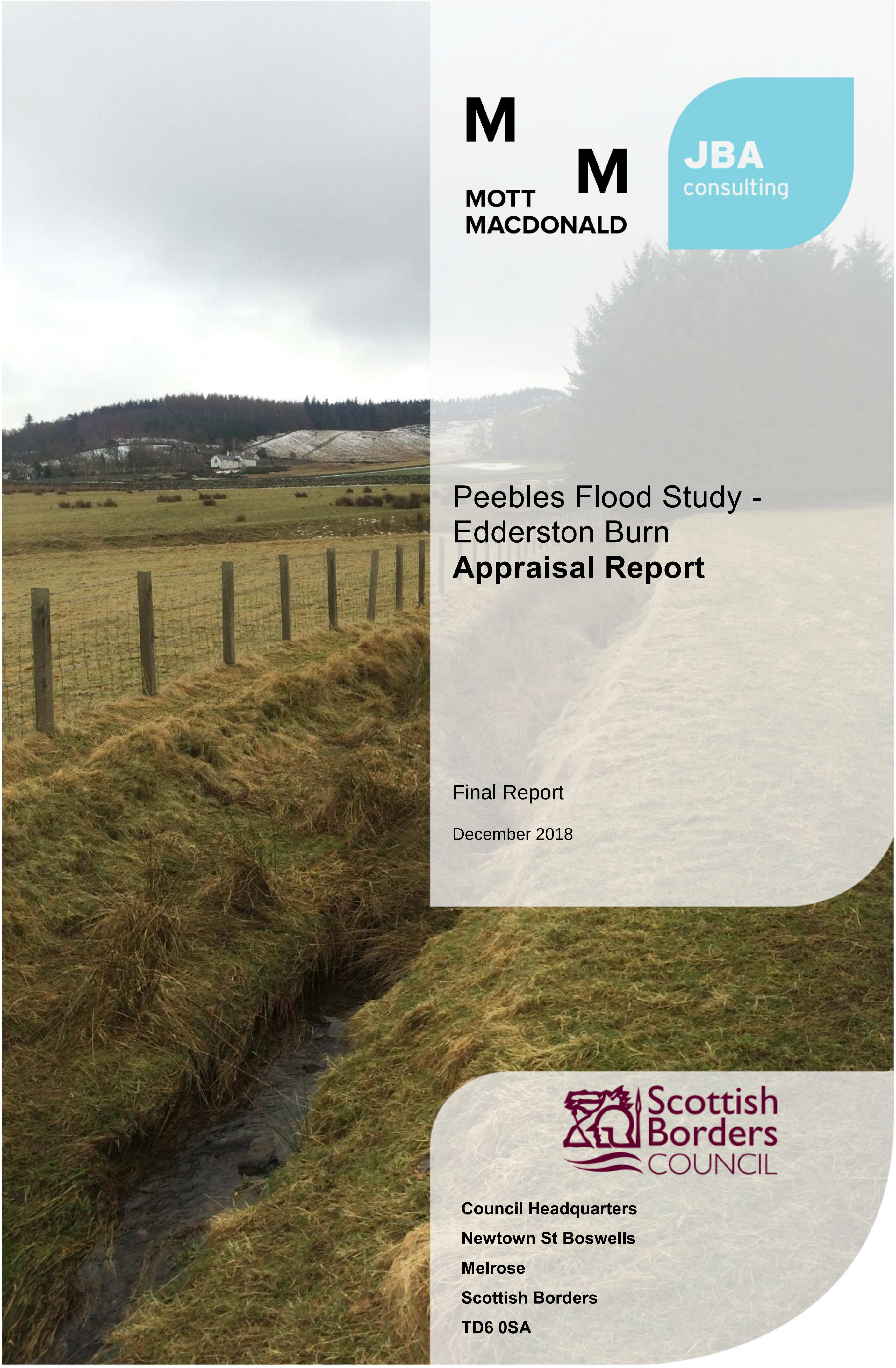

MOTT MACDONALD

JBA consulting

Peebles Flood Study - Edderston Burn
Appraisal Report

Final Report

December 2018

Scottish Borders COUNCIL

Council Headquarters

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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. Jonathan Garrett, Hannah Otton and Christina Kampanou of JBA Consulting carried out this work.

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Purpose

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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 South Parks 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 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. We would also like to thank Euro Environmental Group Ltd for providing CCTV information to support the study.

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Edderston Flood Risk Management Business Case

Context

South Parks, a residential area within 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 South Parks, Peebles. A number of supporting documents and drawings have also been prepared to complement this report and provide additional detail on certain aspects.

The Edderston Burn is a small burn in Peebles flowing north into the River Tweed. It consists of two main tributaries which combine to form the main Edderston Burn channel approximately 600 m upstream of its confluence with the River Tweed. As part of the South Parks Flood Prevention Scheme (FPS) 1988 a diversion channel was built to divert flows from the west tributary of the Edderston Burn to drain directly into the River Tweed via a culvert under South Parks Road. The diversion channel consists of an overflow structure, a re-graded drainage channel and culvert extending from South Park Road to the outfall at the River Tweed.

A hydrological and hydraulic modelling exercise was carried out to estimate river levels and map flood extents on the Edderston Burn. A range of possible flood events were modelled from the 2 year flood to a 1000 year flood. Increases due to predicted climate changes were included (using a 33% uplift) for the 30 year and 200 year floods.

This analysis suggests that 39 properties are at risk of flooding from the 200 year event and 42 are at risk for the same event with a climate change allowance. The main flood mechanisms appear to be due to the under capacity of culverts and overland flow through the urban area and onto low lying areas to the south of the River Tweed.

Risk metrics

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

Properties at risk	39 at the 200 year flood (42 with climate change)
Non-residential properties at risk	1 at the 200 year flood (1 with climate change)
Key receptors at risk	Scottish Ambulance Service station Access to Fire Station maybe restricted

Flood Mitigation Options

A range of flood protection options were reviewed and short listed based on their viability. 6 options were short listed as potentially viable solutions to protect to a 200 year standard of protection. The short-listed options are as follows:

- Option 1 - Property Level Protection (PLP)
- Option 2 - Online Storage
- Option 3a - Culvert Upgrade with Channel Deepening
- Option 3b - Culvert Upgrade with Channel Widening
- Option 3c - Culvert Upgrade with Direct Defences
- Option 4 - Secondary Diversion Channel

Improving public awareness and resilience

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

- Installation of a flow gauge on the Edderston Burn would have multiple benefits. It would give greater confidence to the size of the estimated peak flow flood events, provide calibration data to increase the confidence of the hydraulic model and could be used to develop a crude flood alert system for the community.

- The Council provide partial funding for at risk home owners to purchase PLP. This has not been taken up by any resident in South Parks yet. The Council's PLP discount scheme could be implemented further in advance of any possible flood protection scheme.
- 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 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 the use of a flood 'pod' system. These 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. They are also light weight so can be positioned without difficulty by a larger number of people. 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 in the vicinity of Edderston.

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 £3.4m and £2.5m respectively. The damages avoided for each option are in the range of £2.5-3.2m, protecting 36-38 residential and 1 non-residential properties (depending on the option assessed). Total damages avoided for each option are provided in the investment appraisal summary table overleaf.

Working with natural processes and decrease burden on sewer network

NFM

Natural Flood Management (NFM) is a method whereby wider catchment benefits could be achieved alongside a traditional flood protection option, potentially reducing flood flows within South Parks. Opportunities with the upper catchment could to some extent counteract the effects of increasing river flows with climate change. Natural Flood Management opportunities should be progressed where feasible through 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.

The NFM measures which are likely to have the largest influence on reducing flood risk are:

- Blockage of highly straightened field drainage in the upper catchment
- Wetland creation in the upper catchment
- Increase riparian vegetation above South Parks with 5m buffer strips

Burden reduction on sewer network

Each of the shortlisted schemes, with the exception of the PLP option, reduce the burden on the sewer network within South Parks during times of flood by keeping flood water out of South Parks' urban area. Scottish Borders Council are undertaking a South Peebles Flood Study to investigate the impacts of surface water on the south side of Peebles. This is a drainage study which will identify options to mitigate the worst of the surface water flooding and impacts behind any proposed defences.

Costs

Costs for each option have been estimated using the Environment Agency's Long Term Costing tool (2015). An optimism bias factor of 60% has been added to the total costs to allow for uncertainties in design at this level of appraisal and is typical for schemes at an early stage of appraisal. Whole life present value costs range from £1.0m to £3.5m. Total costs for each option are provided in the investment appraisal summary table overleaf.

Investment appraisal

The investment appraisal is provided below. The option with the highest benefit-cost ratio (BCR) is the online storage option, with a benefit ratio of 3.0 and a net present value of £3,219k. This option should be considered to be the preferred option on the basis of economics alone. This is compared to the secondary diversion channel option with a BCR of 2.6 and net present value of £2,468k. All the options with the exception of the culvert upgrade and channel widening option have a BCR above unity.

			Option 1	Option 2	Option 3	Option 3b	Option 3c	Option 4
Option name	Do Nothing	Do Minimum	PLP	Online storage	Culvert Upgrade with Channel Deepening	Culvert Upgrade with Channel Widening	Culvert Upgrade with Direct Defences	Diversion Channel
PV Costs (£k)	-	-	602	676	1,240	2,203	1,414	701
Optimism Bias (60%)	-	-	361	406	744	1,322	848	421
Total PV Costs (£k)	0	0	963	1,081	1,985	3,525	2,262	1,122
PV damage (£k)	3,367	2,468	429	148	148	148	148	291
PV damage avoided (£k)	-	899	2,468	3,219	3,219	3,219	3,219	3,076
Benefit-cost ratio	-	-	2.6	3.0	1.6	0.9	1.4	2.7

For each of the options assessed there are a number of constraints and opportunities that must be considered and discussed with stakeholders and the public before a preferred option is selected. A summary of these is provided in the appraisal summary table overleaf.

Residual risks and planning for future flooding

The shortlisted options protect to the 200 year flood event. As the effects of climate change continue to be felt this level of protection will diminish. Ideally, the 200 year plus climate change event would be designed for now or would allow the chosen scheme to easily adapt to larger flows with minimal cost at a later date.

Flood protection in South Parks is complex. The three options with the highest BCR have been considered for adaptation to future flood flows. These are discussed further below and reviewed as part of the option matrix in the table overleaf.

1. PLP - as the flood depths are relatively low, South Parks is well suited to PLP. The increase in flood extent due to climate change means 3 additional properties will need PLP. The increase in depth does not exclude properties currently proposed for PLP. However, PLP will need replacement every 25 years and may not therefore be considered a suitable long term option and sustainable option.
2. Secondary diversion channel - a secondary diversion can easily be constructed to cater for greater flows, however, it can only cater for flows from the western tributary. The increased flows on the eastern tributary would start to cause flooding so other flood defence measures would need to be implemented to cater for flooding arising from the eastern tributary.
3. Online storage option - For the online storage option there are several possible adaptations to be made:
    a. Increase storage capacity by raising wall heights or excavating ground.
    b. Install an adjustable flow control to allow a larger pass forward rate.
    c. Decrease the flow entering the reservoir.

Conclusions and recommendations

In South Parks a number of “Quick Wins” are recommended. These “Quick Wins” shall help to alleviate choke points and increase conveyance in the channel. The Council should seek to implement these as short-term measures prior to a flood scheme being implemented in South Parks, or in the case where the scheme is not sufficiently high up SEPA's prioritisation list to obtain funding from the Scottish Government. The proposed scheme options have been assessed under the assumption that these recommendations are carried out so should be considered as 'no regrets' options that benefit the community:

- The two small bridges on the Diversion Channel should be removed (the wooden water gates should be removed in the interim).
- The two bridges on the Edderston Burn closest to the upstream face of the South Parks culvert should be removed.
- The weir at the upstream face of the Edderston Culvert should be removed and channel reprofiled.
- The screens on the Diversion Channel Culvert and South Parks Culvert should be enlarged so that they no longer obstruct water flow when a third of the culvert opening is blocked. Trash screen design guidance can be found in the EA Guide “Trash and Security Screen Guide 2009”. Safer access for cleaning of the culvert screen is also recommended. If the hybrid option is chosen then the Diversion Channel could be made obsolete, negating the need to make these changes. Likewise, if the culvert on South Parks is upgraded a screen is unlikely to be needed at all.

The summary table in the Business case highlights the positives and negatives of each scheme.

The options requiring a culvert upgrade have the lowest benefit cost ratio due to the high costs involved. The online storage, secondary diversion channel and the PLP option come out as the top three contenders with a BCR of 2.6 or more in all cases.

The online storage option has the best BCR although it has several drawbacks. This option will store in excess of 10,000m^3 in an urban environment so the risk of failure could pose a risk to life. Due to the fact it holds in excess of 10,000m^3, it is subject to a number of requirements under The Reservoirs (Scotland) Regulations 2016. These requirements include an annual inspection from a Reservoir Panel Engineer and an additional freeboard height above peak water, which increases the length and height required of the side walls. Additionally, it would be preferable to construct the online storage with an allowance for climate change increasing the size further. There are a number of options to adapt this option to cope with climate change (building additional storage upstream, utilising NFM in the upper catchment and upgrading the culvert downstream (this may be needed anyway due to its poor condition).

The secondary diversion channel, passing through agricultural land shall be relatively easy to construct. The increase in size to accommodate the 200 year plus climate change event is achievable for a small cost increase and should be incorporated. This option only reduces flow approaching South Parks from the western tributary, flooding resulting from flow from the eastern tributary is not reduced.

PLP, as an alternative option, would reduce flood risk from both tributaries and could be implemented quite easily without any large scale construction works and can protect to the 200 year plus climate change flood event (bar one property) for an additional capital cost of less than £25k on top of the 200 year PLP costs. On the downside there is always some post-event property damage and clean-up costs associated with PLP and roads and gardens will not be protected. Furthermore, this option would need to be reassessed in the future and repeated approximately every 20-25 years as the life of PLP is significantly lower than a FPS scheme; PLP equipment needs replacement on average every 25 years. Funding for this is unclear, replacement will either place a heavy cost burden on the council or residents. PLP is usually regarded as a short term flood protection solution.

Whilst all three options have pros and cons the recommended scheme is a hybrid of the secondary diversion channel and the online storage. Essentially the secondary diversion channel would cater for all flow from the western tributary and the reservoir would cater for the flow from the eastern tributary. The reservoir would be much smaller than in the standalone option. The reservoir embankment/wall would be contained within the natural valley. Smaller online storage (less than 10,000 m^3) would hold less water, be constructed at a lower height and greatly reduce the risk to life due to sudden failure. As it is below the 10,000 m^3 threshold, a smaller online storage would be free of additional restrictions under the 2016 Regulations. . It could be designed to hold a portion of water all year round to increase its amenity value to the public. Building both schemes in full would result in a BCR of more than 1.4.

JBA therefore recommends a hybrid of the Diversion Channel and online storage as the preferred option but PLP is considered a viable solution in the short term if culvert upgrading is planned.

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
Property level protection (PLP) (0.5% AP - 200 year)	38	No impact	Natural Flood Management Measures have been identified and, subject to further investigation, could be incorporated within the scheme to provide additional benefits.	Intrusive into people's homes, will require reinstallation every 25 years. Some flood damages are associated with each flood event, as well as clean up cost. Roads and gardens are not protected.	All bar one property could be protected by PLP. A single property will experience flood depths in excess of what PLP can provide. Installing PLP to an additional three properties will protect properties up to the 200 year plus climate change event.	Option should be presented to public for comment. Signage relating to flooding and sand bag stores and work with South Parks residents alongside Resilient Communities programme. Installation of a flow gauge on the Edderston Burn for flood warning, calibration and flow estimates.	Second highest benefit cost ratio of defended options. Benefit cost ratio (BCR) 3.1	None
Online Storage (0.5% AP - 200 year)	39	Implications for RBMP. Some impediment to movement of sediment and fauna but could be designed to minimise this.	Natural Flood Management Measures have been identified and, subject to further investigation, could be incorporated within the scheme to provide additional benefits. Further modelling and discussions with landowners are required to determine the most appropriate measures and locations for these works and the benefits they may provide. Surface water from the south and south west will be caught and contained by the watercourses Natural	Wall heights above bank are approximately 1.3m at street level so should not be too much of a visual impact. It requires land from peoples gardens.	Wall height would increase too much to accommodate 200 year climate change flows, but it may be possible to excavate into the hill, continue to utilise the existing diversion channel or increase the pass forward rate and protect those properties left exposed to risk as a result of the higher pass forward flow.		Highest benefit cost ratio of defended options. BCR 3.3	Could be designed to hold some water to increase the amenity value, additional storage capacity would need to be found elsewhere.
Culvert Upgrade – Channel Deepening (0.5% AP - 200 year)	39	Temporary loss of habitat during construction. Shall be undertaken at appropriate time of year. Culverts can be designed to hold a layer of sediment to simulate a more natural river bed and allow for easier movement of river fauna		Land take and bridge removal required. Replacement of culverts shall be disruptive to the community for access and noise.	Channel could be made larger now to accommodate further increase in flows. Culverts already designed for the 200 year plus climate change flow.		BCR 1.6	None

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
Culvert Upgrade – Channel Widening (0.5% AP - 200 year)	39	Disruption caused to existing channel however new more naturalised channel will be created. Culverts can be designed to hold a layer of sediment to simulate a more natural river bed and allow for easier movement of river fauna	Flood Management Measures have been identified and, subject to further investigation, could be incorporated within the scheme to provide additional benefits. Further modelling and discussions with landowners are required to determine the most appropriate measures and locations for these works and the benefits they may provide. Surface water from the south and south west will be caught and contained by the watercourses			Option should be presented to public for comment. Signage relating to flooding and sand bag stores and work with South Parks residents alongside Resilient Communities programme. Installation of a flow gauge on the Edderston Burn for flood warning, calibration and flow estimates.	BCR 0.9	
Culvert Upgrade – Direct defences (0.5% AP - 200 year))	39	Minimal in-channel works.		Walls are low so visual impact will be minimal. Replacement of culverts shall be disruptive to the community for access and noise.	Walls could be built higher now with only a small increase in height. Culverts already designed for the 200 year plus climate change flow.		BCR 1.4	
Secondary Diversion Channel	37	New naturalised river channel and rock pools created.		Land purchase agreement required. The land is steep on approach to the River Tweed so a stepped rock pools will be required. The majority of construction work will be carried out outwith the urban area of South Parks so there should be minimal disturbance to residence. .	Channel widening is an easy way to create additional capacity in the future or could be built larger now, however, there is no reduction on flows from the eastern culvert which will cause problems with climate change applied to the flows.		BCR 2.7	Possible scope to improve biodiversity and amenity value through careful design of diversion channel.
Diversion Channel and Online Storage hybrid	39	Some increase in river pressure under RBMP classification as reservoir will act as impendment sediment and fauna.			Can easily be designed to accommodate future flood flows.		Between 1.4 and 2.2	Could be designed to hold some water to increase the amenity value.

Negative			Neutral			Positive

Contents

Legislative framework ii

1 Introduction 1

1.1 Flooding mechanism from the Edderston Burn 3
1.2 Aims and objectives 3

2 Preliminary investigations 4

2.1 Flood history 4
2.2 Review of Previous flood studies 4
2.3 Flood estimation 4
2.4 Survey data 6
2.5 River Basin Management plan – Summary 10
2.6 Preliminary ecological appraisal – Summary 11
2.7 Hydraulic modelling 11

3 Appraisal approach 16

3.1 Problem definition 16
3.2 Aims of investment appraisal 17

4 Flood risk management options 18

4.1 Critical success factors (objectives) 18
4.2 Guideline standard of protection 18
4.3 Short term structural and maintenance recommendations and quick wins 18
4.4 Non-structural flood risk management recommendations 21
4.5 Long list of options 25
4.6 Short list of options 28
4.7 Flood Mitigation Options - South Parks 28

5 Investment appraisal 43

5.1 Damage methodology 43
5.2 Flood damage results 43
5.3 Damage benefit summary 46

6 Cost estimates 47

6.1 Price Base Date 47
6.2 Whole life cost estimates 47
6.3 Maintenance costs 47
6.4 Edderston Burn - Option 1- PLP with 200 year standard of protection 48
6.5 Edderston Burn - Option 2- Flood storage with a 200-year standard of protection 48
6.6 Edderston Burn - Option 3A- Culvert upgrade with bed lowering providing a 200-year standard of protection 49
6.7 Edderston Burn - Option 3B- Culvert upgrade with channel widening providing a 200-year standard of protection 50
6.8 Edderston Burn - Option 3C- Culvert upgrade with direct defences providing a 200-year standard of protection 51
6.9 Edderston Burn - Option 4- New Diversion channel with rock cascade - 200-year standard of protection 52
6.10 Summary of whole life costs 52

7 Benefit-cost analysis 54

7.1 Introduction 54
7.2 Benefit-cost results - Edderston Burn 54
7.3 Benefit-cost results with climate change 55

8 Public Consultation 56

9 Conclusions and recommendations 57

Appendices I

A Appendix A - Economic Analysis I

B Public Consultation Questionnaire V

List of Figures

Figure 1-1: Edderston Burn catchment with channels and culverts indicated 2
Figure 2-1: Model schematic 12
Figure 2-2: 200 year Do Minimum flood depth map 13
Figure 2-3: Do Minimum Standard of Protection Map 14
Figure 2-4: 0.5% AP (200 year) flood outlines with and without a 33% allowance for climate 15
Figure 4-1: Edderston Burn NFM opportunities 25
Figure 4-2: Properties who could benefit from PLP for the 0.5% AP(200 year) flood event 28
Figure 4-3: Benefit map for 200 year Flood Storage Option 30
Figure 4-4: Multiple small storage areas 31
Figure 4-5: Culvert upgrade with channel deepening 34
Figure 4-6: Culvert upgrade with channel deepening 36
Figure 4-7: Culvert upgrade with direct defences 38
Figure 4-8: Secondary diversion channel 40
Figure 5-1: Aspects of flood damage 43
Figure B-1: Loss Probability Curve ....

List of Tables

Table 2-1: Peak flow estimates upstream of the site of interest 4
Table 2-2: Flow estimate comparison 5
Table 2-3: Critical infrastructure 7
Table 3-1: Key culvert screens in South Parks 16
Table 3-2: Condition of South Parks' culvert 17
Table 4-1: Short term structural recommendations and quick wins for the Edderston Burn 19
Table 4-2: Long list of options 25
Table 6-1: Unit and total estimated capital costs 48
Table 6-2: Total cash and Present Value (PV) option costs 48
Table 6-3: Unit and total estimated capital costs 48
Table 6-4: Total cash and Present Value (PV) option costs 49
Table 6-5: Unit and total estimated capital costs 49
Table 6-6: Total cash and Present Value (PV) option costs 50
Table 6-7: Unit and total estimated capital costs 50
Table 6-8: Total cash and Present Value (PV) option costs 51
Table 6-9: Unit and total estimated capital costs 51
Table 6-10: Total cash and Present Value (PV) option costs 51
Table 6-11: Unit and total estimated capital costs 52
Table 6-12: Total cash and Present Value (PV) option costs 52

Table 6-13: Summary of total present value option costs 52
Table 7-1: Benefit cost ratio for the short-listed option for the Edderston Burn (£k). 54
Table A-1: Damage considerations and method ....

Abbreviations

1D	One Dimensional (modelling)
2D	Two Dimensional (modelling)
BGS	British Geological Survey
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
FWA	Flood Warning Area
HEC-RAS	Hydrologic Engineering Center – River Analysis System (developed by the US Army)
LiDAR	Light Detection And Ranging
mAOD	metres Above Ordnance Datum
PLP	Property Level Protection
PV	Present Value
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
SUDS	Sustainable Urban Drainage Systems
TPO	Tree Preservation Order

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.

Throughout this report a flood event will primarily be written as a return period in years, i.e. 200 year 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-0010-Edderston_Burn_Model_Audit-S4-P02.pdf

Asset Review Report -AEM-JBAU-PB-00-RP-A-0004-Asset_Review-S4-P01

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

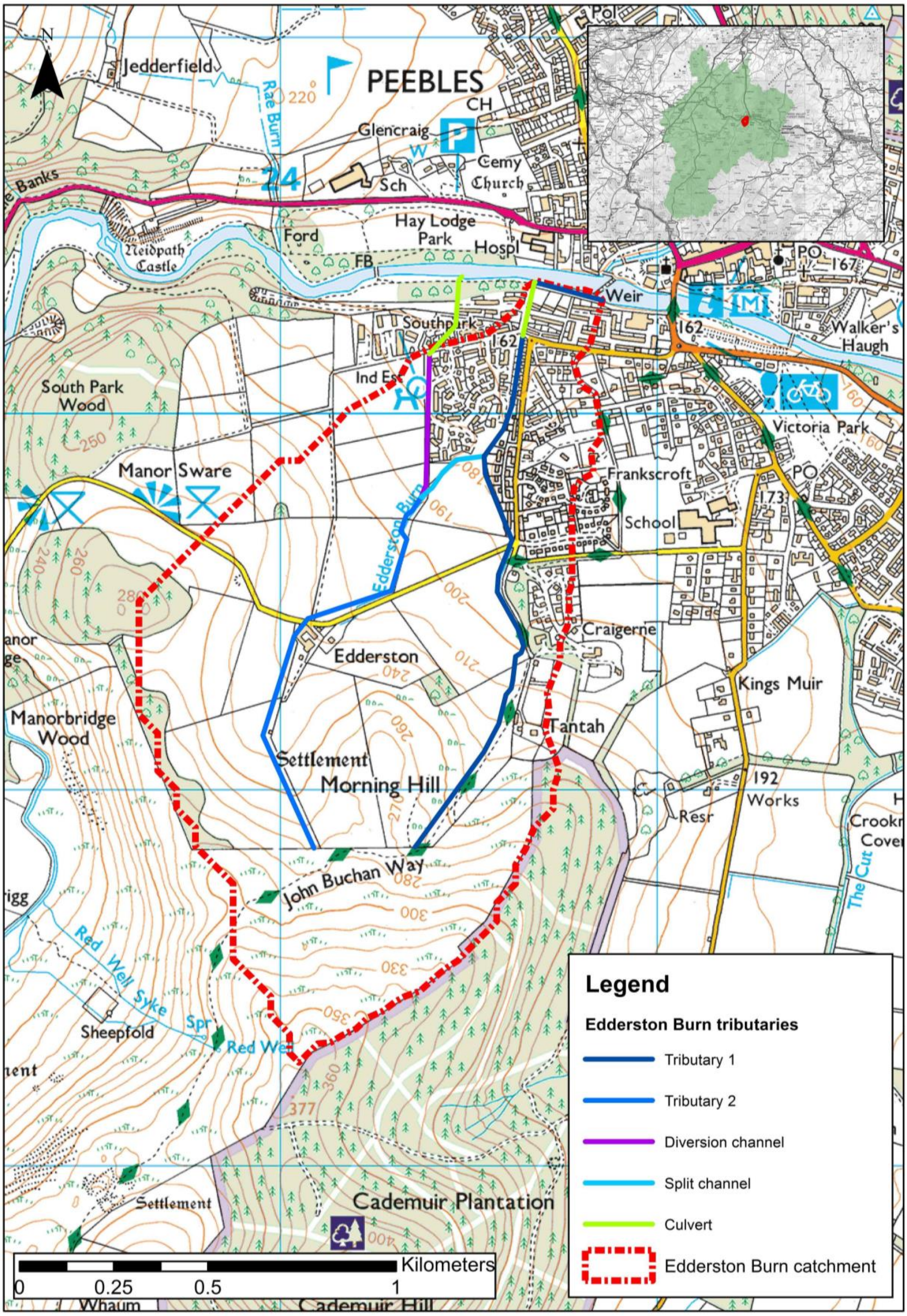
1 Introduction

The Edderston Burn catchment is a small sub-catchment of the River Tweed and covers a total area of approximately 1.75 km^{2}. The Edderston Burn originates in grasslands in the southernmost extent of the catchment where a number of overland flow pathways drain towards a boundary wall before the watercourse becomes more defined. The burn is split with one tributary, which springs near the summit of Morning Hill, flowing down the eastern extent of the catchment, referred to in this report as the eastern tributary. It then runs parallel to Edderston Road where the watercourse has been straightened and is constrained by roads, walls and private properties as it flows through the urban region of the catchment, to where it ultimately discharges into the River Tweed (Figure 1-1).

The second tributary, or the western tributary, flows north past Edderston Farmhouse to a small area of forest. Here the burn is split by the South Park Flood Prevention Scheme with one section being diverted north in a highly straightened diversion channel past a number of properties in the South Park housing estate and is culverted for the final few hundred metres. The other section of split channel flows to the east to join with the Edderston Burn's eastern tributary (Figure 1-1).

The catchment exhibits a rolling topography with elevations highest in the south reaching approximately 360 mAOD. The land slopes relatively steeply in the uppermost portion of the catchment before gently sloping towards the River Tweed at South Parks where elevations are approximately 160 mAOD. The catchment is urbanised in the north but land use within the rest of the catchment is predominantly pasture with natural grassland in the southernmost extent.

Figure 1-1: Edderston Burn catchment with channels and culverts indicated



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1.1 Flooding mechanism from the Edderston Burn

Flooding in South Parks was first addressed by the installation of a diversion channel as part of the South Parks FPS in the late 80's, however in recent times, blockage of the culverts have resulted in some flooding to properties to the north of South Parks Road.

