Initial assessment report
Silsden Beck
September 2016

Using this template

The standard headings and tables in this template should be modified to meet the requirements of each Initial Assessment. The sites may have diverse issues and constraints and problems and the standard template is therefore just a guide on typical requirements but flexibility is allowed to amend/ add headings as required

Hidden guidance

The template contains various pieces of guidance covering content, use of tables etc. The guidance is shown in blue text and can be turned 'on' to assist in the writing stages or 'hidden' for viewing or when printing the document. You can switch between 'hidden' and 'on' and back to 'hidden' at any time.

To show/hide the guidance click on the ¶ icon on the MS Word toolbar.

If the hidden text does not disappear off the screen when the ¶ icon is clicked, go to: Tools>Options>View Tab and uncheck the 'Hidden text' box.

It is advisable to work with the hidden text turned on, as this helps to format new text and to avoid deleting the hidden text itself.

Auto-updating of contents page

The contents page will update to reflect changed information in the main text and tables. To update right click on the relevant area of the contents page, to highlight it, and select 'Update Field" to access the update option.

To enable these updating features to be created, the document contains specific text types and "fields". These are Headings 1, 2, 3 & 4; fields in the table labels and in the appendix labels. When editing the document, take care to maintain these aspects.

Inserting new headings

To insert new headings in the main text go to: Format>Styles and Formatting to open the styles box. Insert the new headings, highlight it and click on the appropriate Heading level in the 'Pick formatting to apply' box. Paragraph text can be inserted and formatted in a similar way.

Inserting new tables

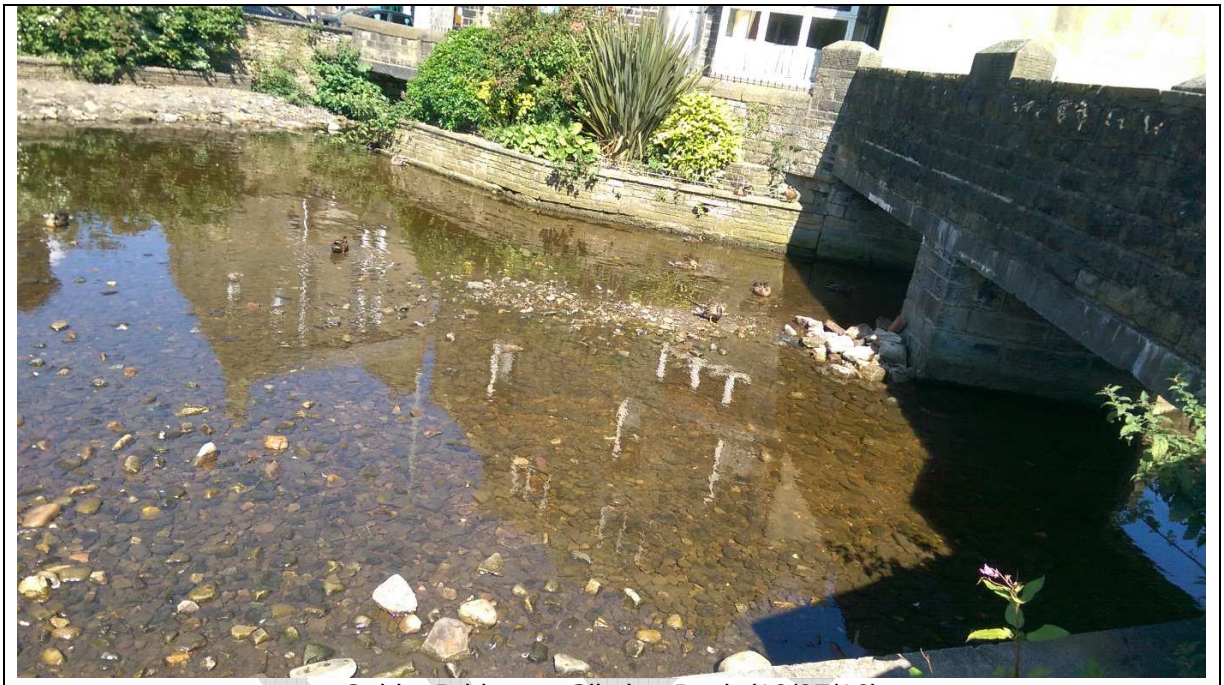
Table labels should be added by Insert>Reference>Caption and selecting 'Table' from the drop down 'Label' box. This will insert the Table title with the correct number and the caption can be typed in after the label. Tables can then be cross referenced from the text by Insert>Reference>Cross Reference and selecting the appropriate reference type and caption from the drop down box and list.

