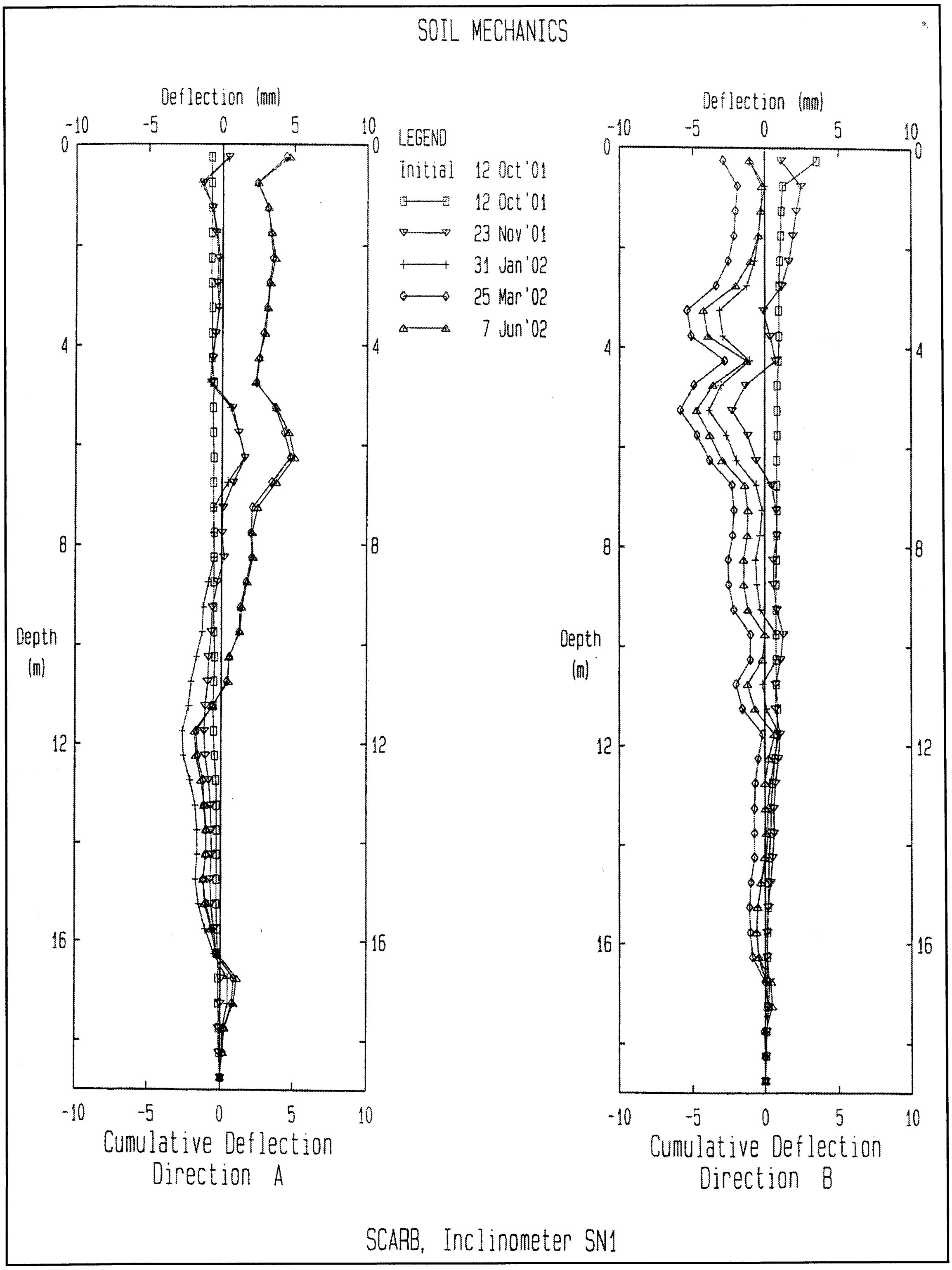

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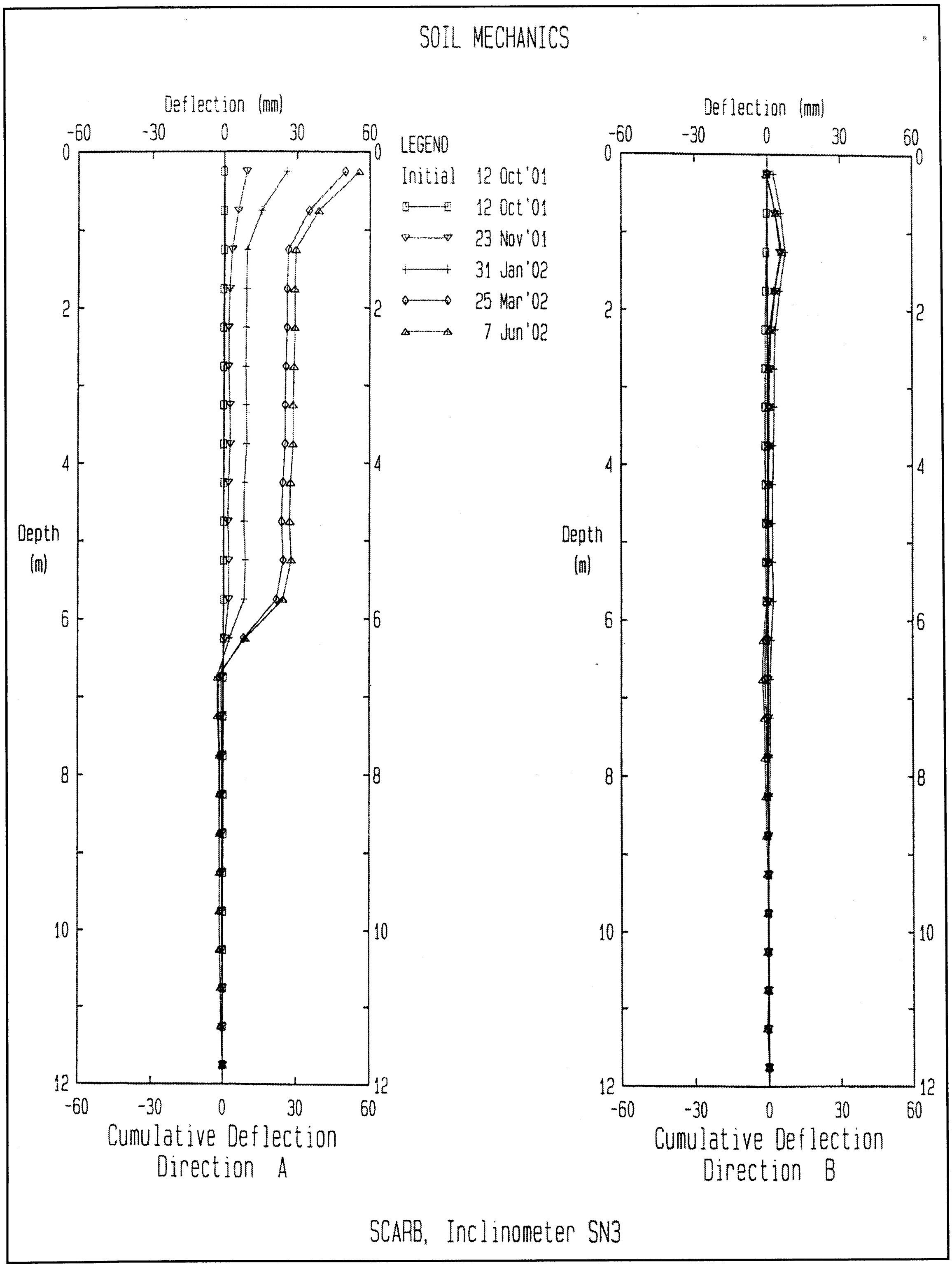
Figure 3.2a Not to Scale	High-Point Rendel



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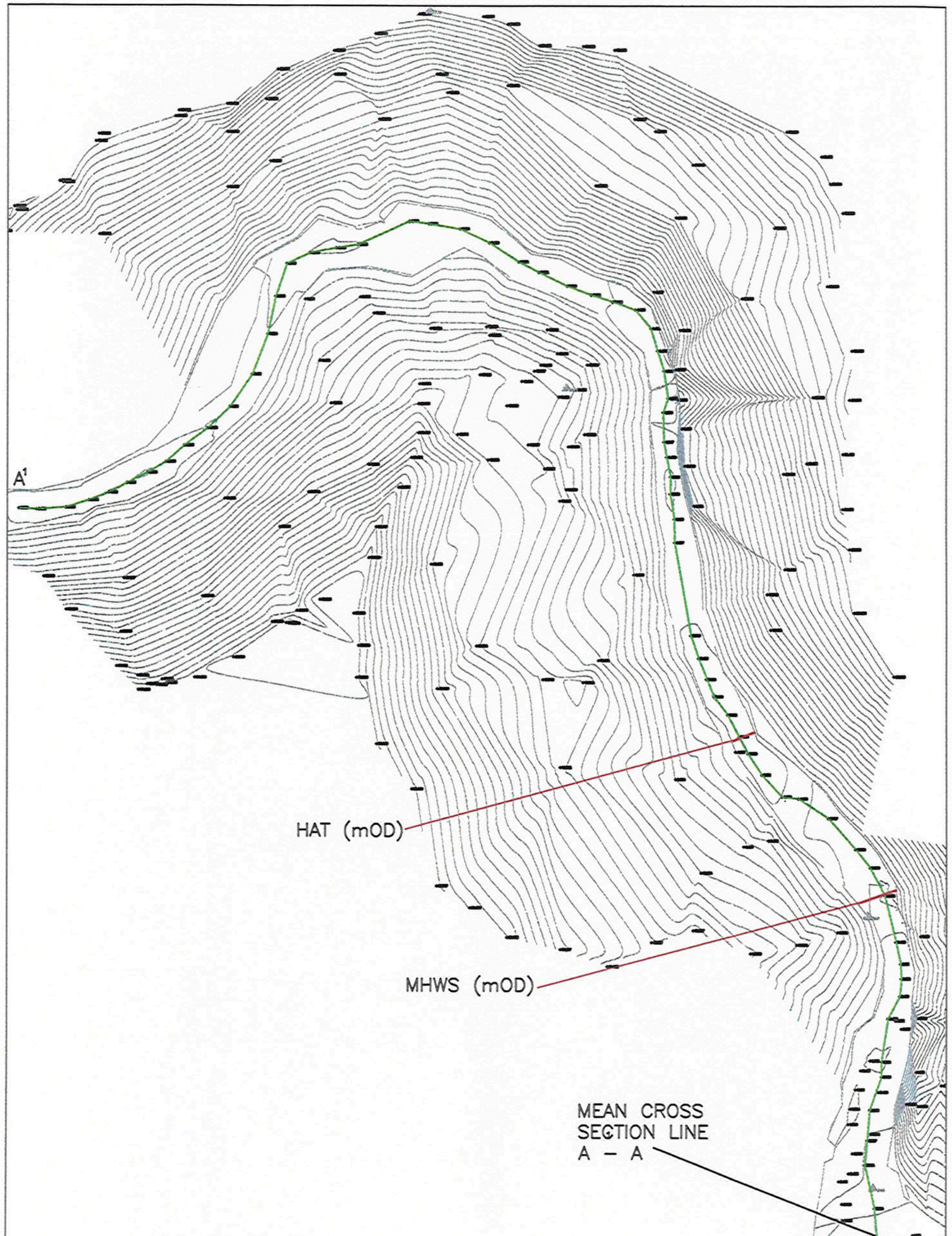


SCALBY BECK SURVEY

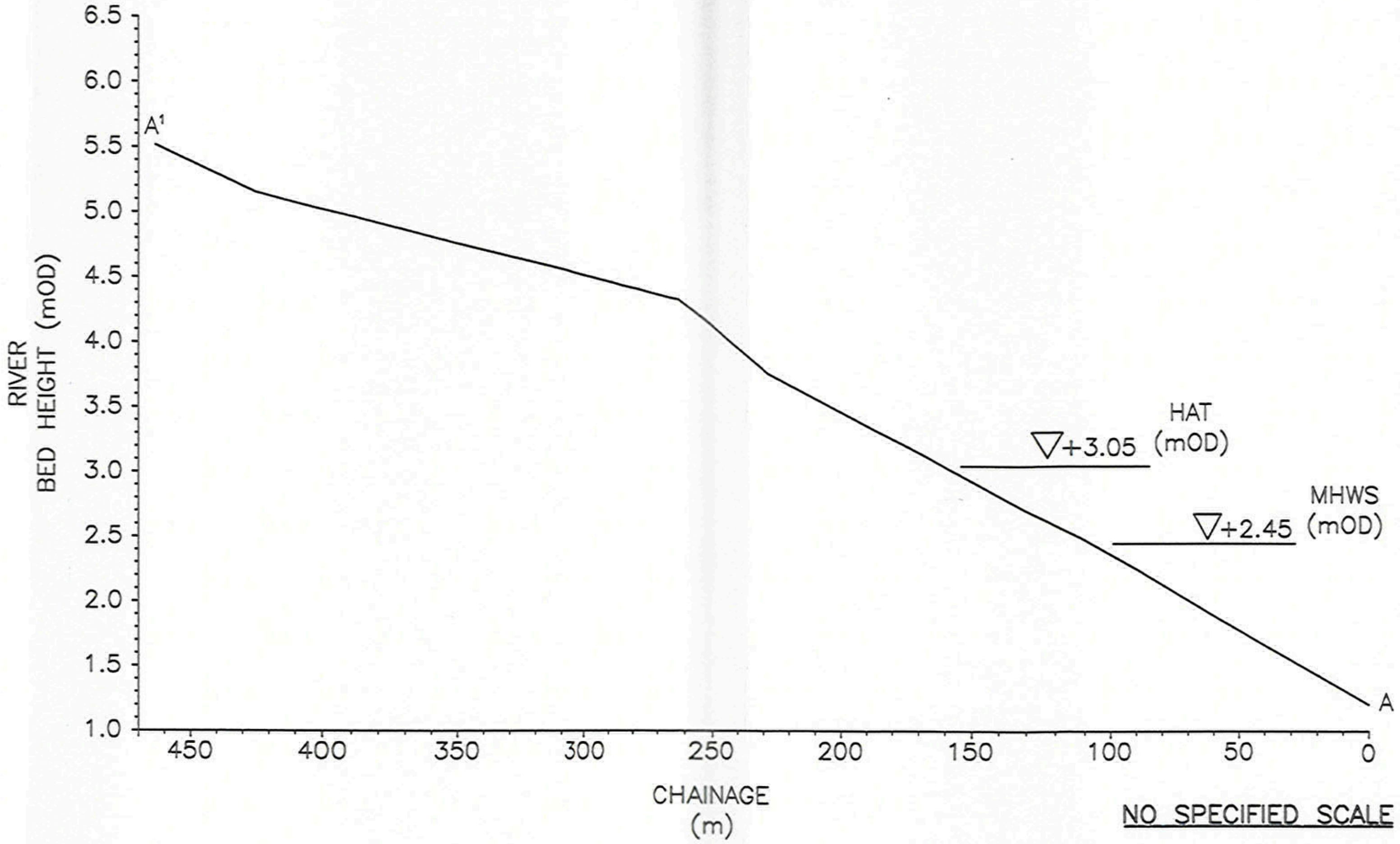
SCALE 1:1250

Produced by .... on dd/mm/yr.

Notes:

1. All dimensions are in millimetres.
2. All levels are in metres related to Ordnance Datum (Newlyn).
3. All chainages are in metres.

SCALBY BECK BED
MEAN CROSS SECTION



NO SPECIFIED SCALE

Revision	Date	Description	Drawn	Checked	Approved

Client
SCARBOROUGH BOROUGH COUNCIL

Project
HUNDALE POINT TO SCALBY NESS STRATEGY STUDY

Drawing Title
SCALBY BECK SURVEY AND BECK BED CROSS SECTION

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61 Southwark Street, London SE1 1SA, UK
Tel: +44 (0)20 7654 0400 Fax: +44 (0)20 7654 0401

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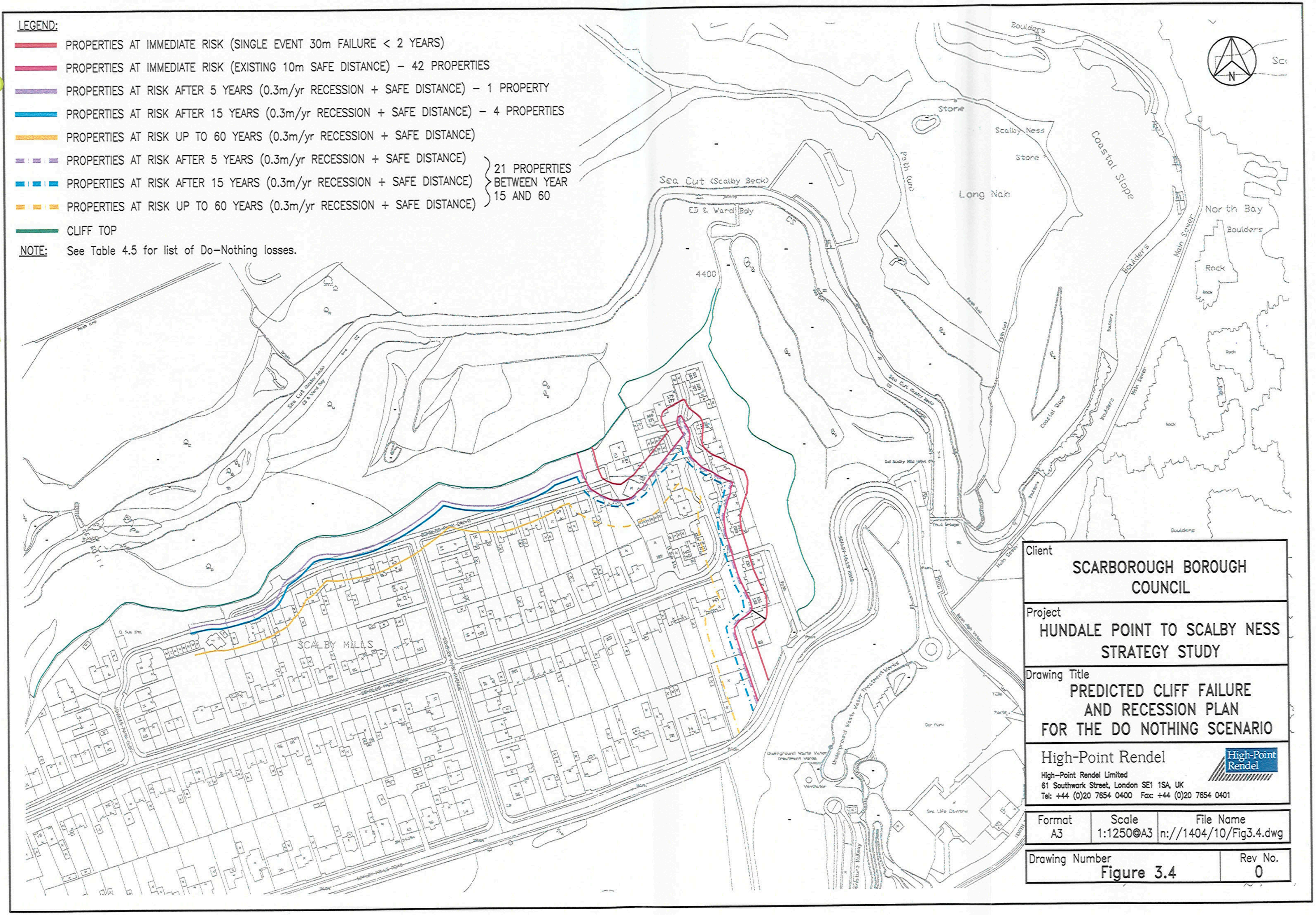
LEGEND:
PROPERTIES AT IMMEDIATE RISK (SINGLE EVENT 30m FAILURE < 2 YEARS)
PROPERTIES AT IMMEDIATE RISK (EXISTING 10m SAFE DISTANCE) – 42 PROPERTIES
PROPERTIES AT RISK AFTER 5 YEARS (0.3m/yr RECESSION + SAFE DISTANCE) – 1 PROPERTY
PROPERTIES AT RISK AFTER 15 YEARS (0.3m/yr RECESSION + SAFE DISTANCE) – 4 PROPERTIES
PROPERTIES AT RISK UP TO 60 YEARS (0.3m/yr RECESSION + SAFE DISTANCE)
PROPERTIES AT RISK AFTER 5 YEARS (0.3m/yr RECESSION + SAFE DISTANCE)
PROPERTIES AT RISK AFTER 15 YEARS (0.3m/yr RECESSION + SAFE DISTANCE)
PROPERTIES AT RISK UP TO 60 YEARS (0.3m/yr RECESSION + SAFE DISTANCE)
21 PROPERTIES BETWEEN YEAR 15 AND 60
CLIFF TOP
NOTE: See Table 4.5 for list of Do-Nothing losses.
Boulders
Stone
Scalby Ness
Coastal Slope
Long Nab
Path (un)
Sea Cut (Scalby Beck)
ED & Ward Bay
North Bay
Boulders
Rock
Main Sewer
4400
SCALBY MILLS
Client
SCARBOROUGH BOROUGH COUNCIL
Project
HUNDALE POINT TO SCALBY NESS STRATEGY STUDY
Drawing Title
PREDICTED CLIFF FAILURE AND RECESSION PLAN FOR THE DO NOTHING SCENARIO
High-Point Rendel
High-Point Rendel Limited
61 Southwark Street, London SE1 1SA, UK
Tel: +44 (0)20 7654 0400 Fax: +44 (0)20 7654 0401
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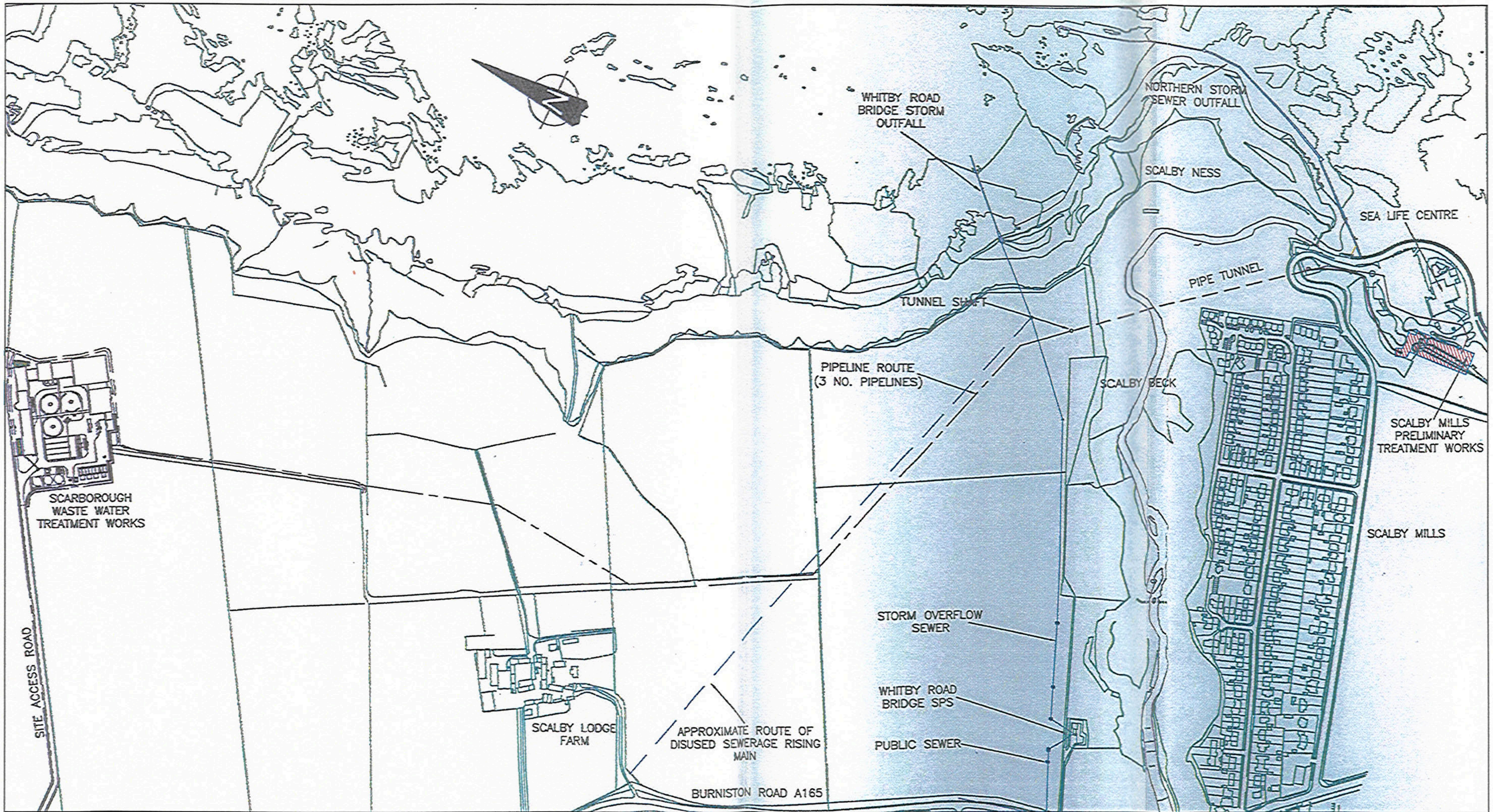
Rev No. 0

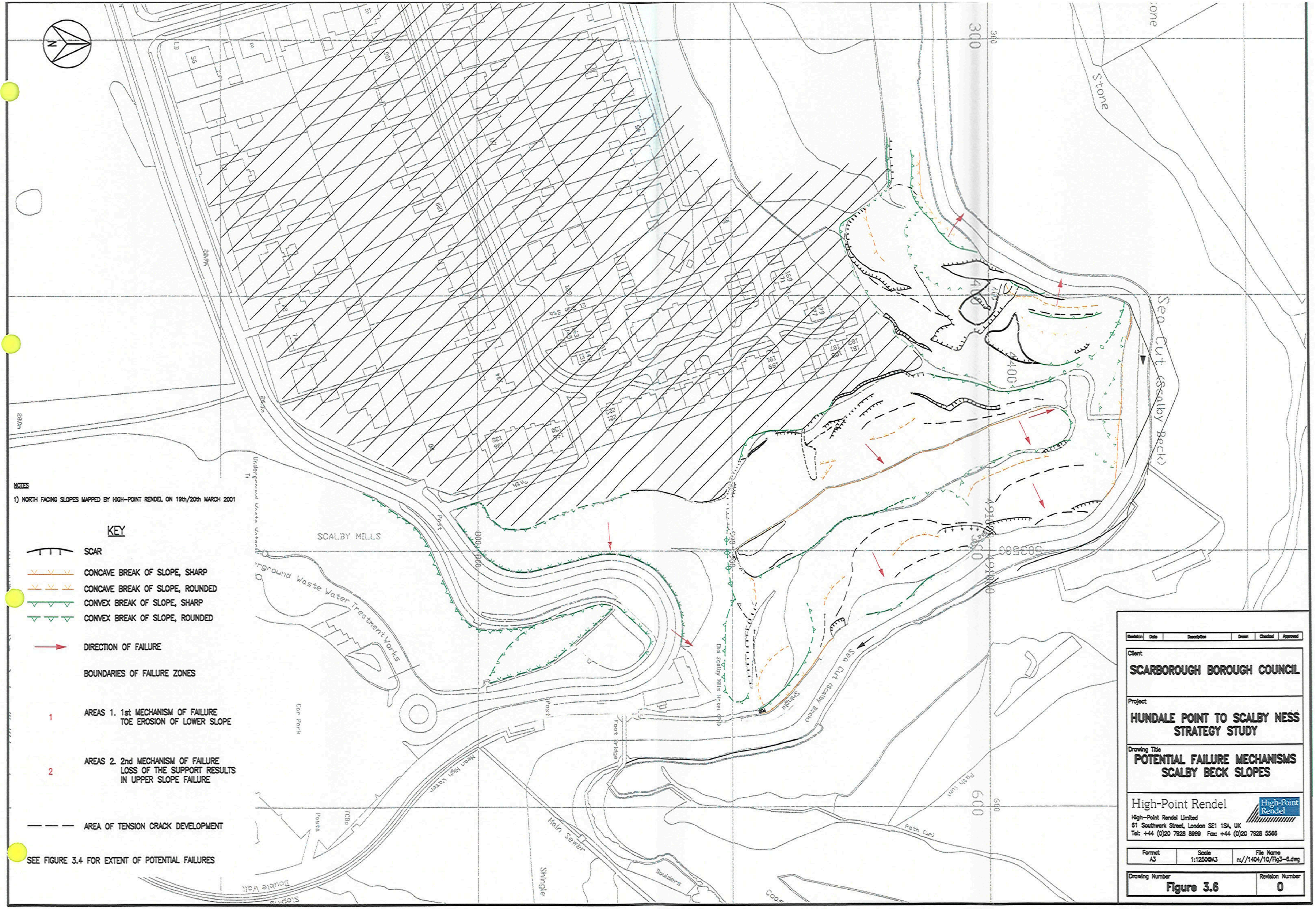


HUNDALE POINT TO SCALBY NESS STRATEGY STUDY

YORKSHIRE WATER ASSESTS

Figure 3.5
Approx. Scale 1:5000

High-Point Rendel



NOTES

1) NORTH FACING SLOPES MAPPED BY HIGH-POINT RENDEL ON 19th/20th MARCH 2001

KEY

- SCAR
- CONCAVE BREAK OF SLOPE, SHARP
- CONCAVE BREAK OF SLOPE, ROUNDED
- CONVEX BREAK OF SLOPE, SHARP
- CONVEX BREAK OF SLOPE, ROUNDED
- DIRECTION OF FAILURE
- BOUNDARIES OF FAILURE ZONES
- 1 AREAS 1. 1st MECHANISM OF FAILURE TOE EROSION OF LOWER SLOPE
- 2 AREAS 2. 2nd MECHANISM OF FAILURE LOSS OF THE SUPPORT RESULTS IN UPPER SLOPE FAILURE
- AREA OF TENSION CRACK DEVELOPMENT

SEE FIGURE 3.4 FOR EXTENT OF POTENTIAL FAILURES

Revision	Date	Description	Drawn	Checked	Approved

Client
SCARBOROUGH BOROUGH COUNCIL

Project
HUNDALE POINT TO SCALBY NESS STRATEGY STUDY

Drawing Title
POTENTIAL FAILURE MECHANISMS SCALBY BECK SLOPES

High-Point Rendel
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Drawing Number	Revision Number
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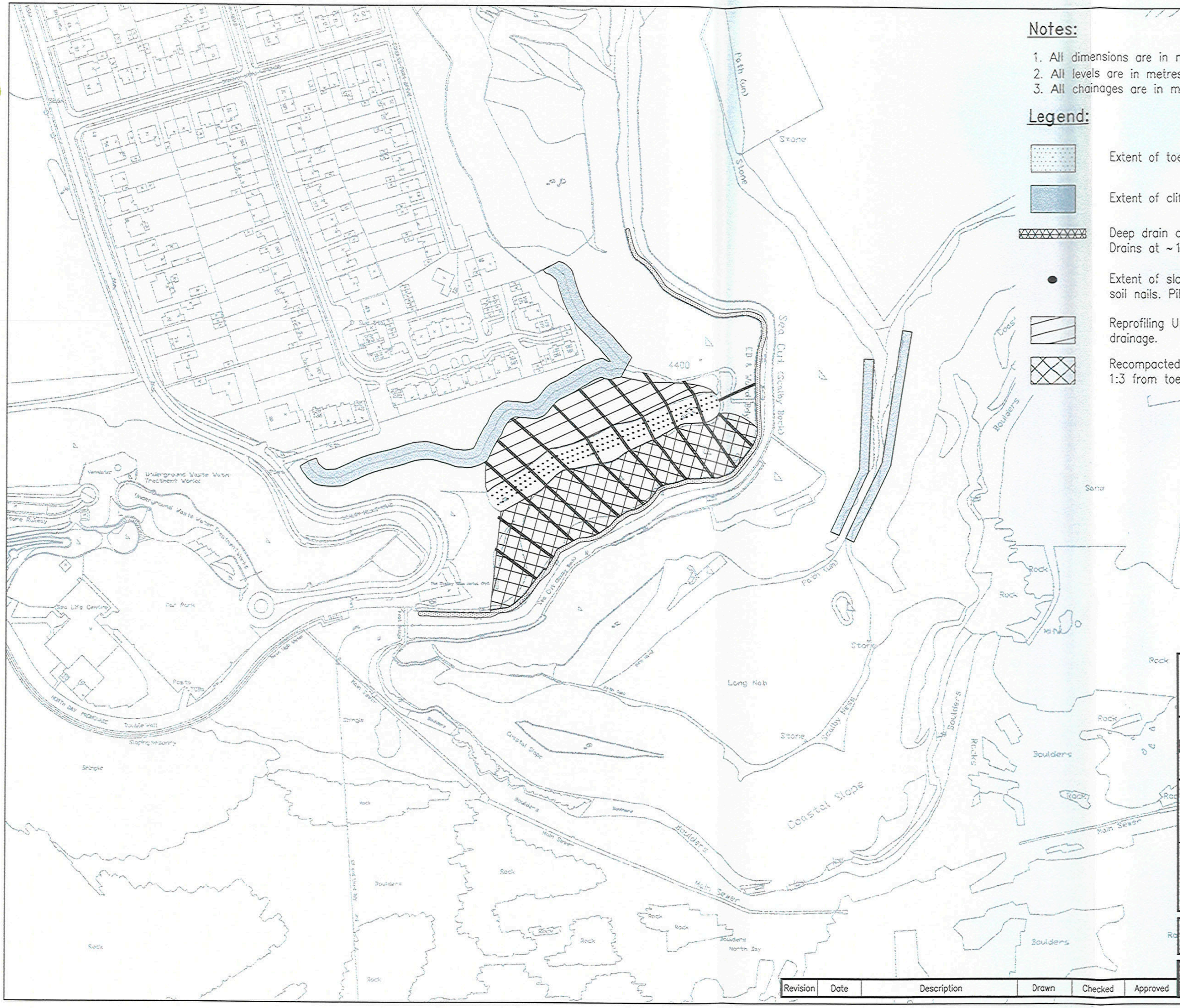

Notes:

1. All dimensions are in millimetres.
2. All levels are in metres related to Ordnance Datum (Newlyn).
3. All chainages are in metres.

Legend:

- Extent of toe protection.
- Extent of cliff top works. Geomaterial and soil nails.
- Deep drain counterforts. 3–4m bgl. discharging onto back. Drains at ~15m centres.
- Extent of slope stabilisation works. Geomaterial and soil nails. Piles at 3m centres.
- Reprofiling Upper slope with recompacted material and drainage.
- Recompacted material in stepped excavations to a slope 1:3 from toe level.

Revision	Date	Description	Drawn	Checked	Approved

Client
SCARBOROUGH BOROUGH COUNCIL

Project
HUNDALE POINT TO SCALBY NESS STRATEGY STUDY

Drawing Title
GENERAL ARRANGEMENTS OF OPTION 3 WORKS

High-Point Rendel
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61 Southwark Street, London SE1 1SA, UK
Tel: +44 (0)20 7654 0400 Fax: +44 (0)20 7654 0401

Format	Scale	File Name
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Drawing Number	Rev No.
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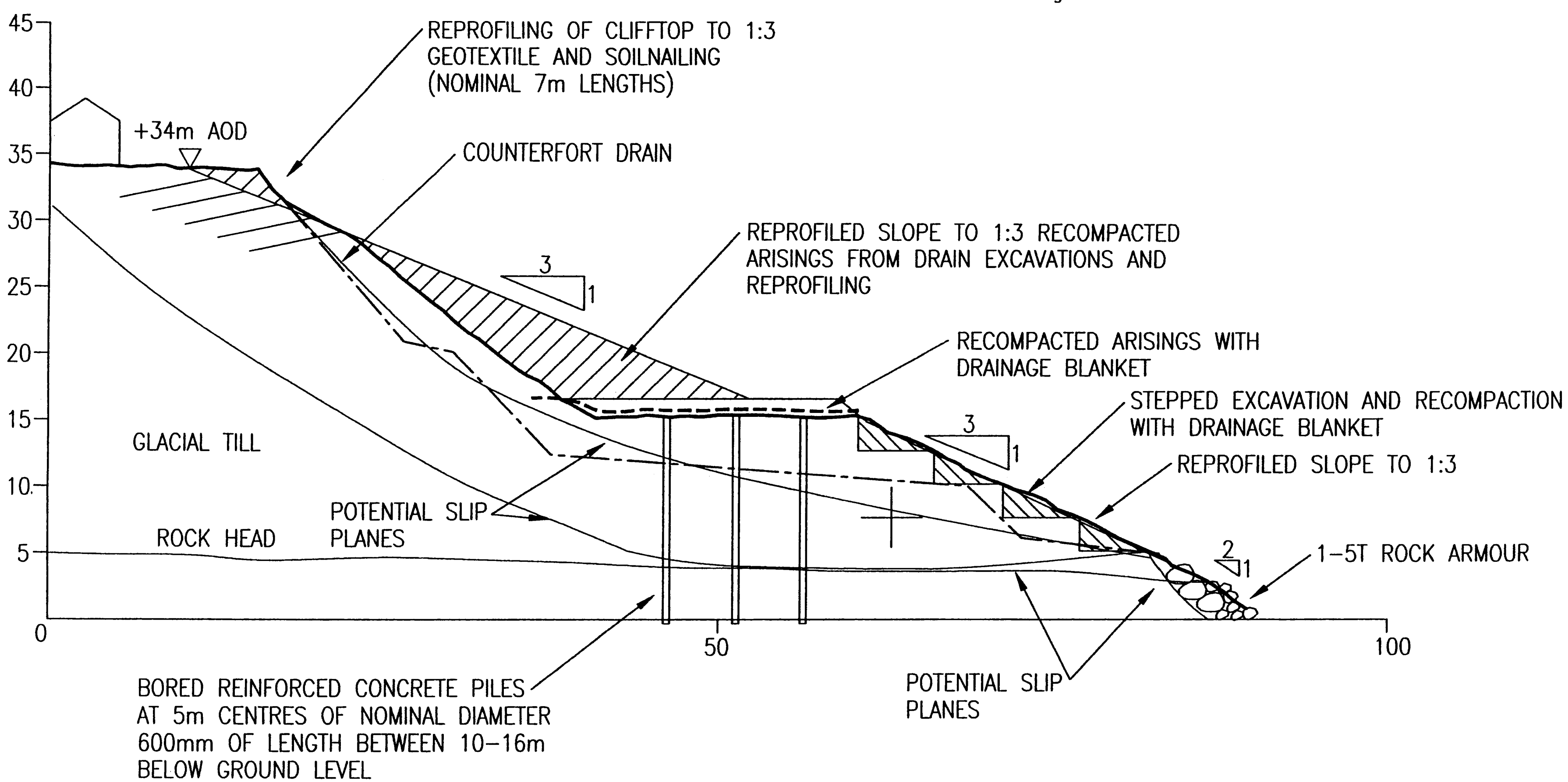
Notes:

1. All dimensions are in millimetres.
2. All levels are in metres related to Ordnance Datum (Newlyn).
3. All chainages are in metres.

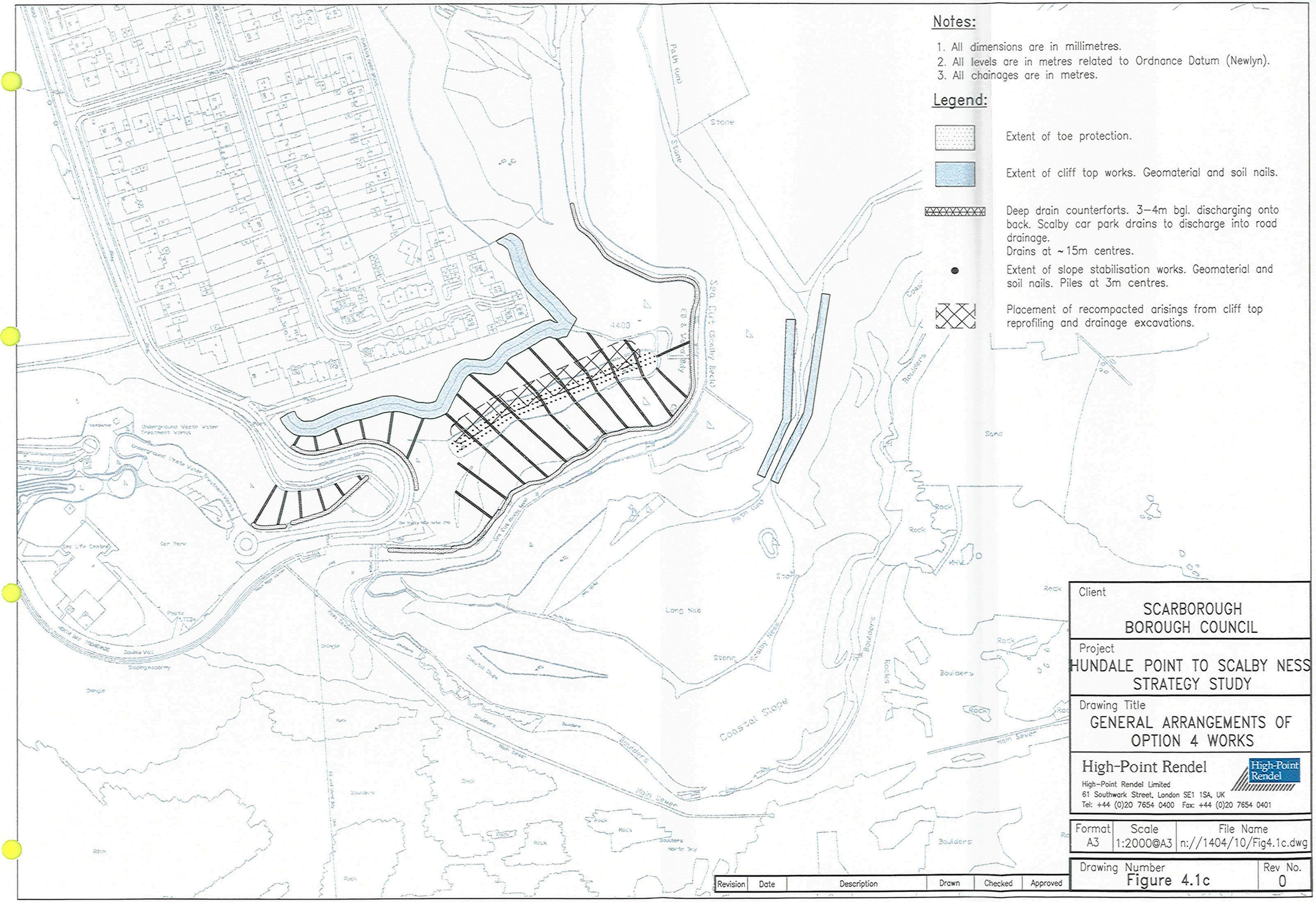


SECTION A-A'

SCHEMATIC CROSS SECTION OF STRATEGY OPTION 3 (FULL SCHEME)

HUNDALE POINT TO SCALBY NESS STRATEGY STUDY	
Figure No. 4.1b Scale 1:500	High-Point Rendel

FILE 1494/10/fig4.1b



Notes:

1. All dimensions are in millimetres.
2. All levels are in metres related to Ordnance Datum (Newlyn).
3. All chainages are in metres.

Legend:

- Extent of toe protection.
- Extent of cliff top works. Geomaterial and soil nails.
- Deep drain counterforts. 3–4m bgl. discharging onto back. Scalby car park drains to discharge into road drainage. Drains at ~15m centres.
- Extent of slope stabilisation works. Geomaterial and soil nails. Piles at 3m centres.
- Placement of recompacted arisings from cliff top reprofiling and drainage excavations.

Revision	Date	Description	Drawn	Checked	Approved

Client
SCARBOROUGH BOROUGH COUNCIL

Project
HUNDALE POINT TO SCALBY NESS STRATEGY STUDY

Drawing Title
GENERAL ARRANGEMENTS OF OPTION 4 WORKS

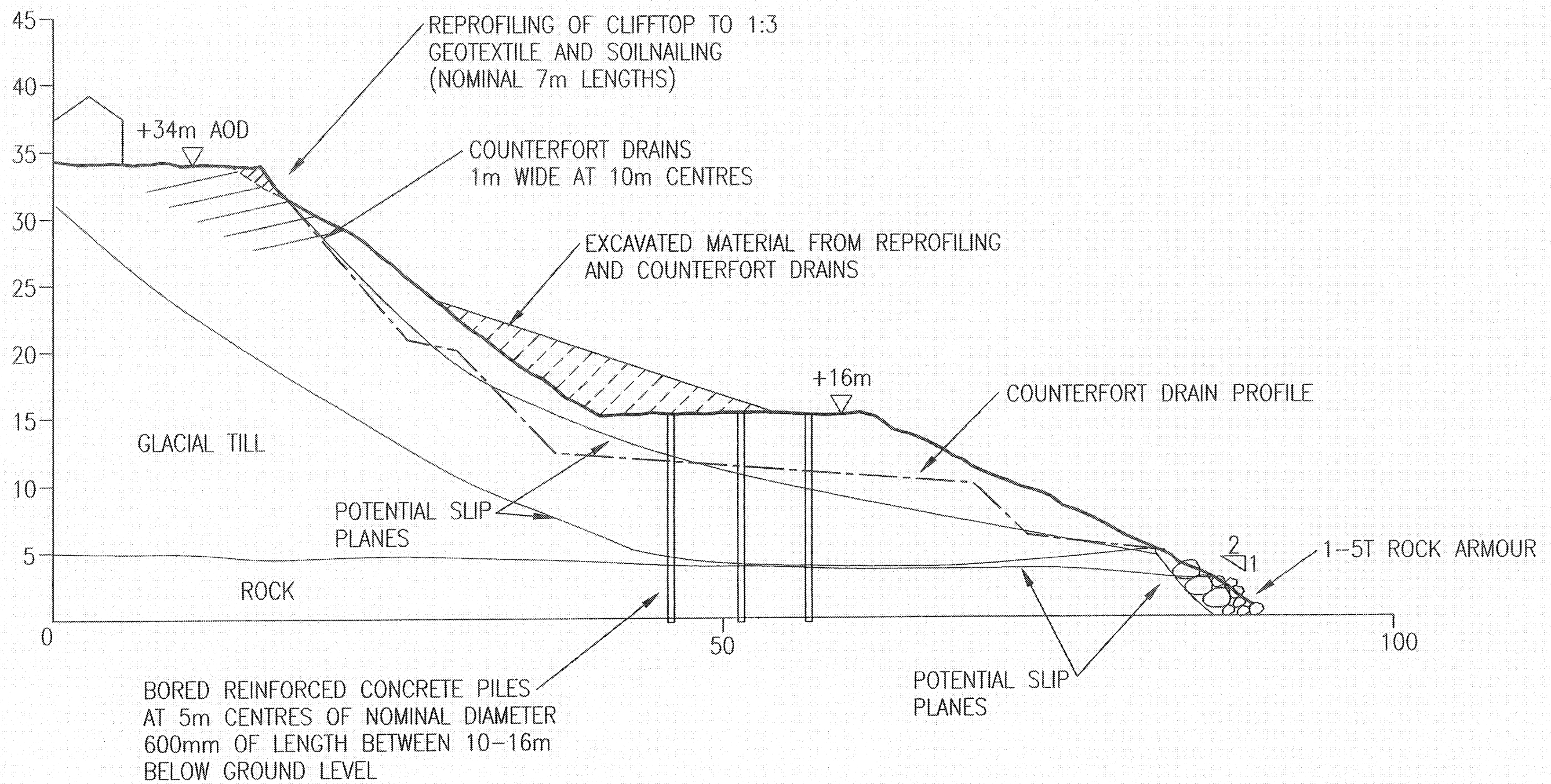
High-Point Rendel
High-Point Rendel Limited
61 Southwark Street, London SE1 1SA, UK
Tel: +44 (0)20 7654 0400 Fax: +44 (0)20 7654 0401

Format	Scale	File Name
A3	1:2000@A3	n://1404/10/Fig4.1c.dwg

Drawing Number	Rev No.
Figure 4.1c	0

Notes:

1. All dimensions are in millimetres.
2. All levels are in metres related to Ordnance Datum (Newlyn).
3. All chainages are in metres.

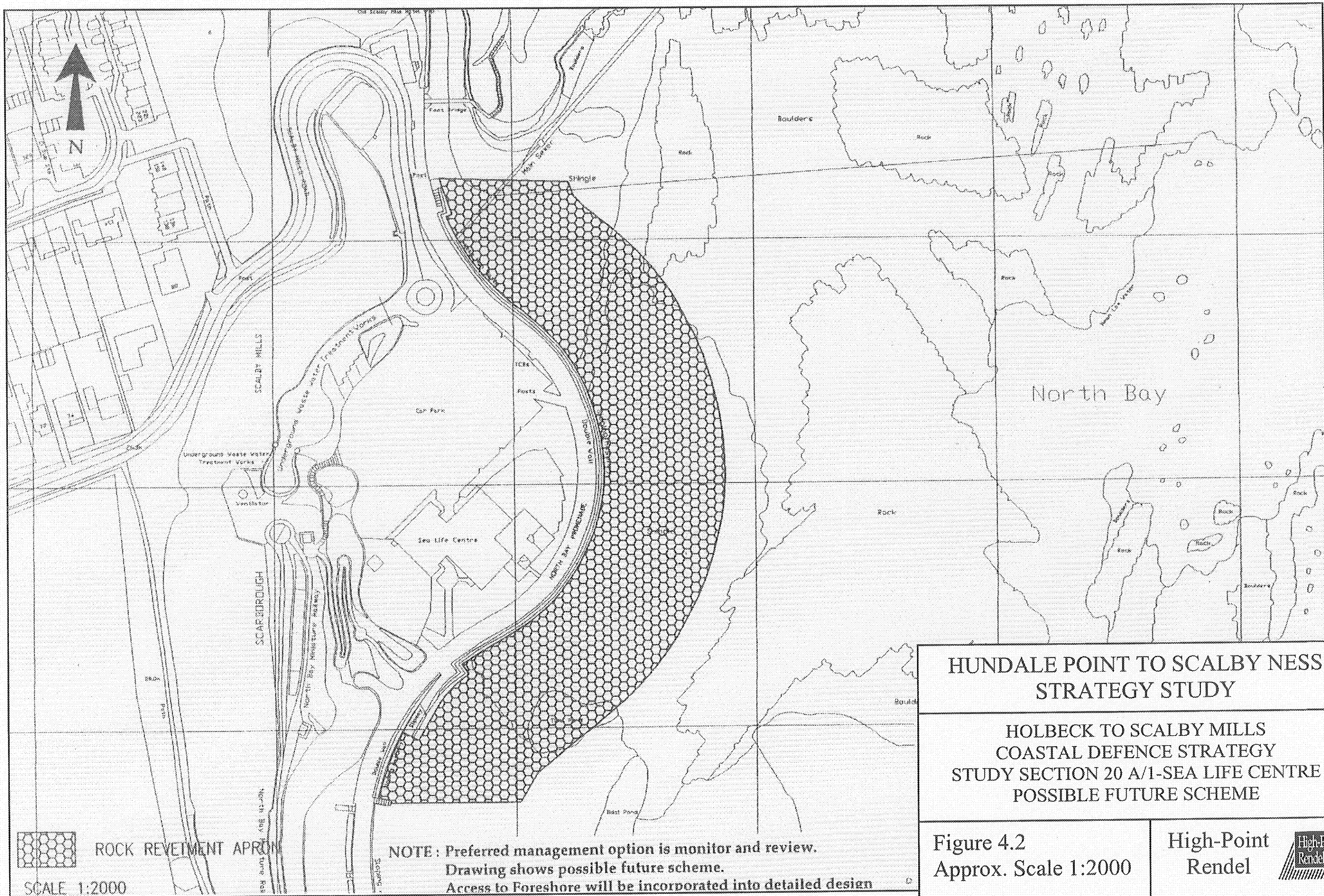


SECTION A–A'

SCHEMATIC CROSS SECTION OF

STRATEGY OPTION 4 (PARTIAL SCHEME)

HUNDALE POINT TO SCALBY NESS STRATEGY STUDY	
Figure No. 4.1d Scale 1:500	High-Point Rendel



NOTE : Preferred management option is monitor and review.
Drawing shows possible future scheme.
Access to Foreshore will be incorporated into detailed design

HUNDALE POINT TO SCALBY NESS STRATEGY STUDY

HOLBECK TO SCALBY MILLS
COASTAL DEFENCE STRATEGY
STUDY SECTION 20 A/1-SEA LIFE CENTRE
POSSIBLE FUTURE SCHEME

Figure 4.2
Approx. Scale 1:2000

High-Point Rendel

PLATES

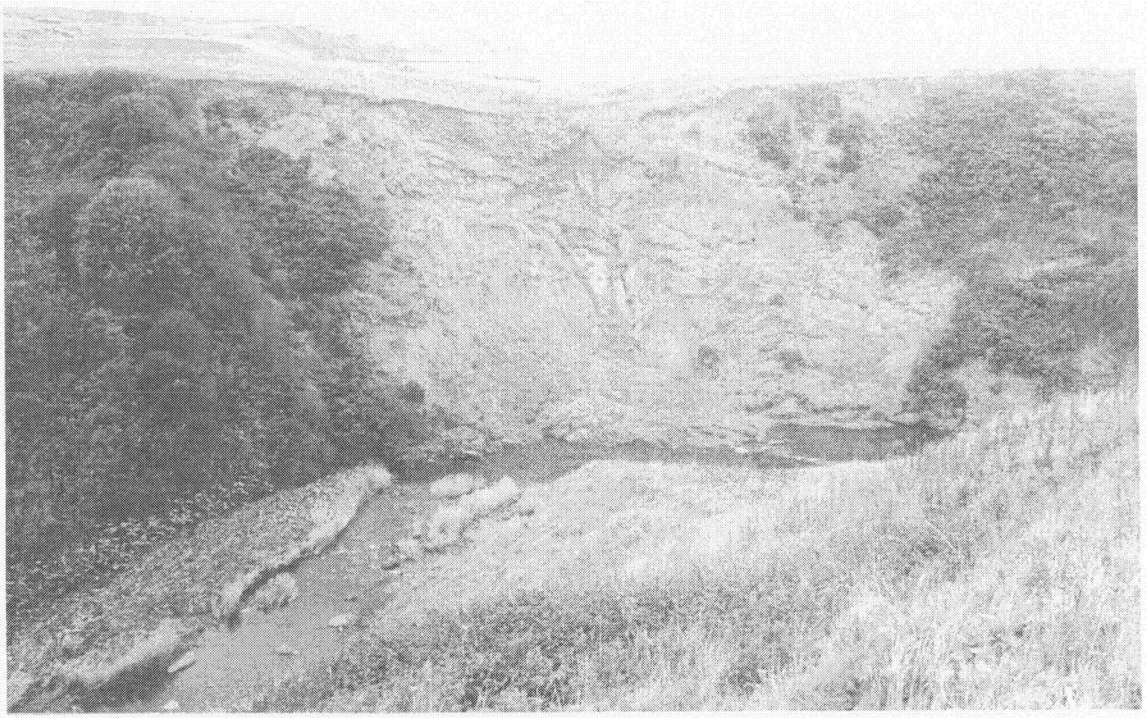


Plate 1 – Typical elongated mudslide.

Plate 2 – Pinchpoint Scalby Ness Sands.

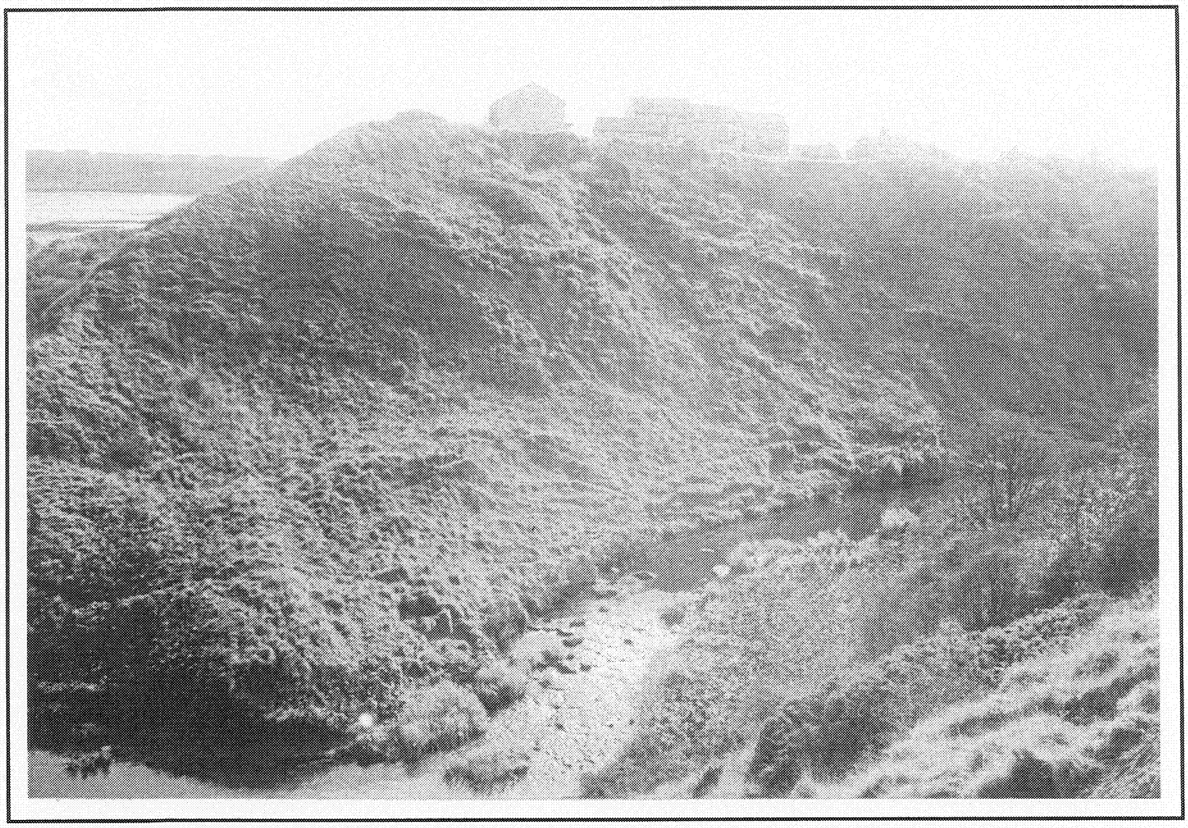


Plate 3 – North westerly facing slope.

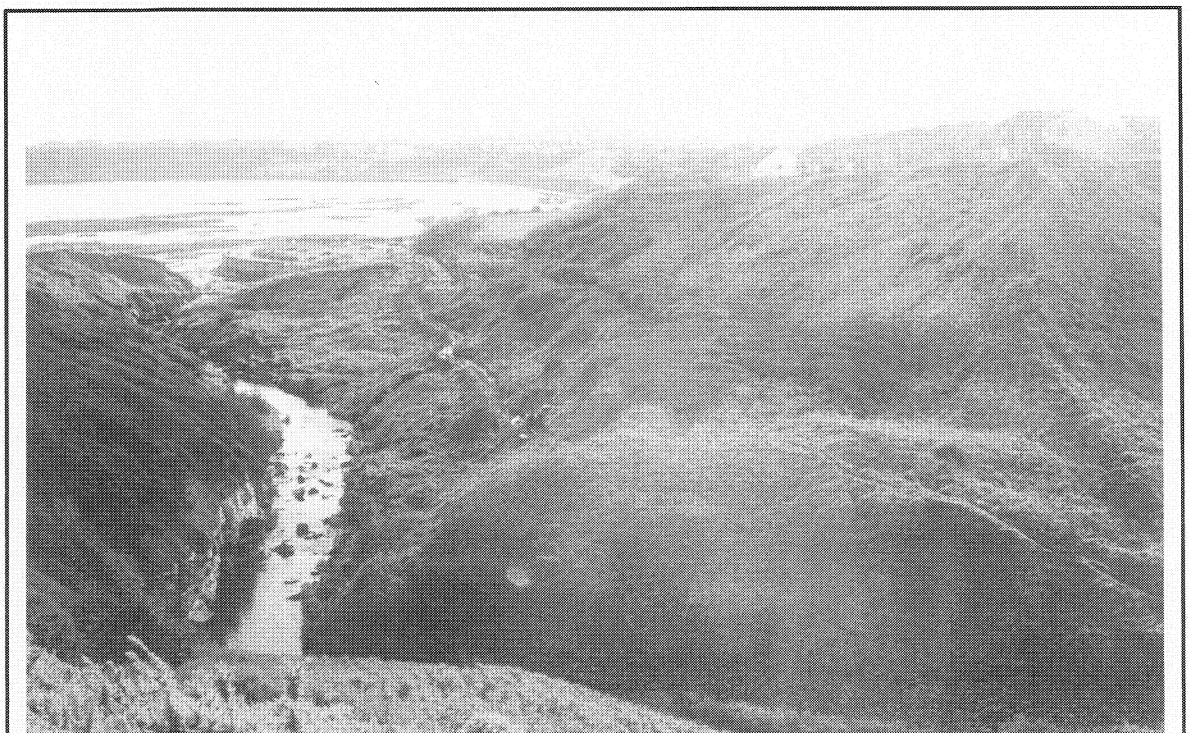


Plate 4 – North easterly facing slope.

Plate 5 – Properties located above north easterly facing slopes.

Plate 6 – Properties above north easterly facing slope showing cliff top recession

Plate 7 – High angled debris slide on north westerly facing slope showing drainage pipe.

Plate 8 – Aerial Photograph showing Scalby Ness Headland prior to recent slope failures.

APPENDICES

APPENDIX A

A1 Holbeck to Scalby Mills Coastal Defence Strategy Study, HPR, November 1999

This report included a section on the stability of the North Cliffs in North Bay, Scarborough. It provided a range of options for coastal defence improvements including slope stabilisation measures to improve the integrity of the cliffs and reduce the likelihood of major first-time landslides or reactivation of previous landslides.

The geomorphological maps confirmed a deep-seated landslide system on the slopes above Scalby Beck. However, the report was largely confined to considering only Coastal Process Units 20 to 23 and therefore did not specifically include a detailed assessment of Scalby Ness within the overall strategy study.

A2 Holbeck to Scalby Mills Coastal Defence Strategy, Scarborough Coastal Slope Inspection: September - November 2000. HPR December 2000.

This report included an update of the geomorphological mapping originally presented in the Coastal Defence Strategy. Maps were produced to give an indication of the development of slope instability features. All monitoring data was presented in the report, together with specific recommendations for further monitoring of areas giving cause for concern.

A3 Holbeck to Scalby Mills Coastal Defence Strategy, Scarborough Emergency Coastal Slope Inspection: HPR January 2001.

This report was requested by SBC following reports of rapidly deteriorating condition of a number of slopes including those at Scalby Ness following the heavy rainfall of the 2000/2001 winter season. It included a detailed up-date of the previous geomorphological mapping. The maps confirmed the presence of deep-seated valley side landslides on the slopes above Scalby Beck (Sheet 1 of 19) and the proximity of the Scalby Mills housing estate to the sites of slope instability. As part of the report, evidence of recent slope movement was assessed in terms of risk to public and capital investment. The assessment concluded the site was a high priority and recommended further mapping and investigation.

A4 Rapid Risk Assessment - Scalby Ness

The report recommended a ground investigation including limited topographical survey be carried out to confirm ground profiles and installation of instrumentation to monitor ground movements and groundwater behaviour within the main slip system.

The report suggested that the recent ground movements on north facing slopes at Scalby Ness probably resulted from a combination of the high rainfall during September 2000 to March 2001 and erosion of the toe of the slope by Scalby Beck.

The report was issued in April 2001 as an Interim Report with the view that the completion of the RRA Report would address the following aspects:

- Preparation, management and completion of a ground investigation.
- Review and interpretation of existing information including historical data.
- Confirmation of the mechanisms of ground movement and its causes.

- Numeral stability analyses.
- Assessment of the risk and consequences of large scale ground movements.
- Calculation of cliff top recession rates and the means to manage them.

A5 Waste Water Treatment Tunnel

A letter report from consultants Earth Tech provided a drawing showing a waste water treatment tunnel passing below the north east slope. The alignment of the tunnel was shown to pass approximately between the Sea Life Centre and sea outfall at Scalby Ness Sands.

