Hurlston Brook Flood Risk Study

Lancashire County Council

Optioneering Report

B2237306-JAC-HB-RP-D-010 | P01

7th April 2017

LCC Order No.678

Document history and status

Revision	Date	Description	By	Review	Approved
P01	31/03/2017	Issued	G.Price/S.Loughrey	M Shepard	M Shepard

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments
P01				

Hurlston Brook Flood Risk Study

Project No:	B2237306
Document Title:	Optioneering Report
Document No.:	B2237306-JAC-HB-RP-C-0010
Revision:	P01
Date:	7th April 2017
Client Name:	Lancashire County Council
Client No:	LCC Order No.678
Project Manager:	Mark Shepard
Author:	Gareth Price / Sarah Loughrey
File Name:	Appendix D - Optioneering Report.docx

Jacobs U.K. Limited

4th Floor, Metro
33 Trafford Road
Salford
M5 3NN
United Kingdom
T +44 (0)161 873 8500
F +44 (0)161 873 7115
www.jacobs.com

Contents

1. Introduction

1.1 Background

Jacobs have been commissioned by Lancashire County Council (LCC) to undertake a review of flood risk in the West Lancashire town of Ormskirk with a focus on the flood risk from Hurlston Brook which flows through the centre of Ormskirk and the risk from surface water from direct rainfall within the catchment. The review includes in depth analysis of:

- Flood risk history;
- Flooding Mechanisms;
- Flood Risk Reduction Measures;
- Economic assessment and scheme viability.

The findings of this review and prospective measures for reducing flood risk are contained within the project Viability Report (Ref. B2237306_JAC_RP_C_001).

This report forms Appendix D of the Viability Report and provides detailed information on the optioneering exercise for the potential Flood Risk Management (FRM) options across Ormskirk.

1.2 Scope of this Report

This document contains details of the multi-stage optioneering exercise that has been undertaken to help select appropriate flood risk management options for inclusion as a proposed package of works.

The key findings of this report are summarised in the Viability Report.

1.3 Methodology

The optioneering process has been broken down into three distinct stages as shown in Table 1.1 below.

Table 1.1 : Methodology Stages

Stage	Process	Description
1	Identification	Develop a long-list of practical FRM options
2	Rationalisation	Rationalise the long-list to eliminate those options which are less likely to be effective
3	Testing	Model a number of options and rank them based on their effectiveness

The outcome of these stages will be a shortlist of the most effective FRM options, which could form the basis of a package of works to reduce flood risk.

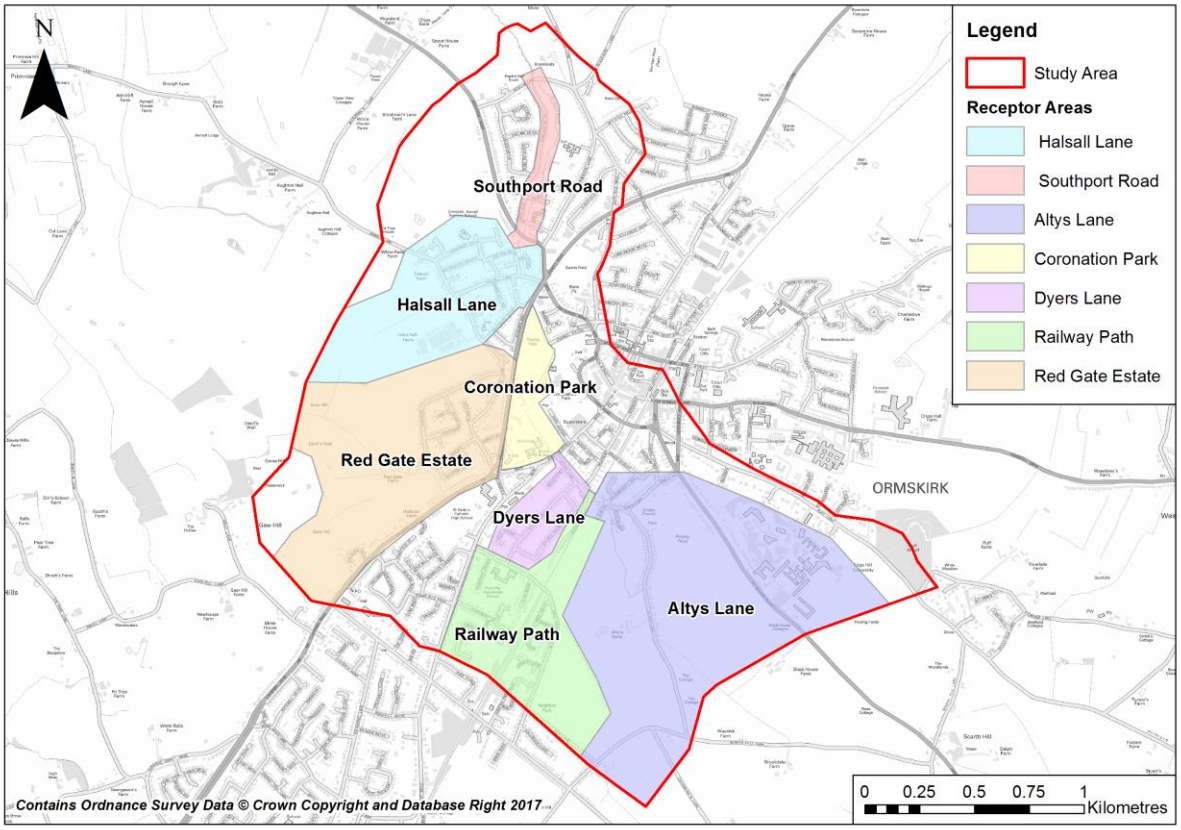
The activities undertaken in each of these stages are discussed in the following sections.

2. Option Review Stage 1 - Identification

2.1 Available Options

The objective of this first stage of the optioneering exercise is to identify FRM options, which are appropriate to reduce the flood risk in key receptor sites, the locations of which were defined in the project scope and can be seen in Figure 2.1 below.

Figure 2.1 - Ormskirk & Key Receptor Areas



A wide range of options for managing flood risk are available for any given site. These range from enhancing current maintenance regimes to more complex works such as replacing drainage networks or providing flood storage areas.

Table 2.1 below gives an indication of the options typically available for an inland FRM scheme with a brief description of what each option would likely involve.

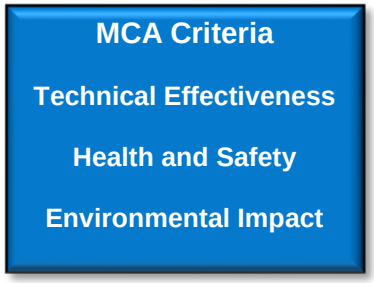
Table 2.1 : Matrix of Flood Risk Management Options

Option	Description
Enhanced Maintenance	Increase the current maintenance regime to reduce the likelihood of blockages on the existing river and surface water drainage network.
Permanent Raised Defences	Provide raised permanent defences along the banks of a watercourse in the form of walls or compacted earth embankments. Alternatively, provide elements of raised infrastructure to direct water away from properties or into existing channels.
Active Defences	Provide temporary raised flood defences (e.g. floodgates, demountable barriers etc.) which can be deployed in advance of flood events.
Channel Bypass / Diversion	Construction of a new channel to bypass problem areas or a permanent diversion of the river channel.
Flood Storage	Construct new storage areas, with associated flow control, to impound water during a flood event, or formalise and increase the capacity of areas known to currently store water (e.g. existing floodplain).
Channel Widening	Increase the width or depth of existing sections of the river channel to increase storage capacity and improve conveyance.
Culvert or Drainage Network Upgrades	Enhance the buried drainage network, by upsizing culverts, increasing pipe diameters, removing blockages, or improving network connectivity and conveyance.
Natural Flood Management (NFM)	Soft solutions using natural features to manage the flow of water from one location to another and reduce the speed and volume of rainfall run-off.
Property Level Protection (PLP)	Protection at property thresholds including but not limited to flood doors, stoplogs and other home resilience measures. Some elements will require deployment by individual residents / property owners.
Flood Warning Improvements	Improve the existing flood warning system to provide an improved response time.

2.2 Suitability of Options

To begin the process of establishing which options are best suited to each receptor area, a high-level multi-criteria assessment (MCA) review has been undertaken.

Within this exercise, each option is assessed against a range of criteria: technical effectiveness, health and safety, and environmental impact.



An initial assessment of ***Technical effectiveness*** has been made to determine the likely impact of each measure in influencing flood water levels in both the immediate vicinity and downstream in the river catchment.

Considerations of the impact on ***Health & Safety*** of each option, with regards to the Construction, Maintenance and Public interaction with any new assets, has been made to ensure that any associated risks are captured and can be evaluated.

Environmental Impact has been assessed from the perspective of impact on existing ecology and the possible social impact on local residents and stakeholders.

Upon being assessed, each criterion is 'scored', recording whether the impact of the option is positive, negative or neutral. For ease of use, coloured symbols (as defined in Table 2.2 : MCA Scoring Symbols below) have been used.

Table 2.2 : MCA Scoring Symbols

Symbol	Technical Effectiveness	Health & Safety	Environmental
✓	Reduction in water level or flood frequency	Safety improvement for users	Enhancement opportunity
≈	No significant change	No change or no unusual risks	No significant impact
✘	Increase in water level or flood frequency	Increase in risk (hazard and / or probability)	Environmental or social detriment, likely to be met with some resistance
✘✘	Option not ***applicable***	Option not **acceptable**	Option not **acceptable**

Where options are either not applicable for a given receptor area, or risks associated or impacts as a result of it are not acceptable, then they are discounted immediately.

Comments collated against each of these criteria will factor into the decision of whether or not an FRM option for a given receptor site progresses to the next stage of the optioneering exercise.

With this in mind, 'Enhanced Maintenance' and 'Flood Warning Improvements' as listed in Table 1.1, will not been reviewed further at this stage. Whilst these options can provide benefits to an area as part of a wide-reaching scheme, they will not eliminate or reduce the flood probability significantly and thus are not considered to be technically effective at any of the highlighted flood receptor areas.

The records of the MCA exercise can be found in Tables 2.2 to 2.8, which follow in Section 2.3. Each table represents a geographic area within the study boundary.

