Initial assessment report
Castlefields Lane, Bingley
November 2016

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1 Initial Assessment Report

Scheme or project location name	Yorkshire Area Initial Assessments: Castlefields Lane, Bingley

River Aire at Castlefields Lane

Date	November 2016
Version	1.0

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Project Sponsor Approval:				

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APPENDICES

1.1 Introduction and background

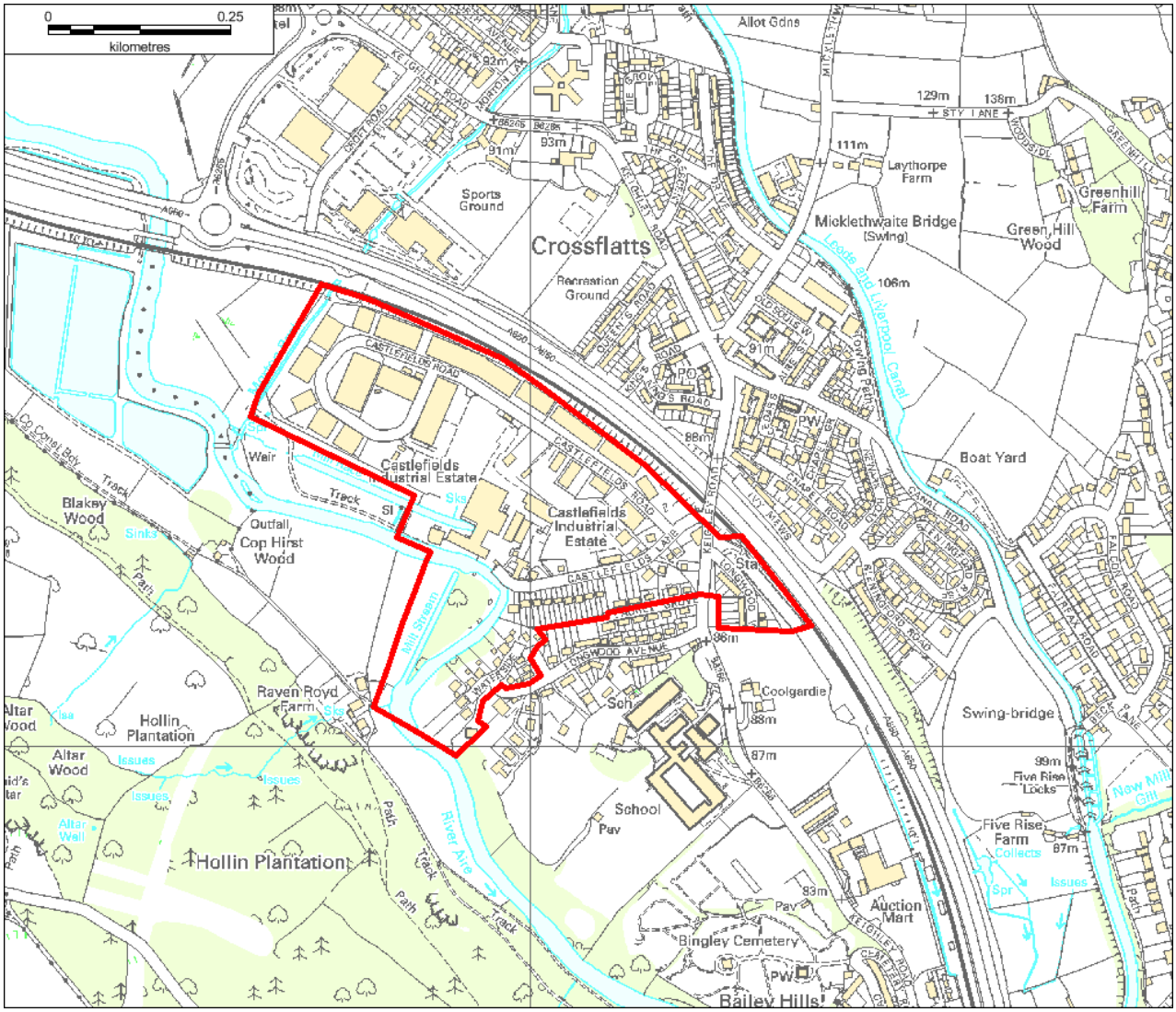
1.1.1 Description of Location

Castlefields Lane is a road in the town of Bingley within the Bradford Metropolitan District close to Castlefield Industrial Estate. The lower extent of this road is located alongside the River Aire. The study area incorporates the low-lying area of this road and the industrial estate, both of which are at risk of flooding from the left bank of the River Aire. The area experienced severe flooding during December 2015.

The study area falls under the Aire CFMP[1], and is covered by sub-area 3 Worth and Aire. The designated policy for the area at risk is Policy Option 5: *Areas of moderate to high flood risk where we can generally take further action to reduce flood risk.*

There are no previous studies for this area. The site has been identified for appraisal based on the impacts of the December 2015 flooding.

