

Joint Defra/EA Flood and Coastal Erosion Risk  
Management R&D Programme

## Annex B.4:

Case study no.4:

Assessment of the River Chet flood alleviation  
scheme

R&D Project Record FD2013/PR2

Produced: November 2004

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# 1. Introduction

In May 2001 Broadland Environmental Services Limited (BESL) was awarded a long-term contract by the Environment Agency to improve and maintain flood defences in Broadland. The Agency's approach to flood alleviation in Broadland was adopted in the 1990's and is based on a strategy consisting mainly of bank strengthening and erosion protection and reducing the risks of bank breaching. BESL has recently updated this strategy and it now sets the scene for how this and future improvement schemes are designed, programmed and carried out. Recent detailed surveys and monitoring confirm that improvements are needed to flood defences for the left bank of the River Chet (Chedgrave Common and Hardley Marshes). However, the BESL is also concerned with flood alleviation work on the opposite bank of the river, Compartment 22.

The River Chet is a navigable, embanked, tidal river, 7m to 20 m wide, and relatively deep. This report presents the MCA-based project appraisal process for the River Chet, part of Compartment 22, south bank from Pyes Mill to Nogdam End.

Our interest in the River Chet Defence Scheme is based on it being local scheme project that has been facing problems relating to conflict stakeholders. There seems to exist significant controversy in relation to which options to consider for appraisal. The information reported here is based on the following main documents:

- EA (1996a): Broadland Flood Alleviation Strategy Study, Bank Strengthening and Erosion Protection, Compartment 22 (Burgh Norton) Detailed Appraisal;
- EA (1996b): Broadland Compartment 22, Local Environmental Assessment, Final Report; and
- Halcrow (2003): draft Environmental Statement for the flood alleviation improvements for AU 2.

## 1.1 Summary of the project area

The River Chet runs for approximately 3.5 miles, from the Town of Loddon until it joins the River Yare, between Cantley and Reedham. The river is narrow in places, wooded at first, then as it nears Hardley Cross is becomes more canal like, with extensive grazing marshes and big skies.

The River Chet case study comprises the south bank of the River Chet from Pyes Mill to Nogdam End, which is part of Compartment 22 - Burgh Norton - of the Broadland Flood Alleviation Strategy. Also part of this Compartment is the right hand bank of the River Yare from the Chet to Haddiscoe Cut, Haddiscoe Cut south west bank, and the River Waveney left bank from Haddiscoe Cut to Burgh St Peter (EA, 1996). The flood and coastal defence management in the Broadland is covered under the Broadland Flood Alleviation Strategy (BFAS).

Compartment 22 is typical of Broadland, land use is almost 100% agriculture and the land is very low lying. The area is particularly susceptible to flooding, either from high freshwater river flows or more frequently high sea levels (EA, 1996).

The two main natural features to be highlighted and that would be threatened by flooding in the south bank of the River Chet are:

- the fresh water soke dykes which support a varied marginal and aquatic flora, including reed sweet grass, common reed, common duckweed and ivy-leave duckweed; and
- wet woodland which occurs along the Chet Valley

Ronds (area between channel and the floodbank) are a local feature and provide a vital flood defence function in that they minimise erosion of the floodbank and provide additional water holding capacity during the high flows.

The River Chet, as part of Broadland, is one of the few remaining areas of lowland river valley grassland in Britain and considered to be ecologically unique in Europe. Characteristic species in the floodbank include common reed, common couch, creeping thistle, spear thistle, cleavers, nettle and bramble. Furthermore, the vegetation along the landward berm of the floodbank (i.e. the folding) is typically dominated by common reed along with creeping thistle, hemlock, nettle, false oat grass and couch grass. Notable species include marsh sow thistle and stands of marsh mallow. Notable habitats along the folding include occasional wet hallows, with areas of turf and saltmarsh in some sections. There are no nature conservation sites within the study area and the area has been designated an ESA by MAFF. However, Species Actions Plans exist for species present in the soke dykes, such as the water vole and floating water plantain. It is unclear at this point whether this species are present in the soke dykes of the River Chet.

Finally, it is worth noting that there are no schedule Ancient Monuments in the study area and there are no archaeological sites of interest.

## **1.2 Existing defences**

In general, the existing frontline defences comprise earth embankments (floodbank), with a mixture of reed ronds, and a variety of erosion protection measures, such as piling, protecting some areas.

The embankments are generally in poor condition, being susceptible to seepage and, on occasion, to failure that can lead to breaching (NRA, 1995a in EA, 1996b). In addition, the floodbanks have settled since they were last improved and are now at risk of being overtopped by flood water on an event with a return period of once every five years or less (EA, 1996b).

The defences in some areas are also threatened by undermining due to erosion at the edge of the river channel. Within the River Chet the erosion protection comprises of high level steel and timber piling along much of the riverbank, with some areas of unprotected reed rond. In many cases, the timber/steel piling is nearing the end of its useful life (residual life less than 10 years) and scour out of the bank behind is occurring. In other areas, the unprotected reed rond is rapidly eroding leaving the floodbank unprotected (EA, 1996b).

There is a double dyke intersection and crosswall at the upstream end of Nogdam End. The majority of the bank is made up of a narrow crest and steep backface, making it vulnerable to breaching when overtopped (Halcrow, 2003).

The overall standard of flood defence has progressively reduced due to settlement, age and the combined effects of erosion, corrosion and sea level rise. The standard of defence in the all Compartment varies from 1 in 1.5 to 1 in 5 years (EA, 1996a).

### **1.3 The policy framework**

The Environment Agency's approach for flood and coastal defence of the Broadland was adopted in the 1990's in the Broadland Flood Alleviation Strategy (BFAS). The general aim of erosion protection and bank strengthening is to sustain the existing flood defences in the area for the next 50 years, i.e. to improve and subsequently maintain their condition without raising the long term standard of protection they provide (EA, 1996a).

In 2001, Broadland Environmental Services Limited (BESL) was commissioned by the Environment Agency (the Agency) in 2001 to carry out the Broadland Flood Alleviation Project, a long-term 20-year programme of sustainable flood defence maintenance and improvements.

Because the River Chet case study is part of the Broadland, its policy framework is somewhat different from the remaining case studies. Schemes under the BFAS do not follow the traditional flood and coastal defence project appraisal norms, namely in respect of funding allocation which comes directly from the government grant allocated to the Broadland area, rather than for individually justified schemes.

The BFAS constituted a high level assessment, using Cost Benefit Analysis (CBA) as a decision-aiding tool. The BFAS proved conclusively, by consideration of loss avoidance, that the undertaking of works in the whole area is economically justified. Predicted future flooding patterns indicate that construction should start in the most seaward compartments of which Compartment 22 is one (EA, 1996a).

Under the Strategy, local flood alleviation schemes were subsequently developed for each compartment and a preferred flood defence option was recommended. Alternatives were subject to further environmental assessment through the production of non-statutory Local Environmental Assessment (LEA)

reports (Halcrow, 2003). In parallel, a detailed appraisal report was also developed for the recommended options for Compartment 22.

The LEA for Compartment 22 recommended that the flood defences should be sustained through a programme of bank strengthening, erosion protection and local set back, in line with the Strategy (Halcrow, 2003).

Finally, in order to identify the environmental risks and opportunities that may arise from the flood alleviation works in the Broads, the Agency carried out, in 1997, a Strategic Environmental Assessment (SEA) which summarises the results of extensive consultation with interested parties and groups in the area as well as recommendations on how to deal with the key topics raised during the consultation.

## 1.4 List of stakeholders and interested parties

BESL has been working with local representatives by forming the Chet Liaison Group. Its specific purpose is to enable BESL to present evolving and emerging scheme details for informed discussion. Membership of the group comprises local people who have agreed to be representative of a cross section of interests. The Group has a valuable role in advising BESL about important issues that need to be addressed. Since the Group was inaugurated in January 2003, five meetings have been held, most recently on the 2<sup>nd</sup> of February when a wide-ranging report-back was given to the Liaison Group and to landowners separately (Halcrow, 2003).

In addition, BESL has been in detailed discussion about the proposals in the wider Chet valley with officers and members of the Broads Authority (BA) and English Nature, both key stakeholders and have consulted with the Chet Liaison Group on a regular basis. Table 1.1 lists the members of the Chet Liaison Group.

**Table 1.1 Groups and individuals consulted on the Chet Liaison Group**

<b>Organisation</b>	<b>Number of representatives</b>
County councillors	1
District councillors	4
Parish councillors	6
Broads authority	2
English Nature	1
Boatyards/boat owners	2
Land owners/occupiers	2

## 2. Definition of objectives and management options

The BFAS defined both long term and short-term objectives for the Broads. The long-term objectives were (EA, 1996a):

- to sustain the integrity of the flood defences for the period of the strategy (50 years) therefore all current defended land will continue to be protected;
- to ensure that all works undertaken as part of the strategy are sustainable;
- to promote conservation of the natural environment;
- to ensure continuation of navigation of the Broads, where flood defences may impact.

The short-term objectives were (EA, 1996a):

- to secure the defences within Compartment 22 so that the existing standard of defence is sustained for the next 15 years;
- to ensure that the existing flood defence structures are stabilised to meet accepted factors of safety; and
- to undertake works that mitigate the effects of continued erosion of the berm.

The Detailed Appraisal Report for Compartment 22 mentioned in section 1.3 (EA, 1996a) developed the findings and recommendations of the BFAS to give a detailed appraisal of flood alleviation works required for the next 50 years. Within this report, compartment wide issues, existing flood defence deficiencies, proposed solutions, constraints and detailed cost estimates are identified. Benefit scenarios were not developed since they had been fully covered by and unchanged from the BFAS.

For the River Chet (right hand bank) the options considered in Detailed Appraisal Study were (EA, 1996a):

- **sustain along the existing line** - the floodbanks would be widened to become more secure, and would be raised by 375 mm above average defence level of 1.3m AOD to counter effects of settlement and sea level rise over a 15 year period. This would necessitate moving the soke dyke behind the bank, and widening it;
- **sustain along set back line of defence** - this option involves setting back the bank landward from its existing position; and
- **management retreat** existing hard defences would be removed strategically, the bank in this area would be reprofiled and the river would be allowed to erode and accrete naturally until it met higher ground. Eventually the existing floodbanks would be eroded, and they would also continue to settle.

