Initial assessment report
Branksome Drive
November 2016

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Initial Assessment Report

Scheme or project location name	Yorkshire Area Initial Assessments: Branksome Drive

Date	November 2016
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Version control

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Project Sponsor Approval:				

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Appendix C	Funding calculation sheet/s
Appendix D	Benefit details
Appendix E	Index of multiple deprivation

1.1 Introduction and background

Working in partnership with the City of Bradford Metropolitan District Council, 15 locations within Bradford were identified to have been significantly affected by the 2015 December Floods. These locations were subsequently grouped into five main catchment areas to be put forward for initial assessments to consider the viability of a flood risk management scheme.

1.1.1 Description of Location

Branksome Drive is located at the confluence of the River Aire and a small, un-named watercourse, between Saltaire and Cottingley, West Yorkshire. The study area incorporates approximately 30 low lying properties at risk of flooding from the right bank of the River Aire. This area was severely flooded during December 2015.

Work to establish the current standard of protection (SoP) provided by the riverbank is being undertaken by the Environment Agency (EA).

According to the Index of Multiple Deprivation (IMD) reported in Appendix E, the area is amongst the 30% least deprived neighbourhoods in the country.

Detailed information has been collected during the site visit in July 2016 and can be found in Appendix B. Figure 1, below, shows the extent of the study area.