According to the Index of Multiple Deprivation (IMD), the area is amongst the 40 to 50% least deprived neighbourhoods in the country.



[1] River Aire Catchment Flood Management Plan - https://www.gov.uk/government/publications/river-aire-catchment-flood-management-plan

Figure 1: Castlefields Lane site location

1.1.2 Description of Watercourses and Geology

The River Aire is a major river in Yorkshire flowing from Malham in the Yorkshire Dales, through the urban areas of Bradford and Leeds, before joining the River Ouse at Airmyn. The Aire is approximately 71 miles in length from its source to its confluence.

The Upper Aire around Bradford is heavily urbanised and the floodplain is constrained by development. There are a number of tributaries within this area that respond rapidly to rainfall. There is also a large number of structures such as bridges in this area.

1.1.3 History of Flooding

The properties in the study area have been flooded several times in recent years. During the 2015 Boxing Day flood incident properties were flooded when high river levels in the River Aire caused the river to overtop its banks. Properties close to the river were flooded to a depth of 1.5m. This area was also flooded from the river in 2000, 2002 and 2012.

The Boxing Day 2015 flood incident was the largest flood event recorded across the Upper Aire. The return period of this event was estimated to be between 80 and 100 years (1.25%-1% AEP) at Kildwick in the Upper Aire and was higher further downstream with a return period of 200 years (0.5% AEP) at Armley.

There are also issues with surface water and ground water in the area with properties at low points reporting flooding from these sources.

1.1.4 Summary of Modelling Analysis

In 2008 hydraulic and hydrological modelling of the Upper River Aire was completed by JBA to support the development of the Flood Risk Management Strategy. For this study the River Aire was modelled from High Hill Weir upstream of Gargrave to Fleet Weir downstream of Leeds. The Upper River Aire model is a 1D hydrodynamic ISIS model containing 1922 nodes.

The 2008 modelling study aimed to define flood risk within this area and identify potential flood risk management options. This informed the Flood Risk Management Strategy for the Upper Aire. This strategy recommended local flood risk management schemes where there is a justification for this and identified a number of sites that should be progressed. Castlefields Lane was not identified as a priority site in this report.

1.1.5 Drivers, Constraints, Opportunities

The following drivers, constraints and opportunities have been identified within the study area. Refer to Appendix B for the full list of constraints that were considered.

Political Drivers	**Summary Description**
Catchment Flood Management Plan	River Aire Catchment Flood Management Plan 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**
Funding Time Constraints	Must be obtained within 6 year programme of capital investment
Technological Drivers	**Summary Description**
Improved Public Safety	Via reduced flood risk
Environmental Constraints	**Summary Description**
Special Area of Conservation (SAC)	South Pennine Moors 1.7km north east of study area
Listed Buildings	5 listed buildings along riverbank in area at risk
SSSI	Bingley South Bog SSSI 2km southeast of study area, South Pennine Moors 1.7km north east
Ancient Woodland	Blakey Wood 0.1 kilometre to the south west from the site

1.2 Problem and objectives

1.2.1 Problem

The site is at risk of fluvial flooding due to its proximity to the River Aire. The river bank at Castlefields Lane is low and close to properties. As such there is a risk of flooding from relatively small increases in river level.

There are 10 residential properties on Castlefields Lane, and 20 non-residential properties within Castlefield Industrial Estate thought to be at risk from a 1 in 25 (4%) flood incident and a further 2 residential properties on Castlefields Lane, and a further 6 commercial properties on the adjacent industrial estate at risk from a 1 in 200 (0.5%) flood incident.

Work is currently ongoing to determine the standard of protection provided by the riverbank at this location.

There are no flood defences in this location. Flood risk is currently managed through maintenance of the river channel, particularly by managing gravel build-up. Following the December 2015 flooding, a gravel shoal has been removed from the river adjacent to Castlefields Lane.

Properties are also at risk from surface water flooding due to the steep slope toward the river and the combined sewer that discharges into the river. In addition to this, there is thought to be a risk to properties from groundwater flooding.

1.2.2 Objectives

The primary objective of this initial assessment is to undertake a scoping study to identify the flood risk issues and viable solutions for the affected properties and to identify any other potential flood risk management measures which are consistent with the current CFMP policy.

The purpose of this report is to lay the groundwork and, where applicable, provide a business case for future more detailed 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

In this area the primary benefit associated with a reduction in flood risk would be the reduction in economic damages to properties. This in turn would reduce disruption to local transport, businesses, schools and other infrastructure.

The properties at risk consist of residential properties on Castlefields Lane and commercial properties within the adjacent Castlefield Industrial Estate. There are no significant public buildings within the study area.

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 100 years is assumed, over which the current Standard of Protection of existing assets is expected to decrease as a result of climate change.

In order to quantify the benefits of a scheme the 2008 modelled flood outlines were used to estimate the properties currently located within each risk band. Properties within the 1 in 25 year outline were assessed as being in the Very Significant risk band as there is no 1 in 20 year outline available. Properties within the 1 in 75 year outline were assessed as being in the Significant Risk band and Properties within the 1 in 200 year outline were assessed as being in the Moderate Risk band.