2.3 Multi-Criteria Assessment Records

Table 2.3 : Altys Lane Options Matrix

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
1	Permanent Raised Defences	✓	✘	≈	✘	≈	≈	✘	✓	Raised defences to intercept and divert overland flows avoid the issue of watercourse disconnect. While this option will not reduce flood depths downstream it could be effective at providing protection to properties in the immediate vicinity.
		Option could provide effective protection to properties from fluvial flooding, but could prevent surface water run-off from entering channel.	Option may cause an increase in downstream flood risk by keeping water within the channel.	No unusual construction risks.	Increase in maintenance regime (annual inspections).	No significant change in land use, risk profile unchanged.	Would disconnect the watercourse and the floodplain if applied immediately on river banks; however offsetting defences from the river banks to intercept overland flow avoid this issue.	Residents unlikely to be receptive to high walls being constructed along watercourse in close proximity to houses.		
2	Active Defences	✘✘							✘	Option is not appropriate for the receptor area.
		Option not appropriate in this receptor area due to the nature of the flooding mechanisms and the lack of existing infrastructure with which it would be required to interact with.								
3	Channel Bypass / Diversion	≈	✘	≈	✘	≈	✓	✘	✘	Option would not alleviate flooding due to flooding mechanisms in the area and could result in an increase in flooding downstream.
		Impact likely to be minimal due to the flooding mechanisms of the study area.	Potential increase in downstream flood risk by improved conveyance of upstream flow.	No unusual construction risks.	Increase in maintenance regime (annual inspections).	Safety risks would be equal to that of a normal river channel.	Change of land-use from agricultural to watercourse – potential ecology benefit.	Temporary disruption during construction, loss of agricultural land.		
4	Flood Storage	✓	✓	≈	✘	✘	✓	✘	✓	Option could drastically reduce

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
		Option could be effective in protecting properties all along Altys Lane.	Option could provide a reduction in flood risk by holding back water, providing more space for downstream inflows.	No unusual construction risks.	Storage area and associated flow control structures would require a regular maintenance and inspection regime.	Storage areas could be accessed by public – risks associated with untrained persons near water.	Change of land-use from agricultural to wetland – potential ecology benefit.	Temporary disruption during construction, loss of agricultural land during times of flood.		flood risk downstream and in the vicinity of Altys Lane. Potential risks and detriment associated with the option can be mitigated and managed by careful design.
5	Channel Widening	✓	✘	≈	≈	≈	≈	✘	✘	Although the option could help protect the properties at the southern end of Altys Lane, it could increase flood risk downstream and is discounted for this reason.
		Option would increase channel capacity and could reduce local flood depth.	Option could increase flood risk downstream by increasing the pass forward flow.	No unusual construction risks.	No significant change in maintenance regime.	No significant change in land use, risk profile unchanged.	Loss of vegetation immediately adjacent to river bank, but this would be expected to recover.	Temporary disruption during construction.		
6	Culvert / Drainage Network Upgrades	✓	✓	✘	≈	≈	≈	✘	✓	Option could reduce the immediate flood risk and the flood risk downstream. Whilst construction would be disruptive, once the works are complete there would be no additional maintenance or environmental detriment.
		Option could protect the properties along Altys Lane.	Option could reduce flood risk downstream by reducing surface water run-off down Altys Lane.	Extensive interaction with buried services and likely need for road closures.	No significant change in maintenance regime.	No significant change in land use, risk profile unchanged.	No significant impact.	Temporary disruption during construction.		
7	Natural Flood Management	✓	✓	≈	≈	≈	✓	✘	✓	Influencing wider drainage catchment surface water flows through NFM could benefit properties across multiple receptor sites and has potential environmental enhancement benefits.
		Option has the potential to provide both immediate and downstream benefits by improving surface water conveyance.		No unusual construction risks.	Minimal maintenance required.	No significant change in land use, risk profile unchanged.	Potential ecological enhancement.	Option will likely require re-appropriation of agricultural land.		
8	Property Level	✓	≈	≈	✘	≈	≈	✘	✓	Option could provide immediate

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
	Protection	Immediate benefit to each individual property.	Option would have no effect on flood risk downstream.	No unusual construction risks, other than sensitive nature of works to private dwellings.	Option requires maintenance of a large number of individual assets that will require co-ordination with residents.	No significant change in land use.	No significant impact.	Residents will be responsible for deployment of protection measures.		protection at affected properties, but is reliant on residents deploying defences prior to a flood event.

Table 2.4 - Railway Path Options Matrix

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
1	Permanent Raised Defences	✓	≈	✘	≈	≈	≈	✘	✓	Small, local elements of raised defence to divert water into the channel will be investigated further.
		Some raised kerbs or similar elements could divert overland flow away from residential properties and encourage it to enter the brook.	Implementing these measures would only provide a local benefit.	Construction access and working space is limited. Interaction with buried services is also likely.	No significant change in maintenance regime.	No significant change in land use, risk profile unchanged.	No significant impact.	Significant disruption to residents due to raised defences being constructed.		
2	Active Defences	✘✘							✘	Option is not appropriate for the receptor area.
		Option not appropriate in this receptor area due to the nature of the flooding mechanisms and the lack of existing infrastructure with which it would be required to interact.								
3	Channel Bypass / Diversion	✘✘							✘	Option is not appropriate for the receptor area.
		The main flooding mechanism is overland rather than fluvial flow. There is no watercourse in the immediate vicinity that could provide a benefit from diversion or bypass works.								
4	Flood Storage	✓	✓	≈	✘	✘	✓	✘	✓	Flood storage could be provided in several locations such as within the farmland adjacent to the railway lines or a buried option within the playing fields of Pontville School. Both options could provide a reduction in local and downstream flood risk.
		Upstream storage could be effective in protecting properties along Railway Path.	Option could provide a reduction in flood risk by holding back water, making more space for downstream inflows.	No unusual construction risks.	Storage area and associated flow control structures would require a regular maintenance and inspection regime.	Storage areas could be accessed by public – risks associated with untrained persons near water.	Potential ecological enhancement.	Temporary disruption during construction, loss of use of land during times of flood.		
5	Channel Widening	✘✘							✘	Option is not appropriate for the receptor area.
		The main flooding mechanism is overland rather than fluvial flow. There is no watercourse in the immediate vicinity that could provide a benefit from widening works.								

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
6	Culvert or Drainage Network Upgrades	✓	✓	✖	≈	≈	≈	✖	✓	Option could provide benefits in reducing flood risk both locally and downstream of railway path. While the works would be challenging to undertake the impact to local residents/land users would be minimal once construction is complete.
		Option could reduce flood risk to the properties along Railway Path.	Option could reduce flood risk downstream.	Extensive interaction with buried services, likely need for road closures. Limited working space and close proximity to residential properties will also constrain construction	No significant change in maintenance regime.	No significant change in land use, risk profile unchanged.	No significant impact.	Temporary disruption during construction.		
7	Natural Flood Management	✓	✓	≈	≈	≈	✓	✖	✓	Influencing wider drainage catchment surface water flows through NFM could benefit properties across multiple receptor sites and has potential environmental enhancement benefits.
		Option has the potential to provide both immediate and downstream benefits by improving surface water conveyance.		No unusual construction risks.	Minimal maintenance required.	No significant change in land use, risk profile unchanged.	Potential ecological enhancement.	Option will likely require re-appropriation of agricultural land.		
8	Property Level Protection	✓	≈	≈	✖	≈	≈	✖	✓	Option will provide immediate protection at affected properties, but is reliant on residents deploying defences prior to a flood event.
		Immediate benefit to each individual property.	Option would have no effect on flood risk downstream.	No unusual construction risks, other than sensitive nature of works to private dwellings.	Option requires maintenance of a large number of individual assets that will require co-ordination with residents.	No significant change in land use.	No significant impact.	Residents will be responsible for deployment of protection measures.		

Table 2.5 - Dyers Lane Options Matrix

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
1	Permanent Raised Defences	✓	≈	✘	≈	≈	✘	✘	✓	An option which raises low spots on the right bank could provide a benefit to properties on the right bank (Eastern side) of Dyers Lane. Construction work would be disruptive and complex and is unlikely to provide any downstream reduction in flood risk.
		Option could provide a local reduction in flood risk.	Unlikely to have an impact on downstream levels.	Extensive interaction with buried services, likely need for road closures. Limited working space and close proximity to residential properties will also be significant.	No significant change in maintenance regime.	No significant change in land use, risk profile unchanged.	Could increase disconnection between the watercourse and the floodplain.	Significant disruption to residents due to raised defences being constructed. Could restrict access to residential properties		
2	Active Defences	✘✘							✘	Option is not appropriate for the receptor area.
		Option not appropriate in this receptor area due to the nature of the flooding mechanisms and the lack of existing infrastructure with which it would be required to interact.								
3	Channel Bypass / Diversion	✘✘							✘	Given the developed nature of Dyers Lane, channel bypass / diversion is not considered to be a feasible option.
		The river channel is between residential properties on its left bank and the public highway (Dyers Lane) on its right. Attempting to incorporate a diversion or bypass within this limited area while retaining the existing infrastructure and maintaining access to private residences is unlikely to perform favourably in a cost-benefit analysis.								
4	Flood Storage	✘✘							✘	Given space restrictions along Dyers Lane, flood storage is not a feasible option.
		The river channel is between residential properties on its left bank and the public highway (Dyers Lane) on its right. There is not sufficient available open or undeveloped space within the boundary of this receptor site to pursue formalised storage.								
5	Channel Widening	✘✘							✘	Given the proximity of houses, buried services and the public highway to the watercourse along Dyers Lane, channel widening is not a feasible option.
		The river channel is between residential properties on its left bank and the public highway (Dyers Lane) on its right. Any attempt to widen the river channel would likely result in a loss of carriageway width, which is unlikely to be acceptable to local residents and road-users.								
6	Culvert or Drainage Network Upgrades	✓	✓	✘	≈	≈	≈	✘	✓	Option could provide benefits in reducing flood risk both locally and downstream of railway path.
		Option could reduce flood risk	Option could reduce flood risk	Extensive interaction with buried services,	No significant change in	No significant change in land	No significant impact.	Temporary disruption during		

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
		to the properties along Dyers Lane.	downstream.	likely need for road closures. Limited working space and close proximity to residential properties will also be significant.	maintenance regime.	use, risk profile unchanged.		construction.		While the works would be challenging to undertake the impact to local residents/land users would be minimal once construction is complete.
7	Natural Flood Management	✘✘							✘	NFM is not appropriate for the Dyers Lane receptor area.
		Given the heavily developed, residential nature of Dyers Lane, floodplain management is not considered to be an option, which would provide significant benefits in reducing flood risk. However, its application outside the Dyers Lane receptor area boundary could provide a benefit.								
8	Property Level Protection	✓	≈	≈	✘	≈	≈	✘	✓	Option will provide immediate protection at affected properties, but is reliant on residents deploying defences prior to a flood event.
		Immediate benefit to each individual property.	Option would have no effect on flood risk downstream.	No unusual construction risks, other than sensitive nature of works to private dwellings.	Option requires maintenance of a large number of individual assets that will require co-ordination with residents.	No significant change in land use.	No significant impact.	Residents will be responsible for deployment of protection measures.		

Table 2.6 - Coronation Park Options Matrix

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
1	Permanent Raised Defences	✓	≈	≈	≈	≈	✖	✖	✓	Potential benefit to the tennis club, which has suffered flood damage during recent events are worthwhile investigating. Raised defences elsewhere across the watercourse will be discounted as they would cause the river to be disconnected from its existing floodplain and likely result in an increase in flood risk.
		Option could provide benefit to the tennis club, but would cause disconnection between overland flows and the watercourse if applied elsewhere.	Unlikely to have an impact on downstream levels.	No unusual construction risks.	No significant change in maintenance regime.	No significant change in land use, risk profile unchanged.	Could increase disconnection between the watercourse and the floodplain.	Some disruption to residents / users of the tennis club during works to construct new defences.		
2	Active Defences	✖✖							✖	Option is not appropriate for the receptor area.
		Option not appropriate in this receptor area due to the nature of the flooding mechanisms and the lack of existing infrastructure with which it would be required to interact.								
3	Channel Bypass / Diversion	≈	≈	✖	✖	≈	✓	✖	✖	Owing to restrictions relating to space, inflows and upstream and downstream connectivity, this option would not provide a significant benefit in reducing flood depths.
		Additional channel would provide a minimal increase in storage but is unlikely to reduce flood outline.	Unlikely to provide any significant change in water depths as flows downstream are still governed by the culvert crossing at County Road.	No unusual construction risks, however a new channel would likely interact with existing buried services within the park.	An additional asset would be maintained.	The new asset would be no different to the existing hazards.	Potential ecological enhancement.	A new channel within the park would result in some loss of public amenity.		
4	Flood Storage	✓	✓	✖	✖	≈	✓	✖	✓	While the option would likely require significant investment, and need appropriate safety measures in place for its operation, it could provide a significant benefit in reducing
		Providing a formalised storage area in the downstream	Option could provide a reduction in flood risk by holding back water,	No unusual construction risks, however it is likely that works would	Storage area and associated flow control structures would require a	Storage area could be accessed by public – however	Potential ecological enhancement.	Temporary disruption during construction, loss of use of land during		