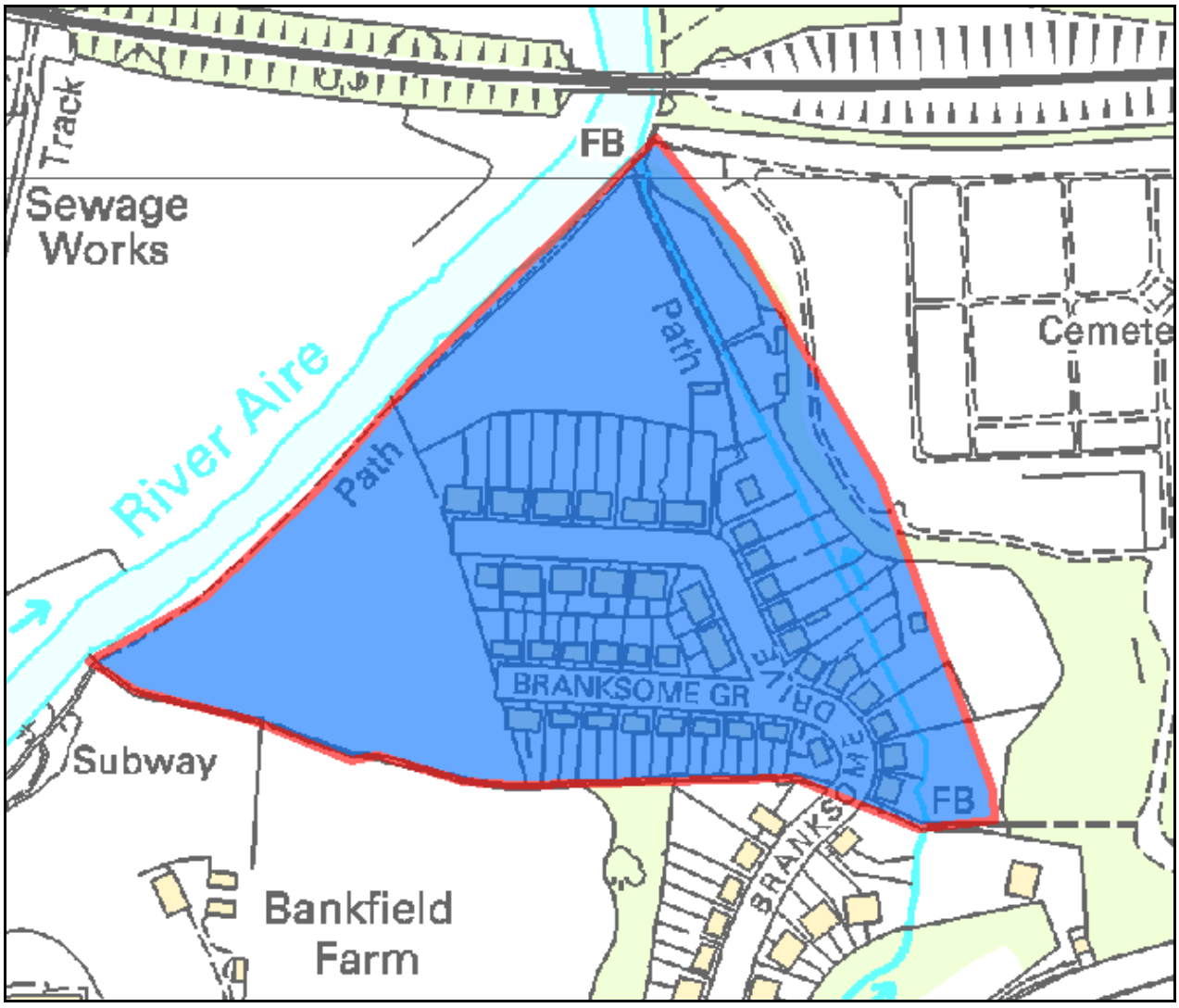

Figure 1: Study area

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 are also a large number of structures such as bridges and screens in this area.

The River Aire catchment has been considerably modified for flood defence purposes. Flood embankments have been built up along much of the channel and there are several controlled washland (floodplain) areas in the upper reaches as well as downstream of Leeds. These act as both controlled and uncontrolled washlands and significantly attenuate peak flows along the river.

The geology of the study area is characterised by clay, sand and silts.

1.1.3 History of Flooding

There are approximately 30 low-lying properties on Branksome Drive that have suffered extensive flooding on several occasions in recent years. There have been widespread major flood events throughout the River Aire recently in 2000, 2012 and 2015. As the Branksome Drive properties are close to the river, these events caused flooding to significant depths.

During the 2015 Boxing Day flood event, properties on Branksome Drive were flooded to a depth of approximately 1.5m from the River Aire overtopping its banks.

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 short, medium and long-term, which included progressing a flood management scheme for defences at Branksome Drive.

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

Branksome Drive falls under the River Aire Catchment Flood Management Plan[1] CFMP, 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.*

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

Political Drivers	**Summary Description**
Catchment Flood Management Plan	Aire CFMP 2010
Catchment Flood Management Policy	Policy 4: Areas of low, moderate or high flood risk where the flood risk is already effectively managed