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

Property Type	Flood Risk	Number of Properties
Residential	≥1 in 20 year (5% AEP) (Very Significant Risk)	10
	<1 in 20 year (5% AEP) ≥1 in 75 year (1.33% AEP) (Significant Risk)	0
	<1 in 75 year (1.33% AEP) ≥1 in 200 year (0.5% AEP) (Moderate Risk)	2
Non-Residential	≥1 in 20 year (5% AEP) (Very Significant Risk)	20
	<1 in 20 year (5% AEP) ≥1 in 75 year (1.33% AEP) (Significant Risk)	1
	<1 in 75 year (1.33% AEP) ≥1 in 200 year (0.5% AEP) (Moderate Risk)	5

1.4 **Options**

A long list of options has been compiled for the study area and is summarised in the table on the following pages. The table shows the range of options considered and the reasoning for or against them being taken forward to the shortlist 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.	Yes	Required to support development of business case and incremental b/c ratio.
Non-structural (by EA)	Improved flood warning	Enhanced flood warning to allow residents to prepare plus appropriate implementation of flood action plans	No	Not funded via the capital programme. A Flood warning system is already in place for the River Aire at Crossflatts. Improving the current system would require further modelling which is beyond the scope of this study.
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 Warning and 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	This may be viable given the high risk and relatively small number of properties. Several properties in the area already have a degree of property-level protection. This option could also reduce the risk of surface water flooding. This would not have been effective for the depths of flooding experienced in December 2015.
Urban drainage	Improve urban drainage.	Improved surface water drainage system.	Yes	The area has been identified as being at risk of surface water flooding. This occurs during relatively minor incidents. Raising the level of the surface water drainage outfall in the area will allow this system to drain during high river levels. This will reduce the risk of surface water flooding.
Structural	Flood walls	Flood walls	Yes	Construction of a defence wall along the riverbank at Castlefields Lane will raise the standard of protection from fluvial flooding for properties in this area. Two Alignments for walls are considered, one focuses on

Category	Long List Option	Description	Take Forward for assessment?	Reasoning / Notes / Past Study Reference
				the residential properties at Castlefields Lane, the other defends this area and the adjacent Castlefield industrial estate
Structural	Conveyance	Channel deepening or widening	No	There is no available space for widening the river channel. The EA currently undertakes gravel removal from the channel at this location to maintain conveyance.
Structural	Conveyance	Supplementary bypass channel(s), tunnels or floodway	Yes	There is a historical mill race within the study area, this is currently blocked and disused. This channel could be reinstated to act as a flood relief channel. This would reduce flood risk but will not be effective in larger events.
Structural	Conveyance	River restoration and/or pinch point improvements (bridges, culverts and weirs)	No	There are no significant pinch points nearby contributing to flood risk.
Flood storage area	Online	Use of active structures and re-profiling to store water online.	Yes	The Upper Aire SFRA considered 2 online storage areas at Keighley Holden Park and Marley Bridge. These are upstream of Castlefields Lane and would reduce flood levels in the study area. These areas are being investigated for their benefits to Leeds City Centre as part of phase 2 of the Leeds FAS. This storage would also have benefits across the River Aire including the properties at risk at Castlefields Lane.
Flood storage area	Offline	Gravity or pumping to offline storage area	No	No offline storage sites have been identified.

1.4.1 Shortlisted Options Description

On-line Storage on River Aire

The modelling carried out to support the Upper Aire SFRA tested a number of on-line flood storage areas (FSA). Two of these were found to lead to significant reductions in flood risk. These sites are at Keighley Holden Park and Marley Bridge. Holden Park is the larger of these sites.

Both these storage sites are upstream of the Castlefields Lane study area. As such these sites would reduce flood risk at Castlefields Lane. The Marley Bridge FSA site is immediately upstream of Castlefields Lane on the north side of the A650.

These two FSAs were tested for a 1 in 100 (1%) AEP flood incident and were estimated to reduce flood levels by 0.89m at Castlefields Lane. There are also benefits across the River Aire downstream with an estimated reduction in flood levels of 0.43m in Leeds City Centre.

As the FSAs considered are active structures these would only provide a benefit when operated. This may not be the case in minor flood incidents. The current standard of protection at Castlefields Lane is low with 30 properties at risk of flooding from a 1 in 25 (4%) AEP flood incident. The FSAs may not protect against these lower return period flood events.

These FSAs have been considered primarily for their benefit in reducing risk to Leeds City Centre and are to be assessed as part of the modelling work for phase 2 of the Leeds FAS. However they will provide benefits to areas along the River Aire downstream of the FSA.

This initial assessment considers the Castlefields Lane area. Whilst the FSA upstream of here would reduce risk to Castlefields Lane it will have significant benefits beyond the study area. As such assessing the benefits and costs of this option are considered to be outside of the scope of this study, and therefore the option has not been taken forward for further assessment.