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
		area of the park could provide a benefit to the tennis club and minimise out of bank flow elsewhere.	making more space for downstream inflows.	interact with existing buried services within the park.	regular maintenance and inspection regime.	land already acts as flood plain so risk profile remains the same.		times of flood.		flood risk downstream, with Halsall Lane an area that could benefit particularly.
5	Channel Widening	✓	✓	✖	≈	≈	✖	≈	✓	Option could provide multiple benefits and would have a comparatively small impact during construction and operation.
		If applied downstream within the park, this option could improve the conveyance of water past the tennis courts providing a local benefit.	Creating more space for water within the park could reduce downstream flood depths.	No unusual construction risks, however it is likely that works would interact with existing buried services within the park.	No significant change in maintenance regime.	No significant change in land use, risk profile unchanged.	May have a negative impact on the environment.	Some minor loss of public amenity and disruption during construction phase but no change in the long run.		
6	Culvert or Drainage Network Upgrades	✖	✓	✖	≈	≈	≈	✖	✓	Whilst option would not protect the tennis club from flooding, option could decrease flood risk downstream. Impacts are minimal once construction is complete.
		Due to the flooding mechanism, it is unlikely to reduce flood risk to tennis club.	Enhancing drainage through and around the park could decrease flood risk along County Road and further downstream.	Road closures would be required due to drainage running below the public highway.	No significant change in maintenance regime.	No significant change in land use, risk profile unchanged.	No significant impact.	Could disrupt residents due to road closures during construction.		
7	Natural Flood Management	✖✖							✖	Site itself is not suitable, but would benefit from the application of NFM elsewhere.
		As the public park, which despite currently acting as floodplain to the main river, is surrounded by developed land the receptor area is not immediately suitable for the application of NFM, however it is likely that it would benefit from the application of NFM elsewhere.								
8	Property Level	✖✖							✖	Property level protection is not

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
	Protection	Due to the nature of the flooding mechanisms, property level protection is unlikely to be effective. It would not intercept or exert any form of control over incoming flows and as a standalone option would not reduce flood risk to the tennis club.								applicable.

Table 2.7 - Halsall Lane Options Matrix

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
1	Permanent Raised Defences	✓	≈	≈	≈	≈	≈	✖	✓	Option could provide some local benefit which could prove effective if used in combination with other measures.
		Raised defences at Asmall Lane, and raising low spots along Halsall lane could provide local benefits.	Unlikely to provide a downstream benefit.	No unusual construction risks.	No significant change in maintenance regime.	No significant change in land use, risk profile unchanged.	No significant impact.	Temporary disruption during construction, loss of use of land during times of flood.		
2	Active Defences	✖✖							✖	Option is not appropriate for the receptor area.
		Option not appropriate in this receptor area due to the nature of the flooding mechanisms and the lack of existing infrastructure with which it would be required to interact.								
3	Channel Bypass / Diversion	✖✖							✖	Option is not appropriate for the receptor area.
		The land on both banks of Hurlston Brook is heavily developed through the Halsall Lane receptor site, restricting the scope for development, which would directly benefit the main watercourse.								
4	Flood Storage	✓	✓	≈	✖	✖	✓	✖	✓	If this option were applied to the west of Halsall Lane/ Asmall Lane it could reduce flood risk to both the properties in the immediate area and benefit properties downstream of Halsall Lane.
		Option could protect the properties along Asmall Lane and Halsall Lane.	Option could drastically reduce flood risk downstream.	No unusual construction risks.	Storage area and associated flow control structures would require a regular maintenance and inspection regime.	Formalised storage provides a change in current land use, and as area could be accessed by public there is an increased risk to public safety.	Potential ecological enhancement.	Temporary disruption during construction, loss of use of land during times of flood. Large potential impact on local business at White Rails and Little Hall Farms.		
5	Channel Widening	✖✖							✖	Option is not appropriate for the receptor area.
		Hurlston Brook is split between culvert and open channel across the Halsall Lane receptor area. Where it is in open channel it is heavily developed on both sides with residential properties and is not suitable for widening works.								

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
6	Culvert or Drainage Network Upgrades	✓	✓	✖	≈	≈	≈	✖	✓	Option could reduce flood risk along Halsall Lane and provide benefits downstream.
		Improved conveyance along Halsall Lane could be effective in reducing flood risk.	Improved capacity or conveyance could decrease flood risk downstream.	Road closures would be required due to drainage running below the public highway; interaction with buried services would be expected.	No significant change in maintenance regime.	No significant change in land use, risk profile unchanged.	No significant impact.	Could disrupt residents due to road closures during construction.		
7	Natural Flood Management	✓	✓	≈	≈	≈	✓	✖	✓	Application of NFM to the adjacent rural catchment and enhanced water management could provide a significant benefit to the Halsall Lane area.
		Option has the potential to provide both immediate and downstream benefits by improving surface water conveyance.		No unusual construction risks.	Minimal maintenance required.	No significant change in land use, risk profile unchanged.	Potential ecological enhancement.	Option will likely require re-appropriation of agricultural land.		
8	Property Level Protection	✓	≈	≈	✖	≈	≈	✖	✓	Option will provide immediate protection at affected properties, but is reliant on residents deploying defences prior to a flood event.
		Immediate benefit to each individual property.	Option would have no effect on flood risk downstream.	No unusual construction risks, other than sensitive nature of works to private dwellings.	Option requires maintenance of a large number of individual assets that will require co-ordination with residents.	No significant change in land use.	No significant impact.	Residents will be responsible for deployment of protection measures.		

Table 2.8 - Southport Road Options Matrix

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
1	Permanent Raised Defences	✓	✘	≈	≈	≈	✘	✘	✓	Shortly downstream of Southport road, the Brook leaves Ormskirk and runs through agricultural land. Permanent raised defences could be used to channel the flow past the residential properties and into the agricultural land beyond.
		Option could be used to protect the properties that run either side of Hurlston Brook, around the Southport Road culvert.	Option would have little effect on flood risk downstream. Flood risk downstream is not known and shortly downstream Hurlston Brook leaves Ormskirk.	Working close to watercourse and general construction risks.	No significant change in maintenance regime.	No significant change in land use, risk profile unchanged.	Could increase disconnection between the watercourse and the floodplain.	Disrupt residents due to raised defences being constructed around residential properties.		
2	Active Defences	✘✘							✘	Option is not appropriate for the receptor area.
		Option not appropriate in this receptor area due to the nature of the flooding mechanisms and the lack of existing infrastructure with which it would be required to interact.								
3	Channel Bypass / Diversion	✘✘							✘	Given the proximity of the Brook to residential properties, channel bypass / diversion would not be a feasible option.
		The land on both banks of Hurlston Brook is heavily developed through the Southport Road receptor catchment, restricting the scope for development, which would directly benefit the main watercourse.								
4	Flood Storage	✘✘							✘	Ineffective location for prospective storage.
		Owing to the heavily developed nature of the Southport Road catchment, there are no readily available sites that could provide storage until the downstream reaches of the brook – at which point storage would have limited effectiveness in managing flood risk.								
5	Channel Widening	✘✘							✘	Given the proximity of the Brook to residential properties, channel widening would not be a feasible option.
		As with the bypass and storage options, there is limited space to undertake widening works in locations that could be effective in reducing flood risk, either locally or elsewhere in the model catchment area.								
6	Culvert or Drainage Network Upgrades	✘✘							✘	Given the flooding mechanisms in the area (from the Brook), culvert or drainage network upgrades would not be a feasible option.
		The main flooding mechanism for Southport Road is out-of-channel flow from the watercourse. This is directly influenced by flows entering the watercourse from upstream, rather than inadequacies with the local drainage network.								

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
7	Natural Flood Management	✖✖							✖	Given the proximity of the Brook to residential properties, floodplain management would not be a feasible option.
		Owing to the heavily developed nature of the Southport Road catchment there are no readily available sites that are suitable for the application of NFM.								
8	Property Level Protection	✓	≈	≈	✖	≈	≈	✖	✓	Option will provide immediate protection at affected properties, but is reliant on residents deploying defences prior to a flood event.
		Immediate benefit to each individual property.	Option would have no effect on flood risk downstream.	No unusual construction risks, other than sensitive nature of works to private dwellings.	Option requires maintenance of a large number of individual assets that will require co-ordination with residents.	No significant change in land use.	No significant impact.	Residents will be responsible for deployment of protection measures.		

Table 2.9 - Redgate Estate Options Matrix

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
1	Permanent Raised Defences	✓	≈	≈	✖	≈	✖	✖	✖	While an immediate benefit could be provided to some properties, disconnecting the overland flow and the drainage network could generate issues elsewhere.
		Option could protect the properties that back onto Redgate Farm.	Option is unlikely to have an impact in reducing flood risk downstream.	No unusual construction risks.	Annual inspection and maintenance regime would need to be applied.	No significant impact.	May increase disconnect between surface water flows and the adjacent drainage network, which could change characteristics of the local environment and impact upon ecology.	Disrupt residents due to raised defences being constructed around residential properties.		
2	Active Defences	✖✖							✖	The flooding mechanism in this area means that active defences are not applicable.
		Option not appropriate in this receptor area due to the nature of the flooding mechanisms and the lack of existing infrastructure with which it would be required to interact.								
3	Channel Bypass / Diversion	✖✖							✖	Option would have minimal impact on identified mechanisms.
		The principal flooding mechanism for this area is surface water run-off from the surrounding agricultural land. Widening of existing drainage ditches will have minimal impact compared to formalised storage and changes to the drainage network.								
4	Flood Storage	✓	✓	≈	✖	✖	✓	≈	✓	Option could reduce the flood risk both immediately and downstream of the Redgate Estate.
		A storage area west of Redgate Estate could provide protection to the properties in the Redgate Estate.	Option could reduce flood risk downstream.	No unusual construction risks.	Annual inspection and maintenance regime would need to be applied.	Formalised storage provides a change in current land use, and as area could be accessed by public there is an increased risk to public safety.	Potential ecological enhancement.	Storage area is located behind residential properties and can be accessed away from major traffic routes. Impact during works would be minimal.		

Flood Risk Management Option		Technical Effectiveness		Health and Safety			Environmental		Conclusion	
		Immediate	Downstream	Construction	Maintenance	Public Use	Ecological	Stakeholder	Yes / No	Justification
5	Channel Widening	≈	≈	≈	≈	≈	≈	≈	✖	Option would provide little benefit in reducing flood risk either immediately or downstream of the Redgate Estate.
		Minimal impact on flows, which are controlled by 225mm diameter drain connection.	Option unlikely to influence downstream flows.	No unusual construction risks.	No significant change in maintenance regime.	No significant change in land use, risk profile unchanged.	Unlikely to have a significant impact.	No significant impact.		
6	Culvert or Drainage Network Upgrades	✓	✓	✖	≈	≈	≈	✖	✓	Option could reduce flood risk both immediately and downstream of the Redgate Estate. Impacts are minimal once construction is complete.
		Option could protect the properties within the Redgate Estate.	Option could decrease flood risk downstream.	Works could be required beneath the public highway and thus road closures could be required.	Maintenance requirements would be equal to that of the current drainage network.	No significant impact.	No impact.	Could disrupt residents during road closures.		
7	Natural Flood Management	✓	✓	≈	≈	≈	✓	✖	✓	Option could reduce flood risk both immediately or downstream of Redgate Estate. Option could have environmental benefits.
		Option has the potential to provide both immediate and downstream benefits by improving surface water conveyance.		No unusual construction risks.	Minimal maintenance required.	No significant change in land use, risk profile unchanged.	Potential ecological enhancement.	Option will likely require re-appropriation of agricultural land.		
8	Property Level Protection	✓	≈	≈	✖	≈	≈	✖	✓	Option will provide immediate protection at affected properties, but is reliant on residents deploying defences prior to a flood event.
		Immediate benefit to each individual property.	Option would have no effect on flood risk downstream.	No unusual construction risks, other than sensitive nature of works to private dwellings.	Option requires maintenance of a large number of individual assets that will require co-ordination with residents.	No significant change in land use.	No significant impact.	Residents will be responsible for deployment of protection measures.		