SEPA's Flood Risk Management Maps did not model the Edderston Burn, although fluvial flooding is shown to occur from the Tweed in the low lying area to the north of South Parks Road. Flood extent, frequency and damage is likely to be exacerbated with time as the effects of climate change are felt.

Historic flooding and anecdotal evidence suggest that there are numerous locations where the banks overtop. Previous modelling[1] of the burns have suggested that all structures on the Edderston Burn and Diversion Channel are undersized. Water backing up behind bridges and culverts is the main flood mechanism for South Parks. Flood water flow paths have been identified to flow down Edderston Ridge and South Parks Road and into the low lying residential streets of South Park Crescent and South Park Drive.

As discussed in paragraph 2.3, climate change is predicted to increase flood flows by 33% by 2080. The 200 year event with an allowance for climate change will result in higher flood levels.

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 catchment. Section 2.3 details how climate change has been approached within this study.

1.1.1 Previous studies

Previous flood studies have been undertaken, these are discussed in paragraph 2.2.

1.1.2 Watercourse condition and catchment opportunities

The Edderston Burn can be divided into an upper and lower catchment to help describe the catchment as a whole. The upper catchment is defined as the area south of the Edderston Road junction on the outskirts of the town. Land use in this area is pasture and grassland. A number of man-made, over-straightened drainage ditches direct runoff toward culverts which are directed straight to the burn. Small masonry stone walls cross the upper catchment defining field edges and act as natural barriers to slow runoff. Both tributaries flow relatively naturally, meandering through the land and riparian vegetation was evident along these reaches.

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 in South Parks that contributes to achieving RBMP objectives and are 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 River Tweed catchment and local communities.
c. Highlight opportunities to reduce river flows through Natural Flood Management practices and quick wins.

1 Peebles South Park SFDAD Report, August 2006.

2 Preliminary investigations

2.1 Flood history

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

While South Parks must have a history of flooding to warrant a FPS in the late 80s no written records were retrievable. Anecdotal evidence from a community meeting in Peebles in February 2018 reported that flooding resulted from blockage of the culvert on South Parks Road which conveys the Edderston Burn. The blockage was mainly caused by a bike and resulted in water flowing into South Park Drive and Caledonian Road.

2.2 Review of Previous flood studies

A range of previous studies have been conducted within the catchment with the most relevant information summarised as follows:

Peebles South Park SFDAD Report, August 2006

- This study examined the existing scheme at Peebles South Park. It found that the scheme offered only a 5-year protection and the flood extent for the defended case is greater than that of the undefended case due to flooding from the diversion channel.

South Park Peebles FPS Storage Appraisal Report, June 2007

- This study confirmed that the culverts can maintain only a 2-year flood on the Edderston Burn and a 5-year flood on the diversion channel. By keeping the flood water "in channel" further upstream this would improve culvert capacity as the culvert on the diversion channel cannot be improved as it is in a densely developed area. Storage options upstream to prevent 100-year event flooding were investigated and a large storage area that gathers flow from both sub-catchments of the Edderston Burn was suggested. No further follow-up work was undertaken following this assessment.

2.3 Flood estimation

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

Both the Edderston Burn and Diversion channel are ungauged. The catchment areas of the Edderston Burn are too small to be reliably estimated using the FEH Statistical methodology. ReFH2 with donor parameters and FEH13 rainfall provided the most appropriate method for peak flow estimation for the Edderston Burn, however, SEPA have recommended the use of the more conservative Rainfall Runoff be used instead. It should be noted that the Rainfall Runoff estimate are reliant on default catchment descriptors. A 33% climate change allowance has been applied to the 200 year plus climate change flood event as per SEPA guidance for Local Authority studies for the River Tweed.

The flood estimation was made at the confluence of the Edderston Burn with the River Tweed. The catchment area included that of the diversion channel. This lumped catchment area was divided based on the relative catchment area contributing to the diversion channel and the Edderston Burn. Table 2-1 displays the flow estimate at the confluence with the Tweed for the range of modelled flood events. The 30 year peak water level on the River Tweed was applied as a downstream boundary to all model runs.

Table 2-1: Peak flow estimates upstream of the site of interest

Return Period (Years)	Annual Probability (AP) (%)	Edderston Burn at Tweed Confluence (m^3/s)	Flow applied to Western Tributary	Flow applied to Eastern Tributary
2	50	1.04	0.71	0.33
5	20	1.55	1.06	0.49
10	10	1.87	1.28	0.59
30	3.33	2.44	1.68	0.76

Return Period (Years)	Annual Probability (AP) (%)	Edderston Burn at Tweed Confluence (m^3/s)	Flow applied to Western Tributary	Flow applied to Eastern Tributary
50	2	2.75	1.89	0.86
75	1.33	2.97	2.04	0.93
100	1	3.15	2.16	0.99
200	0.5	3.79	2.60	1.19
500	0.2	4.75	3.26	1.49
1000	0.1	5.79	3.98	1.81

Since the Edderston Burn is ungauged there is some uncertainty in the flow estimates produced. Whilst JBA was requested to use the more conservative flood flow estimates the lack of flood history coupled with the model results suggest that the FEH Rainfall Runoff flows are over estimating. There is a significant difference between the ReFH2 flow estimates and the FEH Rainfall Runoff estimates. Table 2-2 highlights this by showing the equivalent return period in years for a given flow rate, for example, the current 10 year Rainfall runoff return period event has the equivalent flow of a 200 year flood event using ReFH2. The flow rates in the table below are taken at the upstream face of the culvert on Edderston at South Parks.

Whilst a precautionary approach is recommended, due to this uncertainty in design flows, the ungauged catchment and the lack of significant 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: Flow estimate comparison

Flow (m^3/s)	Rainfall runoff Return Period (Years)	ReFH2 Return Period (Years)
1.00	2	32
1.50	5	114
1.81	10	205
2.36	30	468
2.66	50	680
2.87	75	862
3.04	100	1,031
3.66	200	1,841

2.3.1 Climate change

SEPA's summary report on Flood Risk Management and climate change[2] 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 52 years) by 2080. These future changes are something that must be considered when

2 Flood risk management and climate change - Sepa
https://www.sepa.org.uk/media/219494/ceh-cc-report-wp1-overview-final.pdf

designing flood protection measures and is explored further during the options appraisal later in the report.

2.4 Survey data

Topographic survey data from a previous modelling exercises in South Parks was made available for this study and primarily consisted of river cross section data which was used in the 1D hydraulic model. This survey data was collected in April 2005 by Loy Surveys and did not cover the full model reach. This information was combined with a LIDAR Digital Terrain Model (DTM) to provide ground levels across the study area. Combined, this data provides the physical basis for the hydraulic model.

A site visit was conducted to check that the original survey data was still suitable, to photograph key areas and to provide an assessment of the condition of the watercourse, particularly at structures such as bridges and weirs as is summarised below. The site visit indicated that the channel and key structures have not changed significantly and that resurvey of the channel and structures was not warranted. There was poor consistency between the survey data and LiDAR data in some locations. This lead to uncertainty when estimating channel capacity and required defence heights. Additional topographic survey will be required if a preferred scheme reaches outline design stage. At this point the model can be updated if necessary.

To supplement the survey data, CCTV culvert surveys were carried out to determine the condition of the Diversion Culvert and Edderston Burn on South Parks Road. These culverts have been highlighted in the modelling as having a poor conveyance capacity so a close representation of these structures is important to the model. A CCTV culvert condition report can be found as part of the Asset Review Report "AEM-JBAU-PB-00-RP-A-0004-Asset_Review-S4-P01" in the supporting document section of this report. In summary, the double barrel eastern tributary was found to have a blockage of 30% and 10% while the western tributary was found to have a blockage of 10%.

2.4.1 Digital elevation model

1m and 2m LiDAR data has been collected for large parts of Scotland. South Parks has been included in this LiDAR data. This LiDAR data was used as the ground model for 2D element of the model, which represents the floodplain of the channels.

2.4.2 Asset condition assessment

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

There are structures on the Edderston Burn and Diversion Channel which have an impact on flood risk, however, the single most important asset within South Parks is the diversion structure which controls the amount of water passing on to the Edderston Burn and into the Diversion Channel. The channel bank and the weir structure are not tied in well. The bank immediately downstream of the weir is approximately 300mm lower and is only slightly elevated over the channel bed. This compromises the ability of diversion channel to separate the flow.

The other important structures are the culverts on the Diversion Channel and on the Edderston Burn at South Parks Road. When these culverts are overtopped flooding of properties occur.

Table 2-3: Critical infrastructure

<table>
<tr><th colspan="2">Diversion Structure at the Upstream Extent of the Diversion Channel</th></tr>
<tr><td>

Type: Diversion structure
Grid Ref: NT 24375 39775
Material: Concrete
Condition: Grade 2 (Good)
Part of FPS: Yes
Comments:

- Gabion wall along left and right bank upstream of overflow structure in good condition.
- Concrete diversion structure in good condition.
- Opening of structure is clear.

While the concrete structure is in good condition the earthen bank on the right side where the concrete structure ends has been eroded and allows water to leave the Diversion channel to re-enter the Edderston Burn.

</td><td>

Diversion structure

</td></tr>
</table>

<table>
<tr><th colspan="2">Diversion Channel and Culvert</th></tr>
<tr><td>

Type: Culvert and Channel
Grid Ref: NT 24399 40111
Width (m): 0.90
Material: Earth
Condition: Grade 3 (Fair)
Part of FPS: Yes
Comments:

- Channel is heavily overgrown with vegetation.

Garden cuttings dumped in the diversion channel. Cuttings could contribute to a blockage during high flows

</td><td>

Debris screen and concrete headwall

</td></tr>
</table>

Edderston Culvert Inlet and Debris Screen

Type: Culvert with debris screen

Upstream Grid Ref: NT 24398 40160

Width (m): 1.99 (wingwalls rather than culvert barrel)

Height (m): 2.19 (wingwalls rather than culvert barrel)

Material: Concrete

Condition: Grade 2 (Good)

Part of FPS: Yes

Comments:

- Concrete culvert under South Parks at downstream end of diversion channel
- Concrete headwall in good condition
- Opening to inlet clear
- Debris been dumped on culvert headwall
- Smaller inlet inside
- Telemetry installed on headwall

A fence has been placed just upstream of the culvert to prevent high flows getting into the garden behind.

Edderston Culvert

Culvert - Right barrel of Edderston Culvert

Surveyed length - 88.3 (actual length = 89 m) (m)

Inlet section -680/570 (mm)

Outlet section -720/580 (mm)

Made from Masonry

Condition

Sand bags holding up wall Significant infiltration Collapsing roof slates. Some silt and stone deposition. Large blockage at outlet

Maintenance recommendation - Repair or replace sand bag wall.

Rectify collapsing roof.

Clear debris remove blockage from in flow connection from 150 vitrified clay pipe from house 6.

Clear obstruction at outlet.

.

Culvert - Left barrel of Edderston Culvert	
Surveyed length - 83 (actual length = 90 m) (m) **Inlet section -**610/570 (mm) **Outlet section -**610/560 (mm) **Made from** Masonry **Condition** Missing slate in culvert roof and hole. Occasional missing brick, some infiltration, some debris, silt and stones causing blockage. Blocked at outlet **Maintenance recommendation** - Replace roof slate. Clear debris and blockage and repair brickwork.	. 

Culvert Name	Diversion Culvert
Surveyed length (m)	215 (actual length = 215 m)
Inlet diameter (mm)	600
Outlet diameter (mm)	900
Made from:	Concrete
Condition:	Some silt and debris, mostly crack free
Modelling recommendation:	Model with 10% blockage in 600 mm section (south of South Park Crescent) and 15% blockage in 900 mm section (north of South Park Crescent). Flap valve on outlet
Maintenance recommendation:	Clear debris

2.5 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 Edderston Burn catchment is approximately 1.75km^2 and is therefore too small to be characterised within the RBMP. Pressures along the burn were investigated through site visits and it was found that a number of straightened drainage ditches discharged into the burn. Meandering of these sections in the upper catchment would increase sinuosity and the overall physical condition of the Edderston Burn. There are also sections in the lower catchment west of Edderston Ridge that would benefit from being re-meandered as the channel is highly straightened. Leaky bunds have been suggested near Edderston Road to reduce runoff from the road into the burn and improve water quality.

2.5.1 Natural Flood Management – Summary

Natural Flood Management options have been assessed as a standalone report, (referenced in the Supporting Documents section at the start of this report), numerous NFM opportunities were identified. The NFM measures which are likely to have the largest influence on reducing flood risk are:

- Blockage of highly straightened field drainage in the upper catchment.
- Wetland creation in the upper catchment.
- Increase riparian vegetation above South Parks with 5m buffer strips.

These measures will not interfere with any of the proposed options and could be implemented as soon as funding and consent is available. All of the above NFM measures require consultation and agreement from landowners. Meeting landowners to determine the level of acceptance could be carried out at the next stage

2.6 Preliminary ecological appraisal – Summary

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

The River Tweed, into which the Edderston Burn discharges, is designated as a Site of Special Scientific Interest (SSSI) and Special Area of Conservation (SAC) as the whole river system supports Atlantic Salmon, Otter, Lamprey and invertebrate assemblages. The Edderston Water was considered to have the potential to support Water Vole and Otters.

Peebles and the immediate surrounding area is a designated Conservation Area and all trees within it are designated with Tree Protection Orders (TPOs). 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.

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 is known and the impact they may have on holt sites and resting places.

2.7 Hydraulic modelling

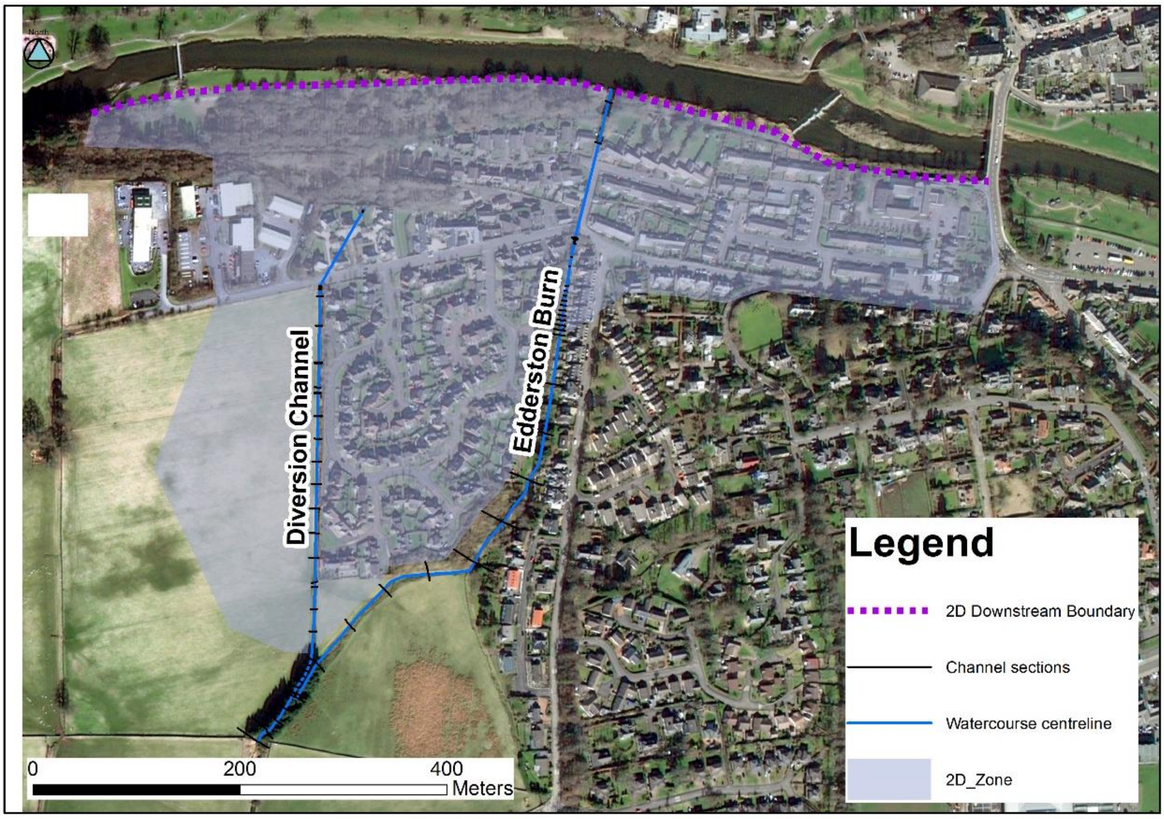
A hydraulic model was developed, informed by the above-mentioned datasets, to estimate water levels during simulated floods. Below is a summary of the models structure and the results used to generate flood maps and to calculate the cost of flood damages in the later stages of the appraisal. Further 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 used was HEC-RAS 5.0 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.

As noted above, survey data for the 1D model was based on survey from 2005 and was supplemented by LiDAR, culvert CCTV and threshold levels of numerous properties. No bank-top survey was available to inform the link between 1D and 2D model domains, so the LiDAR data was relied upon. There was poor consistency in level between LiDAR and the survey data in several places, especially along the Diversion Channel. Where there was conflict between the two levels, survey data was given priority. Despite these concerns the flow mechanism seem to represent anecdotal evidence of flood flows escaping from the burns. The 2D floodplain was formed from 1m LIDAR, resampled to 2m by HEC-RAS for increased simulation efficiency.

Figure 2-1: Model schematic



No photographic evidence or data is available with which to calibrate the Edderston Burn model. In place of this information the time-varying model outputs have been interrogated to ensure that model flows follow reasonable flow paths and achieve sensible depths. Maximum flood depths appear realistic, water can leave the downstream domain with ease (i.e. no 'glass walling' or backing up), and a visual check suggests that extents and depth grids realistically align with the underlying topography, however, a top of bank survey as well as the installation of a flow gauge is recommended to provide calibration data to the model, to give greater confidence to the flow estimates and to remove the ambiguity associated with the level of the bank between cross sections.

2.7.2 Model scenarios

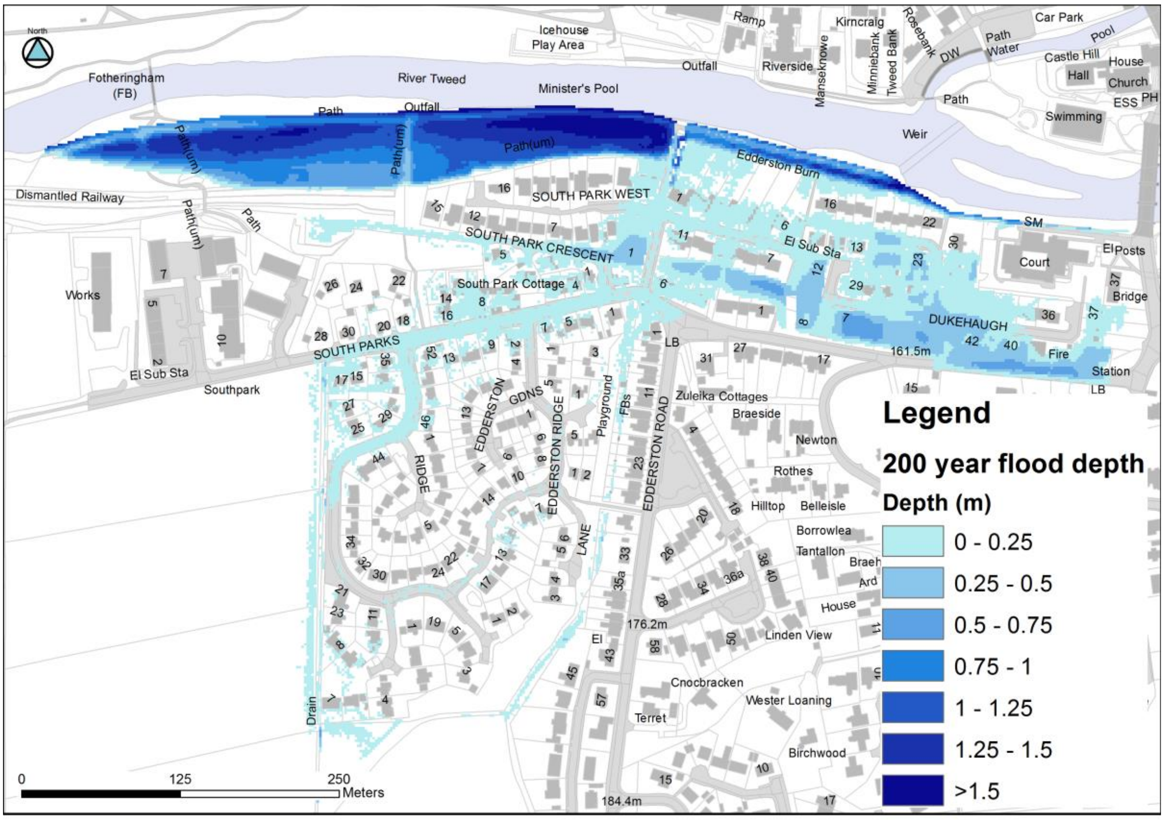
A full range of model simulations were performed covering the full range of annual probability events for a worst case ‘Do Nothing’ and present day ‘Do Minimum’ scenario, with the model being modified slightly between scenarios. A description of the differences between these model scenarios is provided in Section 3.1.

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 2-2 below is the 200 year flood depth map for the Do Minimum Scenario. The results show that the flooding mechanism water backing-up behind each of the structures along the diversion channel, forcing water out onto Edderston Ridge View, Edderston Ridge and South Parks. This is predicted to occur at the 5 year flood event. The Edderston Burn also contributes to flooding at and upstream of the culvert on South Parks. Some flooding can be seen emerging at the culvert from the 2 year flood event. From the diversion channel the flow progresses down the east along South Parks and flows through properties towards South Parks Crescent. Flood water joins with flood water from the Edderston Burn culvert at South Parks and flows into South Park Drive.

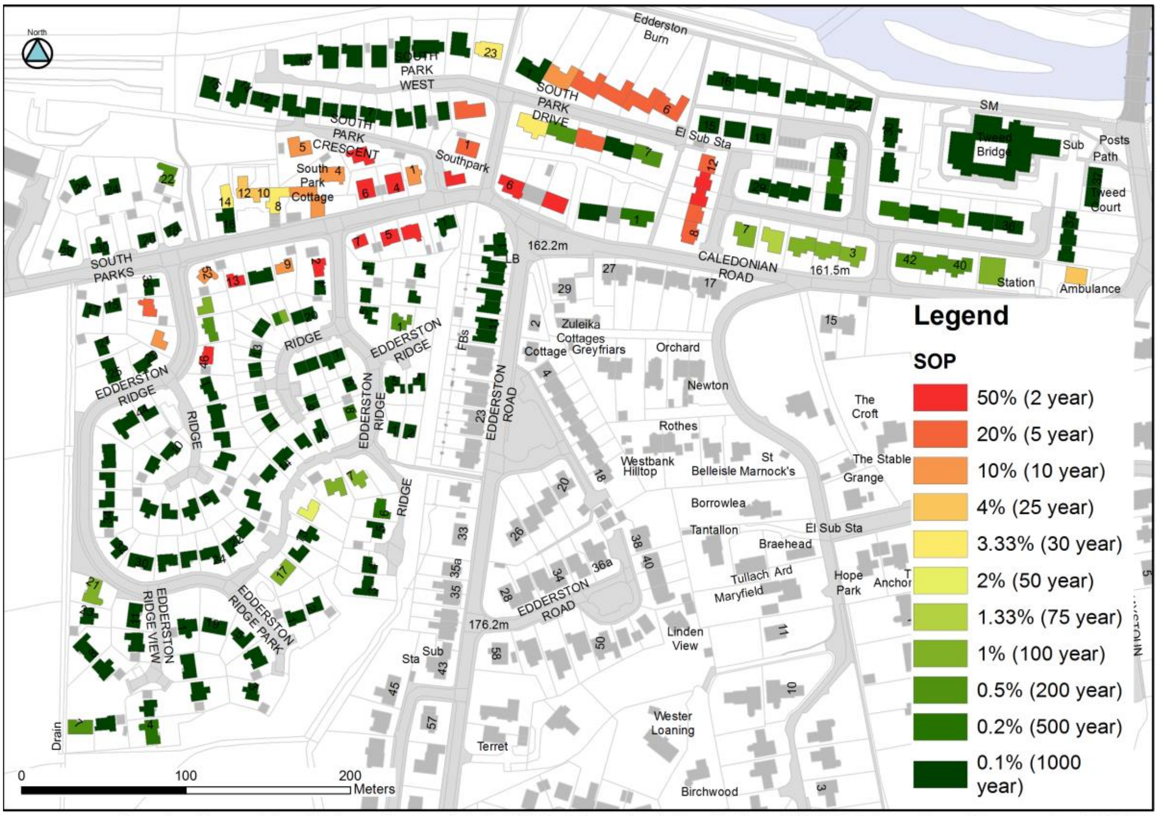
Figure 2-2: 200 year Do Minimum flood depth map



2.7.4 Current standard of protection

The figure below shows the present-day level of protection each property in South Parks has from flooding from the Edderston Burn. '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.

Figure 2-3: Do Minimum Standard of Protection Map

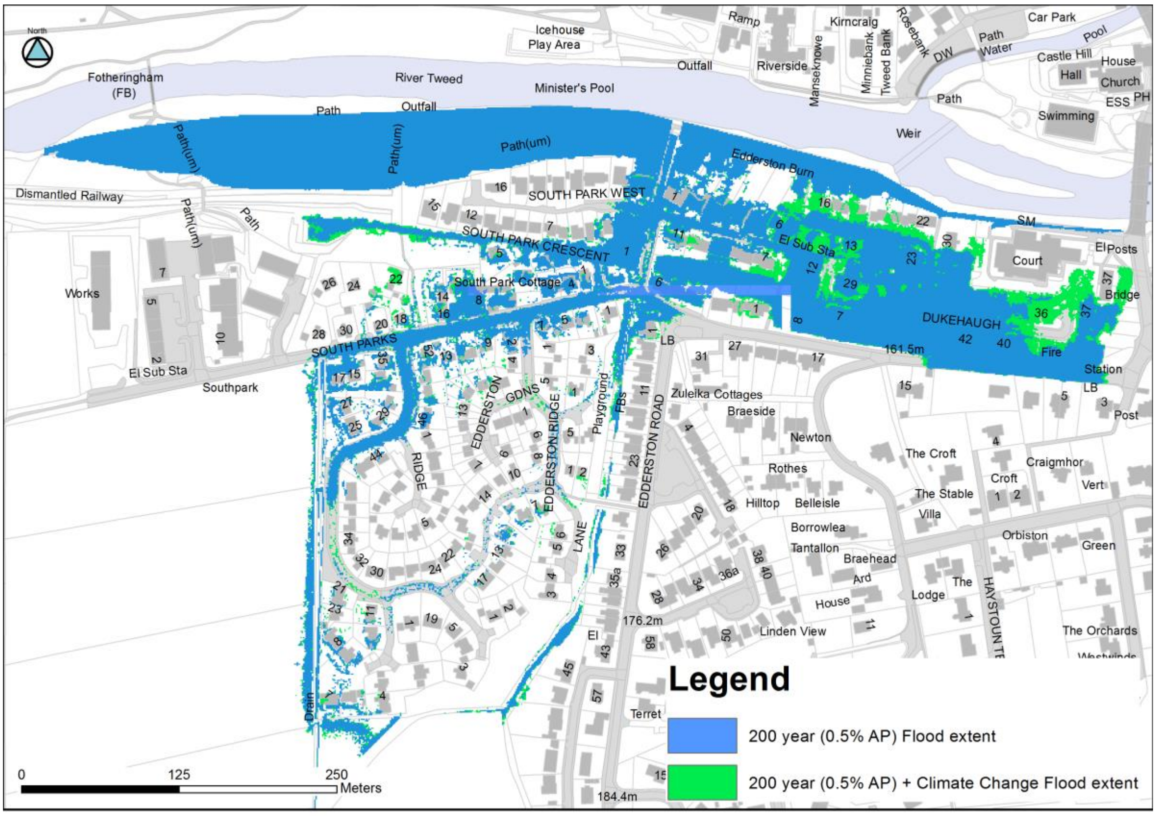


2.7.5 The effects of climate change on flood extents

Climate change is expected to increase the frequency of flood events. For South Parks, a 200 year flood event which has a 1 in 200 (0.5%) chance of occurring in any one year at the present time could, under a climate change scenario, occur at the same magnitude but with a 1 in 100 (1%) chance of occurring in any one year in the future. For the Edderston Burn, a 650 year event which has a 1 in 650 (0.15%) chance of occurring in any one year at the present time could, under a climate change scenario, occur at the same magnitude but with a 1 in 200 change of occurring in any one year 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 2-4 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 are not as significant as expected, there is only a slightly enlarged flood extent and flood depths are only marginally increased in many places, peak water level increase is in the region of 0.15m. The most noticeable increase is in the in the Dukehaugh estate.

Figure 2-4: 0.5% AP (200 year) flood outlines with and without a 33% allowance for climate



3 Appraisal approach

3.1 Problem definition

There are 39 properties at risk from the Edderston Burn for the 200 year flood event. Flooding is estimated to begin at the 2 year return period under existing conditions.