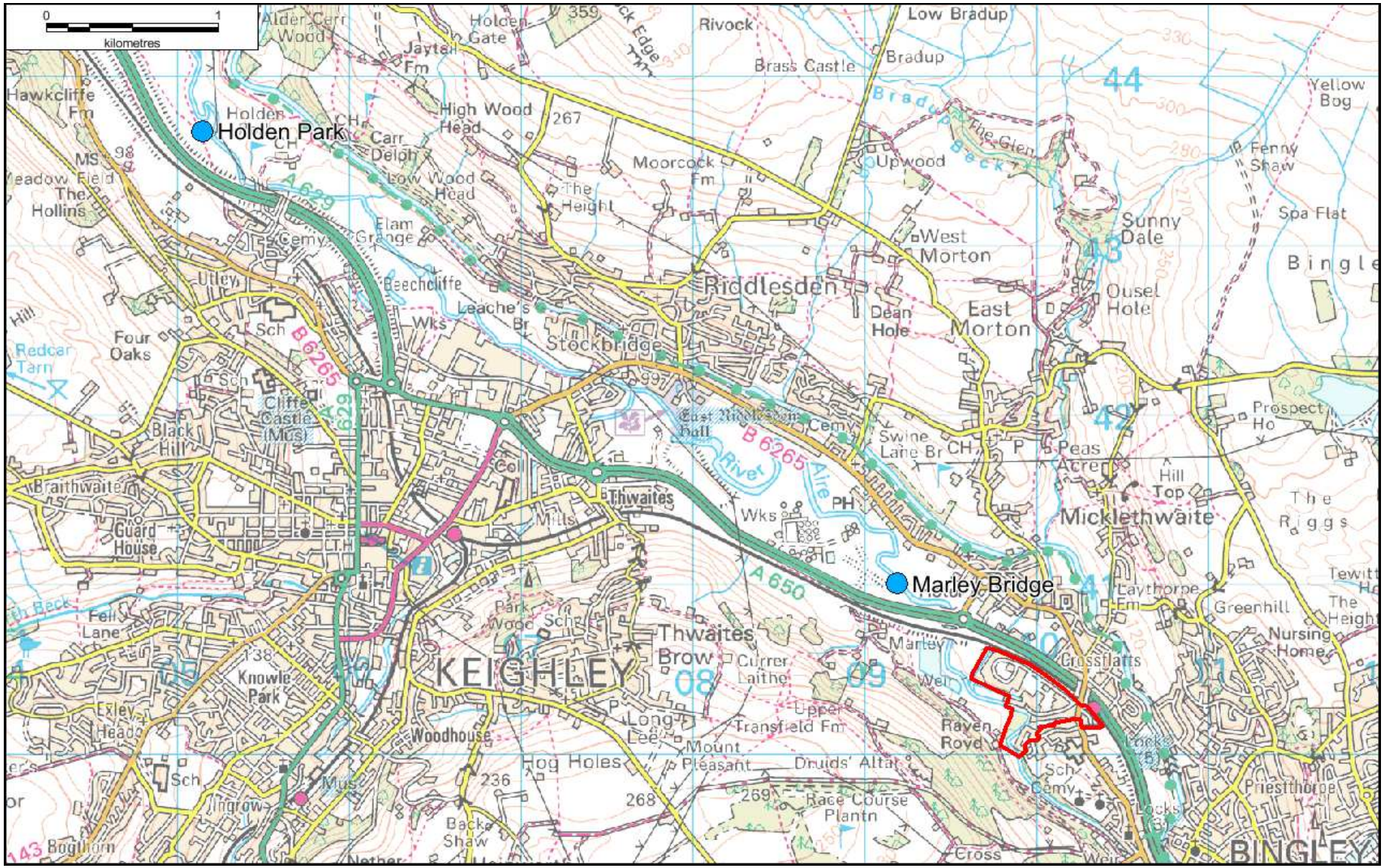


Figure 2: Approximate location of potential storage sites on River Aire

The following options were chosen to be taken forward for assessment in conjunction with the EA and Bradford Metropolitan District Council (MDC).

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.

Under this assumption, the natural deterioration of the channel would occur, leading to reduced conveyance and increased flooding.

The Do Nothing option is not to be taken forward as a viable option as it results in an unacceptable increase in flood risk to people and property due to failure and deterioration of assets. However, it needs to be considered as a baseline in order to measure the benefits of other options.

Do Minimum

The Do Minimum option is normally defined as the minimum level of action or intervention necessary to continue to maintain the existing flood management approach whilst it is sustainable to do so. It does not allow for any capital works and forms an alternative appraisal baseline to Do Nothing.

This option assumes continuation of the existing maintenance regime. For this site this will include channel maintenance and management of gravel build-up. This also maintains existing non-structural measures such as flood forecasting and flood warning. This site is within the Crossflatts flood warning area.