Flood Risk Management Strategy	Short-term recommendations from the Upper Aire Flood Risk Management Strategy included progressing a flood management scheme at Branksome Drive
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**
SSSI	Bingley South Bog SSSI 1km northwest of study area
World Heritage Site	The Saltaire World Heritage site is approximately 1.5km East from the study area.

1.2 Problem and objectives

1.2.1 Problem

The event of the 25th to 29th December 2015 was the result of a weather front which travelled in a north easterly direction immediately following behind Storm Eva. The front first passed over West Yorkshire before heading across through North Yorkshire.
The more significant rainfall totals and rainfall return periods occurred for the peak 24 hour and 36 hour period over the 25th and 26th December. During this time, the average monthly rainfall for December fell over the Pennine edge of West Yorkshire and through central North Yorkshire.
Rainfall return periods of more than 1 in 50 years were recorded in parts of the Upper Calder, Upper Aire, and Middle Wharfe catchments for the 24 hour peak totals.

The only data available, regarding the flow in the river Aire at Branksome Drive, is from a gauge station located approximately 10 Km upstream of the site. At the Kildwick gauging station a flow of 163 m^3/s was recorded which corresponds to an 80- 100 years return period. Note that the return period of rainfall and flow is quite different, this is because the rainfall fell on already saturated ground and into rivers that were already high.

[1] . https://www.gov.uk/government/publications/river-aire-catchment-flood-management-plan

The site is at risk of flooding from various sources, including that from surface water. There are approximately 30 low-lying properties at risk that have been flooded during past events. The lower lying of these properties were flooded to a depth of 1.5m during the 2015 Boxing Day event.

