



Initial assessment report

Ilkley Denton Road FAS

February 2017

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Initial Assessment Report

Scheme
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or

Yorkshire Area Initial Assessment:
036 Ilkley Denton Road FAS



Flooding at Denton Road, Ilkley, Christmas 2015, on the River Wharfe

Date

February 2017

Version

1

Version control

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Project Sponsor Approval:				

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1.1 Introduction and background

1.1.1 Background

This is an initial assessment looking at possible new flood defences at Ilkley, West Yorkshire. At present, there are no registered flood defences at Ilkley and no areas benefiting from defences. An initial design for a flood alleviation scheme was proposed in 1992, however, this was not taken forward to construction. This scheme has funding allocated in year 7 (2022 – 2024).

1.1.2 Description of Location

The study area extends from the west of Ilkley town at the upstream end to the Ilkley sewage works at the downstream end (shown in Figure 1).

The River Wharfe at Ilkley is a predominantly natural channel, with several semi natural weirs.

Ilkley falls within the Ouse Catchment Flood Management Plan and the Bradford District Local Flood Risk Management Strategy.

Ilkley is in the low-range of deprivation, with areas ranging from the 1st to the 4th decile of deprivation (Figure 2). The majority of the area in question is within the 3rd decile, therefore, there are minimal opportunities for socio-economic improvements in the area.

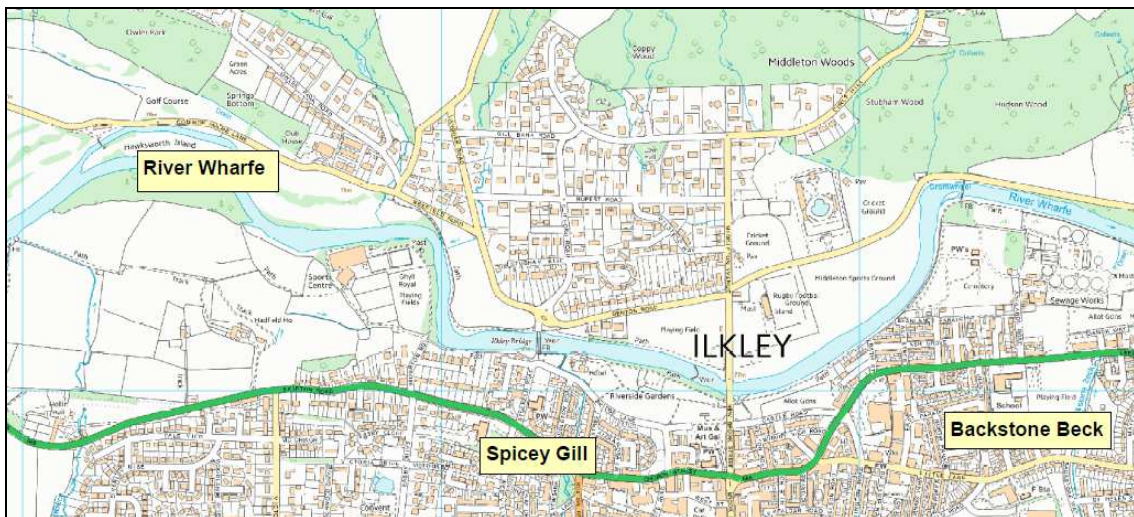


Figure 1: Location map. The study area is shown in red.

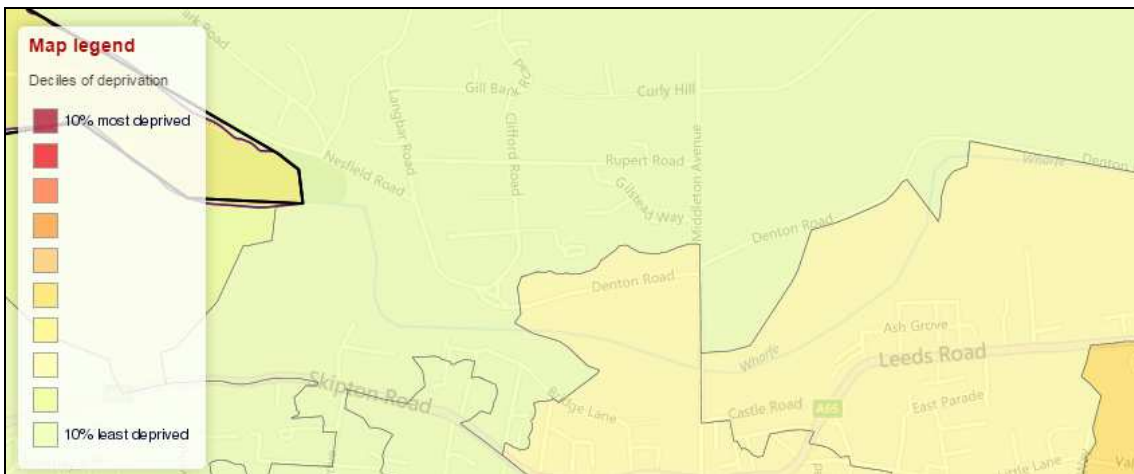


Figure 2: Levels of social deprivation in Ilkley, West Yorkshire (<http://dclgapps.communities.gov.uk/imd/idmap.html>)

1.1.3 Description of Watercourses and Geology

The main watercourse running through Ilkley is the River Wharfe. The River Wharfe is a tributary of the River Ouse (which itself is a tributary of the River Humber). The River Wharfe originates in the Yorkshire Dales National Park to the south of Bainbridge and flows south east through Ilkley, Otley, Wetherby and Tadcaster before entering the River Ouse near Cawood. There are also several tributaries that run through Ilkley into the River Wharfe including the Spicey Gill and Backstone Beck.

The River Wharfe through Ilkley is a mainly natural channel, which has possibly had its route altered in the past (shown in Figure 3). The Environment Agency have stated that this original route is now a possible flow path of the flood water across the farm land.

The geology around Ilkley is mainly superficial deposits of alluvium and till with a bedrock of sandstone.