The advantage of Do Minimum is that it continues current flood risk management practice within the study area and there is 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. The properties within the study area are at risk of flooding from relatively common events and a further solution would therefore be required in order to reduce the effects of this.

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

Option 1 - Flood Walls along River Aire for Castlefields Lane properties

Construct flood walls to raise the level of the riverbank at the properties at risk of flooding.

The Standard of Protection offered by these flood walls is assumed to be 1 in 100 (1%) AEP throughout the appraisal period including the effects of climate change. As such the initial standard of protection would be expected to be greater than 1 in 100. The alignment of the walls and their dimensions are a rough estimate. If this option is taken forward, they will have to be assessed and optimised at that stage. The design of the flood walls must be made to fit visually in to the surrounding area.

This option is a permanent structural solution and does not require operation during a flood. Floodgates may be required to maintain access through the defence wall, these would therefore require closing prior to a flood incident. This will move 10 residential and 7 commercial properties at Castlefields Lane at significant or very significant risk to the moderate risk band.

Further modelling would be required in order to assess the impact of removal of flood plain due to the construction of this flood wall 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.

There may be aesthetic challenges to the scheme due to the close proximity of the walls to many properties. Views of the river, in particular from properties, would be adversely impacted as would access to the river for maintenance purposes. There are no environmental benefits to the scheme. Construction of the wall has the potential to cause temporary disruption to roads and properties.

More detailed assessment of this option would need to investigate the area and ground conditions to assess the technical challenges with constructing a wall at this location. This wall would need to be close to the river and close to properties with a limited working area available. Hydraulic modelling would also be required to determine the height of wall that would be required to provide the required standard of protection.

Option 2 - Direct Defences around Industrial Estate and Castlefields Lane properties

Construct flood walls and embankments around Castlefield Industrial Estate

This option is similar to Option 1 but constructs a longer length of defences to defend a larger area. Castlefield Industrial Estate is protected in addition to the properties on Castlefields Lane. Closer to the industrial estate there is sufficient space available to construct an embankment in place of a defence wall.

This will protect the commercial properties in the industrial estate in addition to the residential properties defended by Option 1. The advantages and limitations of this are similar to Option 1.

The Standard of Protection offered by these flood walls is assumed to be 1 in 100 (1%) AEP throughout the appraisal period including the effects of climate change. The alignment of the walls and their dimensions are an estimate. If this option is taken forward, these will have to be assessed and optimised at that stage. The design of the flood walls must be made to fit visually into the surrounding area.

More detailed assessment of this option would need to investigate the industrial estate to identify the business types in more detail to give estimates of the damages and benefits in this area. This would also allow any potential partnership funding opportunities to be identified. As with Option 1 the required height of wall would need to be assessed with modelling and technical feasibility investigated in more detail.

Option 3 - Reinstate Historical Mill Race as overflow channel

There is a historical mill race within the study area opposite the properties at risk. This channel has been blocked by the land owner and currently does not take any flow. This mill race could be reinstated and used as an overflow channel reducing flow in the main channel during flood events.

The channel is relatively small and would not have significantly affected flood depths during the 2015 Boxing Day event. However, the properties close to the river are at risk from minor events and this channel may reduce this risk. At this stage the assumption is made that this option would only benefit properties within the Very Significant risk band.

This will also have a benefit for properties at risk of surface water flooding. As this option will lower the river level the drainage network will be more able to discharge when there is a large river flow.

This would require engagement with the current landowner. There would also be additional maintenance associated with the new channel.

The benefits of this channel would need to be estimated in more detail in a more detailed assessment. Hydraulic modelling of the channel would be required to determine the amount that this channel would lower river levels in the main channel.

Option 4 - Raise outfall level of surface water drainage

Raising the outfall of the surface water drainage system would allow surface water to drain during high river levels. This will reduce the risk of surface water backing up and causing flooding during high river levels.

This outfall is currently owned and operated by Bradford MDC. Work was recently undertaken to raise the level of this outfall however these is still a risk of flooding and it is thought to be technically possible to raise the outfall further. It is assumed that pumps would not be required for the drainage system. Raising this outfall may have impacts on the drainage system further upstream, this has not been considered in the costs for this initial assessment.

This will not reduce the risk of fluvial flooding but evidence suggests that there is currently a high risk of surface water flooding. This would not have prevented the flooding caused by the Boxing Day 2015 event.

The current drainage network would need to be assessed to ensure that this option is feasible. The effects of raising this outfall on the drainage of nearby properties would need to be assessed to ensure this did not increase flood risk.

Option 5 - Property Level Protection

This option is to offer property level protection (PLP) to the 10 ground floor residential properties identified as being at Very Significant risk of flooding. 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.

Several properties within the area have already implemented property level protection to some extent.

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 the surroundings.

Disadvantages of this option include the requirement for residents to receive sufficient warning and for them to be available and trained in deploying PLP measures. Furthermore, PLP does not provide any wider environmental benefits and does not prevent the flooding of areas surrounding the property.