For the preferred option, and due to extensive amount of erosion protection required for the river, the Detail Appraisal Study (EA, 1996a) proposed to locally set back the bank from the most upstream point of Compartment 22 (near Loddon) to Nogdam End. The Cross bank at Nogdam End would need to be strengthened, and strengthening and erosion works along the existing line would continue downstream to Nogdam End. The bank would be set back a maximum of 25 m from the line of the river, including any existing road. It was envisaged that a haul road would be constructed behind the works, and a new soke dyke would be created, set back from the new floodbank to allow for working area.

The Detailed Appraisal Study (EA, 1996a) does not consider the benefit scenarios of each option because these have already been covered in the BFAS. A detailed review of the Flood Alleviation Strategy makes clear that, although considerations about the benefits of each option were contemplated and a contingent valuation (CV) survey was carried out for recreational and amenity impacts, these considerations were not included in the assessment of options. The benefits valued for each option consisted of solely the damages avoided by doing something as opposed to doing nothing. This is a valid approach but totally ignores the majority of environmental and social benefits of options that, although not easily valued in monetary terms, should be taken into account in decision-making.

Recently, the BFAS has been being reviewed by BESL, this in parallel with the development of flood alleviation schemes for a number of Broad's rivers, including the Chet. This revised BFAS is still not in the public domain.

Following from the BFAS, BESL divided the right hand bank of the River Chet into two different assessment units (AU):

- AU 1, running from Pyes Mill to Nogdam End (3.4 km)
- AU 2, running from Nogdam End to the Yare confluence.

For AU 2, BESL proposes the following flood defence works:

- set back floodbank from Nogdam End to Ferry Road (including crosswall); and,
- maintain defences as existing from Ferry Road to the Yare confluence.

These proposals went through public consultation in 2002, and the planning application was submitted in February 2004.

For AU 1 the process has been less straightforward.

BESL investigated the following options for flood defence from Pyes Mill to Nogdam End:

- **do something** - mostly reactive maintenance works. This option is still being considered for the short term;

- **renew as existing** - considered to be not affordable;
- **set back floodbank** - considered to be risky (technically) and has a high capital and maintenance cost; and
- **managed flooding to high ground** - considered to be low maintenance and of lower risk, but changes to land use would still need consultation.

In addition, BESL is investigating sustainable long-term options, but none seem to be possible at present (BESL, 2003).

During the consultation group meeting (in which RPA participated as an observer) no details of economic, environmental and social costs and/or benefits were presented. In fact, the consultation process for this part of Compartment 22 has been characterised by strong conflict between stakeholders on opposite banks of the river and also between stakeholders and consultants.

In addition, for the option - managed flooding to high ground - BESL is aware that there exist very strong feelings for and against this option (in particular due to the fact that no compensation can be paid to landowners and properties may be flooded). However, BESL and English Nature believe that there could be wider benefits in the long term.

As a result of the public consultation and the fact that there is no mechanism at present (within the legislation) to buy land from landowners in order to flood it as the least cost option, BESL have embarked on maintaining the defences as a short term option.

In order to follow the proposed MCA based methodology for the River Chet case study (which constitutes the object of this report) it will be necessary to carry out an economic and/or quantitative valuation of the costs and benefits of different options. Besides the options considered by BESL, the appraisal of the case study will also consider a do-nothing option as it is indicated in Government guidance (MAFF, 1999) and maintain until the defences fail (year 9) followed by managed flooding to high ground.

In this context, the following five options were defined for the purpose of the assessment of this case study:

- **'do-nothing'**: where there is no investment in flood defence assets or activities;
- **maintain**: maintenance of the existing flood defences at the current standard (assumed to be 1 in 5 return period), involving reactive repairs to the flood defences as necessary. This option would involve some strengthening of flood banks and setting back the soke dyke where necessary, including clearing the banks of excess vegetation and re-shaping the crest of the banks (equivalent to BESL's do something option);
- **improve**: the existing flood standards would be increased to 1 in 20 return period (the indicative standard of protection) through strengthening of the

flood banks, restoring them to their earlier levels where excessive settlement has occurred, accounting for sea level rise, and replacing or providing new erosion protection where the integrity of the floodbanks is threatened;

- **flooding to high ground:** existing hard defences would be removed strategically, the bank in this area would be reprofiled and the river would be allowed to erode and accrete naturally until it met higher ground. However, flood defences would be provided to properties (in particular their gardens) to achieve a 1 in 20 standard; and
- **maintain then flood to high ground:** a combination of the two options (set out above) but with a limited time for maintain due to the very poor ground conditions and deterioration of the peaty material that form the embankments. This also gives time for discussions with landowners and the Agency to find a way to flood to high ground as an option (in line with Defras guidance on exit strategies).

Table 2.1 presents a summary of the consequences that each of these options would have on the right hand River Chet.

**Table 2.1: Summary of consequences of each management option on the River Chet**

Option	Summary of consequences
<b>Do nothing</b>	The defences will continue to deteriorate resulting in progressive failure of the floodbanks and flooding of the land currently protected. Ultimately, all the land below mean high water level would become permanently inundated with salt water, resulting in loss of some property, the abandonment of agricultural land and impacts on the local infrastructure. In addition, this extensive and permanent flooding would replace large areas of high conservation value open grazing marsh with open water, although this may eventually develop saltmarsh and reed bed communities along the margins. The major changes to landscape and the loss of habitats of ecological interest would alter the character of the area and may have significant effect on its attraction to visitors and its use for recreation and amenity. This option would also have significant negative impacts on navigation, since the navigation channel would be obstructed by siltation. The loss of piling may reduce angling bank facilities.
<b>Maintain existing defences (1 in 5 return period)</b>	The existing embankments are widened to provide additional stability and then subsequently maintained. The consequences of this option are that the defences will continue to deteriorate as the embankments continue to settle and sea level rise increases. The strengthening will prevent failure of these defences but eventually they will have settled to the extent that they will be overtopped so frequently that they will have to be abandoned. Some temporary positive impacts on freshwater dykes are expected as well as potential improvement of these systems. The agricultural activities behind the defences would also be improved temporarily due to reduced flooding frequency. However, this option is not sustainable in the long term.

**Table 2.1: Summary of consequences of each management option on the River Chet**

<b>Option</b>	<b>Summary of consequences</b>
<p><b>Improve (strengthening and raising to account for sea level rise and settlement – 1 in 20 return period)</b></p>	<p>In addition to widening, the floodbanks will be raised by a certain amount (375mm in Strategy) to account for a settlement rate of 25mm/yr (occurring in the following 15 years). At the end of this period (and each subsequent 15 year period) the floodbanks will be raised again by the same amount. In the intervening years the banks will be maintained as normal.</p> <p>Although the flood regimes would not be significantly altered, raising the floodbanks would make the water levels rise in extreme events causing increased flooding in unprotected areas (not so much of a problem on the River Chet south bank). It will also have impacts on the landscape like obstructing the view. Other concerns include the volume of materials needed for the earthworks, integrated engineering and environmental opportunities. However, this option would also have positive impacts such the reduction of flooding to the protected areas, potential improvement of freshwater dykes, and improved agriculture due to less frequent flooding.</p>
<p><b>Flooding to high ground</b></p>	<p>A large-scale managed retreat would lead to water inundation of high quality freshwater grazing marsh and their associated wildlife. In addition, this option could result in major impacts on local infrastructure as described for the do-nothing option. Rind creation of this type could be viewed as a long-term alternative to the use of hard erosion protection measures such as piling. The gardens of properties at risk from flooding would be protected for floods with 1 in 20 return period, so these properties would not be affected.</p> <p>This option will have the same effects as the do nothing option up to the new line of defence. Concerns include effects on the landscape, environmental change and opportunities and effects on agriculture. Positive impacts include increased in biodiversity due to new wetland habitat. This option would also have negative impacts on navigation due to siltation and increased velocities at the mouth of the river.</p> <p>The loss of piling may reduce angling bank facilities.</p>
<p><b>Maintain followed by flooding to high ground</b></p>	<p>This option comprises maintain for years 0 to 9 followed by flooding to high ground. The consequences will therefore be the same as those for maintain for years 0 to 9 and flood to high ground from year 10 onwards.</p>

### **3. Structuring the problem**

This section breaks down the problem into its component parts, identifying the set of impacts and associated criteria that will be used to make the decision. In other words it carries out a screening exercise for the Chet, south bank.

#### **3.1 Summary of the screening exercise**

This screening exercise is used to determine (i) which categories are relevant, (ii) which categories will be appraised by assigning monetary value to impacts and (iii) which will be appraised by assigning a score to the impacts. Relevant categories are those where there is a difference in the impacts of the options being appraised.

The screening and definition of potential impacts for the River Chet was based on the Local Impact Assessment for Compartment 22 (EA, 1996b), on the draft Environmental Statement for the flood alleviation improvements for AU 2 (Halcrow, 2003) and other sources of information such as conversations with local people and area maps etc. The Assessment Summary Table for High Level Screening (AST – S) is presented in Annex 1 of this report. Table 3.1 summarises the results of the screening exercise.

The high level screening exercise highlighted the fact that the vast majority of impacts of the options are related to environmental impacts, i.e. water quality, physical habitats and landscape and visual amenity, and, to a lesser extent, economic impacts, especially with regard to business development because of loss of boating activity.

The number of impact categories being assessed through monetary valuation is smaller than the number of impact categories being assessed through scoring. Moreover, when monetary valuation has been undertaken, such as for assets and land use, values have been found considerably low. In the former case, it is because only four gardens are expected to be affected while the main housing buildings are not expected to be affected from flooding, in the latter case, because valuation has been based on ESA payments.

**Table 3.1: Table summarising the results in the screening exercise**

<b>Project name</b>	<b>River Chet flood defence scheme – AU2</b>	
<b>Impact category</b>	<b>Monetary valuation</b>	<b>Score</b>
<b><i>Economic impacts</i></b>		
Assets	✓	
Land use	✓	
Transport	Not relevant	Not relevant
Business development		✓
<b><i>Environmental impacts</i></b>		
Physical habitats		✓
Water quality		✓
Water quantity	Not relevant	Not relevant
Historical environment	Not relevant	Not relevant
Natural processes	Not relevant	Not relevant
Landscape and visual amenity		✓
<b><i>Social impacts</i></b>		
Recreation	✓	
Health and safety	Not relevant	Not relevant
Availability and accessibility of services	Not relevant	Not relevant
Equity	Not relevant	Not relevant
Sense of community		✓
<b><i>Cross-cutting impacts</i></b>		
Policy integration		✓

## 4. Cost of options

The do-nothing option has zero (£0) costs. The costs of the other options were provided, by personal communication, by the consultants in charge of the project. The case study does not correspond exactly to the original project, as some additional options have been included in the MCA appraisal; hence the costs provided by the Consultants had to be adjusted to take into account the differences. The resulting costs for the options are presented in Table 4.1.

