Cork County Council/Office of Public Works

Glashaboy River (Glanmire/Sallybrook) Drainage Scheme

Final Options Report

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Ove Arup & Partners Ireland Ltd

Arup
One Albert Quay
Cork
T12 X8N6
Ireland
www.arup.com

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			Prepared by	Checked by	Approved by
		Name	Wolfram Schluter	Wolfram Schluter	Ken Leahy
		Signature			
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			Prepared by	Checked by	Approved by
		Name	Emer Nic Aoidh	Wolfram Schluter	Ken Leahy
		Signature	Emer Nic Aoidh	Schl	
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		Name			
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1 Introduction

1.1 Context

The Office of Public Works (OPW) in partnership with both Cork City and Cork County Councils have recognised the high levels of existing flood risk in the River Lee Catchment and have carried out a Catchment Flood Risk Assessment and Management (CFRAM) Study for the Lee Catchment which includes the Glashaboy River catchment. The Draft Catchment Flood Risk Management Plan, which was published in February 2010, had identified a preferred option for the alleviation of flood risk in the Glashaboy catchment.

During June 2012, significant flooding occurred in the Glanmire and Sallybrook areas in Cork. As a result, Cork County Council, acting as Agents for the OPW, has commissioned Arup in association with JBA Consulting to develop a Flood Relief Scheme for Glanmire/Sallybrook areas.

The scheme will be designed to provide protection to properties in the study area from the 1 in 100 year fluvial/1 in 200 year tidal flood events.

The overall scheme will consist of:

- Flood alleviation measures in the form of hard defences along the Glashaboy River to provide the required standard of protection.
- Alterations to the geometry of some existing bridge structures located along the Glashaboy River at Hazelwood in order to prevent afflux at constricted areas within the channel.
- Other measures to improve conveyance through the Glashaboy River and its tributaries.

There a number of stages to the project:

- Stage I – Development of a number of flood defence options and the identification and outline design of a preferred scheme.
- Stage II – Public exhibition.
- Stage III – Detailed design, confirmation and tender.
- Stage IV – Construction.
- Stage V – Handover of works.

This Options Assessment Report is produced as part of Stage I of the project. It follows on from work carried out to-date and should be read in conjunction with the following reports:

- The Constraints Study.
- The Hydrology Report, and
- The Hydraulics Report.

1.2 Scope of Report

The purpose of this report is to assess all possible flood relief options that could be implemented in the Glanmire/Sallybrook area and to outline the procedure for development and selection of the preferred option. The process for the selection of the preferred flood relief options is outlined below:

- An initial screening of a long list of possible flood risk management measures against a predetermined set of criteria, was carried out to determine their potential viability.
- A technical assessment of potentially viable flood risk management measures was undertaken.
- Potential flood relief options were developed using combinations of flood risk management measures which were determined to be technically viable.

These flood relief options were then subjected to economic, environmental, and multi-criteria assessments, allowing a preferred flood relief option to be selected.

1.3 Study Area

The study area for the project consists of the Glashaboy River catchment as shown in Figure 1. A key plan of the study area at and north of Hazelwood Shopping Centre is shown in Figure 2 and Figure 3 shows the area from south of the Hazelwood area to Glanmire Village.

Figure 1: Glashaboy Study Area Map

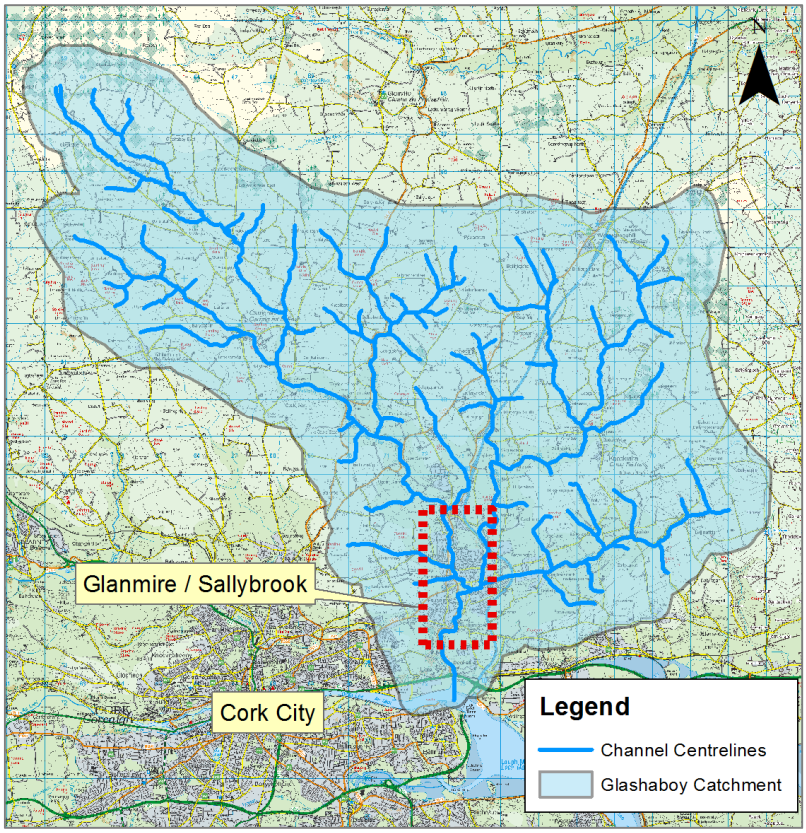


Figure 2: Key Plan – Sallybrook to Hazelwood

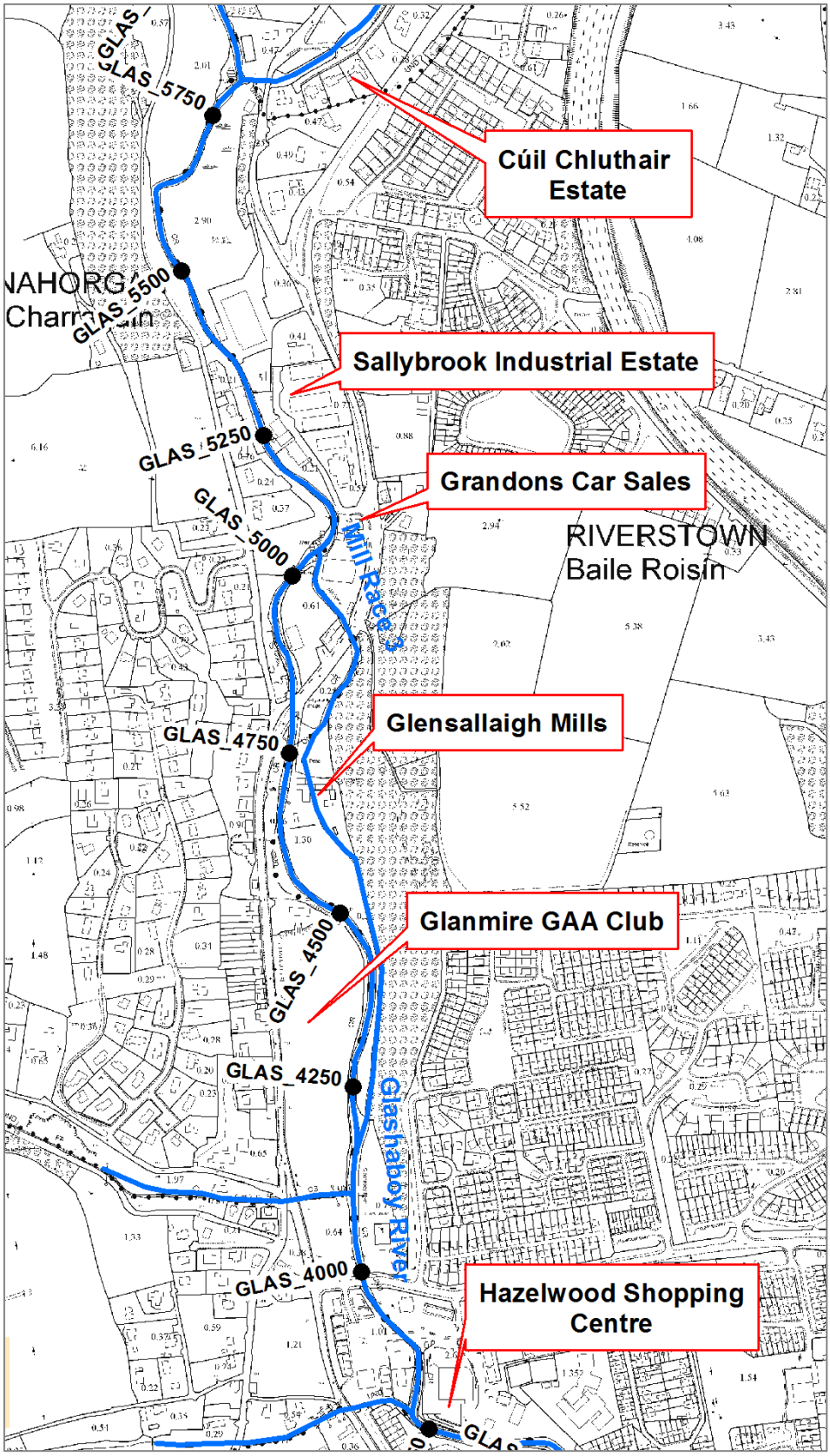
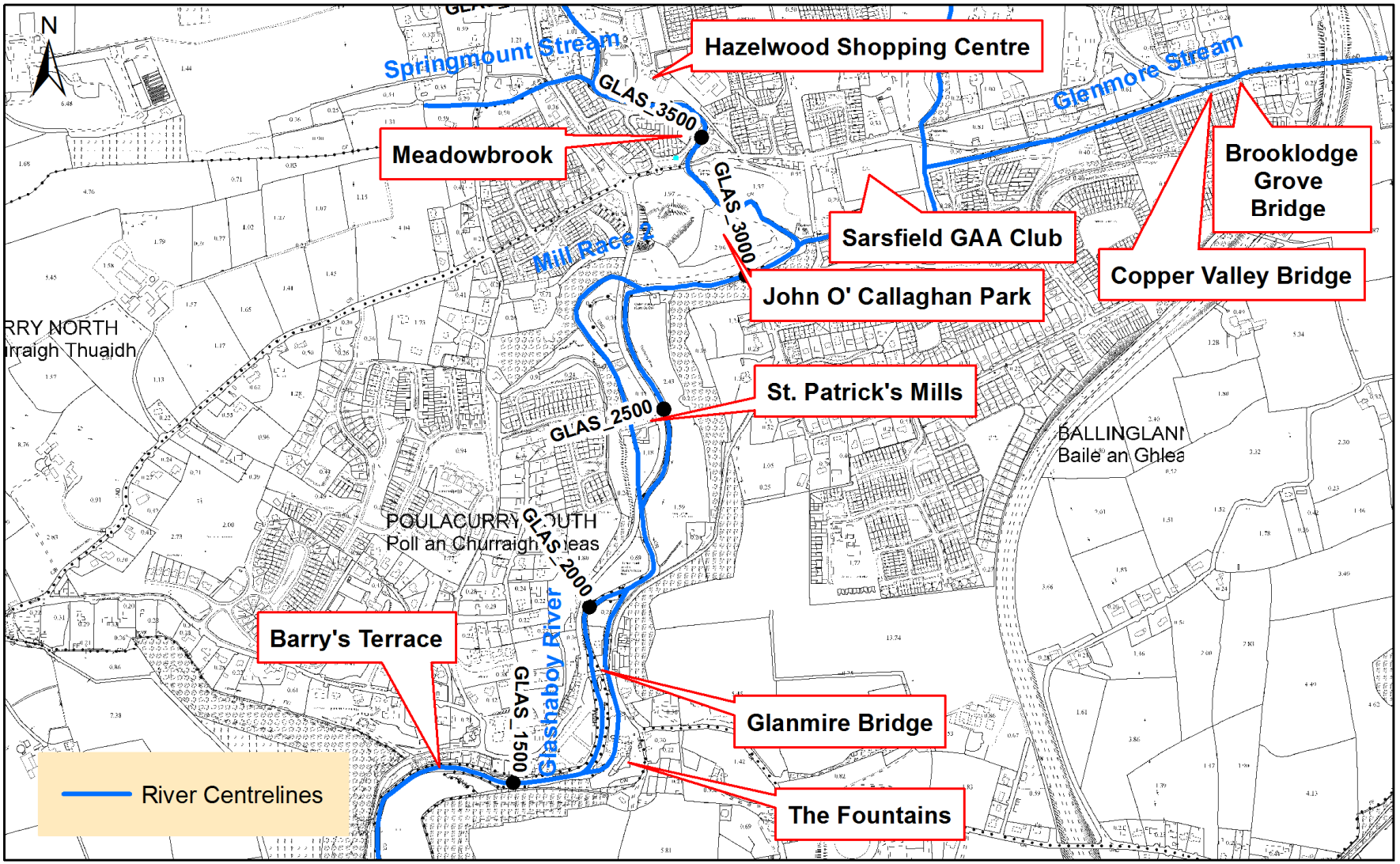