Numbering paragraphs

All paragraphs should be numbered sequentially as sub-sets of the section number. Prompts for paragraph numbering are provided as ‘Start writing here’ after which pressing <return> will automatically provide the next paragraph number.

1 Initial Assessment Report

Scheme or project location name	Yorkshire Area Initial Assessments: Silsden Beck



Cobby Bridge on Silsden Beck (19/07/16)

Date	August 2016
Version	0

Version control

Version	Status	Signed off by:	Date signed	Date issued
01	Draft	Graham Fardell		
	Final			

Contact Details

Role	Name	Post Title
Project Sponsor		
Senior User		
Senior Supplier	Richard Crowder	
Project Executive	Paul Stainer	
Project Manager	Glenn Fieldhouse	

Sign Off

Form completed by:	Name:	Title: Project Manager	Signature:	Date:
Project Executive Approval:	Name:	Title: Project Team Leader	Signature:	Date:
Senior User Approval:	Name:	Title:	Signature:	Date:
Project Sponsor Approval:				

CONTENTS

APPENDICES

Appendix A	Option cost details
Appendix B	Site visit
Appendix C	Funding calculation sheet/s
Appendix D	Benefit details
Appendix E	Site location plan

1.1 Introduction and background

In May 2016 CH2M were commissioned by the Environment Agency, on behalf of Bradford Metropolitan District Council, to undertake Yorkshire Area Initial Assessments report for Silsden Beck providing guidance on measures to reduce flood risk and potential funding availability. A site visit for this Initial Assessment was undertaken on 19th July 2016. This report has been made based on information from the site visit and previous studies and reports that are relevant to this Initial Assessment.

1.1.1 Description of Location

Silsden is a town and civil parish situated in West Yorkshire. The town is located at the intersection of the Leeds & Liverpool Canal and Silsden beck. It lies in the catchment of the River Aire, approximately 1 km upstream of the Silsden Beck confluence with the River Aire. The town has an estimated population of approximately 8250 people.

During the Boxing Day 2015 flood event, most of the town, especially the centre, was affected by flooding. The principal source of flooding has been identified as two low points located between Cobby Bridge and the weir (Locations of identified low points are shown in Appendix E – Figure 2). During rainfall events the site is affected by surface water runoff from the nearby playing fields.

According to the Index of Multiple Deprivation (IMD), this area is amongst the 40% least deprived neighbourhoods in the country.

A location plan is shown in Appendix E – Figure 1.

1.1.2 Description of Watercourses and Geology

Silsden Beck is a small watercourse that flows between Silsden Reservoir and the River Aire over a length of approximately 3.6 km. The Silsden beck catchment area is 13.4km^2, which has been considerably modified for flood defence purposes.

1.1.3 History of Flooding

Major historic flooding in the Aire catchment occurred in 1775, 1866 and 1946. Minor events occurred in 1967, 1980, June 2000, October/November 2000, February 2002 and August 2002, and July 2007.

Specific information for Silsden beck is not available.

1.1.4 Summary of Modelling Analysis

In 2001, the Upper and Lower Aire Preliminary Strategic Reviews concluded that a combined hydrological-hydraulic model was required to better understand the flooding mechanisms in the catchment and to support the development of a comprehensive strategy to manage flood risk to communities in the floodplain.

In 2001, Atkins were commissioned to deliver Phase 1 of the River Aire Modelling Study. Phase 1 involved the collection of new topographic survey and hydrometric data, estimation of flows using the methods detailed in the Flood Estimation Handbook (FEH) and construction and calibration of a hydrodynamic model of the River Aire and associated floodplains. This further lead onto the development of a robust calibrated model, which was then used to undertake a series of design runs.