PLP is also only possible for properties in the Very Significant risk bank (based on NaFRA), and where flooding is less than 500mm deep. This option would not have prevented flooding of the scale experienced on Boxing Day 2015. The effectiveness of PLP reduces with long duration floods due to seepage. Deliverability of this option is reliant on the residents up take of PLP.

More detailed assessment of this option would require information on the current extent of PLP within the area. Depths of flooding would also be needed to assess the benefits of PLP and what standard of protection this could offer.

1.4.2 Costs of options

The costs for the options were calculated using the Environment Agency's Project Cost Tool and Long Term Costing Workbook. The maintenance and operation costs relate to mechanical maintenance of the assets to Target Condition 3. Land purchase costs for Option 3 are based on an estimate of £10,000 per acre of land purchased.

It is assumed that a major refurbishment 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), and the assumptions are outlined in Appendix C.

An appraisal period of 100 years has been used. A detailed breakdown of costs across this period is included in Appendix C.

Table 1.2 shows the build-up of costs for all options.

Table 1.2 Initial Project costs and ongoing maintenance (£k)

Item	Option 1 Flood Wall along Riverbank at Castlefields Lane	Option 2 Flood Wall for Castlefields Lane and properties at industrial estate	Option 3 Mill Race Bypass	Option 4 Raised Outfall	Option 5 PLP
Construction Costs	280.2	965.6	100.8	50.4	65.8
Environment Agency staff	44.3	152.6	15.9	8.0	10.4
Consultant fees (appraisal)	17.9	61.8	6.5	3.2	4.2
Consultant fees (design)	60.8	209.1	21.9	10.9	14.3
Consultant fees (construction)	15.7	54.1	5.6	2.8	3.7
Site investigation & survey	4.2	13.5	1.5	0.8	1.0
Land Purchase	0.3	4.8	25.9	0.1	0.1
Optimism Bias	186.3	643.7	67.0	33.5	43.8
TOTAL	**609.8**	**2106.6**	**245.1**	**109.6**	**143.2**
Annual Operation and Maintenance Costs	0.67	1.02	0.76	0.65	0.65

1.5 Initial environmental assessment

The main impacts of each option are summarised in Table 1.3.

Table 1.3 Key environmental impacts, mitigation and opportunities

Key positive impacts	Key negative impacts	Mitigation/ enhancement opportunity
Option 1 Flood Wall along riverbank at Castlefields Lane		
Reduced risk of flooding	Visual impact of wall Construction work alongside watercourse. Risk of pollution incidents and disruption to area during construction	Best practice should be followed including referring to EA Pollution Prevention Guidance
Option 2 Flood Wall for Castlefields Lane and properties at industrial estate		
Reduced risk of flooding	Visual impact of wall Construction work alongside watercourse. Risk of pollution incidents and disruption to area during construction	Best practice should be followed including referring to EA Pollution Prevention Guidance
Option 3 Mill Race Bypass		
Reduced risk of flooding Additional length of channel with associated ecological benefits	Loss of land between Mill Race and River	Early engagement with landowners recommended to enhance opportunities and minimise negative impacts
Option 4 Raised Outfall		
Reduced risk of surface water flooding if technically feasible		
Option 5 PLP		
Reduced risk of flooding	Flood protection measures may be limited for listed buildings in area	

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.

1.7 Economic summary and preliminary preferred option

Table 1.4 summarises the economic assessment carried out for all options. The calculations for PV benefits area shown in Appendix E. The options are ordered by benefit (lowest benefit first).

This benefit values are estimates based on the methodology detailed in Appendix D. There is significant uncertainty in these estimates, which are based on Weighted Annual Average Data (WAAD) from the Multi-Coloured Manual (MCM, 2015/16). If this project progresses to further appraisal the benefits of these options should be more accurately assessed though hydraulic modelling and use of the more detailed flood depth/damage data from MCM.

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	16.9	72.5	4.3			High ABCR but properties remain at Very Significant risk
Option 4 - Raised Outfall	128.5	442.0	3.44	3.31	Do Minimum	Highest ABCR and IBCR of Do Something Options
Option 5 - PLP	302.9	517.0	1.17	0.43	Option 4	PV Benefits highly uncertain as depends on reliability of deployment and technical suitability
Option 3 – Mill Race Bypass	265.3	700.1	2.64	2.89	Option 4	Higher benefit at lower cost than option 5. High ABCR and protects against Fluvial flooding
Option 1 – Flood Wall along riverbank	610.4	908.0	1.49	0.60	Option 3	Provides greater protection against overtopping but IBCR below parity compared to option 3
Option 2 – Direct defences around industrial estate	2176.5	4438.0	2.04	2.25	Option 1	Positive ABCR and IBCR. Provides greater benefits than other options. Possibly greater potential for Partnership Funding

The Do Minimum scenario has the highest average BCR justifying the continuation of the current maintenance regime. However, properties in the study area will remain at Very Significant risk in this scenario.