The following possible flooding mechanisms have been identified:

- Surface water flooding from run-off from the surrounding hills flowing towards the study area.
- There is a combined sewer that discharges into the river at this location, during high river levels this sewer cannot discharge and backs up causing flooding to nearby properties.
- Flooding due to groundwater
- Fluvial flooding from the River Aire overtopping its bank

This report will identify potential solutions to the fluvial flooding and determine if there is scope to determine the best cost/benefit solution to manage this flood risk.

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, and to identify any other potential flood risk management measures which are consistent with the current CFMP (Catchment Flood Management Plan).

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 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 order to make an initial quantification of the potential benefits of a scheme, the Upper Aire FRMS modelled flood outlines (Atkins, 2004) 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. 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 0.1 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)	29
	<1 in 25 year (4% 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)	0
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)	0
	<1 in 75 year (1.33% AEP) ≥1 in 200 year (0.5% AEP) (Moderate Risk)	0

Details of the methodology used for assessing the benefits of each option are presented in Appendix D. It should be noted that the methodology uses the Weighted Annual Average Damages (WAAD) data from the MCM (2015/16 prices). While this approach gives a first approximation it is recommended that a more detailed assessment is carried out if this project is progressed further, to better estimate the economic benefits of the proposed works.

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 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 Nab Wood and Branksome Drive. It was reported that flood warnings were not received prior to the Boxing Day event. 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. This would not have been effective in flooding of the depths experienced in December 2015
Operational (by Others)	Improve operation/design	Improve operation/design of assets not owned by the EA	No	No third party assets affecting fluvial flood risk in the study area.
Urban drainage	Improve urban drainage.	Improved surface water drainage system.	Yes	During high river levels the sewer cannot discharge and back up causing flooding. A pumping station could be an option, to reduce the risks during flood incidents.
Structural	Earth bunds	Flood bund	Yes	A bund around the river-side of the low-lying properties would reduce the flood

Category	Long List Option	Description	Take Forward for assessment?	Reasoning / Notes / Past Study Reference
				risk to these properties from the river. Due to the flood damage caused to properties in this area it is worth investigating the viability of constructing a bund at this location.
Structural	Conveyance	Channel deepening or widening	No	There is no available route or space for this option.
Structural	Conveyance	Supplementary bypass channel(s), tunnels or floodway	No	There is no available route or space for this option.
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 area immediately upstream of Branksome Drive could be used as a flood storage area (although may not be effective as volume is small compare to the upstream catchment). A large scale FSA system was considered in the upper Aire SFRA, it will have a large impact beyond the Branksome Drive area, and is considered to be outside of the scope of this appraisal.
Flood storage area	Offline	Gravity or pumping to offline storage area	No	No offline storage sites with potential for a significant impact on flood risk have been identified

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.

Under this assumption, the natural deterioration of the river channel will occur, leading to an increase in flood risk. There are no assets within the study area to be considered.

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 to measure the benefits of the other options.

Do Minimum

The Do Minimum option is defined as the minimum level of action or intervention necessary to continue to maintain and operate the current flood risk management arrangements offered throughout the study area. It will form the appraisal baseline.

This option assumes continuation of the existing maintenance regime. This includes 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 the 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 future 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 expected in future.

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 29 ground floor residential properties in the Very 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 can help 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 considered viable for properties in the Very Significant risk band (based on NaFRA), and where flooding is less than 500mm deep. The effectiveness of PLP reduces with long duration floods due to seepage.

The event that occurred on Boxing Day 2015 was an extreme event. For such an extreme event, PLP would not be applicable but for less severe events would be effective.

Deliverability of this option is reliant on the residents up take of PLP.

Option 2: Earth Bund around properties at risk

This option is to construct a flood bund around the low-lying properties on Branksome Drive at risk from flooding. The bund is to be as close as possible to the properties at risk, in order to minimise the area removed from the flood plain, and therefore minimising the compensatory flood plain creation required. The design of the flood bunds must be made to fit visually in to the surrounding area, especially due to their close proximity to properties.