The River Aire model reach was defined from Gargrave at its upstream extent, down to its confluence with the River Ouse downstream of Airmyn. In order to accommodate this long stretch, the River Aire was subdivided into the following three reaches and modelled accordingly:

- "Upper Aire" - from upstream of Gargrave Bridge to Leeds Station Weir (FDMS reaches 16-29)
- "Lower Aire" - from Leeds Station Weir to Fairburn Ings (FDMS reaches 12-15) and the Lower Calder from Stanley Ferry to its confluence with the Aire (FDMS reaches 1-3)
- "Tidal Aire" - from Fairburn Ings to the River Ouse at Airmyn (FDMS reaches 1-11)

The final three models combined to form a catchment wide one-dimensional hydrodynamic (ISIS) model which was deemed to effectively capture the flow attenuation within the catchment. The 1 in 100 year fluvial and 1 in 200 year tidal design flood levels were key deliverables from this study, which was completed in autumn 2004. This work formed the basis for the Upper Aire Flood Risk Management Strategy which aimed to define flood risk within this area and identify potential flood risk management options. The FRMS proposed flood risk management options for the medium and term, which included progressing a flood management scheme for defences at Silsden.

The existing hydraulic model has allowed for climate change up to the year 2105 with a 30% increase to the hydrological inflow. However the guidance for climate change analysis has been updated since the Upper Aire Modelling Study and therefore these results are now outdated. Climate change modelled flood outlines were not considered in this initial assessment with analysis using present day outlines to assign flood risk bands. The model has not been calibrated since the work undertaken in 2002-2004 and should be updated including recent events, if the scheme progresses to OBC stage.

1.1.5 Drivers, Constraints, Opportunities

Silsden is within the area of the River Aire Catchment Flood Management Plan (CFMP), issued by the Environment Agency in 2010, and is covered by sub-area 3 Worth and Aire. The designated policy for residential areas at risk is Policy Option 5: *areas of moderate to high flood risk where we can generally take further action to reduce flood risk.* This policy will tend to be applied to those areas where the case for further action to reduce flood risk is most compelling. The CFMP vision is to improve the co-ordination between the several organizations that manage the different source of risk.

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

Political Drivers	Summary Description
Catchment Flood Management Plan	River Aire CFMP 2010
Catchment Flood Management Policy	Policy 5: Areas of moderate to high flood risk where we can generally take further action to reduce flood risk
Economic Drivers	**Summary Description**
Enable Development	There is potential development at this site but is dependent on flood risk and the outcome of this options analysis.
Technological Drivers	**Summary Description**
Improved Public Safety	Via reduced flood risk.

1.2 Problem and objectives

1.2.1 Problem

Site observations from local residents state that during the December 2015 flooding, high river levels inundated the study area at several locations, particularly at the two low points detailed in Section 1.1.1. The flow overtopped the left bank low point, flowed southwards down St. John's Street inundating the properties on either side of the street. During the Boxing Day rainfall event, circa 340 residential and commercial properties were flooded.

Other damage was caused by a significant amount of surface water cascading down from playing fields. The flow was blocked by a wall on St John's Street that took the full force of the flow resulting in part of St John's Street and the riverside wall being seriously damaged. The structural integrity of the wall is also compromised by a large tree that is growing through it.

This initial assessment focuses on fluvial issues in Silsden and in particular the current condition of the linear defences along Silsden Beck's left bank, adjacent to Silsden Weir. If the proposed options are progressed beyond initial assessment stage, further modelling will be required in order to assess the surface water problem at this site.

1.2.2 Objectives

The primary objective of this initial assessment is to undertake a scoping study for the area to identify the flood risk issues and viable solutions for the affected properties in order to reduce the flood risk.

The aim is to identify the most cost beneficial option for addressing flood risk at this site. 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 primary benefit associated with a reduction in flood risk would be the reduction in economic damages to properties. This would result in the reduction of disruption to local transport, businesses, schools and other infrastructure.

The properties at risk include residential, commercial and public buildings.

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

An appraisal period of 100years is assumed, over which the current standard of protection of existing assets is expected to decrease as a result of climate change. This appraisal assesses the current asset to 'maintain the current standard of protection'. In order to quantify the benefits of a scheme, Flood Map for Planning (Rivers and Sea) – Flood Zone 2 was used in order to assess which properties are at risk of flooding. In addition NaFRA data was used to define the current flood risk associated to the properties in the benefit area. The properties were classed into the Very Significant, Significant and Moderate risk bands. It was assumed that properties in 1in20 year (5%) Annual Exceedance Probability (AEP) and higher were at Very Significant risk, properties which fall between 1in20 year (5% AEP) and 1in75 year (1.3% AEP) were at Significant risk, properties between 1in75 year (1.3% AEP) and 1in200 year (0.05% AEP) were at Moderate risk and 1in200 year (0.05% AEP) and lower were at Low risk. A more detailed methodology for this benefit assessment, and the assumptions made, are included in Appendix D.