Options 3 and 4, reinstatement of the mill race as a bypass channel and raising of the surface water outfall both have high benefit-cost ratios. These options have high benefits through reducing damage from high frequency incidents. Neither of these options will prevent flooding in large flood incidents such as the Boxing Day flooding and properties will remain at some risk, so it is possible the benefits are overstated.

Option 2, defending the industrial estate and residential properties, also has high BCR although at a significantly higher cost than other options. This benefits the Non-Residential properties in the industrial estate that are also at risk from high frequency events. There may also be greater potential for partnership funding for this option due to the properties in the industrial estate benefiting from the scheme.

Preliminary estimates for Partnership Funding scores for Options 2, 3 and 4 have been calculated as shown in Table 1.5.

The benefit period for the bypass channel is 100 years as no further major investments will be required. The benefit period for the raised outfall and defence structures is 90 years as beyond this a further investment will be required to replace the outfall structure or defence walls. For PLP the benefit period is 20 years as after this the PLP measures will require replacement. The details of this calculation and sensitivity testing are including in Appendix F.

Table 1.5 Benefit-cost ratios and outcome measures

Contributions to outcome measures	Option 1 – Flood Wall along riverbank	Option 2 – Direct defences around industrial estate	Option 3 – Mill Race Bypass
OM1 – Economic Benefit:			
Benefit period used for Partnership Funding calcs	*90*	*90*	*100*
PV Benefits (£)	*890,229*	*4,351,172*	*700,066*
PV Costs (£)	*626,229*	*2,136,438*	*265,259*
Benefit/Cost ratio	*1.42*	*2.04*	*2.92*
OM2 – No. of households moved out of any flood probability category to a lower category	10	10	10
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	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 category	0	0	0
OM3 – No. of households better protected from coastal erosion	0	0	0
OM3b – No. of households protected against loss in 20 years from coastal erosion	0	0	0
OM3c – No. of households in the 20% most deprived areas protected against loss in 20 years from coastal erosion	0	0	0
OM4a – Hectares of water dependent habitat created or improved to help meet the objectives of the Water Framework Directive	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
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
Partnership Funding (PF) Score	16%	14%	30%
Contributions required for a PF score of 100%	£526,665	£1,843,930	£168,168
Contributions required for a PF score of 120%	£543,022	£1,891,662	£179,795

Contributions to outcome measures	Option 4 – Raised Outfall	Option 5 – Property Level Protection
OM1 – Economic Benefit:		
Benefit period used for Partnership Funding calcs	*90*	*20*
PV Benefits (£)	*477,269*	*241,750*
PV Costs (£)	*126,085*	*154,515*
Benefit/Cost ratio	*3.44*	*1.56*

Contributions to outcome measures	Option 4 – Raised Outfall	Option 5 – Property Level Protection
OM2 – No. of households moved out of any flood probability category to a lower category	8	10
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	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	0
OM3 – No. of households better protected from coastal erosion	0	0
OM3b – No. of households protected against loss in 20 years from coastal erosion	0	0
OM3c – No. of households in the 20% most deprived areas protected against loss in 20 years from coastal erosion	0	0
OM4a – Hectares of water dependent habitat created or improved to help meet the objectives of the Water Framework Directive	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
OM4c – Kilometres of rivers protected under the EU Habitats/Birds Directive improved to help meet the objectives of the Water Framework Directive	0	0
Partnership Funding (PF) Score	39%	19%
Contributions required for a PF score of 100%	£76,623	£124,604
Contributions required for a PF score of 120%	£84,695	£129,486

Option 2 has the lowest PF score and would require significant contributions to proceed. This option is considered less viable than Options 3 and 4 due its high cost. The preferred options from this appraisal are therefore Options 3 and 4.

Neither of these options fully addresses the risk of flooding from overtopping of the bank. Option 4 only addresses surface water flooding and not fluvial flooding. Option 3 will only have a benefit during minor events.

1.7.1 Limitations and Uncertainties

This initial assessment has produced a high-level appraisal of options available to manage flood risk at Castlefields Lane. There are limitations to the methodology applied and more robust appraisal would be required to have greater confidence in the results.

Costs for options are based on the EA Project Costing Tool. These costs will need to be reviewed in more detail for any future appraisal work.

The Weighted Annual Average Damages (WAAD) from the Multi-coloured Manual have been used to assess damages and hence benefits. This assesses damages based on the number of properties affected. This does not take into account the depths of flooding and more accurate damages could be calculated if this information on expected flood depths was available.

The WAAD methodology is unsuitable for assessing the impacts of climate change. Defences have been assessed as provided a constant standard of protection throughout the appraisal

period. Options accounting for future climate change will provide a higher standard of protection early in the appraisal period.

There is uncertainty of the risk of surface water flooding and the potential benefits options would have in reducing this. Properties at risk have been estimated based on LIDAR data and the risk of surface water flooding within the study area should be investigated in more detail.