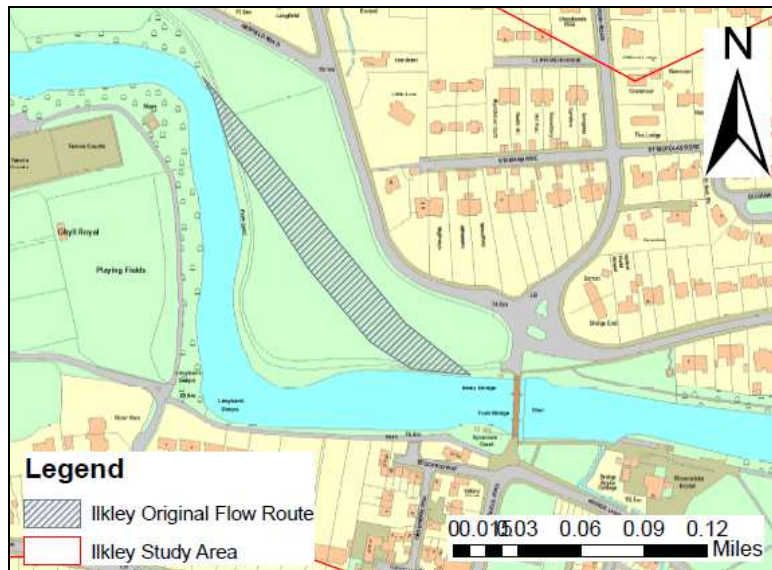


Figure 3: Possible historic watercourse route

1.1.4 History of Flooding

There have been several floods in Ilkley, notably severe floods in 1965, 1982, 1991 and 2002. The most recent floods were on Boxing Day 2015 where Ilkley was heavily affected and transport routes were disrupted in the area. It is assumed that properties did flood, however, there are no confirmed reports.

The flooding outline from the Boxing Day 2015 flood event is shown in Figure 4.



Figure 4: Boxing Day 2015 Flood Map

1.1.5 Summary of modelling analysis

The most recent modelling analysis is the 1D-2D ‘River Wharfe Modelling Study’ published by the Environment Agency in September 2014. This modelling does not, however, include Backstone Beck.

Previously in 2009 Halcrow carried out the River Wharfe Flood Risk Mapping & NFCDD report on behalf of the Environment Agency. This report found the peak flows at various points on the River Wharfe with rainfall events with a 50%, 20%, 10%, 4%, 2%, 1.33%, 1%, 0.5%, 0.2% and 0.1% annual probability of exceedance.

There is NaFRA modelling of the River Wharfe at Ilkley and the Flood Zone 2 and Flood Zone 3 flood extents. There is also a Flood Map for Surface Water (FMSW) 1000yr event for the region.

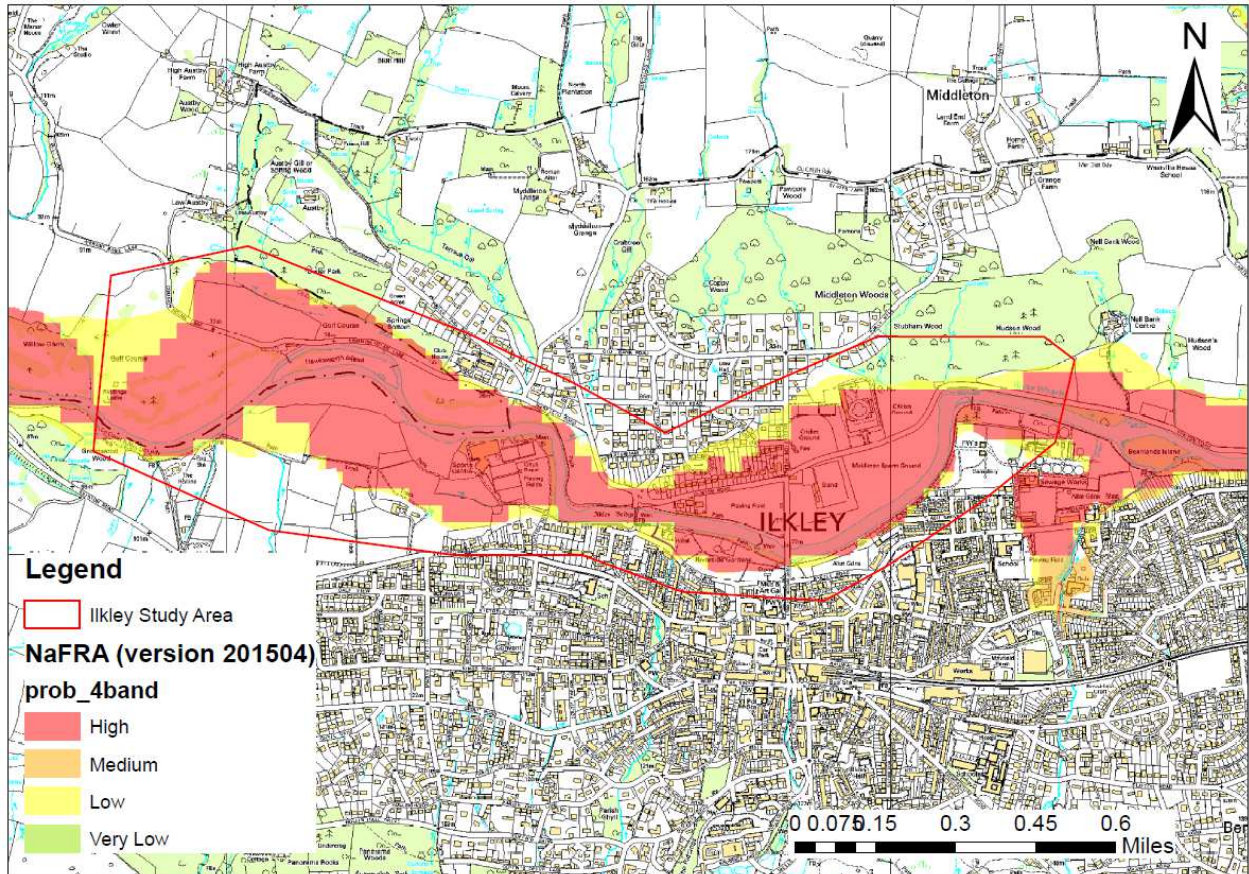


Figure 5: NaFRA Risk Bands at Ilkley

1.1.6 Drivers, Constraints and Opportunities

The following drivers constraints and opportunities have been identified within the study area.

Table 1: Ilkley drivers, constraints and opportunities

Political Drivers	Summary Description
<i>Catchment Flood Management Plan</i>	Ouse CFMP 2009
<i>Catchment Flood Management Policy</i>	5 - areas of moderate to high flood risk where we can generally take further action to reduce flood risk
Social Constraints	Summary Description
<i>Existing Public Space</i>	Ilkley Park, Ilkley Rugby Football Club, East Holmes Fields
<i>Existing Area of Multi-Functional Beneficial Open Space</i>	Ilkley Park, Ilkley Rugby Football Club, East Holmes Fields

Technological Drivers	Summary Description
<i>Improved Public Safety</i>	Through reduction of flood risk
Legal Drivers	Summary Description
<i>Countryside Rights of Way Formal Notice Required</i>	Dales Way
Environmental Constraints	Summary Description
Ancient Woodland	Owler Park, Stubham Wood and Hudson Wood within the study area.
Scheduled Monument	There are four listed buildings within the study area
Listed Buildings/Structures	There are four listed buildings within the study area
WFD Body	Good ecological status by 2027
WFD Status	Moderate

1.2 Problem and objectives

Problem

There are currently no registered flood defences at Ilkley and the town has a long history of flooding, most recently in 2015.

