



# Colwyn Bay Waterfront Project

Coastal Defence Improvements - Project Appraisal Report (PAR)  
Update

October 2010  
Conwy County Borough Council

# Colwyn Bay Waterfront Project

Coastal Defence Improvements - Project Appraisal Report (PAR)  
Update

October 2010

Conwy County Borough Council

# Issue and revision record

Revision	Date	Originator	Checker	Approver	Description
A	September 2010	V Tonks	A Allen	P Phipps	First Issue
B	October 2010	V Tonks	A Allen	P Phipps	Second Issue
C	October 2010	V Tonks <i>V Tonks</i>	A Allen <i>[Signature]</i>	P Phipps <i>P. Phipps</i>	Third Issue

This document is issued for the party which commissioned it and for specific purposes connected with the above-captioned project only. It should not be relied upon by any other party or used for any other purpose.

We accept no responsibility for the consequences of this document being relied upon by any other party, or being used for any other purpose, or containing any error or omission which is due to an error or omission in data supplied to us by other parties

This document contains confidential information and proprietary intellectual property. It should not be shown to other parties without consent from us and from the party which commissioned it.

# Content

<b>Chapter</b>	<b>Title</b>	<b>Page</b>
<b>1.</b>	<b>Executive Summary</b>	<b>1</b>
1.1	Introduction and Background	1
1.2	Problem	1
1.3	Options Considered	1
1.4	Preferred Option	2
1.5	Recommendation	5
1.6	Key Plan	5
<b>2.</b>	<b>Introduction and Background</b>	<b>7</b>
2.1	Purpose of this Report	7
2.2	Background	7
2.3	Current Approach to Flood and Erosion Risk Management	7
<b>3.</b>	<b>Problem Definition and Objectives</b>	<b>9</b>
3.1	Outline of the Problem	9
3.2	Consequences of Doing Nothing	9
3.3	Strategic Issues	10
3.4	Objectives	10
<b>4.</b>	<b>Options for Managing Flood Risk and Erosion</b>	<b>12</b>
4.1	Potential FCRM Measures	12
4.2	Long List of Options	12
4.3	Options Rejected at Preliminary Stage	13
4.4	Options Short-listed for Appraisal	14
4.5	Planning Considerations for the scheme	15
<b>5.</b>	<b>Options Appraisal and Comparison</b>	<b>16</b>
5.1	Technical Issues	16
5.1.1	Assessment Criteria	16
5.1.2	Draft PAR	16
5.1.3	Numerical and Physical Modelling	16
5.1.4	Ground Investigations	17
5.1.5	Asset Condition Surveys	17
5.1.6	Preliminary Design	18
5.2	Environmental Assessment	18
5.3	Social and Community Impacts	18
5.4	Option Costs	18
5.5	Options Benefits (Damages Avoided)	19
5.5.1	Assessment of damages	19
5.5.2	Contingent Valuation	23
5.5.3	Summary table of the PV losses for each option	23
5.6	Benefit Cost Appraisal	24

<b>6.</b>	<b>Selection and Details of the Preferred Option</b>	<b>25</b>
6.1	Selecting the Preferred Option _____	25
6.2	Sensitivity Testing _____	25
6.3	Details of the Preferred Option _____	26
<b>7.</b>	<b>Implementation</b>	<b>27</b>
7.1	Project Planning _____	27
7.2	Delivery Risks _____	27
<b>8.</b>	<b>References</b>	<b>29</b>
<b>Appendices</b>		<b>30</b>
Appendix A. Condition Assessment of the Coastal Defences _____		31
Appendix B. Draft PAR (CEUK, 2008) _____		36
Appendix C. Contingent Valuation Questionnaire _____		37
Appendix D. Economic Assessment _____		38

# 1. Executive Summary

## 1.1 Introduction and Background

This Project Appraisal Report (PAR) covers the Colwyn Bay frontage from Rhos Jetty to Beach Road, Old Colwyn. Local defences are provided at Rhos Harbour at the western end and also between Old Colwyn and Tan Penmaen Head at the eastern end, the latter being under the jurisdiction of Network Rail and the Welsh Assembly Government's (WAG) Highways Directorate. The shoreline in between is defended by vertical masonry and/or concrete walls that date back to the early 1900s.

The shoreline has been subject to a number of studies including the North West England and North Wales Shoreline Management Plan SMP2 (Halcrow, 2009), the Colwyn Bay Coastal Defence Strategy Plan (CEUK, 2007) and a Draft PAR (CEUK, 2008). This PAR update supersedes the 2008 Draft PAR.

## 1.2 Problem

The defences along the frontage are frequently overtopped leading to significant damage to the promenade and frequent closures of the road behind it. In April 2010, a severe storm resulted in approximately £1 million of damage to the promenade and damage to the railway embankment behind it. In addition, the defences are recorded to be in a poor condition with a residual life of less than five years. The defences along the frontage are subject to ongoing maintenance and repair by Conwy County Borough Council (CCBC) to ensure that they function as a coastal defence but urgent action is required to ensure the continued sustainable protection of the frontage.

## 1.3 Options Considered

Options previously considered in the Draft PAR were developed from the work carried out for the first Shoreline Management Plan (SMP) (Shoreline Management Partnership, 1999) and for the Coastal Defence Strategy Plan. The four options considered in the Draft PAR (in addition to the Do Nothing scenario) were:

**Option 1** – Do Nothing

**Option 2** – Maintenance but no improvement of the existing defence assets – reducing standard of service

**Option 3** – Sustaining existing defence assets – maintaining existing minimum standard of service

**Option 4** – Improve and maintain linear defences – improved standard of service

**Option 5** – Improve defences by artificially supplementing and managing beach volumes and profiles – improved standard of service

The two Options that have been taken forward for consideration by this PAR are:

- **Option 4** – Improvement of the current standard of defence through the construction of a linear rock revetment along the frontage
- **Option 5** – Improvement of the current standard of defence through beach recharge works and construction of associated beach control structures and a short stretch of revetment.

## 1.4 Preferred Option

The Preferred Option has been selected based on a review of the construction and ongoing maintenance costs of the scheme, the benefits provided by the scheme and the damages avoided over its lifetime, together with a review of environmental considerations. The Draft PAR previously identified that a rock revetment option for the entire frontage (Option 4) was the most cost beneficial option. This PAR finds that a beach recharge option, with beach control structures and some revetment to the east of the frontage (Option 5) is in fact the most cost beneficial option.

This change in Preferred Option is as a result of the detailed assessment of the benefits and costs of each of Options 4 and 5. The main changes are derived from:

- an increase in benefits by assessing tourism benefits based on actual visitor data and a contingent valuation exercise
- an update to the estimated residual life of the existing defences based on a survey in 2009
- a subsequent reassessment of the erosion rate along the frontage, which is comprised mostly of made ground and can thus be expected to fail more rapidly than natural geology once the man-made defences have failed
- more accurate estimation of construction and maintenance costs using information from the Detailed Design being developed for Phase 1. The whole life costs of each of the options has been calculated based on detailed unit costs of each element of the potential scheme. These have significantly increased from the Draft PAR, but to a lesser extent than the benefits achieved.

The Preferred Option (Option 5) proposed for the Colwyn Bay frontage includes three phases of work.

- Phase 1 of the works will include a 200m rock groyne, a 100m rock revetment and the raising of 100m Promenade by approximately 2m to provide a 'hotspot' area together with improved beach access via steps and the existing slipway
- Phase 2 of the works will include 1.56 million cubic metres of beach recharge and the raising of the Promenade behind
- Phase 3 of the works includes an extension of 1282m to the rock revetment to the east of the proposed rock groyne and the raising of the Promenade behind.

## Environmental Considerations

An Environmental Impact Assessment that reviews the impacts of both Options 4 and 5 across the entire frontage has been prepared for submission to CCBC.

The site lies within the boundary of Liverpool Bay possible Special Protection Area (pSPA). The pSPA regularly supports more than 1% of the British populations of red-throated diver *Gavia stellata*, 1% of the biogeographical population of common scoter *Melanitta nigra* and more than 20,000 waterfowl during the non-breeding season.

The western boundary of the site is also located <5km from the Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC. Within the EIA this designated site has been included owing to some marine mammal species which are listed in this SAC being observed within Colwyn Bay.

## **Benefits**

The proposed scheme will safeguard the integrity of the present coastal defence and safeguard the land, property and infrastructure at risk including the A55, commercial and residential properties and the main Chester to Holyhead railway line for 100 years.

The scheme will improve the amenity of the area and, linked to other regeneration initiatives associated with waterfront and town centre, will form part of a wider regeneration package that will benefit the whole of Colwyn Bay, not just the seafront.

The benefits identified in this PAR update have been updated from the Draft PAR. In comparison with the Draft PAR the benefits identified are greater. The main difference in benefits is derived from a more detailed assessment of the tourism benefits associated with each option. The PAR included a survey of tourists in Colwyn Bay to determine the Value of Enjoyment that they would place on the present day conditions and also the proposed Options along the frontage. This has provided a Present Value (PV) tourism benefit of approximately £28 million compared with the £20 million in the Draft PAR.

The erosion scenario and the timing when assets were considered lost was also reassessed based on the 2009 SMP. This provided a PV benefit of £18.1 million compared to £4.1 million in the Draft PAR.

## **Costs**

The construction costs for the Preferred Option are based upon a rock groyne design including a 3.6m wide crest and a varying side slope to a total height of +5.5mOD at the landwards end of the structure and +2.5mOD at the seawards end. The groyne is to be constructed of 3-6 tonne rock armour layer, 0.3-1.0 tonne rock underlayer and a fill layer. The cost outline for the rock groyne is £12,776.50 per metre run. The total cost of the rock groyne is £2,555,300.

The revetment structure proposed to the east of the rock groyne has an overall length of 1382m and a footprint of 29.7m. The armour layer is comprised 3-6 tonne rock, 0.3-1.0 tonne under layer and fill material. The cost based on this design per metre run is £10,777 giving a total cost of £14,894,112. Along the frontage the Promenade will also require raising at a cost of £4,447 per metre run giving a total cost of £16,234,798.

The initial beach recharge proposed will be 1.56 million cubic metres of sand. The total cost of this beach recharge based on this volume, a unit rate of £10/m<sup>3</sup> and mobilisation and demobilisation costs is £16,192,500. The maintenance of the beach for the Preferred Option is based upon a loss of 475,000m<sup>3</sup> of sand every 10 years as derived from sediment modelling undertaken (Royal Haskoning, 2010). It has been assumed that some ongoing maintenance of the rock groyne and revetment will be required.



## Economic Summary

The economic analysis is based upon benefits associated with prevention or delay of property and infrastructure losses to coastal erosion, and potential tourism losses or benefits to the Town. Annual average damages have been calculated for flood losses. The discount rate used in the analysis is based on the HM Treasury Green Book (March 2003). An Optimism Bias of 30% has been used in this PAR based on the level of understanding of the frontage, the detailed design that has taken place and Early Contractor Involvement.

## Funding and Contributions

The Preferred Option has been planned for delivery in three phases. For the Phase 1 works, Conwy County Borough Council is being supported by grant funding from the European Convergence Funding Programme with match funding provided by the Welsh Assembly Government. The grant funding expenditure profile agreed between Conwy County Borough Council and its funding partners identifies that works to commence Phase 1 of the coastal defence must be delivered during the 2010/11 financial year. Circa £4.5 million of grant funding is to be utilised by Conwy County Borough Council during the 2010/11 financial year to commence Phase 1 of the coastal defence works.

## Key Delivery Risks (economic, social and environmental)

Five key risks are highlighted in Table 1.1.

Table 1.1: Risks and mitigation

Risk	Key Mitigation
Potential for further coastal erosion/damage to the beach levels and seawall/promenade before the works begin	The risk can be mitigated against by ensuring that the works are procured and constructed as soon as possible.
Potential for further coastal erosion/damage to the beach levels and seawall/promenade during the works	This risk can be mitigated by working practices and onsite sequencing. If the works can be completed by late summer/early autumn then the likelihood of erosion is reduced compared to the work being undertaken in autumn/winter
Combination of individual threats to project extension leading to extension of capital works, cost and potential remobilisation costs	This risk will be mitigated through ongoing project risk management, project planning and through robustness in initial programme. Suitable contract terms will implemented to manage potential financial risk exposure. Programme to sensitive aspects like beach recharge early in programme
Summer working impacts on tourism income to the town	Through stakeholder engagement, careful scheme phasing to minimise impact on the beach etc. this risk has been significantly reduced. Ongoing communication with local businesses and general population throughout design and delivery phases is vital in mitigating this risk.
Potentially volatile exchange rates alter the material costs of the scheme	A contingency allowance has been given in the cost, but Contractors have advised that this remains a live and difficult to mitigate risk.

## **1.5 Recommendation**

Conwy County Borough Council proposes that along the Colwyn Bay frontage construction of the Preferred Option, comprising a rock groyne, rock revetment and beach recharge, is undertaken. The rock groyne is 200m in length with a crest height that varies along the length. A revetment of 1382m is to be constructed to the east of the rock groyne and 1.56 million cubic metres of beach recharge placed to the west of the rock groyne. The Promenade will be raised along the entire frontage. Maintenance recharge is proposed during the 100 year life of the scheme at 10 year intervals.

The total PV cost of the preferred scheme is £62,269,780.

## **1.6 Key Plan**

Figure 1 overleaf presents the key plan for the frontage including the phasing of the construction works.

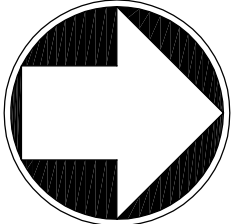


Figure 1. Key Plan



## 2. Introduction and Background

### 2.1 Purpose of this Report

This report has been commissioned by Conwy County Borough Council (CCBC) for submission to the Welsh Assembly Government (WAG) in support of an application for grant aid for coastal protection elements of the proposed Colwyn Bay Waterfront Project (CBWP). This report presents the results of an assessment of alternative solutions for the provision of coastal protection along the Colwyn Bay frontage and provides recommendations of a Preferred Option and proposals for the implementation of that Preferred Option. It builds on the work undertaken to develop the Draft PAR previously submitted to WAG by CCBC. The findings of this current PAR supersede those of the Draft PAR.

### 2.2 Background

CCBC is seeking to provide improved coastal protection to the area between Rhos-on-Sea and Old Colwyn to protect properties, businesses and vital infrastructure present along the frontage. The coastal protection improvement works are to be delivered in parallel to regeneration works to the promenade, which are being developed as part of efforts to drive the economic redevelopment of the town of Colwyn Bay through the Colwyn Bay Waterfront Project.

The existing defences were constructed over 100 years ago and are beyond their effective design life. The level of protection afforded by the defences is inadequate under present conditions and will become more so under future climate change scenarios putting important infrastructure and assets at greater risk.

### 2.3 Current Approach to Flood and Erosion Risk Management

The Colwyn Bay coastline between Rhos Point and Tan Penmaen Head is approximately 3650m in length. Defences were constructed for much of the coastline in the late nineteenth century and in general now comprise vertical seawalls in either masonry or concrete. The current approach to defence along the frontage is in response to the legacy of these Victorian and Edwardian defences.

Since the construction of the defences, beach levels have been noted to have dropped, requiring ongoing maintenance and repairs to the toe of the defences to ensure their integrity and stability. Groynes that were constructed in response to retain the wide sand beach have failed and are now absent due to a lack of ongoing maintenance. As a result, the present foreshore is typically a low gradient variably thin sandy beach overlaying fluvio-glacial sands, gravel and glacial tills. To the rear of the foreshore adjacent to the seawalls, there is some sand, shingle and cobbles that form the upper beach.

Since 1987 there has been specific, localised works carried out to extend the life of the existing sea walls and to reintroduce a beach. This has included a 650m rock revetment along the worst affected stretch of seawall constructed in 1987, and a series of long rock groynes in 1990. These structures have led to improvements in beach levels, with sand accretion within the groyne bays and in front of the rock revetment.

Since the 1990's routine maintenance of the existing structures has been carried out in order to extend their residual life. This has included patch repair of the concrete and masonry walls as well as the addition of protective rock toes and revetment facings in some areas. Emergency works have also been required in a number of locations along the seawalls, such as at Old Colwyn, in response to the rapid lowering of beach levels following severe storms. These emergency works have included the addition of rock

revetment, toe protection or concrete apron construction and an 800m section of steel sheet piling to the East of the Victoria Pier. This is in addition to repairs to the copings and safety railings along the crest of the seawall and the frequent damage to the promenade and road to the rear of the defences.

## 3. Problem Definition and Objectives

### 3.1 Outline of the Problem

The existing defences were constructed over 100 years ago and have exceeded their design life, are no longer performing to the required defence standards, and their structural integrity is in some areas already compromised. The seawalls along the frontage range in crest height between +5.0mAOD at the Victoria Pier and +8.2mAOD. This variability in height provides an inconsistent standard of protection along the frontage that can allow flooding of better protected sections via flows from less well-protected areas.

The level of protection afforded by the defences is inadequate, allowing frequent overtopping of defences under present conditions. The effect of sea level rise and increased storminess due to climate change will increase the incidence of overtopping of the seawalls.

The area immediately to the rear of the defences includes assets of both local and regional importance and therefore requires continued coastal protection of an adequate standard. There is therefore a need to improve the standard of coastal protection along the entire frontage.

### 3.2 Consequences of Doing Nothing

In a Do Nothing scenario, the programme of ongoing maintenance and repairs to the existing defences will stop allowing the defences to rapidly deteriorate over time. The conditions for which the defences were originally designed in the early 1900s have changed to the present day. Sea level has risen and storms of increasing frequency and scale are being seen.

An inspection in October 2009 found the current defences to be in generally Poor-Fair condition as presented in Appendix A (Mott MacDonald, 2010). Given the current condition of the defences, the timeline for failure is likely to occur within 0-5 years of the maintenance of the defences being stopped. The stability of the structures has been a key concern with undermining of the structures considered likely to lead to sudden failure of the defences. The Draft PAR estimated the residual life of the structures to be five years indicating that their failure is potentially imminent and urgent action is required to ensure their continued performance.

The defences are also more frequently being overtopped causing significant damage to the infrastructure to their rear. Predicted climate change scenarios show increasing sea levels that will lead to increased heights of wave impacting the seawalls. This, coupled with an increase in the frequency and scale of storms, will lead to more frequent and more damaging flood events.

Under a Do Nothing scenario, it is considered that the Promenade and the local road along the Promenade will be subject to increasing overtopping of the coastal defences until these defences fail. Once the defences fail, there will be a loss of commercial and residential properties, in addition to the promenade, and the road behind it. The loss of these assets is a result of coastal erosion and increased flood frequency. Over the 100 years the Do Nothing scenario predicts that owing to the erosion rate along the frontage both the Chester to Holyhead railway and the A55 will be lost to coastal erosion.

The loss of the A55, railway, Promenade and commercial and residential properties will have a significant impact on the value of tourism and amenity in Colwyn Bay.

### 3.3 Strategic Issues

A number of plans and studies exist for the Colwyn Bay frontage, these include:

- North West England and North Wales Shoreline Management Plan (SMP2)
- Colwyn Bay Coastal Defence Strategy Plan
- Colwyn Bay Regeneration Plan

The SMP2 indicates the following policies for the Colwyn Bay frontage (Management Unit 11a):

Table 3.1: SMP2 policies for the management of the Colwyn Bay frontage (Halcrow, 2009)

Epoch	Policy	Mechanism for Delivery
0 – 20 years	Hold the Line	By maintaining and improving / raising the existing defences. A strategy study needs to be undertaken to confirm the long-term economic viability.
20 – 50 years	Hold the Line	By maintaining and improving / raising the existing defences, subject to confirmation through the strategy study
50 – 100 years	Hold the Line	By maintaining and improving / raising the existing defences, subject to confirmation through the strategy study

In the SMP2, these policies have been reviewed under social, environmental and economic criteria, the results of which are summarised in Table 3.2 below:

Table 3.2: SMP2 justification for the Hold the Line policy for the Colwyn Bay frontage (Halcrow, 2009)

Social	Environmental	Economic
Manages risk to the railway and other infrastructure as well as other assets in the erosion risk zone. Manages risk to the cycleway and coastal path.	No conservation designations present. Local opportunities for environmental improvements and the layout and size of the groynes should be considered in a more detailed local study.	The recommended policy is potentially economically viable depending on estimated costs for relocating the railway and road which would be at long term risk. (Needs further investigation and more detailed strategy studies to confirm the policy).

The Strategy Plan also recommends a Hold the Line policy for the Colwyn Bay frontage. It advises that the policy be implemented through an upgrade of the coastal defences along the frontage using a combination of beach recharge, linear rock revetment and control structures.

CCBC is developing a regeneration strategy for the town of Colwyn Bay. This sets out environmental improvements to the public realm along the Colwyn Bay promenade, and aims to create a more usable and attractive amenity space to attract increased visitor numbers to the town, improve the visitor experience and strengthen links with the town centre. It is essential that the coastal protection options for the frontage take into consideration the needs of the wider regeneration proposals for the area.

### 3.4 Objectives

The principle objective of the Draft PAR was to develop a scheme that provides:

- Improved coastal defence measures within Colwyn Bay that are commensurate with the risk of flooding and erosion to the local population, local property and local and national infrastructure.