Figure 3: Key Plan – Hazelwood to Glanmire Village



1.4 Scope of the Problem

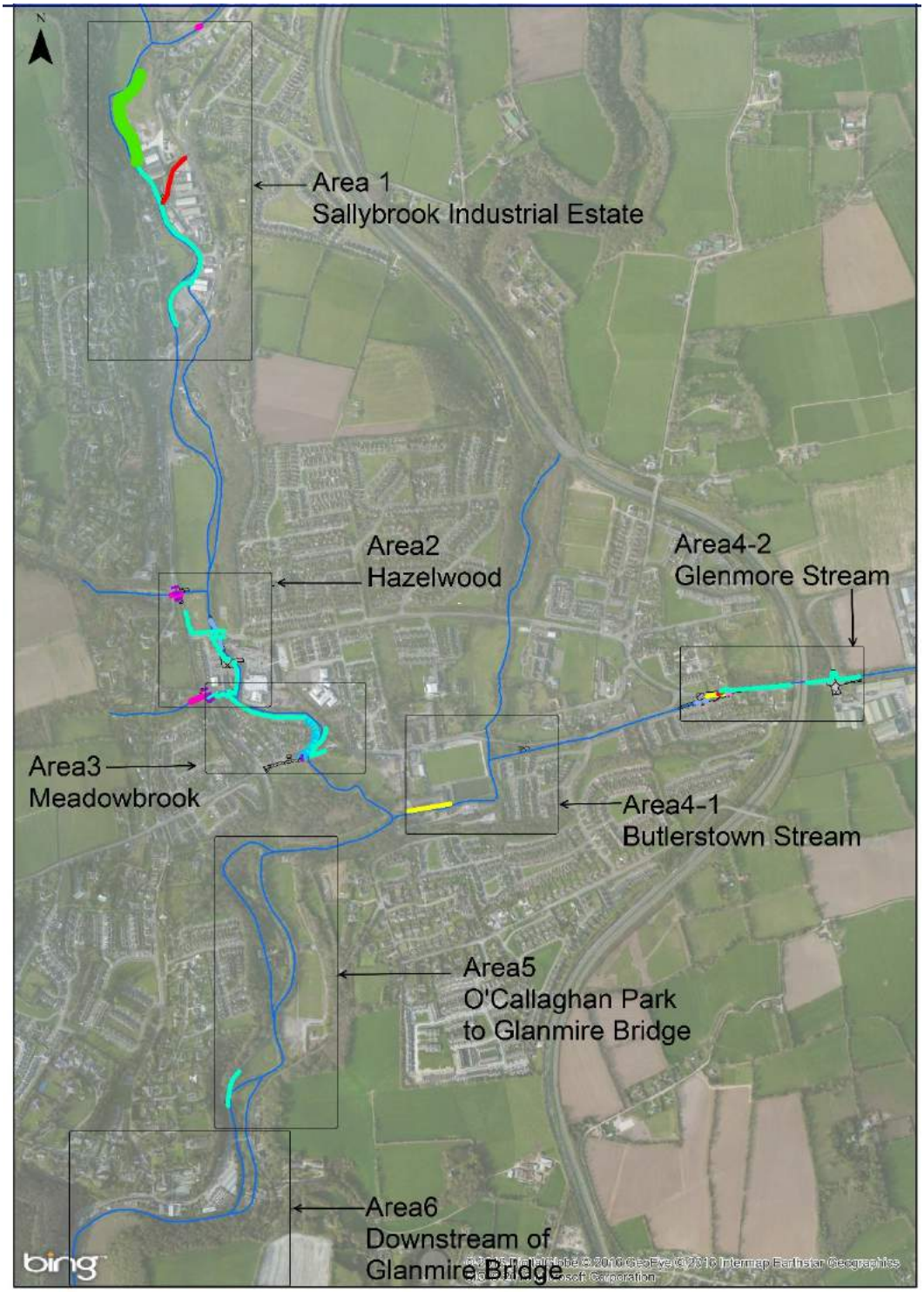
A hydrology study and hydraulic modelling of the existing situation in the study area, has been carried out as part of this project. The existing flood risk and flood mechanisms are described in detail in the accompanying Hydrology Report and Hydraulics Report. As the locations at risk are spread over a large area, it was considered appropriate to divide the assessment of the potential flood risk management measures into discrete areas as shown in Table 1 and Figure 4 below. The flood risk management option for the overall area at risk will consist of the combination of measures for each of these areas.

Based on anecdotal evidence from the 2012 and 2015 flood events, and based on the hydraulic analysis carried out as part of this study, the following areas were identified as being the critical locations at risk.

Table 1: Areas at Risk

Area Number	Area Name	Categories of Properties at Risk in this Area	Potential Flood Mechanisms
1	Sallybrook Industrial Estate	Industrial buildings, commercial properties, domestic properties	Fluvial
2	Hazelwood Shopping Centre	Commercial properties	Fluvial
3	Meadowbrook Housing Estate	Domestic properties	Fluvial
4	Butlerstown/Glenmore	Domestic and Commercial properties	Fluvial
5	Glanmire Bridge to O'Callaghan Park	Domestic properties, water treatment infrastructure, wastewater treatment infrastructure	Fluvial/Tidal
6	Downstream of Glanmire Bridge	Domestic, commercial properties	Tidal

Figure 4: Key Plan of Scheme Areas



1.5 Stakeholder Input and Consultation

An important element of the Glashaboy Flood Relief Scheme (FRS) is consultation with all interested parties including the public. This is carried out at strategic stages of the study, including the identification of a preferred options.

This gives interested parties an opportunity to communicate local knowledge, how they are currently affected, and to give their views on the preferred options, thereby influencing the decision-making process.

The consultation includes a wide range of interested parties with general or specific interests such as impact on society, the environment, cultural heritage or the economy. All comments are considered and, where relevant, further updates to the options carried out.

1.6 Public Consultation Days

A public information day (PID) was held on 25 February 2014 at Glanmire GAA club. The purpose of the PID was to outline the study area to the general public and outline the process involved in the development of the Glashaboy FRS.

Information was gathered in the form of questionnaires and through meetings with local members of the community and business owners. Feedback gathered from the PID is outlined in the Constraints Report and was considered in the development and assessment of potential flood alleviation options.

A second PID was held on 20 February 2015 to outline the emerging preferred flood alleviation option for the Glashaboy FRS.

Feedback from this second PID day was considered in the final selection of the preferred flood alleviation option.

2 Initial Screening of Potential Measures

2.1 Introduction

This section outlines the initial options considered as part of the Glashaboy FRS.

At this initial stage, some measures were deemed to be not viable for this project and as a result were screened out. Other measures were considered as potentially viable options and these were carried forward for further assessment.

The initial screening of measures was assessed in terms of:

- Applicability to the study area (including technical feasibility, constructability, and Health and Safety)
- Economic viability
- Environmental
- Social
- Cultural

The flood risk management options which have been reviewed as part of this initial screening process are outlined in Table 2 below.

Table 2: Summary of Initial Screening

Possible Flood Risk Management Measure	Potentially viable?					Initial Screening Result	Comment
	Applicability	Economic	Environmental	Social	Cultural		
Do Nothing	Y	N	Y	N	Y	Not viable as a standalone measure. May be viable in isolated areas.	This option provides the baseline for the study and assumes no further work or expenditure on measures to reduce flood risk in the study area. The Do Nothing scenario is defined as the option involving no future flood defence expenditure. The implication is that the existing risk of flooding persists in the study area. This is not considered to be a viable standalone option as it fails to meet the needs of the residents and business owners. Using this as the baseline scenario, however, allows the benefits of all existing measures to reduce the flood risk to be identified. It places the benefit of these measures into true perspective.
Do Minimum	Y	N	Y	N	Y	Not viable	This measure would consist of minor works and maintenance measures, which could include filling in gaps in existing masonry river walls, regularly clearing the channel of vegetation, etc. The risk of flooding would remain high. Therefore, this is not considered to be a viable measure as it fails to meet the needs of the residents and business owners.
Non-Structural Measures							
Planning Control/ Land Use Management	Y	Y	Y	Y	Y	Not viable as a standalone measure. May be viable as an ancillary measure.	This measure would assist in ensuring flood risk is not increased by future development. The measure would take a long time to implement, and would not reduce the current flood risk to an acceptable level. Therefore, it is not considered viable as a standalone measure. It may still be appropriate to implement along with other measures.

Possible Flood Risk Management Measure	Potentially viable?					Initial Screening Result	Comment
	Applicability	Economic	Environmental	Social	Cultural		
SUDS	N					Not viable	Glanmire-Sallybrook is already heavily urbanised with little space for attenuation or other SUDS features. Furthermore, the steep topography is not well suited to surface water attenuation measures.
Flood Forecasting/Flood Warning System	Y	Y	Y	Y	Y	Potentially viable	Undertake Further Technical Assessment.
Public Awareness Campaign	Y	Y	Y	Y	Y	Not viable as a standalone measure. May be viable as an ancillary measure.	This measure would help to increase public awareness and preparedness for future flood events. However, the measure would not reduce the current flood risk to an acceptable level. Therefore, it is considered unviable as a standalone measure. It may still be appropriate to implement along with other measures.
Structural Measures							
Upstream Storage	Y	Y	Y	Y	Y	Potentially viable	Undertake Further Technical Assessment.
Direct Flood Defences	Y	Y	Y	Y	Y	Potentially viable	Undertake Further Technical Assessment.
Diversion Channels or Culverts	N					Not viable	The lower Glashaboy River valley is narrow, steep sided and heavily urbanised. Therefore a diversion of the Glashaboy away from the areas at risk is not considered viable.
Sediment/Debris Control	Y	Y	Y	Y	Y	Potentially viable	Undertake Further Technical Assessment.
Conveyance Improvements	Y	Y	Y	Y	Y	Potentially viable	Undertake Further Technical Assessment.
Relocation	N					Not viable	This measure involves the relocation of people and businesses from properties at risk of flooding to an area with lower flood risk. It is not considered feasible, due to the urbanised nature of the area at risk and the large number of properties at risk.

Possible Flood Risk Management Measure	Potentially viable?					Initial Screening Result	Comment
	Applicability	Economic	Environmental	Social	Cultural		
Individual Property Protection	Y	Y	Y	Y	Y	Potentially viable	This measure may be viable for some isolated properties at risk, such as the existing mill buildings, and water/wastewater sites. In other areas, this measure is not considered to be viable due to the number of properties at risk.
Pumping	Y	Y	Y	Y	Y	Potentially viable	Undertake Further Technical Assessment.
Tidal Barrier	Y	N	Y	Y	Y	Not viable	Given the scale of the works required to construct a tidal barrier versus the small area at risk of tidal flooding, this option is not considered to be economically viable

2.2 Non-Viable Flood Risk Management Measures

Further to the initial screening, the following flood risk management measures have been identified as being non-viable and have not been carried forward for further technical assessment:

- Do Nothing.
- Do Minimum.
- Relocation.
- Diversion channels or culverts.
- Tidal Barrier.
- Non-structural Measures
    - SUDS.
    - Planning Control/Land Use Management.
    - Public Awareness.

The '**Do Nothing**' scenario is defined as the option involving no future expenditure on flood defences or maintenance of existing defences/channels etc. The implication is that the existing risk of flooding persists in the study area. This is not considered to be a sustainable option as it fails to meet the needs of the residents and business owners in Glanmire/Sallybrook. It has been considered and has therefore been ruled out as standalone option at the initial screening stage.

Relocation involves moving the occupiers of properties at risk to new properties constructed outside of the area at risk. Due to the large number of properties at risk in area, property relocation has been ruled out of at the initial screening stage.

Non-structural measures, such as land use management within a catchment, affect the way in which rainfall is directed to watercourses. Hard surfaces reduce the amount of rainfall that can infiltrate to ground water, and intensive drainage schemes will increase the speed of runoff, giving rise to earlier and higher flood peaks. River restoration is about mitigating the negative impacts that past changes in catchment management practices, such as land drainage or deforestation, may have had on river systems. Modifications to land drainage systems within the catchment can reduce the rate at which rainfall is conveyed into the river channel and thus help to reduce peak flows. This option would take a long time to implement and would not reduce the flood risk to an acceptable level and therefore has not been carried forward for further technical assessment. The proposed scheme would not however, prevent such methods being implemented in the future.

2.3 Potentially Viable Flood Risk Management Measures

Further to the initial screening, the following flood risk management measures were identified as potentially viable measures for the Glashaboy catchment and have been taken forward for further technical assessment as outlined in Section 3 below:

- Flood forecasting/flood warning.
- Upstream Storage.
- Direct Flood Defences.
- Sediment/Debris Control.
- Individual Property protection.
- Conveyance Improvements.
- Pumping.

3 Further Assessment of Potentially Viable Measures

3.1 Introduction

The potentially viable measures were generally assessed for each area at risk (as per Table 1).

3.2 Non-Structural Measures

3.2.1 Flood Forecasting

The viability of a fluvial flood forecasting system has been assessed as part of this study and is separately reported on.

Flood forecasting was not found to be a viable measure due to the short lead time that would be available for warning, due to the fast response to rainfall of catchment runoff, i.e. flashy nature of the catchment.

As the majority of options considered would likely not require the use of 'demountable' flood defences, i.e. likely to be a 'passive' scheme, there would be limited benefit to be gained from a fluvial flood forecasting system.

The existing Cork harbour tidal flood forecasting/warning system is deemed to be sufficient for the relevant areas at tidal flood risk in Glanmire.

3.3 Structural Measures

3.3.1 Upstream Storage

This measure seeks to store excess flood waters upstream of the area at risk by the creation of a designated storage area. If a suitable storage area was available, the peak flow could be regulated to ensure that the capacity of the existing channel is not exceeded.

It is noted that the project brief specifically requires an assessment of the feasibility of implementing flood storage areas, both individually and in combination.

The catchment was reviewed for potential storage areas; in the first instance by interrogating the LiDAR digital terrain model and then by undertaking a site walkover of potential storage areas in the catchment.

Due to the steep gradient of the channel upstream of Glanmire/Sallybrook and because of the steep sided nature of the valley, generally only small volumes of storage could potentially be created unless very high impounding structures were constructed.