**Table 4.1 Summary of costs of options used in the case study appraisal (£)**

	<b>Capital cost</b>	<b>Maintenance</b>	<b>Total PV cost</b>
<b>Maintain</b>	150,000	34,000	174,996
<b>Sustain</b>	2,700,000	194,000	1,887,787
<b>Flood to High Ground</b>	530,000	40,000	324,639
<b>Maintain then Flood to High Ground</b>	630,000	56,000	389,157

## 5. Assessment of impacts

### 5.1. Qualitative and quantitative assessment

The qualitative and quantitative assessment of the different options for each of the management units was carried out using the appraisal summary table for the main assessment (MA-AST) and it is presented in Appendix B4.2 to this Annex.

The assessment followed a stepped approach, starting with the qualitative assessment of all impact categories and moving to the quantitative assessment whenever information was available.

### 5.2 Monetary valuation of impacts

Benefits accruing from provision of defences (i.e. damages avoided) can be subdivided into 4 categories:

- write-off benefits;
- intermittent flooding after breach benefits;
- overtopping benefits; and
- erosion protection benefits.

In order to calculate the benefits the following probabilities of breach have been assumed under the different Options.

**Table 5.1: Probability of breach under different options by year**

<b><i>Do nothing</i></b>				
Year	0	4	99	99
Probability of breach	0.2	1.0	1.0	1.0
<b><i>Maintain existing defences</i></b>				
Year	0	9	99	99
Probability of breach	0.2	1.0	1.0	1.0
<b><i>Improve</i></b>				
Year	0	10	99	99
Probability of breach	0.05	0.05	0.05	0.05
<b><i>Flooding to high ground</i></b>				
Year	0	10	99	99
Probability of breach	0.2	1.0	1.0	1.0
<b><i>Maintain then flood to high ground</i></b>				
Year	0	9	99	99
Probability of breach	0.2	1.0	1.0	1.0

Also, the following assumptions were made under each option:

- **Do-nothing:** No work is undertaken either as capital improvement or maintenance. The poor state of the existing defences mean that they will fail by year 4. The gardens of properties affected will be written off and the effects on navigation will lead to the closure of two boatyards. The

freshwater habitat will be lost but the new flooded area will be similar to Hardley Flood and therefore has the potential to develop greater conservation value equivalent to an SSSI. There will be a reduction in boating activity (assumed to be 50%) due to siltation and navigation being more difficult for larger boats;

- **Maintain:** Under maintain, work is undertaken to strengthen and repair the defences until this becomes impossible in year 9. After year 9, therefore, the option reverts to do-nothing. This means that the gardens and agricultural land are written-off and that recreational trips are also lost. The write-off costs are the same as for do-nothing, but occur further into the future such that the Present Value damages are reduced;
- **Sustain:** Under sustain, there would be negligible damages to gardens, while the agricultural land and recreational use of the area would be protected to a 1 in 20 year standard;
- **Flood to High Ground:** Under the flood to high ground option, there would be negligible impacts on gardens as defences would be provided to properties. Recreation would be affected to a degree but some dredging would be undertaken to maintain navigation channels but not to the same depth as at present. Agricultural land would be written-off following breaching of the defences in year 4;
- **Maintain then Flood to High Ground:** This option would involve maintaining the defences until they can no longer be maintained and then reverting to the flood to high ground option such that further breaching of the defences is managed. This would result in negligible damages to properties, as these would again be protected by the construction of defences. Recreation would be protected by the dredging of navigation channels. Agricultural land would be written-off, but over a longer time period, with breaching not expected to occur until year 9.

### 5.2.1 Write-off benefits

#### **Assets**

On the River Chet there are approximately five residential complexes along the road between Heckingham and Loddon, with additional properties at Nogdam End. Of these, 4 properties (in particular their gardens) are at risk from flooding under the do nothing option, thus, they will be written-off. The Multi-Coloured Manual (Penning-Rowse et al., 2003) notes that gardens make up for 2.3% of the total value of properties. The Property Register for Loddon shows an average value per property of £168,399. Thus, the value to be written-off is around £15,500.

#### **Land use**

Almost all of the adjacent land to the River Chet south bank is under the Environmental Sensitive Area Scheme. Table 4.2 shows the areas of agricultural land flooded for each ESA Tier.

**Table 5.2: ESA area flooded in the right bank of the River Chet**

ESA tiers	Agricultural land type	Area flooded (ha)
Tier 1	Permanent grassland	14.732
Tier 2	Extensive grassland	49.7986
Tier 3	Wet grassland	15.5034
Tier 4	Arable reversion to permanent grassland	0
Non ESA land		1.9113

Under the do-nothing option it is assumed that the agricultural land will be flooded very frequently and therefore the benefits accrue from its maintenance will be totally lost (or written off). Values for agricultural land have been used from Nix (1998). The write-off value assigned corresponds to the market value of the land (Nix (1998) average value of £7,075/ha), factored by 0.45 to account for subsidies of agricultural land. Over the 82 ha affected, this is equivalent to around £260,000.

### **5.2.2 Intermittent flooding after breach benefits**

#### **Assets**

Infrequent flooding can occur around the edge of a written-off zone, where properties are flooded on some events but not frequently enough to be written off. For the study area, however, it was concluded that damages to assets from infrequent flooding would not be significant and have not been monetised.

#### **Land use**

For option 2, the standard of protection would initially be 1 in 5, which means that the agricultural land will be producing the same as it is today, therefore no significant benefits would be gained from protection. For the improve option, where the standard of protection would be increased to 1 in 20, the agricultural land under the ESA scheme would be less frequently flooded than today. ESA agricultural land has to guarantee a certain amount of flooding to maintain the characteristics for which it was designated. The 1 in 20 standard might prevent this flooding from occurring; therefore, in order for the benefits not to be lost some arrangements would have to be made so that the area is flooded at the appropriate frequency. This may represent a small additional cost.

#### **Transport**

The only important road in the study area is the B1140 that runs alongside the Chet close to Nogdam End, but is outside the study area. There are also alternative routes for any of the minor roads that may be impassable for a short time and hence the impacts are considered not to be significant.

### ***Business development***

Tourism linked with navigation is an important industry in Loddon. If the area floods after a breach, recreational activities could potentially be lost, and this will have an impact on the economic development of the village, with potential loss of commerce and, consequently, jobs. However, the Red Manual notes that flooding of retail, distribution, office and leisure services are unlikely to generate significant indirect loss to the nation. Therefore this has not been assessed in monetary terms. They will, however, be considered in qualitative terms.

### ***Historic environment***

There are no Schedule Ancient Monuments in the study area and there are no archaeological sites of interest. Impacts for this category are therefore not considered.

### **5.2.3 Erosion protection benefits**

The erosion protection benefits accruing from carrying out protection works are derived from an assessment of the economic value of extension to the life of, or delay in, loss of the erosion-prone properties for a period of time equal to the life of the works (Penning-Rowsell et al., 1992).

The water quality of the River Chet might be affected under the do nothing option. This is because more erosion will give rise to increasing the sediment load of the river water. Also, if flooding is more frequent, then agricultural land will be drained more often into the river, which in turn can increase the concentration of pesticides for example. It is worth to note that most agricultural land in the Chet margins is under the ESA scheme, which means that more environmentally friendly agricultural practices are undertaken which in turn means that the impact of agricultural land drainage is not so acute and can even be insignificant.

It is difficult to put a value on water quality changes due to erosion. Therefore, benefits have been assessed qualitatively and scores given.

### **5.2.4 Overtopping damages**

Overtopping damages, without breach, are expected to be negligible. Therefore, no valuation has been undertaken.

## 5.2.5 Monetary valuation of intangible benefits

### *Recreation*

The River Chet's main recreational activity is linked to leisure navigation. There are two mooring sites on the south bank of the Chet; one in Loddon Staithe (with moorings for a number of boats of all sizes) and another at Pyes Mill, where there is also a public picnic site. The August 1994 boat census undertaken by the BA recorded approximately 150-200 boat movements (upstream and downstream) per day on the River Chet at Chet Mouth.

Using the data above (150 to 200 boat movements upstream and downstream per day (Posford Duvivier, 1996)), the number of boats is estimated at 75 to 100 boats on a single day, or 2,300 to 3,100 for the month of August. The Benefits Assessment Guidance notes that boating in the summer can be up to 40% of annual totals; thus the number of boats can be estimated at 6,000 to 8,000. Regarding the value of recreational boating, Willis and Garrod (1991) estimate this at £0.47 to £1.17 per boating visit (2003 values). Therefore, and assuming 3 people per boat, the value of boating activities can be estimated at £8,000 to £28,000 annually.

Angling is permitted between Loddon and Hardley Cross, with bream and roach being a common catch (Waterscape, 2004). The season for coarse fishing runs from 16<sup>th</sup> June, 2003 to 14<sup>th</sup> March, 2004. However, anglers do not have access to the south bank of the river, except at Loddon Staithe, which is not part of the study area.

Other recreational activities known, to be undertaken in the river include: wildfowling, walking, cycling and birdwatching. Access to the south bank of the Chet is very restricted, which makes these activities almost impossible. However, the potential decrease in water quality under the do-nothing option due to increased siltation and sediment transport may have impacts on the informal recreation that occurs in the left bank of the river. The number of visits per year to picnic site in East Anglia (based on BAG) can be estimated at 1,000 visits. Coker (1990) value per visit is of £1.41 per adult/visit (£2003). Thus, the value of informal recreation is estimated at £1,500 per year. We have assumed that not all recreational value will be lost and only 50% will be lost under the do-nothing option. The loss of recreational value, or benefits from protection, is thus estimated at between £4,750 and £14,750 per year.

The breach in the do-nothing option is assumed to have taken place by year 4 (probability in year 4 = 1.0). After this, the breach is not repaired so gardens of properties and agricultural land are written off. The value of recreational trips continues to be lost annually as recreation cannot occur again in the area.

### ***Physical habitats***

According to consultation responses to the Environmental Impact Assessment (Halcrow, 2003), the Norfolk Wildlife Trust survey in 2002 recorded breeding redshank (poss 2 pairs), oystercatcher (poss 1 – 2 pairs) and lapwing (poss 10 pairs) in a limited area at Nogdam End.