This assessment only considers benefits for a scheme which addresses fluvial issues. Although there are surface water problems at this site, there is insufficient information to be able to quantify benefits associated with schemes focusing on surface water. If the proposed options are progressed beyond initial assessment stage, it is recommended that further modelling is undertaken to consider surface water problems.

Table 1.1 Number of Properties at Risk (based on current outlines)

Property Type	Flood Risk	Number of Properties
Residential	≥1 in 25 year (4% AEP) (Very Significant Risk)	0
	<1 in 25 year (4% AEP) ≥1 in 75 year (1.33% AEP) (Significant Risk)	46
	<1 in 75 year (1.33% AEP) ≥1 in 200 year (0.5% AEP)	179

	(Moderate Risk)	
Non-Residential	≥1 in 25 year (4% AEP) (Very Significant Risk)	1
	<1 in 25 year (4% AEP) ≥1 in 75 year (1.33% AEP) (Significant Risk)	16
	<1 in 75 year (1.33% AEP) ≥1 in 200 year (0.5% AEP) (Moderate Risk)	30

The property count showing in Table 1.1 is based on NaFRA data. Due to the current condition of the wall on the left bank of Silsden Beck, we believe that properties are at higher risk. Therefore, for the Do Nothing and Do Minimum scenario have been assumed by shifting properties into a higher risk band.

1.4 Options

A long list of options has been compiled for the study area and is summarised in the table below. The table shows the range of options considered and the reasoning for or against them being taken forward to the short list of options to be assessed.

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: channel, weir and wall maintenance.	Yes	Represents current approach to asset maintenance and repair. Minor works to retain necessary performance.
Non-structural (by EA)	Improved flood warning	Enhanced flood warning to allow residents to prepare	No	Fluvial warning was issued but there is the need to align warning to include surface water.
Non-structural (by EA)	Flood action plans	Improved direction of reactionary flood defence measure (fire crews, temporary pumps, etc.)	No	The study area is already within a Flood Alert area operated by the Environment Agency.
Property level protection	Property level protection	Protection to individual properties (e.g. via air brick covers, door guards etc).	Yes	PLP is assumed to be viable for all ground floor residential properties in the very significant risk band. However, the depth of flooding at these properties would have to be analysed at the next stage, as PLP is only suitable where the flood depth is less than 500mm and duration less than 3 days.
Operational (by Others)	Improve operation/design	Improve operation/design of assets not owned	Yes	There is a privately owned wall along Silsden Beck that is in need of imminent repair. This wall could be replaced by a formal

Category	Long List Option	Description	Take Forward for assessment?	Reasoning / Notes / Past Study Reference
		by the EA		flood defence with a scheme which prevents impoundment / obstruction of surface water flows into the beck.
Urban drainage	Improve urban drainage.	Improved surface water drainage system.	Yes	Implementing surface water drainage scheme to allow any overland flow to drain back into the river immediately downstream of the weir where there is capacity (see option 3 in the short list of option)
Structural	Flood Wall	Bank raising	Yes	Filling in two low spots upstream of weir to reduce overtopping. This does not address the current condition of the wall. To be considered in combination with another option (Improve Operation/Design)
Structural	Conveyance	Channel deepening or widening, including routine dredging.	No	No space to accommodate this.
Structural	Conveyance	River restoration and/or pinch point improvements (bridges, culverts and weirs)	No	The efficiency of the weir is not judged the reason of the flooding
Flood storage area	Online	Use of active structures and re-profiling to store water online.	Yes	Utilise Yorkshire Water Reservoir as a flood storage area. A study is ongoing as part of Yorkshire Water Price review 2019. Although data is not available for

Category	Long List Option	Description	Take Forward for assessment?	Reasoning / Notes / Past Study Reference
				this option currently, this option should be considered for any future appraisal. Further information has been detailed in section 1.4.1. under option 5.
Flood storage area	Offline	Gravity or pumping to offline storage area	No	There is not sufficient space to create FSAs of the required size in or near the study area.

1.4.1 Shortlisted Options Description

The options below were chosen to be taken forward for assessment in the initial assessment

Do Nothing

The Do Nothing option is defined as taking no action whatsoever; under this option all management activities would cease, including maintenance and repair work to existing assets.

There could be some advantages of this option in the form of habitat creation due to wetting of dry areas and naturalisation of channel, however, this is also likely to increase the risk for the urbanized areas.