The report also provided the results of Structural Condition Surveys including weekly monitoring of ground movements at properties in close proximity to the works at Scholes Park Road during the tunnelling. The records confirmed no movements affected the properties during the period of the works.

A6 Exploration Associates Investigation, 1995.

Exploration Associates carried out a borehole investigation at Scalby Ness in March 1995. The aim of the investigation was to provide Yorkshire Water with information for the construction of the tunnelled wastewater pipeline below the site.

As part of this investigation, borehole (BH114) was located just behind the crest of the northeast facing slope. Descriptions from this borehole provided a complete record of the full succession of undisturbed material including both superficial (Glacial Till) and solid (bedrock) strata in close proximity to properties at Scholes Park Road.

A7 Structural Soils Ltd Investigation, 2001.

Structural Soils Ltd, carried out a ground investigation including a limited topographical survey, under instruction from HPR, between 4th and 20th October 2001. The fieldwork included 4 No. rotary cored boreholes to depths of 12.1m to 20m. The boreholes were located within the slipped materials of the northeast facing slopes. Difficulty with access to the steeper northwest facing slopes prevented intrusive investigations of this slope.

In-situ testing carried out in boreholes included variable head (falling) permeability testing and Standard Penetration Tests (SPT) in the superficial deposits and between core runs. All core recovered from the boreholes was dispatched to the laboratory for detailed logging.

On completion of the boreholes, inclinometers were installed to the base of boreholes SN1 and SN3 to assess the level/s, directions, rates and magnitudes of any lateral ground movements within the main slip block. A total of three standpipe piezometers were installed in the boreholes SN2 and SN4 to assess groundwater behaviour within and below the anticipated slip block. Baseline readings were taken to confirm satisfactory operation of all the instrumentation.

A limited topographical survey of the slopes was carried out. Survey lines approximately perpendicular to the slope contours were established between borehole locations to assist in the construction of a series of cross sections. The survey lines included features such ground levels behind the crest of the slopes, back scarps and river bed levels of Scalby Beck. These features were assessed as part of the detailed analyses of the existing slope stability.

APPENDIX B – LIST OF CONSULTEES AND COMMENTS

ENGLISH NATURE

North & East Yorkshire Team
Genesis 1 University Road Heslington York YO10 5ZQ
Tel +44(0)1904 435500 Fax +44(0)1904 435520

www.english-nature.org.uk
Susan.wilson@english-nature.org.uk

Charles Storm
High-Point Rendell
61 Southwark Street
London
SE1 1SA

Your ref: 1404/5.1/203-1/DGC
Our ref: TA09 SR3

Date: 18 July 2003

Dear Charles

Iron Scar and Hundale Point to Scalby Ness SSSI
Hundale Point to Scalby Ness Coastal Strategy Study Final Report

Further to our telephone conversation today, I can now confirm that English Nature is satisfied that nature conservation issues have been adequately addressed in the final report. The issue of breeding birds using the project area was not mentioned, however disturbance to breeding birds can be avoided by appropriate timing of works (outside the breeding season).

I understand that the detail of the works around Scalby Beck are still to be confirmed. As part of the Scalby Beck Scheme English Nature advise that a full ecological survey is carried out, details were given in my letter of 23 June 2003.

I look forward to receiving more detailed plans of the Scalby Beck Scheme in due course.

Yours sincerely

Susan Wilson

Susan Wilson
Conservation Officer
North and East Yorkshire Team

RECEIVED
22 JUL 2003

AS. .N. No						612
HPR.	INITIALS	COPY	ACT			DATE
RECD 22.07.03	CS					
REG No.						
FILE No. 1402						

RESPONSES FROM CONSULTEES 05.08.02

Organisation	Contact	Date of Issue	Response	Date response received	Date contacted	Comments Made	Action Outsiding
Planning Department Scarborough Borough Council	Mr D Williams (Principal Planning Officer)	09.05.02	3	20.05.02		*Section 3.1* – the third bullet point should read "Heritage Coast" status… *Section 3.2* – the North Yorkshire County Structure Plan was also amended by Alteration No. 3 adopted in 1995. *Section 4* – the list of environmental considerations should include the Waste Water Treatment Works. *Table 1* – the valley of Scalby Beck also has SINC status. *List of Consultees* – Mr M McGunn should be Mr M McGinn. *Figures 1 & 6* – should show extent of Scalby Beck with the study area. *Figure 6* – the siting of the Waste Water Treatment works & pipelines is wrong (map attached to 1404/03.g/25). - it would be useful to show the long sea outfall from the Scalby Mills Preliminary Treatment Works as its long term future is important. - The extent of the Scalby Beck SINC should be shown.	
County Ecologist Scarborough Borough Council	Mr Bob Missen **Response via James Gillespie County Ecologist**	09.05.02	3	01.08.02	10.07.02 & 15.07.02 & 25.07.02	Table 1 may be misleading as far as fauna is concerned. Further research may elevate the status of fauna to a primary issue within your study area. Some of the cliffs in the area are known to have high invertebrate interest, and whilst I do not know that the cliffs are noted for their ornithology, their status should be confirmed following consultation with the local ornithological society. Other comments included: - What would be considered an acceptable level of impact on ant feature? This may be a matter for the detailed stage but at this stage some consideration should be given to the	

Organisation	Contact	Date of Issue	Response	Date response received	Date contacted	Comments Made	Action Outsiding
						requirement for a) proper evaluation of natural features, and b) a thorough impact assessment. - What opportunities present themselves for enhancement of the natural environment within any particular option (apart from "do nothing"). - The proposed description of the environmental baseline in Section 5.1 they recommend clarification over what aspects of the environment will be included in this. - At the detailed design stage, appropriate detailed data gathering will be necessary. This will necessitate the collation and evaluation of data from a range of other organisations as well as original survey using appropriate methods.	
Heritage Officer Scarborough Borough Council	Mr Chris Hall	09.05.02	8		10.07.02 & 15.07.02		Had never seen the document & doesn't believe he needs to.
English Nature Genesis 1 University Road Heslington York YO10 5ZQ	Mr Stephen Morely	09.05.02	3	17.07.02	10.07.02	The range of environmental issues proposed seems appropriate for the location and purpose.	
English Heritage Yorkshire Region 37 Tanner Row York YO1 6WP	Mr Dan Smith	09.05.02	3	30.07.02	10.07.02 & 25.07.02	More investigation should be done into the 'consideration of Cultural Heritage'. The document states that in terms of protecting historic buildings, no structures of heritage significance are understood to be in close proximity to the study area. While this may be true, it is important to realise that other features are part of the cultural heritage of the area. Archaeological remains may be present & could be affected either by erosion or by coastal protection measures. It would be wise to contact the Sites and Monuments Records at North York. County Council, and National Park, in order to determine what archaeology to consider.	

Organisation	Contact	Date of Issue	Response	Date response received	Date contacted	Comments Made	Action Outsiding
Environment Agency Coverdale House Aviator Court Amy Johnson Way Clifton Moor York YO30 4UZ	Ms Karen Parker (Customer Services)	09.05.02	3	12.07.02		The only section that we can comment on at this stage is the Environmental Constraints & Benefits section. The EA would be interested in hearing any future works deemed necessary to prevent the changes in the profile of Scalby Ness headland as discussed. The Sea Cut is under riparian ownership for what is perceived as the tidal limit – the cascade weirs downstream of Whitby Road Bridge. Any change in water level profile due to marine influence in these reaches could well form instability to the bank sides and cliffs. Although the EA would therefore not be the responsible maintainer in this case they have a level gauge of some importance at the cascade weirs which is used for flood warning & operational response purposes in flood events. The EA would therefore be interested in any changes through the lower reaches with this in mind.	
Yorkshire Water Capital Development Department PO Box 500 Western House Halifax Road Bradford BD6 2LZ	Mr Martin Barran (Project Manager WW North) **Response from Noel Fisher EarthTech**	09.05.02	3	30.07.02	10.07.02 & 15.07.02 & 25.07.02	Not in a position to comment on the scope of the works, however the drawing in the report has the WWTW & pipelines in the wrong position. HPR had drawings from the originally.	
Cloughton Parish Council Whitestone Farm Cottage Staintondale Scarborough YO13 0EZ	Mrs J Marley (Clerk to Parish Council)	09.05.02	8		10.07.02	No comment	E-mail sent with 15 working days deadline. No response.

Organisation	Contact	Date of Issue	Response	Date response received	Date contacted	Comments Made	Action Outsiding
Burniston Parish Council 26 Burniston Gardens Burniston Scarborough YO13 0HW	Mrs M H Warters (Clerk to Burniston Parish Council)	09.05.02	3	10.07.02		No comments.	
Newby and Scalby Parish Council Council Offices Scalby Road Scarborough YO13 0RA	Mr M Guinn (Clerk to Newby and Scalby Parish Council)	09.05.02	3	18.07.02	10.07.02 & 15.07.02	No comments.	
Heritage Unit North Yorkshire County Council County Hall Northallerton DL7 8AH	Mr J Gillespie	09.05.02	3	13.06.02		The document does identify many of the natural environment issues that will need to be addressed, in the broadest sense. However they feel that Table 1 may be misleading as far as fauna is concerned. Further research may elevate the status of fauna to a primary issue within your study. Some cliffs are noted for their ornithology, their status should be confirmed following consultation with the local ornithological group. Other comments included. - What would be considered an acceptable level of impact on any particular feature? This may be a matter for the detailed stage but at this stage some consideration should be given to the requirement for a) proper evaluation of natural features, and b) a thorough impact assessment. - What opportunities present themselves for enhancement of the natural environment within any particular option (apart from "do nothing")? - The proposed description of the environmental baseline in	

Organisation	Contact	Date of Issue	Response	Date response received	Date contacted	Comments Made	Action Outsiding
						Section 5: Clarification over what aspects of the environment will be included in this. - At the detailed stage, appropriate detailed data gathering will be necessary. This will necessitate the collation & evaluation of data from a range of other organisations as well as original survey using appropriate methods. -	
North York Moors National Parks Authority The Old Vicarage Bondgate Helmsley YO6 5BP	Ms Rhona Charles	09.05.02	3	31.07.02	10.07.02 & 15.07.02 & 25.07.02	The heritage coast project carried out a landscape assessment of this area in 1998 along with a study of Crook Ness access point.	
DEFRA (Regional Engineer) Foss House Kings Pool 1-2 Peasholme Green York YO1 2PX	Mr Jim Hutchison	09.05.02	3	15.05.02		Expecting the study to address the limit of marine influence within Sea Cut.. Make sure that Yorkshire Water are fully consulted as their assets are within the study area.	
DEFRA (Marine Consents and Environment Unit) Room 132, 17 Smith Square London SW1P 3JR	Mr Tim Hallum	09.05.02	8		10.07.02 & 15.07.02 & 25.07.02		TH will send document out 23.07 & collect comments by 02.08. He will then return them to HPR

APPENDIX C – CLIFF RECESSION RATES

Calculation of cliff top recession rates has been based mainly on the following two approaches:

i) Observations and monitoring currently being carried out by SBC as a basis to measure and predict the effect of short term (< 5 years) instability, and,

ii) Evaluation of historical data as a basis to predict long term (< 50 years) recession rates.

Studies of the northeast Yorkshire coast in 1960 (*Ref 9*) suggested active erosion of the coastal cliffs was occurring at a rate of approximately 32.8m (100 feet) per century. The rate of recession was reported to be governed by the presence of beach sand and the shelter of headlands. The figure of 32.8m per 100 years provides a predicted average annual cliff recession rate of 0.32m.

The amount of recession occurring along the Whitby to Sandsend coast was determined over a 53 year period between Ordnance Survey map editions dated 1913 to 1966 (*Ref 10*). Cliff toe recession rates of between 8m to 18m and a maximum of 24m over the 53 year period was reported. This gives a range of average toe recession of between 0.15m to 0.45m per year. In contrast, cliff top recession was less and on average 14m over the 53 year period giving an average annual recession rate of **0.26m.**

Previous editions of Ordnance Survey maps and a series of aerial photographs were examined to assess the historical development of the study area since 1928. This information formed the basis of a site specific prediction of rates of cliff top recession associated with the main slip areas on the northeast and northwest slopes. The following information was examined.

Table 2 : Summary of available Ordnance Survey maps and aerial photography

Reference	Date	Scale
Ordnance Survey Map (Sheet No. 77). Yorkshire (North Riding)	1928	25.34 inches to 1 mile
Black & white aerial photograph (vertical) No. (not shown)	1972 (assumed)	1:10,000
Colour aerial photograph (oblique) No. 4179/52	October 1984	Not shown (approx 1:3600)
Colour aerial photograph (vertical) No's 65 & 66	October 1999	1:4000

Cliff top recession of the northeast and northwest facing slopes was predicted by enlarging the image of the 1999 vertical aerial photograph to the identical scale of the 1928 OS map and directly comparing the recession of the mapped cliff lines for the 71 year period between 1928 to 1999. The error in enlargement and scale comparison was estimated to be less than 3%.

As a check on sensitivity of this method, the line of the cliff tops of the southwest and southeast facing slopes were also compared. The results of this exercise are summarised in Table 3.

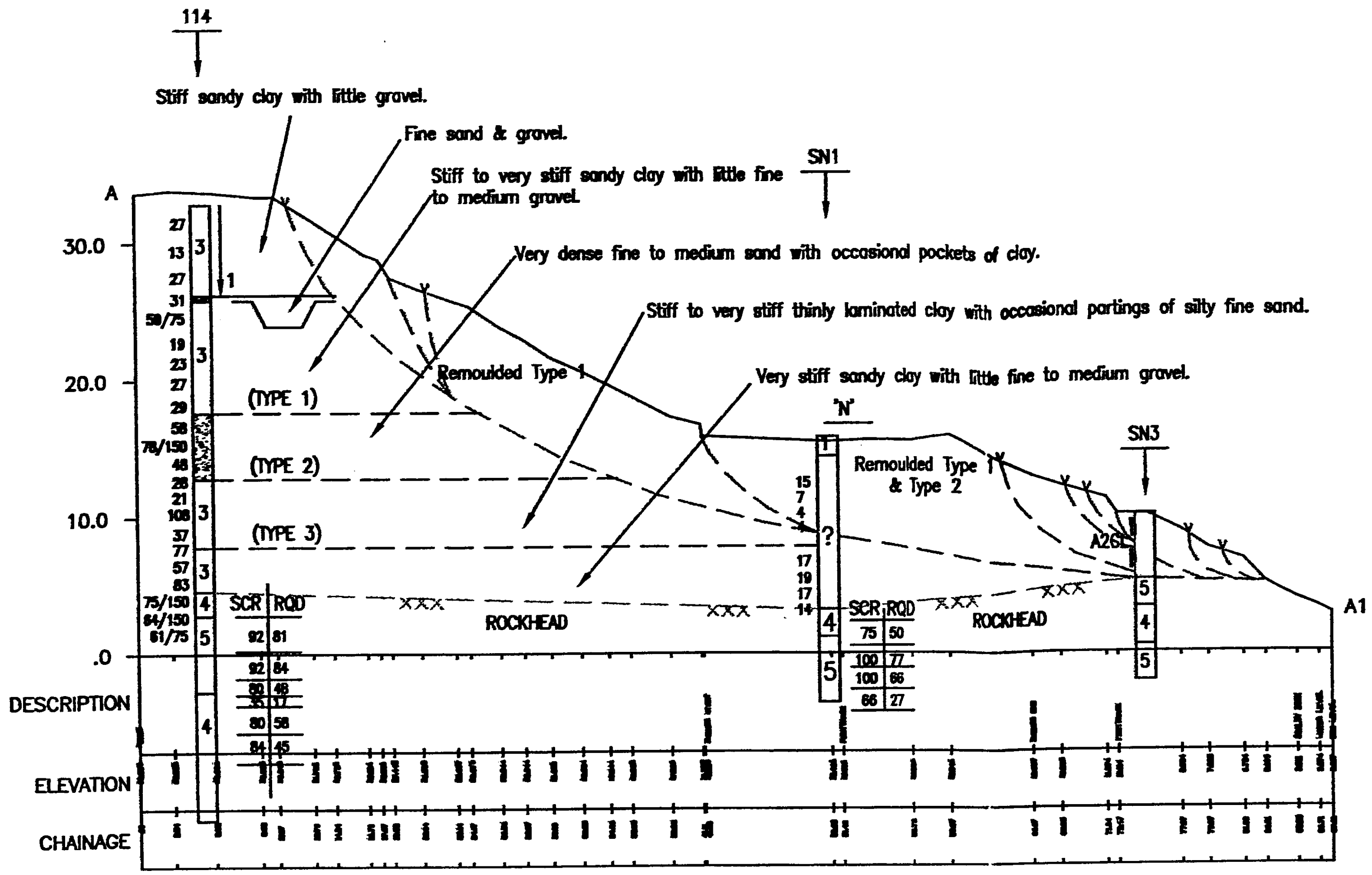
Table 3. Predicted historical cliff top recession rates at Scalby Beck (1928 – 1999).

Measured section	Calculated recession (m)	Calculated annual recession (m/year)	Average annual recession (m/year)
Northeast facing slope	6.3 to 12.7	0.089 to 0.179	0.134
Northwest facing slope	Inconclusive	Inconclusive	Inconclusive
Southeast facing slope	19.0 to 31.7	0.267 to 0.446	0.356
Southwest facing slope	12.7 to 44.4	0.179 to 0.625	0.402

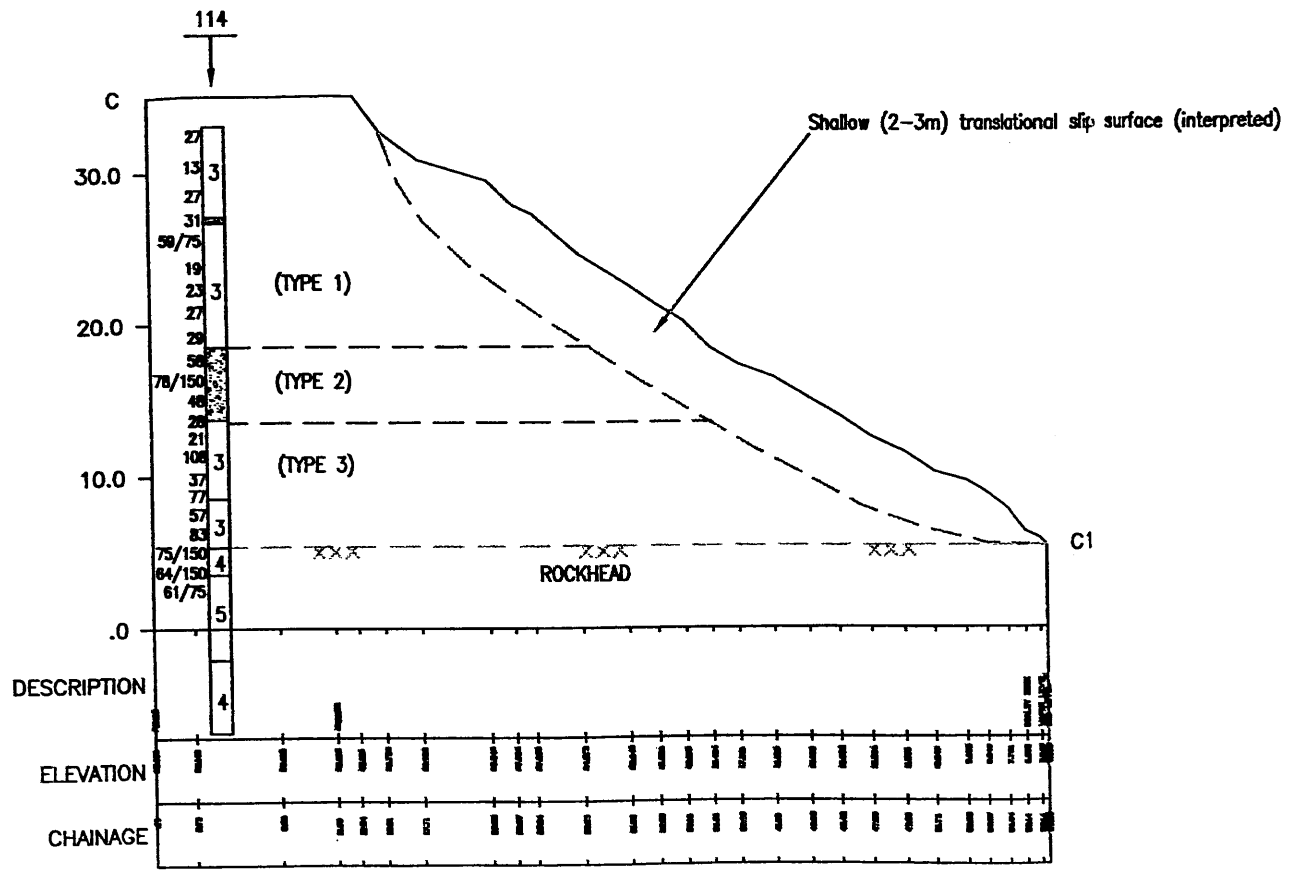
A comparison of the 1972 and 1999 vertical aerial photographs suggest the general form of the landsliding does not appear to have altered significantly. Indeed the 1928 Ordnance Survey map of the area may suggest the predominant back tilted block on the northeast facing slope could pre-date 1928. The location of the cliff top along the northwest facing slope is partially obscured by the 1972 works and therefore makes a comparative assessment of this cliff top and its recession more conjectural.

It is apparent from the 1972 aerial photographs that a new housing development was constructed at the northern limit to Scholes Park Road in that year. Between 1972 and the 1984 aerial photograph (oblique) a further smaller development of four houses was constructed at the southern end of the northeast facing slope.

APPENDIX D – SLOPE STABILITY ANALYSES



SECTION A – A1



SECTION C – C1

NOTES:

1. All dimensions are in metres.
2. All levels are in metres related to Ordnance Datum (Newlyn).
3. All chainages are in metres.
4. Sections taken from survey carried out by Line Surveys in October 2001.

KEY:

SOIL TYPE	DESCRIPTION
1	Firm brown silty clay.
2	Firm grey laminated clay with slickensides.
3	Stiff to very stiff sandy gravely clay with subrounded sandstone, mudstone and coal gravel.
4	Very stiff to weak highly weathered mudstone. Fissures extremely closely spaced. Completely weathered ash lithorelicts near surface.
5	Very weak to weak becoming moderately strong fine grained sandstone. Closely spaced fractures. Highly to moderately weathered.

0 5 10 15 20 25m
SCALE 1:500

Revision	Date	Description	Drawn	Checked	Approved
0	20/02/02	Original Sections	NHC		

Client
SCARBOROUGH BOROUGH COUNCIL

Project
SCALBY BECK – RAPID RISK ASSESSMENT

Drawing Title
GEOTECHNICAL LONG SECTIONS A – A1 AND C – C1

High-Point Rendel
High-Point Rendel Ltd
61 Southwark Street, London SE1 1SA, UK
Tel: +44 (0)207 9288999 Fax: +44 (0)207 9285566

Format	Scale	File Name
A3	1:500	N://1248/P/001

Drawing Number	Revision Number
P/001	0

Table D-1 - Results of Parametric Analyses For Section A-A'

Topography/ Slip Location	Ø	C'	Groundwater Level (m)	Recession behind cliff (m)	FOS
Existing Topography/ Overall Slip of Type 4 *Appendix 1 (i)*	27	0	17.5 16 12.5 0	0	**1.144 1.329 1.579 1.940**
	25	0	17.5 16 12.5 0	0	**1.105 1.280 1.445 1.776**
	22	0	17.5 16 12.5 0	0	**0.957 1.109 1.252 1.538**
First Stage Recession toe end removal *Appendix 1 (ii)*	27	0	17.5 16 15.5 0	0	**1.000 1.127 1.308 1.482**
	25	0	17.5 16 12.5 0	0	**0.915 1.031 1.197 1.356**
	22	0	17.5 16 12.5 0	0	**0.793 0.894 1.037 1.175**
Second Stage Recession toe end and middle slope removal *Appendix 1 (iii)*	27	0	17.5 16 15.5 0	0	**0.750 0.896 1.088 1.088**
	25	0	17.5 16 12.5 0	0	**0.686 0.820 0.995 0.995**
	22	0	17.5 16 12.5 0	0	**0.595 0.710 0.862 0.862**
Existing Topography Intact slope *Appendix 1 (i)*	27	0	17.5 16 12.5 0	15/30	**1.230/1.207 1.456/1.403 1.692/1.659 2.391/1.840**
	25	0	17.5 16 12.5 0	15/30	**1.125/1.105 1.333/1.284 1.548/1.518 1.790/2.374**
	22	0	17.5 16 12.5 0	15/30	**0.975/0.957 1.155/1.113 1.315/1.341 1.717/2.348**

Table D-1 (Cont'd) - Results of Parametric Analyses For Section C-C'

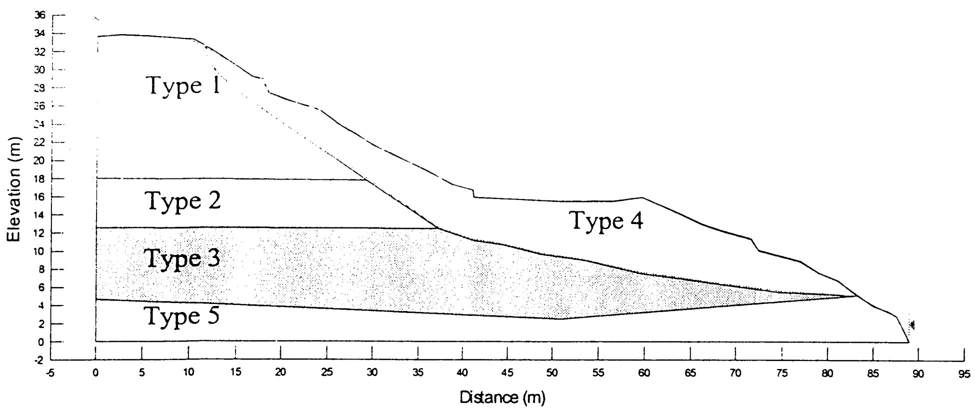
Topography/ Slip Location	Ø	C'	Groundwater Level (m)	Recession behind cliff (m)	FOS
15m Recession following failure of Type 4 (Failure through Type 3) *Appendix 2 (iii)*	27-30	0	17.5 15.5 0	15	**0.858** **0.958** **1.119**
30m Recession following failure of Type 4 (Failure through Type 3) *Appendix 2 (v)*	27-30	0	17.5 15.5 0	30	**1.419** **1.333** **1.548**

Sensitivity Analyses For Section C-C'

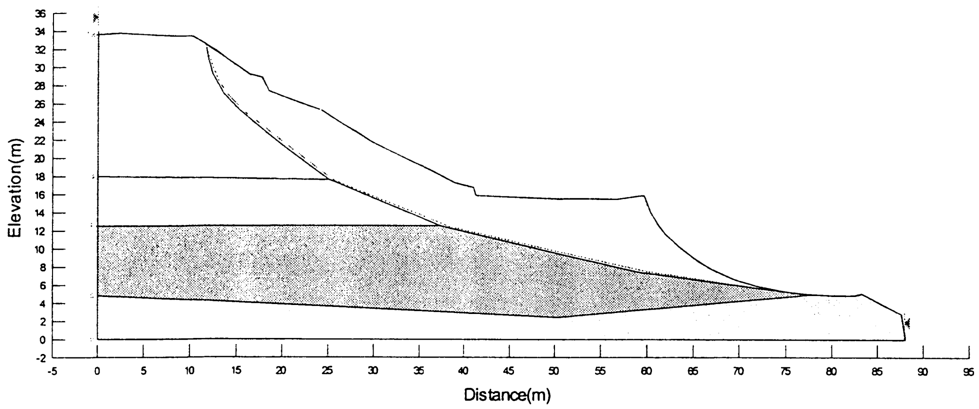
Topography/ Slip Location	Ø	C' Both (Type 1 and Type 3)	Groundwater Level (m)	Recession behind cliff (m)	FOS
Existing Topography Intact slope *Appendix 3 (i)*	27-30	7	17.5 15.5 0	0	0.996 1.100 1.180
	27-30	5	17.5 15.5 0	0	0.942 1.046 1.127
	27-30	2.5	17.5 15.5 0	0	0.820 1.000 1.061
15m Recession Intact *Appendix 3 (ii)*	27-30	7	17.5 15.5	0	1.253 1.425
	27-30	5	17.5 15.5	0	1.290 1.395
	27-30	2.5	17.5 15.5	0	1.320 1.358
30m Recession Intact *Appendix 3 (iii)*	27-30	7	17.5 15.5	0	1.720 1.783
	27-30	5	17.5 15.5	0	1.693 1.755
	27-30	2.5	17.5 15.5	0	1.659 1.721

Appendix D
(Accompanies Table D-1)

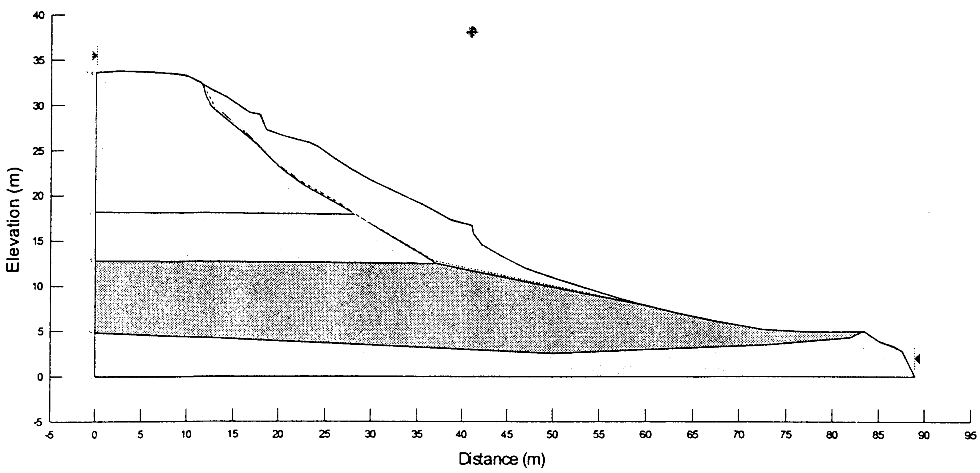
<u>Section A-A' (Refer to Figure P/001)</u>



(i) Geology and soil layers

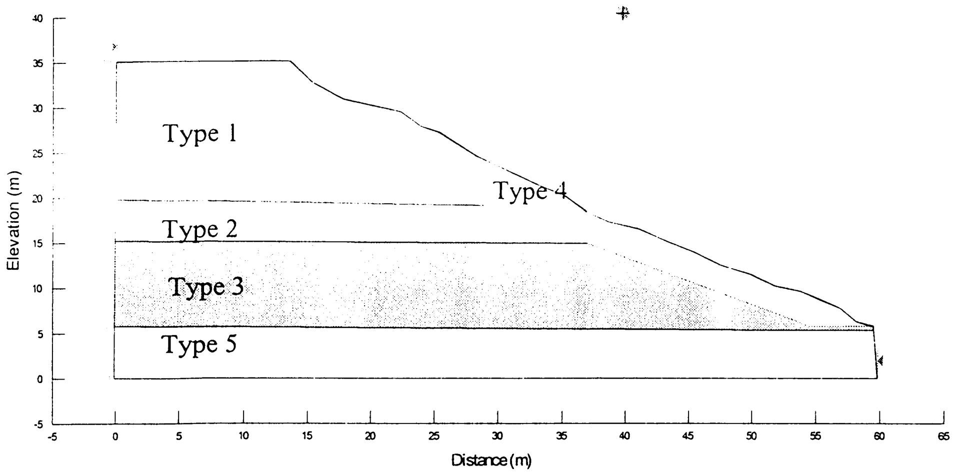


(ii) First stage recession

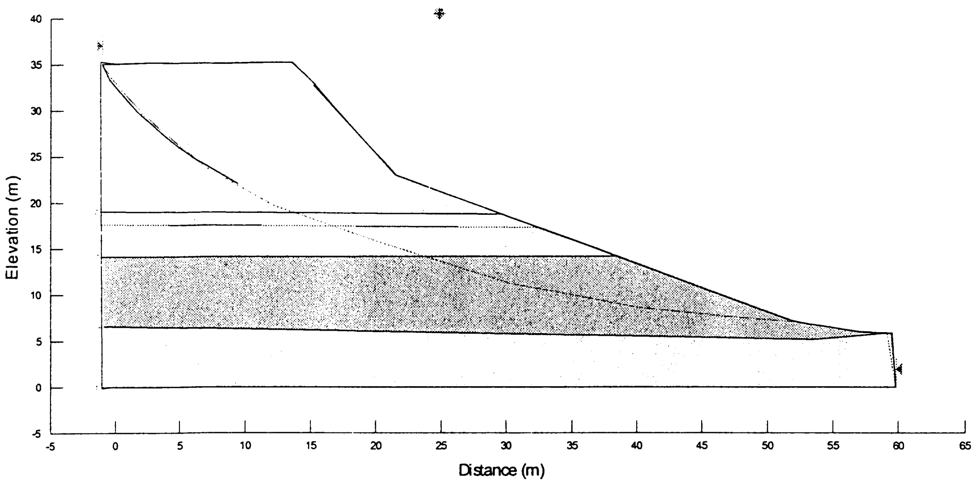


(iii) Second stage recession

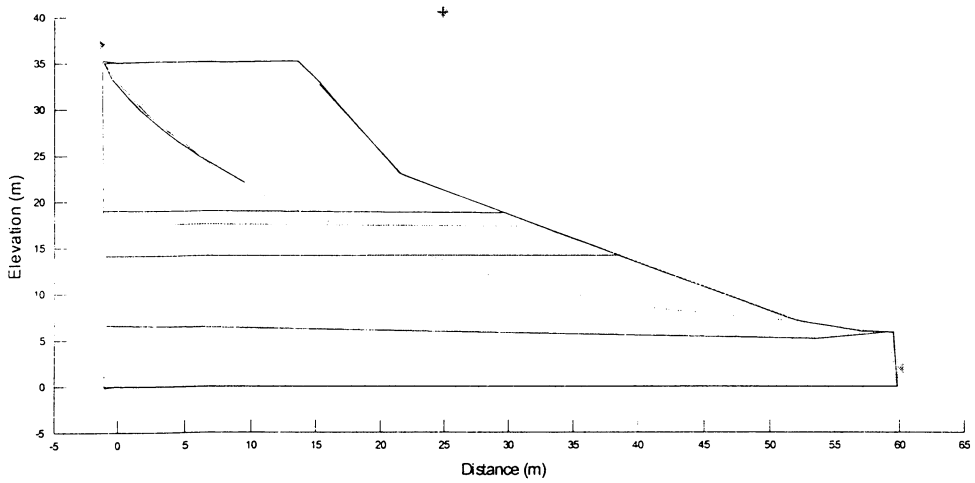
<u>Section C-C' (Refer to Figure P/001)</u>



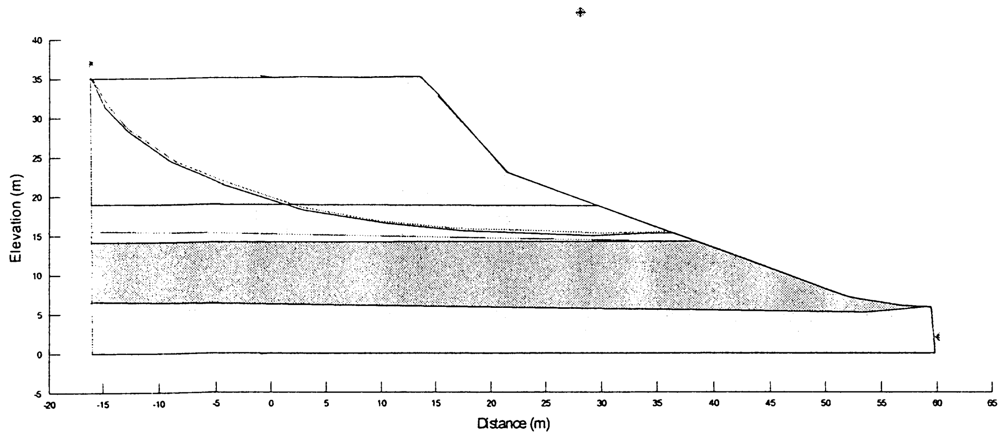
(i) Geology and soil layers



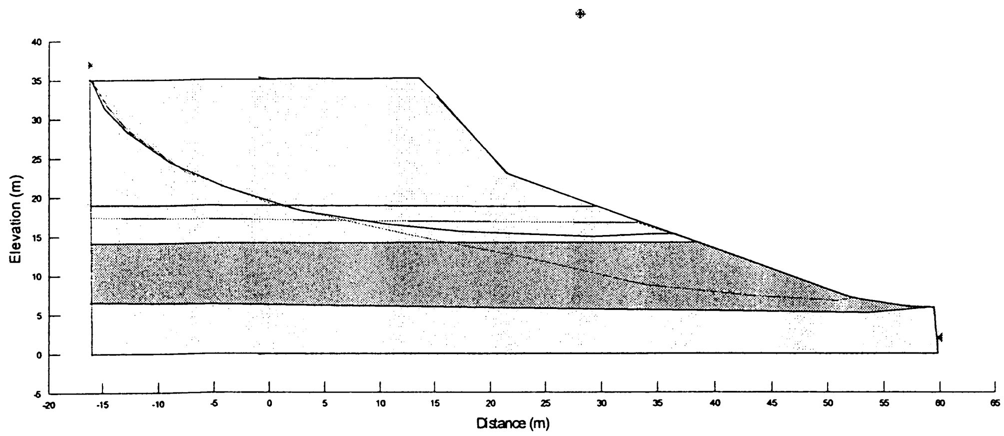
(ii) 15m recession small scale



(iii) 15m recession full scale



(iv) 30m recession small scale



(v) 30m recession full scale

Table D-2 - Results of Parametric Analyses For Section A-A'

Modified geometry of intact till slope will suffer 1st time failure with loss of 30m of cliff top

Strata	PHI	C	GAMMA
Intact Glacial Till (Type 1)	27	0	19
(Type 2)	30	0	18
(Type 3)	27	0	20
Slip Debris (Type 4)	26	0	18.5
(Type 5)	40	50	22

Topography/ Slip Location	RU value	FOS	FOS
		Bishop	M-P
Existing Topography Full scale slip Appendix 1 (I)	0.5	1.145	1.033
	0.4	1.441	1.304
	0.3	1.700	1.542
First stage recession Full scale slip Appendix 1 (iii)	0.5	1.024	0.923
	0.4	1.257	1.135
	0.3	1.491	1.350
Second stage recession Full scale slip Appendix 1 (iv)	0.5	0.911	0.817
	0.4	1.124	1.011
	0.3	1.338	1.207
Slip surface along base of debris plane Appendix 1 (v)	0.5	0.808	0.749
	0.4	0.997	0.925
	0.3	1.186	1.103
Slip debris removed Full scale slip Appendix (vi)	0.5	0.896	0.830
	0.4	1.105	1.026
	0.3	1.318	1.225

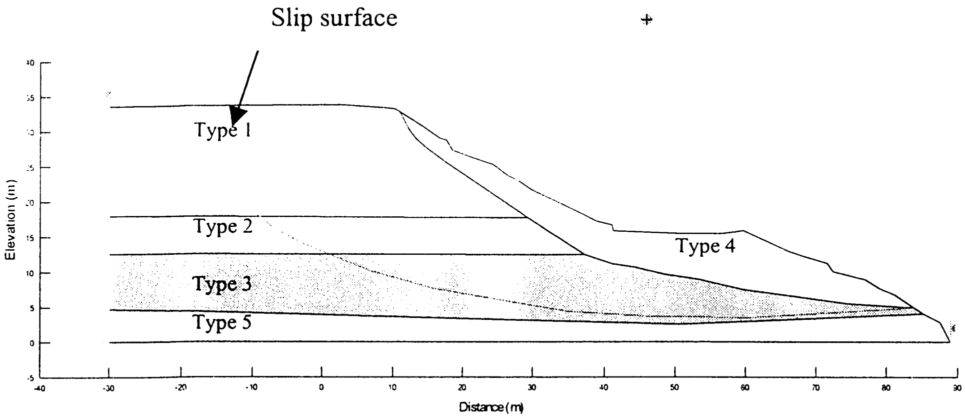
Table D-2 (Cont'd) - Results of Parametric Analyses For Section C-C'

Modified geometry of intact slope will suffer 1st time failure with loss of 30m of cliff top

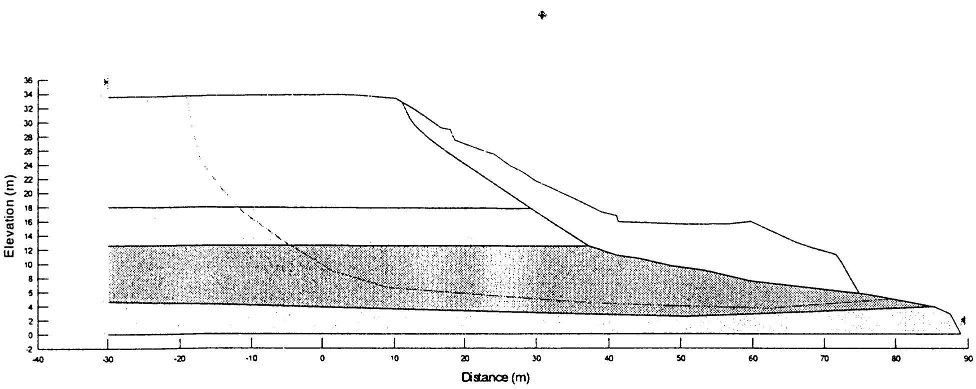
Topography/ Slip Location	RU value	FOS B	FOS B
		Bishop	M-P
Existing Topography	0.5	0.929	1.003
Full scale slip	0.4	1.148	1.236
Appendix 1 (I)	0.3	1.369	1.471
Slip debris removed	0.5	0.805	0.844
Full scale slip	0.4	0.994	1.047
Appendix 2 (ii)	0.3	1.188	1.251
Slip debris removed	0.5	1.021	1.069
Small scale slip	0.4	1.251	1.311

Appendix D
(Accompanies Table D-2)

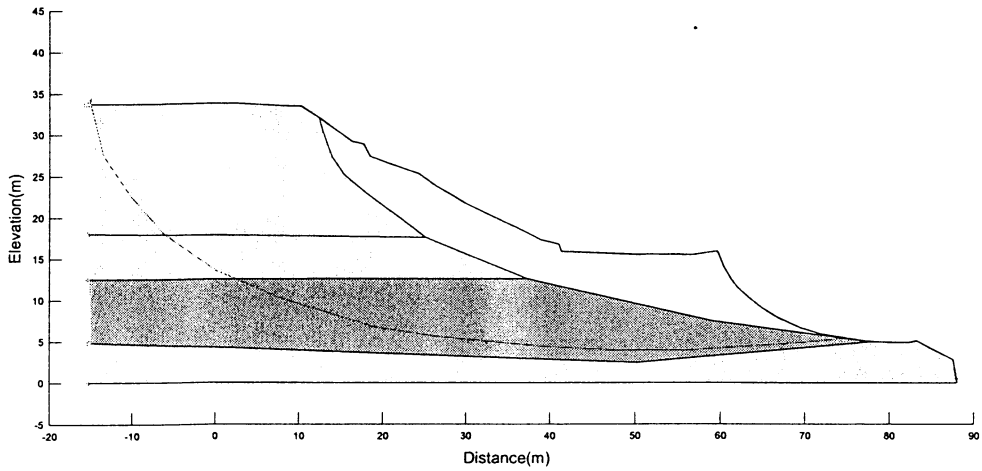
<u>Section A-A'(Refer to Figure P/001)</u>



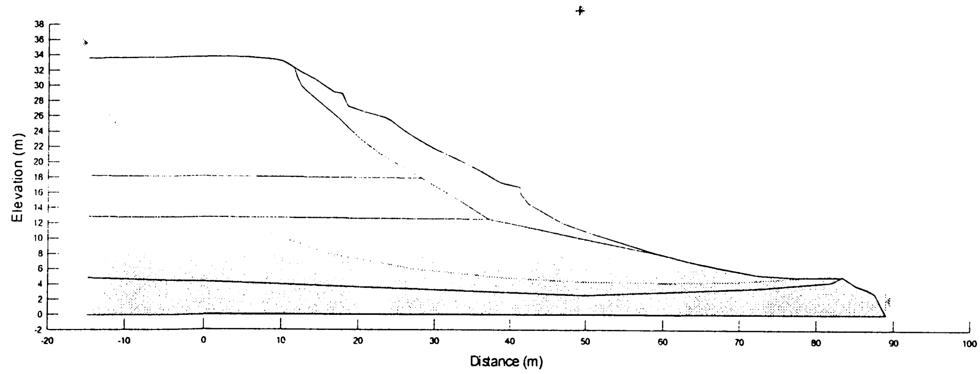
(i) Existing Topography – Full scale slip



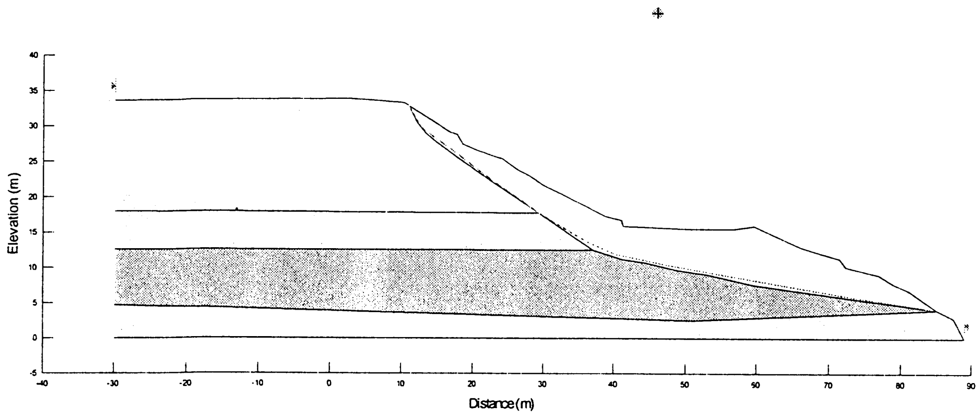
(ii) Toe end removal – Full scale slip



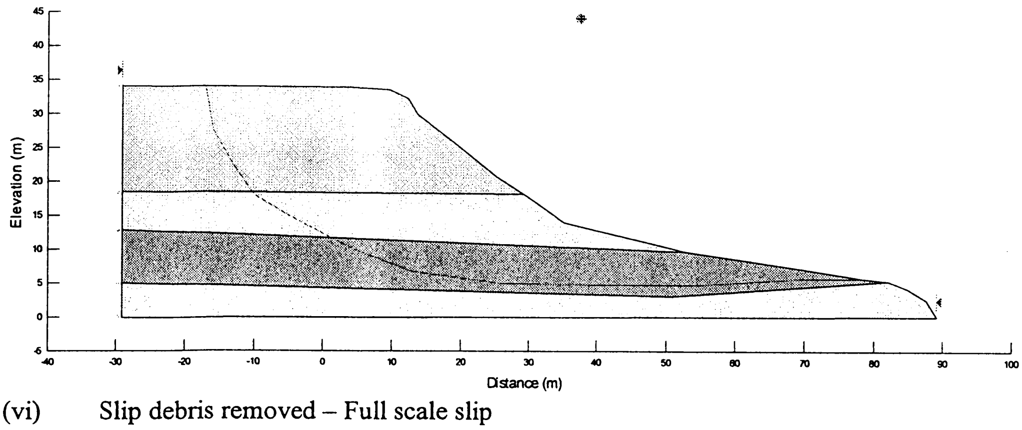
(iii) First stage recession – Full scale slip



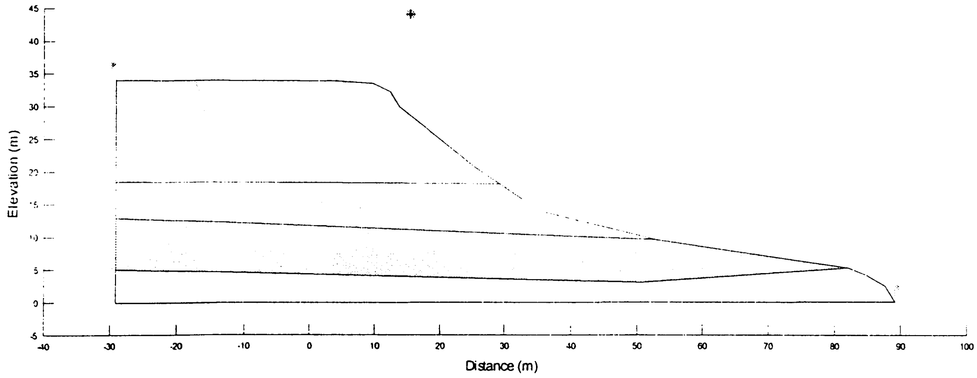
(iv) Second stage recession – Full scale slip



(v) Slip surface along base of debris plane

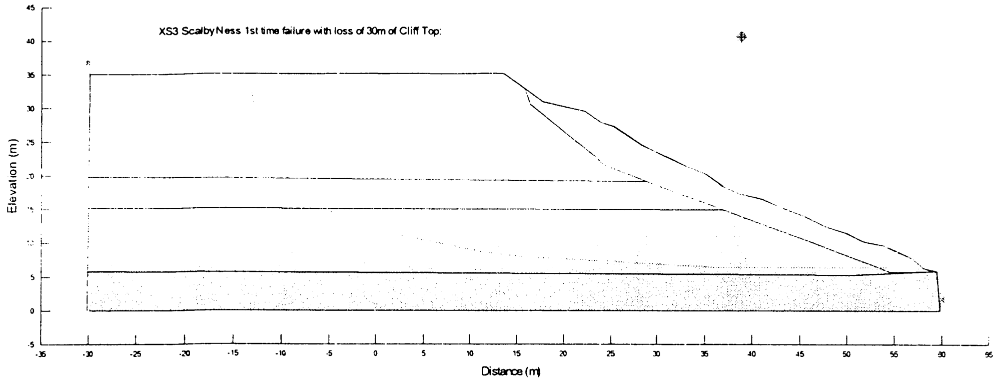


(vi) Slip debris removed – Full scale slip

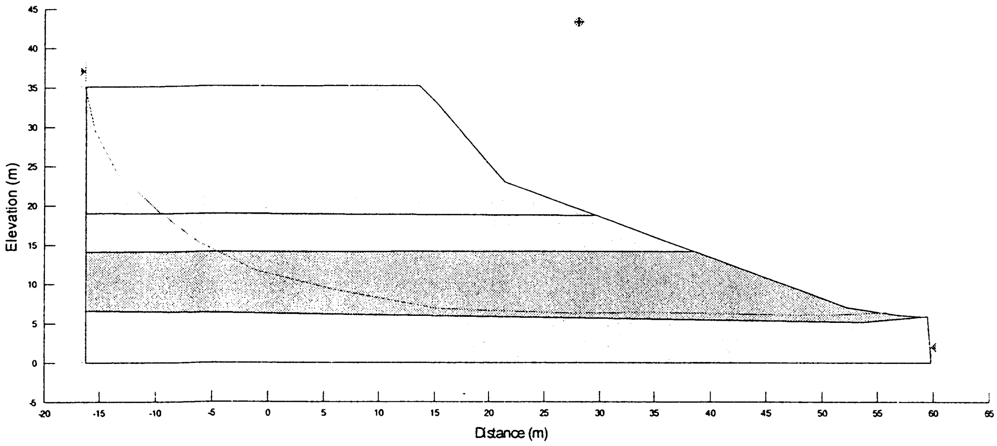


(vii) Slip debris removed – Small scale slip

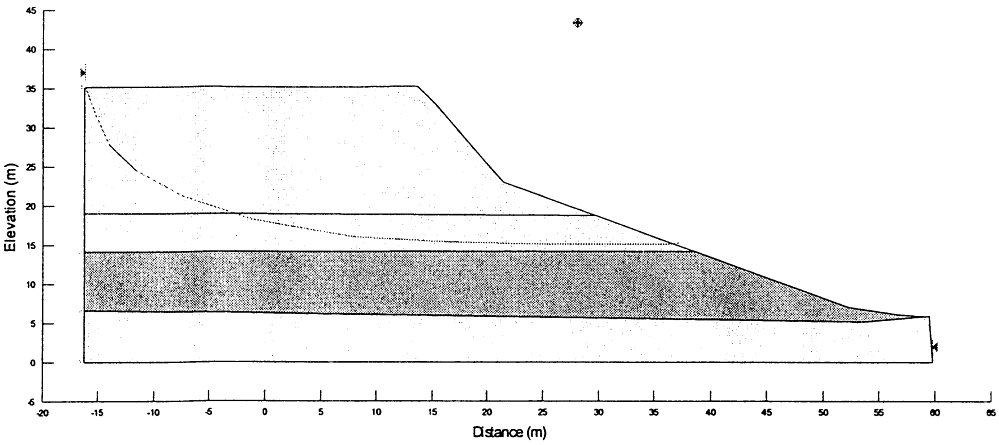
Section C-C'(Refer to Figure P/001)



(i) Existing topography – Full scale slip



(ii) Slip debris removed – Full scale slip



(iii) Slip debris removed – Small scale slip

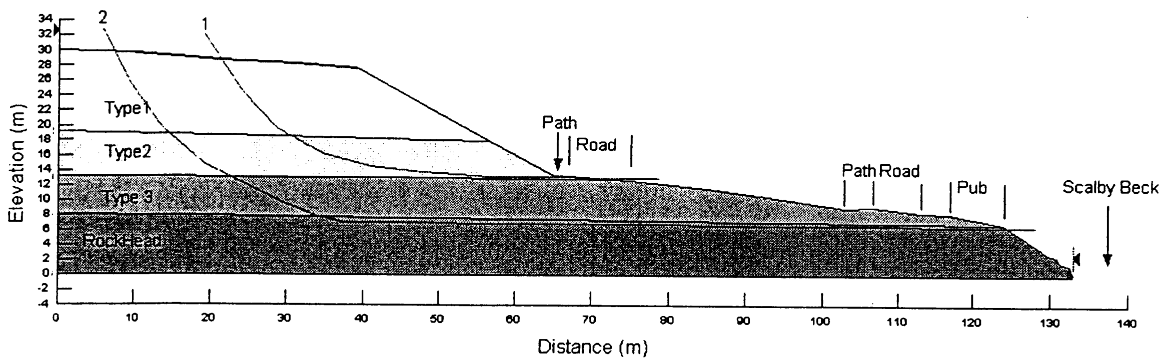
Section X-X1

Soil Type	Φ	C’	γ
1	27	0	20
2	30	0	18
3	27	0	20
RockHead	18-14	0	20

Shear Plane	RU	Φ	FOS
1	0.5	18	1.154
	0.5 0.4 0.3	14	0.931 1.142 1.355
2	0.5	18	1.301
	0.5 0.4 0.3	14	0.757 0.944 1.132

Analysis Method: Morgenstern-Price
Direction of Slip Movement: Left to Right
Slip Surface Option: Fully Specified
P.W.P. Option: Piezometric lines with Ru

Section X-X1

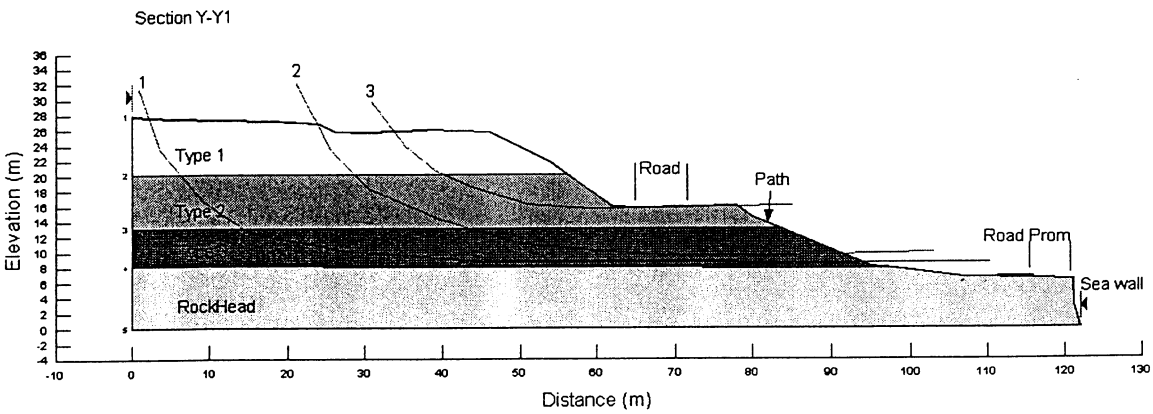


Section Y-Y1

Soil Properties (as above)

Shear Plane	RU	Φ	FOS
1	0.5	18	1.654
	0.5 0.4 0.3	14	0.861 1.067 1.273
2	0.5	18	1.137
	0.5 0.4 0.3	14	1.116 1.363 1.611
3	0.5	18	0.860
	0.5 0.4 0.3	14	1.000 1.226 1.453

Analysis Method: Morgenstern-Price
Direction of Slip Movement: Left to Right
Slip Surface Option: Fully Specified
P.W.P. Option: Piezometric lines with Ru



APPENDIX E – ECOMOMIC EVALUATION

This appendix comprises the spreadsheets (from FCDPAG3) for the evaluation of the benefits of the costs.

The first set of spreadsheets contains the details used for the costs of the preferred strategy following failure of the northeasterly facing beck slope and the different scenarios associated with loss of Scalby Mills Road (ie 1: 10 year loss of revenue to the Sea Life Centre; 2: relocation of the car park; and, 3: total losss of the Sea Life Centre). This is followed by the spreadsheets for deferred erosion losses over years 5, 7 and 10. Further analysis of the increase of construction costs at 25% and 50% to each of the 3 realistic options is also included. The final set of spreadsheets shows the evaluation of the CBR for no indirect losses (ie no loss of revenue to the Sea Life Centre and Scalby Mills Car park).

The following describes the methodology of how each option was economically evaluated.

Option 1, pv damage given slope failure in Year 2

The total loss of property and impact to loss of revenue has been estimated (using the erosion sheet as having a PV of a maximum of £11,811.2k for the relocation of the Sea Life Centre. This takes into account the delay in failure and that not all property will be lost at once, and different consequences of losing Scalby Mills Road. Properties lost at various stages of the strategy have been given a reduced probability of loss accordingly.

The resulting pv damage from Erosion has then be transferred to the DNE Sheet, where the loss can be adjusted for the increasing probability with time. A probability of initial failure of 0.8 has been used. This is a subjective probability built on engineering judgement, from this value an order of magnitude can be used for options (with 'schemes').

Option 2, Costs and damages

In the do minimum + works option, it is proposed to carry out slope stabilisation work throughout the strategy duration. Costs have been worked out based on the full scheme (described in Option 3) phased over 60 years. An allowance for emergency works has been made of £100k/10 years. The pv cost for this option is £1,143k.

The probability of initial failure has been reduced to 0.5, but the overall probability that a failure will occur during the strategy is considered likely. Therefore, there has been no decrease in probability following one set of construction works. However, the pv damage is much smaller sum, calculated as the costs associated with small scale failure prior to expansion.

Option 3, Costs and damages

Costs are estimated on a full scheme being implemented by Year 2 + work at Scalby Sands pinchpoint in Years 2, 20 and 40. The pv costs (including monitoring and maintenance) are £2,415.75k for this option.

The probability of initial failure has been reduced to 0.01 as the works are to be undertaken prior to a major landslide event. The construction is to have an expected life of 60 years.

Costings of additional/ further works will be required during the strategy life have been estimated at £250k per event.

Option 4, Costs and damages

Option 4 involves partial slope stabilisation and cliff top works in Year 2. The pv costs are £1,769.4k.

The probability of failure is 0.01 as the works are to be undertaken prior to a major landslide event. The life expectancy of the construction works is 60 years. Costings of additional/ further works will be required during the strategy life have been estimated at £250k per event.