CCBC has developed new objectives since the Draft PAR was prepared and the Colwyn Bay Waterfront Project has evolved to encompass objectives for coastal protection of the town. In summary, the overarching objectives for the Colwyn Bay frontage are to:

- Provide renewed coastal defences along the waterfront to protect the residents and businesses of the town from the threat of the sea.
- Integrate the renewed sea defences with environmental improvements along the promenade to provide a coordinated approach to delivery of the project which maximises the regeneration potential of the scheme while also providing the necessary level of coastal protection.
- Provide environmental improvements to the promenade to offer a modern, robust, sustainable and attractive public realm to draw new visitors to the area and coordinate with the Bay Life Initiative's development plan.



## 4. Options for Managing Flood Risk and Erosion

### 4.1 Potential FCRM Measures

The Strategy Plan considered a number of options for managing the risk of flooding and coastal erosion of the frontage under a Hold the Line policy option:

**Maintain Defences** - the minimum “do-something” option in terms of intervening with the present defences. Implies routine maintenance only to preserve an existing defence function and prolong its usual life and/or delay failure.

**Sustain Standard of Defences** – this option aims to sustain the present standard of defence for the intended strategy life of 100 years (e.g. by keeping pace with, or pre-empting, sea level rise). This generic option can include maintenance and the construction of new defences, as appropriate.

**Improve Standard of Defences** - this option aims to improve the present standard of defence for the intended strategy life of 100 years.

These were compared to the **Do Nothing (No Active Intervention)** scenario, where natural processes are allowed to act without interference.

### 4.2 Long List of Options

A range of options for providing improved coastal defence for this section of frontage were considered and assessed as part of the Strategy Plan development. These options were subsequently consulted on as part of the Strategy Plan consultation process. CCBC held a public exhibition in December 2006 to determine public perception to a number of potential schemes, which were being considered to deliver the Hold the Line policy option recommended by the first SMP.

The five potential schemes, which formed the basis for the Stage 1 public exhibition, were:

- Maintain the existing defences
- Sustain the existing defences by provision of a rock toe in front of the existing walls (as already exists on some sections of frontage)
- Improve the defences with a linear (stepped or sloping) concrete revetment
- Improve the defences with a linear rock revetment
- Improve the defences by artificially recharging the beach (with or without control structures)

From the Strategy Consultation period the following comments were made for each of the Strategy Units (SU) detailed in the Strategy Plan reports:

**Cayley Promenade (SU 2/2/2) (At the western end of the proposed Phase 2 works)**

A clear majority (43%) favoured Beach Recharge, with significant support also for the Concrete Step Revetment (31%). The Rock Revetment (14%) and Rock Toe (8%) options received little support.

**Beach Zone (SU 2/3/1 (West)) (At the middle and eastern end of the proposed Phase 2 works)**

A clear majority (55%) favoured Beach Recharge, with support also for the Concrete Step Revetment (25%). The Rock Revetment (12%) and Rock Toe (4%) options received very little support.

**Watersports Zone (SU 2/3/1 (West)) (Close to the proposed Phase 1 works)**

The public consultation favoured Beach Recharge (39%) with support also for the Concrete Step Revetment (22%).

**Old Colwyn (SU 2/3/2) (At the location of the proposed Phase 3 works)**

Beach Recharge was still supported (28%) as was Concrete Step Revetment (20%), but the most popular option was the Rock Revetment (29%), an option not favoured for other zones.

### 4.3 Options Rejected at Preliminary Stage

The Draft PAR assessed a number of options derived from the Strategy Plan using the PAG guidance and the 2005 Multi-Coloured Manual (Flood Hazard Research Centre, 2010). It demonstrated that there is clearly an economic case for providing improved coastal defence to Colwyn Bay. Table 4.1 summarises the results of the Draft PAR assessment.

Table 4.1: Summary of options considered and Benefit:Cost results from the Draft PAR (CEUK, 2008)

	Option 1	Option 2	Option 3	Option 4	Option 5
Option Description	Do nothing	Maintenance but no improvement of the existing defence assets	Sustaining existing defence assets	Improve and maintain linear defences	Improve defences by artificially supplementing and managing beach volumes and profiles.
Method of delivery		Maintenance and remedial works to existing masonry and concrete structures	Maintenance and remedial works. Rock toe re-profiling. Raising of backshore defences. Improvements to National Rail embankment.	New linear rock revetment and raised promenade. Ongoing maintenance of these new structures.	Construction of control structures, linear defences and crest works followed by beach recharge. Ongoing maintenance of new structures including beach management.
Impact on Standard of Service	Reduced	Reduced	Maintained	Improved	Improved
<b>Benefit Cost Ratio</b>		<b>18.34</b>	<b>9.40</b>	<b>5.04</b>	<b>3.21</b>

The Draft PAR considered that Options 1 and 2 did not meet the policy recommendations of either the SMP2 or the Strategy Plan, leading to a reduced standard of defences and significant losses of assets and infrastructure over time. Neither option supported the principle objective of the original Draft PAR which was to develop a scheme that provides improved coastal defence measures within Colwyn Bay commensurate with the risk of flooding and erosion to the local population, local property and local and national infrastructure. The objectives of the Colwyn Bay Waterfront Project, which incorporates objectives for coastal protection, are also not met by either option. Options 1 and 2 of the Draft PAR have therefore been dismissed from further consideration in this updated PAR.

Option 3 of the Draft PAR maintained the integrity of the defence line throughout the next 50 years and adjusted the structure crest level to maintain the level of risk of overtopping due to rising sea levels at its present level. However it was identified that in the longer-term maintaining the integrity of the existing structures is not considered to be viable and there is risk to infrastructure associated with this maintain option. In the longer-term promenade access and the railway would be under threat with associated risk of damage and eventual loss beyond 50 years. The works will enhance the life of the defences and reduce but not eliminate the risk of shoreline recession. Overtopping will continue to take place at the present rate. For this reason, Option 3 was not considered to meet the policy recommendations of either the SMP2 and the Strategy Plan or the objectives of either the Draft PAR or the Colwyn Bay Waterfront Project and for this reason has not been considered further in this updated PAR.

Option 4 comprises a new linear rock armour revetment built directly in front of the existing sea wall along the whole frontage similar to that which exists between Rhos-on-Sea and Penrhyn Bay. It also includes for a new promenade and improved crest levels that would limit overtopping. It is considered that this option would not significantly improve the beach condition or provide any significant amenity benefit and therefore that it fails to meet the objectives of the Colwyn Bay Waterfront Project, although it does deliver the objectives of both the SMP2 and the Strategy Plan. For this reason, Option 4 has not been immediately rejected and has been considered in this updated PAR.

#### **4.4 Options Short-listed for Appraisal**

CCBC has short-listed options for the coastal management of the Colwyn Bay frontage in response to the recommendations of the SMP2 and the Strategy Plan and in response to the findings of extensive public consultation as part of both the Strategy Plan and the Colwyn Bay Waterfront Project.

Options 4 and 5 were the favoured alternatives arising from the Draft PAR and have been developed and refined in the light of subsequent technical evaluation and modelling carried out. Both alternatives provide an improved level of flood and coastal protection that achieves the best balance between the costs of providing and maintaining the defences and the potential damages that would occur for different levels of service, which would be determined during detailed design and appraisal. They also include for amending crest levels and/or profiles in 50 years time in response to increased sea levels and climate change.

Option 4 comprises a new linear rock armour revetment built directly in front of the existing sea wall along the whole frontage, a new promenade and improved crest levels. This option will safeguard the integrity of the defences, protect local and national infrastructure and improve the level of service provided to one that is commensurate with the level of risk.

Option 5 is a combined approach developed from the technical appraisal carried out and the Stage 1 Strategy Plan consultation, consisting of beach recharge and revised beach control structures combined with new linear revetments and promenade improvements in places with the following proposed arrangements applying for the individual lengths of frontage:

- Western Section - Rhos Jetty to Penrhos College: Beach Recharge
- Central Section - Penrhos College to Eirias Park: Beach Recharge, Control Structures and new Crest Works in places
- Eastern Section - Eirias Park to Old Colwyn: New Linear Rock Revetment and new Crest Works

Option 5 requires ongoing beach management and periodic “topping up” of beach levels to maintain the necessary design level of protection. The beach management is required as there will be movement of the beach under the action of waves and tide and to a lesser extent wind resulting in potential losses from time to time. Beaches are dynamic landforms and such temporal and spatial changes are a natural part of their successful function. Option 5 provides not only improved defence function but also opportunities for improved amenity and development to meet the aspirations of the local community for the economic regeneration of Colwyn Bay. The approach is in line with the recommendations of the SMP2 and Strategy Plan, responds to public feedback and fully supports the objectives of the Colwyn Bay Waterfront Development.

For Option 5, several configurations of beach control structures have been considered and developed using the outputs of the modelling work carried out. These have included a single Y-shaped groyne, a single straight groyne and several shorter Y-shaped and straight groynes.

An optioneering workshop was carried out to select the preferred configuration for Option 5. Options for Y-shaped/T-head groynes are shown by the modelling to result in less longshore transport of beach recharge material and therefore reduced beach management costs, but have a significantly higher initial construction cost leading to little variance in whole-life costs and no variation in benefits achieved. For this reason a single, straight groyne was selected as the preferred layout for Option 5.

## **4.5 Planning Considerations for the scheme**

Conwy County Borough Council's Planning Committee considered planning conditions for the Preferred Option on 13 October 2010. Decisions made at the Planning Committee will need to be considered in selection of the final option to be implemented.

## 5. Options Appraisal and Comparison

Conwy County Borough Council has undertaken substantial background work to develop proposals for the coastal defences along Colwyn Bay's frontage. This PAR builds on this previous work, in particular the Draft PAR, and provides an up to date appraisal of the options brought forward.

### 5.1 Technical Issues

#### 5.1.1 Assessment Criteria

The appraisal and comparison of options has been carried out using FCDPAG and reviewed against the Environment Agency's FCERM-AG, which was published earlier this year, with figures updated to reflect those in the latest version of the Multi-Coloured Manual.

#### 5.1.2 Draft PAR

In developing this PAR, the findings of the Draft PAR have been reviewed and used where appropriate, having first been updated using current guidance and values. The method is described in Section 5.4 and 5.5. Reference is made throughout this report to information in the Draft PAR, which is provided in Appendix B of this report.

#### 5.1.3 Numerical and Physical Modelling

Following completion of the Strategy Plan, CCBC commissioned a detailed numerical and physical coastal modelling study to examine the feasibility of their preferred option from the Stage 1 consultation process and to optimise arrangements of the defences based on the results obtained.

The numerical modelling study provided an assessment of a number of configurations of defences along the frontage. There is consideration within the model report of a single straight groyne (as in Option 5), in a similar location to the current proposed straight rock groyne. The following key points have been identified:

- The single groyne is effective in providing a barrier to drift and holding a beach to the west
- Across the frontage immediately west of the groyne, the model predicts retreat of the frontage in the first 5 years reducing in magnitude moving away from the groyne, followed by recovery thereafter
- The groyne clearly interferes with drift across the upper part of the active zone, causing downdrift beach erosion to the east of the groynes location
- At the western end the recession identified in the unrestrained beach scenario is replicated. Despite significant retreat in the west end, the beach width would however still be wider than its current situation after 19 years of simulated conditions.

The numerical modelling report provides estimated losses of between 425,000m<sup>3</sup> to 450,000m<sup>3</sup> for multiple straight groynes and a single 'Y' shaped groyne respectively. Therefore based on these estimates a recharge value of 475,000m<sup>3</sup> for a single straight rock groyne has been assumed.

The numerical modelling report also considered the frontage if no control structures were constructed and only beach recharge was undertaken. The following key points were identified:

- Gradual beach retreat would occur at the western end of the frontage
- There would be a relatively stable beach in the middle section between chainage 700m and 1700m
- Significant retreat of the eastern end of the recharged frontage would occur
- Beach advancement to the east of the recharged section, reducing in magnitude towards the east

The modelling estimated losses over the first ten years after recharge of 575,000m<sup>3</sup> for  $d_{50} = 0.25\text{mm}$  and 400,000m<sup>3</sup> for  $d_{50} = 0.45\text{mm}$ .

The physical model study focused on the Phase 1 area of the frontage. A report summarising the results of the study and a rationale behind the recommendation of the proposed defence arrangement for the Phase 1 area has been produced. The study modelled eight alternative designs for the revetment along the Phase 1 frontage. The results indicated that to keep the crest levels to a minimum whilst reducing overtopping the revetment required a slope of 1V:3H, a recurve crest wall and a permeable crest.

#### **5.1.4 Ground Investigations**

Conwy County Borough Council commissioned a ground investigation for the entire Colwyn Bay Waterfront Project area (Allied Exploration and Geotechnics Limited, 2010). The ground investigation was carried out both landward and seaward of the existing sea wall to inform the regeneration and coastal defence elements of the project respectively.

#### **5.1.5 Asset Condition Surveys**

Conwy County Borough Council commissioned a detailed condition survey of the existing sea wall in support of the development of options for the frontage. The October 2009 inspection found the current defences to be in generally Poor-Fair condition. Defects included:

- Cracking
- Distortion, misalignment and tilting
- Bulging
- Loss of mortar
- Loss of facing
- Spalled or eroded surface
- Erosion, undermining
- Exposed steel reinforcing bars
- Localised water seepage
- Externally corroding steel elements

The stability of the structures has been a key concern with undermining of the structures considered likely to lead to sudden failure of the defences. The improvement of the levels of beach material is important for the protection and stability of the existing seawalls. The existing groynes at their present height are insufficient to raise beach levels to an effective level to provide this protection to the rear of the foreshore. The Draft PAR estimated the residual life of the structures to be five years. Given the current condition of

the defences, the timeline for failure may reasonably occur within 0-5 years of the cessation of maintenance of the defences.

#### **5.1.6 Preliminary Design**

CCBC has developed Preliminary Designs for Option 5, which has been split into a three-phase approach to work. Phase 1, which comprises a 200m long groyne and 100m revetment, together with beach access improvements via steps and slipway, has been developed to Detailed Design stage.

### **5.2 Environmental Assessment**

Conwy County Borough Council views a strong environmental performance as a vital element in the success of this scheme. An Environmental Impact Assessment which reviews the impacts of both Options 4 and 5 across the entire frontage has been prepared.

The site lies within the boundary of Liverpool Bay potential Special Protection Area (pSPA). The pSPA regularly supports more than 1% of the British populations of red-throated diver *Gavia stellata*, 1% of the biogeographical population of common scoter *Melanitta nigra* and more than 20,000 waterfowl during the non-breeding season.

The western boundary of the site is also located <5km from the Y Fenai a Bae Conwy/Menai Strait and Conwy Bay SAC. Within the EIA this designated site has been included owing to some of marine mammals which are listed in this SAC being observed within Colwyn Bay.

### **5.3 Social and Community Impacts**

Conwy County Borough Council recognises the importance of community acceptance of the proposed coastal protection works. They have carried out significant consultation throughout the development of the Strategy Plan and Waterfront Development Project to develop an understanding of the concerns and priorities of local residents and visitors to the Colwyn Bay waterfront. CCBC has carried out additional survey work during the summer of 2010 to determine visitor numbers and to develop contingent valuation data for the waterfront.

### **5.4 Option Costs**

The Detailed Design of Phase 1 of the coastal defence improvements has enabled unit costs for each element of works to be established. This has enabled robust and sensible costs for the design, construction and whole-life maintenance of Options 4 and 5 to be developed. These supersede the costs originally developed in the Draft PAR. The costs for the revetment in Option 4 include half the rock being sourced from overseas to ensure that the required volume of rock can be obtained within the short construction period.

An optimism bias of 30% has been applied to the whole scheme costs based on an understanding of the frontage, detailed design and Early Contractor Involvement. The price date for the costs is July 2010.

The cost basis for the options is based on a 100 year design including:

- Option 4 – 3650m rock revetment and the raising of the Promenade
- Option 5 – 200m rock groyne, 1382m revetment to the east, 1.56 million cubic metres of sand recharge to the west and the raising of the Promenade

Table 5.1 provides a summary of the whole life and present value (PV) costs of each option considered.

Table 5.1: Summary of Options 4 and 5 whole life and PV costs

		Option 4 - Improve - Linear Defences	Option 5 - Improve – <b>Combined Approach</b>
Cash costs (not discounted)	Initial Capital Costs including fees (£k)	64,708	49,877
	Maintenance/Management Costs over 100 years (£k)	39,336	64,949
	Total cost (no OB) (£k)	104,044	114,826
Discounted costs	Total PV costs (£k)	67,648	62,270
	Total cost including Optimism Bias (£k)	87,942	80,951

## 5.5 Options Benefits (Damages Avoided)

The assessment of benefits of each option, or damages avoided, is derived from the Draft PAR and new data collected and updated as appropriate under the FCDPAG/FCERM guidance and in accordance with indexed values from the Multi-Coloured Manual, the latest retail price index (RPI) and housing price index. This section describes the approach adopted for the review and update of the benefits.

The price date for all calculations is July 2010.

The discount rates used for the benefit cost analysis are taken from the HM Treasury Green Book (March 2003) to allow for the uncertainties of future to be taken into account. The discount rates from year 0-30 is 3.5%, year 30-75 is 3% and year 75-100 is 2.5%.

### 5.5.1 Assessment of damages

Under a Do Nothing scenario it is considered, over 100 years, that there will be a loss of including the A55, Chester to Holyhead railway line and the Promenade and promenade road as a result of coastal erosion and flooding as well as a number of commercial and residential properties.

The damages arise from two principal areas:

- Overtopping of defences causing closure of the promenade and traffic diversion
- Failure of defences leading to permanent traffic diversions, loss of commercial and residential properties and loss of railway and highway infrastructure



The recession lines from the Draft PAR have been updated on the basis of a greater understanding of the frontage developed from new studies including the SMP2, modelling reports and ground investigations. The existing defences are considered to have failed in Year 5. After this, it can be anticipated that the ground behind will quickly suffer the effects of washing out as it comprises mainly made ground under the existing promenade and road. Access along the promenade road for traffic, and hence access to a number of residential and commercial properties will be prevented. It is assumed that this also occurs in Year 5 as once the defences have failed the promenade and promenade road cannot be considered safe for use. The railway embankment to the rear of the promenade road comprises earthworks and is therefore vulnerable to the effects of inundation and erosion following the collapse of the promenade and promenade road. This is therefore considered to be unsafe for use once the coastline has reached within 5.0m of its base. It is considered that this will be in Year 10. From Year 20 onwards, the new erosion rate presented for Colwyn Bay in the SMP2 of 0.3m per year until Year 50 and then 0.7m per year from 50-100 has been applied. This results in the loss of the A55 in Year 55.

### **Commercial and Residential losses**

An assessment of the losses to commercial and residential properties was undertaken in the Draft PAR. The values for commercial and residential properties have been updated from the using known house sale prices values and the latest mid-point council tax bands from CCBC. To ensure that the values are up to date the House Price Index (HPI) from the Land Registry has been applied.

The timing of the losses for commercial and residential properties has been based on the predicted erosion rate along the frontage. The assets are considered lost when the erosion line reaches within 5.0m of the property boundary based on guidance in the Multi-Coloured Manual. Within the benefit cost analysis the sensitivity of the assets being lost has been considered based on including the probability of when the asset would be lost and in which year. Along the main frontage the erosion scenarios indicated that the majority assets would be lost by Year 5 as a result of the loss of the promenade road.

The total PV damage of the properties from erosion over the 100 year life of the scheme is £18,146k.

### **A55 road losses**

The loss of the A55 trunk road has been considered to occur in Year 55 based on the erosion rate along the frontage. Once the road was considered lost the cost of diverting traffic permanently was calculated. The cost of diverting the traffic is based on the methodology provided in the Multi-Coloured Manual which identifies that there are additional costs associated with each vehicle using the road network.

These costs relate to the additional distance travelled or the additional time taken. The number of vehicles that are expected to be affected by the loss of the A55 was identified in the Draft PAR as 961 vehicles per hour. The costs associated with the diversion are presented in Table 5.2. The cost of travelling along the A55 assumes a speed of 50mph compared to the local diversion which assumes a speed of 25mph.

Table 5.2: Diversion costs

	A55 route	Local diversion route	A55 route	Local diversion route
	Travel Cost (£/km)	Travel Cost (£/km)	Cost per hour (£/km)	Cost per hour (£/km)
Car	0.15	0.31	545	1,206
LGV	0.20	0.37	242	480
OGV1	0.27	0.44	163	285
OGV2	0.37	0.57	202	333
PSV	1.06	2.16	64	140
<b>Total</b>			<b>1,216</b>	<b>2,444</b>

The difference in the cost of travelling on the A55 route and the local diversion is £1,228/hour giving an annual diversion cost of £10,761k. The PV loss of the A55 over the 100 years is estimated to be £47,752K.

### Local traffic losses

The impact of the loss of the Promenade road along the frontage has been assessed using the information provided in the Draft PAR.

The numbers in the Draft PAR were calculated based on local traffic count data and information relating to historic promenade closures between 1996 and 2010. The two areas where overtopping would cause flooding and diversion of traffic are as follows:

- Central Promenade: Toad Hall to A55 Junction 22, Old Colwyn
- East Promenade: A55 Junction 22, Old Colwyn to Beach Road

For each of the routes alternative diversion routes were identified and the additional travel costs for different types of vehicles calculated per event based on average closure lengths from historical flood event data. It has been assumed that during the diversion the speed of traffic will reduce from 25mph to 20mph.