According to the mandate, residential properties on Denton Road, Gilstead Way and Middleton Avenue on the left bank of the River Wharfe are presently unprotected and at risk of flooding. There are estimated to be 58 properties at risk from a rainfall event with a 1 in 100 (1%) annual probability of exceedance, 51 of which are residential.

There are also known flooding problems at the rugby ground and cricket pavilion.

A flood alleviation scheme was proposed in 1992, including earth embankments, flood walls, footpath and road elevation and football field relocation, all in order to mitigate damages from a potential flood event. The earth embankment and walls had elevations between 1.4 and 2 metres high, however, the outline design didn't go to construction.

The current WFD status of the River Wharfe at Ilkley is moderate with a target of good ecological status by 2027 and good chemical status by 2015 (Humber river basin district RBMP 2009 Annex B: Water body status objectives).

Objectives

The objective is to identify a cost beneficial option to protect properties that are currently at risk from flooding at this location.

The purpose of this report is to lay the groundwork and, where applicable, provide a business case for future appraisal. The report aims to achieve the following:

- Confirm the need for a project;
- Identify the issues and Political, Environmental, Societal, Technological, Legislative and Economic (PESTLE) drivers and opportunities related to the need;
- Identify the options to address the need and problem;
- Demonstrate that viable options exist based upon the available information;

- Provide sufficient information to allow the packaging and optimisation of packages of future appraisal, design and construction packages;
- Provide sufficient information for the appraisal scope to be prepared;
- Make an assessment on the deliverability of the project;
- Provide a basis/starting point for discussion with communities and partner organisations for use in the development of potential schemes and negotiations regarding funding contributions.

1.3 Benefits

The benefits in this area associated with a reduction in flood risk would primarily be the reduction in economic damages to properties and maintaining open roads during high rainfall events. This in turn would reduce disruption to local transport, businesses, schools and other infrastructure.

The properties at risk according to NaFRA include 78 residential and 10 commercial buildings, distributed within the risk bands as shown below.

Table 2: Ground floor and basement properties at risk from flooding - NaFRA

Ground floor and Basement Properties at Risk from Flooding				
Residential Ground floor and Basement Properties at Risk				
	Low Risk	Moderate Risk	Significant Risk	Very Significant Risk
20% most deprived areas	0	0	0	0
20%-40% most deprived areas	0	0	0	0
60% least deprived areas	27	0	0	51
Commercial Ground floor and Basement Properties at Risk				
	Low Risk	Moderate Risk	Significant Risk	Very Significant Risk
20% most deprived areas	0	0	0	0
20%-40% most deprived areas	0	0	0	0
60% least deprived areas	3	0	0	7

Social benefits relate primarily to a reduction in stress, health effects (including risk to life) and loss of memorabilia for those at risk.

The economic benefits for each option has been assessed against the Do Nothing scenario, in which the number of properties in each risk band have been increased by 20% to demonstrate the increased risk from climate change.

An appraisal period of 100 years is assumed, over which the current standard of protection of existing assets is expected to decrease as a result of climate change.

A description of the benefits assessment method is shown in Appendix B.

1.4 Options

A longlist of options has been compiled. The table on the following page shows the large range of longlist options considered and the reasoning for or against them being taken forward to the shortlist of options to be assessed.

Table 3: Long-list of options

Category	Long List Option	Description	Take Forward for assessment?	Reasoning / Notes / Past Study Reference
Do nothing	Do nothing	All operational and maintenance activities cease.	Yes	Required to support development of business case and benefit cost ratios.
Do minimum	Do minimum	Continue with current operational and maintenance activities.	Yes	Represents the existing situation with maintenance of the river channel and river banks.
Improve Maintenance and/or operation	Do more	Enhanced maintenance activities, including routine dredging, etc. Capital Maintenance.	No	As per our consultation with the Environment Agency, minimal maintenance is carried out along the river corridor of Ilkley. This is to allow some naturalisation of the channel with intervention only if necessary. There are three bridges, located within the study area. However, there are no reported blockage issues/damage problems. There is a weir - where the gauging station is located - at the Ilkley Old Bridge, however, there have been no reported issues with operation.
Non-structural (by EA)	Improved flood warning	Enhanced flood warning to allow residents to prepare plus appropriate implementation of flood action plans	No	There are three gauging stations to the west of Ilkley on the river Wharfe at Addingham Town Beck, Addingham and Ilkley. These gauging stations are used to provide flood warnings and alerts for Ilkley therefore no additional gauging or warnings is thought to be needed.

Category	Long List Option	Description	Take Forward for assessment?	Reasoning / Notes / Past Study Reference
Non-structural (by EA)	Flood action plans	Improved direction of reactionary flood defence measure (fire crews, temporary pumps, etc.)	Yes, as a recommendation	There are no known local flood groups in Ilkley, therefore, there is an opportunity to engage with the community and help people help themselves with flood awareness and action plans.
Property level protection	Property level protection	Protection to individual properties (e.g. via air brick covers, door guards etc).	Yes	Property Level protection may be a viable option. 51 residential properties in Ilkley are estimated to be at a very significant risk of fluvial flooding. Four listed buildings around Ilkley flooded in the 2015 event, appropriate consents may be required for any proposed protection to them. Property Level Protection could also be useful as part of a wider scheme to offer protection to some properties not benefitting from the main option. This could particularly be the case for properties 1-9 Denton Road.
Operational (by Others)	Improve operation/design of assets not owned by the EA	For example, appropriate control of flood flows from/through 3 rd party sluices/weirs.	No	A site visit informed that there are no such defences present within the study area. There is a weir at Old Ilkley Bridge but it is owned by the Environment Agency.
Land management	Attenuate flows in rural area (farmland use)	Changes to land management practices or in certain parts of the catchment specific areas managed in specific ways.	Yes	The catchment upstream of Ilkley Tennis Club is mainly rural, with the potential to attenuate flows in a flood event. A wider catchment flood risk management plan to attenuate flows upstream in the catchment could be effective at Ilkley.