SPREADSHEETS FOR PREFERRED STRATEGY
YEAR 2
(LOSS OF REVENUE TO SEA LIFE CENTRE AND SCALBY CAR PARK)

Project Summary Sheet

Client/Authority		Prepared (date)	20 02 03
SBC		Printed	14/05/03
Project name		Prepared by	dgc
Scalby Ness Strategy - **Preferred Strategy with SLC & CP losses**		Checked by	
Project reference	1404	Checked date	
Base date for estimates (year 0)	Dec 01		
Scaling factor (e.g. £m, £k, £)	£k	(used for all costs, losses and benefits)	
Principle land use band	B	(A to E)	
Discount rate	6%		

Costs and benefits of options

	Costs and benefits £k				
	No Project	Option 2	Option 3	Option 4	
PV costs PVc	0.00	1,143.04	2,415.75	1,769.44	
PV damage PVd	6,871.65	6,169.54	74.46	74.46	
PV damage avoided		702.11	6,797.19	6,797.19	
PV assets Pva					
PV asset protection benefits		0.00	0.00	0.00	
Total PV benefits PVb		702.11	6,797.19	6,797.19	
Net Present Value NPV		-440.92	4,381.44	5,027.74	
Average benefit/cost ratio		0.6	2.8	3.84	
Incremental benefit/cost ratio			4.79	0.00	
		-	-	Highest b/c	

Brief description of options:

Option 1	Do nothing
Option 2	Do Minimum - Phased Work Short to Long Term
Option 3	Do Something - Full Scheme
Option 4	Do Something - Partial Scheme + Maintenance

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting
2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
   PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
   PV benefits calculated as PV damage avoided + PV asset protection benefits
3) Incremental benefit/cost ratio is calculated as:
   (PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Damage Cost Calculation Sheet - Do Nothing (Exponential)

Sheet Nr. 2

Client/Authority
SBC
Project name
Scalby Ness Strategy - Preferred Strategy with S
Option:
Do nothing
Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%
Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date
PV breach/failure £k 6951.08
Remaining structure life 2
Ave Annual Damage (overtopping) £k 0.00 /yr
Initial probability of failure 0.800
Calculations assum 0.99 **prob of failure in year 2**
Calculated factors: -0.01005 -0.30743
PV Total Damage £k 6871.65 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	has not occurred	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.800	0.800	0.200	5560.87	0.00		5560.87
1	0.943	0.990	0.198	0.002	1298.41	0.00		1298.41
2	0.890	1.000	0.002	0.000	12.37	0.00		12.37
3	0.840	1.000	0.000	0.000	0.00	0.00		0.00
4	0.792	1.000	0.000	0.000	0.00	0.00		0.00
5	0.747	1.000	0.000	0.000	0.00	0.00		0.00
6	0.705	1.000	0.000	0.000	0.00	0.00		0.00
7	0.665	1.000	0.000	0.000	0.00	0.00		0.00
8	0.627	1.000	0.000	0.000	0.00	0.00		0.00
9	0.592	1.000	0.000	0.000	0.00	0.00		0.00
10	0.558	1.000	0.000	0.000	0.00	0.00		0.00
11	0.527	1.000	0.000	0.000	0.00	0.00		0.00
12	0.497	1.000	0.000	0.000	0.00	0.00		0.00
13	0.469	1.000	0.000	0.000	0.00	0.00		0.00
14	0.442	1.000	0.000	0.000	0.00	0.00		0.00
15	0.417	1.000	0.000	0.000	0.00	0.00		0.00
16	0.394	1.000	0.000	0.000	0.00	0.00		0.00
17	0.371	1.000	0.000	0.000	0.00	0.00		0.00
18	0.350	1.000	0.000	0.000	0.00	0.00		0.00
19	0.331	1.000	0.000	0.000	0.00	0.00		0.00
20	0.312	1.000	0.000	0.000	0.00	0.00		0.00
21	0.294	1.000	0.000	0.000	0.00	0.00		0.00
22	0.278	1.000	0.000	0.000	0.00	0.00		0.00
23	0.262	1.000	0.000	0.000	0.00	0.00		0.00
24	0.247	1.000	0.000	0.000	0.00	0.00		0.00
25	0.233	1.000	0.000	0.000	0.00	0.00		0.00
26	0.220	1.000	0.000	0.000	0.00	0.00		0.00
27	0.207	1.000	0.000	0.000	0.00	0.00		0.00
28	0.196	1.000	0.000	0.000	0.00	0.00		0.00
29	0.185	1.000	0.000	0.000	0.00	0.00		0.00
30	0.174	1.000	0.000	0.000	0.00	0.00		0.00
31	0.164	1.000	0.000	0.000	0.00	0.00		0.00
32	0.155	1.000	0.000	0.000	0.00	0.00		0.00
33	0.146	1.000	0.000	0.000	0.00	0.00		0.00
34	0.138	1.000	0.000	0.000	0.00	0.00		0.00
35	0.130	1.000	0.000	0.000	0.00	0.00		0.00
36	0.123	1.000	0.000	0.000	0.00	0.00		0.00
37	0.116	1.000	0.000	0.000	0.00	0.00		0.00
38	0.109	1.000	0.000	0.000	0.00	0.00		0.00
39	0.103	1.000	0.000	0.000	0.00	0.00		0.00
40	0.097	1.000	0.000	0.000	0.00	0.00		0.00
41	0.092	1.000	0.000	0.000	0.00	0.00		0.00
42	0.087	1.000	0.000	0.000	0.00	0.00		0.00
43	0.082	1.000	0.000	0.000	0.00	0.00		0.00
44	0.077	1.000	0.000	0.000	0.00	0.00		0.00
45	0.073	1.000	0.000	0.000	0.00	0.00		0.00
46	0.069	1.000	0.000	0.000	0.00	0.00		0.00
47	0.065	1.000	0.000	0.000	0.00	0.00		0.00
48	0.061	1.000	0.000	0.000	0.00	0.00		0.00
49	0.058	1.000	0.000	0.000	0.00	0.00		0.00
50	0.054	1.000	0.000	0.000	0.00	0.00		0.00
51	0.051	1.000	0.000	0.000	0.00	0.00		0.00
52	0.048	1.000	0.000	0.000	0.00	0.00		0.00
53	0.046	1.000	0.000	0.000	0.00	0.00		0.00
54	0.043	1.000	0.000	0.000	0.00	0.00		0.00
55	0.041	1.000	0.000	0.000	0.00	0.00		0.00
56	0.038	1.000	0.000	0.000	0.00	0.00		0.00
57	0.036	1.000	0.000	0.000	0.00	0.00		0.00
58	0.034	1.000	0.000	0.000	0.00	0.00		0.00
59	0.032	1.000	0.000	0.000	0.00	0.00		0.00
Totals					6871.65	0.00		6871.65

Notes

Complete one spreadsheet for the 'do nothing' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
It is assumed that breaches are not repaired and that once breach damage has occurred it will not recur.
A separate check should be made to ensure that overtopping damages do not exceed write off values.
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 3

Client/Authority
SBC

Project name
Scalby Ness Strategy - Preferred Strategy with SLC &

Option:
Do Minimum - Phased Work Short to Long Term

Project reference	1404				
Base date for estimates (year 0)	Dec 01				
Scaling factor (e.g. £m, £k, £)	£k			Prepared (date)	
Discount rate	6%			Printed	14/05/03
		PV breach/failure	£k 675.80	Prepared by	dgc
Remaining structure life	60	**Ave Annual Damage**		Checked by	
Initial probability of failure	0.500	**(overtopping)**	£k ______ /yr	Checked date	
Calculations assume	**0.99** prob of failure in year 60				
Calculated factors:	-0.01005 -0.16684	**PV Total Damage**	£k 6169.54 (calculated below)		

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.500	0.500	0.500	337.90	0.00		337.90
1	0.943	0.501	0.501	0.499	319.67	0.00		319.67
2	0.890	0.503	0.503	0.497	302.44	0.00		302.44
3	0.840	0.504	0.504	0.496	286.15	0.00		286.15
4	0.792	0.506	0.506	0.494	270.75	0.00		270.75
5	0.747	0.507	0.507	0.493	256.19	0.00		256.19
6	0.705	0.509	0.509	0.491	242.43	0.00		242.43
7	0.665	0.510	0.510	0.490	229.42	0.00		229.42
8	0.627	0.512	0.512	0.488	217.12	0.00		217.12
9	0.592	0.514	0.514	0.486	205.50	0.00		205.50
10	0.558	0.515	0.515	0.485	194.51	0.00		194.51
11	0.527	0.517	0.517	0.483	184.12	0.00		184.12
12	0.497	0.519	0.519	0.481	174.30	0.00		174.30
13	0.469	0.521	0.521	0.479	165.01	0.00		165.01
14	0.442	0.523	0.523	0.477	156.23	0.00		156.23
15	0.417	0.525	0.525	0.475	147.93	0.00		147.93
16	0.394	0.527	0.527	0.473	140.08	0.00		140.08
17	0.371	0.529	0.529	0.471	132.66	0.00		132.66
18	0.350	0.531	0.531	0.469	125.64	0.00		125.64
19	0.331	0.533	0.533	0.467	119.01	0.00		119.01
20	0.312	0.535	0.535	0.465	112.73	0.00		112.73
21	0.294	0.537	0.537	0.463	106.80	0.00		106.80
22	0.278	0.540	0.540	0.460	101.19	0.00		101.19
23	0.262	0.542	0.542	0.458	95.89	0.00		95.89
24	0.247	0.544	0.544	0.456	90.88	0.00		90.88
25	0.233	0.547	0.547	0.453	86.14	0.00		86.14
26	0.220	0.550	0.550	0.450	81.66	0.00		81.66
27	0.207	0.552	0.552	0.448	77.42	0.00		77.42
28	0.196	0.555	0.555	0.445	73.41	0.00		73.41
29	0.185	0.558	0.558	0.442	69.63	0.00		69.63
30	0.174	0.561	0.561	0.439	66.04	0.00		66.04
31	0.164	0.564	0.564	0.436	62.66	0.00		62.66
32	0.155	0.568	0.568	0.432	59.46	0.00		59.46
33	0.146	0.571	0.571	0.429	56.44	0.00		56.44
34	0.138	0.575	0.575	0.425	53.58	0.00		53.58
35	0.130	0.579	0.579	0.421	50.88	0.00		50.88
36	0.123	0.583	0.583	0.417	48.32	0.00		48.32
37	0.116	0.587	0.587	0.413	45.91	0.00		45.91
38	0.109	0.591	0.591	0.409	43.64	0.00		43.64
39	0.103	0.596	0.596	0.404	41.49	0.00		41.49
40	0.097	0.601	0.601	0.399	39.46	0.00		39.46
41	0.092	0.606	0.606	0.394	37.55	0.00		37.55
42	0.087	0.611	0.611	0.389	35.74	0.00		35.74
43	0.082	0.617	0.617	0.383	34.04	0.00		34.04
44	0.077	0.623	0.623	0.377	32.44	0.00		32.44
45	0.073	0.630	0.630	0.370	30.94	0.00		30.94
46	0.069	0.637	0.637	0.363	29.52	0.00		29.52
47	0.065	0.645	0.645	0.355	28.20	0.00		28.20
48	0.061	0.654	0.654	0.346	26.96	0.00		26.96
49	0.058	0.664	0.664	0.336	25.81	0.00		25.81
50	0.054	0.674	0.674	0.326	24.74	0.00		24.74
51	0.051	0.686	0.686	0.314	23.75	0.00		23.75
52	0.048	0.700	0.700	0.300	22.85	0.00		22.85
53	0.046	0.716	0.716	0.284	22.04	0.00		22.04
54	0.043	0.734	0.734	0.266	21.34	0.00		21.34
55	0.041	0.757	0.757	0.243	20.75	0.00		20.75
56	0.038	0.786	0.786	0.214	20.32	0.00		20.32
57	0.036	0.824	0.824	0.176	20.11	0.00		20.11
58	0.034	0.882	0.882	0.118	20.30	0.00		20.30
59	0.032	0.990	0.990	0.010	21.50	0.00		21.50
Totals					6169.54	0.00		6169.54

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 4

Client/Authority
SBC
Project name
Scalby Ness Strategy - Preferred Strategy with SLC &
Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Option:
Do Something - Full Scheme

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 210.72
Ave Annual Damage (overtopping) £k 0.00 /yr

Remaining structure life 60
Initial probability of failure 0.010
Calculations assume 0.99 prob of failure in year 60
Calculated factors: -0.01005 -1.12231

PV Total Damage £k 74.46 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	Prob that breach/failure: does not occur	PV damage due to: breach or failure	PV damage due to: over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	2.11	0.00		2.11
1	0.943	0.010	0.010	0.990	2.03	0.00		2.03
2	0.890	0.010	0.010	0.990	1.95	0.00		1.95
3	0.840	0.011	0.011	0.989	1.87	0.00		1.87
4	0.792	0.011	0.011	0.989	1.80	0.00		1.80
5	0.747	0.011	0.011	0.989	1.74	0.00		1.74
6	0.705	0.011	0.011	0.989	1.67	0.00		1.67
7	0.665	0.011	0.011	0.989	1.61	0.00		1.61
8	0.627	0.012	0.012	0.988	1.55	0.00		1.55
9	0.592	0.012	0.012	0.988	1.50	0.00		1.50
10	0.558	0.012	0.012	0.988	1.44	0.00		1.44
11	0.527	0.013	0.013	0.987	1.39	0.00		1.39
12	0.497	0.013	0.013	0.987	1.35	0.00		1.35
13	0.469	0.013	0.013	0.987	1.30	0.00		1.30
14	0.442	0.013	0.013	0.987	1.26	0.00		1.26
15	0.417	0.014	0.014	0.986	1.21	0.00		1.21
16	0.394	0.014	0.014	0.986	1.17	0.00		1.17
17	0.371	0.015	0.015	0.985	1.14	0.00		1.14
18	0.350	0.015	0.015	0.985	1.10	0.00		1.10
19	0.331	0.015	0.015	0.985	1.07	0.00		1.07
20	0.312	0.016	0.016	0.984	1.04	0.00		1.04
21	0.294	0.016	0.016	0.984	1.01	0.00		1.01
22	0.278	0.017	0.017	0.983	0.98	0.00		0.98
23	0.262	0.017	0.017	0.983	0.95	0.00		0.95
24	0.247	0.018	0.018	0.982	0.92	0.00		0.92
25	0.233	0.018	0.018	0.982	0.90	0.00		0.90
26	0.220	0.019	0.019	0.981	0.88	0.00		0.88
27	0.207	0.020	0.020	0.980	0.85	0.00		0.85
28	0.196	0.020	0.020	0.980	0.83	0.00		0.83
29	0.185	0.021	0.021	0.979	0.82	0.00		0.82
30	0.174	0.022	0.022	0.978	0.80	0.00		0.80
31	0.164	0.023	0.023	0.977	0.78	0.00		0.78
32	0.155	0.024	0.024	0.976	0.77	0.00		0.77
33	0.146	0.025	0.025	0.975	0.75	0.00		0.75
34	0.138	0.026	0.026	0.974	0.74	0.00		0.74
35	0.130	0.027	0.027	0.973	0.73	0.00		0.73
36	0.123	0.028	0.028	0.972	0.72	0.00		0.72
37	0.116	0.029	0.029	0.971	0.72	0.00		0.72
38	0.109	0.031	0.031	0.969	0.71	0.00		0.71
39	0.103	0.032	0.032	0.968	0.71	0.00		0.71
40	0.097	0.034	0.034	0.966	0.70	0.00		0.70
41	0.092	0.036	0.036	0.964	0.70	0.00		0.70
42	0.087	0.039	0.039	0.961	0.70	0.00		0.70
43	0.082	0.041	0.041	0.959	0.71	0.00		0.71
44	0.077	0.044	0.044	0.956	0.72	0.00		0.72
45	0.073	0.047	0.047	0.953	0.73	0.00		0.73
46	0.069	0.051	0.051	0.949	0.74	0.00		0.74
47	0.065	0.056	0.056	0.944	0.76	0.00		0.76
48	0.061	0.061	0.061	0.939	0.78	0.00		0.78
49	0.058	0.067	0.067	0.933	0.81	0.00		0.81
50	0.054	0.075	0.075	0.925	0.85	0.00		0.85
51	0.051	0.084	0.084	0.916	0.91	0.00		0.91
52	0.048	0.096	0.096	0.904	0.98	0.00		0.98
53	0.046	0.111	0.111	0.889	1.07	0.00		1.07
54	0.043	0.133	0.133	0.867	1.20	0.00		1.20
55	0.041	0.163	0.163	0.837	1.39	0.00		1.39
56	0.038	0.209	0.209	0.791	1.68	0.00		1.68
57	0.036	0.289	0.289	0.711	2.19	0.00		2.19
58	0.034	0.455	0.455	0.545	3.26	0.00		3.26
59	0.032	0.990	0.990	0.010	6.70	0.00		6.70
Totals					74.46	0.00		74.46

Notes
Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 5

Client/Authority
SBC

Project name
Scalby Ness Strategy - Preferred Strategy with SLC &

Option:
Do Something - Partial Scheme + Maintenance

Project reference	1,404.00				
Base date for estimates (year 0)	Dec 01				
Scaling factor (e.g. £m, £k, £)	£k			Prepared (date)	
Discount rate	6%			Printed	14/05/03
		PV breach/failure £k	210.72	Prepared by	dgc
Remaining structure life	60	**Ave Annual Damage**		Checked by	
Initial probability of failure	0.010	**(overtopping) £k**	0.00 /yr	Checked date	
Calculations assume 0.99	prob of failure in year 60				
Calculated factors: -0.01005	-1.12231	**PV Total Damage £k**	74.46 (calculated below)		

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	2.11	0.00		2.11
1	0.943	0.010	0.010	0.990	2.03	0.00		2.03
2	0.890	0.010	0.010	0.990	1.95	0.00		1.95
3	0.840	0.011	0.011	0.989	1.87	0.00		1.87
4	0.792	0.011	0.011	0.989	1.80	0.00		1.80
5	0.747	0.011	0.011	0.989	1.74	0.00		1.74
6	0.705	0.011	0.011	0.989	1.67	0.00		1.67
7	0.665	0.011	0.011	0.989	1.61	0.00		1.61
8	0.627	0.012	0.012	0.988	1.55	0.00		1.55
9	0.592	0.012	0.012	0.988	1.50	0.00		1.50
10	0.558	0.012	0.012	0.988	1.44	0.00		1.44
11	0.527	0.013	0.013	0.987	1.39	0.00		1.39
12	0.497	0.013	0.013	0.987	1.35	0.00		1.35
13	0.469	0.013	0.013	0.987	1.30	0.00		1.30
14	0.442	0.013	0.013	0.987	1.26	0.00		1.26
15	0.417	0.014	0.014	0.986	1.21	0.00		1.21
16	0.394	0.014	0.014	0.986	1.17	0.00		1.17
17	0.371	0.015	0.015	0.985	1.14	0.00		1.14
18	0.350	0.015	0.015	0.985	1.10	0.00		1.10
19	0.331	0.015	0.015	0.985	1.07	0.00		1.07
20	0.312	0.016	0.016	0.984	1.04	0.00		1.04
21	0.294	0.016	0.016	0.984	1.01	0.00		1.01
22	0.278	0.017	0.017	0.983	0.98	0.00		0.98
23	0.262	0.017	0.017	0.983	0.95	0.00		0.95
24	0.247	0.018	0.018	0.982	0.92	0.00		0.92
25	0.233	0.018	0.018	0.982	0.90	0.00		0.90
26	0.220	0.019	0.019	0.981	0.88	0.00		0.88
27	0.207	0.020	0.020	0.980	0.85	0.00		0.85
28	0.196	0.020	0.020	0.980	0.83	0.00		0.83
29	0.185	0.021	0.021	0.979	0.82	0.00		0.82
30	0.174	0.022	0.022	0.978	0.80	0.00		0.80
31	0.164	0.023	0.023	0.977	0.78	0.00		0.78
32	0.155	0.024	0.024	0.976	0.77	0.00		0.77
33	0.146	0.025	0.025	0.975	0.75	0.00		0.75
34	0.138	0.026	0.026	0.974	0.74	0.00		0.74
35	0.130	0.027	0.027	0.973	0.73	0.00		0.73
36	0.123	0.028	0.028	0.972	0.72	0.00		0.72
37	0.116	0.029	0.029	0.971	0.72	0.00		0.72
38	0.109	0.031	0.031	0.969	0.71	0.00		0.71
39	0.103	0.032	0.032	0.968	0.71	0.00		0.71
40	0.097	0.034	0.034	0.966	0.70	0.00		0.70
41	0.092	0.036	0.036	0.964	0.70	0.00		0.70
42	0.087	0.039	0.039	0.961	0.70	0.00		0.70
43	0.082	0.041	0.041	0.959	0.71	0.00		0.71
44	0.077	0.044	0.044	0.956	0.72	0.00		0.72
45	0.073	0.047	0.047	0.953	0.73	0.00		0.73
46	0.069	0.051	0.051	0.949	0.74	0.00		0.74
47	0.065	0.056	0.056	0.944	0.76	0.00		0.76
48	0.061	0.061	0.061	0.939	0.78	0.00		0.78
49	0.058	0.067	0.067	0.933	0.81	0.00		0.81
50	0.054	0.075	0.075	0.925	0.85	0.00		0.85
51	0.051	0.084	0.084	0.916	0.91	0.00		0.91
52	0.048	0.096	0.096	0.904	0.98	0.00		0.98
53	0.046	0.111	0.111	0.889	1.07	0.00		1.07
54	0.043	0.133	0.133	0.867	1.20	0.00		1.20
55	0.041	0.163	0.163	0.837	1.39	0.00		1.39
56	0.038	0.209	0.209	0.791	1.68	0.00		1.68
57	0.036	0.289	0.289	0.711	2.19	0.00		2.19
58	0.034	0.455	0.455	0.545	3.26	0.00		3.26
59	0.032	0.990	0.990	0.010	6.70	0.00		6.70
Totals					74.46	0.00		74.46

Notes
Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Erosion Value Calculation Sheet with delay options

Sheet Nr. 6

Client/Authority
SBC

Project name		**Option:**	**Delay (yrs)**	Prepared (date)	
Scalby Ness Strategy - Preferred Strategy with SLC		Do Minimum - Phased Work S	40	Printed	14/05/03
Project reference	1,404.00	Do Something - Full Scheme	60	Prepared by	dgc
Base date for estimates (year 0)	Dec 01	Do Something - Partial Schem	60	Checked by	
Scaling factor (e.g. £m, £k, £)	£k			Checked date	
Discount rate	6%				

Ref	Asset Description	MV £k	Year	Prob of loss without project in year	Expected value of asset losses £k: Without Project	Do Minimum - Phased Work Short to Long Term	Do Something - Full Scheme	Do Something - Partial Scheme + Maintenance	
0	Property Yr 2	3571.00	1	0.03	101.07	9.83	3.06	3.06	
0	Property Yr 2	3571.00	2	0.95	3,019.27	293.54	91.53	91.53	
0	Property Yr 2	3571.00	3	0.02	59.97	5.83	1.82	1.82	
1	Scalby CP+ Sea Life Cen 0yr	396.28	1	0.05	18.69	1.82	0.57	0.57	
2	YW WWTW	320	2	0.95	270.56	26.30	8.20	8.20	
3	YW WWTW	320	1	0.05	15.09	1.47	0.46	0.46	
4	Scalby CP+ Sea Life Cen 1yr	396.28	2	0.95	335.05	32.57	10.16	10.16	
5	Scalby CP+ Sea Life Cen 2yr	396.28	3	1	332.72	32.35	10.09	10.09	
6	Scalby CP+ Sea Life Cen 3yr	396.28	4	1	313.89	30.52	9.52	9.52	
7	Scalby CP+ Sea Life Cen 4yr	396.28	5	1	296.12	28.79	8.98	8.98	
8	Scalby CP+ Sea Life Cen 5yr	396.28	6	1	279.36	27.16	8.47	8.47	
9	Scalby CP+ Sea Life Cen 6yr	396.28	7	1	263.55	25.62	7.99	7.99	
10	Scalby CP+ Sea Life Cen 7yr	396.28	8	1	248.63	24.17	7.54	7.54	
11	Scalby CP+ Sea Life Cen 8yr	396.28	9	1	234.56	22.80	7.11	7.11	
12	Scalby CP+ Sea Life Cen 9yr	396.28	10	1	221.28	21.51	6.71	6.71	
12	Scalby CP+ Sea Life Cen 10yr	396.28	11	1	208.76	20.30	6.33	6.33	
12	Property Yr 5	302.00	4	0.15	35.88	3.49	1.09	1.09	
13	Property Yr 5	302.00	5	0.75	169.25	16.46	5.13	5.13	
14	Property Yr 5	302.00	6	0.1	21.29	2.07	0.65	0.65	
15	Property Yr 15	402.00	10	0.15	33.67	3.27	1.02	1.02	
16	Property Yr 15	402.00	15	0.75	125.81	12.23	3.81	3.81	
17	Property Yr 15	402.00	20	0.1	12.53	1.22	0.38	0.38	
18	Property Yr 30	255.00	25	0.25	14.85	1.44	0.45	0.45	
19	Property Yr 30	255.00	30	0.5	22.20	2.16	0.67	0.67	
20	Property Yr 30	255.00	35	0.25	8.29	0.81	0.25	0.25	
21	Property Yr 45	673.00	40	0.25	16.36	1.59	0.50	0.50	
22	Property Yr 45	673.00	45	0.5	24.45	2.38	0.74	0.74	
23	Property Yr 45	673.00	50	0.25	9.13	0.89	0.28	0.28	
24	Property Yr 60	657.00	60	0.25	4.98	0.48	0.15	0.15	
25	Property Yr 60	657.00	65	0.75	11.16	1.09	0.34	0.34	
26	H&S Works following failure	250.00	1	0.03	7.08	0.69	0.21	0.21	
27	H&S Works following failure	250.00	2	0.95	211.37	20.55	6.41	6.41	
28	H&S Works following failure	250.00	3	0.02	4.20	0.41	0.13	0.13	
29					-	-	-	-	
30					-	-	-	-	
31					-	-	-	-	
32					-	-	-	-	
33	[For property losses see Tables 4.6 A & B]				-	-	-	-	
34					-	-	-	-	
35					-	-	-	-	
36					-	-	-	-	
37					-	-	-	-	
38					-	-	-	-	
39					-	-	-	-	
40					-	-	-	-	
41					-	-	-	-	
42					-	-	-	-	
43					-	-	-	-	
44					-	-	-	-	
45					-	-	-	-	
46					-	-	-	-	
47					-	-	-	-	
48					-	-	-	-	
49					-	-	-	-	
50					-	-	-	-	
51					-	-	-	-	
52					-	-	-	-	
53					-	-	-	-	
54					-	-	-	-	
55					-	-	-	-	
56					-	-	-	-	
57					-	-	-	-	
58					-	-	-	-	
59					-	-	-	-	
Totals		22672.08			6951.08	675.80	210.72	210.72	

Notes
Make one entry in the description column for each property (or group of properties) as this determines subsequent calculation
MV = risk free market value at base date for estimate - must be entered on each line when probaility distribution is used
Equivalent annual value = MV x discount rate (assumes infinite life)
Year is year by which there is the cumulative probability of loss shown
If no distribution is used enter year after expected year of loss and enter 1.0 in probability column
(i.e. certainty of loss before start of year so year must be 1.0 or greater)
(e.g. If certain of loss in year 5 enter 6 in year column and 1 in probability column)
Asset value in first year for each property (or group) shown is cumulative to the year of first loss
Asset value in subsequent years for each property is additional value for that property if life extended

Present Value Costs for all options

Client/Authority
SBC
Project name
Scalby Ness Strategy - Preferred Strategy wi
Project reference 1,404.00
Base date for estimates (year 0 Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Results £k

	Option 1	Option 2	Option 3	Option 4
	(Do nothing)	Do Minimum - Phased W	Do Something - Full Sch	Do Something - Partial S
PV total costs	0.00	1143.04	2415.75	1769.44

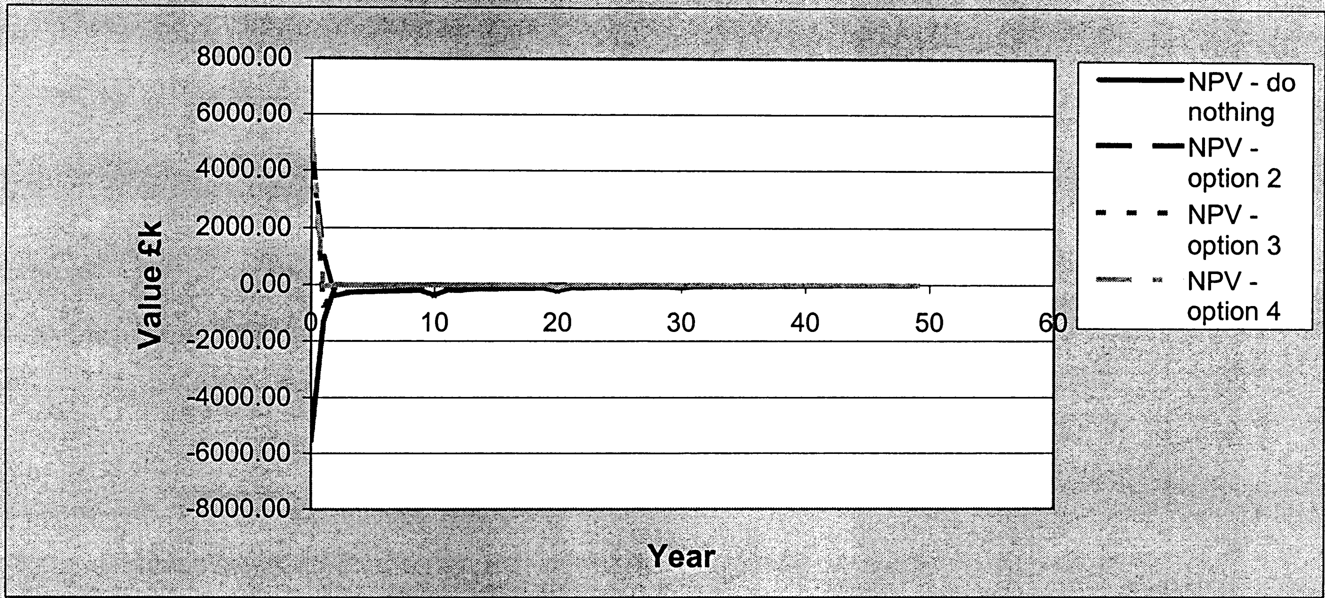
Sheet Nr. 7

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

		Option 1 (Do nothing)			TOTALS:		Option 2 Do Minimum - Phased W			TOTALS:		Option 3 Do Something - Full Sche			TOTALS:		Option 4 Do Something - Partial S			TOTALS:	
		Capital	Maint.	Other	Cash	PV	Mon	Works	Emergency	Cash	PV	Capital	Main	All Mon	Cash	PV	Capital	Maint.	All Mon	Cash	PV
	cash sum	0	0	0	0.00	0.00	180	2556	600	3336.00	1143.04	3056	61	180	3297.00	2415.75	2338	240	180	2758.00	1769.44
year	Discount Factor																				
0	1.000				0.00	0.00	3	408		411.00	411.00	100	2	3	105.00	105.00	100	2	3	105.00	105.00
1	0.943				0.00	0.00	3			3.00	2.83	2156	1	3	2160.00	2037.74	1438	2	3	1443.00	1361.32
2	0.890				0.00	0.00	3	40	100	143.00	127.27	40	1	3	44.00	39.16	40	2	3	45.00	40.05
3	0.840				0.00	0.00	3			3.00	2.52		1	3	4.00	3.36		2	3	5.00	4.20
4	0.792				0.00	0.00	3			3.00	2.38		1	3	4.00	3.17		2	3	5.00	3.96
5	0.747				0.00	0.00	3			3.00	2.24		1	3	4.00	2.99		2	3	5.00	3.74
6	0.705				0.00	0.00	3			3.00	2.11		1	3	4.00	2.82		2	3	5.00	3.52
7	0.665				0.00	0.00	3			3.00	2.00		1	3	4.00	2.66		2	3	5.00	3.33
8	0.627				0.00	0.00	3			3.00	1.88		1	3	4.00	2.51		2	3	5.00	3.14
9	0.592				0.00	0.00	3			3.00	1.78		1	3	4.00	2.37		2	3	5.00	2.96
10	0.558				0.00	0.00	3	368		371.00	207.16	60	1	3	64.00	35.74	60	2	3	65.00	36.30
11	0.527				0.00	0.00	3			3.00	1.58		1	3	4.00	2.11		2	3	5.00	2.63
12	0.497				0.00	0.00	3		100	103.00	51.19		1	3	4.00	1.99		2	3	5.00	2.48
13	0.469				0.00	0.00	3			3.00	1.41		1	3	4.00	1.88		2	3	5.00	2.34
14	0.442				0.00	0.00	3			3.00	1.33		1	3	4.00	1.77		2	3	5.00	2.21
15	0.417				0.00	0.00	3			3.00	1.25		1	3	4.00	1.67		2	3	5.00	2.09
16	0.394				0.00	0.00	3			3.00	1.18		1	3	4.00	1.57		2	3	5.00	1.97
17	0.371				0.00	0.00	3			3.00	1.11		1	3	4.00	1.49		2	3	5.00	1.86
18	0.350				0.00	0.00	3			3.00	1.05		1	3	4.00	1.40		2	3	5.00	1.75
19	0.331				0.00	0.00	3			3.00	0.99		1	3	4.00	1.32		2	3	5.00	1.65
20	0.312				0.00	0.00	3	408		411.00	128.15	350	1	3	354.00	110.38	350	5	3	358.00	111.63
21	0.294				0.00	0.00	3			3.00	0.88		1	3	4.00	1.18		5	3	8.00	2.35
22	0.278				0.00	0.00	3		100	103.00	28.58		1	3	4.00	1.11		5	3	8.00	2.22
23	0.262				0.00	0.00	3			3.00	0.79		1	3	4.00	1.05		5	3	8.00	2.09
24	0.247				0.00	0.00	3			3.00	0.74		1	3	4.00	0.99		5	3	8.00	1.98
25	0.233				0.00	0.00	3			3.00	0.70		1	3	4.00	0.93		5	3	8.00	1.86
26	0.220				0.00	0.00	3			3.00	0.66		1	3	4.00	0.88		5	3	8.00	1.76
27	0.207				0.00	0.00	3			3.00	0.62		1	3	4.00	0.83		5	3	8.00	1.66
28	0.196				0.00	0.00	3			3.00	0.59		1	3	4.00	0.78		5	3	8.00	1.57
29	0.185				0.00	0.00	3			3.00	0.55		1	3	4.00	0.74		5	3	8.00	1.48
30	0.174				0.00	0.00	3	308		311.00	54.15		1	3	4.00	0.70		5	3	8.00	1.39
31	0.164				0.00	0.00	3			3.00	0.49		1	3	4.00	0.66		5	3	8.00	1.31
32	0.155				0.00	0.00	3		100	103.00	15.96		1	3	4.00	0.62		5	3	8.00	1.24
33	0.146				0.00	0.00	3			3.00	0.44		1	3	4.00	0.58		5	3	8.00	1.17
34	0.138				0.00	0.00	3			3.00	0.41		1	3	4.00	0.55		5	3	8.00	1.10
35	0.130				0.00	0.00	3			3.00	0.39		1	3	4.00	0.52		5	3	8.00	1.04
36	0.123				0.00	0.00	3			3.00	0.37		1	3	4.00	0.49		5	3	8.00	0.98
37	0.116				0.00	0.00	3			3.00	0.35		1	3	4.00	0.46		5	3	8.00	0.93
38	0.109				0.00	0.00	3			3.00	0.33		1	3	4.00	0.44		5	3	8.00	0.87
39	0.103				0.00	0.00	3			3.00	0.31		1	3	4.00	0.41		5	3	8.00	0.82
40	0.097				0.00	0.00	3	408		411.00	39.96	350	1	3	354.00	34.42	350	5	3	358.00	34.81
41	0.092				0.00	0.00	3			3.00	0.28		1	3	4.00	0.37		5	3	8.00	0.73
42	0.087				0.00	0.00	3		100	103.00	8.91		1	3	4.00	0.35		5	3	8.00	0.69
43	0.082				0.00	0.00	3			3.00	0.24		1	3	4.00	0.33		5	3	8.00	0.65
44	0.077				0.00	0.00	3			3.00	0.23		1	3	4.00	0.31		5	3	8.00	0.62
45	0.073				0.00	0.00	3			3.00	0.22		1	3	4.00	0.29		5	3	8.00	0.58
46	0.069				0.00	0.00	3			3.00	0.21		1	3	4.00	0.27		5	3	8.00	0.55
47	0.065				0.00	0.00	3			3.00	0.19		1	3	4.00	0.26		5	3	8.00	0.52
48	0.061				0.00	0.00	3			3.00	0.18		1	3	4.00	0.24		5	3	8.00	0.49
49	0.058				0.00	0.00	3			3.00	0.17		1	3	4.00	0.23		5	3	8.00	0.46
50	0.054				0.00	0.00	3	308		311.00	16.88		1	3	4.00	0.22		5	3	8.00	0.43
51	0.051				0.00	0.00	3			3.00	0.15		1	3	4.00	0.20		5	3	8.00	0.41
52	0.048				0.00	0.00	3		100	103.00	4.98		1	3	4.00	0.19		5	3	8.00	0.39
53	0.046				0.00	0.00	3			3.00	0.14		1	3	4.00	0.18		5	3	8.00	0.36
54	0.043				0.00	0.00	3			3.00	0.13		1	3	4.00	0.17		5	3	8.00	0.34
55	0.041				0.00	0.00	3			3.00	0.12		1	3	4.00	0.16		5	3	8.00	0.32
56	0.038				0.00	0.00	3			3.00	0.11		1	3	4.00	0.15		5	3	8.00	0.31
57	0.036				0.00	0.00	3			3.00	0.11		1	3	4.00	0.14		5	3	8.00	0.29
58	0.034				0.00	0.00	3			3.00	0.10		1	3	4.00	0.14		5	3	8.00	0.27
59	0.032				0.00	0.00	3	308		311.00	9.99		1	3	4.00	0.13		5	3	8.00	0.26

Net Present Value over time

Client/Authority		**Sheet Nr.**	8
SBC		Prepared (date)	16/09/99
Project name		Printed	14/05/03
Scalby Ness Strategy - Preferred Strategy wit		Prepared by	DR
Project reference	1,404.00	Checked by	GS
Base date for estimates (year 0)	Dec 01	Checked date	16/10/99
Scaling factor (e.g. £m, £k, £)	£k		
Discount rate	6%		



SPREADSHEETS FOR PREFERRED STRATEGY
YEAR 2
(RELOCATION OF SCALBY CAR PARK)

Project Summary Sheet

Client/Authority
SBC
Project name
Scalby Ness Strategy - Preferred Strategy with New Car Park

Prepared (date)	14 8 02	
Printed	14/05/03	
Prepared by	dgc	
Checked by		
Checked date		

Project reference	1404	
Base date for estimates (year 0)	Dec 01	
Scaling factor (e.g. £m, £k, £)	£k	(used for all costs, losses and benefits)
Principle land use band	B	(A to E)
Discount rate	6%	

Costs and benefits of options

	Costs and benefits £k				
	No Project	Option 2	Option 3	Option 4	
PV costs PVc	0.00	1,143.04	2,415.75	1,769.44	
PV damage PVd	5,481.25	4,921.20	59.40	59.40	
PV damage avoided		560.05	5,421.85	5,421.85	
PV assets Pva					
PV asset protection benefits		0.00	0.00	0.00	
Total PV benefits PVb		560.05	5,421.85	5,421.85	
Net Present Value NPV		-582.99	3,006.10	3,652.41	
Average benefit/cost ratio		0.5	2.2	3.06	
Incremental benefit/cost ratio			3.82	0.00	
		-	-	Highest b/c	

Brief description of options:

Option 1	Do nothing
Option 2	Do Minimum - Phased Work Short to Long Term
Option 3	Do Something - Full Scheme
Option 4	Do Something - Partial Scheme + Maintenance

Notes:
1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting
2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
PV benefits calculated as PV damage avoided + PV asset protection benefits
3) Incremental benefit/cost ratio is calculated as:
(PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Damage Cost Calculation Sheet - Do Nothing (Exponential)

Sheet Nr. 2

Client/Authority
SBC

Project name
Scalby Ness Strategy - Preferred Strategy with N

Option:
Do nothing

Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 5544.61

Remaining structure life 2
Initial probability of failure 0.800
Calculations assum **0.99** **prob of failure in year 2**
Calculated factors: -0.01005 -0.30743

Ave Annual Damage (overtopping) £k 0.00 /yr

PV Total Damage £k 5481.25 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	has not occurred	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.800	0.800	0.200	4435.69	0.00		4435.69
1	0.943	0.990	0.198	0.002	1035.69	0.00		1035.69
2	0.890	1.000	0.002	0.000	9.87	0.00		9.87
3	0.840	1.000	0.000	0.000	0.00	0.00		0.00
4	0.792	1.000	0.000	0.000	0.00	0.00		0.00
5	0.747	1.000	0.000	0.000	0.00	0.00		0.00
6	0.705	1.000	0.000	0.000	0.00	0.00		0.00
7	0.665	1.000	0.000	0.000	0.00	0.00		0.00
8	0.627	1.000	0.000	0.000	0.00	0.00		0.00
9	0.592	1.000	0.000	0.000	0.00	0.00		0.00
10	0.558	1.000	0.000	0.000	0.00	0.00		0.00
11	0.527	1.000	0.000	0.000	0.00	0.00		0.00
12	0.497	1.000	0.000	0.000	0.00	0.00		0.00
13	0.469	1.000	0.000	0.000	0.00	0.00		0.00
14	0.442	1.000	0.000	0.000	0.00	0.00		0.00
15	0.417	1.000	0.000	0.000	0.00	0.00		0.00
16	0.394	1.000	0.000	0.000	0.00	0.00		0.00
17	0.371	1.000	0.000	0.000	0.00	0.00		0.00
18	0.350	1.000	0.000	0.000	0.00	0.00		0.00
19	0.331	1.000	0.000	0.000	0.00	0.00		0.00
20	0.312	1.000	0.000	0.000	0.00	0.00		0.00
21	0.294	1.000	0.000	0.000	0.00	0.00		0.00
22	0.278	1.000	0.000	0.000	0.00	0.00		0.00
23	0.262	1.000	0.000	0.000	0.00	0.00		0.00
24	0.247	1.000	0.000	0.000	0.00	0.00		0.00
25	0.233	1.000	0.000	0.000	0.00	0.00		0.00
26	0.220	1.000	0.000	0.000	0.00	0.00		0.00
27	0.207	1.000	0.000	0.000	0.00	0.00		0.00
28	0.196	1.000	0.000	0.000	0.00	0.00		0.00
29	0.185	1.000	0.000	0.000	0.00	0.00		0.00
30	0.174	1.000	0.000	0.000	0.00	0.00		0.00
31	0.164	1.000	0.000	0.000	0.00	0.00		0.00
32	0.155	1.000	0.000	0.000	0.00	0.00		0.00
33	0.146	1.000	0.000	0.000	0.00	0.00		0.00
34	0.138	1.000	0.000	0.000	0.00	0.00		0.00
35	0.130	1.000	0.000	0.000	0.00	0.00		0.00
36	0.123	1.000	0.000	0.000	0.00	0.00		0.00
37	0.116	1.000	0.000	0.000	0.00	0.00		0.00
38	0.109	1.000	0.000	0.000	0.00	0.00		0.00
39	0.103	1.000	0.000	0.000	0.00	0.00		0.00
40	0.097	1.000	0.000	0.000	0.00	0.00		0.00
41	0.092	1.000	0.000	0.000	0.00	0.00		0.00
42	0.087	1.000	0.000	0.000	0.00	0.00		0.00
43	0.082	1.000	0.000	0.000	0.00	0.00		0.00
44	0.077	1.000	0.000	0.000	0.00	0.00		0.00
45	0.073	1.000	0.000	0.000	0.00	0.00		0.00
46	0.069	1.000	0.000	0.000	0.00	0.00		0.00
47	0.065	1.000	0.000	0.000	0.00	0.00		0.00
48	0.061	1.000	0.000	0.000	0.00	0.00		0.00
49	0.058	1.000	0.000	0.000	0.00	0.00		0.00
50	0.054	1.000	0.000	0.000	0.00	0.00		0.00
51	0.051	1.000	0.000	0.000	0.00	0.00		0.00
52	0.048	1.000	0.000	0.000	0.00	0.00		0.00
53	0.046	1.000	0.000	0.000	0.00	0.00		0.00
54	0.043	1.000	0.000	0.000	0.00	0.00		0.00
55	0.041	1.000	0.000	0.000	0.00	0.00		0.00
56	0.038	1.000	0.000	0.000	0.00	0.00		0.00
57	0.036	1.000	0.000	0.000	0.00	0.00		0.00
58	0.034	1.000	0.000	0.000	0.00	0.00		0.00
59	0.032	1.000	0.000	0.000	0.00	0.00		0.00
Totals					5481.25	0.00		5481.25

Notes

Complete one spreadsheet for the 'do nothing' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
It is assumed that breaches are not repaired and that once breach damage has occurred it will not recur.
A separate check should be made to ensure that overtopping damages do not exceed write off values.
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 3

Client/Authority
SBC

Project name
Scalby Ness Strategy - Preferred Strategy with New C:

Option:
Do Minimum - Phased Work Short to Long Term

Project reference	1404	
Base date for estimates (year 0)	Dec 01	
Scaling factor (e.g. £m, £k, £)	£k	
Discount rate	6%	
Remaining structure life	60	
Initial probability of failure	0.500	
Calculations assume 0.99	**prob of failure**	**in year 60**
Calculated factors: -0.01005	-0.16684	

PV breach/failure	£k	539.06
Ave Annual Damage (overtopping)	£k	________/yr
PV Total Damage	£k	4921.20 (calculated below)

Prepared (date)	
Printed	14/05/03
Prepared by	dgc
Checked by	
Checked date	

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	Prob that breach/failure: does not occur	PV damage due to: breach or failure	PV damage due to: over-topping	Other damage (specify)	PV total damage
0	1.000	0.500	0.500	0.500	269.53	0.00		269.53
1	0.943	0.501	0.501	0.499	254.99	0.00		254.99
2	0.890	0.503	0.503	0.497	241.24	0.00		241.24
3	0.840	0.504	0.504	0.496	228.25	0.00		228.25
4	0.792	0.506	0.506	0.494	215.96	0.00		215.96
5	0.747	0.507	0.507	0.493	204.35	0.00		204.35
6	0.705	0.509	0.509	0.491	193.38	0.00		193.38
7	0.665	0.510	0.510	0.490	183.00	0.00		183.00
8	0.627	0.512	0.512	0.488	173.19	0.00		173.19
9	0.592	0.514	0.514	0.486	163.92	0.00		163.92
10	0.558	0.515	0.515	0.485	155.15	0.00		155.15
11	0.527	0.517	0.517	0.483	146.86	0.00		146.86
12	0.497	0.519	0.519	0.481	139.03	0.00		139.03
13	0.469	0.521	0.521	0.479	131.62	0.00		131.62
14	0.442	0.523	0.523	0.477	124.62	0.00		124.62
15	0.417	0.525	0.525	0.475	117.99	0.00		117.99
16	0.394	0.527	0.527	0.473	111.73	0.00		111.73
17	0.371	0.529	0.529	0.471	105.81	0.00		105.81
18	0.350	0.531	0.531	0.469	100.22	0.00		100.22
19	0.331	0.533	0.533	0.467	94.93	0.00		94.93
20	0.312	0.535	0.535	0.465	89.92	0.00		89.92
21	0.294	0.537	0.537	0.463	85.19	0.00		85.19
22	0.278	0.540	0.540	0.460	80.72	0.00		80.72
23	0.262	0.542	0.542	0.458	76.49	0.00		76.49
24	0.247	0.544	0.544	0.456	72.49	0.00		72.49
25	0.233	0.547	0.547	0.453	68.71	0.00		68.71
26	0.220	0.550	0.550	0.450	65.13	0.00		65.13
27	0.207	0.552	0.552	0.448	61.75	0.00		61.75
28	0.196	0.555	0.555	0.445	58.56	0.00		58.56
29	0.185	0.558	0.558	0.442	55.54	0.00		55.54
30	0.174	0.561	0.561	0.439	52.68	0.00		52.68
31	0.164	0.564	0.564	0.436	49.98	0.00		49.98
32	0.155	0.568	0.568	0.432	47.43	0.00		47.43
33	0.146	0.571	0.571	0.429	45.02	0.00		45.02
34	0.138	0.575	0.575	0.425	42.74	0.00		42.74
35	0.130	0.579	0.579	0.421	40.58	0.00		40.58
36	0.123	0.583	0.583	0.417	38.55	0.00		38.55
37	0.116	0.587	0.587	0.413	36.62	0.00		36.62
38	0.109	0.591	0.591	0.409	34.81	0.00		34.81
39	0.103	0.596	0.596	0.404	33.09	0.00		33.09
40	0.097	0.601	0.601	0.399	31.48	0.00		31.48
41	0.092	0.606	0.606	0.394	29.95	0.00		29.95
42	0.087	0.611	0.611	0.389	28.51	0.00		28.51
43	0.082	0.617	0.617	0.383	27.15	0.00		27.15
44	0.077	0.623	0.623	0.377	25.88	0.00		25.88
45	0.073	0.630	0.630	0.370	24.68	0.00		24.68
46	0.069	0.637	0.637	0.363	23.55	0.00		23.55
47	0.065	0.645	0.645	0.355	22.49	0.00		22.49
48	0.061	0.654	0.654	0.346	21.51	0.00		21.51
49	0.058	0.664	0.664	0.336	20.58	0.00		20.58
50	0.054	0.674	0.674	0.326	19.73	0.00		19.73
51	0.051	0.686	0.686	0.314	18.94	0.00		18.94
52	0.048	0.700	0.700	0.300	18.23	0.00		18.23
53	0.046	0.716	0.716	0.284	17.58	0.00		17.58
54	0.043	0.734	0.734	0.266	17.02	0.00		17.02
55	0.041	0.757	0.757	0.243	16.55	0.00		16.55
56	0.038	0.786	0.786	0.214	16.21	0.00		16.21
57	0.036	0.824	0.824	0.176	16.04	0.00		16.04
58	0.034	0.882	0.882	0.118	16.19	0.00		16.19
59	0.032	0.990	0.990	0.010	17.15	0.00		17.15
Totals					4921.20	0.00		4921.20

Notes
Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 4

Client/Authority
SBC

Project name
Scalby Ness Strategy - Preferred Strategy with New C

Option:
Do Something - Full Scheme

Project reference	1,404.00					
Base date for estimates (year 0)	Dec 01					
Scaling factor (e.g. £m, £k, £)	£k				Prepared (date)	
Discount rate	6%				Printed	14/05/03
		PV breach/failure	£k	168.08	Prepared by	dgc
Remaining structure life	60	**Ave Annual Damage**			Checked by	
Initial probability of failure	0.010	**(overtopping)**	£k	0.00 /yr	Checked date	
Calculations assume	**0.99** prob of failure in year 60					
Calculated factors:	-0.01005 -1.12231	**PV Total Damage**	£k	59.40 (calculated below)		

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	Prob that breach/failure: does not occur	PV damage due to: breach or failure	PV damage due to: over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	1.68	0.00		1.68
1	0.943	0.010	0.010	0.990	1.62	0.00		1.62
2	0.890	0.010	0.010	0.990	1.55	0.00		1.55
3	0.840	0.011	0.011	0.989	1.49	0.00		1.49
4	0.792	0.011	0.011	0.989	1.44	0.00		1.44
5	0.747	0.011	0.011	0.989	1.38	0.00		1.38
6	0.705	0.011	0.011	0.989	1.33	0.00		1.33
7	0.665	0.011	0.011	0.989	1.28	0.00		1.28
8	0.627	0.012	0.012	0.988	1.24	0.00		1.24
9	0.592	0.012	0.012	0.988	1.19	0.00		1.19
10	0.558	0.012	0.012	0.988	1.15	0.00		1.15
11	0.527	0.013	0.013	0.987	1.11	0.00		1.11
12	0.497	0.013	0.013	0.987	1.07	0.00		1.07
13	0.469	0.013	0.013	0.987	1.04	0.00		1.04
14	0.442	0.013	0.013	0.987	1.00	0.00		1.00
15	0.417	0.014	0.014	0.986	0.97	0.00		0.97
16	0.394	0.014	0.014	0.986	0.94	0.00		0.94
17	0.371	0.015	0.015	0.985	0.91	0.00		0.91
18	0.350	0.015	0.015	0.985	0.88	0.00		0.88
19	0.331	0.015	0.015	0.985	0.85	0.00		0.85
20	0.312	0.016	0.016	0.984	0.83	0.00		0.83
21	0.294	0.016	0.016	0.984	0.80	0.00		0.80
22	0.278	0.017	0.017	0.983	0.78	0.00		0.78
23	0.262	0.017	0.017	0.983	0.76	0.00		0.76
24	0.247	0.018	0.018	0.982	0.74	0.00		0.74
25	0.233	0.018	0.018	0.982	0.72	0.00		0.72
26	0.220	0.019	0.019	0.981	0.70	0.00		0.70
27	0.207	0.020	0.020	0.980	0.68	0.00		0.68
28	0.196	0.020	0.020	0.980	0.67	0.00		0.67
29	0.185	0.021	0.021	0.979	0.65	0.00		0.65
30	0.174	0.022	0.022	0.978	0.64	0.00		0.64
31	0.164	0.023	0.023	0.977	0.62	0.00		0.62
32	0.155	0.024	0.024	0.976	0.61	0.00		0.61
33	0.146	0.025	0.025	0.975	0.60	0.00		0.60
34	0.138	0.026	0.026	0.974	0.59	0.00		0.59
35	0.130	0.027	0.027	0.973	0.58	0.00		0.58
36	0.123	0.028	0.028	0.972	0.58	0.00		0.58
37	0.116	0.029	0.029	0.971	0.57	0.00		0.57
38	0.109	0.031	0.031	0.969	0.57	0.00		0.57
39	0.103	0.032	0.032	0.968	0.56	0.00		0.56
40	0.097	0.034	0.034	0.966	0.56	0.00		0.56
41	0.092	0.036	0.036	0.964	0.56	0.00		0.56
42	0.087	0.039	0.039	0.961	0.56	0.00		0.56
43	0.082	0.041	0.041	0.959	0.57	0.00		0.57
44	0.077	0.044	0.044	0.956	0.57	0.00		0.57
45	0.073	0.047	0.047	0.953	0.58	0.00		0.58
46	0.069	0.051	0.051	0.949	0.59	0.00		0.59
47	0.065	0.056	0.056	0.944	0.60	0.00		0.60
48	0.061	0.061	0.061	0.939	0.62	0.00		0.62
49	0.058	0.067	0.067	0.933	0.65	0.00		0.65
50	0.054	0.075	0.075	0.925	0.68	0.00		0.68
51	0.051	0.084	0.084	0.916	0.72	0.00		0.72
52	0.048	0.096	0.096	0.904	0.78	0.00		0.78
53	0.046	0.111	0.111	0.889	0.85	0.00		0.85
54	0.043	0.133	0.133	0.867	0.96	0.00		0.96
55	0.041	0.163	0.163	0.837	1.11	0.00		1.11
56	0.038	0.209	0.209	0.791	1.34	0.00		1.34
57	0.036	0.289	0.289	0.711	1.75	0.00		1.75
58	0.034	0.455	0.455	0.545	2.60	0.00		2.60
59	0.032	0.990	0.990	0.010	5.35	0.00		5.35
Totals					59.40	0.00		59.40

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 5

Client/Authority
SBC

Project name
Scalby Ness Strategy - Preferred Strategy with New C:

Option:
Do Something - Partial Scheme + Maintenance

Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 168.08
Ave Annual Damage (overtopping) £k 0.00 /yr

Remaining structure life 60
Initial probability of failure 0.010
Calculations assume 0.99 **prob of failure in year 60**
Calculated factors: -0.01005 -1.12231

PV Total Damage £k 59.40 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	1.68	0.00		1.68
1	0.943	0.010	0.010	0.990	1.62	0.00		1.62
2	0.890	0.010	0.010	0.990	1.55	0.00		1.55
3	0.840	0.011	0.011	0.989	1.49	0.00		1.49
4	0.792	0.011	0.011	0.989	1.44	0.00		1.44
5	0.747	0.011	0.011	0.989	1.38	0.00		1.38
6	0.705	0.011	0.011	0.989	1.33	0.00		1.33
7	0.665	0.011	0.011	0.989	1.28	0.00		1.28
8	0.627	0.012	0.012	0.988	1.24	0.00		1.24
9	0.592	0.012	0.012	0.988	1.19	0.00		1.19
10	0.558	0.012	0.012	0.988	1.15	0.00		1.15
11	0.527	0.013	0.013	0.987	1.11	0.00		1.11
12	0.497	0.013	0.013	0.987	1.07	0.00		1.07
13	0.469	0.013	0.013	0.987	1.04	0.00		1.04
14	0.442	0.013	0.013	0.987	1.00	0.00		1.00
15	0.417	0.014	0.014	0.986	0.97	0.00		0.97
16	0.394	0.014	0.014	0.986	0.94	0.00		0.94
17	0.371	0.015	0.015	0.985	0.91	0.00		0.91
18	0.350	0.015	0.015	0.985	0.88	0.00		0.88
19	0.331	0.015	0.015	0.985	0.85	0.00		0.85
20	0.312	0.016	0.016	0.984	0.83	0.00		0.83
21	0.294	0.016	0.016	0.984	0.80	0.00		0.80
22	0.278	0.017	0.017	0.983	0.78	0.00		0.78
23	0.262	0.017	0.017	0.983	0.76	0.00		0.76
24	0.247	0.018	0.018	0.982	0.74	0.00		0.74
25	0.233	0.018	0.018	0.982	0.72	0.00		0.72
26	0.220	0.019	0.019	0.981	0.70	0.00		0.70
27	0.207	0.020	0.020	0.980	0.68	0.00		0.68
28	0.196	0.020	0.020	0.980	0.67	0.00		0.67
29	0.185	0.021	0.021	0.979	0.65	0.00		0.65
30	0.174	0.022	0.022	0.978	0.64	0.00		0.64
31	0.164	0.023	0.023	0.977	0.62	0.00		0.62
32	0.155	0.024	0.024	0.976	0.61	0.00		0.61
33	0.146	0.025	0.025	0.975	0.60	0.00		0.60
34	0.138	0.026	0.026	0.974	0.59	0.00		0.59
35	0.130	0.027	0.027	0.973	0.58	0.00		0.58
36	0.123	0.028	0.028	0.972	0.58	0.00		0.58
37	0.116	0.029	0.029	0.971	0.57	0.00		0.57
38	0.109	0.031	0.031	0.969	0.57	0.00		0.57
39	0.103	0.032	0.032	0.968	0.56	0.00		0.56
40	0.097	0.034	0.034	0.966	0.56	0.00		0.56
41	0.092	0.036	0.036	0.964	0.56	0.00		0.56
42	0.087	0.039	0.039	0.961	0.56	0.00		0.56
43	0.082	0.041	0.041	0.959	0.57	0.00		0.57
44	0.077	0.044	0.044	0.956	0.57	0.00		0.57
45	0.073	0.047	0.047	0.953	0.58	0.00		0.58
46	0.069	0.051	0.051	0.949	0.59	0.00		0.59
47	0.065	0.056	0.056	0.944	0.60	0.00		0.60
48	0.061	0.061	0.061	0.939	0.62	0.00		0.62
49	0.058	0.067	0.067	0.933	0.65	0.00		0.65
50	0.054	0.075	0.075	0.925	0.68	0.00		0.68
51	0.051	0.084	0.084	0.916	0.72	0.00		0.72
52	0.048	0.096	0.096	0.904	0.78	0.00		0.78
53	0.046	0.111	0.111	0.889	0.85	0.00		0.85
54	0.043	0.133	0.133	0.867	0.96	0.00		0.96
55	0.041	0.163	0.163	0.837	1.11	0.00		1.11
56	0.038	0.209	0.209	0.791	1.34	0.00		1.34
57	0.036	0.289	0.289	0.711	1.75	0.00		1.75
58	0.034	0.455	0.455	0.545	2.60	0.00		2.60
59	0.032	0.990	0.990	0.010	5.35	0.00		5.35
Totals					59.40	0.00		59.40

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Erosion Value Calculation Sheet with delay options

Sheet Nr. 6

Client/Authority
SBC

Project name
Scalby Ness Strategy - Preferred Strategy with Nev
Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Option:	Delay (yrs)
Do Minimum - Phased Work S	40
Do Something - Full Scheme	60
Do Something - Partial Scherr	60

Prepared (date)	
Printed	14/05/03
Prepared by	dgc
Checked by	
Checked date	

Ref	Asset Description	MV £k	Year	Prob of loss without project in year	Expected value of asset losses £k: Without Project	Do Minimum - Phased Work Short to Long Term	Do Something - Full Scheme	Do Something - Partial Scheme + Maintenance	
0	Property Yr 2	3571.00	1	0.02	67.38	6.55	2.04	2.04	
0	Property Yr 2	3571.00	2	0.95	3,019.27	293.54	91.53	91.53	
0	Property Yr 2	3571.00	3	0.03	89.95	8.74	2.73	2.73	
1	New car park	1431.00	1	1	1,350.00	131.25	40.92	40.92	
2	YW WWTW	320	1	0.05	15.09	1.47	0.46	0.46	
3	YW WWTW	320	2	0.95	270.56	26.30	8.20	8.20	
4	Property Yr 5	302.00	4	0.15	35.88	3.49	1.09	1.09	
5	Property Yr 5	302.00	5	0.75	169.25	16.46	5.13	5.13	
6	Property Yr 5	302.00	6	0.1	21.29	2.07	0.65	0.65	
7	Property Yr 15	402.00	10	0.15	33.67	3.27	1.02	1.02	
8	Property Yr 15	402.00	15	0.75	125.81	12.23	3.81	3.81	
9	Property Yr 15	402.00	20	0.1	12.53	1.22	0.38	0.38	
10	Property Yr 30	255.00	25	0.25	14.85	1.44	0.45	0.45	
11	Property Yr 30	255.00	30	0.5	22.20	2.16	0.67	0.67	
12	Property Yr 30	255.00	35	0.25	8.29	0.81	0.25	0.25	
12	Property Yr 45	673.00	40	0.25	16.36	1.59	0.50	0.50	
12	Property Yr 45	673.00	45	0.5	24.45	2.38	0.74	0.74	
13	Property Yr 45	673.00	50	0.25	9.13	0.89	0.28	0.28	
14	Property Yr 60	657.00	60	0.25	4.98	0.48	0.15	0.15	
15	Property Yr 60	657.00	65	0.75	11.16	1.09	0.34	0.34	
16	H&S Works following failure	250.00	2	1	222.50	21.63	6.74	6.74	
17					-	-	-	-	
18					-	-	-	-	
19					-	-	-	-	
20					-	-	-	-	
21					-	-	-	-	
22					-	-	-	-	
23	[For property losses see Tables 4.6 A & B]				-	-	-	-	
24					-	-	-	-	
25					-	-	-	-	
26					-	-	-	-	
27					-	-	-	-	
28					-	-	-	-	
29					-	-	-	-	
30					-	-	-	-	
31					-	-	-	-	
32					-	-	-	-	
33					-	-	-	-	
34					-	-	-	-	
35					-	-	-	-	
36					-	-	-	-	
37					-	-	-	-	
38					-	-	-	-	
39					-	-	-	-	
40					-	-	-	-	
41					-	-	-	-	
42					-	-	-	-	
43					-	-	-	-	
44					-	-	-	-	
45					-	-	-	-	
46					-	-	-	-	
47					-	-	-	-	
48					-	-	-	-	
49					-	-	-	-	
50					-	-	-	-	
51					-	-	-	-	
52					-	-	-	-	
53					-	-	-	-	
54					-	-	-	-	
55					-	-	-	-	
56					-	-	-	-	
57					-	-	-	-	
58					-	-	-	-	
59					-	-	-	-	
Totals		19244.00			5544.61	539.06	168.08	168.08	

Notes
Make one entry in the description column for each property (or group of properties) as this determines subsequent calculation
MV = risk free market value at base date for estimate - must be entered on each line when probability distribution is used
Equivalent annual value = MV x discount rate (assumes infinite life)
Year is year by which there is the cumulative probability of loss shown
If no distribution is used enter year after expected year of loss and enter 1.0 in probability column
(i.e. certainty of loss before start of year so year must be 1.0 or greater)
(e.g. If certain of loss in year 5 enter 6 in year column and 1 in probability column)
Asset value in first year for each property (or group) shown is cumulative to the year of first loss
Asset value in subsequent years for each property is additional value for that property if life extended

Present Value Costs for all options

Sheet Nr. 7

Client/Authority
SBC

Project name
Scalby Ness Strategy - Preferred Strategy wi

Project reference	1,404.00
Base date for estimates (year 0	Dec 01
Scaling factor (e.g. £m, £k, £)	£k
Discount rate	6%

Results £k

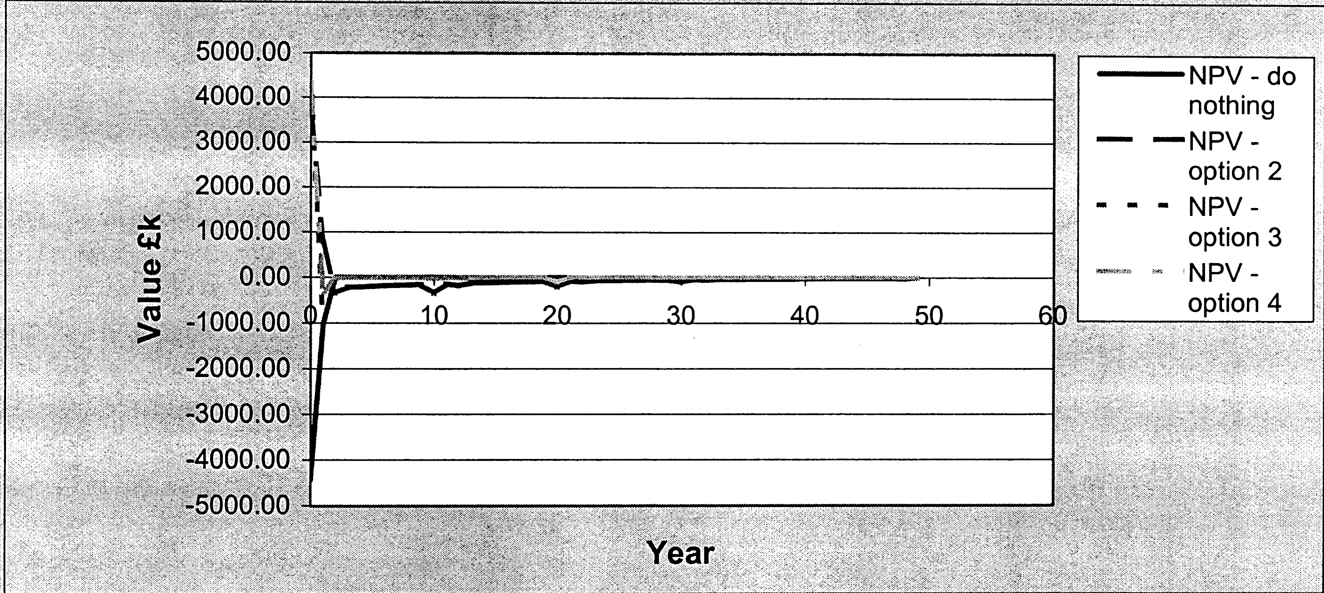
PV total costs	Option 1 (Do nothing)	Option 2 Do Minimum - Phased W	Option 3 Do Something - Full Sch	Option 4 Do Something - Partial S
	0.00	1143.04	2415.75	1769.44