1.7.2 Funding and contributions

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

- Local Authority Funding
- Community Infrastructure Levy
- Council Tax
- Benefitting Local Businesses (Option 2 only)

1.7.3 Key delivery risks (economic, social and environmental)

Key delivery risk and recommendations for mitigating these risks are shown in Table 1.6.

Table 1.6 Risks and mitigation

Risk	Key Mitigation
Bypass channel does not reduce flood levels to a sufficient extent to protect properties	Modelling of this option should be carried out to assess its impact on flood flows
Insufficient 3rd party Funding available to allow scheme to progress	Assess potential funding options before progressing scheme appraisal further.
Inaccurate benefits assessment due to limitations of approach to economic damage calculations used for IA	A more accurate damages assessment based on hydraulic modelling and flood depth damage data should be considered before progressing to further appraisal.

1.8 Project Scoring

The data used in this assessment has been subjected to a RAG assessment. The RAG score assesses the project against the categories shown below. This gives a three figure score with the first number being the number of reds, where there is significant uncertainty or challenges. The second and third numbers are the numbers of amber(defined as needs development, but is manageable) and green(well defined, not likely to be an issue) scores. The results are shown below:

- A – Problem Definition: The fluvial flooding is well defined with flood outlines but further investigations required to understand the surface water flooding mechanisms – **AMBER**
- B – Economic: There are limitations to the methodology applied and more robust appraisal would be required to have greater confidence – **RED**:
- C – Funding: The options are likely to require external funding. Potential funding sources have been identified – **AMBER**
- D – Engineering case: Preferred solutions are tried and tested defence options – **AMBER**
- E – Permissions & Consents: Solutions are unlikely to require unusual permissions or consents – **GREEN**
- F – Environmental sensitivities: Initial environmental assessments has been completed based on outline options, some impact from options requiring work close to river – **AMBER**
- G – Opportunities: Some potential opportunities for partnership working – **AMBER**

Model A	Economic B	Funding C	Eng. D	Permissions E	Env. F	RAG	Opps. G
2	3	2	2	1	2	141	2

1.9 Further work requirements

If the project is taken forward for further appraisal it is recommended that the effects of the bypass are modelled to assess what benefits this channel will have and how much damage is avoided from more frequent events. Similarly the effect of raising the outfall should be assessed in detail to determine the reduction in risk that can be achieved from this.

The condition of the mill race channel will need to be assessed to determine the work required to reinstate this. The structure associated with this channel is reported to have collapsed and this may increase the costs associated with its reinstatement.

More accurate information on flood depths at the properties for different annual flood probabilities are required in order to more accurately estimate economic damages and to confirm or rule out the viability of the PLP option. Table 1.7 outlines key dates if these options are taken forward for further appraisal.

A culvert was identified on the left bank of the River Aire close to Castlefield Industrial Estate. The ownership and route of this culvert is currently not known. This would need to be

inspected prior to any works taking place in order to understand if it influences flood risk in the area.

Neither of the preferred options prevent flooding to the area from larger flood incidents. Options providing higher standards of protection were seen to be less viable.

It is recommended to consider this area within larger appraisal projects. The flood storage areas investigated in the Upper Aire SFRA are being considered in Leeds FAS phase 2 would benefit Castlefields Lane as well as other properties close to the Aire at high risk where local schemes may be less beneficial. The Marley Bridge site is of particular benefit to Castlefields Lane due to its close proximity upstream of the site.

1.10 Conclusions and Recommendation

- Properties at Castlefields Lane and the adjacent Castlefield Industrial Estate are at high risk of flooding from the River Aire. The main risk of flooding is fluvial from the River Aire overtopping its banks. There is also a risk of surface water flooding particularly when the surface water drainage is unable to discharge into the river. There was significant flooding in the area during Boxing Day 2015.
- Due to the high risk of flooding in this area solutions providing a relatively low standard of protection have high benefits and can be shown to be economically viable. Option 3, creating a bypass channel, is a viable solution for managing flood risk and could be taken forward for further appraisal. This will reduce risk from both fluvial flooding and surface water flooding. Option 4, raising the surface water outfall will reduce the risk of surface water flooding to the area.
- Properties remain at high risk of flooding with both these options and these options would not have significantly reduced flooding to the area during the Boxing Day 2015 incident. Options that provide a higher standard of protection are less viable due to their higher costs.
- Previous assessment work has considered options for large-scale flood storage on the River Aire at Holden Park and Marley Bridge upstream of the study area. These would reduce flood risk to Castlefields Lane as well as to other areas along the River Aire. The predicted 0.89m reduction in flood levels from this storage would reduce the need for direct defences at the study area. This would also increase the effectiveness of PLP and other options.
- These online storage areas on the Aire may present a viable solution to providing a higher standard of protection to Castlefields Lane and it is recommended that this FSA is assessed further. Appraisal of these storage areas should consider benefits to Castlefields Lane as well as the wider Aire catchment including Leeds and other sites in Bradford.

Appendices