3.1.1 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:

3.1.2 Do Nothing - Edderston 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 from year 0 in the appraisal.

There is a Flood Prevention Scheme on the Edderston Burn; as such the Council has a duty to maintain FPS assets and significant deterioration of assets is not applicable. No deterioration of assets is therefore assumed under the Do Nothing scenario.

Key structures that may influence flood mechanisms on the Edderston Burn relate to the presence of trash and security screens on culvert inlets. Whilst the Council has an inspection and maintenance regime for these (and water level sensors to warn of high flows), these will be prone to blockage under the Do Nothing scenario (as evidenced from the photos below). A 2/3rds blockage scenario has therefore been assumed.

Table 3-1: Key culvert screens in South Parks

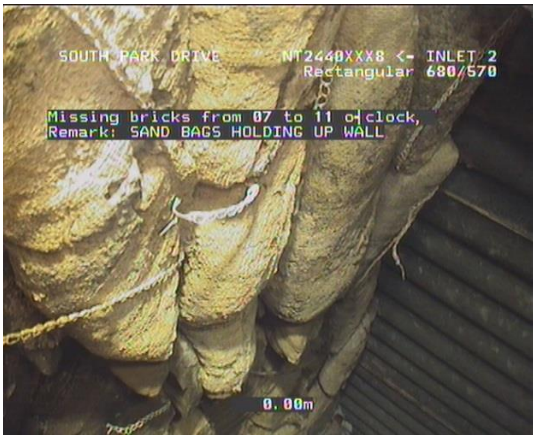
Screen on diversion channel	Screen upstream of South Parks (partially blocked)
	

CCTV surveys noted the following blockage:

- 10-15% on the South Park diversion channel culvert.
- 10% blockage on the western portion of the double culvert on the Edderston Burn.
- 30% blockage on the eastern portion of the double culvert on the Edderston Burn.

The above blockage percentages are recommended for the Do Nothing scenario with the exception of the eastern culvert of the double culvert on the Edderston Burn which is in need of maintenance and at risk of failure. As this culvert is not part of the FPS, the Do Nothing scenario assumed 100% blockage throughout the appraisal period.

Table 3-2: Condition of South Parks' culvert

Failure of culvert wall	Failure of culvert roof
	

3.1.3 Do Minimum - Edderston 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. Screens may still block and are modelled as 1/3rd blocked. No bridge blockage is assumed and the culverts are blocked as per the Do Nothing scenario.

The failing culvert on the Edderston Burn is assumed to be repaired and blocked to 30%; representing a base sediment load as shown by the recent CCTV survey. Even if, as part of the repair work the sediment was removed the assumption is that this would build back up to the level shown in the current CCTV survey.

3.2 Aims of investment appraisal

The aim of the investment appraisal is to identify the properties that are most at risk, identify the flood mechanism, the damage that results from flooding and the cost of partially or completely protecting against the ensuing flood damage. Critical infrastructure such as the Ambulance Centre should be given particular attention, it currently has a standard of protection of less than 200 years.

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) flood if possible, but to test lower return period events if appropriate.

Based on the fact that 0.2% AP floods (1 in 50 year) have been witnessed recently on the River Tweed 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 1:33% AP (75 year) 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. These 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

Table 4-1: Short term structural recommendations and quick wins for the Edderston Burn

Problem	Actions	Photo
Immediately downstream of the concrete diversion structure the right bank is very low. This allows flows that should be contained within the diversion channel to flow back into the into the Edderston Burn. Whilst the Council has a duty to maintain this structure, the impact of any repair should be investigated prior to the work being carried out. Possible for debris to collect in diversion structure channel	Investigate and repair. Monitor and maintain diversion structure channel.	 ***Diversion structure***
Undersized bridges cause water to back up and overtop the bank during high flows. Vegetation caught in fence opening causing partial blockage.	As a first stage the fence should be removed. There are several of these small bridges/culverts that are now obsolete or act as garden features. Wherever possible, these should be removed. At a minimum the following bridges/culverts need to be removed for implementation of the options: The two bridges on the diversion structure and the 2 garden bridges that are closest to the culvert under South Parks on the Edderston Burn.	 ***Culvert outlet with vegetation caught in fence partially blocking the opening***

Problem	Actions	Photo
Channel heavily overgrown with vegetation. Garden cuttings dumped into diversion channel, could cause blockage during high flows.	General vegetation maintenance and consider warning notice for prevention of garden waste dumping. Monitor condition of watercourse.	 ***Garden cuttings dumped in diversion channel***
The current screens are both undersized and hard to access for cleaning. Additionally the wingwalls on the Diversion channel need to be extended so that there is a tie in with the existing earth embankment	Redesign culvert screen and wingwalls so that they do not have a negative impact on flood risk and are easier to maintain.	 ***Debris screen and concrete headwall***
Garden weir significantly reduces the channel capacity at this point.	Weir needs to be removed for options to work	 ***Upstream of culvert into gardens of Edderston Road***

Problem	Actions	Photo
Edderston Burn Culvert is in need of maintenance. Damage to roof of culvert. Culvert partially blocked with sediment and other debris. Sandbags holding up wall; significant infiltration and collapsing roof slates. Large blockage at outlet. Diversion channel culvert partially silted.	Repair or replace sandbag wall; rectify collapsing roof; clear debris and remove blockage.	 ***Sandbags holding up wall***  ***Broken roof slates***  ***Roof slates missing***

4.4 Non-structural flood risk management recommendations

4.4.1 Flood warning

The Edderston Burn does not benefit from a flood forecasting system to warn the residents of an impending flood. Sufficient warning and forecasting on such a small catchment is unlikely to be possible due to the limited lead time between rain falling and high flows in the burns.

A gauge is installed on the both the diversion channel culvert and the South Parks Edderston Burn culvert inlet. These system records the level within the culvert and continuously monitors river levels. At present, when the water level reaches a predefined level this system is set up to issue text messages to alert SBC employees signed up to the system. Including the neighbourhood services foreman who checks the grille/trash screen and clears it as required. No residents are currently alerted by the alert system. If it is desired by the community it may be possible for these systems to warn the public directly; for example, community leads, a flood action group or all those in the community who are interested.

SEPA should be kept informed of any such development in flood warning on the Edderston Burn and should also be consulted on the suitability and current research for warning on such a small catchment. The hydrometric teams should also be consulted on supporting the addition of new gauging sites on the burn (this would assist both future hydrological analysis and forecasting calibration).

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 others 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. The Council's emergency action plan[3] defines the process of how warnings issued from the Met Office and SEPA are to be disseminated to the public and the preparation of an appropriate responses to such warnings. It is recommended, if it has not already been done, that the Action Plan 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).

It is recommended that the information produced as part of this study is shared with the Fire Service and Scottish Ambulance Service so that their respective emergency plans and climate change risk assessments on these properties can be updated.

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. A Flood Action Group could assist with this awareness raising and resilience.

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

3 Named as the 'Flood Risk Management Emergency Actions, Key Locations & Check List Information' document

Peebles, which South Parks is part of. As an ongoing action, Scottish Borders Council will continue to work closely with this 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 associate 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 sand bag stores

Scottish Borders Council continues to use community sandbag stores located at publicly accessible areas including fire stations and school grounds - the community sandbag store at the fire station in Peebles holds 300 bags. Resilient Communities sandbag stores are now widely distributed across the Scottish Borders in areas that have signed up to the Resilient Communities Initiative - this includes Peebles which holds an estimated 100 sandbags at its resilient community store. The Council should consider moving the location of the sand bag store in Peebles. The Fire Station, whilst not at risk of flooding, is surrounded by water for the 200 year flood event on the Edderston Burn which could hinder access when trying to collect sandbags.

As an alternative, it is recommended that the Council considers the use of the flood 'pod' system. 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. 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 South Parks due to the short lead times. This approach would need to be combined with the above flood warning and flood awareness campaign.

4.4.5 Property level protection (PLP)

The Council already have in place a subsided PLP scheme which assists at risk home owners to purchase PLP for their property. No one in South Parks has yet utilised this scheme. PLP could be implemented as a full FPS and be managed by the Council. PLP is discussed as an option in its own right later in this report.

4.4.6 Natural Flood Management

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. In the Edderston Burn catchment, there are many opportunities for Natural Flood Management. A growing body of evidence suggests that careful introduction of NFM measures may allow for reduced river flows in some cases. The greatest benefits are thought be gained for communities suffering from flooding directly from a small watercourse, such as the Edderston Burn. NFM measures which include woodland planting have a larger impact on flood risk reduction as they mature, woodland in excess of 50 years has a soil hydraulic conductivity four times higher than grassland[4]. Whilst the evidence for influence of NFM on flood flows is growing, the impact on larger flows at this stage appears minimal. Mature NFM measures may help to some extent to counteract climate change increases for the more frequent flows. 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

Within the upper catchment of the Edderston Burn, there is potential to create a wetland south of the boundary wall to increase upper catchment storage and delay runoff. Increasing the area of riparian vegetation along all tributaries within the catchment is recommended as well as implementing 5m buffer strips along the eastern tributary, Figure 4-1. Debris dams should be considered along the natural tributaries to slow flow and encourage pooling. To reduce the volume of runoff from the roads, roadside and riparian vegetation should be increased.

4 Natural flood management - an Ecosystem based Adaptation response for climate change - Iacob, Oana - 2015

Downstream in the east of the catchment, the land is ploughed and gently undulating. Runoff is conveyed straight toward the eastern tributary that runs along the roadside. Riparian vegetation was limited, the channel is straight in form and confined by a wall running parallel to the roadside, Fencing along the burn acts as an instream barrier. Buffer strips, meandering and in-stream woody debris dams are suggested NFM measures in this area. The road leading south to the main junction with the Edderston Road is very steep and evidence of surface runoff directly from the road to the burn was evident in a number of locations. Additionally, roadside drainage ditches along the road heading west toward Edderston Farmhouse were directing surface water toward the Edderston Burn at the junction corner.

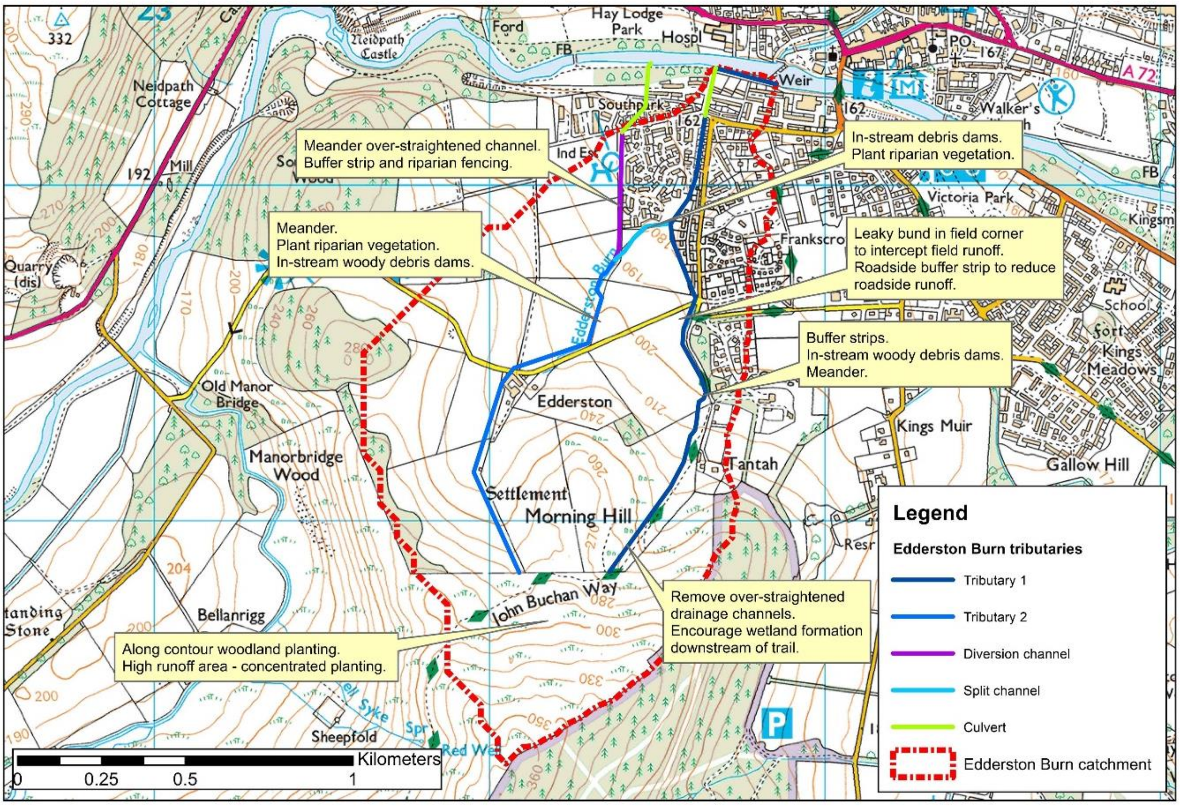
The lower catchment is defined as the area north of the Edderston Road junction toward the town of Peebles. The lower catchment to the west of the diversion channel is grazing land. Along the length of the diversion channel a fence separates the grazed land from the watercourse allowing riparian vegetation to develop but this strip of land is narrow. The diversion channel is straightened and runs in very close proximity to the houses. A NFM recommendation is to increase the area of riparian buffer zone and meander the diversion channel. In contrast the split channel meanders more naturally through the agricultural land only becoming straightened and confined when it joins the eastern tributary and enters South Parks where it becomes confined as it runs through a number of private properties towards the culverted section of watercourse.

A number of NFM options to reduce catchment runoff, increase storage and improve watercourse conditions were identified.

- Block or meander highly straightened overland drainage channels in the upper catchment which direct runoff rapidly towards the lower catchment.
- Potential for wetland creation in the upper catchment south of the boundary wall to increase upper-catchment storage and delay runoff.
- Increase the area of riparian vegetation along all tributaries within the catchment but particularly along eastern tributary in the upper catchment where it runs parallel to the road, and along the diversion channel in the lower catchment. 5 m buffer strips with riparian fencing would be recommended.
- Reduce the volume of runoff from the road north of the Edderston Road junction by increasing roadside and burn riparian vegetation.
- Consider implementing debris dams along the natural tributaries to slow flow and encourage pooling.

Meander sections of the Edderston Burn within the rural areas of the upper catchment.

Figure 4-1: Edderston Burn NFM opportunities



4.4.7 Burden reduction on sewer network

Surface water has not been identified as posing a significant flood risk. The town is cut off from surface water flows coming down from the surrounding hills by the Edderston Burn and its diversion channel. Each of the shortlisted schemes, with the exception of the PLP option, reduce the burden on the sewer network within South Parks during times of flood by keeping flood water out of Edderston's urban area.

Scottish Borders Council are undertaking a South Peebles Flood Study to investigate the impacts of surface water on the south side of Peebles. This is a drainage study which will identify options to mitigate the worst of the surface water flooding and impacts behind any proposed defences.

4.5 Long list of options

The following table provides an overview of potential flood alleviation options targeting flood risk to South Parks from the Edderston Burn. 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.

Table 4-2: Long list of options

Measure	Discussion
Relocation	**Technical**: Relocation or abandonment of properties not politically or socially viable. 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 the Edderston Burn but is already operational for flooding from the River Tweed. Properties shown to be affected from flooding from the River Tweed should sign up to the flood warning alerts if they have not already done so. Information can be found on the SEPA website or directly from Floodline. For implementation of this option for flooding from the Edderston Burn, this option would require gauge installation and monitoring. There is a manual level gauge attached to

Measure	Discussion
	the diversion channel culvert at South Parks. See section 4.4.1 for more details. **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. Out of 39 properties at risk only 1 suffers from flooding to a depth above 600mm for 200 year Do Minimum event in South Parks (this is inclusive of commercial properties.) which makes South Parks a very suitable location for PLP. See Figure 4-2 for a map of suitable properties. **Environmental**: No significant environmental or RBMP benefits or impacts. **Constraints**: Will need widespread public acceptance in South Parks to be a real option. May face resistance by the community if it is the only flood protection measure. **Decision: 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 and unlikely to be economically viable. **Decision: Option discounted**
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. If the current maintenance schedule is not continued flood risk and flood damages shall increase. **Environmental**: Channel maintenance may have minor negative impacts if spawning areas disrupted but these are unlikely to be significant. **Constraints**: Possible stretching of council resources if further inspection / maintenance is proposed. **Decision: Option to be taken forward alongside other options**
Natural Flood Management (NFM)	Natural Flood Management options have been assessed as a standalone report, while NFM is not seen as an option in itself, NFM could be implemented with any option to have a positive effect. **Decision: Option to be taken forward alongside other options**
Storage	**Technical: A** simple online storage model was tested. The storage was located at the confluence of the eastern and western branch of the Edderston Burn. It assumes that the bypass channel is not utilised. It was tested for 0.5% AP (200 year) event. A 6.6m high reservoir, located in channel valley, can attenuate the 0.5% AP (200 year) year flow event to the 50% AP (2 year) equivalent flood event. The wall height at street level, which forms the side walls to the reservoir, are approximately 1.3m high. A freeboard of 0.9m has been applied to the walls which is a requirement for reservoirs holding over 10,000m^3. If the reservoir was designed to hold less than this then a freeboard closer to 600mm would likely be acceptable.. See section 4.7.2 and drawing AEM-JBAU-PB-EB-SK-C-1500-Opt2_200Yr_Onli_Strg_Atten-S3-P01 for more details. **Environmental**: Large scale construction in the watercourse with a structure that would impede movement of creatures and sediment unless carefully designed. **Constraints:** Land ownership constraints likely to be encountered. Visual aesthetics may be an issue for some property owners overlooking the area. **Decision: Option taken forward**
Control structures	**Technical:** Several small bridges and long culverts contribute significantly to out of bank flooding in South Parks. Removing or increases the capacity of these structures can contribute to a significant improvement to flood risk to South Parks. Removing of the small bridges and culvert structures is a prerequisite to most of the proposed options. See section 0 to 4.7.5 **Environmental:** Low environmental impact. Overall neutral impact. The small bridges could be removed which would be returning the watercourse closer to a natural state. Culverts would need to be bypassed while they are being replaced, some disturbance

Measure	Discussion
	to wildlife. **Constraints:** Costly to lay new culverts, disruption to road access and residents. **Decision: Option to be taken forward alongside other options**
Demountable defences	**Technical:** 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. This option depends on an operating and reliable flood warning system which does not exist for Edderston Burn, the watercourse reaches a flood peak in less than 2 hours so it is unlikely that there would be sufficient time to deploy demountable defences even if a warning was issued. **Environmental:** No significant environmental or RBMP benefits or impacts although likely to be preferred from an environmental standpoint when compared to direct defences. **Constraints:** May face public opposition. **Decision: Option discounted**
Direct defences	**Technical:** In this case Direct defences include embankments, walls and adaptable walls. Direct defences may be spatially constrained in certain locations within South Parks, impacting on residents gardens. In some places it may be possible to increase embankment heights to increase standard of protection or to adapt to future climate change. 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. However, the wall heights required make this an unrealistic option unless they are used in combination with culvert upgrade or storage. For the direct defence option seepage analysis should be undertaken prior to detailed design **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**: No viable floodplain reconnection locations, however, localised channel widening has been shown to be effective. Care would be needed to grade the channel in such a way as to avoid sedimentation and high maintenance but water becomes bottle necked at the culverts so would need to be done in conjunction with a culvert upgrade. **Environmental**: A Habitats Regulations Appraisal would be necessary to identify whether dredging would pose a negative impact on the Edderston Burn, however only a relatively short length of channel widening is required. **Constraints**: Channel bank reinforcement would likely to be required and channel cross section regrading. **Decision: Option carried forward**
Diversion	**Technical**: The natural topography would allow for the creation of a diversion channel on the western branch of the Edderston Burn. This could follow the contour along the agricultural field to enter the River Tweed at the western end of South Parks Road. This can be achieved through making modifications to an existing manmade concrete pond to the north of the unnamed road that turns into Morning Hill. It is likely that the 200 year flow at this point could be reduced to the 2 year flow in the Edderston Burn by diverting the water to into a swale. The swale would have a top width of 14 m, a bottom width of 4 m with gentle side slopes of 1:5. Near the lower end of this new swale a rock ramp is recommended to safely convey the flood down a steep incline without erosion. Because this secondary diversion is located higher up in the catchment it can only capture and divert some of the western tributary water. The eastern tributary flow will not be reduced. See section 4.7.6 and drawing AEM-JBAU-PB-EB-SK-C-1402-Opt4_200Yr_Pt_Byp_Ch_Stor-S3-P01 for more detail. **Environmental**: May remove other valuable habitats in the short term but if bypass was naturalised then could provide RBMP benefits. **Constraints**: Requires landowner permission and cooperation required. **Decision: Option carried forward**
Bridge and Weir modification	**Technical**: A small weir to the south of the South Parks Culvert is having a negative effect on flood risk. The crest of this weir is to be lowered, or the weir could be removed all together. Bridge removal discussed in control structure option. This is a quick win and should be done as soon as possible. See drawing AEM-JBAU-PB-EB-

Measure	Discussion
	SK-C-1600-General_Require_All_Opts-S3-P01 for further details. **Environmental**: Potential small improvement in RMBP impacts if weir is removed. **Constraints**: Owner of weir which is a garden feature is unlikely to look favourably on this option. **Decision: Option taken forward**

4.6 Short list of options

Watercourse maintenance and NFM shall be implemented to some extent with all short-listed options. The following options have been short listed:

- Property Level Protection (PLP),
- Online flood storage,
- Culvert upgrade with channel deepening,
- Culvert upgrade with channel widening,
- Culvert upgrade with direct defences and
- Secondary diversion channel

Each option should be undertaken alongside non-structural options such as flood warning, emergency planning and by working closely with local flood groups to increase preparedness/resilience.

4.6.1 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.

If climate change is to be accounted for then additional measures will be needed. For example, additional properties will need PLP, at some properties PLP may no longer be effective for the larger events. The online storage will need to have a greater storage capacity. Channel widening will need to be larger and the diversion channel will have to be larger. This is discussed further in each option below.

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.

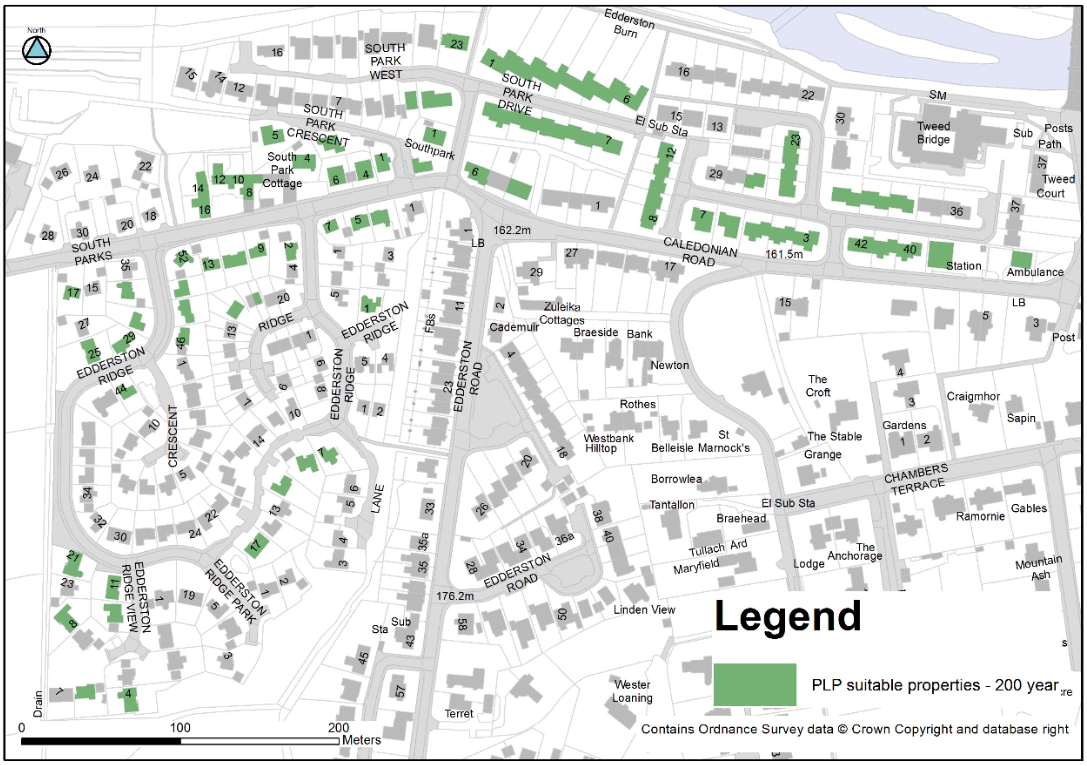
4.7 Flood Mitigation Options - South Parks

The following section details the constraints and benefits of the shortlisted options for the Edderston Burn. A plan is included which shows the location, extents and the area benefiting for the various interventions.

4.7.1 Option 1 - Property Level Protection (PLP)

Option 1 - Property Level Protection (PLP)
Description This option aims to provide an increase in standard of protection for all properties where relevant by protecting properties 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 that could benefit from from PLP is 38. This is the number of properties where the 0.5% AP (200 year) flood level is at or above the properties finished floor level. An additional 44 properties whose water level is within 0.3m of the finished floor level i.e. where water could get into the subfloor of the building. The Figure below shows the total number of properties who could benefit from PLP Figure 4-2: Properties who could benefit from PLP for the 0.5% AP(200 year) flood

event



Standard of Protection (SOP)

Modelling suggests that PLP will protect all bar 1 property in South Parks up to the 200 year flood event.

Alternative quick wins / Preliminary investigations

In some cases minor modifications to the grounds of the property, i.e. a raised lip on the driveway may be enough to deflect flows away from the property.

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. Conversely some minor changes may be enough to protect the property without the need for PLP specific products.

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.

Environmental issues

None

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

None.

Additional information required

- A property threshold survey (if not already present).
- 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.

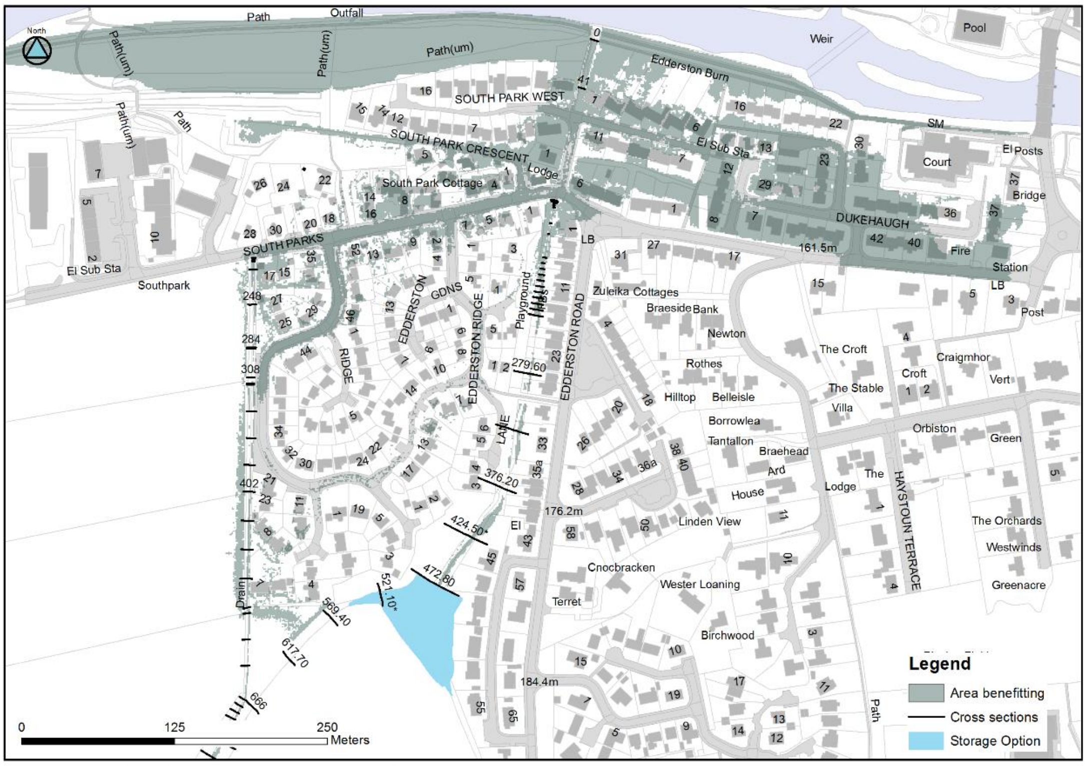
4.7.2 Option 2 - Storage of flood water at tributary confluence.

Option 2 - Storage of flood water at tributary confluence

Description

The local topography along the Edderston Burn lends itself to easy installation of flood storage. The single most suitable location is at the confluence of the eastern and western branch of the Edderston Burn. It captures flow from both tributaries and it assumes that the bypass channel is not utilised. A 6.6 m high reservoir, located in channel valley, can reduce the 200 year flow event to an equivalent 2 year flood. The online storage side walls shall be less than 1.3m above top of bank ground level. However, the flood outline and side walls will impact on the gardens of several properties on the right bank of the eastern Tributary along Edderston Road. This option is presented in further detail in drawing " AEM-JBAU-PB-EB-SK-C-1500-Opt2_200Yr_Onli_Strg_Atten-S".