Prepared (date)	
Printed	14/05/03
Prepared by	dqc
Checked by	
Checked date	

year	Discount Factor	Option 1 Capital	(Do nothing) Maint.	Other	TOTALS: Cash	PV	Option 2 Mon	Do Minimum - Phased W Works	Emergency	TOTALS: Cash	PV	Option 3 Capital	Do Something - Full Sche Main	All Mon	TOTALS: Cash	PV	Option 4 Capital	Do Something - Partial S Maint.	All Mon	TOTALS: Cash	PV
	cash sum	0	0	0	0.00	0.00	180	2556	600	3336.00	1143.04	3056	61	180	3297.00	2415.75	2338	240	180	2758.00	1769.44
0	1.000				0.00	0.00	3	408		411.00	411.00	100	2	3	105.00	105.00	100	2	3	105.00	105.00
1	0.943				0.00	0.00	3			3.00	2.83	2156	1	3	2160.00	2037.74	1438	2	3	1443.00	1361.32
2	0.890				0.00	0.00	3	40	100	143.00	127.27	40	1	3	44.00	39.16	40	2	3	45.00	40.05
3	0.840				0.00	0.00	3			3.00	2.52		1	3	4.00	3.36		2	3	5.00	4.20
4	0.792				0.00	0.00	3			3.00	2.38		1	3	4.00	3.17		2	3	5.00	3.96
5	0.747				0.00	0.00	3			3.00	2.24		1	3	4.00	2.99		2	3	5.00	3.74
6	0.705				0.00	0.00	3			3.00	2.11		1	3	4.00	2.82		2	3	5.00	3.52
7	0.665				0.00	0.00	3			3.00	2.00		1	3	4.00	2.66		2	3	5.00	3.33
8	0.627				0.00	0.00	3			3.00	1.88		1	3	4.00	2.51		2	3	5.00	3.14
9	0.592				0.00	0.00	3			3.00	1.78		1	3	4.00	2.37		2	3	5.00	2.96
10	0.558				0.00	0.00	3	368		371.00	207.16	60	1	3	64.00	35.74	60	2	3	65.00	36.30
11	0.527				0.00	0.00	3			3.00	1.58		1	3	4.00	2.11		2	3	5.00	2.63
12	0.497				0.00	0.00	3		100	103.00	51.19		1	3	4.00	1.99		2	3	5.00	2.48
13	0.469				0.00	0.00	3			3.00	1.41		1	3	4.00	1.88		2	3	5.00	2.34
14	0.442				0.00	0.00	3			3.00	1.33		1	3	4.00	1.77		2	3	5.00	2.21
15	0.417				0.00	0.00	3			3.00	1.25		1	3	4.00	1.67		2	3	5.00	2.09
16	0.394				0.00	0.00	3			3.00	1.18		1	3	4.00	1.57		2	3	5.00	1.97
17	0.371				0.00	0.00	3			3.00	1.11		1	3	4.00	1.49		2	3	5.00	1.86
18	0.350				0.00	0.00	3			3.00	1.05		1	3	4.00	1.40		2	3	5.00	1.75
19	0.331				0.00	0.00	3			3.00	0.99		1	3	4.00	1.32		2	3	5.00	1.65
20	0.312				0.00	0.00	3	408		411.00	128.15	350	1	3	354.00	110.38	350	5	3	358.00	111.63
21	0.294				0.00	0.00	3			3.00	0.88		1	3	4.00	1.18		5	3	8.00	2.35
22	0.278				0.00	0.00	3		100	103.00	28.58		1	3	4.00	1.11		5	3	8.00	2.22
23	0.262				0.00	0.00	3			3.00	0.79		1	3	4.00	1.05		5	3	8.00	2.09
24	0.247				0.00	0.00	3			3.00	0.74		1	3	4.00	0.99		5	3	8.00	1.98
25	0.233				0.00	0.00	3			3.00	0.70		1	3	4.00	0.93		5	3	8.00	1.86
26	0.220				0.00	0.00	3			3.00	0.66		1	3	4.00	0.88		5	3	8.00	1.76
27	0.207				0.00	0.00	3			3.00	0.62		1	3	4.00	0.83		5	3	8.00	1.66
28	0.196				0.00	0.00	3			3.00	0.59		1	3	4.00	0.78		5	3	8.00	1.57
29	0.185				0.00	0.00	3			3.00	0.55		1	3	4.00	0.74		5	3	8.00	1.48
30	0.174				0.00	0.00	3	308		311.00	54.15		1	3	4.00	0.70		5	3	8.00	1.39
31	0.164				0.00	0.00	3			3.00	0.49		1	3	4.00	0.66		5	3	8.00	1.31
32	0.155				0.00	0.00	3		100	103.00	15.96		1	3	4.00	0.62		5	3	8.00	1.24
33	0.146				0.00	0.00	3			3.00	0.44		1	3	4.00	0.58		5	3	8.00	1.17
34	0.138				0.00	0.00	3			3.00	0.41		1	3	4.00	0.55		5	3	8.00	1.10
35	0.130				0.00	0.00	3			3.00	0.39		1	3	4.00	0.52		5	3	8.00	1.04
36	0.123				0.00	0.00	3			3.00	0.37		1	3	4.00	0.49		5	3	8.00	0.98
37	0.116				0.00	0.00	3			3.00	0.35		1	3	4.00	0.46		5	3	8.00	0.93
38	0.109				0.00	0.00	3			3.00	0.33		1	3	4.00	0.44		5	3	8.00	0.87
39	0.103				0.00	0.00	3			3.00	0.31		1	3	4.00	0.41		5	3	8.00	0.82
40	0.097				0.00	0.00	3	408		411.00	39.96	350	1	3	354.00	34.42	350	5	3	358.00	34.81
41	0.092				0.00	0.00	3			3.00	0.28		1	3	4.00	0.37		5	3	8.00	0.73
42	0.087				0.00	0.00	3		100	103.00	8.91		1	3	4.00	0.35		5	3	8.00	0.69
43	0.082				0.00	0.00	3			3.00	0.24		1	3	4.00	0.33		5	3	8.00	0.65
44	0.077				0.00	0.00	3			3.00	0.23		1	3	4.00	0.31		5	3	8.00	0.62
45	0.073				0.00	0.00	3			3.00	0.22		1	3	4.00	0.29		5	3	8.00	0.58
46	0.069				0.00	0.00	3			3.00	0.21		1	3	4.00	0.27		5	3	8.00	0.55
47	0.065				0.00	0.00	3			3.00	0.19		1	3	4.00	0.26		5	3	8.00	0.52
48	0.061				0.00	0.00	3			3.00	0.18		1	3	4.00	0.24		5	3	8.00	0.49
49	0.058				0.00	0.00	3			3.00	0.17		1	3	4.00	0.23		5	3	8.00	0.46
50	0.054				0.00	0.00	3	308		311.00	16.88		1	3	4.00	0.22		5	3	8.00	0.43
51	0.051				0.00	0.00	3			3.00	0.15		1	3	4.00	0.20		5	3	8.00	0.41
52	0.048				0.00	0.00	3		100	103.00	4.98		1	3	4.00	0.19		5	3	8.00	0.39
53	0.046				0.00	0.00	3			3.00	0.14		1	3	4.00	0.18		5	3	8.00	0.36
54	0.043				0.00	0.00	3			3.00	0.13		1	3	4.00	0.17		5	3	8.00	0.34
55	0.041				0.00	0.00	3			3.00	0.12		1	3	4.00	0.16		5	3	8.00	0.32
56	0.038				0.00	0.00	3			3.00	0.11		1	3	4.00	0.15		5	3	8.00	0.31
57	0.036				0.00	0.00	3			3.00	0.11		1	3	4.00	0.14		5	3	8.00	0.29
58	0.034				0.00	0.00	3			3.00	0.10		1	3	4.00	0.14		5	3	8.00	0.27
59	0.032				0.00	0.00	3	308		311.00	9.99		1	3	4.00	0.13		5	3	8.00	0.26

Net Present Value over time

Client/Authority		**Sheet Nr.**	8
SBC		Prepared (date)	16/09/99
Project name		Printed	14/05/03
Scalby Ness Strategy - Preferred Strategy wit		Prepared by	DR
Project reference	1,404.00	Checked by	GS
Base date for estimates (year 0)	Dec 01	Checked date	16/10/99
Scaling factor (e.g. £m, £k, £)	£k		
Discount rate	6%		



SPREADSHEETS FOR PREFERRED STRATEGY
YEAR 2
(SEA LIFE CENTRE CLOSURE AS A RESULT OF LOSS OF SCALBY MILLS ROAD)

Project Summary Sheet

Client/Authority		Prepared (date)	20 02 03
SBC		Printed	14/05/03
Project name		Prepared by	dgc
Scalby Ness Strategy - **Preferred Strategy with SLC as Total Loss**		Checked by	
Project reference	1404	Checked date	
Base date for estimates (year 0)	Dec 01		
Scaling factor (e.g. £m, £k, £)	£k	(used for all costs, losses and benefits)	
Principle land use band	B	(A to E)	
Discount rate	6%		

Costs and benefits of options

	Costs and benefits £k				
	No Project	Option 2	Option 3	Option 4	
PV costs PVc	0.00	1,143.04	2,415.75	1,769.44	
PV damage PVd	11,811.17	10,604.36	127.99	127.99	
PV damage avoided		1,206.81	11,683.18	11,683.18	
PV assets Pva					
PV asset protection benefits		0.00	0.00	0.00	
Total PV benefits PVb		1,206.81	11,683.18	11,683.18	
Net Present Value NPV		63.77	9,267.43	9,913.73	
Average benefit/cost ratio		1.1	4.8	6.60	
Incremental benefit/cost ratio			8.23	0.00	
		-	-	Highest b/c	

Brief description of options:

Option 1	Do nothing
Option 2	Do Minimum - Phased Work Short to Long Term
Option 3	Do Something - Full Scheme
Option 4	Do Something - Partial Scheme + Maintenance

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting
2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
   PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
   PV benefits calculated as PV damage avoided + PV asset protection benefits
3) Incremental benefit/cost ratio is calculated as:
   (PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Damage Cost Calculation Sheet - Do Nothing (Exponential)

Sheet Nr. 2

Client/Authority
SBC

Project name
Scalby Ness Strategy - Preferred Strategy with S

Option:
Do nothing

Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 11947.70
Ave Annual Damage (overtopping) £k 0.00 /yr
PV Total Damage £k 11811.17 (calculated below)

Remaining structure life 2
Initial probability of failure 0.800
Calculations assum 0.99 **prob of failure in year 2**
Calculated factors: -0.01005 -0.30743

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	has not occurred	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.800	0.800	0.200	9558.16	0.00		9558.16
1	0.943	0.990	0.198	0.002	2231.74	0.00		2231.74
2	0.890	1.000	0.002	0.000	21.27	0.00		21.27
3	0.840	1.000	0.000	0.000	0.00	0.00		0.00
4	0.792	1.000	0.000	0.000	0.00	0.00		0.00
5	0.747	1.000	0.000	0.000	0.00	0.00		0.00
6	0.705	1.000	0.000	0.000	0.00	0.00		0.00
7	0.665	1.000	0.000	0.000	0.00	0.00		0.00
8	0.627	1.000	0.000	0.000	0.00	0.00		0.00
9	0.592	1.000	0.000	0.000	0.00	0.00		0.00
10	0.558	1.000	0.000	0.000	0.00	0.00		0.00
11	0.527	1.000	0.000	0.000	0.00	0.00		0.00
12	0.497	1.000	0.000	0.000	0.00	0.00		0.00
13	0.469	1.000	0.000	0.000	0.00	0.00		0.00
14	0.442	1.000	0.000	0.000	0.00	0.00		0.00
15	0.417	1.000	0.000	0.000	0.00	0.00		0.00
16	0.394	1.000	0.000	0.000	0.00	0.00		0.00
17	0.371	1.000	0.000	0.000	0.00	0.00		0.00
18	0.350	1.000	0.000	0.000	0.00	0.00		0.00
19	0.331	1.000	0.000	0.000	0.00	0.00		0.00
20	0.312	1.000	0.000	0.000	0.00	0.00		0.00
21	0.294	1.000	0.000	0.000	0.00	0.00		0.00
22	0.278	1.000	0.000	0.000	0.00	0.00		0.00
23	0.262	1.000	0.000	0.000	0.00	0.00		0.00
24	0.247	1.000	0.000	0.000	0.00	0.00		0.00
25	0.233	1.000	0.000	0.000	0.00	0.00		0.00
26	0.220	1.000	0.000	0.000	0.00	0.00		0.00
27	0.207	1.000	0.000	0.000	0.00	0.00		0.00
28	0.196	1.000	0.000	0.000	0.00	0.00		0.00
29	0.185	1.000	0.000	0.000	0.00	0.00		0.00
30	0.174	1.000	0.000	0.000	0.00	0.00		0.00
31	0.164	1.000	0.000	0.000	0.00	0.00		0.00
32	0.155	1.000	0.000	0.000	0.00	0.00		0.00
33	0.146	1.000	0.000	0.000	0.00	0.00		0.00
34	0.138	1.000	0.000	0.000	0.00	0.00		0.00
35	0.130	1.000	0.000	0.000	0.00	0.00		0.00
36	0.123	1.000	0.000	0.000	0.00	0.00		0.00
37	0.116	1.000	0.000	0.000	0.00	0.00		0.00
38	0.109	1.000	0.000	0.000	0.00	0.00		0.00
39	0.103	1.000	0.000	0.000	0.00	0.00		0.00
40	0.097	1.000	0.000	0.000	0.00	0.00		0.00
41	0.092	1.000	0.000	0.000	0.00	0.00		0.00
42	0.087	1.000	0.000	0.000	0.00	0.00		0.00
43	0.082	1.000	0.000	0.000	0.00	0.00		0.00
44	0.077	1.000	0.000	0.000	0.00	0.00		0.00
45	0.073	1.000	0.000	0.000	0.00	0.00		0.00
46	0.069	1.000	0.000	0.000	0.00	0.00		0.00
47	0.065	1.000	0.000	0.000	0.00	0.00		0.00
48	0.061	1.000	0.000	0.000	0.00	0.00		0.00
49	0.058	1.000	0.000	0.000	0.00	0.00		0.00
50	0.054	1.000	0.000	0.000	0.00	0.00		0.00
51	0.051	1.000	0.000	0.000	0.00	0.00		0.00
52	0.048	1.000	0.000	0.000	0.00	0.00		0.00
53	0.046	1.000	0.000	0.000	0.00	0.00		0.00
54	0.043	1.000	0.000	0.000	0.00	0.00		0.00
55	0.041	1.000	0.000	0.000	0.00	0.00		0.00
56	0.038	1.000	0.000	0.000	0.00	0.00		0.00
57	0.036	1.000	0.000	0.000	0.00	0.00		0.00
58	0.034	1.000	0.000	0.000	0.00	0.00		0.00
59	0.032	1.000	0.000	0.000	0.00	0.00		0.00
Totals					11811.17	0.00		11811.17

Notes

Complete one spreadsheet for the 'do nothing' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
It is assumed that breaches are not repaired and that once breach damage has occurred it will not recur.
A separate check should be made to ensure that overtopping damages do not exceed write off values.
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 3

Client/Authority
SBC

Project name
Scalby Ness Strategy - Preferred Strategy with SLC as

Option:
Do Minimum - Phased Work Short to Long Term

Project reference	1404			
Base date for estimates (year 0)	Dec 01			
Scaling factor (e.g. £m, £k, £)	£k		**Prepared (date)**	
Discount rate	6%		**Printed**	14/05/03
		PV breach/failure £k 1161.58	**Prepared by**	dgc
Remaining structure life	60	**Ave Annual Damage**	**Checked by**	
Initial probability of failure	0.500	**(overtopping)** £k ________ /yr	**Checked date**	
Calculations assume 0.99	**prob of failure in year 60**			
Calculated factors: -0.01005	-0.16684	**PV Total Damage** £k 10604.36 (calculated below)		

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	Prob that breach/failure: does not occur	PV damage due to: breach or failure	PV damage due to: over-topping	Other damage (specify)	PV total damage
0	1.000	0.500	0.500	0.500	580.79	0.00		580.79
1	0.943	0.501	0.501	0.499	549.45	0.00		549.45
2	0.890	0.503	0.503	0.497	519.83	0.00		519.83
3	0.840	0.504	0.504	0.496	491.83	0.00		491.83
4	0.792	0.506	0.506	0.494	465.37	0.00		465.37
5	0.747	0.507	0.507	0.493	440.35	0.00		440.35
6	0.705	0.509	0.509	0.491	416.70	0.00		416.70
7	0.665	0.510	0.510	0.490	394.34	0.00		394.34
8	0.627	0.512	0.512	0.488	373.20	0.00		373.20
9	0.592	0.514	0.514	0.486	353.22	0.00		353.22
10	0.558	0.515	0.515	0.485	334.33	0.00		334.33
11	0.527	0.517	0.517	0.483	316.47	0.00		316.47
12	0.497	0.519	0.519	0.481	299.58	0.00		299.58
13	0.469	0.521	0.521	0.479	283.62	0.00		283.62
14	0.442	0.523	0.523	0.477	268.53	0.00		268.53
15	0.417	0.525	0.525	0.475	254.26	0.00		254.26
16	0.394	0.527	0.527	0.473	240.77	0.00		240.77
17	0.371	0.529	0.529	0.471	228.01	0.00		228.01
18	0.350	0.531	0.531	0.469	215.95	0.00		215.95
19	0.331	0.533	0.533	0.467	204.55	0.00		204.55
20	0.312	0.535	0.535	0.465	193.77	0.00		193.77
21	0.294	0.537	0.537	0.463	183.57	0.00		183.57
22	0.278	0.540	0.540	0.460	173.93	0.00		173.93
23	0.262	0.542	0.542	0.458	164.82	0.00		164.82
24	0.247	0.544	0.544	0.456	156.20	0.00		156.20
25	0.233	0.547	0.547	0.453	148.06	0.00		148.06
26	0.220	0.550	0.550	0.450	140.35	0.00		140.35
27	0.207	0.552	0.552	0.448	133.07	0.00		133.07
28	0.196	0.555	0.555	0.445	126.18	0.00		126.18
29	0.185	0.558	0.558	0.442	119.67	0.00		119.67
30	0.174	0.561	0.561	0.439	113.52	0.00		113.52
31	0.164	0.564	0.564	0.436	107.70	0.00		107.70
32	0.155	0.568	0.568	0.432	102.20	0.00		102.20
33	0.146	0.571	0.571	0.429	97.00	0.00		97.00
34	0.138	0.575	0.575	0.425	92.09	0.00		92.09
35	0.130	0.579	0.579	0.421	87.45	0.00		87.45
36	0.123	0.583	0.583	0.417	83.06	0.00		83.06
37	0.116	0.587	0.587	0.413	78.92	0.00		78.92
38	0.109	0.591	0.591	0.409	75.01	0.00		75.01
39	0.103	0.596	0.596	0.404	71.31	0.00		71.31
40	0.097	0.601	0.601	0.399	67.82	0.00		67.82
41	0.092	0.606	0.606	0.394	64.54	0.00		64.54
42	0.087	0.611	0.611	0.389	61.43	0.00		61.43
43	0.082	0.617	0.617	0.383	58.51	0.00		58.51
44	0.077	0.623	0.623	0.377	55.76	0.00		55.76
45	0.073	0.630	0.630	0.370	53.17	0.00		53.17
46	0.069	0.637	0.637	0.363	50.75	0.00		50.75
47	0.065	0.645	0.645	0.355	48.47	0.00		48.47
48	0.061	0.654	0.654	0.346	46.34	0.00		46.34
49	0.058	0.664	0.664	0.336	44.36	0.00		44.36
50	0.054	0.674	0.674	0.326	42.52	0.00		42.52
51	0.051	0.686	0.686	0.314	40.82	0.00		40.82
52	0.048	0.700	0.700	0.300	39.27	0.00		39.27
53	0.046	0.716	0.716	0.284	37.89	0.00		37.89
54	0.043	0.734	0.734	0.266	36.67	0.00		36.67
55	0.041	0.757	0.757	0.243	35.67	0.00		35.67
56	0.038	0.786	0.786	0.214	34.92	0.00		34.92
57	0.036	0.824	0.824	0.176	34.57	0.00		34.57
58	0.034	0.882	0.882	0.118	34.89	0.00		34.89
59	0.032	0.990	0.990	0.010	36.95	0.00		36.95
Totals					10604.36	0.00		10604.36

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 4

Client/Authority
SBC

Project name
Scalby Ness Strategy - Preferred Strategy with SLC as

Option:
Do Something - Full Scheme

Project reference	1,404.00			Prepared (date)	
Base date for estimates (year 0)	Dec 01			Printed	14/05/03
Scaling factor (e.g. £m, £k, £)	£k	**PV breach/failure** £k	362.19	Prepared by	dgc
Discount rate	6%	**Ave Annual Damage (overtopping)** £k	0.00 /yr	Checked by	
Remaining structure life	60			Checked date	
Initial probability of failure	0.010				
Calculations assume	**0.99** prob of failure in year 60				
Calculated factors:	-0.01005 / -1.12231	**PV Total Damage** £k	127.99 (calculated below)		

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	3.62	0.00		3.62
1	0.943	0.010	0.010	0.990	3.48	0.00		3.48
2	0.890	0.010	0.010	0.990	3.35	0.00		3.35
3	0.840	0.011	0.011	0.989	3.22	0.00		3.22
4	0.792	0.011	0.011	0.989	3.10	0.00		3.10
5	0.747	0.011	0.011	0.989	2.98	0.00		2.98
6	0.705	0.011	0.011	0.989	2.87	0.00		2.87
7	0.665	0.011	0.011	0.989	2.77	0.00		2.77
8	0.627	0.012	0.012	0.988	2.67	0.00		2.67
9	0.592	0.012	0.012	0.988	2.57	0.00		2.57
10	0.558	0.012	0.012	0.988	2.48	0.00		2.48
11	0.527	0.013	0.013	0.987	2.39	0.00		2.39
12	0.497	0.013	0.013	0.987	2.31	0.00		2.31
13	0.469	0.013	0.013	0.987	2.23	0.00		2.23
14	0.442	0.013	0.013	0.987	2.16	0.00		2.16
15	0.417	0.014	0.014	0.986	2.09	0.00		2.09
16	0.394	0.014	0.014	0.986	2.02	0.00		2.02
17	0.371	0.015	0.015	0.985	1.95	0.00		1.95
18	0.350	0.015	0.015	0.985	1.89	0.00		1.89
19	0.331	0.015	0.015	0.985	1.84	0.00		1.84
20	0.312	0.016	0.016	0.984	1.78	0.00		1.78
21	0.294	0.016	0.016	0.984	1.73	0.00		1.73
22	0.278	0.017	0.017	0.983	1.68	0.00		1.68
23	0.262	0.017	0.017	0.983	1.63	0.00		1.63
24	0.247	0.018	0.018	0.982	1.59	0.00		1.59
25	0.233	0.018	0.018	0.982	1.55	0.00		1.55
26	0.220	0.019	0.019	0.981	1.51	0.00		1.51
27	0.207	0.020	0.020	0.980	1.47	0.00		1.47
28	0.196	0.020	0.020	0.980	1.43	0.00		1.43
29	0.185	0.021	0.021	0.979	1.40	0.00		1.40
30	0.174	0.022	0.022	0.978	1.37	0.00		1.37
31	0.164	0.023	0.023	0.977	1.35	0.00		1.35
32	0.155	0.024	0.024	0.976	1.32	0.00		1.32
33	0.146	0.025	0.025	0.975	1.30	0.00		1.30
34	0.138	0.026	0.026	0.974	1.28	0.00		1.28
35	0.130	0.027	0.027	0.973	1.26	0.00		1.26
36	0.123	0.028	0.028	0.972	1.24	0.00		1.24
37	0.116	0.029	0.029	0.971	1.23	0.00		1.23
38	0.109	0.031	0.031	0.969	1.22	0.00		1.22
39	0.103	0.032	0.032	0.968	1.21	0.00		1.21
40	0.097	0.034	0.034	0.966	1.21	0.00		1.21
41	0.092	0.036	0.036	0.964	1.21	0.00		1.21
42	0.087	0.039	0.039	0.961	1.21	0.00		1.21
43	0.082	0.041	0.041	0.959	1.22	0.00		1.22
44	0.077	0.044	0.044	0.956	1.23	0.00		1.23
45	0.073	0.047	0.047	0.953	1.25	0.00		1.25
46	0.069	0.051	0.051	0.949	1.27	0.00		1.27
47	0.065	0.056	0.056	0.944	1.30	0.00		1.30
48	0.061	0.061	0.061	0.939	1.34	0.00		1.34
49	0.058	0.067	0.067	0.933	1.40	0.00		1.40
50	0.054	0.075	0.075	0.925	1.47	0.00		1.47
51	0.051	0.084	0.084	0.916	1.56	0.00		1.56
52	0.048	0.096	0.096	0.904	1.68	0.00		1.68
53	0.046	0.111	0.111	0.889	1.84	0.00		1.84
54	0.043	0.133	0.133	0.867	2.06	0.00		2.06
55	0.041	0.163	0.163	0.837	2.39	0.00		2.39
56	0.038	0.209	0.209	0.791	2.90	0.00		2.90
57	0.036	0.289	0.289	0.711	3.77	0.00		3.77
58	0.034	0.455	0.455	0.545	5.61	0.00		5.61
59	0.032	0.990	0.990	0.010	11.52	0.00		11.52
Totals					127.99	0.00		127.99

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 5

Client/Authority
SBC
Project name
Scalby Ness Strategy - Preferred Strategy with SLC as

Option:
Do Something - Partial Scheme + Maintenance

Project reference	1,404.00						
Base date for estimates (year 0)	Dec 01						
Scaling factor (e.g. £m, £k, £)	£k					**Prepared (date)**	
Discount rate	6%					**Printed**	14/05/03
		PV breach/failure	**£k**	362.19		**Prepared by**	dgc
Remaining structure life	60	**Ave Annual Damage**				**Checked by**	
Initial probability of failure	0.010	**(overtopping)**	**£k**	0.00	**/yr**	**Checked date**	
Calculations assume 0.99	**prob of failure in year 60**						
Calculated factors: -0.01005	-1.12231	**PV Total Damage**	**£k**	127.99	(calculated below)		

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	3.62	0.00		3.62
1	0.943	0.010	0.010	0.990	3.48	0.00		3.48
2	0.890	0.010	0.010	0.990	3.35	0.00		3.35
3	0.840	0.011	0.011	0.989	3.22	0.00		3.22
4	0.792	0.011	0.011	0.989	3.10	0.00		3.10
5	0.747	0.011	0.011	0.989	2.98	0.00		2.98
6	0.705	0.011	0.011	0.989	2.87	0.00		2.87
7	0.665	0.011	0.011	0.989	2.77	0.00		2.77
8	0.627	0.012	0.012	0.988	2.67	0.00		2.67
9	0.592	0.012	0.012	0.988	2.57	0.00		2.57
10	0.558	0.012	0.012	0.988	2.48	0.00		2.48
11	0.527	0.013	0.013	0.987	2.39	0.00		2.39
12	0.497	0.013	0.013	0.987	2.31	0.00		2.31
13	0.469	0.013	0.013	0.987	2.23	0.00		2.23
14	0.442	0.013	0.013	0.987	2.16	0.00		2.16
15	0.417	0.014	0.014	0.986	2.09	0.00		2.09
16	0.394	0.014	0.014	0.986	2.02	0.00		2.02
17	0.371	0.015	0.015	0.985	1.95	0.00		1.95
18	0.350	0.015	0.015	0.985	1.89	0.00		1.89
19	0.331	0.015	0.015	0.985	1.84	0.00		1.84
20	0.312	0.016	0.016	0.984	1.78	0.00		1.78
21	0.294	0.016	0.016	0.984	1.73	0.00		1.73
22	0.278	0.017	0.017	0.983	1.68	0.00		1.68
23	0.262	0.017	0.017	0.983	1.63	0.00		1.63
24	0.247	0.018	0.018	0.982	1.59	0.00		1.59
25	0.233	0.018	0.018	0.982	1.55	0.00		1.55
26	0.220	0.019	0.019	0.981	1.51	0.00		1.51
27	0.207	0.020	0.020	0.980	1.47	0.00		1.47
28	0.196	0.020	0.020	0.980	1.43	0.00		1.43
29	0.185	0.021	0.021	0.979	1.40	0.00		1.40
30	0.174	0.022	0.022	0.978	1.37	0.00		1.37
31	0.164	0.023	0.023	0.977	1.35	0.00		1.35
32	0.155	0.024	0.024	0.976	1.32	0.00		1.32
33	0.146	0.025	0.025	0.975	1.30	0.00		1.30
34	0.138	0.026	0.026	0.974	1.28	0.00		1.28
35	0.130	0.027	0.027	0.973	1.26	0.00		1.26
36	0.123	0.028	0.028	0.972	1.24	0.00		1.24
37	0.116	0.029	0.029	0.971	1.23	0.00		1.23
38	0.109	0.031	0.031	0.969	1.22	0.00		1.22
39	0.103	0.032	0.032	0.968	1.21	0.00		1.21
40	0.097	0.034	0.034	0.966	1.21	0.00		1.21
41	0.092	0.036	0.036	0.964	1.21	0.00		1.21
42	0.087	0.039	0.039	0.961	1.21	0.00		1.21
43	0.082	0.041	0.041	0.959	1.22	0.00		1.22
44	0.077	0.044	0.044	0.956	1.23	0.00		1.23
45	0.073	0.047	0.047	0.953	1.25	0.00		1.25
46	0.069	0.051	0.051	0.949	1.27	0.00		1.27
47	0.065	0.056	0.056	0.944	1.30	0.00		1.30
48	0.061	0.061	0.061	0.939	1.34	0.00		1.34
49	0.058	0.067	0.067	0.933	1.40	0.00		1.40
50	0.054	0.075	0.075	0.925	1.47	0.00		1.47
51	0.051	0.084	0.084	0.916	1.56	0.00		1.56
52	0.048	0.096	0.096	0.904	1.68	0.00		1.68
53	0.046	0.111	0.111	0.889	1.84	0.00		1.84
54	0.043	0.133	0.133	0.867	2.06	0.00		2.06
55	0.041	0.163	0.163	0.837	2.39	0.00		2.39
56	0.038	0.209	0.209	0.791	2.90	0.00		2.90
57	0.036	0.289	0.289	0.711	3.77	0.00		3.77
58	0.034	0.455	0.455	0.545	5.61	0.00		5.61
59	0.032	0.990	0.990	0.010	11.52	0.00		11.52
Totals					127.99	0.00		127.99

Notes
Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Erosion Value Calculation Sheet with delay options

Sheet Nr. 6

Client/Authority
SBC

Project name
Scalby Ness Strategy - Preferred Strategy with SL(

Project reference	1,404.00	**Option:**	**Delay (yrs)**	Prepared (date)		
Base date for estimates (year 0)	Dec 01	Do Minimum - Phased Work S	40	Printed		14/05/03
Scaling factor (e.g. £m, £k, £)	£k	Do Something - Full Scheme	60	Prepared by		dgc
Discount rate	6%	Do Something - Partial Schem	60	Checked by		
				Checked date		

Ref	Asset Description	MV £k	Year	Prob of loss without project in year	Expected value of asset losses £k: Without Project	Do Minimum - Phased Work Short to Long Term	Do Something - Full Scheme	Do Something - Partial Scheme + Maintenance	
0	Property Yr 2	3571.00	1	0.03	101.07	9.83	3.06	3.06	
0	Property Yr 2	3571.00	2	0.95	3,019.27	293.54	91.53	91.53	
0	Property Yr 2	3571.00	3	0.02	59.97	5.83	1.82	1.82	
1	Scalby CP+ Sea Life Cen 0yr	9028.00	2	1	8,034.89	781.17	243.57	243.57	
2	Property Yr 5	302.00	4	0.15	35.88	3.49	1.09	1.09	
3	Property Yr 5	302.00	5	0.75	169.25	16.46	5.13	5.13	
4	Property Yr 5	302.00	6	0.1	21.29	2.07	0.65	0.65	
5	Property Yr 15	402.00	10	0.15	33.67	3.27	1.02	1.02	
6	Property Yr 15	402.00	15	0.75	125.81	12.23	3.81	3.81	
7	Property Yr 15	402.00	20	0.1	12.53	1.22	0.38	0.38	
8	Property Yr 30	255.00	25	0.25	14.85	1.44	0.45	0.45	
9	Property Yr 30	255.00	30	0.5	22.20	2.16	0.67	0.67	
10	Property Yr 30	255.00	35	0.25	8.29	0.81	0.25	0.25	
11	Property Yr 45	673.00	40	0.25	16.36	1.59	0.50	0.50	
12	Property Yr 45	673.00	45	0.5	24.45	2.38	0.74	0.74	
12	Property Yr 45	673.00	50	0.25	9.13	0.89	0.28	0.28	
12	Property Yr 60	657.00	60	0.25	4.98	0.48	0.15	0.15	
13	Property Yr 60	657.00	65	0.75	11.16	1.09	0.34	0.34	
14	H&S Works following failure	250.00	1	0.03	7.08	0.69	0.21	0.21	
15	H&S Works following failure	250.00	2	0.95	211.37	20.55	6.41	6.41	
16	H&S Works following failure	250.00	3	0.02	4.20	0.41	0.13	0.13	
17					-	-	-	-	
18					-	-	-	-	
19					-	-	-	-	
20					-	-	-	-	
21					-	-	-	-	
22					-	-	-	-	
23					-	-	-	-	
24					-	-	-	-	
25					-	-	-	-	
26					-	-	-	-	
27					-	-	-	-	
28					-	-	-	-	
29					-	-	-	-	
30					-	-	-	-	
31					-	-	-	-	
32					-	-	-	-	
33	[For property losses see Tables 4.6 A & B]				-	-	-	-	
34					-	-	-	-	
35					-	-	-	-	
36					-	-	-	-	
37					-	-	-	-	
38					-	-	-	-	
39					-	-	-	-	
40					-	-	-	-	
41					-	-	-	-	
42					-	-	-	-	
43					-	-	-	-	
44					-	-	-	-	
45					-	-	-	-	
46					-	-	-	-	
47					-	-	-	-	
48					-	-	-	-	
49					-	-	-	-	
50					-	-	-	-	
51					-	-	-	-	
52					-	-	-	-	
53					-	-	-	-	
54					-	-	-	-	
55					-	-	-	-	
56					-	-	-	-	
57					-	-	-	-	
58					-	-	-	-	
59					-	-	-	-	
Totals		26701.00			11947.70	1161.58	362.19	362.19	

Notes
Make one entry in the description column for each property (or group of properties) as this determines subsequent calculation
MV = risk free market value at base date for estimate - must be entered on each line when probability distribution is used
Equivalent annual value = MV x discount rate (assumes infinite life)
Year is year by which there is the cumulative probability of loss shown
If no distribution is used enter year after expected year of loss and enter 1.0 in probability column
(i.e. certainty of loss before start of year so year must be 1.0 or greater)
(e.g. If certain of loss in year 5 enter 6 in year column and 1 in probability column)
Asset value in first year for each property (or group) shown is cumulative to the year of first loss
Asset value in subsequent years for each property is additional value for that property if life extended

Present Value Costs for all options

Client/Authority
SBC
Project name
Scalby Ness Strategy - Preferred Strategy wi
Project reference 1,404.00
Base date for estimates (year 0 Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Sheet Nr. 7

Results £k	Option 1 (Do nothing)	Option 2 Do Minimum - Phased W	Option 3 Do Something - Full Sch	Option 4 Do Something - Partial !
PV total costs	0.00	1143.04	2415.75	1769.44

Prepared (date)	14/05/03
Printed	
Prepared by	dgc
Checked by	
Checked date	

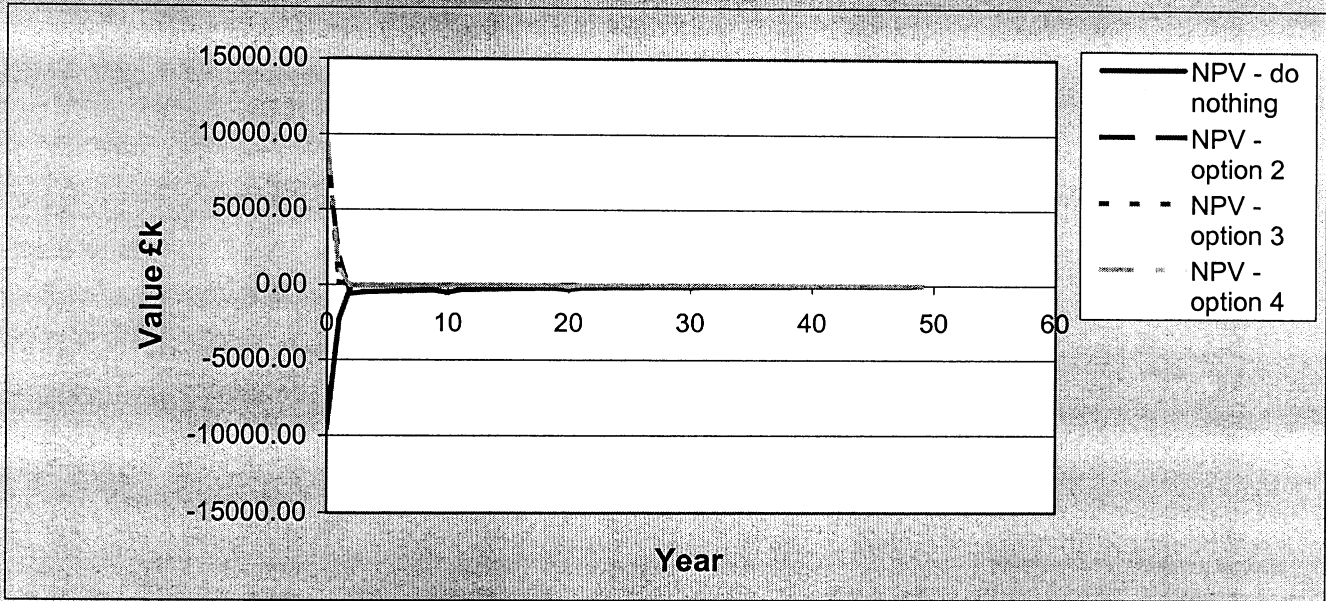
		Option 1 (Do nothing)			TOTALS:		Option 2 Do Minimum - Phased W			TOTALS:		Option 3 Do Something - Full Sche			TOTALS:		Option 4 Do Something - Partial S			TOTALS:	
		Capital	Maint.	Other	Cash	PV	Mon	Works	Emergency	Cash	PV	Capital	Main	All Mon	Cash	PV	Capital	Maint.	All Mon	Cash	PV
	cash sum	0	0	0	0.00	0.00	180	2556	600	3336.00	1143.04	3056	61	180	3297.00	2415.75	2338	240	180	2758.00	1769.44
year	Discount Factor																				
0	1.000				0.00	0.00	3	408		411.00	411.00	100	2	3	105.00	105.00	100	2	3	105.00	105.00
1	0.943				0.00	0.00	3			3.00	2.83	2156	1	3	2160.00	2037.74	1438	2	3	1443.00	1361.32
2	0.890				0.00	0.00	3	40	100	143.00	127.27	40	1	3	44.00	39.16	40	2	3	45.00	40.05
3	0.840				0.00	0.00	3			3.00	2.52		1	3	4.00	3.36		2	3	5.00	4.20
4	0.792				0.00	0.00	3			3.00	2.38		1	3	4.00	3.17		2	3	5.00	3.96
5	0.747				0.00	0.00	3			3.00	2.24		1	3	4.00	2.99		2	3	5.00	3.74
6	0.705				0.00	0.00	3			3.00	2.11		1	3	4.00	2.82		2	3	5.00	3.52
7	0.665				0.00	0.00	3			3.00	2.00		1	3	4.00	2.66		2	3	5.00	3.33
8	0.627				0.00	0.00	3			3.00	1.88		1	3	4.00	2.51		2	3	5.00	3.14
9	0.592				0.00	0.00	3			3.00	1.78		1	3	4.00	2.37		2	3	5.00	2.96
10	0.558				0.00	0.00	3	368		371.00	207.16	60	1	3	64.00	35.74	60	2	3	65.00	36.30
11	0.527				0.00	0.00	3			3.00	1.58		1	3	4.00	2.11		2	3	5.00	2.63
12	0.497				0.00	0.00	3		100	103.00	51.19		1	3	4.00	1.99		2	3	5.00	2.48
13	0.469				0.00	0.00	3			3.00	1.41		1	3	4.00	1.88		2	3	5.00	2.34
14	0.442				0.00	0.00	3			3.00	1.33		1	3	4.00	1.77		2	3	5.00	2.21
15	0.417				0.00	0.00	3			3.00	1.25		1	3	4.00	1.67		2	3	5.00	2.09
16	0.394				0.00	0.00	3			3.00	1.18		1	3	4.00	1.57		2	3	5.00	1.97
17	0.371				0.00	0.00	3			3.00	1.11		1	3	4.00	1.49		2	3	5.00	1.86
18	0.350				0.00	0.00	3			3.00	1.05		1	3	4.00	1.40		2	3	5.00	1.75
19	0.331				0.00	0.00	3			3.00	0.99		1	3	4.00	1.32		2	3	5.00	1.65
20	0.312				0.00	0.00	3	408		411.00	128.15	350	1	3	354.00	110.38	350	5	3	358.00	111.63
21	0.294				0.00	0.00	3			3.00	0.88		1	3	4.00	1.18		5	3	8.00	2.35
22	0.278				0.00	0.00	3		100	103.00	28.58		1	3	4.00	1.11		5	3	8.00	2.22
23	0.262				0.00	0.00	3			3.00	0.79		1	3	4.00	1.05		5	3	8.00	2.09
24	0.247				0.00	0.00	3			3.00	0.74		1	3	4.00	0.99		5	3	8.00	1.98
25	0.233				0.00	0.00	3			3.00	0.70		1	3	4.00	0.93		5	3	8.00	1.86
26	0.220				0.00	0.00	3			3.00	0.66		1	3	4.00	0.88		5	3	8.00	1.76
27	0.207				0.00	0.00	3			3.00	0.62		1	3	4.00	0.83		5	3	8.00	1.66
28	0.196				0.00	0.00	3			3.00	0.59		1	3	4.00	0.78		5	3	8.00	1.57
29	0.185				0.00	0.00	3			3.00	0.55		1	3	4.00	0.74		5	3	8.00	1.48
30	0.174				0.00	0.00	3	308		311.00	54.15		1	3	4.00	0.70		5	3	8.00	1.39
31	0.164				0.00	0.00	3			3.00	0.49		1	3	4.00	0.66		5	3	8.00	1.31
32	0.155				0.00	0.00	3		100	103.00	15.96		1	3	4.00	0.62		5	3	8.00	1.24
33	0.146				0.00	0.00	3			3.00	0.44		1	3	4.00	0.58		5	3	8.00	1.17
34	0.138				0.00	0.00	3			3.00	0.41		1	3	4.00	0.55		5	3	8.00	1.10
35	0.130				0.00	0.00	3			3.00	0.39		1	3	4.00	0.52		5	3	8.00	1.04
36	0.123				0.00	0.00	3			3.00	0.37		1	3	4.00	0.49		5	3	8.00	0.98
37	0.116				0.00	0.00	3			3.00	0.35		1	3	4.00	0.46		5	3	8.00	0.93
38	0.109				0.00	0.00	3			3.00	0.33		1	3	4.00	0.44		5	3	8.00	0.87
39	0.103				0.00	0.00	3			3.00	0.31		1	3	4.00	0.41		5	3	8.00	0.82
40	0.097				0.00	0.00	3	408		411.00	39.96	350	1	3	354.00	34.42	350	5	3	358.00	34.81
41	0.092				0.00	0.00	3			3.00	0.28		1	3	4.00	0.37		5	3	8.00	0.73
42	0.087				0.00	0.00	3		100	103.00	8.91		1	3	4.00	0.35		5	3	8.00	0.69
43	0.082				0.00	0.00	3			3.00	0.24		1	3	4.00	0.33		5	3	8.00	0.65
44	0.077				0.00	0.00	3			3.00	0.23		1	3	4.00	0.31		5	3	8.00	0.62
45	0.073				0.00	0.00	3			3.00	0.22		1	3	4.00	0.29		5	3	8.00	0.58
46	0.069				0.00	0.00	3			3.00	0.21		1	3	4.00	0.27		5	3	8.00	0.55
47	0.065				0.00	0.00	3			3.00	0.19		1	3	4.00	0.26		5	3	8.00	0.52
48	0.061				0.00	0.00	3			3.00	0.18		1	3	4.00	0.24		5	3	8.00	0.49
49	0.058				0.00	0.00	3			3.00	0.17		1	3	4.00	0.23		5	3	8.00	0.46
50	0.054				0.00	0.00	3	308		311.00	16.88		1	3	4.00	0.22		5	3	8.00	0.43
51	0.051				0.00	0.00	3			3.00	0.15		1	3	4.00	0.20		5	3	8.00	0.41
52	0.048				0.00	0.00	3		100	103.00	4.98		1	3	4.00	0.19		5	3	8.00	0.39
53	0.046				0.00	0.00	3			3.00	0.14		1	3	4.00	0.18		5	3	8.00	0.36
54	0.043				0.00	0.00	3			3.00	0.13		1	3	4.00	0.17		5	3	8.00	0.34
55	0.041				0.00	0.00	3			3.00	0.12		1	3	4.00	0.16		5	3	8.00	0.32
56	0.038				0.00	0.00	3			3.00	0.11		1	3	4.00	0.15		5	3	8.00	0.31
57	0.036				0.00	0.00	3			3.00	0.11		1	3	4.00	0.14		5	3	8.00	0.29
58	0.034				0.00	0.00	3			3.00	0.10		1	3	4.00	0.14		5	3	8.00	0.27
59	0.032				0.00	0.00	3	308		311.00	9.99		1	3	4.00	0.13		5	3	8.00	0.26

Net Present Value over time

Sheet Nr. 8

Client/Authority	
SBC	
Project name	
Scalby Ness Strategy - Preferred Strategy wit	
Project reference	1,404.00
Base date for estimates (year 0)	Dec 01
Scaling factor (e.g. £m, £k, £)	£k
Discount rate	6%

Prepared (date)	
Printed	14/05/03
Prepared by	
Checked by	
Checked date	



SPREADSHEETS FOR YEAR 5 DEFERRED LOSSES

Project Summary Sheet

Client/Authority		Prepared (date)	14 8 02
SBC		Printed	14/05/03
Project name		Prepared by	dgc
Scalby Ness Strategy - **Year 5** Preferred Strategy with SLC & CP losses		Checked by	
Project reference	1404	Checked date	
Base date for estimates (year 0)	Dec 01		
Scaling factor (e.g. £m, £k, £)	£k	(used for all costs, losses and benefits)	
Principle land use band	B	(A to E)	
Discount rate	6%		

Costs and benefits of options

	Costs and benefits £k				
	No Project	Option 2	Option 3	Option 4	
PV costs PVc	0.00	1,143.04	2,415.75	1,769.44	
PV damage PVd	5,723.02	5,138.27	62.02	62.02	
PV damage avoided		584.75	5,661.00	5,661.00	
PV assets Pva					
PV asset protection benefits		0.00	0.00	0.00	
Total PV benefits PVb		584.75	5,661.00	5,661.00	
Net Present Value NPV		-558.29	3,245.25	3,891.56	
Average benefit/cost ratio		0.5	2.3	3.2	
Incremental benefit/cost ratio			3.99	0.00	
		-	-	Highest b/c	

Brief description of options:

Option 1	Do nothing
Option 2	Do Minimum - Phased Work Short to Long Term
Option 3	Do Something - Full Scheme
Option 4	Do Something - Partial Scheme + Maintenance

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting
2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
   PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
   PV benefits calculated as PV damage avoided + PV asset protection benefits
3) Incremental benefit/cost ratio is calculated as:
   (PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Damage Cost Calculation Sheet - Do Nothing (Exponential)

Sheet Nr. 2

Client/Authority
SBC

Project name
Scalby Ness Strategy - Year 5 Preferred Strategy

Option:
Do nothing

Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 5789.17
Remaining structure life 2
Ave Annual Damage (overtopping) £k 0.00 /yr
Initial probability of failure 0.800
Calculations assum **0.99** **prob of failure in year 2**
Calculated factors: -0.01005 -0.30743
PV Total Damage £k 5723.02 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	has not occurred	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.800	0.800	0.200	4631.34	0.00		4631.34
1	0.943	0.990	0.198	0.002	1081.37	0.00		1081.37
2	0.890	1.000	0.002	0.000	10.30	0.00		10.30
3	0.840	1.000	0.000	0.000	0.00	0.00		0.00
4	0.792	1.000	0.000	0.000	0.00	0.00		0.00
5	0.747	1.000	0.000	0.000	0.00	0.00		0.00
6	0.705	1.000	0.000	0.000	0.00	0.00		0.00
7	0.665	1.000	0.000	0.000	0.00	0.00		0.00
8	0.627	1.000	0.000	0.000	0.00	0.00		0.00
9	0.592	1.000	0.000	0.000	0.00	0.00		0.00
10	0.558	1.000	0.000	0.000	0.00	0.00		0.00
11	0.527	1.000	0.000	0.000	0.00	0.00		0.00
12	0.497	1.000	0.000	0.000	0.00	0.00		0.00
13	0.469	1.000	0.000	0.000	0.00	0.00		0.00
14	0.442	1.000	0.000	0.000	0.00	0.00		0.00
15	0.417	1.000	0.000	0.000	0.00	0.00		0.00
16	0.394	1.000	0.000	0.000	0.00	0.00		0.00
17	0.371	1.000	0.000	0.000	0.00	0.00		0.00
18	0.350	1.000	0.000	0.000	0.00	0.00		0.00
19	0.331	1.000	0.000	0.000	0.00	0.00		0.00
20	0.312	1.000	0.000	0.000	0.00	0.00		0.00
21	0.294	1.000	0.000	0.000	0.00	0.00		0.00
22	0.278	1.000	0.000	0.000	0.00	0.00		0.00
23	0.262	1.000	0.000	0.000	0.00	0.00		0.00
24	0.247	1.000	0.000	0.000	0.00	0.00		0.00
25	0.233	1.000	0.000	0.000	0.00	0.00		0.00
26	0.220	1.000	0.000	0.000	0.00	0.00		0.00
27	0.207	1.000	0.000	0.000	0.00	0.00		0.00
28	0.196	1.000	0.000	0.000	0.00	0.00		0.00
29	0.185	1.000	0.000	0.000	0.00	0.00		0.00
30	0.174	1.000	0.000	0.000	0.00	0.00		0.00
31	0.164	1.000	0.000	0.000	0.00	0.00		0.00
32	0.155	1.000	0.000	0.000	0.00	0.00		0.00
33	0.146	1.000	0.000	0.000	0.00	0.00		0.00
34	0.138	1.000	0.000	0.000	0.00	0.00		0.00
35	0.130	1.000	0.000	0.000	0.00	0.00		0.00
36	0.123	1.000	0.000	0.000	0.00	0.00		0.00
37	0.116	1.000	0.000	0.000	0.00	0.00		0.00
38	0.109	1.000	0.000	0.000	0.00	0.00		0.00
39	0.103	1.000	0.000	0.000	0.00	0.00		0.00
40	0.097	1.000	0.000	0.000	0.00	0.00		0.00
41	0.092	1.000	0.000	0.000	0.00	0.00		0.00
42	0.087	1.000	0.000	0.000	0.00	0.00		0.00
43	0.082	1.000	0.000	0.000	0.00	0.00		0.00
44	0.077	1.000	0.000	0.000	0.00	0.00		0.00
45	0.073	1.000	0.000	0.000	0.00	0.00		0.00
46	0.069	1.000	0.000	0.000	0.00	0.00		0.00
47	0.065	1.000	0.000	0.000	0.00	0.00		0.00
48	0.061	1.000	0.000	0.000	0.00	0.00		0.00
49	0.058	1.000	0.000	0.000	0.00	0.00		0.00
50	0.054	1.000	0.000	0.000	0.00	0.00		0.00
51	0.051	1.000	0.000	0.000	0.00	0.00		0.00
52	0.048	1.000	0.000	0.000	0.00	0.00		0.00
53	0.046	1.000	0.000	0.000	0.00	0.00		0.00
54	0.043	1.000	0.000	0.000	0.00	0.00		0.00
55	0.041	1.000	0.000	0.000	0.00	0.00		0.00
56	0.038	1.000	0.000	0.000	0.00	0.00		0.00
57	0.036	1.000	0.000	0.000	0.00	0.00		0.00
58	0.034	1.000	0.000	0.000	0.00	0.00		0.00
59	0.032	1.000	0.000	0.000	0.00	0.00		0.00
Totals					5723.02	0.00		5723.02

Notes

Complete one spreadsheet for the 'do nothing' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
It is assumed that breaches are not repaired and that once breach damage has occurred it will not recur.
A separate check should be made to ensure that overtopping damages do not exceed write off values.
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 3

Client/Authority
SBC
Project name
Scalby Ness Strategy - Year 5 Preferred Strategy with
Option:
Do Minimum - Phased Work Short to Long Term

Project reference	1404					
Base date for estimates (year 0)	Dec 01					
Scaling factor (e.g. £m, £k, £)	£k				Prepared (date)	
Discount rate	6%				Printed	14/05/03
		PV breach/failure	£k	562.84	Prepared by	dgc
Remaining structure life	60	**Ave Annual Damage**			Checked by	
Initial probability of failure	0.500	**(overtopping)**	£k	/yr	Checked date	
Calculations assume 0.99	prob of failure in year 60					
Calculated factors: -0.01005	-0.16684	**PV Total Damage**	£k	5138.27	(calculated below)	

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.500	0.500	0.500	281.42	0.00		281.42
1	0.943	0.501	0.501	0.499	266.23	0.00		266.23
2	0.890	0.503	0.503	0.497	251.88	0.00		251.88
3	0.840	0.504	0.504	0.496	238.31	0.00		238.31
4	0.792	0.506	0.506	0.494	225.49	0.00		225.49
5	0.747	0.507	0.507	0.493	213.37	0.00		213.37
6	0.705	0.509	0.509	0.491	201.91	0.00		201.91
7	0.665	0.510	0.510	0.490	191.07	0.00		191.07
8	0.627	0.512	0.512	0.488	180.83	0.00		180.83
9	0.592	0.514	0.514	0.486	171.15	0.00		171.15
10	0.558	0.515	0.515	0.485	162.00	0.00		162.00
11	0.527	0.517	0.517	0.483	153.34	0.00		153.34
12	0.497	0.519	0.519	0.481	145.16	0.00		145.16
13	0.469	0.521	0.521	0.479	137.43	0.00		137.43
14	0.442	0.523	0.523	0.477	130.11	0.00		130.11
15	0.417	0.525	0.525	0.475	123.20	0.00		123.20
16	0.394	0.527	0.527	0.473	116.66	0.00		116.66
17	0.371	0.529	0.529	0.471	110.48	0.00		110.48
18	0.350	0.531	0.531	0.469	104.64	0.00		104.64
19	0.331	0.533	0.533	0.467	99.11	0.00		99.11
20	0.312	0.535	0.535	0.465	93.89	0.00		93.89
21	0.294	0.537	0.537	0.463	88.95	0.00		88.95
22	0.278	0.540	0.540	0.460	84.28	0.00		84.28
23	0.262	0.542	0.542	0.458	79.86	0.00		79.86
24	0.247	0.544	0.544	0.456	75.69	0.00		75.69
25	0.233	0.547	0.547	0.453	71.74	0.00		71.74
26	0.220	0.550	0.550	0.450	68.01	0.00		68.01
27	0.207	0.552	0.552	0.448	64.48	0.00		64.48
28	0.196	0.555	0.555	0.445	61.14	0.00		61.14
29	0.185	0.558	0.558	0.442	57.99	0.00		57.99
30	0.174	0.561	0.561	0.439	55.00	0.00		55.00
31	0.164	0.564	0.564	0.436	52.19	0.00		52.19
32	0.155	0.568	0.568	0.432	49.52	0.00		49.52
33	0.146	0.571	0.571	0.429	47.00	0.00		47.00
34	0.138	0.575	0.575	0.425	44.62	0.00		44.62
35	0.130	0.579	0.579	0.421	42.37	0.00		42.37
36	0.123	0.583	0.583	0.417	40.25	0.00		40.25
37	0.116	0.587	0.587	0.413	38.24	0.00		38.24
38	0.109	0.591	0.591	0.409	36.34	0.00		36.34
39	0.103	0.596	0.596	0.404	34.55	0.00		34.55
40	0.097	0.601	0.601	0.399	32.86	0.00		32.86
41	0.092	0.606	0.606	0.394	31.27	0.00		31.27
42	0.087	0.611	0.611	0.389	29.77	0.00		29.77
43	0.082	0.617	0.617	0.383	28.35	0.00		28.35
44	0.077	0.623	0.623	0.377	27.02	0.00		27.02
45	0.073	0.630	0.630	0.370	25.77	0.00		25.77
46	0.069	0.637	0.637	0.363	24.59	0.00		24.59
47	0.065	0.645	0.645	0.355	23.49	0.00		23.49
48	0.061	0.654	0.654	0.346	22.45	0.00		22.45
49	0.058	0.664	0.664	0.336	21.49	0.00		21.49
50	0.054	0.674	0.674	0.326	20.60	0.00		20.60
51	0.051	0.686	0.686	0.314	19.78	0.00		19.78
52	0.048	0.700	0.700	0.300	19.03	0.00		19.03
53	0.046	0.716	0.716	0.284	18.36	0.00		18.36
54	0.043	0.734	0.734	0.266	17.77	0.00		17.77
55	0.041	0.757	0.757	0.243	17.28	0.00		17.28
56	0.038	0.786	0.786	0.214	16.92	0.00		16.92
57	0.036	0.824	0.824	0.176	16.75	0.00		16.75
58	0.034	0.882	0.882	0.118	16.91	0.00		16.91
59	0.032	0.990	0.990	0.010	17.90	0.00		17.90
Totals					5138.27	0.00		5138.27

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 4

Client/Authority
SBC

Project name
Scalby Ness Strategy - Year 5 Preferred Strategy with

Option:
Do Something - Full Scheme

Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 175.49
Ave Annual Damage (overtopping) £k 0.00 /yr
PV Total Damage £k 62.02 (calculated below)

Remaining structure life 60
Initial probability of failure 0.010
Calculations assume 0.99 prob of failure in year 60
Calculated factors: -0.01005 -1.12231

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	Prob that breach/failure: does not occur	PV damage due to: breach or failure	PV damage due to: over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	1.75	0.00		1.75
1	0.943	0.010	0.010	0.990	1.69	0.00		1.69
2	0.890	0.010	0.010	0.990	1.62	0.00		1.62
3	0.840	0.011	0.011	0.989	1.56	0.00		1.56
4	0.792	0.011	0.011	0.989	1.50	0.00		1.50
5	0.747	0.011	0.011	0.989	1.45	0.00		1.45
6	0.705	0.011	0.011	0.989	1.39	0.00		1.39
7	0.665	0.011	0.011	0.989	1.34	0.00		1.34
8	0.627	0.012	0.012	0.988	1.29	0.00		1.29
9	0.592	0.012	0.012	0.988	1.25	0.00		1.25
10	0.558	0.012	0.012	0.988	1.20	0.00		1.20
11	0.527	0.013	0.013	0.987	1.16	0.00		1.16
12	0.497	0.013	0.013	0.987	1.12	0.00		1.12
13	0.469	0.013	0.013	0.987	1.08	0.00		1.08
14	0.442	0.013	0.013	0.987	1.05	0.00		1.05
15	0.417	0.014	0.014	0.986	1.01	0.00		1.01
16	0.394	0.014	0.014	0.986	0.98	0.00		0.98
17	0.371	0.015	0.015	0.985	0.95	0.00		0.95
18	0.350	0.015	0.015	0.985	0.92	0.00		0.92
19	0.331	0.015	0.015	0.985	0.89	0.00		0.89
20	0.312	0.016	0.016	0.984	0.86	0.00		0.86
21	0.294	0.016	0.016	0.984	0.84	0.00		0.84
22	0.278	0.017	0.017	0.983	0.81	0.00		0.81
23	0.262	0.017	0.017	0.983	0.79	0.00		0.79
24	0.247	0.018	0.018	0.982	0.77	0.00		0.77
25	0.233	0.018	0.018	0.982	0.75	0.00		0.75
26	0.220	0.019	0.019	0.981	0.73	0.00		0.73
27	0.207	0.020	0.020	0.980	0.71	0.00		0.71
28	0.196	0.020	0.020	0.980	0.70	0.00		0.70
29	0.185	0.021	0.021	0.979	0.68	0.00		0.68
30	0.174	0.022	0.022	0.978	0.67	0.00		0.67
31	0.164	0.023	0.023	0.977	0.65	0.00		0.65
32	0.155	0.024	0.024	0.976	0.64	0.00		0.64
33	0.146	0.025	0.025	0.975	0.63	0.00		0.63
34	0.138	0.026	0.026	0.974	0.62	0.00		0.62
35	0.130	0.027	0.027	0.973	0.61	0.00		0.61
36	0.123	0.028	0.028	0.972	0.60	0.00		0.60
37	0.116	0.029	0.029	0.971	0.60	0.00		0.60
38	0.109	0.031	0.031	0.969	0.59	0.00		0.59
39	0.103	0.032	0.032	0.968	0.59	0.00		0.59
40	0.097	0.034	0.034	0.966	0.59	0.00		0.59
41	0.092	0.036	0.036	0.964	0.59	0.00		0.59
42	0.087	0.039	0.039	0.961	0.59	0.00		0.59
43	0.082	0.041	0.041	0.959	0.59	0.00		0.59
44	0.077	0.044	0.044	0.956	0.60	0.00		0.60
45	0.073	0.047	0.047	0.953	0.60	0.00		0.60
46	0.069	0.051	0.051	0.949	0.62	0.00		0.62
47	0.065	0.056	0.056	0.944	0.63	0.00		0.63
48	0.061	0.061	0.061	0.939	0.65	0.00		0.65
49	0.058	0.067	0.067	0.933	0.68	0.00		0.68
50	0.054	0.075	0.075	0.925	0.71	0.00		0.71
51	0.051	0.084	0.084	0.916	0.76	0.00		0.76
52	0.048	0.096	0.096	0.904	0.81	0.00		0.81
53	0.046	0.111	0.111	0.889	0.89	0.00		0.89
54	0.043	0.133	0.133	0.867	1.00	0.00		1.00
55	0.041	0.163	0.163	0.837	1.16	0.00		1.16
56	0.038	0.209	0.209	0.791	1.40	0.00		1.40
57	0.036	0.289	0.289	0.711	1.83	0.00		1.83
58	0.034	0.455	0.455	0.545	2.72	0.00		2.72
59	0.032	0.990	0.990	0.010	5.58	0.00		5.58
Totals					62.02	0.00		62.02

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 5

Client/Authority
SBC

Project name
Scalby Ness Strategy - Year 5 Preferred Strategy with

Option:
Do Something - Partial Scheme + Maintenance

Project reference	1,404.00				
Base date for estimates (year 0)	Dec 01				
Scaling factor (e.g. £m, £k, £)	£k			Prepared (date)	
Discount rate	6%			Printed	14/05/03
		PV breach/failure	£k 175.49	Prepared by	dgc
Remaining structure life	60	**Ave Annual Damage**		Checked by	
Initial probability of failure	0.010	**(overtopping)**	£k 0.00 /yr	Checked date	
Calculations assume 0.99	prob of failure in year 60				
Calculated factors: -0.01005	-1.12231	**PV Total Damage**	£k 62.02 (calculated below)		