The Standard of Protection offered by these flood bunds is 1 in 100 in the current scenario, and is expected to be approximately 1 in 75 at the end of the appraisal period, including the effects of climate change. The alignment of the bunds and their dimensions are an estimate for this initial assessment. The costs are based on an embankment with a length of 240 m, 1.5m height and 12m width at the base; figure 2 shows an approximate alignment of the asset. On the east side of the study area there is a small un-named watercourse. At this stage the bund is thought to protect the site against flooding from the River Aire; if this option is taken forward, alignment and dimensions will have to be assessed and optimised in order to consider all potential sources of flooding and an appropriate standard of protection.

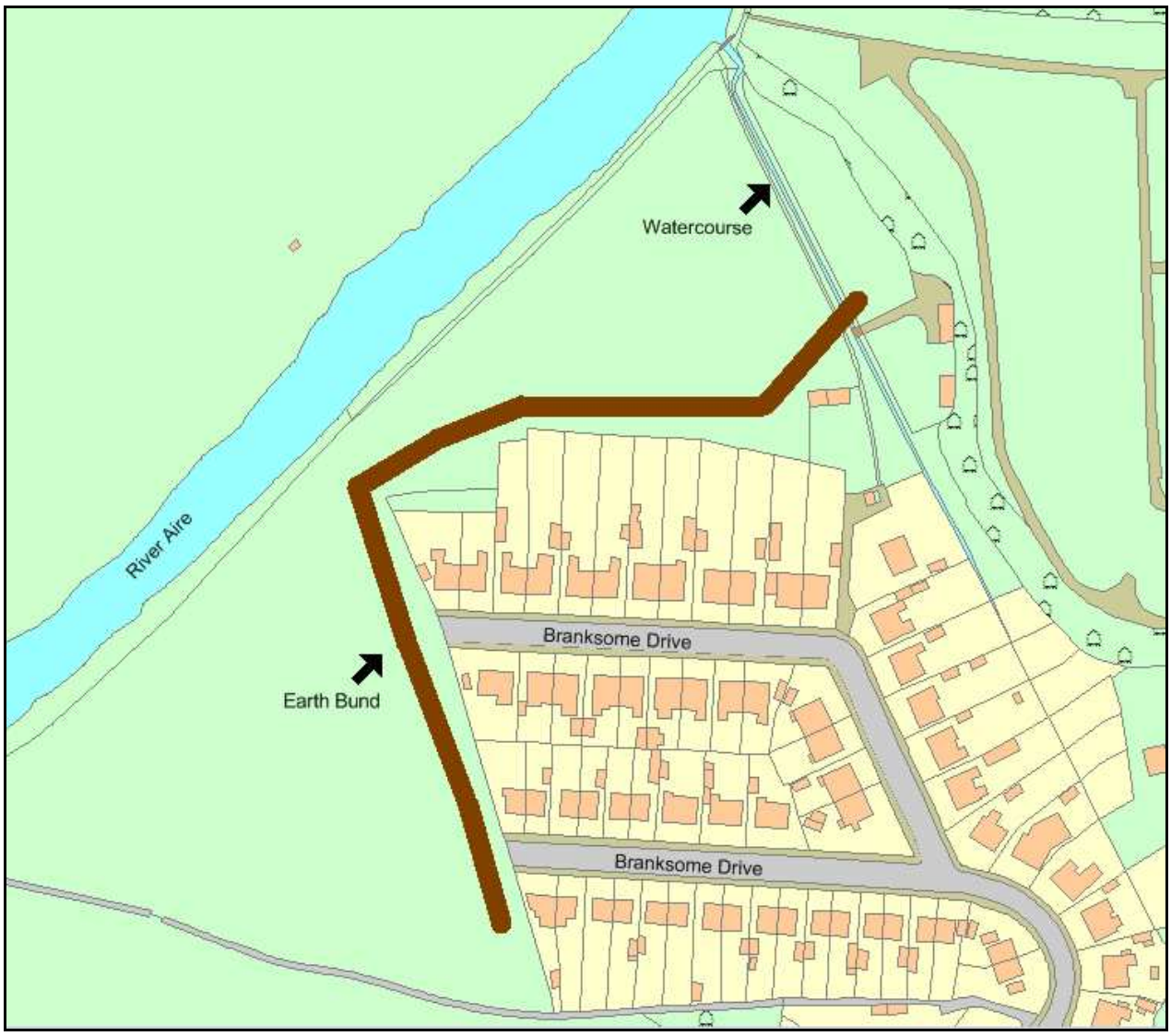

Figure 2: Alignment of the Earth bound in Branksome Drive

This option is a permanent structure and does not require any operational input. This will move the properties on Branksome Drive from the very significant risk band to the low 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 bund 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. With this option impacts on groundwater and surface water flooding must also be investigated.

A high level bund would not be viable, as the bunds require side slopes of 1:3, and this leads to a very large footprint. Construction of the bund has the potential to cause temporary disruption to roads and properties.

Option 3: Online flood storage area upstream of Branksome Drive

This option is to utilise the area on the right bank of the River Aire, upstream of the properties at risk, to create a formalised flood storage area. The scheme would incorporate ground re-profiling to enable flows to come out of bank and be stored in the existing farmland area, behind raised earth embankments. The total area occupied by the FSA will be approximately 15000 m², requiring approximately 240m in length of embankments (2 m high by 15 m wide). It is assumed this storage area would be sufficient to attenuate flood peaks, benefitting to properties that lie in the study area and downstream, however hydraulic modelling will be required to check this at appraisal stage.

If proven technically viable through hydraulic modelling, this option could increase the standard of protection to properties in the study area and potentially downstream, by providing upstream storage to attenuate flood flows. It is a permanent defence solution that does not reduce the capacity of the river and increases connection between the river and the floodplain. Embankments can be made to fit visually within the surrounding area.

There may be aesthetic and landscape impacts associated with this option. The proposed location is on private land and would therefore require land negotiation. An increase in maintenance commitment will be required to control vegetation.

This option requires testing in the hydraulic model to confirm its viability and effectiveness. The option is technically feasible however there are risks associated with gaining land owner consent. However, the standard of protection provided by this scheme is highly uncertain until further modelling is carried out.