Prior to assessing the potential for upstream storage, it was necessary to establish the likely volume of storage required to satisfactorily pass the resultant design flow through Glanmire/Sallybrook.

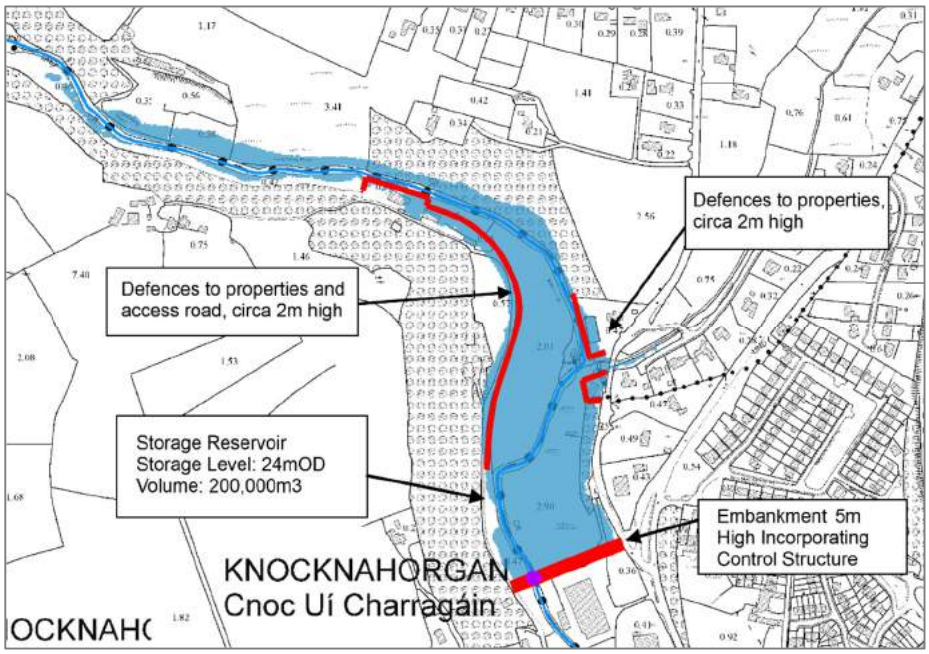
The threshold of flooding for Hazelwood is approximately the 1 in 20 year flood event, which equates to a peak flow of approximately 53m^3/s at that location. In order for flood storage to be viable as a standalone measure, it would need to attenuate sufficient volumes to reduce the peak flow in the 100 year event to this value.

The total volume of the Q100 hydrograph is approximately 2.9 million m^3. The volume of the Q100 hydrograph above the threshold flow (of 53m^3/s) is approximately 270,000m^3 which equates approximately to the volume that would need to be stored to make storage a technically viable option.

3.3.1.1 Upstream of Sallybrook

A possible storage area at Knocknahorgan, just upstream of Sallybrook Industrial Estate is shown in Figure 5. This area is reasonably wide and existing development is minimal. Figure 5 shows a possible flood storage scheme which is considered to be close to the limit of what would be technically feasible. The required measures would consist of a 5m high embankment with a flow control structure at the downstream end, along with flood defences up to 2m high around isolated properties along both banks of the river. It was found that a maximum volume of approximately 200,000m^3 could be mobilised, which is significantly short of what would be required for storage to be viable as a standalone measure. Also, the actual volume of storage available would be somewhat less, due to a portion of the floodplain volume being taken up before the threshold flow is reached. We would also note that there are a number of live planning applications in this area.

Figure 5: Knocknahorgan Potential Storage Area



Therefore, on the basis of the above, some direct defences would be required downstream in Areas 1-3 and Area 5 in order to achieve the design standard. The required heights of defences would likely be under 1m in each of these locations.

Furthermore, this option would not reduce the existing flood risk in Area 4 and Area 6 and would therefore not provide a standalone solution.

In summary, whilst upstream storage could significantly attenuate peak flows, it would not be sufficient to eliminate the need for defences downstream. In addition, given the scale of the works that would be required, it is considered that the option would be socially and environmentally unacceptable and therefore, it has not been considered further.

3.3.1.2 Glanmire GAA field

The Glanmire GAA pitches are a significant floodplain in the urban area of Glanmire. They provide a significant amount of flood attenuation due to the raised level of the R639 road. It is proposed to maintain the existing situation at the location of the pitches.

3.3.1.3 Glashaboy Tributaries

A review of potential flood storage locations on the tributaries of the Glashaboy was carried out. However, each stream was generally found to be too small and too steep to have any significant potential for flood storage.

The Butlerstown stream catchment was found to have some limited potential for storage, however since the confluence of the Butlerstown stream and the Glashaboy River is downstream of the majority of the area at risk, any potential benefit would be negligible. Therefore, storage on the tributaries was not investigated further.

3.3.2 Individual Property Protection

Individual property protection can consist of localised works to exclude flood waters from properties, or to minimise the effect of flooding on the contents of properties. It is generally suited to properties that are inundated to a shallow depth (typically maximum 0.6m depth), and which would otherwise not be protected by defences.

Flood proofing works best when it can be activated from outside the property, for example stop logs set outside doors and other openings. However, the scope of works required to flood proof properties should not be underestimated. Significant maintenance of flood protection may also be required. For example, works may be necessary to prevent flood waters from coming up through the floor. Given the flashy nature of floods on the Glashaboy and given the need for manual intervention to close flood doors, install stop logs, etc., the reliability of individual property protection is generally considered to be too low as a standalone option.

In Glanmire, this measure may be viable for some isolated properties at risk, such as the existing mill buildings, and water/wastewater sites where site wide flood defence measures are unlikely to be cost beneficial.

Area 1: Sallybrook Industrial Estate

Not considered viable due to the number of properties at risk in this area

Area 2: Hazelwood Shopping Centre

Not considered viable due to the number of properties at risk. Also, the flood depths would be too deep for this measure to be effective (defences would be required up to a height of approximately 1.3m including 500mm freeboard).

Area 3: Meadowbrook Housing Estate

Not considered viable due to the number of properties at risk. Also, the flood depths would be too deep for this measure to be effective (defences would be required up to a height of approximately 1.3m including 500mm freeboard.

Area 4: Butlerstown/Glenmore

Copper Valley Housing Estate: Not considered viable due to the number of properties at risk. Also, the flood depths would be too deep for this measure to be effective (defences would be required up to a height of approximately 0.8m including 500mm freeboard.

Area 5: O'Callaghan Park to Glanmire Bridge

There are several isolated properties in this area which are at risk:

- Water treatment intake (Figure 6): This building has a floor level of 5.69mOD and is located alongside the weir, immediately downstream of O'Callaghan Park. The predicted 100 year flood level at this location is 6.36mOD. Therefore, to defend to the design standard (including 500mm freeboard), defences would be required to be 1.17m high. Currently, no flood defences are installed at the water intake site. During high flows, flow can be regulated by controlling penstock valves located on the outside of the intake house. A number of voids for cable ducting are located near the floor level of the building. The building houses a range of electrical equipment in the form of a rotary sand screen, electric heaters and other devices. Due to the required defence height, it is considered unlikely that individual property protection would be viable to defend to the 1 in 100year standard. Site wide flood defences were shown not to be cost beneficial and following liaison with Irish it became apparent that alternative water supply (Inniscarra) is available. As a result, it was concluded that Irish Water will progress with individual flood protection measures separate from this scheme.

Figure 6: Water Treatment Intake

- St Patricks Mills: This option was not considered viable for the mill buildings and outhouses due to the flood depth; defences would be required up to a height of approximately 1.6m above existing ground levels (including 500mm freeboard). However, individual property protection may be viable for the domestic property on the site, as predicted flood depths in this area are approximately 0.6m (including 300mm freeboard).
- Water treatment pumping station (Figure 7): This building has a ground floor level of 3.97mOD and already has demountable defences installed on the doors to a level of 4.4mOD. However, the predicted 100 year flood level at this location is 4.85mOD. Therefore, to defend to the design standard, including 500mm freeboard, would require defences 1.38m in height. Therefore, due to the height of defences required, this was found not to represent a viable solution. Similarly to the Water Treatment Intake shown in Figure 6, Irish Water will progress measures separate from the current Scheme.

Figure 7: Water Treatment Pumping Station

- Wastewater treatment pumping station (Figure 8): This site is located immediately upstream of Glanmire Bridge. Currently, no flood defences are installed at the wastewater pumping station. An open intake tank is located to the north of the site where the combined inflow sewer is fed by gravity.

The inflow is then subject to maceration before entering the wastewater pump house. Flooding of the site has been noted to be caused by existing capacity issues within the combined sewer system. A number of gaps and voids were noted at the wastewater pump house station at locations of services, vents and pipework entering and exiting the building. Large scale pumps and electrical equipment are located within the building. Ground levels on site are approximately 2.94mOD. The predicted 100 year fluvial flood level at this location is 3.50mOD. Therefore, given that the flood level plus freeboard is likely to be greater than 1m above floor level, individual property protection is not considered viable at this site. Again and similarly to the other Irish Water assets presented above, Irish Water will progress measures separate from the OPW scheme.

Figure 8: Wastewater Pumping Station

- The residential property at No 1 The Grove (see Figure 9) flooded in 2012 and December 2015 due to the Glashaboy River overtopping its banks. Following the flooding in 2012, a removable flood barrier was installed at the entrance doorway. However flooding occurred again in December 2015 due to internal water ingress through the bathroom. Direct defences and additional protection measures such as drain protection may be viable for the domestic property.

  Figure 9: No1 The Grove (Residential Property)

Area 6: Downstream of Glanmire Bridge

- The Fountains (Mill buildings): The predicted 1 in 100 year fluvial flood level at this location is 2.5mOD, with the predicted 1 in 200 year tidal flood level being 2.93mOD. Based on these levels, it appears that the required defence

height would be less than 600mm. Therefore individual property protection may be viable and is considered further below.

Figure 10: The Fountains (Mill building)

- The predicted 1 in 200 year tidal flood level at Barry's Terrace is 2.93mOD. There is one derelict property at this location at flood risk. The required defence height would be less than 600mm and individual property protection may be viable and is considered further below. Figure 11 shows the derelict property.

  Figure 11: Derelict Property at Barry's Terrace

3.3.3 Conveyance Improvements

Along the Glashaboy River and its tributaries, the capacity of isolated sections of the channel constrict flow in the design scenario resulting in elevated upstream flood levels. There is also evidence that blockage issues have arisen at a number of bridges in the vicinity of Sallybrook and Glanmire during flood events, most notably in June 2012. This is discussed in further detail in Section 3.3.7.

At locations where existing bridges/culverts were found to be causing a flood risk, preliminary sizing of new replacement culverts was carried out using the CIRIA C689 guidance document. It was assumed that the new culverts would be required to pass the 1 in 100 year flow including climate change, as per OPW Section 50 requirements.

Areas where potential conveyance improvements were considered are outlined below:

Area 1: Sallybrook Industrial Estate

Bleach Hill Stream at Cúil Chluthair:

The existing 2 x 900mm diameter pipe culverts at the entrance to this estate were assessed and found to have insufficient capacity to pass the design flow. The option of conveyance improvement here would consist of replacing the existing culverts with a single 2.6m wide x 2.4m high rectangular culvert.

Area 2: Hazelwood Shopping Centre

Glashaboy River

It has been determined that both the Hazelwood Avenue Bridge and the Hazelwood Shopping Centre (SC) Bridge have cross sections which are too small to pass the design flow. As both of these bridges are relatively close to each other, they were analysed in combination in the context of potential flood conveyance improvements in this area. A number of options were assessed using the hydraulic model. Detailed findings are outlined in the Hydraulics Report. The summary findings are as follows:

a) Increasing the capacity of the Hazelwood Avenue Bridge and Hazelwood SC Bridge would result in a significant reduction in peak water levels. However, in each case it was found that some direct defences would still be required to meet the design standard. Therefore, this option on its own was not considered a viable solution. However, it was considered further in combination with direct defences – refer to Section 4.3.

b) Increasing the capacity of the channel through Hazelwood by dredging part of the channel through Meadowbrook/Hazelwood could technically reduce water levels sufficiently to meet the design standard in Hazelwood without requiring further defences. This option was considered viable and carried forward to options development stage.

Cois na Gleann Stream:

The existing culverts under the R639 were assessed and found to have insufficient capacity to pass the design flow. The option of conveyance improvement here would consist of replacing the existing culverts with a single 2.75m wide x 0.9m high rectangular culvert. As part of this option, the existing open section and trash screen (well-like structure) adjacent to the R639 would be removed to minimise the risk of blockage from illegal dumping.

Area 3: Meadowbrook Housing Estate

Glashaboy River:

Increasing the capacity of the channel through Meadowbrook by dredging could technically reduce water levels to below the existing defence wall height. However, as this wall was assessed and considered unsuitable, this option can only be considered in combination with direct defences.

Significant underpinning of existing bridges and retaining walls, and ongoing maintenance, would also be required. There may also be significant environmental impacts associated with this option.

The potential benefit of conveyance improvements at Riverstown Bridge was also assessed. It was found that conveyance improvements at the bridge alone would not remove the need for direct defences upstream at Meadowbrook. Therefore, the option was not carried forward as a standalone measure. However, the potential for conveyance improvements at the bridge to minimise the risk of blockage is assessed in further detail in Section 3.3.7 of this report.

Springmount Stream:

The existing 2 x 400mm diameter pipe culverts under the R639 were assessed and found to have insufficient capacity to pass the design flow. The option of conveyance improvement here would consist of replacing the existing culverts with a single 1.75m wide x 0.9m high rectangular culvert, along with minor channel re-grading to facilitate the deeper culvert cross section.

