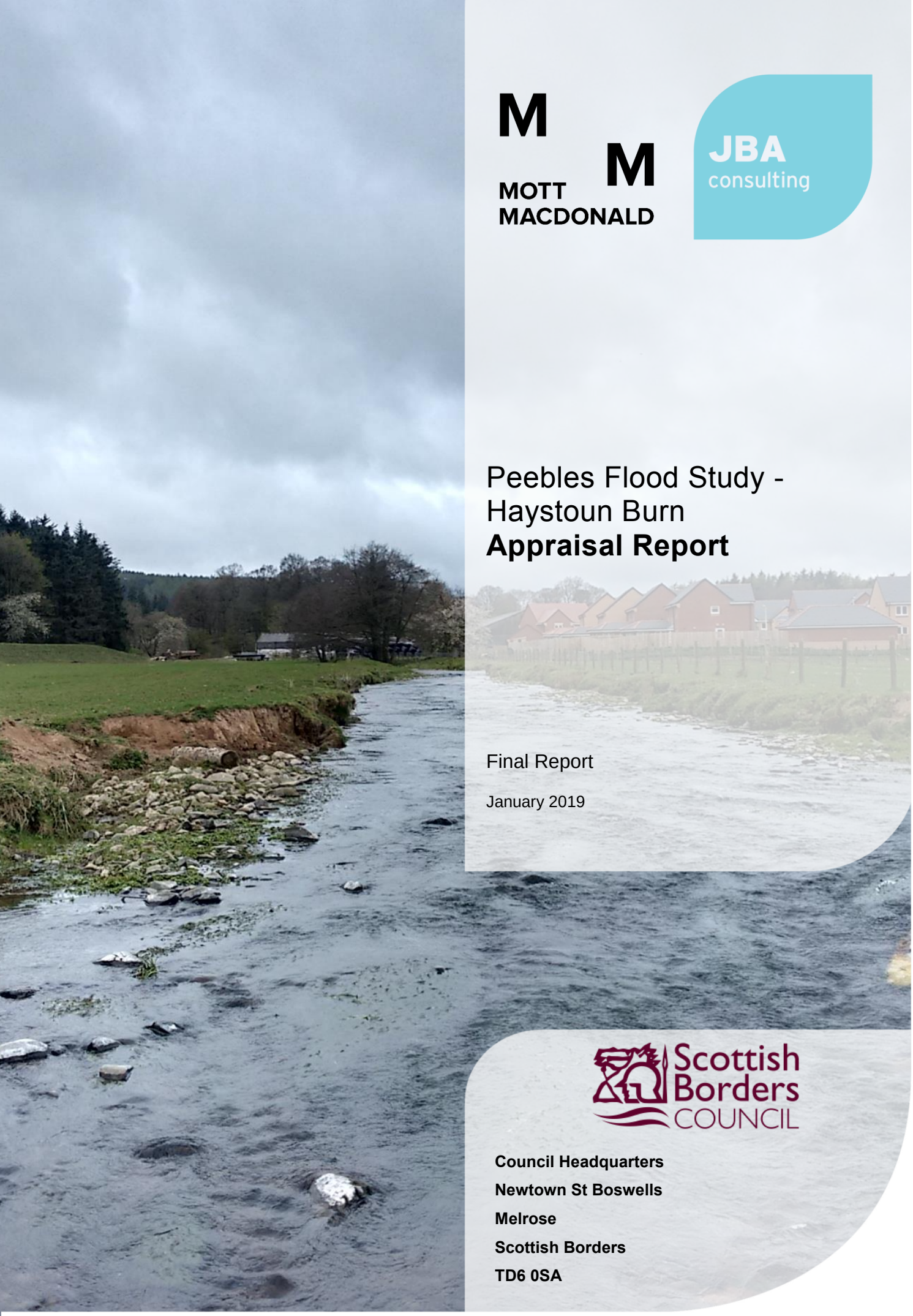

MOTT MACDONALD

JBA consulting

Peebles Flood Study - Haystoun Burn
Appraisal Report

Final Report

January 2019

Scottish Borders COUNCIL

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Revision History

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S0-P01	Minor amendments	
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S4-P02 / January 2019	-	Scottish Borders Council / SEPA

Contract

This report describes work commissioned by Duncan Morrison, on behalf of Scottish Borders Council, by a letter dated 16 January 2017. Scottish Borders Council's representative for the contract was Duncan Morrison). Tasmin Fletcher, Barney Bedford, Hannah Otton and Christina Kampanou of JBA Consulting carried out this work.

Prepared by ..... Barney Bedford BSc MSc
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Technical Director

Purpose

This document has been prepared as a Final Report for Scottish Borders Council. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

JBA Consulting has no liability regarding the use of this report except to Scottish Borders Council.

Our work has followed accepted procedure in providing the services but given the residual risk associated with any prediction and the variability which can be experienced in flood conditions, we can take no liability for the consequences of flooding in relation to items outside our control or agreed scope of service.

Legislative framework

This flood study was commissioned in order to gain a greater understanding of the flood mechanisms in Peebles, improve upon SEPA's Flood Risk Management maps, and provide an appraisal of options which could reduce flood risk. In 2015, as part of the Flood Risk Management (Scotland) Act 2009, the Scottish parts of the Tweed catchment were designated as the Tweed Local Plan District by SEPA. Flood risk must therefore be addressed by SEPA's Flood Risk Management Strategy (FRMS) and the local authorities' Local Flood Risk Management Plan (LFRMP). Of the 13 Potentially Vulnerable Areas (PVA) defined by SEPA within the Tweed

catchment, the Peebles PVA (reference 13/04) includes Peebles and the surrounding communities of Eddleston, Innerleithen, Selkirk, Stow and Galashiels. According to this PVA, Peebles has a lengthy history of flooding and the potential for approximately £1,200,000 Annual Average Damages (AAD). A flood protection study is identified as one of the key actions to be taken as a means to reduce this risk and this report presents the findings of part of the study.

Acknowledgements

We would like to thank the Scottish Borders Council, Turner Townsend and Mott MacDonald for the data, supporting information and reviews undertaken throughout the study. We would also like to thank members of SEPA for the review of the hydrological calculations and flood modelling methodologies.

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JBA is aiming to reduce its per capita carbon emissions.

Haystoun Burn FRM Business Case

Context

Peebles in the Scottish Borders has a history of property flooding. JBA was commissioned in 2017 to carry out a review of past flood events, determine the likely risk to different properties and to propose a set of 'options' that may reduce the flood risk to an acceptable level. This report is the culmination of this work and aims to provide a detailed explanation of the various steps carried out in order to identify a preferred set of interventions that offer a sustainable method of flood protection whilst seeking to benefit the environment and the community of Peebles.

This report focusses on the Haystoun Burn, a tributary of the River Tweed in the east of Peebles which runs southwest to northeast. In recent years the development of land adjacent to the Haystoun Burn has dramatically increased the number of properties at risk of flooding.

A modelling exercise was carried out to estimate river levels on the Haystoun Burn from downstream of the confluence with the Crookston Burn to its confluence with the River Tweed. A range of possible flood events were modelled from the 2 year flood to a 1000 year flood. Increases due to predicted climate change were included for at the 3.3% AP (30 year) and 0.5% AP (200 year) events.

It was found that 192 properties are at risk of flooding from the 0.5% AP (200 year) event and 216 are at risk for the same event with a climate change allowance. A range of flood protection options were then reviewed and short listed based on their viability.

Risk metrics

The following risk metrics are provided to aid prioritisation by SEPA:

Properties at risk	192 at the 200 year flood (256 with climate change)
Non-residential properties at risk	21 at the 200 year flood (24 with climate change)
Key receptors at risk	Whitehaugh Farm and Kittlegairy Estate

Flood Mitigation Options

A range of flood protection options were then reviewed and short listed based on their viability. The only viable option on the Haystoun Burn capable of providing a 200 year standard of protection would be a direct defences option involving the construction of walls and embankments close to Whitehaugh Farm. The short-listed options are as follows:

- Option 1 - direct defence option with a 200 year standard of protection with no protection for Whitehaugh Farm;
- Option 2 - direct defence option with a 200 year standard of protection protecting Whitehaugh Farm;
- Option 3 - provision of property level protection.

Improving public awareness and resilience

In addition to these short-listed options a number of non-structural options and good practice FRM measures have been investigated and recommended for implementation by the Scottish Borders Council. Some of these are already in place elsewhere and could be implemented either in the short term or alongside a Flood Protection Scheme. These include the following:

- Flood warning is not currently in place on the Haystoun Burn and should be implemented, particularly to assist with emergency procedures if a scheme is not promoted in short-term. Consideration of the preferred option should be given as flood gate closure may be an implication of the preferred scheme and therefore flood warning would be essential. PLP measures would also benefit from flood warning.
- Flood action groups, in partnership with the Community Council should seek to establish a network of support between members of the community, Scottish Borders Council, Tweed Forum and emergency services. Community engagement should be continued to raise awareness of flood risk and potential short and longer-term solutions.

- Resilient Communities sandbag stores are available in Peebles. The Council should consider if these are suitably located to assist with the residents in the Kittlegiary Estate. Furthermore, the use of a flood 'pod' system that can also be used by the community closer to the Haystoun Burn should be considered. Flood 'pods' are community storage boxes which contain flood sacks; purpose designed bags filled with absorbent material. The key advantage of this approach is that they can be distributed before a flood and are ideal for locations with limited warning or response times. It may also save the Council time in filling, distributing and delivering sandbags to communities when sandbag stores run out.
- Scottish Planning Policy should be leveraged to provide the potential for future implementation of other options that are currently not possible or to avoid unnecessary development on the floodplain downstream of Whitehaugh Farm.

Expected benefits

A flood damage assessment has been undertaken for the present-day Do Nothing, Do Minimum and each of the above options. The Present Value flood damages calculated for the Do Nothing and Do Minimum scenario are estimated to be £17.1m and £15.7m respectively. The damages avoided for each option are in the range of £12.9-16.1m (depending on the option assessed). Total damages avoided for each option are provided in the investment appraisal summary table.

Number of properties protected:

	Option 1	Option 2	PLP
Damages avoided (£k)	15,172	16,126	12,890
Residential properties benefitting	171	171	166
Non-residential properties benefitting	12	21	12
Total no. properties benefitting	183	192	178

Working with natural processes

Natural Flood Management (NFM) is a method whereby wider catchment benefits could be achieved alongside potentially reducing flood flows on the Haystoun Burn. Opportunities within the Crookston Burn, Waddenshope Burn and Glensax Burn catchments could to some extent counteract the effects of increasing river flows with climate change. Natural Flood Management opportunities should be progressed where feasible through additional catchment modelling (making use of newly available LIDAR data) and early engagement with land owners and other stakeholders. Should NFM be progressed as part of a scheme funding should be sought through the scheme itself but in the shorter term it may be possible to secure funding through other sources if the focus can be widened from flood risk management to catchment and land management benefit.

Costs

Costs for each option have been estimated using the Environment Agency's Long Term Costing tool (2012). An optimism bias factor of 60% has been added to the total costs to allow for uncertainties in design at this stage and is typical for schemes at an early stage of appraisal. Whole life present value costs range from £2.0m to £5.4m. Total costs for each option are provided in the investment appraisal summary table overleaf.

Investment appraisal

The investment appraisal is provided overleaf. All options are estimated to be cost-effective with Option 1 achieving the highest benefit-cost ratio, 7.7, with a net present value of £13,214k. The PLP option has the lowest benefit-cost ratio of the options tested, with a ratio of 2.8 and a net present value of £9,922. The incremental benefit-cost ratio shows that there is sufficient benefit in Option 2 over and above that of Option 1 to offset the additional costs of protecting Whitehaugh Farm. Since the two defended options are highly cost beneficial either option could be put forward by the Council with flood defence heights in public places likely to be a factor in the decision.

Investment appraisal summary table:

	Do Nothing	Do Minimum	Option 1	Option 2	PLP
Total PV Costs (£k)	-	-	1,958	2,745	5,422
PV damage (£k)	17,124	15,654	1,952	998	1,779
PV damage avoided (£k)	-	1,470	15,172	16,126	12,890
Net present value (£k)	-	1,470	13,214	13,381	9,922
Benefit-cost ratio	-	-	7.7	5.9	2.8

Residual risks and planning for future flooding

A number of measures could be implemented to reduce the residual risk brought by above design standard flood events, particularly likely with climate change:

- Natural Flood Management (NFM) practices could aid in reducing flows in the Haystoun Burn and provide some resilience to climate change. If one of the direct defences options is carried forward, then the reliance on NFM would be reduced but wider catchment benefits such as habitat creation and carbon sequestration make this a sensible intervention outside of flood risk management. A detailed NFM study should be carried out to attempt to focus the placement of works within the catchment and quantify the benefits of these practices.
- Direct defences could be designed to protect against future climate change increases in flow now, or be adaptable through the use of demountable defences to be added on top of the proposed defences in the future. The cost and infrastructure required to implement demountable defences are substantial and should be avoided if possible. Alternatively, designing defences that can be easily raised in the future would be a more preferable option.
- Property Level Protection (PLP) would increase property resistance to flood waters and if implemented alongside a Flood Protection Scheme could be an effective means of further reducing property flood damages.
- As recommended by SEPA during stakeholder engagement, Scottish Planning Policy should be leveraged to avoid development on the parcel of land between Kittlegairy estate, Haystoun Burn and the River Tweed which is not to be protected by the measures proposed in this report.

Conclusions and recommendations

Direct defences Options 1 and 2 are both economically viable and the longer-term benefits of Option 2 suggest that it is a sound option to provide protection to properties at risk from the Haystoun Burn. Wider benefits and opportunities in the surrounding catchment could be packaged and put forward for funding during the next FRM cycle.

Option (Standard of protection)	Properties protected	Environmental implications	Working with natural processes	Constraints/ limitations	Mitigating residual risks	Improved public awareness	Best use of public money	Wider benefits
Option 1 Direct Defences not protecting Whitehaugh Farm (0.5% AP - 200 year)	183	Few implications for RBMP. No in-channel works required so little impact on watercourse.	NFM measures have been identified and can be incorporated within the scheme to provide additional benefits. These additional benefits are likely to be mainly environmental for the Haystoun Burn since the direct defence options provide a high standard of protection.	Whitehaugh Farm not protected.	Whitehaugh Farm buildings expected to be resilient but may require some remedial works to increase resilience. Increased defence extents and heights possible but should be designed for at this stage rather than added on later. Possible to use NFM to manage residual risk.	Options should be presented to public for comment. Signage relating to flooding and sand bag stores and work with Peebles residents alongside 'Resilient communities' programme. Flood Warning should be implemented on the Haystoun Burn, especially if flood gates are required as part of the final design.	Highest benefit cost ratio of defended options but Option 2 provides greater long term benefit and protects all properties.	Maintain existing businesses and employment locally. Minimal impacts to community beyond visual impacts.
Option 2 Direct Defences protecting Whitehaugh Farm (0.5% AP - 200 year)	192	Some implications for RBMP due to walls on riverside. Minimal in-channel works but some bank reinforcement likely.		May be slight complications for farm access across the river but design process should be able to overcome this.	Increased defence extents and heights possible but should be designed for at this stage rather than added on later. Possible to use NFM to manage residual risk.		Incremental benefit cost ratio of 1.2 relative to Option 1 meaning that this option has the longest-term benefits.	As above with flood protection for Whitehaugh Farm.
PLP (20% AP – 5 year)	178 at the 0.5% AP (200 year) flood event	Little to no impact. Does not mitigate the risks of contaminated runoff from the farm into Kittlegairy Estate.		Little improvement in standard of protection for some properties e.g. Whitehaugh Farm not protected. Inconsistent standard of protection.	Possible to use NFM to manage residual risk.	Flood Warning should be implemented on the Haystoun Burn.	Acceptable benefit cost ratio due to low relative costs but not a long-term solution.	Aside from individual property works wider community not affected. Minimal community disruption and change to the affected area of the town.

Negative			Neutral			Positive

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Abbreviations

1D	One Dimensional (modelling)
2D	Two Dimensional (modelling)
BCR	Benefit-cost Ratio
CCTV	Closed Circuit Television
DTM	Digital Terrain Model
EA	Environment Agency
FCERM	Flood and Coastal Erosion Risk Management (R&D programme)

FEH	Flood Estimation Handbook
FPS	Flood Protection Scheme
FRM	Flood Risk Management
GIS	Geographical Information System
mAOD	metres Above Ordnance Datum
OS	Ordnance Survey
PLP	Property Level Protection
PV	Present Value
PVb	Present Value benefits
PVc	Present Value costs
QMED	Median Annual Flood (with return period 2 years)
Ramsar	The intergovernmental Convention on Wetlands, signed in Ramsar, Iran, in 1971
RBMP	River Basin Management Plan
SAC	Special Area of Conservation, protected under the EU Habitats Directive
SEPA	Scottish Environment Protection Agency
SPA	Special Protection Area for birds, protected under the EU Habitats Directive
SSSI	Site of Special Scientific Interest
TPO	Tree Preservation Order
TUFLOW	Two-dimensional Unsteady FLOW (a hydraulic model)

Return period and probability

For flood frequency analysis the probability of an event occurring is often expressed as a return period. A return period is the average interval (number of years) between two years containing one or more floods of a given magnitude or greater. As an example, the flood magnitude with a return period of 200 is referred to as the 200 year flood.

Another useful term closely linked to return period is a floods annual probability, AP. This is the probability of a flood greater than a given magnitude occurring in any year and calculates as the inverse of the return period. For example, there is a 1 in 200 chance of a flood exceeding the 200 year flood in any one year so the AP is calculated by 1/200 giving a 0.5% AP for the 200 year flood event.

Supporting Documents

Hydrology report - AEM-JBAU-PB-00-RP-A-0003-Peebles_Hydrology_Report-S4-P03.pdf

Asset condition assessment report - AEM-JBAU-PB-00-RP-A-0002-Asset_condition_assessment-S0-P01.02.pdf

RBMP & NFM report - AEM-JBAU-PB-00-RP-E-0002-Peebles_NFM_Report-S4-P02.pdf

Preliminary Ecological Appraisal - AEM-JBAU-PB-00-RP-E-0001-PEA-S1-P01.pdf

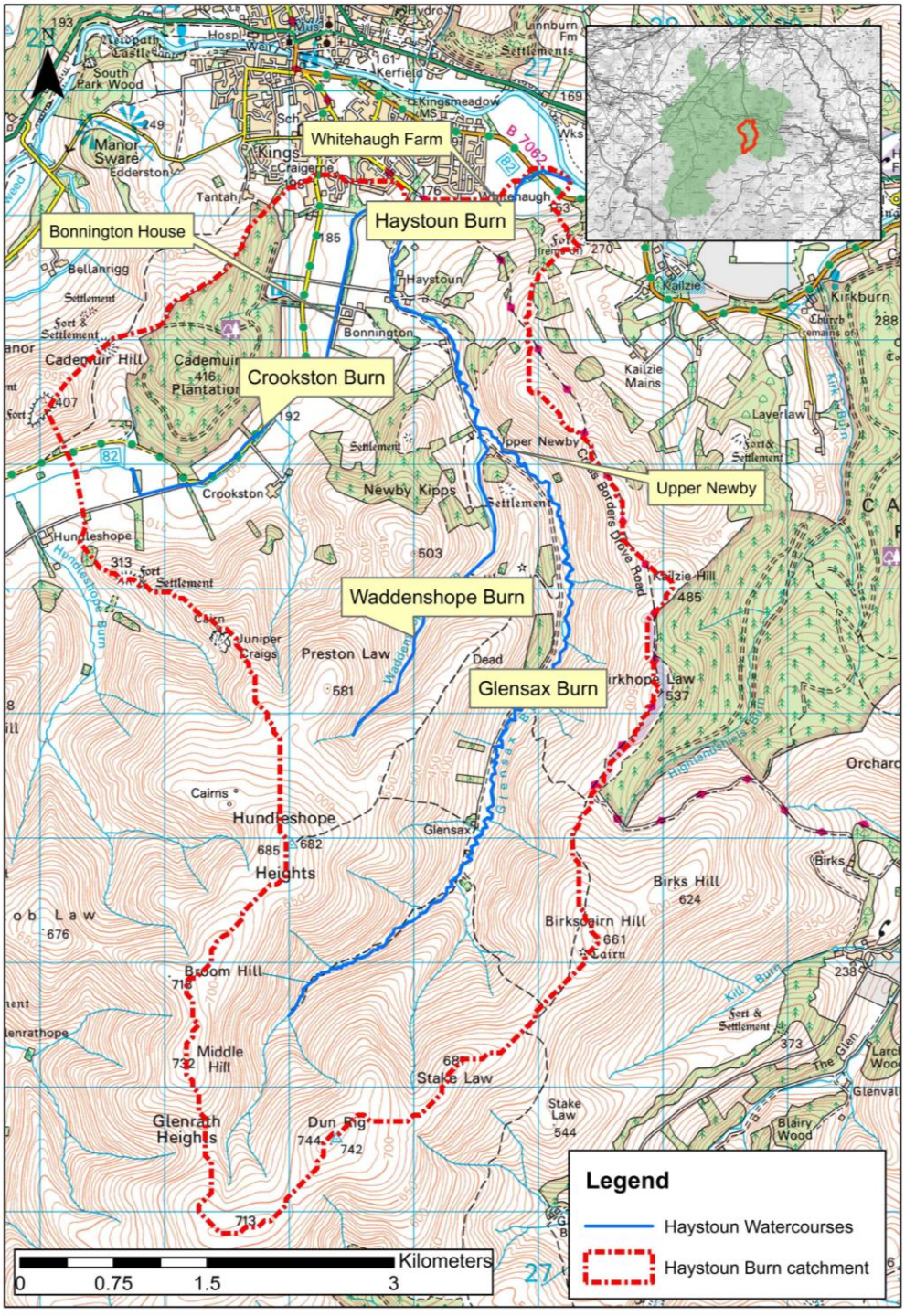
Modelling report - AEM-JBAU-PB-00-RP-A-0009-Haystoun_Model_Report-S4-P02.pdf

Flood maps - supplied as PDF's for return periods 2-1000 years including climate change runs and for the Do Nothing and Do Minimum scenarios.

1 Introduction

The Haystoun Burn is a tributary of the River Tweed that lies to the south-east of the Borders town of Peebles. It has three main sub-catchments; the Crookston Burn to the west, Waddenshope Burn to the south, and Glensax Burn to the south-east. The Glensax Burn becomes the Haystoun Burn downstream of the ornamental pond at Haystoun House. The Haystoun and Crookston Burns converge downstream of Hogbridge Covert and flow a further 1.3 kilometres in a north easterly direction as the Haystoun Burn before discharging into the River Tweed. The location of the watercourses is shown in Figure 1-1.

Figure 1-1: Study area and Haystoun Burn catchment



The main reach addressed in this study is the section of the Haystoun Burn from the confluence with the Crookston Burn to its confluence with the River Tweed. Along this reach the key areas at risk of flooding from the burn are Whitehaugh Farm and Kittlegairy Estate. Kittlegairy Estate has witnessed only minor flooding since it was built, but the flowpath from the Haystoun Burn witnessed during that event suggests larger floods are likely to cause more widespread problems.

The catchment mainly comprises moorland, grazing land and managed forest with few dwellings upstream of Whitehaugh Farm. The northwest catchment is wide, flat agricultural land in contrast to the narrow v-shaped valleys within the rest of the catchment through which the Glensax, Waddenshope and upper Crookston Burn meander. Sections of the upland burns, such as the Crookston Burn are highly straightened prior to converging to become the Haystoun Burn.

The Haystoun Burn has a critical storm duration of 4.75 hours and a moderately fast response to rainfall. Apart from its lower extents it behaves largely independently of the River Tweed into which it discharges.

At present there are no formal flood defences along the Haystoun Burn that mitigate flood risk.

1.1 Flooding from the Haystoun Burn

SEPA flood maps show that there is a high (10% AP) probability of flooding from the Haystoun Burn to properties in the Kittlegairy Estate. Peebles forms part of the Tweed Local Plan District and is within Potentially Vulnerable Area (PVA) 13/04 which also includes Eddleston, Innerleithen, Selkirk, Stow and Galashiels. Within this PVA there are estimated to be 1,900 residential properties and 1,000 non-residential properties at risk of flooding.

Until 2015 no flooding had been recorded from the Haystoun Burn. However, during the December 2015 event floodwaters overtopped the left bank, flowed across the floodplain through the adjacent farm and onto the Kittlegairy Estate. Figure 1-2 shows photographs of a flow route through fields to the north-west of the watercourse and from one of the properties that lie on the flow path of the flood waters during that event.

Figure 1-2: Flow routes from the Haystoun Burn in the December 2015 flood event

Photo shows flow path towards farm buildings after the peak of the flood. Evidence collected by landowner during event showed entire field flooded (photograph not provided).

Evidence of flooding from farm to gardens of a property in Kittlegairy Estate.

Land use is not expected to change significantly with climate change and thus the relationship between the watercourse and surrounding land is not expected to vary to a major extent. Nevertheless, the increases in flows expected from climate change make good land management practices - potentially capable of influencing river levels - particularly important in this largely rural landscape. Section 2.2.1 details how climate change has been approached within this study.

1.1.1 Previous studies

Aside from property-specific Flood Risk Assessment's conducted within the catchment there have been no previous flood studies on the Haystoun Burn and therefore no formal flood protection assets proposed to protect the relatively new Kittlegairy Estate.

Based on the information available and our knowledge of the site, no existing topographic survey or models were available for the Haystoun Burn prior to this study. Consequently, new survey was commissioned and a new hydraulic model has been developed.