2.4 Outcome

The outcome of applying the MCA to the list of available options is summarised in Table 2.10 below. The green boxes signify options that are to be considered further, and the red boxes signify options that are to be screened out at this stage.

Table 2.10 : Longlist Results

Option	Receptor Area						
	Altys Lane	Railway Path	Dyers Lane	Coronation Park	Halsall Lane	Southport Road	Redgate Estate
Permanent Raised Defences	✓	✓	✓	✓	✓	✓	✘
Active Defences	✘	✘	✘	✘	✘	✘	✘
Channel Bypass / Diversion	✘	✘	✘	✘	✘	✘	✘
Flood Storage	✓	✓	✘	✓	✓	✘	✓
Channel Widening	✘	✘	✘	✓	✘	✘	✘
Culvert or Drainage Network Upgrades	✓	✓	✓	✓	✓	✘	✓
Natural Flood Management (NFM)	✓	✓	✘	✘	✓	✘	✓
Property Level Protection (PLP)	✓	✓	✓	✘	✓	✓	✓

Further detail on how these techniques could be applied within each receptor site is documented in the next section of the report, describing the ‘Rationalisation’ stage.

3. Option Review Stage 2 - Rationalisation

This next stage of the optioneering process is a rationalisation of all viable options as discussed in Section 2; into a shortlist of options the effectiveness of which is tested using the purpose built Integrated Catchment Model.

Of the 28 option-location combinations that have passed the first stage of the option review, some can be eliminated or streamlined from the modelling process.

The objective of the hydraulic modelling is to assess the effectiveness of these options in reducing flood risk. Some options by their nature;

- may not provide clear results of their effectiveness if modelled,
- may be ineffective if modelled for each receptor site in isolation and would benefit from being treated as a single catchment-wide option.

Three such options that meet this last category are Natural Flood Management (NFM), Property Level Protection (PLP) and improvements to the drainage network.

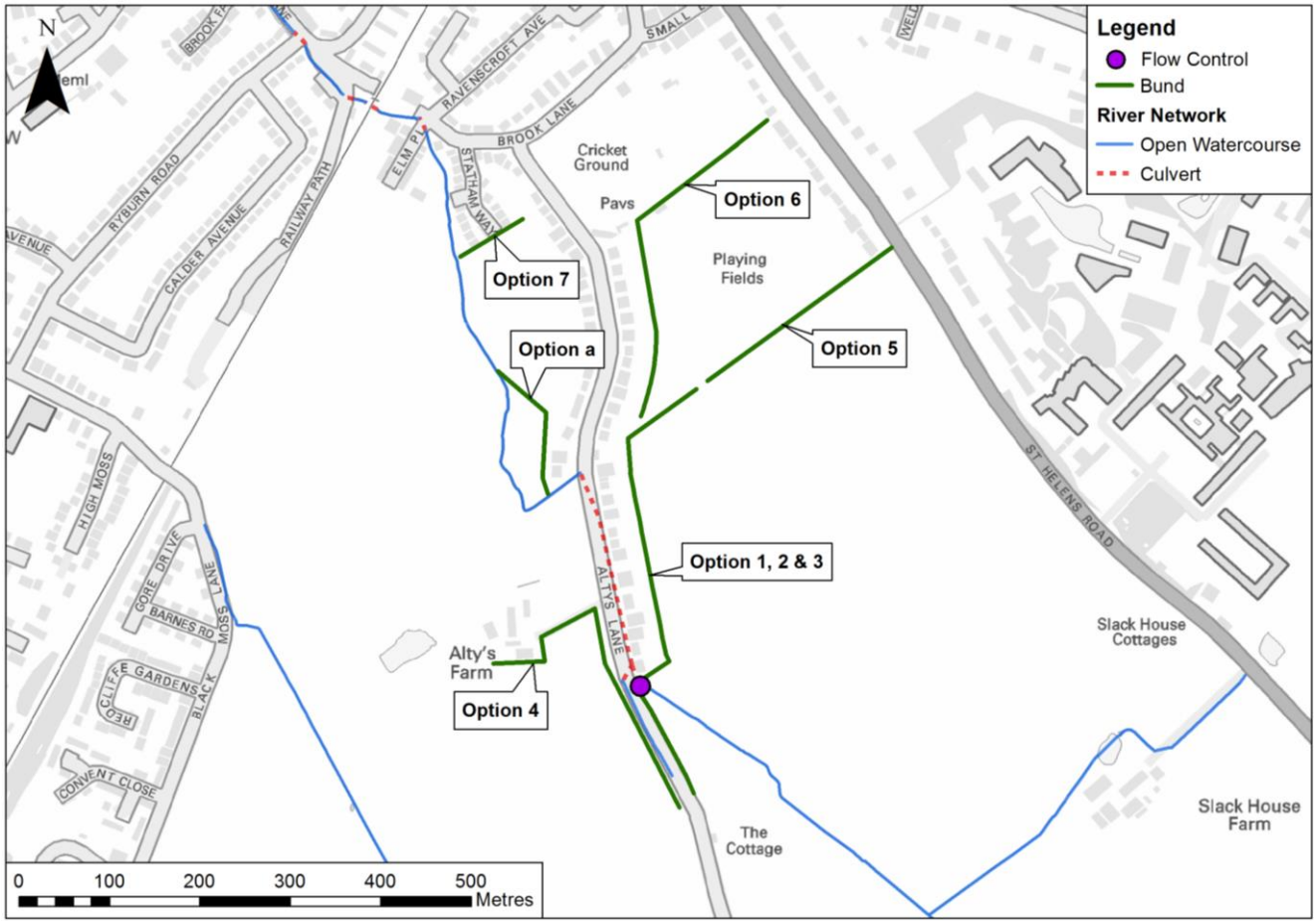
- NFM is appropriate for most receptor areas however techniques that could be practicably applied and accurately modelled within the study area are limited. NFM will only be tested at Redgate in an area with natural features that readily lends itself to this management option. Further commentary on the application of NFM as part of a long-term surface water management is provided in the Viability Report.
- PLP has also passed the initial screening in several locations. However, owing to its reliance on resident deployment it is normally viewed as a last resort option. As an option, it does not provide a benefit in reducing flood depths, and as such will not be modelled as an individual option. It is however, expected that PLP will be an appropriate measure for inclusion as part of a wider scheme using a combination of options, and its potential application will be discussed further in the Viability Report.
- Changes to the drainage network, comprising the surface water, foul and combined network operated by United Utilities will also be assessed as a single option. From reviewing the flooding mechanisms, it is clear that there are a number of interdependent factors, which in combination, result in the drainage system becoming surcharged during comparatively low-magnitude flood events.

The sections that follow provide a discussion of the possible application of the remaining options at each receptor site, which culminates in a list of options, which will be taken forward and modelled in Stage 3. For ease of identification, the options that successfully pass to Stage 3 are numbered, while the unsuccessful options are labelled with letters.

3.1 Altys Lane

Around Altys Lane, 8 options have progressed from the initial long-list. These options are described below and their respective locations are shown on Figure 3.1.

Figure 3.1 : Altys Lane



1) Flood storage and Permanent Defences

This option considers the creation of a formal storage area upstream of the Altys Lane culvert, reducing the likelihood of water spilling out onto the highway as it does at present. Raised embankment defences to the rear of the residential properties will intercept overland flow from the adjacent fields and attenuate it on the agricultural land.

2) Flood storage, Permanent Defences and Increased culvert size

This option applies the same principles as Option 1 and includes an increase in the size of the Altys Lane culvert (from 525mm to 750mm diameter), which would enable an increased pass forward flow. This option will assess whether improved conveyance downstream will reduce flood risk to the properties at the northern end of Altys Lane, with any flows exceeding this increased rate being stored in the formal storage area.

3) Flood storage, Permanent Defences and Reduced culvert size

Option 3 also operates on a similar principle to Option 1, however on this occasion the pass forward flow is reduced by decreasing the size of the culvert to 350mm. This option will result in a larger volume of water being formally stored, providing protection to properties in the immediate vicinity while also providing a benefit to downstream properties by restricting flows entering the drainage system and reducing the frequency of the system surcharging.

4) Flood Storage around Altys Farm

Overland flow from the fields to the west of Altys Lane contributes to flooding along the highway, which affects the residential properties and contributes to downstream flooding. Option 4 intercepts these overland flow paths and seeks to redirect the run-off into Hurlston Brook. This option could provide a benefit to the properties located along Altys Lane.

5) Flood Storage Bund along Playing Field Boundary

Overland flow from St Helens Road and the adjacent farmland also contributes to flooding at the downstream end of Altys Lane, near the junction with Brook Lane. Option 5 involves the construction of a storage bund along the boundary between grazing farmland and playing fields next to the cricket club, with water being stored on the farmland. The purpose of this storage is to hold back this water until the peak of the flood has passed, reducing the strain on the drainage system as it travels downstream towards Dyers Lane.

6) Flood Storage Bund along Cricket Club Boundary

Option 6 is a variation of the principles of Option 5, the significant difference being its location is closer to the boundary of the Cricket club. Option 6 seeks to capture a larger proportion of the surface water flows, including those which travel along the highway and into the cricket club via a stone access track from St Helens Road. Whilst using the playing fields to attenuate water is not ideal due to its recreational use, by locating the bund further downstream, the benefits of the storage would be maximised due a greater number of overland flow routes being cut off.

7) Flood Storage Bund South of Statham Way

The purpose of Option 7 is to intercept water which is observed in the model to travel along Statham Way towards the open channel alongside Elm Place. This option seeks to create a barrier to ensure that this water does not flow down the highways and add to the ponding experienced along Brook Lane.