The Do Nothing option is not to be taken forward as a viable option (progressed for benchmarking only) as it results in an unacceptable increase in flood risk to people and property due to failure and deterioration of assets and blockages to the channel.

Do Minimum

The Do Minimum option is defined as the minimum level of action or intervention necessary to sustain the standard of service (SOS) presently offered throughout the study area. It will form the appraisal baseline.

This option assumes continuation of the existing maintenance regime. This includes maintenance requirements for existing structures and assets, channel maintenance, operation and maintenance of weirs and other in-channel structures and where possible, existing non-structural measures such as flood forecasting and flood warning.

The advantage of Do Minimum is that it sustains current standard of service within the study area and there are no increase in costs associated with this option.

The disadvantages of Do Minimum is that the current maintenance regime is not believed to significantly reduce the flood risk to people and properties in the study area. It does not account for the increase in flood risk due to climate change. A further solution would therefore be required in order to reduce the effect of higher frequency flood events.

Due to the current condition of the wall on the left bank of Silsden Beck, the Do Minimum option will require an initial intervention to repair the damaged wall in order to sustain the standard of service as defined above. The works assumed for this intervention are as detailed in Option 2 (however the two low points in the banks will not be addressed here).

There are no indicators to suggest that this option is non-viable or undeliverable.

Option 1: Property Level Protection

This option is to offer property level protection (PLP) to the 46 ground floor residential properties in the Significant risk band. PLP can take the form of barriers in doorways, non-return valves fitted to drains, and airbrick/vent covers. Properties can also be made more flood resilient, using waterproof plaster, solid concrete floors or tiled floor coverings in order to reduce the amount of time and money needed to recover from a flood event. PLP is generally used as an option for properties that experience less than 500mm of flooding.

Advantages of this option include the fact that defences have minimal visual and land impact, and do not remove any of the flood plain area. PLP will protect against surface water as well as fluvial flooding. Any changes would need to be in keeping with surroundings.

Disadvantages of this option include the requirement for residents to receive sufficient alert and for them to be available and educated in deploying PLP measures. Furthermore, PLP does not provide any wider environmental benefits and does not prevent the flooding of areas surrounding the property. The effectiveness of PLP reduces with long duration floods due to seepage. Deliverability of this option is reliant on the resident's take-up of PLP.

For the purpose of this IA, this option has been assessed for 46 properties which are currently in the Significant risk band (according to NaFRA), however further modelling is recommended to better understand if there are any properties at high risk of flooding which will be eligible for FDGiA funding.

Option 2: Wall replacement to existing standard of protection

This option focuses on the current condition of the wall which runs along the left bank of Silsden Beck. The damaged wall is approximately 80m in length and from initial judgement at the site visit for this initial assessment, the first 60m needs to be completely replaced and the remaining part requires only a partial refurbishment. If this option is considered in future, structural surveys will be required to confirm the length of wall requiring full replacement. The damage was caused by the high energy flow that originated from the Mitchell Lane area, and increased hydrostatic loading on the wall.

This option is a permanent option and does not require operation. It consists of the replacement of the damaged wall for a length of approximately 60m with a 12m sheet pile wall. Considering the poor condition of the remaining portion of the wall, it is also recommended to refurbish the top of the remaining part for a length of 20m with a reinforced concrete wall, 1,5m high.

The wall replacement and refurbishment will be to the same height in order to maintain the existing standard of protection. The current standard of protection is not known, however based on NaFRA data, a standard of protection of 1in50 year (0.2% AEP) has been assumed for the purpose of this initial assessment. Should this work be progressed beyond this stage, it is highly recommended that further modelling is undertaken to understand the flood risk in the area and provide a more accurate benefits assessment.

Site observations from local residents, verified by a review of crest levels, show that the majority of the flooding came from the two low points just upstream of the weir. Part of this option involves continuing the wall, on both the sides of the river, where the two low points are located. Locations of identified low points are shown in Appendix E – Figure 2.

It is highly recommended to increase the number of outfalls in the wall in order to allow surface water drainage to discharge into the beck.

Option 3: Wall replacement to improve standard of protection to 1in100 year (1% AEP)

This option is similar to Option 2, however the height of the wall on the left bank of Silsden Beck will be increased to provide a standard of protection of 1in100 year (1% AEP).

