

# **Coastal Defence Strategy: Rivers Arun to Adur Supplement to Executive Summary**

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Scott Wilson Kirkpatrick  
Scott House  
Basing View  
Basingstoke  
RG21 4JG



## DOCUMENT APPROVAL FORM

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Author: Scott Wilson in association with Risk & Policy Analysts

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Mike Turville – Project Manager

**NOTE:**

This document should be read in conjunction with the Main Strategy Document “Coastal Defence Strategy: Rivers Arun to Adur, Strategy Plan” dated March 2000 and Technical Report 13: Implementation Plan. Where expenditure figures and economic justifications differ, this report supersedes that information given in those earlier documents. .

## 1. Introduction

A review of the economic analysis for the Rivers Arun to Adur Strategy has been undertaken to investigate whether the options recommended in the Strategy would change if the PAG3 decision rule was applied.

It should be noted that the economic analysis in the Strategy was undertaken to requirements as set out in PAGN, as PAG 3 had not been published until after the production of the Draft Final Report. Furthermore, the letter accompanying the issue of PAG3 implied that Strategies submitted prior to 1 April 2000 would only need to comply with PAGN, not PAG3. The economic analysis within the Rivers Arun to Adur Strategy was completed in summer 1999, and the Strategy was finalised in March 2000.

It should also be noted that this review is only concerned with the application of the PAG3 decision rule, not the application of the PAG3 requirements as a whole. An updating of the results requires a re-interpretation of the results from the cost-benefit analysis and **not** a re-working of the original figures. The original analysis was based on economic efficiency criteria, especially in relation to the incremental benefit-cost ratio (which, if greater than one justifies a move to a more expensive option). Given the increasing pressure on public funds, MAFF have tighter requirements than would be accepted under a standard economic appraisal - illustrated in the PAG 3 decision rules.

## 2. PAG3 Decision Rule

Page 65 of PAG 3 sets out the 'new' decision process and associate rules. A summary of which is provided below:

- if the benefit-cost ratio is less than one, then that option is not justified;
- consider the option with the highest benefit-cost ratio;
- if the option is below the indicative standard, then does the next option have an incremental benefit-cost ratio greater than one?
- if the option standard is within the indicative range, does the next highest option have an incremental benefit-cost ratio greater than three? and/or
- if the option is above the indicative range, does the next highest option have an exceptional incremental benefit-cost ratio?

Clearly the key change here is the requirement for the incremental benefit-cost ratio to be greater than three if the standard of the scheme is within the indicative range. The key part of the analysis now becomes correctly identifying land use band from those as set out in PAG 3 (as Table 1 illustrates, for coastal/saline flooding).

Band	Description	Indicative standard (yrs)
A	Typically intensively developed urban areas at risk from flooding and/or erosion	100-300
B	Typically less intensive urban areas with some high-grade agricultural land and/or environmental assets of international importance requiring protection	50-200
C	Typically large areas of high-grade agricultural land and/or environmental assets of national significance requiring protection with some properties also at risk, including caravans and temporary structures	10-100
D	Typically mixed agricultural land with occasional, often agriculturally related, properties at risk. Agricultural land may be prone to flooding, waterlogging or coastal erosion. May also apply to environmental assets of local significance	2.5-20
E	Typically low-grade agricultural land, often grass, at risk from flooding, impeded land drainage or coastal erosion, with isolated agricultural or seasonally occupied properties at risk, or environmental assets at little risk from frequent inundation	<5

**Table 1: Summary of land use bands from PAG 3**

### 3. The Updated Analysis

Table 2 provides a summary of the preferred options as set out in the original economic appraisal derived using PAGN.

Benefit frontage	PAGN preferred	Breaching standard		Overtopping/flooding standard	
		Year 0	Year 50	Year 0	Year 50
1	Phased improve	200 (100 at year 25)	200		
2	Improve			1 in 200	1 in 200
3	Improve			1 in 100	1 in 100
4	Improve			1 in 100	1 in 100
5a	Maintain			1 in 50	1 in 50
5b	Improve (200)	1 in 200	1 in 200		
6	Improve defer	1 in 100	1 in 200		
7 & 8	Improve (groynes and crestwall)			1 in 200	1 in 200
9 - 12	Improve (200)	1 in 200	1 in 200		
13	Phased improve	1 in 200 (100 at year 25)	1 in 200		

**Table 2: Summary of original Strategy results under PAGN**

The relevant land use bands for each benefit frontage are set out in Table 3. It should be noted that these are crucial to the analysis when following PAG 3 decision rules.