The loss or substitution of this biodiversity does not represent a significant loss in general when considered in the context of the whole of the Broads. However, it is important to point out that reedbeds and floodplain grazing marshes constitute a habitat for which a habitat action plan exists.

In the do nothing option, these habitats and species will suffer the impacts of river water inundation or more frequent flooding, and in this way may be altered. The River Chet has no particularly important environmental features, therefore the impacts on the environment will not be significant as these habitats and species exist in other rivers of the Broads. Thus, monetary valuation is not considered necessary.

Moreover, if the right bank of the river is permanently flooded, an area of washland similar to that in Hardley flood could be created. With time this area has the potential to become a site for nature conservation, and even be designated as an SSSI and/or SPA.

### **5.3 Scoring of impacts**

When impacts have not been valued, scores have been assigned instead. Overall, scores have been given based on the extent of the site's properties affected, to the extent possible. There are, however, difficulties when trying to score impacts when quantitative units affected are more difficult to account for and/or are not available, such as water quality and sense of community.

The following Table summarises the monetary valuation and impact scores and gives justification for the latter.

**Table B5.1 Table summarising scores and monetary estimates**

<b>Project Name</b>		River Chet Flood Management Options Figures have been rounded to two significant figures				
<b>Category</b>	<b>Do Nothing</b>	<b>Maintain</b>	<b>Improve</b>	<b>Flooding to high ground</b>	<b>Maintain then flood to high ground</b>	<b>Justification</b>
<b>Economic impacts</b>						
Assets	£15,000	£14,000	Negligible	Negligible	Negligible	Gardens will be protected under flooding to high ground to a 1 in 20 return period; so costs under flooding to high ground are equal to the option of improve (1 in 20).
Land use	£220,000	£201,000	£6,000	£220,000	£200,000	Flooding to high ground will have the same effects as the do nothing option, as agricultural land will be lost.
Transport	-	-	-	-	-	Not relevant
Business development	0	10	100	50	60	Business developed from navigation is noted to be as a contributor to the local economy. Considering that the quality status of the river, in particular the navigation channels, influences significantly tourism, it is assumed that any change (positive or negative) to the navigation channels will have a significant impact on business development. In this context, the option that will score the highest (100) is the one that will have the most positive influence on the local area (Option 3, i.e. improve). Option 4 (Flooding to high ground) will have less of a positive impact. There are three boatyards in the area. We have assumed that 1 will close and the others will remain as a result of dredging and channel maintenance (score of 50). Against this, two boatyards will close under the Do-Nothing Option. An issue for business development is how to score the closure of 2 boatyards in year 10 from Option 2. If information was available to boatyards about the impacts, it seems likely that business development would be affected from year 10. Thus a score of 10 has been given. Maintain then flood to high ground scores allows ten years for businesses to adapt to future flooding and, therefore, scores 60.
<b>Environmental impacts</b>						
Physical habitats	100	90	0	100	90	Floodwaters under the do-nothing will have a significant impact on soke dykes, through increased water content and salinity. The species present within the soke dyke habitat will be lost. The wet woodland habitat will also be partially damaged by more frequent or permanent flooding. The species that relate to this

**Table B5.1 Table summarising scores and monetary estimates**

Project Name						
River Chet Flood Management Options						
Figures have been rounded to two significant figures						
Category	Do Nothing	Maintain	Improve	Flooding to high ground	Maintain then flood to high ground	Justification
						<p>habitat might be partially lost but it is likely that the majority of mobile species will tend to move towards the non-flooded area of the wood. In the medium to long term a wash land habitat will be created potentially similar to that on Hardley flood (designated SSSI and Ramsar site) on the left bank of the Chet. Under the other Options, impacts will be minimised, with improve having a less of a negative impact than maintain. Impacts from flooding to high ground will be similar to do nothing.</p> <p>It is considered that the potential development of an SSSI would result in greater conservation value than the protection of the soke dykes. Do-nothing, maintain, flood to high ground and maintain then flood to high ground will all result in development of an SSSI. Do-nothing and flood to high ground would result in the SSSI developing over the next 5 years, with maintain and maintain then flood to high ground resulting in the SSSI developing over the next 10-15 years. Therefore, do-nothing and flood to high ground score 100. Maintain and maintain then flood to high ground score 90. Sustain would not result in the development of an SSSI and sea level rise is likely to result in increased salinity of the soke dykes over time in any case, therefore, this is the worst option and scores 0.</p>
Water quality	0	10	100	0	10	<p>There is no quantitative indication of the impact on water quality of the different options being assessed, (which makes the scoring exercise difficult). The 'do-nothing' and flooding to high ground will have a negative impact on water quality; under the former, this is for two reasons, first the impact of increased suspended sediments and, second, the increased run-off from agricultural land due to increased flooding. Under flooding to high ground, water will become brackish due to increased water exchange in the washland. Under the improve option the level of sediments will be reduced, thus, the Option scores 100. Maintain will delay impacts to year 10. Maintain then flood to high ground is assigned a score of 10 as it would result in the same impacts as maintain.</p>
Water quantity	-	-	-	-		Not relevant
Natural processes	-	-	-	-		Not relevant
Historical environment	-	-	-	-		Not relevant

**Table B5.1 Table summarising scores and monetary estimates**

<b>Project Name</b>						
River Chet Flood Management Options Figures have been rounded to two significant figures						
<b>Category</b>	<b>Do Nothing</b>	<b>Maintain</b>	<b>Improve</b>	<b>Flooding to high ground</b>	<b>Maintain then flood to high ground</b>	<b>Justification</b>
Landscape and visual amenity	100	90	0	100	90	The best available option between those considered for the Chet is when landscape changes from grazing marsh to washland, under the 'do-nothing' option and flooding to high ground. Thus, these options score 100. The landscape will become more natural in year 10, under the maintain option. Improve will have the worst impact to the landscape, in comparison with rest of the options, thus it scores 0. Maintain then flood to high ground is assigned a score of 90, as it would have the same impacts as maintain.
<b>Social impacts</b>						
Recreation	£130,000 - £410,000	£130,000-£390,000	£7,100-£22,000	£120,000-380,000	£130,000-£380,000	Flooding to high ground will have greater impacts on recreation than the improve option; as part of the informal recreational activity will be lost together with boating activities. The option with the least impacts on recreation will be 'sustain'; thus the costs expected are less than for the remaining options. Values are however presented in ranges to reflect uncertainty (note that the lower bound for the 'do nothing' and 'maintain' option is the same due to rounding).
Health and safety	-	-	-	-	-	Not relevant
Availability and accessibility of services	-	-	-	-	-	Not relevant
Equity	-	-	-	-	-	Not relevant
Sense of community	0	10	100	50	60	Sense of community is mostly affected by loss of property, jobs and business development. Scoring this category on the basis of loss of jobs and business development could incur in double counting with equity. Loss of property (the physical loss rather than the monetary loss) would then be the most relevant factor in scoring this category. Since loss of property would occur in the do nothing option, it could be said that this option would score 0, whereas improve will score 100. Gardens will be protected under flooding to high ground; however agricultural land will be lost which could affect the sense of community. This Option scores 50. Maintain will only delay flooding but same effects as for the do-nothing could be expected. Thus, it scores 10. Maintain then flood to high ground scores allows ten years for businesses to adapt to future flooding and, therefore, scores 60.
<b>Cross-cutting impacts</b>						

**Table B5.1 Table summarising scores and monetary estimates**

Project Name	River Chet Flood Management Options Figures have been rounded to two significant figures					Justification
Category	Do Nothing	Maintain	Improve	Flooding to high ground	Maintain then flood to high ground	
Policy integration	0	0	100	66	75	<p>The scoring of Policy Integration has been based on the elements in common with the Strategy covering the Chet and other relevant stakeholders' viewpoints on conservation, i.e. EN and the Broads Authority. The worst expected impacts on policy integration relate to the integrated management of the River Chet as a whole, since different margins are part of different compartments and therefore are being treated separately. These are expected under the 'do-nothing' option and the 'maintain' option, thus, they score 0. On the other hand, it is difficult to establish which is the best option of the two remaining, since one only agrees partly with the Strategy whereas the other does not agree with the Strategy but is more in line with EN expectations and, likely, the Broads authority. Therefore, a score of 100 has been assigned to option 3 and 66 to option 4. 'Maintain' then flood to high ground in allowing ten years for adaptation is more in line with Defra's exit strategy than flood to high ground and is assigned a score of 75.</p>

## 6. Weighting

### 6.1 Weighting methods and analysis used

Weight elicitation for the Chet case study was carried out by means of a paper based questionnaire. The starting point for the approach was a condensed version of the (more theoretically correct) full pair wise comparison method requiring comparison of all categories of impact with all others. A condensed approach was used because the number of comparisons required using the full approach would have been too time consuming and inconsistent with obtaining a sufficient number of responses.

Table 6.1 provides an example diagram for a simple five-category analysis using the full approach. As can be seen from the figure, ten sets of pair wise comparisons would be required to complete the response.

**Table 6.1 Full weight elicitation for impact categories A-E**

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
<b>A</b>	=	Elicit	Elicit	Elicit	Elicit
<b>B</b>		=	Elicit	Elicit	Elicit
<b>C</b>			=	Elicit	Elicit
<b>D</b>				=	Elicit
<b>E</b>					=

The condensed approach seeks to reduce the number of comparisons that have to be made, and thus speed up the process for the respondent. The approach requires respondents to first rank categories of impact and then to indicate the importance of one factor relative to another down the rank order. Thus, for five categories, four comparisons are required initially, the weights between the remaining categories being inferred mathematically, see for example Table 6.2.

**Table 6.2 Condensed weight elicitation for impact categories A-E**

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
<b>A</b>	=	Elicit	<i>Infer</i>	<i>Infer</i>	<i>Infer</i>
<b>B</b>		=	Elicit	<i>Infer</i>	<i>Infer</i>
<b>C</b>			=	Elicit	<i>Infer</i>
<b>D</b>				=	Elicit
<b>E</b>					=

However, both full and condensed approaches may provide inconsistent results, but for different reasons. In the full approach, inconsistencies may arise because the weight apportioned between some comparisons may be inconsistent with the weights implied by other comparisons. Thus, if the respondent has indicated that Category A is twice as important as Category B and Category B is as important as Category C, an entirely consistent set of data would also record that Category A is twice as important as Category C. Such an entirely consistent result is rarely delivered from the full approach, requiring consideration as to how one deals with the inconsistent responses.