Area 4: Butlerstown/Glenmore

Area 4.1 Butlerstown L3010 Bridge:

The existing masonry arch bridge under the L3010 was assessed and found to have insufficient capacity to pass the design flow. The option of conveyance improvement here would consist of installing a new 4.5m wide x 2.5m high rectangular culvert in parallel with the existing bridge.

Area 4.1 Butlerstown Maintaining Overland Flow

Maintaining overland flow was considered as an alternative measure. This could consist of modifying boundary walls at the recent Lidl Development to ensure that overland flood flow routes are maintained and allowed to return back into the Butlerstown Stream.

Area 4.2 Brooklodge Grove Bridge/Copper Valley Bridge:

It was found that both of these bridges have cross sections which are too small to pass the design flow. As the bridges are relatively close to each other, they were analysed in combination in the context of a potential conveyance improvement solution in this area.

The existing concrete culvert at the entrance to Copper Valley Vue estate is 3.75m wide x 1.6m high.

The existing bridge at Brooklodge Grove consists of two No. 3m wide concrete openings and one 2.3m wide old masonry arch. The existing road level at this bridge is only 1.2m above the channel bed at this location.

One potential conveyance improvement option at this location is to improve the conveyance of the Copper Valley Bridge and maintain the existing Brooklodge Grove Bridge. As the Brooklodge Grove Bridge would still be under-capacity, water would overtop the road during the design flood event.

However, measures to direct the overland flow back into the channel upstream of the Copper Valley Bridge could be installed to prevent flooding of nearby properties. These measures would likely consist of some minor works, e.g. local modifications to road levels.

An alternative arrangement would consist of replacing both crossings with relatively wide openings, which would minimise the risk of blockage and maintain flood flow in bank. Re-grading of the road would be required to facilitate this option.

The culvert upstream of the M8 motorway crossing has also been assessed and found to be under capacity and causing potential flood risk as to properties along Brooklodge Grove Road. As a result this culvert is also proposed to be upgraded as part of this option.

Area 5: O'Callaghan Park to Glanmire Bridge

Conveyance improvement measures are not considered to be viable in this area, as there are no major restrictions on flow. Also, due to the small number of properties at risk in this area, it is considered that works to increase channel capacity would not be cost-beneficial. This covers the area of The Grove as well as the area of St. Patrick Mills.

Area 6: Downstream of Glanmire Bridge

Conveyance improvement measures are not considered to be viable in this area, as tidal flooding is the dominant source of flood risk and therefore, conveyance improvement measures would be ineffective.

3.3.4 Pumping

This measure involves pumping excess flood water away from the main channel during a flood, in order to allow water to remain in-bank in the open channel. This measure would involve construction of a water offtake structure and pumping chamber upstream of the area at risk, and a rising main/gravity main to the discharge point. When the water level in the river rises above a certain threshold, water spills into the wet well of the pumping station and is pumped downstream in parallel to the main channel. At a suitable point downstream of the area at risk, the pumped flow re-joins the main river.

The threshold of flooding at Hazelwood is approximately the 1 in 20 year event. Therefore, a pumping station sited upstream of Sallybrook would need to have a pump capacity of approximately 17m^3/s in order to keep flow in-bank in Hazelwood.

It is considered that this option would have prohibitively high capital cost as well as high ongoing maintenance costs. This measure would also likely have significant negative environmental and social impacts.

Based on the above it is clear that pumping is not a viable option and it is therefore not considered further.

Some small local surface water pumps will be required to cater for back of wall drainage during a flood event. This pumping of local surface water is particularly necessary in the vicinity of Meadowbrook due to the particularly low lying topography relative to river levels.

3.3.5 Construction of Direct Flood Defences

This measure involves the construction of direct defences along the banks of the existing river and/or floodplain at key locations to contain flood flows and avoid flooding of properties.

This measure was considered feasible for all areas and is developed further in Section 4.

3.3.6 Combination of Direct Flood Defences and Conveyance Improvements

Area 1: Sallybrook Industrial Estate

This measure was not considered viable as it is unlikely that conveyance improvement works would significantly reduce the level or extent of required flood defences.

Area 2: Hazelwood Shopping Centre

This measure was considered viable for this area and is developed further in Section 4.3.

Area 3: Meadowbrook Housing Estate

This combination of measures was not considered viable in this area, as there are no major restrictions on flow within this reach of the Glashaboy River which would benefit from conveyance improvements. Also, it is considered unlikely that conveyance improvement works would significantly reduce the level or extent of required flood defences. Direct defences for this area are considered to be the most suitable measure. This measure is developed further in Section 4.4.

Area 4: Butlerstown/Glenmore

This measure was considered viable for this area and is developed further in Section 4.5.

Area 5: O'Callaghan Park to Glanmire Bridge

This solution was not deemed to be viable in this area, as there are no major restrictions on flow which would benefit from conveyance improvements. Also, it is considered unlikely that conveyance improvement works could significantly reduce the level or extent of required flood defences.

Area 6: Downstream of Glanmire Bridge

This solution was not considered to be viable in this area, as tidal flooding is the dominant source of flood risk, and conveyance improvement measures would therefore be ineffective.

3.3.7 Debris Control

In order to determine the risk of blockage within the Glashaboy catchment, hydraulic modelling was carried out of potential blockage at key structures. The model runs assessed the impact of 30% to 70% blockage on water levels at key structures within the Glashaboy catchment. Results demonstrate that blockage can cause a significant afflux of water levels at Sallybrook Bridge and Glanmire Bridge. The model also shows that water levels at Hazelwood Avenue Bridge are largely insensitive to blockage.

Partial blockages of structures by debris is understood to have contributed significantly to flooding during past flood events in the catchment; most recently during the December 2015 event.

One possible measure to alleviate this risk, would be the construction of a trash screen structure within the channel. A trash screen would capture debris at a point upstream of the area at risk, in order to prevent blockage issues downstream. The required size of a trash screen for a watercourse of this size would be very substantial and current international guidance recommend the avoidance of trash-screens where possible. This is mainly due to the risk of blockage of screens, which often outweigh the risk of blockage of culverts/bridges. This is particularly the case where bridges/culverts are short in length and large in cross section, as is the case on the Glashaboy.

Identifying suitable locations for installation of trash screens in a heavily vegetated catchment is also challenging. Access for maintenance must also be considered. This would most likely result in constructing access paths for maintenance vehicles and personnel.

A robust maintenance system would need to be implemented to ensure that debris is regularly removed. This may require automated telemetry equipment to measure the head-loss across the trash screens to warn maintenance crews of blockages. Furthermore, fish passage may be hindered by installation of trash screens due to matting from vegetation.

Given the above concerns, the construction of trash screens is not considered feasible for the main watercourses in the Glashaboy FRS. However, it is still considered appropriate to provide measures to mitigate the risk of blockage, which are as follows:

<u>Riverstown Bridge</u>

Blockage/partial blockage of Riverstown Bridge is reported to have occurred in the past and hydraulic modelling and the following measures would reduce the sensitivity of the bridge to blockages.

- Removal of the existing manhole in the western arch, along with lowering of ground levels.
- Clearance of vegetation/excess sediment in the eastern arches.
- Creation of an overland flow route for any water overtopping the bridge in the event of a full blockage.

Brooklodge Grove Bridge/ Copper Valley Bridge/ Upstream of M8 (New Line culvert)

Blockage/ partial blockage of the Brooklodge Grove Bridge was noted during the December 2015 flood and the following measures would reduce the risk of blockage:

- Replacement of the three culverts with larger openings;
- Clearance of vegetation/ excess sedimentation in the vicinity of the two crossings.

3.4 Summary

The options that have been shortlisted for further development are summarised in Table 3 below:

Table 3: Summary of Further Assessment of Potentially Viable Measures

Carried forward to Development of Shortlisted Options?							
	Catchment-wide	**Area 1 – Sallybrook Industrial Estate**	**Area 2 – Hazelwood Shopping Centre**	**Area 3 – Meadowbrook Housing Estate**	**Area 4 – Butlerstown / Glenmore**	**Area 5 – O'Callaghan Park to Glanmire Bridge**	**Area 6 – Downstream of Glanmire Bridge**
Direct Defences Only	-	Y	Y	Y	N	Y	N
Conveyance Improvements	-	Bleach Hill Stream Only	Y	Springmount Stream only	Y	N	N
Combination of Direct Defences and Conveyance Improvements	-	N	Y	N	Y	N	N
Pumping	-	N	N	N	N	N	N
Debris Control	-	N	N	Y	Y	N	N
Individual Property Protection	-	N	N	N	N	Residential Property's at St. Patricks Mill and The Grove	The Fountains Mill and derelict property at Barry's Terrace
Flood forecasting	N	N/A	N/A	N/A	N/A	N/A	N/A
Flood Storage	N	N/A	N/A	N/A	N/A	N/A	N/A

4 Development of Shortlisted Options

4.1 Introduction

The flood relief options that are carried forward for further development as part of the Glashaboy Drainage Scheme are summarised below.

For the purposes of the initial development and assessment of options, a fixed freeboard of 500mm on all direct defences was initially assumed. This assumption was tested by undertaking a more detailed freeboard analysis on the preferred option and this is discussed later in the report.

Area 1: Sallybrook Industrial Estate

Option 1A – Direct defences with conveyance improvements on Bleach Hill Stream (only option considered)

Area 2: Hazelwood Shopping Centre

Option 2A – Direct defences (with conveyance improvements on Cois na Gleann Stream);

Option 2B – Conveyance Improvements (Dredging);

Option 2C – Combination of direct defences and conveyance improvements – Arrangement 1 - Raising and widening of Hazelwood Avenue Bridge and upgrade of the Cois na Gleann culvert;

Option 2D – Combination of direct defences and conveyance improvements – Arrangement 2 – New flood relief culvert at Hazelwood Avenue Bridge and upgrade of the Cois na Gleann culvert;

Option 2E – Combination of direct defences and conveyance improvements – Arrangement 3 – New flood relief culvert at Hazelwood Avenue Bridge, upgrade of the Cois na Gleann culvert and replacement of existing Hazelwood Shopping Centre road bridge with elevated footbridge;

Option 2F – Combination of direct defences and conveyance improvements – Arrangement 4 – New flood relief culvert at Hazelwood Avenue Bridge, upgrade of the Cois na Gleann culvert and replacement of existing Hazelwood Shopping Centre road bridge with new raised bridge;

Area 3: Meadowbrook Housing Estate

Option 3A – Direct defences (with conveyance improvements on Springmount Stream) (only option considered)

Area 4: Butlerstown/Glenmore

Option 4.1A – Butlerstown Stream - Conveyance improvements

Option 4.1B – Butlerstown Stream - Direct defences and conveyance improvements

Option 4.1C – Butlerstown Stream – Maintaining overland flow path

Option 4.2A – Glenmore - Overland flow management

Option 4.2B – Glenmore - Culvert replacements and conveyance improvements

Area 5: O'Callaghan Park to Glanmire Bridge

Option 5A – Direct defences at The Grove and local property protection at St. Patricks Mills