Benefit frontage	Land use band
1: River Arun (Ford Railway Bridge to A259)	D (agricultural)
2: River Arun (A259 to Littlehampton Pier)	A (intensive urban)
3: Littlehampton East Pier to The Green	A (intensive urban)
4: The Green to Rustington	B (less intensive urban)
5a: Rustington to Sea Lane, Goring (exc. Ferring Rife)	B (less intensive urban)
5b: Ferring Rife	A (intensive urban)
6: Marine Crescent	A (intensive urban)
7 & 8: Worthing	A (intensive urban)
9 - 12: Brooklands to Shoreham	A (intensive urban)
13: River Adur (Breakwater to A27 Flyover)	B (less intensive urban)

**Table 3: Land use bands for benefit frontages**

Following a re-interpretation of the results based on the land use bands given in Table 3 and the guidance in PAG 3, Table 4 shows a summary of the updated preferred options.

It can be seen from a comparison of the results from Tables 2 and 4 that four frontages have a change in the preferred option:

- frontage 1 (from phased improve to maintain);
- frontage 2 (from improve to phased improve);
- frontage 4; (from improve to sustain) and
- aggregated frontage 7&8 (from improve with groynes and crest wall to improve with groynes only).

It should be noted that the preferred options have been derived purely on economic analysis grounds and do not consider any further technical/environmental/political factors that may change the preferred Strategy.

Benefit frontage	PAG 3 preferred (land use band)	Breaching standard		Overtopping/flooding standard	
		Year 0	Year 50	Year 0	Year 50
1	Maintain* (D)	1 in 10	1 in 5		
2	Phased improve** (A)			1 in 200 (100 at year 25)	1 in 200
3	Improve (A)			1 in 100	1 in 100
4	Sustain*** (B)			1 in 50	1 in 50
5a	Maintain (B)			1 in 50	1 in 50
5b	Improve (200) (A)	1 in 200	1 in 200		
6	Improve defer (A)	1 in 100	1 in 200		
7 & 8	Improve (groynes)**** (A)			1 in 100	1 in 100
9 - 12	Improve (200) (A)	1 in 200	1 in 200		
13	Phased improve (B)	1 in 200 (100 at year 25)	1 in 200		

\*given the agricultural nature of this land a higher standard is not justified. However, its interlinking with benefit frontage 2 may justify a higher standard  
\*\*this option is well within the indicative range  
\*\*\*incremental does not justify a higher standard, 1 in 50 is at lower bound in PAG 3 (especially given that properties are set back)  
\*\*\*\*incremental does not justify a higher standard, at lower bound of PAG 3 range

**Table 4: Summary of Strategy results under PAG 3**

## 4. Updated Sensitivity Analysis

A re-interpretation of the results from the sensitivity analysis has also been undertaken to test the robustness of the results. Table 5 provides a summary of each test.

Benefit Frontage	Sensitivity Test and Preferred Option Number								
	Base Justified Option	Benefits +20%	Benefits -20%	Costs +20%	Costs -20%	Recreational Benefits Omitted	Property Write-off not used	Erosion doubled	Over-topping divided by four
1	2 (Maintain)	2	2	2	2				2
2 and 3:									
2	3 (Phased Improve)	3	3	3	3				3
3	4 (Improve)	4	4a (Improve Defer)	4a	4	4a		4	4a
4	3 (Sustain)	3	3	3	3		3		3
5a	2 (Maintain)	2	2	2	2	2		2	2
5b	5 (Improve)	5	5	5	5			5	5
6	4a (Improve Defer)	4a	4a	4a	4a				4a
7-8	4 (Improve)	4	4	4	4	4		4	4
9-12	5 (Improve)	5	4a (Improve Defer)	4a	4a				5
13	3 (Phased Improve)	3	3	3	3				3

**Table 5: Sensitivity test results**

From the above table it can be concluded that, on the whole, the results are robust and defensible. However, a defer option may provide a better economic return for benefit frontage 3 and the aggregated frontage 9-12.

## 5. Summary of Preferred Options

Table 6 provides a comparison between the preferred option under PAGN and PAG 3.