Figure 4-3: Benefit map for 200 year Flood Storage Option



Standard of Protection (SOP)

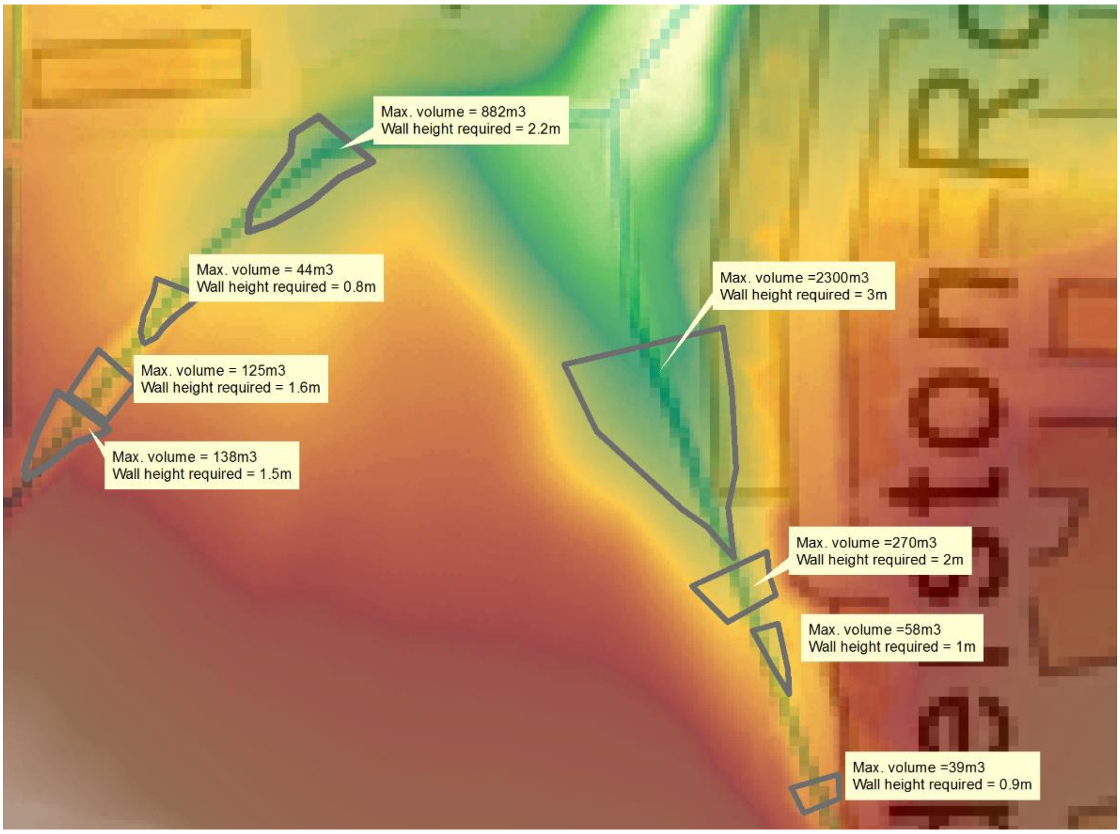
Modelling of the above option suggests that a standard of protection of a 0.5% AP (200 year) flood is achievable.

Alternative approach

A series of smaller storage areas further up the catchment were considered. Figure 4-4 below shows the alternative locations where smaller reservoirs could be built. Their height and approximate volume. The total volume is approximately 3,800 m^3, which is less than 40% of what is needed.

Alternatively, the large reservoir could have a reduced peak storage level if the hill to the south west was excavated. This ground is anticipated to have a good proportion of clay in it which would make it useful for building this online storage or for embankments elsewhere in Peebles.

Figure 4-4: Multiple small storage areas



Geotechnical issues

A review of available BGS borehole logs and mapping of superficial deposits indicates that most of the works are likely to be constructed on sandy or gravelly alluvial deposits. Further details provided in BGS review drawing; AEM-JBAU-PB-00-SK-C-1002-Operations_Schematic--P01.02.

Assumptions

- 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.
- Walls. A 1.25m deep x 0.5m wide mass concrete filled trench cut-off is included under walls for costing purposes.
- Dam Wall: Piled foundations have been assumed for the construction of the dam wall, for costing purposes. Alternatively, the online storage wall could be an earth embankment.

Services

Overhead and underground services have been identified and their location is shown on drawing AEM-JBAU-PB-EB-SK-C-1004-EB_Service_Plan.

Construction access

Construction access to the online storage will be possible through the fields off the unnamed road, west of Morning Hill.

Waste

According to SEPA regulations, before excavation the soil will be assessed for suitability to be classified as greenfield soil and the end-use of the soil will be identified. Soil must be of undeveloped, uncontaminated land, agricultural and forestry land or uncontaminated overburden from mining and quarries and can include vegetation i.e. grass, turf, mulch and leaf debris, but not tree stumps. The soil could be used to another development for engineering works as per the planning permission, in development on brownfield land to meet site-specific capping requirements for remediation, in SUDS and in the construction of roads and verges. A planning permission specifying the volumes of greenfield soil excavated is required.

- Expected quantity of waste material: Minimal
- Nature (inert, non-hazardous, hazardous): It is known that very limited industry was present in Peebles – soil expected to be inert. No potential land contamination constraints identified.
- Proposed disposal: According to SEPA guidance

Environmental issues

- Statutory Environmental Designations (SSSI, SPA, SAC, Ramsar Sites Nature Reserves, INNS). River Tweed is a designated site of special scientific interest (SSSI).
- The area south of South Parks and approximately 30m west of Edderston Road and extending to the East, is part of Peebles Conservation Area. It also includes the right bank of River Tweed.
- Habitat: The proposed storage is located in an area of improved grassland and young woodland to the south of Edderston Ridge Park and also covers the edges of gardens of properties on Edderston Road with trees. Detailed design to consider moving dam to be located entirely within the grassland habitat to preserve the more valuable ecological areas and residential gardens.
- Additional surveys / assessments may be required for bats (for works affecting trees, walls, built structures and culverts), otter, badger, breeding birds (including breeding waders), hydromorphology, fish and water flow.
- Upland storage issue may offer opportunities for biodiversity enhancements and creation of wetland habitat for waders and wildfowl.
- Consultation required with SNH and SEPA.

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 mitigating to a more frequent flood event. The online storage will be empty for the majority of the time, so the large retaining wall or embankment will be visible.

Impact on other reaches

The flow into the river Tweed during times of flood shall be throttled. This will mean there will a much lower peak flow rate but it will be maintained for a much longer time. This may have some minor benefit for flood relief on the Tweed if the peak of the flood event coincided with at that of the Edderston Burn, however given the difference in scale of the two catchments the impact on the River Tweed will be negligible.

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

For the online storage option there are several possible adaptations to be made:

- Increase storage capacity by raising wall heights or excavating ground.
- Install an adjustable flow control to allow a larger pass forward rate
- Decrease the flow entering the reservoir

Increased storage capacity

This could be achieved by digging out the hill that bounds the southern extent of the reservoir. This may be a feasible solution especially if the soil dug from here could be used in the construction of flood embankments along the Tweed. The wall height on the reservoir is already close to eye level from street level, an increase in wall height to account for climate change is approximately 1.1m, so a further increase in wall height to accommodate flow is not recommended.

Install an adjustable flow control to allow a larger pass forward rate

By building in an adjustable orifice, the pass forward flow could be increased in the future. Currently if a larger flow was allowed through the reservoir then some flooding would occur. However, the impact would be far less than if the reservoir was not there, for example, it would decrease the 200 year flow to the 30 year flow. The existing culvert on the Edderston Burn is nearing the end of it useful life, in the future this culvert could be replaced with a larger one, this accompanied by some minor banks works would be enough to allow the reservoir to protect to the 200 year plus climate change event.

Utilise the existing Diversion Channel to reduce flow into the reservoir

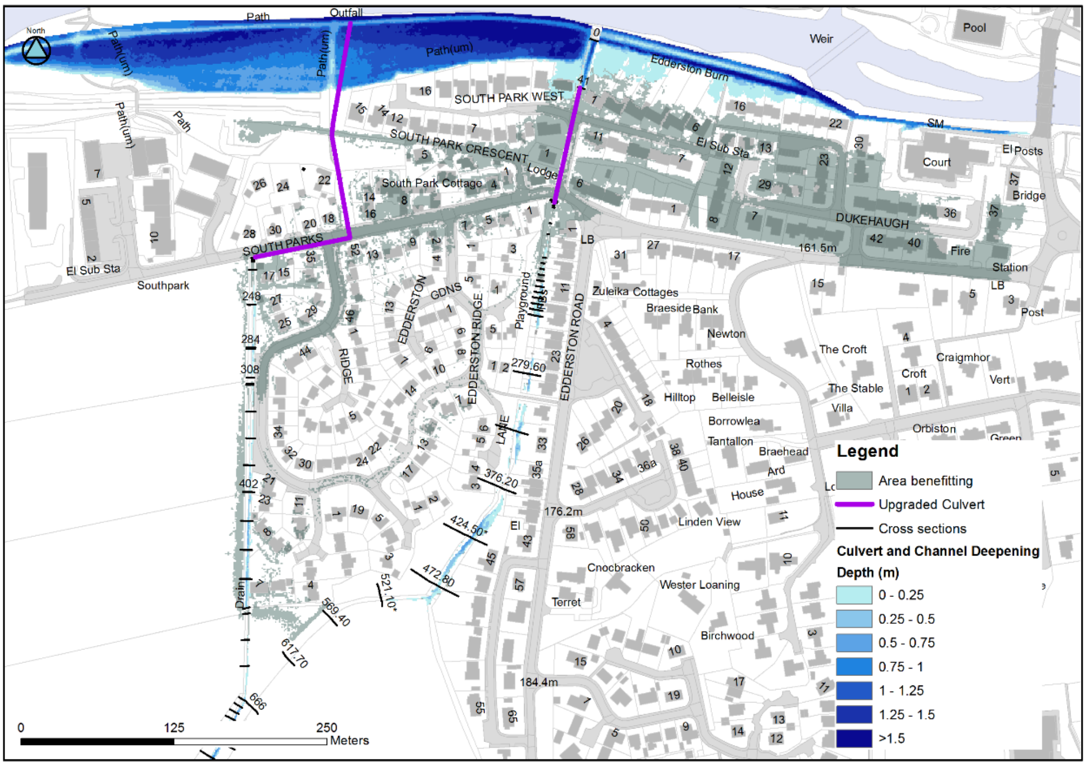
The online storage design assumes the existing Diversion Channel shall be abandoned. If instead the Diversion Channel was reinstated then this would contribute greatly to reducing the effects of increased flow into the reservoir as a result of climate change. This has not been modelled but assuming the diversion structure was redesigned then, the increase in flow due to climate change 1.25m^3/s and the Diversion Channel capacity with only Quick Wins improvements is 1.17 m^3/s.

Of course, a combination of the above options could be implemented. Regardless of the chosen option NFM should be integrated into the scheme. The NFM measures recommended takes place throughout the catchment. NFM, when implemented correctly, shall have a positive effect on flood flows, helping the soil to absorb more water, slow the flow of water into the watercourse and create more open water bodies on the land and may help to mitigate against the increase in frequent flood flows from climate change.

4.7.3 Option 3a - Culvert enlargement with channel deepening

Option 3a - Culvert enlargement with channel deepening
Description When the conveyance of the watercourses are improved the culverts become a choke point for flows. The culverts reach capacity and flood water overtops the banks. To overcome this the culverts are to be increased in size to cater for the 200 year plus climate change flood event. The channel conveyance shall be increased by deepening the channel. The Diversion Channel culvert shall be replaced with a 1350mm diameter culvert. This culvert currently runs under a housing estate, to avoid disturbance to these properties the culvert is to be realigned to avoid these properties. The length of the new Diversion culvert is approximately 257m. The existing culvert could be capped with the option of reopening in the future if required. The channel shall be deepened to a maximum depth of 1.1m at the culvert inlet and tie back into the existing bed level approximately 40m upstream. Edderston Burn culvert upgrade shall be 1.8m wide by 1m high, the banks upstream shall be raised very slightly. The channel bed shall be lowered to a maximum depth of 0.56m at the culvert inlet and tie back into the existing bed level 70m upstream. This option is presented in further detail in drawing " AEM-JBAU-PB-EB-SK-C-1304-Opt3A_200+CC_Cul_Bed_Rep-S3-P01"

Figure 4-5: Culvert upgrade with channel deepening



Standard of Protection (SOP)

Modelling suggests that this option will protect all properties to the 200 year flood event.

Alternative quick wins / Preliminary investigations

Removal of small bridges and garden weir will be complimentary to this option.

Geotechnical issues

A review of available BGS borehole logs and mapping of superficial deposits indicates that most of the works are likely to be constructed on sandy or gravelly alluvial deposits. Further details are provided in the BGS review drawing: BGS Data Reference; AEM-JBAU-PB-00-SK-C-1002-Operations_Schematic--P01.02.

Assumptions:

- 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.
- Walls. A 1.25m deep x 0.5m wide mass concrete filled trench cut-off is included under walls for costing purposes

Services

Overhead and underground services have been identified and their location is shown on drawing AEM-JBAU-PB-EB-SK-C-1004-EB_Service_Plan.

Storm water sewer along the proposed culvert, Water Main close to the proposed culvert,

- Storm water sewer also present close to proposed bed lowering at Edderston Burn.

Construction issues

- Construction access to all proposed defences will be via South Parks.
- Proposed option intersects the route of the historic railway.

Waste

According to SEPA regulations, before excavation the soil will be assessed for suitability to be classified as greenfield soil and the end-use of the soil will be identified. Soil must be of undeveloped, uncontaminated land, agricultural and forestry land or uncontaminated overburden from mining and quarries and can include vegetation i.e. grass, turf, mulch and leaf debris, but not tree stumps. The soil could be used to another development for engineering works as per the planning permission, in development on brownfield land to meet site-specific capping requirements for remediation, in SUDS and in the construction of roads and verges. A planning permission specifying the volumes of greenfield soil excavated is required.

- Expected quantity of waste material: Approximately 265m^3.
- Nature (inert, non-hazardous, hazardous): limited industry was present in the area of Peebles designated for this option – soil expected to be inert. No potential land contamination constraints identified.
- Detailed design to take cognisance of historical railway line
- Proposed disposal: According to SEPA guidance.

Environmental issues

- Statutory Environmental Designations (SSSI, SPA, SAC, Ramsar Sites Nature Reserves, INNS). River Tweed is a designated site of special scientific interest (SSSI). The area south of South Parks and approximately 30m west of Edderston Road and extending to the East, is a Conservation Area. It also includes the right bank of River Tweed.
- Habitat: The area north of South Parks and west of the proposed culvert (South Park Woods) is identified as National Forest Inventory and is a Scottish Wildlife Trust Local Wildlife Site. There is amenity grassland within the area of the proposed defences. Impact of construction on these areas to be assessed at detailed design.
- Additional surveys / assessments may be required for bats (for works affecting trees, walls, built structures and culverts), otter, badger, breeding birds (including breeding waders), hydromorphology, fish and water flow.
- Consultation required with SNH and SEPA.

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

During construction road access will be restricted.

Impact on other reaches

Negligible effect on the River Tweed.

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

The culvert has been sized to accommodate the 200 year plus climate change event, therefore only an increase in channel conveyance is required. This could be achieved by channel widening or raising embankments or walls as required. Channel widening is generally an easy form of adaptation, otherwise walls could be built now that will allow for future raising at a later date.

4.7.4 Option 3b - Culvert enlargement with channel widening

Option 3b - Culvert enlargement with channel widening
Description This option applies the same culvert upgrade as Option 3a but replaces the channel deepening with channel widening. The Edderston Burn shall be widened by 2.5 m into the left bank for a length of approximately 45 m upstream of the culvert inlet. The Diversion Channel shall be increased by 3m into the left bank for approximately 100m upstream of the culvert inlet.. This option is presented in further detail in drawing " AEM-JBAU-PB-EB-SK-C-1305-Opt3B_200Yr_Cul_Chnl_Reprf-S3-P01".

Figure 4-6: Culvert upgrade with channel deepening

Standard of Protection (SOP)

Modelling suggests that this option will protect all properties to the 200 year event.

Alternative quick wins / Preliminary investigations

Removal of small bridges and garden weir will be complimentary to this option.

Geotechnical issues

A review of available BGS borehole logs and mapping of superficial deposits indicates that most of the works are likely to be constructed on sandy or gravelly alluvial deposits. Further information provided in BGS Data Reference; AEM-JBAU-PB-00-SK-C-1002-Operations_Schematic-P01.02.

A full GI will be required at a later stage in the project.

Services

Overhead and underground services have been identified and their location is shown on drawing AEM-JBAU-PB-EB-SK-C-1004-EB_Service_Plan.

Storm water sewer along the proposed culvert, Water Main close to the proposed culvert.

Construction access

- Construction access to all proposed defences via South Parks.
- Proposed option intersects the area where the railway was historically located

Waste

According to SEPA regulations, before excavation the soil will be assessed for suitability to be classified as greenfield soil and the end-use of the soil will be identified. Soil must be of undeveloped, uncontaminated land, agricultural and forestry land or uncontaminated overburden from mining and quarries and can include vegetation i.e. grass, turf, mulch and leaf debris, but not tree stumps. The soil could be used to another development for engineering works as per the planning permission, in development on brownfield land to meet site-specific capping requirements for remediation, in SUDS and in the construction of roads and verges. A planning permission specifying the volumes of greenfield soil excavated is required.

- Expected quantity of waste material: Approximately 400m^3.
- Nature (inert, non-hazardous, hazardous): It is known that very limited industry was present

in Peebles – soil expected to be inert. No potential land contamination constraints identified

- Proposed disposal: According to SEPA guidance.

Environmental issues

- Statutory Environmental Designations (SSSI, SPA, SAC, Ramsar Sites Nature Reserves, INNS). River Tweed is a designated site of special scientific interest (SSSI). The area south of South Parks and approximately 30m west of Edderston Road and extending to the East, is a Conservation Area. It also includes the right bank of River Tweed.
- Habitat: The area north of South Parks and west of the proposed culvert (South Park Woods) is identified as National Forest Inventory and is a Scottish Wildlife Trust Local Wildlife Site. There is amenity grassland within the area of the proposed defences. Impact of construction on these areas to be assessed at detailed design.
- Additional surveys / assessments may be required for bats (for works affecting trees, walls, built structures and culverts), otter, badger, breeding birds (including breeding waders), hydromorphology, fish and water flow.
- Consultation required with SNH and SEPA.

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

During construction road access will be restricted.

Impact on other reaches

Negligible effect on the River Tweed.

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

The culvert has been sized to accommodate the 200 year plus climate change event, therefore only an increase in channel conveyance is required. This could be achieved by channel widening or raising embankments or walls as required.

4.7.5 Option 3c - Culvert enlargement with direct defences

Option 3c - Culvert enlargement with direct defences

Description

The culvert upgrade shall be the same as per Option 3a and 3b. Instead of channel works the flood water shall be contained to the watercourse through the use of flood walls. The wall height requirement is small, coming to a height of 0.5m, which includes a 300mm freeboard. 2 lengths of wall are required on the right bank of the Diversion Channel, one for a length of 30m where Edderston Ridge runs parallel to the road, the other for a length of 25m on the right bank upstream of the culvert inlet. On the Edderston Burn, two low walls, 0.5m high for a length of 8m and 30m extending out form the upstream face of the culvert is required. This option is presented in further detail in drawing " AEM-JBAU-PB-EB-SK-C-1306-Opt3C_200Yr_New_Cul_&_DD-S3-P01"

Figure 4-7: Culvert upgrade with direct defences

Standard of Protection (SOP)

Modelling suggests that this option will protect all properties to the 200 year event.

Alternative quick wins / Preliminary investigations

Removal of small bridges and garden weir will be complimentary to this option.

Geotechnical issues

A review of available BGS borehole logs and mapping of superficial deposits indicates that most of the works are likely to be constructed on sandy or gravelly alluvial deposits. Further details are provided in the BGS review data AEM-JBAU-PB-00-SK-C-1002-Operations_Schematic--P01.02.

Assumptions

- 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.
- Walls. A 1.25m deep x 0.5m wide mass concrete filled trench cut-off is included under walls for costing purposes.

Services

Overhead and underground services have been identified and their location is shown on drawing AEM-JBAU-PB-EB-SK-C-1004-EB_Service_Plan.

Storm water sewer along the proposed culvert, Water Main close to the proposed culvert, Storm water sewer also present close to proposed Wall 2.

Construction access

- Construction access to most proposed defences via South Parks.
- Construction access to Wall 2 via Edderston Ridge
- Proposed option intersects the area where the railway was historically located - to be further considered at design stage

Waste

According to SEPA regulations, before excavation the soil will be assessed for suitability to be classified as greenfield soil and the end-use of the soil will be identified. Soil must be of undeveloped, uncontaminated land, agricultural and forestry land or uncontaminated overburden from mining and quarries and can include vegetation i.e. grass, turf, mulch and leaf debris, but not tree stumps. The soil could be used to another development for engineering works as per the planning permission, in development on brownfield land to meet site-specific capping requirements for remediation, in SUDS and in the construction of roads and verges. A planning permission specifying the volumes of greenfield soil excavated is required.

- Expected quantity of waste material: Approximately 190m^3.
- Nature (inert, non-hazardous, hazardous): It is known that very limited industry was present in Peebles – soil expected to be inert. No land contamination constraints identified.
- Proposed disposal: According to SEPA guidance.

Environmental issues

- Statutory Environmental Designations (SSSI, SPA, SAC, Ramsar Sites Nature Reserves, INNS). River Tweed is a designated site of special scientific interest (SSSI). The area south of South Parks and approximately 30m west of Edderston Road and extending to the East, is a Conservation Area. It also includes the right bank of River Tweed.
- Habitat: The area north of South Parks and west of the proposed culvert is identified as National Forest Inventory. There is amenity grassland within the area of the proposed defences
- Additional surveys / assessments may be required for bats (for works affecting trees, walls, built structures and culverts), otter, badger, breeding birds (including breeding waders), hydromorphology, fish and water flow.
- Consultation required with SNH and SEPA.
- Consideration to be taken of a historical mill pond adjacent to 17 Edderston Ridge which is understood to have been infilled.

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

During construction road access will be restricted.

Proposed direct defences lie on the boundary of the Peebles Conservation Area - detailed design to take account of the character and design of the area.

Impact on other reaches

Negligible effect on the River Tweed.

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

The culvert has been sized to accommodate the 200 year plus climate change event, therefore only an increase in channel conveyance is required. This could be achieved by channel widening or raising embankments or walls as required.

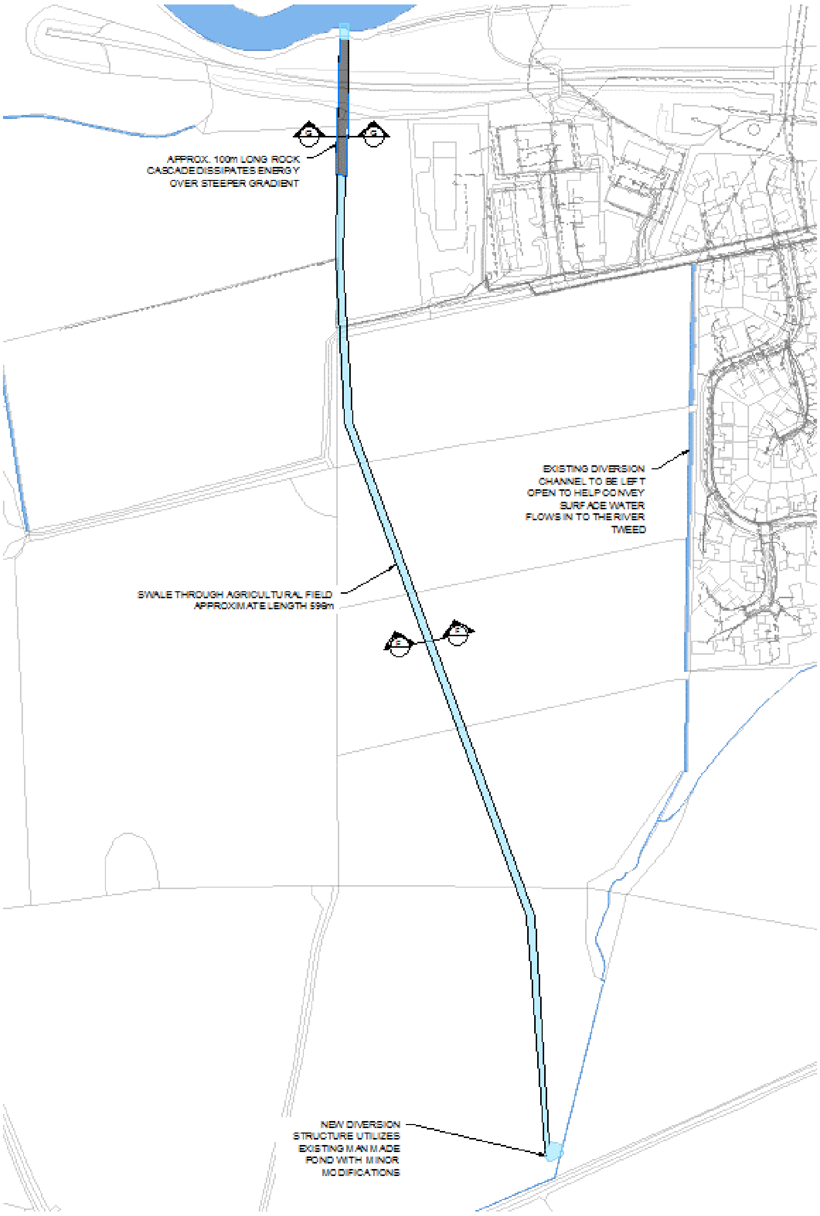
4.7.6 Option 4 - Secondary diversion channel

Option 4 - Diversion channel/swale

Description

The natural topography would allow for the creation of a diversion channel on the western branch of the Edderston Burn. This could follow the contour along the agricultural field to enter the River Tweed at the western end of South Parks Road and into the River Tweed. This can be achieved through making modifications to an existing manmade concrete pond to the north of the unnamed road that turns into Morning Hill. The 200 year flow at this point could be reduced to the 2 year flow by directing excess flow into this new Diversion Channel. The Diversion Channel would have a top width of 11 m, a bottom width of 2 m and a depth of 0.9m with gentle side slopes of 1:5. This is inclusive of a 300mm freeboard on the Diversion Channel. Near the lower end of this new diversion channel a rock ramp is recommended to safely convey flood waters down a steep incline without erosion. A small portion of water escapes from the Edderston Burn for the 200 year event as the flow from the eastern tributary has not been altered. This will affect two properties on South Parks but the flood water level not expected to be higher than the finished floor level of the properties. This option is presented in further detail in drawing " AEM-JBAU-PB-EB-SK-C-1402-Opt4_200Yr_Pt_Byp_Ch_Stor-S3-P01".

Figure 4-8: Secondary diversion channel



Standard of Protection (SOP)

Modelling suggests that this option will protect all bar two properties to the 200 year event. Modelling shows two properties effected will not experience flood water above their finished floor level.

Alternative quick wins / Preliminary investigations

Removal of small bridges and garden weir will be complimentary to this option.

Geotechnical issues

Buried services in the proposed area of defence have not been investigated. A full buried services investigation should be undertaken at the time of detailed design. Agreement with affected landowners.

Services

Overhead and underground services have been identified and their location is shown on drawing AEM-JBAU-PB-EB-SK-C-1004-EB_Service_Plan.

Construction access

Construction access to the bypass channel is via South Park and the unnamed road to the south of South Parks

Waste

According to SEPA regulations, before excavation the soil will be assessed for suitability to be classified as greenfield soil and the end-use of the soil will be identified. Soil must be of undeveloped, uncontaminated land, agricultural and forestry land or uncontaminated overburden from mining and quarries and can include vegetation i.e. grass, turf, mulch and leaf debris, but not tree stumps. The soil could be used to another development for engineering works as per the planning permission, in development on brownfield land to meet site-specific capping requirements for remediation, in SUDS and in the construction of roads and verges. A planning permission specifying the volumes of greenfield soil excavated is required.

Expected quantity of waste material: Minimal.

- Nature (inert, non-hazardous, hazardous): It is known that very limited industry was present in Peebles – soil expected to be inert. No potential land contamination constraints identified.
- Proposed disposal: According to SEPA guidance.

Environmental issues

- Depending on the final location of the secondary diversion channel the lower portion of it may pass through the South Park Wood Local Wildlife Site. The impact on this wood and possible mitigation measures will be assessed at detailed design stage. As an alternative route for this secondary diversion channel, an old channel which is feed from a spring could be utilised. This channel is marked on historic maps and runs along the edge of South Park Wood.
- Statutory Environmental Designations (SSSI, SPA, SAC, Ramsar Sites Nature Reserves, INNS). River Tweed is a designated site of special scientific interest (SSSI). The area south of South Parks and approximately 30m west of Edderston Road and extending to the East, is a Conservation Area. It also includes the right bank of the River Tweed.
- Habitat: The area north of South Parks and west of the proposed culvert is identified as National Forest Inventory. There is improved grassland in the area east of the proposed swale.
- Additional surveys / assessments may be required for bats (for works affecting trees, walls, built structures and culverts), otter, badger, breeding birds (including breeding waders), hydromorphology, fish and water flow.
- Consultation required with SNH and SEPA.