1.1.2 Watercourse condition and catchment opportunities

The catchment of the Haystoun Burn is dominated by rural land uses and provides scope for improvements in watercourse condition and flood risk management by means of emulation of natural processes that slow the passage of flood waters. Natural means of land and watercourse management are of particular importance here since the Haystoun Burn is designated a Special Area of Conservation (SAC) as far upstream as the pond at Haystoun House.

The Glensax and Haystoun Burns were graded as good by SEPA under the River Basin Management Plan (RBMP) 2014 study and will therefore only require monitoring to ensure their good status is maintained.

Within the Haystoun Burn catchment SEPA's NFM maps show that there is medium potential for runoff reduction in the southern parts of the catchment, and medium to high potential for floodplain storage along the Crookston Burn. The SEPA NFM database also identifies potential to increase tree cover to reduce runoff and increase infiltration along the Crookston Burn. A full review of the specific opportunities for NFM interventions within the Haystoun catchment is provided in the NFM report summarised in section 2.5.

1.2 Aims and objectives

The options appraisal seeks to provide information appropriate to Scottish Borders Council to inform their decision on the most sustainable catchment-wide strategy for flood risk management to the east of Peebles that contributes, where possible, to achieving RBMP objectives and is acceptable to key stakeholders and the community. This report describes the information used to form conclusions on the suitability, feasibility and economic viability of different options for flood risk mitigation.

Proposals and conceptual designs have been developed to:

a. Provide protection from a 0.5% AP (200 year) magnitude flood event if feasible or a lower magnitude event in other cases
b. Deliver multiple benefits to the wider Haystoun and River Tweed catchments and local communities
c. Highlight opportunities to reduce river flows through Natural Flood Management practices and quick wins

2 Preliminary investigations

2.1 Flood history

A comprehensive review of historic flood events in Peebles has been carried out and is included in the Hydrology report referenced in the Supporting Documents section at the start of this report.

Until 2015, there were no reports of property flooding from the Haystoun Burn, however the fields to the south west of Whitehaugh Farm have been reported to flood fairly regularly. In December 2015, water from the burn flowed into the back gardens of the properties at the southern end of the Kittlegairy Estate. There is anecdotal evidence of subsequent flooding to these properties since 2015.

Across Peebles and the wider area there is a history of flooding with the majority of this flooding being dealt with in separate reports created as part of this study.

2.2 Flood estimation

The methodology used to derive flood estimates for the Haystoun Burn catchment is explained in the Hydrology report referenced in the Supporting Documents section at the start of this report.

Hydrological analysis was conducted to obtain information about flow characteristics in the reach of interest. Due to the short reach of interest only one location for flow estimation was chosen. Analyses were based on the total catchment area of the Haystoun Burn at its confluence with the River Tweed.

As the Haystoun Burn catchment is ungauged the Flood Estimation Handbook (FEH) Rainfall-Runoff method and ReFH2 methods were used to derive peak river flows for a range of Annual Probability events. SEPA recommended the use of the Rainfall Runoff method to take a conservative approach due to the higher flows estimated using this method. As agreed with SEPA the hydrograph used in the modelling was generated using a ReFH unit within the 1D model, which was scaled to appropriate peak flows. The peak flow estimates for the Haystoun Burn upstream of the confluence with the Tweed (National Grid Reference: NT 2725 3925) for a range of Annual Probability (AP) events are presented in Table 2-1.

Table 2-1: Peak flow estimates for the Haystoun Burn (FEH Rainfall Runoff)

Return Period (Years)	Annual Probability (AP) (%)	Haystoun Burn Flow (m^3/s)
2	50	10.1
5	20	14.8
10	10	17.9
25	4	22.9
30	3.33	24.3
50	2	28.0
75	1.33	30.7
100	1	33.0
200	0.5	39.1
500	0.2	48.8
1000	0.1	59.4
30+CC	3.33+CC	32.3
200+CC	0.5+CC	51.9

Due to the lack of gauging there is some uncertainty in the flow estimates produced. If the ReFH2 method were used rather than Rainfall Runoff this would result in a higher standard of protection in the Do Minimum scenario than is the case with the Rainfall Runoff method. Table 2-2 below shows the equivalent return periods with the ReFH2 and Rainfall Runoff methods. Using peak flows from the ReFH2 method would increase the standard of protection substantially. For example, a flood

defence designed to protect against the 100 year event with rainfall runoff would be equivalent to the 320 year event using the ReFH2 method. This highlights a critical uncertainty in the flood flow estimates for this catchment.

Whilst a precautionary approach is recommended, due to this uncertainty in design flows, the ungauged catchment and the lack of flood records for the burn, it is recommended that SEPA or the Council install a flow gauge on the burn prior to undertaking any flood mitigation works so that an improved estimate of design flows can be investigated further.

Table 2-2: Comparison of return periods with the Rainfall Runoff method versus ReFH2 method

Return period using Rainfall Runoff method (Years)	Equivalent return period with ReFH2 method (Years)
2	6
5	23
10	42
30	116
50	187
75	254
100	322
200	561

2.2.1 Climate change

SEPA's summary report on Flood Risk Management and climate change[1] concludes that climate change impacts are likely to vary spatially across Scotland. In summarising the different increases in river flows predicted by climate models as we move towards the 2080's a number of estimates for the River Tweed were provided. The high emissions scenario, 'unlikely to be exceeded' uplift estimate of 33% has been used to enable the impacts of climate change to be integrated into the overall assessment.

This uplift was applied to the 3.33% AP (30 year) and 0.5% AP (200 year) magnitude events only.

A 33% uplift in river flows by the year 2080 would mean that larger floods will be expected to occur more regularly. For example, a flood with an annual probability of 10% (likely to occur every 10 years) in the present day would increase to having a probability of 18% (likely to occur every 6 years) by 2080. For the larger magnitude events this is likely to be more concerning, with a present-day 1% AP (100 year) event, for example, being expected to occur with an annual probability of 2% (every 51 years) by 2080. These future changes are something that must be considered when designing flood protection measures and is explored further during the options appraisal later in the report.

2.3 Survey data

A topographic channel survey was conducted by JBA Consulting in April/May 2017. This data was used to build the 1D component of the hydraulic model and was combined with a LIDAR Digital Terrain Model (DTM) to provide ground levels across the study area. Additional topographic survey was undertaken in the newly developed housing estate in the region of Kittlegairy Road, Kittlegairy View, Kittlegairy Park and Kittlegairy Avenue. This topographic survey data was used to update the LIDAR data which was flown during the construction of this housing estate before roads were complete and while spoil heaps were still on site. Additionally, property finished floor levels were provided by Scottish Borders Council for Kittlegairy properties as provided by the developer. Combined, this data provides the physical basis for the hydraulic model.

Several site visits were conducted to provide context to the data, to photograph key areas and to provide an assessment of the condition of the watercourse, particularly at structures such as bridges, as is summarised below.

1 Flood Risk Management and Climate Change, SEPA, https://www.sepa.org.uk/media/219494/ceh-cc-report-wp1-overview-final.pdf

2.3.1 Asset condition assessment

A full report into the condition of assets along the Haystoun Burn is provided in the Asset Condition Assessment report, referenced in the Supporting Documents section at the beginning of this report. This is summarised overleaf.

Both bridges assessed in the asset review were graded as being in 'Good' condition, with no major maintenance issues identified. Blockage of the bridge upstream of Kittlegairy Estate is not expected to have any influence on flooding to the estate itself or Whitehaugh Farm due to its distance from these properties. Similarly, the arch bridge that carries the B7062 may constrict flows and cause rising water levels upstream but its distance from the main site of interest means this is not expected to be a problem.

Concrete Bridge over Haystoun Burn - upstream of Kittlegairy Estate

Concrete bridge spanning Haystoun Burn

Type: Single span footbridge.
Grid Ref: NT 26280 38956
Opening Width (m): 6.4
Opening Height (m): 1.14
Soffit Level (m): 165.27
Material: Concrete
Condition: Grade 2 (Good)
Part of FPS: No
Comments:

- Single span bridge in good condition
- Minor vegetation growth through crack in structure
- Rock armour has been put in place to prevent further erosion of left bank, upstream of bridge
- Significant amount of erosion on left bank just downstream of the confluence of Crookston Burn and Haystoun Burn.

Arch Bridge carrying B7062

Upstream face of bridge

Type: Single span arch bridge
Grid Ref: NT 26997 39337
Opening Width (m): 3.67
Opening Height (m): 1.53
Soffit Level (m): 156.29
Material: Stone
Condition: Grade 2 (Good)
Part of FPS: No
Comments:

- Bridge in good condition
- Both openings are clear from vegetation
- Bridge in line with watercourse and no signs of scouring

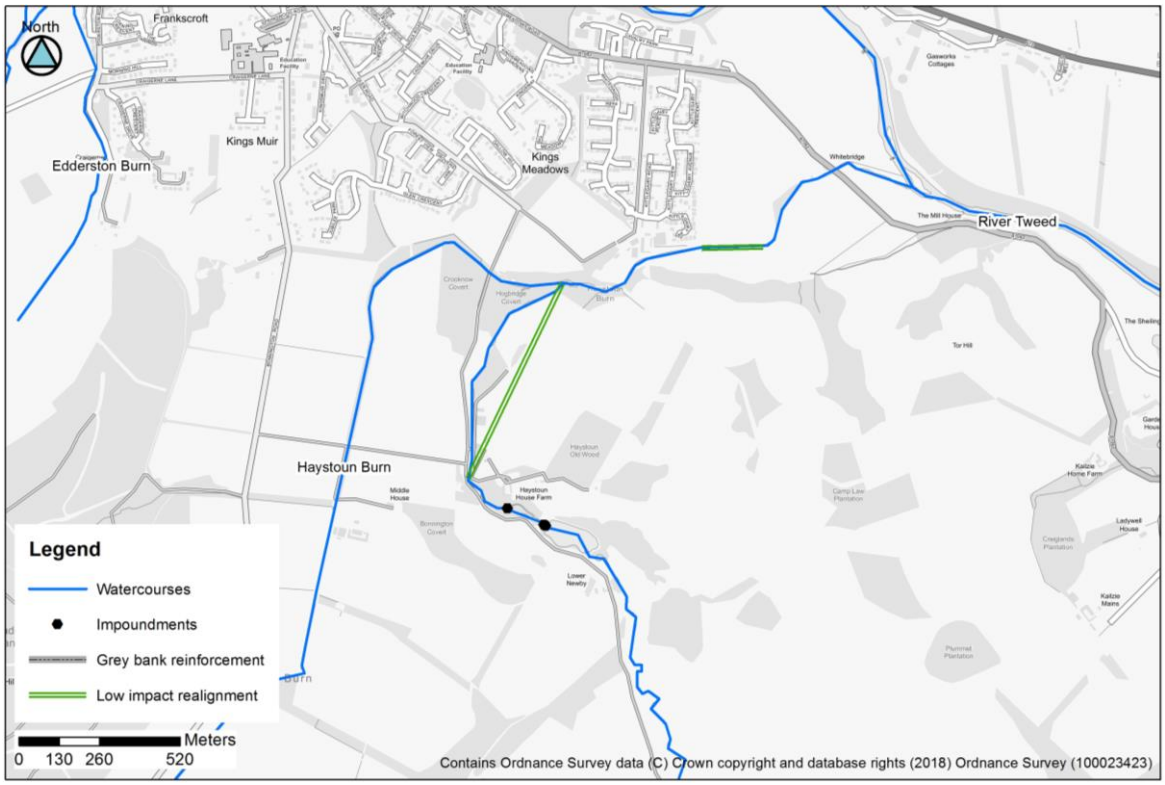
2.4 River Basin Management plan – Summary

A full report into the condition of the watercourse is provided in the Natural Flood Risk Management and River Basin Management Plan report, referenced in the Supporting Documents section at the beginning of this report.

The Glensax and Haystoun catchments were graded as 'Good' in the RBMP report, as they were not identified as having a high number of morphological pressures. Meandering of the straightened

sections of the Crookston Burn to increase sinuosity and overall physical condition is suggested. It is recommended that these are investigated further as part of any wider NFM/RBMP studies in the wider Tweed catchment.

Figure 2-1: Physical pressures within the scheme extent



2.5 Natural Flood Management – Summary

A full report into the NFM opportunities within the Tweed catchment is provided in the Natural Flood Risk Management and River Basin Management Plan report, referenced in the Supporting Documents section at the beginning of this report.

Based on a review of these two datasets and a walkover survey of the catchment, there are a number of NFM opportunities for the River Tweed catchment, as well as many recommendations within its sub-catchments that contribute a large proportion of flow to the watercourse. The findings and recommendations for the Haystoun Burn catchment are included in section 4.4.6.

2.6 Preliminary Ecological Appraisal – Summary

A full report into the presence and importance of different habitats along the Haystoun Burn is provided in the Preliminary Ecological Appraisal report, referenced in the Supporting Documents section at the beginning of this report.

The Haystoun Burn is part of the Tweed catchment Special Area of Conservation (SAC) as far upstream as the pond at Haystoun House, due to its potential to support Atlantic Salmon, Otter, Lamprey and invertebrate assemblages. Several protected and notable species have been recorded within 2km of the Peebles surveyed extent, which includes the Haystoun Burn study area, including otter, kingfisher, red squirrel and Atlantic salmon. A Habitat Regulation Appraisal (HRA) should be undertaken to identify any significant effects/impacts on the protected species. An Appropriate Assessment (AA) needs to be conducted if possible impacts are identified.

The proposed flood alleviation works are likely to be undertaken mostly out of channel. However, if any in-channel works are required they should be scheduled outside of the spawning seasons for Atlantic Salmon and Lamprey, leaving August and September as potential working windows. Night time working should be avoided as bats are most active at night and works on trees should be

avoided between February and September when red squirrels' kits are born and dependant on their mother.

A further Water Vole survey should be carried out if finalised works are likely to have an adverse impact on the banks of the tributaries, and an Otter Survey of the area may be necessary once the location of the works and the impact they may have on holt sites and resting places is known.

Peebles and the immediate surrounding area is a designated Conservation Area and all trees within it are designated with Tree Protection Orders (TPO's). If arboricultural works to trees cannot be avoided, it might be necessary to apply for the TPO to be lifted to allow for the works to proceed; compensatory planting would also be recommended in this instance.

2.7 Hydraulic modelling

A hydraulic model was developed, informed by the above-mentioned datasets, to estimate water levels during simulated floods. Below is a summary of the model structure and the results used to generate flood maps and to calculate the cost of flood damages in the later stages of the appraisal. Further details of the modelling approach, including calibration and sensitivity analysis, is provided in the Model Audit report referenced in the Supporting Documents section at the beginning of this report.

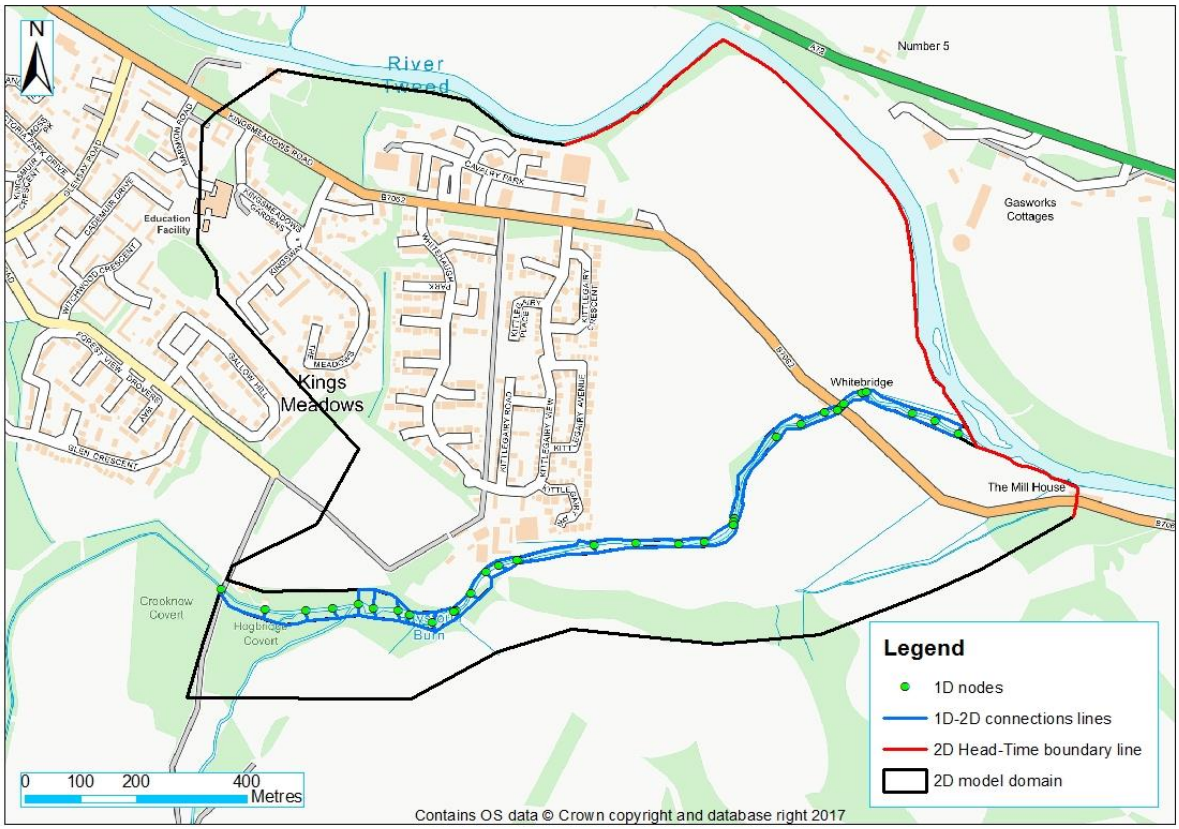
2.7.1 Model setup

The modelling package Flood Modeller-TUFLOW was used to develop the hydraulic model, offering the ability to create a 1D-2D model where the river channel is modelled in 1D and the floodplain in 2D. This approach allows for complex floodplain flow routing not possible with a simpler 1D only model. The model extends from downstream of the Crookston Burn confluence to the Haystoun Burns' confluence with the River Tweed.

Survey data for the 1D model was collected in 2017 by JBA Consulting. No bank-top survey was available to inform the link between 1D and 2D model domains but there was enough combined confidence in the LIDAR and surveyed channel cross sections to give a good indication of the elevations at which water should pass from the channel onto the floodplains. The 2D floodplain was formed from 1m LIDAR, resampled to 2m by TUFLOW for increased simulation efficiency. The 2D model domain extended over the full study area.

The downstream boundary of the model was controlled by estimated river levels from a flood model of the River Tweed developed for this study. A 3.33% AP (30 year) flood event on the River Tweed was calculated to have a joint probability of occurring at the same time as the 0.5% AP (200 year) flood event on the Haystoun Burn. This flood event was used for all annual probability events on the Haystoun Burn as a conservative approach.

Figure 2-2: Haystoun Burn model overview schematic



In the absence of surveyed flood levels, the model was proved against photographs taken during a post-flood survey carried out in the Scottish Borders following the 5th December 2015 floods. The flow paths predicted by the model appear to be representative of those experienced to date and also agree with those predicted in the SEPA flood risk maps. The extents of flooding from the model developed for this study are comparatively larger than those produced for SEPA's flood risk maps but this is likely a result of the smaller 2D grid resolution used in the most recent study, identifying smaller flow paths.

2.7.2 Model scenarios

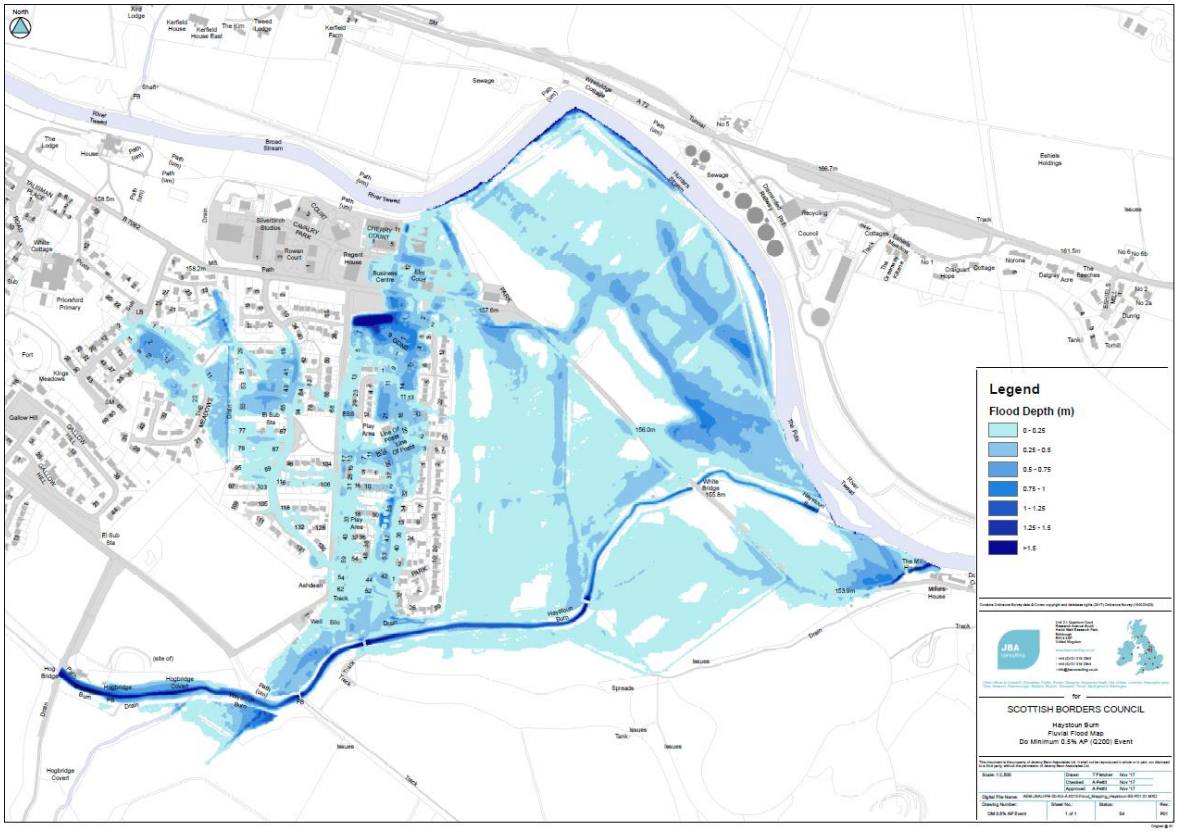
A full range of model simulations were performed covering the full range of AP events for a worst case 'Do Nothing' and present day 'Do Minimum' scenario, with the model being modified slightly between scenarios. A description of the differences between these model scenarios is provided in section 3.2 below. A full suite of sensitivity tests were also carried out to test the models response to changes in roughness, bridge blockage, inflows and downstream boundary conditions.

Additional model scenarios were used to test the feasibility and successes of different flood protection options that emerged during the options long-listing process described in section 4.5.

2.7.3 Model results

Figure 2-3 below shows the estimated flood depths for the 0.5% AP (200 year) flood event on the Haystoun Burn. The remaining flood depth maps are supplied alongside this report.

Figure 2-3: 0.5% AP (200 year) flood depth map for the Do Minimum scenario



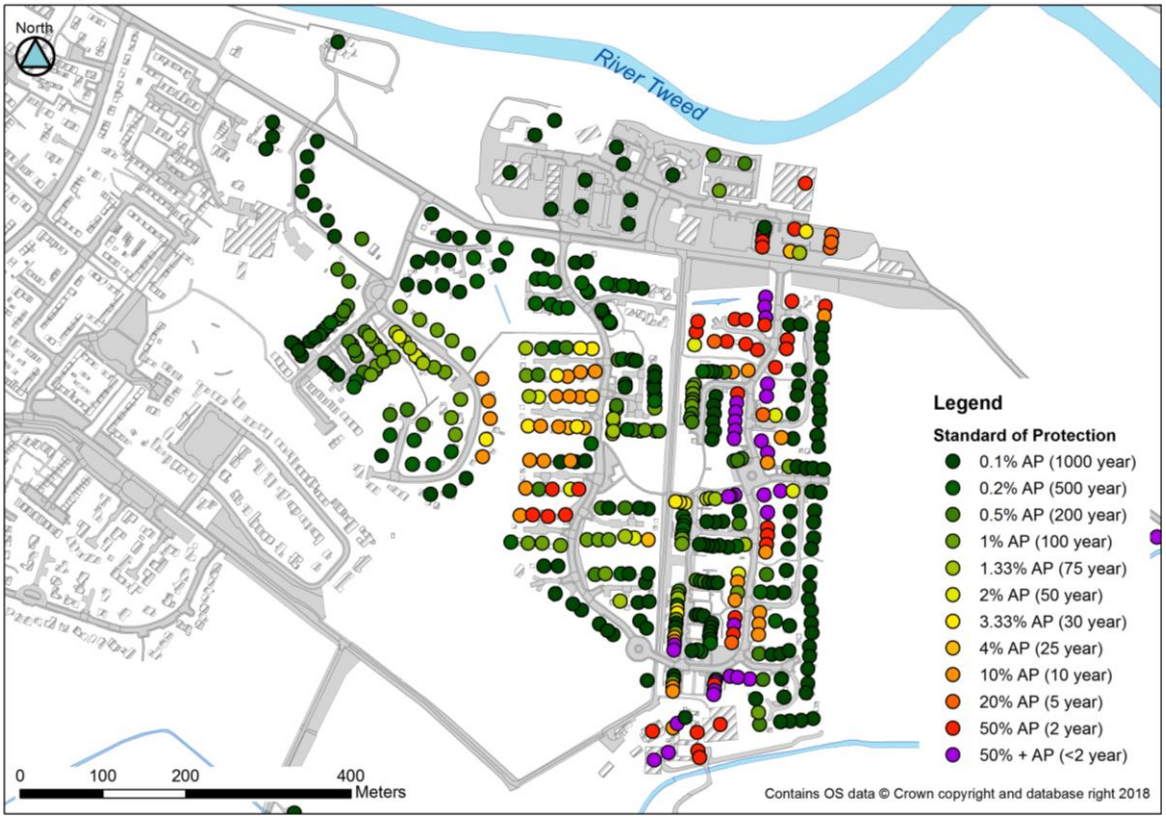
Flooding from the Haystoun Burn originates at Whitehaugh Farm at which point it can flow north through Kittlegairy Estate towards the B7062 and the River Tweed beyond. The roads and driveways of the Kittlegairy Estate provide a flow pathway. This pathway is estimated to occur from the 50% AP (2 year) flood event and upwards, although the flow estimates do carry some uncertainty due to the lack of flow gauging on the burn. Further downstream of Whitehaugh Farm flood waters spill onto the floodplains either side of the burn and spread across the agricultural land, eventually joining the River Tweed.