Benefit frontage	PAGN preferred	PAG 3 preferred
1	Phased improve	Maintain
2	Improve	Phased improve
3	Improve	Improve
4	Improve	Sustain
5a	Maintain	Maintain
5b	Improve (200)	Improve (200)
6	Improve defer	Improve defer
7 & 8	Improve (200)	Improve (100)
9 - 12	Improve (200)	Improve (200)
13	Phased improve	Phased improve

**Table 6: Comparison of preferred options**

The results are logical considering the types of assets being protected. It should be noted that although PAG3 gives a lower standard (of 100 years) than PAGN for the Worthing frontage (benefit frontages 7&8), there is no need for a change to the Strategy, as the responsible authority for the Worthing frontage has opted for an improve-defer (100 year standard) option.

Finally, Table 7 provides an updated CBA for the Strategy as a whole.

Benefit Frontage	Benefits (£m)	Cost (£m)	NPV (£m)	B/C
1	1.02	0.08	0.94	13.24
2 and 3	17.55	1.70	15.85	10.32
4	4.72	1.10	3.62	4.28
5 (excluding Ferring Rife)	6.97	3.62	3.35	1.93
5 (Ferring Rife only)	18.86	1.33	17.52	14.15
6	6.41	1.72	4.69	3.73
7 and 8	65.84	10.14	55.70	6.49
9, 10, 11 and 12	88.47	13.12	75.35	6.74
13	3.42	0.82	2.60	4.19
Total for frontage (PAG 3)	213.26	33.63	179.63	6.34

**Table 7: Overall Strategy CBA**

## 6. Impacts on Strategy

Section 5 compares the highest investment preferred options which could be obtained from a strict application of the economic rules. In the Strategy, the preferred option for a number of the frontages was actually driven by other considerations – for example funding limitations and environmental impacts. Also, the Strategy documents present the preferred options in terms of Operational Management units, rather than benefit frontages.

Table 8 provides a comparison between the preferred option from PAG3 and the actual preferred option from the Strategy.

OMU	Location	Benefit Frontage	Preferred Option (existing Strategy)	Preferred Option (PAG 3)
1	River Arun	1	Phased improve	<b>Maintain</b>
1		2	Phased improve	Phased improve
2	Littlehampton-Rustington	3	Improve-defer	Improve-defer
2		4	Improve-defer	<b>Sustain</b>
3	Rustington-Goring	5a	Maintain	Maintain
4	Ferring Rife	5b	Improve	Improve
5	Marine Crescent	6	Improve-defer	Improve-defer
6	West Worthing	7-8	Improve-defer	Improve-defer
7	Brooklands-Shoreham	9-12	Improve	Improve
8	River Adur	13	Phased improve	Phased improve

**Table 8: Comparison of preferred options**

There are two OMUs where changes to the Strategy are necessary:

**OMU 1** – the Strategy would be changed to maintain for the length north of the A259. The Strategy itself acknowledges that this length needs to be reviewed, given the representations made on environmental grounds (concerning the advantages of managed retreat) and the need for an integrated river Arun Strategy. Also, the result of the analysis is determined by the land use category assumed, which in section 5 does not take into account the presence of the railway.

It is recommended that the preferred option for this length is reviewed following the further studies already recommended.

**OMU 2** – the preferred option for the eastern part changes from Improve-defer to sustain. Again this result is a function of the land use category assumed, which might be reviewed. In practical terms, there is no difference between sustain and improve-defer over the first 5 years of the Strategy as no major capital works are planned. The minor works recommended to bring the frontage to a common standard should be included in the Sustain option.

It is recommended that the preferred option for this length is reviewed prior to any major expenditure on groyne replacement.

**OMU 7** –Following the PAG3 decision rule results in the first standard in the indicative range (Improve 200 year standard) being selected. However, it was felt during the review that further consideration needed to be given to intermediate options at the lower end of the indicative range. As a result, two new options were considered – both were phased improve, with a 5 year completion period, to standards of 100 and 200 years.