Option 5B – Direct defences only

Area 6: Downstream of Glanmire Bridge

Option 6A – Individual property protection for property at Barry's Terrace

Option 6B – Do Nothing

4.2 Area 1: Sallybrook Industrial Estate

4.2.1 Option 1A – Direct defences with Conveyance Improvements on Bleach Hill Stream

Figure 12: Option 1A – Direct Defences at Sallybrook Industrial Estate

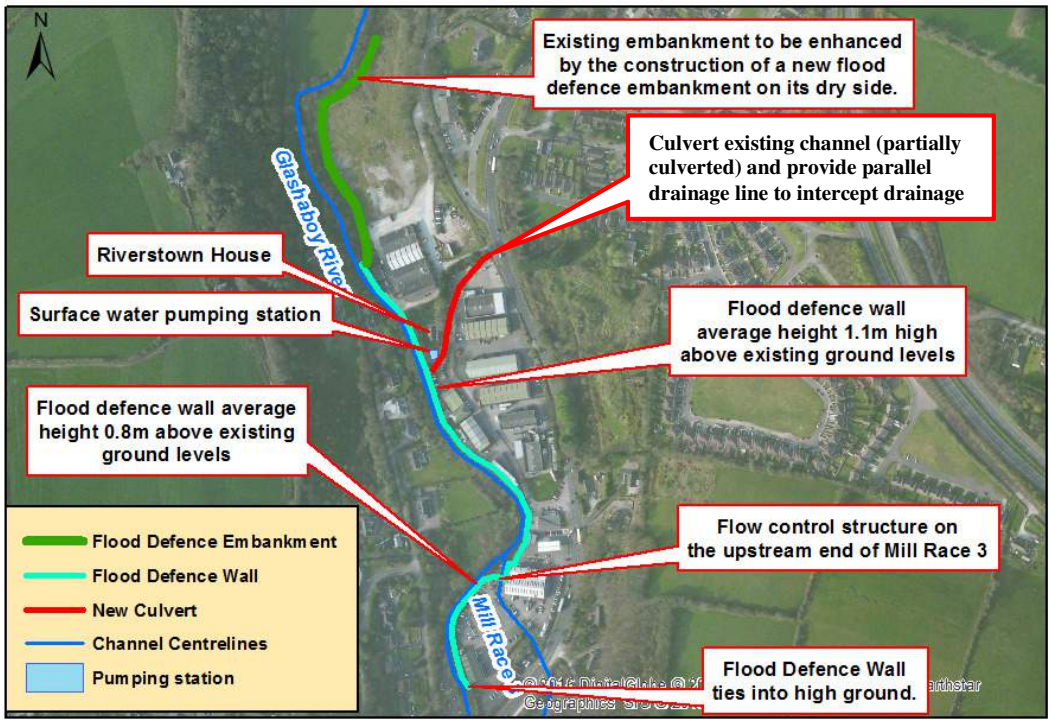


Figure 13: Option 1A - Conveyance Improvement at Cúil Chluthair

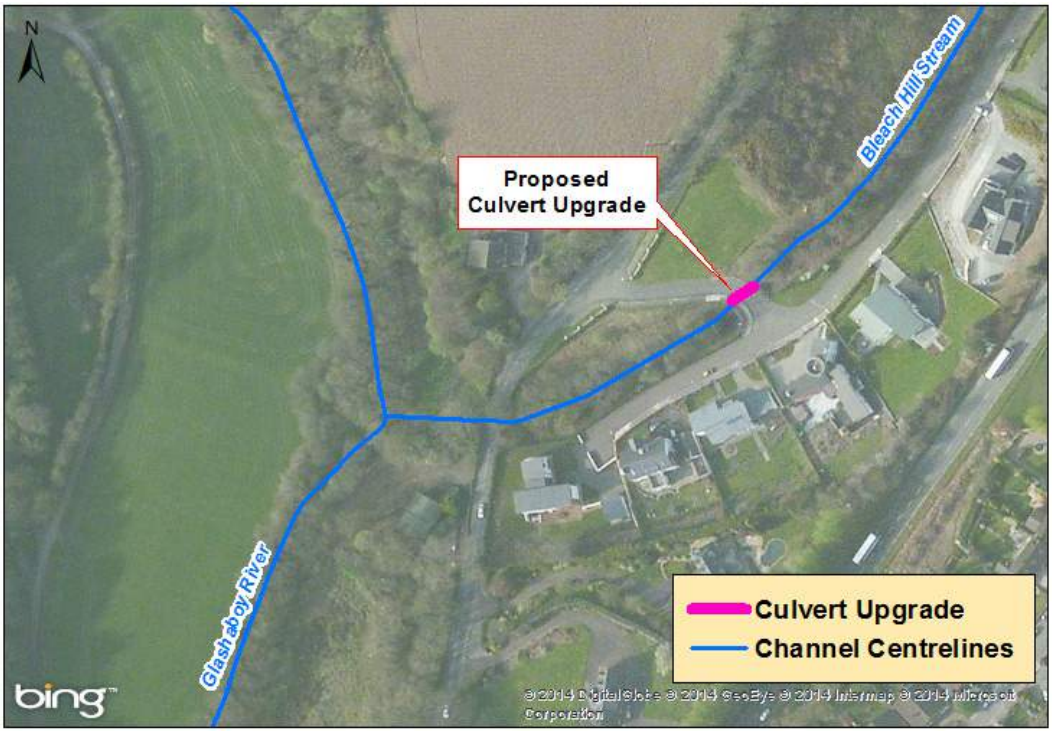


Table 4: Option 1A - Direct Defences - Description of Works

Location	Channel	Chainage (m)	Description	Comments
Sallybrook Industrial Estate	Glashaboy	4881 - 5711	Flood defence walls (ranging from 0.5 - 1.7m high above ground levels including up to 0.76m freeboard) to be constructed on the left bank approximately 552m in length from upstream of Sallybrook House to Brook Inn. A further 270m long existing embankment upstream of Sallybrook House is to be enhanced by the construction of a formalised flood defence embankment to its east which will protect the existing treeline. Any drainage connections into this reach of the Glashaboy River will require non-return valves to be installed. A new flow control structure at the inlet to the Mill Race will be constructed to reduce flow for maintenance purposes. There is a small existing Stream "Sallybrook Stream" along the eastern boundary of Sallybrook House which appears to be the remains of an old Mill Race. This stream is partially open channel, partially culverted. As this channel would be cut off by the construction of the flood defences, it is proposed to culvert the entire channel for a distance upstream sufficient to prevent the backwater from the Glashaboy River from flooding properties. The culverting of Sallybrook Stream will adopt a new alignment to protect existing mature trees. Pumping station to be constructed downstream of Sallybrook House to pump surface water caught behind the flood defence.	It is likely that removal of vegetation and trees along the river bank will be required to construct the flood walls, however efforts have been made to eliminate the extent of tree removal in the alignment of the embankment and Sallybrook Stream. Services, drainage and utilities likely to require diversion, to facilitate the works.
Cúil Chluthair	Bleach Hill Stream	135 - 144	Replace existing 0.9m diameter twin pipes with new 2.6m wide x 2.4m high rectangular culvert	A temporary alternative access route to the estate may be required during construction.

4.3 Area 2: Hazelwood Shopping Centre

4.3.1 Option 2A – Direct Defences (with Conveyance Improvements on Cois na Gleann Stream)

Figure 14: Option 2A – Direct Defences (with Conveyance Improvements on Cois na Gleann Stream)

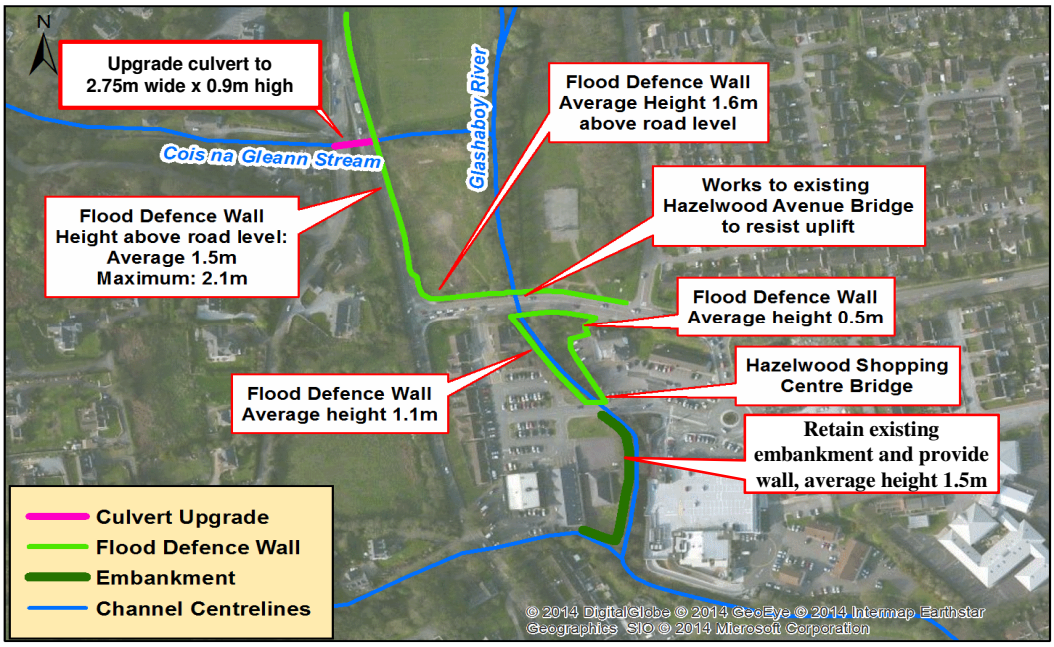


Table 5: Option 2A - Direct Defences (with Conveyance Improvements on Cois na Gleann Stream) - Description of Works

Location	Channel	Chainage (m)	Description	Comments
Hazelwood Centre and Hazelwood Bridges	Glashaboy	3785 - 4180	Flood defence wall to be constructed on the line of existing boundary wall immediately upstream of Hazelwood Avenue Bridge. The defence shall be approximately 300m in length and up to 2.1m in height (average height approximately 1.5m) and shall tie into higher ground at each end. The flood wall will need to be designed to span across the Hazelwood Avenue Bridge (approximately 13m length). Works will be required to strengthen Hazelwood Avenue Bridge to resist water surcharge forces in the design flood event. Flood defence walls to be constructed along both banks between Hazelwood Avenue Bridge and Hazelwood Shopping Centre Bridge (length of reach is 80m). Average height of wall on the left bank will be 0.5m, and 1.1m on the right bank. Underpinning/strengthening of the existing bridges will be required to ensure that the bridges can resist the lateral water load during a flood. Also, as a result the new flood walls across the bridges will need to be independently supported at each end. On the right bank downstream of Hazelwood Shopping Centre Bridge, the existing embankment is to be retained and a flood defence wall reconstructed over a length of 91m. Typical wall height 1.5m.	Services, drainage and utilities likely to require diversion to facilitate the works.
Cois na Gleann Stream at R639 Road	Cois na Glean Stream	75 - 100	Replace the existing culverts with a single 2.75m wide x 0.9m high rectangular culvert. This will require local road raising in the vicinity of the culvert. Remove the existing open section of culvert adjacent to the R639.	

4.3.2 Option 2B - Conveyance Improvements (Dredging)

Figure 15: Option 2B – Conveyance improvements (Dredging)

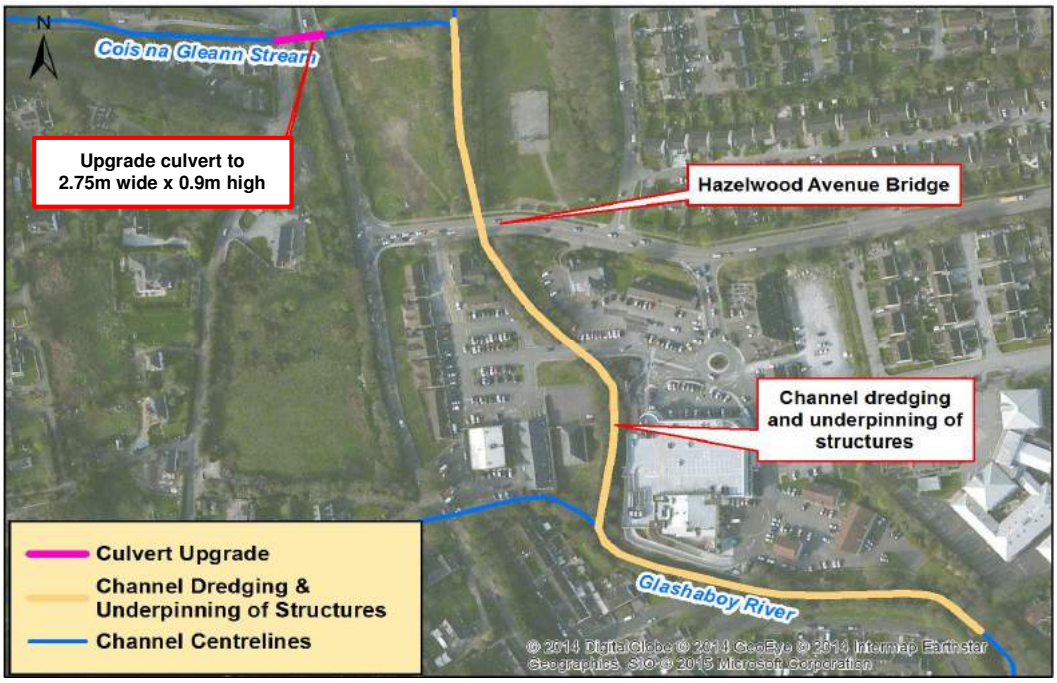


Table 6: Option 2B - Conveyance Improvements (Dredging) - Description of Works

Location	Channel	Chainage (m)	Description	Comments
Hazelwood Centre and Hazelwood Bridges	Glashaboy	3730 - 4150	Reduce river bed elevation by dredging (depth of dredging 1.2m – 1.4m) over a distance of 550m from approximately 150m upstream of Hazelwood Ave. Bridge to approximately 325m downstream of Hazelwood SC Bridge. Underpinning/strengthening of existing bridges and river banks/walls will be required.	Sustainability of dredging may be an issue in terms of the frequently with which it will need to be maintained. The river channel is heavily vegetated at this location and some tree loss will be unavoidable.
Cois na Gleann Stream at R639 Road	Cois na Glean Stream	75 - 100	Replace the existing culverts with a single 2.75m wide x 0.9m high rectangular culvert. This will require local road raising in the vicinity of culvert. Remove the existing 'well-type' structure adjacent to the R639.	

4.3.3 Option 2C - Combination of Direct Defences and Conveyance Improvements (Arrangement 1)

Figure 16: Option 2C - Combination of Direct Defences and Conveyance Improvements (Arrangement 1)

Table 7: Option 2C - Combination of Direct Defences and Conveyance Improvements (Arrangement 1) - Description of Works

Location	Channel	Chainage (m)	Description	Comments
Hazelwood Centre and Hazelwood Bridges	Glashaboy	3785 - 4040	The existing Hazelwood Avenue Bridge is to be replaced with a bridge 3m wider, and with a soffit level 0.8m higher than existing. This will require local road raising in the vicinity of the bridge. Flood defence wall to be constructed on the line of existing boundary wall immediately upstream of Hazelwood Avenue Bridge. The defence shall be approximately 130m in length and average height 1m. The wall will tie into higher ground at each end. Flood defence walls to be constructed along both banks between Hazelwood Avenue Bridge and Hazelwood Shopping Centre Bridge (length of reach is 80m). The average height of the wall bank will be 0.5m and 1.1m on the left and the right bank, respectively. Underpinning/strengthening of the existing shopping centre bridge will be required to ensure that the bridge can resist the lateral water load during a flood. Also, as a result the new flood wall across the bridge will need to be independently supported at each end. On the right bank downstream of Hazelwood Shopping Centre Bridge, the existing embankment is to be retained and a flood defence wall reconstructed over a length of 91m. Typical wall height 1.5m.	Works would require temporary road closure during construction. Possible temporary diversion route through Hazelwood Shopping Centre.
Cois na Gleann Stream at R639 Road	Cois na Glean Stream	75 - 100	Replace the existing culverts with a single 2.75m wide x 0.9m high rectangular culvert. This will require local road raising in the vicinity of the culvert. Remove the existing 'well-type' structure adjacent to the R639.	