During the first 5 years of the scheme design life the Promenade is assumed to be affected by flooding owing to the presence of the coastal defences. The cost of the damage caused as a result of a flooding event has been calculated using information provided by CCBC and the Multi-Coloured Manual. The Eastern end of the Promenade has been recorded to be closed from flooding events, on average, 6 times a year compared with once for the Central Promenade section. The cost of diverting the traffic was calculated using information from the Multi-Coloured Manual. The cost per disruption was based on the average number of hours each section has been closed for based on historical data. The information indicates that along the Eastern Promenade the cost per disruption was £4,663 and for the Central Section £2,445. The total cost of the diversion annually is estimated to be £30.4k.

Following the loss of the road in Year 5 from coastal erosion the annual diversion cost is estimated to be £2,594k based on the cost of diversion for the Eastern and Central Promenade.

The PV loss of the Promenade road over 100 years is estimated to be £65,496k.

## Railway Losses

The loss of the railway is considered to occur in Year 10 owing to the failure of defences in a number of locations. Loss of the asset would require provision of a bus diversion service to be implemented between the two stations to either side – Abergele and Pensarn and Llandudno Junction. The loss is valued as the delay cost to passengers arising from having to change from train to bus and vice versa at each end and the cost of provision of the bus service. The compensation payment costs and alternative bus costs developed in the Draft PAR have been updated using July 2010 RPI figures. A summary of the costs is included in

Table 5.3.

Table 5.3: Cost associated with the loss of the railway based on the Multi-Coloured Manual (Flood Hazard Research Centre, 2010)

Percentage of Rail services delayed	40%
Total Passengers travelling across the area per hour	170
Compensation payments per hour delay for regional trains	£18.00
Compensation payments per hour delay for intercity trains	£17.20
Cost of delay per day	£29,018
Provision of replacement Bus service	£3929
<b>Total cost per year of diversion</b>	<b>£12025.67k</b>

The annual cost of the diversion of the railway from Year 10 onwards is estimated to be £12,026k.

Therefore, over the 100 year scheme life the PV cost is £255,614k.

## Loss of Services under the Promenade

Within the Promenade it has been identified that there are a number of services that would be lost at the same time that the Promenade is lost in Year 5, including:

- Two BT Cables
- Low Voltage Cable
- Combined Water Pipe
- Street Light Cables
- Water supply Pipe
- Foul Water Pipe
- Gas Pipe

The cost associated with losing these services is £5,792.55k based on estimates provided by service companies for replacement and re-routing. The PV cost is therefore 4,877k.

### 5.5.2 Contingent Valuation

Under a Do Nothing scenario, it is considered that there will be a loss of visitors to the frontage as a result of the loss of promenade and amenity value. To establish the potential impact of this loss, a contingent valuation (CV) survey was carried out (as part of a wider survey of visitors to the Colwyn Bay Waterfront area) during the weekend of 21<sup>st</sup> June 2010. This was in accordance with the method described in the Multi-Coloured Manual. The extract of CV questions from the questionnaire together with the responses given is provided in Appendix C. Responses to the CV questions enabled a Value of Enjoyment to be derived for the Colwyn Bay Waterfront under the following scenarios:

- Do nothing
- Option 4 – Revetment along the frontage
- Option 5 – Beach Recharge, Rock Groyne and Revetment

Table 5.4 presents the Value of Enjoyment figures derived from the survey.

Table 5.4: Value of Enjoyment for the various proposed schemes

	Do Nothing	Option 4 - Revetment along the whole frontage	Option 5 - Beach Recharge, Rock Groyne and Revetment
Value of Enjoyment	£8.97	£7.84	£17.74

Surveys carried out between May and June 2010 have enabled visitor numbers to be assessed. Figures have been indexed, as per the Multi-Coloured Manual to provide annual visitor numbers. From these numbers it has been possible to derive the impacts, either positive or negative, of each of the options on the value of tourism provided by the frontage. Table 5.5 presents the losses/gains as a result of the implementation of each of the scheme options. A gain in tourism value associated with the construction of an Option is indicated by a negative number whilst a loss is indicated by a positive number.

Table 5.5: The tourism losses/gains associated with each scheme

	Do Nothing	Option 4 - Revetment along the whole frontage	Option 5 - Beach Recharge, Rock Groyne and Revetment
Potential loss / gain (£k)	14,221.72	12,430.13	-28,126.34

### 5.5.3 Summary table of the PV losses for each option

Table 5.6: The PV losses and benefits associated with each scheme

	Do Nothing	Option 4 - Revetment along the whole frontage	Option 5 - Beach Recharge, Rock Groyne and Revetment
Assets (£k)	18,146	-18,146	-18,146
Damage (£k)	373,610	2.74	2.74
Tourism (£k)	14,222	12,430	-28,126
<b>Total PV losses (£k)</b>		<b>393,545</b>	<b>434,101</b>

## 5.6 Benefit Cost Appraisal

	Option 1 (do nothing)	Option 4	Option 5
PV costs PVc		67,647.60	62,269.78
Optimism bias adjustment		20,294.28	18,680.94
Total PV Costs for appraisal PVc		87,941.88	80,950.72
PV damage PVd	373,609.65	2.74	2.74
CV damages	14,221.72	12,430.13	-28,126.34
PV damage avoided		375,398.50	415,954.97
PV assets Pva	18,146.07		
PV asset protection benefits		18,146.07	18,146.07
Total PV benefits PVb		393,544.57	434,101.04
Net Present Value NPV		305,602.69	353,150.32
Average benefit/cost ratio		5.82	6.97

## 6. Selection and Details of the Preferred Option

### 6.1 Selecting the Preferred Option

The Preferred Option has been developed using the Draft PAR as a baseline. Additional information to update the Draft PAR has been used to select the Preferred Option including the latest erosion rates from the 2009 SMP2, the modelling results and other additional sources of information.

The tourism benefits that were considered for the Preferred Option were developed through a survey to determine the value of enjoyment that visitors would put on their trip to Colwyn Bay. The process indicated that people would pay more for the Preferred Option owing to the beach recharge providing a wider and improved beach.

The Preferred Option is consistent with the outcome of the Draft PAR and the Strategy. It will provide Colwyn Bay not only with an improvement in the standard of coastal defence but also opportunities to improve amenity and leisure interests across the frontage and in combination with other proposals aid regeneration of the town. In this regard it also meets the objectives of the SMP2 and the Colwyn Bay regeneration plans.

Table 6.1: Benefit cost assessment

	PV Costs (no Optimism Bias)	PV Costs (including Optimism Bias)	PV Benefits	Av. Benefit/Cost Ratio
Option 4 - Revetment along the whole frontage	67,647.60	87,941.88	393,544.57	5.82
Option 5 - Beach Recharge, Rock Groyne and Revetment	62,269.78	80,950.72	434,101.04	6.97

The two options considered have been designed to have the same function and level of protection and therefore are directly comparable. The benefit cost analysis has demonstrated that Option 5 offers the highest benefit cost ratio at 6.97, demonstrating that Option 5 offers the best long-term value.

### 6.2 Sensitivity Testing

Various phasings and timings for ongoing maintenance works for each option have been assessed for both options but have not been shown to have significant effect on the overall benefit cost ratio, due to the effect of discounting, or the selection of the Preferred Option. A reduction or increase in erosion rate has an impact on the overall cost benefit ratio but does not change the selection of the Preferred Option.

It has been assumed in the benefit cost analysis that the initial recharge phase will take place during one summer season. This will minimise losses of recharge material which could be vulnerable to removal during storms etc. Additionally, a one season construction period will minimise disturbance to the tourism industry of the Town.

### 6.3 Details of the Preferred Option

#### Technical Aspects

The Preferred Option is for a 200m long rock groyne with a crest height of +5.5mOD at the landwards end of the structure and +2.5mOD at the seaward end. To the east of the groyne a 1382m rock revetment is proposed with a 29.7m footprint. To allow construction of the revetment it is considered necessary to raise the Promenade level by approximately 2m.

The Preferred Option includes beach recharge from the west of the rock groyne to Rhos Jetty. The recharge is proposed to be similar to the existing beach material and a volume of 1.56 million cubic metres is required. Maintenance recharge of 450,000 cubic metres is proposed for every 10 years, based on the sediment transport modelling undertaken.

The design life of the Preferred Option is 100 years.

#### Costs for the Preferred Option

Details of the cost basis for the Preferred Option are summarised in Section 5.4, with a cost date of July 2010. The spreadsheets are presented in Appendix D.

Table 6.2: Capital costs for construction

	Option 4 – revetment only	Option 5 – Rock groyne, revetment and beach recharge
Promenade Construction (£k)	16,235	16,235
Revetment (£k)	48,473	14,894
Rock Groyne (£k)		2,555
Beach Recharge including mobilisation and demobilisation (£k)		16,193
Total PV Costs (£k)	62,520	48,190
<b>Total Costs including Optimism Bias of 30%</b>	<b>81,276</b>	<b>62,647</b>

## 7. Implementation

### 7.1 Project Planning

The Preferred Option has been planned for delivery in three phases. For the Phase 1 works, Conwy County Borough Council is being supported by grant funding from the European Convergence Funding Programme with match funding provided by the Welsh Assembly Government. The grant funding expenditure profile agreed between CCBC and its funding partners identifies that works to commence Phase 1 of the coastal defence must be delivered during the 2010/11 financial year. Circa £4.5 million of grant funding is to be utilised by CCBC during the 2010/11 financial year to commence Phase 1 coastal defence works.

- Phase 1 of the works will include a 200m rock groyne, a 100m rock revetment and the raising of 100m Promenade by approximately 2m to provide a 'hotspot' amenity area including improved beach access via steps and the existing slipway
- Phase 2 of the works will include 1.56 million cubic metres of beach recharge and the raising of the Promenade
- Phase 3 of the works includes an extension of 1122m to the rock revetment to the east of the proposed rock groyne and the raising of the Promenade.
- Beach recharge is recommended every 10 years to supplement the beach levels.

Maintenance of the rock groyne and revetment is recommended every 25 years. The cost of this is estimated to increase by 10% of the initial construction costs every 25 years starting from 10% of the initial construction cost in Year 25.

### 7.2 Delivery Risks

The key risks are presented in Table 7.1.

Table 7.1: Key Risks of the Preferred Option

Key Project Risk	Adopted Mitigation Measure
Potential for further coastal erosion/damage to the beach levels and seawall/promenade before the works begin	The funding will need to be made available as soon as possible to prevent any losses
Potential for further coastal erosion/damage to the beach levels and seawall/promenade during the works	Depending on the construction method adopted and the timing of construction then sections of the currently protected coastline may be exposed to storm events. If the works can be completed by late summer/early autumn then the likelihood of erosion is reduced compared to the work being undertaken in autumn/winter
Potential for further coastal erosion/damage to the beach levels and seawall/promenade following the works	The Preferred Option does not prevent dynamic response of beaches to storm events and that seasonal changes in beach profile and beach level are an inherent part of the Preferred Option.





## 8. References

Allied Exploration and Geotechnics Limited	2010	Colwyn Bay Waterfront Project – Phase 1 Coastal Defence – Ground Investigation Works (AM 26714)
Coastal Engineering UK	2008	Colwyn Bay Preliminary Project Appraisal Report, Draft
Coastal Engineering UK	2007	Colwyn Bay Coastal Defence Strategy Plan, Draft for Consultation
Coastal Engineering UK	2006	Colwyn Bay Coastal Defence Strategy Plan, Natural Processes and Coastal Defence Baseline Report
Flood Hazard Research Centre	2010	The Benefits of Flood and Coastal Risk Management: A Handbook of Assessment Techniques
Halcrow	2009	North West England and North Wales Shoreline Management Plan (SMP2), Consultation Draft
HR Wallingford	2008	Coastal process study: Rhyl to Prestatyn. Report EC 5690, June 2008. Report produced for Martin Wright Associates, as part of the Denbighshire County Council Report on the Development of a Coastal Defence Strategy
HR Wallingford	1991	Colwyn Borough Sea Defence Review – Report EX 2367
Mott MacDonald	2010	Colwyn Bay Waterfront Project – Principle Inspection of Colwyn Bay Seawall
Royal Haskoning	2010	Colwyn Bay Detailed Modelling Study for Coast Defence Scheme. Phase 1 Interim Modelling Technical Note
Royal Haskoning	2010	Detailed Modelling Studies For Colwyn Bay Coastal Defence Scheme Physical Model Tests of New Linear Defences

# Appendices

Appendix A. Condition Assessment of the Coastal Defences	31
Appendix B. Draft PAR (CEUK, 2008)	36
Appendix C. Contingent Valuation Questionnaire	37
Appendix D. Economic Assessment	38

# Appendix A. Condition Assessment of the Coastal Defences

The following plates have been extracted from Colwyn Bay Waterfront Project – Principle Inspection of Colwyn Bay Seawall (Mott MacDonald, 2010)

Plate 1: Storm damage on the Promenade



Plate 2: Access steps at the eastern end of the frontage



278569///1/C 15 October 2010



Plate 3: Exposed masonry wall along the front



Plate 4: Seawall to the west of the Pier



Plate 5: Seawall to the west of the groyne



Plate 6: Lowering beach levels at the access ramp opposite Sea Bank Road





Plate 7: Beach drop along West Promenade east of the Pier



Plate 8: Beach drop along Rhos Promenade





## Appendix B. Draft PAR (CEUK, 2008)

***Draft***



**Colwyn Bay**

**Proposed Coastal Defence Improvements**



**Preliminary Project Appraisal Report**

**August 2008**

ENVIRONMENTAL SERVICES  
Conwy County Borough Council  
Civic Offices  
COLWYN BAY  
LL29 8AR  
Tel. 01492 574000  
Fax. 01492 575199

Coastal Engineering UK Ltd  
THURSTASTON  
Wirral  
CH61 0HG  
e-mail: [ajw@coasteng.co.uk](mailto:ajw@coasteng.co.uk)  
Tel. (0151) 648 8896  
Fax. (0151) 648 8896

***Draft***

**Conwy County Borough Council**  
**Colwyn Bay – Proposed Coastal Defence Improvements**  
**Project Appraisal Report**  
**August 2008**

**Document History Record**

This report has been issued and amended as follows:

Issue	Revision	Description	Date
1	0	Draft for Comment	31/08/08

**Coastal Engineering UK Ltd**

104 Thurstaston Road, Thurstaston Wirral CH61 0HG

Tel: +44 (0)151 648 8896 Fax: +44 (0) 151 648 8896

e-mail: [ajw@coasteng.co.uk](mailto:ajw@coasteng.co.uk)

<http://www.coasteng.co.uk>

This report has been prepared by Coastal Engineering UK Ltd in accordance with the instructions of their client, Conwy County Borough Council. Any other persons who use any information contained herein do so at their own risk.

## **TABLE OF CONTENTS**

<b>1</b>	<b>INTRODUCTION .....</b>	<b>1</b>
1.1	Key Objectives .....	1
1.2	Appraisal Details .....	1
1.3	Previous Reports and Studies .....	1
1.4	Approvals & Consents .....	1
1.5	Consultations .....	2
1.6	Assets Protected.....	2
1.7	Benefits of The Proposed Scheme .....	2
1.8	Summary of Conclusions .....	2
<b>2</b>	<b>PROBLEM DEFINITION .....</b>	<b>4</b>
2.1	Site Description .....	4
2.2	Current Conditions.....	4
2.3	Problem Description .....	5
2.4	History of Erosion and System Failures.....	5
2.5	Frequency of Events .....	6
2.6	Links with Strategy Plans and Details of Interdependencies.....	6
2.7	Review of Existing Policy Options.....	7
2.8	Residual Life of Existing Structures .....	7
2.9	Probability of Overtopping.....	7
2.10	Do-Nothing Evaluation .....	7
2.11	Designated Areas and Sites Affected.....	8
2.12	Impact Assessment .....	9
2.13	Opportunities and Constraints .....	9
<b>3</b>	<b>APPRAISAL OF OPTIONS .....</b>	<b>11</b>
3.1	Alternatives Considered.....	11
3.2	Costs .....	15
3.3	Assessment of Damages.....	15
3.4	Benefits and Impacts.....	16
3.5	Benefit Cost Appraisal .....	17
3.6	Uncertainty Considerations .....	18
3.7	Choice of Scheme .....	20
<b>4</b>	<b>DESCRIPTION OF PROPOSED SCHEME .....</b>	<b>21</b>
4.1	Scheme Description .....	21
4.2	Defence Standards & Criteria.....	21
4.3	Materials To Be Used .....	22
4.4	Outline Method of Construction.....	22
4.5	Environmental Impact of Scheme.....	23
4.6	Timing/Phasing of Works .....	24
4.7	Future Monitoring & Management.....	24
4.8	Effects of Proposals on Coastal Cell.....	25
<b>5</b>	<b>CONCLUSIONS &amp; RECOMMENDATIONS.....</b>	<b>26</b>
5.1	Conclusions .....	26
5.2	Recommendations.....	26
<b>6</b>	<b>REFERENCES .....</b>	<b>27</b>

## List of Figures

Figure 1.1 – General Location Plan .....	29
Figure 1.2 – Colwyn Bay Strategy Area Plan .....	31
Figure 2.1 – Predicted Do-Nothing Recession Limits .....	31
Figure 3.1 – SUSTAIN (Rock Toe) Option (as existing in places) .....	32
Figure 3.2 – IMPROVE (Linear Rock Armour Revetment) Option (Artists Impression) .....	33
Figure 3.3 – IMPROVE (Beach Recharge) Option (Artists Impression) .....	34
Figure 4.1 – Plan of Preferred Arrangements .....	35
Figure 4.2 – Central Section: Preliminary Plan and Control Structure Cross Section .....	36

## APPENDICES

- I. Summary of Public Consultation
- II. Photographic Plates
- III. Optimism Bias Derivation

## **1 INTRODUCTION**

### **1.1 KEY OBJECTIVES**

1.1.1 The PAR presented here relates to the provision of improved coastal defence measures along the coastal frontage of Colwyn Bay between Rhos-on-Sea and Old Colwyn, as shown on figure 1.1.

1.1.2 The principle objective of the scheme is:

- To provide improved coastal defence measures within Colwyn Bay that are commensurate with the risk of flooding and erosion to the local population, local property and local and national infrastructure.

### **1.2 APPRAISAL DETAILS**

1.2.1 The appraisal has been carried out in accordance with Flood and Coastal Defence Project Appraisal Guidance (MAFF, 2000) as amended by the supplementary note to Operating Authorities (DEFRA, March 2003). Data used in the appraisal has been obtained from a variety of sources, including:

- Site visits and historic/contemporary surveys (including Authority Beach Monitoring Records)
- Assessment of historical reports and records (Ordnance Survey maps, photographs (aerial/ground) etc)
- Review of effects of historic events, the causes and impacts on property and land
- Middlesex University "Multi-coloured Manual" - 2005

1.2.2 The scope of the work for the current study involved:

- Site visits to confirm status of current position of site features and to obtain relevant information from land/property owners
- Consultation with Countryside Council for Wales with regard to potential impacts on nature conservation interests.
- Establishing the boundaries of land ownership at the site
- Discussions with local estate agents to establish current property values
- Identification of potential future behaviour of the cliff frontage without further intervention
- Economic, environmental and technical evaluation of a range of coastal defence options
- Identification of a preferred scheme of improvements

### **1.3 PREVIOUS REPORTS AND STUDIES**

1.3.1 The appraisal is based on the work carried out in development and production of the Colwyn Bay Coastal Defence Strategy Plan, which was produced by and on behalf of the Council in 2006/07 (Conwy CBC/Coastal Engineering UK Ltd, November 2007). The Colwyn Bay frontage was part of a wider strategy area from the Little Orme to Tan Penmaen Head, as shown on figure 1.2.

1.3.2 The Coastal defence strategy plan provided technical, economic and environmental appraisal of a range of options to maintain or improve coastal defences across the frontage.

### **1.4 APPROVALS & CONSENTS**

1.4.1 The proposed scheme of work will require approval from different local and central government departments before any works can proceed. The specific approvals required may include, but will not necessarily be limited to, all or some of the following:

- Planning Approval under Town and Country Planning Legislation.
- A licence to deposit materials on the foreshore below mean high water spring tide (MHWST) level in accordance with the Food and Environmental Protection Act (1985) - FEPA Licence;
- Approval under the Coast Protection Act 1949, Section 34.
- Coast Protection Act Approval by the Coast Protection Authority (Conwy County BC).
- Approval for Grant Aid Assistance from Welsh Assembly Government (WAG).

The FEPA and section 34 Coast Protection Act approvals in Wales are currently dealt with under a single application to

Marine and Fisheries Agency in London. It is understood that this role will be transferred to Welsh Assembly Government sometime in 2008.

## **1.5 CONSULTATIONS**

- 1.5.1 Public consultation played a key role in the development of the Coastal Defence Strategy Plan in 2006 and 2007.
- 1.5.2 As part of the strategy development a range of options for maintaining or improving the coastal defences within Colwyn Bay were identified and examined, which formed the basis for initial public consultation, which included a public exhibition held in December 2006.
- 1.5.3 The results of the initial consultation are provided in a report produced by the Authority (Conwy County Borough Council, February 2007), a summary of which is provided in Appendix I.
- 1.5.4 The Authority has consulted the Countryside Council for Wales with regard to the effects changes to the coastal defences would have on nature conservation interests and a Strategic Environmental Assessment was carried out as part of the strategy development (CMACS Ltd, October 2007).
- 1.5.5 Further to the initial public consultation exercise, further technical development of options, economic analysis and environmental appraisal was carried out, in order to complete the strategy and the Draft Strategy Option was presented for further public examination in November 2007.
- 1.5.6 Results of draft strategy plan consultation to be inserted here.