Category	Long List Option	Description	Take Forward for assessment?	Reasoning / Notes / Past Study Reference
Land management	Attenuate flows in urban areas (SUDS)	Use of SUDS drainage on new developments, make changes to urban areas to reduce speed of runoff.	No	There are no planned new developments in Ilkley.
Urban drainage	Improve urban drainage	Improved surface water drainage system.	No	The updated flood map for surface water 100-year and 1000-year shows that there are some residential properties, particularly in Bridge Lane, Middleton Road, Lakeside Close and Gilstead Way at risk. Bradford County Council are responsible for ensuring surface water drainage is sufficient.
Structural	Earth bunds	Flood bund	Yes	<p>In August 1992, Anthony Walker and Partners proposed a solution to construct new flood defences, a combination of embankments and walls, to provide protection against a rainfall event with a 1 in 100 (1%) annual probability of exceedance. However, this scheme wasn't taken forward to construction.</p> <p>There are locations where flood bunds and defences could be newly constructed, but this would involve impinging on the football pitch due to the large footprint needed, making this a less desirable option compared to a wall which has a much narrower footprint, avoiding the football field and maximising the size of the flood plain.</p> <p>Previous engagement with Sport England have indicated very little appetite for any loss of amenity.</p>

Category	Long List Option	Description	Take Forward for assessment?	Reasoning / Notes / Past Study Reference
Structural	Flood walls	Flood walls	Yes	<p>As detailed in section above, a design for the flood protection scheme was proposed in 1992, but was not taken forward to construction.</p> <p>A low rise brick wall running along the south side of Denton Road from the junction with Middleton Avenue to the western edge of the football pitch is proposed. This would need to be in conjunction with raising of the road level at Denton Road/Middleton Avenue junction.</p> <p>Detailed modelling would be required for this option to be considered viable.</p>
Structural	Demountable	Temporary demountable defences	Yes	<p>There are locations where demountable defences could be a viable solution.</p> <p>The temporary defence barriers on the west would begin from Nesfield Road and run along Denton Road and turning north up Middleton Avenue to join with the high-point. All residential properties could benefit, however Riverside hotel, located to the south of Dales Way, would still be at risk of flooding.</p>
Structural	Conveyance	Channel deepening or widening	No	<p>Channel deepening and widening could potentially be carried out along much of the River Wharfe, particularly outside the urban reach of the river, however, due to the River Wharfe being a WFD body with moderate status, channel deepening is not considered a suitable solution. Due to river crossings</p>

Category	Long List Option	Description	Take Forward for assessment?	Reasoning / Notes / Past Study Reference
				restricting the width of the channel, channel widening is not considered a suitable option.
Structural	Conveyance	Channel straightening	No	This is not considered to be a suitable option for this watercourse.
Structural	Conveyance	Supplementary bypass channel (s, tunnels or floodway	No	There is no suitable location for a bypass channel at Ilkley.
Structural	Conveyance	River restoration and/or pinch point improvements (bridges, culverts and weirs)	No	This is not considered to be a suitable option for this watercourse as the River Wharfe is largely a natural channel.
Flood storage area	Online	Use of active structures and re-profiling to store water online.	Yes	It is possible to create an online flood storage within the river corridor of Ilkley. This option could be used in conjunction with either a flood wall along Denton Road or raising the height of Denton Road It would be possible to reduce flood risk to the residential properties north of Denton Road, however, the properties located between Denton road and the river would remain at risk of flooding.
Flood storage area	Offline	Gravity or pumping to offline storage area	No	This is not considered to be a suitable option for this watercourse.
Floodplain storage	Washlands-type scheme	Enhance/increase natural floodplain attenuation with cascade of passive storage areas in existing floodplain	No	There are no suitable washlands for increased floodplain storage.

Shortlisted options description

Do Nothing

All operational and maintenance activities cease, this is the walkaway scenario. It is not a realistic option but is required as part of the appraisal by Defra Flood and Coastal Erosion Risk Management Appraisal Guidance.

Do Minimum

This option involves carrying out the basic level of maintenance required. Very little maintenance is currently carried out on the River Wharfe, however, there is an operational response. Due to this, this option is very similar to Do Nothing.

Option 1

Option 1 is to provide property level protection (PLP) for all residential properties that are currently at a very significant risk of flooding according to the NaFRA risk bands.

This option will move 51 properties from the very significant to the significant risk band and the assessment has an appraisal period of 20 years.

Option 2

Construction of an earth embankment along the south side of Langbar Road, to the south of all Denton Road properties through the football playing fields and to the south of Ilkley rugby ground. The embankment will have a maximum side slope of 1 in 4 and a total length of 1410m. Surface water outfall from Denton Road and Middleton Avenue will be designed into the embankment using penstocks and non-return valves. This option will protect all properties to the north of the embankment against a rainfall event with a 1 in 100 (1%) +CC annual probability of exceedance.

Property level protection has been included for the 8 properties at a very significant risk of flooding that are located to the south of the river and won't be protected by the earth embankment. Therefore, the cost of PLP for 8 properties has been included in Year 0, with only the cost of the main scheme to be used as an intervention cost in Year 50. As the appraisal period for property level protection is 20 years, these benefits have been calculated in a separate benefits spreadsheet from the main option benefits. This can be seen in Appendix B. The risk of flooding to these properties may also be increased further due to the loss of flood plain to the north of the river, at appraisal stage this will need to be fully assessed and compensatory works will need to be costed.

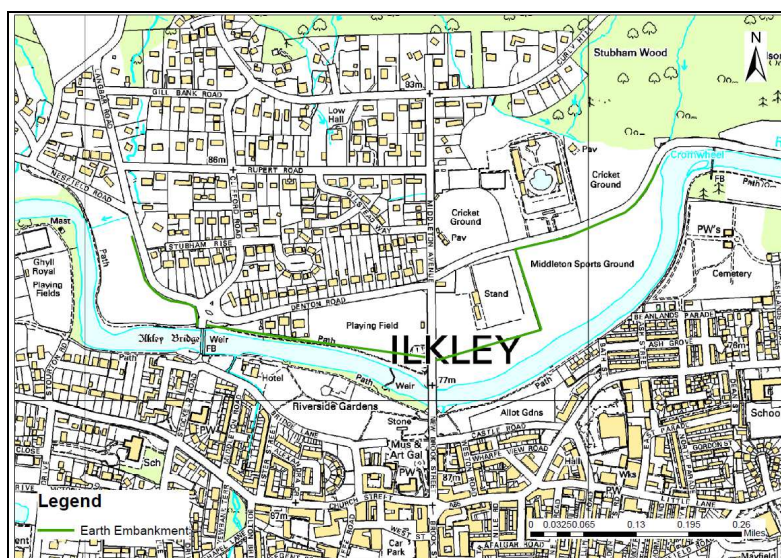


Figure 6: Location of new embankment

Option 3

Construction of a brick-clad reinforced concrete flood wall along the south side of Denton Road. This wall will be 1.1m high and will run for a total of 1110m. Road raising will also be carried out at the junction between Denton Road and Middleton Avenue. Surface water outfall from Denton Road and Middleton Avenue will be designed into the embankment using penstocks and non-return valves.