The condensed version does not suffer from this particular type of inconsistency because entirely consistent results are inferred mathematically from the subset of comparisons. However, the risk with such an approach is that the respondent is not aware of the effect of his/her initial choices on the derivation of the inferred preferences. In previous attempts, using this approach, we have noticed a tendency for some respondents to place a disproportionate amount of weight to the higher order categories to the detriment of the lower order ones. To prevent this tendency but maintain a less time consuming approach, in the Chet Case Study respondents were also asked to compare their top ranked impact category with the middle ranked category; and their middle ranked category with the bottom ranked category. In effect, the idea was to complete some of the data points that would otherwise have been inferred alone. This is illustrated in Table 6.3, which shows which sets of comparisons are elicited and inferred using this approach.

**Table 6.3 Calibrated condensed weight elicitation for impact categories A-E**

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>
<b>A</b>	=	Elicit	<b><i>Infer and Elicit</i></b>	<i>Infer</i>	<i>Infer</i>
<b>B</b>		=	Elicit	<i>Infer</i>	<i>Infer</i>
<b>C</b>			=	Elicit	<b><i>Infer and Elicit</i></b>
<b>D</b>				=	Elicit
<b>E</b>					=

The approach provides two sets of weights per respondent. The first is the initial set that denotes the relative distance between the importance of the different categories, and the second set, which provides verification of the relative distance between the top, middle and bottom ranked categories. Ideally, the gradient of weight down the categories should be the same or similar. Where they are not, this suggests that the respondent has allotted weight disproportionately; however, the second data set (which provides for the overall gradient) can be used to calibrate the first.

Figures 6.1 and 6.2 provide the results of two responses drawn from the case study. Figure 1.4 shows a response where the respondent initial full response disagrees with the second, partial response. The data can be combined to provide a corrected response lying between the two. This is achieved simply by reducing the gradient of the initial response so that it lies mid-way between the initial full response and the second (partial) response. As can be seen by examination of the corrected response, the data points are both tilted and squeezed closer together to achieve this. However, the proportionality of weights allotted to neighbouring ranks is the same in the corrected response as in the initial response.

Figure 6.1 Correction of disproportionate response

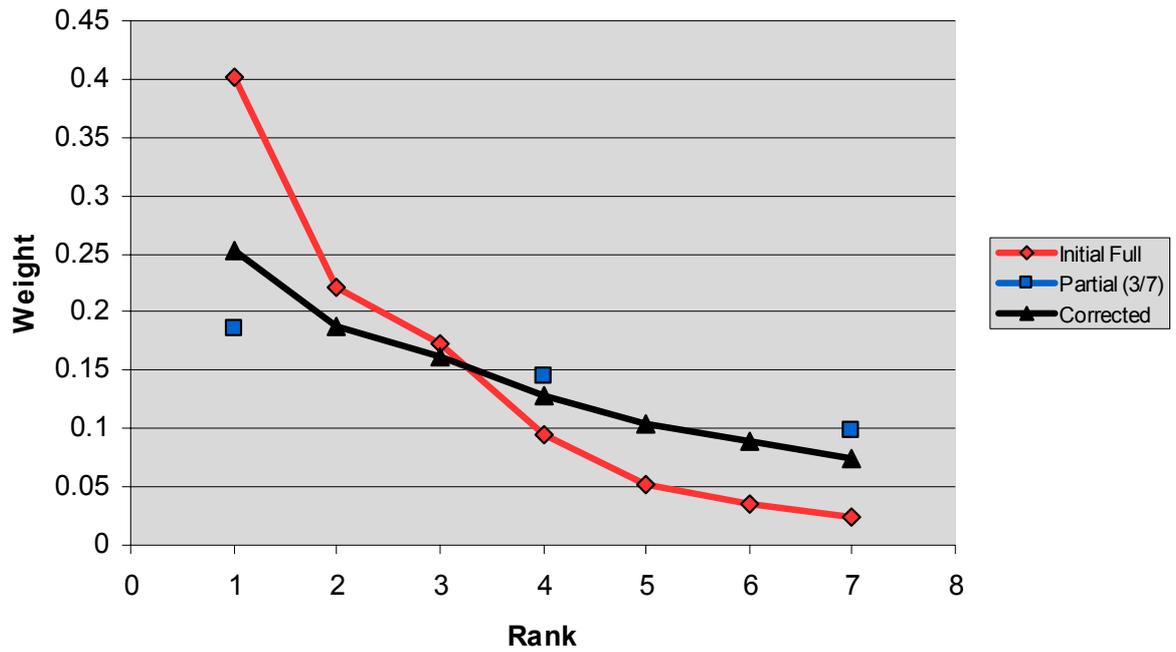
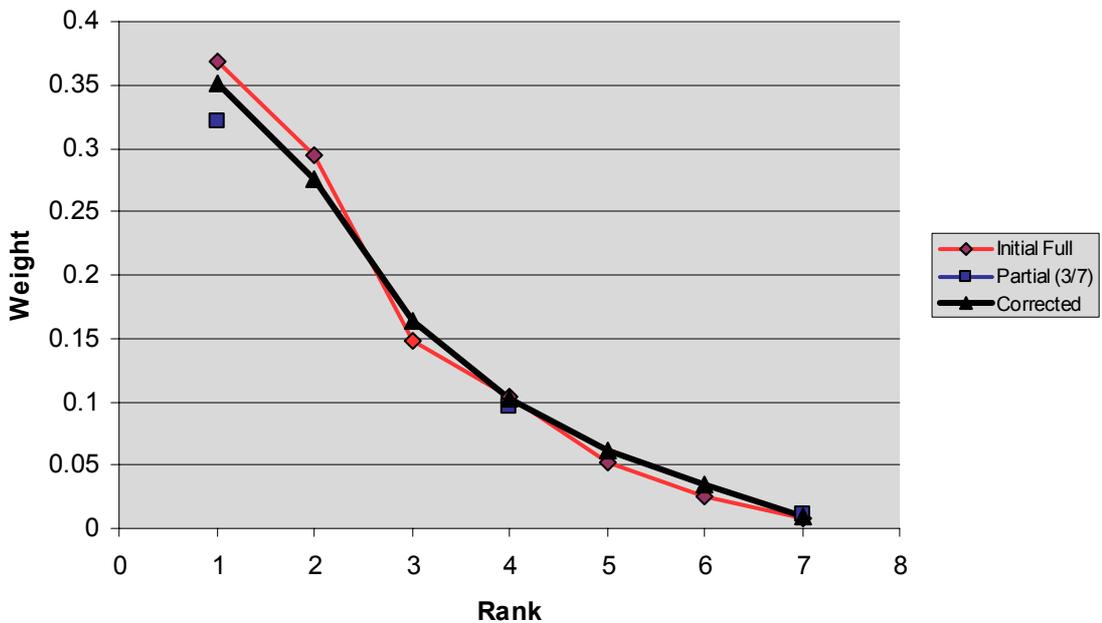


Figure 6.2 provides an example response where the respondents' initial and second responses are very similar. The application of the same calibration approach to provide corrected results thus has little effect on the resulting weights.

Figure 6.2 Minor Correction of Response



**6.2 Results of the weight elicitation**

One of the potential advantages of using individual questionnaire responses rather than focus groups is that a consensus on, for example, rank order, does not have to be forced. Each (informed) individual may record their own preferences without reference to a group and the restrictions that may be placed on them by the rest of a group.

However, one of the potential disadvantages can be that, because different people have different priorities, their rank orders are different. A lack of consensus between respondents will be apparent where there is little consistency between responses concerning the position or weight that is applied to the categories.

An obvious solution to the approach would be to take the average weight for each category across all responses, alongside the standard deviation to give a range of possible values for sensitivity analysis. However, this makes the resulting weights highly sensitive to the sample population and the proportion of different people with different views and agendas.

However, the focus of the whole analysis is not on what the weighted score of each of the options is but rather, which has the highest total weighted score and hence performs best. In other words, it is the outcome that is important. Therefore, an alternative approach is to combine all weight responses with the scores for the different options to generate the total weighted score for each respondent. Thus, even where there is considerable disagreement on the relative importance of different categories of impact in the MCA, there may be little disagreement concerning which option performs best in the end.

For the Chet case study, there was very little consensus in the rank order of categories and associated weights between the responses. However, an analysis of the outcomes from the application of each of the responses (using both uncorrected and corrected responses) provides the results in Table 6.4.

As can be seen from the table, on the basis of the intangible weighted scores only (i.e. before the monetary costs and benefits are taken into account) 83% of responses result in the Improve option being the highest scoring option and 17% being either of the Flood to High Ground options. As such, whilst there is little consensus between respondents in terms of weights, a consensus is apparent once these weights are applied to the scores.

**Table 6.4 Outcomes of individual Chet responses**

<b>Option</b>	<b>Uncorrected initial full</b>	<b>Corrected response</b>
Do nothing	0%	0%
Maintain	0%	0%
Improve	83%	83%
Flood to high ground	17%	0%
Maintain then flood to high ground	0%	17%

## 7. Comparison of options

### 7.1 Selecting the preferred option

The total intangible weighted score only makes up a part of the overall decision-making process concerning the preferred option. The next stage is to consider the total weighted scores for the options alongside the monetary costs and benefits of the options.

The overall benefit cost ratio of an option is given by  $(B/C) + (I_{\text{£}}/C)$ , where B denotes the monetary benefits, C the monetary costs, and  $I_{\text{£}}$  the monetary value of the intangible benefits. As described elsewhere,  $I_{\text{£}}$  for an option is given by the product of the total weighted score (I) and the multiplication factor (k), expressed as pounds per point on the 100 point intangible score. Because the value of k is not known, the analysis uses a range of possible values for k from k minimum (k min - which as a default is defined as 0.1% of the 'Do Nothing damage' costs<sup>1</sup>) to k maximum (k max – which as an absolute maximum default is taken as 10% of the 'Do Nothing damage' costs<sup>2</sup>).