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	1.75	0.00		1.75
1	0.943	0.010	0.010	0.990	1.69	0.00		1.69
2	0.890	0.010	0.010	0.990	1.62	0.00		1.62
3	0.840	0.011	0.011	0.989	1.56	0.00		1.56
4	0.792	0.011	0.011	0.989	1.50	0.00		1.50
5	0.747	0.011	0.011	0.989	1.45	0.00		1.45
6	0.705	0.011	0.011	0.989	1.39	0.00		1.39
7	0.665	0.011	0.011	0.989	1.34	0.00		1.34
8	0.627	0.012	0.012	0.988	1.29	0.00		1.29
9	0.592	0.012	0.012	0.988	1.25	0.00		1.25
10	0.558	0.012	0.012	0.988	1.20	0.00		1.20
11	0.527	0.013	0.013	0.987	1.16	0.00		1.16
12	0.497	0.013	0.013	0.987	1.12	0.00		1.12
13	0.469	0.013	0.013	0.987	1.08	0.00		1.08
14	0.442	0.013	0.013	0.987	1.05	0.00		1.05
15	0.417	0.014	0.014	0.986	1.01	0.00		1.01
16	0.394	0.014	0.014	0.986	0.98	0.00		0.98
17	0.371	0.015	0.015	0.985	0.95	0.00		0.95
18	0.350	0.015	0.015	0.985	0.92	0.00		0.92
19	0.331	0.015	0.015	0.985	0.89	0.00		0.89
20	0.312	0.016	0.016	0.984	0.86	0.00		0.86
21	0.294	0.016	0.016	0.984	0.84	0.00		0.84
22	0.278	0.017	0.017	0.983	0.81	0.00		0.81
23	0.262	0.017	0.017	0.983	0.79	0.00		0.79
24	0.247	0.018	0.018	0.982	0.77	0.00		0.77
25	0.233	0.018	0.018	0.982	0.75	0.00		0.75
26	0.220	0.019	0.019	0.981	0.73	0.00		0.73
27	0.207	0.020	0.020	0.980	0.71	0.00		0.71
28	0.196	0.020	0.020	0.980	0.70	0.00		0.70
29	0.185	0.021	0.021	0.979	0.68	0.00		0.68
30	0.174	0.022	0.022	0.978	0.67	0.00		0.67
31	0.164	0.023	0.023	0.977	0.65	0.00		0.65
32	0.155	0.024	0.024	0.976	0.64	0.00		0.64
33	0.146	0.025	0.025	0.975	0.63	0.00		0.63
34	0.138	0.026	0.026	0.974	0.62	0.00		0.62
35	0.130	0.027	0.027	0.973	0.61	0.00		0.61
36	0.123	0.028	0.028	0.972	0.60	0.00		0.60
37	0.116	0.029	0.029	0.971	0.60	0.00		0.60
38	0.109	0.031	0.031	0.969	0.59	0.00		0.59
39	0.103	0.032	0.032	0.968	0.59	0.00		0.59
40	0.097	0.034	0.034	0.966	0.59	0.00		0.59
41	0.092	0.036	0.036	0.964	0.59	0.00		0.59
42	0.087	0.039	0.039	0.961	0.59	0.00		0.59
43	0.082	0.041	0.041	0.959	0.59	0.00		0.59
44	0.077	0.044	0.044	0.956	0.60	0.00		0.60
45	0.073	0.047	0.047	0.953	0.60	0.00		0.60
46	0.069	0.051	0.051	0.949	0.62	0.00		0.62
47	0.065	0.056	0.056	0.944	0.63	0.00		0.63
48	0.061	0.061	0.061	0.939	0.65	0.00		0.65
49	0.058	0.067	0.067	0.933	0.68	0.00		0.68
50	0.054	0.075	0.075	0.925	0.71	0.00		0.71
51	0.051	0.084	0.084	0.916	0.76	0.00		0.76
52	0.048	0.096	0.096	0.904	0.81	0.00		0.81
53	0.046	0.111	0.111	0.889	0.89	0.00		0.89
54	0.043	0.133	0.133	0.867	1.00	0.00		1.00
55	0.041	0.163	0.163	0.837	1.16	0.00		1.16
56	0.038	0.209	0.209	0.791	1.40	0.00		1.40
57	0.036	0.289	0.289	0.711	1.83	0.00		1.83
58	0.034	0.455	0.455	0.545	2.72	0.00		2.72
59	0.032	0.990	0.990	0.010	5.58	0.00		5.58
Totals					62.02	0.00		62.02

Notes
Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Erosion Value Calculation Sheet with delay options

Sheet Nr. 6

Client/Authority
SBC

Project name		**Option:**	**Delay (yrs)**	Prepared (date)	
Scalby Ness Strategy - Year 5 Preferred Strategy w		Do Minimum - Phased Work S	40	Printed	14/05/03
Project reference	1,404.00	Do Something - Full Scheme	60	Prepared by	dgc
Base date for estimates (year 0)	Dec 01	Do Something - Partial Schem	60	Checked by	
Scaling factor (e.g. £m, £k, £)	£k			Checked date	
Discount rate	6%				

Ref	Asset Description	MV £k	Year	Prob of loss without project in year	Without Project	Do Minimum - Phased Work Short to Long Term	Do Something - Full Scheme	Do Something - Partial Scheme + Maintenance
					Expected value of asset losses £k			
0	Property Yr 2	3571.00	4	0.03	84.86	8.25	2.57	2.57
0	Property Yr 2	3571.00	5	0.95	2,535.04	246.46	76.85	76.85
0	Property Yr 2	3571.00	6	0.02	50.35	4.89	1.53	1.53
1	Scalby CP+ Sea Life Cen 0yr	396.28	4	0.05	15.69	1.53	0.48	0.48
2	YW WWTW	320	5	0.95	227.17	22.09	6.89	6.89
3	YW WWTW	320	4	0.05	12.67	1.23	0.38	0.38
4	Scalby CP+ Sea Life Cen 1yr	396.28	5	0.95	281.32	27.35	8.53	8.53
5	Scalby CP+ Sea Life Cen 2yr	396.28	6	1	279.36	27.16	8.47	8.47
6	Scalby CP+ Sea Life Cen 3yr	396.28	7	1	263.55	25.62	7.99	7.99
7	Scalby CP+ Sea Life Cen 4yr	396.28	8	1	248.63	24.17	7.54	7.54
8	Scalby CP+ Sea Life Cen 5yr	396.28	9	1	234.56	22.80	7.11	7.11
9	Scalby CP+ Sea Life Cen 6yr	396.28	10	1	221.28	21.51	6.71	6.71
10	Scalby CP+ Sea Life Cen 7yr	396.28	11	1	208.76	20.30	6.33	6.33
11	Scalby CP+ Sea Life Cen 8yr	396.28	12	1	196.94	19.15	5.97	5.97
12	Scalby CP+ Sea Life Cen 9yr	396.28	13	1	185.79	18.06	5.63	5.63
12	Scalby CP+ Sea Life Cen 10yr	396.28	14	1	175.28	17.04	5.31	5.31
12	Property Yr 5	302.00	9	0.15	26.81	2.61	0.81	0.81
13	Property Yr 5	302.00	10	0.75	126.48	12.30	3.83	3.83
14	Property Yr 5	302.00	11	0.1	15.91	1.55	0.48	0.48
15	Property Yr 15	402.00	15	0.15	25.16	2.45	0.76	0.76
16	Property Yr 15	402.00	20	0.75	94.01	9.14	2.85	2.85
17	Property Yr 15	402.00	25	0.1	9.37	0.91	0.28	0.28
18	Property Yr 30	255.00	30	0.25	11.10	1.08	0.34	0.34
19	Property Yr 30	255.00	35	0.5	16.59	1.61	0.50	0.50
20	Property Yr 30	255.00	40	0.25	6.20	0.60	0.19	0.19
21	Property Yr 45	673.00	45	0.25	12.22	1.19	0.37	0.37
22	Property Yr 45	673.00	50	0.5	18.27	1.78	0.55	0.55
23	Property Yr 45	673.00	55	0.25	6.83	0.66	0.21	0.21
24	Property Yr 60	657.00	65	0.25	3.72	0.36	0.11	0.11
25	Property Yr 60	657.00	70	0.75	8.34	0.81	0.25	0.25
26	H&S Works following failure	250.00	4	0.03	5.94	0.58	0.18	0.18
27	H&S Works following failure	250.00	5	0.95	177.47	17.25	5.38	5.38
28	H&S Works following failure	250.00	6	0.02	3.52	0.34	0.11	0.11
29					-	-	-	-
30					-	-	-	-
31					-	-	-	-
32					-	-	-	-
33	[For property losses see Tables 4.6 A & B]				-	-	-	-
34					-	-	-	-
35					-	-	-	-
36					-	-	-	-
37					-	-	-	-
38					-	-	-	-
39					-	-	-	-
40					-	-	-	-
41					-	-	-	-
42					-	-	-	-
43					-	-	-	-
44					-	-	-	-
45					-	-	-	-
46					-	-	-	-
47					-	-	-	-
48					-	-	-	-
49					-	-	-	-
50					-	-	-	-
51					-	-	-	-
52					-	-	-	-
53					-	-	-	-
54					-	-	-	-
55					-	-	-	-
56					-	-	-	-
57					-	-	-	-
58					-	-	-	-
59					-	-	-	-
Totals		22672.08			5789.17	562.84	175.49	175.49

Notes
Make one entry in the description column for each property (or group of properties) as this determines subsequent calculation
MV = risk free market value at base date for estimate - must be entered on each line when probaility distribution is used
Equivalent annual value = MV x discount rate (assumes infinite life)
Year is year by which there is the cumulative probability of loss shown
If no distribution is used enter year after expected year of loss and enter 1.0 in probability column
(i.e. certainty of loss before start of year so year must be 1.0 or greater)
(e.g. If certain of loss in year 5 enter 6 in year column and 1 in probability column)
Asset value in first year for each property (or group) shown is cumulative to the year of first loss
Asset value in subsequent years for each property is additional value for that property if life extended

Present Value Costs for all options

Sheet Nr. 7

Client/Authority
SBC

Project name
Scalby Ness Strategy - Year 5 Preferred Stra
Project reference 1,404.00
Base date for estimates (year 0 Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Results £k

	Option 1 (Do nothing)	Option 2 Do Minimum - Phased W	Option 3 Do Something - Full Sch	Option 4 Do Something - Partial S
PV total costs	0.00	1143.04	2415.75	1769.44

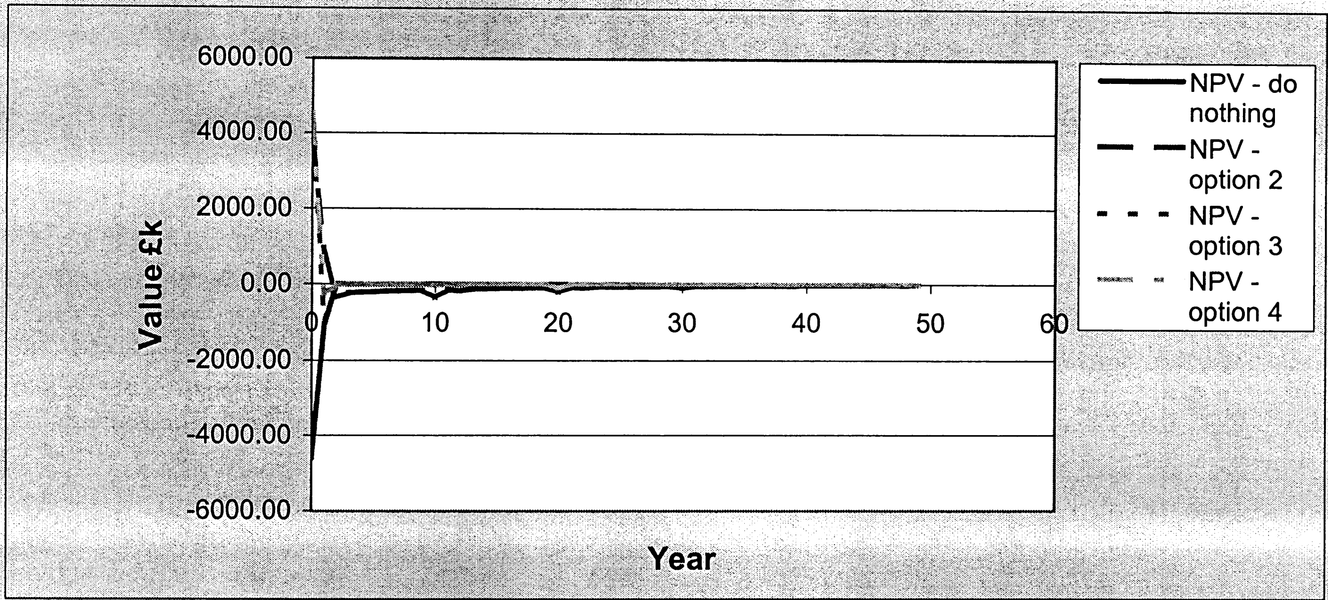
Prepared (date)
Printed 14/05/03
Prepared by dqc
Checked by
Checked date

year	Discount Factor	Option 1 Capital	(Do nothing) Maint.	Other	TOTALS: Cash	PV	Option 2 Mon	Do Minimum - Phased W Works	Emergency	TOTALS: Cash	PV
cash sum		0	0	0	0.00	0.00	180	2556	600	3336.00	1143.04
0	1.000				0.00	0.00	3	408		411.00	411.00
1	0.943				0.00	0.00	3			3.00	2.83
2	0.890				0.00	0.00	3	40	100	143.00	127.27
3	0.840				0.00	0.00	3			3.00	2.52
4	0.792				0.00	0.00	3			3.00	2.38
5	0.747				0.00	0.00	3			3.00	2.24
6	0.705				0.00	0.00	3			3.00	2.11
7	0.665				0.00	0.00	3			3.00	2.00
8	0.627				0.00	0.00	3			3.00	1.88
9	0.592				0.00	0.00	3			3.00	1.78
10	0.558				0.00	0.00	3	368		371.00	207.16
11	0.527				0.00	0.00	3			3.00	1.58
12	0.497				0.00	0.00	3		100	103.00	51.19
13	0.469				0.00	0.00	3			3.00	1.41
14	0.442				0.00	0.00	3			3.00	1.33
15	0.417				0.00	0.00	3			3.00	1.25
16	0.394				0.00	0.00	3			3.00	1.18
17	0.371				0.00	0.00	3			3.00	1.11
18	0.350				0.00	0.00	3			3.00	1.05
19	0.331				0.00	0.00	3			3.00	0.99
20	0.312				0.00	0.00	3	408		411.00	128.15
21	0.294				0.00	0.00	3			3.00	0.88
22	0.278				0.00	0.00	3		100	103.00	28.58
23	0.262				0.00	0.00	3			3.00	0.79
24	0.247				0.00	0.00	3			3.00	0.74
25	0.233				0.00	0.00	3			3.00	0.70
26	0.220				0.00	0.00	3			3.00	0.66
27	0.207				0.00	0.00	3			3.00	0.62
28	0.196				0.00	0.00	3			3.00	0.59
29	0.185				0.00	0.00	3			3.00	0.55
30	0.174				0.00	0.00	3	308		311.00	54.15
31	0.164				0.00	0.00	3			3.00	0.49
32	0.155				0.00	0.00	3		100	103.00	15.96
33	0.146				0.00	0.00	3			3.00	0.44
34	0.138				0.00	0.00	3			3.00	0.41
35	0.130				0.00	0.00	3			3.00	0.39
36	0.123				0.00	0.00	3			3.00	0.37
37	0.116				0.00	0.00	3			3.00	0.35
38	0.109				0.00	0.00	3			3.00	0.33
39	0.103				0.00	0.00	3			3.00	0.31
40	0.097				0.00	0.00	3	408		411.00	39.96
41	0.092				0.00	0.00	3			3.00	0.28
42	0.087				0.00	0.00	3		100	103.00	8.91
43	0.082				0.00	0.00	3			3.00	0.24
44	0.077				0.00	0.00	3			3.00	0.23
45	0.073				0.00	0.00	3			3.00	0.22
46	0.069				0.00	0.00	3			3.00	0.21
47	0.065				0.00	0.00	3			3.00	0.19
48	0.061				0.00	0.00	3			3.00	0.18
49	0.058				0.00	0.00	3			3.00	0.17
50	0.054				0.00	0.00	3	308		311.00	16.88
51	0.051				0.00	0.00	3			3.00	0.15
52	0.048				0.00	0.00	3		100	103.00	4.98
53	0.046				0.00	0.00	3			3.00	0.14
54	0.043				0.00	0.00	3			3.00	0.13
55	0.041				0.00	0.00	3			3.00	0.12
56	0.038				0.00	0.00	3			3.00	0.11
57	0.036				0.00	0.00	3			3.00	0.11
58	0.034				0.00	0.00	3			3.00	0.10
59	0.032				0.00	0.00	3	308		311.00	9.99

year	Discount Factor	Option 3 Capital	Do Something - Full Sche Main	All Mon	TOTALS: Cash	PV	Option 4 Capital	Do Something - Partial S Maint.	All Mon	TOTALS: Cash	PV
cash sum		3056	61	180	3297.00	2415.75	2338	240	180	2758.00	1769.44
0	1.000	100	2	3	105.00	105.00	100	2	3	105.00	105.00
1	0.943	2156	1	3	2160.00	2037.74	1438	2	3	1443.00	1361.32
2	0.890	40	1	3	44.00	39.16	40	2	3	45.00	40.05
3	0.840		1	3	4.00	3.36		2	3	5.00	4.20
4	0.792		1	3	4.00	3.17		2	3	5.00	3.96
5	0.747		1	3	4.00	2.99		2	3	5.00	3.74
6	0.705		1	3	4.00	2.82		2	3	5.00	3.52
7	0.665		1	3	4.00	2.66		2	3	5.00	3.33
8	0.627		1	3	4.00	2.51		2	3	5.00	3.14
9	0.592		1	3	4.00	2.37		2	3	5.00	2.96
10	0.558	60	1	3	64.00	35.74	60	2	3	65.00	36.30
11	0.527		1	3	4.00	2.11		2	3	5.00	2.63
12	0.497		1	3	4.00	1.99		2	3	5.00	2.48
13	0.469		1	3	4.00	1.88		2	3	5.00	2.34
14	0.442		1	3	4.00	1.77		2	3	5.00	2.21
15	0.417		1	3	4.00	1.67		2	3	5.00	2.09
16	0.394		1	3	4.00	1.57		2	3	5.00	1.97
17	0.371		1	3	4.00	1.49		2	3	5.00	1.86
18	0.350		1	3	4.00	1.40		2	3	5.00	1.75
19	0.331		1	3	4.00	1.32		2	3	5.00	1.65
20	0.312	350	1	3	354.00	110.38	350	5	3	358.00	111.63
21	0.294		1	3	4.00	1.18		5	3	8.00	2.35
22	0.278		1	3	4.00	1.11		5	3	8.00	2.22
23	0.262		1	3	4.00	1.05		5	3	8.00	2.09
24	0.247		1	3	4.00	0.99		5	3	8.00	1.98
25	0.233		1	3	4.00	0.93		5	3	8.00	1.86
26	0.220		1	3	4.00	0.88		5	3	8.00	1.76
27	0.207		1	3	4.00	0.83		5	3	8.00	1.66
28	0.196		1	3	4.00	0.78		5	3	8.00	1.57
29	0.185		1	3	4.00	0.74		5	3	8.00	1.48
30	0.174		1	3	4.00	0.70		5	3	8.00	1.39
31	0.164		1	3	4.00	0.66		5	3	8.00	1.31
32	0.155		1	3	4.00	0.62		5	3	8.00	1.24
33	0.146		1	3	4.00	0.58		5	3	8.00	1.17
34	0.138		1	3	4.00	0.55		5	3	8.00	1.10
35	0.130		1	3	4.00	0.52		5	3	8.00	1.04
36	0.123		1	3	4.00	0.49		5	3	8.00	0.98
37	0.116		1	3	4.00	0.46		5	3	8.00	0.93
38	0.109		1	3	4.00	0.44		5	3	8.00	0.87
39	0.103		1	3	4.00	0.41		5	3	8.00	0.82
40	0.097	350	1	3	354.00	34.42	350	5	3	358.00	34.81
41	0.092		1	3	4.00	0.37		5	3	8.00	0.73
42	0.087		1	3	4.00	0.35		5	3	8.00	0.69
43	0.082		1	3	4.00	0.33		5	3	8.00	0.65
44	0.077		1	3	4.00	0.31		5	3	8.00	0.62
45	0.073		1	3	4.00	0.29		5	3	8.00	0.58
46	0.069		1	3	4.00	0.27		5	3	8.00	0.55
47	0.065		1	3	4.00	0.26		5	3	8.00	0.52
48	0.061		1	3	4.00	0.24		5	3	8.00	0.49
49	0.058		1	3	4.00	0.23		5	3	8.00	0.46
50	0.054		1	3	4.00	0.22		5	3	8.00	0.43
51	0.051		1	3	4.00	0.20		5	3	8.00	0.41
52	0.048		1	3	4.00	0.19		5	3	8.00	0.39
53	0.046		1	3	4.00	0.18		5	3	8.00	0.36
54	0.043		1	3	4.00	0.17		5	3	8.00	0.34
55	0.041		1	3	4.00	0.16		5	3	8.00	0.32
56	0.038		1	3	4.00	0.15		5	3	8.00	0.31
57	0.036		1	3	4.00	0.14		5	3	8.00	0.29
58	0.034		1	3	4.00	0.14		5	3	8.00	0.27
59	0.032		1	3	4.00	0.13		5	3	8.00	0.26

Net Present Value over time

Client/Authority		**Sheet Nr.**	8
SBC			
Project name		Prepared (date)	16/09/99
Scalby Ness Strategy - Year 5 Preferred Strat		Printed	14/05/03
Project reference	1,404.00	Prepared by	DR
Base date for estimates (year 0)	Dec 01	Checked by	GS
Scaling factor (e.g. £m, £k, £)	£k	Checked date	16/10/99
Discount rate	6%		



SPREADSHEETS FOR YEAR 7 DEFERRED LOSSES

Project Summary Sheet

Client/Authority		Prepared (date)	14 8 02
SBC		Printed	14/05/03
Project name		Prepared by	dgc
Scalby Ness Strategy - **Year 7** Preferred Strategy with SLC & CP losses		Checked by	
Project reference	1404	Checked date	
Base date for estimates (year 0)	Dec 01		
Scaling factor (e.g. £m, £k, £)	£k	(used for all costs, losses and benefits)	
Principle land use band	B	(A to E)	
Discount rate	6%		

Costs and benefits of options

	Costs and benefits £k				
	No Project	Option 2	Option 3	Option 4	
PV costs PVc	0.00	1,143.04	2,415.75	1,769.44	
PV damage PVd	5,093.46	4,573.04	55.19	55.19	
PV damage avoided		520.43	5,038.27	5,038.27	
PV assets Pva					
PV asset protection benefits		0.00	0.00	0.00	
Total PV benefits PVb		520.43	5,038.27	5,038.27	
Net Present Value NPV		-622.61	2,622.52	3,268.83	
Average benefit/cost ratio		0.5	2.1	2.8	
Incremental benefit/cost ratio			3.55	0.00	
		-	-	Highest b/c	

Brief description of options:

Option 1	Do nothing
Option 2	Do Minimum - Phased Work Short to Long Term
Option 3	Do Something - Full Scheme
Option 4	Do Something - Partial Scheme + Maintenance

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting
2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
   PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
   PV benefits calculated as PV damage avoided + PV asset protection benefits
3) Incremental benefit/cost ratio is calculated as:
   (PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Damage Cost Calculation Sheet - Do Nothing (Exponential)

Sheet Nr. 2

Client/Authority
SBC
Project name
Scalby Ness Strategy - Year 7 Preferred Strategy
Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Option:
Do nothing

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 5152.34
Remaining structure life 2
Ave Annual Damage (overtopping) £k 0.00 /yr
Initial probability of failure 0.800
Calculations assum **0.99** **prob of failure in year 2**
Calculated factors: -0.01005 -0.30743
PV Total Damage £k 5093.46 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	Prob that breach/failure: has not occurred	PV damage due to: breach or failure	PV damage due to: over-topping	Other damage (specify)	PV total damage
0	1.000	0.800	0.800	0.200	4121.87	0.00		4121.87
1	0.943	0.990	0.198	0.002	962.42	0.00		962.42
2	0.890	1.000	0.002	0.000	9.17	0.00		9.17
3	0.840	1.000	0.000	0.000	0.00	0.00		0.00
4	0.792	1.000	0.000	0.000	0.00	0.00		0.00
5	0.747	1.000	0.000	0.000	0.00	0.00		0.00
6	0.705	1.000	0.000	0.000	0.00	0.00		0.00
7	0.665	1.000	0.000	0.000	0.00	0.00		0.00
8	0.627	1.000	0.000	0.000	0.00	0.00		0.00
9	0.592	1.000	0.000	0.000	0.00	0.00		0.00
10	0.558	1.000	0.000	0.000	0.00	0.00		0.00
11	0.527	1.000	0.000	0.000	0.00	0.00		0.00
12	0.497	1.000	0.000	0.000	0.00	0.00		0.00
13	0.469	1.000	0.000	0.000	0.00	0.00		0.00
14	0.442	1.000	0.000	0.000	0.00	0.00		0.00
15	0.417	1.000	0.000	0.000	0.00	0.00		0.00
16	0.394	1.000	0.000	0.000	0.00	0.00		0.00
17	0.371	1.000	0.000	0.000	0.00	0.00		0.00
18	0.350	1.000	0.000	0.000	0.00	0.00		0.00
19	0.331	1.000	0.000	0.000	0.00	0.00		0.00
20	0.312	1.000	0.000	0.000	0.00	0.00		0.00
21	0.294	1.000	0.000	0.000	0.00	0.00		0.00
22	0.278	1.000	0.000	0.000	0.00	0.00		0.00
23	0.262	1.000	0.000	0.000	0.00	0.00		0.00
24	0.247	1.000	0.000	0.000	0.00	0.00		0.00
25	0.233	1.000	0.000	0.000	0.00	0.00		0.00
26	0.220	1.000	0.000	0.000	0.00	0.00		0.00
27	0.207	1.000	0.000	0.000	0.00	0.00		0.00
28	0.196	1.000	0.000	0.000	0.00	0.00		0.00
29	0.185	1.000	0.000	0.000	0.00	0.00		0.00
30	0.174	1.000	0.000	0.000	0.00	0.00		0.00
31	0.164	1.000	0.000	0.000	0.00	0.00		0.00
32	0.155	1.000	0.000	0.000	0.00	0.00		0.00
33	0.146	1.000	0.000	0.000	0.00	0.00		0.00
34	0.138	1.000	0.000	0.000	0.00	0.00		0.00
35	0.130	1.000	0.000	0.000	0.00	0.00		0.00
36	0.123	1.000	0.000	0.000	0.00	0.00		0.00
37	0.116	1.000	0.000	0.000	0.00	0.00		0.00
38	0.109	1.000	0.000	0.000	0.00	0.00		0.00
39	0.103	1.000	0.000	0.000	0.00	0.00		0.00
40	0.097	1.000	0.000	0.000	0.00	0.00		0.00
41	0.092	1.000	0.000	0.000	0.00	0.00		0.00
42	0.087	1.000	0.000	0.000	0.00	0.00		0.00
43	0.082	1.000	0.000	0.000	0.00	0.00		0.00
44	0.077	1.000	0.000	0.000	0.00	0.00		0.00
45	0.073	1.000	0.000	0.000	0.00	0.00		0.00
46	0.069	1.000	0.000	0.000	0.00	0.00		0.00
47	0.065	1.000	0.000	0.000	0.00	0.00		0.00
48	0.061	1.000	0.000	0.000	0.00	0.00		0.00
49	0.058	1.000	0.000	0.000	0.00	0.00		0.00
50	0.054	1.000	0.000	0.000	0.00	0.00		0.00
51	0.051	1.000	0.000	0.000	0.00	0.00		0.00
52	0.048	1.000	0.000	0.000	0.00	0.00		0.00
53	0.046	1.000	0.000	0.000	0.00	0.00		0.00
54	0.043	1.000	0.000	0.000	0.00	0.00		0.00
55	0.041	1.000	0.000	0.000	0.00	0.00		0.00
56	0.038	1.000	0.000	0.000	0.00	0.00		0.00
57	0.036	1.000	0.000	0.000	0.00	0.00		0.00
58	0.034	1.000	0.000	0.000	0.00	0.00		0.00
59	0.032	1.000	0.000	0.000	0.00	0.00		0.00
Totals					5093.46	0.00		5093.46

Notes
Complete one spreadsheet for the 'do nothing' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
It is assumed that breaches are not repaired and that once breach damage has occurred it will not recur.
A separate check should be made to ensure that overtopping damages do not exceed write off values.
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 3

Client/Authority
SBC
Project name
Scalby Ness Strategy - Year 7 Preferred Strategy with
Option:
Do Minimum - Phased Work Short to Long Term

Project reference	1404					
Base date for estimates (year 0)	Dec 01					
Scaling factor (e.g. £m, £k, £)	£k				**Prepared (date)**	
Discount rate	6%				**Printed**	14/05/03
		PV breach/failure	£k	500.92	**Prepared by**	dgc
Remaining structure life	60	**Ave Annual Damage**			**Checked by**	
Initial probability of failure	0.500	**(overtopping)**	£k	/yr	**Checked date**	
Calculations assume 0.99	prob of failure in year 60					
Calculated factors: -0.01005	-0.16684	**PV Total Damage**	£k	4573.04 (calculated below)		

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.500	0.500	0.500	250.46	0.00		250.46
1	0.943	0.501	0.501	0.499	236.95	0.00		236.95
2	0.890	0.503	0.503	0.497	224.17	0.00		224.17
3	0.840	0.504	0.504	0.496	212.10	0.00		212.10
4	0.792	0.506	0.506	0.494	200.69	0.00		200.69
5	0.747	0.507	0.507	0.493	189.90	0.00		189.90
6	0.705	0.509	0.509	0.491	179.70	0.00		179.70
7	0.665	0.510	0.510	0.490	170.05	0.00		170.05
8	0.627	0.512	0.512	0.488	160.94	0.00		160.94
9	0.592	0.514	0.514	0.486	152.32	0.00		152.32
10	0.558	0.515	0.515	0.485	144.18	0.00		144.18
11	0.527	0.517	0.517	0.483	136.47	0.00		136.47
12	0.497	0.519	0.519	0.481	129.19	0.00		129.19
13	0.469	0.521	0.521	0.479	122.31	0.00		122.31
14	0.442	0.523	0.523	0.477	115.80	0.00		115.80
15	0.417	0.525	0.525	0.475	109.65	0.00		109.65
16	0.394	0.527	0.527	0.473	103.83	0.00		103.83
17	0.371	0.529	0.529	0.471	98.33	0.00		98.33
18	0.350	0.531	0.531	0.469	93.13	0.00		93.13
19	0.331	0.533	0.533	0.467	88.21	0.00		88.21
20	0.312	0.535	0.535	0.465	83.56	0.00		83.56
21	0.294	0.537	0.537	0.463	79.16	0.00		79.16
22	0.278	0.540	0.540	0.460	75.01	0.00		75.01
23	0.262	0.542	0.542	0.458	71.08	0.00		71.08
24	0.247	0.544	0.544	0.456	67.36	0.00		67.36
25	0.233	0.547	0.547	0.453	63.85	0.00		63.85
26	0.220	0.550	0.550	0.450	60.53	0.00		60.53
27	0.207	0.552	0.552	0.448	57.39	0.00		57.39
28	0.196	0.555	0.555	0.445	54.42	0.00		54.42
29	0.185	0.558	0.558	0.442	51.61	0.00		51.61
30	0.174	0.561	0.561	0.439	48.95	0.00		48.95
31	0.164	0.564	0.564	0.436	46.44	0.00		46.44
32	0.155	0.568	0.568	0.432	44.07	0.00		44.07
33	0.146	0.571	0.571	0.429	41.83	0.00		41.83
34	0.138	0.575	0.575	0.425	39.71	0.00		39.71
35	0.130	0.579	0.579	0.421	37.71	0.00		37.71
36	0.123	0.583	0.583	0.417	35.82	0.00		35.82
37	0.116	0.587	0.587	0.413	34.03	0.00		34.03
38	0.109	0.591	0.591	0.409	32.35	0.00		32.35
39	0.103	0.596	0.596	0.404	30.75	0.00		30.75
40	0.097	0.601	0.601	0.399	29.25	0.00		29.25
41	0.092	0.606	0.606	0.394	27.83	0.00		27.83
42	0.087	0.611	0.611	0.389	26.49	0.00		26.49
43	0.082	0.617	0.617	0.383	25.23	0.00		25.23
44	0.077	0.623	0.623	0.377	24.05	0.00		24.05
45	0.073	0.630	0.630	0.370	22.93	0.00		22.93
46	0.069	0.637	0.637	0.363	21.88	0.00		21.88
47	0.065	0.645	0.645	0.355	20.90	0.00		20.90
48	0.061	0.654	0.654	0.346	19.98	0.00		19.98
49	0.058	0.664	0.664	0.336	19.13	0.00		19.13
50	0.054	0.674	0.674	0.326	18.33	0.00		18.33
51	0.051	0.686	0.686	0.314	17.60	0.00		17.60
52	0.048	0.700	0.700	0.300	16.94	0.00		16.94
53	0.046	0.716	0.716	0.284	16.34	0.00		16.34
54	0.043	0.734	0.734	0.266	15.81	0.00		15.81
55	0.041	0.757	0.757	0.243	15.38	0.00		15.38
56	0.038	0.786	0.786	0.214	15.06	0.00		15.06
57	0.036	0.824	0.824	0.176	14.91	0.00		14.91
58	0.034	0.882	0.882	0.118	15.05	0.00		15.05
59	0.032	0.990	0.990	0.010	15.94	0.00		15.94
Totals					4573.04	0.00		4573.04

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 4

Client/Authority
SBC

Project name
Scalby Ness Strategy - Year 7 Preferred Strategy with

Option:
Do Something - Full Scheme

Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 156.19
Ave Annual Damage (overtopping) £k 0.00 /yr
PV Total Damage £k 55.19 (calculated below)

Remaining structure life 60
Initial probability of failure 0.010
Calculations assume 0.99 prob of failure in year 60
Calculated factors: -0.01005 -1.12231

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	1.56	0.00		1.56
1	0.943	0.010	0.010	0.990	1.50	0.00		1.50
2	0.890	0.010	0.010	0.990	1.44	0.00		1.44
3	0.840	0.011	0.011	0.989	1.39	0.00		1.39
4	0.792	0.011	0.011	0.989	1.34	0.00		1.34
5	0.747	0.011	0.011	0.989	1.29	0.00		1.29
6	0.705	0.011	0.011	0.989	1.24	0.00		1.24
7	0.665	0.011	0.011	0.989	1.19	0.00		1.19
8	0.627	0.012	0.012	0.988	1.15	0.00		1.15
9	0.592	0.012	0.012	0.988	1.11	0.00		1.11
10	0.558	0.012	0.012	0.988	1.07	0.00		1.07
11	0.527	0.013	0.013	0.987	1.03	0.00		1.03
12	0.497	0.013	0.013	0.987	1.00	0.00		1.00
13	0.469	0.013	0.013	0.987	0.96	0.00		0.96
14	0.442	0.013	0.013	0.987	0.93	0.00		0.93
15	0.417	0.014	0.014	0.986	0.90	0.00		0.90
16	0.394	0.014	0.014	0.986	0.87	0.00		0.87
17	0.371	0.015	0.015	0.985	0.84	0.00		0.84
18	0.350	0.015	0.015	0.985	0.82	0.00		0.82
19	0.331	0.015	0.015	0.985	0.79	0.00		0.79
20	0.312	0.016	0.016	0.984	0.77	0.00		0.77
21	0.294	0.016	0.016	0.984	0.75	0.00		0.75
22	0.278	0.017	0.017	0.983	0.72	0.00		0.72
23	0.262	0.017	0.017	0.983	0.70	0.00		0.70
24	0.247	0.018	0.018	0.982	0.68	0.00		0.68
25	0.233	0.018	0.018	0.982	0.67	0.00		0.67
26	0.220	0.019	0.019	0.981	0.65	0.00		0.65
27	0.207	0.020	0.020	0.980	0.63	0.00		0.63
28	0.196	0.020	0.020	0.980	0.62	0.00		0.62
29	0.185	0.021	0.021	0.979	0.60	0.00		0.60
30	0.174	0.022	0.022	0.978	0.59	0.00		0.59
31	0.164	0.023	0.023	0.977	0.58	0.00		0.58
32	0.155	0.024	0.024	0.976	0.57	0.00		0.57
33	0.146	0.025	0.025	0.975	0.56	0.00		0.56
34	0.138	0.026	0.026	0.974	0.55	0.00		0.55
35	0.130	0.027	0.027	0.973	0.54	0.00		0.54
36	0.123	0.028	0.028	0.972	0.54	0.00		0.54
37	0.116	0.029	0.029	0.971	0.53	0.00		0.53
38	0.109	0.031	0.031	0.969	0.53	0.00		0.53
39	0.103	0.032	0.032	0.968	0.52	0.00		0.52
40	0.097	0.034	0.034	0.966	0.52	0.00		0.52
41	0.092	0.036	0.036	0.964	0.52	0.00		0.52
42	0.087	0.039	0.039	0.961	0.52	0.00		0.52
43	0.082	0.041	0.041	0.959	0.53	0.00		0.53
44	0.077	0.044	0.044	0.956	0.53	0.00		0.53
45	0.073	0.047	0.047	0.953	0.54	0.00		0.54
46	0.069	0.051	0.051	0.949	0.55	0.00		0.55
47	0.065	0.056	0.056	0.944	0.56	0.00		0.56
48	0.061	0.061	0.061	0.939	0.58	0.00		0.58
49	0.058	0.067	0.067	0.933	0.60	0.00		0.60
50	0.054	0.075	0.075	0.925	0.63	0.00		0.63
51	0.051	0.084	0.084	0.916	0.67	0.00		0.67
52	0.048	0.096	0.096	0.904	0.72	0.00		0.72
53	0.046	0.111	0.111	0.889	0.79	0.00		0.79
54	0.043	0.133	0.133	0.867	0.89	0.00		0.89
55	0.041	0.163	0.163	0.837	1.03	0.00		1.03
56	0.038	0.209	0.209	0.791	1.25	0.00		1.25
57	0.036	0.289	0.289	0.711	1.63	0.00		1.63
58	0.034	0.455	0.455	0.545	2.42	0.00		2.42
59	0.032	0.990	0.990	0.010	4.97	0.00		4.97
Totals					55.19	0.00		55.19

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 5

Client/Authority
SBC
Project name
Scalby Ness Strategy - Year 7 Preferred Strategy with
Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Option:
Do Something - Partial Scheme + Maintenance

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 156.19
Ave Annual Damage
(overtopping) £k 0.00 /yr

Remaining structure life 60
Initial probability of failure 0.010
Calculations assume 0.99 **prob of failure in year 60**
Calculated factors: -0.01005 -1.12231
PV Total Damage £k 55.19 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	1.56	0.00		1.56
1	0.943	0.010	0.010	0.990	1.50	0.00		1.50
2	0.890	0.010	0.010	0.990	1.44	0.00		1.44
3	0.840	0.011	0.011	0.989	1.39	0.00		1.39
4	0.792	0.011	0.011	0.989	1.34	0.00		1.34
5	0.747	0.011	0.011	0.989	1.29	0.00		1.29
6	0.705	0.011	0.011	0.989	1.24	0.00		1.24
7	0.665	0.011	0.011	0.989	1.19	0.00		1.19
8	0.627	0.012	0.012	0.988	1.15	0.00		1.15
9	0.592	0.012	0.012	0.988	1.11	0.00		1.11
10	0.558	0.012	0.012	0.988	1.07	0.00		1.07
11	0.527	0.013	0.013	0.987	1.03	0.00		1.03
12	0.497	0.013	0.013	0.987	1.00	0.00		1.00
13	0.469	0.013	0.013	0.987	0.96	0.00		0.96
14	0.442	0.013	0.013	0.987	0.93	0.00		0.93
15	0.417	0.014	0.014	0.986	0.90	0.00		0.90
16	0.394	0.014	0.014	0.986	0.87	0.00		0.87
17	0.371	0.015	0.015	0.985	0.84	0.00		0.84
18	0.350	0.015	0.015	0.985	0.82	0.00		0.82
19	0.331	0.015	0.015	0.985	0.79	0.00		0.79
20	0.312	0.016	0.016	0.984	0.77	0.00		0.77
21	0.294	0.016	0.016	0.984	0.75	0.00		0.75
22	0.278	0.017	0.017	0.983	0.72	0.00		0.72
23	0.262	0.017	0.017	0.983	0.70	0.00		0.70
24	0.247	0.018	0.018	0.982	0.68	0.00		0.68
25	0.233	0.018	0.018	0.982	0.67	0.00		0.67
26	0.220	0.019	0.019	0.981	0.65	0.00		0.65
27	0.207	0.020	0.020	0.980	0.63	0.00		0.63
28	0.196	0.020	0.020	0.980	0.62	0.00		0.62
29	0.185	0.021	0.021	0.979	0.60	0.00		0.60
30	0.174	0.022	0.022	0.978	0.59	0.00		0.59
31	0.164	0.023	0.023	0.977	0.58	0.00		0.58
32	0.155	0.024	0.024	0.976	0.57	0.00		0.57
33	0.146	0.025	0.025	0.975	0.56	0.00		0.56
34	0.138	0.026	0.026	0.974	0.55	0.00		0.55
35	0.130	0.027	0.027	0.973	0.54	0.00		0.54
36	0.123	0.028	0.028	0.972	0.54	0.00		0.54
37	0.116	0.029	0.029	0.971	0.53	0.00		0.53
38	0.109	0.031	0.031	0.969	0.53	0.00		0.53
39	0.103	0.032	0.032	0.968	0.52	0.00		0.52
40	0.097	0.034	0.034	0.966	0.52	0.00		0.52
41	0.092	0.036	0.036	0.964	0.52	0.00		0.52
42	0.087	0.039	0.039	0.961	0.52	0.00		0.52
43	0.082	0.041	0.041	0.959	0.53	0.00		0.53
44	0.077	0.044	0.044	0.956	0.53	0.00		0.53
45	0.073	0.047	0.047	0.953	0.54	0.00		0.54
46	0.069	0.051	0.051	0.949	0.55	0.00		0.55
47	0.065	0.056	0.056	0.944	0.56	0.00		0.56
48	0.061	0.061	0.061	0.939	0.58	0.00		0.58
49	0.058	0.067	0.067	0.933	0.60	0.00		0.60
50	0.054	0.075	0.075	0.925	0.63	0.00		0.63
51	0.051	0.084	0.084	0.916	0.67	0.00		0.67
52	0.048	0.096	0.096	0.904	0.72	0.00		0.72
53	0.046	0.111	0.111	0.889	0.79	0.00		0.79
54	0.043	0.133	0.133	0.867	0.89	0.00		0.89
55	0.041	0.163	0.163	0.837	1.03	0.00		1.03
56	0.038	0.209	0.209	0.791	1.25	0.00		1.25
57	0.036	0.289	0.289	0.711	1.63	0.00		1.63
58	0.034	0.455	0.455	0.545	2.42	0.00		2.42
59	0.032	0.990	0.990	0.010	4.97	0.00		4.97
Totals					55.19	0.00		55.19

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Erosion Value Calculation Sheet with delay options

Sheet Nr. 6

Client/Authority
SBC

Project name		**Option:**	**Delay (yrs)**	Prepared (date)	
Scalby Ness Strategy - Year 7 Preferred Strategy w		Do Minimum - Phased Work S	40	Printed	14/05/03
Project reference	1,404.00	Do Something - Full Scheme	60	Prepared by	dgc
Base date for estimates (year 0)	Dec 01	Do Something - Partial Schem	60	Checked by	
Scaling factor (e.g. £m, £k, £)	£k			Checked date	
Discount rate	6%				

Ref	Asset Description	MV £k	Year	Prob of loss without project in year	Expected value of asset losses £k: Without Project	Do Minimum - Phased Work Short to Long Term	Do Something - Full Scheme	Do Something - Partial Scheme + Maintenance
0	Property Yr 2	3571.00	6	0.03	75.52	7.34	2.29	2.29
0	Property Yr 2	3571.00	7	0.95	2,256.17	219.35	68.39	68.39
0	Property Yr 2	3571.00	8	0.02	44.81	4.36	1.36	1.36
1	Scalby CP+ Sea Life Cen 0yr	396.28	6	0.05	13.97	1.36	0.42	0.42
2	YW WWTW	320	7	0.95	202.18	19.66	6.13	6.13
3	YW WWTW	320	6	0.05	11.28	1.10	0.34	0.34
4	Scalby CP+ Sea Life Cen 1yr	396.28	7	0.95	250.37	24.34	7.59	7.59
5	Scalby CP+ Sea Life Cen 2yr	396.28	8	1	248.63	24.17	7.54	7.54
6	Scalby CP+ Sea Life Cen 3yr	396.28	9	1	234.56	22.80	7.11	7.11
7	Scalby CP+ Sea Life Cen 4yr	396.28	10	1	221.28	21.51	6.71	6.71
8	Scalby CP+ Sea Life Cen 5yr	396.28	11	1	208.76	20.30	6.33	6.33
9	Scalby CP+ Sea Life Cen 6yr	396.28	12	1	196.94	19.15	5.97	5.97
10	Scalby CP+ Sea Life Cen 7yr	396.28	13	1	185.79	18.06	5.63	5.63
11	Scalby CP+ Sea Life Cen 8yr	396.28	14	1	175.28	17.04	5.31	5.31
12	Scalby CP+ Sea Life Cen 9yr	396.28	15	1	165.35	16.08	5.01	5.01
12	Scalby CP+ Sea Life Cen 10yr	396.28	16	1	155.99	15.17	4.73	4.73
12	Property Yr 5	302.00	11	0.15	23.86	2.32	0.72	0.72
13	Property Yr 5	302.00	12	0.75	112.56	10.94	3.41	3.41
14	Property Yr 5	302.00	13	0.1	14.16	1.38	0.43	0.43
15	Property Yr 15	402.00	17	0.15	22.39	2.18	0.68	0.68
16	Property Yr 15	402.00	22	0.75	83.67	8.13	2.54	2.54
17	Property Yr 15	402.00	27	0.1	8.34	0.81	0.25	0.25
18	Property Yr 30	255.00	32	0.25	9.88	0.96	0.30	0.30
19	Property Yr 30	255.00	37	0.5	14.76	1.44	0.45	0.45
20	Property Yr 30	255.00	42	0.25	5.52	0.54	0.17	0.17
21	Property Yr 45	673.00	47	0.25	10.88	1.06	0.33	0.33
22	Property Yr 45	673.00	52	0.5	16.26	1.58	0.49	0.49
23	Property Yr 45	673.00	57	0.25	6.07	0.59	0.18	0.18
24	Property Yr 60	657.00	67	0.25	3.31	0.32	0.10	0.10
25	Property Yr 60	657.00	72	0.75	7.42	0.72	0.23	0.23
26	H&S Works following failure	250.00	6	0.03	5.29	0.51	0.16	0.16
27	H&S Works following failure	250.00	7	0.95	157.95	15.36	4.79	4.79
28	H&S Works following failure	250.00	8	0.02	3.14	0.30	0.10	0.10
29					-	-	-	-
30					-	-	-	-
31					-	-	-	-
32					-	-	-	-
33	[For property losses see Tables 4.6 A & B]				-	-	-	-
34					-	-	-	-
35					-	-	-	-
36					-	-	-	-
37					-	-	-	-
38					-	-	-	-
39					-	-	-	-
40					-	-	-	-
41					-	-	-	-
42					-	-	-	-
43					-	-	-	-
44					-	-	-	-
45					-	-	-	-
46					-	-	-	-
47					-	-	-	-
48					-	-	-	-
49					-	-	-	-
50					-	-	-	-
51					-	-	-	-
52					-	-	-	-
53					-	-	-	-
54					-	-	-	-
55					-	-	-	-
56					-	-	-	-
57					-	-	-	-
58					-	-	-	-
59					-	-	-	-
Totals		22672.08			5152.34	500.92	156.19	156.19

Notes
Make one entry in the description column for each property (or group of properties) as this determines subsequent calculation
MV = risk free market value at base date for estimate - must be entered on each line when probaility distribution is used
Equivalent annual value = MV x discount rate (assumes infinite life)
Year is year by which there is the cumulative probability of loss shown
If no distribution is used enter year after expected year of loss and enter 1.0 in probability column
(i.e. certainty of loss before start of year so year must be 1.0 or greater)
(e.g. If certain of loss in year 5 enter 6 in year column and 1 in probability column)
Asset value in first year for each property (or group) shown is cumulative to the year of first loss
Asset value in subsequent years for each property is additional value for that property if life extended

Present Value Costs for all options

Sheet Nr. 7

Client/Authority
SBC

Project name
Scalby Ness Strategy - Year 7 Preferred Stra
Project reference 1,404.00
Base date for estimates (year 0 Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

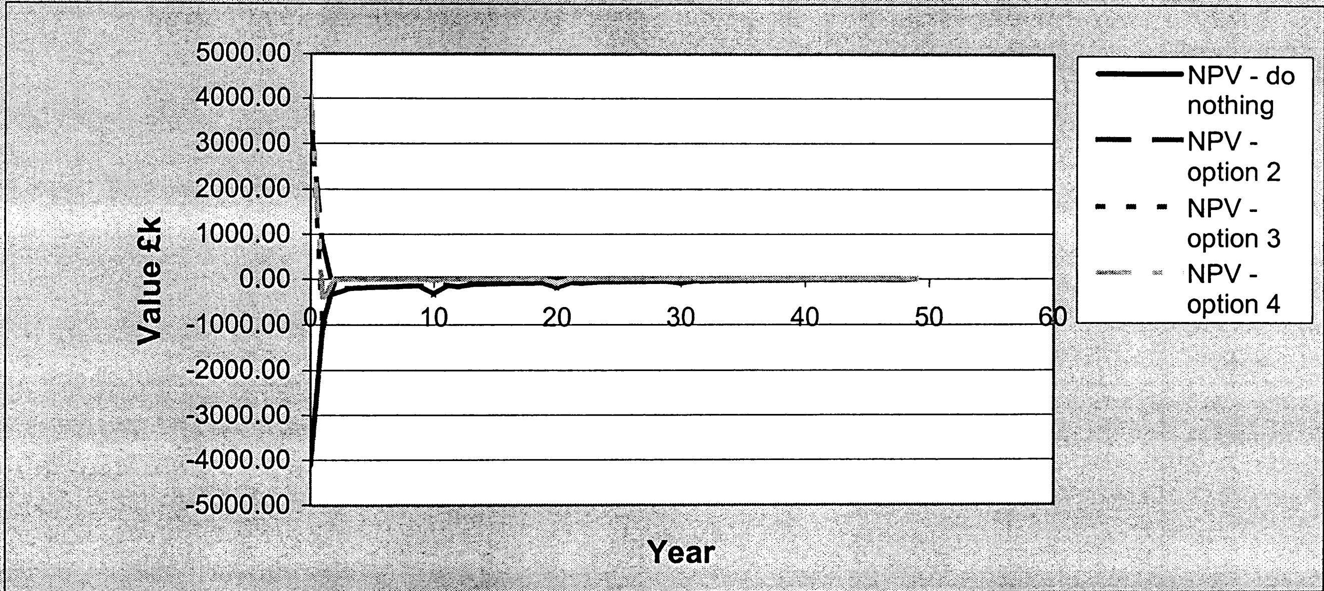
Results £k	Option 1 (Do nothing)	Option 2 Do Minimum - Phased W	Option 3 Do Something - Full Sch	Option 4 Do Something - Partial S
PV total costs	0.00	1143.04	2415.75	1769.44

Prepared (date)	
Printed	14/05/03
Prepared by	dqc
Checked by	
Checked date	

		Option 1 (Do nothing)			TOTALS:		Option 2 Do Minimum - Phased W			TOTALS:		Option 3 Do Something - Full Sche			TOTALS:		Option 4 Do Something - Partial S			TOTALS:	
		Capital	Maint.	Other	Cash	PV	Mon	Works	Emergency	Cash	PV	Capital	Main	All Mon	Cash	PV	Capital	Maint.	All Mon	Cash	PV
	cash sum	0	0	0	0.00	0.00	180	2556	600	3336.00	1143.04	3056	61	180	3297.00	2415.75	2338	240	180	2758.00	1769.44
year	Discount Factor																				
0	1.000				0.00	0.00	3	408		411.00	411.00	100	2	3	105.00	105.00	100	2	3	105.00	105.00
1	0.943				0.00	0.00	3			3.00	2.83	2156	1	3	2160.00	2037.74	1438	2	3	1443.00	1361.32
2	0.890				0.00	0.00	3	40	100	143.00	127.27	40	1	3	44.00	39.16	40	2	3	45.00	40.05
3	0.840				0.00	0.00	3			3.00	2.52		1	3	4.00	3.36		2	3	5.00	4.20
4	0.792				0.00	0.00	3			3.00	2.38		1	3	4.00	3.17		2	3	5.00	3.96
5	0.747				0.00	0.00	3			3.00	2.24		1	3	4.00	2.99		2	3	5.00	3.74
6	0.705				0.00	0.00	3			3.00	2.11		1	3	4.00	2.82		2	3	5.00	3.52
7	0.665				0.00	0.00	3			3.00	2.00		1	3	4.00	2.66		2	3	5.00	3.33
8	0.627				0.00	0.00	3			3.00	1.88		1	3	4.00	2.51		2	3	5.00	3.14
9	0.592				0.00	0.00	3			3.00	1.78		1	3	4.00	2.37		2	3	5.00	2.96
10	0.558				0.00	0.00	3	368		371.00	207.16	60	1	3	64.00	35.74	60	2	3	65.00	36.30
11	0.527				0.00	0.00	3			3.00	1.58		1	3	4.00	2.11		2	3	5.00	2.63
12	0.497				0.00	0.00	3		100	103.00	51.19		1	3	4.00	1.99		2	3	5.00	2.48
13	0.469				0.00	0.00	3			3.00	1.41		1	3	4.00	1.88		2	3	5.00	2.34
14	0.442				0.00	0.00	3			3.00	1.33		1	3	4.00	1.77		2	3	5.00	2.21
15	0.417				0.00	0.00	3			3.00	1.25		1	3	4.00	1.67		2	3	5.00	2.09
16	0.394				0.00	0.00	3			3.00	1.18		1	3	4.00	1.57		2	3	5.00	1.97
17	0.371				0.00	0.00	3			3.00	1.11		1	3	4.00	1.49		2	3	5.00	1.86
18	0.350				0.00	0.00	3			3.00	1.05		1	3	4.00	1.40		2	3	5.00	1.75
19	0.331				0.00	0.00	3			3.00	0.99		1	3	4.00	1.32		2	3	5.00	1.65
20	0.312				0.00	0.00	3	408		411.00	128.15	350	1	3	354.00	110.38	350	5	3	358.00	111.63
21	0.294				0.00	0.00	3			3.00	0.88		1	3	4.00	1.18		5	3	8.00	2.35
22	0.278				0.00	0.00	3		100	103.00	28.58		1	3	4.00	1.11		5	3	8.00	2.22
23	0.262				0.00	0.00	3			3.00	0.79		1	3	4.00	1.05		5	3	8.00	2.09
24	0.247				0.00	0.00	3			3.00	0.74		1	3	4.00	0.99		5	3	8.00	1.98
25	0.233				0.00	0.00	3			3.00	0.70		1	3	4.00	0.93		5	3	8.00	1.86
26	0.220				0.00	0.00	3			3.00	0.66		1	3	4.00	0.88		5	3	8.00	1.76
27	0.207				0.00	0.00	3			3.00	0.62		1	3	4.00	0.83		5	3	8.00	1.66
28	0.196				0.00	0.00	3			3.00	0.59		1	3	4.00	0.78		5	3	8.00	1.57
29	0.185				0.00	0.00	3			3.00	0.55		1	3	4.00	0.74		5	3	8.00	1.48
30	0.174				0.00	0.00	3	308		311.00	54.15		1	3	4.00	0.70		5	3	8.00	1.39
31	0.164				0.00	0.00	3			3.00	0.49		1	3	4.00	0.66		5	3	8.00	1.31
32	0.155				0.00	0.00	3		100	103.00	15.96		1	3	4.00	0.62		5	3	8.00	1.24
33	0.146				0.00	0.00	3			3.00	0.44		1	3	4.00	0.58		5	3	8.00	1.17
34	0.138				0.00	0.00	3			3.00	0.41		1	3	4.00	0.55		5	3	8.00	1.10
35	0.130				0.00	0.00	3			3.00	0.39		1	3	4.00	0.52		5	3	8.00	1.04
36	0.123				0.00	0.00	3			3.00	0.37		1	3	4.00	0.49		5	3	8.00	0.98
37	0.116				0.00	0.00	3			3.00	0.35		1	3	4.00	0.46		5	3	8.00	0.93
38	0.109				0.00	0.00	3			3.00	0.33		1	3	4.00	0.44		5	3	8.00	0.87
39	0.103				0.00	0.00	3			3.00	0.31		1	3	4.00	0.41		5	3	8.00	0.82
40	0.097				0.00	0.00	3	408		411.00	39.96	350	1	3	354.00	34.42	350	5	3	358.00	34.81
41	0.092				0.00	0.00	3			3.00	0.28		1	3	4.00	0.37		5	3	8.00	0.73
42	0.087				0.00	0.00	3		100	103.00	8.91		1	3	4.00	0.35		5	3	8.00	0.69
43	0.082				0.00	0.00	3			3.00	0.24		1	3	4.00	0.33		5	3	8.00	0.65
44	0.077				0.00	0.00	3			3.00	0.23		1	3	4.00	0.31		5	3	8.00	0.62
45	0.073				0.00	0.00	3			3.00	0.22		1	3	4.00	0.29		5	3	8.00	0.58
46	0.069				0.00	0.00	3			3.00	0.21		1	3	4.00	0.27		5	3	8.00	0.55
47	0.065				0.00	0.00	3			3.00	0.19		1	3	4.00	0.26		5	3	8.00	0.52
48	0.061				0.00	0.00	3			3.00	0.18		1	3	4.00	0.24		5	3	8.00	0.49
49	0.058				0.00	0.00	3			3.00	0.17		1	3	4.00	0.23		5	3	8.00	0.46
50	0.054				0.00	0.00	3	308		311.00	16.88		1	3	4.00	0.22		5	3	8.00	0.43
51	0.051				0.00	0.00	3			3.00	0.15		1	3	4.00	0.20		5	3	8.00	0.41
52	0.048				0.00	0.00	3		100	103.00	4.98		1	3	4.00	0.19		5	3	8.00	0.39
53	0.046				0.00	0.00	3			3.00	0.14		1	3	4.00	0.18		5	3	8.00	0.36
54	0.043				0.00	0.00	3			3.00	0.13		1	3	4.00	0.17		5	3	8.00	0.34
55	0.041				0.00	0.00	3			3.00	0.12		1	3	4.00	0.16		5	3	8.00	0.32
56	0.038				0.00	0.00	3			3.00	0.11		1	3	4.00	0.15		5	3	8.00	0.31
57	0.036				0.00	0.00	3			3.00	0.11		1	3	4.00	0.14		5	3	8.00	0.29
58	0.034				0.00	0.00	3			3.00	0.10		1	3	4.00	0.14		5	3	8.00	0.27
59	0.032				0.00	0.00	3	308		311.00	9.99		1	3	4.00	0.13		5	3	8.00	0.26

Net Present Value over time

Client/Authority			**Sheet Nr.**	8
SBC			Prepared (date)	16/09/99
Project name			Printed	14/05/03
Scalby Ness Strategy - Year 7 Preferred Strat			Prepared by	DR
Project reference	1,404.00		Checked by	GS
Base date for estimates (year 0)	Dec 01		Checked date	16/10/99
Scaling factor (e.g. £m, £k, £)	£k			
Discount rate	6%			



SPREADSHEETS FOR YEARS 10 DEFERRED LOSSES

Project Summary Sheet

Client/Authority		Prepared (date)	14 8 02
SBC		Printed	14/05/03
Project name		Prepared by	dgc
Scalby Ness Strategy - **Year 10** Preferred Strategy with	SLC & CP losse	Checked by	
Project reference	1404	Checked date	
Base date for estimates (year 0)	Dec 01		
Scaling factor (e.g. £m, £k, £)	£k	(used for all costs, losses and benefits)	
Principle land use band	B	(A to E)	
Discount rate	6%		

Costs and benefits of options

	Costs and benefits £k				
	No Project	Option 2	Option 3	Option 4	
PV costs PVc	0.00	1,143.04	2,415.75	1,769.44	
PV damage PVd	4,283.68	3,845.99	46.42	46.42	
PV damage avoided		437.69	4,237.26	4,237.26	
PV assets Pva					
PV asset protection benefits		0.00	0.00	0.00	
Total PV benefits PVb		437.69	4,237.26	4,237.26	
Net Present Value NPV		-705.35	1,821.51	2,467.81	
Average benefit/cost ratio		0.4	1.8	2.4	
Incremental benefit/cost ratio			2.99	0.00	
		-	-	Highest b/c	

Brief description of options:

Option 1	Do nothing
Option 2	Do Minimum - Phased Work Short to Long Term
Option 3	Do Something - Full Scheme
Option 4	Do Something - Partial Scheme + Maintenance

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting

2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
PV benefits calculated as PV damage avoided + PV asset protection benefits

3) Incremental benefit/cost ratio is calculated as:
(PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Damage Cost Calculation Sheet - Do Nothing (Exponential)

Sheet Nr. 2

Client/Authority
SBC

Project name
Scalby Ness Strategy - Year 10 Preferred Strateg

Option:
Do nothing

Project reference	1,404.00					
Base date for estimates (year 0)	Dec 01				Prepared (date)	
Scaling factor (e.g. £m, £k, £)	£k				Printed	14/05/03
Discount rate	6%				Prepared by	dgc
		PV breach/failure	£k	4333.19	Checked by	
Remaining structure life	2	**Ave Annual Damage**			Checked date	
Initial probability of failure	0.800	**(overtopping)**	£k	0.00 /yr		
Calculations assum	**0.99** prob of failure in year 2					
Calculated factors:	-0.01005 -0.30743	**PV Total Damage**	£k	4283.68 (calculated below)		

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	has not occurred	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.800	0.800	0.200	3466.55	0.00		3466.55
1	0.943	0.990	0.198	0.002	809.41	0.00		809.41
2	0.890	1.000	0.002	0.000	7.71	0.00		7.71
3	0.840	1.000	0.000	0.000	0.00	0.00		0.00
4	0.792	1.000	0.000	0.000	0.00	0.00		0.00
5	0.747	1.000	0.000	0.000	0.00	0.00		0.00
6	0.705	1.000	0.000	0.000	0.00	0.00		0.00
7	0.665	1.000	0.000	0.000	0.00	0.00		0.00
8	0.627	1.000	0.000	0.000	0.00	0.00		0.00
9	0.592	1.000	0.000	0.000	0.00	0.00		0.00
10	0.558	1.000	0.000	0.000	0.00	0.00		0.00
11	0.527	1.000	0.000	0.000	0.00	0.00		0.00
12	0.497	1.000	0.000	0.000	0.00	0.00		0.00
13	0.469	1.000	0.000	0.000	0.00	0.00		0.00
14	0.442	1.000	0.000	0.000	0.00	0.00		0.00
15	0.417	1.000	0.000	0.000	0.00	0.00		0.00
16	0.394	1.000	0.000	0.000	0.00	0.00		0.00
17	0.371	1.000	0.000	0.000	0.00	0.00		0.00
18	0.350	1.000	0.000	0.000	0.00	0.00		0.00
19	0.331	1.000	0.000	0.000	0.00	0.00		0.00
20	0.312	1.000	0.000	0.000	0.00	0.00		0.00
21	0.294	1.000	0.000	0.000	0.00	0.00		0.00
22	0.278	1.000	0.000	0.000	0.00	0.00		0.00
23	0.262	1.000	0.000	0.000	0.00	0.00		0.00
24	0.247	1.000	0.000	0.000	0.00	0.00		0.00
25	0.233	1.000	0.000	0.000	0.00	0.00		0.00
26	0.220	1.000	0.000	0.000	0.00	0.00		0.00
27	0.207	1.000	0.000	0.000	0.00	0.00		0.00
28	0.196	1.000	0.000	0.000	0.00	0.00		0.00
29	0.185	1.000	0.000	0.000	0.00	0.00		0.00
30	0.174	1.000	0.000	0.000	0.00	0.00		0.00
31	0.164	1.000	0.000	0.000	0.00	0.00		0.00
32	0.155	1.000	0.000	0.000	0.00	0.00		0.00
33	0.146	1.000	0.000	0.000	0.00	0.00		0.00
34	0.138	1.000	0.000	0.000	0.00	0.00		0.00
35	0.130	1.000	0.000	0.000	0.00	0.00		0.00
36	0.123	1.000	0.000	0.000	0.00	0.00		0.00
37	0.116	1.000	0.000	0.000	0.00	0.00		0.00
38	0.109	1.000	0.000	0.000	0.00	0.00		0.00
39	0.103	1.000	0.000	0.000	0.00	0.00		0.00
40	0.097	1.000	0.000	0.000	0.00	0.00		0.00
41	0.092	1.000	0.000	0.000	0.00	0.00		0.00
42	0.087	1.000	0.000	0.000	0.00	0.00		0.00
43	0.082	1.000	0.000	0.000	0.00	0.00		0.00
44	0.077	1.000	0.000	0.000	0.00	0.00		0.00
45	0.073	1.000	0.000	0.000	0.00	0.00		0.00
46	0.069	1.000	0.000	0.000	0.00	0.00		0.00
47	0.065	1.000	0.000	0.000	0.00	0.00		0.00
48	0.061	1.000	0.000	0.000	0.00	0.00		0.00
49	0.058	1.000	0.000	0.000	0.00	0.00		0.00
50	0.054	1.000	0.000	0.000	0.00	0.00		0.00
51	0.051	1.000	0.000	0.000	0.00	0.00		0.00
52	0.048	1.000	0.000	0.000	0.00	0.00		0.00
53	0.046	1.000	0.000	0.000	0.00	0.00		0.00
54	0.043	1.000	0.000	0.000	0.00	0.00		0.00
55	0.041	1.000	0.000	0.000	0.00	0.00		0.00
56	0.038	1.000	0.000	0.000	0.00	0.00		0.00
57	0.036	1.000	0.000	0.000	0.00	0.00		0.00
58	0.034	1.000	0.000	0.000	0.00	0.00		0.00
59	0.032	1.000	0.000	0.000	0.00	0.00		0.00
Totals					4283.68	0.00		4283.68