During the review two minor errors in the previous analysis were corrected:

- The benefits of the Improve (200) option were reduced, as a result of amending the breach probability in the damage spreadsheet
- The costs of Sustain were increased as a result of correcting the omission of a short length of replacement sea wall

Table 9 shows the results:

Option	Benefits (£m)	Cost (£m)	NPV (£m)	B/C	Inc
Do Nothing	-	-	-	-	-
Maintain	55.87	6.41	49.46	8.71	-
Sustain	81.02	8.01	73.01	10.11	15.73
Phased Improve 100	83.89	10.66	73.23	7.87	1.08
Phased Improve 200	85.24	11.59	73.65	7.35	1.45
Improve 100	84.75	11.72	73.03	7.23	-3.70
Improve 200	86.61	13.12	73.49	6.60	1.33

**Table 9: Summary of OMU 7 results**

When considering the robustness of the incremental benefit/cost ratio, the following factors need to be addressed:

- The defences protect a large urban area consisting of housing and commercial premises;
- Within the economic assessment no account has been made of personal health and stress affects resulting from living within a flood risk area;
- A conservative approach has been taken with respect to the damages which could include amenity areas and holiday parks omitted from the appraisal;
- No allowance has been made of the intensity of the management required on this urban frontage i.e. political input, frequency of re-cycling, re-profiling required to maintain the current standards.

Taking these factors in to consideration should achieve an additional benefit comfortably in excess of £2.5M to obtain an incremental benefit/cost ratio of greater than 1.5.

Applying the PAG3 decision rule results in Phased Improve (100) being selected as the preferred option. We believe that this is an appropriate option for this urban frontage.

## 7. Recommendations

The PAG 3 economic review has identified modified decisions on benefit frontages 1, 2, 4 and 7 & 8. However, the impact on the Strategy and the 5-year implementation programme is minimal as frontages 1, 2 (OMU1) and 4 (OMU2) have already been identified as requiring review or any works occur beyond 5 years. The lower standard (1:100 year) identified for benefit frontages 7 & 8 (OMU 6) concurs with the chosen option within the Strategy for that OMU. The further review of the additional options in benefit frontages 9 to 12 (OMU 7) has resulted in a change in the recommended option from Improve (200) to Phased Improve (100) which will have some impact on the expenditure profile within the 5-year programme.

In the case of OMU's 1 and 2, and other frontages where work has been identified beyond year 5, timing and justification of such works will be re-addressed in the strategy review. Operational requirements will not be affected by this PAG3 review.

The review of the Strategy will be undertaken in 5 years, including assessments in line with the requirements of all the current MAFF guidance notes. This will ensure the continued consistent and coherent approach to the protection of this whole frontage.

The re-assessment of OMU 7 results in the need to revise the investment programme for the preferred option of Phased Improve (100) and this is shown in table 10. In addition to this a review of the LDW11 scoring has also been undertaken, and is as follows:

Priority	Urgency	Benefit/Cost	Total prioritisation Score
8	6*	10	24

\* LDW11 Table 2a – Current defence relies on intensive beach management, should this cease, then failure would be expected within 5 years.

OMU	Year					Total (5-year Plan)	5-6**
	0	1	2	3	4*		
1	£188,000	£0	£0	£248,800	£0	£436,800	
4	£0	£0	£1,182,000	£0	£0	£1,182,000	
7 (Part)	£0	£0	£1,656,451 <sup>+</sup>	£2,304,233	£1,806,663	£5,767,347	£3,612,967
8	£70,000	£0	£822,000	£0	£0	£892,000	
<b>Total EA</b>	<b>£258,000</b>	<b>£0</b>	<b>£3,660,451</b>	<b>£2,55,033</b>	<b>£1,806,663</b>	<b>£8,278,147</b>	

**Table 10 – Revised Implementation Expenditure for Capital Works on the Environment Agency Frontages**

\* At year 4 the Strategy will undergo the first review.

\*\* Expenditure beyond year 4 to complete phased approach to OMU7. Total expenditure for this OMU is £10,506,968 (EA = £9,380,673; WBC = £1,126,295).

+ Expenditure will also be incurred by Worthing Borough Council for the remainder of this frontage at a cost of £1,126,295.

The following table 11 summarises the expenditure programme over 5 years. Reference should be made to both Table 12-4 of the Strategy document and Technical Report 13 – Implementation Plan. All costs are shown in £ million.

Year	OMU								Total
	1	2	3	4	5	6	7	8	
0-1	0.19	0	0	0	0	0	0	0.07	0.26
2	0	0	0	1.18	1.03	1.62	2.78	0.8	7.41
3	0.25	0	0	0	0	0	2.3	0	2.55
4	0	0	0	0	0	0	1.8	0	1.8
5	0	0	0	0	0	0	1.8	0	1.8

**Table 11 – Strategy Expenditure Profile**