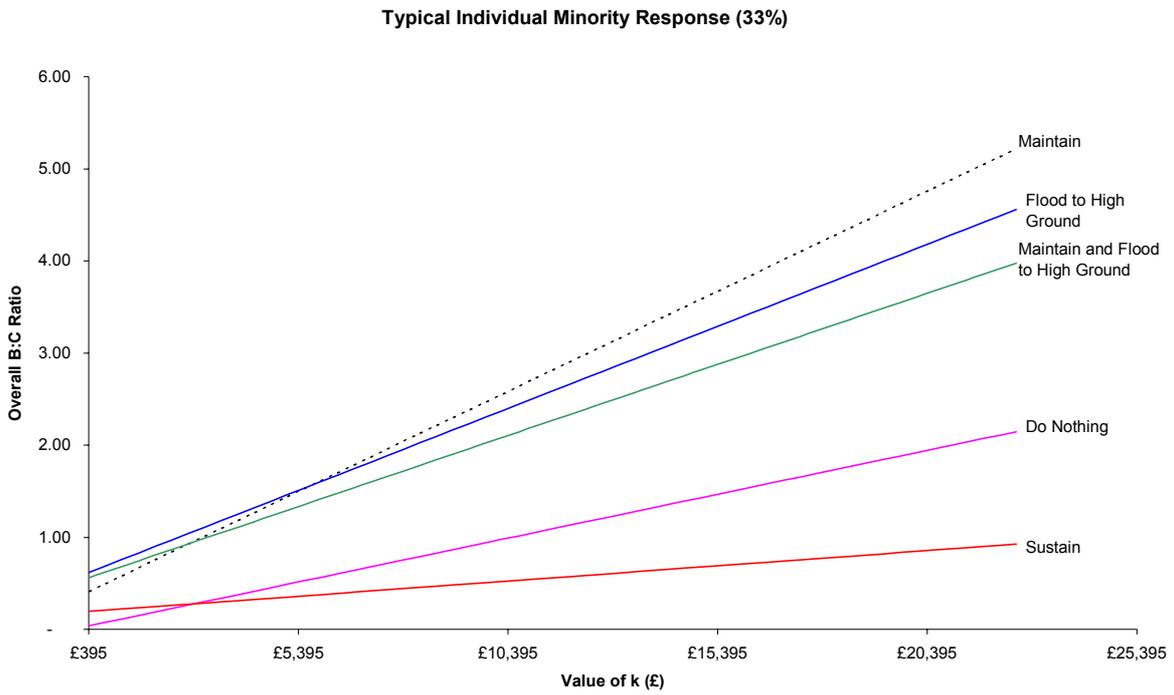
The result of such an analysis across the range of k was calculated for all respondents. The results fell into a majority (66%) and a minority (33%) response, with responses within these groups having more or less identical outcomes at the various levels of k. Typical examples of minority and majority response results are provided in Figures 7.1 and 7.2 overleaf. The average response result is provided in Figure 7.3.

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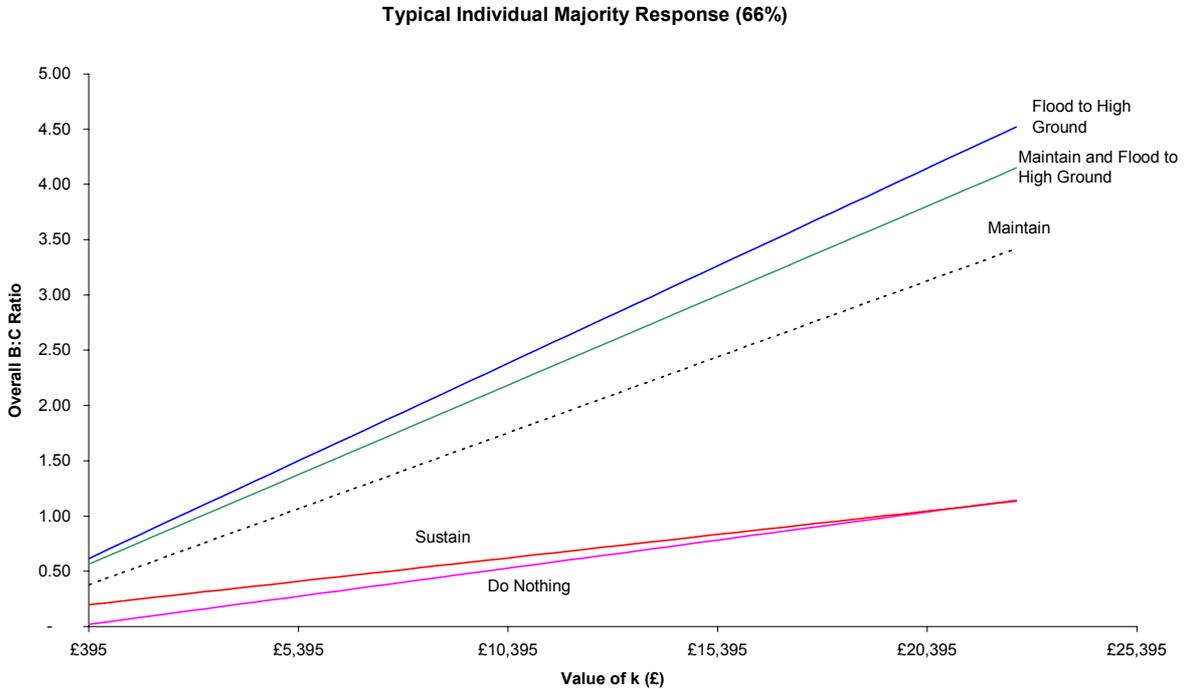
<sup>1</sup> i.e. at k min the Total Economic value (TEV) of the intangible assets at stake is 10% of the 'Do nothing' damage costs.

<sup>2</sup> i.e. at k max the TEV of the intangible assets at stake is 10 times the 'Do nothing' damage costs.

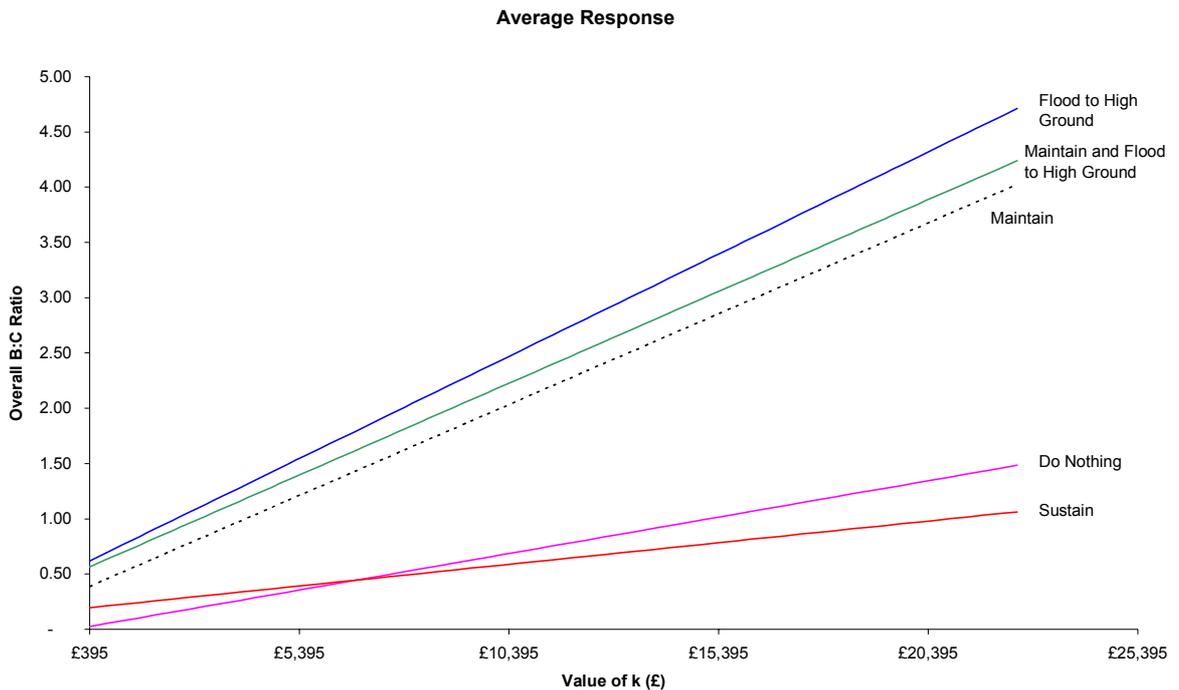
**Figure 7.1 Typical individual minority response**



**Figure 7.2 Typical individual majority response**



**Figure 7.3 Average response**



## 7.2 Drawing conclusions on the preferred option

As can be seen from all figures, for all responses there are two to three competing options: 'maintain'; 'flood to high ground'; and 'maintain and flood to high ground'.

In the majority and average response, whatever the value of k, 'flood to high ground' is always the preferred option, closely followed by 'maintain and flood to high ground' and, in turn, the 'maintain' option. All of the minority responses show the same outcome until k reaches a value of £5,900, whereupon the 'maintain' option becomes the preferred option.

From these data, there is complete consensus that 'flood to high ground' is the preferred option from an economic perspective, until k reaches a value of around £5,900. Above this, there is a 33% response, which indicates that 'maintain' would be the preferred option. Thus, the first step in making a final decision on the preferred option for the River Chet requires consideration of the likelihood that k is greater or less than £5,900.

A k value of £5,900 for the Chet implies that the Total Economic Value (TEV) of the intangible assets at stake is £590,000. This is a figure equivalent to 1.5 times the 'no-nothing' damage costs of £395,000. As this is a value at least bordering on the unreasonably high it might be concluded that the 'flood to high ground' option should be the preferred option.