Due to limited data, it is not fully understood at this stage if increasing the height of the wall will increase flood risk on the opposite bank. For the purpose of this initial assessment, a fixed cost of £100k has been assumed to cover any required works on the right bank of Silsden Beck as a result of this option. It is recommended that for any future appraisal further hydraulic modelling is carried out to understand the flood risk caused by increasing the height of the defences on the left bank.

Option 4: Improve urban drainage

This option will attenuate the surface water run-off from the playing fields at Mitchell Lane. This will consist of building a 200m embankment around the playing field to form a basin to store surface water. This will require 550m of pipeline to allow this basin to drain into Silsden Beck.

This option increases flooding to the playing fields during a flood event. However this is not thought to be a significant impact as the field will only be flooded during exceptional events.

This basin will need periodical maintenance work such as debris removal, grass cutting and management of the vegetation.

Previously, Yorkshire Water had some serious issues with their networks within this area. After sewage flooding in 2011, the Keighley Low Level Drainage Area Plan has been prepared by Yorkshire Water Services, Environment Agency, Aire River Trust and councillors.

This option will not be assessed further as part of this initial assessment because there is insufficient information available in order to assess the flood risk due to surface water. However, should this initial assessment be progressed to outline business case and beyond, further modelling should be undertaken to better understand the surface water problem in this area. Yorkshire Water is interested in a partnership opportunity and would be happy to provide a 1D-1D sewer model for the Keighley Lower Drainage Area within any further studies.

Option 5: Flood Storage (Silsden Reservoir)

Silsden Reservoir has been identified as a potential storage reservoir to attenuate fluvial flood waters.

The impact of using Silsden Reservoir as a storage area could be a reduction in flood risk, however this is uncertain. The Environment Agency would have to undertake detailed hydraulic modelling to understand whether altering the way the reservoir is operated could provide a flood risk benefit.

In operating the reservoir for flood risk management, there may be serious implications for reservoir safety and compensation flows in the downstream catchment.

A study is ongoing with Defra, the Environment Agency, Yorkshire Water and United Utilities to understand what potential there is across the region for using reservoirs for flood storage, whilst also taking into account drinking water supply, reservoir safety, and other risks. This option could be used in conjunction with other options, for example repairing the flood defences.

At this stage, there is insufficient information to fully assess the costs/benefits of this option. Therefore, the economic analysis for this option is not presented in this report but the option could be considered in any future studies. As a first step, the Environment Agency would have to undertake detailed hydraulic modelling to understand whether the reservoir could provide a flood risk benefit. Should it be shown that some flood risk benefit could be provided, a range of other issues would also have to be considered before any such option could be progressed. Amongst other issues, consideration would have to be given to reservoir safety and the future ability to provide environmental compensation flows into the downstream catchment. A regional study is ongoing with Defra, the Environment Agency, Yorkshire Water and United Utilities to understand these wider issues. The costs of any work required to modify the reservoir to allow its use for flood storage would have to be assessed in the same way as any other flood mitigation options. Further, any such costs would have to be funded through FDGiA or similar sources, not through Yorkshire Water bills.

1.4.2 Costs of options

The costs for the options were provided by the Environment Agency and were calculated using the Environment Agency's Project Cost Tool and Long Term Costing Workbook. The maintenance and operation costs relate to maintenance to assets to target condition 3, carried out mechanically. The maintenance and operation costs are outlined in Appendix A.

It is assumed that a major replacement of assets will be required at some point during the appraisal period after the initial construction phase. The timing of these replacements is based on the EA's Asset Deterioration Guidance (2013), an appraisal period of 100 years has been used and the assumptions are outlined in Appendix A. Table 1.1 show the initial cost of the option.

Table 1.2 Project costs (£k)

Item	Do Min	Option 1	Option 2	Option 3
Construction Base Cost	353	197	403	*Assume same cost as Option 2 with additional £100k for additional works on right bank (as detailed above in shortlisted options) and additional £100k as an initial estimate for height increase in wall
Environment Agency staff	56	31	64	
Consultant fees (appraisal)	23	13	26	
Consultant fees (design)	77	43	87	
Consultant fees (construction)	20	11	23	
Surveys (Ground investigation)	4	2	4	
Surveys (Archaeological)	1	0	2	
Land purchase	0	0	0	
Sub-total	533	298	609	
Optimism Bias	234	131	268	
TOTAL	**767**	**429**	**877**	**1077**
Annual Maintenance costs	0.68	0.65	0.68	0.68

* These costs will need to be calculated more accurately for any future appraisal.