A simplified representation of the storage area is shown in figure 3

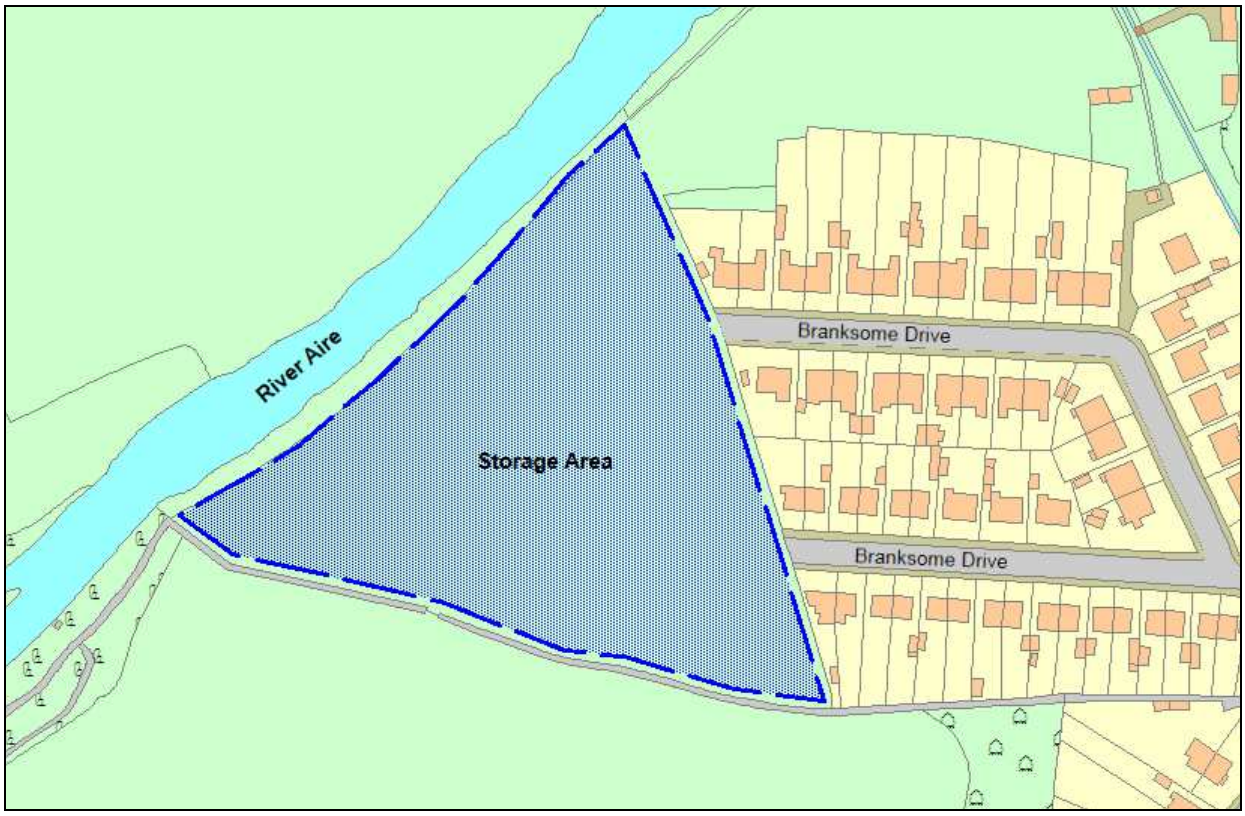

Figure 3: Location of the storage area

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.

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 1.2 shows the initial costs for the options, it is assumed that replacement of the assets will be required when the assets reach Condition Grade 4 (CG4): 20 years for the Option 1 (PLP) and 60 years for the option 2 and 3 (embankment).

Table 0.2 Project costs (£k)

Item	Do Minimum	Option 1	Option 2	Option 3
Construction Base Cost		237.0	326.3	1740.5
Environment Agency staff		37.4	51.6	130.0
Consultant fees (appraisal)		15.2	20.9	90.5
Consultant fees (design)		51.4	70.8	247.2
Consultant fees (construction)		13.3	18.3	102.7
Surveys (Ground investigation)		2.4	3.3	60.9
Surveys (Ground investigation)		0.9	1.3	8.7
Land purchase		0.2	0.3	8.7

Item	Do Minimum	Option 1	Option 2	Option 3
Sub-total		357.8	492.7	2389.1
Optimism Bias		157.4	216.8	1051.2
TOTAL		**515.2**	**709.4**	**3,440.4**
Annual operations and maintenance costs	541 £/year	541 £/year	716 £/year	716 £/year

1.5 Initial environmental assessment

Table 0.3 Key environmental impacts, mitigation and opportunities

Key positive impacts	Key negative impacts	Mitigation/ enhancement opportunity
Option1		
-Reduced risk of fluvial flooding, -Low risk of pollution incidents and disruption to area during construction. -Low aesthetic effect		
Option 2		
-Reduced risk of flooding -Low aesthetic effect	Construction work takes place 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		
-Reduced risk of flooding -Low aesthetic effect	Construction work takes place alongside watercourse. Risk of pollution incidents and disruption to area during construction	Best practice should be followed including referring to EA Pollution Prevention Guidance

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:

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

1.7 Economic summary and preliminary preferred option

Table 0.4 Benefit-cost assessment

	PV costs (£k)	PV benefits (£k)	Av. BCR	Incr' BCR	Option for iBCR calc	Comments
Do Nothing						
Do Minimum	16	51	3.1			Preferred option due to highest ABCR
Option 1	1062	561	0.6	0.5	Do Minimum	
Option 2	826	1302	1.6	1.6	Do Minimum	Preferred Do Something Option due to ABCR and IBCR
Option 3	3922	1302	0.3	0.3	Do Minimum	IBCR from Do Minimum as benefits are the same as Option 2

As stated in the Handbook for Economic Appraisal 2016, the benefits referred to for option 1 (PLP) are factored by 0.75 to take account of the risk of incorrect use.