## 8. References

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## Appendix B4.1

Appraisal summary table for high level screening –  
S-AST for the River Chet flood alleviation scheme

**Table B4.1.1: Appraisal summary table for flood management and coastal defence – high level screening**

<b>Project name</b>		<b>River Chet flood defence scheme – AU2</b>		
<b>Assumptions:</b>		The high level screening will correspond to the do nothing option.		
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Impact details</b>	<b>Qualitative or quantitative assessment</b>	<b>Monetary valuation</b>
<b><i>Economic impacts</i></b>				
Assets	Y	<ul style="list-style-type: none"> <li>potential impact to residential properties</li> </ul>		✓
Land use	Y	<ul style="list-style-type: none"> <li>potential impact to tier 1 agricultural land under ESA scheme;</li> <li>potential impact to small areas of tier 2 and 3 agricultural land under the ESA scheme.</li> </ul>		✓
Transport	N	-		
Business development	Y	<ul style="list-style-type: none"> <li>potential impact to the economic development of the local community (Loddon and Chedgrave) due to decrease in recreational interest of the river, in particular navigation.</li> </ul>	✓	
<b><i>Environmental impacts</i></b>				
Physical habitats	Y	<ul style="list-style-type: none"> <li>potential impact to designated Environmental Sensitive Area (low lying river valley grassland – considered under land use impact category);</li> <li>potential impacts to soke dyke habitat and species;</li> <li>potential impact to wet woodland;</li> </ul>	✓	
Water quality	Y	<ul style="list-style-type: none"> <li>potential impact on suspended sediment in the water due to increased erosion;</li> <li>potential impact to water quality due to more frequent flooding of adjacent agriculture land.</li> </ul>	✓	
Water quantity	N	-		
Historical environment	N	-		
Landscape and visual amenity	Y	<ul style="list-style-type: none"> <li>potential impact to nationally important open valley landscape – Area of Outstanding Natural Beauty;</li> <li>potential impact to reed Ronds, which are a distinctive feature of the River Chet.</li> </ul>	✓	

**Table B4.1.1: Appraisal summary table for flood management and coastal defence – high level screening**

<b>Project name</b>	<b>River Chet flood defence scheme – AU2</b>			
<b>Assumptions:</b>	The high level screening will correspond to the do nothing option.			
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Impact details</b>	<b>Qualitative or quantitative assessment</b>	<b>Monetary valuation</b>
<b><i>Social impacts</i></b>				
Recreation	<b>Y</b>	<ul style="list-style-type: none"> <li>potential impact to navigation for recreation (passenger vessels and light sport vessels);</li> </ul>		✓
Health and safety	<b>N</b>	-		
Availability and accessibility of services	<b>N</b>	-		
Equity	<b>N</b>	-		
Sense of community	<b>Y</b>	<ul style="list-style-type: none"> <li>potential impacts on the relationship between Loddon (south bank) and Chedgrave (north bank) communities due to different treatment of needs of both communities.</li> </ul>	✓	
<b><i>Cross-cutting impacts</i></b>				
Policy Integration	<b>Y</b>	<ul style="list-style-type: none"> <li>potential impact on integrated management of the River Chet as a whole, since different margins are part of different compartments and therefore are being treated separately.</li> </ul>	✓	

## Appendix B4.2:

Appraisal summary table for main assessment –  
MA-AST for the River Chet flood alleviation scheme

<b>Table B4.2.1 Appraisal summary table for flood management and coastal defence – main assessment</b>					
<b>Project name</b>		River Chet flood protection scheme			
<b>Description of option</b>		Do nothing option			
<b>Description of area affected by option</b>		The area being assessed comprises of the south (right) bank of the River Chet, running from Pyes Mill, near Loddon, to Nogdam End.			
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Qualitative description of impacts</b>	<b>Quantitative assessment of impacts (no. units/monetary)</b>	<b>Score</b>	<b>Monetary value</b>
<b>Economic impacts</b>					
Assets	Y	Flooding will have an impact on 4 residential properties, in particular their gardens. The impact on the buildings themselves can be considered insignificant.	The gardens for 4 residential properties will be flooded (written-off)		£15,000
Land use	Y	Flooding of ESA tier 1, 2 and 3 agricultural land plus arable land not under ESA scheme. There will be no change in value of non-ESA land as this will go to wetland.	71.9 ha of ESA agricultural land to be written-off.		£220,000
Transport	N	-	-		
Business development	Y	Impact to the economic development of the local community (Loddon and Chedgrave) due to decrease in recreational interest of the river, in particular navigation.	Of 3 boatyards, 2 will close under the 'Do Nothing' Option	0	
<b>Environmental impacts</b>					
Physical habitats	Y	Floodwaters will have a significant impact on soke dykes, through increased water content and salinity. The species present within the soke dyke habitat will be lost. The wet woodland habitat will also be partially damaged by more frequent or permanent flooding. The species that relate to this habitat might be partially lost.	Difficult to estimate the number of units affected.	100	
Water quality	Y	Impact on quantity of suspended sediment in the water due to increased erosion. Impact to water quality due to more frequent flooding of adjacent agriculture land.	Number of units not quantifiable.	0	
Water quantity	N	-	-		
Historical environment	N	-	-		

**Table B4.2.1 Appraisal summary table for flood management and coastal defence – main assessment**

<b>Project name</b>		River Chet flood protection scheme			
<b>Description of option</b>		Do nothing option			
<b>Description of area affected by option</b>		The area being assessed comprises of the south (right) bank of the River Chet, running from Pyes Mill, near Loddon, to Nogdam End.			
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Qualitative description of impacts</b>	<b>Quantitative assessment of impacts (no. units/monetary)</b>	<b>Score</b>	<b>Monetary value</b>
Landscape and visual amenity	Y	More value because of site more natural, but no quantitative units known.	n/a	100	
<b>Social impacts</b>					
Recreation	Y	Impact to navigation for recreation (including rowing, canoeing, sailing, cruisers, day launches (private and hire), passenger vessels and light sport vessels);  Flooding of public picnic site in Loddon Staithe, as well as small walking path in the same area. In addition, anglers using the Staithe can also be affected by more frequent flooding.	150-200 boat movements (upstream and downstream) per day were recorded in August 1994 (Posford Duvivier, 1996) – 75 to 100 boats = 2,300 to 3,100 per month. Assumes this is 40% of annual visits, thus annual number of boats = 6,000 to 8,000. <i>£0.47-£1.17 per boating visit (Willis and Garrod, 1991, 2003).</i> <b>Value of boating activities (3 people/boat) = £8,000 - £28,000 (2003)</b> Number of visits per year to picnic site in East Anglia (based on BAG) is 1,000. <i>Value of today's visit: £1.41 per adult/visit (Coker, 1990, £2003).</i> <b>Value of informal recreation = £1,500 (2003)</b> <b>Not all will be lost: 50% lost.</b> <b>Total value £4,750-£14,750 (annual)</b>		£130,000-£410,000
Health and safety	N	-			
Availability and accessibility of services	N	-	-		
Equity	N	(Included under sense of community)			

<b>Table B4.2.1 Appraisal summary table for flood management and coastal defence – main assessment</b>					
<b>Project name</b>		River Chet flood protection scheme			
<b>Description of option</b>		Do nothing option			
<b>Description of area affected by option</b>		The area being assessed comprises of the south (right) bank of the River Chet, running from Pyes Mill, near Loddon, to Nogdam End.			
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Qualitative description of impacts</b>	<b>Quantitative assessment of impacts (no. units/monetary)</b>	<b>Score</b>	<b>Monetary value</b>
Sense of community	Y	Impacts on the relationship between Loddon (south bank) and Chedgrave (north bank) communities due to different treatment of needs of both communities.		0	
<b><i>Cross-cutting impacts</i></b>					
Policy integration	Y	Impact on integrated management of the River Chet as a whole, since different margins are part of different compartments and therefore are being treated separately.	n/a	0	

<b>Table B4.2.2 Appraisal summary table for flood management and coastal defence – main assessment</b>					
<b>Project name</b>		River Chet flood protection scheme			
<b>Description of option</b>		Maintain existing defences (1 in 5 return period)			
<b>Description of area affected by option</b>		The area being assessed comprises of the south (right) bank of the River Chet, running from Pyes Mill, near Loddon, to Nogdam End.			
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Qualitative description of impacts</b>	<b>Quantitative assessment of impacts (no. units/monetary)</b>	<b>Score</b>	<b>Monetary value</b>
<b><i>Economic impacts</i></b>					
Assets	Y	Flooding will have an impact on 4 residential properties, in particular their gardens from a 1 in 5 year or larger event. The impact on the building themselves can be considered insignificant.	The gardens for 4 residential properties will be flooded by year 10.		£14,000
Land use	Y	Almost all of the adjacent land to River Chet south bank is under the Environmental Sensitive Area Scheme. The agricultural activities behind the defences would also be improved temporarily due to reduced flooding frequency (ESA tier 1, 2 and 3 agricultural land plus arable land not used under ESA scheme).	71.0ha flooded in year 10		£201,000
Transport	N	-	-		
Business development	Y	Impact to the economic development of the local community (Loddon and Chedgrave) due to decrease in recreational interest of the river in the long term, (year 10+) in particular navigation.	Decreased economic activity linked to recreation. 2 boatyards close in year 10.	10	

<b>Table B4.2.2 Appraisal summary table for flood management and coastal defence – main assessment</b>					
<b>Project name</b>		River Chet flood protection scheme			
<b>Description of option</b>		Maintain existing defences (1 in 5 return period)			
<b>Description of area affected by option</b>		The area being assessed comprises of the south (right) bank of the River Chet, running from Pyes Mill, near Loddon, to Nogdam End.			
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Qualitative description of impacts</b>	<b>Quantitative assessment of impacts (no. units/monetary)</b>	<b>Score</b>	<b>Monetary value</b>
<b>Environmental impacts</b>					
Physical habitats	Y	Some temporary positive impacts on freshwater dykes but in the long-term flood waters will have an impact on the soke dykes (increased water content and salinity). Thus habitat present will be lost. However, a wetland habitat will be created on the right bank that will more than compensate for lost habitats.	Difficult to estimate units.	90	
Water quality	Y	Long-term impact on quantity of suspended sediment in the water due to increased erosion.	-	10	
Water quantity	N	-	-		
Natural processes	N	-	-		
Historical environment	N	-	-		
Landscape and visual amenity	Y	Long-term impact to nationally important open valley landscape – Area of Outstanding Natural Beauty.  Impact to reed Ronds, which are distinctive feature of the River Chet. Although this could be considered to be an insignificant impact in the landscape, since it can be found somewhere else in the Broads, reed ronds are locally important as they give variation on the riverbanks (the left bank is piled and featurless).	Positive impacts on landscape from year 10 (going to more natural). Number of units unknown.	90	

<b>Table B4.2.2 Appraisal summary table for flood management and coastal defence – main assessment</b>					
<b>Project name</b>		River Chet flood protection scheme			
<b>Description of option</b>		Maintain existing defences (1 in 5 return period)			
<b>Description of area affected by option</b>		The area being assessed comprises of the south (right) bank of the River Chet, running from Pyes Mill, near Loddon, to Nogdam End.			
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Qualitative description of impacts</b>	<b>Quantitative assessment of impacts (no. units/monetary)</b>	<b>Score</b>	<b>Monetary value</b>
<b>Social impacts</b>					
Recreation	Y	<p>Long-term impact to navigation for recreation (including rowing, canoeing, sailing, cruisers, day launches (private and hire), passenger vessels and light sport vessels) after year 10 as channel changes due to piling and embankment failure;</p> <p>Flooding of public picnic site in Loddon Staithe, as well as small walking path in the same area in the long-term.</p>	<p>150-200 boat movements (upstream and downstream) per day were recorded in August 1994 (Posford Duvivier, 1996) – 75 to 100 boats = 2,300 to 3,100 per month. Assumes this is 40% of annual visits, thus annual number of boats = 6,000 to 8,000.</p> <p><i>£0.47-£1.17 per boating visit (Willis and Garrod, 1991, 2003).</i></p> <p><b>Value of boating activities (3 people/boat) = £8,000 - £28,000 (2003)</b></p> <p>Number of visits per year to picnic site in East Anglia (based on BAG) is 1,000. <i>Value of today's visit: £1.41 per adult/visit (Coker, 1990, £2003).</i></p> <p><b>Value of informal recreation = £1,500 (2003)</b></p> <p><b>No will not all be lost 50% lost</b></p> <p><b>Total value £4,750-£14,750 (annual)</b></p>		£130,000-£390,000
Health and safety	N	-	-		
Availability and accessibility of services	N	-	-		