This will protect all properties to the north of Denton Road against a rainfall event with a 1 in 100 (1%) +CC annual probability of exceedance.

Property level protection has been included for the 8 properties at a very significant risk of flooding that are located to the south of the river and won't be protected by the flood wall. Therefore, the cost of PLP for 8 properties has been included in Year 0, with only the cost of the main scheme to be used as an intervention cost in Year 50. As the appraisal period for property level protection is 20 years, these benefits have been calculated in a separate benefits spreadsheet from the main option benefits. This can be seen in Appendix B. The risk of flooding to these properties may also be increased further due to the loss of flood plain to the north of the river, at appraisal stage this will need to be fully assessed and compensatory works will need to be costed.

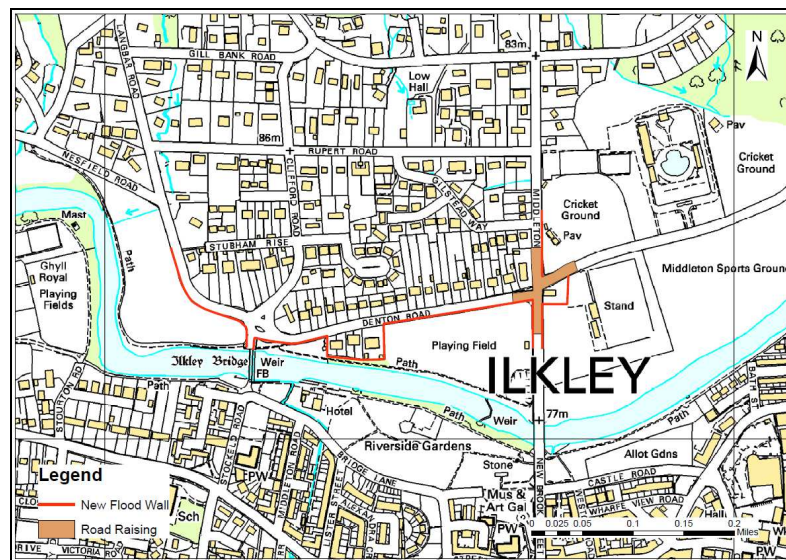


Figure 7: Location of the new flood wall and raised road.

Option 4

Deployment of 900m of demountable defences along Langbar Road, Denton Road and Middleton Avenue to protect properties to the north of Denton Road. The demountable defences will protect properties again a rainfall event with up to a 1 in 30 (3.33%) annual probability of exceedance.

The effectiveness of demountable defences depends on suitable prior warning being given and a comprehensive Temporary Defence Deployment Plan (TDDP) being produced that can be followed and enacted in the event of a flood. Suitable forecasting capabilities will need to be in place for this option to be effective.

The Environment Agency's "Cost estimation for temporary and demountable defences – summary of evidence, March 2015" suggests an appraisal period of 100 years. The cost of deployment prior to the flood, inspection for 24 hours and demobilisation after the flood for 250m of barrier is also suggested to be £6,500. Therefore, for 900m of a barrier a cost of £23,400 has been used and deployment is assumed to be carried out once every 10 years for the first 20 years, then at increasingly more frequent events as the effects of climate change are realised.

Finally, there is an annual maintenance and storage cost for the barriers, that has been taken as £4,500/year from the aforementioned report.

Property level protection has been included for the 8 properties at a very significant risk of flooding that are located to the south of the river and won't be protected by the demountable defences. Therefore, the cost of PLP for 8 properties has been included in Year 0, with only the cost of the main scheme to be used as an intervention cost in Year 50. As the appraisal period for property level protection is 20 years, these benefits have been calculated in a separate benefits spreadsheet from the main option benefits. This can be seen in Appendix B. The risk of flooding to these properties may also be increased further due to the loss of flood plain to the north of the river, at appraisal stage this will need to be fully assessed and compensatory works will need to be costed.

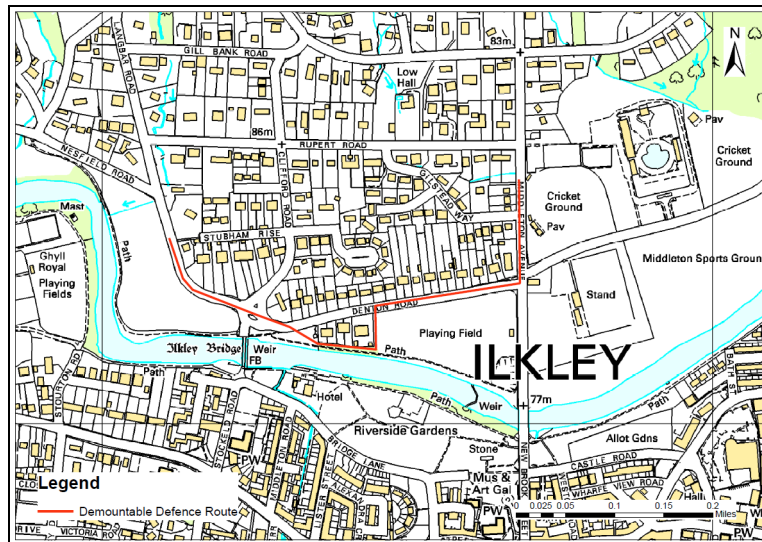


Figure 8: Route of demountable defence

Option 5

A flood storage area (FSA) constructed within farm/agricultural land upstream of Ilkley. This FSA could be landscaped to be 65,000m² in area with a depth of 1m throughout, created by excavation and bunds. The inlet to the FSA would be an inspill that will be set to overtop when the river reaches the equivalent level of a rainfall event with a 1 in 10 (10%) annual probability of exceedance, below the current threshold of flooding. The outlet is just upstream of the Ilkley Lawn Tennis and Squash Club and will allow water in the FSA to empty once the peak flows have passed. Hydraulic modelling will be required to check this option at appraisal stage.