2.7.4 Current standard of protection

The figures below show the present-day level of protection each property in Peebles has from flooding of the River Tweed. 'Standard of protection' is the largest flood event which is not expected to cause flooding to a property, larger magnitude events would be expected to cause property flooding. For example, a property with a 4% AP (25 year) standard of protection would be expected to flood at the 3.33% AP (30 year) flood.

Many properties within Kittlegairy Estate and Whitehaugh Park have a very low standard of protection, estimated to be flooded at the 50% AP (2 year) flood event. Figure 2-4 shows the flow path from Whitehaugh Farm which causes a string of properties to have low standards of protection. As mentioned in section 2.2 there is some uncertainty in the hydrology for this burn. The different hydrological methods used to estimate peak flows show a variation in this minimum standard of protection from 2 to 6 years, something that could influence the investment appraisal significantly,

Figure 2-4: Standard of protection for the properties at risk in the Do Minimum scenario

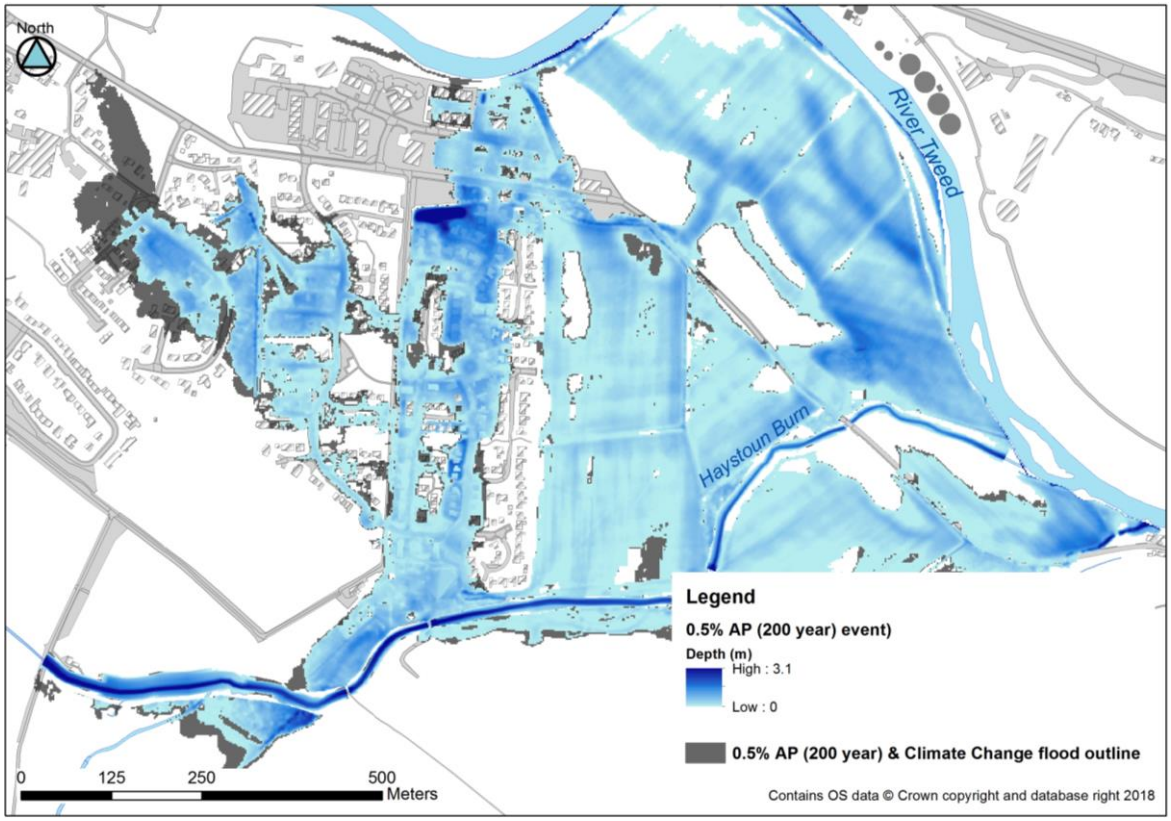


2.7.5 The effects of climate change on flood extents

Climate change is expected to increase both the peak flow of design floods and the frequency of flood events which will mean that an event statistically expected to occur every 2 years at present might be expected to occur every 1 year, for example. Similarly, this might mean a flood currently expected to occur every 200 years flood might be expected to occur nearer to every 100 years in the future.

The 0.5% AP (200 year) event with a 33% increase for climate change produces a more extensive flood outline with greater flood depths. Figure 2-5 shows the difference between the present day 0.5% AP (200 year) flood outline and the flood depth map expected as a result of climate change. The climate change simulation results in a slightly enlarged flood extent and increased flood depths in the order of 0.4m in the vicinity of The Meadows. The Meadows and Kingsmeadows Gardens are most significantly affected.

Figure 2-5: 0.5% AP (200 year) flood outlines with and without an allowance for climate change



3 Appraisal approach

3.1 Overview

The economic appraisal phase of the project requires analysis of the flood damages as calculated from the hydraulic modelling study and identification of problem areas. Through a long and short-listing process flood risk management options for these areas are reviewed and ultimately a short list of viable options is proposed. Comparison of the flood damages with and without the proposed flood risk mitigation options gives the flood damage 'benefit' of that option. Engineering costs are applied to each of the proposed options and this allows calculation of the benefit-cost ratio (BCR). The next sections detail this process and present the findings.

3.2 Problem definition

There are 192 properties in Peebles at risk from the Haystoun Burn at the 0.5% AP (200 year) event. Flooding is estimated to begin at the 50% AP (2 year) flood event or smaller under existing conditions and can therefore be considered a frequent and serious problem. There are at present no defences in place along the burn and no properties are known to have purchased Property Level Protection (PLP) products.

3.2.1 Consequences of Doing Nothing

The starting point for a scheme appraisal is always to develop a suitable Do Nothing and Do Minimum option that can be used as a consistent baseline against which other options are compared. The Do Nothing represents the 'walk-away' option; cease all maintenance and repairs to existing defences and watercourse activities. This therefore represents a scenario with no intervention in the natural processes and serves as a baseline against which all other options are compared.

Assessing the level of risk for both the Do Nothing and Do Minimum options needs to consider how the watercourse will change and how any flow controlling assets or flood defences will react or deteriorate over the appraisal period. The following recommendations are therefore used for the Do Nothing and Do Minimum options:

3.2.2 Do Nothing - Haystoun Burn

Under the Do Nothing scenario the watercourses would not be maintained. This would lead to a gradual degradation of the banks and vegetation growth. However, as the floodplain is grazed, the Do Nothing variation in channel, bank and floodplain roughness is not anticipated to increase significantly. The Do Nothing scenario is represented in the model as a 10% increase in Manning's 'n' roughness throughout the appraisal period.

3.2.3 Do Minimum - Haystoun Burn

The Do Minimum scenario effectively represents the current scenario whereby the watercourse and all structures are maintained and replaced if they deteriorate to a point that is unacceptable. Manning's roughness represents current conditions.

3.2.4 Accounting for climate change

Under the Climate Change (Scotland) Act (2009) local authorities have a duty to use an evidence-based approach to develop means to reduce the impact of climate change through mitigation measures (reducing emissions), planning to adapt to a changing climate and acting sustainably. The Council wherever possible seeks to protect against climate change since this provides long-term sustainable benefits. This project appraisal fulfils the ‘adaptation’ and ‘acting sustainably’ duties.

4 Flood risk management options

4.1 Critical success factors (objectives)

The long list of options has been assessed against a number of critical success factors:

1. Options whether in isolation or combination must reduce flood risk providing an appropriate level of protection to people, property, business, community assets and natural environment.
2. Option must be technically appropriate and feasible.
3. Option should help to deliver sustainable flood risk management (e.g. help contribute to amenity and urban regeneration, improve the environment and biodiversity and improve or reduce existing maintenance regimes).
4. Options should not have insurmountable or legal constraints (e.g. land ownership, health and safety or environmental protection constraints).
5. Options should represent best value for money and minimise the maintenance burden and costs as much as possible.
6. Options should have a desirable BCR when measured in parallel with other success criteria.
7. Options should incorporate National, Regional and Local agendas/objectives.
8. Options should be deliverable by 2028 or a future agreed funding period when assessed with other success criteria.

4.2 Guideline standard of protection

The Scottish Government do not specify design standards for flood protection schemes. However, the standard of protection against flooding typically used in Scotland is the 0.5% AP flood (1 in 200 year). This standard is the level of protection required for most types of residential and commercial/industrial development as defined by Scottish Planning Policy (SPP).

Whilst design standards are a useful tool in terms of engineering goals and useful benchmarks, as well as in clear communication to stakeholders and the public, there is a general move in Scotland away from design standards to a risk based approach. Restricting options to desired standards of protection can limit consideration of factors that influence defence effectiveness and can limit future responses to external factors.

It is expected that a variety of protection levels are considered during the design process including the 0.5% and 1% annual probabilities and in some cases a lesser level. The guidance also states that options should be tested against a 1% annual probability plus allowances for climate change. Ministerial guidance[1] recommends appraising against the 1% AP (100 year) standard with an allowance for climate change but where the 0.5% AP standard is not achievable the focus has been on appraising to an appropriate lower standard rather than specifically the 1% AP standard with an allowance for climate change.

Based on the above guidance the aim of the scheme will be to assess options up to the 0.5% AP (200 year) plus climate change flood if possible, but to test lower return period events if appropriate.

Based on the fact that 2% AP (1 in 50 year) floods have been witnessed recently on the River Tweed into which the Haystoun Burn flows and other schemes within the Scottish Borders deliver a standard of protection in excess or to the 1:33% AP (75 year) plus climate change, it is not anticipated that a standard of protection less than this is deemed to be appropriate in terms of the critical success factors for this study.

4.3 Short term structural and maintenance recommendations and quick wins

Several measures or short term 'quick wins' have been identified that cover a range of aspects from maintenance to small scale works. Due to the relatively short reach of interest and the lack of structures on the burn there are relatively few of these actions recommended. They are summarised in Table 4-1.

[1] Scottish Government (2011) Delivering sustainable flood risk management. Guidance document. Scottish Government, Edinburgh. http://www.gov.scot/Publications/2011/06/15150211/0

4.3.1 Short term structural and channel maintenance and quick wins for Haystoun Burn

Table 4-1: Short term structural and channel maintenance and quick wins for Haystoun Burn.

Problem	Actions	Arch Bridge over B7062
Possibility of vegetation overgrowth	General vegetation management.	 ***Upstream face of bridge***
Erosion on left bank just downstream of Crookston Burn and Haystoun Burn	Consider green bank protection or rock armour protection along area of erosion to stabilise the bank. General vegetation management.	 ***Erosion on left bank***  ***Rock armour protection along left bank***
Invasive non-native species noted in ecological appraisal	Removal/control of invasive non-native species if identified at any stage	

Problem	Actions	Arch Bridge over B7062
Lack of public awareness	Provision of signage at key locations such as around bridges with contact details for emergency response teams and details of how to access the Peebles sandbag store.	

4.4 Non-structural flood risk management recommendations

4.4.1 Flood warning

The Haystoun Burn does not benefit from a flood forecasting system. Whilst flood warning is a challenge for a small catchment there are feasible options that could provide some warning to the community prior to flood events. A formal flood warning gauge could be procured by SEPA and introduced on the burn. Although it might be a challenge to deliver an advanced warning for this small catchment, there may be some benefit if combined with the latest rainfall forecast predictions and the provision of a rain gauge in the upper catchment. A gauge would also provide wider benefits by providing useable hydrometric data to improve hydrological estimates for future flood studies.

Alternatively, a third-party warning system could be procured and managed by either the Council or a local Flood Group. Some such systems monitor river levels and provide a text-based warning to key people within the community when levels reach a predefined point.

Installation of a gauge and recording of flood events when they occur would aid in the development of high flow ratings on the burn. Regardless of whether flood warning is implemented, flood levels should be recorded against stage boards and wrack marks should be surveyed whenever flood events occur to help build up a long-term flood record of events that can be used for future flood forecasting system calibration and general flood understanding.

4.4.2 Emergency action plans

The Council's Emergency Action Plan is the Severe Weather Plan which was updated in July 2018. This describes the Council's emergency response procedures, flood gate procedures and flood warning procedures. It has been designed to run as a standalone plan but can be run in conjunction with other emergency plans such as the Media & Communications Plan and the Care for People Plan. The emergency plan is initiated by Met Office weather warnings and SEPA flood warning information. The plan is coordinated through all Category 1 and Category 2 responders including Scottish Water, voluntary groups (community flood action groups) and public utility companies through the Joint Agency Control Centre (Bunker) at Scottish Borders Council.

This emergency plan is updated regularly as new information becomes available. It is recommended, if it has not already been done, that this is updated with the findings of this study, in particular the revised flood mapping. Regular reviews and preparation of community level emergency plans may be necessary to ensure that the following are up to date:

- Flood maps,
- Properties at risk (and any protected by PLP),
- Safe access and egress routes,
- Flood warning actions and escalation plans,
- Locations of community sandbag stores,
- Dissemination roles and responsibilities,
- Evacuation procedures,
- Onsite and/or temporary refuge locations/planning, and
- Back-up planning.

Emergency planning should encourage communication at a community level to ensure good response rates during a flood. Examples of this include flood group leaders, flood wardens and buddy schemes that encourage communities to act together and to help provide assistance to those needing additional help (e.g. vulnerable residents).

4.4.3 Raising public awareness and community flood action groups

Responsible Authorities have a duty to raise public awareness of flood risk. Helping individuals understand the risks from which they are most vulnerable is the first step in this process.

Everyone is responsible for protecting themselves and their property from flooding. Property and business owners can take simple steps to reduce damage and disruption to their homes and businesses should flooding happen. This includes preparing a flood plan and flood kit, installing property level protection, signing up to the Resilient Communities Initiative, and ensuring that properties and businesses are insured against flood damage. Flood Action Groups are well known to assist with this awareness raising and resilience.

The Scottish Borders Council have a well-established resilient communities programme, of which 43 of 70 community areas are signed up to in the Scottish Borders. These are resilience groups which operate during times of emergency, including flooding. A resilient community group is located in Peebles. As an ongoing action, Scottish Borders Council will continue to work closely with these resilient community groups, other local groups and members of the public to raise awareness of flood risk. It is recommended that the outputs from this study are shared with the resilience group to ensure that they are aware of the new flood maps and to assist with emergency procedures.

Council awareness raising activities are to be combined with on-going public meetings and consultation for proposed flood schemes as part of further developments associated with this study. Information from the Council is also expected to be disseminated through website, social media and other community engagement activity as appropriate.

4.4.4 Community sandbag stores

The Scottish Borders Council continues to use community sandbag stores located at publicly accessible areas including fire stations and school grounds. The Peebles community sandbag store is maintained at the fire station and holds an estimated 300 sandbags. Resilient Communities sandbag stores are now also widely distributed across the Scottish Borders in areas that have signed up to the Resilient Communities Initiative. Resilient Communities stores hold an estimated 60 sandbags. The Council should review the location of these and investigate if a secondary Resilient Communities store should be located in the Kittlegairy Estate.

It is recommended that the Council considers the use of the flood 'pod' system which are community storage boxes, containing flood sacks; purpose designed bags filled with absorbent material. The key advantage of this approach is that they can be distributed before a flood and are ideal for locations with limited warning or response times. It may also save the Council time in filling, distributing and delivering sandbags to communities when sandbag stores run out. Instead residents whose homes are at risk of flooding can access the boxes and can help themselves prior to and during a flood. Whilst careful review of the siting and number of these pods would be required, they may offer a useful approach in Peebles and in particular for the Kittlegairy Estate. This approach would need to be combined with the existing flood warning and flood awareness campaign provided by SEPA (i.e. flood alerts), but also a new Flood Warning system on the Haystoun Burn.

4.4.5 Property level protection (PLP)

Scottish Borders Council currently offer a discounted PLP scheme to properties at risk of flooding through provision of cost price products made more affordable through a capped council-funded subsidy. The scheme makes manual PLP products more affordable than they would otherwise be and there has been some uptake to date.

PLP in general is seen as a short term option for properties near the Haystoun Burn since there are a large number of properties at risk of flooding and there are opportunities to implement a more substantial flood protection scheme without the reliance on flood warning that PLP carries. Nevertheless, a full PLP scheme will be considered alongside the other options in the investment appraisal. Whether full funding would be provided through a flood protection scheme or if resident contributions would be sought is not considered at this stage.

4.4.6 Natural Flood Management

Capitalising on the opportunities for NFM in the Haystoun Burn catchment could provide some flood attenuation on the burn. If widespread NFM is put forward, then care should be taken to estimate the changes in peak flood timings so as not to align flood peaks in the sub-catchments and align them with the peak on the River Tweed and thus generating a greater peak on the River Tweed than would occur without those NFM measures in place.

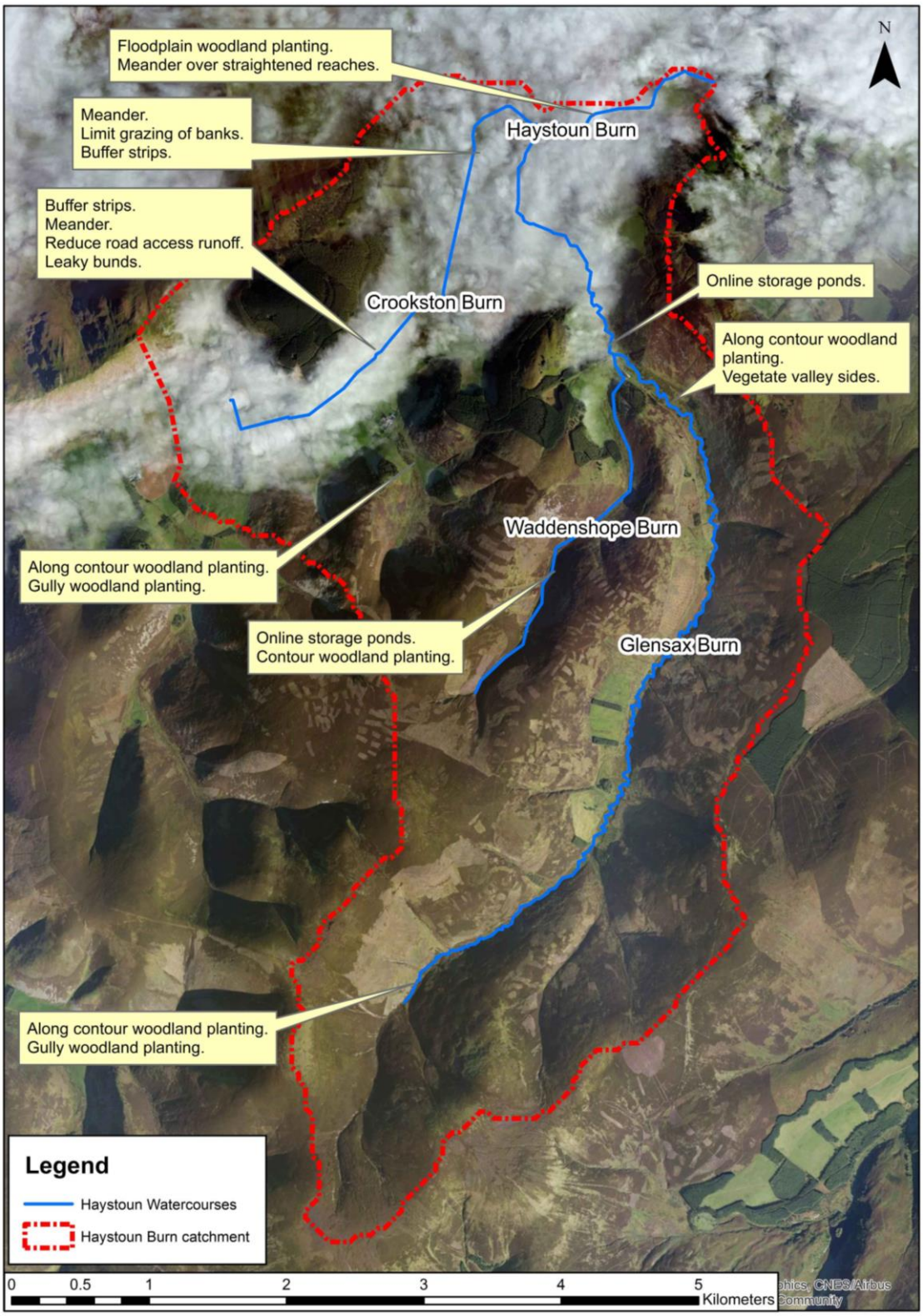
A number of primary opportunities exist and may be considered by the Council. These are summarised in Figure 4-1 and as follows:

- Planting of contour woodland
- Increase floodplain and riparian planting
- Introduce buffer strips around agricultural land on the Crookston Burn
- Re-meander straightened sections of the Crookston Burn
- Installation of leaky bunds in the north of the catchment
- Establish woody debris in straightened agricultural channels

Overall it is recommended that Scottish Borders Council implement some or all of the NFM measures as a 'no regrets' option and in partnership with existing organisations that have experience of discussing NFM with landowners and delivering these types of measures. It is also recommended that the Council purchases available LIDAR data and procures initial hydraulic modelling to inform the refinement of NFM measures in the upper catchment.

How NFM is implemented will require further consideration as to whether these are implemented as part of a Flood Protection Scheme or as part of a wider catchment management approach to NFM.

Figure 4-1: Haystoun Burn NFM opportunities



4.4.7 Planning policy

The Scottish Government laid out several measures to promote sustainable flood risk management in the Scottish Planning Policy[2] published in 2014. The Policy aims to ensure that the planning system promotes a precautionary approach to flood risk from all sources, taking the likely impacts of climate change into account. Further, new developments must not reduce floodplain storage or

2 Scottish Planning Policy, 2014, Scottish Government: https://www.gov.scot/Resource/0045/00453827.pdf

conveyance, achieved by locating new developments outside of the functional floodplain and away from medium to high flood risk areas. Opportunities are expected to be sought for reducing flood magnitude such as through river restoration, enhancing flood storage capacity and reducing the length of culverted watercourses. New developments must comply with requirements for Sustainable Drainage Systems (SuDS) to ensure that surface runoff does not increase as a result of the increase in man-made surfaces common to developments.

Specifically, this means that future developments in Peebles should not increase the number of properties at risk from flooding. The flood maps produced and in particular the climate change mapping produced should be used when reviewing planning policies by the Council.

Discussions with SEPA provided useful insight into the areas where Local Development Plans have land allocated for development which may be at previously unidentified flood risk in the present day or that may be put at risk where the short listed options shown below plan to use undeveloped land for the storage of flood waters. Much of site SPEEB005 identified in the Local Development Plan as a site for longer term mixed use is estimated to be widely at risk of flooding from the 50% AP (2 year) upwards and should therefore be reviewed carefully.

4.5 Long list of options

The following table provides an overview of potential flood alleviation options targeting flood risk from the River Tweed in Peebles. Those with the potential to alleviate flood risk from high magnitude flood events or which offer multiple catchment-wide benefits have been assessed further in the following sections.

The following table provides an overview of potential flood alleviation options that could benefit properties at risk from the Haystoun Burn. Those that are most viable have been assessed further in the later sections of the report.

Table 4-2: Long list of options for the Haystoun Burn

Measure	Discussion
Relocation	**Technical**: Relocation or abandonment of properties not politically or socially viable, partly due to the recent development of the estate. Option not cost-effective as purchase costs will be same as capped damages. **Environmental**: No significant environmental or RBMP benefits or impacts. **Constraints**: Multiple objections likely if carried out via a FPS. **Decision: Option discounted**
Flood warning	**Technical**: No FWA currently for Haystoun Burn. Would require gauge installation or monitoring in order to inform alert stages. Third party river level monitor could also be used. **Environmental**: No environmental or RBMP benefits or impacts. **Constraints**: None **Decision: Option to be taken forward alongside other options**
Resistance - means of reducing water ingress into a property to enable faster recovery	**Technical**: All Scottish Borders properties at risk of flooding are covered by the Flood Protection Products Discount scheme operated by the council. Further properties moving from reliance on the council emergency sandbag store in Peebles to retrofit Property Level Protection (PLP) products is likely to reduce property inundation during small floods. **Environmental**: No significant environmental or RBMP benefits or impacts. **Constraints**: Unlikely to be accepted by the community as the only flood protection measure. **Decision: Viable option for some properties, option taken forward**
Resilience - means of reducing the impacts of flood water ingress on a property to enable faster recovery	**Technical**: Extremely costly due to the number of properties at risk of flooding. **Environmental**: No significant environmental or RBMP benefits or impacts. **Constraints**: Multiple objections likely if carried out via a FPS. **Decision: Unlikely to be economically viable at this stage. Option not progressed further.**
Watercourse maintenance	**Technical**: Maintenance unlikely to reduce flood risk to a useful degree but maintenance schedule should be adhered to. Could play a minor role in reducing flood risk if combined with more substantial options. **Environmental**: Channel maintenance may have minor negative impacts if spawning areas disrupted but these are unlikely to be significant.