Notes

Complete one spreadsheet for the 'do nothing' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
It is assumed that breaches are not repaired and that once breach damage has occurred it will not recur.
A separate check should be made to ensure that overtopping damages do not exceed write off values.
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 3

Client/Authority
SBC

Project name
Scalby Ness Strategy - Year 10 Preferred Strategy witl

Option:
Do Minimum - Phased Work Short to Long Term

Project reference	1404				
Base date for estimates (year 0)	Dec 01				
Scaling factor (e.g. £m, £k, £)	£k			**Prepared (date)**	
Discount rate	6%			Printed	14/05/03
		PV breach/failure	£k 421.28	Prepared by	dgc
Remaining structure life	60	**Ave Annual Damage**		Checked by	
Initial probability of failure	0.500	**(overtopping)**	£k ________ /yr	Checked date	
Calculations assume 0.99	**prob of failure in year 60**				
Calculated factors: -0.01005	-0.16684	**PV Total Damage**	£k 3845.99 (calculated below)		

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.500	0.500	0.500	210.64	0.00		210.64
1	0.943	0.501	0.501	0.499	199.28	0.00		199.28
2	0.890	0.503	0.503	0.497	188.53	0.00		188.53
3	0.840	0.504	0.504	0.496	178.38	0.00		178.38
4	0.792	0.506	0.506	0.494	168.78	0.00		168.78
5	0.747	0.507	0.507	0.493	159.71	0.00		159.71
6	0.705	0.509	0.509	0.491	151.13	0.00		151.13
7	0.665	0.510	0.510	0.490	143.02	0.00		143.02
8	0.627	0.512	0.512	0.488	135.35	0.00		135.35
9	0.592	0.514	0.514	0.486	128.11	0.00		128.11
10	0.558	0.515	0.515	0.485	121.25	0.00		121.25
11	0.527	0.517	0.517	0.483	114.78	0.00		114.78
12	0.497	0.519	0.519	0.481	108.65	0.00		108.65
13	0.469	0.521	0.521	0.479	102.86	0.00		102.86
14	0.442	0.523	0.523	0.477	97.39	0.00		97.39
15	0.417	0.525	0.525	0.475	92.21	0.00		92.21
16	0.394	0.527	0.527	0.473	87.32	0.00		87.32
17	0.371	0.529	0.529	0.471	82.70	0.00		82.70
18	0.350	0.531	0.531	0.469	78.32	0.00		78.32
19	0.331	0.533	0.533	0.467	74.19	0.00		74.19
20	0.312	0.535	0.535	0.465	70.28	0.00		70.28
21	0.294	0.537	0.537	0.463	66.58	0.00		66.58
22	0.278	0.540	0.540	0.460	63.08	0.00		63.08
23	0.262	0.542	0.542	0.458	59.78	0.00		59.78
24	0.247	0.544	0.544	0.456	56.65	0.00		56.65
25	0.233	0.547	0.547	0.453	53.70	0.00		53.70
26	0.220	0.550	0.550	0.450	50.90	0.00		50.90
27	0.207	0.552	0.552	0.448	48.26	0.00		48.26
28	0.196	0.555	0.555	0.445	45.76	0.00		45.76
29	0.185	0.558	0.558	0.442	43.40	0.00		43.40
30	0.174	0.561	0.561	0.439	41.17	0.00		41.17
31	0.164	0.564	0.564	0.436	39.06	0.00		39.06
32	0.155	0.568	0.568	0.432	37.07	0.00		37.07
33	0.146	0.571	0.571	0.429	35.18	0.00		35.18
34	0.138	0.575	0.575	0.425	33.40	0.00		33.40
35	0.130	0.579	0.579	0.421	31.72	0.00		31.72
36	0.123	0.583	0.583	0.417	30.12	0.00		30.12
37	0.116	0.587	0.587	0.413	28.62	0.00		28.62
38	0.109	0.591	0.591	0.409	27.20	0.00		27.20
39	0.103	0.596	0.596	0.404	25.86	0.00		25.86
40	0.097	0.601	0.601	0.399	24.60	0.00		24.60
41	0.092	0.606	0.606	0.394	23.41	0.00		23.41
42	0.087	0.611	0.611	0.389	22.28	0.00		22.28
43	0.082	0.617	0.617	0.383	21.22	0.00		21.22
44	0.077	0.623	0.623	0.377	20.22	0.00		20.22
45	0.073	0.630	0.630	0.370	19.29	0.00		19.29
46	0.069	0.637	0.637	0.363	18.40	0.00		18.40
47	0.065	0.645	0.645	0.355	17.58	0.00		17.58
48	0.061	0.654	0.654	0.346	16.81	0.00		16.81
49	0.058	0.664	0.664	0.336	16.09	0.00		16.09
50	0.054	0.674	0.674	0.326	15.42	0.00		15.42
51	0.051	0.686	0.686	0.314	14.80	0.00		14.80
52	0.048	0.700	0.700	0.300	14.24	0.00		14.24
53	0.046	0.716	0.716	0.284	13.74	0.00		13.74
54	0.043	0.734	0.734	0.266	13.30	0.00		13.30
55	0.041	0.757	0.757	0.243	12.94	0.00		12.94
56	0.038	0.786	0.786	0.214	12.67	0.00		12.67
57	0.036	0.824	0.824	0.176	12.54	0.00		12.54
58	0.034	0.882	0.882	0.118	12.65	0.00		12.65
59	0.032	0.990	0.990	0.010	13.40	0.00		13.40
Totals					3845.99	0.00		3845.99

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 4

Client/Authority
SBC
Project name
Scalby Ness Strategy - Year 10 Preferred Strategy witl

Option:
Do Something - Full Scheme

Project reference	1,404.00					
Base date for estimates (year 0)	Dec 01					
Scaling factor (e.g. £m, £k, £)	£k				Prepared (date)	
Discount rate	6%				Printed	14/05/03
		PV breach/failure	£k	131.36	Prepared by	dgc
Remaining structure life	60	Ave Annual Damage			Checked by	
Initial probability of failure	0.010	(overtopping)	£k	0.00 /yr	Checked date	
Calculations assume 0.99	prob of failure in year 60					
Calculated factors: -0.01005	-1.12231	PV Total Damage	£k	46.42 (calculated below)		

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	1.31	0.00		1.31
1	0.943	0.010	0.010	0.990	1.26	0.00		1.26
2	0.890	0.010	0.010	0.990	1.21	0.00		1.21
3	0.840	0.011	0.011	0.989	1.17	0.00		1.17
4	0.792	0.011	0.011	0.989	1.12	0.00		1.12
5	0.747	0.011	0.011	0.989	1.08	0.00		1.08
6	0.705	0.011	0.011	0.989	1.04	0.00		1.04
7	0.665	0.011	0.011	0.989	1.00	0.00		1.00
8	0.627	0.012	0.012	0.988	0.97	0.00		0.97
9	0.592	0.012	0.012	0.988	0.93	0.00		0.93
10	0.558	0.012	0.012	0.988	0.90	0.00		0.90
11	0.527	0.013	0.013	0.987	0.87	0.00		0.87
12	0.497	0.013	0.013	0.987	0.84	0.00		0.84
13	0.469	0.013	0.013	0.987	0.81	0.00		0.81
14	0.442	0.013	0.013	0.987	0.78	0.00		0.78
15	0.417	0.014	0.014	0.986	0.76	0.00		0.76
16	0.394	0.014	0.014	0.986	0.73	0.00		0.73
17	0.371	0.015	0.015	0.985	0.71	0.00		0.71
18	0.350	0.015	0.015	0.985	0.69	0.00		0.69
19	0.331	0.015	0.015	0.985	0.67	0.00		0.67
20	0.312	0.016	0.016	0.984	0.65	0.00		0.65
21	0.294	0.016	0.016	0.984	0.63	0.00		0.63
22	0.278	0.017	0.017	0.983	0.61	0.00		0.61
23	0.262	0.017	0.017	0.983	0.59	0.00		0.59
24	0.247	0.018	0.018	0.982	0.58	0.00		0.58
25	0.233	0.018	0.018	0.982	0.56	0.00		0.56
26	0.220	0.019	0.019	0.981	0.55	0.00		0.55
27	0.207	0.020	0.020	0.980	0.53	0.00		0.53
28	0.196	0.020	0.020	0.980	0.52	0.00		0.52
29	0.185	0.021	0.021	0.979	0.51	0.00		0.51
30	0.174	0.022	0.022	0.978	0.50	0.00		0.50
31	0.164	0.023	0.023	0.977	0.49	0.00		0.49
32	0.155	0.024	0.024	0.976	0.48	0.00		0.48
33	0.146	0.025	0.025	0.975	0.47	0.00		0.47
34	0.138	0.026	0.026	0.974	0.46	0.00		0.46
35	0.130	0.027	0.027	0.973	0.46	0.00		0.46
36	0.123	0.028	0.028	0.972	0.45	0.00		0.45
37	0.116	0.029	0.029	0.971	0.45	0.00		0.45
38	0.109	0.031	0.031	0.969	0.44	0.00		0.44
39	0.103	0.032	0.032	0.968	0.44	0.00		0.44
40	0.097	0.034	0.034	0.966	0.44	0.00		0.44
41	0.092	0.036	0.036	0.964	0.44	0.00		0.44
42	0.087	0.039	0.039	0.961	0.44	0.00		0.44
43	0.082	0.041	0.041	0.959	0.44	0.00		0.44
44	0.077	0.044	0.044	0.956	0.45	0.00		0.45
45	0.073	0.047	0.047	0.953	0.45	0.00		0.45
46	0.069	0.051	0.051	0.949	0.46	0.00		0.46
47	0.065	0.056	0.056	0.944	0.47	0.00		0.47
48	0.061	0.061	0.061	0.939	0.49	0.00		0.49
49	0.058	0.067	0.067	0.933	0.51	0.00		0.51
50	0.054	0.075	0.075	0.925	0.53	0.00		0.53
51	0.051	0.084	0.084	0.916	0.57	0.00		0.57
52	0.048	0.096	0.096	0.904	0.61	0.00		0.61
53	0.046	0.111	0.111	0.889	0.67	0.00		0.67
54	0.043	0.133	0.133	0.867	0.75	0.00		0.75
55	0.041	0.163	0.163	0.837	0.87	0.00		0.87
56	0.038	0.209	0.209	0.791	1.05	0.00		1.05
57	0.036	0.289	0.289	0.711	1.37	0.00		1.37
58	0.034	0.455	0.455	0.545	2.03	0.00		2.03
59	0.032	0.990	0.990	0.010	4.18	0.00		4.18
Totals					46.42	0.00		46.42

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 5

Client/Authority
SBC

Project name
Scalby Ness Strategy - Year 10 Preferred Strategy witl

Option:
Do Something - Partial Scheme + Maintenance

Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 131.36
Remaining structure life 60
Ave Annual Damage (overtopping) £k 0.00 /yr
Initial probability of failure 0.010
Calculations assume 0.99 prob of failure in year 60
Calculated factors: -0.01005 -1.12231
PV Total Damage £k 46.42 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	1.31	0.00		1.31
1	0.943	0.010	0.010	0.990	1.26	0.00		1.26
2	0.890	0.010	0.010	0.990	1.21	0.00		1.21
3	0.840	0.011	0.011	0.989	1.17	0.00		1.17
4	0.792	0.011	0.011	0.989	1.12	0.00		1.12
5	0.747	0.011	0.011	0.989	1.08	0.00		1.08
6	0.705	0.011	0.011	0.989	1.04	0.00		1.04
7	0.665	0.011	0.011	0.989	1.00	0.00		1.00
8	0.627	0.012	0.012	0.988	0.97	0.00		0.97
9	0.592	0.012	0.012	0.988	0.93	0.00		0.93
10	0.558	0.012	0.012	0.988	0.90	0.00		0.90
11	0.527	0.013	0.013	0.987	0.87	0.00		0.87
12	0.497	0.013	0.013	0.987	0.84	0.00		0.84
13	0.469	0.013	0.013	0.987	0.81	0.00		0.81
14	0.442	0.013	0.013	0.987	0.78	0.00		0.78
15	0.417	0.014	0.014	0.986	0.76	0.00		0.76
16	0.394	0.014	0.014	0.986	0.73	0.00		0.73
17	0.371	0.015	0.015	0.985	0.71	0.00		0.71
18	0.350	0.015	0.015	0.985	0.69	0.00		0.69
19	0.331	0.015	0.015	0.985	0.67	0.00		0.67
20	0.312	0.016	0.016	0.984	0.65	0.00		0.65
21	0.294	0.016	0.016	0.984	0.63	0.00		0.63
22	0.278	0.017	0.017	0.983	0.61	0.00		0.61
23	0.262	0.017	0.017	0.983	0.59	0.00		0.59
24	0.247	0.018	0.018	0.982	0.58	0.00		0.58
25	0.233	0.018	0.018	0.982	0.56	0.00		0.56
26	0.220	0.019	0.019	0.981	0.55	0.00		0.55
27	0.207	0.020	0.020	0.980	0.53	0.00		0.53
28	0.196	0.020	0.020	0.980	0.52	0.00		0.52
29	0.185	0.021	0.021	0.979	0.51	0.00		0.51
30	0.174	0.022	0.022	0.978	0.50	0.00		0.50
31	0.164	0.023	0.023	0.977	0.49	0.00		0.49
32	0.155	0.024	0.024	0.976	0.48	0.00		0.48
33	0.146	0.025	0.025	0.975	0.47	0.00		0.47
34	0.138	0.026	0.026	0.974	0.46	0.00		0.46
35	0.130	0.027	0.027	0.973	0.46	0.00		0.46
36	0.123	0.028	0.028	0.972	0.45	0.00		0.45
37	0.116	0.029	0.029	0.971	0.45	0.00		0.45
38	0.109	0.031	0.031	0.969	0.44	0.00		0.44
39	0.103	0.032	0.032	0.968	0.44	0.00		0.44
40	0.097	0.034	0.034	0.966	0.44	0.00		0.44
41	0.092	0.036	0.036	0.964	0.44	0.00		0.44
42	0.087	0.039	0.039	0.961	0.44	0.00		0.44
43	0.082	0.041	0.041	0.959	0.44	0.00		0.44
44	0.077	0.044	0.044	0.956	0.45	0.00		0.45
45	0.073	0.047	0.047	0.953	0.45	0.00		0.45
46	0.069	0.051	0.051	0.949	0.46	0.00		0.46
47	0.065	0.056	0.056	0.944	0.47	0.00		0.47
48	0.061	0.061	0.061	0.939	0.49	0.00		0.49
49	0.058	0.067	0.067	0.933	0.51	0.00		0.51
50	0.054	0.075	0.075	0.925	0.53	0.00		0.53
51	0.051	0.084	0.084	0.916	0.57	0.00		0.57
52	0.048	0.096	0.096	0.904	0.61	0.00		0.61
53	0.046	0.111	0.111	0.889	0.67	0.00		0.67
54	0.043	0.133	0.133	0.867	0.75	0.00		0.75
55	0.041	0.163	0.163	0.837	0.87	0.00		0.87
56	0.038	0.209	0.209	0.791	1.05	0.00		1.05
57	0.036	0.289	0.289	0.711	1.37	0.00		1.37
58	0.034	0.455	0.455	0.545	2.03	0.00		2.03
59	0.032	0.990	0.990	0.010	4.18	0.00		4.18
Totals					46.42	0.00		46.42

Notes
Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Erosion Value Calculation Sheet with delay options

Sheet Nr. 6

Client/Authority
SBC

Project name		**Option:**	**Delay (yrs)**	Prepared (date)	
Scalby Ness Strategy - Year 10 Preferred Strategy		Do Minimum - Phased Work S	40	Printed	14/05/03
Project reference	1,404.00	Do Something - Full Scheme	60	Prepared by	dgc
Base date for estimates (year 0)	Dec 01	Do Something - Partial Schem	60	Checked by	
Scaling factor (e.g. £m, £k, £)	£k			Checked date	
Discount rate	6%				

Ref	Asset Description	MV £k	Year	Prob of loss without project in year	Expected value of asset losses £k: Without Project	Do Minimum - Phased Work Short to Long Term	Do Something - Full Scheme	Do Something - Partial Scheme + Maintenance
0	Property Yr 2	3571.00	9	0.03	63.41	6.16	1.92	1.92
0	Property Yr 2	3571.00	10	0.95	1,894.33	184.17	57.43	57.43
0	Property Yr 2	3571.00	8	0.02	44.81	4.36	1.36	1.36
1	Scalby CP+ Sea Life Cen 0yr	396.28	9	0.05	11.73	1.14	0.36	0.36
2	YW WWTW	320	10	0.95	169.75	16.50	5.15	5.15
3	YW WWTW	320	9	0.05	9.47	0.92	0.29	0.29
4	Scalby CP+ Sea Life Cen 1yr	396.28	10	0.95	210.22	20.44	6.37	6.37
5	Scalby CP+ Sea Life Cen 2yr	396.28	11	1	208.76	20.30	6.33	6.33
6	Scalby CP+ Sea Life Cen 3yr	396.28	12	1	196.94	19.15	5.97	5.97
7	Scalby CP+ Sea Life Cen 4yr	396.28	13	1	185.79	18.06	5.63	5.63
8	Scalby CP+ Sea Life Cen 5yr	396.28	14	1	175.28	17.04	5.31	5.31
9	Scalby CP+ Sea Life Cen 6yr	396.28	15	1	165.35	16.08	5.01	5.01
10	Scalby CP+ Sea Life Cen 7yr	396.28	16	1	155.99	15.17	4.73	4.73
11	Scalby CP+ Sea Life Cen 8yr	396.28	17	1	147.16	14.31	4.46	4.46
12	Scalby CP+ Sea Life Cen 9yr	396.28	18	1	138.83	13.50	4.21	4.21
12	Scalby CP+ Sea Life Cen 10yr	396.28	19	1	130.98	12.73	3.97	3.97
12	Property Yr 5	302.00	14	0.15	20.04	1.95	0.61	0.61
13	Property Yr 5	302.00	15	0.75	94.51	9.19	2.87	2.87
14	Property Yr 5	302.00	16	0.1	11.89	1.16	0.36	0.36
15	Property Yr 15	402.00	20	0.15	18.80	1.83	0.57	0.57
16	Property Yr 15	402.00	25	0.75	70.25	6.83	2.13	2.13
17	Property Yr 15	402.00	30	0.1	7.00	0.68	0.21	0.21
18	Property Yr 30	255.00	35	0.25	8.29	0.81	0.25	0.25
19	Property Yr 30	255.00	40	0.5	12.40	1.21	0.38	0.38
20	Property Yr 30	255.00	45	0.25	4.63	0.45	0.14	0.14
21	Property Yr 45	673.00	50	0.25	9.13	0.89	0.28	0.28
22	Property Yr 45	673.00	55	0.5	13.65	1.33	0.41	0.41
23	Property Yr 45	673.00	60	0.25	5.10	0.50	0.15	0.15
24	Property Yr 60	657.00	70	0.25	2.78	0.27	0.08	0.08
25	Property Yr 60	657.00	75	0.75	6.23	0.61	0.19	0.19
26	H&S Works following failure	250.00	9	0.03	4.44	0.43	0.13	0.13
27	H&S Works following failure	250.00	10	0.95	132.62	12.89	4.02	4.02
28	H&S Works following failure	250.00	11	0.02	2.63	0.26	0.08	0.08
29					-	-	-	-
30					-	-	-	-
31					-	-	-	-
32					-	-	-	-
33	[For property losses see Tables 4.6 A & B]				-	-	-	-
34					-	-	-	-
35					-	-	-	-
36					-	-	-	-
37					-	-	-	-
38					-	-	-	-
39					-	-	-	-
40					-	-	-	-
41					-	-	-	-
42					-	-	-	-
43					-	-	-	-
44					-	-	-	-
45					-	-	-	-
46					-	-	-	-
47					-	-	-	-
48					-	-	-	-
49					-	-	-	-
50					-	-	-	-
51					-	-	-	-
52					-	-	-	-
53					-	-	-	-
54					-	-	-	-
55					-	-	-	-
56					-	-	-	-
57					-	-	-	-
58					-	-	-	-
59					-	-	-	-
Totals		22672.08			4333.19	421.28	131.36	131.36

Notes
Make one entry in the description column for each property (or group of properties) as this determines subsequent calculation
MV = risk free market value at base date for estimate - must be entered on each line when probaility distribution is used
Equivalent annual value = MV x discount rate (assumes infinite life)
Year is year by which there is the cumulative probability of loss shown
If no distribution is used enter year after expected year of loss and enter 1.0 in probability column
(i.e. certainty of loss before start of year so year must be 1.0 or greater)
(e.g. If certain of loss in year 5 enter 6 in year column and 1 in probability column)
Asset value in first year for each property (or group) shown is cumulative to the year of first loss
Asset value in subsequent years for each property is additional value for that property if life extended

Present Value Costs for all options

Sheet Nr. 7

Client/Authority
SBC
Project name
Scalby Ness Strategy - Year 10 Preferred St
Project reference 1,404.00
Base date for estimates (year 0 Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Results £k				
	Option 1 (Do nothing)	Option 2 Do Minimum - Phased W	Option 3 Do Something - Full Sch	Option 4 Do Something - Partial S
PV total costs	0.00	1143.04	2415.75	1769.44

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

year	Discount Factor	Option 1 (Do nothing) Capital	Maint.	Other	TOTALS: Cash	PV	Option 2 Do Minimum - Phased W Mon	Works	Emergency	TOTALS: Cash	PV	Option 3 Do Something - Full Sche Capital	Main	All Mon	TOTALS: Cash	PV	Option 4 Do Something - Partial S Capital	Maint.	All Mon	TOTALS: Cash	PV
	cash sum	0	0	0	0.00	0.00	180	2556	600	3336.00	1143.04	3056	61	180	3297.00	2415.75	2338	240	180	2758.00	1769.44
0	1.000				0.00	0.00	3	408		411.00	411.00	100	2	3	105.00	105.00	100	2	3	105.00	105.00
1	0.943				0.00	0.00	3			3.00	2.83	2156	1	3	2160.00	2037.74	1438	2	3	1443.00	1361.32
2	0.890				0.00	0.00	3	40	100	143.00	127.27	40	1	3	44.00	39.16	40	2	3	45.00	40.05
3	0.840				0.00	0.00	3			3.00	2.52		1	3	4.00	3.36		2	3	5.00	4.20
4	0.792				0.00	0.00	3			3.00	2.38		1	3	4.00	3.17		2	3	5.00	3.96
5	0.747				0.00	0.00	3			3.00	2.24		1	3	4.00	2.99		2	3	5.00	3.74
6	0.705				0.00	0.00	3			3.00	2.11		1	3	4.00	2.82		2	3	5.00	3.52
7	0.665				0.00	0.00	3			3.00	2.00		1	3	4.00	2.66		2	3	5.00	3.33
8	0.627				0.00	0.00	3			3.00	1.88		1	3	4.00	2.51		2	3	5.00	3.14
9	0.592				0.00	0.00	3			3.00	1.78		1	3	4.00	2.37		2	3	5.00	2.96
10	0.558				0.00	0.00	3	368		371.00	207.16	60	1	3	64.00	35.74	60	2	3	65.00	36.30
11	0.527				0.00	0.00	3			3.00	1.58		1	3	4.00	2.11		2	3	5.00	2.63
12	0.497				0.00	0.00	3		100	103.00	51.19		1	3	4.00	1.99		2	3	5.00	2.48
13	0.469				0.00	0.00	3			3.00	1.41		1	3	4.00	1.88		2	3	5.00	2.34
14	0.442				0.00	0.00	3			3.00	1.33		1	3	4.00	1.77		2	3	5.00	2.21
15	0.417				0.00	0.00	3			3.00	1.25		1	3	4.00	1.67		2	3	5.00	2.09
16	0.394				0.00	0.00	3			3.00	1.18		1	3	4.00	1.57		2	3	5.00	1.97
17	0.371				0.00	0.00	3			3.00	1.11		1	3	4.00	1.49		2	3	5.00	1.86
18	0.350				0.00	0.00	3			3.00	1.05		1	3	4.00	1.40		2	3	5.00	1.75
19	0.331				0.00	0.00	3			3.00	0.99		1	3	4.00	1.32		2	3	5.00	1.65
20	0.312				0.00	0.00	3	408		411.00	128.15	350	1	3	354.00	110.38	350	5	3	358.00	111.63
21	0.294				0.00	0.00	3			3.00	0.88		1	3	4.00	1.18		5	3	8.00	2.35
22	0.278				0.00	0.00	3		100	103.00	28.58		1	3	4.00	1.11		5	3	8.00	2.22
23	0.262				0.00	0.00	3			3.00	0.79		1	3	4.00	1.05		5	3	8.00	2.09
24	0.247				0.00	0.00	3			3.00	0.74		1	3	4.00	0.99		5	3	8.00	1.98
25	0.233				0.00	0.00	3			3.00	0.70		1	3	4.00	0.93		5	3	8.00	1.86
26	0.220				0.00	0.00	3			3.00	0.66		1	3	4.00	0.88		5	3	8.00	1.76
27	0.207				0.00	0.00	3			3.00	0.62		1	3	4.00	0.83		5	3	8.00	1.66
28	0.196				0.00	0.00	3			3.00	0.59		1	3	4.00	0.78		5	3	8.00	1.57
29	0.185				0.00	0.00	3			3.00	0.55		1	3	4.00	0.74		5	3	8.00	1.48
30	0.174				0.00	0.00	3	308		311.00	54.15		1	3	4.00	0.70		5	3	8.00	1.39
31	0.164				0.00	0.00	3			3.00	0.49		1	3	4.00	0.66		5	3	8.00	1.31
32	0.155				0.00	0.00	3		100	103.00	15.96		1	3	4.00	0.62		5	3	8.00	1.24
33	0.146				0.00	0.00	3			3.00	0.44		1	3	4.00	0.58		5	3	8.00	1.17
34	0.138				0.00	0.00	3			3.00	0.41		1	3	4.00	0.55		5	3	8.00	1.10
35	0.130				0.00	0.00	3			3.00	0.39		1	3	4.00	0.52		5	3	8.00	1.04
36	0.123				0.00	0.00	3			3.00	0.37		1	3	4.00	0.49		5	3	8.00	0.98
37	0.116				0.00	0.00	3			3.00	0.35		1	3	4.00	0.46		5	3	8.00	0.93
38	0.109				0.00	0.00	3			3.00	0.33		1	3	4.00	0.44		5	3	8.00	0.87
39	0.103				0.00	0.00	3			3.00	0.31		1	3	4.00	0.41		5	3	8.00	0.82
40	0.097				0.00	0.00	3	408		411.00	39.96	350	1	3	354.00	34.42	350	5	3	358.00	34.81
41	0.092				0.00	0.00	3			3.00	0.28		1	3	4.00	0.37		5	3	8.00	0.73
42	0.087				0.00	0.00	3		100	103.00	8.91		1	3	4.00	0.35		5	3	8.00	0.69
43	0.082				0.00	0.00	3			3.00	0.24		1	3	4.00	0.33		5	3	8.00	0.65
44	0.077				0.00	0.00	3			3.00	0.23		1	3	4.00	0.31		5	3	8.00	0.62
45	0.073				0.00	0.00	3			3.00	0.22		1	3	4.00	0.29		5	3	8.00	0.58
46	0.069				0.00	0.00	3			3.00	0.21		1	3	4.00	0.27		5	3	8.00	0.55
47	0.065				0.00	0.00	3			3.00	0.19		1	3	4.00	0.26		5	3	8.00	0.52
48	0.061				0.00	0.00	3			3.00	0.18		1	3	4.00	0.24		5	3	8.00	0.49
49	0.058				0.00	0.00	3			3.00	0.17		1	3	4.00	0.23		5	3	8.00	0.46
50	0.054				0.00	0.00	3	308		311.00	16.88		1	3	4.00	0.22		5	3	8.00	0.43
51	0.051				0.00	0.00	3			3.00	0.15		1	3	4.00	0.20		5	3	8.00	0.41
52	0.048				0.00	0.00	3		100	103.00	4.98		1	3	4.00	0.19		5	3	8.00	0.39
53	0.046				0.00	0.00	3			3.00	0.14		1	3	4.00	0.18		5	3	8.00	0.36
54	0.043				0.00	0.00	3			3.00	0.13		1	3	4.00	0.17		5	3	8.00	0.34
55	0.041				0.00	0.00	3			3.00	0.12		1	3	4.00	0.16		5	3	8.00	0.32
56	0.038				0.00	0.00	3			3.00	0.11		1	3	4.00	0.15		5	3	8.00	0.31
57	0.036				0.00	0.00	3			3.00	0.11		1	3	4.00	0.14		5	3	8.00	0.29
58	0.034				0.00	0.00	3			3.00	0.10		1	3	4.00	0.14		5	3	8.00	0.27
59	0.032				0.00	0.00	3	308		311.00	9.99		1	3	4.00	0.13		5	3	8.00	0.26

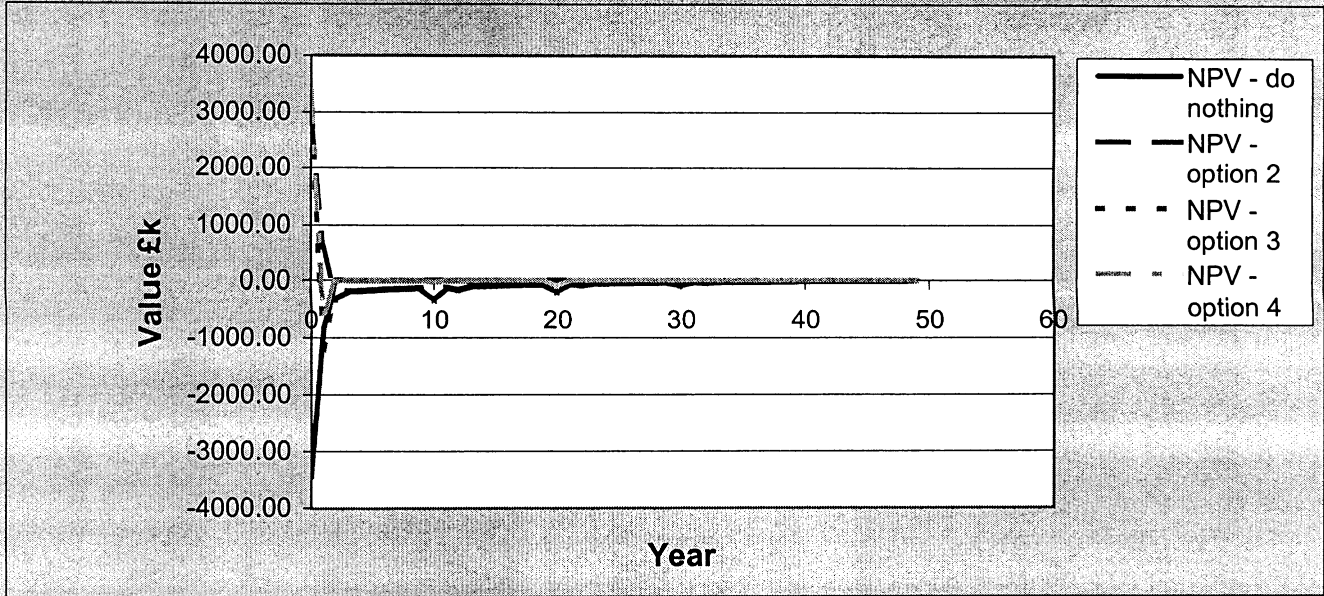
Net Present Value over time

Sheet Nr. 8

Client/Authority
SBC
Project name
Scalby Ness Strategy - Year 10 Preferred Str

Project reference	1,404.00
Base date for estimates (year 0)	Dec 01
Scaling factor (e.g. £m, £k, £)	£k
Discount rate	6%

Prepared (date)	16/09/99
Printed	14/05/03
Prepared by	DR
Checked by	GS
Checked date	16/10/99



SPREADSHEETS FOR 25% INCREASE IN CONSTRUCTION COSTS

Project Summary Sheet

Client/Authority		Prepared (date)	14 8 02
SBC		Printed	14/05/03
Project name		Prepared by	dgc
MU19E Strategy - Preferred Strategy with SLC & CP losses **+25% Cons**		Checked by	
Project reference	1404	Checked date	
Base date for estimates (year 0)	Dec 01		
Scaling factor (e.g. £m, £k, £)	£k	(used for all costs, losses and benefits)	
Principle land use band	B	(A to E)	
Discount rate	**6%**		

Costs and benefits of options

	Costs and benefits £k				
	No Project	Option 2	Option 3	Option 4	
PV costs PVc	0.00	1,143.04	2,870.18	2,089.80	
PV damage PVd	6,871.65	6,169.54	74.46	74.46	
PV damage avoided		702.11	6,797.19	6,797.19	
PV assets Pva					
PV asset protection benefits		0.00	0.00	0.00	
Total PV benefits PVb		702.11	6,797.19	6,797.19	
Net Present Value NPV		-440.92	3,927.00	4,707.39	
Average benefit/cost ratio		0.6	2.4	3.3	
Incremental benefit/cost ratio			3.53	0.00	
		-	-	Highest b/c	

Brief description of options:

Option 1	Do nothing
Option 2	Do Minimum - Phased Work Short to Long Term
Option 3	Do Something - Full Scheme
Option 4	Do Something - Partial Scheme + Maintenance

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting
2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
   PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
   PV benefits calculated as PV damage avoided + PV asset protection benefits
3) Incremental benefit/cost ratio is calculated as:
   (PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Damage Cost Calculation Sheet - Do Nothing (Exponential)

Sheet Nr. 2

Client/Authority
SBC
Project name
MU19E Strategy - Preferred Strategy with SLC &
Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Option:
Do nothing

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 6951.08
Ave Annual Damage (overtopping) £k 0.00 /yr
PV Total Damage £k 6871.65 (calculated below)

Remaining structure life 2
Initial probability of failure 0.800
Calculations assum 0.99 prob of failure in year 2
Calculated factors: -0.01005 -0.30743

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	has not occurred	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.800	0.800	0.200	5560.87	0.00		5560.87
1	0.943	0.990	0.198	0.002	1298.41	0.00		1298.41
2	0.890	1.000	0.002	0.000	12.37	0.00		12.37
3	0.840	1.000	0.000	0.000	0.00	0.00		0.00
4	0.792	1.000	0.000	0.000	0.00	0.00		0.00
5	0.747	1.000	0.000	0.000	0.00	0.00		0.00
6	0.705	1.000	0.000	0.000	0.00	0.00		0.00
7	0.665	1.000	0.000	0.000	0.00	0.00		0.00
8	0.627	1.000	0.000	0.000	0.00	0.00		0.00
9	0.592	1.000	0.000	0.000	0.00	0.00		0.00
10	0.558	1.000	0.000	0.000	0.00	0.00		0.00
11	0.527	1.000	0.000	0.000	0.00	0.00		0.00
12	0.497	1.000	0.000	0.000	0.00	0.00		0.00
13	0.469	1.000	0.000	0.000	0.00	0.00		0.00
14	0.442	1.000	0.000	0.000	0.00	0.00		0.00
15	0.417	1.000	0.000	0.000	0.00	0.00		0.00
16	0.394	1.000	0.000	0.000	0.00	0.00		0.00
17	0.371	1.000	0.000	0.000	0.00	0.00		0.00
18	0.350	1.000	0.000	0.000	0.00	0.00		0.00
19	0.331	1.000	0.000	0.000	0.00	0.00		0.00
20	0.312	1.000	0.000	0.000	0.00	0.00		0.00
21	0.294	1.000	0.000	0.000	0.00	0.00		0.00
22	0.278	1.000	0.000	0.000	0.00	0.00		0.00
23	0.262	1.000	0.000	0.000	0.00	0.00		0.00
24	0.247	1.000	0.000	0.000	0.00	0.00		0.00
25	0.233	1.000	0.000	0.000	0.00	0.00		0.00
26	0.220	1.000	0.000	0.000	0.00	0.00		0.00
27	0.207	1.000	0.000	0.000	0.00	0.00		0.00
28	0.196	1.000	0.000	0.000	0.00	0.00		0.00
29	0.185	1.000	0.000	0.000	0.00	0.00		0.00
30	0.174	1.000	0.000	0.000	0.00	0.00		0.00
31	0.164	1.000	0.000	0.000	0.00	0.00		0.00
32	0.155	1.000	0.000	0.000	0.00	0.00		0.00
33	0.146	1.000	0.000	0.000	0.00	0.00		0.00
34	0.138	1.000	0.000	0.000	0.00	0.00		0.00
35	0.130	1.000	0.000	0.000	0.00	0.00		0.00
36	0.123	1.000	0.000	0.000	0.00	0.00		0.00
37	0.116	1.000	0.000	0.000	0.00	0.00		0.00
38	0.109	1.000	0.000	0.000	0.00	0.00		0.00
39	0.103	1.000	0.000	0.000	0.00	0.00		0.00
40	0.097	1.000	0.000	0.000	0.00	0.00		0.00
41	0.092	1.000	0.000	0.000	0.00	0.00		0.00
42	0.087	1.000	0.000	0.000	0.00	0.00		0.00
43	0.082	1.000	0.000	0.000	0.00	0.00		0.00
44	0.077	1.000	0.000	0.000	0.00	0.00		0.00
45	0.073	1.000	0.000	0.000	0.00	0.00		0.00
46	0.069	1.000	0.000	0.000	0.00	0.00		0.00
47	0.065	1.000	0.000	0.000	0.00	0.00		0.00
48	0.061	1.000	0.000	0.000	0.00	0.00		0.00
49	0.058	1.000	0.000	0.000	0.00	0.00		0.00
50	0.054	1.000	0.000	0.000	0.00	0.00		0.00
51	0.051	1.000	0.000	0.000	0.00	0.00		0.00
52	0.048	1.000	0.000	0.000	0.00	0.00		0.00
53	0.046	1.000	0.000	0.000	0.00	0.00		0.00
54	0.043	1.000	0.000	0.000	0.00	0.00		0.00
55	0.041	1.000	0.000	0.000	0.00	0.00		0.00
56	0.038	1.000	0.000	0.000	0.00	0.00		0.00
57	0.036	1.000	0.000	0.000	0.00	0.00		0.00
58	0.034	1.000	0.000	0.000	0.00	0.00		0.00
59	0.032	1.000	0.000	0.000	0.00	0.00		0.00
Totals					6871.65	0.00		6871.65

Notes
Complete one spreadsheet for the 'do nothing' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
It is assumed that breaches are not repaired and that once breach damage has occurred it will not recur.
A separate check should be made to ensure that overtopping damages do not exceed write off values.
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 3

Client/Authority
SBC
Project name
MU19E Strategy - Preferred Strategy with SLC & CP l(
Option:
Do Minimum - Phased Work Short to Long Term

Project reference	1404					
Base date for estimates (year 0)	Dec 01					
Scaling factor (e.g. £m, £k, £)	£k				Prepared (date)	
Discount rate	6%				Printed	14/05/03
			PV breach/failure	£k 675.80	Prepared by	dgc
Remaining structure life	60		Ave Annual Damage		Checked by	
Initial probability of failure	0.500		(overtopping)	£k ________/yr	Checked date	
Calculations assume 0.99	prob of failure	in year 60				
Calculated factors: -0.01005	-0.16684		PV Total Damage	£k 6169.54 (calculated below)		

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	Prob that breach/failure: does not occur	PV damage due to: breach or failure	PV damage due to: over-topping	Other damage (specify)	PV total damage
0	1.000	0.500	0.500	0.500	337.90	0.00		337.90
1	0.943	0.501	0.501	0.499	319.67	0.00		319.67
2	0.890	0.503	0.503	0.497	302.44	0.00		302.44
3	0.840	0.504	0.504	0.496	286.15	0.00		286.15
4	0.792	0.506	0.506	0.494	270.75	0.00		270.75
5	0.747	0.507	0.507	0.493	256.19	0.00		256.19
6	0.705	0.509	0.509	0.491	242.43	0.00		242.43
7	0.665	0.510	0.510	0.490	229.42	0.00		229.42
8	0.627	0.512	0.512	0.488	217.12	0.00		217.12
9	0.592	0.514	0.514	0.486	205.50	0.00		205.50
10	0.558	0.515	0.515	0.485	194.51	0.00		194.51
11	0.527	0.517	0.517	0.483	184.12	0.00		184.12
12	0.497	0.519	0.519	0.481	174.30	0.00		174.30
13	0.469	0.521	0.521	0.479	165.01	0.00		165.01
14	0.442	0.523	0.523	0.477	156.23	0.00		156.23
15	0.417	0.525	0.525	0.475	147.93	0.00		147.93
16	0.394	0.527	0.527	0.473	140.08	0.00		140.08
17	0.371	0.529	0.529	0.471	132.66	0.00		132.66
18	0.350	0.531	0.531	0.469	125.64	0.00		125.64
19	0.331	0.533	0.533	0.467	119.01	0.00		119.01
20	0.312	0.535	0.535	0.465	112.73	0.00		112.73
21	0.294	0.537	0.537	0.463	106.80	0.00		106.80
22	0.278	0.540	0.540	0.460	101.19	0.00		101.19
23	0.262	0.542	0.542	0.458	95.89	0.00		95.89
24	0.247	0.544	0.544	0.456	90.88	0.00		90.88
25	0.233	0.547	0.547	0.453	86.14	0.00		86.14
26	0.220	0.550	0.550	0.450	81.66	0.00		81.66
27	0.207	0.552	0.552	0.448	77.42	0.00		77.42
28	0.196	0.555	0.555	0.445	73.41	0.00		73.41
29	0.185	0.558	0.558	0.442	69.63	0.00		69.63
30	0.174	0.561	0.561	0.439	66.04	0.00		66.04
31	0.164	0.564	0.564	0.436	62.66	0.00		62.66
32	0.155	0.568	0.568	0.432	59.46	0.00		59.46
33	0.146	0.571	0.571	0.429	56.44	0.00		56.44
34	0.138	0.575	0.575	0.425	53.58	0.00		53.58
35	0.130	0.579	0.579	0.421	50.88	0.00		50.88
36	0.123	0.583	0.583	0.417	48.32	0.00		48.32
37	0.116	0.587	0.587	0.413	45.91	0.00		45.91
38	0.109	0.591	0.591	0.409	43.64	0.00		43.64
39	0.103	0.596	0.596	0.404	41.49	0.00		41.49
40	0.097	0.601	0.601	0.399	39.46	0.00		39.46
41	0.092	0.606	0.606	0.394	37.55	0.00		37.55
42	0.087	0.611	0.611	0.389	35.74	0.00		35.74
43	0.082	0.617	0.617	0.383	34.04	0.00		34.04
44	0.077	0.623	0.623	0.377	32.44	0.00		32.44
45	0.073	0.630	0.630	0.370	30.94	0.00		30.94
46	0.069	0.637	0.637	0.363	29.52	0.00		29.52
47	0.065	0.645	0.645	0.355	28.20	0.00		28.20
48	0.061	0.654	0.654	0.346	26.96	0.00		26.96
49	0.058	0.664	0.664	0.336	25.81	0.00		25.81
50	0.054	0.674	0.674	0.326	24.74	0.00		24.74
51	0.051	0.686	0.686	0.314	23.75	0.00		23.75
52	0.048	0.700	0.700	0.300	22.85	0.00		22.85
53	0.046	0.716	0.716	0.284	22.04	0.00		22.04
54	0.043	0.734	0.734	0.266	21.34	0.00		21.34
55	0.041	0.757	0.757	0.243	20.75	0.00		20.75
56	0.038	0.786	0.786	0.214	20.32	0.00		20.32
57	0.036	0.824	0.824	0.176	20.11	0.00		20.11
58	0.034	0.882	0.882	0.118	20.30	0.00		20.30
59	0.032	0.990	0.990	0.010	21.50	0.00		21.50
Totals					6169.54	0.00		6169.54

Notes
Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 4

Client/Authority
SBC

Project name
MU19E Strategy - Preferred Strategy with SLC & CP Ic

Option:
Do Something - Full Scheme

Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 210.72
Ave Annual Damage (overtopping) £k 0.00 /yr

Remaining structure life 60
Initial probability of failure 0.010
Calculations assume 0.99 **prob of failure in year 60**
Calculated factors: -0.01005 -1.12231

PV Total Damage £k 74.46 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	Prob that breach/failure: does not occur	PV damage due to: breach or failure	PV damage due to: over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	2.11	0.00		2.11
1	0.943	0.010	0.010	0.990	2.03	0.00		2.03
2	0.890	0.010	0.010	0.990	1.95	0.00		1.95
3	0.840	0.011	0.011	0.989	1.87	0.00		1.87
4	0.792	0.011	0.011	0.989	1.80	0.00		1.80
5	0.747	0.011	0.011	0.989	1.74	0.00		1.74
6	0.705	0.011	0.011	0.989	1.67	0.00		1.67
7	0.665	0.011	0.011	0.989	1.61	0.00		1.61
8	0.627	0.012	0.012	0.988	1.55	0.00		1.55
9	0.592	0.012	0.012	0.988	1.50	0.00		1.50
10	0.558	0.012	0.012	0.988	1.44	0.00		1.44
11	0.527	0.013	0.013	0.987	1.39	0.00		1.39
12	0.497	0.013	0.013	0.987	1.35	0.00		1.35
13	0.469	0.013	0.013	0.987	1.30	0.00		1.30
14	0.442	0.013	0.013	0.987	1.26	0.00		1.26
15	0.417	0.014	0.014	0.986	1.21	0.00		1.21
16	0.394	0.014	0.014	0.986	1.17	0.00		1.17
17	0.371	0.015	0.015	0.985	1.14	0.00		1.14
18	0.350	0.015	0.015	0.985	1.10	0.00		1.10
19	0.331	0.015	0.015	0.985	1.07	0.00		1.07
20	0.312	0.016	0.016	0.984	1.04	0.00		1.04
21	0.294	0.016	0.016	0.984	1.01	0.00		1.01
22	0.278	0.017	0.017	0.983	0.98	0.00		0.98
23	0.262	0.017	0.017	0.983	0.95	0.00		0.95
24	0.247	0.018	0.018	0.982	0.92	0.00		0.92
25	0.233	0.018	0.018	0.982	0.90	0.00		0.90
26	0.220	0.019	0.019	0.981	0.88	0.00		0.88
27	0.207	0.020	0.020	0.980	0.85	0.00		0.85
28	0.196	0.020	0.020	0.980	0.83	0.00		0.83
29	0.185	0.021	0.021	0.979	0.82	0.00		0.82
30	0.174	0.022	0.022	0.978	0.80	0.00		0.80
31	0.164	0.023	0.023	0.977	0.78	0.00		0.78
32	0.155	0.024	0.024	0.976	0.77	0.00		0.77
33	0.146	0.025	0.025	0.975	0.75	0.00		0.75
34	0.138	0.026	0.026	0.974	0.74	0.00		0.74
35	0.130	0.027	0.027	0.973	0.73	0.00		0.73
36	0.123	0.028	0.028	0.972	0.72	0.00		0.72
37	0.116	0.029	0.029	0.971	0.72	0.00		0.72
38	0.109	0.031	0.031	0.969	0.71	0.00		0.71
39	0.103	0.032	0.032	0.968	0.71	0.00		0.71
40	0.097	0.034	0.034	0.966	0.70	0.00		0.70
41	0.092	0.036	0.036	0.964	0.70	0.00		0.70
42	0.087	0.039	0.039	0.961	0.70	0.00		0.70
43	0.082	0.041	0.041	0.959	0.71	0.00		0.71
44	0.077	0.044	0.044	0.956	0.72	0.00		0.72
45	0.073	0.047	0.047	0.953	0.73	0.00		0.73
46	0.069	0.051	0.051	0.949	0.74	0.00		0.74
47	0.065	0.056	0.056	0.944	0.76	0.00		0.76
48	0.061	0.061	0.061	0.939	0.78	0.00		0.78
49	0.058	0.067	0.067	0.933	0.81	0.00		0.81
50	0.054	0.075	0.075	0.925	0.85	0.00		0.85
51	0.051	0.084	0.084	0.916	0.91	0.00		0.91
52	0.048	0.096	0.096	0.904	0.98	0.00		0.98
53	0.046	0.111	0.111	0.889	1.07	0.00		1.07
54	0.043	0.133	0.133	0.867	1.20	0.00		1.20
55	0.041	0.163	0.163	0.837	1.39	0.00		1.39
56	0.038	0.209	0.209	0.791	1.68	0.00		1.68
57	0.036	0.289	0.289	0.711	2.19	0.00		2.19
58	0.034	0.455	0.455	0.545	3.26	0.00		3.26
59	0.032	0.990	0.990	0.010	6.70	0.00		6.70
Totals					74.46	0.00		74.46

Notes
Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 5

Client/Authority
SBC

Project name
MU19E Strategy - Preferred Strategy with SLC & CP Ic

Option:
Do Something - Partial Scheme + Maintenance

Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 210.72
Ave Annual Damage (overtopping) £k 0.00 /yr

Remaining structure life 60
Initial probability of failure 0.010
Calculations assume **0.99** **prob of failure in year 60**
Calculated factors: -0.01005 -1.12231

PV Total Damage £k 74.46 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	2.11	0.00		2.11
1	0.943	0.010	0.010	0.990	2.03	0.00		2.03
2	0.890	0.010	0.010	0.990	1.95	0.00		1.95
3	0.840	0.011	0.011	0.989	1.87	0.00		1.87
4	0.792	0.011	0.011	0.989	1.80	0.00		1.80
5	0.747	0.011	0.011	0.989	1.74	0.00		1.74
6	0.705	0.011	0.011	0.989	1.67	0.00		1.67
7	0.665	0.011	0.011	0.989	1.61	0.00		1.61
8	0.627	0.012	0.012	0.988	1.55	0.00		1.55
9	0.592	0.012	0.012	0.988	1.50	0.00		1.50
10	0.558	0.012	0.012	0.988	1.44	0.00		1.44
11	0.527	0.013	0.013	0.987	1.39	0.00		1.39
12	0.497	0.013	0.013	0.987	1.35	0.00		1.35
13	0.469	0.013	0.013	0.987	1.30	0.00		1.30
14	0.442	0.013	0.013	0.987	1.26	0.00		1.26
15	0.417	0.014	0.014	0.986	1.21	0.00		1.21
16	0.394	0.014	0.014	0.986	1.17	0.00		1.17
17	0.371	0.015	0.015	0.985	1.14	0.00		1.14
18	0.350	0.015	0.015	0.985	1.10	0.00		1.10
19	0.331	0.015	0.015	0.985	1.07	0.00		1.07
20	0.312	0.016	0.016	0.984	1.04	0.00		1.04
21	0.294	0.016	0.016	0.984	1.01	0.00		1.01
22	0.278	0.017	0.017	0.983	0.98	0.00		0.98
23	0.262	0.017	0.017	0.983	0.95	0.00		0.95
24	0.247	0.018	0.018	0.982	0.92	0.00		0.92
25	0.233	0.018	0.018	0.982	0.90	0.00		0.90
26	0.220	0.019	0.019	0.981	0.88	0.00		0.88
27	0.207	0.020	0.020	0.980	0.85	0.00		0.85
28	0.196	0.020	0.020	0.980	0.83	0.00		0.83
29	0.185	0.021	0.021	0.979	0.82	0.00		0.82
30	0.174	0.022	0.022	0.978	0.80	0.00		0.80
31	0.164	0.023	0.023	0.977	0.78	0.00		0.78
32	0.155	0.024	0.024	0.976	0.77	0.00		0.77
33	0.146	0.025	0.025	0.975	0.75	0.00		0.75
34	0.138	0.026	0.026	0.974	0.74	0.00		0.74
35	0.130	0.027	0.027	0.973	0.73	0.00		0.73
36	0.123	0.028	0.028	0.972	0.72	0.00		0.72
37	0.116	0.029	0.029	0.971	0.72	0.00		0.72
38	0.109	0.031	0.031	0.969	0.71	0.00		0.71
39	0.103	0.032	0.032	0.968	0.71	0.00		0.71
40	0.097	0.034	0.034	0.966	0.70	0.00		0.70
41	0.092	0.036	0.036	0.964	0.70	0.00		0.70
42	0.087	0.039	0.039	0.961	0.70	0.00		0.70
43	0.082	0.041	0.041	0.959	0.71	0.00		0.71
44	0.077	0.044	0.044	0.956	0.72	0.00		0.72
45	0.073	0.047	0.047	0.953	0.73	0.00		0.73
46	0.069	0.051	0.051	0.949	0.74	0.00		0.74
47	0.065	0.056	0.056	0.944	0.76	0.00		0.76
48	0.061	0.061	0.061	0.939	0.78	0.00		0.78
49	0.058	0.067	0.067	0.933	0.81	0.00		0.81
50	0.054	0.075	0.075	0.925	0.85	0.00		0.85
51	0.051	0.084	0.084	0.916	0.91	0.00		0.91
52	0.048	0.096	0.096	0.904	0.98	0.00		0.98
53	0.046	0.111	0.111	0.889	1.07	0.00		1.07
54	0.043	0.133	0.133	0.867	1.20	0.00		1.20
55	0.041	0.163	0.163	0.837	1.39	0.00		1.39
56	0.038	0.209	0.209	0.791	1.68	0.00		1.68
57	0.036	0.289	0.289	0.711	2.19	0.00		2.19
58	0.034	0.455	0.455	0.545	3.26	0.00		3.26
59	0.032	0.990	0.990	0.010	6.70	0.00		6.70
Totals					74.46	0.00		74.46

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Erosion Value Calculation Sheet with delay options

Sheet Nr. 6

Client/Authority
SBC

Project name		**Option:**	**Delay (yrs)**	Prepared (date)	
MU19E Strategy - Preferred Strategy with SLC & C		Do Minimum - Phased Work S	40	Printed	14/05/03
Project reference	1,404.00	Do Something - Full Scheme	60	Prepared by	dgc
Base date for estimates (year 0)	Dec 01	Do Something - Partial Schem	60	Checked by	
Scaling factor (e.g. £m, £k, £)	£k			Checked date	
Discount rate	6%				

Ref	Asset Description	MV £k	Year	Prob of loss without project in year	Expected value of asset losses £k: Without Project	Do Minimum - Phased Work Short to Long Term	Do Something - Full Scheme	Do Something - Partial Scheme + Maintenance	
0	Property Yr 2	3571.00	1	0.03	101.07	9.83	3.06	3.06	
0	Property Yr 2	3571.00	2	0.95	3,019.27	293.54	91.53	91.53	
0	Property Yr 2	3571.00	3	0.02	59.97	5.83	1.82	1.82	
1	Scalby CP+ Sea Life Cen 0yr	396.28	1	0.05	18.69	1.82	0.57	0.57	
2	YW WWTW	320	2	0.95	270.56	26.30	8.20	8.20	
3	YW WWTW	320	1	0.05	15.09	1.47	0.46	0.46	
4	Scalby CP+ Sea Life Cen 1yr	396.28	2	0.95	335.05	32.57	10.16	10.16	
5	Scalby CP+ Sea Life Cen 2yr	396.28	3	1	332.72	32.35	10.09	10.09	
6	Scalby CP+ Sea Life Cen 3yr	396.28	4	1	313.89	30.52	9.52	9.52	
7	Scalby CP+ Sea Life Cen 4yr	396.28	5	1	296.12	28.79	8.98	8.98	
8	Scalby CP+ Sea Life Cen 5yr	396.28	6	1	279.36	27.16	8.47	8.47	
9	Scalby CP+ Sea Life Cen 6yr	396.28	7	1	263.55	25.62	7.99	7.99	
10	Scalby CP+ Sea Life Cen 7yr	396.28	8	1	248.63	24.17	7.54	7.54	
11	Scalby CP+ Sea Life Cen 8yr	396.28	9	1	234.56	22.80	7.11	7.11	
12	Scalby CP+ Sea Life Cen 9yr	396.28	10	1	221.28	21.51	6.71	6.71	
12	Scalby CP+ Sea Life Cen 10yr	396.28	11	1	208.76	20.30	6.33	6.33	
12	Property Yr 5	302.00	4	0.15	35.88	3.49	1.09	1.09	
13	Property Yr 5	302.00	5	0.75	169.25	16.46	5.13	5.13	
14	Property Yr 5	302.00	6	0.1	21.29	2.07	0.65	0.65	
15	Property Yr 15	402.00	10	0.15	33.67	3.27	1.02	1.02	
16	Property Yr 15	402.00	15	0.75	125.81	12.23	3.81	3.81	
17	Property Yr 15	402.00	20	0.1	12.53	1.22	0.38	0.38	
18	Property Yr 30	255.00	25	0.25	14.85	1.44	0.45	0.45	
19	Property Yr 30	255.00	30	0.5	22.20	2.16	0.67	0.67	
20	Property Yr 30	255.00	35	0.25	8.29	0.81	0.25	0.25	
21	Property Yr 45	673.00	40	0.25	16.36	1.59	0.50	0.50	
22	Property Yr 45	673.00	45	0.5	24.45	2.38	0.74	0.74	
23	Property Yr 45	673.00	50	0.25	9.13	0.89	0.28	0.28	
24	Property Yr 60	657.00	60	0.25	4.98	0.48	0.15	0.15	
25	Property Yr 60	657.00	65	0.75	11.16	1.09	0.34	0.34	
26	H&S Works following failure	250.00	1	0.03	7.08	0.69	0.21	0.21	
27	H&S Works following failure	250.00	2	0.95	211.37	20.55	6.41	6.41	
28	H&S Works following failure	250.00	3	0.02	4.20	0.41	0.13	0.13	
29					-	-	-	-	
30					-	-	-	-	
31					-	-	-	-	
32					-	-	-	-	
33	[For property losses see Tables 4.6 A & B]				-	-	-	-	
34					-	-	-	-	
35					-	-	-	-	
36					-	-	-	-	
37					-	-	-	-	
38					-	-	-	-	
39					-	-	-	-	
40					-	-	-	-	
41					-	-	-	-	
42					-	-	-	-	
43					-	-	-	-	
44					-	-	-	-	
45					-	-	-	-	
46					-	-	-	-	
47					-	-	-	-	
48					-	-	-	-	
49					-	-	-	-	
50					-	-	-	-	
51					-	-	-	-	
52					-	-	-	-	
53					-	-	-	-	
54					-	-	-	-	
55					-	-	-	-	
56					-	-	-	-	
57					-	-	-	-	
58					-	-	-	-	
59					-	-	-	-	
Totals		22672.08			6951.08	675.80	210.72	210.72	

Notes
Make one entry in the description column for each property (or group of properties) as this determines subsequent calculation
MV = risk free market value at base date for estimate - must be entered on each line when probaility distribution is used
Equivalent annual value = MV x discount rate (assumes infinite life)
Year is year by which there is the cumulative probability of loss shown
If no distribution is used enter year after expected year of loss and enter 1.0 in probability column
(i.e. certainty of loss before start of year so year must be 1.0 or greater)
(e.g. If certain of loss in year 5 enter 6 in year column and 1 in probability column)
Asset value in first year for each property (or group) shown is cumulative to the year of first loss
Asset value in subsequent years for each property is additional value for that property if life extended

Present Value Costs for all options

Sheet Nr. 7

Client/Authority
SBC
Project name
MU19E Strategy - Preferred Strategy with SL
Project reference 1,404.00
Base date for estimates (year 0 Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Results £k

	Option 1 (Do nothing)	Option 2 Do Minimum - Phased W	Option 3 Do Something - Full Sch	Option 4 Do Something - Partial S
PV total costs	0.00	1143.04	2870.18	2089.80

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

year	Discount Factor	Option 1 Capital	(Do nothing) Maint.	Other	TOTALS: Cash	PV	Option 2 Mon	Do Minimum - Phased W Works	Emergency	TOTALS: Cash	PV	Option 3 Capital	Do Something - Full Sche Main	All Mon	TOTALS: Cash	PV	Option 4 Capital	Do Something - Partial S Maint.	All Mon	TOTALS: Cash	PV
cash sum		0	0	0	0.00	0.00	180	2556	600	3336.00	1143.04	3537.7	61	180	3778.70	2870.18	2677.575	240	180	3097.58	2089.80
0	1.000				0.00	0.00	3	408		411.00	411.00	100	2	3	105.00	105.00	100	2	3	105.00	105.00
1	0.943				0.00	0.00	3			3.00	2.83	2638	1	3	2641.70	2492.17	1778	2	3	1782.58	1681.67
2	0.890				0.00	0.00	3	40	100	143.00	127.27	40	1	3	44.00	39.16	40	2	3	45.00	40.05
3	0.840				0.00	0.00	3			3.00	2.52		1	3	4.00	3.36		2	3	5.00	4.20
4	0.792				0.00	0.00	3			3.00	2.38		1	3	4.00	3.17		2	3	5.00	3.96
5	0.747				0.00	0.00	3			3.00	2.24		1	3	4.00	2.99		2	3	5.00	3.74
6	0.705				0.00	0.00	3			3.00	2.11		1	3	4.00	2.82		2	3	5.00	3.52
7	0.665				0.00	0.00	3			3.00	2.00		1	3	4.00	2.66		2	3	5.00	3.33
8	0.627				0.00	0.00	3			3.00	1.88		1	3	4.00	2.51		2	3	5.00	3.14
9	0.592				0.00	0.00	3			3.00	1.78		1	3	4.00	2.37		2	3	5.00	2.96
10	0.558				0.00	0.00	3	368		371.00	207.16	60	1	3	64.00	35.74	60	2	3	65.00	36.30
11	0.527				0.00	0.00	3			3.00	1.58		1	3	4.00	2.11		2	3	5.00	2.63
12	0.497				0.00	0.00	3		100	103.00	51.19		1	3	4.00	1.99		2	3	5.00	2.48
13	0.469				0.00	0.00	3			3.00	1.41		1	3	4.00	1.88		2	3	5.00	2.34
14	0.442				0.00	0.00	3			3.00	1.33		1	3	4.00	1.77		2	3	5.00	2.21
15	0.417				0.00	0.00	3			3.00	1.25		1	3	4.00	1.67		2	3	5.00	2.09
16	0.394				0.00	0.00	3			3.00	1.18		1	3	4.00	1.57		2	3	5.00	1.97
17	0.371				0.00	0.00	3			3.00	1.11		1	3	4.00	1.49		2	3	5.00	1.86
18	0.350				0.00	0.00	3			3.00	1.05		1	3	4.00	1.40		2	3	5.00	1.75
19	0.331				0.00	0.00	3			3.00	0.99		1	3	4.00	1.32		2	3	5.00	1.65
20	0.312				0.00	0.00	3	408		411.00	128.15	350	1	3	354.00	110.38	350	5	3	358.00	111.63
21	0.294				0.00	0.00	3			3.00	0.88		1	3	4.00	1.18		5	3	8.00	2.35
22	0.278				0.00	0.00	3		100	103.00	28.58		1	3	4.00	1.11		5	3	8.00	2.22
23	0.262				0.00	0.00	3			3.00	0.79		1	3	4.00	1.05		5	3	8.00	2.09
24	0.247				0.00	0.00	3			3.00	0.74		1	3	4.00	0.99		5	3	8.00	1.98
25	0.233				0.00	0.00	3			3.00	0.70		1	3	4.00	0.93		5	3	8.00	1.86
26	0.220				0.00	0.00	3			3.00	0.66		1	3	4.00	0.88		5	3	8.00	1.76
27	0.207				0.00	0.00	3			3.00	0.62		1	3	4.00	0.83		5	3	8.00	1.66
28	0.196				0.00	0.00	3			3.00	0.59		1	3	4.00	0.78		5	3	8.00	1.57
29	0.185				0.00	0.00	3			3.00	0.55		1	3	4.00	0.74		5	3	8.00	1.48
30	0.174				0.00	0.00	3	308		311.00	54.15		1	3	4.00	0.70		5	3	8.00	1.39
31	0.164				0.00	0.00	3			3.00	0.49		1	3	4.00	0.66		5	3	8.00	1.31
32	0.155				0.00	0.00	3		100	103.00	15.96		1	3	4.00	0.62		5	3	8.00	1.24
33	0.146				0.00	0.00	3			3.00	0.44		1	3	4.00	0.58		5	3	8.00	1.17
34	0.138				0.00	0.00	3			3.00	0.41		1	3	4.00	0.55		5	3	8.00	1.10
35	0.130				0.00	0.00	3			3.00	0.39		1	3	4.00	0.52		5	3	8.00	1.04
36	0.123				0.00	0.00	3			3.00	0.37		1	3	4.00	0.49		5	3	8.00	0.98
37	0.116				0.00	0.00	3			3.00	0.35		1	3	4.00	0.46		5	3	8.00	0.93
38	0.109				0.00	0.00	3			3.00	0.33		1	3	4.00	0.44		5	3	8.00	0.87
39	0.103				0.00	0.00	3			3.00	0.31		1	3	4.00	0.41		5	3	8.00	0.82
40	0.097				0.00	0.00	3	408		411.00	39.96	350	1	3	354.00	34.42	350	5	3	358.00	34.81
41	0.092				0.00	0.00	3			3.00	0.28		1	3	4.00	0.37		5	3	8.00	0.73
42	0.087				0.00	0.00	3		100	103.00	8.91		1	3	4.00	0.35		5	3	8.00	0.69
43	0.082				0.00	0.00	3			3.00	0.24		1	3	4.00	0.33		5	3	8.00	0.65
44	0.077				0.00	0.00	3			3.00	0.23		1	3	4.00	0.31		5	3	8.00	0.62
45	0.073				0.00	0.00	3			3.00	0.22		1	3	4.00	0.29		5	3	8.00	0.58
46	0.069				0.00	0.00	3			3.00	0.21		1	3	4.00	0.27		5	3	8.00	0.55
47	0.065				0.00	0.00	3			3.00	0.19		1	3	4.00	0.26		5	3	8.00	0.52
48	0.061				0.00	0.00	3			3.00	0.18		1	3	4.00	0.24		5	3	8.00	0.49
49	0.058				0.00	0.00	3			3.00	0.17		1	3	4.00	0.23		5	3	8.00	0.46
50	0.054				0.00	0.00	3	308		311.00	16.88		1	3	4.00	0.22		5	3	8.00	0.43
51	0.051				0.00	0.00	3			3.00	0.15		1	3	4.00	0.20		5	3	8.00	0.41
52	0.048				0.00	0.00	3		100	103.00	4.98		1	3	4.00	0.19		5	3	8.00	0.39
53	0.046				0.00	0.00	3			3.00	0.14		1	3	4.00	0.18		5	3	8.00	0.36
54	0.043				0.00	0.00	3			3.00	0.13		1	3	4.00	0.17		5	3	8.00	0.34
55	0.041				0.00	0.00	3			3.00	0.12		1	3	4.00	0.16		5	3	8.00	0.32
56	0.038				0.00	0.00	3			3.00	0.11		1	3	4.00	0.15		5	3	8.00	0.31
57	0.036				0.00	0.00	3			3.00	0.11		1	3	4.00	0.14		5	3	8.00	0.29
58	0.034				0.00	0.00	3			3.00	0.10		1	3	4.00	0.14		5	3	8.00	0.27
59	0.032				0.00	0.00	3	308		311.00	9.99		1	3	4.00	0.13		5	3	8.00	0.26