4.3.4 Option 2D - Combination of Direct Defences and Conveyance Improvements (Arrangement 2)

Figure 17: Option 2D - Combination of Direct Defences and Conveyance Improvements (Arrangement 2)

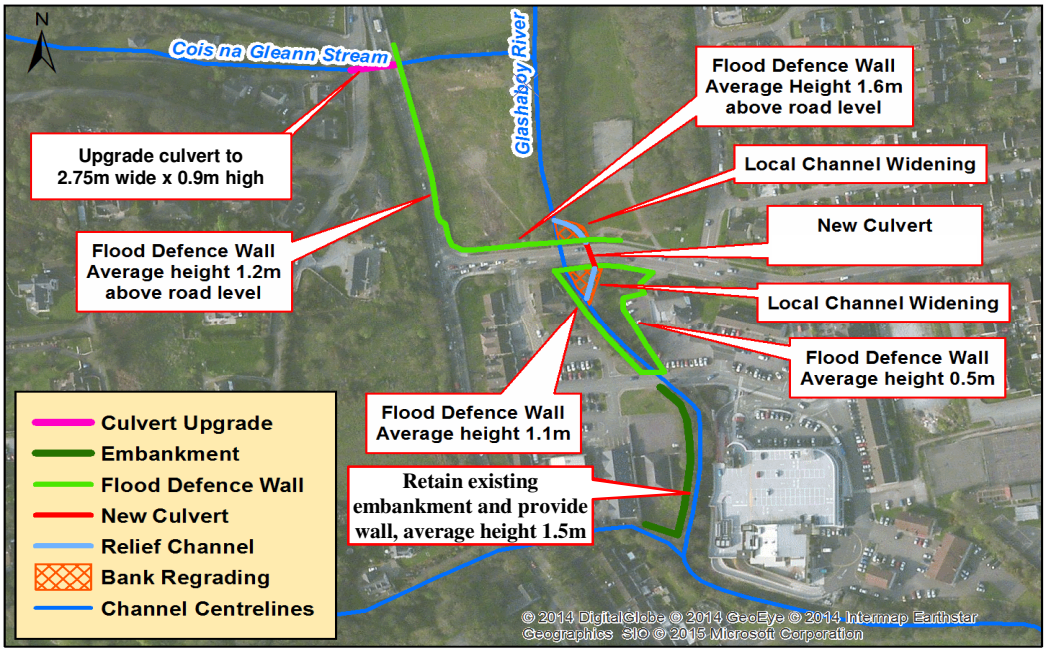


Table 8: Option 2D - Combination of Direct Defences and Conveyance Improvements (Arrangement 2) - Description of Works

Location	Channel	Chainage (m)	Description	Comments
Hazelwood Centre and Hazelwood Bridges	Glashaboy	3785 - 4080	New flood relief culvert to be constructed on the eastern side of Hazelwood Avenue bridge as shown in Figure 17. Culvert to be 5.5m wide x 1.75m high. Associated local flood relief channels to be excavated upstream and downstream of the flood relief culvert. Flood defence wall to be constructed on the line of existing boundary wall immediately upstream of Hazelwood Avenue Bridge. The defence shall be approximately 210m in length and up to 1.6m high. The wall will tie into higher ground at each end. Flood defence walls to be constructed along both banks between Hazelwood Avenue Bridge and Hazelwood Shopping Centre Bridge (length of reach is 80m). Average height of wall on the left bank will be 0.5m, and 1.1m on the right bank. Underpinning/strengthening of the existing shopping centre bridge will be required to ensure that the bridge can resist the lateral water load during a flood. Also, as a result the new flood wall across the bridge will need to be independently supported at each end. On the right bank downstream of Hazelwood Shopping Centre Bridge, the existing embankment is to be retained and a flood defence wall reconstructed over a length of 91m. Typical wall height 1.5m.	Works would require temporary road closure during construction. Possible temporary diversion route through Hazelwood Shopping Centre
Cois na Gleann Stream at R639 Road	Cois na Glean Stream	75 - 100	Replace the existing culverts with a single 2.75m wide x 0.9m high rectangular culvert. This will require local road raising in the vicinity of the culvert. Remove the existing ‘well-type’ structure adjacent to the R639.	

4.3.5 Option 2E - Combination of Direct Defences and Conveyance Improvements (Arrangement 3)

Figure 18: Option 2E - Combination of Direct Defences and Conveyance Improvements (Arrangement 3)

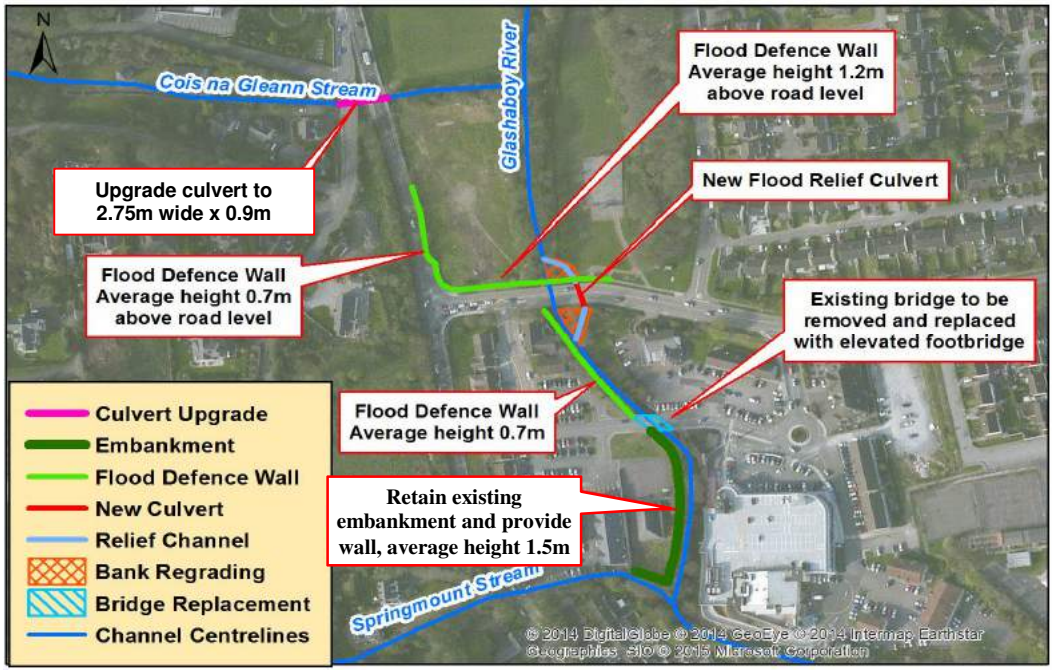


Table 9: Option 2E - Combination of Direct Defences and Conveyance Improvements (Arrangement 3) - Description of Works

Location	Channel	Chainage (m)	Description	Comments
Hazelwood Centre and Hazelwood Bridges	Glashaboy	3785 - 4050	New flood relief culvert to be constructed on the eastern side of the bridge as shown in Figure 18 . Culvert to be 5.5m wide x 1.75m high. Flood defence wall to be constructed on the line of existing boundary wall immediately upstream of Hazelwood Avenue Bridge. The defence shall be approximately 150m in length and up to 1.2m high. The wall will tie into higher ground at each end. Hazelwood Shopping Centre Bridge to be removed and replaced with an elevated footbridge. On the right bank downstream of Hazelwood Shopping Centre Bridge, the existing embankment is to be retained and a flood defence wall reconstructed over a length of 91m. Typical wall height 1.5m.	Works would require temporary closure of part of Hazelwood Avenue during construction. Possible temporary diversion route through Hazelwood Shopping Centre.
Cois na Gleann Stream at R639 Road	Cois na Glean Stream	75 - 100	Replace the existing culverts with a single 2.75m wide x 0.9m high rectangular culvert. This will require local road raising in the vicinity of the culvert. Remove the existing 'well-type' structure adjacent to the R639.	

4.3.6 Option 2F - Combination of Direct Defences and Conveyance Improvements (Arrangement 4)

Figure 19: Option 2F - Combination of Direct Defences and Conveyance Improvements (Arrangement 4)

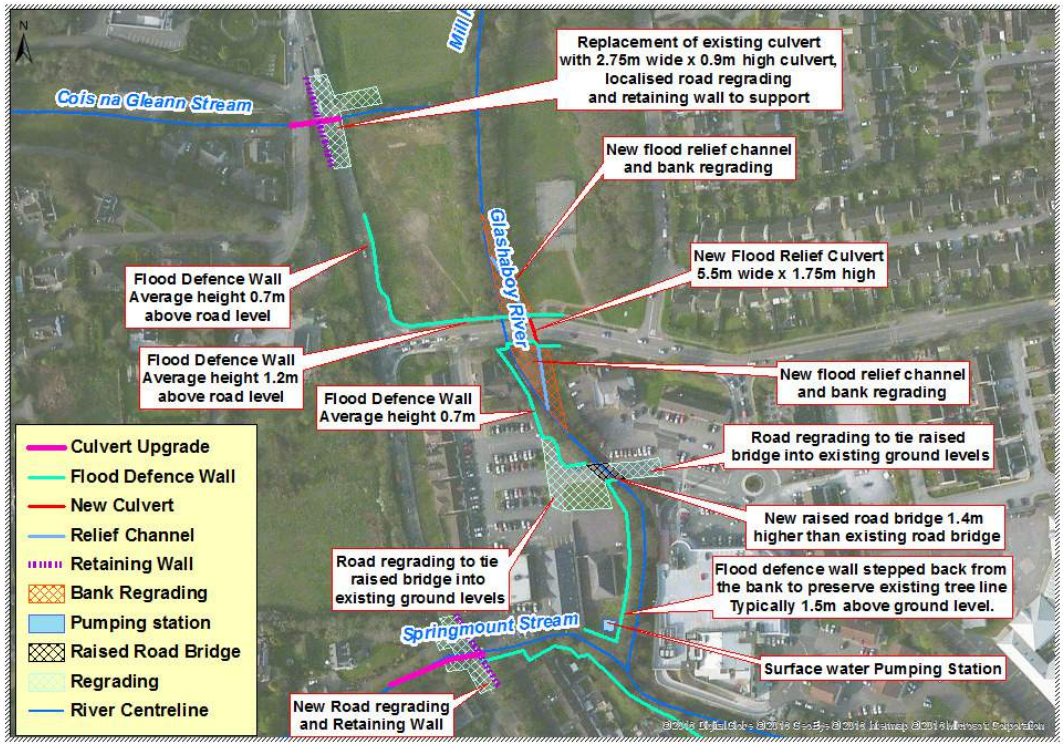


Table 10: Option 2F - Combination of Direct Defences and Conveyance Improvements (Arrangement 4) - Description of Works

Location	Channel	Chainage (m)	Description	Comments
Hazelwood Centre and Hazelwood Bridges	Glashaboy	3785 - 4050	New flood relief culvert to be constructed on the eastern side of Hazelwood Avenue bridge as shown in Figure 19. Culvert to be 5.5m wide x 1.75m high. Flood defence wall to be constructed on the line of existing boundary wall immediately upstream of Hazelwood Avenue Bridge. The defence shall be approximately 159m in length and up to 1.2m high. The wall will tie into higher ground at each end. Hazelwood Shopping Centre Bridge to be replaced with an elevated road bridge. The road on either side of the bridge to be re-graded to slope from existing ground levels up to the road bridge. The raised road to be supported by engineered slopes. On the right bank downstream of Hazelwood Shopping Centre Bridge, the existing embankment is to be retained and a flood defence wall reconstructed over a length of 91m. Typical wall height 1.5m. Pumping station to be constructed upstream of the confluence with Springmount Stream to pump surface water caught behind the flood defence.	Works would require temporary part closure of Hazelwood Avenue Bridge during construction. Possible temporary diversion route through Hazelwood Shopping Centre. Temporary and permanent changes to parking arrangements and traffic circulation within Hazelwood Centre will also be required
Cois na Gleann Stream at R639 Road	Cois na Glean Stream	50 - 100	Replace the existing culverts (and open channel between the two culverts) with a single 2.75m wide x 0.9m high rectangular culvert. Remove the existing 'well-type' structure adjacent to the R639. Localised road regrading and retaining wall support required to facilitate the replacement culvert.	