## **1.6 ASSETS PROTECTED**

- 1.6.1 The assets protected comprise the following:
  - The Chester to Holyhead Railway line and associated track and station infrastructure
  - The A55 Trunk road
  - 12 Commercial properties
  - 180 Residential properties

## **1.7 BENEFITS OF THE PROPOSED SCHEME**

- 1.7.1 The proposed scheme will safeguard the integrity of the present coastal defence and safeguard the land, property and infrastructure at risk that is identified in section 1.6.1.
- 1.7.2 The scheme will improve the amenity of the area and linked to other regeneration initiatives, associated with waterfront and town centre, will form part of a wider regeneration package that will benefit the whole of Colwyn Bay, not just the seafront.

## **1.8 SUMMARY OF CONCLUSIONS**

- 1.8.1 The present minimum standard of protection against erosion is estimated to be between 1 and 5 years and protection against flooding at < 1 years, both of which are below the indicative standard of protection of 1 in 100-300 years (Land Use Band A) as stated in current Flood and Coastal Defence Project Appraisal Guidance (MAFF, 2000).
- 1.8.2 Project Appraisal has confirmed that there is technical, environmental and economic justification for carrying out a scheme of coast protection improvements to provide an improved uniform level of defence across Colwyn Bay
- 1.8.3 The preferred scheme comprises initial capital works as follows:
  - Eastern Section between Eirias Park and Old Colwyn: Construction of a new rock armour revetment, promenade and crest wall
  - Central and Western Sections between Rhos Jetty and Eirias Park: Recharging of the beach with sand and improvements to the promenade and crest of existing defences
  - Central Section between Penrhos College site (Toad Hall) and Eirias Park: Provision of beach control structures (breakwaters, groynes etc) on the foreshore

1.8.4 The scheme also includes future management and maintenance actions comprising:

- Maintenance and repair of rock structures
- Maintenance and repair of promenade and crest works
- Beach management – movement of material on the beach
- Clearance of wind blown sand from promenades
- Topping up of beach levels as necessary
- Reworking of rock structures to maintain standard of service in line with sea level rise

1.8.5 The Environmental Impact of the proposed measures has been evaluated within the SEA carried out as part of the strategy development (CMACS Ltd, October 2007).

1.8.6 The estimated capital cost of the scheme over a 100 year timescale is approximately £39,750,000 (PV=£28,750,000).

1.8.7 The estimated costs of the works required immediately are approximately £27,000,000 including an allowance for fees. On-going capital works and structure maintenance and beach management, as identified in 1.8.5 above is estimated to cost on average approximately £100,000 per annum.

1.8.8 With appropriate maintenance and management the proposed works will provide an estimated design life of 40-70 years and potentially more, with material able to be re-used in any re-working to upgrade defence levels in the future.

1.8.9 The preferred scheme provides a benefit to cost ratio of about 1:3 and under a range of sensitivities tested between 1:2.5 and 1:4.

1.8.10 The improvements proposed will reduce the risk of flooding to events with an estimated annual probability of exceedance of  $\leq 1-2\%$  (1 in 50-100 year return period event or greater). The risk of erosion will be reduced by implementation and subject to suitable maintenance and beach management will provide protection for at least the design life expectancy of the materials elements of the structure. Over the lifetime of the scheme changes to the level of risk will be mitigated by a combination of increasing beach levels and/or modifications to structure crest levels.



## **2 PROBLEM DEFINITION**

### **2.1 SITE DESCRIPTION**

2.1.1 The Colwyn Bay frontage is situated between the fixed shoreline locations of Rhos Point and Tan Penmaen Head. Local defences are provided at Rhos harbour at the western end and also between Old Colwyn and Tan Penmaen Head at the eastern end, the latter being under the jurisdiction of Network Rail and the WAG Highways Directorate. The shoreline in between, a distance of some 3500 metres, is defended by primarily a series of vertical masonry and/or concrete walls that date back to the early 1900s. For the purposes of evaluation and to accord with linked amenity regeneration initiatives the frontage is split into three discrete units, described below.

- SU 2/2/2 – CAYLEY PROMENADE - From Rhos Jetty around to the site of the former Penrhos College (Toad Hall)
- SU 2/3/1 – CENTRAL PIER FRONTAGE - From the site of the former Penrhos College (Toad Hall) to Eirias Park
- SU 2/3/2 – OLD COLWYN - From Eirias Park to Beach Road, Old Colwyn

The location of the key points that identify the start and finish locations of these units are shown on figure 1.1

2.1.2 Plates illustrating the current conditions applying and referred to in the text are provided in Appendix II.

2.1.3 The foreshore across the frontage is largely sand overlying boulder clay. In places the sand forms only a thin veneer and the clay can be exposed when significant beach movement occurs. At the top of the beach the sand is mixed with larger shingle and cobbles which are the remnants of the natural shoreline that existed prior to the erection of the first defences.

2.1.4 Across this frontage the foreshore is backed by a series of masonry and concrete vertical walls, the western parts of which date back to the 19th century. These walls have been subject to a great deal of repair and reconstruction almost from the date of construction, as beach levels have fallen. The situation has not been helped by the fact that groynes along parts of this frontage were allowed to fall into disrepair allowing beach levels to deteriorate. In 1987 the Council constructed a 650m rock berm along the most severely affected stretch of wall, and this has encouraged some sand accretion thus further assisting seawall stability. Further revetment improvements and construction of a number of long, low rock groynes (1990) encouraged beach recovery, with sand now covering large parts of the formerly exposed intertidal cobbles.

2.1.5 The section from Rhos-on-Sea to the Victoria Pier (SU 2/2/2 and the western half of SU2/3/1) comprises a mixture of masonry wall constructions which have been added to with various concrete and rock toe constructions (Plates 1-6). The crest level of these structures varies across this section of frontage between 8 and 5 metres AOD being typically 7-8 metres AOD across unit SU 2/2/2 before falling to 5m AOD adjacent to the Pier.

2.1.6 The section immediately east of the Victoria Pier (the eastern half of SU2/2/2) includes an integral wave recurved along the crest of the masonry wall, which is supported on a line of steel sheet piles over a length of about 800 metres. A rock revetment has been constructed in front of the wall along the majority of its length (plate 7). The crest level along this section is 6.2m AOD

2.1.7 Further to the east approaching Old Colwyn the crest level drops to 5.5 metres AOD and there is no wave recurve along the crest (plates 8-9). Routine remedial works are carried out across this frontage, generally to provide additional toe protection as beach levels fluctuate. The most recent storm event in February 2005 caused a beach level drop of about a metre over a 200 metre length of frontage, which undermined the wall and necessitated a further apron construction, comprising steel sheet piles and concrete infill (plate 10). Damage also occurs to the copings along the crest of the wall.

### **2.2 CURRENT CONDITIONS**

2.2.1 Exposure conditions within Colwyn Bay vary across the frontage as a result of the natural features that bound the wider bay area and the orientation of adjacent shoreline lengths. The western end is sheltered from directions west of north but as the shoreline moves eastwards direct exposure to more westerly directions increases as the shoreline moves out of the shelter of Rhos Point. As a result the shoreline becomes more exposed to waves that approach the shoreline from oblique directions.

2.2.2 About 70% of wind generated waves occur from directions west of north (<360° WCB) and inshore these are generally

less than 3.0 metres in height with a significant wave height (Hs) of approximately 1.2 metres [HR Wallingford, 1991]

- 2.2.3 Predicted tide levels have a range of 7.0 metres on spring tides and 3.80 metres on neap tides. Mean High Water Spring Tide is 3.65 metres above Ordnance Datum (OD) and Highest Astronomical Tide is 4.60 metres above Ordnance Datum.
- 2.2.4 Current estimates of extreme tidal levels suggest a figure of 5.19 metres above Ordnance Datum for a tide level with a 10% annual probability of exceedance (1 in 10 year return period) and a figure of 5.64 metres above Ordnance Datum for a tide level with a 1% annual probability of exceedance (1 in 100 year return period).
- 2.2.5 Current allowances for future sea level rise (WAG, July 2007) show a rising trend as shown in table 2.1 below.

<b>TABLE 2.1: REGIONAL NET SEA LEVEL RISE ALLOWANCES</b>					
	<b>Assumed vertical land movement (mm/yr)</b>	<b>Net Sea Level Rise (mm/year) relative to 1990</b>			
		1990-2025	2025-2055	2055-2085	2085-2115
Wales	-0.5	3.5	8.0	11.5	14.5

- 2.2.6 The overall trend of littoral drift is from west to east along the North Wales coast. The magnitude of drift varies with wave exposure and the pattern is segmented into sub-units by estuaries and bays where tidal currents and local wave patterns dominate sediment transport.
- 2.2.7 Changes in beach volume across the frontage are available from the Authorities' KeyShore beach monitoring database and reported in their annual monitoring reports (Coastal Engineering, June 2006).
- 2.2.8 Beach levels have fallen and volumes reduced historically across this frontage and although there is cyclical behaviour, volumes recorded in 2007 were nearly 40,000m<sup>3</sup> lower than in 2001 although across the SU 2/2/2 frontage in isolation volumes were approximately the same in 2007 as 10 years ago. Observations from inspections identify changes in beach level of up to a metre over a twelve month period can occur.
- 2.2.9 Beach response modelling carried out as part of the Strategy development confirms that, based on the last twenty years of wave conditions, the beach across SU2/2/2 is in reasonable equilibrium. However as the shoreline curves easterly the propensity to longshore movement increases, before slowing towards the old Colwyn end where shoreline orientation is more normal to the predominant wave directions.

## **2.3 PROBLEM DESCRIPTION**

- 2.3.1 There are three key issues associated with the present coastal defence provision across the Colwyn Bay frontage:
- Beach lowering requiring on-going intervention
  - Ageing and decaying defences with an imminent risk of failure in the immediate term (0-5 years)
  - Regular overtopping and its effects on defences and adjacent infrastructure
- 2.3.2 Beach volumes across the Colwyn Bay frontage have historically dropped since the defences were originally constructed, primarily as a result of reduction in the natural feed of material from the shoreline within the bay, due to a reduction in littoral drift from the west exacerbated by the hardening of the shoreline here and by the vertical nature of the defences which induced wave reflections and scour necessitating extensions of the toe in many places to mitigate the risk of undermining. Despite attempts to control the movement of the beach in the past, this trend is continuing and increasing the exposure of the present defences.
- 2.3.3 Many of the defences are over 100 years old and despite the addition of newer toe works many sections include life expired elements that have failed and been patched up in the past, most recently in February 2005.
- 2.3.4 The crest level of defences varies significantly across the frontage by up to 3 metres, with the lowest levels being less than 0.5 metres above predicted Highest Astronomical tide. Overtopping of these lowest defences (at Old Colwyn and adjacent to the Pier) occurs on a regular basis, causing damage to the promenade and road infrastructure and necessitating closure of the public highway to traffic (plate 11). Severe events have caused damage to the embankment on the landward side of the road that supports the Chester to Holyhead railway (plate 12).

## **2.4 HISTORY OF EROSION AND SYSTEM FAILURES**

- 2.4.1 The defences are subject to an on-going regime of repair and management to maintain their functionality.

- 2.4.2 Storm damage occurs regularly. The most significant recent event was in February 2005, when sections of walls were undermined requiring addition of further sections of sheet piled and concrete toe (plate 9) and damage was caused to promenade surfacing and along the crest of the sea wall to copings and railings (plate 11).
- 2.4.3 Pre 2005 damage to the defences has occurred on a regular basis with the following specific events
- 2.4.4 Surveys of the beach identify that beach elevation changes of up to one metre can occur year on year.

## **2.5 FREQUENCY OF EVENTS**

- 2.5.1 With beach volumes and therefore elevations falling, overtopping of defences and the potential for damage occurs with a > 100% annual probability of occurrence (< 1 in 1 year return period).
- 2.5.2 Over the past thirty years the following major storm events have occurred in Liverpool Bay
- November 1977
  - January 1983
  - February 1990                      Estimated Annual Probability of occurrence < 1%
  - February 1997                      Estimated Annual probability of occurrence 12.5%
  - February 2002                      Estimated Annual probability of occurrence 16.6%
  - February 2005                      Estimated Annual probability of occurrence > 100%

## **2.6 LINKS WITH STRATEGY PLANS AND DETAILS OF INTERDEPENDENCIES**

- 2.6.1 The Shoreline Management Plan (SMP) for sub-cell 11a [Liverpool Bay (Great Orme, Llandudno to Formby Point)] was produced over the period 1997-1999 [Shoreline Management Partnership, 1999].
- 2.6.2 The SMP identified the shoreline from Rhos Point Tan Penmaen Head as two management units.
- Rhos Point to Penrhos College (MU 2/2) – where the principal coastal defence risk was flooding
  - Penrhos College to Tan Penmaen Head (MU 2/3) – where the principal coastal defence risk was erosion
- 2.6.3 The preferred future coastal defence policies identified, and subsequently adopted, for both the management units were as follows:
- Short Term (< 10 years)                      **Hold the Line**
  - Anticipated Long Term (> 10 years)                      **Hold the Line**
- 2.6.4 The Shoreline Management Plan however only identifies what the appropriate policy should be, not the ways in which the policy is to be achieved.
- 2.6.5 Further to recommendations in the Shoreline Management Plan, Conwy County Borough Council produced a Coastal Defence Strategy for Colwyn Bay covering the shoreline from the Little Orme to Tan Penmaen Head (Coastal Engineering UK Ltd, November 2007). This document is currently open to public consultation.
- 2.6.6 The Strategy split the Colwyn bay frontage into three separate strategy units, as detailed in section 2.1.1 above. However due to the inter connection and dependency between the units, appraisal was carried out as a single frontage. The strategy considered a range of options for implementing the Shoreline Management Policy - MAINTAIN, SUSTAIN and IMPROVE
- 2.6.7 Strategic assessment of a range of options identified that - “Only the IMPROVE management approaches proposed accord with the shoreline management policy of Hold the Line in this strategy unit, due to the general poor condition and low residual life expectancy of the existing defences. The DO-NOTHING, MAINTAIN and SUSTAIN options do not accord with the policy and are therefore inappropriate and not considered further”
- 2.6.8 The strategy recommended that - “The proposed management approach for this strategy unit is IMPROVE with the preferred option, subject to availability of funding, being the combined approach that not only provides an improvement in the standard of coastal defence but provides opportunities to improve amenity and leisure interests across the frontage and in combination with other proposals aid regeneration of the town”.

## **2.7 REVIEW OF EXISTING POLICY OPTIONS**

- 2.7.1 The existing policy along this frontage is one of HOLD THE LINE by monitoring the foreshore and condition and maintaining the present defences.
- 2.7.2 The results of the on-going monitoring have confirmed that the beach levels are continuing to fall and that the condition of the defences is worsening.

## **2.8 RESIDUAL LIFE OF EXISTING STRUCTURES**

- 2.8.1 The residual life of the existing defences depends on the magnitude and frequency of future storm events and the ability of the defences to resist the imposed loadings. Accordingly this will vary with location, age and type of structure.
- 2.8.2 The condition of the existing defences varies across the frontage, with fluctuating beach levels in front of the defences causing undermining and wave impacts and overtopping causing structural damage to the wall and promenade fabric.
- 2.8.3 Certain elements of the defences can be considered as nearly life expired. Without further attention the minimum residual life of sections of the defences is estimated to be < 5 years.

## **2.9 PROBABILITY OF OVERTOPPING**

- 2.9.1 Due to the varying forms and crest level of the structures, and the changing relationship between the orientation of the shoreline and the wave conditions applying, the existing structures provide a variable level of defence to overtopping and flood prevention.
- 2.9.2 Examination of the overtopping criteria for a range of defence profiles however suggests that due to the general low beach levels applying across the frontage (toe level typically at or below mean high water level) all lengths are vulnerable to overtopping for conditions that are predicted to occur on at least an annual basis. In the case of the highest level of defences this may just be in the form of spray, but for the lower defended sections this will provide for “green water” overtopping the defences, which causes disruption to hinterland infrastructure. At its lowest sections overtopping can occur typically on a monthly frequency and sometimes on every spring tide, if wave conditions occur at the same time as high waters.

## **2.10 DO-NOTHING EVALUATION**

- 2.10.1 The Do-nothing (or No Active Intervention) scenario provides the basis for establishing whether it is economically viable to artificially intervene in management of the shoreline, or whether the shoreline should be left to its own devices.
- 2.10.2 In accordance with the latest guidance on Flood and Coastal Defence Project Appraisal (FCDPAG3), the basis of evaluation of future shoreline management strategies or individual schemes is the economic viability of incurring expenditure against the option of doing nothing (the ‘do-nothing’ scenario). The technical robustness and environmental effects of adoption of such a policy also require consideration.
- 2.10.3 The do-nothing scenario varies dependant on the specific existing circumstances applying:
- Where existing defences are in place, walk-away, cease all maintenance, repairs and similar activities. Any expenditure for health and safety reasons to abandoned works should be counted as a scheme cost.
  - Where there are no existing defences in place do not intervene in natural process behaviour.
- 2.10.4 The starting point for evaluation of the do-nothing scenario can be defined by the following criteria:
- The current condition and residual life of the existing coastal defences.
  - The current and likely future position of the shoreline.
  - The effects on the assets being protected of erosion of the natural shoreline;
  - The effects on the natural environment

2.10.5 Under a No Active Intervention scenario, overtopping of the defences will continue to occur on a regular basis, in the immediate term (0-5 years) necessitating closure of the promenade from “Toad Hall” to the A55 junction 22 and/or from the A55 junction 22 to Beach Road during particularly severe occasions.

2.10.6 With major damage to the existing defence structures occurring on typically a five year frequency in the recent past, it is anticipated that failure of the defences is unlikely to occur in the immediate term but is likely to occur in the short term. The most likely sections for initial failure are the Old Colwyn end or the section west of the Pier.

2.10.7 The principal future effects would be:

- Loss of promenade highway access and closure of promenade businesses
- Erosion of the embankment supporting the railway and closure of the railway
- Detachment of the pier from the shoreline
- Loss of the A55
- Gradual spread of recession inland and longshore until the beach reaches an equilibrium, leading to loss of a number of properties in the centre of Colwyn Bay and along the front between the Pier and Cayley Promenade in the medium to long term

2.10.8 The predicted timeline of effects under the Do-Nothing scenario for this unit are provided in table 2.1 below:

<b>TABLE 2.1: TIMELINE OF PREDICTED DO-NOTHING IMPACTS</b>		
<b>Term</b>	<b>Years</b>	<b>Predicted Behaviour</b>
Immediate	2007-2012	<ul style="list-style-type: none"> <li>• Overtopping of defences causing damage to structures and temporary closure of the promenade to traffic</li> </ul>
Short	2013-2027	<ul style="list-style-type: none"> <li>• Overtopping of defences causing damage to structures and temporary closure of the promenade to traffic</li> <li>• Initial failure of the defences leading to immediate closure of the promenade to traffic from Toad Hall to Beach Road, Old Colwyn (years 10-20)</li> </ul>
Medium	2028-2057	<ul style="list-style-type: none"> <li>• Continued overtopping of intact defences</li> <li>• Erosion of embankment supporting the railway and closure of the railway (year 30-40)</li> <li>• Gradual longshore and inshore spread of recession leading to failure of more lengths of defences</li> <li>• Potential loss of a number of properties along the front between the Pier and Cayley Promenade (year 40-50)</li> <li>• Probable detachment of the pier from the shoreline (year 50)</li> </ul>
Long	2058-2107	<ul style="list-style-type: none"> <li>• Continued overtopping of intact defences</li> <li>• Loss of the A55 (year 50-60)</li> <li>• Further longshore and inshore spread of recession leading to failure of more lengths of defences</li> <li>• Loss of a number of properties in the centre of Colwyn Bay and along the front between the Pier and Cayley Promenade (year 50-100)</li> </ul>

2.10.9 The predicted limits for recession under the DO-Nothing scenario are shown in figure 2.1

## **2.11 DESIGNATED AREAS AND SITES AFFECTED**

2.11.1 There are no designated areas of environmental importance within this frontage.

2.11.2 A proposed SPA covering the Liverpool Bay area (Liverpool Bay pSPA), a Natura 2000 site, will potentially abut the Colwyn Bay frontage and would therefore be an important site of nature conservation interest.