The option will protect properties to the north of the river against a rainfall event with up to a 1 in 75 (1.33%) annual probability of exceedance and properties to the south of the river against a rainfall event with a 1 in 20 (5%) annual probability of exceedance.

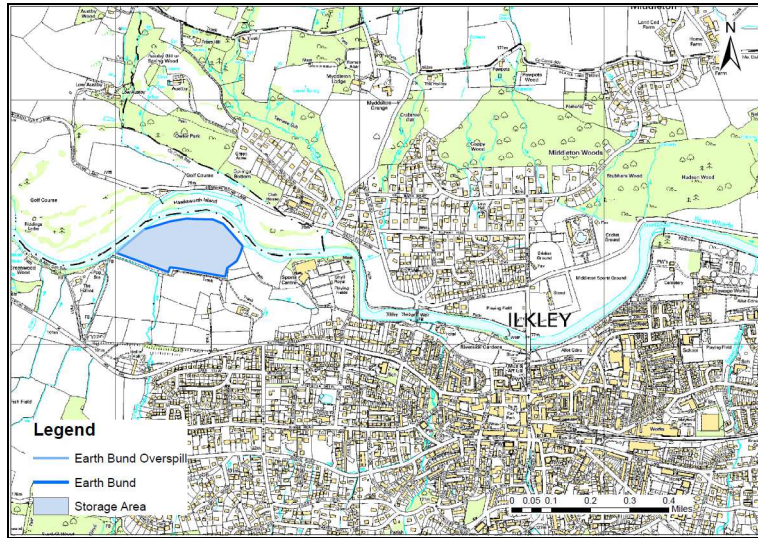


Figure 9: Location of flood storage area

1.1.7 Costs of options

The costs for the five options were calculated using the Environment Agency's Project Cost Tool and Long Term Costing Workbook. The maintenance and operation costs relate to:

- Maintenance of the assets to Target Condition 3, carried out mechanically.
- Annual incident response cost

It is assumed that a major replacement of assets will be required at some point during the appraisal period and after the initial construction phase. A detailed breakdown of costs is included in Appendix A.

Table 4: Project costs (£)

Item	Do Minimum	Option 1	Option 2	Option 3	Option 4	Option 5
Costs to PAR						
Consultant Fees (Appraisal)		19,997.71	55,490.71	153,535.39	52,710.34	162,283.74
Costs post PAR						
Construction Base Cost		357,102	1,124,461	3,125,373	941,256	3,311,913
Environment Agency staff		54,636.61	84,430.05	226,494.80	144,012.17	235,145.82
Consultant fees (design)		68,920.69	155,051.17	425,174.29	181,662.41	447,108.26
Consultant fees (construction)		17,855.10	63,702.17	177,754.15	47,062.80	188,779.04
Site investigation & survey		4,642.33	41,329.13	117,373.78	13,121.57	125,852.70
Land Purchase		228.55	5,378.08	15,382.64	4,462.05	16,559.57
Risk Contingency (44%)		230,288.51	673,130.60	1,866,074.33	609,086.43	1,974,562.53
TOTAL		753,671.48	2,202,972.86	6,107,152.36	1,993,373.76	6,462,204.65
Annual Maintenance Cost (target condition 3)	1407.36	1407.36	2370.27	2713.83	5,907.36	3542.26
Annual Operational Cost	650	650	650	650	650	650
Appraisal Period	100	20	100	100	100	100
Intervention						

Item	Do Minimum	Option 1	Option 2	Option 3	Option 4	Option 5
Costs						
Year 10					24,000	
Year 20					24,000	
Year 28					24,000	
Year 36					24,000	
Year 44					24,000	
Year 50			2,084,749.88	5,988,929.38	1,899,150.78	6,462,204.65
Year 52					24,000	
Year 59					24,000	
Year 66					24,000	
Year 73					24,000	
Year 79					24,000	
Year 85					24,000	
Year 90					24,000	
Year 95					24,000	
Present Value Cost	61,335	784,969	2,704,258	7,388,829	2,634,742	7,861,939

1.5 Initial environmental assessment

The River Wharfe at Ilkley is primarily a natural channel. The works being proposed do not significantly affect the environmental status of the watercourse or the surrounding environment. The main impacts of each option are described in the table below.

Table 5: Key environmental impacts, mitigation and opportunities

Key positive impacts	Key negative impacts	Mitigation/ enhancement opportunity
Option 1 – Property Level Protection		
No major impacts upon the existing environment	Minor works on buildings may produce noise, vibration and dust.	It is recommended that adverse impacts should be minimised as much as possible through the adoption of 'best practicable means' as defined in the Control of Pollution Act 1974 to minimise noise and vibration resulting from construction operations and shall have regard to British Standard BS 5228 1997 code of Practice for Noise Control on Construction and Open Sites.
	Short-term, temporary dust impacts possible during construction.	Adverse impacts should be minimised through the adoption of 'best practice measures'.
Option 2 – Construction of flood bund		

Key positive impacts	Key negative impacts	Mitigation/ enhancement opportunity
Improved standard of protection from flooding	Noise, Vibration and dust.	It is recommended that adverse impacts should be minimised as much as possible through the adoption of 'best practicable means' as defined in the Control of Pollution Act 1974 to minimise noise and vibration resulting from construction operations and shall have regard to British Standard BS 5228 1997 code of Practice for Noise Control on Construction and Open Sites.
Potential opportunities for betterment and WFD improvements.	The construction of any hard structures within the town of Ilkley have the potential to have a visual impact.	Defence raising will require a suitable visual assessment, however this is dependent upon the option selected. Innovative solutions may be available that maintain visual standards permanently or which only obstruct vision during a flood event.
	Trees may be affected by raising of embankments/construction of flood walls.	It is recommended to pursue an Extended Phase 1 habitat survey during which trees and vegetation will be identified and recorded.
	Potential for temporary footpath diversion during construction and permanent diversion following construction.	Any restrictions need to be fully explored and mitigated for during the detailed design stage of the project. Opportunities should be explored to enhance those footpaths which may be permanently moved following the works.
	Loss of floodplain	Further modelling would be required in order to assess the impact of removal of flood plain due to the construction of flood bunds/walls on communities further downstream. Compensatory flood plain storage may be required, adding to the costs of the scheme. It must be ensured that the compensatory storage is hydraulically linked to the flood plain lost, otherwise the benefits from it may not be fully realised.
	Loss of amenity of the football field.	Embankment to be designed either to minimise the side slope (allowing use of the football field) or to maximise the side slope (to reduce the intrusion onto the football field).
Option 3 – Construction of flood wall		
As per option 2 above.	As per option 2 above.	As per option 2 above.
Option 4 – Demountable Defences		