Measure	Discussion
	Constraints: Possible stretching of council resources if further inspection/maintenance is proposed. **Decision: Option discounted**
Natural Flood Management (NFM)	Natural Flood Management options have been assessed as a standalone report. It is recommended that the options proposed are taken forward either as a standalone action to make the catchment more flood resilient or as part of a wider NFM study on the Tweed. It is recommended that further data gathering and modelling is undertaken to develop the options assessed.
Storage	**Technical:** Potential storage locations upstream of Crooknow Covert on the Crookston Burn and upstream of Lower Newby on the Glensax Burn, although this would require construction of an embankment to attenuate flows. Smaller scale storage in the upper catchment in tandem with natural flood management options may be viable, see separate NFM report for details. **Environmental**: Special Area of Conservation (SAC) designation along Haystoun Burn as far as Haystoun House Farm. The potential storage areas are outside of the designated area. **Constraints:** Land ownership constraints likely to be encountered. **Decision: Option carried forward but reviewed in more detail in Section 4.6.2**
Control structures	**Technical:** Flows during flood events are generally small, so it is likely that the cost of installation and maintenance of control structures would outweigh any potential benefits. Likely to provide more problems than solutions in terms of overall flood conveyance. **Environmental:** Could provide wetland habitats but likely to impede movement of flora, fauna and sediment along the watercourse thus having a net negative impact on the watercourse. Haystoun Burn is a SAC as far as the pond at Haystoun House Farm. **Constraints:** Unlikely to be cost-effective due to the lack of floodplain space for useful volumes of water to be held back, and potential objections from residents. **Decision: Option discounted**
Demountable defences	**Technical:** The option to install demountable barriers on the road between Kittlegairy View and Whitehaugh Park was investigated to block a key flow path into the Whitehaugh Park Estate. Whilst technically viable, the option would inevitably further increase the risk to the Kittlegairy Estate; as a result this option was discounted. Ensuring constant availability of trained personnel capable of deploying defences may put excessive pressure on council. Residents may be able to assist but reliability of defence deployment may be reduced. **Environmental:** No significant environmental or RBMP benefits or impacts although likely to be preferred from an environmental standpoint when compared to direct defences. **Constraints:** Not enough lead time for reliable deployment on such a small watercourse with a fast time to peak, especially without Flood Warning. **Decision: Option discounted**
Direct defences	**Technical:** Direct defences may be feasible to the south of the Kittlegairy Estate and Whitehaugh Farm, in the form of a wall or embankment. Walls are more appropriate than embankments in some locations and should be made adaptable where possible to accommodate future storm intensification due to climate change. Erosion on the left bank of the burn around Whitehaugh Farm may need to be addressed in conjunction with this option. **Environmental:** Direct defences likely to have negative RBMP impact through increased morphological pressure on the watercourse. May also disconnect river from land for some species, especially if walls are constructed rather than embankments. **Constraints:** Some objections likely at public consultation but in general likely to be an acceptable option. **Decision: Option carried forward**
Channel modification	**Technical**: Channel deepening possible in some locations. This is unlikely to provide sufficient flood protection as an independent measure.

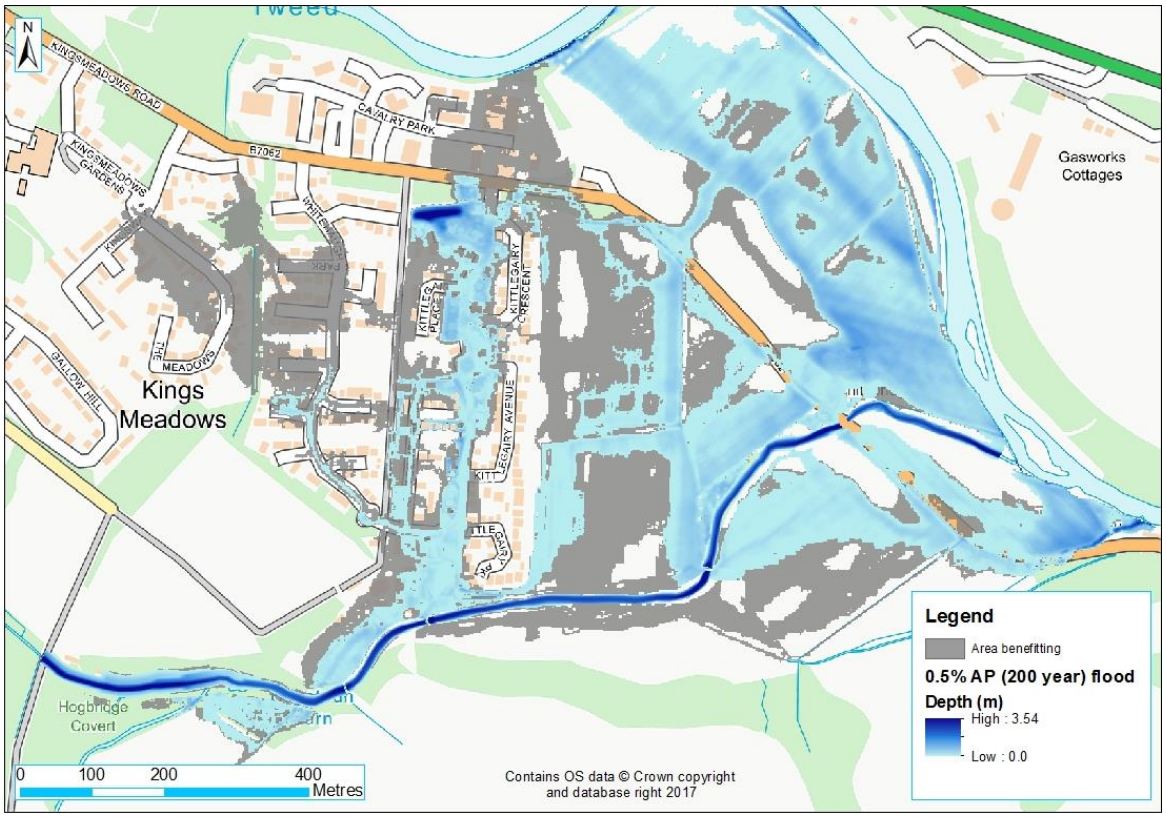
Measure	Discussion
	Environmental: Considerable environmental impacts including destruction of sensitive habitats e.g. fish spawning grounds. No significant environmental benefits. **Constraints**: Haystoun Burn is a SAC therefore unlikely to be permissible. Dredging would be an ongoing maintenance burden. **Decision: Option discounted but reviewed in more detail in Section 4.6.1**
Diversion	**Technical**: No scope for channel diversion at Whitehaugh Farm due to topographic constrictions. Other locations would provide no benefit if diversion channel installed. **Environmental**: May remove other valuable habitats in the short term but if bypass was naturalised then could provide RBMP benefits. **Constraints**: Topography does not promote diversion. **Decision: Option discounted**
Structure modification	**Technical**: Bridge conveyance is good as structures are in good condition and have no piers or other obstructions to flow. Therefore, there is little scope for improving conveyance on these structures. **Environmental**: Net improvement in RMBP impacts likely if bridges are widened or raised but changes are unlikely to be significant. **Constraints**: Removal or modifications of bridges is likely to be objected to due to community value of this infrastructure. **Decision: Option discounted**

4.6 Rejected options following further testing

4.6.1 Channel deepening analysis on Haystoun Burn

The possibility of increasing channel capacity through deepening the channel (i.e. by removal of sediment) was considered. This option was tested along the entire modelled reach of the watercourse by reducing the bed level of the 1D channel by 1m. This option was considered in an attempt to improve channel capacity and conveyance. The results of the analysis when compared to the Do Minimum 0.5% AP flood extent are shown in Figure 4-2.

Figure 4-2: Impact of channel deepening on flood extent in the 0.5% AP event

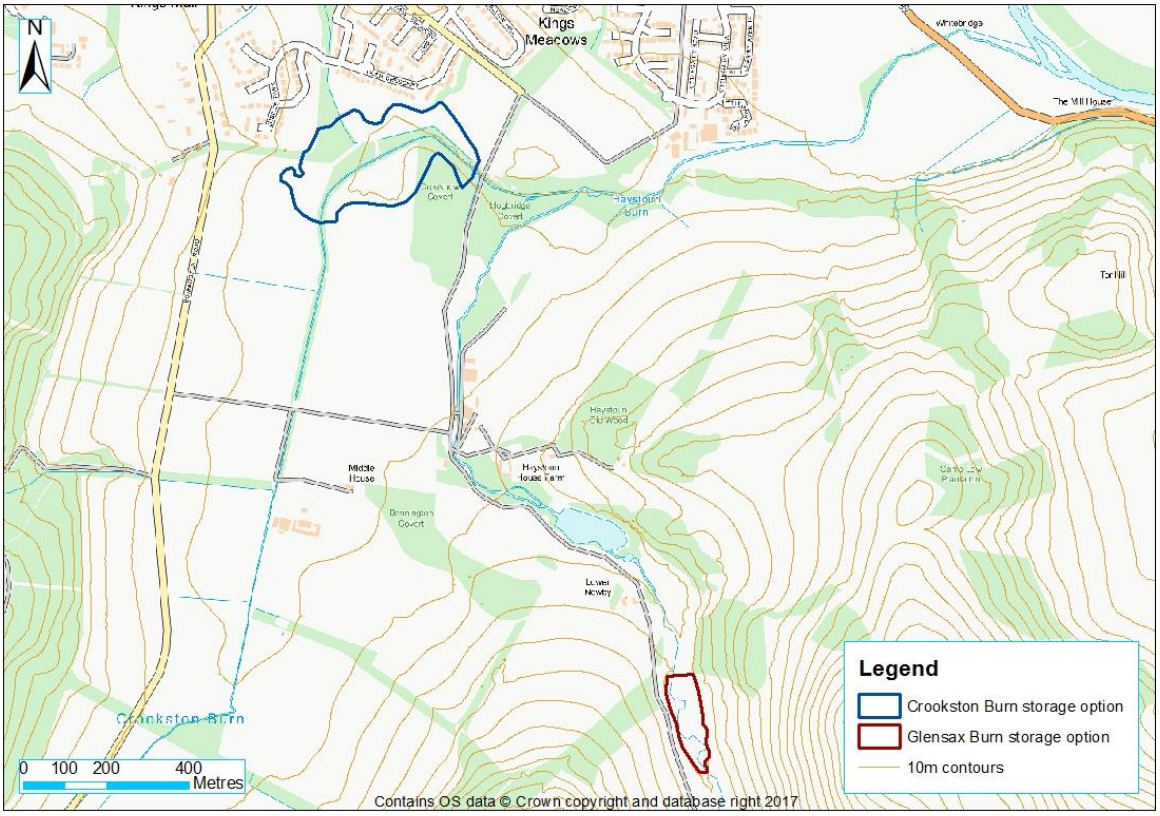


The modelling suggests that although flood extents are reduced in the bed lowering scenario, it is not sufficient to prevent flooding in the 0.5% AP event. The potential environmental impact of this scale of dredging is considered too great compared to the estimated reduction in flooding. Furthermore, the deepened channel would require regular work to maintain its depth and extensive bank stabilisation works would be required to make this a sustainable option. Bed lowering through the removal of sediment to 1m depth is an extreme scenario, and this analysis therefore demonstrates that lowering of the bed to less than 1m would not provide sufficient protection to prevent properties on the Kittlegairy Estate from flooding in the 0.5% AP event. For these reasons this option is not seen as a long-term strategy for the reduction of flood risk and has not been carried forward beyond this stage of analysis.

4.6.2 Storage analysis on Haystoun Burn

The possibility of attenuating floodwater in the upper Haystoun Burn catchment was considered. Two locations were selected for testing, as shown in Figure 4-3.

Figure 4-3: Locations of storage areas tested on the Haystoun Burn



A basic Flood Modeller model was built to test the attenuation of flows at each location by creating an orifice opening and the storage behind a theoretical dam structure. The storage behind the dam was based on an area/elevation relationship extracted from the LIDAR data. The estimated design flows for both the Crookston Burn and Glensax Burn were derived by splitting the total catchment inflow by the proportional area of each sub catchment.

A range of model tests were undertaken based on the peak downstream flow that the current watercourse can convey before property flooding occurs, the pass forward flow on each sub catchment and the maximum elevation that can be achieved at the selected storage options before third party or infrastructure impacts occur.

The analysis suggests that modest storage is available which could attenuate only small flood events (in the range of the 1 in 2 or 1 in 5 year flood). The ability to attenuate a larger flood is not feasible due to the height of embankments required and the impact on existing roads and properties.

The results suggest that a significant structure would be required to store and attenuate flood flows in the upper catchment. Because the inflow into the main watercourse is split between two similarly sized tributaries, attenuating flows on only one tributary would not provide a high standard of protection overall for properties downstream of the confluence. The structures would have

significant aesthetic implications, and the occasional storage of large volumes of water directly upstream of an urbanised area would also represent a new risk and a critical maintenance burden for the Council. For these reasons, the option for storage on Haystoun Burn has been discounted and is not appraised further in the short listed options.

4.7 Short list of options

4.7.1 Designing for climate change

In line with Scottish Planning Policy a 0.5% AP (200 year) standard of protection for any scheme was the goal throughout the short listing process. Wherever possible, options have been short-listed that at least aim to mitigate flooding to this standard and strive to meet the design standard for this event with an allowance for climate change, a 33% increase in the peak river flow.

Where a 0.5% AP (200 year) standard is not feasible interventions have been designed to allow for the greatest flood risk benefit possible after consideration of technical, environmental and social limitations and opportunities. River flood flows are expected to rise and where possible this has been accounted for in the design, for example by allowing for adaptable defences or by targeting a slightly higher standard of protection than may be ideal at the current time.

In the Tweed catchment the opportunities for Natural Flood Management are many. A growing body of evidence suggests that careful introduction of NFM measures may allow for reduced river flows in some cases. Although the greatest benefits would likely be seen for communities suffering from flooding directly from smaller watercourses, mature NFM measures and improved land management in the Haystoun Burn catchment may reduce river flows in the main watercourse and to some extent counteract climate change increases. For this reason we recommend that NFM measures be taken forward either alongside the more traditional options listed below or on their own if ultimately no other options are taken forward to outline design stage.

4.8 Flood Mitigation Options - Haystoun Burn

The following section details the constraints and benefits of the shortlisted options on the Haystoun Burn. A plan, included in the Figures section at the end of the report, shows the location and extents of the various interventions.

4.8.1 Option 1 - Construction of direct defences at southern end of Kittlegairy Estate

Option 1 - Construction of direct defences at southern end of Kittlegairy Estate

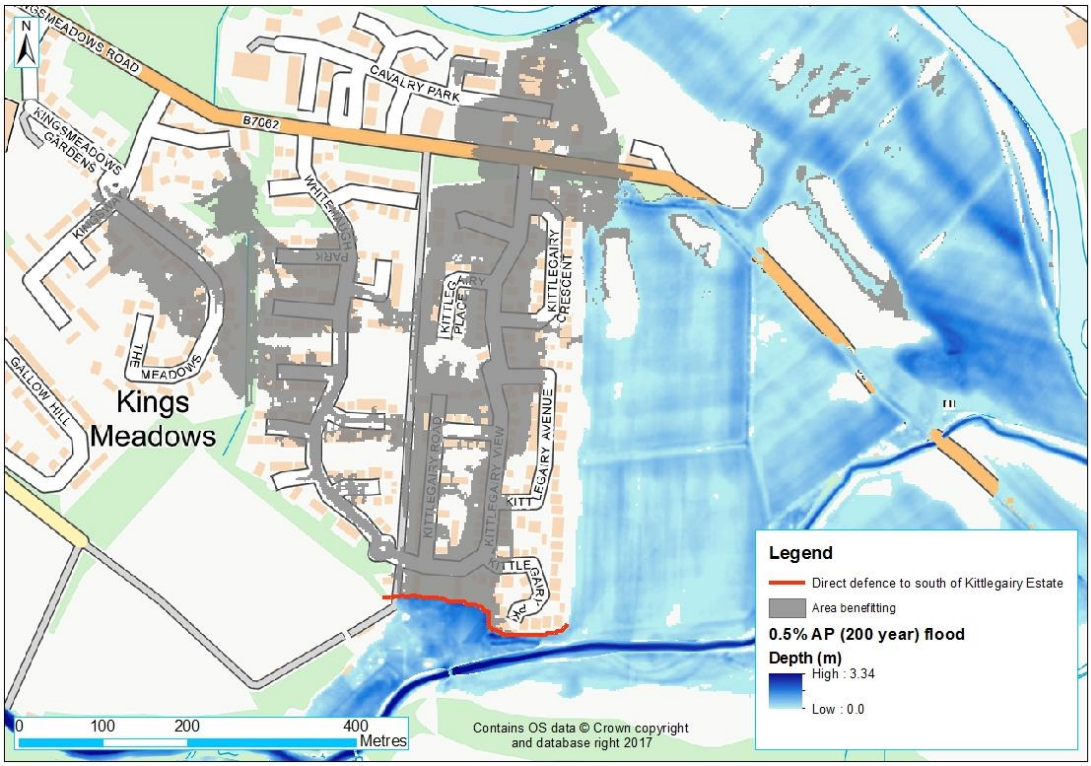
Description

This option aims to provide a high standard of protection through the installation of an approximately 270m long section of wall along the southern end of Kittlegairy Estate. The work includes the following:

- Install wall between Whitehaugh Farm access road and the rear of houses on Kittlegairy Park for a distance of approximately 270m, to a maximum height of 1.5m (includes a 300mm freeboard).

A technical drawing relating to this option has been produced and is provided alongside this report, named as follows:

AEM-JBAU-PB-HB-SK-C-1100-Opt1_200Yr_SB_Direct_Def-S3-P01.pdf



Standard of Protection (SOP)

Modelling of the above option suggests that a standard of protection of a 0.5% AP (200 year) flood is achievable. This equates to a flow of 39.05m^3/s.

Alternative quick wins / Preliminary investigations

Lower wall raising would offer a lesser standard of protection but for a marginally lower cost.

Geotechnical issues

- A review of available BGS borehole logs and mapping of superficial deposits indicates that most of the defences are likely to be constructed on sandy or gravelly alluvial deposits.
- A full GI will be required at a later stage in the project.
- A cut-off is likely to be needed. Piling may be difficult in this material and other forms of cut-off may need to be considered.

Services

Overhead and underground services have been identified and their location is shown on drawing AEM-JBAU-PB-HB-SK-C-1001-Services_Plan.

- Low voltage electrical cables were identified in the plans close to western extent of the flood wall.

Construction access

Construction access has been considered and is not considered too difficult, although consultation with the farm owner will be critical. Issues include:

- Construction would entail heavy machinery working near to the bank in places.
- Temporary storage of topsoil and subsoil in heaps and stockpiles.
- Groundworks and construction vehicles are likely to cause noise and vibration.
- Exclusion of public from working areas - good practice working methods such as alternative access routes and phasing of works to be considered. Alternative access may be required to reduce impacts to Whitehaugh Farm.

Waste

- Production of waste including silt, dust and construction waste. Further investigation required through GI into level of contamination and ownership.
- Expected quantity of waste material: 145.8m^3.
- Nature (inert, non-hazardous, hazardous): It is known that very limited industry was present in Peebles – soil expected to be inert.
- Proposed disposal: According to SEPA guidance.

Environmental issues

- Statutory Environmental Designations (SSSI, SPA, SAC, Ramsar Sites Nature Reserves, INNS). Haystoun Burn is a special area of conservation (SAC).
- Habitat: The area within the site boundaries is a National Forest Inventory.
- Listed Buildings: Whitehaugh Farm is a Category B listed Building.
- SEPA pollution prevention guidelines should be adhered to throughout the works.

Health and Safety hazards noted

- Geotechnical and excavation works - In channel works, falling into excavations, collapse of the sides of excavation, damage to underground services, undermining of nearby structures.
- Construction – flooding of works.

Social and community issues

Some aesthetic issues as this option has been designed to mitigate flood risk to extreme flood events which requires greater intervention than the quick win option. Land take is minimal but a substantial length of flood wall is proposed. Access along the B7062 will not be possible in times of flood.

Impact on other reaches

The works will increase the flow in the channel downstream of the works as a result of the reduction in out of bank flows. The increase in flow would be in the order of 0.62m^3/s at the downstream model extent relative to the Do Minimum scenario. Due to ponding of water behind the flood wall the risk to Whitehaugh Farm may be increased. There will be an increased likelihood of flooding to the agricultural land either side of the burn downstream of the farm and there are likely to be increased flood depths on the B7062 in times of flood.

Additional information required

- A detailed topographic survey.
- Detailed buried services survey, plotting their position with regards to site works.
- Ground investigation.

Additional works required to account for increase in 200 year flow due to climate change

- Consider building adaptable walls that can be easily raised in the future.
- The increase in wall height required to protect against the 0.5% AP (200 year) event with climate change is likely to be in the order of 200mm. We therefore recommend that should this option be carried forward to outline design stage further analysis is performed to assess the additional benefit of designing for climate change.

4.8.2 Option 2 - Construction of direct defence to south of Whitehaugh Farm

Option 2 - Construction of direct defence to south of Whitehaugh Farm

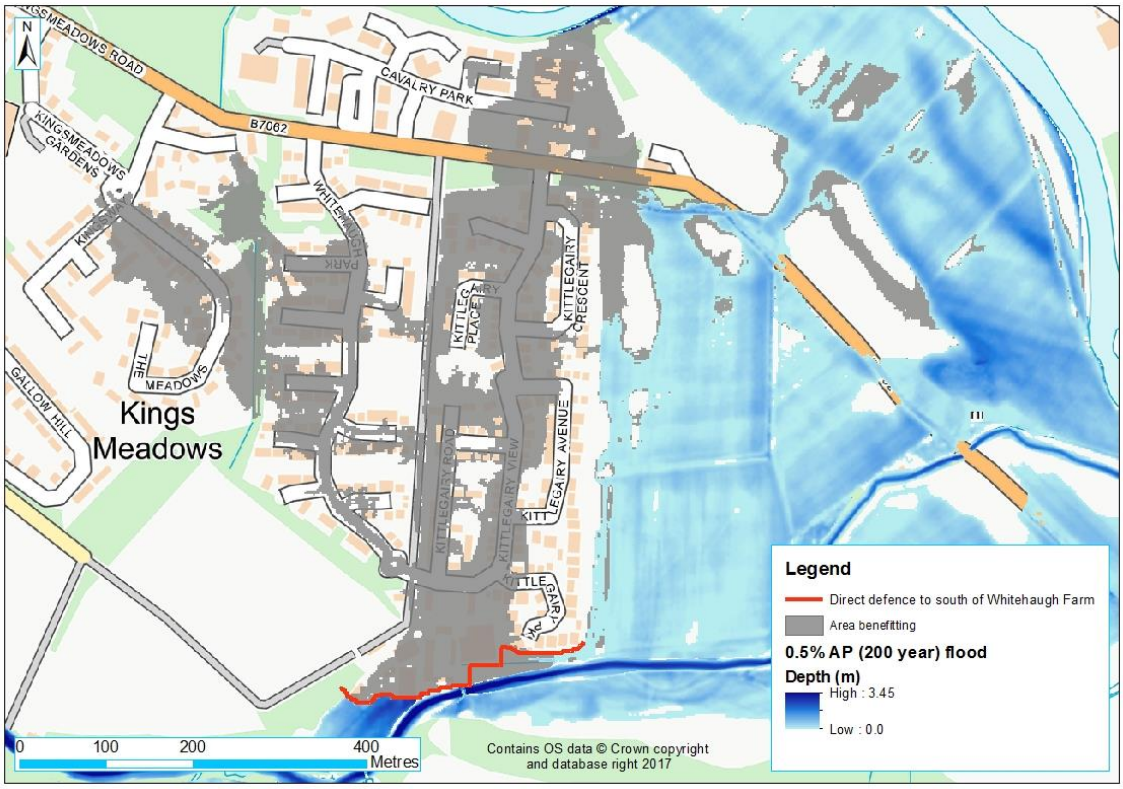
Description

This option aims to provide a high standard of protection through the installation of an approximately 210m long section of wall and 120m of embankment to the south of Kittlegairy Estate and Whitehaugh Farm. The work includes the following:

- Install wall/embankment along the southern and eastern edges of Whitehaugh Farm and the rear of houses on Kittlegairy Park for a distance of approximately 350m, to a maximum height of 1.7m (includes a 300mm freeboard for the wall and 600mm freeboard for the embankment).

A technical drawing relating to this option has been produced and is provided alongside this report, named as follows:

AEM-JBAU-PB-HB-SK-C-1200-Opt2_200Yr_SB_Direct_Def-S3-P01.pdf



Standard of Protection (SOP)

Modelling of the above option suggests that a standard of protection of a 0.5% AP (200 year) flood is achievable. This equates to flow of 39.05m^3/s.

Alternative quick wins / Preliminary investigations

Smaller embankment or wall raising would offer a lesser standard of protection but for a marginally lower cost.

Geotechnical issues

- A review of available BGS borehole logs and mapping of superficial deposits indicates that most of the defences are likely to be constructed on sandy or gravelly alluvial deposits.
- A full GI will be required at a later stage in the project.
- A cut-off is likely to be needed. Piling may be difficult in this material and other forms of cut-off may need to be considered.
- The structural integrity of the banks near the defence have not been assessed, however photographs of the site suggest that there is significant erosion of the left bank around Whitehaugh Farm, which may need to be addressed in conjunction with the direct defences.