2.11.3 There are no scheduled ancient monuments or listed buildings located within this section of frontage.



## 2.12 IMPACT ASSESSMENT

- 2.12.1 A Strategic Environmental Assessment was produced as part of the Colwyn Bay Coastal Defence Strategy Plan. (CMACS Ltd, November 2007). This considered the impacts of adopting different strategic management options.
- 2.12.2 Under the Do-Nothing scenario eventual failure of the defences would release sediments and gradual alteration to shoreline alignment would provide for different conditions applying – changed sediment transport patterns etc, providing eventually for a more equilibrium process/shoreline interaction. The loss of sediment trapping groynes on beaches could result in loss of current beach sediments and, potentially, a change in intertidal character. Hard structures such as sea walls, cycle track etc would be colonised by marine algae and encrusting fauna as they collapsed into the sea and the area would eventually be expected to equilibrate to a sedimentary shore habitat. There would be a **Negative** impact on the built environment due to the loss of promenade and cycle track, highway access and closure of promenade businesses which would all have a detrimental impact upon the local economy and the regions tourism. Further infrastructure and economic impacts would also occur from loss of the A55, loss of integrity of the railway embankment and a number of commercial/residential properties in the medium to long term. Failure of sea wall and recession of shoreline is considered to have a **Negative** landscape impact
- 2.12.3 The impacts of maintaining defences would be as for the Do-Nothing scenario but over a longer timescale. Maintenance of structures may impact habitats and associated species from construction plant. Such impacts would be highly localised and temporary but would increase in frequency as higher levels of maintenance would be required over time.
- 2.12.4 Sustaining the present defences would have similar impacts to the maintain option but at a different frequency. Provision of a rock toe would provide for improved shoreline/defence interaction mitigating against beach lowering and fluctuations in beach levels in front of the defences. It would also initially cover up existing habitat although it would then provide a small area for colonisation. There would be a short to medium positive impact regarding the protection of the existing land infrastructure; however modifications to the crest may have a negative impact on the panorama of the seascape from the road/promenade. Eventual failure of the defences in the long term would have the same ultimate **Negative** impacts as the Do Nothing and Maintain options.
- 2.12.5 Linear defence improvements will move the high water mark to seaward but would provide for improved shoreline/defence interaction mitigating against beach lowering and fluctuations in beach levels along the toe. Generally the existing longshore sediment movement regime would be maintained. New structures would cause a loss of habitat due to coverage of foreshore, however this impact would be ameliorated by subsequent colonisation by marine algae and encrusting species. Subsequent habitat could be altered in places from a predominantly soft-substratum environment to one dominated by hard-substratum favouring species. In places these structures would also attract fish for feeding opportunities during high water periods. Built environment impacts are considered to be positive regarding the protection of the existing land infrastructure; however changes in elevation of the promenade may have a **Negative** impact on the panorama of the seascape from the road and foreshore
- 2.12.6 Beach recharge would provide more material for potential movement but increased elevations would reduce impacts with existing defences e.g. wave reflections. Control structures will modify wave, tide and sediment patterns but longshore drift offshore of groynes will persist. Losses of material at eastern end will continue to provide feed to down drift areas albeit at a reduced rate. It would smother existing benthic and intertidal infauna and may also cause elevated suspended sediments impacting upon water quality and subsequently benthic and fish species. Additional impacts to coastal bird species may occur due to smothering of infaunal prey items. Control structures would remove habitat previously available for benthic and fish species foraging, spawning and nursery areas. Such structures may have the benefit of providing additional complex “reef” like habitat which would provide increased habitat availability for commercial species such as crabs and lobster. Such structures may also act to aggregate fish species utilising it for food, shelter from currents and predators. Impacts on the built environment are generally as for linear defences. In addition greater visual impacts would be incurred from control structures with connected groynes impacting the beach panorama or offshore breakwaters affecting the seaward views. The artificial beach recharge would also cause a visual impact, due to the elevation of levels. However, as this is seen as enhancement of a natural habitat and because the levels would not be above the current sea defences this visual impact is considered to be low.

## 2.13 OPPORTUNITIES AND CONSTRAINTS

- 2.13.1 The principal opportunity associated with coastal defence improvements is in providing a uniform level of coastal defence to the entire frontage, thereby safeguarding the integrity of the present defence line and providing long term security to local residents and commercial business operators.

2.13.2 By linking the provision of improved coastal defences to a comprehensive plan for physical regeneration of the whole of Colwyn Bay, the proposals also provide opportunities for:

- Improved amenity and tourism
- Improved town identity
- Increased social inclusion
- Greater attraction for business relocation
- Improved employment opportunities

2.13.3 The principal constraint on provision of improved coastal defences is funding for the works, specifically:

- Obtaining EU Convergence Funding
- WAG approval for Coastal Defence Expenditure and associated Grant Aid

### **3 APPRAISAL OF OPTIONS**

#### **3.1 ALTERNATIVES CONSIDERED**

3.1.1 Options considered have been developed from the strategic assessment carried out for the Strategy Plan.

3.1.2 Intervention Options considered comprise the following options:

- Maintenance but no improvement of the existing defence assets – reducing standard of service
- Sustaining existing defence assets – maintaining existing minimum standard of service
- Improve and maintain linear defences – improved standard of service
- Improve defences by artificially supplementing and managing beach volumes and profiles – improved standard of service

Specific arrangements associated with each of these alternatives are discussed below.

#### **Maintain Existing Defence Assets**

3.1.3 For the maintain option, maintenance works comprising repair of damage and maintenance of the existing concrete/masonry walls, promenade and rock toe structures will be carried out.

3.1.4 Maintenance of the beach and defence structures is estimated to be sufficient to prolong the integrity of the defence line by up to 20 years with overtopping continuing during that period. Failure of the defences will occur eventually however and the impacts of the Do-Nothing scenario will take place but delayed, as this option does not include for major capital works to be carried out.

3.1.5 This option provides a slight reduction in risk compared to the Do-Nothing case but would not improve conditions along the frontage and the standard of service would reduce over time.

#### **Sustain Existing Defence Assets**

3.1.6 The sustain option provides for the on-going maintenance of structures and the promenade together with the provision of a uniform rock toe along the whole frontage, to assist in stabilising beach levels. It also includes for topping up and re-profiling of the rock toe structure and increasing the crest level of the defences through provision and upgrading of additional crest walls.

3.1.7 This would initially improve the level of defence but due to the variable elevation of the defences across the frontage a uniform level of defence and hence standard of service would not be achieved.

3.1.8 This option would maintain the integrity of the defence line throughout the next 50 years and adjusts the structure crest level to maintain the level of risk of overtopping due to rising sea levels at its present level. However in the longer term maintaining the integrity of the existing structures is not considered to be viable and there is associated risk to infrastructure concomitant with the maintain option. In the longer term promenade access and the railway would be under threat with associated risk of damage and eventual loss beyond 50 years.

3.1.9 These works will enhance the life of the defences and reduce but not eliminate entirely the risk of shoreline recession. Overtopping will continue to take place at the present rate.

3.1.10 This form of construction already exists in sections across this frontage, as shown in figure 3.1

#### **Improve Existing Defences**

3.1.11 The indicative standard of protection for the Colwyn Bay frontage is 1 in 100-300 years (Land Use Band A), or an annual probability of exceedance of  $\frac{1}{3}$  - 1% (MAFF, 2000).

3.1.12 A range of options for providing improved coastal defence for this section of frontage have been considered and assessed as part of strategy development. These options were subsequently consulted on as part of the strategy consultation



process (Ref. section 1.5) and two favoured alternatives were developed and refined in the light of subsequent technical evaluation and modelling carried out.

- 3.1.13 Both the alternatives will provide an improved level of flood and coastal protection that achieves the best balance between the costs of providing and maintaining the defences and the potential damages that would occur for different levels of service, which would be determined during detailed design and appraisal. They also include for amending crest levels and/or profiles in 50 years time in response to increased sea levels and climate change.
- 3.1.14 The first alternative would comprise a new linear rock armour revetment built directly in front of the existing sea wall along the, whole frontage, similar to that which exists between Rhos-on-Sea and Penrhyn Bay. It would also include for a new promenade and improved crest defences that would limit overtopping. This option would not significantly improve the beach condition or provide any significant amenity benefit. This represents the least cost option to safeguard the integrity of the defences, protect local and national infrastructure and improve the level of service provided to that which is commensurate with the level of risk applying.
- 3.1.15 An artists impression of how this might look, viewed from the Pier westerly is provided in figure 3.2
- 3.1.16 The second alternative represents a combined approach developed from the technical appraisal carried out and the Stage 1 strategy consultation, consisting of beach recharge and revised beach control structures combined with new linear revetments and promenade in places with the following proposed arrangements applying for the individual lengths of frontage:
- Western Section - Rhos Jetty to Penrhos College: Beach Recharge.
  - Central Section - Penrhos College to Eirias Park: Beach Recharge, Control Structures and New Crest Works in Places.
  - Eastern Section - Eirias Park to Old Colwyn: New Linear Rock Revetment, Crest Works and Promenade.
- 3.1.17 An artists impression of how the beach recharge with control structures might look, viewed from the Pier westerly, is provided in figure 3.3.
- 3.1.18 This alternative requires regular beach management and periodic “topping up” of beach levels to maintain the necessary design level of protection, as there will be movement of the beach under the action of the wind, waves and tide and losses will occur from time to time.
- 3.1.19 This alternative also provides not only improved defence function but opportunities for improved amenity and development to meet the aspirations of the local community for economic regeneration of the Colwyn Bay frontage.

### **Summary**

- 3.1.20 Table 3.1 below provides a summary of the timing of actions required under each of the options within four epochs:
- Immediate Term: Years 0-5;
  - Short Term: Years 6-20;
  - Medium Term: Years 21-50 and,
  - Long Term: Years 51-100.

**TABLE 3.1: SUMMARY OF INTERVENTION OPTION ACTIONS**

<b>OPTIONS</b>				
<b>Term</b>	<b>Option 2 Maintain Existing</b>	<b>Option 3 Sustain Existing</b>	<b>Option 4 Improve - Linear Defences</b>	<b>Option 5 Improve – Combined Approach</b>
<b>Immediate</b>	<ul style="list-style-type: none"> <li>Maintenance of existing masonry/concrete structures and promenade (Annually) and rock armour structures (5 yearly)</li> </ul>	<ul style="list-style-type: none"> <li>Maintenance of existing masonry/concrete structures (Annually) and rock armour structures (5 yearly)</li> <li>Major remedial work to masonry/concrete structures and promenade (year 60, 70, 80 &amp; 90)</li> <li>Rock toe reprofiling (year 75)                             <ul style="list-style-type: none"> <li>Raise crest level of backshore defences (year 75)</li> </ul> </li> <li>Possible remedial repairs to NR embankment (dependant on storm frequency and magnitude)</li> </ul>	<ul style="list-style-type: none"> <li>Construct new linear rock revetment and promenade</li> </ul>	<ul style="list-style-type: none"> <li>Recharge beach &amp; construct control structures, linear defences and crest works</li> </ul>
<b>Short</b>	<ul style="list-style-type: none"> <li>Maintenance of existing masonry/concrete structures and promenade (Annually) and rock armour structures (5 yearly)</li> <li>Major remedial work to masonry/concrete structures and promenade (year 10, 20)</li> </ul>	<ul style="list-style-type: none"> <li>Maintenance of existing masonry/concrete structures (Annually) and rock armour structures (5 yearly)</li> <li>Major remedial work to masonry/concrete structures and promenade (year 60, 70, 80 &amp; 90)</li> <li>Rock toe reprofiling (year 75)</li> <li>Raise crest level of backshore defences (year 75)</li> <li>Possible remedial repairs to NR embankment (dependant on storm frequency and magnitude)</li> </ul>	<ul style="list-style-type: none"> <li>Maintain new rock armour structures (5 yearly)</li> <li>Regular maintenance of crest works and promenade (5 yearly)</li> </ul>	<ul style="list-style-type: none"> <li>Beach Management (1/2 yearly)</li> <li>Maintain new rock armour structures (5 yearly)</li> <li>Regular maintenance of crest works and promenade (5 yearly)</li> </ul>
<b>Medium</b>	<ul style="list-style-type: none"> <li>Maintenance of existing masonry/concrete structures and promenade (Annually) and rock armour structures (5 yearly to year 40)</li> <li>Major remedial work to masonry/concrete structures and promenade (year 30)</li> </ul>	<ul style="list-style-type: none"> <li>Maintenance of existing masonry/concrete structures (Annually) and rock armour structures (5 yearly)</li> <li>Major remedial work to masonry/concrete structures and promenade (year 60, 70, 80 &amp; 90)</li> <li>Rock toe reprofiling (year 75)</li> <li>Raise crest level of backshore defences (year 75)</li> <li>Possible remedial repairs to NR embankment (dependant on storm frequency and magnitude)</li> </ul>	<ul style="list-style-type: none"> <li>Maintain new rock armour structures (5 yearly)</li> <li>Regular maintenance of crest works and promenade (5 yearly)</li> <li>Review crest level and profile of sustain level of protection (year 50)</li> </ul>	<ul style="list-style-type: none"> <li>Beach Management (1/2 yearly)</li> <li>Maintain new rock armour structures (5 yearly)</li> <li>Regular maintenance of crest works and promenade (5 yearly)</li> <li>Review crest level and profile of defences to sustain level of protection (year 50)</li> </ul>

**TABLE 3.1: SUMMARY OF INTERVENTION OPTION ACTIONS**

<b>OPTIONS</b>				
<b>Term</b>	<b>Option 2 Maintain Existing</b>	<b>Option 3 Sustain Existing</b>	<b>Option 4 Improve - Linear Defences</b>	<b>Option 5 Improve – Combined Approach</b>
<b>Long</b>	<ul style="list-style-type: none"> <li>No works – Do Nothing applies</li> </ul>	<ul style="list-style-type: none"> <li>Maintenance of existing masonry/concrete structures (Annually) and rock armour structures (5 yearly)</li> <li>Major remedial work to masonry/concrete structures and promenade (year 60, 70, 80 &amp; 90)</li> <li>Rock toe reprofiling (year 75)</li> <li>Raise crest level of backshore defences (year 75)</li> <li>Possible remedial repairs to NR embankment (dependant on storm frequency and magnitude)</li> </ul>	<ul style="list-style-type: none"> <li>Maintain new rock armour structures (5 yearly)</li> <li>Major maintenance of crest and promenade works (year 60)</li> <li>Regular maintenance of crest works and promenade (5 yearly)</li> </ul>	<ul style="list-style-type: none"> <li>Beach Management (1/2 yearly)</li> <li>Maintain new rock armour structures (5 yearly)</li> <li>Regular maintenance of crest works and promenade (5 yearly)</li> <li>Major maintenance of crest and promenade works (year 60)</li> </ul>
<b>Notes</b> * Frequency to be confirmed, subject to on-going monitoring and beach management plan				

### 3.2 COSTS

3.2.1 Table 3.2 below provides a summary of the estimated costs applying in relation to each of the options.

<b>TABLE 3.2: SUMMARY OF OPTION COSTS</b>					
<b>Cost Element<sup>1</sup></b>	<b>OPTIONS</b>				
	<b>Option 1</b>	<b>Option 2</b>	<b>Option 3</b>	<b>Option 4</b>	<b>Option 5</b>
	<b>Do-Nothing</b>	<b>Maintain Existing</b>	<b>Sustain Existing</b>	<b>Improve - Linear Defences</b>	<b>Improve – Combined Approach</b>
<b>Initial Capital Costs (1<sup>st</sup> five years)</b>	0	165,000	2,990,000	15,420,000	26,320,000
<b>Design &amp; Construction Fees (Initial)</b>	0	30,000	260,000	1,055	1,625,000
<b>Maintenance/Management Costs (Year 5 on)</b>	0	3,695,000 <sup>2</sup>	79,000	265,000	190,000
<b>Future Capital Costs (Year 5 on)</b>	0	0	17,438,000	2,408	10,340,000
<b>Future Fees (Year 5 on)</b>	0	503	1,940,000	330,000	1,270,000
<b>Notes</b> <sup>1</sup> All costs are £k <sup>2</sup> Costs to year 50 only					

3.2.2 Cost estimates used are based on recent figures provided in competitive tenders to the Authority and/or historical rates uplifted to the present day.

3.2.3 In accordance with the supplementary note to Operating Authorities (DEFRA, March 2003) - “Revisions to Economic Appraisal Procedures Arising from the New HM treasury Green Book” - the risk associated with the above costs has been accounted for by inclusion of an optimism bias within the economic appraisal carried out.

3.2.4 For the economic analysis of the proposals examined an optimism bias of 60% has been used, which has been derived, as shown in Appendix III.

3.2.5 Economic Assessment of each of the options has been carried out over a 100 year timeframe, in accordance with the revised FCDPAG3 guidance (DEFRA, March 2003). On-going maintenance and management costs are included over the full 100 year time frame.

### 3.3 ASSESSMENT OF DAMAGES

3.3.1 Damages in relation to the proposed scheme arise from two principal areas:

- Overtopping of defences causing closure of the promenade and traffic diversion and flooding to residential and commercial property
- Failure of defences leading to permanent traffic diversions, loss of commercial and residential properties and loss of railway and highway infrastructure.

3.3.2 Residential and commercial property flood damages have been obtained from the database contained on the “Multi-Coloured CD version 2.1 that accompanies the most recent version of the Multi-Coloured manual (Middlesex University Flood Hazard Research Centre, 2005/06).

3.3.3 Where properties would be lost due to erosion, average values for residential properties in Conwy have been obtained from the Land Registry website (<http://www.landreg.gov.uk/houseprices/>), supplemented by specific local valuations, where available. Generalised local valuations have been made for commercial properties.

3.3.4 The numbers of properties at risk of erosion were obtained by overlaying the predicted recession limits for each area, onto the OS survey data and the timescales to losses of property and infrastructure obtained from technical evaluation, detailed modelling and estimated average rates of recession.

3.3.5 Traffic and rail diversion losses are calculated using methodologies and data from the Multi-Coloured manual,

specifically:

- **Chester to Holyhead railway line:** This asset could be lost due to failure of defences in a number of locations. Loss of the asset would require provision of a bus diversion service to be implemented between the two stations to either side – Abergele and Pensarn and Llandudno Junction. The loss would be valued as the delay cost to passengers due to having to change from train to bus and vice versa at each end and the cost of provision of the bus service. The annual damage associated with loss of the railway is estimated at approximately £10 million.
- **A55 Trunk Road:** As with the railway, this asset could be lost due to failure of defences in a number of locations and its effect would be considered as for the railway. Valuation of the loss would be the lower of the following:
  - Cost of maintaining a permanent diversion for traffic from junction 23 at Llandulas to the east to junction 20 for Rhos-on-Sea to the west. The estimated annual cost of maintaining this diversion and additional travel time, due to a longer diversion distance and slower travel time is estimated at approximately £2,000 million.
  - Provision of a permanent alternative route. In 1976 when alternative routes for the A55 were being considered the estimated cost for an alternative route was £6.63 million (Proceedings of the ICE, 1988). Updating this to the present day using price adjustment indices for construction work provides an estimated cost for provision of a replacement route of £40-50 million
- **Local traffic losses:** These have been calculated based on local traffic count data and information relating to historic promenade closures. There are two areas where overtopping would cause flooding and diversion of traffic:
  - Central Promenade: Toad Hall to A55 Junction 22, Old Colwyn
  - East Promenade: A55 Junction 22, Old Colwyn to Beach Road

For each of the routes alternative diversion routes have been identified and the additional travel costs for different types of vehicles have been calculated per event based on average closure lengths from historical data. Where roads are lost under a recession scenario an annual diversion cost has been calculated and used in perpetuity until the end of the strategy timescale. Where the PV of this cost exceeds the PV cost of re-building a new route prior to the route being lost the lesser value has been used.

3.3.6 For the purposes of evaluation of the damages, a probabilistic approach in accordance with the methodology identified in Appendix A3.2 of FCDPAG3 – “Changing Probabilities of Failure” – has been used.

### 3.4 **BENEFITS AND IMPACTS**

- 3.4.1 The Do-Nothing option provides no benefits above the existing situation. Present risk levels remain locally in the short term with risks increasing with time with sea level rise and falling beach levels which will allow increased wave energy to impact the shoreline and which will lead to inevitable breaching of the defences.
- 3.4.2 The MAINTAIN option manages in the short term the risks by repairing the structures for a limited time until such time that they are no longer fit for purpose. Risk levels will similarly increase as under the Do-Nothing but the inevitable consequences will be the same. The only benefit provided by this option is in the delay of collapse of defence infrastructure and of erosion of the shoreline, which extends the residual life of property and infrastructure within the predicted zone of recession.
- 3.4.3 The SUSTAIN option manages the risk better by maintaining the present minimum level of defence, and upgrading the defences over time to keep the risk level constant. However there is a residual risk of erosion due to the lower standard of service provided. The deteriorating fabric of the present defences, which still form an integral part of this option, means that collapse of the defences and erosion of the shoreline will still take place but only in the longer term (50-100 years). The benefits of this option are the further delay of collapse of defence infrastructure and of erosion of the shoreline, which further extends the residual life of property and infrastructure within the predicted zone of recession. Under this option there is little residual risk to properties and the A55 would not be lost.
- 3.4.4 The provision of IMPROVED linear defences across the frontage will reduce the risk of wave and tidal waters causing disruption to traffic, property and infrastructure by providing defences that will, with appropriate maintenance and management, provide an appropriate level of service to the frontage. Over time sea level rise will nominally increase that risk but modifying the crest level of defences over time mitigates against that risk. The benefits of this option are the prevention of erosion of the shoreline and protection of those assets at risk.
- 3.4.5 The combined approach of IMPROVED linear defences and beach recharge and management will provide an equivalent level of protection to the linear defence option although it will be need to be maintained through regular beach management and topping up of levels. There may be localised (spatial and/or temporal) increased risk of flooding

damage if successive storms occur between beach management exercises e.g. over a single winter period. This risk can be mitigated against by carrying out beach management immediately following storms. As with the linear defence options, sea level rise will nominally increase the overall level of risk across the frontage but management of the beach and modifying crest levels of the linear defence sections over time mitigates against that risk. This option provides the same benefit as the linear defence only option in terms of providing protection to assets at risk. It also however provides a more flexible and innovative approach to the provision of coastal defence, whilst offering potential additional benefits and improvements in terms of amenity and regeneration.