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

During construction road access will be restricted.

Impact on other reaches

Negligible effect on the River Tweed.

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

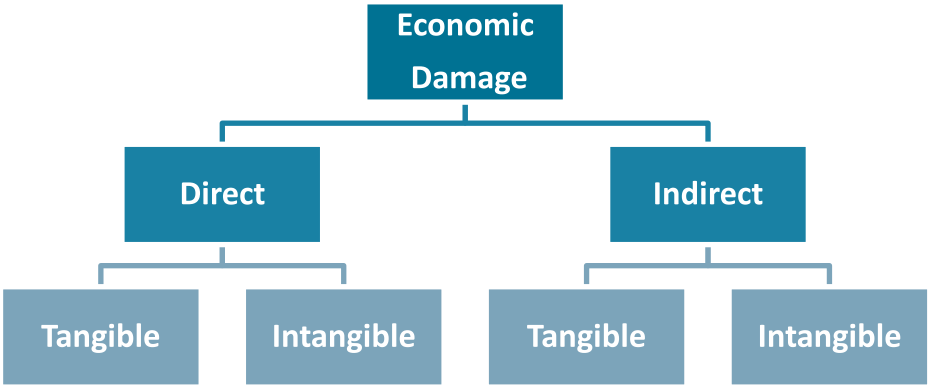
The Diversion Channel should be constructed to cater for the 200 year with climate change flow. With a 300mm freeboard this would revise the dimensions of the channel to a bottom width of 3.75m, a top width of 12.75 and a depth of 0.9m with side slopes of 1:5.

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, methodology and additional data used to calculate the flood damages is provided in Appendix A.

5.2 Flood damage results

Flood damage results for the Do Nothing and Do Minimum options are shown overleaf.

Do Nothing

Assumptions:

10% increase in Manning's 'n' roughness to channel, 2/3 blockage applied to culvert thrash screens. The Edderston Burn culvert is double barrelled and in poor condition, the right section was assumed to be 100% blocked.

Properties at risk:

The total number of properties inundated above threshold level for the "Do Nothing" Scenario in South Parks 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	0	7	20	22	22	23	26	29	36	39	47
Non-residential	0	0	0	0	0	0	0	0	1	1	1
Total	0	7	20	22	22	23	26	29	37	40	48

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 10 properties with highest flood damages from all sources are listed below.

Rank	Property address	Pvd (£k)	Percentage of total Pvd
1	1, SOUTH PARK WEST, EH45 9EF	287	11%
2	6, CALEY COTTAGES, CALEDONIAN ROAD, EH45 9DW	171	7%
2	10, DUKEHAUGH, EH45 9DN	171	7%
2	SOUTH PARK COTTAGE, SOUTH PARKS, EH45 9DS	171	7%
5	8, DUKEHAUGH, EH45 9DN	161	6%
6	6, SOUTH PARK DRIVE, EH45 9DR	155	6%
7	11, DUKEHAUGH, EH45 9DN	133	5%
8	12, DUKEHAUGH, EH45 9DN	132	5%
9	9, DUKEHAUGH, EH45 9DN	130	5%
10	2, SOUTH PARK WEST, EH45 9EF	119	5%

Event property damages:

JBA's damage calculation method provides event damages based on MCM depth damage curves. Full results are provided in Appendix A. 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	0	87	505	588	605	646	692	718	852	1,102	1,373
Non-residential	0	0	0	0	1	2	2	3	9	18	24
Total	0	87	505	588	606	648	695	720	861	1,120	1,397

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 loss probability 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.

Breakdown of damages:

A summary of the proportion of total damages by each damage component is provided in the table below. Total AAD's are converted to Present Value damages assuming a 100 year appraisal period and HM Treasury discount rates.

Do Nothing flood damages (£k):

Property AAD	Property PVd	Indirect PVd	Intangible PVd	Total PVd
110	3,116	174	77	3,367

Do Minimum

Assumptions:

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. The debris screens were modelled with a 33% blockage and one barrel of the double barrel culvert was blocked to 30%.

Properties at risk:

The total number of properties inundated above threshold level for the "Do Minimum" Scenario in South Parks 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	0	6	18	22	22	21	26	29	38	39	47
Non-residential	0	0	0	0	0	0	0	0	1	1	1
Total	0	6	18	22	22	21	26	29	39	40	48

Key beneficiaries:

The flood damages derived have been ranked (top 10) 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 properties in the "Do Minimum" scenario top ten are the same as those for the "Do Nothing" option, just reordered.

Rank	Property address	Pvd (£k)	Percentage of total Pvd
1	1, SOUTH PARK WEST, EH45 9EF	199	9%
2	6 CALEY COTTAGES, CALEDONIAN ROAD, EH45 9DW	171	8%
2	10, DUKEHAUGH, EH45 9DN	171	8%
2	SOUTH PARK COTTAGE, SOUTH PARKS, EH45 9DS	171	8%
5	8, DUKEHAUGH, EH45 9DN	155	7%
6	11, DUKEHAUGH, EH45 9DN	128	6%
7	12, DUKEHAUGH, EH45 9DN	127	6%
8	9, DUKEHAUGH, EH45 9DN	125	6%
9	6, SOUTH PARK DRIVE, EH45 9DR	120	6%
10	2, SOUTH PARK WEST, EH45 9EF	89	4%

Event property damages:

JBA's damage calculation method provides event damages based on MCM depth damage curves. Full results are provided in Appendix A. 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	0	40	278	572	591	625	692	714	871	1,131	1,385
Non-residential	0	0	0	0	0	2	2	3	8	18	24
Total	0	40	278	572	591	627	695	716	879	1,149	1,409

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 loss probability 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.

Breakdown of damages:

A summary of the proportion of total damages by each damage component is provided in the table below. Total AAD's are converted to Present Value damages assuming a 100 year appraisal period and HM Treasury discount rates.

Do Nothing flood damages (£k):

Property AAD	Property PVd	Indirect PVd	Intangible PVd	Total PVd
80	2,265	127	76	2,468

5.2.1 Options

The flood damages for each option were calculated for each return period event up to the 1000 year flood 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 level of damages avoided as a result of the option, also known as the benefit of the option.

In line with current guidance[5] 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. Option 2 to Option 6 protects against approximately 100% of the total damage experienced in the Do Nothing scenario up to the 200 year flood event.

5.3 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 £2.4-3.2m, the benefit gained from the Do Minimum option is approximately £0.9m. This highlights a couple of points with regard to the options:

- The difference in the damages between the Do Nothing and Do Minimum shows the positive impact that the proactive ongoing maintenance carried out by the Council is contributing to flood damage reduction. However, the residual damage from just the Do Minimum option is £2.4 m, which these proposed scheme aim to mitagate.
- With the proposed scheme in place there will still be a residual damage of £0.15 m to £0.43 m. This is due to the flood damages associated with the 500 year and 1000 year flood event.

Table 5-1: Option benefit table (£k)

Option number			Option 1	Option 2	Option 3a	Option 3b	Option 3c	Option 4
Option name	Do Nothing	Do Minimum	PLP	Online Storage	Culvert Upgrade with Channel Deepening	Culvert Upgrade with Channel Widening	Culvert Upgrade with Direct Defences	Diversion Channel
SoP	2	5	200	200	200	200	200	200
BENEFITS:								
PV flood damages	3,367	2,468	429	148	148	148	148	291
PV flood benefits		899	2,938	3,219	3,219	3,219	3,219	3,076
Total PV damages benefits adjusted		899	2,468	3,219	3,219	3,219	3,219	3,076

5 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. Costs have been updated from 2012 values to present day (2018) values using CPI (Consumer Price Index) to account for inflation.

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, therefore these costs are unlikely.

The Environment Agency's Long Term Costing Tool 2012 was used to derive the whole life costs for each assessed scheme option. This is an interactive excel spreadsheet which determines capital costs based primarily on defence dimensions but also considers other factors influence costs. Enabling and operation and maintenance costs are also estimated using this spreadsheet. The whole life costs of PLP was costed separately using Scottish Government Guidance "Assessing the Flood Risk Management Benefits of Property Level Protection Technical and Economic Appraisal Report Final Report v2.0 November 2014 ".

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

SEPA's 'Costing of Flood Risk Management Measures' 2013 project report was used to determine maintenance costs for the proposed assets based. 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[6]. 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.

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

6.4 Edderston Burn - Option 1- PLP with 200 year standard of protection

This option consists of property level protection (PLP) to 38 properties. The PLP will take the form of automatic PLP that will seal the property against water ingress without any input from the inhabitants. Examples of what this will be include door guards, airbrick sealers, non-return valves on plumbing and sump pumps. Costs are based on the Scottish Government Guidance "Assessing the Flood Risk Management Benefits of Property Level Protection Technical and Economic Appraisal Report Final Report v2.0 November 2014 ".

Table 6-1: Unit and total estimated capital costs

Property type	Count	Capital cost - mid range automatic
Detached	17	£142,511
Semi-detached	2	£15,716
Terraced	17	£76,364
Flat	1	£4,608
Shop	1	£12,117
Other	0	£0
Total	38	£251,316

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

Element	Cash cost (£k)	PV Cost (£k)
Enabling cost	45	45
Capital cost	1,005	417
Maintenance cost	493	140
Total	1,543	602
Total incl. Optimism Bias	-	963

6.5 Edderston Burn - Option 2- Flood storage with a 200-year standard of protection

Description of the defence construction: The online storage shall be located at the confluence of East and West tributary of the Edderston Burn and utilise the existing valley to help form the storage. A piled wall or earth embankment shall form the wall which blocks up the valley. An orifice shall be installed to convey mean daily flows through the storage unaffected. Side walls will rise above the top of the valley bank by approximately 1.3 m but will reduce in height heading south. The online storage holds a volume of approximately 10,150m^3.

- The online storage cost is based on a unit price for each cubic metre of water stored. The unit price was priced according to the EA Costing Guidance.
- The side walls are priced on the basis of a reinforced concrete inverted T design with 300mm thick stem and 300mm thick foundation base with 500mm cover, and (a 1.25m deep mass concrete) cut-off. An allowance of 300mm freeboard is provided.
- Dam Wall: Piled foundations have been assumed for the construction of the dam wall, for costing purposes.

Storage: The enabling costs of storage include land acquisition.

Table 6-3: Unit and total estimated capital costs

Location	Length / Volume	Unit cost	Total Cost (Rounded)
Storage - cost per unit volume stored	10,150m^3	£43.9	£445,133
	Total Capital cost	£445,133	

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

Element	Cash cost (£k)	PV Cost (£k)
Enabling cost	122	122
Capital cost	445	430
Maintenance cost	436	124
Total	**1,003**	**676**
Total incl. Optimism Bias	-	1,082

6.6 Edderston Burn - Option 3A- Culvert upgrade with bed lowering providing a 200-year standard of protection

A description of the key defence assets required are as follows:

- New proposed culvert: A concrete culvert, 1.5m diameter, approximately 258m long.
- Upgraded existing culvert: A single box, concrete culvert, 1.75m wide by 1m high. Approximately 96m long.
- Bed of culvert lowering at diversion channel: Maximum bed lowering of 1.1m, 40m upstream of the face of the proposed culvert.
- Bed of culvert lowering at Edderston Burn: Maximum bed lowering of 0.56m, 7m upstream of the existing culvert face.
- Wall: A low concrete wall (<1.2m high), approximately 42m long including wingwall to culvert inlet.

The walls are priced according to the EA Costing Guidance and assuming an average cost. The total cost accounts for Operating and Maintenance costs for a target Condition Grade 2 of each asset. Enabling costs have also been considered. The side walls are priced on the basis of a reinforced concrete inverted T design with 300mm thick stem and 300mm thick foundation base with 500mm cover, and (a 1.25m deep mass concrete) cut-off. An allowance of 300mm freeboard is provided. The bed lowering cost has been calculated according to SPON's Civil Engineering and Highway Works Price Book 2013 and assuming excavation, haulage, tip charge and landfill tax.

Table 6-5: Unit and total estimated capital costs

Location	Typical defence height	Length / Volume	Unit cost	Total Cost (Rounded)
New Proposed Culvert	1.5m dia.	258m	£2,190	£564,923
Upgrade of existing Culvert	1.75 x 1.0 m	96m	£3,649	£350,340
Wall	0.5m	42m	£1,428	£59,980
Bed Lowering (Diversion Channel)	1.1m	132m^3	£211.6	£27,931
Bed Lowering (Edderston Burn)	0.56m	129m^3	£211.6	£27,296
Bridge Removal	-	34m^2	£550	£18,700
New Trash Screen	1.75	-	£4,600	£4,600
Excavation and tipping (only for the wall)	-	23m^3	£125.05	£2,876

Location	Typical defence height	Length / Volume	Unit cost	Total Cost (Rounded)
	Total Capital cost		£1,056,647	

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

Element	Cash cost (£k)	PV Cost (£k)
Enabling cost	94.4	94.4
Capital cost	1,057	1,021
Maintenance cost	440	125
Total	**1,591**	**1,240**
Total incl. Optimism Bias	-	1,984

6.7 Edderston Burn - Option 3B- Culvert upgrade with channel widening providing a 200-year standard of protection

A description of the key defence assets required are as follows :

- New proposed culvert: A concrete culvert, 1.5m diameter, approximately 258m long.
- Upgraded existing culvert: A single box, concrete culvert, 1.75m wide by 1m high. Approximately 96m long.
- Diversion Channel Widening: Approximately 105m long of the diversion channel upstream of the new proposed culvert to be widened by 3m.
- Edderston Burn Widening: Approximately 44m long of Edderston Burn upstream of the upgraded culvert to be widened by 2.5m.

The total cost accounts for Operating and Maintenance costs for a target Condition Grade 2 of each asset. Enabling costs have also been considered. The channels widening is estimated assuming unlined, earth type of channel.

Table 6-7: Unit and total estimated capital costs

Location	Typical defence height	Length / Volume	Unit cost	Total Cost (Rounded)
New Proposed Culvert	1.5m dia.	258m	£2,190	£564,923
Upgrade of existing Culvert	1.75 x 1.0 m	96m	£3,649	£350,340
Diversion Channel Widening	-	105m	£4,448	£467,080
Edderston Burn Widening	-	44m	£10,994	£483,729
New Trash Screen	1.75	-	£4,600	£4,600
Other costs – Diversion channel land purchase	-	0.09acre	£2,500	£227
Other costs – Edderston Burn land purchase	-	0.03acre	£10,000	£272

Location	Typical defence height	Length / Volume	Unit cost	Total Cost (Rounded)
	Total Capital cost	£1,871,171		

Table 6-8: Total cash and Present Value (PV) option costs

Element	Cash cost (£k)	PV Cost (£k)
Enabling cost	269	269
Capital cost	1,871	1,808
Maintenance cost	443.5	126
Total	**2,583**	**2,202.5**
Total incl. Optimism Bias	-	3,524

6.8 Edderston Burn - Option 3C- Culvert upgrade with direct defences providing a 200-year standard of protection

A description of the key defence assets required are as follows:

- New proposed culvert: A concrete culvert, 1.5m diameter, approximately 258m long.
- Upgraded existing culvert: A single box, concrete culvert, 1.75m wide by 1m high. Approximately 96m long.
- Wall 1: A concrete wall, 450mm high and 30m long.
- Wall 2: A concrete wall, 550mm high and 25m long.
- Wall 3: A concrete wall, less than 550mm high and approximately 42m long

The walls are priced according to the EA Costing Guidance and assuming an average cost. The total cost accounts for Operating and Maintenance costs for a target Condition Grade 2 of each asset. Enabling costs have also been considered. The wall is priced on the basis of a reinforced concrete inverted T design with 300mm thick stem and 300mm thick foundation base with 500mm cover, and (a 1.25m deep mass concrete) cut-off. An allowance of 300mm freeboard is provided

Table 6-9: Unit and total estimated capital costs

Location	Typical defence height	Length / Volume	Unit cost	Total Cost (Rounded)
New Proposed Culvert	1.5m dia.	258m	£2,190	£564,923
Upgrade of existing Culvert	1.75 x 1.0 m	96m	£3,649	£350,340
Wall 1	0.45m	30m	£1,428	£42,843
Wall 2	0.55m	25m	£1,428	£35,702
Wall 3	<0.55m	42m	£1,428	£59,980
New Trash Screen	1.75	-	£4,600	£4,600
Excavation and tipping	-	183m^3	£125.05	£22,925
	Total Capital cost	£1,113,214		

Table 6-10: Total cash and Present Value (PV) option costs

Element	Cash cost (£k)	PV Cost (£k)
Enabling cost	211	211
Capital cost	1,113	1,077
Maintenance cost	442	125.5

Element	Cash cost (£k)	PV Cost (£k)
Total	**1,766**	**1,412**
Total incl. Optimism Bias	-	2,259

6.9 Edderston Burn - Option 4- New Diversion channel with rock cascade - 200-year standard of protection

A description of the key defence assets required are as follows:

- Rock Cascade: Approximately 1.65m excavation by 4.2m wide, bottom stone haunched in concrete. Bedding and haunching extends to 150mm from top of stones. Assuming rocks 1.9t/m^3.
- Culvert on South Parks: A 1200mm diameter culvert, approximately 10m long.
- Swale: 11m wide at the top, 2m at the bottom by 0.9m deep swale, with side slope of 1:5. Approximately 708m long. Erosion protection and/or barrier may be required.

The total cost accounts for Operating and Maintenance costs for a target Condition Grade 2 of each asset. Enabling costs have also been considered. Rock Cascade: The cost of earthworks, ST4 concrete, 1.9t/m^3 rock armour, stony cohesive and haulage have been considered.

Table 6-11: Unit and total estimated capital costs

Location	Typical defence height	Length / Volume	Unit cost	Total Cost (Rounded)
Rock Cascade	-	97m	£1,750	£169,750
Culvert downstream	1200mm diameter	10m	£2,311	£23,113
New Channel	-	708m	£610	£432,530
Bank raising	400mm	42m	£167	£66,947
Other costs – Swale land purchase	-	2.45acre	£2,500	£6,123
	Total Capital cost		£362,106	

Table 6-12: Total cash and Present Value (PV) option costs

Element	Cash cost (£k)	PV Cost (£k)
Enabling cost	77	77
Capital cost	625	604
Maintenance cost	70	19.9
Total	**772**	**701**
Total incl. Optimism Bias	-	1,122

6.10 Summary of whole life costs

Table 6-13: Summary of total present value option costs

Option number	Option name	Total PV Cost with 60% optimism bias (£k)
	Do Nothing	0
	Do Minimum	0
Option 1	PLP	963
Option 2	Online storage	1,081

Option 3a	Culvert upgrade with channel deepening	1,985
Option 3b	Culvert upgrade with channel widening	3,525
Option 3c	Culvert upgrade with direct defences	2,262
Option 4	Diversion Channel	1,122

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 (BCR) 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 - Edderston Burn

The benefit cost results for the shortlisted options are provided in the table below. A scheme with a benefit cost ratio greater than 1 means that the benefits outweigh the costs therefore the scheme is cost effective.

The two most favourable options from a benefit cost ratio perspective is the online storage option and the secondary diversion channel option. The online storage option is slightly more favourable with a benefit cost ratio of 3.0 as opposed to a benefit cost ratio of 2.7 for the diversion channel. The PLP option also has a healthy benefit cost ratio of 2.6. Incremental BCR's have not been assessed as the benefits between options are minimal; thus the choice of moving from the cheapest option, PLP, to the more expensive options would not be cost effective.

Table 7-1: Benefit cost ratio for the short-listed option for the Edderston Burn (£k).

			Option 1	Option 2	Option 3	Option 3b	Option 3c	Option 4
Option name	Do Nothing	Do Minimum	PLP	Online storage	Culvert Upgrade with Channel Deepening	Culvert Upgrade with Channel Widening	Culvert Upgrade with Direct Defences	Diversion Channel
PV Costs (£k)	-	-	602	676	1,240	2,203	1,414	701
Optimism Bias (60%)	-	-	361	406	744	1,322	848	421
Total PV Costs (£k)	0	0	963	1,081	1,985	3,525	2,262	1,122
PV damage (£k)	3,367	2,468	429	148	148	148	148	291
PV damage avoided (£k)	-	899	2,468	3,219	3,219	3,219	3,219	3,076
Benefit-cost ratio	-	-	2.6	3.0	1.6	0.9	1.4	2.7

The culvert upgrade options have a much lower benefit cost ratio and do not offer additional benefits to the community or the environment so has not been considered further. PLP has a positive BCR but is not usually seen as sustainable long term solution. Both the online storage and Diversion Channel work independently up to the 200 year plus climate change flow but struggle to cope with the effects of climate change. The scheme used together will complement each other, the reservoir could be scaled back and also be used as an amenity area. Even if both options were undertaken in full the BCR is expected to be 1.5, as the reservoir could be made much smaller the actual BCR of this scheme is expected to be higher. Therefore, a hybrid option of the Diversion Channel and online storage is proposed.

7.3 Benefit-cost results with climate change

The shortlisted options protect to the 200 year flood event. As the effects of climate change continue to be felt this level of protection will diminish. Ideally, the 200 year plus climate change event would be designed for now or would allow the chosen scheme to easily adapt to larger flows with minimal cost at a later date.

Flood protection in South Parks is complex. The three options with the highest BCR have been considered for adaptation to future flood flows. These are discussed further below and reviewed as part of the option matrix in the table overleaf.

1. PLP - as the flood depths are relatively low, South Parks is well suited to PLP. The increase in flood extent due to climate change means 3 additional properties will need PLP. The increase in depth does not exclude properties currently proposed for PLP. However, PLP will need replacement every 25 years and may not therefore be considered a suitable long term option and sustainable option.
2. Secondary diversion channel - a secondary diversion can easily be constructed to cater for greater flows, however, it can only cater for flows from the western tributary. The increased flows on the eastern tributary would start to cause flooding so other flood defence measures would need to be implemented to cater for flooding arising from the eastern tributary.
3. Online storage option - For the online storage option there are several possible adaptations to be made:
    a. Increase storage capacity by raising wall heights or excavating ground.
    b. Install an adjustable flow control to allow a larger pass forward rate
    c. Decrease the flow entering the reservoir

Increased storage capacity

This could be achieved by digging out the hill that bounds the southern extent of the reservoir. This may be a feasible solution especially if the soil dug from here (assuming it is suitable) could be used in the construction of flood embankments along the Tweed. The wall height on the reservoir is already close to eye level from street level, an increase in wall height to account for climate change is approximately 1.1m, so a further increase in wall height to accommodate flow is not recommended.

Install an adjustable flow control to allow a larger pass forward rate

By building in an adjustable orifice the flow to be pass forward could be increased in the future. Currently if a larger flow was allowed through the reservoir then some flooding would occur. However, the impact would be far less than if the reservoir was not there, for example, it would decrease the 200 year flow to the 30 year flow. The existing culvert on the Edderston Burn is nearing the end of it useful life, in the future this culvert could be replaced with a larger one, this accompanied by some minor banks works would be enough to allow the reservoir to protect to the 200 year plus climate change event.

Utilise the existing Diversion Channel to reduce flow into the reservoir

The online storage design assumes the existing Diversion Channel shall be abandoned. If instead the Diversion Channel was reinstated then this would contribute greatly to reducing the effects of increased flow into the reservoir as a result of climate change. This has not been modelled but assuming the diversion structure was redesigned then, the increase in flow due to climate change 1.25m^3/s and the Diversion Channel capacity with only Quick Wins improvements is 1.17 m^3/s.

Of course, a combination of the above options could be implemented. Regardless of the chosen option NFM should be integrated into the scheme. The NFM measures recommended takes place throughout the catchment. NFM, when implemented correctly, shall have a positive effect on flood flows, helping the soil to absorb more water, slow the flow of water into the watercourse and create more open water bodies on the land and may help to mitigate against the increase in frequent flood flows from climate change.

8 Public Consultation

A public consultation event was held in Peebles on the 6th November 2018 to gauge opinion on the flood mitigation options proposed as part of this study. The public consultation was well attended with 56 residents taking part. The Edderston Burn was presented to the public alongside 4 other watercourses (The River Tweed, Eddleston Water, Soonhope Burn and Haystoun Burn) who pose a flood risk to Peebles. Of the 56 people who attended 17 people responded to the provided questionnaire. 4 out of the 17 responses said they were impacted by flooding from the Edderston Burn. The public responded positively to a flood protection scheme that would protect the properties in South Parks however, no strong opinion on the individual options proposed for Edderston Burn were voiced. The results of the questionnaire are presented in Appendix B. One important point raised was that of a culvert on the eastern tributary of the Edderston Burn, which has not been considered as part of this flood risk study, caused flooding along Edderston Road and Caledonian Road in 2003 or 2004 when its capacity was exceeded. This should be accounted for in future design work. The other concern raised was that of over development on the agricultural land to the west of South Parks increasing flood risk to existing residents.

9 Conclusions and recommendations

In South Parks a number of "Quick Wins" are recommended. These "Quick Wins" shall help to alleviate choke points and increase conveyance in the channel. The Council should seek to implement these as short-term measures prior to a flood scheme being implemented in South Parks, or in the case where the scheme is not sufficiently high up SEPA's prioritisation list to obtain funding from the Scottish Government. The proposed scheme options have been assessed under the assumption that these recommendations are carried out so should be considered as 'no regrets' options that benefit the community:

- The two small bridges on the Diversion Channel should be removed (the wooden water gates should be removed in the interim).
- The two bridges on the Edderston Burn closest to the upstream face of the South Parks culvert should be removed.
- The weir at the upstream face of the Edderston Culvert should be removed and channel reprofiled.
- The screens on the Diversion Channel Culvert and South Parks Culvert should be enlarged so that they no longer obstruct water flow with a 1/3 blockage. Trash screen design guidance can be found in the EA Guide "Trash and Security Screen Guide 2009". Safer access for cleaning of the culvert screen is also recommended.

If the hybrid option is chosen then the Diversion Channel could be made obsolete, negating the need to make these changes. Likewise, if the culvert on South Parks is upgraded a screen is unlikely to be needed at all.

The summary table in the Business case highlights the positives and negatives of each scheme.

The options requiring a culvert upgrade have the lowest benefit cost ratio. The online storage, secondary diversion channel and the PLP option come out as the top three contenders with a BCR of 2.6 or more in all cases.

The online storage option has the best BCR, although it has several drawbacks. It requires land from peoples gardens and involves the construction of walls along the banks. This option will store in excess of 10,000m^3 in an urban environment so the risk of failure could pose a risk to life. Due to the fact it holds in excess of 10,000m^3, it is subject to a number of requirements under The Reservoirs (Scotland) Regulations 2016. These requirements include an annual inspection from a Reservoir Panel Engineer and an additional freeboard height above peak water, which increases the length and height required of the side walls. Additionally, it would be preferable to construct the online storage with an allowance for climate change increasing the size further. There are a number of options to adapt this option to cope with climate change (building additional storage upstream, utilising NFM in the upper catchment and upgrading the culvert downstream (this may be needed anyway due to its poor condition).

The secondary diversion channel, passing through agricultural land shall be relatively easy to construct. The increase in size to accommodate the 200 year plus climate change event is achievable for a small cost increase and should be incorporated. This option only reduces flow approaching South Parks from the western tributary, flooding resulting from flow from the eastern tributary is not reduced.

PLP, as an alternative option, would reduce flood risk from both tributaries and could be implemented quite easily without any large scale construction works and can protect to the 200 year plus climate change flood event for an additional capital cost of less than £25k on top of the 200 year PLP costs. On the downside there is always some post-event property damage and clean-up costs associated with PLP and roads and gardens will not be protected. Furthermore, this option would need to be reassessed in the future and repeated approximately every 20-25 years as the life of PLP is significantly lower than a FPS scheme; PLP equipment needs replacement on average every 25 years. Funding for this is unclear, replacement will either place a heavy cost burden on the council or residents. PLP is usually regarded as a short term flood protection solution.

Whilst all three options have pros and cons the recommended scheme is a hybrid of the secondary diversion channel and the online storage. Essentially the secondary diversion channel would cater for all flow from the western tributary and the reservoir would cater for the flow from the eastern tributary. The reservoir would be much smaller than in the standalone option. The reservoir embankment/wall would be contained within the natural valley. Smaller online storage (less than

10,000 m^3) would hold less water, be constructed at a lower height and greatly reduce the risk to life due to sudden failure. As it is below the 10,000 m^3 threshold, a smaller online storage would be free of additional restrictions under the 2016 Regulations. It could be designed to hold a portion of water all year round to increase its amenity value to the public. Building both schemes in full would result in a BCR of more than 1.4.

JBA therefore recommends a hybrid of the diversion channel and online storage as the preferred option but PLP is considered a viable solution in the short term if culvert upgrading is planned.