Net Present Value over time

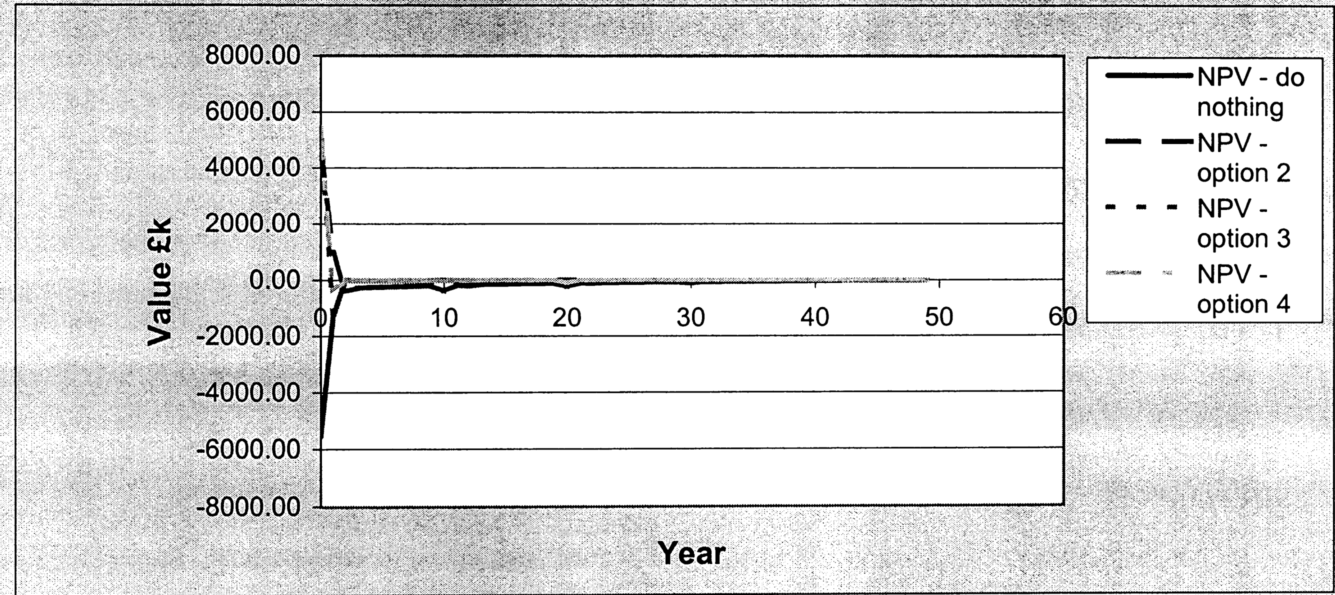
Sheet Nr. 8

Client/Authority
SBC

Project name
MU19E Strategy - Preferred Strategy with SL(

Project reference	1,404.00
Base date for estimates (year 0)	Dec 01
Scaling factor (e.g. £m, £k, £)	£k
Discount rate	6%

Prepared (date)	16/09/99
Printed	14/05/03
Prepared by	DR
Checked by	GS
Checked date	16/10/99



SPREADSHEETS FOR 50% INCREASE IN CONSTRUCTION COSTS

Project Summary Sheet

Client/Authority		Prepared (date)	14 8 02
SBC		Printed	14/05/03
Project name		Prepared by	dgc
MU19E Strategy - Preferred Strategy with SLC & CP losses **+50% Cons**		Checked by	
Project reference	1404	Checked date	
Base date for estimates (year 0)	Dec 01		
Scaling factor (e.g. £m, £k, £)	£k	(used for all costs, losses and benefits)	
Principle land use band	B	(A to E)	
Discount rate	6%		

Costs and benefits of options

	Costs and benefits £k				
	No Project	Option 2	Option 3	Option 4	
PV costs PVc	0.00	1,143.04	3,324.43	2,367.55	
PV damage PVd	6,871.65	6,169.54	74.46	74.46	
PV damage avoided		702.11	6,797.19	6,797.19	
PV assets Pva					
PV asset protection benefits		0.00	0.00	0.00	
Total PV benefits PVb		702.11	6,797.19	6,797.19	
Net Present Value NPV		-440.92	3,472.76	4,429.63	
Average benefit/cost ratio		0.6	2.0	2.9	
Incremental benefit/cost ratio			2.79	0.00	
		-	-	Highest b/c	

Brief description of options:

Option 1	Do nothing
Option 2	Do Minimum - Phased Work Short to Long Term
Option 3	Do Something - Full Scheme
Option 4	Do Something - Partial Scheme + Maintenance

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting
2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
PV benefits calculated as PV damage avoided + PV asset protection benefits
3) Incremental benefit/cost ratio is calculated as:
(PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Damage Cost Calculation Sheet - Do Nothing (Exponential)

Sheet Nr. 2

Client/Authority
SBC
Project name
MU19E Strategy - Preferred Strategy with SLC &
Option:
Do nothing

Project reference	1,404.00			
Base date for estimates (year 0)	Dec 01			Prepared (date)
Scaling factor (e.g. £m, £k, £)	£k			Printed 14/05/03
Discount rate	6%			Prepared by dgc
		PV breach/failure £k	6951.08	Checked by
Remaining structure life	2	**Ave Annual Damage**		Checked date
Initial probability of failure	0.800	**(overtopping)** £k	0.00 /yr	
Calculations assum 0.99	prob of failure in year 2			
Calculated factors: -0.01005	-0.30743	**PV Total Damage** £k	6871.65 (calculated below)	

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	has not occurred	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.800	0.800	0.200	5560.87	0.00		5560.87
1	0.943	0.990	0.198	0.002	1298.41	0.00		1298.41
2	0.890	1.000	0.002	0.000	12.37	0.00		12.37
3	0.840	1.000	0.000	0.000	0.00	0.00		0.00
4	0.792	1.000	0.000	0.000	0.00	0.00		0.00
5	0.747	1.000	0.000	0.000	0.00	0.00		0.00
6	0.705	1.000	0.000	0.000	0.00	0.00		0.00
7	0.665	1.000	0.000	0.000	0.00	0.00		0.00
8	0.627	1.000	0.000	0.000	0.00	0.00		0.00
9	0.592	1.000	0.000	0.000	0.00	0.00		0.00
10	0.558	1.000	0.000	0.000	0.00	0.00		0.00
11	0.527	1.000	0.000	0.000	0.00	0.00		0.00
12	0.497	1.000	0.000	0.000	0.00	0.00		0.00
13	0.469	1.000	0.000	0.000	0.00	0.00		0.00
14	0.442	1.000	0.000	0.000	0.00	0.00		0.00
15	0.417	1.000	0.000	0.000	0.00	0.00		0.00
16	0.394	1.000	0.000	0.000	0.00	0.00		0.00
17	0.371	1.000	0.000	0.000	0.00	0.00		0.00
18	0.350	1.000	0.000	0.000	0.00	0.00		0.00
19	0.331	1.000	0.000	0.000	0.00	0.00		0.00
20	0.312	1.000	0.000	0.000	0.00	0.00		0.00
21	0.294	1.000	0.000	0.000	0.00	0.00		0.00
22	0.278	1.000	0.000	0.000	0.00	0.00		0.00
23	0.262	1.000	0.000	0.000	0.00	0.00		0.00
24	0.247	1.000	0.000	0.000	0.00	0.00		0.00
25	0.233	1.000	0.000	0.000	0.00	0.00		0.00
26	0.220	1.000	0.000	0.000	0.00	0.00		0.00
27	0.207	1.000	0.000	0.000	0.00	0.00		0.00
28	0.196	1.000	0.000	0.000	0.00	0.00		0.00
29	0.185	1.000	0.000	0.000	0.00	0.00		0.00
30	0.174	1.000	0.000	0.000	0.00	0.00		0.00
31	0.164	1.000	0.000	0.000	0.00	0.00		0.00
32	0.155	1.000	0.000	0.000	0.00	0.00		0.00
33	0.146	1.000	0.000	0.000	0.00	0.00		0.00
34	0.138	1.000	0.000	0.000	0.00	0.00		0.00
35	0.130	1.000	0.000	0.000	0.00	0.00		0.00
36	0.123	1.000	0.000	0.000	0.00	0.00		0.00
37	0.116	1.000	0.000	0.000	0.00	0.00		0.00
38	0.109	1.000	0.000	0.000	0.00	0.00		0.00
39	0.103	1.000	0.000	0.000	0.00	0.00		0.00
40	0.097	1.000	0.000	0.000	0.00	0.00		0.00
41	0.092	1.000	0.000	0.000	0.00	0.00		0.00
42	0.087	1.000	0.000	0.000	0.00	0.00		0.00
43	0.082	1.000	0.000	0.000	0.00	0.00		0.00
44	0.077	1.000	0.000	0.000	0.00	0.00		0.00
45	0.073	1.000	0.000	0.000	0.00	0.00		0.00
46	0.069	1.000	0.000	0.000	0.00	0.00		0.00
47	0.065	1.000	0.000	0.000	0.00	0.00		0.00
48	0.061	1.000	0.000	0.000	0.00	0.00		0.00
49	0.058	1.000	0.000	0.000	0.00	0.00		0.00
50	0.054	1.000	0.000	0.000	0.00	0.00		0.00
51	0.051	1.000	0.000	0.000	0.00	0.00		0.00
52	0.048	1.000	0.000	0.000	0.00	0.00		0.00
53	0.046	1.000	0.000	0.000	0.00	0.00		0.00
54	0.043	1.000	0.000	0.000	0.00	0.00		0.00
55	0.041	1.000	0.000	0.000	0.00	0.00		0.00
56	0.038	1.000	0.000	0.000	0.00	0.00		0.00
57	0.036	1.000	0.000	0.000	0.00	0.00		0.00
58	0.034	1.000	0.000	0.000	0.00	0.00		0.00
59	0.032	1.000	0.000	0.000	0.00	0.00		0.00
Totals					6871.65	0.00		6871.65

Notes
Complete one spreadsheet for the 'do nothing' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
It is assumed that breaches are not repaired and that once breach damage has occurred it will not recur.
A separate check should be made to ensure that overtopping damages do not exceed write off values.
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 3

Client/Authority
SBC
Project name
MU19E Strategy - Preferred Strategy with SLC & CP lc
Option:
Do Minimum - Phased Work Short to Long Term

Project reference	1404				
Base date for estimates (year 0)	Dec 01				
Scaling factor (e.g. £m, £k, £)	£k			**Prepared (date)**	
Discount rate	6%			Printed	14/05/03
		PV breach/failure	£k 675.80	Prepared by	dgc
Remaining structure life	60	**Ave Annual Damage**		Checked by	
Initial probability of failure	0.500	**(overtopping)**	£k ________ /yr	Checked date	
Calculations assume 0.99	prob of failure in year 60				
Calculated factors: -0.01005	-0.16684	**PV Total Damage**	£k 6169.54 (calculated below)		

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.500	0.500	0.500	337.90	0.00		337.90
1	0.943	0.501	0.501	0.499	319.67	0.00		319.67
2	0.890	0.503	0.503	0.497	302.44	0.00		302.44
3	0.840	0.504	0.504	0.496	286.15	0.00		286.15
4	0.792	0.506	0.506	0.494	270.75	0.00		270.75
5	0.747	0.507	0.507	0.493	256.19	0.00		256.19
6	0.705	0.509	0.509	0.491	242.43	0.00		242.43
7	0.665	0.510	0.510	0.490	229.42	0.00		229.42
8	0.627	0.512	0.512	0.488	217.12	0.00		217.12
9	0.592	0.514	0.514	0.486	205.50	0.00		205.50
10	0.558	0.515	0.515	0.485	194.51	0.00		194.51
11	0.527	0.517	0.517	0.483	184.12	0.00		184.12
12	0.497	0.519	0.519	0.481	174.30	0.00		174.30
13	0.469	0.521	0.521	0.479	165.01	0.00		165.01
14	0.442	0.523	0.523	0.477	156.23	0.00		156.23
15	0.417	0.525	0.525	0.475	147.93	0.00		147.93
16	0.394	0.527	0.527	0.473	140.08	0.00		140.08
17	0.371	0.529	0.529	0.471	132.66	0.00		132.66
18	0.350	0.531	0.531	0.469	125.64	0.00		125.64
19	0.331	0.533	0.533	0.467	119.01	0.00		119.01
20	0.312	0.535	0.535	0.465	112.73	0.00		112.73
21	0.294	0.537	0.537	0.463	106.80	0.00		106.80
22	0.278	0.540	0.540	0.460	101.19	0.00		101.19
23	0.262	0.542	0.542	0.458	95.89	0.00		95.89
24	0.247	0.544	0.544	0.456	90.88	0.00		90.88
25	0.233	0.547	0.547	0.453	86.14	0.00		86.14
26	0.220	0.550	0.550	0.450	81.66	0.00		81.66
27	0.207	0.552	0.552	0.448	77.42	0.00		77.42
28	0.196	0.555	0.555	0.445	73.41	0.00		73.41
29	0.185	0.558	0.558	0.442	69.63	0.00		69.63
30	0.174	0.561	0.561	0.439	66.04	0.00		66.04
31	0.164	0.564	0.564	0.436	62.66	0.00		62.66
32	0.155	0.568	0.568	0.432	59.46	0.00		59.46
33	0.146	0.571	0.571	0.429	56.44	0.00		56.44
34	0.138	0.575	0.575	0.425	53.58	0.00		53.58
35	0.130	0.579	0.579	0.421	50.88	0.00		50.88
36	0.123	0.583	0.583	0.417	48.32	0.00		48.32
37	0.116	0.587	0.587	0.413	45.91	0.00		45.91
38	0.109	0.591	0.591	0.409	43.64	0.00		43.64
39	0.103	0.596	0.596	0.404	41.49	0.00		41.49
40	0.097	0.601	0.601	0.399	39.46	0.00		39.46
41	0.092	0.606	0.606	0.394	37.55	0.00		37.55
42	0.087	0.611	0.611	0.389	35.74	0.00		35.74
43	0.082	0.617	0.617	0.383	34.04	0.00		34.04
44	0.077	0.623	0.623	0.377	32.44	0.00		32.44
45	0.073	0.630	0.630	0.370	30.94	0.00		30.94
46	0.069	0.637	0.637	0.363	29.52	0.00		29.52
47	0.065	0.645	0.645	0.355	28.20	0.00		28.20
48	0.061	0.654	0.654	0.346	26.96	0.00		26.96
49	0.058	0.664	0.664	0.336	25.81	0.00		25.81
50	0.054	0.674	0.674	0.326	24.74	0.00		24.74
51	0.051	0.686	0.686	0.314	23.75	0.00		23.75
52	0.048	0.700	0.700	0.300	22.85	0.00		22.85
53	0.046	0.716	0.716	0.284	22.04	0.00		22.04
54	0.043	0.734	0.734	0.266	21.34	0.00		21.34
55	0.041	0.757	0.757	0.243	20.75	0.00		20.75
56	0.038	0.786	0.786	0.214	20.32	0.00		20.32
57	0.036	0.824	0.824	0.176	20.11	0.00		20.11
58	0.034	0.882	0.882	0.118	20.30	0.00		20.30
59	0.032	0.990	0.990	0.010	21.50	0.00		21.50
Totals					6169.54	0.00		6169.54

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 4

Client/Authority
SBC
Project name
MU19E Strategy - Preferred Strategy with SLC & CP k

Option:
Do Something - Full Scheme

Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 210.72
Remaining structure life 60
Ave Annual Damage
Initial probability of failure 0.010
(overtopping) £k 0.00 /yr
Calculations assume **0.99** **prob of failure in year 60**
Calculated factors: -0.01005 -1.12231
PV Total Damage £k 74.46 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	2.11	0.00		2.11
1	0.943	0.010	0.010	0.990	2.03	0.00		2.03
2	0.890	0.010	0.010	0.990	1.95	0.00		1.95
3	0.840	0.011	0.011	0.989	1.87	0.00		1.87
4	0.792	0.011	0.011	0.989	1.80	0.00		1.80
5	0.747	0.011	0.011	0.989	1.74	0.00		1.74
6	0.705	0.011	0.011	0.989	1.67	0.00		1.67
7	0.665	0.011	0.011	0.989	1.61	0.00		1.61
8	0.627	0.012	0.012	0.988	1.55	0.00		1.55
9	0.592	0.012	0.012	0.988	1.50	0.00		1.50
10	0.558	0.012	0.012	0.988	1.44	0.00		1.44
11	0.527	0.013	0.013	0.987	1.39	0.00		1.39
12	0.497	0.013	0.013	0.987	1.35	0.00		1.35
13	0.469	0.013	0.013	0.987	1.30	0.00		1.30
14	0.442	0.013	0.013	0.987	1.26	0.00		1.26
15	0.417	0.014	0.014	0.986	1.21	0.00		1.21
16	0.394	0.014	0.014	0.986	1.17	0.00		1.17
17	0.371	0.015	0.015	0.985	1.14	0.00		1.14
18	0.350	0.015	0.015	0.985	1.10	0.00		1.10
19	0.331	0.015	0.015	0.985	1.07	0.00		1.07
20	0.312	0.016	0.016	0.984	1.04	0.00		1.04
21	0.294	0.016	0.016	0.984	1.01	0.00		1.01
22	0.278	0.017	0.017	0.983	0.98	0.00		0.98
23	0.262	0.017	0.017	0.983	0.95	0.00		0.95
24	0.247	0.018	0.018	0.982	0.92	0.00		0.92
25	0.233	0.018	0.018	0.982	0.90	0.00		0.90
26	0.220	0.019	0.019	0.981	0.88	0.00		0.88
27	0.207	0.020	0.020	0.980	0.85	0.00		0.85
28	0.196	0.020	0.020	0.980	0.83	0.00		0.83
29	0.185	0.021	0.021	0.979	0.82	0.00		0.82
30	0.174	0.022	0.022	0.978	0.80	0.00		0.80
31	0.164	0.023	0.023	0.977	0.78	0.00		0.78
32	0.155	0.024	0.024	0.976	0.77	0.00		0.77
33	0.146	0.025	0.025	0.975	0.75	0.00		0.75
34	0.138	0.026	0.026	0.974	0.74	0.00		0.74
35	0.130	0.027	0.027	0.973	0.73	0.00		0.73
36	0.123	0.028	0.028	0.972	0.72	0.00		0.72
37	0.116	0.029	0.029	0.971	0.72	0.00		0.72
38	0.109	0.031	0.031	0.969	0.71	0.00		0.71
39	0.103	0.032	0.032	0.968	0.71	0.00		0.71
40	0.097	0.034	0.034	0.966	0.70	0.00		0.70
41	0.092	0.036	0.036	0.964	0.70	0.00		0.70
42	0.087	0.039	0.039	0.961	0.70	0.00		0.70
43	0.082	0.041	0.041	0.959	0.71	0.00		0.71
44	0.077	0.044	0.044	0.956	0.72	0.00		0.72
45	0.073	0.047	0.047	0.953	0.73	0.00		0.73
46	0.069	0.051	0.051	0.949	0.74	0.00		0.74
47	0.065	0.056	0.056	0.944	0.76	0.00		0.76
48	0.061	0.061	0.061	0.939	0.78	0.00		0.78
49	0.058	0.067	0.067	0.933	0.81	0.00		0.81
50	0.054	0.075	0.075	0.925	0.85	0.00		0.85
51	0.051	0.084	0.084	0.916	0.91	0.00		0.91
52	0.048	0.096	0.096	0.904	0.98	0.00		0.98
53	0.046	0.111	0.111	0.889	1.07	0.00		1.07
54	0.043	0.133	0.133	0.867	1.20	0.00		1.20
55	0.041	0.163	0.163	0.837	1.39	0.00		1.39
56	0.038	0.209	0.209	0.791	1.68	0.00		1.68
57	0.036	0.289	0.289	0.711	2.19	0.00		2.19
58	0.034	0.455	0.455	0.545	3.26	0.00		3.26
59	0.032	0.990	0.990	0.010	6.70	0.00		6.70
Totals					74.46	0.00		74.46

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 5

Client/Authority
SBC

Project name
MU19E Strategy - Preferred Strategy with SLC & CP l(

Option:
Do Something - Partial Scheme + Maintenance

Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 210.72
Remaining structure life 60
Ave Annual Damage (overtopping) £k 0.00 /yr
Initial probability of failure 0.010
Calculations assume 0.99 prob of failure in year 60
Calculated factors: -0.01005 -1.12231
PV Total Damage £k 74.46 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	Prob that breach/failure: does not occur	PV damage due to: breach or failure	PV damage due to: over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	2.11	0.00		2.11
1	0.943	0.010	0.010	0.990	2.03	0.00		2.03
2	0.890	0.010	0.010	0.990	1.95	0.00		1.95
3	0.840	0.011	0.011	0.989	1.87	0.00		1.87
4	0.792	0.011	0.011	0.989	1.80	0.00		1.80
5	0.747	0.011	0.011	0.989	1.74	0.00		1.74
6	0.705	0.011	0.011	0.989	1.67	0.00		1.67
7	0.665	0.011	0.011	0.989	1.61	0.00		1.61
8	0.627	0.012	0.012	0.988	1.55	0.00		1.55
9	0.592	0.012	0.012	0.988	1.50	0.00		1.50
10	0.558	0.012	0.012	0.988	1.44	0.00		1.44
11	0.527	0.013	0.013	0.987	1.39	0.00		1.39
12	0.497	0.013	0.013	0.987	1.35	0.00		1.35
13	0.469	0.013	0.013	0.987	1.30	0.00		1.30
14	0.442	0.013	0.013	0.987	1.26	0.00		1.26
15	0.417	0.014	0.014	0.986	1.21	0.00		1.21
16	0.394	0.014	0.014	0.986	1.17	0.00		1.17
17	0.371	0.015	0.015	0.985	1.14	0.00		1.14
18	0.350	0.015	0.015	0.985	1.10	0.00		1.10
19	0.331	0.015	0.015	0.985	1.07	0.00		1.07
20	0.312	0.016	0.016	0.984	1.04	0.00		1.04
21	0.294	0.016	0.016	0.984	1.01	0.00		1.01
22	0.278	0.017	0.017	0.983	0.98	0.00		0.98
23	0.262	0.017	0.017	0.983	0.95	0.00		0.95
24	0.247	0.018	0.018	0.982	0.92	0.00		0.92
25	0.233	0.018	0.018	0.982	0.90	0.00		0.90
26	0.220	0.019	0.019	0.981	0.88	0.00		0.88
27	0.207	0.020	0.020	0.980	0.85	0.00		0.85
28	0.196	0.020	0.020	0.980	0.83	0.00		0.83
29	0.185	0.021	0.021	0.979	0.82	0.00		0.82
30	0.174	0.022	0.022	0.978	0.80	0.00		0.80
31	0.164	0.023	0.023	0.977	0.78	0.00		0.78
32	0.155	0.024	0.024	0.976	0.77	0.00		0.77
33	0.146	0.025	0.025	0.975	0.75	0.00		0.75
34	0.138	0.026	0.026	0.974	0.74	0.00		0.74
35	0.130	0.027	0.027	0.973	0.73	0.00		0.73
36	0.123	0.028	0.028	0.972	0.72	0.00		0.72
37	0.116	0.029	0.029	0.971	0.72	0.00		0.72
38	0.109	0.031	0.031	0.969	0.71	0.00		0.71
39	0.103	0.032	0.032	0.968	0.71	0.00		0.71
40	0.097	0.034	0.034	0.966	0.70	0.00		0.70
41	0.092	0.036	0.036	0.964	0.70	0.00		0.70
42	0.087	0.039	0.039	0.961	0.70	0.00		0.70
43	0.082	0.041	0.041	0.959	0.71	0.00		0.71
44	0.077	0.044	0.044	0.956	0.72	0.00		0.72
45	0.073	0.047	0.047	0.953	0.73	0.00		0.73
46	0.069	0.051	0.051	0.949	0.74	0.00		0.74
47	0.065	0.056	0.056	0.944	0.76	0.00		0.76
48	0.061	0.061	0.061	0.939	0.78	0.00		0.78
49	0.058	0.067	0.067	0.933	0.81	0.00		0.81
50	0.054	0.075	0.075	0.925	0.85	0.00		0.85
51	0.051	0.084	0.084	0.916	0.91	0.00		0.91
52	0.048	0.096	0.096	0.904	0.98	0.00		0.98
53	0.046	0.111	0.111	0.889	1.07	0.00		1.07
54	0.043	0.133	0.133	0.867	1.20	0.00		1.20
55	0.041	0.163	0.163	0.837	1.39	0.00		1.39
56	0.038	0.209	0.209	0.791	1.68	0.00		1.68
57	0.036	0.289	0.289	0.711	2.19	0.00		2.19
58	0.034	0.455	0.455	0.545	3.26	0.00		3.26
59	0.032	0.990	0.990	0.010	6.70	0.00		6.70
Totals					74.46	0.00		74.46

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Erosion Value Calculation Sheet with delay options

Sheet Nr. 6

Client/Authority
SBC

Project name
MU19E Strategy - Preferred Strategy with SLC & C

Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Option:	Delay (yrs)
Do Minimum - Phased Work S	40
Do Something - Full Scheme	60
Do Something - Partial Scherr	60

Prepared (date)	
Printed	14/05/03
Prepared by	dgc
Checked by	
Checked date	

Ref	Asset Description	MV £k	Year	Prob of loss without project in year	Expected value of asset losses £k Without Project	Do Minimum - Phased Work Short to Long Term	Do Something - Full Scheme	Do Something - Partial Scheme + Maintenance	
0	Property Yr 2	3571.00	1	0.03	101.07	9.83	3.06	3.06	
0	Property Yr 2	3571.00	2	0.95	3,019.27	293.54	91.53	91.53	
0	Property Yr 2	3571.00	3	0.02	59.97	5.83	1.82	1.82	
1	Scalby CP+ Sea Life Cen 0yr	396.28	1	0.05	18.69	1.82	0.57	0.57	
2	YW WWTW	320	2	0.95	270.56	26.30	8.20	8.20	
3	YW WWTW	320	1	0.05	15.09	1.47	0.46	0.46	
4	Scalby CP+ Sea Life Cen 1yr	396.28	2	0.95	335.05	32.57	10.16	10.16	
5	Scalby CP+ Sea Life Cen 2yr	396.28	3	1	332.72	32.35	10.09	10.09	
6	Scalby CP+ Sea Life Cen 3yr	396.28	4	1	313.89	30.52	9.52	9.52	
7	Scalby CP+ Sea Life Cen 4yr	396.28	5	1	296.12	28.79	8.98	8.98	
8	Scalby CP+ Sea Life Cen 5yr	396.28	6	1	279.36	27.16	8.47	8.47	
9	Scalby CP+ Sea Life Cen 6yr	396.28	7	1	263.55	25.62	7.99	7.99	
10	Scalby CP+ Sea Life Cen 7yr	396.28	8	1	248.63	24.17	7.54	7.54	
11	Scalby CP+ Sea Life Cen 8yr	396.28	9	1	234.56	22.80	7.11	7.11	
12	Scalby CP+ Sea Life Cen 9yr	396.28	10	1	221.28	21.51	6.71	6.71	
12	Scalby CP+ Sea Life Cen 10yr	396.28	11	1	208.76	20.30	6.33	6.33	
12	Property Yr 5	302.00	4	0.15	35.88	3.49	1.09	1.09	
13	Property Yr 5	302.00	5	0.75	169.25	16.46	5.13	5.13	
14	Property Yr 5	302.00	6	0.1	21.29	2.07	0.65	0.65	
15	Property Yr 15	402.00	10	0.15	33.67	3.27	1.02	1.02	
16	Property Yr 15	402.00	15	0.75	125.81	12.23	3.81	3.81	
17	Property Yr 15	402.00	20	0.1	12.53	1.22	0.38	0.38	
18	Property Yr 30	255.00	25	0.25	14.85	1.44	0.45	0.45	
19	Property Yr 30	255.00	30	0.5	22.20	2.16	0.67	0.67	
20	Property Yr 30	255.00	35	0.25	8.29	0.81	0.25	0.25	
21	Property Yr 45	673.00	40	0.25	16.36	1.59	0.50	0.50	
22	Property Yr 45	673.00	45	0.5	24.45	2.38	0.74	0.74	
23	Property Yr 45	673.00	50	0.25	9.13	0.89	0.28	0.28	
24	Property Yr 60	657.00	60	0.25	4.98	0.48	0.15	0.15	
25	Property Yr 60	657.00	65	0.75	11.16	1.09	0.34	0.34	
26	H&S Works following failure	250.00	1	0.03	7.08	0.69	0.21	0.21	
27	H&S Works following failure	250.00	2	0.95	211.37	20.55	6.41	6.41	
28	H&S Works following failure	250.00	3	0.02	4.20	0.41	0.13	0.13	
29					-	-	-	-	
30					-	-	-	-	
31					-	-	-	-	
32					-	-	-	-	
33	[For property losses see Tables 4.6 A & B]				-	-	-	-	
34					-	-	-	-	
35					-	-	-	-	
36					-	-	-	-	
37					-	-	-	-	
38					-	-	-	-	
39					-	-	-	-	
40					-	-	-	-	
41					-	-	-	-	
42					-	-	-	-	
43					-	-	-	-	
44					-	-	-	-	
45					-	-	-	-	
46					-	-	-	-	
47					-	-	-	-	
48					-	-	-	-	
49					-	-	-	-	
50					-	-	-	-	
51					-	-	-	-	
52					-	-	-	-	
53					-	-	-	-	
54					-	-	-	-	
55					-	-	-	-	
56					-	-	-	-	
57					-	-	-	-	
58					-	-	-	-	
59					-	-	-	-	
Totals		22672.08			6951.08	675.80	210.72	210.72	

Notes
Make one entry in the description column for each property (or group of properties) as this determines subsequent calculation
MV = risk free market value at base date for estimate - must be entered on each line when probability distribution is used
Equivalent annual value = MV x discount rate (assumes infinite life)
Year is year by which there is the cumulative probability of loss shown
If no distribution is used enter year after expected year of loss and enter 1.0 in probability column
(i.e. certainty of loss before start of year so year must be 1.0 or greater)
(e.g. If certain of loss in year 5 enter 6 in year column and 1 in probability column)
Asset value in first year for each property (or group) shown is cumulative to the year of first loss
Asset value in subsequent years for each property is additional value for that property if life extended

Present Value Costs for all options

Sheet Nr. 7

Client/Authority
SBC
Project name
MU19E Strategy - Preferred Strategy with SL
Project reference 1,404.00
Base date for estimates (year 0 Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Results £k	Option 1 (Do nothing)	Option 2 Do Minimum - Phased W	Option 3 Do Something - Full Sch	Option 4 Do Something - Partial S
PV total costs	0.00	1143.04	3324.43	2367.55

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

		Option 1	(Do nothing)		TOTALS:		Option 2	Do Minimum - Phased W		TOTALS:		Option 3	Do Something - Full Sche		TOTALS:		Option 4	Do Something - Partial S		TOTALS:	
		Capital	Maint.	Other	Cash	PV	Mon	Works	Emergency	Cash	PV	Capital	Main	All Mon	Cash	PV	Capital	Maint.	All Mon	Cash	PV
	cash sum	0	0	0	0.00	0.00	180	2556	600	3336.00	1143.04	4019.2	61	180	4260.20	3324.43	2972	240	180	3392.00	2367.55
year	Discount Factor																				
0	1.000				0.00	0.00	3	408		411.00	411.00	100	2	3	105.00	105.00	100	2	3	105.00	105.00
1	0.943				0.00	0.00	3			3.00	2.83	3119.2	1	3	3123.20	2946.42	2072	2	3	2077.00	1959.43
2	0.890				0.00	0.00	3	40	100	143.00	127.27	40	1	3	44.00	39.16	40	2	3	45.00	40.05
3	0.840				0.00	0.00	3			3.00	2.52		1	3	4.00	3.36		2	3	5.00	4.20
4	0.792				0.00	0.00	3			3.00	2.38		1	3	4.00	3.17		2	3	5.00	3.96
5	0.747				0.00	0.00	3			3.00	2.24		1	3	4.00	2.99		2	3	5.00	3.74
6	0.705				0.00	0.00	3			3.00	2.11		1	3	4.00	2.82		2	3	5.00	3.52
7	0.665				0.00	0.00	3			3.00	2.00		1	3	4.00	2.66		2	3	5.00	3.33
8	0.627				0.00	0.00	3			3.00	1.88		1	3	4.00	2.51		2	3	5.00	3.14
9	0.592				0.00	0.00	3			3.00	1.78		1	3	4.00	2.37		2	3	5.00	2.96
10	0.558				0.00	0.00	3	368		371.00	207.16	60	1	3	64.00	35.74	60	2	3	65.00	36.30
11	0.527				0.00	0.00	3			3.00	1.58		1	3	4.00	2.11		2	3	5.00	2.63
12	0.497				0.00	0.00	3		100	103.00	51.19		1	3	4.00	1.99		2	3	5.00	2.48
13	0.469				0.00	0.00	3			3.00	1.41		1	3	4.00	1.88		2	3	5.00	2.34
14	0.442				0.00	0.00	3			3.00	1.33		1	3	4.00	1.77		2	3	5.00	2.21
15	0.417				0.00	0.00	3			3.00	1.25		1	3	4.00	1.67		2	3	5.00	2.09
16	0.394				0.00	0.00	3			3.00	1.18		1	3	4.00	1.57		2	3	5.00	1.97
17	0.371				0.00	0.00	3			3.00	1.11		1	3	4.00	1.49		2	3	5.00	1.86
18	0.350				0.00	0.00	3			3.00	1.05		1	3	4.00	1.40		2	3	5.00	1.75
19	0.331				0.00	0.00	3			3.00	0.99		1	3	4.00	1.32		2	3	5.00	1.65
20	0.312				0.00	0.00	3	408		411.00	128.15	350	1	3	354.00	110.38	350	5	3	358.00	111.63
21	0.294				0.00	0.00	3			3.00	0.88		1	3	4.00	1.18		5	3	8.00	2.35
22	0.278				0.00	0.00	3		100	103.00	28.58		1	3	4.00	1.11		5	3	8.00	2.22
23	0.262				0.00	0.00	3			3.00	0.79		1	3	4.00	1.05		5	3	8.00	2.09
24	0.247				0.00	0.00	3			3.00	0.74		1	3	4.00	0.99		5	3	8.00	1.98
25	0.233				0.00	0.00	3			3.00	0.70		1	3	4.00	0.93		5	3	8.00	1.86
26	0.220				0.00	0.00	3			3.00	0.66		1	3	4.00	0.88		5	3	8.00	1.76
27	0.207				0.00	0.00	3			3.00	0.62		1	3	4.00	0.83		5	3	8.00	1.66
28	0.196				0.00	0.00	3			3.00	0.59		1	3	4.00	0.78		5	3	8.00	1.57
29	0.185				0.00	0.00	3			3.00	0.55		1	3	4.00	0.74		5	3	8.00	1.48
30	0.174				0.00	0.00	3	308		311.00	54.15		1	3	4.00	0.70		5	3	8.00	1.39
31	0.164				0.00	0.00	3			3.00	0.49		1	3	4.00	0.66		5	3	8.00	1.31
32	0.155				0.00	0.00	3		100	103.00	15.96		1	3	4.00	0.62		5	3	8.00	1.24
33	0.146				0.00	0.00	3			3.00	0.44		1	3	4.00	0.58		5	3	8.00	1.17
34	0.138				0.00	0.00	3			3.00	0.41		1	3	4.00	0.55		5	3	8.00	1.10
35	0.130				0.00	0.00	3			3.00	0.39		1	3	4.00	0.52		5	3	8.00	1.04
36	0.123				0.00	0.00	3			3.00	0.37		1	3	4.00	0.49		5	3	8.00	0.98
37	0.116				0.00	0.00	3			3.00	0.35		1	3	4.00	0.46		5	3	8.00	0.93
38	0.109				0.00	0.00	3			3.00	0.33		1	3	4.00	0.44		5	3	8.00	0.87
39	0.103				0.00	0.00	3			3.00	0.31		1	3	4.00	0.41		5	3	8.00	0.82
40	0.097				0.00	0.00	3	408		411.00	39.96	350	1	3	354.00	34.42	350	5	3	358.00	34.81
41	0.092				0.00	0.00	3			3.00	0.28		1	3	4.00	0.37		5	3	8.00	0.73
42	0.087				0.00	0.00	3		100	103.00	8.91		1	3	4.00	0.35		5	3	8.00	0.69
43	0.082				0.00	0.00	3			3.00	0.24		1	3	4.00	0.33		5	3	8.00	0.65
44	0.077				0.00	0.00	3			3.00	0.23		1	3	4.00	0.31		5	3	8.00	0.62
45	0.073				0.00	0.00	3			3.00	0.22		1	3	4.00	0.29		5	3	8.00	0.58
46	0.069				0.00	0.00	3			3.00	0.21		1	3	4.00	0.27		5	3	8.00	0.55
47	0.065				0.00	0.00	3			3.00	0.19		1	3	4.00	0.26		5	3	8.00	0.52
48	0.061				0.00	0.00	3			3.00	0.18		1	3	4.00	0.24		5	3	8.00	0.49
49	0.058				0.00	0.00	3			3.00	0.17		1	3	4.00	0.23		5	3	8.00	0.46
50	0.054				0.00	0.00	3	308		311.00	16.88		1	3	4.00	0.22		5	3	8.00	0.43
51	0.051				0.00	0.00	3			3.00	0.15		1	3	4.00	0.20		5	3	8.00	0.41
52	0.048				0.00	0.00	3		100	103.00	4.98		1	3	4.00	0.19		5	3	8.00	0.39
53	0.046				0.00	0.00	3			3.00	0.14		1	3	4.00	0.18		5	3	8.00	0.36
54	0.043				0.00	0.00	3			3.00	0.13		1	3	4.00	0.17		5	3	8.00	0.34
55	0.041				0.00	0.00	3			3.00	0.12		1	3	4.00	0.16		5	3	8.00	0.32
56	0.038				0.00	0.00	3			3.00	0.11		1	3	4.00	0.15		5	3	8.00	0.31
57	0.036				0.00	0.00	3			3.00	0.11		1	3	4.00	0.14		5	3	8.00	0.29
58	0.034				0.00	0.00	3			3.00	0.10		1	3	4.00	0.14		5	3	8.00	0.27
59	0.032				0.00	0.00	3	308		311.00	9.99		1	3	4.00	0.13		5	3	8.00	0.26

Net Present Value over time

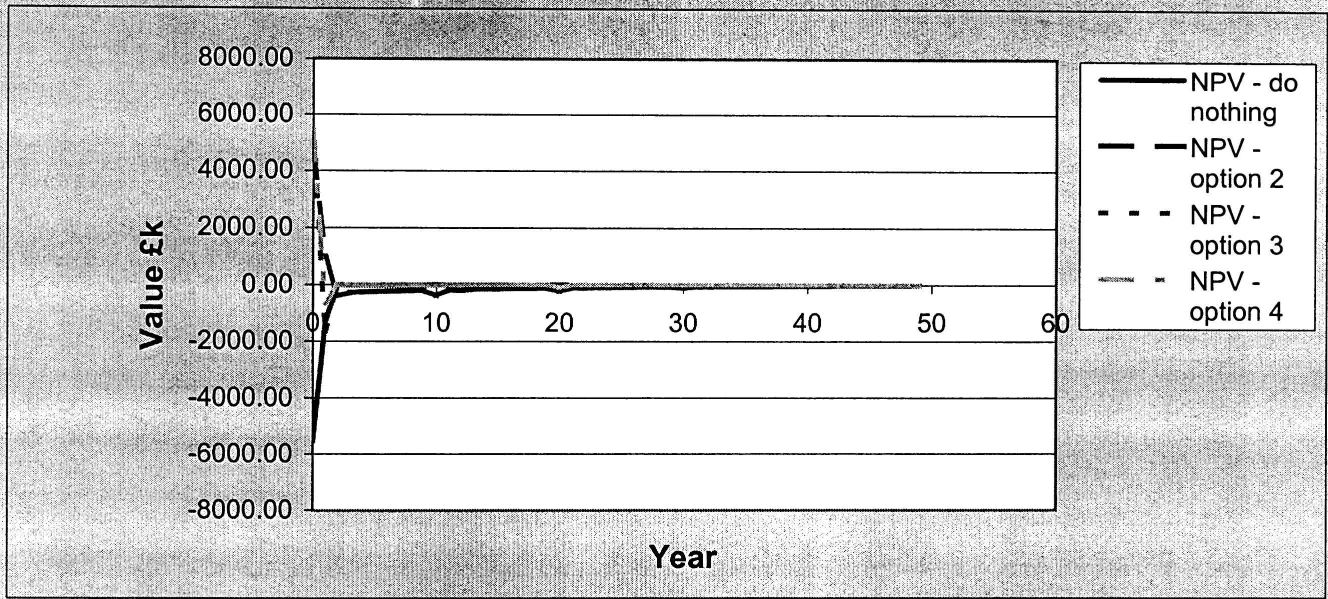
Sheet Nr. 8

Client/Authority
SBC

Project name
MU19E Strategy - Preferred Strategy with SL(

Project reference	1,404.00
Base date for estimates (year 0)	Dec 01
Scaling factor (e.g. £m, £k, £)	£k
Discount rate	6%

Prepared (date)	16/09/99
Printed	14/05/03
Prepared by	DR
Checked by	GS
Checked date	16/10/99



SPREADSHEETS FOR NO INDIRECT LOSSES

Project Summary Sheet

Client/Authority
SBC
Project name
MU19E Strategy - Preferred Strategy with **No Indirect Losses**

Project reference	1404	
Base date for estimates (year 0)	Dec 01	
Scaling factor (e.g. £m, £k, £)	£k	(used for all costs, losses and benefits)
Principle land use band	B	(A to E)
Discount rate	6%	

Prepared (date)	14 8 02
Printed	14/05/03
Prepared by	dgc
Checked by	
Checked date	

Costs and benefits of options

	Costs and benefits £k				
	No Project	Option 2	Option 3	Option 4	
PV costs PVc	0.00	1,143.04	2,416.41	1,770.10	
PV damage PVd	4,160.37	3,735.28	45.08	45.08	
PV damage avoided		425.09	4,115.29	4,115.29	
PV assets Pva					
PV asset protection benefits		0.00	0.00	0.00	
Total PV benefits PVb		425.09	4,115.29	4,115.29	
Net Present Value NPV		-717.95	1,698.88	2,345.19	
Average benefit/cost ratio		0.4	1.7	2.3	
Incremental benefit/cost ratio			2.90	0.00	
		-	-	Highest b/c	

Brief description of options:

Option 1	Do nothing
Option 2	Do Minimum - Phased Work Short to Long Term
Option 3	Do Something - Full Scheme
Option 4	Do Something - Partial Scheme + Maintenance

Notes:
1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting
2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
PV benefits calculated as PV damage avoided + PV asset protection benefits
3) Incremental benefit/cost ratio is calculated as:
(PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Damage Cost Calculation Sheet - Do Nothing (Exponential)

Sheet Nr. 2

Client/Authority
SBC
Project name
MU19E Strategy - Preferred Strategy with No Ind
Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Option:
Do nothing

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

Remaining structure life 2
Initial probability of failure 0.800
Calculations assum 0.99 prob of failure in year 2
Calculated factors: -0.01005 -0.30743

PV breach/failure £k 4208.46
Ave Annual Damage (overtopping) £k 0.00 /yr
PV Total Damage £k 4160.37 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	Prob that breach/failure: has not occurred	PV damage due to: breach or failure	PV damage due to: over-topping	Other damage (specify)	PV total damage
0	1.000	0.800	0.800	0.200	3366.77	0.00		3366.77
1	0.943	0.990	0.198	0.002	786.11	0.00		786.11
2	0.890	1.000	0.002	0.000	7.49	0.00		7.49
3	0.840	1.000	0.000	0.000	0.00	0.00		0.00
4	0.792	1.000	0.000	0.000	0.00	0.00		0.00
5	0.747	1.000	0.000	0.000	0.00	0.00		0.00
6	0.705	1.000	0.000	0.000	0.00	0.00		0.00
7	0.665	1.000	0.000	0.000	0.00	0.00		0.00
8	0.627	1.000	0.000	0.000	0.00	0.00		0.00
9	0.592	1.000	0.000	0.000	0.00	0.00		0.00
10	0.558	1.000	0.000	0.000	0.00	0.00		0.00
11	0.527	1.000	0.000	0.000	0.00	0.00		0.00
12	0.497	1.000	0.000	0.000	0.00	0.00		0.00
13	0.469	1.000	0.000	0.000	0.00	0.00		0.00
14	0.442	1.000	0.000	0.000	0.00	0.00		0.00
15	0.417	1.000	0.000	0.000	0.00	0.00		0.00
16	0.394	1.000	0.000	0.000	0.00	0.00		0.00
17	0.371	1.000	0.000	0.000	0.00	0.00		0.00
18	0.350	1.000	0.000	0.000	0.00	0.00		0.00
19	0.331	1.000	0.000	0.000	0.00	0.00		0.00
20	0.312	1.000	0.000	0.000	0.00	0.00		0.00
21	0.294	1.000	0.000	0.000	0.00	0.00		0.00
22	0.278	1.000	0.000	0.000	0.00	0.00		0.00
23	0.262	1.000	0.000	0.000	0.00	0.00		0.00
24	0.247	1.000	0.000	0.000	0.00	0.00		0.00
25	0.233	1.000	0.000	0.000	0.00	0.00		0.00
26	0.220	1.000	0.000	0.000	0.00	0.00		0.00
27	0.207	1.000	0.000	0.000	0.00	0.00		0.00
28	0.196	1.000	0.000	0.000	0.00	0.00		0.00
29	0.185	1.000	0.000	0.000	0.00	0.00		0.00
30	0.174	1.000	0.000	0.000	0.00	0.00		0.00
31	0.164	1.000	0.000	0.000	0.00	0.00		0.00
32	0.155	1.000	0.000	0.000	0.00	0.00		0.00
33	0.146	1.000	0.000	0.000	0.00	0.00		0.00
34	0.138	1.000	0.000	0.000	0.00	0.00		0.00
35	0.130	1.000	0.000	0.000	0.00	0.00		0.00
36	0.123	1.000	0.000	0.000	0.00	0.00		0.00
37	0.116	1.000	0.000	0.000	0.00	0.00		0.00
38	0.109	1.000	0.000	0.000	0.00	0.00		0.00
39	0.103	1.000	0.000	0.000	0.00	0.00		0.00
40	0.097	1.000	0.000	0.000	0.00	0.00		0.00
41	0.092	1.000	0.000	0.000	0.00	0.00		0.00
42	0.087	1.000	0.000	0.000	0.00	0.00		0.00
43	0.082	1.000	0.000	0.000	0.00	0.00		0.00
44	0.077	1.000	0.000	0.000	0.00	0.00		0.00
45	0.073	1.000	0.000	0.000	0.00	0.00		0.00
46	0.069	1.000	0.000	0.000	0.00	0.00		0.00
47	0.065	1.000	0.000	0.000	0.00	0.00		0.00
48	0.061	1.000	0.000	0.000	0.00	0.00		0.00
49	0.058	1.000	0.000	0.000	0.00	0.00		0.00
50	0.054	1.000	0.000	0.000	0.00	0.00		0.00
51	0.051	1.000	0.000	0.000	0.00	0.00		0.00
52	0.048	1.000	0.000	0.000	0.00	0.00		0.00
53	0.046	1.000	0.000	0.000	0.00	0.00		0.00
54	0.043	1.000	0.000	0.000	0.00	0.00		0.00
55	0.041	1.000	0.000	0.000	0.00	0.00		0.00
56	0.038	1.000	0.000	0.000	0.00	0.00		0.00
57	0.036	1.000	0.000	0.000	0.00	0.00		0.00
58	0.034	1.000	0.000	0.000	0.00	0.00		0.00
59	0.032	1.000	0.000	0.000	0.00	0.00		0.00
Totals					4160.37	0.00		4160.37

Notes

Complete one spreadsheet for the 'do nothing' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
It is assumed that breaches are not repaired and that once breach damage has occurred it will not recur.
A separate check should be made to ensure that overtopping damages do not exceed write off values.
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 3

Client/Authority
SBC
Project name
MU19E Strategy - Preferred Strategy with No Indirect I
Option:
Do Minimum - Phased Work Short to Long Term
Project reference 1404
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 409.16
Ave Annual Damage (overtopping) £k ________/yr
Remaining structure life 60
Initial probability of failure 0.500
Calculations assume **0.99** **prob of failure in year 60**
Calculated factors: -0.01005 -0.16684
PV Total Damage £k 3735.28 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.500	0.500	0.500	204.58	0.00		204.58
1	0.943	0.501	0.501	0.499	193.54	0.00		193.54
2	0.890	0.503	0.503	0.497	183.11	0.00		183.11
3	0.840	0.504	0.504	0.496	173.24	0.00		173.24
4	0.792	0.506	0.506	0.494	163.92	0.00		163.92
5	0.747	0.507	0.507	0.493	155.11	0.00		155.11
6	0.705	0.509	0.509	0.491	146.78	0.00		146.78
7	0.665	0.510	0.510	0.490	138.90	0.00		138.90
8	0.627	0.512	0.512	0.488	131.46	0.00		131.46
9	0.592	0.514	0.514	0.486	124.42	0.00		124.42
10	0.558	0.515	0.515	0.485	117.76	0.00		117.76
11	0.527	0.517	0.517	0.483	111.47	0.00		111.47
12	0.497	0.519	0.519	0.481	105.53	0.00		105.53
13	0.469	0.521	0.521	0.479	99.90	0.00		99.90
14	0.442	0.523	0.523	0.477	94.59	0.00		94.59
15	0.417	0.525	0.525	0.475	89.56	0.00		89.56
16	0.394	0.527	0.527	0.473	84.81	0.00		84.81
17	0.371	0.529	0.529	0.471	80.32	0.00		80.32
18	0.350	0.531	0.531	0.469	76.07	0.00		76.07
19	0.331	0.533	0.533	0.467	72.05	0.00		72.05
20	0.312	0.535	0.535	0.465	68.25	0.00		68.25
21	0.294	0.537	0.537	0.463	64.66	0.00		64.66
22	0.278	0.540	0.540	0.460	61.27	0.00		61.27
23	0.262	0.542	0.542	0.458	58.06	0.00		58.06
24	0.247	0.544	0.544	0.456	55.02	0.00		55.02
25	0.233	0.547	0.547	0.453	52.15	0.00		52.15
26	0.220	0.550	0.550	0.450	49.44	0.00		49.44
27	0.207	0.552	0.552	0.448	46.87	0.00		46.87
28	0.196	0.555	0.555	0.445	44.45	0.00		44.45
29	0.185	0.558	0.558	0.442	42.15	0.00		42.15
30	0.174	0.561	0.561	0.439	39.99	0.00		39.99
31	0.164	0.564	0.564	0.436	37.94	0.00		37.94
32	0.155	0.568	0.568	0.432	36.00	0.00		36.00
33	0.146	0.571	0.571	0.429	34.17	0.00		34.17
34	0.138	0.575	0.575	0.425	32.44	0.00		32.44
35	0.130	0.579	0.579	0.421	30.80	0.00		30.80
36	0.123	0.583	0.583	0.417	29.26	0.00		29.26
37	0.116	0.587	0.587	0.413	27.80	0.00		27.80
38	0.109	0.591	0.591	0.409	26.42	0.00		26.42
39	0.103	0.596	0.596	0.404	25.12	0.00		25.12
40	0.097	0.601	0.601	0.399	23.89	0.00		23.89
41	0.092	0.606	0.606	0.394	22.73	0.00		22.73
42	0.087	0.611	0.611	0.389	21.64	0.00		21.64
43	0.082	0.617	0.617	0.383	20.61	0.00		20.61
44	0.077	0.623	0.623	0.377	19.64	0.00		19.64
45	0.073	0.630	0.630	0.370	18.73	0.00		18.73
46	0.069	0.637	0.637	0.363	17.87	0.00		17.87
47	0.065	0.645	0.645	0.355	17.07	0.00		17.07
48	0.061	0.654	0.654	0.346	16.32	0.00		16.32
49	0.058	0.664	0.664	0.336	15.62	0.00		15.62
50	0.054	0.674	0.674	0.326	14.98	0.00		14.98
51	0.051	0.686	0.686	0.314	14.38	0.00		14.38
52	0.048	0.700	0.700	0.300	13.83	0.00		13.83
53	0.046	0.716	0.716	0.284	13.34	0.00		13.34
54	0.043	0.734	0.734	0.266	12.92	0.00		12.92
55	0.041	0.757	0.757	0.243	12.56	0.00		12.56
56	0.038	0.786	0.786	0.214	12.30	0.00		12.30
57	0.036	0.824	0.824	0.176	12.18	0.00		12.18
58	0.034	0.882	0.882	0.118	12.29	0.00		12.29
59	0.032	0.990	0.990	0.010	13.02	0.00		13.02
Totals					3735.28	0.00		3735.28

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 4

Client/Authority
SBC

Project name
MU19E Strategy - Preferred Strategy with No Indirect I

Option:
Do Something - Full Scheme

Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 127.58
Ave Annual Damage (overtopping) £k 0.00 /yr

Remaining structure life 60
Initial probability of failure 0.010
Calculations assume **0.99** **prob of failure in year 60**
Calculated factors: -0.01005 -1.12231
PV Total Damage £k 45.08 (calculated below)

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	does not occur	PV damage due to: breach or failure	over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	1.28	0.00		1.28
1	0.943	0.010	0.010	0.990	1.23	0.00		1.23
2	0.890	0.010	0.010	0.990	1.18	0.00		1.18
3	0.840	0.011	0.011	0.989	1.13	0.00		1.13
4	0.792	0.011	0.011	0.989	1.09	0.00		1.09
5	0.747	0.011	0.011	0.989	1.05	0.00		1.05
6	0.705	0.011	0.011	0.989	1.01	0.00		1.01
7	0.665	0.011	0.011	0.989	0.98	0.00		0.98
8	0.627	0.012	0.012	0.988	0.94	0.00		0.94
9	0.592	0.012	0.012	0.988	0.91	0.00		0.91
10	0.558	0.012	0.012	0.988	0.87	0.00		0.87
11	0.527	0.013	0.013	0.987	0.84	0.00		0.84
12	0.497	0.013	0.013	0.987	0.81	0.00		0.81
13	0.469	0.013	0.013	0.987	0.79	0.00		0.79
14	0.442	0.013	0.013	0.987	0.76	0.00		0.76
15	0.417	0.014	0.014	0.986	0.74	0.00		0.74
16	0.394	0.014	0.014	0.986	0.71	0.00		0.71
17	0.371	0.015	0.015	0.985	0.69	0.00		0.69
18	0.350	0.015	0.015	0.985	0.67	0.00		0.67
19	0.331	0.015	0.015	0.985	0.65	0.00		0.65
20	0.312	0.016	0.016	0.984	0.63	0.00		0.63
21	0.294	0.016	0.016	0.984	0.61	0.00		0.61
22	0.278	0.017	0.017	0.983	0.59	0.00		0.59
23	0.262	0.017	0.017	0.983	0.57	0.00		0.57
24	0.247	0.018	0.018	0.982	0.56	0.00		0.56
25	0.233	0.018	0.018	0.982	0.54	0.00		0.54
26	0.220	0.019	0.019	0.981	0.53	0.00		0.53
27	0.207	0.020	0.020	0.980	0.52	0.00		0.52
28	0.196	0.020	0.020	0.980	0.51	0.00		0.51
29	0.185	0.021	0.021	0.979	0.49	0.00		0.49
30	0.174	0.022	0.022	0.978	0.48	0.00		0.48
31	0.164	0.023	0.023	0.977	0.47	0.00		0.47
32	0.155	0.024	0.024	0.976	0.47	0.00		0.47
33	0.146	0.025	0.025	0.975	0.46	0.00		0.46
34	0.138	0.026	0.026	0.974	0.45	0.00		0.45
35	0.130	0.027	0.027	0.973	0.44	0.00		0.44
36	0.123	0.028	0.028	0.972	0.44	0.00		0.44
37	0.116	0.029	0.029	0.971	0.43	0.00		0.43
38	0.109	0.031	0.031	0.969	0.43	0.00		0.43
39	0.103	0.032	0.032	0.968	0.43	0.00		0.43
40	0.097	0.034	0.034	0.966	0.43	0.00		0.43
41	0.092	0.036	0.036	0.964	0.43	0.00		0.43
42	0.087	0.039	0.039	0.961	0.43	0.00		0.43
43	0.082	0.041	0.041	0.959	0.43	0.00		0.43
44	0.077	0.044	0.044	0.956	0.43	0.00		0.43
45	0.073	0.047	0.047	0.953	0.44	0.00		0.44
46	0.069	0.051	0.051	0.949	0.45	0.00		0.45
47	0.065	0.056	0.056	0.944	0.46	0.00		0.46
48	0.061	0.061	0.061	0.939	0.47	0.00		0.47
49	0.058	0.067	0.067	0.933	0.49	0.00		0.49
50	0.054	0.075	0.075	0.925	0.52	0.00		0.52
51	0.051	0.084	0.084	0.916	0.55	0.00		0.55
52	0.048	0.096	0.096	0.904	0.59	0.00		0.59
53	0.046	0.111	0.111	0.889	0.65	0.00		0.65
54	0.043	0.133	0.133	0.867	0.73	0.00		0.73
55	0.041	0.163	0.163	0.837	0.84	0.00		0.84
56	0.038	0.209	0.209	0.791	1.02	0.00		1.02
57	0.036	0.289	0.289	0.711	1.33	0.00		1.33
58	0.034	0.455	0.455	0.545	1.98	0.00		1.98
59	0.032	0.990	0.990	0.010	4.06	0.00		4.06
Totals					45.08	0.00		45.08

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Damage Cost Calculation Sheet - Do Something (Exponential)

Sheet Nr. 5

Client/Authority
SBC

Project name
MU19E Strategy - Preferred Strategy with No Indirect I

Option:
Do Something - Partial Scheme + Maintenance

Project reference 1,404.00
Base date for estimates (year 0) Dec 01
Scaling factor (e.g. £m, £k, £) £k
Discount rate 6%

Prepared (date)
Printed 14/05/03
Prepared by dgc
Checked by
Checked date

PV breach/failure £k 127.58
Ave Annual Damage (overtopping) £k 0.00 /yr
PV Total Damage £k 45.08 (calculated below)

Remaining structure life 60
Initial probability of failure 0.010
Calculations assume 0.99 prob of failure in year 60
Calculated factors: -0.01005 -1.12231

Year	Discount factor	Prob of a breach/ failure	Prob that breach/failure: occurs in year	Prob that breach/failure: does not occur	PV damage due to: breach or failure	PV damage due to: over-topping	Other damage (specify)	PV total damage
0	1.000	0.010	0.010	0.990	1.28	0.00		1.28
1	0.943	0.010	0.010	0.990	1.23	0.00		1.23
2	0.890	0.010	0.010	0.990	1.18	0.00		1.18
3	0.840	0.011	0.011	0.989	1.13	0.00		1.13
4	0.792	0.011	0.011	0.989	1.09	0.00		1.09
5	0.747	0.011	0.011	0.989	1.05	0.00		1.05
6	0.705	0.011	0.011	0.989	1.01	0.00		1.01
7	0.665	0.011	0.011	0.989	0.98	0.00		0.98
8	0.627	0.012	0.012	0.988	0.94	0.00		0.94
9	0.592	0.012	0.012	0.988	0.91	0.00		0.91
10	0.558	0.012	0.012	0.988	0.87	0.00		0.87
11	0.527	0.013	0.013	0.987	0.84	0.00		0.84
12	0.497	0.013	0.013	0.987	0.81	0.00		0.81
13	0.469	0.013	0.013	0.987	0.79	0.00		0.79
14	0.442	0.013	0.013	0.987	0.76	0.00		0.76
15	0.417	0.014	0.014	0.986	0.74	0.00		0.74
16	0.394	0.014	0.014	0.986	0.71	0.00		0.71
17	0.371	0.015	0.015	0.985	0.69	0.00		0.69
18	0.350	0.015	0.015	0.985	0.67	0.00		0.67
19	0.331	0.015	0.015	0.985	0.65	0.00		0.65
20	0.312	0.016	0.016	0.984	0.63	0.00		0.63
21	0.294	0.016	0.016	0.984	0.61	0.00		0.61
22	0.278	0.017	0.017	0.983	0.59	0.00		0.59
23	0.262	0.017	0.017	0.983	0.57	0.00		0.57
24	0.247	0.018	0.018	0.982	0.56	0.00		0.56
25	0.233	0.018	0.018	0.982	0.54	0.00		0.54
26	0.220	0.019	0.019	0.981	0.53	0.00		0.53
27	0.207	0.020	0.020	0.980	0.52	0.00		0.52
28	0.196	0.020	0.020	0.980	0.51	0.00		0.51
29	0.185	0.021	0.021	0.979	0.49	0.00		0.49
30	0.174	0.022	0.022	0.978	0.48	0.00		0.48
31	0.164	0.023	0.023	0.977	0.47	0.00		0.47
32	0.155	0.024	0.024	0.976	0.47	0.00		0.47
33	0.146	0.025	0.025	0.975	0.46	0.00		0.46
34	0.138	0.026	0.026	0.974	0.45	0.00		0.45
35	0.130	0.027	0.027	0.973	0.44	0.00		0.44
36	0.123	0.028	0.028	0.972	0.44	0.00		0.44
37	0.116	0.029	0.029	0.971	0.43	0.00		0.43
38	0.109	0.031	0.031	0.969	0.43	0.00		0.43
39	0.103	0.032	0.032	0.968	0.43	0.00		0.43
40	0.097	0.034	0.034	0.966	0.43	0.00		0.43
41	0.092	0.036	0.036	0.964	0.43	0.00		0.43
42	0.087	0.039	0.039	0.961	0.43	0.00		0.43
43	0.082	0.041	0.041	0.959	0.43	0.00		0.43
44	0.077	0.044	0.044	0.956	0.43	0.00		0.43
45	0.073	0.047	0.047	0.953	0.44	0.00		0.44
46	0.069	0.051	0.051	0.949	0.45	0.00		0.45
47	0.065	0.056	0.056	0.944	0.46	0.00		0.46
48	0.061	0.061	0.061	0.939	0.47	0.00		0.47
49	0.058	0.067	0.067	0.933	0.49	0.00		0.49
50	0.054	0.075	0.075	0.925	0.52	0.00		0.52
51	0.051	0.084	0.084	0.916	0.55	0.00		0.55
52	0.048	0.096	0.096	0.904	0.59	0.00		0.59
53	0.046	0.111	0.111	0.889	0.65	0.00		0.65
54	0.043	0.133	0.133	0.867	0.73	0.00		0.73
55	0.041	0.163	0.163	0.837	0.84	0.00		0.84
56	0.038	0.209	0.209	0.791	1.02	0.00		1.02
57	0.036	0.289	0.289	0.711	1.33	0.00		1.33
58	0.034	0.455	0.455	0.545	1.98	0.00		1.98
59	0.032	0.990	0.990	0.010	4.06	0.00		4.06
Totals					45.08	0.00		45.08