Services

Overhead and underground services have been identified and their location is shown on

drawing AEM-JBAU-PB-HB-SK-C-1001-Services_Plan.

- Low voltage electrical cables were identified in the plans close to western extent of the flood wall.

Construction access

Construction access has been considered and is not considered too difficult, although consultation with the farm owner will be critical. Issues include:

- Construction would entail heavy machinery working along the bank with possible in-channel working and bank repair works.
- Temporary storage of topsoil and subsoil in heaps and stockpiles.
- Noise and vibration during construction. Groundworks and construction vehicles are likely to cause noise and vibration.
- Exclusion of public from working areas - good practice working methods such as alternative access routes and phasing of works.
- Production of waste including silt, dust and construction waste. Further investigation required through GI into level of contamination and ownership.

Waste

- Expected quantity of waste material: 983.15m^3.
- Nature (inert, non-hazardous, hazardous): It is known that very limited industry was present in Peebles – soil expected to be inert.
- Proposed disposal: According to SEPA guidance.

Environmental issues

- Statutory Environmental Designations (SSSI, SPA, SAC, Ramsar Sites Nature Reserves, INNS). Haystoun Burn is a special area of conservation (SAC).
- Habitat: The area within the site boundaries is a National Forest Inventory.
- Listed Buildings: Whitehaugh Farm is a Category B listed Building.

SEPA pollution prevention guidelines should be adhered to throughout the works.

Health and Safety hazards noted

- Geotechnical and excavation works - In channel works, falling into excavations, collapse of the sides of excavation, damage to underground services, undermining of nearby structures.
- Construction – flooding of works.

Social and community issues

Some aesthetic issues as this option has been designed to mitigate flood risk to extreme flood events which requires greater intervention than the quick win option. Land take is minimal but a substantial length of flood defence is proposed. Access along the B7062 will not be possible in times of flood due to the presence of flood waters.

Impact on other reaches

The works will increase the flow in the channel downstream of the works as a result of the reduction in out of bank flows. The increase in flow would be in the order of 0.58m^3/s at the downstream model extent relative to the Do Minimum scenario. There will be an increased likelihood of flooding to the agricultural land either side of the burn downstream of the farm and there are likely to be increased flood depths on the B7062 in times of flood.

Additional information required

- A detailed topographic survey.
- Detailed buried services survey, plotting their position with regards to site works.
- Ground investigation.

Additional works required to account for increase in 200 year flow due to climate change

- Consider building adaptable walls that can be easily raised in the future.
- The increase in wall height required to protect against the 0.5% AP (200 year) event with climate change is likely to be in the order of 200mm. We therefore recommend that should this option be carried forward to outline design stage further analysis is performed to assess the additional benefit of designing for climate change.

4.8.3 Option 3 - Property Level Protection (PLP)

Option 3 - Property Level Protection (PLP)

Description

This option aims to provide an increase in standard of protection for all properties where relevant by protecting them up to a maximum depth of 0.6m. Beyond this water depth a building's integrity can be compromised. This option includes the survey, design and implementation of relevant PLP products to each property experiencing flooding.

The number of properties expected to benefit from PLP:

- 39 properties at the 0.5% AP (200 year) event,
- 19 properties at the 1% AP (100 year) event,
- 10 properties at the 1.33% AP (75 year) event.

Standard of Protection (SOP)

PLP will offer a variable standard of protection dependent on the property. The property with the lowest standard will be protected to a maximum of the 20% AP (5 year) event. This property and two others with low standards of protection are on Kittlegairy View. Aside from these properties this option has a standard of the 1% AP (100 year) event.

Technical issues

All properties would require surveying by competent parties to determine which products are appropriate. Properties with non-standard or large entrances may require bespoke options which can significant increase costs. The Scottish Government's Blueprint on PLP[3] should be considered when implementing this option.

Construction issues

Some, particularly non-residential, properties may require bespoke PLP products and building remedial works may be required to allow the products to work effectively. May be some objection from residents who have not previously flooded.

Agricultural buildings on Whitehaugh farm are assumed to be resilient and would otherwise require bespoke PLP products. They are therefore assumed to continue to flood when PLP is implemented for other properties at flood risk.

Environmental issues

Flood water flowing through the farm into the estate could be contaminated. This option does not mitigate against this.

Social and community issues

Due to the prevalence of flooding and highly engaged community PLP alone may not be an acceptable option. Residents are likely to expect more significant measures to be undertaken.

Impact on other reaches

There will be negligible impact on other reaches due to the small volume that would otherwise flow through properties.

Additional information required

- A property threshold survey for any properties not already surveyed (e.g. Kittlegairy Estate has known threshold levels).
- Public engagement meetings.
- Flood risk reviews on each property.

Additional works required to account for increase in flow due to climate change

- Some properties identified as suitable for PLP may become unsuitable with increasing river flows. Additionally, some properties that are not expected to flood frequently enough to make PLP worthwhile at present may be expected to flood more frequently in the future.

4.9 Residual risk

Whitebridge House at the base of the Haystoun Burn sits on its own on the floodplain. This property is estimated to flood to depths of 0.06m during the 50% AP (2 year) flood event up to 0.26m during the 0.1% AP (1000 year) flood event. Since this is an individual property direct flood defences have

3 Scottish Government (2014). Assessing the Flood Risk Management Benefits of Property Level; Blueprint for Local Authorities and Scottish Water. Final Report v2.0. 13 November 2014

not been explored as a solution but there are a number of alternatives that could be implemented by the council. Flood Warning could be implemented on the Haystoun Burn to provide advanced warning to all residents and allow the residents of Whitebridge House to prepare. The council may also consider providing PLP to this property if necessary since the flood depths are well within the scope of most PLP products. The B7062 is estimated to flood at present but may flood more significantly if either of the above short-listed options are constructed. For road users to determine whether the road is passable or not stage boards and warning signs could be installed in the areas expected to flood. Interactive road signs could also be used to warn approaching vehicles of flood waters.

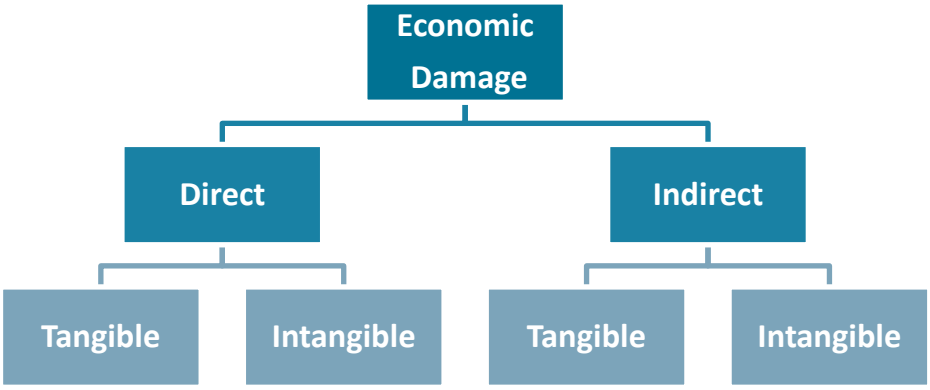
Unless designed for, climate change will represent a residual risk. The difference in the defence height required for the 0.5% AP (200 year) event with and without climate change is in the region of 200mm. This additional wall height is achievable and unlikely to cause further complications for the design. Further economic assessment at outline design stage should investigate the extent to which the demands of climate change can be met whilst remaining economic.

5 Investment appraisal

5.1 Damage methodology

Flood damage assessment can include direct, indirect, tangible and intangible aspects of flooding, as shown in the Figure 5-1. Direct damages are the most significant in monetary terms, although the MCM and additional research provide additional methodologies, recommendations and estimates to account for the indirect and intangible aspects of flood damage.

Figure 5-1: Aspects of flood damage



Flood damage estimates have been derived for the following items:

1. Direct damages to residential properties;
2. Direct damages to commercial and industrial properties;
3. Indirect damages (emergency services);
4. Intangible damages associated with the impact of flooding;
5. Damage to vehicles;
6. Emergency evacuation and temporary accommodation costs.

The assumptions and additional data used to calculate the flood damages is provided in Appendix A.

5.2 Baseline Damages

Baseline damage results are presented for the Do Nothing and Do Minimum options overleaf.

Do Nothing

Assumptions:

Maintenance ceased, increasing hydraulic roughness due to vegetation growth and degradation of banks.

Bridges are small single span structures but their influence on property flooding is not significant and they are not considered likely to block so no changes are made to structures for the Do Nothing scenario.

Properties at risk:

The total number of properties inundated above threshold level for the Do Nothing Scenario on the Haystoun Burn has been assessed and is provided in the table below.

Return period (years)	2	5	10	25	30	50	75	100	200	500	1000
Residential	27	52	64	93	95	110	127	142	181	222	282
Non-residential	3	16	16	19	20	20	20	21	22	24	24
Total	30	68	80	112	115	130	147	163	203	246	306

Key beneficiaries:

The flood damages derived have been ranked and assessed in terms of the proportion of flood damages per property. This highlights key beneficiaries of the scheme and is a useful auditing tool. The top three properties are listed in the table below. There are 21 properties all ranked fourth in terms of their estimated damages as a result of property damages being capped at the market value. All of these properties are within Kittlegairy Estate on Kittlegairy Gardens, Kittlegairy Park and Kittlegairy View. These properties have not been listed.

Rank	Property address	Pvd (£k)	Percentage of total Pvd
1	INTERSPORT, 8 CAVALRY PARK, EH45 9BU	715	4.8%
2	WHITEHAUGH FARM, EH45 9HS	349	2.3%
3	WHITEHAUGH FARM, EH45 9HS	305	2.0%

Event property damages:

JBA's damage calculation method provides event damages based on MCM depth damage curves. Full results are provided in Appendix B. These represent the total potential flood damages based on the modelled flood level. Damages include all direct and indirect property flood damages and are presented in £k.

Return period (years)	2	5	10	25	30	50	75	100	200	500	1000
Residential (£k)	475	1,049	1,220	1,943	2,067	2,524	2,846	3,456	4,654	6,379	8,640
Non-residential (£k)	31	317	404	526	559	633	697	751	881	1,036	1,137
Total (£k)	506	1,366	1,624	2,468	2,626	3,158	3,542	4,207	5,535	7,415	9,777

The above damages are used to calculate Annual Average Damages (AAD). Plotting the damages against the frequency of flooding (annual probabilities) allows us to determine the AAD as the area beneath the curve. This figure shows that flood damages are relatively small for the lower to medium flood events but rise significantly once the flood defences are exceeded.

Intangible & intangible damages:

A summary of the proportion of total damages by each damage component is provided in the table below.

Do Nothing flood damages (£k):

Property PVd	Capped Property PVd	Total AAD	Indirect PVd	Intangible PVd	Total PVd
21,084	14,936	743	1,069	1,119	17,124

Do Minimum

Assumptions:

Watercourse maintenance continued and structures replaced if they become badly deteriorated. Hydraulic roughness represents current conditions.

Properties at risk:

The total number of properties inundated above threshold level for the Do Minimum Scenario on the Haystoun Burn has been assessed and is provided in the table below. Due to the high likelihood of flooding from the Haystoun Burn during all return periods the Do Minimum scenario estimates only marginally fewer properties to be at risk of flooding when compared to the Do Nothing.

Return period (years)	2	5	10	25	30	50	75	100	200	500	1000
Residential	24	47	55	87	91	104	114	132	171	217	278
Non-residential	2	11	16	17	19	20	20	21	21	24	24
Total	26	58	71	104	110	124	134	153	192	241	302

Key beneficiaries:

The flood damages derived have been ranked and assessed in terms of the proportion of flood damages per property. This highlights key beneficiaries of the scheme and is a useful auditing tool. The top three properties are listed in the table below. There are 21 properties all ranked fourth in terms of their estimated damages as a result of property damages being capped at the market value (which is the same for all properties of a certain type). All of these properties are within Kittlegairy Estate on Kittlegairy Gardens, Kittlegairy Park and Kittlegairy View. These properties have not been listed below for brevity.

Rank	Property address	Pvd (£k)	Percentage of total Pvd
1	INTERSPORT, 8 CAVALRY PARK, EH45 9BU	715	5.1%
2	WHITEHAUGH FARM, EH45 9HS	308	2.2%
3	WHITEHAUGH FARM, EH45 9HS	304	2.2%

Event property damages:

JBA's damage calculation method provides event damages based on MCM depth damage curves. Full results are provided in Appendix B. These represent the total potential flood damages based on the modelled flood level. Damages include all direct and indirect property flood damages and are presented in £k.

Return period (years)	2	5	10	25	30	50	75	100	200	500	1000
Residential (£k)	363	940	1,138	1,722	1,911	2,323	2,628	3,003	4,306	6,167	8,377
Non-residential (£k)	28	174	330	432	472	544	599	672	792	1,012	1,140
Total (£k)	391	1,114	1,469	2,154	2,383	2,867	3,227	3,675	5,098	7,179	9,517

The above damages are used to calculate Annual Average Damages (AAD). Plotting the damages against the frequency of flooding (annual probabilities) allows us to determine the AAD as the area beneath the curve. This figure shows that flood damages are relatively small for the lower to medium flood events but rise significantly once the flood defences are exceeded.

Intangible & intangible damages:

A summary of the proportion of total damages by each damage component is provided in the table below.

Do Minimum flood damages (£k):

Property PVd	Capped Property PVd	Total AAD	Indirect PVd	Intangible PVd	Total PVd
18,420	13,892	649	942	820	15,654

5.3 Options

The flood damages for each option were calculated for each return period up to the 1% AP (1000 year) event. Average annual flood damages were converted to present value damages using the discount factor and the residual damages for each option were compared against the flood damages estimated for the Do Nothing scenario. This comparison shows the damages avoided as a result of the options' interventions, also known as the benefit.

In line with current guidance[4] the PLP option was factored to account for the effectiveness and performance of measures and availability of homeowners to install and operate the measures. PLP was assumed to be 84% effective.

5.4 Damage benefit summary

The table below summarises the damages avoided for each option. The results show that each of the options assessed significantly reduce flood damages in the order of £12.9-16.1m, leaving comparatively low residual present value damages in the range £1.0-2.0m. The Do Minimum option has little benefit over the Do Nothing option relative to the defended options.

Table 5-1: Damage benefit summary

	DN	DM	Option 1	Option 2	PLP
Option name	Do Nothing	Do Minimum	Direct Defences	Direct Defences	PLP
Standard of Protection	<2	<2	200	200	5 (Variable)
BENEFITS:					
PV monetised flood damages (£k)	17,124	15,654	1,952	998	1,779
Total PV damages avoided/ benefits (£k)	-	1,470	15,172	16,126	12,890*
***Note:** PLP benefits are scaled down by 16% to account for the likelihood of PLP products only being 84% effective					

4 Post-Installation Effectiveness of Property Level Flood Protection, Final Report FD2668, 2014, DEFRA

6 Cost estimates

6.1 Price Base Date

The price base date is January 2018. The costs and benefits have been discounted over the 100 year life of the scheme to determine present values.

6.2 Whole life cost estimates

Whole life costs are typically compiled from the following four key cost categories:

1. Enabling costs. These costs relate to the next stage of appraisal, design, site investigation, consultation, planning and procurement of contractors.
2. Capital costs. These costs relate to the construction of the flood mitigation measures and include all relevant costs such as project management, construction and materials, licences, administration, supervision and land purchase costs (if relevant).
3. Operation and maintenance costs. Maintenance of assets is essential to ensure that the assets remain fit for purpose and to limit asset deterioration. Costs may include inspections, maintenance and intermittent asset repairs/replacement.
4. End of life replacement or decommissioning costs. These costs are only required when the design life of assets is less than the appraisal period. Most assets are likely to have a design life in excess of the 100 year financial period but PLP is expected to have a 25 year design life so this has been included in the cost estimate for PLP.

The Environment Agency's 'Long Term Costing' tool (2012) was the basis of all costs for this assessment to provide a uniform approach to costing across the flood studies.

Whole life (present value) costs have been estimated based on the above enabling, capital and maintenance costs. The following assumptions have been made:

1. The life span of the scheme and appraisal period is 100 years.
2. Discounting of costs are based on the standard Treasury discount rates as recommended by the 2003 revision to the HM Green Book (3.5% for years 0-30, 3.0% for years 31-75 and 2.5% for years 76-99).
3. Capital costs are assumed to occur in year 1 (equivalent to 2019).
4. Enabling costs occur in year 0.
5. An optimism bias of 60% has been applied and is representative of a scheme at the appraisal design stage of development. This provides a significant safety factor for cost implications and risks.

6.3 Maintenance costs

The EA Long Term Costing tool was used to calculate maintenance costs. These maintenance costs account for a default set of maintenance regimes for associated annual or frequent operation and maintenance activities.

The costs used assume efforts are made to maintain assets at condition grade 2 (Good) using the grading system described in the Environment Agency's asset condition assessment manual[5]. Average costs were used - between lower and upper bounds reproduced in the report - given the absence of detailed maintenance plans at this early design stage of development.

6.3.1 Optimism bias

An optimism bias of 60% has been applied and is representative of a scheme at the appraisal design stage of development. This provides a significant safety factor for cost implications and risks. This uplift is applied to present value capital and present value maintenance costs after their calculation.

5 Condition Assessment Manual (CAM) (Environment Agency, 2012)

6.4 Haystoun Burn - Option 1 - Direct defences with 200-year standard of protection

This option consists of the following measures:

- Flood Wall: A concrete wall, approximately 267m long. The height of the wall varies between 1.8m and 2.5m.

Costs are based on achieving a 200-year standard of protection and on near immediate initiation of works.

Table 6-1: Unit and total estimated costs (£)

Location	Typical defence height	Length / Volume	Unit cost	Total Cost (Rounded)
Wall	2.5m (maximum)	267m	£3,529	£942,243
Flood Gate for farm access	2.8 x 2.45m	-	£41,650	£41,650
Excavation and tipping	-	1,458.8m^3	£125.05	£18,232
			Total Capital cost	£1,002,125

Table 6-2: Total cash and Present Value (PV) option costs (£k)

Element	Cash cost	PV Cost
Enabling cost	253	253
Capital cost	1,002	368
Maintenance cost	8.6	2.4
Total	**1,264**	**1,224**
Total incl. Optimism Bias	-	1,958

6.5 Haystoun Burn - Option 2 - Direct defences with 200-year standard of protection

This option consists of the following measures:

- Flood Wall: A concrete wall, approximately 210m long. Height varies between 1.1m and 2.05m.
- Flood Embankment: Approximately 122.5m long and 1.7m high.
- New Bridge: The new bridge to replace the existing temporary bridge. Width is 4m and the span of the bridge is 6.2m.
- Flood Gate 1: A flood gate to allow access to farm, approximately 4.2m wide by 1.7m high.
- Flood Gate 2: A flood gate to allow access to farm, approximately 13.3m wide and 1.7m high.
- Ramped Access to farm downstream of the proposed embankment: Approximately 20m long and 2m wide.

Costs are based on achieving a 200-year standard of protection and on near immediate initiation of works.

Table 6-3: Unit and total estimated costs (£)

Location	Typical defence height	Length / Volume	Unit cost	Total Cost (Rounded)
Flood Wall	2.05m (maximum)	210m	£3,432	£720,615
Flood Embankment	1.7m	2,765m^3	£120	£330,817

Location	Typical defence height	Length / Volume	Unit cost	Total Cost (Rounded)
New Bridge	-	25.6m^2	£2,737	£70,067
Ramped Access to Field	-	40m^2	£100	£4,000
Flood Gate 1	1.7 x 4.2m	-	£60,350	£60,350
Flood Gate 2	1.7 x 13.3m	-	£119,000	£119,000
Excavation and tipping	-	983.2m^3	£125.05	£122,943
			Total Capital cost	£1,096,975

Table 6-4: Total cash and Present Value (PV) option costs (£k)

Element	Cash cost	PV Cost
Enabling cost	334	334
Capital cost	1,428	1,380
Maintenance cost	6.8	1.9
Total	**1,768**	**1,715**
Total incl. Optimism Bias	-	2,745

6.6 Haystoun Burn - Option 3 - PLP

The costs for this option are derived from an estimate of the number of properties of different types that are likely to require PLP. These different property types are shown in Table 6-5. The base cost data is taken from the Scottish Government guidance document on PLP (2014)[6].

Table 6-5: Unit and total estimated capital costs (£)

Property type	Count	Capital cost - mid range automatic
Detached	117	£980,811
Semi-detached	10	£78,580
Terraced	45	£202,140
Flat	0	-
Shop	0	-
Office	12	£169,896
Total	184	£1,431,427

Table 6-6: Total cash and Present Value (PV) option costs (£k)

Element	Cash cost	PV Cost
Enabling cost	218	218
Capital cost	5,726	2,374
Maintenance cost	2,806	797
Total	**8,749**	**3,389**
Total incl. Optimism Bias	-	5,422

6 Assessing the Flood Risk Management Benefits of Property Level Protection, Scottish Government (2014)

6.7 Summary of whole life costs

The table below summarises all Present Value costs for all of the short-listed options:

Table 6-7: Summary of PV costs for all options

Option	PV Cost (£k)
1 - Option 1 standard direct defences	1,958
2 - Option 2 standard direct defences	2,745
3 - Property Level Protection	5,422

7 Benefit-cost analysis

7.1 Introduction

This section discusses the economic appraisal carried out during this study. The methods of calculating the benefits and costs are outlined together with an assessment of the benefit-cost ratios for the range of options assessed. Benefit-cost analysis looks at a flood risk management strategy or practice and compares all the benefits that will be gained by its implementation to all the costs that will be incurred during the lifetime of the project. In accordance with the FCERM appraisal guidance, benefits are taken as annual average damages avoided, expressed as their present value using Treasury discount rates. These are compared with the whole life cost of the capital and maintenance costs of selected options, expressed as present value. If the benefits exceed the costs for the option, the scheme is deemed to be cost-effective and worthwhile for promotion.

Benefits are assessed as the flood damages that will be avoided by the implementation of a project. To calculate the benefits it is necessary to assess the damages that are likely to occur under both the Do Nothing and Do Something scenarios. The benefits of any particular Do Something option can then be calculated by deducting the Do Something damages from the Do Nothing damages.

7.2 Benefit-cost results

The benefit-cost results for the shortlisted options are provided in the table below. All three 'Do Something' options have been found to be cost-effective.

Table 7-1: Benefit-cost ratio for options on the Haystoun Burn (£k)

	Do Nothing	Do Minimum	Option 1	Option 2	PLP
PV Costs (£k)	-	-	1,224	1,715	3,389
Optimism Bias (60%)	-	-	734	1,029	2,033
Total PV Costs (£k)	-	-	1,958	2,745	5,422
PV damage (£k)	17,124	15,654	1,952	998	1,779
PV damage avoided (£k)	-	1,470	15,172	16,126	12,890
Net present value (£k)	-	1,470	13,214	13,381	9,922
Benefit-cost ratio	-	-	7.7	5.9	2.8
Incremental benefit-cost ratio	-	-	7.0	1.2	-0.3

The benefit-cost ratios show that Option 1 is most cost-effective yet the incremental benefit-cost ratio (identifying whether offering further protection is worth the additional costs involved) shows that Option 2 is likely to be the best option; i.e. the additional costs of protecting the farm are outweighed by the additional benefits. The benefit-cost ratios for both options are high and make a strong economic case for implementing a scheme on the Haystoun Burn.

The PLP option is economically viable but has a smaller benefit relative to the two direct defences options so should not be put forward as a long-term solution to the flooding problem due to the large scale of works required to new properties, inherent risks that PLP carries and the variable standard of protection provided. PLP would be difficult to implement for the agricultural buildings at risk on Whitehaugh Farm. Although they are likely to be resilient they have not been counted to benefit from this option and therefore continue to flood.

Furthermore, a number of properties in Kittlegairy Estate flood to depths greater than 0.6m at the 10% AP (10 year) flood event and upwards and therefore are not suitable for PLP beyond a 20% AP (5 year) flood event. This significantly restricts this option as it does not provide a suitable nor consistent standard of protection.

Table 7-2: Number of properties at risk in the Do Minimum and PLP options

Return period (years)	2	5	10	25	30	50	75	100	200	500	1000
Do Minimum	26	58	71	104	110	124	134	153	192	241	302
With PLP	2	6	8	10	11	11	12	12	14	64	94
Difference	24	52	63	94	99	113	122	141	178	177	208

7.3 Residual risks

The most cost-effective option offers a 200 year standard of protection reducing property flood damages considerably and leaving comparatively little risk. There are also likely to be opportunities to increase this standard of protection to account for climate change. Nevertheless, a range of additional actions are proposed which could be used either in the interim prior to scheme approval or to further reduce this residual risk:

- Natural Flood Management (NFM) practices could aid in reducing flows in the Haystoun Burn and provide some resilience to climate change. The two catchments contributing to the Haystoun Burn would both require a suite of NFM interventions to best reduce flows on the burn as it approaches the properties at risk. A detailed NFM modelling study should be carried out to attempt to quantify the benefits of these practices in the wider Tweed valley.
- Direct defences could be designed to allow for either raising of the defences or demountable defences to be added on top of the walls in the future to provide additional protection against climate change. The cost and infrastructure required to implement demountable defences are substantial and should be avoided if possible. Alternatively, designing defences that can be easily raised in the future would be a more preferable option. For example, installing a wall on top of a flood embankment would be a suitable option. It is recommended that the option to either build for climate change now or adapt in the future is considered during the outline design stage of scheme development.

8 Public consultation

A public consultation event was held in Peebles during November 2018 to gauge opinion on the flood mitigation options proposed as part of this study. In general, the residents in attendance were in approval of the scheme across Peebles.