4.4 Area 3: Meadowbrook Housing Estate

4.4.1 Option 3A – Direct Defences (with Conveyance Improvements on Springmount Stream)

Figure 20: Option 3A – Direct Defences (with Conveyance Improvements on Springmount Stream)

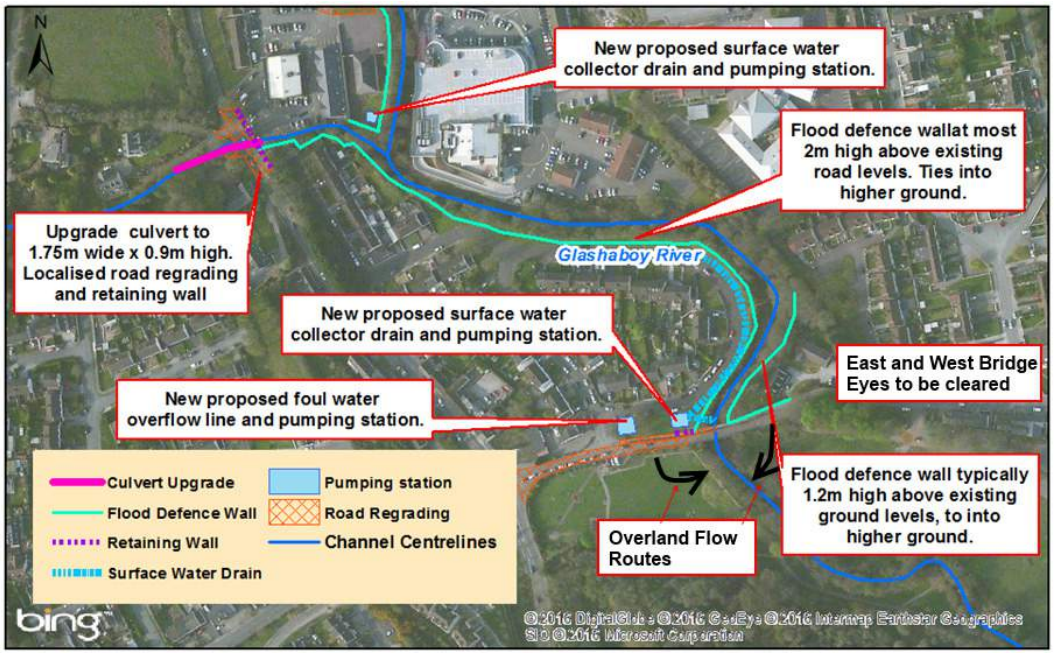


Table 11: Option 3A - Direct Defences (with Conveyance Improvements on Springmount Stream) - Description of Works

Location	Channel	Chainage (m)	Description	Comments
Meadowbrook (Right Bank)	Glashaboy River	3440 - 3780	Existing wall to be replaced with a 334m long flood defence wall, height varies from 1m to 2m above existing ground level. A Surface water pumping station and a collector drain will be installed in Meadowbrook estate. A separate foul water overflow line and a pumping station will be constructed.	Existing wall has insufficient height and structural capacity.
Meadowbrook (Left Bank)	Glashaboy River	3440 - 3525	A new flood defence wall will be constructed along the existing fence line.	
Riverstown Bridge	Glashaboy River	3440	Conveyance improvements to Riverstown Bridge will be carried out by clearing the east and west bridge eye. The existing footpath on the eastern bridge extent will be regraded to tie in with the flood defence wall and the L3010 will be recambered. Both of these measures will direct overland flood flow back into the Glashaboy River.	Existing mature trees along the channel will need to be removed to facilitate the works.
Meadowbrook	Springmount Stream	0 - 85	New 1.1m high, 81m long flood defence wall to be constructed along the Springmount Stream.	It may be necessary to carry out this work at night, as this road is heavily trafficked.
Springmount Stream at R639 road	Springmount Stream	85 - 110	Replace the existing culverts with a single 1.75m wide x 0.9m high rectangular culvert. Localised road regrading and a retaining wall will be required to facilitate the culvert replacement.	
Meadowbrook (Left Bank)	Glashaboy River	3440 - 3525	A new flood defence wall will be constructed along the existing fence line.	

4.5 Area 4.1: Butlerstown Stream

4.5.1 Option 4.1A – Conveyance Improvements

Figure 21: Option 4.1A – Conveyance Improvements at Butlerstown (L3010 road).

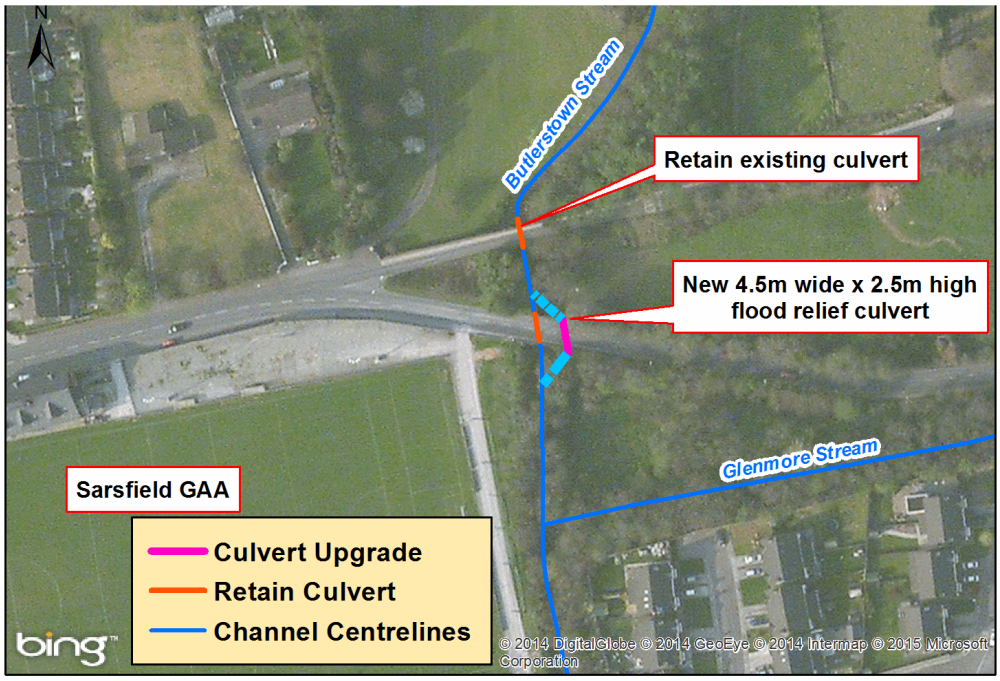


Table 12: Option 4.1A - Conveyance Improvements – Description of Works

Location	Channel	Chainage (m)	Description	Comments
L3010 Road	Butlerstown	435	Install a new 4.5m wide x 2.5m high rectangular culvert in parallel with the existing masonry arch bridge.	Would need to check for backwater effect.

4.5.2 Option 4.1B – Direct Defences

Figure 22: Option 4.1B - Direct Defences at Butlerstown (L3010 road)

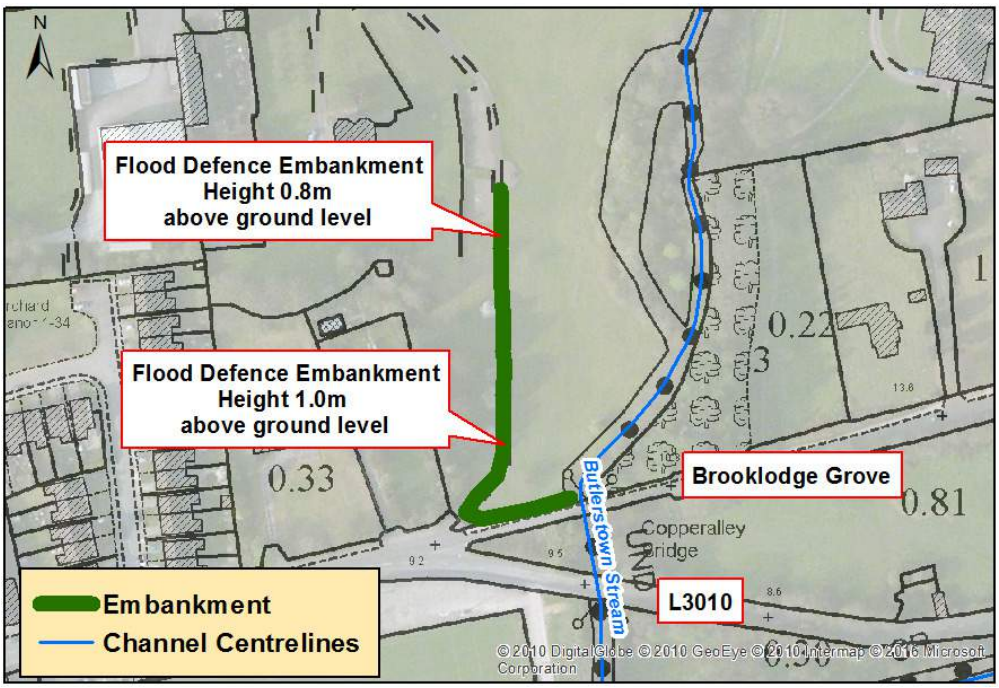


Table 13: Option 4.1B – Direct Defences – Description of Works

Location	Channel	Chainage (m)	Description	Comments
Upstream of L3010 Road	Butlerstown	470 - 575	New flood defence embankment to be constructed, average height 0.75m, maximum height 1m, 100m long.	The existing bridges may be surcharged during the design flood event. Bridges would need to be checked for uplift.

4.5.3 Option 4.1C – Overland Flow Management

Figure 23: Option 4.1C – Overland Flow Management

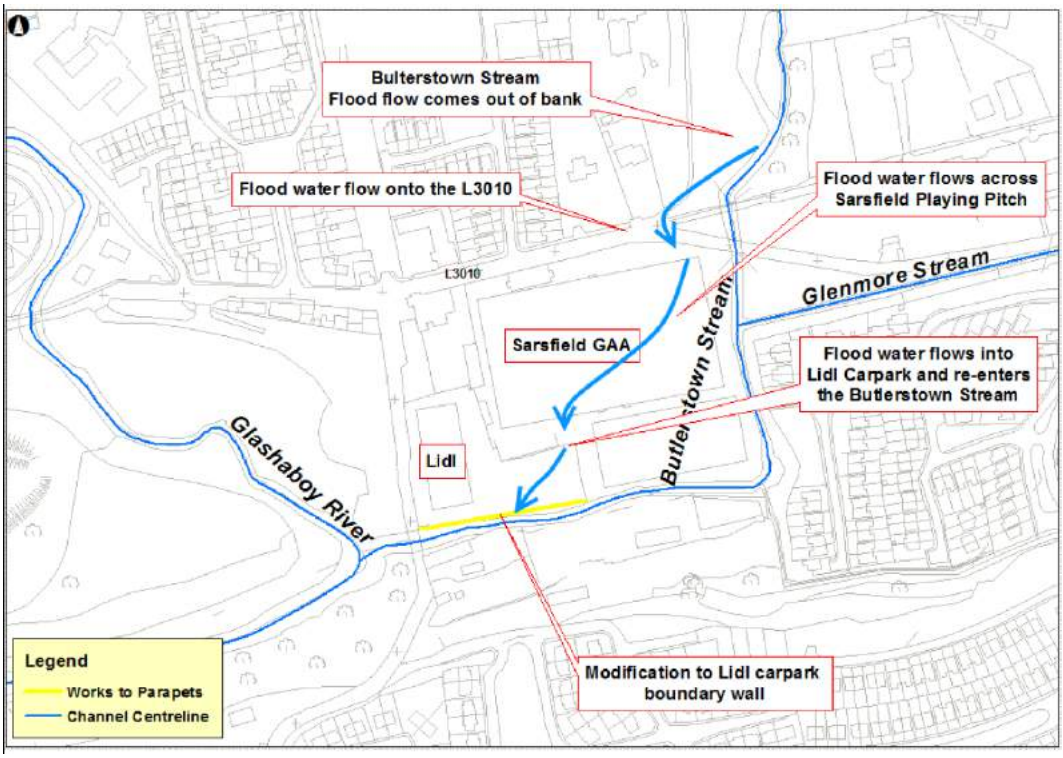


Table 14: Option 4.1C - Overland Flow Management – Description of Works

Location	Channel	Chainage (m)	Description	Comments
Riverstown House/ Sarsfield GAA/ Lidl	Butlerstown Stream	35 - 570	Modification to Lidl car park boundary wall required to allow existing overland flow path to re-enter the Butlerstown stream.	

4.6 Area 4.2: Glenmore Stream

4.6.1 Option 4.2A – Overland Flow Management

Figure 24 presents the option of overland flow management.

Figure 24: Option 4.2A – Overland Flow Management

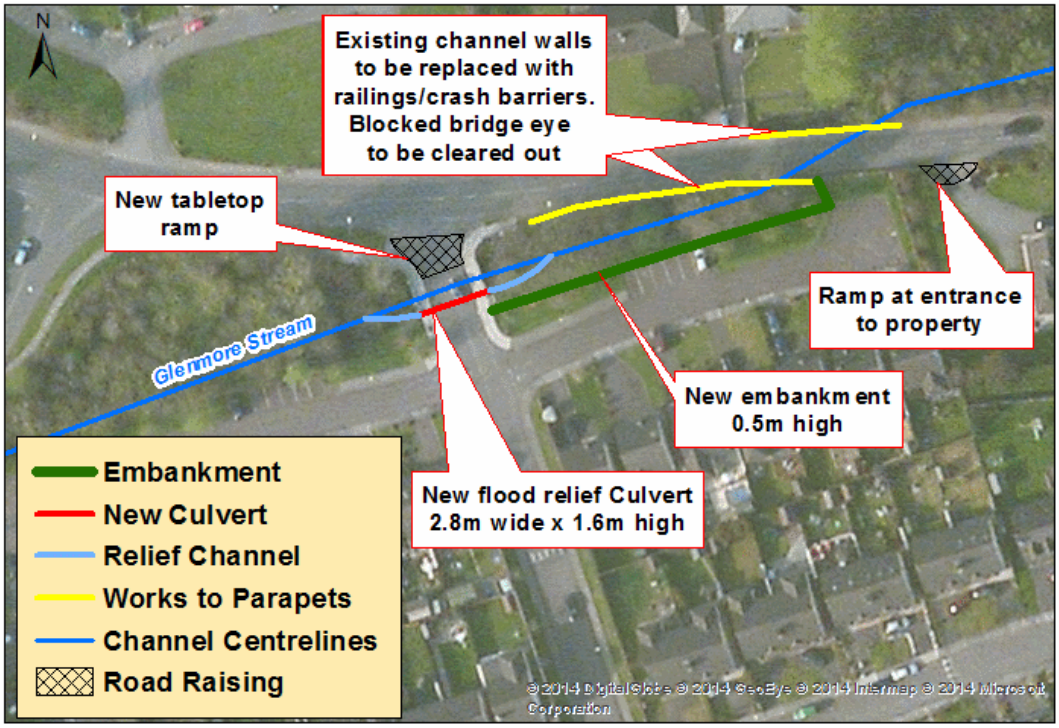


Table 15: Option 4.2A - Overland Flow Management – Description of Works

Location	Channel	Chainage (m)	Description	Comment
Copper Valley Bridge / Brooklodge Grove Bridge	Glenmore	590 - 660	New 2.8m wide x 1.6m high rectangular flood relief culvert in parallel with the existing Copper Valley Bridge. Brooklodge Grove Bridge to be cleared of silt and debris. The Brooklodge Grove Bridge will be allowed to overtop in the design flood event. Measures to allow overland flow to re-enter the Glenmore stream without flooding properties as follows: Install table-top ramp at the entrance to Copper Valley Estate; Replace existing parapet walls with a crash barrier (40m length);between the two bridges along the right bank At Brooklodge Grove Bridge, replace existing parapet walls with railings (15m length); Construct embankment 0.5m high along the left bank between the two bridges; Local ramping at the entrance to one domestic property as shown in Figure 24 Ramp circa 0.15m high.	