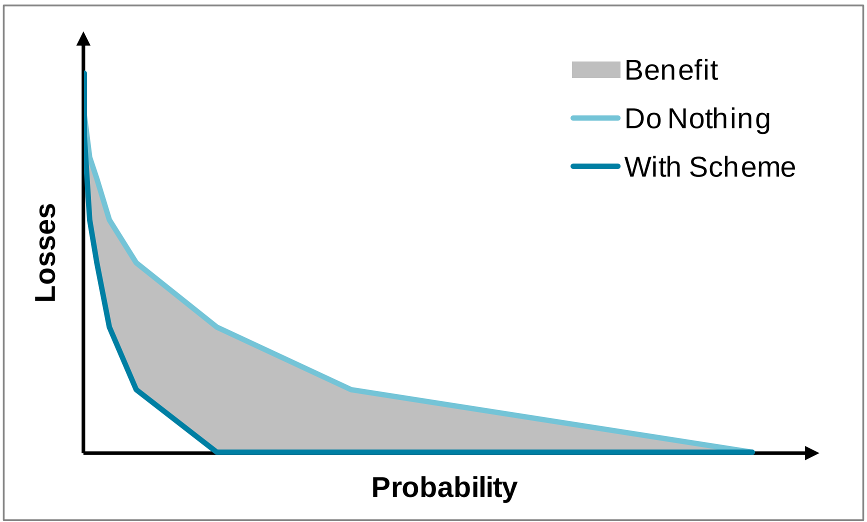
Appendices

A Appendix A - Economic Analysis

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 **Error! Reference source not found.**.

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 been 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 does 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

Project Summary Sheet

Client/Authority			Prepared (date)	
Scottish Borders Council			Printed	07/12/2018
Project name			Prepared by	JG
Broughton FPS			Checked by	
Project reference			Checked date	
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

	Costs and benefits £k							
Option number	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**	**Option 7**	**Option 8**
Option name	Do Nothing	Do Minimum	PLP	Reservoir	Culvert Upgrade with Channel Deepening	Culvert Upgrade with Channel Widening	Culvert Upgrade with Direct Defences	Diversion Channel
AEP or SoP (where relevant)	2	5	200.0	200.0	200.0	200.0	200.0	200.0
COSTS:								
Enabling costs	0	0	45.0	121.9	94.4	269.0	211.0	77.2
Capital costs	0	0	416.8	430.1	1021.0	1808.0	1077.0	604.2
PV operation and maintenance costs	0	0	140.0	124.0	125.0	126.0	125.5	19.9
PV Costs			601.8	675.9	1240.4	2203.0	1413.5	701.4
Optimism bias adjustment	0	0	361.1	405.5	744.2	1321.8	848.1	420.8
PV contributions								
Total PV Costs £k excluding contributions	0	0	963	1,081	1,985	3,525	2,262	1,122
Total PV Costs £k taking contributions into account	0	0	963	1,081	1,985	3,525	2,262	1,122
BENEFITS:								
PV monetised flood damages	3,367	2,468	429	148	148	148	148	291
PV monetised flood damages avoided		899	2,468	3,219	3,219	3,219	3,219	3,076
PV monetised erosion damages	0	0	0	0	0			0
PV monetised erosion damages avoided (protected)		0	0	0	0			0
Total monetised PV damages £k	3,367	2,468	429	148	148	148	148	291
Total monetised PV benefits £k		899	2,938	3,219	3,219	3,219	3,219	3,076
Total PV damages £k	3,367	2,468	429	148	148	148	148	291
Total PV benefits £k		899	2,468	3,219	3,219	3,219	3,219	3,076
DECISION-MAKING CRITERIA:								
Based on monetised PV benefits (** ex **cludes benefits from scoring and weighting and ecosystem services)								
Net Present Value **NPV**		899	1,975	2,138	1,235	-306	958	1,954
Average benefit/cost ratio **BCR**			2.6	3.0	1.6	0.9	1.4	2.7
Incremental benefit/cost ratio **IBCR**			2.1	2.4	-	-	-	0.1
Best practicable environmental option (WFD)								

Brief description of options:

Option 1	Do Nothing
Option 2	Do Minimum
Option 3	PLP
Option 4	Reservoir
Option 5	Culvert Upgrade with Channel Deepening
Option 6	Culvert Upgrade with Channel Widening
Option 7	Culvert Upgrade with Direct Defences
Option 8	Diversion Channel

Comments and assumptions:

Summary Annual Average Damage

Sheet Nr.

Client/Authority
Scottish Borders Council
Project name
Broughton FPS
Project reference -

Option:
Do Nothing

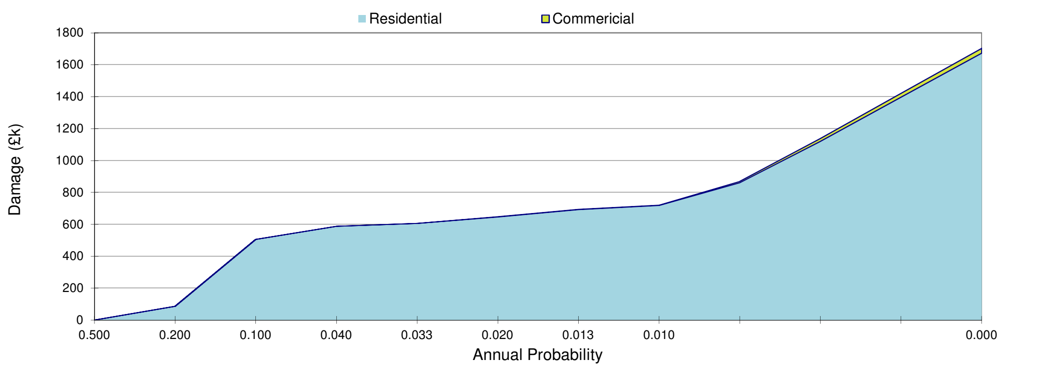
Base date for estimates (year 0)	01/01/2018	First year of damage:	0	Prepared (date)	00/01/1900
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed	07/12/2018
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by	JG
				Checked by	0
Applicable year (if time varying)				Checked date	0

Average waiting time (yrs) between events/frequency per year	2	5	10	25	30	50	75	100	200	500	1000	Infinity	Total PV
	0.500	0.200	0.100	0.040	0.033	0.020	0.013	0.010	0.005	0.002	0.001	0	£k
Damage category	Damage £k												
Residential property	0	87.3	505.1	587.9	604.9	645.9	692.4	717.6	860.7	1120.0	1396.7	1673.3	3111.1
Ind/commercial (direct)	0	0.0	0.0	0.0	0.9	1.8	2.2	2.7	8.9	18.3	24.0	29.7	4.8
Ind/comm (indirect)	0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.3	0.6	0.7	0.9	0.1
Traffic related												0.0	0.0
Emergency services	0.0	4.9	28.3	32.9	33.9	36.2	38.8	40.2	48.2	62.7	78.2	93.7	174.2
Other	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Intangible damages												0.0	76.6
												0.0	0.0
Total damage £k	0	92.2	533.4	620.9	639.6	683.9	733.5	760.5	918.1	1201.6	1499.6	1797.6	
Area (damagexfrequency)		13.84	31.28	34.63	4.20	8.82	4.72	2.49	4.20	3.18	1.35	1.65	

Total area, as above	110.36	
PV Factor, as above	29.813	
Present value (assuming no change in damage or event frequency)	3290	3,367

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: Broughton FPS **Option: Do Nothing**



Summary Annual Average Damage

Sheet Nr.

Client/Authority
Scottish Borders Council
Project name
Broughton FPS
Project reference -

Option:
Do Minimum

Base date for estimates (year 0)	01/01/2018	First year of damage:	0	Prepared (date)	00/01/1900
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed	07/12/2018
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by	JG
				Checked by	0
Applicable year (if time varying)				Checked date	0

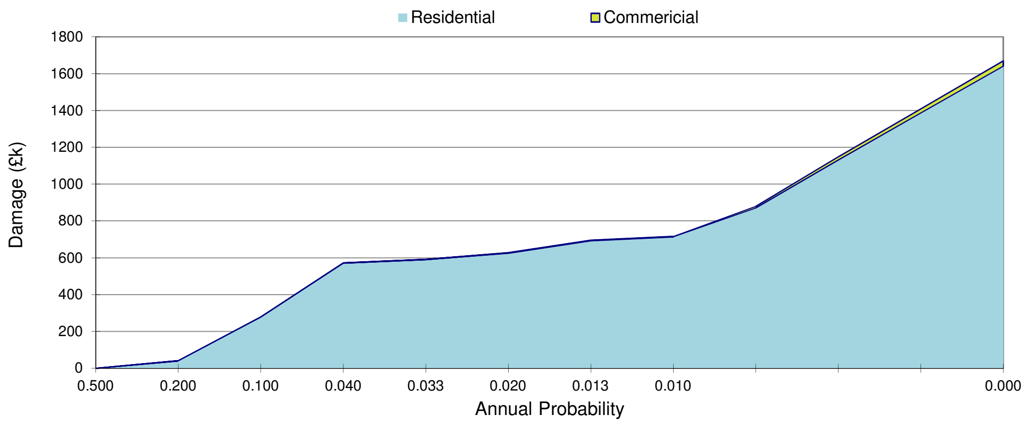
Average waiting time (yrs) between events/frequency per year

Damage category	2 / 0.500	5 / 0.200	10 / 0.100	25 / 0.040	30 / 0.033	50 / 0.020	75 / 0.013	100 / 0.010	200 / 0.005	500 / 0.002	1000 / 0.001	Infinity / 0	Total PV £k
	Damage £k												
Residential property	0	39.7	278.4	571.5	591.1	624.9	692.4	713.8	870.7	1130.8	1385.5	1640.1	2260.3
Ind/commercial (direct)	0	0.0	0.0	0.0	0.0	1.8	2.2	2.6	8.1	17.8	23.5	29.2	4.3
Ind/comm (indirect)	0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.5	0.7	0.9	0.1
Traffic related												0.0	0.0
Emergency services	0	2.2	15.6	32.0	33.1	35.0	38.8	40.0	48.8	63.3	77.6	91.8	126.6
Other	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Intangible damages												0.0	76.2
												0.0	0.0
Total damage £k	0	42.0	294.0	603.5	624.2	661.8	733.4	756.4	927.8	1212.5	1487.3	1762.0	
Area (damagexfrequency)		6.30	16.80	26.92	4.09	8.57	4.65	2.48	4.21	3.21	1.35	1.62	

Total area, as above	80.21	
PV Factor, as above	29.813	
Present value (assuming no change in damage or event frequency)	2391	2,468

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: Broughton FPS **Option: Do Minimum**



Summary Annual Average Damage

Sheet Nr.

Client/Authority
Scottish Borders Council
Project name
Broughton FPS
Project reference -

Option:
PLP

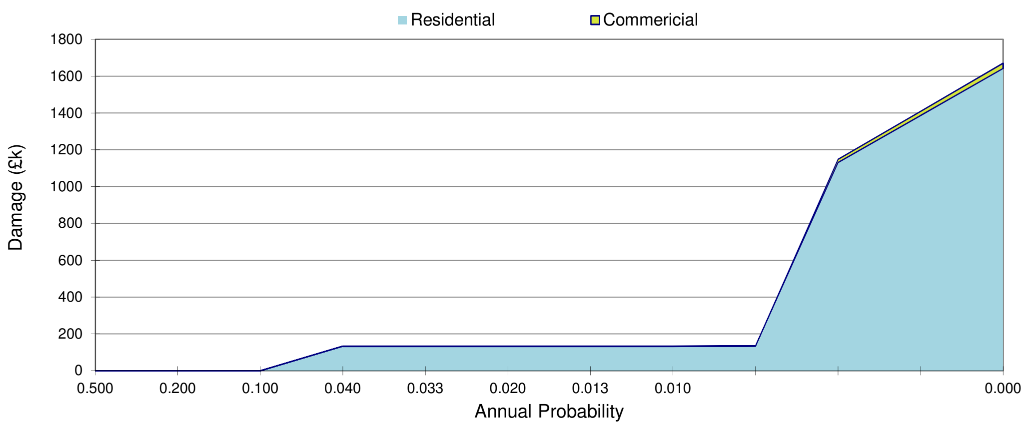
Base date for estimates (year 0)	43101	First year of damage:	0	Prepared (date)	00/01/1900
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed	07/12/2018
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by	JG
				Checked by	0
Applicable year (if time varying)				Checked date	0

	Average waiting time (yrs) between events/frequency per year												Total PV
	2	5	10	25	30	50	75	100	200	500	1000	Infinity	£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	0	0.0	0.0	132.1	132.6	133.0	133.1	133.1	133.4	1130.8	1385.5	1640.1	395.9
Ind/commercial (direct)	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.8	23.5	29.2	2.2
Ind/comm (indirect)	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.7	0.9	0.1
Traffic related												0.0	0.0
Emergency services	0	0.0	0.0	7.4	7.4	7.4	7.5	7.5	7.5	63.3	77.6	91.8	22.2
Other	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Intangible damages												0.0	8.4
												0.0	0.0
Total damage £k	0	0.0	0.0	139.5	140.1	140.4	140.5	140.6	140.8	1212.5	1487.3	1762.0	
Area (damagexfrequency)		0.00	0.00	4.18	0.93	1.87	0.94	0.47	0.70	2.03	1.35	4.76	

Total area, as above	17.23	
PV Factor, as above	29.813	
Present value (assuming no change in damage or event frequency)	514	428.66

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: Broughton FPS **Option: PLP**



Summary Annual Average Damage

Sheet Nr.

Client/Authority
Scottish Borders Council
Project name
Broughton FPS
Option:
Direct Defences
Project reference -

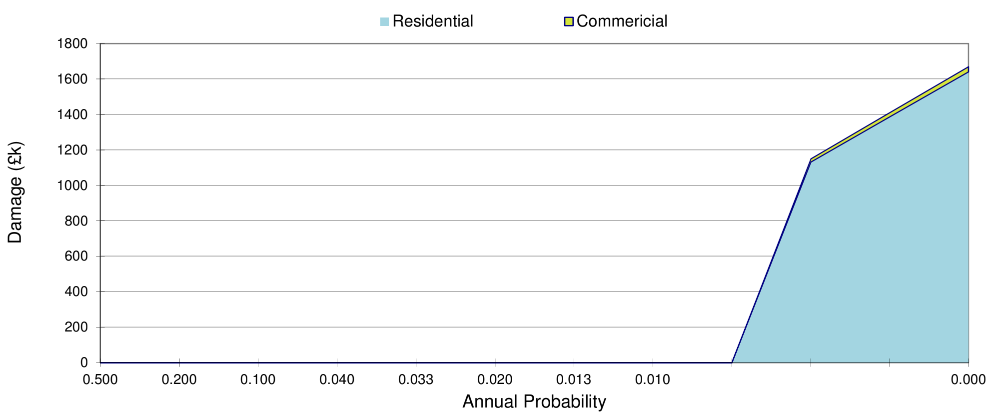
Base date for estimates (year 0)	43101	First year of damage:	0	Prepared (date)	00/01/1900
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed	07/12/2018
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by	JG
				Checked by	0
Applicable year (if time varying)				Checked date	0

	Average waiting time (yrs) between events/frequency per year												Total PV
	2	5	10	25	30	50	75	100	200	500	1000	Infinity	£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	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1130.8	1385.5	1640.1	133.2
Ind/commercial (direct)	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.8	23.5	29.2	2.2
Ind/comm (indirect)	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.7	0.9	0.1
Traffic related												0.0	0.0
Emergency services	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63.3	77.6	91.8	7.5
Other	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Intangible damages												0.0	4.7
												0.0	0.0
Total damage £k	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1212.5	1487.3	1762.0	
Area (damagexfrequency)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.82	1.35	1.62	

Total area, as above	4.79	
PV Factor, as above	29.813	
Present value (assuming no change in damage or event frequency)	143	148

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: Broughton FPS **Option: Direct Defences**



Summary Annual Average Damage

Sheet Nr.

Client/Authority
Scottish Borders Council
Project name
Broughton FPS
Project reference -

Base date for estimates (year 0)	43101	First year of damage:	0	Prepared (date)	00/01/1900
Scaling factor (e.g. £m, £k, £)	£k	Last year of period:	99	Printed	07/12/2018
Discount rate	3.5%	PV factor for mid-year 0:	29.813	Prepared by	JG
				Checked by	0
Applicable year (if time varying)				Checked date	0

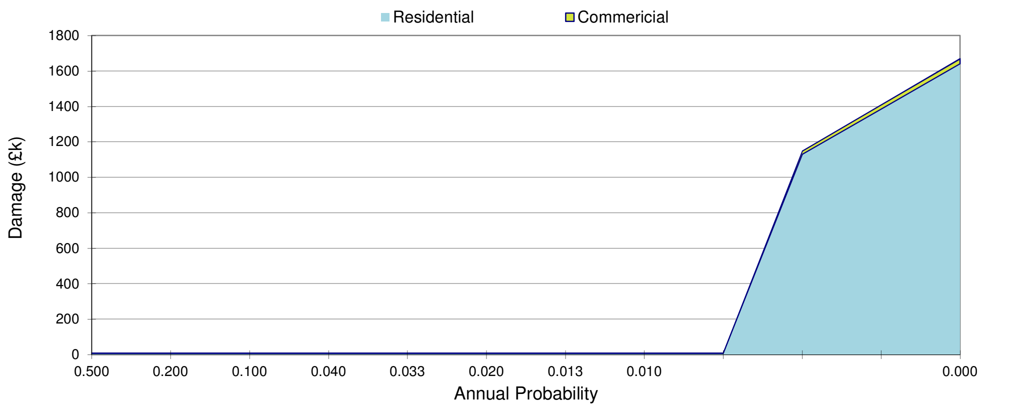
Option: Direct Defences

	Average waiting time (yrs) between events/frequency per year												Total PV
	2	5	10	25	30	50	75	100	200	500	1000	Infinity	£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	8.648229	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	1130.8	1385.5	1640.1	261.2
Ind/commercial (direct)	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.8	23.5	29.2	2.2
Ind/comm (indirect)	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.7	0.9	0.1
Traffic related												0.0	0.0
Emergency services	0.484301	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	63.3	77.6	91.8	14.6
Other	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Intangible damages												0.0	13.0
												0.0	0.0
Total damage £k	9.132529	9.1	9.1	9.1	9.1	9.1	9.1	9.1	9.1	1212.5	1487.3	1762.0	
Area (damagexfrequency)		2.74	0.91	0.55	0.06	0.12	0.06	0.03	0.05	1.83	1.35	1.62	

Total area, as above	9.33	
PV Factor, as above	29.813	
Present value (assuming no change in damage or event frequency)	278	291

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: Broughton FPS **Option: Direct Defences**



Whole life cost and PVc analysis Edderston - 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)	£45.0
Year of capital works (year)	1
Capital cost (£k)	£251.3
Annual maintenance cost (£k)	£5.0
Other cost (£k)	£0.0
Other works frequency (years)	1
Other cost (£k)	£0.0
Other works frequency (years)	1
Replacement (£)	251.316
Replacement frequency (years)	25
Optimism Bias	60%

Key

	Information
	Calculation
	Cost input
	Default

Element	Cash cost (£k)	PV Cost (£k)
Enabling cost	45	45
Capital cost	1,005	417
Maintenance cost	493	140
Total	**1,543**	**602**
Total incl. Optimism Bias	-	963

						al PVc (£k) with Optimism Bias:	963
Initial discount rate		**3.5%**	**29.813**			**Total PVc (£k):**	**602**
		Cost Elements				**TOTALS:**	
		Enabling	**Capital**	**Maint.**	**Interm.**	**Cash**	**PV**
	Cash sum	45	1005	493	0	1543	**602**
year	**Discount Factor**						
0	1.000	45.0			0	45.0	45.0
1	0.966		251		0	251.3	242.8
2	0.934			5	0	5.0	4.7
3	0.902			5	0	5.0	4.5
4	0.871			5	0	5.0	4.4
5	0.842			5	0	5.0	4.2
6	0.814			5	0	5.0	4.1
7	0.786			5	0	5.0	4.0
8	0.759			5	0	5.0	3.8
9	0.734			5	0	5.0	3.7
10	0.709			5	0	5.0	3.6
11	0.685			5	0	5.0	3.4
12	0.662			5	0	5.0	3.3
13	0.639			5	0	5.0	3.2
14	0.618			5	0	5.0	3.1
15	0.597			5	0	5.0	3.0
16	0.577			5	0	5.0	2.9
17	0.557			5	0	5.0	2.8
18	0.538			5	0	5.0	2.7
19	0.520			5	0	5.0	2.6
20	0.503			5	0	5.0	2.5
21	0.486			5	0	5.0	2.4
22	0.469			5	0	5.0	2.4
23	0.453			5	0	5.0	2.3
24	0.438			5	0	5.0	2.2
25	0.423			5	0	5.0	2.1
26	0.409		251	5	0	256.3	104.8
27	0.395			5	0	5.0	2.0
28	0.382			5	0	5.0	1.9
29	0.369			5	0	5.0	1.9
30	0.356			5	0	5.0	1.8
31	0.346			5	0	5.0	1.7
32	0.336			5	0	5.0	1.7
33	0.326			5	0	5.0	1.6
34	0.317			5	0	5.0	1.6
35	0.307			5	0	5.0	1.5
36	0.298			5	0	5.0	1.5
37	0.290			5	0	5.0	1.5
38	0.281			5	0	5.0	1.4
39	0.273			5	0	5.0	1.4
40	0.265			5	0	5.0	1.3
41	0.257			5	0	5.0	1.3
42	0.250			5	0	5.0	1.3
43	0.243			5	0	5.0	1.2
44	0.236			5	0	5.0	1.2
45	0.229			5	0	5.0	1.1
46	0.222			5	0	5.0	1.1
47	0.216			5	0	5.0	1.1
48	0.209			5	0	5.0	1.1
49	0.203			5	0	5.0	1.0
50	0.197			5	0	5.0	1.0
51	0.192		251	5	0	256.3	49.1
52	0.186			5	0	5.0	0.9
53	0.181			5	0	5.0	0.9
54	0.175			5	0	5.0	0.9
55	0.170			5	0	5.0	0.9
56	0.165			5	0	5.0	0.8
57	0.160			5	0	5.0	0.8
58	0.156			5	0	5.0	0.8
59	0.151			5	0	5.0	0.8
60	0.147			5	0	5.0	0.7
61	0.143			5	0	5.0	0.7
62	0.138			5	0	5.0	0.7
63	0.134			5	0	5.0	0.7
64	0.130			5	0	5.0	0.7
65	0.127			5	0	5.0	0.6
66	0.123			5	0	5.0	0.6
67	0.119			5	0	5.0	0.6
68	0.116			5	0	5.0	0.6
69	0.112			5	0	5.0	0.6
70	0.109			5	0	5.0	0.5
71	0.106			5	0	5.0	0.5
72	0.103			5	0	5.0	0.5
73	0.100			5	0	5.0	0.5
74	0.097			5	0	5.0	0.5
75	0.094			5	0	5.0	0.5
76	0.092		251	5	0	256.3	23.6
77	0.090			5	0	5.0	0.5
78	0.087			5	0	5.0	0.4
79	0.085			5	0	5.0	0.4
80	0.083			5	0	5.0	0.4
81	0.081			5	0	5.0	0.4
82	0.079			5	0	5.0	0.4
83	0.077			5	0	5.0	0.4
84	0.075			5	0	5.0	0.4
85	0.074			5	0	5.0	0.4
86	0.072			5	0	5.0	0.4
87	0.070			5	0	5.0	0.4
88	0.068			5	0	5.0	0.3
89	0.067			5	0	5.0	0.3
90	0.065			5	0	5.0	0.3
91	0.063			5	0	5.0	0.3
92	0.062			5	0	5.0	0.3
93	0.060			5	0	5.0	0.3
94	0.059			5	0	5.0	0.3
95	0.057			5	0	5.0	0.3
96	0.056			5	0	5.0	0.3
97	0.055			5	0	5.0	0.3
98	0.053			5	0	5.0	0.3
99	0.052			5	0	5.0	0.3

Summary of costs

Client/Authority		Prepared (date)	
Scottish Borders Council		Printed	07/12/2018
Project/Option name		Prepared by	C.Kampanou
South Parks - Reservoir		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	£121.88
Capital Costs	£445.13
O & M Costs	£436.23
Other Costs	£0.00
Total Real Cost	£1,003.24
Total Cost PV	£675.91
Total Cost PV + OB	**£1,081.46**

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								
	Wall								
	Sheet Piling								
Channel management	N/A								
Culvert & screen	N/A								
Control assets	Weir								
	Pumping station								
	Flood gate								
	Outfall								
	Flow barrier								
Coastal protection	Wall								
	Revetment								
	Groyne								
	Recharge								
Flood storage	N/A			£121.88	£445.13	£436.23	£0.00	£1,003.24	£675.91
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								
User Defined 2	Various								
User Defined 3	Various								

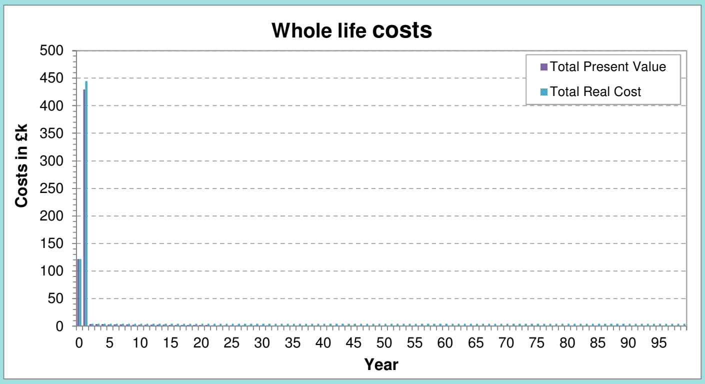
Whole Life and Present Value Cost Analysis