There were few specific comments on the strategy for managing flood risk on the Haystoun Burn but those residents in attendance were strongly in favour of any strategy that would provide them protection against flooding of their properties given the low standard of protection suggested by the flood maps. Although the occupier of Whitehaugh Farm was not present to express an opinion on defence alignment close to the farm, it was generally the opinion that the farm should be protected if possible and hence Option 2 provides the best overall direct defences option.

Some Peebles residents suggested that rural land management could play an important role in controlling flows in the burn. One resident suggested that prior to forestry clearing operations the burn had much lower water levels but that following the clearance levels in the burn are generally higher. None of the residents in attendance expressed concern over the height of defences, most probably because those in attendance, living at the other end of Kittlegairy Estate to the proposed defences, would not be affected by any visual impact the defences may have.

9 Conclusions and recommendations

9.1 Summary

This report presents the results of a detailed flood risk appraisal for the area of Peebles at risk from the Haystoun Burn. Properties in this area including in Whitehaugh Farm and Kittlegairy Estate have come close to flooding as recently as 2015. 192 properties are estimated to be at risk of flooding from the 0.5% AP (200 year) flood event.

A detailed set of preliminary investigations was carried out ahead of this appraisal such that it was possible to inform discussion of flood protection options for this area of Peebles. These investigations involved a review of Peebles' flood history, an assessment of the hydrological inputs to the Haystoun Burn, collection and review of survey data, a River Basin Management Plan review, an assessment of Natural Flood Management opportunities in the catchment, a Preliminary Ecological Appraisal, asset condition assessment and hydraulic modelling of the burn.

The hydraulic model, consisting of a 1D-2D Flood Modeller Pro - TUFLOW model covering the reach from the confluence with the Crookston Burn to the River Tweed, allowed generation of flood inundation maps for a range of Annual Probability (AP) flood events ranging from 50% AP (2 year) to 0.1% AP (1000 year). A number of scenarios were modelled to provide sufficient information on which to base the economic appraisal at a later stage in the study. These included the Do Nothing and Do Minimum scenarios with the former representing a 'walkaway' scenario where maintenance of the watercourse ceases, and the latter representing the present-day watercourse condition. Once these maps were produced it was possible to review flood flow pathways and progress from a wide-ranging long-list of potential flood protection options to a short-list of feasible solutions tailored to Peebles' flood risk problem.

Several short-term measures were proposed which may assist in reducing flood risk to some properties. The Haystoun Burn does not have any Flood Warning and this could therefore be implemented to provide local residents with advanced warning of forecast flood events. Natural Flood Management (NFM) is a method whereby wider catchment benefits could be achieved alongside potentially reducing flows in the burn. Opportunities within the upper catchment could to some extent counteract the effects of increasing river flows with climate change. Property Level Protection (PLP) is not known to be in use by any of the properties at risk but could be purchased with the aid of the Scottish Borders Council PLP discount scheme in advance of any possible flood protection scheme that might be implemented in the next flood risk management funding cycle or beyond.

A shortlist of flood protection options was produced and reviewed by comparing the expected benefit of the scheme (property damages avoided) with the estimated costs for scheme implementation and maintenance. Two of the short list options are based on direct defences being constructed close to Whitehaugh Farm and both protect a large number of properties against the 0.5% AP (200 year) flood event. Option 1 does not protect the farm itself, with defences being placed to the north of this property to protect properties in and around Kittlegairy Estate. Option 2 involves construction of defences to the south of Whitehaugh Farm on the left bank of the Haystoun Burn, protecting the farm. Both of these options involve construction of walls and Option 2 also makes use of embankments in agricultural land where space allows. Property Level Protection (PLP) was included as an option, providing protection for properties experiencing flooding up to 0.6m in depth. This option is less favourable than a direct defences option since it carries greater risk of defence failure and does not protect all properties against the same magnitude flood event.

A benefit-cost analysis has been undertaken for the present-day (Do Minimum) scenario and each of the above options. The Present Value flood damages calculated for the Do Minimum scenario are estimated to be £15,654,000. Costs for each option have been estimated using the Environment Agency's Long Term Costing tool (2012). An optimism bias factor of 60% has been added to the total capital costs to allow for uncertainties in design at this level of appraisal and is typical for schemes at an early stage of appraisal.

Both direct defences options are cost beneficial in addition to the PLP option. Whilst Option 1 has the highest benefit-cost ratio (7.7) the incremental benefit-cost ratio shows that the benefit of defending Whitehaugh Farm in Option 2 is worth the additional investment over and above Option 1, giving an incremental benefit-cost ratio of 1.2.

9.2 Recommendations

The above assessments have led to the following key recommendations for Peebles:

Option 2 which provides protection to Whitehaugh Farm and other properties to the north should be progressed having been presented to the public. It is likely that the proposed defences could be raised to meet the higher flows expected with climate change and remain economic. Further analysis should be carried out at outline design stage to confirm this and defences should be built to protect against climate change if sufficient benefit can be achieved either now or in the future.

In the short term PLP should be marketed to those at flood risk in the wider community. Flood action groups, in partnership with the Community Council should seek to establish a network of support between members of the community, Scottish Borders Council, Tweed Forum and emergency services. Community engagement should be continued to raise awareness of flood risk and potential short and longer-term solutions.

Natural Flood Management opportunities should be progressed where feasible through engagement with land owners and other stakeholders to bring wider catchment benefits such as habitat provision and carbon management. Due to the high standard of protection offered by the direct defence options NFM measures are not necessarily a crucial factor in mitigating flood risk on the Haystoun Burn but could reduce reliance on the physical flood defences. Should NFM be progressed as part of a scheme, funding should be sought through the scheme itself but in the shorter term it may be possible to secure funding through other sources if the focus can be widened from flood risk management to catchment and land management benefit.

Flood Warning should be introduced on the Haystoun Burn and will be required for any future direct defences option involving flood gates or for any PLP products that require temporary installation. The installation of a gauge may also be useful for updating future estimates of flood flows on this ungauged catchment.

Wherever possible, Scottish Planning Policy should be leveraged to provide the potential for future implementation of other options that are currently not possible due to the sporadic presence of properties on the floodplain. As recommended by SEPA during stakeholder engagement this includes avoiding development of the parcel of land between Kittlegairy estate, Haystoun Burn and the River Tweed which is not to be protected by the measures proposed in this report.

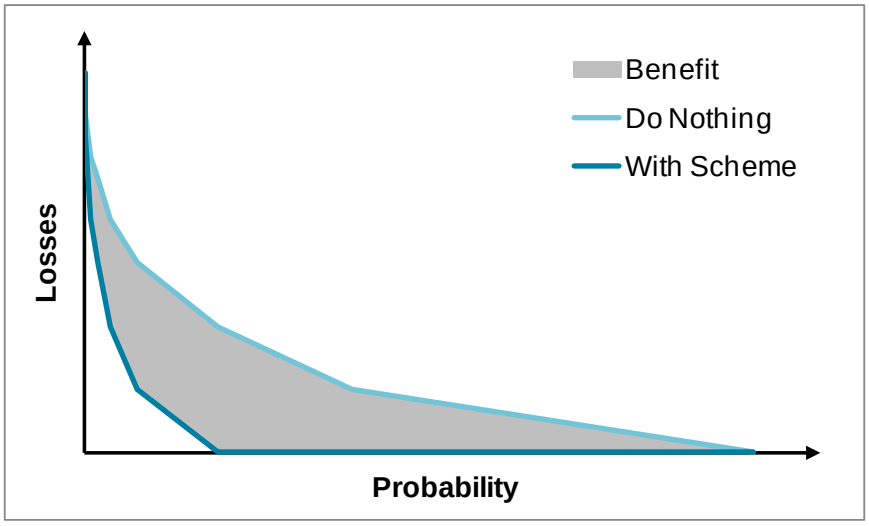
Appendices

A Appendix A - Damage Methodology

A.1 Direct damages - methodology

The process to estimate the benefits of an intervention option is to plot the two loss-probability curves: that for the situation now, and that with the proposed option as shown in Figure B-1. The scale on the y axis is the event loss (£); the scale on the x axis is the probability of the flood events being considered. When the two curves are plotted the difference in the areas beneath the curve is the annual reduction in flood losses to be expected from the scheme or mitigation approach.

Figure B-1: Loss Probability Curve



To derive these two curves, straight lines are drawn between the floods for which there are data from the threshold event (the most extreme flood which does not cause any damage) to an extreme flood above the intended standard of protection. The greater the number of flood event probabilities, the more accurately the curves can be plotted.

A.1.1 Flood damage calculation and data

The FHRC Multi Coloured Manual (MCM) provides standard flood depth/direct damage datasets for a range of property types, both residential and commercial. This standard depth/damage data for direct and indirect damages has been utilised in this study to assess the potential damages that could occur under each of the options. Flood depths within each property have been calculated from the hydraulic modelling by comparing predicted water levels at each property to the surveyed threshold levels.

A flood damage estimate was generated using JBA's in-house flood damage tools. These estimate flood damages using FHRC data and the modelled flood level data. Each property data point was mapped on to its building's footprint. A mean, minimum and maximum flood level within each property is derived using GIS tools based on the range of flood levels around the building footprint. The inundation depth is calculated by comparing water levels with the surveyed threshold level. The mean (based on mean flood water level across the buildings floor area) flood damage estimates have been calculated and are presented in section 5.2.

The following assumptions, presented in the Table A-1, were used to generate direct flood damage estimates.

Table A-1: Damage considerations and method

Aspect	Values used	Justification
Flood duration	<12hrs	Flood water is not anticipated to inundate properties for prolonged periods.
Residential	MCM codes broken down by type	Appropriate for this level of

Aspect	Values used	Justification
property type	and age.	analysis.
Non-residential property type	Standard 2016 MCM codes applied.	Best available data used.
Upper floor flats	Upper floor flats have been removed from the flood damage estimates.	Whilst homeowners may be affected it is assumed that no direct flood damages are applicable.
MCM damage type	MCM 2016 data with no basements.	Most up to date economic analysis data used. Basements are not appropriate for the type of properties within the study area.
MCM flood type	MCM 2016 fluvial depth damages for combined fluvial-tidal scenario.	Best available data used.
Threshold level	Thresholds surveyed by surveyor for the majority of properties in area of interest.	Best available data used.
Property areas	OS Mastermap used to define property areas	Best available data used.
Capping value	Residential properties based on house prices from Zoopla. Commercial properties valued from rateable values for individual properties (supplied by SAA).	Best available data used.

A.1.2 Property data set

The property dataset was compiled for all residential and commercial properties. The majority of these properties were visited by a JBA Surveyor during the threshold survey.

A.1.3 Capping

The FHRC and appraisal guidance suggests that care should be exercised for properties with high total (Present Value) damages which might exceed the market value of the property. In most cases it is prudent to assume that the long-term economic losses cannot exceed the capital value of the property. The present value flood damages for each property were capped at the market value using average property values obtained from internet sources (e.g. Zoopla).

Market values for non-residential properties were initially estimated from a properties rateable value based on the following equation:

Capital Valuation = (100/Equivalent Yield) x Rateable Value

Rateable values for all available properties in Peebles were obtained from the Scottish Assessors Association website[7]. Equivalent yield varies regionally and temporarily, but is recommended to be a value of 10-12.5 for flood defence purposes[8]. A value of 12.5 was used.

However, the resulting property valuations were judged as being undervalued. An alternative approach was used whereby the estimated value is 3 times the max depth damage MCM curve damage value for the commercial property type multiplied by the properties ground floor area.

A.1.4 Updating of Damage Values

The MCM data used are based on January 2017 values and therefore do not need to be brought up to date to compare the costs and benefits.

7 www.saa.gov.uk
8 Environment Agency (2009). Flood and Coastal Erosion Risk Management - Appraisal Guidance.

A.2 Intangible damages

Current guidance indicates that the value of avoiding health impacts of fluvial flooding is of the order of £286 per year per household. This value is equivalent to the reduction in damages associated with moving from a do-nothing option to an option with an annual flood probability of 1:100 year standard. A risk reduction matrix has been used to calculate the value of benefits for different pre-scheme standards and designed scheme protection standards.

A.3 Indirect damages

The multi coloured manual provides guidance on the assessment of indirect damages. It recommends that a value equal to 10.7% of the direct property damages is used to represent emergency costs. These include the response and recovery costs incurred by organisations such as the emergency services, the local authority and SEPA.

A.3.5 Indirect commercial damages

Obtaining accurate data on indirect flood losses is difficult. Indirect losses are of two kinds:

- losses of business to overseas competitors, and
- the additional costs of seeking to respond to the threat of disruption or to disruption itself which fall upon firms when flooded.

The first of these losses is unusual and is limited to highly specialised companies which are unable to transfer their productive activities to a branch site in this country, and which therefore lose to overseas competitors. The second type of loss is likely to be incurred by most Non-Residential Properties (NRPs) which are flooded. They exclude post-flood clean-up costs but include the cost of additional work and other costs associated with inevitable efforts to minimise or avoid disruption. These costs include costs of moving inventories, hiring vehicles and costs of overtime working. These costs also include the costs of moving operations to an alternative site or branch and may include additional transport costs.

Chapter 5, Section 5.7 of the MCM (2013)[9] recommends estimating and including potential indirect costs where these are the additional costs associated with trying to minimise indirect losses. This is by calculating total indirect losses as an uplift factor of 3% of estimated total direct NRP losses at each return period included within the damage estimation process.

9 Penning-Rowsell et al., 2013. Flood and Coastal Erosion Risk Management - A Manual for Economic Appraisal

B Appendix B - Economic Appraisal

Project Summary Sheet

Client/Authority				Prepared (date)	09/08/2018
Scottish Borders Council				Printed	04/12/2018
Project name				Prepared by	B.Bedford
Haystoun Burn FPS				Checked by	A.Pettit
Project reference				Checked date	01/09/2018
Base date for estimates (year 0)	Jan-2018				
Scaling factor (e.g. £m, £k, £)	£k	(used for all costs, losses and benefits)			
Year	0	30	75		
Discount Rate	3.5%	3.00%	2.50%		
Optimism bias adjustment factor	60%				

Costs and benefits of options

Option number	Costs and benefits £k				
	Do Nothing	**Do Minimum**	**OP01**	**OP02**	**PLP**
Option name	Do Nothing	Do Minimum	OP01-DD. Note: Whitehaugh Farm not protected	OP02-DD	PLP
AEP or SoP (where relevant)	<2	<2	200	200	5 (Variable)
COSTS:					
PV enabling costs	0	0	253	334	218
PV capital costs	0	0	968	1,380	2,374
PV operation and maintenance costs	0	0	2	2	797
Optimism bias adjustment	0	0	734	1,029	2,033
PV contributions					
Total PV Costs £k excluding contributions	0	0	1,958	2,745	5,422
Total PV Costs £k taking contributions into account	0	0	1,958	2,745	5,422
BENEFITS:					
PV monetised flood damages	17,124	15,654	1,952	998	1,779
PV monetised flood damages avoided		1,470	15,172	16,126	12,890
PV monetised erosion damages	0	0	0	0	0
PV monetised erosion damages avoided (protected)		0	0	0	0
Total monetised PV damages £k	17,124	15,654	1,952	998	1,779
Total monetised PV benefits £k		1,470	15,172	16,126	15,345
PV damages (from scoring and weighting)					
PV damages avoided/benefits (from scoring and weighting)					
PV benefits from ecosystem services					
Total PV damages £k	17,124	15,654	1,952	998	1,779
Total PV benefits £k		1,470	15,172	16,126	12,890
DECISION-MAKING CRITERIA:					
Based on monetised PV benefits (excludes benefits from scoring and weighting and ecosystem services)					
Net Present Value **NPV**		1,470	13,214	13,381	9,922
Average benefit/cost ratio **BCR**			7.7	5.9	2.8
Incremental benefit/cost ratio **IBCR**			7.0	1.2	-0.3
			Highest bcr IBCR>1	IBCR>1	
Best practicable environmental option (WFD)					

Brief description of options:

Do Nothing	Do Nothing
Do Minimum	Do Minimum
OP01	OP01-DD. *Note: Whitehaugh Farm not protected*
OP02	OP02-DD
PLP	PLP

Comments and assumptions:

Summary Annual Average Damage

Sheet Nr.

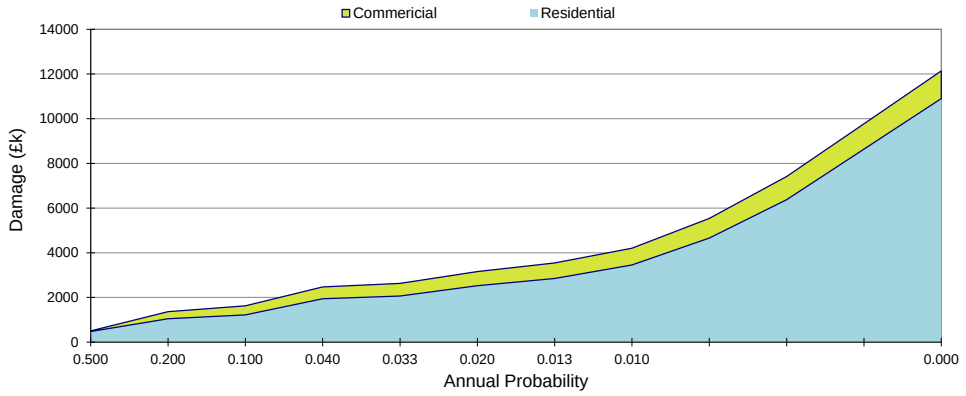
Client/Authority						
Scottish Borders Council						
Project name		**Option:**				
Haystoun Burn FPS		Do Nothing				
Project reference	-					
Base date for estimates (year 0)	43101	First year of damage:	0	Prepared (date)	09/08/2018	
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed	04/12/2018	
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by	B.Bedford	
				Checked by	A.Pettit	
Applicable year (if time varying)				Checked date	43344	

	Average waiting time (yrs) between events/frequency per year												Total PV	Capped PV
	2	5	10	25	30	50	75	100	200	500	1000	Infinity	£k	£k
	0.500	0.200	0.100	0.040	0.033	0.020	0.013	0.010	0.005	0.002	0.001	0		
Damage category	Damage £k													
Residential property	475	1049	1220	1943	2067	2524	2846	3456	4654	6379	8640	10902	16794	12543
Ind/commercial (direct)	31	317	404	526	559	633	697	751	881	1036	1137	1238	4290	2393
Ind/comm (indirect)	1	10	12	16	17	19	21	23	26	31	34	37	129	129
Traffic related												0	0	0
Emergency services	27	59	68	109	116	141	159	194	261	357	484	611	940	940
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Intangible damages												0	1119	1119
												0	0	0
Total damage £k	533	1435	1704	2593	2758	3318	3723	4423	5822	7803	10295	12787		
Area (damagexfrequency)		295	157	129	18	41	23	14	26	20	9	12		

Total area, as above	743		
PV Factor, as above	29.813		
Present value (assuming no change in damage or event frequency)	22,153	23,272	17,124

Notes
Area calculations assume drop to zero at maximum frequency.
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet

Project: Haystoun Burn FPS **Option: Do Nothing**



Summary Annual Average Damage

Sheet Nr.

Client/Authority
Scottish Borders Council

Project name
Haystoun Burn FPS

Option:
Do Minimum

Project reference -

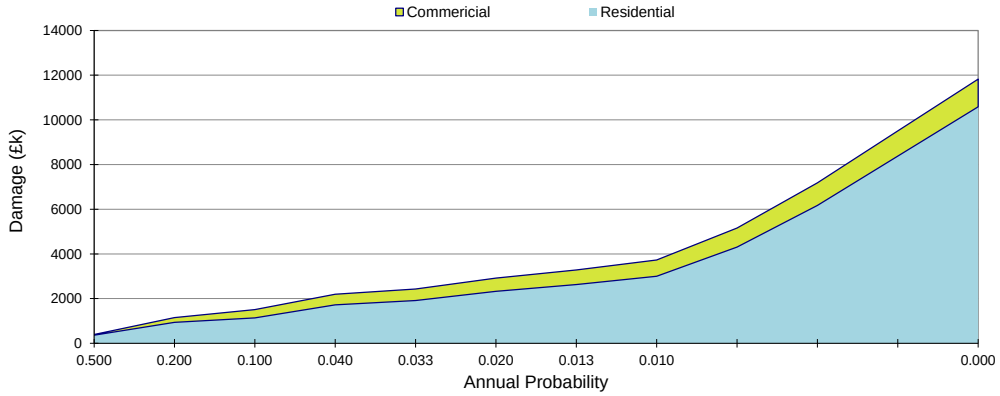
Base date for estimates (year 0)	43101	First year of damage:	0	Prepared (date)	09/08/2018
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed	04/12/2018
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by	B.Bedford
				Checked by	A.Pettit
Applicable year (if time varying)				Checked date	43344

	Average waiting time (yrs) between events/frequency per year											Total PV	Capped PV
	2	5	10	25	30	50	75	100	200	500	1000	Infinity	£k	£k
	0.500	0.200	0.100	0.040	0.033	0.020	0.013	0.010	0.005	0.002	0.001	0		
Damage category	Damage £k													
Residential property	363	940	1138	1722	1911	2323	2628	3003	4306	6167	8377	10587	14,970	11,608
Ind/commercial (direct)	30	208	366	476	518	593	651	728	856	1017	1127	1237	3,450	2,284
Ind/comm (indirect)	1	6	11	14	16	18	20	22	26	31	34	37	104	104
Traffic related												0	-	-
Emergency services	20	53	64	96	107	130	147	168	241	345	469	593	838	838
Other	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Intangible damages												0	820	820
												0	-	-
Total damage £k	414	1206	1579	2308	2551	3065	3446	3921	5429	7560	10008	12455		
Area (damagexfrequency)		243	139	117	16	37	22	12	23	19	9	11		

Total area, as above	649		
PV Factor, as above	29.813		
Present value (assuming no change in damage or event frequency)	19,362	20,182	15,654

Notes
Area calculations assume drop to zero at maximum frequency.
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet

Project: Haystoun Burn FPS **Option: Do Minimum**



Summary Annual Average Damage

Sheet Nr.

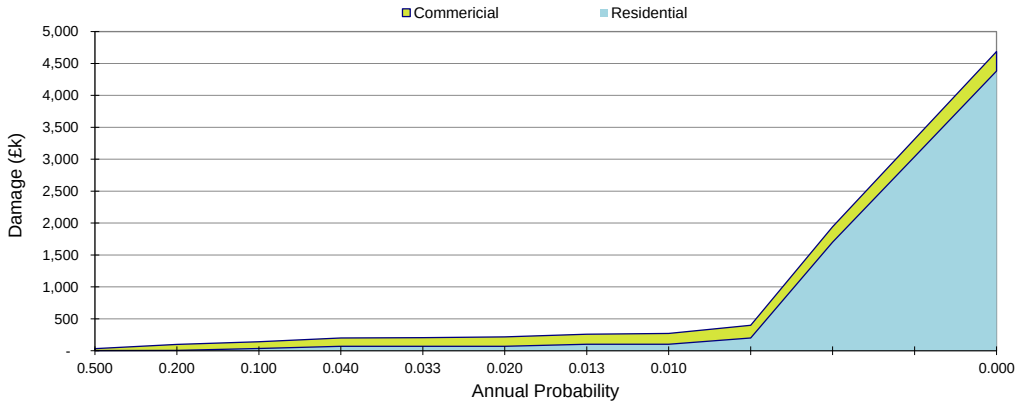
Client/Authority						
Scottish Borders Council						
Project name		**Option:**				
Haystoun Burn FPS		PLP				
Project reference	-					
Base date for estimates (year 0)	43101	First year of damage:	0	Prepared (date)	09/08/2018	
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed	04/12/2018	
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by	B.Bedford	
				Checked by	A.Pettit	
Applicable year (if time varying)				Checked date	43344	

	Average waiting time (yrs) between events/frequency per year												Total PV	Capped PV
	2	5	10	25	30	50	75	100	200	500	1000	Infinity	£k	£k
	0.500	0.200	0.100	0.040	0.033	0.020	0.013	0.010	0.005	0.002	0.001	0		
Damage category	Damage £k													
Residential property	3	5	35	69	70	69	101	102	198	1,701	3,041	4,381	543	544
Ind/commercial (direct)	30	93	105	130	134	148	157	168	200	241	273	306	1,249	974
Ind/comm (indirect)	1	3	3	4	4	4	5	5	6	7	8	9	37	37
Traffic related												-	-	-
Emergency services	0	0	2	4	4	4	6	6	11	95	170	245	30	30
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Intangible damages												-	194	194
												-	-	-
Total damage £k	33	101	146	206	212	226	269	281	415	2,044	3,493	4,942		
Area (damagexfrequency)		20	12	11	1	3	2	1	2	4	3	4		

Total area, as above	62		
PV Factor, as above	29.813		
Present value (assuming no change in damage or event frequency)	1,860	2,054	1,779

Notes
Area calculations assume drop to zero at maximum frequency.
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet

Project: Haystoun Burn FPS **Option: PLP**



Summary Annual Average Damage

Sheet Nr.