Key positive impacts	Key negative impacts	Mitigation/ enhancement opportunity
As per option 1 above.	Flood water level will be increased as the flood plain is reduced.	Adverse impacts should be minimised through the adoption of 'best practice measures'. Further modelling should be undertaken to assess the impact of removal of the flood plain and the affect this will have further downstream. Compensatory storage may be required.
Option 5 – Construction of a flood storage area		
Improved standard of protection from flooding	Noise, Vibration and dust.	It is recommended that adverse impacts should be minimised as much as possible through the adoption of 'best practicable means' as defined in the Control of Pollution Act 1974 to minimise noise and vibration resulting from construction operations and shall have regard to British Standard BS 5228 1997 code of Practice for Noise Control on Construction and Open Sites.
Potential opportunities for betterment and WFD improvements.	Trees may be affected by raising of embankments/construction of flood walls.	It is recommended to pursue an Extended Phase 1 habitat survey during which trees and vegetation will be identified and recorded.
	Potential for temporary footpath diversion during construction and permanent diversion following construction.	Any restrictions need to be fully explored and mitigated for during the detailed design stage of the project. Opportunities should be explored to enhance those footpaths which may be permanently moved following the works.

1.6 Consultation

The options in this Initial Assessment were developed in consultation with the Environment Agency. No public consultations were held at this stage, as the purpose of this work is a broad brush assessment of potential options. Stakeholder engagement will take place at subsequent stages of the project.

1.7 Economic summary and preliminary preferred option

The table below summarises the economic assessment carried out for all options. The calculations for PV benefits are shown in Appendix C.

Table 6: Benefit-cost assessment

	PV costs (£k)	PV benefits (£k)	Av. BCR	Incr' BCR	Option for iBCR calc	Comments
Do Nothing			-	-	-	Baseline option for comparison purposes only.
Do	61	2,166	35.51	N/A	N/A	Do Minimum gives the best BCR. However, the Do

Minimum						Minimum option leaves an unacceptably high level of flood risk and does not meet the project objectives, so is not taken forward for further assessment.
Option 1	785	4,935	6.29	N/A	N/A	PLP for all properties at a Very Significant risk of flooding.
Option 2	2,704	12,973	4.80	N/A	N/A	Construction of an earth embankment to the north of the River Wharfe and PLP for the 8 properties to the south of the river.
Option 3	7,389	11,450	1.55	N/A	N/A	Construction of a flood wall to the north of the River Wharfe and PLP for the 8 properties to the south of the river
Option 4	2,635	10,448	3.97	N/A	N/A	Demountable defences to the north of the River Wharfe and PLP for the 8 properties to the south of the river
Option 5	7,862	6,943	0.88	N/A	N/A	Construction of an offline flood storage area upstream of Ilkley.

Do Minimum has by far the best BCR of 35.51. However, this option does not meet the project objectives of reducing the flood risk to any properties, therefore, it has not been taken forward for further assessment.

Of the Do Something options, Option 1 has the greatest BCR with 6.29. This is due to the fact that the cost is significantly lower than that for Options 2, 3, 4 and 5.

Option 2, 3 and 4 all have good BCRs with 4.80, 1.55 and 3.97 respectively, therefore, they will all be taken forward for further assessment.

Option 5 has the lowest BCR of 0.88, however, this will still be taken forward through the assessment.

Table 7: Benefit-cost ratios and outcome measures

Contributions to outcome measures	Option 1	Option 2	Option 3	Option 4	Option 5
OM1 – Economic Benefit:					
<i>Benefit period used for Partnership Funding calcs</i>	20	100	100	100	100
<i>PV Benefits</i>	4,935,162	12,973,371	11,450,138	10,448,284	6,943,488
<i>PV Costs</i>	784,969	2,704,258	7,388,829	2,634,742	7,861,939
<i>Benefit/Cost ratio</i>	6.29	4.80	1.55	3.97	0.88
OM2 – No. of households moved out of any flood probability category to a lower category	51	51	51	51	43
OM2b – No. of households for which the probability of flooding or coastal erosion is reduced from the very significant or significant category to the moderate or low category	0	43	43	0	0
OM2c – No. of households in the 20% most deprived areas moved from the very significant or significant flood probability category to the moderate or low	0	0	0	0	0

category					
OM4a – Hectares of water dependent habitat created or improved to help meet the objectives of the Water Framework Directive	0	0	0	0	0
OM4b – Hectares of intertidal habitat created to help meet the objectives of the Water Framework Directive for areas protected under the EU Habitats/Birds Directive	0	0	0	0	0
OM4c – Kilometres of rivers protected under the EU Habitats/Birds Directive improved to help meet the objectives of the Water Framework Directive	0	0	0	0	0
Partnership Funding (PF) Score	46%	16%	5%	13%	3%
Contributions required for a PF score of 100% (£)	426,735	2,268,115	6,990,767	2,299,287	7,625,751
Contributions required for a PF score of 120% (£)	583,727	2,808,966	8,468,533	2,826,235	9,198,138

Funding and contributions

A funding analysis tool (see Appendix D) was used to identify potential direct and indirect beneficiaries of the scheme. Based on these beneficiaries, potential funding sources were identified. They include:

- Community Infrastructure Levy (CIL)
- Levy on residential properties (e.g. Council Tax)
- Local businesses

It is recommended that this funding analysis tool is updated at later stages of this scheme, when a more detailed and precise analysis of beneficiaries can be carried out.

1.1.8 Key delivery risks (economic, social and environmental)

Table 8: Risks and mitigation

Risk	Key Mitigation
Assumptions used to calculate damages could result in large inaccuracies in PV benefits. The benefit area has been approximated using best available data and engineering judgement, but could result in large inaccuracies.	Sensitivity testing has been undertaken which shows that the leading option remains cost beneficial. Breach and or blockage modelling should be carried out before progressing this scheme further, to improve estimation of the benefit areas.