- 3.4.6 An assessment of the likely benefit this would produce has been carried out using available visitor enjoyment data from published sources (Middlesex University, 2005). Annual values of this benefit are estimated to be of the order of £0.5 million per annum. The PV of this benefit over 100 years is estimated to be approximately £20 million.
- 3.4.7 Both the linear defence only and the combined alternatives have roughly equivalent Net Present Values (NPV) – the difference between the PV benefits of the scheme and the PV costs – of approximately £100 million

### 3.5 BENEFIT COST APPRAISAL

- 3.5.1 The results of the benefit cost appraisal exercise are shown in table 3.3 below:

**TABLE 3.3: BENEFIT COST SUMMARY**

<b>Client/Authority</b>		Prepared (date)		August 2007	
Conwy County Borough Council		Printed		31/08/2007	
<b>Project name</b>		Prepared by		CEUK	
Colwyn Bay Coastal Strategy		Checked by		AJW	
<b>Project reference</b>		Checked date		September 2007	
Base date for estimates (year 0)		Jan-2007			
Scaling factor (e.g. £m, £k, £)		£k		(used for all costs, losses and benefits)	
Principle land use band		B		(A to E)	
Initial discount rate		3.5%			
Optimism bias factor		60%			
<b>Costs and benefits of options</b>		<b>Original Assessment</b>			
<b>PV costs from estimates</b> <b>Optimism bias adjustment</b> <b>Total PV Costs for appraisal PVc</b> <b>PV damage PVd</b> <b>PV damage avoided</b> <b>PV assets Pva</b> <b>PV asset protection benefits</b> <b>Total PV benefits PVb</b> <b>Net Present Value NPV</b> <b>Average benefit/cost ratio</b> <b>Incremental benefit/cost ratio (1)</b> <b>Incremental benefit/cost ratio (2)</b>	<b>Costs and benefits £k</b>				
	No Project	Option 2	Option 3	Option 4	Option 5
	0.00	2,336.16	7,830.55	15,761.17	28,738.28
		1,401.69	4,698.33	9,456.70	17,242.97
		3,737.85	12,528.89	25,217.88	45,981.25
	126,987.69	58,416.94	9,218.61	0.85	0.85
		68,570.75	117,769.08	126,986.83	126,986.83
					20,600.19
		0.00	0.00	0.00	20,600.19
		68,570.75	117,769.08	126,986.83	147,587.02
		64,832.90	105,240.19	101,768.96	101,605.77
	18.34	9.40	5.04	3.21	
		5.60	0.73	0.99	
			0.73	0.89	
Highest b/c - - -					
<b>Original notes:</b>					
1) Incremental benefit/cost ratio (1) is relative to previous lower cost option					
2) Incremental benefit/cost ratio (2) is relative to Option 3.					
<b>Brief description of options:</b>					
Option 1	Do nothing				
Option 2	Maintain Defences				
Option 3	Sustain Defences				
Option 4	Improve Defences - Rock Revetment Only				
Option 5	Improve Defences - Combined Defence Solution				
<b>Relative Damages</b>	No Project	Option 2	Option 3	Option 4	Option 5
Promenade Disruption and Loss	21,336.97	11,030.96	3,633.44	0.85	0.85
Property	5,567.11	3,113.86	3.84	0.00	0.00
A55	32,485.06	12,346.70	0.95	0.00	0.00
Rail	67,598.55	31,925.42	5,580.39	0.00	0.00

- 3.5.2 It can be seen from the summary that each of the options has a benefit to cost ratio in excess of unity but that as expected the ratio decreases with increase in overall scheme cost.



3.5.3 The whole life PV costs of the combined approach (Option 5) represent an 80% increase compared to the linear defence only option (Option 4), however due to the additional amenity benefit provided by this option (as identified in sections 3.4.5-3.4.7 above and as PV assets in table 3.3), both the IMPROVED schemes may be considered as roughly equivalent in economic terms.

3.5.4 Option 3 is marginally the most economically attractive scheme with the highest NPV. The additional costs associated with Options 4 and 5 compared to Option 3 are roughly the same in monetary terms as the additional benefits that each option provides, however as can be seen from the Relative Damages only the Improve options safeguard local and national infrastructure in the longer term.

### **3.6 UNCERTAINTY CONSIDERATIONS**

3.6.1 Option Appraisal Uncertainties within this unit relate primarily to the following criteria:

- Relative flood damages associated with each option
- Residual Life expectancy of the existing defences
- Rate of deterioration and recession of shoreline and hence timing of losses
- Volume(s) of Beach Nourishment required and frequency of topping up losses and beach management (Improve 2)

3.6.2 The overall cost sensitivity is adequately addressed within the optimism bias allowance (Appendix III) included in the original assessment presented in section 3.5 above

3.6.3 Predominant damages in this unit result from overtopping and/or breaching of the defences causing flooding and or loss of hinterland and assets. Overtopping damages are primarily associated with road closure so can be readily identified for each option although identification of frequencies of overtopping less than one year is more subjective.

3.6.4 The existing defences are known to be at imminent risk of failure. A conservative estimate has been used in determining the damages but modifying the timescale provides an assessment of the robustness of the appraisal.

3.6.5 The timing of losses is to a significant degree subjective although a probabilistic assessment has been used to determine the PV of initial loss assuming a low probability of initial failure. Again amending the timescales provides a handle on how robust the economic case is for intervention. Modifying the timescale of the major property and infrastructure losses by  $\pm 10$  years results in approximately a 35% increase or reduction in the valuation of the damages associated with the Do-Nothing scenario.

3.6.6 The effects on the individual courses of action of amending the timescale at which losses occur provides the following:

- The benefit to cost ratios for all options remain comfortably in excess of unity, with the highest to lowest order remaining the same, only the magnitude changing
- Under the decreased residual life expectancy both Options 4 and 5 become more economically attractive compared to Option 3 and conversely under the increased residual life expectancy they become less attractive, as defined by the changes in Incremental Benefit Cost Ratio (2).
- In all cases the

3.6.7 The volumes of nourishment have been defined from examination of existing sediment sizes on the foreshore, available grading sizes available from viable sources and consideration of placed gradients for recharge schemes locally using similar material. A conservative approach has been adopted in this respect with the design of the beach profile subject to further analysis and review during subsequent detailed design and appraisal. Further detailed modelling will be carried out to determine recharge volumes, topping up rates and re-cycling arrangements.

3.6.8 Table 3.3.4 and 3.3.5 below provides summary results of the effects of decreasing and increasing the timing of losses by 10 years, respectively.



**TABLE 3.5: BENEFIT COST SUMMARY (DECREASED EROSION LOSS TIMING SENSITIVITY)**

<b>Client/Authority</b>		Prepared (date)		August 2007	
Conwy County Borough Council		Printed		31/08/2007	
<b>Project name</b>		Prepared by		CEUK	
Colwyn Bay Coastal Strategy		Checked by		AJW	
<b>Project reference</b>		Checked date		September 2007	
Base date for estimates (year 0)		Jan-2007			
Scaling factor (e.g. £m, £k, £)		£k		(used for all costs, losses and benefits)	
Principle land use band		B		(A to E)	
Initial discount rate		3.5%			
Optimism bias factor		60%			
<b>Costs and benefits of options</b>		<b>Decreased Residual Life Assessment (-10 years)</b>			
	<b>Costs and benefits £k</b>				
	No Project	Option 2	Option 3	Option 4	Option 5
	0.00	2,336.16	7,830.55	15,761.17	28,738.28
		1,401.69	4,698.33	9,456.70	17,242.97
		3,737.85	12,528.89	25,217.88	45,981.25
	171,838.13	81,539.01	15,609.93	0.85	0.85
		90,299.12	156,228.20	171,837.28	171,837.28
					20,600.19
		0.00	0.00	0.00	20,600.19
		90,299.12	156,228.20	171,837.28	192,437.47
		86,561.27	143,699.31	146,619.40	146,456.22
		24.16	12.47	6.81	4.19
		7.50	1.23	0.99	
			1.23	1.08	
Highest b/c - - -					
<b>Original notes:</b>					
1) Incremental benefit/cost ratio (1) is relative to previous lower cost option					
2) Incremental benefit/cost ratio (2) is relative to Option 3.					
<b>Relative Damages</b>	No Project	Option 2	Option 3	Option 4	Option 5
Promenade Disruption and Loss	21,336.97	11,030.96	3,633.44	0.85	0.85
Property	7,451.40	3,113.86	3.84	0.00	0.00
A55	47,958.41	20,712.07	0.95	0.00	0.00
Rail	95,091.34	46,682.12	11,971.71	0.00	0.00

**TABLE 3.6: BENEFIT COST SUMMARY (INCREASED EROSION LOSS TIMING SENSITIVITY)**

Client/Authority		Prepared (date)		August 2007		
Conwy County Borough Council		Printed		31/08/2007		
Project name		Prepared by		CEUK		
Colwyn Bay Coastal Strategy		Checked by		AJW		
Project reference		Checked date		September 2007		
Base date for estimates (year 0)		Jan-2007				
Scaling factor (e.g. £m, £k, £)		£k		(used for all costs, losses and benefits)		
Principle land use band		B		(A to E)		
Initial discount rate		3.5%				
Optimism bias factor		60%				
Costs and benefits of options		Increased Residual Life Assessment (+10 years)				
	Costs and benefits £k					
	No Project	Option 2	Option 3	Option 4	Option 5	
	PV costs from estimates	0.00	2,336.16	7,830.55	15,761.17	28,738.28
	Optimism bias adjustment		1,401.69	4,698.33	9,456.70	17,242.97
	Total PV Costs for appraisal PVc		3,737.85	12,528.89	25,217.88	45,981.25
	PV damage PVd	93,622.64	16,248.89	4,225.72	0.85	0.85
	PV damage avoided		77,373.76	89,396.92	93,621.79	93,621.79
	PV assets Pva					20,600.19
	PV asset protection benefits		0.00	0.00	0.00	20,600.19
	Total PV benefits PVb		77,373.76	89,396.92	93,621.79	114,221.98
Net Present Value NPV		73,635.91	76,868.03	68,403.91	68,240.73	
Average benefit/cost ratio		20.70	7.14	3.71	2.48	
Incremental benefit/cost ratio (1)			1.37	0.33	0.99	
Incremental benefit/cost ratio (2)				0.33	0.74	
Highest b/c - - -						
Original notes:						
1) Incremental benefit/cost ratio (1) is relative to previous lower cost option						
2) Incremental benefit/cost ratio (2) is relative to Option 3.						
Relative Damages	No Project	Option 2	Option 3	Option 4	Option 5	
Promenade Disruption and Loss	21,336.97	11,030.96	3,633.44	0.85	0.85	
Property	4,161.20	3,113.86	3.84	0.00	0.00	
A55	20,970.48	768.28	0.95	0.00	0.00	
Rail	47,153.99	1,335.78	587.50	0.00	0.00	

### 3.7 CHOICE OF SCHEME

- 3.7.1 The economic assessment carried out shows that there is a case for providing improved coastal defence to Colwyn Bay.
- 3.7.2 Using a probabilistic examination of the likely timescales of defence failure and hence land, property and infrastructure loss, the sensitivity of scheme choice to different timescales has been examined.
- 3.7.3 Whilst the timing of recession losses affects the overall value of assets at risk and hence the overall benefit to cost ratios of the different courses of action, it does not suggest that any of the cases do not represent value for money with the case for increased investment (Options 3,4 and 5) above the current regime of maintenance (Option 2), clearly established.
- 3.7.4 Overall the choice of scheme lies between sustaining the present level of defences with some minor amendments initially in the future to maintain the level of risk at its present level (Option 3) or providing improvements to the defences to provide an improved standard of service in the first instance and with appropriate management and maintenance' maintaining this improvement in the future.
- 3.7.5 Under the SUSTAIN option promenade road closures as a result of overtopping will continue to be necessary in the future and in the longer term the defences would become unsustainable due to deterioration in the material fabric of the present defences, which form an integral part of this option. The consequences of this are that ultimately the shoreline will have to recess and under this scenario local road and national rail transport routes would be disrupted/lost.
- 3.7.6 Under the IMPROVE options the fabric of the existing structures will be incorporated within the future defences with the new elements providing significant protection to the existing elements thereby extending their residual life as long as both the existing and new elements are adequately maintained. Under these options the risk of breaching of the defences is mitigated against and the assets identified at risk are protected.
- 3.7.7 In consideration of the relative merits of the IMPROVE options there are a number of key differences, which are summarised below:
- The linear defence only option provides for greater overall security with lesser future costs by virtue of its fixed nature, however it is unlikely to provide any significant amenity benefit to the frontage as beach levels will remain as they are with the potential for reduction in the future. Movement of the beach directly in front of the defences should be reduced by the improved beach/structure interface reducing scour. The linear defence option may also be considered as providing more of a barrier between the promenade and the beach, notwithstanding that stepped and slipway accesses can be incorporated within the defences.
  - There is a greater degree of inherent risk in the combined approach, specifically in sections of the frontage where the defence is reliant on improved beach levels to provide improved protection. Appropriate beach management action plans are necessary to reinstate levels and maintain protection. Conversely the use of such approach has the potential for significantly improved amenity benefits that, with appropriate funding, form an integral part of meeting the overall regeneration objectives for Colwyn Bay.
- 3.7.8 In consideration of the overall conclusions from the assessment and associated sensitivities carried out, the choice of scheme rests between the following:
- Maintaining the status quo until such time that this becomes unsustainable and in the meantime seeing the continued degeneration of the Colwyn Bay frontage
  - Providing a defence strategy that is functional in providing coastal defence but provides little stimulus to regeneration of Colwyn Bay
  - Adopting an innovative but flexible approach to the provision of coastal defence, whilst offering potential additional benefits and improvements in terms of amenity and regeneration.
- 3.7.9 In conclusion either of the above approaches may be considered as economically viable, however the Local Authority is committed to its goal of regenerating Colwyn Bay as a resort for the 21<sup>st</sup> Century and not to let it continue to decline, as it has during the latter part of the 20<sup>th</sup> century. With appropriate investment and enlightened leadership this goal can be achieved, however it needs investment in coastal defences that accord with these aspirations.
- 3.7.10 The preferred future coastal defence management approach for Colwyn Bay is, subject to availability of funding, the combined approach of improved linear defences, promenade changes and beach recharge, that not only provides an improvement in the standard of coastal defence but provides opportunities to improve amenity and leisure interests across the frontage and in combination with other proposals aid regeneration of the town.

## **4 DESCRIPTION OF PROPOSED SCHEME**

### **4.1 SCHEME DESCRIPTION**

4.1.1 The proposed scheme comprises initially the following key elements:

- Eastern Section between Eirias Park and Old Colwyn: Construction of a new rock armour revetment, promenade and crest wall
- Central and Western Sections between Rhos Jetty and Eirias Park: Recharging of the beach with sand and improvements to the promenade and crest of existing defences
- Central Section between Penrhos College site (Toad Hall) and Eirias Park: Provision of beach control structures (breakwaters, groynes etc) on the foreshore

4.1.2 The improvements will provide an increase in the crest level of defences to a minimum of at least 6.5m AOD. Gradients of structures will be designed to a gradient compatible with hydraulic and structural criteria requirements, with the aim of minimising the footprint of the structures on the beach.

4.1.3 The scheme also includes for improvement and dissipation of surface water run-off within the defences and access arrangements between the promenade and the beach.

4.1.4 The different arrangements applying to the lengths of frontage identified are shown in figure 4.1

4.1.5 A preliminary layout plan of arrangements in the central section, to be confirmed by detailed design and modelling, is provided in figure 4.2.

4.1.6 Future management and maintenance actions associated with the scheme will include:

- Maintenance and repair of rock structures
- Maintenance and repair of promenade and crest works
- Beach management – movement of material on the beach
- Clearance of wind blown sand from promenades
- Topping up of beach levels as necessary
- Reworking of rock structures to maintain standard of service in line with sea level rise

### **4.2 DEFENCE STANDARDS & CRITERIA**

4.2.1 The indicative standard of protection for the Colwyn Bay frontage is 1 in 100-300 years (Land Use Band A), or an annual probability of exceedance of 0.33-1% (MAFF, 2000).

4.2.2 With appropriate maintenance and management the proposed works will provide an estimated design life of 40-70 years and potentially more, with material able to be re-used in any re-working to upgrade defence levels in the future.

4.2.3 For the proposed works at Colwyn Bay the appropriate criteria for performance evaluation are threefold:

- Structural safety relating to the revetment structure and the potential damage and risk to structure stability caused by overtopping waters.
- Safety of pedestrians
- Safety of vehicles

4.2.4 Appropriate limiting mean overtopping discharges for these criteria are provided in table 4.1 below. This shows a significant range of allowable overtopping in relation to the risks applying across the frontage.

4.2.5 Further detailed design and modelling will be carried out to establish appropriate crest levels to minimise the overtopping risks and provide an appropriate level of protection.

**TABLE 4.1: SUGGESTED ALLOWABLE MEAN OVERTOPPING LIMITS FOR PERFORMANCE CRITERIA AT COLWYN BAY (EurOtop, 2007)**

Hazard type and reason	Mean discharge $q$ (l/s/m)
<b>Structure Damage</b>	
Damage to paved or armoured promenade behind seawall	200
<b>Overtopping limits for Pedestrians</b>	
Trained staff, well shod and protected, expecting to get wet, overtopping flows at lower levels only, no falling jet, low danger of fall from walkway	1-10
Aware pedestrian, clear view of the sea, not easily upset or frightened, able to tolerate getting wet, wider walkway	0.1
<b>Overtopping limits for Vehicles</b>	
Driving at low speed, overtopping by pulsating flows at low flow depths, no falling jets, vehicle not immersed	10-50
Driving at moderate or high speed, impulsive overtopping giving falling or high velocity jets	0.01-0.05

### 4.3 MATERIALS TO BE USED

- 4.3.1 The primary materials to be used in the works comprise works will require the importation and placing of the following materials:
- Graded primary rock armour and secondary underlayers. Typically primary rock armour will have a mean mass of between 2 and 4 tonnes.
  - In-situ and precast concrete designed to BS8500.
  - Geotextile membranes.
  - Sand beach recharge.
- 4.3.2 Suitable rocks from the existing boulders presently utilised on site, that are located within the footprint of the proposed structure and which meet the required grading requirements, will be selected for re-use in the new structure.
- 4.3.3 Imported graded rocks will be supplied from approved local quarry sources with material matching the indigenous material available and the surrounding landscape of rock outcrops in the area e.g. Little Orme, Tan Penmaen Head.
- 4.3.4 The geotextile will be obtained from approved suppliers whose materials have a proven track record of use in coastal defence works and which match the required permeability and strength requirements for use in the structure.
- 4.3.5 Beach recharge material will either be obtained from existing licensed offshore dredging sites in Liverpool Bay or, if available and suitable, from maintenance dredging exercises such as that which takes place at Mostyn Docks in the River Dee.

### 4.4 OUTLINE METHOD OF CONSTRUCTION

- 4.4.1 Construction of the works will be carried out in accordance with the following broad requirements.
- 4.4.2 The Contractor will be allowed the use of an area of hardstanding on the existing promenade as a compound area and for the storage of plant and materials.
- 4.4.3 Access will be required along the promenade to carry out crest works and appropriate fencing and signing will be erected to demarcate this area. Temporary diversion routes and/or closures of the promenade and public highway in places are likely to be required during the construction period.
- 4.4.4 Access to the foreshore will be gained using existing slipways. Across the foreshore the Contractor will be allowed to gain access within the footprint of the new works plus a working corridor outside the limits, generally not exceeding 5 metres in width but incorporating areas for vehicle turning.

- 4.4.5 Improvements to drainage arrangements to the cliff face will be carried concurrently with revetment construction.
- 4.4.6 The primary linear revetment facing works will generally commence from one end and proceed in a single working face to completion. Crest and promenade works are likely to be carried out following completion of the facing works in any area. Drainage works and accommodation works on the promenade will be carried out concurrently with crest works
- 4.4.7 Beach control structures will be constructed during suitable low water periods generally working from landward to seaward with bulk fill and rock underlayers and shoreward with the primary rock facing and crest works.
- 4.4.8 Beach recharge will only be carried out following completion of control structures. Material will be generally pumped ashore from the dredgers and placed to its final location by land based dozers and excavators.