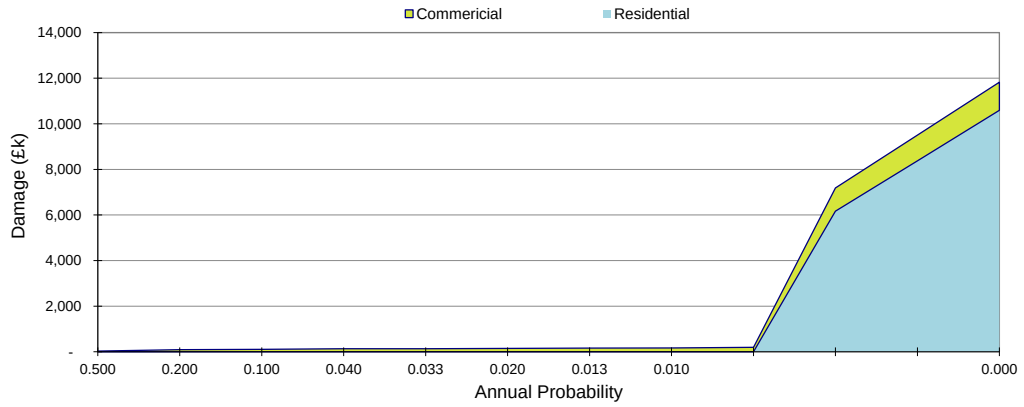
Client/Authority						
Scottish Borders Council						
Project name		**Option:**				
Haystoun Burn FPS		OP01-DD. Note: Whitehaugh Farm not protected				
Project reference	-					
Base date for estimates (year 0)	43101	First year of damage:	0	Prepared (date)	09/08/2018	
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed	04/12/2018	
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by	B.Bedford	
				Checked by	A.Pettit	
Applicable year (if time varying)				Checked date	43344	

	Average waiting time (yrs) between events/frequency per year												Total PV	Capped PV
	2	5	10	25	30	50	75	100	200	500	1000	Infinity	£k	£k
	0.500	0.200	0.100	0.040	0.033	0.020	0.013	0.010	0.005	0.002	0.001	0		
Damage category	Damage £k													
Residential property	-	-	-	-	-	-	-	-	-	6,167	8,377	10,587	775	775
Ind/commercial (direct)	28	90	105	130	134	148	157	168	196	1,017	1,127	1,237	1,306	1,031
Ind/comm (indirect)	1	3	3	4	4	4	5	5	6	31	34	37	39	39
Traffic related												-	-	-
Emergency services	-	-	-	-	-	-	-	-	-	345	469	593	43	43
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Intangible damages												-	63	63
												-	-	-
Total damage £k	28	93	108	134	138	152	162	173	202	7,560	10,008	12,455		
Area (damagexfrequency)		18	10	7	1	2	1	1	1	12	9	11		

Total area, as above	73		
PV Factor, as above	29.813		
Present value (assuming no change in damage or event frequency)	2,164	2,227	1,952

Notes
Area calculations assume drop to zero at maximum frequency.
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet

Project: Haystoun Burn FPS **Option: OP01-DD. Note: Whitehaugh Farm not protected**



Summary Annual Average Damage

Sheet Nr.

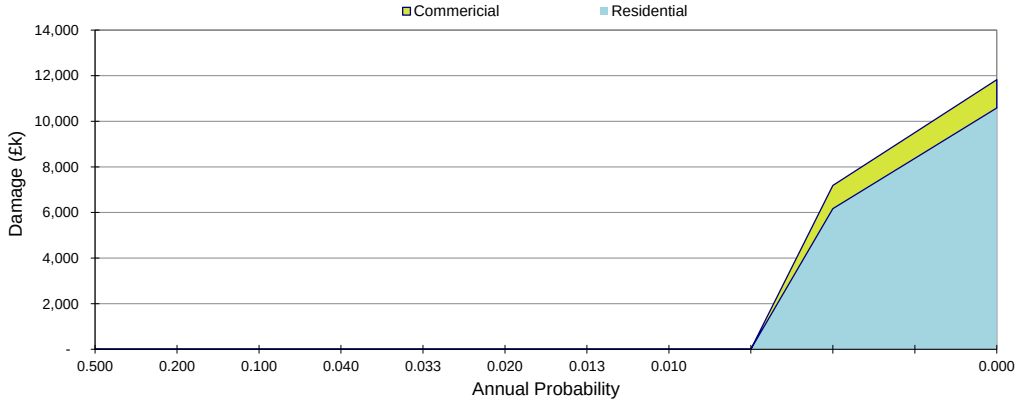
Client/Authority					
Scottish Borders Council					
Project name		**Option:**			
Haystoun Burn FPS		OP02-DD			
Project reference	-				
Base date for estimates (year 0)	43101	First year of damage:	0	Prepared (date)	09/08/2018
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed	04/12/2018
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by	B.Bedford
				Checked by	A.Pettit
Applicable year (if time varying)				Checked date	43344

	Average waiting time (yrs) between events/frequency per year												Total PV	Capped PV
	2	5	10	25	30	50	75	100	200	500	1000	Infinity	£k	£k
	0.500	0.200	0.100	0.040	0.033	0.020	0.013	0.010	0.005	0.002	0.001	0		
Damage category	Damage £k													
Residential property	-	-	-	-	-	-	-	-	-	6,167	8,377	10,587	775	775
Ind/commercial (direct)	-	-	-	-	-	-	-	-	-	1,017	1,127	1,237	113	113
Ind/comm (indirect)	-	-	-	-	-	-	-	-	-	31	34	37	3	3
Traffic related												-	-	-
Emergency services	-	-	-	-	-	-	-	-	-	345	469	593	43	43
Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Intangible damages												-	63	63
												-	-	-
Total damage £k	-	-	-	-	-	-	-	-	-	7,560	10,008	12,455		
Area (damagexfrequency)		-	-	-	-	-	-	-	-	11	9	11		

Total area, as above	31		
PV Factor, as above	29.813		
Present value (assuming no change in damage or event frequency)	935	998	998

Notes
Area calculations assume drop to zero at maximum frequency.
Default value for the highest possible damage assumes continuation of gradient for last two points, an alternative value can be entered, if appropriate.
One form should be completed for each option, including 'without project', and for each representative year if profile changes during scheme life (e.g. sea-level rise)
Residential property, Industrial / commercial (direct), and Other damages are itemised in Asset AAD sheet and automatically linked to this sheet

Project: Haystoun Burn FPS **Option: OP02-DD**



Summary of costs

Client/Authority		Prepared (date)	
Scottish Borders Council		Printed	07/12/2018
Project/Option name		Prepared by	C.Kampanou
Haystoun Burn FPS		Checked by	S.Cooney
Project reference	2017s5526	Checked date	
Base date for estimates (year 0)	Jan-2018		
Scaling factor (e.g. £m, £k, £)	£k		
Optimism bias adjustment factor	60%		

PV Cost Summary	Costs in £k
Enabling Costs	£253.31
Capital Costs	£1,002.13
O & M Costs	£8.59
Other Costs	£0.00
Total Real Cost	£1,264.03
Total Cost PV	£1,223.99
Total Cost PV + OB	**£1,958.39**

Note: Macros are required to open individual cost modules and the user should ensure they are enabled in the Excel Security Settings.

Note: Cost modules are opened from blank templates by clicking on the pentagons below. If a template exists, the user is sent the module. Only one module per worksheet is permitted.

Note: Costs are automatically summed from all individual cost module sheets every time the user returns to this summary sheet. This process takes into account the above scaling factor.

Note: If multiple measures are used, the optimism bias value used in each module is overridden by that selected above (Cell D10).

Additional user notes:

Add additional user notes here.

FRM Measure	Asset	Open / Go to Costing Sheet	Delete Sheet	Enabling Costs	Capital Costs	O & M Costs	Other Costs	Cash	Total Cost PV
Fluvial raised defence	Embankment								
	Wall			£244.98	£942.24	£8.59	£0.00	£1,195.82	£1,157.80
	Sheet Piling								
Channel management	N/A								
Culvert & screen	N/A								
Control assets	Weir								
	Pumping station								
	Flood gate			£8.33	£41.65	£0.00	£0.00	£49.98	£48.57
	Outfall								
	Flow barrier								
Coastal protection	Wall								
	Revetment								
	Groyne								
	Recharge								
Flood storage	N/A								
Flood warning and forecasting	Various								
Temporary & demountable barriers	Various								
Household resistance	Various								
Household resilience	Various								
SUDS and urban drainage	Various								
Managed realignment	Various								
Habitat creation	Various								
Landuse & runoff management	Various								
River Restoration	Various								
User Defined 1	Various			£0.00	£18.23	£0.00	£0.00	£18.23	£17.62
User Defined 2	Various								
User Defined 3	Various								

Direct Defences - 200 year - Option 1

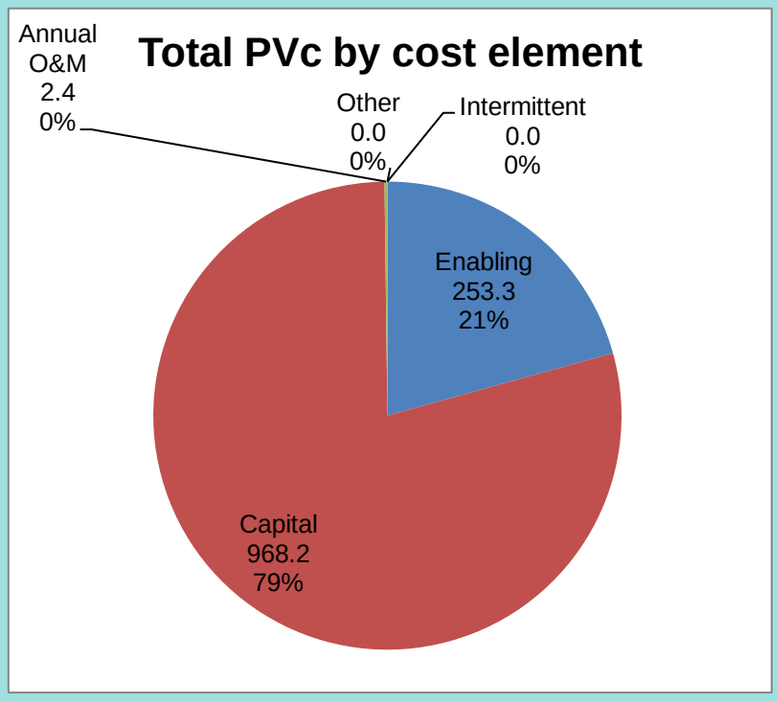
Whole Life and Present Value Cost Analysis

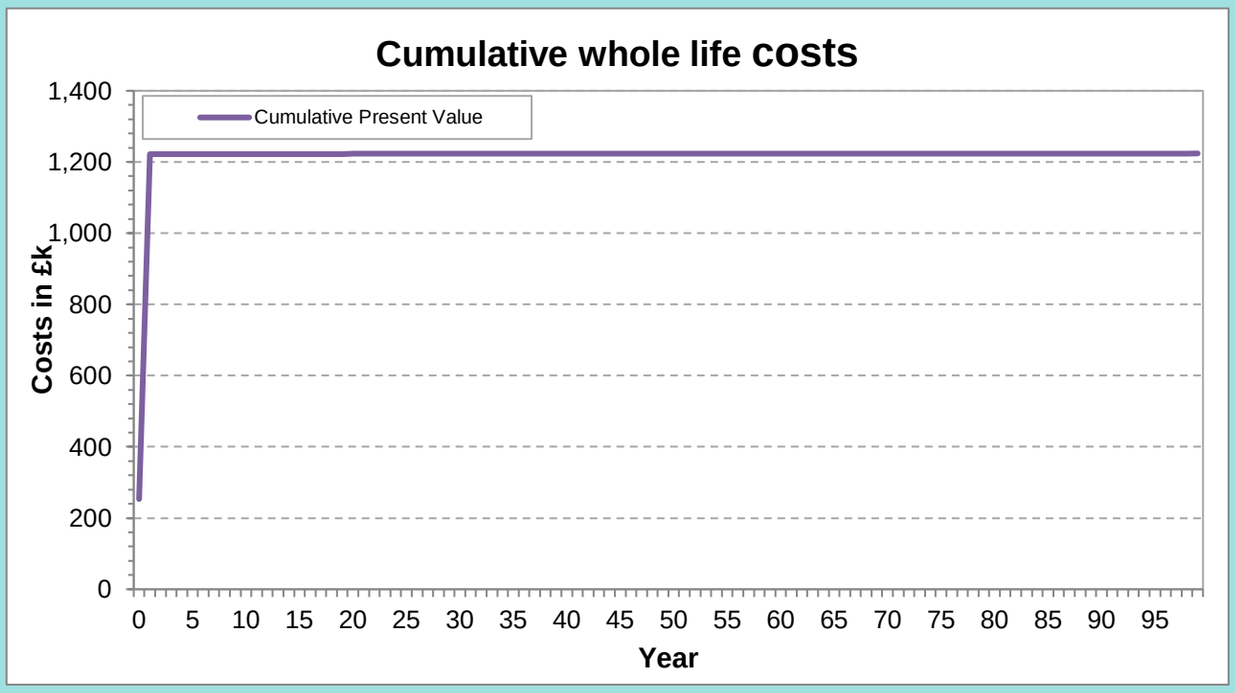
		PV factor	29.813				**Total PVc (£k):**	**1224.0**	
		Enabling £k	**Capital £k**	**Annual O&M £k**	**Intermittent O&M £k**	**Other £k**	**TOTALS: Current price**	**PV (£k)**	
	Total real cost	253.3	1002.1	8.6	0.0	0.0	1264.03	**1224.0**	
	Total PV cost	253.3	968.2	2.4	0.0	0.0		**1224.0**	**Cumulative**
year	**Discount Factor**								**PV Costs (£k)**
0	1.000	253.3	0.0	0.0	0.0	0.0	253.3	253.3	253.3
1	0.966	0.0	1002.1	0.0	0.0	0.0	1002.1	968.2	1221.6
2	0.934	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1221.6
3	0.902	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1221.7
4	0.871	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1221.8
5	0.842	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1221.9
6	0.814	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1221.9
7	0.786	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1222.0
8	0.759	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1222.1
9	0.734	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1222.1
10	0.709	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1222.2
11	0.685	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1222.3
12	0.662	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1222.3
13	0.639	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1222.4
14	0.618	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1222.4
15	0.597	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1222.5
16	0.577	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1222.5
17	0.557	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1222.6
18	0.538	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1222.6
19	0.520	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1222.7
20	0.503	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1222.7
21	0.486	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1222.8
22	0.469	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1222.8
23	0.453	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1222.8
24	0.438	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1222.9
25	0.423	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1222.9
26	0.409	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1222.9
27	0.395	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.0
28	0.382	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.0
29	0.369	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.0
30	0.356	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.1
31	0.346	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.1
32	0.336	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.1
33	0.326	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.2
34	0.317	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.2
35	0.307	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.2
36	0.298	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.2
37	0.290	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.3
38	0.281	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.3
39	0.273	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.3
40	0.265	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.3
41	0.257	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.4
42	0.250	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.4
43	0.243	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.4
44	0.236	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.4
45	0.229	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.5
46	0.222	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.5
47	0.216	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.5
48	0.209	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.5
49	0.203	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.5
50	0.197	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.5
51	0.192	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.6
52	0.186	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.6
53	0.181	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.6
54	0.175	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.6
55	0.170	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.6
56	0.165	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.6
57	0.160	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.7
58	0.156	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.7
59	0.151	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.7
60	0.147	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.7
61	0.143	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.7
62	0.138	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.7
63	0.134	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.7
64	0.130	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.7
65	0.127	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.7
66	0.123	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.8
67	0.119	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.8
68	0.116	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.8
69	0.112	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.8
70	0.109	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.8
71	0.106	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.8
72	0.103	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.8
73	0.100	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.8
74	0.097	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.8
75	0.094	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.8
76	0.092	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9
77	0.090	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9
78	0.087	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9
79	0.085	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9
80	0.083	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9
81	0.081	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9
82	0.079	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9
83	0.077	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9
84	0.075	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9
85	0.074	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9
86	0.072	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9
87	0.070	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9
88	0.068	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9
89	0.067	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9
90	0.065	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1223.9

91	0.063	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1224.0
92	0.062	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1224.0
93	0.060	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1224.0
94	0.059	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1224.0
95	0.057	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1224.0
96	0.056	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1224.0
97	0.055	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1224.0
98	0.053	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1224.0
99	0.052	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1224.0

Direct Defences - 200 year - Option 1

Whole life cost charts





Summary of costs

Client/Authority		Prepared (date)	
Scottish Borders Council		Printed	07/12/2018
Project/Option name		Prepared by	C.Kampanou
Haystoun Burn FPS		Checked by	S.Cooney
Project reference	2017s5526	Checked date	
Base date for estimates (year 0)	Jan-2018		
Scaling factor (e.g. £m, £k, £)	£k		
Optimism bias adjustment factor	60%		

PV Cost Summary	**Costs in £k**
Enabling Costs	£334.02
Capital Costs	£1,427.79
O & M Costs	£6.76
Other Costs	£0.00
Total Real Cost	£1,768.57
Total Cost PV	£1,715.45
Total Cost PV + OB	**£2,744.71**

Note: Macros are required to open individual cost modules and the user should ensure they are enabled in the Excel Security Settings.

Note: Cost modules are opened from blank templates by clicking on the pentagons below. If a template exists, the user is sent the module. Only one module per worksheet is permitted.

Note: Costs are automatically summed from all individual cost module sheets every time the user returns to this summary sheet. This process takes into account the above scaling factor.

Note: If multiple measures are used, the optimism bias value used in each module is overridden by that selected above (Cell D10).

Additional user notes:

Add additional user notes here.

FRM Measure	Asset	Open / Go to Costing Sheet	Delete Sheet	Enabling Costs	Capital Costs	O & M Costs	Other Costs	Total Cost Cash	Total Cost PV
Fluvial raised defence	Embankment			£86.01	£334.82	£0.00	£0.00	£420.83	£409.51
	Wall			£187.36	£720.62	£6.76	£0.00	£914.73	£885.53
	Sheet Piling								
Channel management	N/A								
Culvert & screen	N/A								
Control assets	Weir								
	Pumping station								
	Flood gate			£46.63	£179.35	£0.00	£0.00	£225.98	£219.92
	Outfall								
	Flow barrier								
Coastal protection	Wall								
	Revetment								
	Groyne								
	Recharge								
Flood storage	N/A								
Flood warning and forecasting	Various								
Temporary & demountable barriers	Various								
Household resistance	Various								
Household resilience	Various								
SUDS and urban drainage	Various								
Managed realignment	Various								
Habitat creation	Various								
Landuse & runoff management	Various								
River Restoration	Various								
User Defined 1	Various			£14.01	£70.07	£0.00	£0.00	£84.08	£81.71
User Defined 2	Various			£0.00	£122.94	£0.00	£0.00	£122.94	£118.79
User Defined 3	Various								

Direct Defences - 200 year - Option 2

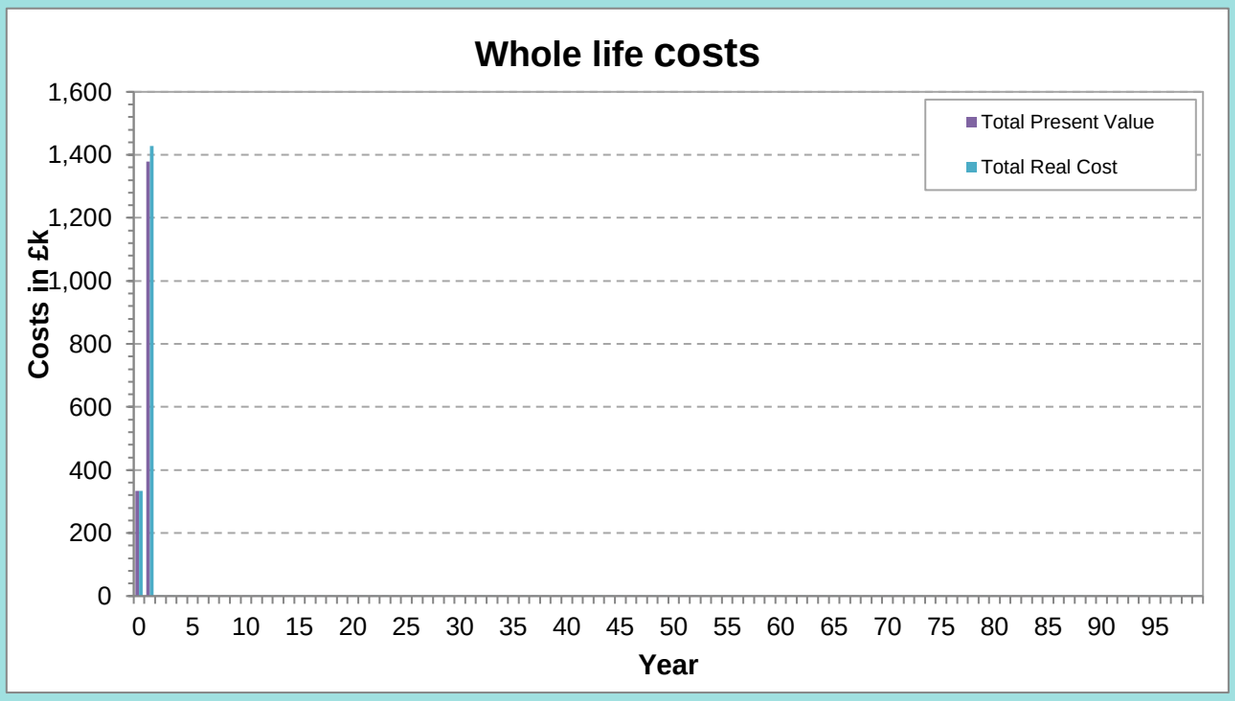
Whole Life and Present Value Cost Analysis		PV factor	29.813				Total PVc (£k):	1715.4	
		Enabling £k	Capital £k	Annual O&M £k	Intermittent O&M £k	Other £k	TOTALS: Current price	PV (£k)	
	Total real cost	334.0	1427.8	6.8	0.0	0.0	1768.57	1715.4	
	Total PV cost	334.0	1379.5	1.9	0.0	0.0		1715.4	Cumulative
year	Discount Factor								PV Costs (£k)
0	1.000	334.0	0.0	0.0	0.0	0.0	334.0	334.0	334.0
1	0.966	0.0	1427.8	0.0	0.0	0.0	1427.8	1379.5	1713.5
2	0.934	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1713.6
3	0.902	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1713.7
4	0.871	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1713.7
5	0.842	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1713.8
6	0.814	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1713.8
7	0.786	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1713.9
8	0.759	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1713.9
9	0.734	0.0	0.0	0.1	0.0	0.0	0.1	0.1	1714.0
10	0.709	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.0
11	0.685	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.1
12	0.662	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.1
13	0.639	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.2
14	0.618	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.2
15	0.597	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.3
16	0.577	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.3
17	0.557	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.3
18	0.538	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.4
19	0.520	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.4
20	0.503	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.4
21	0.486	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.5
22	0.469	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.5
23	0.453	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.5
24	0.438	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.6
25	0.423	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.6
26	0.409	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.6
27	0.395	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.7
28	0.382	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.7
29	0.369	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.7
30	0.356	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.7
31	0.346	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.8
32	0.336	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.8
33	0.326	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.8
34	0.317	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.8
35	0.307	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.8
36	0.298	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.9
37	0.290	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.9
38	0.281	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.9
39	0.273	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.9
40	0.265	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1714.9
41	0.257	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.0
42	0.250	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.0
43	0.243	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.0
44	0.236	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.0
45	0.229	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.0
46	0.222	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.0
47	0.216	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.1
48	0.209	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.1
49	0.203	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.1
50	0.197	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.1
51	0.192	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.1
52	0.186	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.1
53	0.181	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.1
54	0.175	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.1
55	0.170	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.2
56	0.165	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.2
57	0.160	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.2
58	0.156	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.2
59	0.151	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.2
60	0.147	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.2
61	0.143	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.2
62	0.138	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.2
63	0.134	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.2
64	0.130	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.2
65	0.127	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.3
66	0.123	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.3
67	0.119	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.3
68	0.116	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.3
69	0.112	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.3
70	0.109	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.3
71	0.106	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.3
72	0.103	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.3
73	0.100	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.3
74	0.097	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.3
75	0.094	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.3
76	0.092	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.3
77	0.090	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.3
78	0.087	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.3
79	0.085	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
80	0.083	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
81	0.081	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
82	0.079	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
83	0.077	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
84	0.075	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
85	0.074	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
86	0.072	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
87	0.070	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
88	0.068	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
89	0.067	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
90	0.065	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4