Risk	Key Mitigation
The proposed works may cause disruptions to local residents and surrounding businesses. There is likely to be some temporary increased noise during the works.	Consultation and strict working hours will be required. It is recommended that adverse impacts should be minimised as much as possible through the adoption of 'best practicable means' as defined in the Control of Pollution Act 1974 to minimise noise and vibration resulting from construction operations and shall have regard to British Standard BS 5228 1997 code of Practice for Noise Control on Construction and Open Sites.
Environmental risks	Refer to environmental assessment in Appendix A

1.8 Project Scoring

The data used in this assessment has been subjected to a RAG assessment. The results are shown below:

- A – Problem Definition: The fluvial and surface water flooding mechanisms are well understood but no hydraulic modelling data has been used in the assessment – **AMBER**
- B – Economic Case: The benefits assessment has been based on moving properties from flood risk bands and weighted average annual damages – **RED**
- C – Funding: The options are likely to require external funding. Alternative funding sources have been identified – **AMBER**
- D – Engineering Case: Options are based on new engineering solutions and have been taken to an outline design level – **GREEN**
- E – Permissions & Consents: Solutions are likely to require permissions or consents of council/private owners – **GREEN**
- F – Environmental Sensitivities: Initial environmental assessments has been completed based on outline options – **AMBER**
- G – Opportunities: Some potential opportunities for partnership working but minimal environment opportunities – **AMBER**

Model. A	Econ. B	Funding C	Eng. D	Permission E	Env. F	RAG	Opps. G
2	3	2	1	1	2	132	2

The RAG score is used to give an indication of the viability of the project at this stage.

1.9 Further work requirements

It is recommended that to gain a clearer understanding of the flood risk, new modelling of the River Wharfe should be undertaken.

The table below gives an estimate of the complexity and duration of the project at each of the following Gateways.

Table 9: Programme Key dates

Gateway	Activity	Complexity	Duration (months)	Estimated Date
G0	Initial Assessment	Complete	-	-

Gateway	Activity	Complexity	Duration (months)	Estimated Date
	River Wharfe hydraulic modelling	Medium	4	01/01/2017 – 01/05/2017
	Update Initial Assessment and forward programme dates	Simple	1	01/06/2017
G1	Project start date			01/06/2017
	Strategic Outline Case	Simple	3	01/09/2017
	Appraisal	Simple	6	01/03/2018
	Outline Business Case	Medium	4	01/07/2018
G2	Detailed Design	Medium	12	01/07/2019
G3	Financial Business Case /Contract Award	Simple	4	01/11/2019
G4	Construction Completion	Medium	12	01/11/2020
G5	Handover	Simple	12	01/11/2021

1.10 Conclusions and Recommendation

In this Initial Assessment, the following options have been considered:

- **Do Minimum:** Continue with the current basic maintenance carried out on the River Wharfe at Ilkley
- **Option 1:** Provide property level protection (PLP) for the 51 residential properties that are currently at a very significant risk of flooding.
- **Option 2:** Construct an earth embankment through the playing fields to the south of Denton Road to protect effected properties against a rainfall event with a 1 in 100 (1%) annual probability of exceedance and provide PLP for the properties to the south of the river.
- **Option 3:** Construct a flood wall along the south of Denton Road to protect effected properties against a rainfall event with a 1 in 100 (1%) annual probability of exceedance and provide PLP for the properties to the south of the river.
- **Option 4:** Deployment of 900m of demountable defences along Langbar Road, Denton Road and Middleton Avenue to protect properties to the north of Denton Road and provide PLP for the properties to the south of the river.
- **Option 5:** Construction of a 65,000m² flood storage area within farm/agricultural land upstream of Ilkley. This will protect the properties to the north of the river against a rainfall event with a 1 in 100 (1%) annual probability of exceedance and the properties to the south of the river against a rainfall event with a 1 in 75 (1.33%) annual probability of exceedance.

Options not assessed directly but recommended include investigation of maintenance regime for ordinary watercourses and engagement with the local community. Please note that options

considered only address the fluvial flood risk and risk from sources including but not limited to surface water, sewer and canal must be considered in the further development of the options.

The economic benefits for each option has been assessed against the Do Nothing scenario, in which the number of properties in each risk band have been increased by 20% to demonstrate the increased risk from climate change. It is noted that the estimation of scheme benefits for this Initial Assessment has been based on property counts from NAFRA and the Weighted Annual Average Data from the Middlesex Multi-Coloured Manual, which is known to be inaccurate.

Option Scoring Discussion

The Do Minimum option gives the best BCR (35.51), however, the option leaves an unacceptably high level of flood risk and does not meet the project objectives. Therefore, this option has been discounted.

Of the Do Something options, Option 1 gives the best BCR (6.29) and best partnership funding score, 46%. These figures are the result of the low PV cost of PLP for the 51 properties at a very significant risk of flooding (£784,969). The PV benefits provided (£4,935,162) are in fact the lowest amount of benefits provided by any of the Do Something options, and there are no OM2b or OM2c benefits.

Option 2 gives the greatest amount of PV benefits (£12,973,371) and with a PV cost of £2,704,258 there is also a good BCR of 4.80. Option 2 also provides the same OM2 benefits as Option 1, plus OM2b benefits of 43. Option 3 also provides the same OM2 and OM2b benefits as Option 2, however, it only have BCRs of 1.55 as a result of lower PV benefits of £11,450,138 and higher PV costs of £7,388,829.

Option 4 provides the same OM2 benefits as all previous options and, like Option 1, does not provide any OM2b or OM2c benefits. With PV benefits of £10,448,284 and PV costs of £2,634,742, Option 4 provides a BCR of 3.97. However, there are uncertainties surrounding the costs associated with Option 4, as demountable defences have been purchased by the Environment Agency as part of a nationwide scheme to support communities remaining at risk from flooding. Ilkley meets the criteria to be included in this scheme, and therefore costs could be reduced if it is packaged together with other qualifying communities.

Option 5 provides the lowest BCR (0.88) and PF Score of all of the options due to a PV Cost of £7,861,939 and PV Benefits of £6,943,488. There are also uncertainties surrounding the volume of the storage area and whether this will be suitable enough to provide the described benefits. As the BCR is below 1, this option therefore not likely to be taken forward to appraisal, however, if another area is found further upstream that could increase the overall volume of storage the option could potentially be looked into further.

There are only 10 commercial properties at risk from flooding in Ilkley, 3 of which are at a low risk and 7 of which are at a very significant risk. Due to this the potential for Partnership Funding from local businesses is low. Potential funding partners at this stage are:

- Community Infrastructure Levy (CIL)
- Levy on residential properties (e.g. Council Tax)
- Yorkshire Water
- Local businesses

When considering any of the above options, effects on Yorkshire Water assets such as combined sewer overflows (CSOs) and the ability to discharge from surface water outfalls must be assessed. There are also several Yorkshire Water assets downstream including Ilkley's Wastewater Treatment Works.

It is highly recommended that detailed hydraulic modelling should be carried out in order to give a clear understanding of the Do Nothing and Do Minimum scenarios and including 1D and 2D

modelling of the River Wharfe. These should be carried out before a decision is taken on whether to progress to development of an OBC and develop further the options assessed here.

Appendices