Notes

Complete one spreadsheet for each 'do something' option
The formulae assume that breach or failure probability will increase exponentially from the initial probability entered using the formula:
Prob (year i)= EXP(a +b*(LN(life-i)) where a=LN(prob in final year) and b=(LN(initial prob)-LN(prob in final year))/LN(life)
If the structure is to be replaced during the period then calculations should be adjusted to reflect this.
It is assumed that breaches are repaired and damage does not depend on previous ocurrence, PV of breach should include cost of repair
These damage calculations assume that overtopping damage can reasonably be ignored once a breach has occurred.
If these assumptions are not valid then appropriate adjustments need to be made. In this case the total damage is calculated as:
PV damage in year=disc factor*((prob no breach damage in year*annual overtop damage)+(prob breach damage in year*breach damage))

Erosion Value Calculation Sheet with delay options

Sheet Nr. 6

Client/Authority
SBC

Project name		**Option:**	**Delay (yrs)**	Prepared (date)	
MU19E Strategy - Preferred Strategy with No Indire		Do Minimum - Phased Work S	40	Printed	14/05/03
Project reference	1,404.00	Do Something - Full Scheme	60	Prepared by	dgc
Base date for estimates (year 0)	Dec 01	Do Something - Partial Schem	60	Checked by	
Scaling factor (e.g. £m, £k, £)	£k			Checked date	
Discount rate	6%				

Ref	Asset Description	MV £k	Year	Prob of loss without project in year	Expected value of asset losses £k: Without Project	Do Minimum - Phased Work Short to Long Term	Do Something - Full Scheme	Do Something - Partial Scheme + Maintenance	
0	Property Yr 2	3571.00	1	0.03	101.07	9.83	3.06	3.06	
0	Property Yr 2	3571.00	2	0.95	3,019.27	293.54	91.53	91.53	
0	Property Yr 2	3571.00	3	0.02	59.97	5.83	1.82	1.82	
1	Scalby CP+ Sea Life Cen 0yr	212.00	1	0.05	10.00	0.97	0.30	0.30	
2	YW WWTW	320	2	0.95	270.56	26.30	8.20	8.20	
3	YW WWTW	320	1	0.05	15.09	1.47	0.46	0.46	
4	Property Yr 5	302.00	4	0.15	35.88	3.49	1.09	1.09	
5	Property Yr 5	302.00	5	0.75	169.25	16.46	5.13	5.13	
6	Property Yr 5	302.00	6	0.1	21.29	2.07	0.65	0.65	
7	Property Yr 15	402.00	10	0.15	33.67	3.27	1.02	1.02	
8	Property Yr 15	402.00	15	0.75	125.81	12.23	3.81	3.81	
9	Property Yr 15	402.00	20	0.1	12.53	1.22	0.38	0.38	
10	Property Yr 30	255.00	25	0.25	14.85	1.44	0.45	0.45	
11	Property Yr 30	255.00	30	0.5	22.20	2.16	0.67	0.67	
12	Property Yr 30	255.00	35	0.25	8.29	0.81	0.25	0.25	
12	Property Yr 45	673.00	40	0.25	16.36	1.59	0.50	0.50	
12	Property Yr 45	673.00	45	0.5	24.45	2.38	0.74	0.74	
13	Property Yr 45	673.00	50	0.25	9.13	0.89	0.28	0.28	
14	Property Yr 60	657.00	60	0.25	4.98	0.48	0.15	0.15	
15	Property Yr 60	657.00	65	0.75	11.16	1.09	0.34	0.34	
16	H&S Works following failure	250.00	1	0.03	7.08	0.69	0.21	0.21	
17	H&S Works following failure	250.00	2	0.95	211.37	20.55	6.41	6.41	
18	H&S Works following failure	250.00	3	0.02	4.20	0.41	0.13	0.13	
19					-	-	-	-	
20					-	-	-	-	
21					-	-	-	-	
22					-	-	-	-	
23					-	-	-	-	
24					-	-	-	-	
25					-	-	-	-	
26					-	-	-	-	
27					-	-	-	-	
28					-	-	-	-	
29					-	-	-	-	
30					-	-	-	-	
31					-	-	-	-	
32					-	-	-	-	
33	[For property losses see Tables 4.6 A & B]				-	-	-	-	
34					-	-	-	-	
35					-	-	-	-	
36					-	-	-	-	
37					-	-	-	-	
38					-	-	-	-	
39					-	-	-	-	
40					-	-	-	-	
41					-	-	-	-	
42					-	-	-	-	
43					-	-	-	-	
44					-	-	-	-	
45					-	-	-	-	
46					-	-	-	-	
47					-	-	-	-	
48					-	-	-	-	
49					-	-	-	-	
50					-	-	-	-	
51					-	-	-	-	
52					-	-	-	-	
53					-	-	-	-	
54					-	-	-	-	
55					-	-	-	-	
56					-	-	-	-	
57					-	-	-	-	
58					-	-	-	-	
59					-	-	-	-	
Totals		18525.00			4208.46	409.16	127.58	127.58	

Notes
Make one entry in the description column for each property (or group of properties) as this determines subsequent calculation
MV = risk free market value at base date for estimate - must be entered on each line when probability distribution is used
Equivalent annual value = MV x discount rate (assumes infinite life)
Year is year by which there is the cumulative probability of loss shown
If no distribution is used enter year after expected year of loss and enter 1.0 in probability column
(i.e. certainty of loss before start of year so year must be 1.0 or greater)
(e.g. If certain of loss in year 5 enter 6 in year column and 1 in probability column)
Asset value in first year for each property (or group) shown is cumulative to the year of first loss
Asset value in subsequent years for each property is additional value for that property if life extended

Present Value Costs for all options

Client/Authority
SBC

Project name
MU19E Strategy - Preferred Strategy with Nc

Project reference	1,404.00
Base date for estimates (year 0	Dec 01
Scaling factor (e.g. £m, £k, £)	£k
Discount rate	6%

Results £k

	Option 1 (Do nothing)	Option 2 Do Minimum - Phased W	Option 3 Do Something - Full Sch	Option 4 Do Something - Partial S
PV total costs	0.00	1143.04	2416.41	1770.10

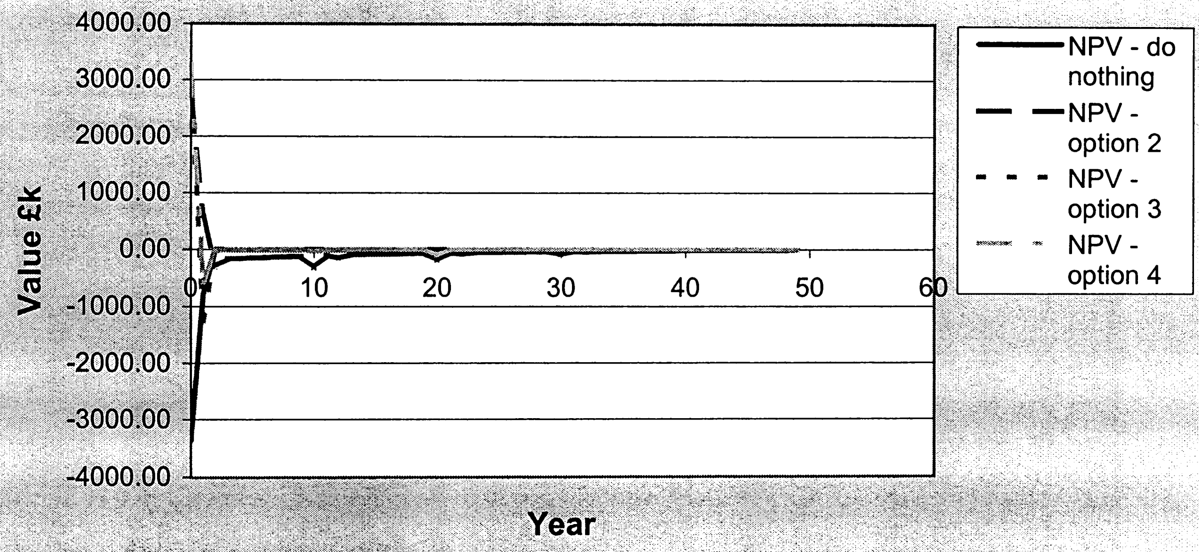
Sheet Nr. 7

Prepared (date)	
Printed	14/05/03
Prepared by	dgc
Checked by	
Checked date	

		Option 1 (Do nothing)			TOTALS:		Option 2 Do Minimum - Phased W			TOTALS:		Option 3 Do Something - Full Sche			TOTALS:		Option 4 Do Something - Partial S			TOTALS:	
		Capital	Maint.	Other	Cash	PV	Mon	Works	Emergency	Cash	PV	Capital	Main	All Mon	Cash	PV	Capital	Maint.	All Mon	Cash	PV
	cash sum	0	0	0	0.00	0.00	180	2556	600	3336.00	1143.04	3056.7	61	180	3297.70	2416.41	2338.7	240	180	2758.70	1770.10
year	Discount Factor																				
0	1.000				0.00	0.00	3	408		411.00	411.00	100	2	3	105.00	105.00	100	2	3	105.00	105.00
1	0.943				0.00	0.00	3			3.00	2.83	2156.7	1	3	2160.70	2038.40	1439	2	3	1443.70	1361.98
2	0.890				0.00	0.00	3	40	100	143.00	127.27	40	1	3	44.00	39.16	40	2	3	45.00	40.05
3	0.840				0.00	0.00	3			3.00	2.52		1	3	4.00	3.36		2	3	5.00	4.20
4	0.792				0.00	0.00	3			3.00	2.38		1	3	4.00	3.17		2	3	5.00	3.96
5	0.747				0.00	0.00	3			3.00	2.24		1	3	4.00	2.99		2	3	5.00	3.74
6	0.705				0.00	0.00	3			3.00	2.11		1	3	4.00	2.82		2	3	5.00	3.52
7	0.665				0.00	0.00	3			3.00	2.00		1	3	4.00	2.66		2	3	5.00	3.33
8	0.627				0.00	0.00	3			3.00	1.88		1	3	4.00	2.51		2	3	5.00	3.14
9	0.592				0.00	0.00	3			3.00	1.78		1	3	4.00	2.37		2	3	5.00	2.96
10	0.558				0.00	0.00	3	368		371.00	207.16	60	1	3	64.00	35.74	60	2	3	65.00	36.30
11	0.527				0.00	0.00	3			3.00	1.58		1	3	4.00	2.11		2	3	5.00	2.63
12	0.497				0.00	0.00	3		100	103.00	51.19		1	3	4.00	1.99		2	3	5.00	2.48
13	0.469				0.00	0.00	3			3.00	1.41		1	3	4.00	1.88		2	3	5.00	2.34
14	0.442				0.00	0.00	3			3.00	1.33		1	3	4.00	1.77		2	3	5.00	2.21
15	0.417				0.00	0.00	3			3.00	1.25		1	3	4.00	1.67		2	3	5.00	2.09
16	0.394				0.00	0.00	3			3.00	1.18		1	3	4.00	1.57		2	3	5.00	1.97
17	0.371				0.00	0.00	3			3.00	1.11		1	3	4.00	1.49		2	3	5.00	1.86
18	0.350				0.00	0.00	3			3.00	1.05		1	3	4.00	1.40		2	3	5.00	1.75
19	0.331				0.00	0.00	3			3.00	0.99		1	3	4.00	1.32		2	3	5.00	1.65
20	0.312				0.00	0.00	3	408		411.00	128.15	350	1	3	354.00	110.38	350	5	3	358.00	111.63
21	0.294				0.00	0.00	3			3.00	0.88		1	3	4.00	1.18		5	3	8.00	2.35
22	0.278				0.00	0.00	3		100	103.00	28.58		1	3	4.00	1.11		5	3	8.00	2.22
23	0.262				0.00	0.00	3			3.00	0.79		1	3	4.00	1.05		5	3	8.00	2.09
24	0.247				0.00	0.00	3			3.00	0.74		1	3	4.00	0.99		5	3	8.00	1.98
25	0.233				0.00	0.00	3			3.00	0.70		1	3	4.00	0.93		5	3	8.00	1.86
26	0.220				0.00	0.00	3			3.00	0.66		1	3	4.00	0.88		5	3	8.00	1.76
27	0.207				0.00	0.00	3			3.00	0.62		1	3	4.00	0.83		5	3	8.00	1.66
28	0.196				0.00	0.00	3			3.00	0.59		1	3	4.00	0.78		5	3	8.00	1.57
29	0.185				0.00	0.00	3			3.00	0.55		1	3	4.00	0.74		5	3	8.00	1.48
30	0.174				0.00	0.00	3	308		311.00	54.15		1	3	4.00	0.70		5	3	8.00	1.39
31	0.164				0.00	0.00	3			3.00	0.49		1	3	4.00	0.66		5	3	8.00	1.31
32	0.155				0.00	0.00	3		100	103.00	15.96		1	3	4.00	0.62		5	3	8.00	1.24
33	0.146				0.00	0.00	3			3.00	0.44		1	3	4.00	0.58		5	3	8.00	1.17
34	0.138				0.00	0.00	3			3.00	0.41		1	3	4.00	0.55		5	3	8.00	1.10
35	0.130				0.00	0.00	3			3.00	0.39		1	3	4.00	0.52		5	3	8.00	1.04
36	0.123				0.00	0.00	3			3.00	0.37		1	3	4.00	0.49		5	3	8.00	0.98
37	0.116				0.00	0.00	3			3.00	0.35		1	3	4.00	0.46		5	3	8.00	0.93
38	0.109				0.00	0.00	3			3.00	0.33		1	3	4.00	0.44		5	3	8.00	0.87
39	0.103				0.00	0.00	3			3.00	0.31		1	3	4.00	0.41		5	3	8.00	0.82
40	0.097				0.00	0.00	3	408		411.00	39.96	350	1	3	354.00	34.42	350	5	3	358.00	34.81
41	0.092				0.00	0.00	3			3.00	0.28		1	3	4.00	0.37		5	3	8.00	0.73
42	0.087				0.00	0.00	3		100	103.00	8.91		1	3	4.00	0.35		5	3	8.00	0.69
43	0.082				0.00	0.00	3			3.00	0.24		1	3	4.00	0.33		5	3	8.00	0.65
44	0.077				0.00	0.00	3			3.00	0.23		1	3	4.00	0.31		5	3	8.00	0.62
45	0.073				0.00	0.00	3			3.00	0.22		1	3	4.00	0.29		5	3	8.00	0.58
46	0.069				0.00	0.00	3			3.00	0.21		1	3	4.00	0.27		5	3	8.00	0.55
47	0.065				0.00	0.00	3			3.00	0.19		1	3	4.00	0.26		5	3	8.00	0.52
48	0.061				0.00	0.00	3			3.00	0.18		1	3	4.00	0.24		5	3	8.00	0.49
49	0.058				0.00	0.00	3			3.00	0.17		1	3	4.00	0.23		5	3	8.00	0.46
50	0.054				0.00	0.00	3	308		311.00	16.88		1	3	4.00	0.22		5	3	8.00	0.43
51	0.051				0.00	0.00	3			3.00	0.15		1	3	4.00	0.20		5	3	8.00	0.41
52	0.048				0.00	0.00	3		100	103.00	4.98		1	3	4.00	0.19		5	3	8.00	0.39
53	0.046				0.00	0.00	3			3.00	0.14		1	3	4.00	0.18		5	3	8.00	0.36
54	0.043				0.00	0.00	3			3.00	0.13		1	3	4.00	0.17		5	3	8.00	0.34
55	0.041				0.00	0.00	3			3.00	0.12		1	3	4.00	0.16		5	3	8.00	0.32
56	0.038				0.00	0.00	3			3.00	0.11		1	3	4.00	0.15		5	3	8.00	0.31
57	0.036				0.00	0.00	3			3.00	0.11		1	3	4.00	0.14		5	3	8.00	0.29
58	0.034				0.00	0.00	3			3.00	0.10		1	3	4.00	0.14		5	3	8.00	0.27
59	0.032				0.00	0.00	3	308		311.00	9.99		1	3	4.00	0.13		5	3	8.00	0.26

Net Present Value over time

Client/Authority		**Sheet Nr.**	8
SBC		Prepared (date)	16/09/99
Project name		Printed	14/05/03
MU19E Strategy - Preferred Strategy with No		Prepared by	DR
Project reference	1,404.00	Checked by	GS
Base date for estimates (year 0)	Dec 01	Checked date	16/10/99
Scaling factor (e.g. £m, £k, £)	£k		
Discount rate	6%		



APPENDIX F – ENVIRONMENTAL APPRAISAL

F THE ENVIRONMENTAL BASELINE

F.1 Introduction

The objective of this section is to provide an overview of the nature and character of the study area against which the relative advantages and disadvantages of management strategies and scheme options considered elsewhere in this report may be evaluated. Information was gathered through informal approaches to key consultees, such as English Nature and the Environment Agency, and through a more formalised consultation exercise which served the dual purpose of advising interested parties of the strategy study process and of obtaining additional information (i.e. the 'Preliminary Environmental Appraisal Scoping Study'). This was augmented by site visits undertaken by members of the consultancy team, such as that required to undertake the geomorphological mapping of the strategy study coastline.

This information has been used to inform the preliminary environmental appraisal whose results are summarised in this section and which takes account of the guidelines for strategic environmental appraisal published by MAFF (now DEFRA) in April 2001 (FCD PAG 2). This section therefore comprises an overview of the characteristics of the area as they currently manifest themselves and the manner in which they may evolve in the absence of the implementation of any coastal management strategies or schemes - the 'Do Nothing' scenario. Potential impacts associated with the implementation of the preferred management strategies are then considered. Individual schemes may require full environmental impact assessment as part of the town planning process.

F.2 Historic Heritage

F.2.1 Architecture

The strategy study area includes a number of buildings of architectural note. The majority of these are located along High Street in the small village of Cloughton, located midway along the study frontage and approximately 1.5km inland of the coastal cliffs. The buildings date from the 18th and 19th centuries.

Aside from the properties in Cloughton the only other listed feature in the strategy area is the site of the old Infectious Diseases Hospital at Scalby Mills. This was built in 1904 primarily to treat (and isolate) victims of smallpox. The site and remains of the foundations are located approximately 500m inland at the top of the northern bank of Scalby Beck.

F.2.2 Archaeology

A number of archaeological finds have been made in the strategy study area, some of which date back to the early Bronze Age. Many of the artifacts are remnants of axe-hammers although the site of a medieval chapel dating back to at least 1590 has been identified at Burniston. The finds are centred in and around the current settlements of Cloughton, Burniston, Scalby and Scalby Mills.

Consultations also revealed the existence of a marine wreck considered to be of heritage value along the strategy coastline although the exact location was not determined. However, enquiries made of Scarborough Fisheries Office indicated the presence of three wrecks in the area, presumably including that identified by the heritage bodies, and that they were all to be found in water exceeding 10 meters in depth.

F.2.3 Implications of the 'Do Nothing' Scenario

None of the architectural of archaeological features noted in the preceding sub-section are located in close proximity to the coastal cliffs or, with the exception of the site of the old Infectious Diseases Hospital, the slopes of Scalby Beck. In most regards a decision to permit coastal erosion and cliff recession to continue unhindered would have no implications within the 60-year strategy timeframe, or indeed, substantially beyond it. The site of the Infectious Diseases Hospital is close to the top of the Scalby Beck valley sides. However, a consideration of this feature is beyond the scope of the study given their location upstream of the limit of tidal influence in the beck.

It may be anticipated that continued wave action would progressively degrade the marine wrecks identified offshore of the strategy coastline. However, the principal aim of any coast protection scheme is to abate coastal erosion rather than protect marine archaeology so the impacts of policy of 'Do Nothing' must also be considered to be neutral.

F.2.4 Potential Impacts of the Preferred Scheme

The preferred scheme works proposed under the strategy are relatively modest in extent and remote from any structures of heritage interest. They relate to the stabilisation of the slopes of Scalby Beck adjacent to Scholes Park Road and the reprofiling of the upper section of the narrow neck of land connecting Scalby Ness with the mainland.

No works are proposed on the open sea coastline and therefore there will be no impacts on the marine archaeology.

F.3 Geology and Geomorphology

F.3.1 General

The management unit is characterised by steep coastal cliffs and generally comprise a near vertical lower section formed from solid rock overlain by an upper section of shallower angle glacial till. The coastal cliffs are generally fronted by rock platforms, boulders, shingle and sand.

The cliffs are incised by streams at various locations along the coastal frontage. The largest of the streams being Scalby Beck at the southerly limit of the study area, which also acts as an overflow to the River Derwent when in flood.

The solid lithology mainly comprises rock of the Middle Jurassic. The youngest horizon being the Scarborough Formation consisting of sandstone and shale beds with the distinct pink-weathering sideritic limestone evident at Hundale Point. Overlying this is the Moor Grit Member (sandstone and siltstones) of the Scalby Formation. Above the Moor Grit Member which dips below the shore level at Long Nab, lies the Long Nab Member, also of the Scalby Formation. This extends from the upper cliff at Hundale Point to where it is observed outcropping at shore level at Long Nab for the entire length of the study area.

The cliffs and intertidal reefs between Iron Scar (north of the study area) and Scalby Ness have been classified a SSSI on the basis of the stratigraphic succession, which provide an almost complete section, of the Lower and Middle Jurassic and the exposures are considered of national importance. In addition important plant fossil localities occur at Scalby Ness.

Hundale Point is the type locality for the Scarborough Formation, the most important marine horizon to occur within the dominantly non-marine Middle Jurassic rocks of Yorkshire, which yields ammonite fossils of great importance for determining the exact age of the Yorkshire Middle Jurassic sequence.

The coast section between Hundale Point and Scalby Ness exposes the best and most important sections of the Scalby Formation. The whole section is regarded of high sedimentological interest.

At Scalby Ness plant beds within the Scalby Formation contain an important fossil flora. The most significant is *Gingko huttoni.*

The study area comprise two locations identified as of national importance in the Geological Conservation review: Hundale Point – Scalby Ness (Bathonian) and Scalby Ness (Palaeobotany).

F.3.3 Implications of the 'Do Nothing' Scenario

The do nothing scenario will allow cliff erosion to occur at the natural rate of recession. The preferred strategy involves no construction schemes on the coastal frontage. However, it has been identified that further cliff recession along the cliff top above Scalby Sands will effectively make Scalby Ness an island.

Within the beck it has been identified that there is the potential for major slope failure of the southerly slope (below the properties at Scalby). This magnitude of landslide will effectively dam the beck and cover the rock exposed in the lower cliff of the northern side of the beck.

F.3.4 Potential Impacts of the Preferred Strategy

The preferred strategy will have no impact on any sections of the coastal cliffs.

It is considered that the preferred scheme for Scalby Beck will maintain the rock exposure on the northerly cliff above the beck and greatly reduce the risk of this exposure being covered in landslide debris.

F.4 Ecology

F.4.1 General

The majority of the land adjacent to the cliffline is agricultural and of limited ecological value. Although the flora and fauna of the coastal slopes and foreshore are included in the SSSI, they are not however mentioned in the citation as being of interest. Nevertheless, a combination of influences gives rise to the habitat interest in this area including the detailed local topography, the neutral/base-rich substrate, soil type, salt spay deposition and exposure. The banks of Scalby Beck are within a SINC (locally designated Site of Importance for Nature Conservation) with flora and fauna of particular interest (see Figure F1).

The Shoreline Management Plan notes that the clifftop community is a mosaic of coarse grass/thistle-dominated areas, including false oat grass (*Arrhenatherum elatius*) and creeping thistle (*Cirisium arvense*) with lower growing swards and occasional more herb-rich areas with species such as kidney vetch (*Anthyllis vulneraria*), restharrow (*Ononis repens*) and yellow rattle (*Rhinanthus mino*r). There are occasional damp areas where characteristic species include horsetails (*Equisetum spp.*), meadowsweet (*Filipendula ulmaria*) and orchids and areas of scrub with shrubs such as hawthorn, blackthorn and gorse.

English Nature state that otters (*Lutra lutra*) have been recorded in the lower part of Scalby Beck. Otters are fully protected under the Wildlife and Countryside Act 1981. It is likely that a license would be required from DEFRA should any works adversely affect any otters.

Although, English Nature have no specific records of Salmonids using the beck and the Environment Agency have no comment on any particular fish species, the North Eastern Sea Fisheries Committee state that Scalby Beck contains significant populations of sea trout.

F.4.2 Marine Interests

The rocky shoreline and sub-tidal seabed along this section of the coastline provide suitable habitats for crustaceans, including crab and lobster. Potting is undertaken by small vessels from local harbours such as Scarborough. Netting also takes place further offshore, some vessels being understood to come from more distant harbours such as Whitby.

F.4.3 Implications of the 'Do Nothing' Scenario

A policy of 'Do Nothing' would allow natural processes to continue unabated, including cliff recession and periodic landslide activity. This instability leads to the occasional loss of vegetated areas and the creation of areas of bare earth. This is a natural process and the process by which bare clifftop areas are re-colonised is integral to the ecological interest of the clifftop habitat. The impact of the 'Do Nothing' scenario is therefore considered to be neutral.

F.4.4 Potential Impacts of the Preferred Strategy

The principal engineering elements of the preferred strategy are confined to two sections of the slopes adjacent to Scalby Beck, both of which are included within the SINC. These are the slopes below Scholes Park Road at the south-eastern end of Scalby Beck (top right, Plate

8) and the narrow neck of land leading from the northern side of Scalby Beck to Scalby Ness (Plate 2). The slopes are predominantly vegetated with rough grassland and feature some areas of bare earth. The latter are a function of landslips and erosion on particularly steep sections of slope, especially the upper parts of the slopes at Scalby Ness.

The engineering works on the slopes adjacent to and below Scholes Park Road will involve substantial clearance of the existing vegetation to enable the construction of a parallel series of deep counterfort drains and associated works. The drains will mostly run from the top of the slope to the bottom for a distance of approximately 170m, set at approximately 10m intervals. This will of course seriously affect the ecological diversity of the slopes during and for some time after construction, but, subject to mitigation measures that may be adopted to secure regeneration, the longer term impact could be of lesser significance.

The toe of the western slope will be protected from marine and fluvial erosion in the tidal beck by means of a rock revetment for about 400 metres upstream of the footbridge. A change in the character of the western and a short part of the southern banks of the beck channel will therefore result but this is not at this stage considered likely to represent the modification of a habitat of particular significance.

The proposed works on the northern slopes of the beck are confined to the upper 5m of slopes on either side of the 'neck' of land, or pinchpoint, between Scalby Ness and the 'mainland'. These slopes are in the SSSI, not the SINC. The unstable upper slopes substantially comprise glacial till material which it is proposed to stabilise using soil nails and geotextile materials. The characteristics of the slopes and the short-term environmental impact of the works are similar to those described for the adjacent slopes below Scholes Park Road. It is also noted that a number of sections to be affected by the works do not support vegetation on account of slips in the tills and steep slope angle.

Further study of ecological mitigation measures will be required as part of the development of the detailed design for the preferred scheme; the proposed arrangement of the works is such as not to build out from the present line of the banks of the beck.

F.5 Landscape and Townscape

F.5.1 Overview

The strategy coastline is dominated by high cliffs (25-30m) fronted by boulder-strewn rock platforms. Areas of sandy foreshore are largely absent with the principal exception of the shoreline on the northern side of Scalby Ness headland (Scalby Ness Sands). The shoreline is oriented broadly north to south with more resistant rocks being responsible for the modest headlands of Long Nab (Hundale Point), Cromer Point and Scalby Ness.

The Cleveland Way long distance path runs along the cliff edge for the length of the strategy area offering panoramic views of the indented coastline. Landward views are across gently undulating agricultural land for most of the length of the strategy frontage, with the eastern scarp of the North York Moors being visible in the distance. The villages of Cloughton and Burniston, towards the northern end of the study area, are apparent in the middle distance. The rural character of the frontage is maintained until the settlement of Scalby Mills is encountered at the southern extremity of the study area.

The inherent aesthetic value of the coastline is acknowledged in its non-statutory status as Heritage Coastline (which also recognises its geological value). The northern section of the frontage is within the North York Moors National Park.

A key landscape feature in the strategy area is Scalby Ness, a substantial headland at the southern end of the frontage adjacent to Scalby Mills. It is bounded by coastal cliffs on its northern and eastern sides and the deeply incised valley of the lower reaches of Scalby Beck to the south and south west. The combination of wave-induced cliff recession and predominantly fluvial erosion from opposite sides of the headland has reduced one section to a very narrow 'neck' or pinchpoint.

Scalby Ness affords the most panoramic views of the study coastline and of Scarborough's North Bay and Castle Headland (outside the strategy area). The views towards the still imposing remnants of Scarborough Castle are particularly notable from this vantage point.

From the western side of Scalby Ness the deeply incised and meandering valley of Scalby Beck may be observed, its natural character somewhat offset by the housing development above. The valley sides are dominated by grass and scrub vegetation at its seaward end before discharging into the sea immediately downstream of the attractively located Old Scalby Mills Hotel. This point effectively marks the northern end of Scarborough's North Bay. The unstable nature of the slopes along the lower section of the valley are evident from their obviously 'slumped' profiles. Further upstream beyond a distinctive, almost 180^{o} meander, the valley sides are wooded and the beck follows a somewhat straighter line with smaller-scale meanders.

The beck also effectively marks the northern boundary of Scarborough's northern suburbs with the linear housing patterns of Scalby Mills following closely along the top of its southern slopes and agricultural land to the north.

F.5.2 Implications of the 'Do Nothing' Scenario

The predominantly rural nature of the strategy area means that a 'Do Nothing' policy would have few impacts upon its landscape value. The landscape character of the existing cliffline and foreshore are attributable to the operation of coastal erosion and other natural processes.

With regard to Scalby Ness it may be anticipated that the constricted 'neck' of land between the mainland and the wider eastern section of the headland will eventually be breached by natural coastal and fluvial processes, isolating the majority of Scalby Ness from the mainland. The creation of a new island feature would also be considered to be part of the natural evolution of the coastline.

In view of the foregoing the impacts of a policy of 'Do Nothing' are considered to be neutral. A possible caveat to this conclusion relates to the visual impacts associated with possible landslide events occurring along the southern banks of Scalby Beck. The proximity of a number of properties to the tops of the slopes of the beck valley make them vulnerable to landslide activity. The possibility therefore exists for landslide debris, including more persistent manmade structural elements, to impact upon the landscape.

F.5.3 Potential Impacts of the Preferred Strategy

For the majority of the strategy study coastline the preferred option is 'Do Nothing', subject to an annual inspection regime. There would be no implications for the visual character of the area.

The slope stabilisation works below Scholes Park Road and at Scalby Ness will have some localised and largely short-term impacts on the visual character of the Scalby Ness and Scalby Beck area. This arises from the requirement to strip the vegetation from the slopes to facilitate installation of drainage measures, geotextiles and soils nails/piles. However, the visual character of the vegetation cover is subdued in nature, comprising rough grass, scrub vegetation and some bare patches of earth, and subject to mitigation measures should be restored relatively quickly. The engineering structures would be covered by reinstated topsoil and (eventually) vegetation and therefore for the most part have no significant permanent impact upon the appearance of the area. However, it is possible that the geotextile material may occasionally become exposed in places along the top of the stabilised 'neck' between Scalby Ness and the mainland. Whilst the works will increase the stability of the till slopes and encourage the growth of vegetation the underlying processes giving rise to the erosion and instability will not be entirely abated so the existing character will not be entirely replicated.

The principal permanent visual expression of the engineering works will be the construction of the rock armour revetment to replace the present toe of the slopes below Schole Park Road (i.e. the southern banks of Scalby Beck). This will be most visible from the vantage point of Scalby Ness and, less significantly, the northern slopes of Scalby Beck.

It is not considered that the revetment would significantly affect the visual character of area as a whole although it will be a noticeable new feature when viewed at close quarters, for example from the footbridge. The revetment itself will be constructed of rock units that will be smaller than those used on the exposed coastline and will to some extent will reflect the character of the stream bed which features many cobbles and boulders. In addition the most striking views from Scalby Ness are those along the coastline, especially across North Bay and towards Scarborough Headland. Views into the beck from this vantage point inevitably take in the new housing development at the top of the southern slope of the beck. Given the existing context, it is not considered that the introduction of an additional 'semi-natural' engineered structure at the toe of the slope would have a significant impact upon the vista.

F.6 Recreation and Amenity

F.6.1 Overview

The strategy coastline is of high aesthetic quality and educational value. The rugged beauty of the coastline, described in Section F.3 (Landscape and Townscape), makes it particularly popular with the walkers who follow the Cleveland Way long distance path. Geologists and geomorphologists are also drawn to the area on account of its mineral- and fossil-rich rock beds and unstable cliff systems.

In addition to the general appeal of the wider coastline, a number of natural and manmade features confer considerable recreational appeal on the southern section of the strategy area (and slightly beyond into North Bay). Scalby Ness is a popular vantage point from which to view Scarborough's North Bay, Scarborough Castle and the undeveloped northern coastline towards Cromer Point. It is readily accessible from the cliffside path that rises from Scalby Beck and the popular Old Scalby Mills Hotel. The North Bay promenade also terminates at the marine confluence of Scalby Beck, drawing visitors and local residents alike past the Sealife Centre, towards the hotel and the path up to Scalby Ness. From this point it is possible to continue across the narrow neck of land that separates Scalby Ness from the mainland and along the main Cleveland Way to the north.

F.6.2 Implications of the 'Do Nothing' Scenario

Under the 'Do Nothing' scenario the intrinsic value of the natural environment would be unaffected. Consequently, much of the amenity and recreational value to be derived from it would be similarly unaffected. However, landslide activity could breach the narrow neck of land joining Scalby Ness to the mainland. In addition, activity on the southern/eastern slopes of Scalby Beck could threaten the security of Scalby Mills Road which provides sole vehicular access to the Old Scalby Mills Hotel and the Sealife Centre. Whilst the Sealife Centre is itself located just outside the strategy study area it is relevant to consider it given that its access is via a route covered by the strategy.

With regard to Scalby Ness, the short section of the coastal path (i.e. the Cleveland Way) that passes across the neck of land would need to be closed if landslide activity threatened the safety of the public. The sole access to Scalby Ness would then be via the cliffside path running up from Scalby Beck at the Old Scalby Mills Hotel. The Cleveland Way would need to be diverted inland along the northern banks of Scalby Beck and to a suitable location at which the beck could be crossed (possibly as far as the A165, Burniston Road). The path would then be directed back to the coastline along a new path or via the existing road network in Scalby Mills.

It is considered that the loss of the Scalby Ness section of the Cleveland Way would be somewhat detrimental to the enjoyment value of this section of the path. This is in recognition of the expansive views of Scarborough North Bay and Castle Headland that are possible from this point. However, in the wider context of this long-distance route, the balance of which would remain unaffected, together with the fact that access to Scalby Ness would still be possible, this is considered to be of limited significance.

In the event of landslide activity affecting the security of Scalby Ness Road the economic viability of the Old Scalby Hotel and the Sealife Centre could be threatened. Both rely upon road access for practical operational reasons and the loss of this facility would present a number of logistical obstacles. It may also deter visitors to the facilities even though pedestrian access via North Bay promenade would be unaffected. It would also be anticipated that restricted pedestrian access down the slopes from Scalby Mills could be ensured. It is suggested that the long-term impact of the former may prove to be the more detrimental to future of the facilities.

F.6.4 Potential Impacts of the Preferred Strategy

The impacts of the preferred scheme elements at Scalby Beck are considered to be wholly positive. They would help to maintain the longer-term security and amenity value of the features considered in the preceding sub-sections. Whilst the amenity value of the coastal area, including the Cleveland Way, would not be significantly impaired in the wider context, the maintenance of link across the neck of land between Scalby Ness and the mainland to the north is of local value. In addition, assured security of access to the Old Scalby Ness Hotel and Sealife Centre are considered to be significant factors in their continued economic viability and therefore availability for the enjoyment of the public.

F.7 Material Assets

F.7.1 Overview

The majority of the strategy coastline is largely undeveloped, although there are several significant exceptions. The assets in question were described in detail under section 4 and are therefore only summarised here. The key assets are:

- Properties at Scholes Park Road (eastern end), Scalby Mills. These properties are located at the top of the southern and eastern slopes of Scalby Beck. The slopes are known to be prone to instability which may be further exacerbated by erosion at their bases by the action of the beck (fluvial action or marine influences associated with storm and tidal surges). A major failure could also damage or destroy the footbridge over Scalby Beck adjacent to the Old Scalby Mills Hotel which currently affords the only means of crossing the beck in the immediate vicinity.

- Scalby Ness Road. This provides sole vehicular access, via the south-eastern slopes of Scalby Beck below the Scholes Park Road residences, to the Old Scalby Ness Hotel and the Sealife Centre. The road terminates at the Sealife Centre car park.

- Coastal Footpath/Cleveland Way.

- Yorkshire Water Sewerage Infrastructure. This relates to a number of flowlines which run in bored tunnels and trenches between Scalby Mills and Burniston and an underground pumping station located in a shaft immediately to the north west of Scalby Ness (on the mainland). These are part of a recently completed infrastructure scheme to transport sewage from the preliminary treatment works behind the Sealife Centre in Scarborough North Bay to the main Scalby Lodge WWTW outside Burniston. A number of redundant sewers and storm overflow sewers are also present in the area. It is understood that the main sewerage shaft is embedded in rock below the level of the potential slip surface and is considered not at high risk.

F.7.2 Implications of the 'Do Nothing' Scenario

Under the 'Do Nothing' scenario the strategy cliff line may be expected to continue to recede under the related influence of wave erosion and clifftop recession processes. These processes also relate to the lower reaches of Scalby Beck which are tidally affected. Sections of the cliff top Cleveland Way footpath may therefore be lost over time. Mention is also made of the former coast guard station located on the cliff top near Hundale Point. This is now used by birdspotters but it may be anticipated that it will become unsafe during the course of the strategy study timeframe if the observed outflanking of its foundations continues to take place.

Section 3.4 described how an annual recession rate had been developed for the strategy coastline. Based upon this it is possible to provide an indication of the likely position of the cliff line at the end of the 60 year strategy timeframe. It was concluded that key water infrastructure assets would be unaffected by recession. However, its is considered that sections of the cliff top Cleveland Way would be lost to cliff recession and that the lifeguard station would suffer further undermining of its foundations.

The possibility of further landslide activity on the south-eastern slopes of Scalby Beck would imperil the properties in the vicinity of Scholes Park Road and the security of Scalby Ness Road which passes across this slope down to the Old Scalby Ness Hotel and the Sea Life Centre. It is considered likely under the 'Do Nothing' scenario that at some point over the 60 year strategy timeframe landslide activity would result in the loss of at least 50 properties and that Scalby Ness Road would have been severed. The footbridge carrying the Cleveland Way footpath over Scalby Beck onto Scalby Ness would also be lost

F.7.3 Potential Impacts of the Preferred Strategy

The potential impacts of the preferred schemes at Scalby Beck are considered to be positive. Principal assets threatened by landslide activity, being properties along and in the vicinity of Scholes Park Road and Scalby Ness Road, would enjoy a higher level of security following implementation of the preferred works.

It would not be feasible on environmental or economic grounds to seek to protect sections of the Cleveland Way from the consequences of clifftop erosion. A monitoring strategy has been proposed to inspect the study frontage. This would identify sections of the path that appeared to approach dangerously close to the clifftop, or those that had been recently lost in single events, and to allow the implementation of suitable policy responses (e.g. realignment of the path further inland). It is likely that use of the old coast guard station, now used as a birdspotting hide, would have to be discontinued eventually since it will not be economic to implement an engineering strategy to protect the cliff section on which it stands.

F.8 Socio-economics

F.8.1 Overview

Economic activity in the immediate vicinity of the strategy frontage is confined to limited shellfishing and that of the Old Scalby Ness Hotel. Scalby Ness Road provides important access to the Sealife Centre in North Bay, although the property itself is located just outside of the strategy study area. Wider social considerations relate principally to the residential properties of Scalby Mills, specifically those located in the vicinity of Scholes Park Road.

F.8.2 Implications of the 'Do Nothing' Scenario

Section 3.6.2 drew attention to the likelihood of the loss of residential properties and breach of Scalby Mills Road under the 'Do Nothing' scenario. Loss or damage to properties would be very traumatic for those residents affected. Financial losses not entirely covered by insurance (especially lost revenue to the hotel) and physical injury may exacerbate the situation. The implications of the 'Do Nothing' scenario could therefore be serious. Fishing activities would not be affected under this scenario.

F.8.3 Potential Impacts of the Preferred Strategy

Given that the adverse impacts of the 'Do Nothing' option are related to the loss of physical assets the associated impacts of implementing the preferred scheme similarly correspond to the benefits described for material assets. The socio-economic impacts arising from the implementation of the preferred scheme, in protecting residences and economic activity, are therefore considered to be positive.

F.9 Other Issues

F.9.1 Water Quality

No detailed information was readily available to assess the existing quality of the freshwater or coastal waters associated with this study. However, it is known that Scalby Beck draws predominantly upon a rural catchment area so it may be anticipated that the chemical and biological quality of its waters have not been unduly compromised.

The quality of inshore waters in the strategy study area would also be expected to be good given the recent commissioning of waste water treatment facilities providing full treatment to the area's sewage. Prior to this untreated sewage from Scarborough and adjacent settlements was discharged untreated into the sea via outfall pipes. Recent inspections of the bathing water, based upon faecal coliform and other bacteriological parameters, indicate excellent water quality in North Bay, to the immediate south of Scalby Mills.

The preferred scheme would have no significant long-term impact on the quality of the waters in the beck or on the coastal waters. Short-term impacts would be associated primarily with construction operations. The proposed works would require the stripping of the existing vegetation raising the possibility of silt-laden run off being generated under wet conditions which would naturally flow downslope into the beck. This may increase the turbidity of water in the water column (reducing penetration of light) and smother the river bed. In many circumstances this can have serious implications for the flora and fauna present in the watercourse. However, the close proximity of the works to the beck's marine confluence serves to minimise the potential impacts. High turbidity levels are frequently experienced in the coastal receiving waters as result of natural wave action. Only a short length of river channel could therefore be affected by possible silt-laden runoff.

Pollution from other sources, such as inadvertent spillages of fuel oil, should be controlled by adherence to good site practice guideline.

F.9.2 Coastal Processes

A detailed study of the coastal processes operating within and adjacent to the strategy frontage was commissioned as part of this study. The results are considered separately in Section 2.5. For the purposes of this PEA it is noted that the proposed implementation of the preferred scheme was not considered to be associated with any significant implications for the coastal processes operating in the strategy area.

F.10 Mitigation

F.10.1 Overview

This coastal strategy study provides a context for the detailed development of proposals and is intended to identify features of importance in the existing environment, the possible impacts likely to arise from the proposed strategy and any measures that may be possible to mitigate adverse impacts. In this case, only one scheme is proposed – that affecting Scalby Beck.

F.10.2 The Preferred Scheme

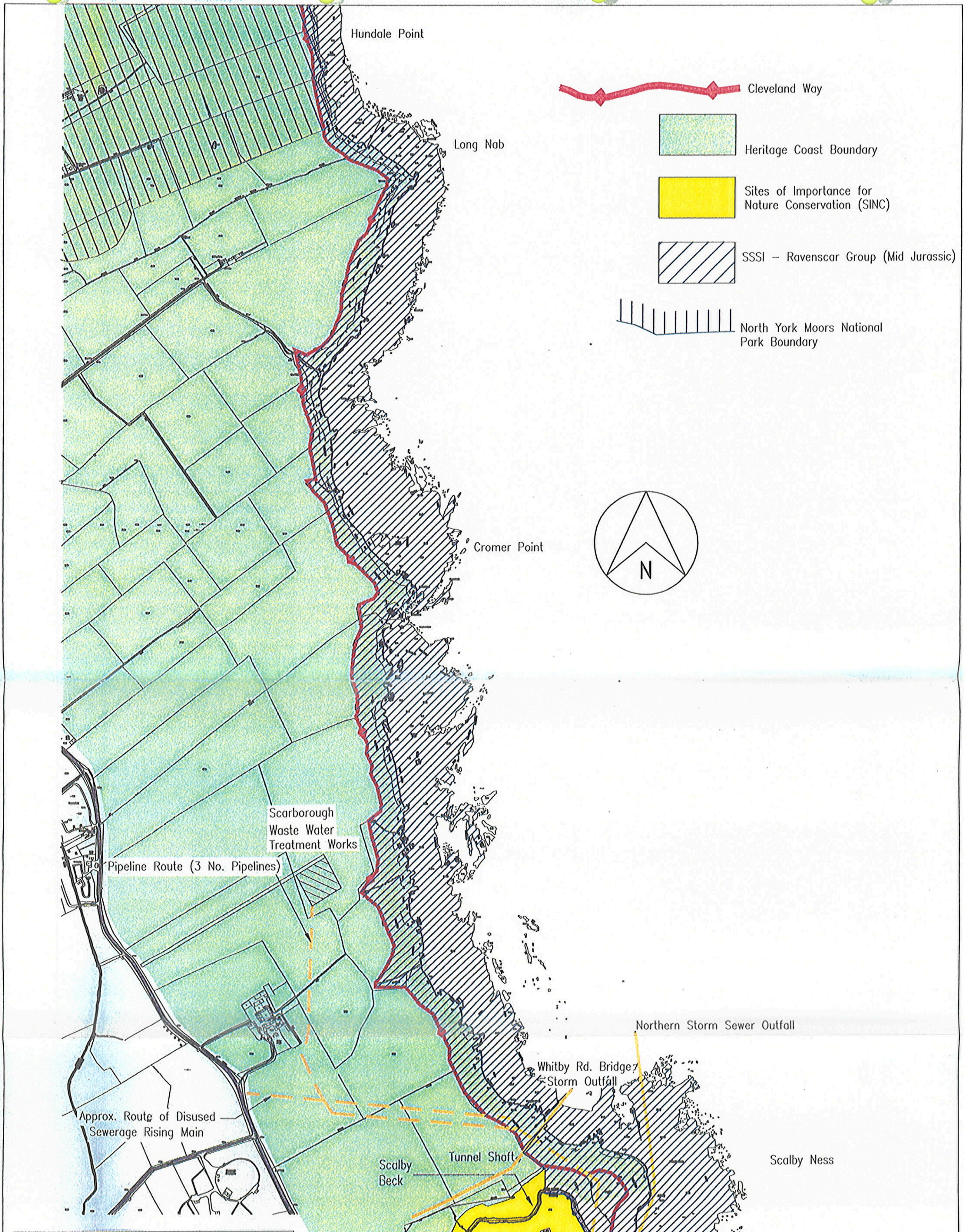
The principal effects identified are those affecting the ecology of the beck itself and the western and southern slopes, below the area of housing development. It is not at this stage considered that there would be any significant effects on the SSSI. The visual impact on the landscape would be significant during the construction phase but, subject to detailed design and mitigation measures could be much reduced in the longer term. In most other topics considered, the impacts are likely to be either neutral or beneficial.

F.10.3 Proposed Mitigation

More detailed study needs to be undertaken, as part of the detailed design work, as to the means of minimising the effects of the engineering works on:

- The ecology of the beck and its banks, as a result of replacing the toe of the slopes with rock armour, bearing in mind the use of the beck by migrating fish and by otters;
- The ecology of the slopes to try to minimise the loss of diversity of vegetation and habitats through well considered means of securing regeneration.

Means and timing of the implementation of the engineering works would also have to be considered in relation to seasonal patterns of fish migration and bird nesting. Also, sufficient investigations would need to be undertaken to obtain a license to carry out activities which would adversely affect otters, or to establish that one was not necessary.



Environmental Features and Constraints

Hundale Point to Scalby Ness
Coastal Strategy Study

Figure No. F1

Scale 1:10000

High-Point Rendel

CORRESPONDENCE RECEIVED FROM CONSULTEES DURING CONSULTATION PERIOD DECEMBER 2002 TO FEBRUARY 2003

David Cliffe

ENGLISH NATURE

North & East Yorkshire Team
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Tel +44(0)1904 435500 Fax +44(0)1904 435520
stephen.morley@english-nature.org.uk

www.english-nature.org.uk

Mr John Riby
Scarborough Borough Council
Technical Services Department
Town Hall, St Nicholas Street
Scarborough
YO11 2HG

Your Ref:
Our Ref: 00140-06/S2002-01B
Date: 31 January 2003

Dear John

HUNDALE POINT TO SCALBY NESS COASTAL STRATEGY STUDY

Thank you for sending English Nature a copy of the Environmental Appraisal and consultation document relating to the above.

Environmental Appraisal

F.3 Geology and Geomorphology
With respect to Iron Scar & Hundale Point to Scalby Ness SSSI, the 'do nothing' scenario will allow cliff erosion to occur and will therefore maintain access to the full sequence of exposures for which the site was notified.

F.4 Ecology
We note that some of the cliff top habitat, coastal cliffs/slopes and foreshore are of ecological interest and are classified as a **SINC**. Although this is a non-statutory classification, such sites are usually protected by local planning policies and are an integral part of the nature conservation interest of the area. Wherever possible, adverse effects on SINCs should be avoided or mitigated against.

We have a record of **otters** (*Lutra lutra*) from the lower part of Scalby Beck, and otters are generally relatively common in the rivers and streams around Scarborough. Otters are fully protected under the Wildlife and Countryside Act 1981. They also receive protection under regulation 39(1) of the Conservation (Natural Habitats, &c.) Regulations 1994. Under this latter legislation it is an offence to;

- deliberately capture or kill otters
- deliberately disturb an otter
- damage or destroy a breeding site or resting site of an otter

Licences to carry out activities which would adversely affect otters are granted by DEFRA only for a restricted range of purposes set out in regulation 44(2). It should be emphasised that even if planning consent is given for a development affecting a European protected species, a licence would still be required from DEFRA under Regulation 44 of the Habitats Regulations. To obtain such a licence, a number of tests would have to be met:

- Regulation 44(2)(e) states that licences may be granted by DEFRA *"to preserve public health or public safety or other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment."*
- Regulation 44(3)(a) states that a licence may not be granted unless DEFRA is satisfied *"that there is no satisfactory alternative"*.
- Under regulation 44(3)(b) a licence cannot be issued unless DEFRA is satisfied that the action proposed *"will not be detrimental to the maintenance of the population of the species concerned at the favourable conservation status in their natural range"*.

The Habitats Regulations as mentioned above will need to be applied to the otters, including aquatic and terrestrial feeding and refuge areas. Licences will be required from DEFRA for works which may affect the otters or their habitats, and in support of any licence application comprehensive information on any otter population will be required, including population size, holt numbers, habitat utilisation etc. We would recommend that this is done as part of an Environmental Statement; this should include information on timing of workings to avoid adverse impacts as well as proposals for creation of habitat to mitigate against any loss of existing habitats.

Otters are also a Biodiversity Action Plan (BAP) species, and there are national UK targets to maintain and expand the current otter population. During any stabilisation/protection works, there may be opportunities for habitat creation in the form of new holts or terrestrial habitats, which may help offset any short-term disturbance to any otters or their habitat.

We have no specific records of which **fish species** use Scalby Beck, but it would be worth checking whether any migratory fish such as salmon or allis shad use the Beck; shad and salmon are both BAP species for which action plans have been prepared or are proposed and are species specially protected under the EC Habitats and Species Directive. Any works proposed in and around the Beck would need to consider the needs of such fish should they be present.

There are areas of suitable **bird habitat** on some of the slopes. All bird nests are protected against damage or destruction while in use or being built. We would therefore recommend that removal of any potential nesting habitat is timed to avoid the main bird breeding season.

Consultation Document

There were no specific maps included with the consultation document to show areas where actions have been proposed, and so our comments are restricted to general principles at this point.

Works proposed on Scholes Park Drive and Scalby Beck appear to be outwith the boundaries of the SSSI, but may need to take into account the presence of protected species or other matters as raised above.

The cliff top betterment works at Scalby Sands are presumably intended to maintain the Cleveland Way footpath? The document states that "The cost of maintaining the footpath along its present alignment would be extremely costly compared to realigning the route inland.". It is therefore not clear to us why these works are proposed. Short-term low-impact stabilisation works may be acceptable from our point of view, but for more permanent longer-term structures or cliff protection measures we would need to consider the long-term impacts of such measures on natural processes and how this might affect the scientific interest of the SSSI.

Yours sincerely

Stephen Morley
Conservation Officer

Clerk of the Committee
Darryl Stephenson, Solicitor
County Hall, Beverley
East Riding of Yorkshire. HU17 9BA

Chief Fishery Officer
David McCandless, BSc, MSc
Town Hall, Bridlington
East Riding of Yorkshire. YO16 4LP

NORTH EASTERN SEA FISHERIES COMMITTEE

All enquiries should be directed to:

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Environmental Officer
Tel: 01482 393692
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Web Site www.neseafish.gov.uk
Your ref:

Our ref: nesfc/ 14JANGB

Mr David Cliffe,
Project Engineer,
High-Point Rendell,
The McLaren Building,
Birmingham,
B4 7NN.

Re; Hundale Point to Scalby Ness Coastal Strategy Study Consultation Document

14th January 2003

Dear Sir,

Thank you for your letter dated the 16th December and consultation document on the Hundale Point to Scalby Ness Coastal Strategy. North Eastern Sea Fisheries Committee is the statutory body concerned with the management of inshore fisheries within six miles of the Coast between the River Tyne and Donna Nook, Lincolnshire. Additionally we have marine environmental responsibilities.

The Committee is appreciative of the need to protect coastal assets from the implications associated with predicted sea level rise. In terms of fisheries the area supports significant populations of crustacea, notably lobster, edible and velvet crabs. Additionally, area supports various whitefish fisheries using a variety of methods including netting, trawling and lining. Generally, the majority of vessels fishing in this area would be based in Scarborough and occasionally Whitby. I would suggest you contact local fishermen through local the organisation or the National Federation of Fishermen's Organisations. Alternatively, we could assist you with this. Also, the area is popular with sea anglers, from both shore and boat. I would recommend you notify local clubs either directly or through the National Federation of Sea Anglers so that they can inform you of any potential implications to them as a result of the scheme. In terms of salmonid species, Scalby Beck contains significant populations of sea trout and the Committee would urge that works in this area take into account of the importance of this watercourse to this species and ensure that the works minimise any disturbance to them. I would suggest you to consult the Environment Agency on this issue. In terms of nature conservation designations the area contains a Site of Special Scientific Interest and I appreciate you are aware of the caution need when carrying out any works in such locations. English Nature should be contacted in the first instance on any issue relating to potential impacts on designated sites.

If you require any further information or wish to discuss any of the points made in this response please do not hesitate to contact me at our Bridlington address.

Yours sincerely,

HPR	INITIALS		SIGN	DATE
1404	DGC		DC	20/1
17/1/03				
R2003/0SB				

44

Giles Bartlett
Environmental Officer

ENVIRONMENT AGENCY

Our Ref : DA/2002/012048-1/1
Your Ref : 001404-06/S2002-01B

Date : 13 January 2003

High-Point Rendel Limited
The McLaren Building
35 Dale End
Birmingham
B4 7NN

1404 DGC
15/1/03
R2003/04B
43

DGC 15-1-03

Dear Sir/Madam

COASTAL STRATEGY STUDY
FROM HUNDALE POINT TO SCALBY NESS

I refer to your correspondence which was received on 18 December 2002 in connection with the above.

General Issues
The Agency thanks you for our inclusion within the consultation process in relation to the study and would wish to make the following comments:

The Environment Agency would wish any proposed development to consider the following general issues:

-Any likely effects to surface and ground water quality and flow, including the impact of foul and surface water drainage for any proposed development during their construction, operation and decommissioning phases.

This should include a baseline study of the existing hydrological, hydro-geological and drainage characteristics of the area and physio-chemical and biological quality of surface watercourses in the vicinity of the site under investigation.

-Any likely effects upon land quality, including the impacts of any excavations, infilling or regrading using imported or non indigenous materials both during the construction, operation and decommissioning phases of any proposed development.

This should include a baseline study of the existing physio-chemical and biological quality of the land, soils and substrata in the vicinity of the site under investigation, including the identification of any previously infilled land or land that contains materials or substances that may give rise to an increased risk of contamination.

-Any likely effects to local, regional and global air quality, including the impacts of emissions from fixed and mobile plant and vehicles both during the construction, operation and decommissioning phases of any proposed development.

authorisation issued by the Environment Agency. Furthermore under the Radioactive Substances Act 1993 the keeping or use of radioactive substances requires a formal registration with the Environment Agency.

Under the E.C. Habitat Directive any Environmental Impact Assessment should seek to address the requirements of the 1994 Habitat Regulations. You may wish to contact English Nature for further information.

If you require any further assistance or need to discuss the content of this letter or any other matter please do not hesitate to contact this office at the address shown.

Yours faithfully

DAN BASTOW
PLANNING LIAISON OFFICER
e-mail: daniel.bastow@environment-agency.gov.uk

APPENDIX G – LDW 13

DEFRA
Department for Environment, Food & Rural Affairs

Department for Environment, Food and Rural Affairs
Flood Management, Capital Grants Branch
Area 3C Ergon House, 17 Smith Square, London SW1P 3JR
E-mail: floodgrants@defra.gsi.gov.uk

DEFRA Forward Planning: Summary Scheme Submission - Unapproved Schemes

- This form replaces form LDW 11.
- Please refer to the Department's Grant Memoranda when completing this form.
- **Please read the notes for guidance (LDW 14) before completing this form.**
- Please complete in BLOCK LETTERS and **Black ink** and return this form to the Department for Environment, Food and Rural Affairs at the above address.
- Please note there is an alternative to this form; an electronic spreadsheet version available for use during the annual forward planning exercise - details with DEFRA commissioning letter.
- For Annual Forward Planning exercise, please refer to status report, where supplied with DEFRA commissioning letter, for details of schemes previously supplied.
- **Enquiries:**
  - **Local Authorities**: please contact Bob McNally on (020) 7238 6147, or use the e-mail address at the top of the form.
  - **IDBs**: please contact Sarah Steeds on (020) 7238 6165, or use the e-mail address at the top of the form.
  - **EA**: please contact National Capital Investment Manager, Mike Brewer.

Part A: Authority Details

Promoting authority: SCARBOROUGH BOROUGH COUNCIL

Authority reference:
your reference; if you have submitted this scheme before, please use the same reference:

Scheme name:
descriptive name for proposal; if previously notified to DEFRA please use the same or a similar name: SCALBY BECK, SCARBOROUGH

Part B: Summary Information

Estimated start date: Month APRIL Year 2003

Location of proposed scheme (town, river etc.): SCALBY, SCARBOROUGH

If part of strategy, please give reference and name: HUNDALE POINT TO SCALBY NESS COASTAL DEFENCE STRATEGY STUDY

Problem to be addressed:

Properties and infrastructure are at threat from potential large-slope instability. Engineering judgement and slope stability analyses has identified that 30m of cliff top could be lost following initial failure of the toe of the lower slope. The toe of the slope is subject to fluvial and marine action and failure has been estimated to occur by Year 2. Geomorphological mapping and borehole instrumentation identify that the site has undergone historic large-scale failure and the slope movement is presently active. Progressive failure of the cliff top will result in additional loss of properties with time. In addition it is anticipated that should no preventative works be undertaken the failure will expand laterally and has the potential to impound the beck which may lead to an increase of beck levels and further instability problems upstream.

Part B: *continued*

escribe any environmental considerations

The site is located adjacent to a geological SSSI (northern side of beck), where exposure could be covered by landslide.

The site itself falls under a Site of Importance for Nature Conservation and is within the boundary of a Heritage Coastline.

Brief description of scheme proposal, including significant factors affecting cost stimate and derivation estimated benefits

The preferred scheme comprises 150m length of mechanical stabilisation (piling) on the mid-slope plateau of the northeasterly facing slope along with the placement of rock armour to protect the toe of the slope from fluvial/marine erosion. In addition, initial works will include cliff top stabilisation and drainage. The cliff top works will comprise geomaterials and soil nails to prevent progressive failure.
Factors affecting scheme costs will include timing of the works (it is preferable to undertake the works during low beck levels in the late Spring/Summer) and risk to the Contractor of working on an active landslide.
The benefits are based on properties lost from a 30m loss of cliff top following a major landslide and progressive failure of the cliff top over the strategy period. An economic assessment of the loss of revenue of car parking and reduced numbers visiting the Sea Life Centre following the loss of Scalby Mills Road has been undertaken.

Part C: DEFRA Scheme Prioritisation

Section 1

Estimated cost of scheme (whole life present value - £'000s) 1,613,824

Is this project necessary to maintain the favourable condition of a designated International site (SAC, cSAC, SPA, pSPA or Ramsar)? YES ☐ NO ☑

(If NO, please go straight to part C, Section 3).

ection 2

ly to be completed for schemes exempt from the priority scoring system on environmental grounds.

- Please complete below if you think this proposed scheme will be eligible for grant aid from DEFRA because of the provisions of the Conservation (Natural Habitats &c.) Regulations, 1994.
- Please see FCDPAG5 Environmental Appraisal for further guidance. Copies of this are available from DEFRA and can also be viewed at the web address; **www.defra.gov.uk/environ/fcd/pubs/pagn/default.htm.**

Designation of site ________ (SAC, cSAC, SPA, pSPA or Ramsar)

Area that would be lost or degraded without this scheme (hectares) ________ In which year would this loss take place if the project were not implemented ________

If this project has been identified through a CHaMP or other Strategic Plan, please identify relevant plan ________

Has English Nature endorsed the need for this project? YES ☐ NO ☐ If YES, please give date: ________

Part C: continued

S‹ ‹tion 3

E‹ ‹nomics score 13.2

Does this project constitute a study which is not designed to lead to a specific capital project (e.g. Coastal Process Study) .... YES ☐ NO ☑

Estimated benefit to accrue from scheme (whole life present value - £'000s): 11,683 ,000

Guidance on benefit assessment is available in DEFRA publication FCDPAG3 E‹onomic Appraisal, available from DEFRA at the address on page 1 or viewable at the Web address: **www.defra.gov.uk/environ/fcd/pubs/pagn/default.htm**

People score 3.34

Number of households protected: 68

tick one box

Level of risk: Very High ☐ High ☐ Other Areas ☑

Social deprivation rank: Between 1501 and 6664

- Details of wards and their rank in the social deprivation index are available at: **www.statistics.gov.uk/neighbourhood** *(Click on an area of the map, then on the specific borough. Select the ward and click 'key stats'. The indices of deprivation (rank out of 8414 wards) are in the far right column).*
- If required details of postcodes are available at: **www.consignia-online.com**
- Street names can be found using: **www.multimap.co.uk**

Environmental score

Area of SSSI protected (hectares): —

Other designated area protected (hectares): —

National Biodiversity Action Plan (BAP) Habitat area net gain (hectares): —

Heritage Designation

Grade I or II* (or equivalent) or scheduled monument .... ☐

Grade II or other (or equivalent) .... ☐

Not applicable .... ☑

NB: Not all fields will apply to all schemes; leave blank where no value

‹‹rt D: Declaration

In ‹ubmitting this scheme for the forward programme, I confirm that I anticipate submission of a valid application for grant aid in accordance with:

- the programme set out in the relevant forward plan; and
- the current technical, economic and environmental criteria for flood defence and coast protection schemes.

Signature

Date

Name in BLOCK LETTERS

Position within promoting authority

E-mail address