1.5 Initial environmental assessment

Table 1.3 Key environmental impacts, mitigation and opportunities

Key positive impacts	Key negative impacts	Mitigation/ enhancement opportunity
Option 1		
• Reduced risk of fluvial flooding • Low risk of pollution incidents and disruption to area during construction.	• Reduced risk of fluvial damages only up to 1in75 year (1.33% AEP) events. • Aesthetic impacts • A large proportion of the benefit area assumed for this initial assessment lies within the Silsden Conservation Area	• Best practice should be followed including referring to EA Pollution Prevention Guidance
Option 2		

Key positive impacts	Key negative impacts	Mitigation/ enhancement opportunity
• Reduced risk of fluvial flooding	• Construction work takes place alongside watercourse. Risk of pollution incidents and disruption to area during construction • Aesthetic impact in removing low spots in wall • A large proportion of the benefit area assumed for this initial assessment lies within the Silsden Conservation Area • Possibly temporary increase to noise/vibration levels during construction	• Best practice should be followed including referring to EA Pollution Prevention Guidance • 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.

1.6 Consultation

The options in this appraisal were developed in consultation with the Environment Agency and Bradford MDC. No public consultations were held at this stage as the work is a high-level assessment of potential options. Stakeholder engagement will take place at subsequent stages of the project.

If this project is taken forward for further appraisal it is recommended that consultation is focused on, but not limited to, the following:

- Statutory Stakeholders
- Residents in the area at risk
- Landowners and developers for the upstream storage option (Option 5).
- Riparian landowners, especially owners of riverside walls acting as informal defences.

A study is ongoing as part of Yorkshire Water Price review 2019 regarding the use of the Silsden Reservoir as a flood storage area. If this option, which is not assessed here, is feasible, then consultation with the Yorkshire Water will be required..

1.7 Economic summary and preliminary preferred option

Table 1.3 summarises the economic assessment carried out for all options. The calculations for PV benefits are shown in Appendix D.

Table 1.4 Benefit-cost assessment

	PV costs (£k)	PV benefits (£k)	Av. BCR	Incr' BCR	Option for iBCR calc	Comments
Do Nothing						

Do Minimum	311.43	Low:29 Mid:39 High:49	Low:0.09 Mid:0.13 High:0.16	N/A	N/A	
Option 1	1,389.92	Low:1100 Mid:1500 High:1900	Low:0.79 Mid:1.08 High:1.37	1.35	Do Minimum	
Option 2	969.62	Low:268 Mid:357 High:447	Low:0.28 Mid:0.37 High:0.46	0.48	Do Minimum	
Option 3	1,186.17	Low:1300 Mid:1800 High:2200	Low:1.10 Mid:1.52 High:1.85	2.01	Do Minimum	This is the preferred option with the highest ABCR

Option 3 is the preferred option with the highest ABCR. Option 3 has been taken forward. Preliminary estimates for Partnership Funding scores have been calculated and are shown in table 1.4. However, its benefit period for the Partnership Funding calculator is reduced to 70 years, as a major investment of greater than 20% of the initial capital cost will be needed at that stage. The calculations of the revised PV costs, PV benefits and PF score for Option 3 is shown in Appendix C, and summarised below.

The maximum grant rate for the Partnership Funding calculations has been reduced to 45% as a strategic approach has not been taken for the benefits assessment. For future appraisal, it is recommended that hydraulic modelling is carried out to better understand the surface water problem at Silsden and the results should be used to estimate benefits based on average depths.

Table 1.5 Benefit-cost ratios and outcome measures

Contributions to outcome measures	**Option 2**
OM1 – Economic Benefit:	
Benefit period used for Partnership Funding calcs	*70*
PV Benefits	Low:£900,000 Mid:£1,200,000 High:£1,600,000
PV Costs	£1,095,520
Benefit/Cost ratio	Low:0.82 Mid:1.10 High:1.46
OM2 – No. of households moved out of any flood probability category to a lower category	225
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
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 category	0
OM4a – Hectares of water dependent habitat created or	0

improved to help meet the objectives of the Water Framework Directive	
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
OM4c – Kilometres of rivers protected under the EU Habitats/Birds Directive improved to help meet the objectives of the Water Framework Directive	0
Partnership Funding (PF) Score	9%
Contributions required for a PF score of 100%	£997,142
Contributions required for a PF score of 120%	£1,013,500