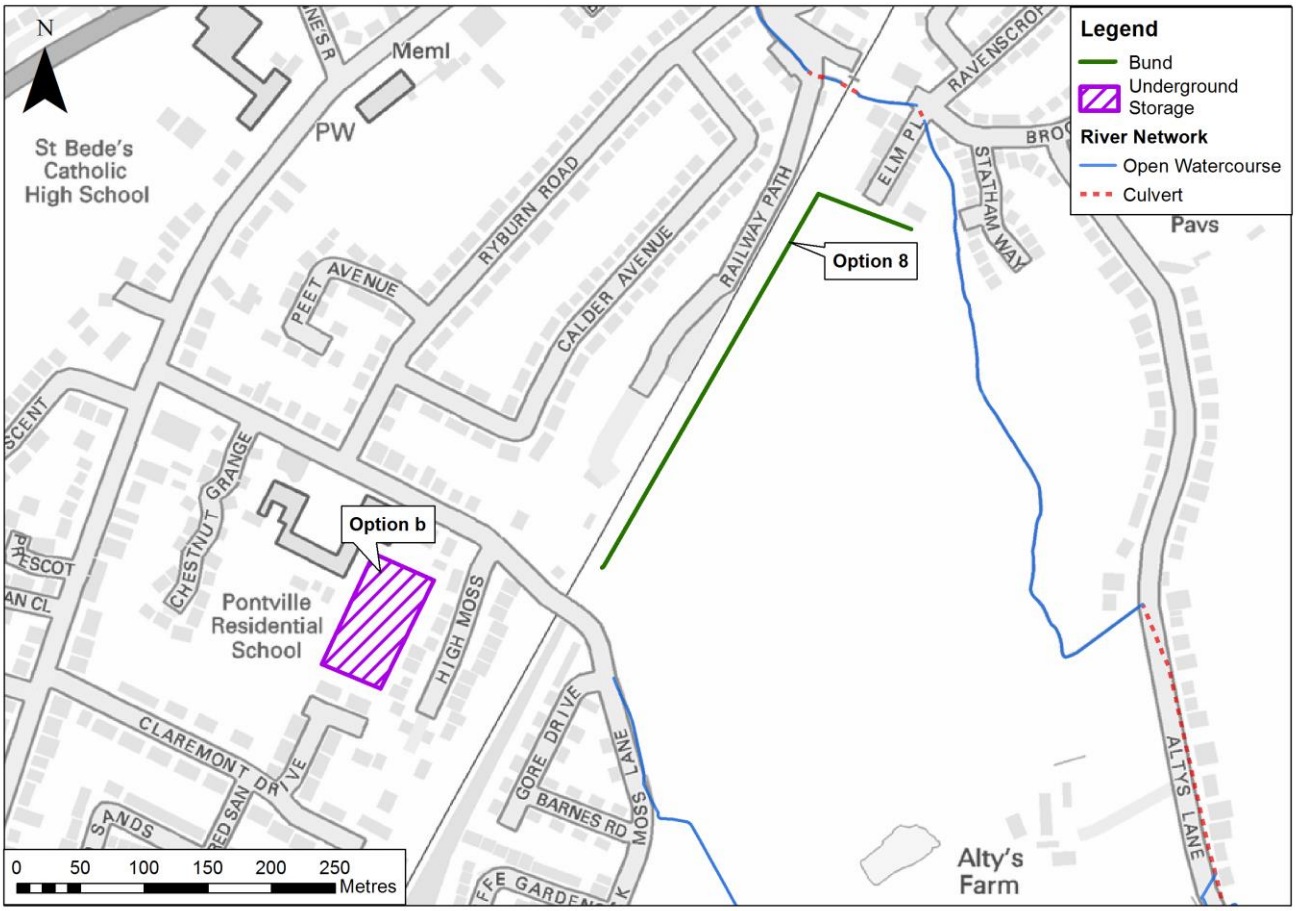
a) Right Bank Flood Storage

The flood model shows flood water ponding behind the properties on the east side of Altys Lane, this likely flooding was verified during a site visit when evidence of ponding induced erosion was identified. This option formalises flood storage in this area either through channel widening or a raised attenuation bund. This option was not taken forward for testing as its location and available storage capacity means it would have little or no impact on flood depths along Altys Lane or further downstream.

3.2 Railway Path

In the Railway Path area 2 options have progressed from the initial long-list. These options are described below and their respective locations are shown on Figure 3.2.

Figure 3.2 : Railway Path



8) Flood Storage along eastern side of Railway

Option 8 formalises flood storage in an area of agricultural land at which the model demonstrates flows converging. A small watercourse runs alongside Moss Lane and due to the elevation of the railway line at this location, flows over the railway line and onto Railway Path. This storage option prevents flow over the railway, and attenuates flows, which contribute to flooding at Elm Place.

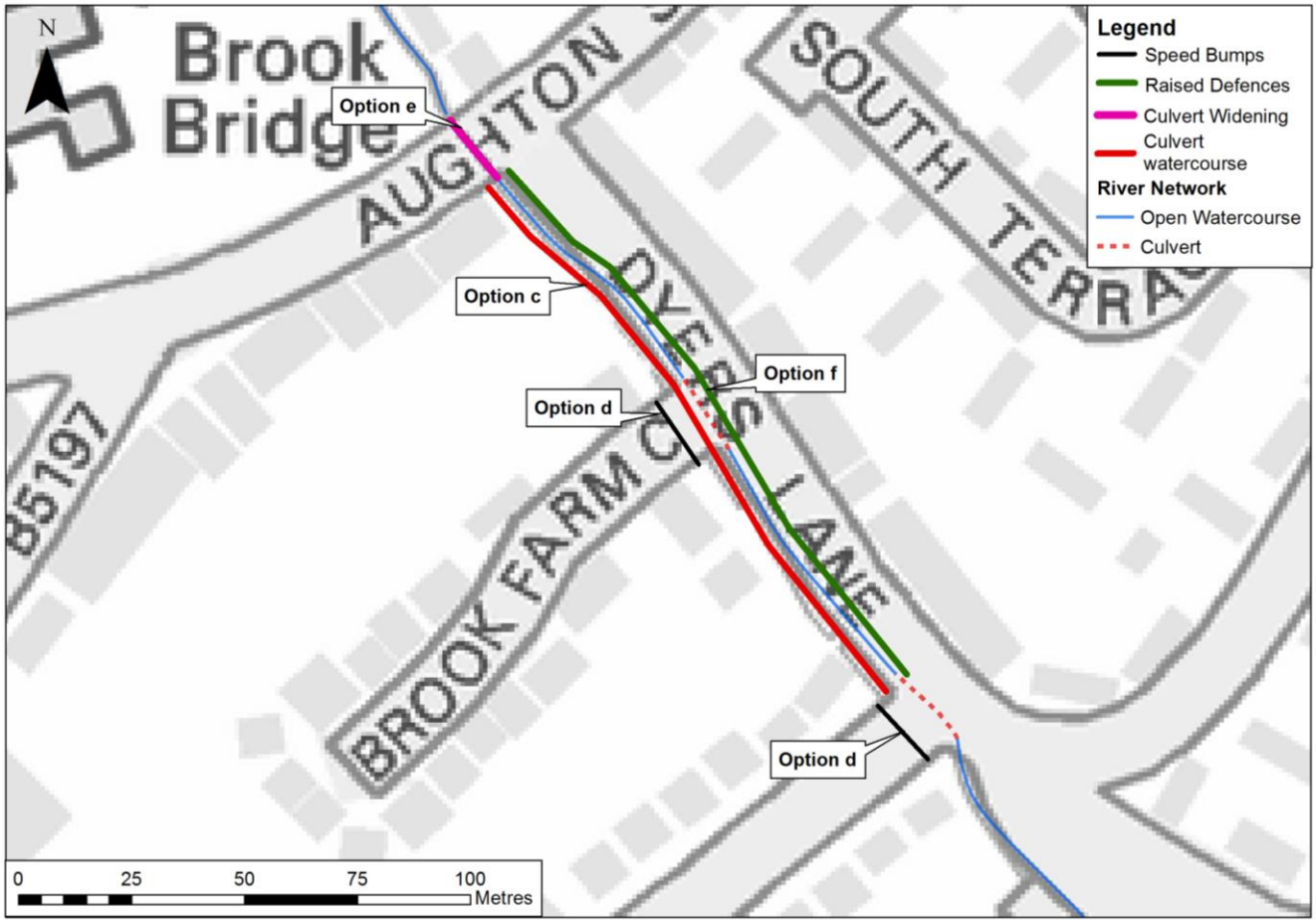
b) Buried Storage within Pontville School

Overland flow paths from the surcharged drainage system south of Black Moss Lane are observed in the model to contributing to the flooding on Railway Path and Dyers Lane. The playing fields at Pontville Residential School appeared on first inspection to be well situated for a formalised flood storage area, however further inspection of flow contributions and the surrounding topography suggest that such a solution would be challenging to implement and would provide minimal benefit in managing flows.

3.3 Dyers Lane

In the Dyers Lane area, 5 options have progressed from the initial long-list. These options are described below and their respective locations are shown on Figure 3.3.

Figure 3.3 : Dyers Lane



c) ***Culverting Watercourse***

Hurlston Brook runs in an open channel with a number of culvert crossings alongside Dyers Lane. This option considered culverting the watercourse along its full length parallel to Dyers Lane to prevent water from overtopping its banks. This option was not taken forward following a review of overland flow paths as it would prevent surface water from the surcharge drainage system from entering the watercourse. Coupled with this, such works would involve numerous actions with buried services and would significantly change the watercourse, which would have detrimental environmental impacts.

d) ***'Speed Bumps' at Dyers Lane Junctions***

Option d considered the use of speed bumps to direct overland flow from Railway Path, Ryburn Road and Brook Farm Close directly into the brook rather than allowing it to contribute to ponding on Dyers Lane. This option was discounted as a further inspection of the flood mechanisms demonstrated that the brook is frequently close to capacity and there is no space for this additional overland flow.

e) ***Widening of Aughton Street Culvert***

During the site walkover it was identified that the culvert beneath Aughton Street, downstream of Dyers Lane was partially blocked. Widening the culvert to increase its achievable flow rate was considered but discounted on the grounds that it would require significant works to the highway and culvert and is likely to have a minimal impact on flood risk.

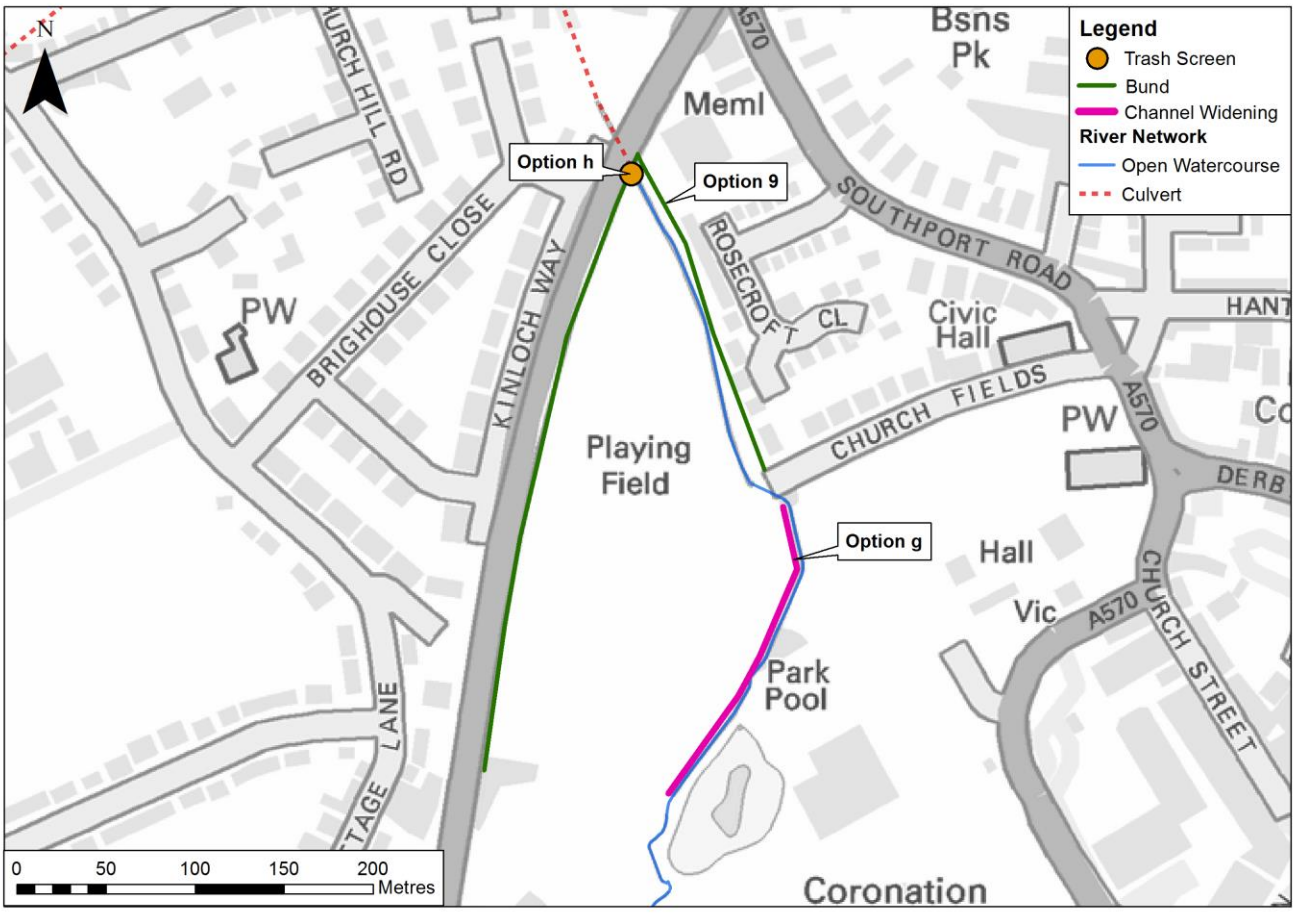
f) Raised Defences Along Right Bank of Watercourse

The right bank of the watercourse is much lower than that of the left bank. This option considered the impacts of raising the right bank of the watercourse to match that of the left with the aim of reducing the likelihood of water spilling out onto Dyers Lane. This option was discounted as the primary cause of the right bank overspill is the existing crossings which provide private access and support utilities crossing the brook.