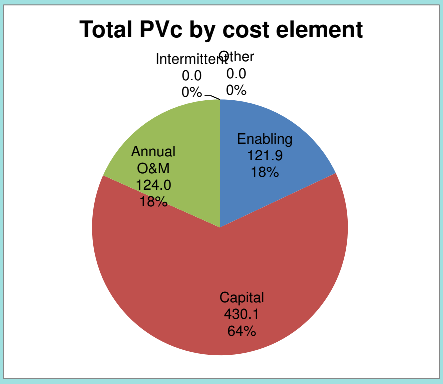
PV factor: 29.813

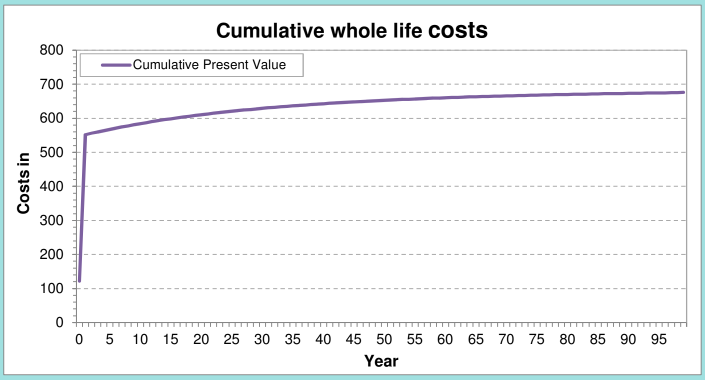
Total PVc (£k): **675.9**

year	Discount Factor	Enabling £k	Capital £k	Annual O&M £k	Intermittent O&M £k	Other £k	TOTALS: Current price	PV (£k)	Cumulative PV Costs (£k)
	Total real cost	121.9	445.1	436.2	0.0	0.0	1003.24	**675.9**	
	Total PV cost	121.9	430.1	124.0	0.0	0.0		**675.9**	
0	1.000	121.9	0.0	0.0	0.0	0.0	121.9	121.9	121.9
1	0.966	0.0	445.1	0.0	0.0	0.0	445.1	430.1	552.0
2	0.934	0.0	0.0	4.5	0.0	0.0	4.5	4.2	556.1
3	0.902	0.0	0.0	4.5	0.0	0.0	4.5	4.0	560.1
4	0.871	0.0	0.0	4.5	0.0	0.0	4.5	3.9	564.0
5	0.842	0.0	0.0	4.5	0.0	0.0	4.5	3.7	567.8
6	0.814	0.0	0.0	4.5	0.0	0.0	4.5	3.6	571.4
7	0.786	0.0	0.0	4.5	0.0	0.0	4.5	3.5	574.9
8	0.759	0.0	0.0	4.5	0.0	0.0	4.5	3.4	578.3
9	0.734	0.0	0.0	4.5	0.0	0.0	4.5	3.3	581.5
10	0.709	0.0	0.0	4.5	0.0	0.0	4.5	3.2	584.7
11	0.685	0.0	0.0	4.5	0.0	0.0	4.5	3.0	587.7
12	0.662	0.0	0.0	4.5	0.0	0.0	4.5	2.9	590.7
13	0.639	0.0	0.0	4.5	0.0	0.0	4.5	2.8	593.5
14	0.618	0.0	0.0	4.5	0.0	0.0	4.5	2.7	596.3
15	0.597	0.0	0.0	4.5	0.0	0.0	4.5	2.7	598.9
16	0.577	0.0	0.0	4.5	0.0	0.0	4.5	2.6	601.5
17	0.557	0.0	0.0	4.5	0.0	0.0	4.5	2.5	604.0
18	0.538	0.0	0.0	4.5	0.0	0.0	4.5	2.4	606.4
19	0.520	0.0	0.0	4.5	0.0	0.0	4.5	2.3	608.7
20	0.503	0.0	0.0	4.5	0.0	0.0	4.5	2.2	610.9
21	0.486	0.0	0.0	4.5	0.0	0.0	4.5	2.2	613.1
22	0.469	0.0	0.0	4.5	0.0	0.0	4.5	2.1	615.2
23	0.453	0.0	0.0	4.5	0.0	0.0	4.5	2.0	617.2
24	0.438	0.0	0.0	4.5	0.0	0.0	4.5	1.9	619.1
25	0.423	0.0	0.0	4.5	0.0	0.0	4.5	1.9	621.0
26	0.409	0.0	0.0	4.5	0.0	0.0	4.5	1.8	622.8
27	0.395	0.0	0.0	4.5	0.0	0.0	4.5	1.8	624.6
28	0.382	0.0	0.0	4.5	0.0	0.0	4.5	1.7	626.3
29	0.369	0.0	0.0	4.5	0.0	0.0	4.5	1.6	627.9
30	0.356	0.0	0.0	4.5	0.0	0.0	4.5	1.6	629.5
31	0.346	0.0	0.0	4.5	0.0	0.0	4.5	1.5	631.1
32	0.336	0.0	0.0	4.5	0.0	0.0	4.5	1.5	632.6
33	0.326	0.0	0.0	4.5	0.0	0.0	4.5	1.5	634.0
34	0.317	0.0	0.0	4.5	0.0	0.0	4.5	1.4	635.4
35	0.307	0.0	0.0	4.5	0.0	0.0	4.5	1.4	636.8
36	0.298	0.0	0.0	4.5	0.0	0.0	4.5	1.3	638.1
37	0.290	0.0	0.0	4.5	0.0	0.0	4.5	1.3	639.4
38	0.281	0.0	0.0	4.5	0.0	0.0	4.5	1.3	640.7
39	0.273	0.0	0.0	4.5	0.0	0.0	4.5	1.2	641.9
40	0.265	0.0	0.0	4.5	0.0	0.0	4.5	1.2	643.1
41	0.257	0.0	0.0	4.5	0.0	0.0	4.5	1.1	644.2
42	0.250	0.0	0.0	4.5	0.0	0.0	4.5	1.1	645.3
43	0.243	0.0	0.0	4.5	0.0	0.0	4.5	1.1	646.4
44	0.236	0.0	0.0	4.5	0.0	0.0	4.5	1.0	647.4
45	0.229	0.0	0.0	4.5	0.0	0.0	4.5	1.0	648.5
46	0.222	0.0	0.0	4.5	0.0	0.0	4.5	1.0	649.4
47	0.216	0.0	0.0	4.5	0.0	0.0	4.5	1.0	650.4
48	0.209	0.0	0.0	4.5	0.0	0.0	4.5	0.9	651.3
49	0.203	0.0	0.0	4.5	0.0	0.0	4.5	0.9	652.2
50	0.197	0.0	0.0	4.5	0.0	0.0	4.5	0.9	653.1
51	0.192	0.0	0.0	4.5	0.0	0.0	4.5	0.9	654.0
52	0.186	0.0	0.0	4.5	0.0	0.0	4.5	0.8	654.8
53	0.181	0.0	0.0	4.5	0.0	0.0	4.5	0.8	655.6
54	0.175	0.0	0.0	4.5	0.0	0.0	4.5	0.8	656.4
55	0.170	0.0	0.0	4.5	0.0	0.0	4.5	0.8	657.1
56	0.165	0.0	0.0	4.5	0.0	0.0	4.5	0.7	657.9
57	0.160	0.0	0.0	4.5	0.0	0.0	4.5	0.7	658.6
58	0.156	0.0	0.0	4.5	0.0	0.0	4.5	0.7	659.3
59	0.151	0.0	0.0	4.5	0.0	0.0	4.5	0.7	660.0
60	0.147	0.0	0.0	4.5	0.0	0.0	4.5	0.7	660.6
61	0.143	0.0	0.0	4.5	0.0	0.0	4.5	0.6	661.2
62	0.138	0.0	0.0	4.5	0.0	0.0	4.5	0.6	661.9
63	0.134	0.0	0.0	4.5	0.0	0.0	4.5	0.6	662.5
64	0.130	0.0	0.0	4.5	0.0	0.0	4.5	0.6	663.0
65	0.127	0.0	0.0	4.5	0.0	0.0	4.5	0.6	663.6
66	0.123	0.0	0.0	4.5	0.0	0.0	4.5	0.5	664.2
67	0.119	0.0	0.0	4.5	0.0	0.0	4.5	0.5	664.7
68	0.116	0.0	0.0	4.5	0.0	0.0	4.5	0.5	665.2
69	0.112	0.0	0.0	4.5	0.0	0.0	4.5	0.5	665.7
70	0.109	0.0	0.0	4.5	0.0	0.0	4.5	0.5	666.2
71	0.106	0.0	0.0	4.5	0.0	0.0	4.5	0.5	666.7
72	0.103	0.0	0.0	4.5	0.0	0.0	4.5	0.5	667.1
73	0.100	0.0	0.0	4.5	0.0	0.0	4.5	0.4	667.6
74	0.097	0.0	0.0	4.5	0.0	0.0	4.5	0.4	668.0
75	0.094	0.0	0.0	4.5	0.0	0.0	4.5	0.4	668.4
76	0.092	0.0	0.0	4.5	0.0	0.0	4.5	0.4	668.8
77	0.090	0.0	0.0	4.5	0.0	0.0	4.5	0.4	669.2
78	0.087	0.0	0.0	4.5	0.0	0.0	4.5	0.4	669.6
79	0.085	0.0	0.0	4.5	0.0	0.0	4.5	0.4	670.0
80	0.083	0.0	0.0	4.5	0.0	0.0	4.5	0.4	670.4
81	0.081	0.0	0.0	4.5	0.0	0.0	4.5	0.4	670.7
82	0.079	0.0	0.0	4.5	0.0	0.0	4.5	0.4	671.1
83	0.077	0.0	0.0	4.5	0.0	0.0	4.5	0.3	671.4
84	0.075	0.0	0.0	4.5	0.0	0.0	4.5	0.3	671.8
85	0.074	0.0	0.0	4.5	0.0	0.0	4.5	0.3	672.1
86	0.072	0.0	0.0	4.5	0.0	0.0	4.5	0.3	672.4
87	0.070	0.0	0.0	4.5	0.0	0.0	4.5	0.3	672.7
88	0.068	0.0	0.0	4.5	0.0	0.0	4.5	0.3	673.0
89	0.067	0.0	0.0	4.5	0.0	0.0	4.5	0.3	673.3
90	0.065	0.0	0.0	4.5	0.0	0.0	4.5	0.3	673.6
91	0.063	0.0	0.0	4.5	0.0	0.0	4.5	0.3	673.9
92	0.062	0.0	0.0	4.5	0.0	0.0	4.5	0.3	674.2
93	0.060	0.0	0.0	4.5	0.0	0.0	4.5	0.3	674.4
94	0.059	0.0	0.0	4.5	0.0	0.0	4.5	0.3	674.7
95	0.057	0.0	0.0	4.5	0.0	0.0	4.5	0.3	675.0
96	0.056	0.0	0.0	4.5	0.0	0.0	4.5	0.2	675.2
97	0.055	0.0	0.0	4.5	0.0	0.0	4.5	0.2	675.4
98	0.053	0.0	0.0	4.5	0.0	0.0	4.5	0.2	675.7
99	0.052	0.0	0.0	4.5	0.0	0.0	4.5	0.2	675.9

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
South Parks - Culvert upgrade with bed deepening		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	£94.37
Capital Costs	£1,056.65
O & M Costs	£439.79
Other Costs	£0.00
Total Real Cost	£1,590.81
Total Cost PV	£1,240.25
Total Cost PV + OB	**£1,984.40**

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.

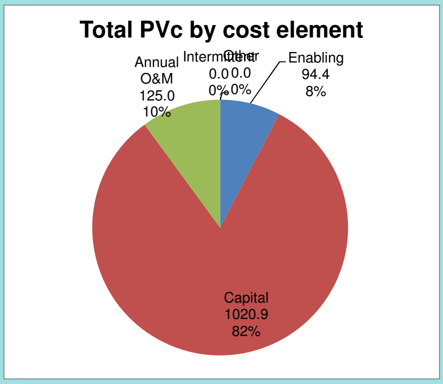
FRM Measure	Asset	Open / Go to Costing Sheet	Delete Sheet	Enabling Costs	Capital Costs	O & M Costs	Other Costs	Total Cost Cash	Total Cost PV
Fluvial raised defence	Embankment								
	Wall			£12.00	£59.98	£1.35	£0.00	£73.33	£70.33
	Sheet Piling								
Channel management	N/A								
Culvert & screen	N/A			£82.37	£919.86	£438.44	£0.00	£1,440.68	£1,095.71
Control assets	Weir								
	Pumping station								
	Flood gate								
	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	£73.93	£0.00	£0.00	£73.93	£71.43
User Defined 2	Various			£0.00	£2.88	£0.00	£0.00	£2.88	£2.78
User Defined 3	Various								

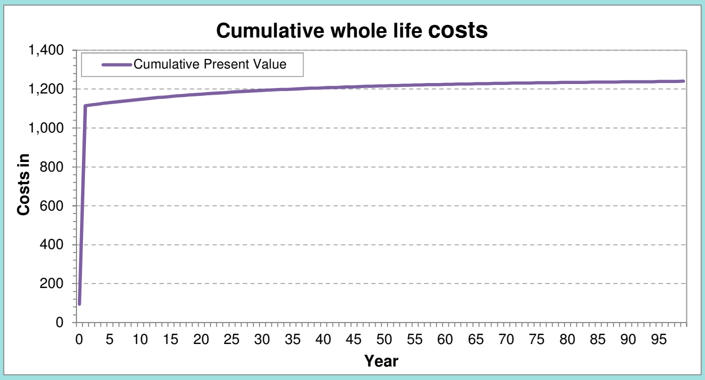
Whole Life and Present Value Cost Analysis

	PV factor	29.813				Total PVc (£k):	1240.3	

year		Enabling £k	Capital £k	Annual O&M £k	Intermittent O&M £k	Other £k	TOTALS: Current price	PV (£k)	Cumulative PV Costs (£k)
	Total real cost	94.4	1056.6	439.8	0.0	0.0	1590.81	**1240.3**	
	Total PV cost	94.4	1020.9	125.0	0.0	0.0		**1240.3**	
	Discount Factor								
0	1.000	94.4	0.0	0.0	0.0	0.0	94.4	94.4	94.4
1	0.966	0.0	1056.6	0.0	0.0	0.0	1056.6	1020.9	1115.3
2	0.934	0.0	0.0	4.5	0.0	0.0	4.5	4.2	1119.5
3	0.902	0.0	0.0	4.5	0.0	0.0	4.5	4.0	1123.5
4	0.871	0.0	0.0	4.5	0.0	0.0	4.5	3.9	1127.4
5	0.842	0.0	0.0	4.5	0.0	0.0	4.5	3.8	1131.2
6	0.814	0.0	0.0	4.5	0.0	0.0	4.5	3.7	1134.9
7	0.786	0.0	0.0	4.5	0.0	0.0	4.5	3.5	1138.4
8	0.759	0.0	0.0	4.5	0.0	0.0	4.5	3.4	1141.8
9	0.734	0.0	0.0	4.5	0.0	0.0	4.5	3.3	1145.1
10	0.709	0.0	0.0	4.5	0.0	0.0	4.5	3.2	1148.3
11	0.685	0.0	0.0	4.5	0.0	0.0	4.5	3.1	1151.3
12	0.662	0.0	0.0	4.5	0.0	0.0	4.5	3.0	1154.3
13	0.639	0.0	0.0	4.5	0.0	0.0	4.5	2.9	1157.2
14	0.618	0.0	0.0	4.5	0.0	0.0	4.5	2.8	1160.0
15	0.597	0.0	0.0	4.5	0.0	0.0	4.5	2.7	1162.6
16	0.577	0.0	0.0	4.5	0.0	0.0	4.5	2.6	1165.2
17	0.557	0.0	0.0	4.5	0.0	0.0	4.5	2.5	1167.7
18	0.538	0.0	0.0	4.5	0.0	0.0	4.5	2.4	1170.1
19	0.520	0.0	0.0	4.5	0.0	0.0	4.5	2.3	1172.5
20	0.503	0.0	0.0	4.5	0.0	0.0	4.5	2.3	1174.7
21	0.486	0.0	0.0	4.5	0.0	0.0	4.5	2.2	1176.9
22	0.469	0.0	0.0	4.5	0.0	0.0	4.5	2.1	1179.0
23	0.453	0.0	0.0	4.5	0.0	0.0	4.5	2.0	1181.0
24	0.438	0.0	0.0	4.5	0.0	0.0	4.5	2.0	1183.0
25	0.423	0.0	0.0	4.5	0.0	0.0	4.5	1.9	1184.9
26	0.409	0.0	0.0	4.5	0.0	0.0	4.5	1.8	1186.7
27	0.395	0.0	0.0	4.5	0.0	0.0	4.5	1.8	1188.5
28	0.382	0.0	0.0	4.5	0.0	0.0	4.5	1.7	1190.2
29	0.369	0.0	0.0	4.5	0.0	0.0	4.5	1.7	1191.9
30	0.356	0.0	0.0	4.5	0.0	0.0	4.5	1.6	1193.5
31	0.346	0.0	0.0	4.5	0.0	0.0	4.5	1.6	1195.0
32	0.336	0.0	0.0	4.5	0.0	0.0	4.5	1.5	1196.5
33	0.326	0.0	0.0	4.5	0.0	0.0	4.5	1.5	1198.0
34	0.317	0.0	0.0	4.5	0.0	0.0	4.5	1.4	1199.4
35	0.307	0.0	0.0	4.5	0.0	0.0	4.5	1.4	1200.8
36	0.298	0.0	0.0	4.5	0.0	0.0	4.5	1.3	1202.1
37	0.290	0.0	0.0	4.5	0.0	0.0	4.5	1.3	1203.4
38	0.281	0.0	0.0	4.5	0.0	0.0	4.5	1.3	1204.7
39	0.273	0.0	0.0	4.5	0.0	0.0	94.4	1.2	1205.9
40	0.265	0.0	0.0	4.5	0.0	0.0	4.5	1.2	1207.1
41	0.257	0.0	0.0	4.5	0.0	0.0	4.5	1.2	1208.3
42	0.250	0.0	0.0	4.5	0.0	0.0	4.5	1.1	1209.4
43	0.243	0.0	0.0	4.5	0.0	0.0	4.5	1.1	1210.5
44	0.236	0.0	0.0	4.5	0.0	0.0	4.5	1.1	1211.5
45	0.229	0.0	0.0	4.5	0.0	0.0	4.5	1.0	1212.6
46	0.222	0.0	0.0	4.5	0.0	0.0	4.5	1.0	1213.6
47	0.216	0.0	0.0	4.5	0.0	0.0	4.5	1.0	1214.5
48	0.209	0.0	0.0	4.5	0.0	0.0	4.5	0.9	1215.5
49	0.203	0.0	0.0	4.5	0.0	0.0	4.5	0.9	1216.4
50	0.197	0.0	0.0	4.5	0.0	0.0	4.5	0.9	1217.3
51	0.192	0.0	0.0	4.5	0.0	0.0	4.5	0.9	1218.1
52	0.186	0.0	0.0	4.5	0.0	0.0	4.5	0.8	1219.0
53	0.181	0.0	0.0	4.5	0.0	0.0	4.5	0.8	1219.8
54	0.175	0.0	0.0	4.5	0.0	0.0	4.5	0.8	1220.6
55	0.170	0.0	0.0	4.5	0.0	0.0	4.5	0.8	1221.3
56	0.165	0.0	0.0	4.5	0.0	0.0	4.5	0.7	1222.1
57	0.160	0.0	0.0	4.5	0.0	0.0	4.5	0.7	1222.8
58	0.156	0.0	0.0	4.5	0.0	0.0	4.5	0.7	1223.5
59	0.151	0.0	0.0	4.5	0.0	0.0	4.5	0.7	1224.2
60	0.147	0.0	0.0	4.5	0.0	0.0	4.5	0.7	1224.8
61	0.143	0.0	0.0	4.5	0.0	0.0	4.5	0.6	1225.5
62	0.138	0.0	0.0	4.5	0.0	0.0	4.5	0.6	1226.1
63	0.134	0.0	0.0	4.5	0.0	0.0	4.5	0.6	1226.7
64	0.130	0.0	0.0	4.5	0.0	0.0	4.5	0.6	1227.3
65	0.127	0.0	0.0	4.5	0.0	0.0	4.5	0.6	1227.8
66	0.123	0.0	0.0	4.5	0.0	0.0	4.5	0.6	1228.4
67	0.119	0.0	0.0	4.5	0.0	0.0	4.5	0.5	1228.9
68	0.116	0.0	0.0	4.5	0.0	0.0	4.5	0.5	1229.4
69	0.112	0.0	0.0	4.5	0.0	0.0	4.5	0.5	1230.0
70	0.109	0.0	0.0	4.5	0.0	0.0	4.5	0.5	1230.4
71	0.106	0.0	0.0	4.5	0.0	0.0	4.5	0.5	1230.9
72	0.103	0.0	0.0	4.5	0.0	0.0	4.5	0.5	1231.4
73	0.100	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1231.8
74	0.097	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1232.3
75	0.094	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1232.7
76	0.092	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1233.1
77	0.090	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1233.5
78	0.087	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1233.9
79	0.085	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1234.3
80	0.083	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1234.7
81	0.081	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1235.0
82	0.079	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1235.4
83	0.077	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1235.7
84	0.075	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1236.1
85	0.074	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1236.4
86	0.072	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1236.7
87	0.070	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1237.0
88	0.068	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1237.3
89	0.067	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1237.6
90	0.065	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1237.9
91	0.063	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1238.2
92	0.062	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1238.5
93	0.060	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1238.8
94	0.059	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1239.0
95	0.057	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1239.3
96	0.056	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1239.5
97	0.055	0.0	0.0	4.5	0.0	0.0	4.5	0.2	1239.8
98	0.053	0.0	0.0	4.5	0.0	0.0	4.5	0.2	1240.0
99	0.052	0.0	0.0	4.5	0.0	0.0	4.5	0.2	1240.3

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
South Parks-Culvert upgrade with channel widening		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	£268.63
Capital Costs	£1,871.17
O & M Costs	£443.52
Other Costs	£0.00
Total Real Cost	£2,583.32
Total Cost PV	£2,202.55
Total Cost PV + OB	**£3,524.07**

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:

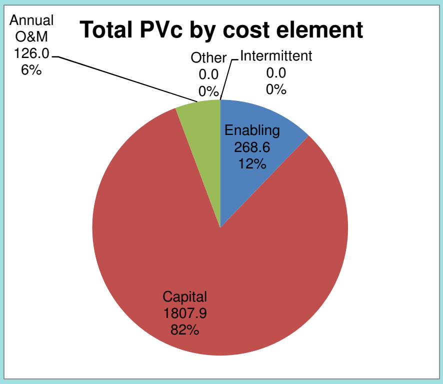
Add additional user notes here.

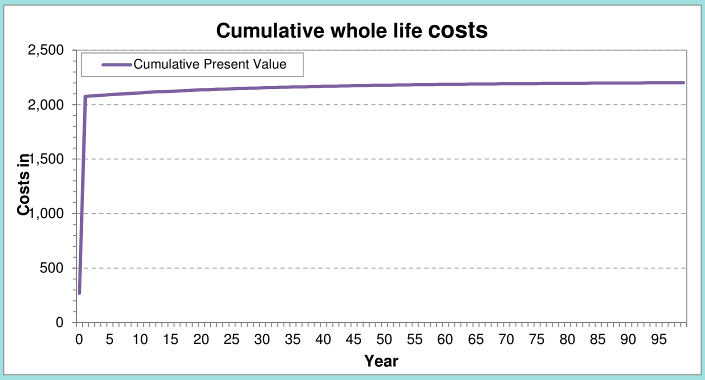
FRM Measure	Asset	Open / Go to Costing	Delete Sheet	Enabling Costs	Capital Costs	O & M Costs	Other Costs	Total Cost Cash	Total Cost PV
Fluvial raised defence	Embankment								
	Wall								
	Sheet Piling								
Channel management	N/A			£85.57	£951.31	£5.08	£0.00	£1,041.96	£1,006.15
Culvert & screen	N/A			£183.05	£919.86	£438.44	£0.00	£1,541.36	£1,196.39
Control assets	Weir								
	Pumping station								
	Flood gate								
	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								
User Defined 2	Various								
User Defined 3	Various								

Whole Life and Present Value Cost Analysis

		PV factor	29.813				Total PVc (£k):	2202.5	
		Enabling £k	Capital £k	Annual O&M £k	Intermittent O&M £k	Other £k	TOTALS: Current price	PV (£k)	
	Total real cost	268.6	1871.2	443.5	0.0	0.0	2583.32	2202.5	
	Total PV cost	268.6	1807.9	126.0	0.0	0.0		2202.5	Cumulative
year	Discount Factor								PV Costs (£k)
0	1.000	268.6	0.0	0.0	0.0	0.0	268.6	268.6	268.6
1	0.966	0.0	1871.2	0.0	0.0	0.0	1871.2	1807.9	2076.5
2	0.934	0.0	0.0	4.5	0.0	0.0	4.5	4.2	2080.7
3	0.902	0.0	0.0	4.5	0.0	0.0	4.5	4.1	2084.8
4	0.871	0.0	0.0	4.5	0.0	0.0	4.5	3.9	2088.8
5	0.842	0.0	0.0	4.5	0.0	0.0	4.5	3.8	2092.6
6	0.814	0.0	0.0	4.5	0.0	0.0	4.5	3.7	2096.3
7	0.786	0.0	0.0	4.5	0.0	0.0	4.5	3.6	2099.8
8	0.759	0.0	0.0	4.5	0.0	0.0	4.5	3.4	2103.3
9	0.734	0.0	0.0	4.5	0.0	0.0	4.5	3.3	2106.6
10	0.709	0.0	0.0	4.5	0.0	0.0	4.5	3.2	2109.8
11	0.685	0.0	0.0	4.5	0.0	0.0	4.5	3.1	2112.9
12	0.662	0.0	0.0	4.5	0.0	0.0	4.5	3.0	2115.9
13	0.639	0.0	0.0	4.5	0.0	0.0	4.5	2.9	2118.8
14	0.618	0.0	0.0	4.5	0.0	0.0	4.5	2.8	2121.6
15	0.597	0.0	0.0	4.5	0.0	0.0	4.5	2.7	2124.3
16	0.577	0.0	0.0	4.5	0.0	0.0	4.5	2.6	2126.9
17	0.557	0.0	0.0	4.5	0.0	0.0	4.5	2.5	2129.4
18	0.538	0.0	0.0	4.5	0.0	0.0	4.5	2.4	2131.8
19	0.520	0.0	0.0	4.5	0.0	0.0	4.5	2.4	2134.2
20	0.503	0.0	0.0	4.5	0.0	0.0	4.5	2.3	2136.5
21	0.486	0.0	0.0	4.5	0.0	0.0	4.5	2.2	2138.7
22	0.469	0.0	0.0	4.5	0.0	0.0	4.5	2.1	2140.8
23	0.453	0.0	0.0	4.5	0.0	0.0	4.5	2.1	2142.8
24	0.438	0.0	0.0	4.5	0.0	0.0	4.5	2.0	2144.8
25	0.423	0.0	0.0	4.5	0.0	0.0	4.5	1.9	2146.7
26	0.409	0.0	0.0	4.5	0.0	0.0	4.5	1.9	2148.6
27	0.395	0.0	0.0	4.5	0.0	0.0	4.5	1.8	2150.4
28	0.382	0.0	0.0	4.5	0.0	0.0	4.5	1.7	2152.1
29	0.369	0.0	0.0	4.5	0.0	0.0	4.5	1.7	2153.8
30	0.356	0.0	0.0	4.5	0.0	0.0	4.5	1.6	2155.4
31	0.346	0.0	0.0	4.5	0.0	0.0	4.5	1.6	2157.0
32	0.336	0.0	0.0	4.5	0.0	0.0	4.5	1.5	2158.5
33	0.326	0.0	0.0	4.5	0.0	0.0	4.5	1.5	2159.9
34	0.317	0.0	0.0	4.5	0.0	0.0	4.5	1.4	2161.4
35	0.307	0.0	0.0	4.5	0.0	0.0	4.5	1.4	2162.8
36	0.298	0.0	0.0	4.5	0.0	0.0	4.5	1.4	2164.1
37	0.290	0.0	0.0	4.5	0.0	0.0	4.5	1.3	2165.4
38	0.281	0.0	0.0	4.5	0.0	0.0	4.5	1.3	2166.7
39	0.273	0.0	0.0	4.5	0.0	0.0	4.5	1.2	2167.9
40	0.265	0.0	0.0	4.5	0.0	0.0	4.5	1.2	2169.1
41	0.257	0.0	0.0	4.5	0.0	0.0	4.5	1.2	2170.3
42	0.250	0.0	0.0	4.5	0.0	0.0	4.5	1.1	2171.4
43	0.243	0.0	0.0	4.5	0.0	0.0	4.5	1.1	2172.5
44	0.236	0.0	0.0	4.5	0.0	0.0	4.5	1.1	2173.6
45	0.229	0.0	0.0	4.5	0.0	0.0	4.5	1.0	2174.6
46	0.222	0.0	0.0	4.5	0.0	0.0	4.5	1.0	2175.6
47	0.216	0.0	0.0	4.5	0.0	0.0	4.5	1.0	2176.6
48	0.209	0.0	0.0	4.5	0.0	0.0	4.5	0.9	2177.6
49	0.203	0.0	0.0	4.5	0.0	0.0	4.5	0.9	2178.5
50	0.197	0.0	0.0	4.5	0.0	0.0	4.5	0.9	2179.4
51	0.192	0.0	0.0	4.5	0.0	0.0	4.5	0.9	2180.2
52	0.186	0.0	0.0	4.5	0.0	0.0	4.5	0.8	2181.1
53	0.181	0.0	0.0	4.5	0.0	0.0	4.5	0.8	2181.9
54	0.175	0.0	0.0	4.5	0.0	0.0	4.5	0.8	2182.7
55	0.170	0.0	0.0	4.5	0.0	0.0	4.5	0.8	2183.5
56	0.165	0.0	0.0	4.5	0.0	0.0	4.5	0.7	2184.2
57	0.160	0.0	0.0	4.5	0.0	0.0	4.5	0.7	2184.9
58	0.156	0.0	0.0	4.5	0.0	0.0	4.5	0.7	2185.6
59	0.151	0.0	0.0	4.5	0.0	0.0	4.5	0.7	2186.3
60	0.147	0.0	0.0	4.5	0.0	0.0	4.5	0.7	2187.0
61	0.143	0.0	0.0	4.5	0.0	0.0	4.5	0.6	2187.6
62	0.138	0.0	0.0	4.5	0.0	0.0	4.5	0.6	2188.3
63	0.134	0.0	0.0	4.5	0.0	0.0	4.5	0.6	2188.9
64	0.130	0.0	0.0	4.5	0.0	0.0	4.5	0.6	2189.5
65	0.127	0.0	0.0	4.5	0.0	0.0	4.5	0.6	2190.0
66	0.123	0.0	0.0	4.5	0.0	0.0	4.5	0.6	2190.6
67	0.119	0.0	0.0	4.5	0.0	0.0	4.5	0.5	2191.1
68	0.116	0.0	0.0	4.5	0.0	0.0	4.5	0.5	2191.7
69	0.112	0.0	0.0	4.5	0.0	0.0	4.5	0.5	2192.2
70	0.109	0.0	0.0	4.5	0.0	0.0	4.5	0.5	2192.7
71	0.106	0.0	0.0	4.5	0.0	0.0	4.5	0.5	2193.1
72	0.103	0.0	0.0	4.5	0.0	0.0	4.5	0.5	2193.6
73	0.100	0.0	0.0	4.5	0.0	0.0	4.5	0.5	2194.1
74	0.097	0.0	0.0	4.5	0.0	0.0	4.5	0.4	2194.5
75	0.094	0.0	0.0	4.5	0.0	0.0	4.5	0.4	2194.9
76	0.092	0.0	0.0	4.5	0.0	0.0	4.5	0.4	2195.3
77	0.090	0.0	0.0	4.5	0.0	0.0	4.5	0.4	2195.7
78	0.087	0.0	0.0	4.5	0.0	0.0	4.5	0.4	2196.1
79	0.085	0.0	0.0	4.5	0.0	0.0	4.5	0.4	2196.5
80	0.083	0.0	0.0	4.5	0.0	0.0	4.5	0.4	2196.9
81	0.081	0.0	0.0	4.5	0.0	0.0	4.5	0.4	2197.3
82	0.079	0.0	0.0	4.5	0.0	0.0	4.5	0.4	2197.6
83	0.077	0.0	0.0	4.5	0.0	0.0	4.5	0.3	2198.0
84	0.075	0.0	0.0	4.5	0.0	0.0	4.5	0.3	2198.3
85	0.074	0.0	0.0	4.5	0.0	0.0	4.5	0.3	2198.7
86	0.072	0.0	0.0	4.5	0.0	0.0	4.5	0.3	2199.0
87	0.070	0.0	0.0	4.5	0.0	0.0	4.5	0.3	2199.3
88	0.068	0.0	0.0	4.5	0.0	0.0	4.5	0.3	2199.6
89	0.067	0.0	0.0	4.5	0.0	0.0	4.5	0.3	2199.9
90	0.065	0.0	0.0	4.5	0.0	0.0	4.5	0.3	2200.2
91	0.063	0.0	0.0	4.5	0.0	0.0	4.5	0.3	2200.5
92	0.062	0.0	0.0	4.5	0.0	0.0	4.5	0.3	2200.8
93	0.060	0.0	0.0	4.5	0.0	0.0	4.5	0.3	2201.0
94	0.059	0.0	0.0	4.5	0.0	0.0	4.5	0.3	2201.3
95	0.057	0.0	0.0	4.5	0.0	0.0	4.5	0.3	2201.6
96	0.056	0.0	0.0	4.5	0.0	0.0	4.5	0.3	2201.8
97	0.055	0.0	0.0	4.5	0.0	0.0	4.5	0.2	2202.1
98	0.053	0.0	0.0	4.5	0.0	0.0	4.5	0.2	2202.3
99	0.052	0.0	0.0	4.5	0.0	0.0	4.5	0.2	2202.5