1.7.1 Funding and contributions

A funding analysis tool was used to identify potential direct and indirect beneficiaries of the scheme. This is included in Appendix C. Based on these beneficiaries potential funding sources identified include:

- Community Infrastructure Levy
- Benefitting local businesses
- Local Enterprise Partnerships

Further consultation would be required to identify potential contributions

1.7.2 Key delivery risks (economic, social and environmental)

Table 1.6 Risks and mitigation

Risk	Key Mitigation
Inaccurate benefits assessment due to limited understanding of flood risk hence unreliable approach to economic damage calculations used for IA's.	A more accurate damages assessment based on hydraulic modelling and flood depth damage data should be considered before progressing to further appraisal.
Risk of pollution incidents and disruption to area during construction	Best practice should be followed including referring to EA Pollution Prevention Guidance
Risk of reducing the aesthetics of buildings (PLP)	When considering resistance measures keep in mind their impact on aesthetics of buildings (PLP)
Insufficient 3rd party Funding available to allow scheme to progress.	Assess potential funding options before progressing scheme appraisal further.

1.8 Further work requirements

If the project is taken forward for further appraisal, it is recommended that the following work is carried out:

- Investigate the potential of using Silsden Reservoir as a storage option. Consultation with Yorkshire Water will be required on completion of the Yorkshire Water Price review 2019

to understand the outcome of the study and the feasibility of the option. Investigate the feasibility of using Silsden Reservoir as a flood storage area. Modelling work would be needed to understand the impact that lowering levels in Silsden Reservoir would have on flood risk downstream. A study is ongoing with Defra, the Environment Agency, Yorkshire Water and United Utilities to understand what potential there is across the region for using reservoirs for flood storage, whilst also taking into account drinking water supply, reservoir safety, and other risks. The outcomes of this work would be needed to assess the feasibility of this option.

- Option 2 and 3 – Further hydraulic modelling will be required to understand the current standard of protection of the existing wall and better quantify the benefits the proposed options will bring. The modelling scenarios should include lower order events to understand the viability of raising the existing wall and providing a standard of protection to 1in100 year (1% AEP) plus climate change and 1in200 year (0.5% AEP) plus climate change.
- Further investigation into the surface water issue in Silsden. Modelling should be undertaken to understand how much surface water contributes to flood risk in this area. Yorkshire Water is interested in a partnership opportunity for upstream storage at Mitchel Lane. They would be happy to provide a 1D-1D sewer model for the Keighley Lower Drainage Area with further studies, so it can be integrated with a model which could look at the overland flow of flood waters.

Table 1.7 Programme Key dates

Gateway	Activity	Complexity	Duration (months)	Estimated Date
G0	Initial Assessment	Complete	-	-
G1	Project start date			January 2017
	Hydraulic Modelling to update IA and inform SOC	Medium	6	June 2017
	Strategic Outline Case	Medium	6	December 2017
	Outline Business Case	Medium	4	April 2018
G2	Detailed Design	Medium	12	April 2019
G3	Financial Business Case /Contract Award	Medium	6	October 2019
G4	Construction Completion	Medium	12	October 2020
G5	Handover	Medium	24	Octobrer 2022

1.9 Conclusions and Recommendation

The main risk of flooding in Silsden is fluvial from overtopping of the river banks in the low spots immediately upstream of Silsden Weir. There was significant flooding during December 2015 from Silsden Beck.

Option 3, is the highest scoring Do Something option. For the purpose of this assessment, the option has been proposed to improve the existing standard of protection to 1in100 year (1% AEP). However, it is recommended that further modelling is undertaken to better understand the current standard of protection in order to better estimate the benefits of increasing the height of the wall.

It is recommended that further work be undertaken to assess the feasibility of option 5; using Silsden Reservoir for flood storage, should this initial assessment be progressed further.

There is also a risk of pluvial flooding in Silsden. During the December 2015 flood event, significant damage was caused to the existing wall on the left bank of Silsden Beck due to surface water cascading down from the adjacent playing fields. Options 2 and 3 consider increasing the number of outfalls which will allow surface water to drain into the beck, however due to insufficient information of pluvial risk in this area, option 4 improve urban drainage has not been assessed as part of this assessment. It is recommended that further modelling is carried out to better understand the pluvial flood risk in Silsden. Potentially, Yorkshire Water would be interested in a partnership opportunity to work towards developing option 4 – improving urban drainage.

Appendices