Table 0.5 Benefit-cost ratios and outcome measures

Contributions to outcome measures	Option 1	Option 2	Option 3
OM1 – Economic Benefit:			
Benefit period used for Partnership Funding calcs	*20*	*60*	*60*
PV Benefits (£k)	278.49	1233.80	1233.80
PV Costs (£k)	523.19	835.45	3979.27
Benefit/Cost ratio	0.53	1.48	0.31
OM2 – No. of households moved out of any flood probability category to a lower category	29	29	29
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	29	29
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
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	13%	24%	5%
Contributions required for a PF score of 100% *(£k)*	457.3	635.0	3779.0

Contributions required for a PF score of 120% *(£k)*	468.0	668.0	3812.0

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
- Council Tax
- Local Enterprise Partnerships

There are a large number of commercial properties at risk within the town. Further consultation would be required to identify potential contributions.

1.7.2 Key delivery risks (economic, social and environmental)

Table 0.6 Risks and mitigation

Risk	Key Mitigation
Estimate of benefits highly uncertain	Undertake more detailed benefit calculations at OBC stage
Risk of pollution incidents and disruption to area during construction	
PLP may not be effective for the properties due to flood depths, durations and presence of groundwater risk.	
The height of the embankment for options 2 and 3 is estimated, and may be insufficient for the SOP required for an event of the magnitude of Boxing Day 2015	Undertake further modelling work to establish the correct level of the defences for such an event.

1.8 Project Scoring

The data used in this assessment has been subjected to a RAG assessment. A green score is well defined, not likely to be an issue: amber score, needs development, but is manageable: red score is poorly defined, lots of uncertainty, likely to cause significant problems. The RAG assessment gives a three figure score with the first number being the number of reds with the second and third numbers being the number of amber and green respectively. The results are shown below:

- A – Problem Definition: The fluvial flood risk is well understood but more accurate information is needed about the sewer and the ground water – **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: All The options require external funding. Work will be needed to obtain funding but there are opportunities – **AMBER**
- D – Engineering case: Solutions taken to outline design are common defence options, no particular issues are expected – **GREEN**

- E – Permissions & Consents: Solution are unlikely to require unusual permissions or consents, but permission for third party properties is required – **AMBER**

- F – Environmental sensitivities: An Environmental check list has been completed and the options will not have any impact on any nearby sites of interest – **GREEN**

- 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	2	1	132	2

1.9 Further work requirements

If the project is taken forward for further appraisal it is recommended that the following work is undertaken to confirm the feasibility of the options

- Hydraulic modelling for the proposed earth bund around the properties
- Topographic survey and ground investigation for the earth bund
- Effect on groundwater and surface water run-off of the options
- Update the PV benefits and re-assess the partnership Funding score.
- Consultation with landowners

1.10 Conclusions and Recommendation

The Do minimum option has the highest BCR because of the very low cost of the option, but this option offers the lower benefits. The properties remain in the current risk band and with the current SoP. Option 2 is the next highest option with an iBCR of 1.55 against Do Minimum. As such this is the preferred option from this appraisal. However, there are considerable uncertainties in the assessed costs and benefits and the preferred option may change with further appraisal. This option will require significant funding contributions but is a viable option and could be considered for further appraisal.

Further analysis is recommended to evaluate the risk of groundwater flooding. If there is significant risk present this will reduce the effectiveness of all the proposed options.

A large scale Flood storage Area (FSA) system is considered in the long list of options. This is a large-scale scheme that will have significant impacts beyond the Branksome Drive area and is considered to be outside the scope of this initial assessment. It is recommended that this is considered in future work to provide protection to Branksome Drive.

Appendices