3.4 Coronation Park

Around Coronation Park 3 options have progressed from the initial long-list. These options are described below and their respective locations are shown on Figure 3.4.

Figure 3.4 : Coronation Park



9) Formalised Flood Storage

Coronation Park is a large area of open space through which Hurlston Brook Flows, which could be utilised for flood storage. The brook exits the park through a culvert which runs under County Road. This option limits the pass forward flow to the size of the culvert and stores the additional flood water within the park, providing protection to properties downstream. Raised defences would be needed to prevent impounded water from spilling over onto County Road to the west, and into the properties on Roscroft Close and Church Fields to the east.

g) Widening channel

This option looks at widening Hurlston Brook to create a two staged channel as it runs through Coronation Park. This would provide additional storage within the channel. Due to the small scale of the widening, it could not be accurately represented in the hydraulic model and thus the option was not taken forward. Space is also limited by the presence of a large sewer which flows beneath the park.

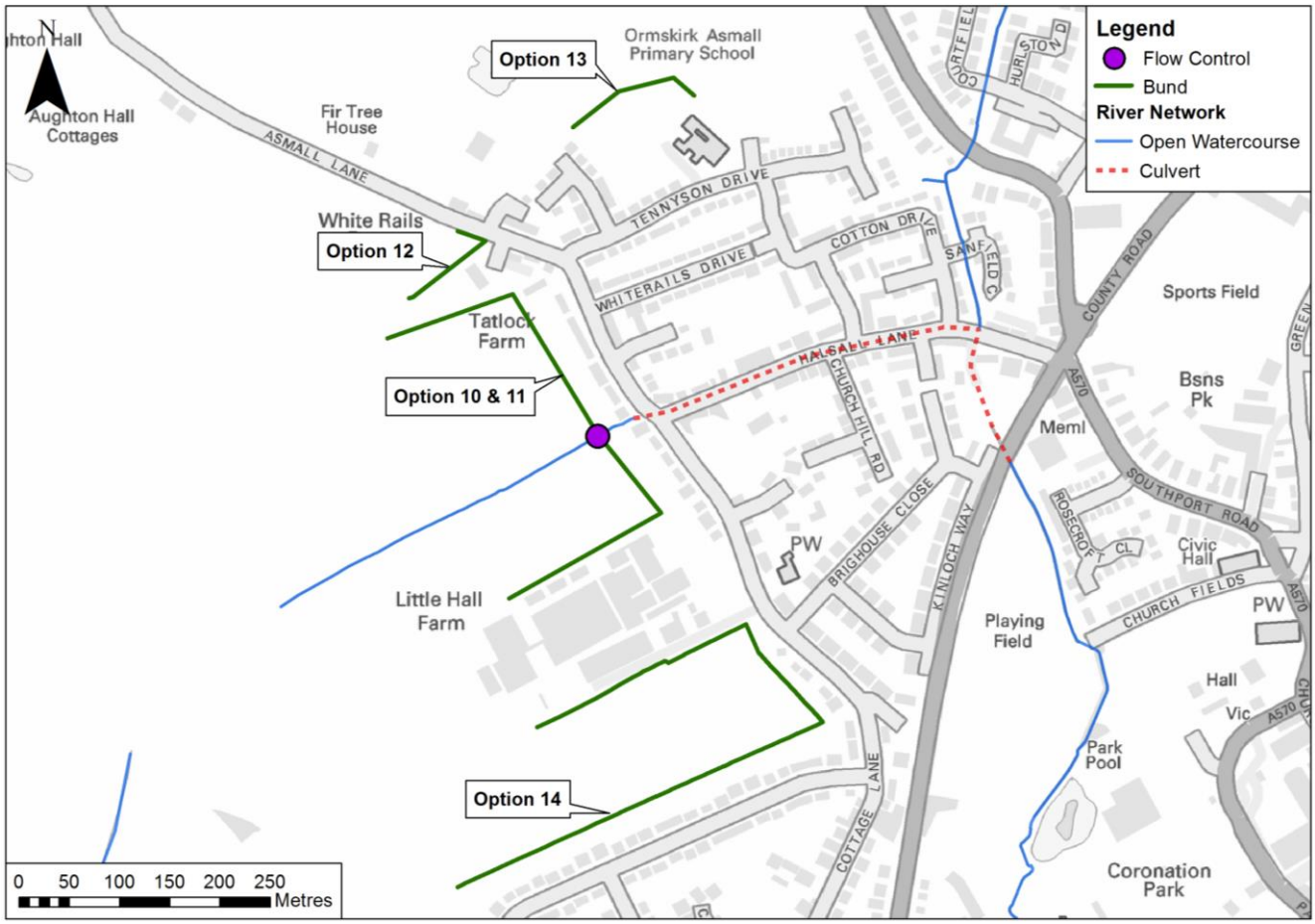
h) Trash screen to County Road culvert

This option looked at upgrading the trash screen to the County Road culvert to reduce blockage risk. This option was not taken forward as during a site visit, it was identified that the trash screen had recently been replaced and provides reasonable access for maintenance and blockage clearance as long as flood levels in the park do not exceed the access route from County Road.

3.5 Halsall Lane

Five options have progressed from the initial long-list for Halsall Lane. These options are described below and their respective locations are shown on Figure 3.5.

Figure 3.5 : Halsall Lane



10) Flood Storage behind Asmall Lane (no change to culvert)

This option involves creating a storage area behind the properties on Asmall Lane. A low level earth embankment to the rear of the properties would be constructed which directs overland flow into the storage area. The pass forward flow from the storage area would then be limited to the capacity of the existing culvert, reducing the overland flow down Altys Lane. This option is likely to provide a reduction in risk to the properties along Asmall Lane and Halsall Lane.

11) Flood Storage behind Asmall Lane (reduced culvert size)

This option is a development of Option 10, discussed above. Whereas Option 10 limited the pass forward flow to the capacity of the existing culvert, this option looks as reducing the culvert size with the objective of holding back more water in the storage area and reduce the flows being passed into the surface water drainage network

12) Flood Storage at Whiterails Farm

The flood outline for the baseline model shows an area of ponding at Whiterails Farm. This option looks to formalise this flood storage area by the construction of a low embankment which ties into natural high ground reducing the contribution of overland flows along Asmall Lane.

13) Flood Storage at Asmall Primary School

This option seeks to intercept an overland flow path from the area behind Asmall Primary School, reducing overland flows along Tennyson Drive by constructing a low embankment.

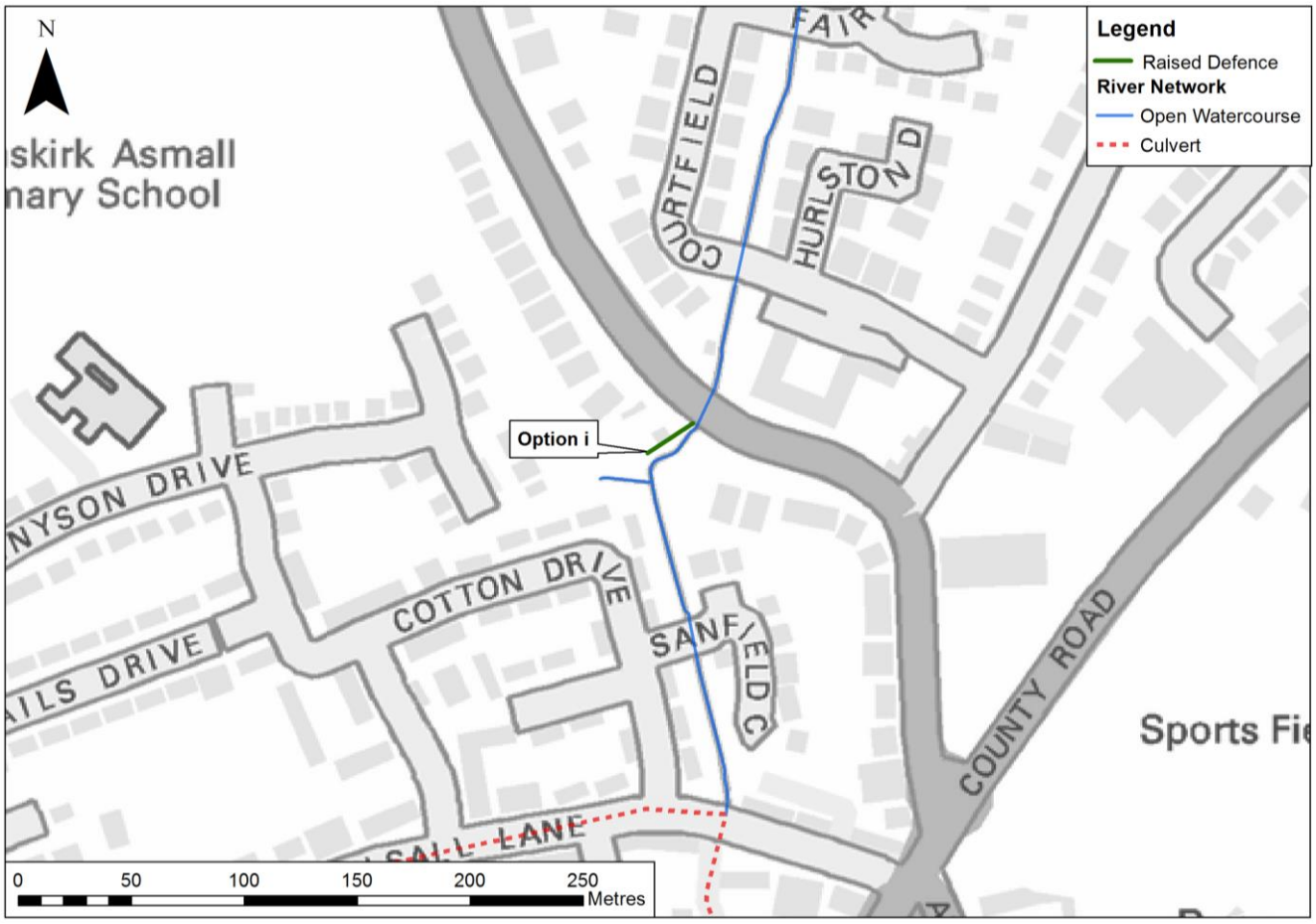
14) Little Hall Farm

This option involves creating a formal storage area to hold back overland flows which contribute to the surcharging of surface water drains around Brighouse Way and Kinloch drive and ponding around the eastern end of Halsall Lane. This is achieved by constructing a low embankment which traps overland flows in the storage area.

3.6 Southport Road

Owing to the number of space constraints around the Southport Road area only one option has progressed from the original long-list, as below.