<b>Table B4.2.2 Appraisal summary table for flood management and coastal defence – main assessment</b>					
<b>Project name</b>		River Chet flood protection scheme			
<b>Description of option</b>		Maintain existing defences (1 in 5 return period)			
<b>Description of area affected by option</b>		The area being assessed comprises of the south (right) bank of the River Chet, running from Pyes Mill, near Loddon, to Nogdam End.			
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Qualitative description of impacts</b>	<b>Quantitative assessment of impacts (no. units/monetary)</b>	<b>Score</b>	<b>Monetary value</b>
Equity	N	-	-		
Sense of community	Y	Impacts on the relationship between Loddon (south bank) and Chedgrave (north bank) communities due to different treatment of needs of both communities.		10	
<b><i>Cross-cutting impacts</i></b>					
Policy integration	Y	Impact on integrated management of the River Chet as a whole, since different margins are part of different compartments and therefore are being treated separately.	n/a	0	

<b>Table B4.2.3 Appraisal summary table for flood management and coastal defence – main assessment</b>					
<b>Project name</b>		River Chet flood protection scheme			
<b>Description of option</b>		Improve (strengthening and raising to account for sea level rise and settlement – 1 in 20 years return period)			
<b>Description of area affected by option</b>		The area being assessed comprises of the south (right) bank of the River Chet, running from Pyes Mill, near Loddon, to Nogdam End.			
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Qualitative description of impacts</b>	<b>Quantitative assessment of impacts (no. units/monetary)</b>	<b>Score</b>	<b>Monetary value</b>
<b><i>Economic impacts</i></b>					
Assets	Y	Properties protected to 1 in 20 year standard. (Increased flooding in unprotected areas but this is not much of a problem in the River Chet south bank. This will be minor).	4 gardens affected.		£400
Land use	Y	Improved agriculture due to less frequent flooding.	71.9ha affected		£6,000
Transport	N	-	-		
Business development	Y	Business activity will remain unhindered as recreation is maintained. However, there could be temporary disruption due to construction (minimal).	No boatyard close.	100	
<b><i>Environmental impacts</i></b>					
Physical habitats	Y	Likely positive impacts due to potential improvement of freshwater dykes and freshwater wetlands but it is considered that the washland would provide far greater conservation value.		0	
Water quality	Y	Reduced erosion will reduce amount of suspended solids in water.	n/a	100	
Water quantity	N	-	-		
Natural processes	N	-	-		
Historical environment	N	-	-		

<b>Table B4.2.3 Appraisal summary table for flood management and coastal defence – main assessment</b>					
<b>Project name</b>		River Chet flood protection scheme			
<b>Description of option</b>		Improve (strengthening and raising to account for sea level rise and settlement – 1 in 20 years return period)			
<b>Description of area affected by option</b>		The area being assessed comprises of the south (right) bank of the River Chet, running from Pyes Mill, near Loddon, to Nogdam End.			
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Qualitative description of impacts</b>	<b>Quantitative assessment of impacts (no. units/monetary)</b>	<b>Score</b>	<b>Monetary value</b>
Landscape and visual amenity	Y	Obstructed view from higher embankments. Also piling will give canalised appearance to river.		0	
<b>Social impacts</b>					
Recreation	Y	Recreation can continue unhindered (damages avoided) until year of breach.	Annual value of recreation £9,500-£29,500, but assumed that loss is only 50% of total value in case of breach, thus £4,750-£14,750		£7,100-£22,000
Health and safety	N	-	-		
Availability and accessibility of services	N	-	-		
Equity	N	-	-		
Sense of community	Y	More 'equal' treatment of communities at south bank and north bank.		100	
<b>Cross-cutting impacts</b>					
Policy integration	Y	This Option is more in line with the Strategy (Strategy's preferred option is sustain). However, it does not take account of undefended areas, and the Strategy notes that protection of undefended properties is going to be improved.		100	

<b>Table B4.2.4 Appraisal summary table for flood management and coastal defence – main assessment</b>					
<b>Project name</b>		River Chet flood protection scheme			
<b>Description of option</b>		Flooding to high ground			
<b>Description of area affected by option</b>		The area being assessed comprises of the south (right) bank of the River Chet, running from Pyes Mill, near Loddon, to Nogdam End.			
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Qualitative description of impacts</b>	<b>Quantitative assessment of impacts (no. units/monetary)</b>	<b>Score</b>	<b>Monetary value</b>
<b>Economic impacts</b>					
Assets	Y	The gardens of properties at risk of flooding would be protected to 1 in 20 standard  Some impacts on local infrastructure	4 gardens protected (as for the improve option);  Impact on local infrastructure difficult to quantify.		£400
Land use	Y	Existing grazing land becomes washland flooded for the majority of the time.	71.9ha agricultural land lost.		£220,000
Transport	N	-	-		
Business development	Y	Navigation is maintained by marking channel and dredging but not to existing depth.	1 boatyard closes.	50	
<b>Environmental impacts</b>					
Physical habitats	Y	Increased salinity, thus affecting soke dykes habitats. However flooding to high ground would result in the creation of a wetland which could result in the creation of an SSSI.	Number of units unknown.	100	
Water quality	Y	Long term impact on quantity of suspended sediment in the water due to increased erosion		0	
Water quantity	N	-	-		
Natural processes	N	-	-		
Historical environment	N	-	-		
Landscape and visual amenity		Landscape changes from grazing marsh to washland.	Number of units (ha) affected unknown.	100	

<b>Table B4.2.4 Appraisal summary table for flood management and coastal defence – main assessment</b>					
<b>Project name</b>		River Chet flood protection scheme			
<b>Description of option</b>		Flooding to high ground			
<b>Description of area affected by option</b>		The area being assessed comprises of the south (right) bank of the River Chet, running from Pyes Mill, near Loddon, to Nogdam End.			
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Qualitative description of impacts</b>	<b>Quantitative assessment of impacts (no. units/monetary)</b>	<b>Score</b>	<b>Monetary value</b>
<b><i>Social impacts</i></b>					
Recreation	Y	This option will have impacts on navigation. Picnic site may be lost (or part of it).  Birdwatching and wildfowling may increase	Assumes that 50% of total recreation, boat based and informal recreation is affected.		£120,000-£380,000
Health and safety	N	-	-	-	
Availability and accessibility of services	N	-	-		
Equity	N				
Sense of community	Y	Gardens will be protected but the loss of agricultural land and business could affect the sense of community.	n/a	50	
<b><i>Cross-cutting impacts</i></b>					
Policy integration	Y	Not in accordance with Strategy but may be in line with English Nature and Broads Authority aspirations.	n/a	66	

<b>Table B4.2.5 Appraisal summary table for flood management and coastal defence – main assessment</b>					
<b>Project name</b>		River Chet Flood Protection Scheme			
<b>Description of option</b>		Maintain (1 in 5 year) and then flood to high ground (year 10)			
<b>Description of area affected by option</b>		The area being assessed comprises of the south (right) bank of the River Chet, running from Pyes Mill, near Loddon, to Nogdam End.			
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Qualitative description of impacts</b>	<b>Quantitative assessment of impacts (no. units/monetary)</b>	<b>Score</b>	<b>Monetary value</b>
<b><i>Economic impacts</i></b>					
Assets	Y	The gardens of properties at risk of flooding would be protected to 1 in 5 standard initially  Some impacts on local infrastructure	4 gardens protected to 1 in 5 year standard to year 9 then 1 in 20.  Impact on local infrastructure difficult to quantify.		Neg.
Land use	Y	Existing grazing land protected to 1 in 5 year until year 9 then becomes washland flooded for the majority of the time.	71.9ha agricultural land lost in year 10.		£200,000
Transport	N	-	-		
Business development	Y	No change until year 10 when 1 boatyard will close (navigation channel is maintained by marking channel and dredging).	1 boatyard closure in year 10.	60 (if marking channel and dredging)	
<b><i>Environmental impacts</i></b>					
Physical habitats	Y	Increased salinity as site is flooded after year 10 thus affecting soke dykes habitats. However flooding to high ground would result in the creation of a wetland which could result in the creation of an SSSI.	Number of units unknown.	90	
Water quality	Y	Long term impact on quantity of suspended sediment in the water due to increased erosion		10	
Water quantity	N	-	-		
Natural processes	N	-	-		

<b>Table B4.2.5 Appraisal summary table for flood management and coastal defence – main assessment</b>					
<b>Project name</b>		River Chet Flood Protection Scheme			
<b>Description of option</b>		Maintain (1 in 5 year) and then flood to high ground (year 10)			
<b>Description of area affected by option</b>		The area being assessed comprises of the south (right) bank of the River Chet, running from Pyes Mill, near Loddon, to Nogdam End.			
<b>Impact category</b>	<b>Impact likely? (Y/N)</b>	<b>Qualitative description of impacts</b>	<b>Quantitative assessment of impacts (no. units/monetary)</b>	<b>Score</b>	<b>Monetary value</b>
Historical environment	N	-	-		
Landscape and visual amenity		Landscape changes from grazing marsh to washland after year 10.		90	
<b>Social impacts</b>					
Recreation	Y	This option will have impacts on navigation. Picnic site may be lost (or part of it)  Birdwatching and wildfowling may increase	Assumes that 50% of total recreation, boat based and informal is affected after year 10.		£120,000 - £380,000
Health and safety	N	-	-	-	
Availability and accessibility of services	N	-	-		
Equity	N				
Sense of community	Y	Gardens will be protected but the loss of agricultural land could affect the sense of community. However this will be in year 10 which will allow time for businesses to adapt.		60	
<b>Cross-cutting impacts</b>					
Policy Integration	Y	Not in accordance with Strategy but may be in line with English Nature and Broads Authority aspirations and is in line with Defras exit strategy.		75	