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
South Parks - Culvert upgrade with walls		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	£210.76
Capital Costs	£1,113.21
O & M Costs	£441.56
Other Costs	£0.00
Total Real Cost	£1,765.54
Total Cost PV	£1,411.80
Total Cost PV + OB	**£2,258.87**

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								
	Wall			£27.71	£138.53	£3.12	£0.00	£169.35	£162.43
	Sheet Piling								
Channel management	N/A								
Culvert & screen	N/A			£183.05	£919.86	£438.44	£0.00	£1,541.36	£1,196.39
Control assets	Weir								
	Pumping station								
	Flood gate								
	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	£54.83	£0.00	£0.00	£54.83	£52.97
User Defined 2	Various								
User Defined 3	Various								

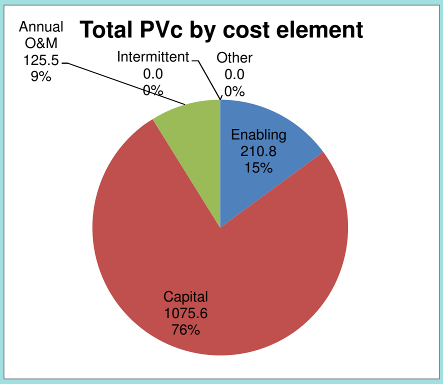
Whole Life and Present Value Cost Analysis

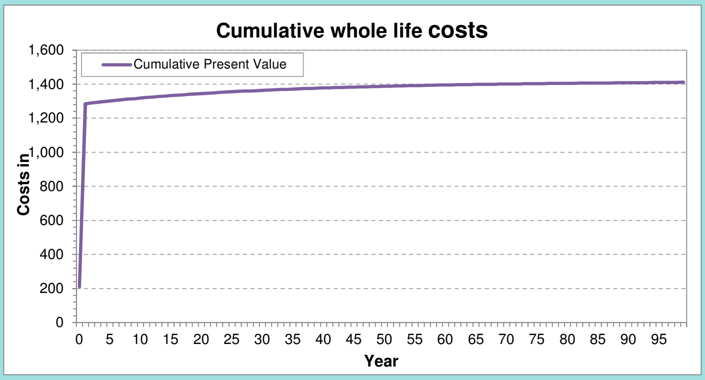
PV factor: 29.813

Total PVc (£k): **1411.8**

year	Discount Factor	Enabling £k	Capital £k	Annual O&M £k	Intermittent O&M £k	Other £k	TOTALS: Current price	PV (£k)	Cumulative PV Costs (£k)
Total real cost		210.8	1113.2	441.6	0.0	0.0	1765.54	**1411.8**	
Total PV cost		210.8	1075.6	125.5	0.0	0.0		**1411.8**	
0	1.000	210.8	0.0	0.0	0.0	0.0	210.8	210.8	210.8
1	0.966	0.0	1113.2	0.0	0.0	0.0	1113.2	1075.6	1286.3
2	0.934	0.0	0.0	4.5	0.0	0.0	4.5	4.2	1290.5
3	0.902	0.0	0.0	4.5	0.0	0.0	4.5	4.1	1294.6
4	0.871	0.0	0.0	4.5	0.0	0.0	4.5	3.9	1298.5
5	0.842	0.0	0.0	4.5	0.0	0.0	4.5	3.8	1302.3
6	0.814	0.0	0.0	4.5	0.0	0.0	4.5	3.7	1306.0
7	0.786	0.0	0.0	4.5	0.0	0.0	4.5	3.5	1309.5
8	0.759	0.0	0.0	4.5	0.0	0.0	4.5	3.4	1312.9
9	0.734	0.0	0.0	4.5	0.0	0.0	4.5	3.3	1316.3
10	0.709	0.0	0.0	4.5	0.0	0.0	4.5	3.2	1319.4
11	0.685	0.0	0.0	4.5	0.0	0.0	4.5	3.1	1322.5
12	0.662	0.0	0.0	4.5	0.0	0.0	4.5	3.0	1325.5
13	0.639	0.0	0.0	4.5	0.0	0.0	4.5	2.9	1328.4
14	0.618	0.0	0.0	4.5	0.0	0.0	4.5	2.8	1331.2
15	0.597	0.0	0.0	4.5	0.0	0.0	4.5	2.7	1333.9
16	0.577	0.0	0.0	4.5	0.0	0.0	4.5	2.6	1336.5
17	0.557	0.0	0.0	4.5	0.0	0.0	4.5	2.5	1339.0
18	0.538	0.0	0.0	4.5	0.0	0.0	4.5	2.4	1341.4
19	0.520	0.0	0.0	4.5	0.0	0.0	4.5	2.3	1343.7
20	0.503	0.0	0.0	4.5	0.0	0.0	4.5	2.3	1346.0
21	0.486	0.0	0.0	4.5	0.0	0.0	4.5	2.2	1348.2
22	0.469	0.0	0.0	4.5	0.0	0.0	4.5	2.1	1350.3
23	0.453	0.0	0.0	4.5	0.0	0.0	4.5	2.0	1352.4
24	0.438	0.0	0.0	4.5	0.0	0.0	4.5	2.0	1354.3
25	0.423	0.0	0.0	4.5	0.0	0.0	4.5	1.9	1356.2
26	0.409	0.0	0.0	4.5	0.0	0.0	4.5	1.8	1358.1
27	0.395	0.0	0.0	4.5	0.0	0.0	4.5	1.8	1359.9
28	0.382	0.0	0.0	4.5	0.0	0.0	4.5	1.7	1361.6
29	0.369	0.0	0.0	4.5	0.0	0.0	4.5	1.7	1363.2
30	0.356	0.0	0.0	4.5	0.0	0.0	4.5	1.6	1364.8
31	0.346	0.0	0.0	4.5	0.0	0.0	4.5	1.6	1366.4
32	0.336	0.0	0.0	4.5	0.0	0.0	4.5	1.5	1367.9
33	0.326	0.0	0.0	4.5	0.0	0.0	4.5	1.5	1369.4
34	0.317	0.0	0.0	4.5	0.0	0.0	4.5	1.4	1370.8
35	0.307	0.0	0.0	4.5	0.0	0.0	4.5	1.4	1372.2
36	0.298	0.0	0.0	4.5	0.0	0.0	4.5	1.3	1373.5
37	0.290	0.0	0.0	4.5	0.0	0.0	4.5	1.3	1374.8
38	0.281	0.0	0.0	4.5	0.0	0.0	4.5	1.3	1376.1
39	0.273	0.0	0.0	4.5	0.0	0.0	4.5	1.2	1377.3
40	0.265	0.0	0.0	4.5	0.0	0.0	4.5	1.2	1378.5
41	0.257	0.0	0.0	4.5	0.0	0.0	4.5	1.2	1379.7
42	0.250	0.0	0.0	4.5	0.0	0.0	4.5	1.1	1380.8
43	0.243	0.0	0.0	4.5	0.0	0.0	4.5	1.1	1381.9
44	0.236	0.0	0.0	4.5	0.0	0.0	4.5	1.1	1383.0
45	0.229	0.0	0.0	4.5	0.0	0.0	4.5	1.0	1384.0
46	0.222	0.0	0.0	4.5	0.0	0.0	4.5	1.0	1385.0
47	0.216	0.0	0.0	4.5	0.0	0.0	4.5	1.0	1386.0
48	0.209	0.0	0.0	4.5	0.0	0.0	4.5	0.9	1386.9
49	0.203	0.0	0.0	4.5	0.0	0.0	4.5	0.9	1387.8
50	0.197	0.0	0.0	4.5	0.0	0.0	4.5	0.9	1388.7
51	0.192	0.0	0.0	4.5	0.0	0.0	4.5	0.9	1389.6
52	0.186	0.0	0.0	4.5	0.0	0.0	4.5	0.8	1390.4
53	0.181	0.0	0.0	4.5	0.0	0.0	4.5	0.8	1391.2
54	0.175	0.0	0.0	4.5	0.0	0.0	4.5	0.8	1392.0
55	0.170	0.0	0.0	4.5	0.0	0.0	4.5	0.8	1392.8
56	0.165	0.0	0.0	4.5	0.0	0.0	4.5	0.7	1393.5
57	0.160	0.0	0.0	4.5	0.0	0.0	4.5	0.7	1394.3
58	0.156	0.0	0.0	4.5	0.0	0.0	4.5	0.7	1395.0
59	0.151	0.0	0.0	4.5	0.0	0.0	4.5	0.7	1395.6
60	0.147	0.0	0.0	4.5	0.0	0.0	4.5	0.7	1396.3
61	0.143	0.0	0.0	4.5	0.0	0.0	4.5	0.6	1396.9
62	0.138	0.0	0.0	4.5	0.0	0.0	4.5	0.6	1397.6
63	0.134	0.0	0.0	4.5	0.0	0.0	4.5	0.6	1398.2
64	0.130	0.0	0.0	4.5	0.0	0.0	4.5	0.6	1398.8
65	0.127	0.0	0.0	4.5	0.0	0.0	4.5	0.6	1399.3
66	0.123	0.0	0.0	4.5	0.0	0.0	4.5	0.6	1399.9
67	0.119	0.0	0.0	4.5	0.0	0.0	4.5	0.5	1400.4
68	0.116	0.0	0.0	4.5	0.0	0.0	4.5	0.5	1401.0
69	0.112	0.0	0.0	4.5	0.0	0.0	4.5	0.5	1401.5
70	0.109	0.0	0.0	4.5	0.0	0.0	4.5	0.5	1401.9
71	0.106	0.0	0.0	4.5	0.0	0.0	4.5	0.5	1402.4
72	0.103	0.0	0.0	4.5	0.0	0.0	4.5	0.5	1402.9
73	0.100	0.0	0.0	4.5	0.0	0.0	4.5	0.5	1403.3
74	0.097	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1403.8
75	0.094	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1404.2
76	0.092	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1404.6
77	0.090	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1405.0
78	0.087	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1405.4
79	0.085	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1405.8
80	0.083	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1406.2
81	0.081	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1406.5
82	0.079	0.0	0.0	4.5	0.0	0.0	4.5	0.4	1406.9
83	0.077	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1407.2
84	0.075	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1407.6
85	0.074	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1407.9
86	0.072	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1408.2
87	0.070	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1408.6
88	0.068	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1408.9
89	0.067	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1409.2
90	0.065	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1409.5
91	0.063	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1409.7
92	0.062	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1410.0
93	0.060	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1410.3
94	0.059	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1410.6
95	0.057	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1410.8
96	0.056	0.0	0.0	4.5	0.0	0.0	4.5	0.3	1411.1
97	0.055	0.0	0.0	4.5	0.0	0.0	4.5	0.2	1411.3
98	0.053	0.0	0.0	4.5	0.0	0.0	4.5	0.2	1411.6
99	0.052	0.0	0.0	4.5	0.0	0.0	4.5	0.2	1411.8

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
South Parks - Secondary diversion channel		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	£77.20
Capital Costs	£625.39
O & M Costs	£70.13
Other Costs	£0.00
Total Real Cost	£772.73
Total Cost PV	£701.37
Total Cost PV + OB	**£1,122.20**

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).

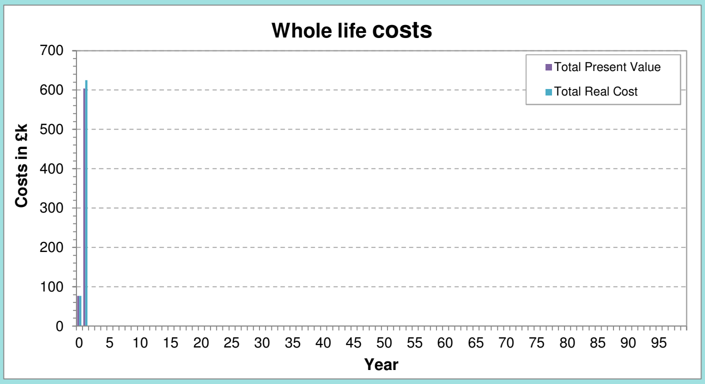
Additional user notes:
Add additional user notes here.

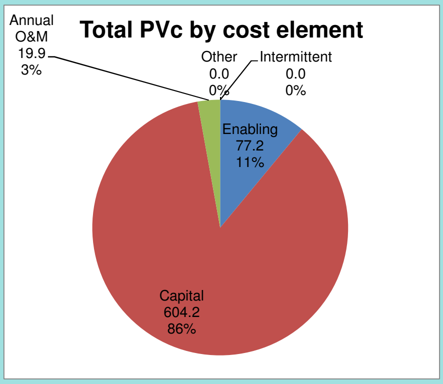
FRM Measure	Asset	Open / Go to Costing Sheet	Delete Sheet	Enabling Costs	Capital Costs	O & M Costs	Other Costs	Total Cost Cash	Total Cost PV
Fluvial raised defence	Embankment								
	Wall								
	Sheet Piling								
Channel management	N/A			£43.25	£432.53	£69.26	£0.00	£545.04	£480.83
Culvert & screen	N/A			£0.00	£23.11	£0.87	£0.00	£23.98	£22.58
Control assets	Weir								
	Pumping station								
	Flood gate								
	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								
User Defined 2	Various			£33.95	£169.75	£0.00	£0.00	£203.70	£197.96
User Defined 3	Various								

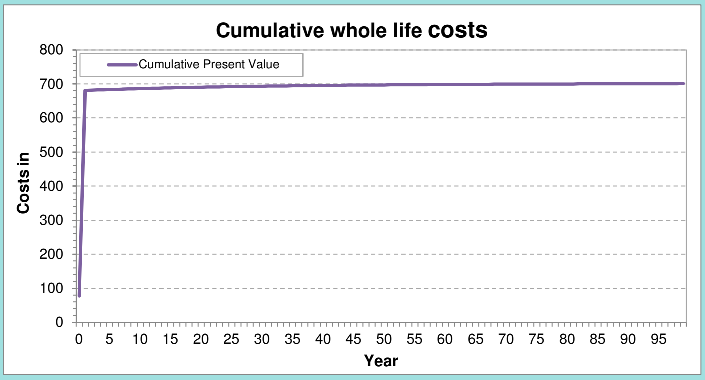
Whole Life and Present Value Cost Analysis

	PV factor	29.813					Total PVc (£k):	701.4	
		Enabling £k	Capital £k	Annual O&M £k	Intermittent O&M £k	Other £k	TOTALS: Current price	PV (£k)	
	Total real cost	77.2	625.4	70.1	0.0	0.0	772.73	**701.4**	
	Total PV cost	77.2	604.2	19.9	0.0	0.0		**701.4**	**Cumulative**
year	**Discount Factor**								**PV Costs (£k)**
0	1.000	77.2	0.0	0.0	0.0	0.0	77.2	77.2	77.2
1	0.966	0.0	625.4	0.0	0.0	0.0	625.4	604.2	681.4
2	0.934	0.0	0.0	0.7	0.0	0.0	0.7	0.7	682.1
3	0.902	0.0	0.0	0.7	0.0	0.0	0.7	0.6	682.8
4	0.871	0.0	0.0	0.7	0.0	0.0	0.7	0.6	683.4
5	0.842	0.0	0.0	0.7	0.0	0.0	0.7	0.6	684.0
6	0.814	0.0	0.0	0.7	0.0	0.0	0.7	0.6	684.6
7	0.786	0.0	0.0	0.7	0.0	0.0	0.7	0.6	685.1
8	0.759	0.0	0.0	0.7	0.0	0.0	0.7	0.5	685.7
9	0.734	0.0	0.0	0.7	0.0	0.0	0.7	0.5	686.2
10	0.709	0.0	0.0	0.7	0.0	0.0	0.7	0.5	686.7
11	0.685	0.0	0.0	0.7	0.0	0.0	0.7	0.5	687.2
12	0.662	0.0	0.0	0.7	0.0	0.0	0.7	0.5	687.7
13	0.639	0.0	0.0	0.7	0.0	0.0	0.7	0.5	688.1
14	0.618	0.0	0.0	0.7	0.0	0.0	0.7	0.4	688.6
15	0.597	0.0	0.0	0.7	0.0	0.0	0.7	0.4	689.0
16	0.577	0.0	0.0	0.7	0.0	0.0	0.7	0.4	689.4
17	0.557	0.0	0.0	0.7	0.0	0.0	0.7	0.4	689.8
18	0.538	0.0	0.0	0.7	0.0	0.0	0.7	0.4	690.2
19	0.520	0.0	0.0	0.7	0.0	0.0	0.7	0.4	690.6
20	0.503	0.0	0.0	0.7	0.0	0.0	0.7	0.4	690.9
21	0.486	0.0	0.0	0.7	0.0	0.0	0.7	0.3	691.3
22	0.469	0.0	0.0	0.7	0.0	0.0	0.7	0.3	691.6
23	0.453	0.0	0.0	0.7	0.0	0.0	0.7	0.3	691.9
24	0.438	0.0	0.0	0.7	0.0	0.0	0.7	0.3	692.2
25	0.423	0.0	0.0	0.7	0.0	0.0	0.7	0.3	692.5
26	0.409	0.0	0.0	0.7	0.0	0.0	0.7	0.3	692.8
27	0.395	0.0	0.0	0.7	0.0	0.0	0.7	0.3	693.1
28	0.382	0.0	0.0	0.7	0.0	0.0	0.7	0.3	693.4
29	0.369	0.0	0.0	0.7	0.0	0.0	0.7	0.3	693.7
30	0.356	0.0	0.0	0.7	0.0	0.0	0.7	0.3	693.9
31	0.346	0.0	0.0	0.7	0.0	0.0	0.7	0.2	694.2
32	0.336	0.0	0.0	0.7	0.0	0.0	0.7	0.2	694.4
33	0.326	0.0	0.0	0.7	0.0	0.0	0.7	0.2	694.6
34	0.317	0.0	0.0	0.7	0.0	0.0	0.7	0.2	694.9
35	0.307	0.0	0.0	0.7	0.0	0.0	0.7	0.2	695.1
36	0.298	0.0	0.0	0.7	0.0	0.0	0.7	0.2	695.3
37	0.290	0.0	0.0	0.7	0.0	0.0	0.7	0.2	695.5
38	0.281	0.0	0.0	0.7	0.0	0.0	0.7	0.2	695.7
39	0.273	0.0	0.0	0.7	0.0	0.0	0.7	0.2	695.9
40	0.265	0.0	0.0	0.7	0.0	0.0	0.7	0.2	696.1
41	0.257	0.0	0.0	0.7	0.0	0.0	0.7	0.2	696.3
42	0.250	0.0	0.0	0.7	0.0	0.0	0.7	0.2	696.5
43	0.243	0.0	0.0	0.7	0.0	0.0	0.7	0.2	696.6
44	0.236	0.0	0.0	0.7	0.0	0.0	0.7	0.2	696.8
45	0.229	0.0	0.0	0.7	0.0	0.0	0.7	0.2	697.0
46	0.222	0.0	0.0	0.7	0.0	0.0	0.7	0.2	697.1
47	0.216	0.0	0.0	0.7	0.0	0.0	0.7	0.2	697.3
48	0.209	0.0	0.0	0.7	0.0	0.0	0.7	0.1	697.4
49	0.203	0.0	0.0	0.7	0.0	0.0	0.7	0.1	697.6
50	0.197	0.0	0.0	0.7	0.0	0.0	0.7	0.1	697.7
51	0.192	0.0	0.0	0.7	0.0	0.0	0.7	0.1	697.8
52	0.186	0.0	0.0	0.7	0.0	0.0	0.7	0.1	698.0
53	0.181	0.0	0.0	0.7	0.0	0.0	0.7	0.1	698.1
54	0.175	0.0	0.0	0.7	0.0	0.0	0.7	0.1	698.2
55	0.170	0.0	0.0	0.7	0.0	0.0	0.7	0.1	698.4
56	0.165	0.0	0.0	0.7	0.0	0.0	0.7	0.1	698.5
57	0.160	0.0	0.0	0.7	0.0	0.0	0.7	0.1	698.6
58	0.156	0.0	0.0	0.7	0.0	0.0	0.7	0.1	698.7
59	0.151	0.0	0.0	0.7	0.0	0.0	0.7	0.1	698.8
60	0.147	0.0	0.0	0.7	0.0	0.0	0.7	0.1	698.9
61	0.143	0.0	0.0	0.7	0.0	0.0	0.7	0.1	699.0
62	0.138	0.0	0.0	0.7	0.0	0.0	0.7	0.1	699.1
63	0.134	0.0	0.0	0.7	0.0	0.0	0.7	0.1	699.2
64	0.130	0.0	0.0	0.7	0.0	0.0	0.7	0.1	699.3
65	0.127	0.0	0.0	0.7	0.0	0.0	0.7	0.1	699.4
66	0.123	0.0	0.0	0.7	0.0	0.0	0.7	0.1	699.5
67	0.119	0.0	0.0	0.7	0.0	0.0	0.7	0.1	699.6
68	0.116	0.0	0.0	0.7	0.0	0.0	0.7	0.1	699.6
69	0.112	0.0	0.0	0.7	0.0	0.0	0.7	0.1	699.7
70	0.109	0.0	0.0	0.7	0.0	0.0	0.7	0.1	699.8
71	0.106	0.0	0.0	0.7	0.0	0.0	0.7	0.1	699.9
72	0.103	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.0
73	0.100	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.0
74	0.097	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.1
75	0.094	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.2
76	0.092	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.2
77	0.090	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.3
78	0.087	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.4
79	0.085	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.4
80	0.083	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.5
81	0.081	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.5
82	0.079	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.6
83	0.077	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.6
84	0.075	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.7
85	0.074	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.8
86	0.072	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.8
87	0.070	0.0	0.0	0.7	0.0	0.0	0.7	0.1	700.9
88	0.068	0.0	0.0	0.7	0.0	0.0	0.7	0.0	700.9
89	0.067	0.0	0.0	0.7	0.0	0.0	0.7	0.0	701.0
90	0.065	0.0	0.0	0.7	0.0	0.0	0.7	0.0	701.0
91	0.063	0.0	0.0	0.7	0.0	0.0	0.7	0.0	701.0
92	0.062	0.0	0.0	0.7	0.0	0.0	0.7	0.0	701.1
93	0.060	0.0	0.0	0.7	0.0	0.0	0.7	0.0	701.1
94	0.059	0.0	0.0	0.7	0.0	0.0	0.7	0.0	701.2
95	0.057	0.0	0.0	0.7	0.0	0.0	0.7	0.0	701.2
96	0.056	0.0	0.0	0.7	0.0	0.0	0.7	0.0	701.3
97	0.055	0.0	0.0	0.7	0.0	0.0	0.7	0.0	701.3
98	0.053	0.0	0.0	0.7	0.0	0.0	0.7	0.0	701.3
99	0.052	0.0	0.0	0.7	0.0	0.0	0.7	0.0	701.4

Whole life cost charts







B 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*

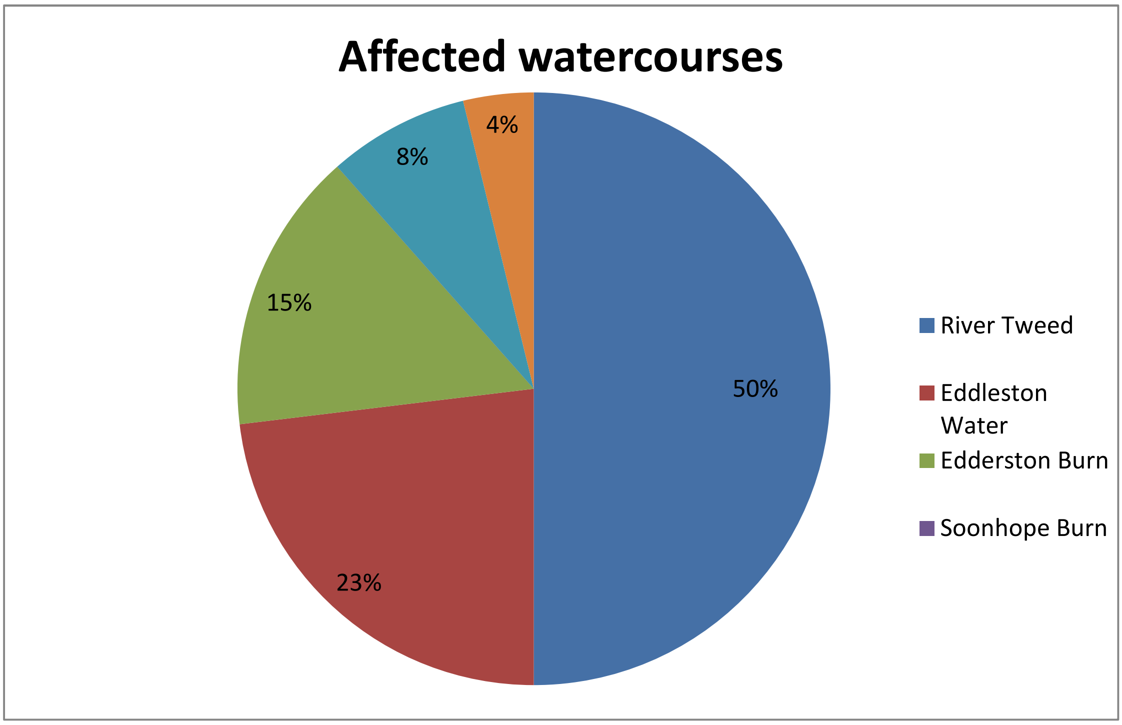
Question 1

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?

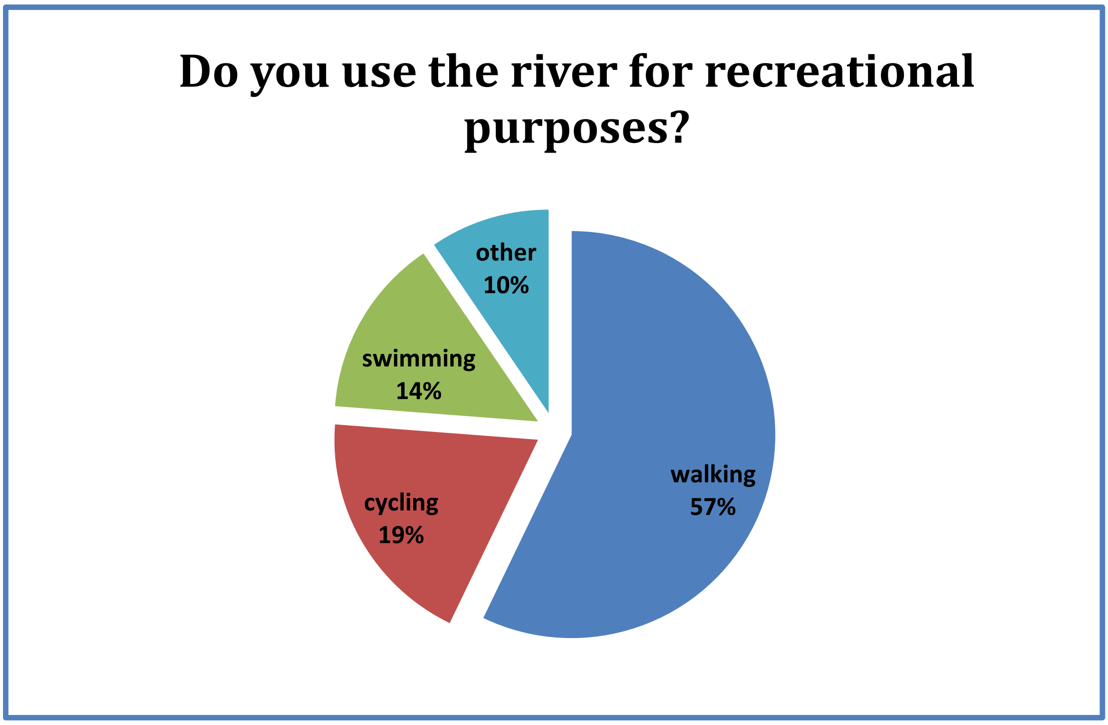
There was a divided response to this question. 8 People answered 'no' showing they are happy that the majority of flood issues in Peebles have been discussed. 3 people answered 'yes' and 6 left it unanswered however included comments regarding some issues that may have been missed. The comments from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