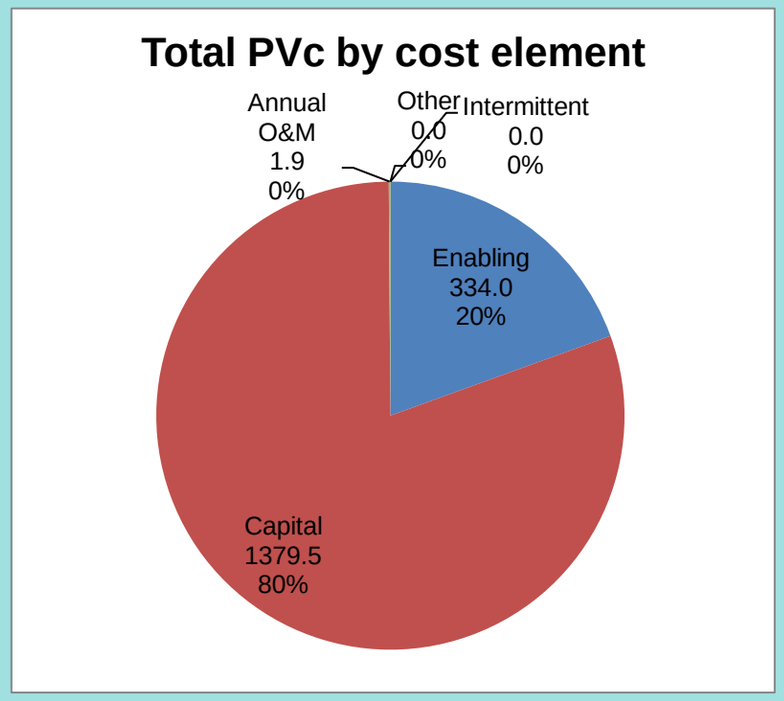
Direct Defences - 200 year - Option 2

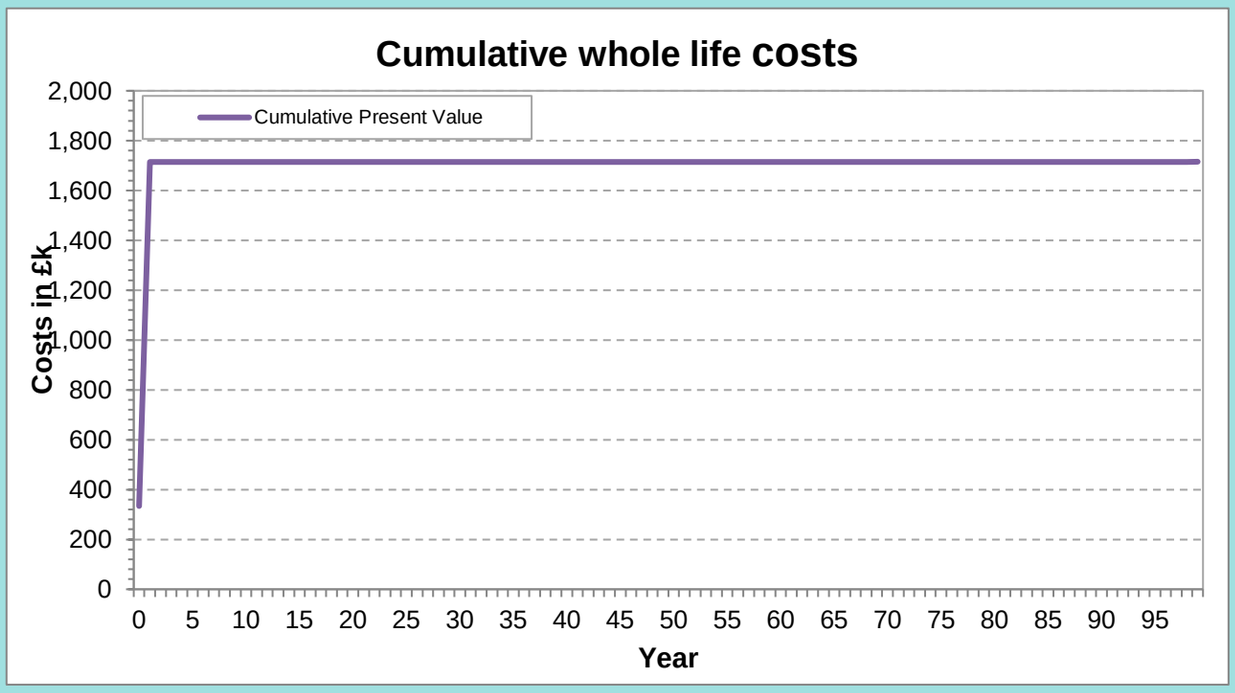
91	0.063	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
92	0.062	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
93	0.060	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
94	0.059	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
95	0.057	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
96	0.056	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
97	0.055	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
98	0.053	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4
99	0.052	0.0	0.0	0.1	0.0	0.0	0.1	0.0	1715.4

Direct Defences - 200 year - Option 2

Whole life cost charts







Whole life cost and PVc analysis example - with replacement costs

Enter enabling, capital, annual O&M and other costs in table below
Enter frequency of other (or replacement) works in table below

Enabling cost (£k)	£217.9
Year of capital works (year)	1
Capital cost (£k)	£1,431.4
Annual maintenance cost (£k)	£28.6
Other cost (£k)	£0.0
Other works frequency (years)	1
Other cost (£k)	£0.0
Other works frequency (years)	1
Replacement (£)	1431.427
Replacement frequency (years)	25
Optimism Bias	60%

Key

	Information
	Calculation
	Cost input
	Default

Total PVc (£k) with Optimism Bias: 5422

Initial discount rate 3.5% 29.813 **Total PVc (£k): 3389**

		Cost Elements				PV			TOTALS:	
		Enabling	Capital	Maint.	Interm.	Enabling	Capital	Maint.	Cash	PV
	Cash sum	218	5726	2806	0	218	2374	797	8749	**3389**
year	Discount Factor									
0	1.000	217.9			0	217.856			217.9	217.9
1	0.966		1431		0		1383.021		1431.4	1383.0
2	0.934			29	0			26.72505	28.6	26.7
3	0.902			29	0			25.8213	28.6	25.8
4	0.871			29	0			24.94812	28.6	24.9
5	0.842			29	0			24.10446	28.6	24.1
6	0.814			29	0			23.28934	28.6	23.3
7	0.786			29	0			22.50177	28.6	22.5
8	0.759			29	0			21.74084	28.6	21.7
9	0.734			29	0			21.00565	28.6	21.0
10	0.709			29	0			20.29531	28.6	20.3
11	0.685			29	0			19.609	28.6	19.6
12	0.662			29	0			18.94589	28.6	18.9
13	0.639			29	0			18.30521	28.6	18.3
14	0.618			29	0			17.68619	28.6	17.7
15	0.597			29	0			17.08811	28.6	17.1
16	0.577			29	0			16.51025	28.6	16.5
17	0.557			29	0			15.95193	28.6	16.0
18	0.538			29	0			15.41249	28.6	15.4
19	0.520			29	0			14.8913	28.6	14.9
20	0.503			29	0			14.38773	28.6	14.4
21	0.486			29	0			13.90119	28.6	13.9
22	0.469			29	0			13.4311	28.6	13.4
23	0.453			29	0			12.97691	28.6	13.0
24	0.438			29	0			12.53807	28.6	12.5
25	0.423			29	0			12.11408	28.6	12.1
26	0.409		1431	29	0	585.2213		11.70443	1460.1	596.9
27	0.395			29	0			11.30862	28.6	11.3
28	0.382			29	0			10.92621	28.6	10.9
29	0.369			29	0			10.55672	28.6	10.6
30	0.356			29	0			10.19973	28.6	10.2
31	0.346			29	0			9.902651	28.6	9.9
32	0.336			29	0			9.614224	28.6	9.6
33	0.326			29	0			9.334199	28.6	9.3
34	0.317			29	0			9.062329	28.6	9.1
35	0.307			29	0			8.798377	28.6	8.8
36	0.298			29	0			8.542114	28.6	8.5
37	0.290			29	0			8.293314	28.6	8.3
38	0.281			29	0			8.051762	28.6	8.1
39	0.273			29	0			7.817244	28.6	7.8
40	0.265			29	0			7.589558	28.6	7.6
41	0.257			29	0			7.368502	28.6	7.4
42	0.250			29	0			7.153886	28.6	7.2
43	0.243			29	0			6.94552	28.6	6.9
44	0.236			29	0			6.743224	28.6	6.7

45	0.229			29	0		6.546819	28.6	6.5
46	0.222			29	0		6.356135	28.6	6.4
47	0.216			29	0		6.171005	28.6	6.2
48	0.209			29	0		5.991267	28.6	6.0
49	0.203			29	0		5.816764	28.6	5.8
50	0.197			29	0		5.647344	28.6	5.6
51	0.192		1431	29	0	274.1429	5.482858	1460.1	279.6
52	0.186			29	0		5.323163	28.6	5.3
53	0.181			29	0		5.168119	28.6	5.2
54	0.175			29	0		5.017592	28.6	5.0
55	0.170			29	0		4.871448	28.6	4.9
56	0.165			29	0		4.729561	28.6	4.7
57	0.160			29	0		4.591807	28.6	4.6
58	0.156			29	0		4.458065	28.6	4.5
59	0.151			29	0		4.328219	28.6	4.3
60	0.147			29	0		4.202154	28.6	4.2
61	0.143			29	0		4.079761	28.6	4.1
62	0.138			29	0		3.960933	28.6	4.0
63	0.134			29	0		3.845566	28.6	3.8
64	0.130			29	0		3.733559	28.6	3.7
65	0.127			29	0		3.624815	28.6	3.6
66	0.123			29	0		3.519238	28.6	3.5
67	0.119			29	0		3.416736	28.6	3.4
68	0.116			29	0		3.317219	28.6	3.3
69	0.112			29	0		3.220601	28.6	3.2
70	0.109			29	0		3.126797	28.6	3.1
71	0.106			29	0		3.035725	28.6	3.0
72	0.103			29	0		2.947306	28.6	2.9
73	0.100			29	0		2.861462	28.6	2.9
74	0.097			29	0		2.778119	28.6	2.8
75	0.094			29	0		2.697203	28.6	2.7
76	0.092		1431	29	0	131.5709	2.631417	1460.1	134.2
77	0.090			29	0		2.567236	28.6	2.6
78	0.087			29	0		2.504621	28.6	2.5
79	0.085			29	0		2.443533	28.6	2.4
80	0.083			29	0		2.383934	28.6	2.4
81	0.081			29	0		2.325789	28.6	2.3
82	0.079			29	0		2.269063	28.6	2.3
83	0.077			29	0		2.21372	28.6	2.2
84	0.075			29	0		2.159727	28.6	2.2
85	0.074			29	0		2.10705	28.6	2.1
86	0.072			29	0		2.055659	28.6	2.1
87	0.070			29	0		2.005521	28.6	2.0
88	0.068			29	0		1.956606	28.6	2.0
89	0.067			29	0		1.908884	28.6	1.9
90	0.065			29	0		1.862326	28.6	1.9
91	0.063			29	0		1.816903	28.6	1.8
92	0.062			29	0		1.772588	28.6	1.8
93	0.060			29	0		1.729354	28.6	1.7
94	0.059			29	0		1.687175	28.6	1.7
95	0.057			29	0		1.646024	28.6	1.6
96	0.056			29	0		1.605878	28.6	1.6
97	0.055			29	0		1.56671	28.6	1.6
98	0.053			29	0		1.528497	28.6	1.5
99	0.052			29	0		1.491217	28.6	1.5

C Appendix C - Public Consultation Questionnaire

Peebles Flood Questionnaire Report

Purpose

In order to gain an insight into the reaction of the public to proposed flood protection schemes, a questionnaire was available to be filled in at the Peebles Flood Study Exhibition on 6th November 2018. Local knowledge and feedback is key to influencing decisions on flood protection schemes and out of 56 people who attended the exhibition, 17 questionnaire responses were received (30%).

Questionnaire Format

The anonymous questionnaires that were available to the local public of Peebles consisted of 10 questions which could be circled 'yes' or 'no' and also included a comments box to elaborate on each answer. This simple layout allowed the questionnaires to be filled in quickly while still giving the option to voice opinions and feedback in greater detail. Below are all the questions which were on the questionnaire sheet:

1. Please name the watercourse(s) which impacts upon you?
2. Have you previously experiences flooding?
3. Do you want to see a flood protection scheme in the site of interest?
4. Do you approve of the approach that we are taking in developing a Flood Protection Scheme in your community?
5. Are there any flood related issues that you feel that we have missed?
6. Do you use the river for recreational purposes?
7. Do you have any concerns about how the flood mitigation options proposed may affect recreation activities at the river?
8. Currently are there any access issues to the existing river infrastructure, including issues which effect individuals with a disability?
9. Are you particularly concerned with any of the proposed options?
10. Do you have any other issues that you would like to raise?

Questionnaire Analysis

****Council responses within red*

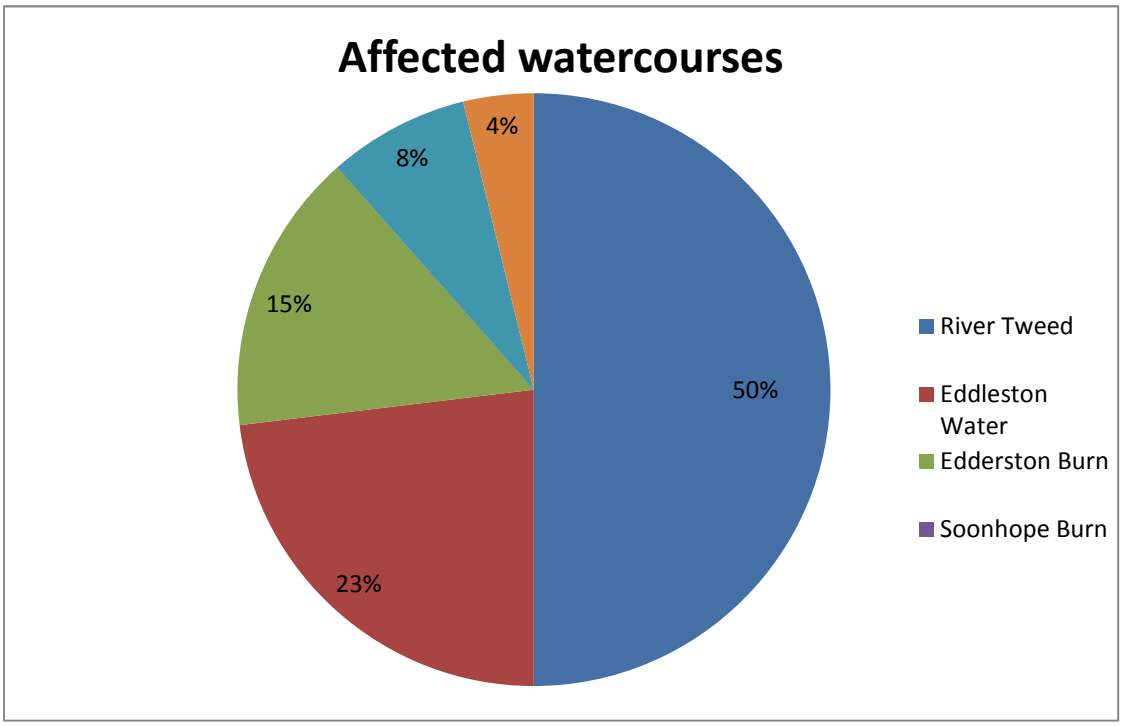
Question 1

Please circle the watercourse/s which impact upon you?

In Peebles there are five main water courses which are of concern and may impact upon different people depending on where they live in the town. The watercourses that were available to circle on the questionnaire were **the River Tweed, Eddleston Water, Edderston Burn, Soonhope Burn and Haystoun Burn**. There was also an 'N/A' option to circle if you were not affected by any of these or would rather not say. Some residents who may have been affected by a few different watercourses circled multiple answers which are reflected in the table below.

Affected watercourse	Number of people affected
River Tweed	13
Eddleston Water	6
Edderston Burn	4
Soonhope Burn	0
Haystoun Burn	2
N/A or unspecified	1

As shown from the data collected, the members of the public who took part in the questionnaire were mostly affected by the River Tweed & Eddleston Water watercourses.



Question 2

Have you previously experienced flooding?

Out of the 17 participants, 11 answered yes to this question and the remaining 6 answered 'No'. Of those who answered 'Yes' there were a variety of comments, mostly explaining what date they experienced the flooding. The majority of comments related to the devastating floods of December 2015, one resident noted "major impact" describing the effect of the flooding in their home in Peebles. A few participants noted that they were evacuated and some had witnessed flooding but not in their homes.

Question 3

Do you want to see a flood protection scheme in the site of interest?

15 people answered yes to this question, indicating that there is a strong desire to have a flood protection scheme in Peebles. 1 person answered no but stated "I realise it is required". The 1 participant who did not circle an answer stated that they were "undecided". Most made comments regarding wanting a protection scheme in order to protect their homes after previously being flooded, examples of which are below;

- *"The exhibition suggested that a proposed scheme was very cost effective. Flooding is devastating for those involved. We all pay a price (e.g. through insurance)".*
- *"To prevent further flooding of our residence."*
- *"Most definitely. Need to reduce risk of this happening again."*
- *"To prevent flooding of properties."*
- *I don't want our house/street to be flooded again - we were affected for 2 years afterward.*

One participant expressed their opinion on what type of scheme they would like making it clear that they would not like a wall to be built and that they would like Natural flood Management (NFM) to be used instead.

- *"It depends, Natural flood management yes, walls etc. no."*

Question 4

Do you approve of the approach that we are taking in developing a Flood Protection Scheme in your community?

14 out of the 17 Participants answered yes to this question and 3 left it unanswered but provided additional details which support why they chose not to answer. Those who answered yes supported their answers with positive comments welcoming the approach that is being taken towards the development of a flood scheme:

- *"Great consultation information and friendly staff to explain info at the event."*
- *"Tweed Green, Tweed Avenue and Walkershaugh were badly affected by the flood in 2015 and the scheme is very much addressing this."*
- *"To protect my home. Any flood reduction would be appreciated. Older folk find it hard to use normal property protection measures. Not everyone can afford them."*
- *"Seems to be very comprehensive."*

The participants who left the question unanswered were concerned about the visual effect of the proposed flood schemes and some believed the flooding is caused by poor land management:

- *"Too much emphasis on structural 'solutions' in town, the main problem is the catchments are terribly managed by landowners / farmers. Tax payers are basically subsiding poor land management. We are paying to create more floods."*
  - *A long list of solutions was drawn up and non-feasible options were withdrawn from the process, allowing us to create a short list of options, with a preferred option. In this instance, there is no feasible alternative to structural solutions within Peebles but we will look at areas where NFM measures can be incorporated. With regards to land management upstream, policy changes etc. would be required out with the remit of flood risk management.*
- *"Partially. I think the council is listening more than before. I still think [there is] too much emphasis on hard solutions and not enough on soft (NFM)."*
  - *Answer as above.*

Question 5

Are there any flood related issues that you feel we have missed?

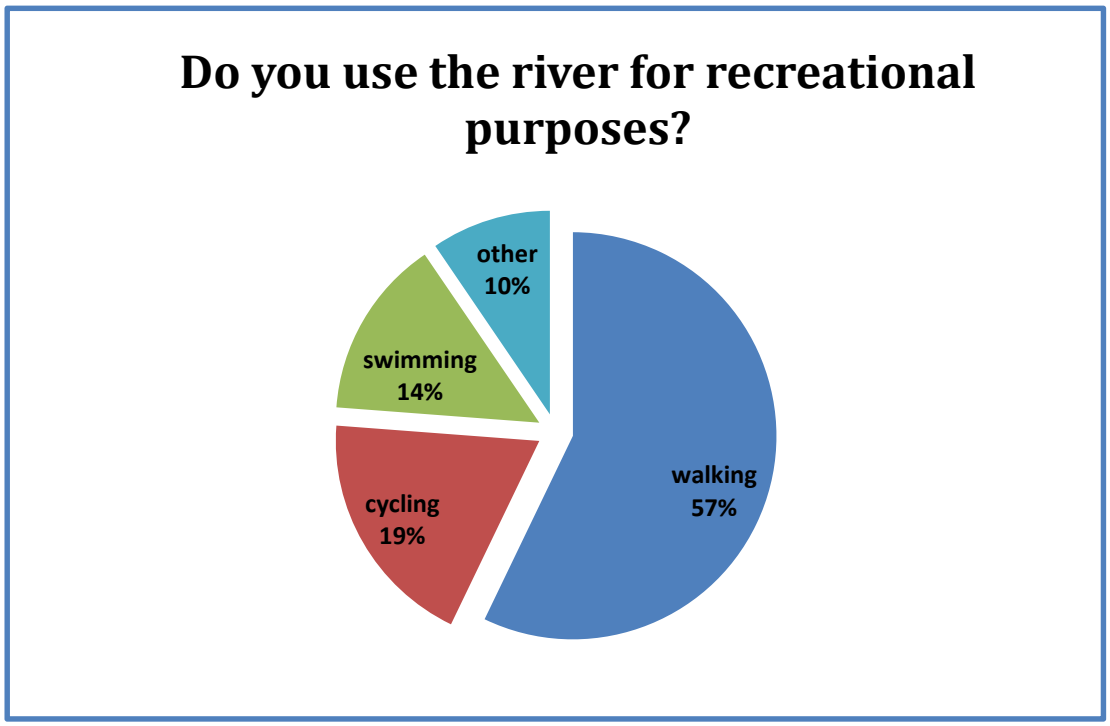
There was a divided response to this question. 8 People answered 'no' showing they are happy that the majority of flood issues in Peebles have been discussed. 3 people answered 'yes' and 6 left it unanswered however included comments regarding some issues that may have been missed. The comments from those that answered yes and where a comment has been left but the question was left unanswered are shown in the table below:

Response no.	Watercourse area	Comments
1	Eddleston Water	*"Timeline of Eddleston water incorrect. Not stating water levels in 2000 (my home was flooded twice)" – Can be incorporated.*
2	Eddleston Water Edderston Burn River Tweed	*"Yes flooding from Eddleston Water at Manor Swore Bridge not included. Advised member of team." – Can be incorporated.*
3	River Tweed Eddleston Water	*"More on NFM. It is more proven than you give credit for. The challenges are also social and political - engaging with and/or regulating land use in the catchment." – NFM potential will be looked at as a long-term strategy?*
4	River Tweed	*"The plan shows how lateral water would be kept out. One of the biggest unknowns is what the water table would do in event of significant flooding." – Protection against groundwater would be incorporated into the design, for example sheet piling for the wall or a waterproof core of an embankment taken down x metres.*
5	River Tweed	*"Natural flood defences upstream of Peebles were mentioned, but largely ignored. Scottish Water and the Forestry Commission could help but do not seem minded too. (They are public bodies in Scotland, and should therefore be accountable to us all, but they don't seem to be in reality)" – Stakeholder engagement with Scottish Water and Forestry will take place / has taken place. NFM potential will be considered.*
6	River Tweed Edderston Burn	*"Despite the poster explaining why sediment removal is not suitable I can see the huge island forming in the Tweed is affecting the river banks (erosion) and will soon impact the Tweed bridge." – Study undertaken on effect on removing the island – very limited effect and will likely re-fill very quickly – we will not be removing (or undertaking any other dredging)*
7	Eddleston Water	*"Yes flooding from Eddleston water at Manor Swore Bridge not included. Advised member of the team." – Can be incorporated.*
8	Eddleston Water	*"The whole grant system which incentivises poor land management, over grazing by sheep etc. is ridiculous. After exiting the CAP, build grants from bottom up to incentivise good land management." – Policy that is out with flood risk management.*

Question 6

Do you use the river for recreational purposes?

Collated data from the questionnaire makes it apparent that walking is the most common recreational activity that people use the riverside for. Other recreational uses include cycling and swimming, as shown in the chart below.



Question 7

Do you have any concerns about how the flood mitigation options proposed may affect recreation activities at the river?

Out of the 17 participants 12 were not concerned about the flood defences affecting any of their recreational activities that they take part in at the river. 1 left the question unanswered and the remaining 4 circled 'yes' indicating that they were concerned. Issues raised by participants who circled 'yes' included concerns about access to the river and the existing walkway and the aesthetics of the proposed flood defence options.

"Too many structures affecting how the river looks and works."

"Yes. It is essential we are not cut off from walking along the river. The "Three Bridges walk" is a very popular and regular walk for many."

"Mitigation for other areas needs to blend in as much as possible, both on the ground & for events."

A mitigation option that blends in suitably with the current area is essential and we will look to reduce the aesthetic losses and mitigate these with alternatives such as raised footpaths. The riverside walkway will exist post-scheme.

Question 8

Currently are there any access issues to the existing river infrastructure including issues which effect individuals with a disability?

9 people responded 'yes' – there were issues accessing the river infrastructure, 3 responded 'no' and 5 left the question unanswered. Below are a couple of comments from participants who responded with 'yes'.

"The hump and the path below riverside house which is not fit for purpose - muddy and eroded."

"Behind Haylodge hospital, pathway not possible in a wheelchair. Both Priorsford & Haylodge footbridge have been successfully dealt with."

The answers to this question are useful as if there are any issues of accessibility, we can work to address these and consider them in the design of flood defences.

Question 9

Are you particularly concerned with any of the proposed options?

11 people respondents were not concerned with the proposed options, representing around 65 percent of the total consultees. Concerns and issues that were raised on the questionnaires by those answering yes are shown in the table below.

Response no.	Watercourse area	Comments
1	River Tweed	*"Somewhat [concerned] about building a wall in Tweed Green"*
2	Eddleston Water	*"Structural protection measures focus on good land management upstream and flood individual houses. Stop grants for land management that increases flood risk."*
3	River Tweed	*"If a wall or embankment is sited at Tweed Green then access to existing footpaths could be an issue."*

Question 10

Do you have any other issues that you would like to raise?

The final question on the questionnaire gave participants the opportunity to voice any issues they had, which may not have applied to the other questions. 3 people raised their concerns, 8 had no issues to raise and 6 left the question unanswered. The concerns highlighted by residents are detailed below;

Response no.	Watercourse area	Comments
1	River Tweed	*"Water level data from the early stages of the Tweed, at Glenbreck and Kingledores, is critical to understanding the potential of flooding in Peebles. The monitoring needs to be well protected."*
2	Eddleston Water	*"Look at link between CAP, land ownership / reform, length / security of tenancy for farmers and floods! Identify and treat the causes not only the symptoms"*
3	Eddleston Water River Tweed	*"Take NFM seriously"*

A participant who raised an issue included a comment displaying their positive thoughts about a flood defence to protect property:

"Fully in support of proposal to protect property affected by the River Tweed with the construction of a flood retaining wall. Seems to be excellent cost/benefit"

Outcome / Conclusion

As shown from the data collected in the questionnaires, there has been a generally positive response to flood defence options presented in Peebles. However, the questionnaire has highlighted issues that will be considered at the next stages of the process, including negative comments about flood walls and the lack of natural flood management.

The mainly positive view is likely to be because many people have unfortunately been affected by flooding in the recent past, understand how devastating flooding can be and appreciate the benefit of having their properties protected by a formal flood protection scheme.

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Limerick
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