Figure 3.6 : Southport Road



i) Permanent Raised Defences

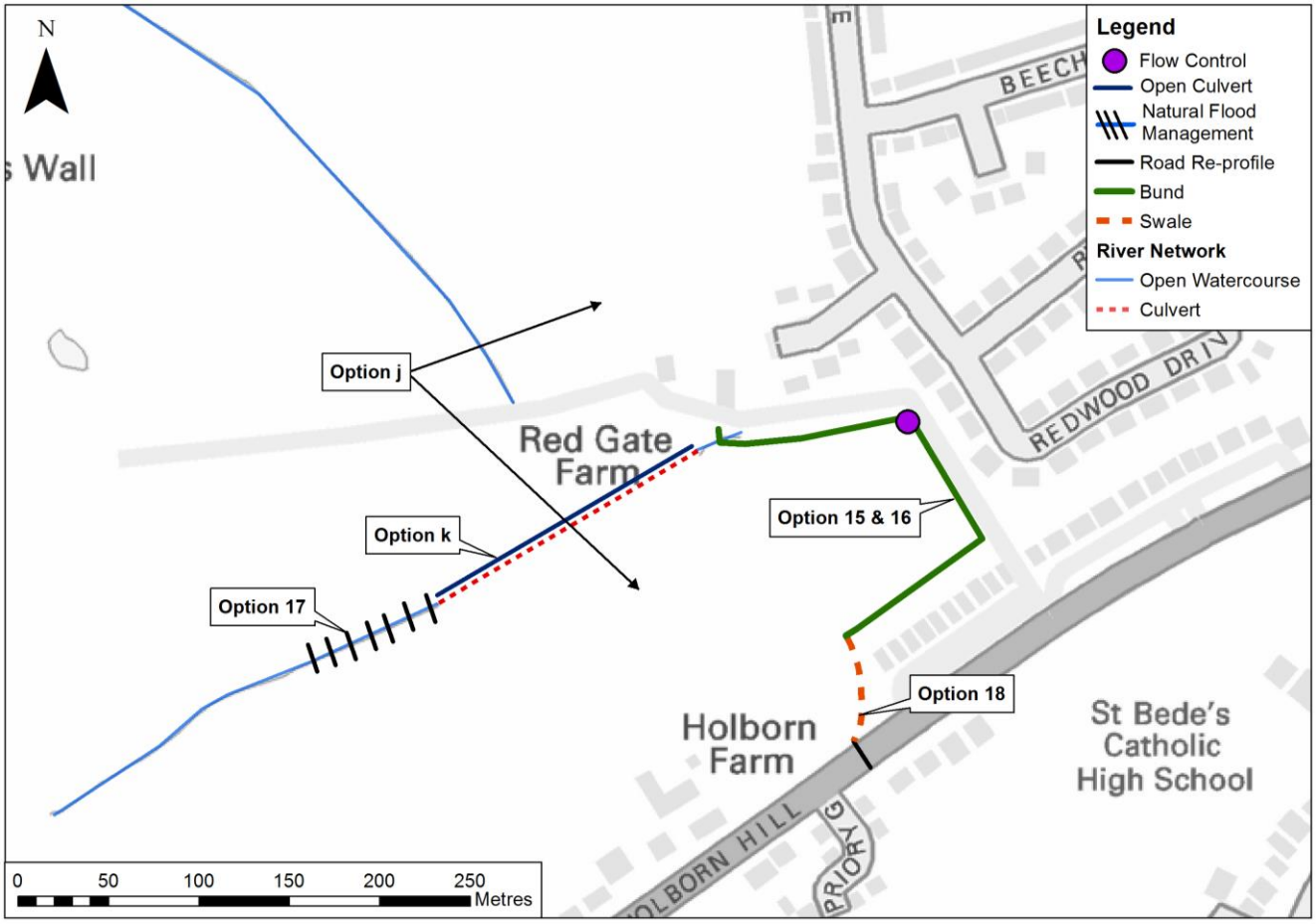
This option involves the raising of a low spot on the left bank of Hurlston Brook, immediately upstream of it entering a culvert beneath Southport Road. Records indicate the property at 123 Southport Road experienced flooding from water spilling over the left bank, however close inspection of the flow mechanisms suggested a combination of flows from the river and overland flows from the Tennyson Drive area. As such, a simple wall

raising exercise would not provide a comprehensive reduction in flood risk and it is instead suggested that a form of PLP could be preferred in this location.

3.7 Redgate

Six options have progressed from the initial long-list for the Redgate area. These options are described below and their respective locations are shown on Figure 3.7.

Figure 3.7 : Redgate



15) Flood Storage (no change to culvert)

This option involves the creation of a formal flood storage area by the construction of a low embankment which would intercept and attenuate overland flows. The pass forward flow is limited by the size of the existing culvert. This is likely to provide protection to the properties within the Redgate Estate.

16) Flood Storage (culvert size reduced)

This option follows the same principles as Option 15, however rather than maintaining the size of the existing culvert, the size is reduced by means of an orifice plate or hydrobrake flow control regulator. This is likely to provide protection to the properties within the Redgate Estate whilst also reducing flows passed into the drainage system downstream.

17) Natural Flood Management

This option looks at implementing NFM methods to reduce the speed of flows down the watercourse that runs along the field boundary between the two farms. Wooded debris dams located at intervals along the watercourse would utilise the farmland either side by providing small areas of flood storage, slowing the flow of water entering the culvert behind the Redgate Estate.

18) Flood Storage (no change to culvert) and Holborn Hill diversion

An extension of the elements described in Option 15, this option intercepts overland flows from the highway down Holborn Hill and diverts it into the Red Gate Farm storage area, via a swale, with the intention of reducing the flows entering the drainage network.

j) Direction of ploughing

This option, linked to NFM, considered a change to landuse management practices in the field upstream of the small watercourse. One option would be to alter the direction of in which the fields upstream of Red Gate Farm are ploughed, so that the furrows run perpendicular to the ground slope. It was observed during a visit to site that the surrounding fields were ploughed parallel to the ground slope, effectively creating preferential flow routes down the hillside towards the small watercourse. This option was not taken forward to modelling due to the small scale benefits that would be experienced; however it may still provide a positive contribution when combined with other FRM measures.

k) Opening up Culvert

For a short length, the small watercourse runs through a culvert. This option looks at opening up this culvert to create additional storage. Due to the short length of this culverted section, this would provide little benefit and so was not taken forward to the detailed modelling assessment.

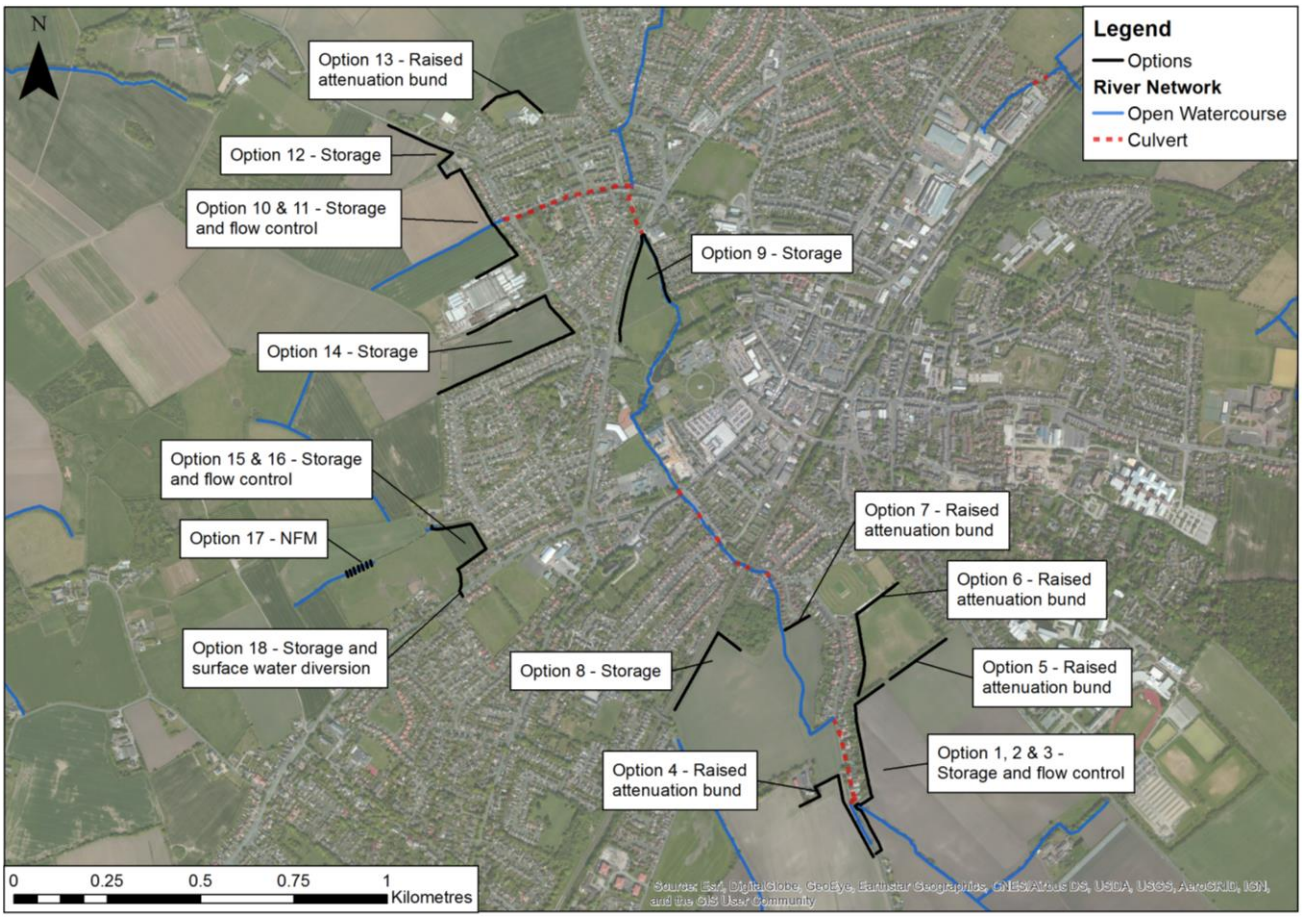
3.8 Short-List Summary

Following the rationalisation process, the following options were taken forward for testing using the Integrated Catchment Model.

Reference	Receptor Site	Description
1	Altys Lane	Flood storage, protective bund immediately upstream of 75 Altys Lane. Pass forward flow in channel is limited by the size of the existing culvert.
2		As Option 1, but existing culvert size is increased to 750mm diameter.
3		As Option 1, but existing culvert size is reduced to 300mm diameter.
4		Bund along field boundary to impound overland flow from Altys Farm, and prevent flooding onto the highway.
5		Bund along boundary between playing fields and farmland.
6		Bund along boundary between cricket club and playing fields.
7		Bund behind Statham Way/Elm Place.
8	Railway Path	Flood storage on eastern side of railway line, to restrict passage of water onto the railway.
9	Coronation Park	Formalise flood storage at the downstream end of the park. Pass forward flow limited to the capacity of the existing culvert.
10	Halsall Lane	Formalise flood storage behind No.1 Asmall Lane. Pass forward flow limited to the capacity of the existing culvert.
11		As option 10, with size of existing outlet culvert reduced by 33%.
12		Formalise flood storage at Whiterails Farm. Pass forward flow limited to the capacity of the existing culvert.
13		Permanent flood defence embankment to block flow path of overland flow from fields behind Asmall Primary School.
14		Storage area behind Little Hall Farm.
15	Redgate	Storage area with pass forward flow restricted by the size of the existing culvert.
16		As option 15, with size of existing outlet culvert reduced by 33%.
17		Natural Flood Management – wooded debris dams.
18		As Option 15, with addition of surface water diversion from Holborn Hill.

The locations and approximate extents of these options can be seen in Figure 3.9.

Figure 3.8 : Options taken forward for testing



In the next phase, these options will be tested using a hydraulic model which will enable the optimum components to be identified and put forward for inclusion as part of a combination of options.

4. Option Review Stage 3 - Testing

This final stage of the optioneering process involves using the Integrated Catchment Model to test the effectiveness of each option in reducing flood risk both locally to the option, and downstream in the areas where the risk is most acute. The process by which this has been undertaken is described below.

4.1 Option Modelling

To enable a fair and structured comparison of the merits of the respective options, it was vital to establish a standard means of comparison.

This has been done by establishing a number of monitoring points at which flood depths generated by the hydraulic model could be recorded and compared.

To provide a baseline to compare against, flood depths have been recorded at each monitoring point for the Do Minimum flood model for both a 3.33% and 1.33% Annual Exceedance Probability (AEP) flood event. Each option is then modelled individually for each return period and its impact on depths recorded.