#### **4.5 ENVIRONMENTAL IMPACT OF SCHEME**

- 4.5.1 The proposed linear revetment cross section will have a construction width of between 15 and 30 metres covering approximately 1.5-3 ha of foreshore.
- 4.5.2 Beach control structures will cover of the order 5-10,000 m<sup>2</sup> of foreshore per structure
- 4.5.3 Beach recharge will increase foreshore levels over approximately 15-20 ha of existing beach
- 4.5.4 The type of imported rock to be used within the works will be carefully chosen to blend in with the existing surrounding landscape.
- 4.5.5 Linear defence improvements will move the high water mark to seaward but would provide for improved shoreline/defence interaction mitigating against beach lowering and fluctuations in beach levels along the toe. Generally the existing longshore sediment movement regime would be maintained.
- 4.5.6 Beach recharge would provide more material for potential movement but increased elevations would reduce impacts with existing defences e.g. wave reflections. Control structures will modify wave, tide and sediment patterns but longshore drift offshore of groynes will persist. Losses of material at eastern end will continue to provide feed to down drift areas albeit at a reduced rate.
- 4.5.7 Wind blown sand is an inevitable consequence of providing elevated beach levels with dry sand from the crest of the beach being transported landward by aeolian forces. Material will settle out on hard defences and the promenade requiring regular clearance.
- 4.5.8 New linear defences would cause a loss of habitat due to coverage of foreshore, however this impact would be ameliorated by subsequent colonisation by marine algae and encrusting species. Subsequent habitat could be altered in places from a predominantly soft-substratum environment to one dominated by hard-substratum favouring species. In places these structures would also attract fish for feeding opportunities during high water periods.
- 4.5.9 Recharge the beach will smother existing benthic and intertidal infauna and may also cause elevated suspended sediments impacting upon water quality and subsequently benthic and fish species. Additional impacts to coastal bird species may occur due to smothering of infaunal prey items. Control structures would remove habitat previously available for benthic and fish species foraging, spawning and nursery areas. Such structures may have the benefit of providing additional complex "reef" like habitat which would provide increased habitat availability for commercial species such as crabs and lobster. Such structures may also act to aggregate fish species utilising it for food, shelter from currents and predators
- 4.5.10 Built environment impacts of linear defences are considered to be positive regarding the protection of the existing land infrastructure; however changes in elevation of the promenade may have a negative impact on the panorama of the seascape from the road and foreshore.
- 4.5.11 Greater visual impacts would be incurred from control structures with connected groynes impacting the beach panorama or offshore breakwaters affecting the seaward views. The artificial beach recharge would also cause a visual impact, due to the elevation of levels. However, as this is seen as enhancement of a natural habitat and because the levels would not be above the current sea defences this visual impact is considered to be low.
- 4.5.12 Transporting of materials to the site will have an environmental impact from the numbers of lorries using the road network. Locally the impact will be relatively low with direct access from the A55 (junction 24) to the promenade

effected with the minimum of disruption to the surrounding area i.e. avoiding travel through the town centre and/or residential areas

#### **4.6 TIMING/PHASING OF WORKS**

- 4.6.1 The proposed works will take an estimated 18-24 months to complete if carried out within a single working timeframe, or longer if the scheme is split into a number of smaller work packages.
- 4.6.2 The scheme potentially lends itself to being split into a number of work packages in accordance with temporal, spatial or funding constraints and specific construction requirements, although this has the potential to increase overall costs with higher contract administration costs and multiple mobilisation and de-mobilisation costs.
- 4.6.3 The principal constraints on the timing of the works, relate to working through the summer months and its potential affect on the holiday trade. An embargo on summer working in some areas may be considered.
- 4.6.4 Alternatively to avoid disruption along the whole of the frontage at once the scheme could be split into three geographic phase and one construction related phase as below:
- Eirias Park to Old Colwyn Linear Defences and Promenade Works
  - Toad Hall to Eirias Park Beach Control Structures and Promenade Works
  - Rhos Jetty to Toad Hall Promenade and Sea Wall Works
  - Beach Recharge
- 4.6.5 The favoured approach would be to let the works as a single contract incorporating requiring completions of works in specific areas before commencement on others, timing constraints relating to specific activities or areas etc.
- 4.6.6 To mitigate against the risk of further damage to existing defences the works would most appropriately be carried out working from east to west across the frontage.

#### **4.7 FUTURE MONITORING & MANAGEMENT**

- 4.7.1 The proposed linear defences and beach control structures will be designed to be hydraulically and structurally stable for the design conditions identified.
- 4.7.2 Maintenance of rock structures will be generally carried out in accordance with maintenance schedules developed as part of CDM scheme requirements. Typically a maximum frequency of once every five years will be required, or less if there is damage arising from severe storms, which might dislodge or move boulders within the face. Maintenance will require mobilisation of heavy excavators with grab attachments to move and replace affected rocks.
- 4.7.3 The recharged beach between Rhos Jetty and Eirias Park will be subject to movement due to the action of the wind, waves and tide with the following maintenance and management requirements:
- Beach Management - Artificial movement of the beach to maintain beach design profiles.
  - Future Recharge - Topping up of beach levels with additional material to mitigate against beach losses and sea level rise.
  - Wind Blown Sand recycling – Movement of sand from the sea wall structures and promenade back onto the beach
- 4.7.4 The likely frequency for beach management is 1-2x per year.
- 4.7.5 Future recharge requirements will be determined from further detailed technical evaluation and modelling but is likely to be required on typically a 10-20 year frequency.
- 4.7.6 Regular clearance of wind blown sand will be required throughout the year, although detailed scheme design will include examination of measures for controlling and reducing the impact of wind blown sand.
- 4.7.7 The Council presently operates a policy of monitoring and beach management at other locations along its frontage and is currently preparing a beach management plan. The Colwyn Bay frontage will be incorporated into the Authority wide beach management plan. Initial requirements will be derived from the detailed modelling work to be carried out as part of



the detailed design of the scheme with modifications, as necessary, informed by analysis of post construction performance monitoring.

- 4.7.8 Crest and promenade structures will be maintained in accordance with maintenance schedules developed as part of CDM scheme requirements.

#### **4.8 EFFECTS OF PROPOSALS ON COASTAL CELL**

- 4.8.1 The frontage between the Little Orme and Tan Penmaen Head is controlled by the natural rock outcrops, the intermediate hard point at Rhos and the shoreline orientation defined by the location of the artificial defence structures that have been built along the shoreline. Littoral drift of material occurs in a net easterly direction across the frontage.
- 4.8.2 The proposed works will stabilise upper beach behaviour across the section where the cross shore structures are to be constructed although longshore drift will continue to seaward and there will be a need for some recharge on the immediate downdrift side of the most easterly control structure, where the beach is in shadow.
- 4.8.3 Overall though lower beach drift to the east will be maintained once the frontage moves away from the influence of this last structure, with no changes to behaviour expected along the adjacent Network Rail and WAG Highways frontage
- 4.8.4 Drift impacts will therefore be local to Colwyn Bay with the works having no effect on areas outside the frontage between Rhos and Tan Penmaen Head.
- 4.8.5 The works will have no impact on general behaviour within the wider sediment cell (Great Orme to Ribble).



## **5 CONCLUSIONS & RECOMMENDATIONS**

### **5.1 CONCLUSIONS**

- 5.1.1 Detailed examination of the technical, environmental and economic factors associated with the provision of improved coastal defence measures at Colwyn Bay and the risk to people, property and infrastructure located to landward of the shoreline has been carried out based on the results of previous strategic assessments, detailed investigations and analysis of available monitoring data.
- 5.1.2 Economic analysis of the likely damages that would accrue as a result has been determined in accordance with current guidance and a preferred approach has been identified.
- 5.1.3 The assessment has confirmed that there is justification for the provision of a scheme of coast protection improvements to be carried out that:
- Provides an improved standard of coastal defence commensurate with the value of assets at risk
  - Is overall environmentally neutral in its affects on habitats
  - Is not considered to be unacceptably visually intrusive.
  - In association with wider plans for regeneration of Colwyn Bay provides opportunities to improve amenity and leisure interests across the frontage that will assist in meeting objectives to provide real improvements to the town and to the lives of the people who inhabit and visit it.
- 5.1.4 The preferred scheme comprises:
- Construction of a new rock armour revetment, promenade and crest wall between Eirias Park and Old Colwyn at the eastern end of the frontage
  - Recharging of the beach with sand and improvements to the promenade and crest of existing defences between Rhos Jetty and Eirias Park
  - Provision of beach control structures (breakwaters, groynes etc) on the foreshore between Penrhos College site (toad Hall) and Eirias Park
  - Future beach management and maintenance of structures in accordance with management and maintenance schedules
  - Future re-working and upgrading of existing structures from time to time to accommodate increasing exposure conditions e.g. sea level rise

### **5.2 RECOMMENDATIONS**

- 5.2.1 That this report be accepted in support of applications for EU convergence funding and for grant aid assistance from the Welsh Assembly Government, under the Coast Protection Act, 1949.

## 6 **REFERENCES**

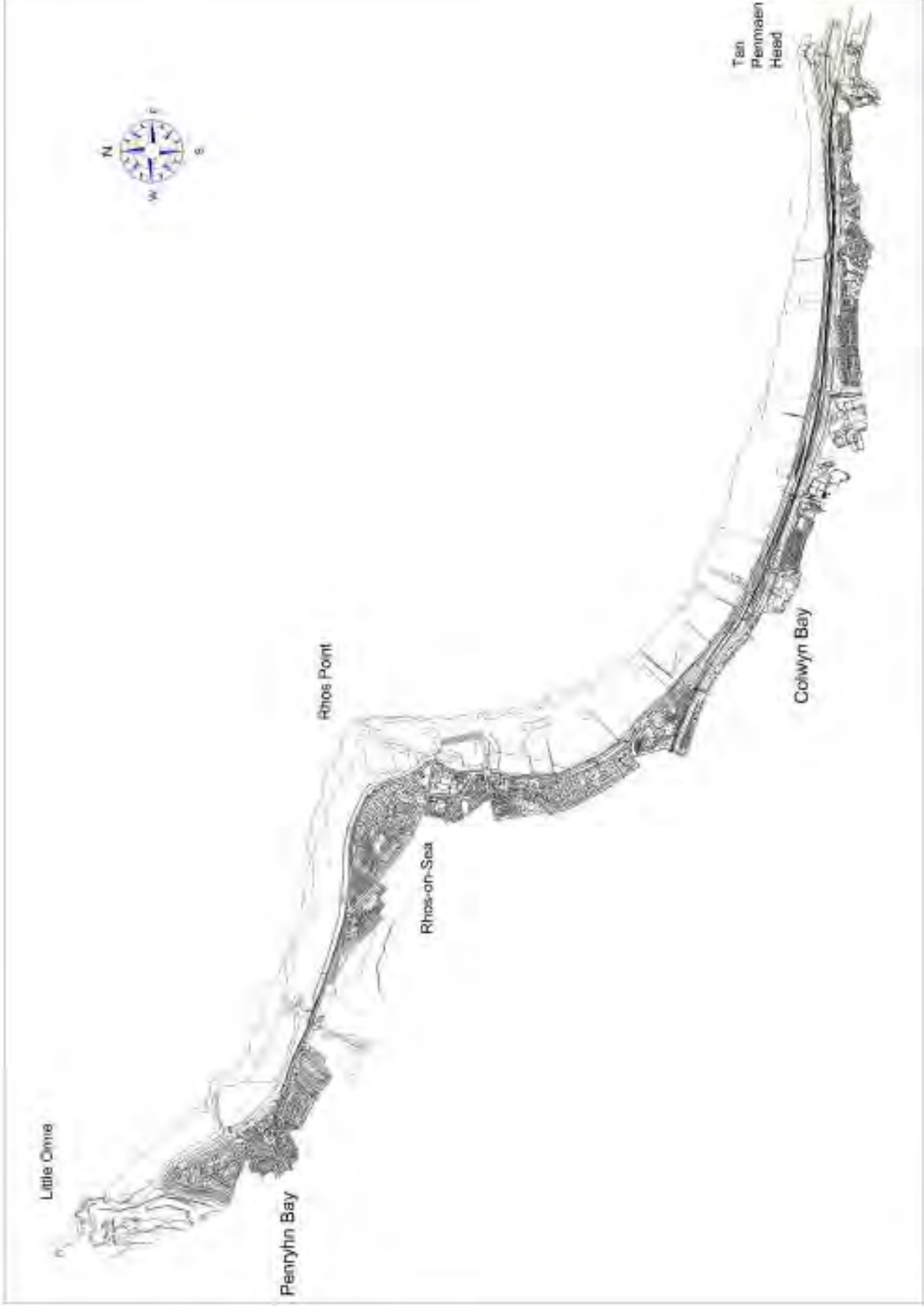
- **CMACS Ltd, October 2007.** Colwyn Bay Strategy Plan – Strategic Environmental Assessment.
- **Coastal Engineering UK Ltd, October 2007.** Colwyn Bay Coastal Defence Strategy Plan – Stage 2: Strategic Assessment and Proposals
- **Conwy County Borough Council, February 2007.** Colwyn Bay Coastal Strategy – Stage 1 Consultation Report
- **DEFRA, March 2003.** Flood and Coastal Defence Project Appraisal Guidance, FCDPAG3 Economic Appraisal – Supplementary Note to Operating Authorities March 2003
- **DEFRA, October 2006.** Flood and Coastal Defence Project Appraisal Guidance, FCDPAG3 Economic Appraisal – Supplementary Note to Operating Authorities - Climate Change Impacts.
- **EA/ENW/KRKL, August 2007.** EurOtop - Wave Overtopping of Sea Defences and Related Structures: Assessment Manual.
- **HR Wallingford, May 2004.** Conwy Tidal Flood Risk Assessment - Stage 1 Report. Report EX 4667
- **Ministry of Agriculture, Fisheries & Food, 2000.** Flood and Coastal Defence Project Appraisal Guidance – Economic Appraisal (FCDPAG3).
- **Shoreline Management Partnership, 1999.** Shoreline Management Plan – Sub Cell 11a: Great Ormes Head to Formby Point.
- **Survey Operations Ltd, October 97 – July 2007.** Little Orme to Colwyn Bay – Bi-annual Topographic Beach Surveys

## **FIGURES**



**Figure 1.1 – General Location Plan**

(Reproduced from OS 1:25,000 Explorer Series Plan – Sheet 17, Snowdonia ©Crown Copyright)



**Figure 1.2 – Colwyn Bay Strategy Area Plan**





Figure 2.1 – Predicted Do-Nothing Recession Limits



**Figure 3.1 – SUSTAIN (Rock Toe) Option (as existing in places)**





**Figure 3.2 – IMPROVE (Linear Rock Armour Revetment) Option (Artists Impression)**



**Figure 3.3 – IMPROVE (Beach Recharge) Option (Artists Impression)**

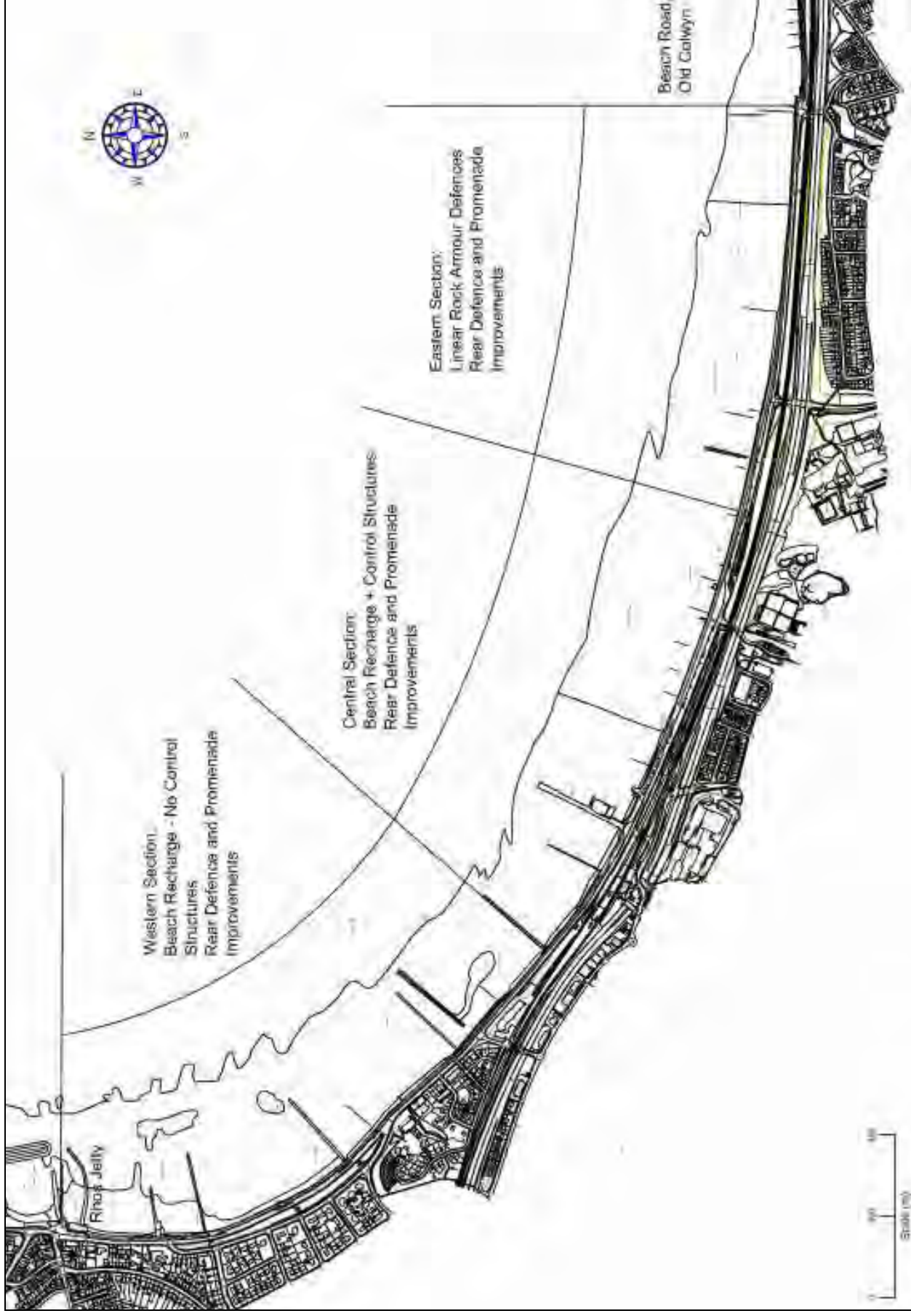


Figure 4.1 – Plan of Preferred Arrangements





**Figure 4.2 – Central Section: Preliminary Plan and Control Structure Cross Section**

**APPENDICES**

## APPENDIX I – SUMMARY OF PUBLIC CONSULTATION

### Consultation Responses

There was a positive reaction to development of the strategy and the opportunity to comment on the preliminary proposals. Individuals and bodies who responded had widely differing views on the various options, but most were supportive of improving the coastal defences. The level of understanding of and interest in coastal defence issues was very high, confirming the value of the results. A total of 248 completed feedback questionnaires were received by the closing date of January 31<sup>st</sup> 2007.

In order to gauge the interests and biases of respondents, a section of the questionnaire asked “*which of the following do you use the coast for?*” More than one box could be ticked. This question was designed to avoid weighting of the results by one particular interest group. No suspicious skews were identified in the data, and the results were considered to give a representative sample of user interests.

During Stage 1 of Strategy development and prior to the public consultation, steering group representatives from Regeneration, Leisure and the Harbourmaster’s office had expressed particular support for defence measures that enhanced amenity arrangements in Colwyn Bay.

The following is a summary of the results obtained from the public consultation exercise:

#### SU 2/2/2 - Cayley Promenade

A clear majority (43%) favoured Beach Recharge, with significant support also for the Concrete Step Revetment (31%). This indicates that respondents see this area as an amenity beach, selecting options that improve beach levels and increase beach access. Support for the Concrete Step Revetment may also reflect concerns with the existing promenade width and associated parking and pedestrian/cyclist conflict issues. This zone was removed from the Waterfront Strategy due to public and political pressure. Therefore there is no mandate for landside development or promenade improvements and no clear strategic reason for a particular defence option. Results for this zone are thus particularly important. The Rock Revetment (14%) and Rock Toe (8%) options received little support.

#### SU 2/3/1 (West) - Beach Zone

A clear majority (55%) favoured Beach Recharge, with support also for the Concrete Step Revetment (25%). Respondents supported the principle that an enhanced beach with improved access was necessary for the Beach Zone, which was identified by the Waterfront Strategy as the focus of traditional (bucket and spade) amenity use. The Rock Revetment (12%) and Rock Toe (4%) options received very little support.

#### SU 2/3/1 (East) - Watersports Zone

The Watersports Zone, from the Pier east to Eirias Park was identified by the Waterfront Strategy as an area for the use of Powered Water Craft (PWC’s) in particular. A new slipway was constructed at the Dingle in 2006 with European Funding as part of this initiative. Assessment of public consultation results for this zone should take into account that PWC’s are not popular with all sections of the Public but that the promotion of this sport is an important part of the area’s Tourism Strategy. More weight should maybe be given to the technical requirements of PWC users and responses from relevant user groups. The public consultation favoured Beach Recharge (39%) with support also for the Concrete Step Revetment (22%).

#### SU 2/3/2 - Old Colwyn

The results for Old Colwyn reflect the different amenity use of the beach in this area and also the problems with the existing promenade and coastal highway. Beach Recharge was still supported (28%) as was Concrete Step Revetment (20%), but the most popular option was the Rock Revetment (29%), an option not favoured for other zones. There may be several reasons for this:

- Amenity use is more dog walking, fishing and cycling, less bucket-and-spade.
- The existing promenade width is inadequate for all current uses. The rock revetment option provides opportunities for increasing the width.
- The coastal highway is frequently closed due to overtopping. Perception may be that this is the most vulnerable area and requires the most robust defence.
- An appreciation that less expensive solutions may be more appropriate for this section of frontage. Of course, it may be that users/residents of the Beach and Cayley Zones voted for a cheaper option for ‘the other end’, in the hope that it would allow higher expenditure on other sections.