4.2 Monitoring Points

The local impact (i.e. flooding in the immediate vicinity of the option) will be assessed as well as the impact on flood depths at a range of locations downstream. To enable a fair and effective comparison, the same locations have been monitored for each option.

Each of the monitoring points captures representative flooding depths at a key receptor location. Figures 4.1 and 4.2, below, illustrate the location of the monitoring point in respect to the flood outlines of the December 2015 event and the modelled Do Minimum 1.33% AEP event.

Figure 4.1 : December 2015 Flood Outline

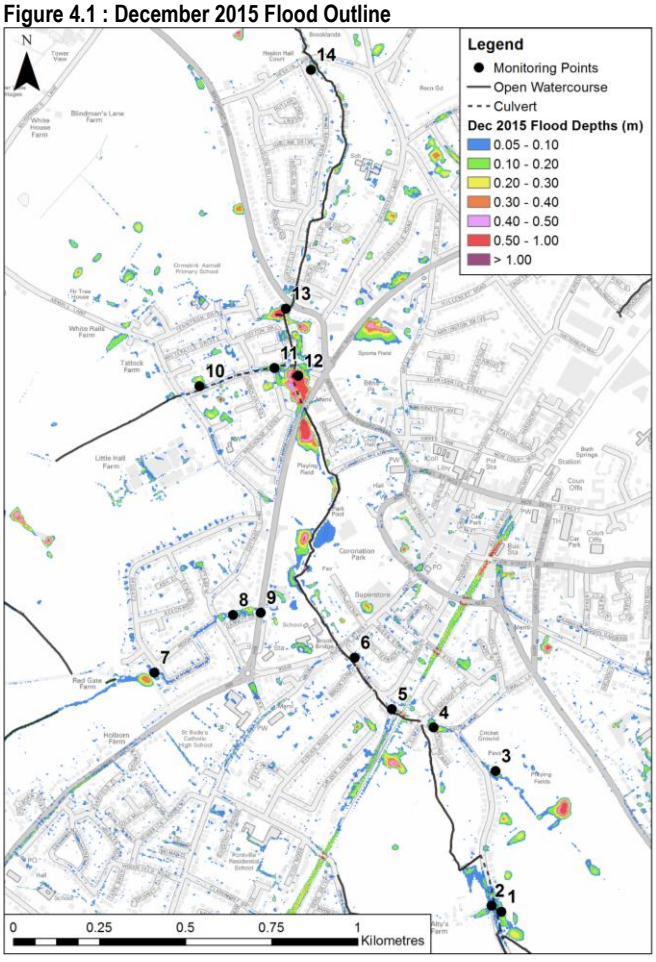
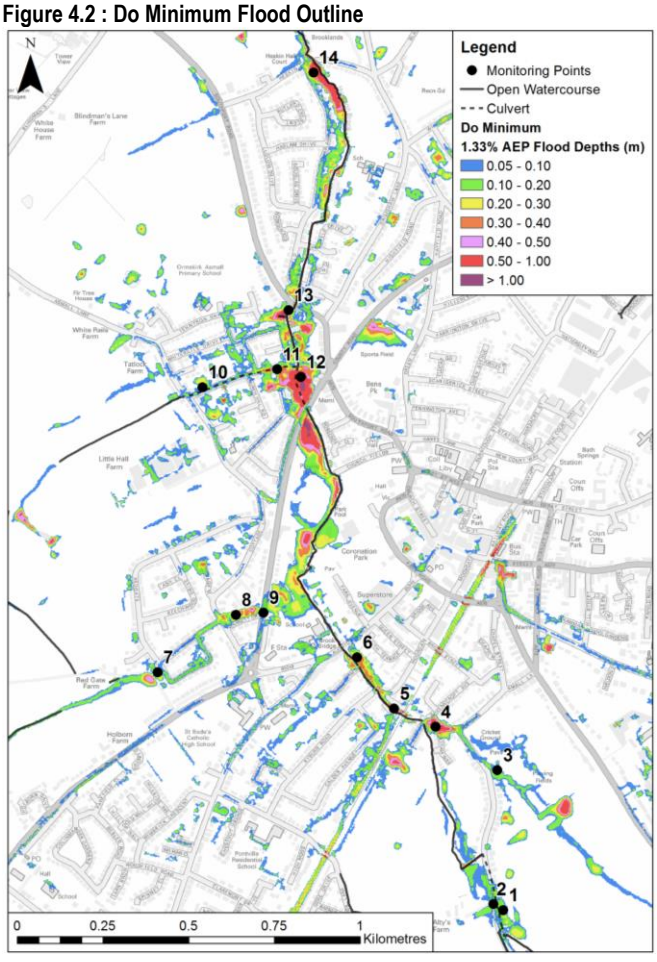


Figure 4.2 : Do Minimum Flood Outline



4.3 Option Effectiveness

The feasibility of each option has been assessed using an approach, which includes a measure of both technical and economic effectiveness. This approach is described below.

4.3.1 Technical Effectiveness

As discussed in Section 4.1, flood depths have been recorded at a number of monitoring points for both the Do Minimum and option scenarios. Based on the depth difference, each option has been scored using the matrix presented in Table 4.1.

Table 4.1 : Depth Scoring Matrix

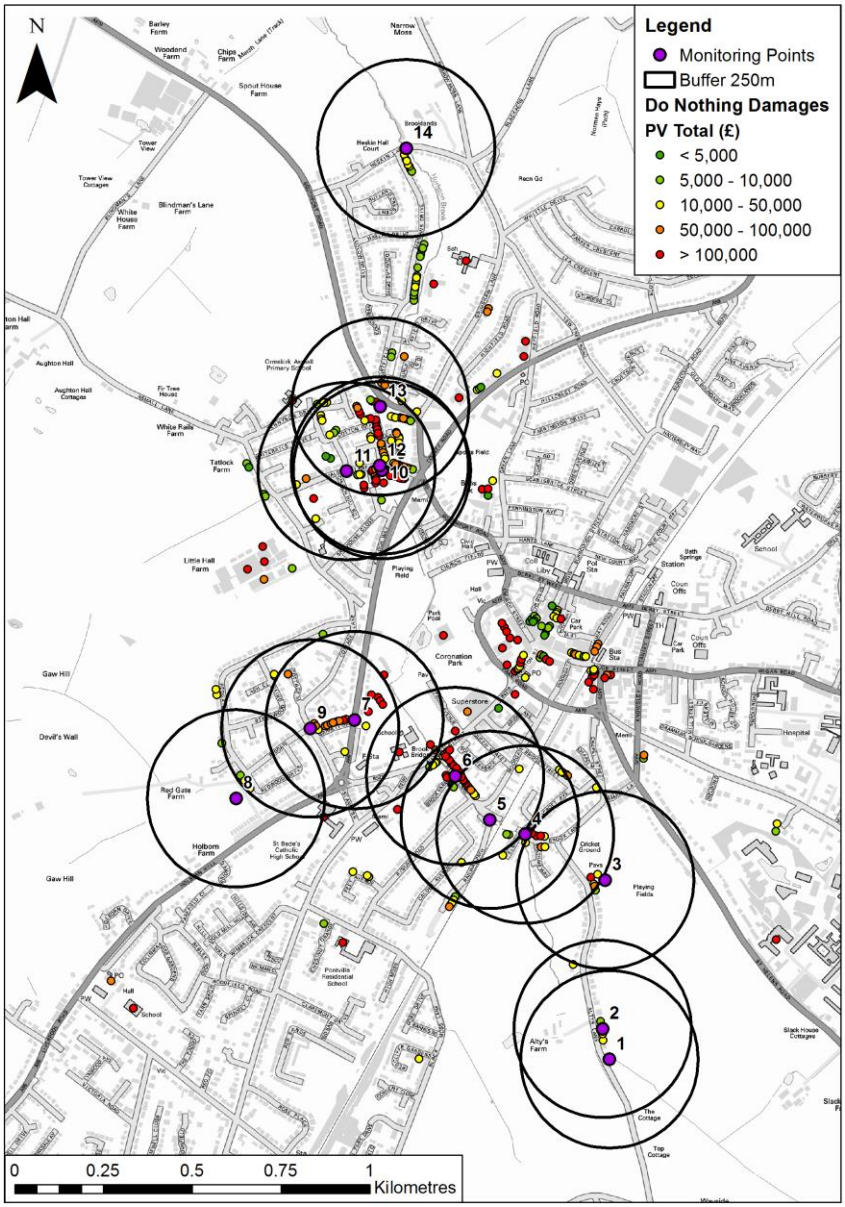
Depth difference (m)	Description
>= -0.150	Very significant reduction
-0.075 to -0.150	Significant reduction
-0.025 to -0.075	Minor reduction
-0.025 to 0.025	No significant change
0.025 to 0.075	Minor increase
0.075 to 0.150	Significant increase
>= 0.150	Very significant increase

If the residual depth at a monitoring point is less than 0.050m, this has also been considered in the technical effectiveness of the option, as it is thought to be a ‘manageable’ depth of water.

4.3.2 Economic Effectiveness

To reflect that some of the monitoring points are located in places where larger numbers of properties are at risk and the value of potential economic damages is greater, each monitoring point has been assigned an economic damage weighting. By applying a 250m buffer to each point, and calculating the value of baseline damage associated with each point, a relative weighting was derived.

Figure 4.3 : Buffered Monitoring Points



The influence of the damages of each monitoring point was determined by calculating the percentage of the total Do Nothing damages located within each buffered area.

4.4 Option Effectiveness Results

Using the results of the economic influence and the technical effectiveness, each of the options have been ranked, see Table 4.2. Rank 1 illustrates the option that provides the greatest depth reduction, either locally or further downstream, and has the greatest damage influence. Where there is no change in depth, options have been discounted and are tied at Rank 15.

Table 4.2 : Option Effectiveness Results

Option	Rank	Taken Forward to Economic Appraisal
Option 9 – Flood Storage within Coronation Park	1	Yes
Option 18 – Option 15 plus road diversion	2	Yes
Option 15 – Flood Storage with existing culvert capacity	3	No
Option 16 – Flood Storage with reduced culvert capacity	3	No
Option 6 – Bund between playing fields and cricket pitch	5	Yes
Option 1 – Flood Storage with existing culvert capacity	6	Yes
Option 3 – Flood Storage with reduced culvert capacity	6	No
Option 10 – Flood Storage with existing culvert capacity	8	Yes
Option 11 – Flood Storage with reduced culvert capacity	8	No
Option 12 – Flood Storage at Whiterails Farm	10	Yes
Option 14 – Flood Storage	11	Yes
Option 2 – Flood Storage with increased culvert capacity	12	No
Option 5 – Bund between playing fields and farmland	13	No
Option 8 – Flood Storage along Railway Line	14	No
Option 4 – Bund around Altys Farm	15	No
Option 7 – Bund behind Statham Way / Elm Place	15	No
Option 13 – Bund being Asmall Primary School	15	No
Option 17 – Wooded Debris Dams	15	No

Where options are similar, or involve variations on a theme (such as Options 15, 16 & 18), the most effective of the group has been passed forward.

Where options have a tied ranking, for example Option 1 and Option 3, this is because the measured benefits are very similar. To determine which one was taken forward, the required works and cost implications of each option was considered and the more cost-effective option was taken forward.

Option 2 is a different arrangement to Options 1 and 3 and does not provide the same benefits, which is why it has been ranked at 12 and discounted.

Option 5 provided fewer benefits than Option 6. As Option 6 is downstream of Option 5, Option 5 was discounted and Option 6 was taken forward as it is able to influence a wider area.

Option 8 provided no benefits in the 3.33% AEP and very small benefits in 1.33% AEP simulations and has therefore, been discounted.

Due to the nature of the flooding to Ormskirk, no single option is effective at reducing the risk of surface water flooding for the entire catchment. Instead, a combination of options, including Options 1, 6, 9, 10, 12, 14 and 18 will be taken forward to the economic appraisal process, details of which are included in the Viability Report.