In addition to the scored results, respondents were also invited to give specific comments. Most comments simply explained and gave background to the choice of option. However a significant number raised new issues and opportunities, which are summarised below:

1. Offshore Breakwaters were suggested frequently as an option in the responses, and were also the subject of questions from the public to officers at the Public Exhibition. Shore-connected breakwaters were presented as the favoured control structure for the Beach Recharge option due to their lower cost. Given the interest in offshore structures, their design has been included in the Stage 2 modelling brief such that more accurate costs can be calculated.
2. Inadequate width of the promenade at Rhos and lack of parking. A more detailed consultation for the Rhos Breakwater Zone would have given more responses of this type. The promenade width here is a known issue, with an opportunity for improvement if the secondary sea wall is re-built.
3. A Marina at the Old Colwyn end. There is a history of aspiration for this. It has been discussed at Steering Group – there appears to be little political or strategic support for it.
4. Creation of marine habitats within revetments.
5. Visual impact of rock or concrete revetments and effect on visitor numbers.
6. Improved disabled access to beach required.
7. Beach Recharge and Concrete Steps together should be used. There were also questions about this at the Exhibition, where the Public was informed that this would not be cost effective.
8. Upgraded and maintained timber groynes are all that is required.
9. Swimming not included or considered as a user activity. Blue Flag status very important to promote tourism.
10. Width of promenade generally inadequate – parking/cyclist/pedestrian conflict a problem.
11. Importance of sea view from parking spaces - a unique feature of Colwyn Bay.
12. Walkways on breakwaters.



## APPENDIX II- PHOTOGRAPHIC PLATES



**Plate 1**



**Plate 2**



**Plate 3**



**Plate 4**





**Plate 5**



**Plate 6**



**Plate 7**



**Plate 8**





**Plate 9**



**Plate 10**



**Plate 11**



**Plate 12**

**APPENDIX III – OPTIMISM BIAS DERIVATION**

<b>Optimism Bias data for flood and coastal defence strategy and scheme costs</b>			
<b>Risk components contributing to optimism bias</b>			
		Average % for FCD Projects	Proposed Project
Procurement	Late contractor involvement in design	1	1
	Dispute and claims occurred	11	11
	Other	1	1
Project Specific	Design Complexity	4	4
	Degree of innovation	4	4
	Environmental Impact	13	13
	Other	9	9
Client Specific	Inadequacy of the business case	23	23
	Funding availability	2	2
	Project Management Team	1	1
	Poor project intelligence	8	8
Environment	Public relations	5	5
	Site characteristics	4	4
External Influences	Economic	5	5
	Legislation/regulations	4	4
	Technology	4	4
	Other	1	1
		100	100
	<b>Proposed Coastal Defence Project</b>		<b>60%</b>



## Appendix C. Contingent Valuation Questionnaire

## **Colwyn Bay Waterfront Project – Water-Sports Zone**

### **Questionnaire.**

We want to hear your opinions about the future of Colwyn Bay Waterfront and would be grateful if you could spend a few minutes of your time answering a few questions:

- 1. Are you aware of the plans to regenerate Colwyn Bay's promenade?**

Yes ☐

No ☐

- 2. Do you agree that the Colwyn Bay prom area is currently in poor condition and improving the look will the benefit of the town and residents?**

Yes ☐

No ☐

- 3. If yes, please specify which areas you think need particular improvements?**

---

---

---

- 4. Do you feel that access to the prom from the town centre needs improving?**

Yes ☐

No ☐

Don't know ☐

- 5. Which area(s) would you use on the new prom?**

Water-sports Zone ☐

Family Zone ☐

Nature Zone ☐

**6. There are plans to build a water-sports centre in the 'water-sports area'. What would you like to see in this building?**

- |   |                          |
|---|--------------------------|
| Café/refreshments Kiosk                     | <input type="checkbox"/> |
| Indoor rock climbing                        | <input type="checkbox"/> |
| Cycle hire facilities                       | <input type="checkbox"/> |
| Classrooms/training room                    | <input type="checkbox"/> |
| Retail outlet – water-sports clothing/gifts | <input type="checkbox"/> |
| Showers/changing facilities                 | <input type="checkbox"/> |
| Toilets                                     | <input type="checkbox"/> |
| Other                                       | <input type="checkbox"/> |

**7. If other, please state below.**

---

---

**8. What other facilities would you like to see in the water-sports hotspot area?**

- |   |                          |
|---|--------------------------|
| Slipways                                | <input type="checkbox"/> |
| Cast-off Dock/Slipway                   | <input type="checkbox"/> |
| Outdoor Sports Facilities               | <input type="checkbox"/> |
| Seating/viewing platform to view sports | <input type="checkbox"/> |
| Outdoor gym                             | <input type="checkbox"/> |
| Water feature/Interactive fountain      | <input type="checkbox"/> |
| Water spray play area                   | <input type="checkbox"/> |
| Children's play area                    | <input type="checkbox"/> |
| Seating                                 | <input type="checkbox"/> |
| Other                                   | <input type="checkbox"/> |

**9. If other, please state below.**

---

---

**10. How would you like the new water-sports centre to look?**

- |  |                          |
|--|--------------------------|
| Modern Stand-out Design                            | <input type="checkbox"/> |
| Traditional Design                                 | <input type="checkbox"/> |
| No opinion as long as the building is eco friendly | <input type="checkbox"/> |
| No opinion as long as the building is functional   | <input type="checkbox"/> |

**11. What would make you want to use the prom more often?**

Easier access

☐

Events area

☐

More seating

☐

Cycle hire facilities

☐

Better water-sports facilities

☐

Children's activities

☐

Nicer surroundings

☐

Heritage Trails/walks

☐

Interactive Art – e.g. interactive fountain

☐

Other

☐

**12. If other, please state below.**

---

---

**13. Do you think there should be dedicated car parking spaces suitable for water-sports users?**

Yes ☐

No ☐

**14. Any other comments about the new Water-sports area?**

---

---

---

---

**15. How important do you think it is to have a clean, healthy sand beach in Colwyn Bay?**

Very Important ☐

Quite Important ☐

Not Important ☐

No Opinion ☐

**16. How important do you think it is for there to be easy access from the promenade to the beach?**

- |                 |                          |
|-----------------|--------------------------|
| Very Important  | <input type="checkbox"/> |
| Quite Important | <input type="checkbox"/> |
| Not Important   | <input type="checkbox"/> |
| No Opinion      | <input type="checkbox"/> |

**17. We are trying to find out how much value you, as an individual, put on your enjoyment of this visit to this seafront today, in £ and pence.**

Think of a visit or activity you have done in the past which gave you the same amount of enjoyment as your visit to this seafront today. Now, try to estimate how much that visit (or other activities) cost you. Remember that the cost of a visit may include petrol and parking costs or bus or train fares as well as admission charges and any other costs. You can use the costs of that visit (or other activities) as a guide to the value of your enjoyment of today's visit to this seafront.

**A) CURRENT SEAFRONT**

What value do you put on your individual enjoyment of this visit to this seafront?

Value of today's visit     £.....:.....pence

Cannot value these things in money terms     ☐

Don't know     ☐

I am now going to describe to you various options being considered for this seafront and ask you to value your likely individual enjoyment of them.

**B) ERODED/DETERIORATED SEAFRONT**

If the seafront changed to look like this would you get more, less or the same amount of enjoyment from a visit compared to your enjoyment of today's visit?

- |                              |                          |
|------------------------------|--------------------------|
| Much less enjoyment          | <input type="checkbox"/> |
| The same amount of enjoyment | <input type="checkbox"/> |
| Much more enjoyment          | <input type="checkbox"/> |
| DON'T KNOW                   | <input type="checkbox"/> |

IF DON'T KNOW, GO TO (C)

So, how much enjoyment would you get from your visit to the seafront in the image in terms of pounds and pence?

Value of today's visit     £.....:.....pence

Cannot value these things in money terms     ☐

Don't know     ☐

The exact form of the proposed works to protect the seafront has not yet been finally determined. This decision will be taken after further investigation and consultation.

### C) OPTION 1 (REVETMENT OPTION)

At present one scheme being considered will involve construction of a rock revetment along the full length of the beach to protect the promenade:

If you were making a visit (similar to today's visit) to the seafront in this image, would you get more, less or the same amount of enjoyment from a visit compared to your enjoyment of today's visit?

Much less enjoyment     ☐

The same amount of enjoyment     ☐

Much more enjoyment     ☐

DON'T KNOW     ☐

IF DON'T KNOW, GO TO (C)

So, how much enjoyment would you get from your visit to the seafront in the image in terms of pounds and pence?

Value of today's visit     £.....:.....pence

Cannot value these things in money terms     ☐

Don't know     ☐

### C) OPTION 2 (BEACH RECHARGE OPTION)

At present one scheme being considered will involve covering the current beach with a raised layer of sand in front of the existing promenade.

If you were making a visit (similar to today's visit) to the seafront in this

image, would you get more, less or the same amount of enjoyment from a visit compared to your enjoyment of today's visit?

- Much less enjoyment ☐
- The same amount of enjoyment ☐
- Much more enjoyment ☐
- DON'T KNOW ☐

IF DON'T KNOW, GO TO (C)

So, how much enjoyment would you get from your visit to the seafront in this image in terms of pounds and pence?

Value of today's visit     £.....:.....pence

Cannot value these things in money terms ☐

Don't know ☐

**Finally, which of the schemes described above do you prefer?**

- Promenade and Beach not developed further ☐
- Option 1 (Revetment Only) ☐
- Option 2 (Revetment and Beach Recharge) ☐
- None of them ☐

**(If none of the above, please describe why)**



## Personal Details:

Remember this is only the first stage of the consultation process for the waterfront. Updates will be published regularly in the local papers and on Conwy County Borough Council's website.

### Gender:

Male ☐

Female ☐

### Age:

Under 25 ☐

25-35 ☐

36-45 ☐

46-55 ☐

56-65 ☐

Over 65 ☐

**Please Tick all of the appropriate boxes that best describes what Colwyn Bay town is to you.**

Colwyn Bay is where I live ☐

Colwyn Bay is where I work ☐

Colwyn Bay is a place I visit ☐

Colwyn bay is a place I shop ☐

Colwyn Bay is where I go to school ☐

Colwyn Bay is where I go for leisure ☐

Are you a member of any water-sports related groups?

Yes ☐

No ☐

If yes, which one?

---

---

---

How often do you use Colwyn Bay Prom for your water-sports hobby?

Less than one per month ☐

2-3 times per month ☐

4 or more times per month ☐

**THANK YOU FOR YOUR FEEDBACK**

**Please hand in your completed questionnaire to one of our team if you are taking part in the face to face survey on the promenade.**

**Alternatively send it to:**

**Waterfront Consultation Questionnaire  
Environment  
Mochdre Offices  
Conwy Road  
Mochdre  
LL28 5AB**

## Appendix D. Economic Assessment

Project Summary Sheet					
<b>Client/Authority</b>			Prepared (date)		
Conwy County Borough Council			01/10/2010		
<b>Project name</b>			Printed		
Colwyn Bay PAR update			07/10/2010		
<b>Project reference</b>			Prepared by		
			VT		
Base date for estimates (year 0)			Checked by		
Jul-2010			PJP		
Scaling factor (e.g. £m, £k, £)			Checked date		
£k					
Principle land use band			(used for all costs, losses and benefits)		
B			(A to E)		
Initial discount rate			3.5%		
Optimism bias factor			30.0%		
<b>Costs and benefits of options</b>					
	<b>Costs and benefits £k</b>				
	Option 1 (do nothing)	Option 4	Option 5		
<b>PV costs PVc</b>		67,647.60	62,269.78		
<b>Optimism bias adjustment</b>		20,294.28	18,680.94		
<b>Total PV Costs for appraisal PVc</b>		87,941.88	80,950.72		
<b>PV damage PVd</b>	373,609.65	2.74	2.74		
<b>CV damages</b>	14,221.72	12,430.13	-28,126.34		
<b>PV damage avoided</b>		375,398.50	415,954.97		
<b>PV assets PVa</b>	18,146.07				
<b>PV asset protection benefits</b>		18,146.07	18,146.07		
<b>Total PV benefits PVb</b>		393,544.57	434,101.04		
<b>Net Present Value NPV</b>		305,602.69	353,150.32		
<b>Average benefit/cost ratio</b>		5.82	6.97		
<b>Incremental benefit/cost ratio</b>		4.48	-5.80		
- Highest b/c					
<b>Brief description of options:</b>					
Option 1 (do nothing)	Do nothing				
Option 4	Rock Revetment				
Option 5	Straight Rock Groyne, revetment and beach recharge				
<b>Notes:</b>					
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:					
$(PVb(\text{current option}) - PVb(\text{previous option})) / (PVc(\text{current option}) - PVc(\text{previous option}))$					

Present Value Losses and Benefits																				Sheet Nr.						
Client/Authority Conwy County Borough Council										Results £k										Prepared (date) Printed Prepared by Checked by Checked date		01/10/2010 VT PJP				
Project name Colwyn Bay PAR update										Option 1 (do nothing)      Option 4      Option 5      0																
Project reference Base date for estimates (year 0) Scaling factor (e.g. £m, £k, £) Discount rate										PV losses PV benefits																
										387831      12430      -28126      0																
										375401      415958      387831																
Option 1 (do nothing)										Option 4      Option 5      0																
loss of A55 in year 55    loss of Prom in year 10    loss of Railway in year 10    Loss of services in year 5    Loss of Tourism    TOTALS    Tourism PV    PV										loss    loss    tourism loss    TOTALS    PV    loss    loss    tourism loss    TOTALS    PV    loss    loss    loss    TOTALS    PV																
495006    249216.435    1094335.7    5792.55    48098.8533    1891973.31    14221.72    387831.37										0    0    42039.5774    42039.58    12430.13    0    0    -95125.268    -95125.27    -28126.34    0    0    0    0.00    0.00																
cash sum																										
Discount Factor																										
year	0	1.000		30.423				476.22627	506.65	476.23	506.65			416.23344	416.23	416.23			-941.83434	-941.83	-941.83				0.00	0.00
	1	0.966		30.423				476.22627	506.65	460.12	489.52			416.23344	416.23	402.16			-941.83434	-941.83	-909.98				0.00	0.00
	2	0.934		30.423				476.22627	506.65	444.56	472.96			416.23344	416.23	388.56			-941.83434	-941.83	-879.21				0.00	0.00
	3	0.902		30.423				476.22627	506.65	429.53	456.97			416.23344	416.23	375.42			-941.83434	-941.83	-849.48				0.00	0.00
	4	0.871		30.423				476.22627	506.65	415.00	441.52			416.23344	416.23	362.72			-941.83434	-941.83	-820.75				0.00	0.00
	5	0.842		2594.42			5792.55	476.22627	8863.20	400.97	7462.57			416.23344	416.23	350.46			-941.83434	-941.83	-793.00				0.00	0.00
	6	0.814		2594.42				476.22627	3070.65	387.41	2497.97			416.23344	416.23	338.61			-941.83434	-941.83	-766.18				0.00	0.00
	7	0.786		2594.42				476.22627	3070.65	374.31	2413.50			416.23344	416.23	327.16			-941.83434	-941.83	-740.27				0.00	0.00
	8	0.759		2594.42				476.22627	3070.65	361.65	2331.88			416.23344	416.23	316.09			-941.83434	-941.83	-715.24				0.00	0.00
	9	0.734		2594.42				476.22627	3070.65	349.42	2253.03			416.23344	416.23	305.40			-941.83434	-941.83	-691.05				0.00	0.00
	10	0.709		2594.42	12025.6671			476.22627	15096.31	337.61	10702.06			416.23344	416.23	295.08			-941.83434	-941.83	-667.68				0.00	0.00
	11	0.685		2594.42	12025.6671			476.22627	15096.31	326.19	10340.16			416.23344	416.23	285.10			-941.83434	-941.83	-645.11				0.00	0.00
	12	0.662		2594.42	12025.6671			476.22627	15096.31	315.16	9990.49			416.23344	416.23	275.46			-941.83434	-941.83	-623.29				0.00	0.00
	13	0.639		2594.42	12025.6671			476.22627	15096.31	304.50	9652.65			416.23344	416.23	266.14			-941.83434	-941.83	-602.21				0.00	0.00
	14	0.618		2594.42	12025.6671			476.22627	15096.31	294.20	9326.23			416.23344	416.23	257.14			-941.83434	-941.83	-581.85				0.00	0.00
	15	0.597		2594.42	12025.6671			476.22627	15096.31	284.25	9010.85			416.23344	416.23	248.45			-941.83434	-941.83	-562.17				0.00	0.00
	16	0.577		2594.42	12025.6671			476.22627	15096.31	274.64	8706.13			416.23344	416.23	240.04			-941.83434	-941.83	-543.16				0.00	0.00
	17	0.557		2594.42	12025.6671			476.22627	15096.31	265.36	8411.72			416.23344	416.23	231.93			-941.83434	-941.83	-524.79				0.00	0.00
	18	0.538		2594.42	12025.6671			476.22627	15096.31	256.38	8127.27			416.23344	416.23	224.08			-941.83434	-941.83	-507.05				0.00	0.00
	19	0.520		2594.42	12025.6671			476.22627	15096.31	247.71	7852.43			416.23344	416.23	216.51			-941.83434	-941.83	-489.90				0.00	0.00
	20	0.503		2594.42	12025.6671			476.22627	15096.31	239.34	7586.89			416.23344	416.23	209.18			-941.83434	-941.83	-473.33				0.00	0.00
	21	0.486		2594.42	12025.6671			476.22627	15096.31	231.24	7330.33			416.23344	416.23	202.11			-941.83434	-941.83	-457.33				0.00	0.00
	22	0.469		2594.42	12025.6671			476.22627	15096.31	223.42	7082.44			416.23344	416.23	195.28			-941.83434	-941.83	-441.86				0.00	0.00
	23	0.453		2594.42	12025.6671			476.22627	15096.31	215.87	6842.94			416.23344	416.23	188.67			-941.83434	-941.83	-426.92				0.00	0.00
	24	0.438		2594.42	12025.6671			476.22627	15096.31	208.57	6611.54			416.23344	416.23	182.29			-941.83434	-941.83	-412.48				0.00	0.00
	25	0.423		2594.42	12025.6671			476.22627	15096.31	201.51	6387.96			416.23344	416.23	176.13			-941.83434	-941.83	-398.53				0.00	0.00
	26	0.409		2594.42	12025.6671			476.22627	15096.31	194.70	6171.94			416.23344	416.23	170.17			-941.83434	-941.83	-385.06				0.00	0.00
	27	0.395		2594.42	12025.6671			476.22627	15096.31	188.12	5963.23			416.23344	416.23	164.42			-941.83434	-941.83	-372.04				0.00	0.00
	28	0.382		2594.42	12025.6671			476.22627	15096.31	181.75	5761.57			416.23344	416.23	158.86			-941.83434	-941.83	-359.46				0.00	0.00
	29	0.369		2594.42	12025.6671			476.22627	15096.31	175.61	5566.74			416.23344	416.23	153.49			-941.83434	-941.83	-347.30				0.00	0.00
	30	0.356		2594.42	12025.6671			476.22627	15096.31	169.67	5378.49			416.23344	416.23	148.29			-941.83434	-941.83	-335.56				0.00	0.00
	31	0.346		2594.42	12025.6671			476.22627	15096.31	164.73	5221.84			416.23344	416.23	143.98			-941.83434	-941.83	-325.78				0.00	0.00
	32	0.336		2594.42	12025.6671			476.22627	15096.31	159.93	5069.74			416.23344	416.23	139.78			-941.83434	-941.83	-316.29				0.00	0.00
	33	0.326		2594.42	12025.6671			476.22627	15096.31	155.27	4922.08			416.23344	416.23	135.71			-941.83434	-941.83	-307.08				0.00	0.00
	34	0.317		2594.42	12025.6671			476.22627	15096.31	150.75	4778.72			416.23344	416.23	131.76			-941.83434	-941.83	-298.14				0.00	0.00
	35	0.307		2594.42	12025.6671			476.22627	15096.31	146.36	4639.53			416.23344	416.23	127.92			-941.83434	-941.83	-289.45				0.00	0.00
	36	0.298		2594.42	12025.6671			476.22627	15096.31	142.10	4504.40			416.23344	416.23	124.19			-941.83434	-941.83	-281.02				0.00	0.00
	37	0.290		2594.42	12025.6671			476.22627	15096.31	137.96	4373.20			416.23344	416.23	120.58			-941.83434	-941.83	-272.84				0.00	0.00
	38	0.281		2594.42	12025.6671			476.22627	15096.31	133.94	4245.83															

Page 1



Erosion Loss Calculation Sheet with delay options

Sheet Nr.

Client/Authority

Conwy County Borough Council

Project name

Colwyn Bay PAR update

Project reference

Base date for estimates (year 0)

Scaling factor (e.g. £m, £k, £)

Discount rate

-

Jul-2010

£k

3.5%

Option:

Do Nothing

Revetment

Rock Groyne, revetment

Delay (yrs)

0

100

100

Prepared (date)

Printed

Prepared by

Checked by

Checked date

01/10/2010

VT

PJP