4.6.2 Option 4.2B – Glenmore - Culvert Replacement

Figure 25: Option 4.2B –Glenmore - Culvert Replacements

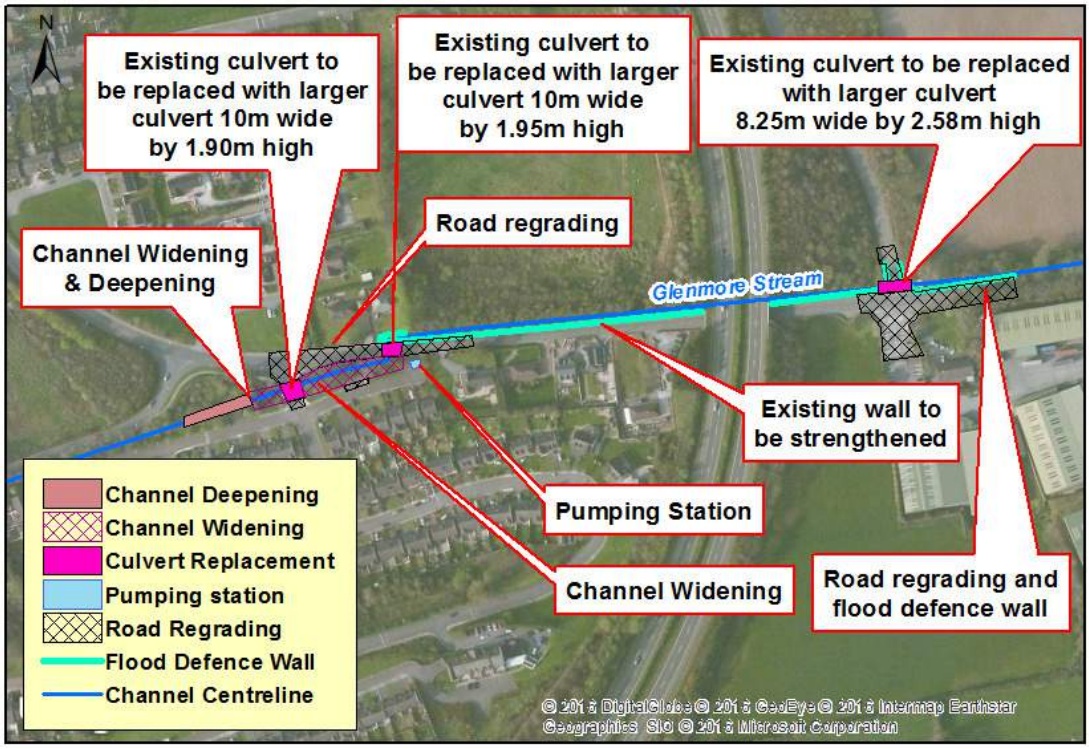


Table 16: Option 4.2B - Conveyance Improvements – Description of Works

Location	Channel	Chainage (m)	Description	Comment
Copper Valley Vue / Brooklodge Grove/New Line Culverts	Glenmore Stream	560 - 973	Brooklodge Grove culverts to be replaced by a single 10m wide x 1.95m high culvert. Copper Valley Vue culvert to be replaced by10m wide x 1.90m high culvert. The New Line Culvert to be replaced with 8.25m wide by 2.58m high culvert. Each culvert replacement is to reduce risk of blockage and improve conveyance. There will be road regrading required to facilitate the replacement of each culvert. Channel widening will be required upstream and downstream of the Copper Valley Vue Culvert, while localised channel deepening will be necessitated with the replacement of each culvert. The wall along the northern side of Brooklodge Grove will be strengthened so that it can function as a flood defence, and it will be extended along its western extent to wrap around on to the right bank of the river. All outfalls across this wall will be fitted with a non-return flap valve. Provision a pumping station to alleviate pluvial flooding.	Measures selected to maintain flood waters in-bank Providing clear span culverts to reduce risk of blockage.

4.7 Area 5: O'Callaghan Park to Glanmire Bridge

4.7.1 Option 5A – Direct Defences and IPP

Figure 26: Option 5A – Individual Property Protection at St. Patricks Mills

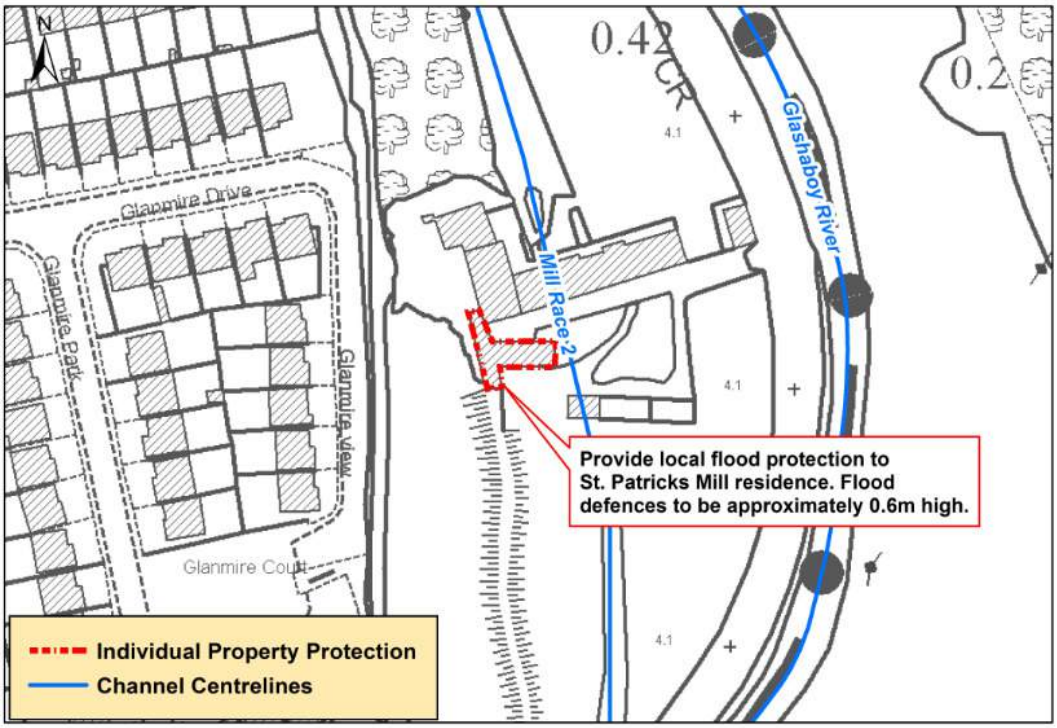


Table 17: Option 5A - Individual Property Protection - Description of Works

Location	Channel	Chainage (m)	Description
St. Patricks Mills	Glashaboy	2485	New individual property protection measures, approximately 0.6m high, to be installed locally around the residence building only. Non-return valves on drainage lines and ducts to be installed.

Figure 26: Option 5A – Direct Defences at The Grove

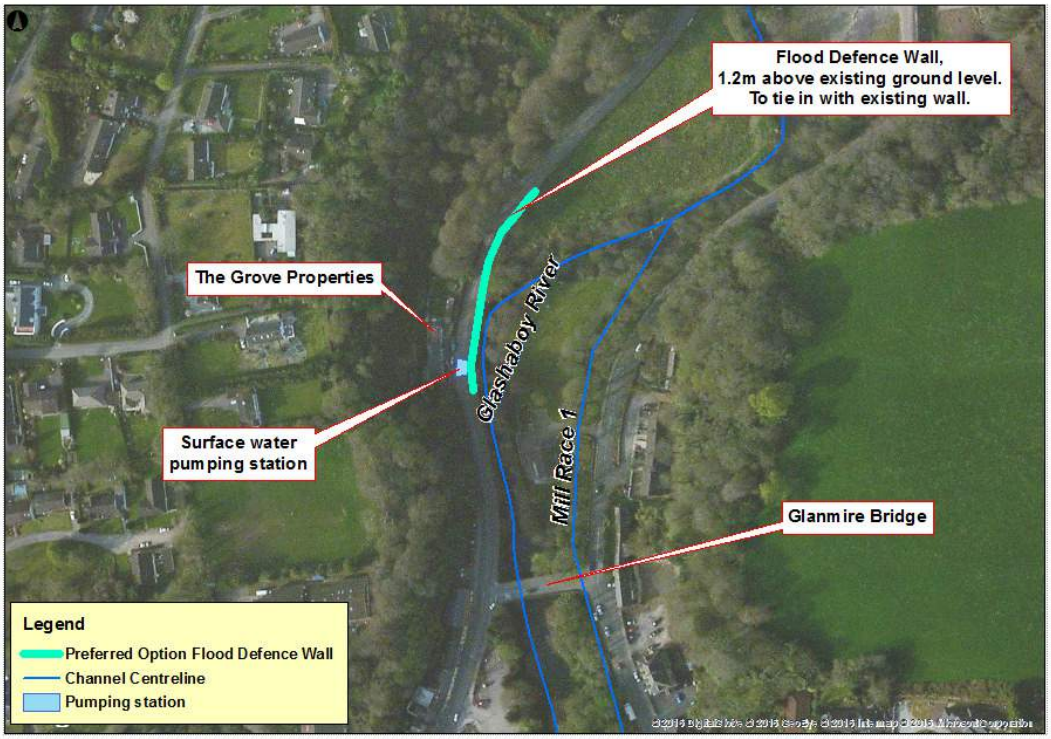


Table 18: Option 5A - Direct Defences – Description of Works

Location	Channel	Chainage (m)	Description
The Grove	Glashaboy	1754 - 1842	New flood defence wall 1.2m high approximately 100m in length. Provision of local stormwater drainage in combination with pumping station to alleviate pluvial flooding

4.7.2 Option 5B – Direct Defences Only

This options consists of direct defences at The Grove only. It does not include Individual Property Protection at St. Patricks Mills. Figure 26 and Table 18 provide an overview of the proposed works.

4.8 Area 6: Downstream of Glanmire Bridge

4.8.1 Option 6A –IPP

Figure 27: Option 6A – IPP Measures at Barry's Terrace

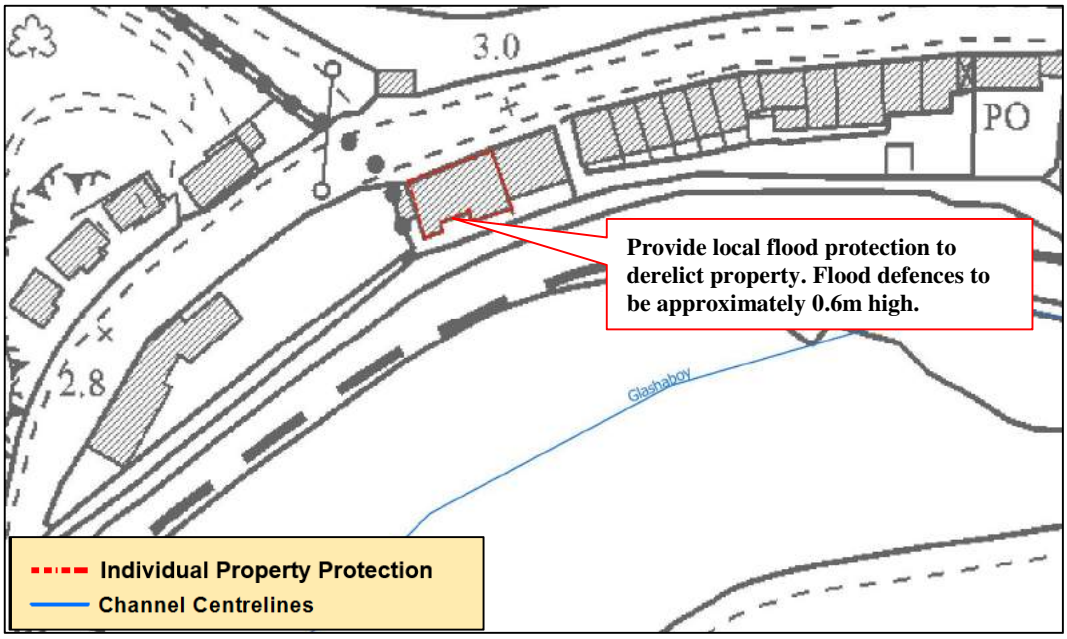


Figure 28: Option 6A - Proposed Defence Works - The Fountains Mill

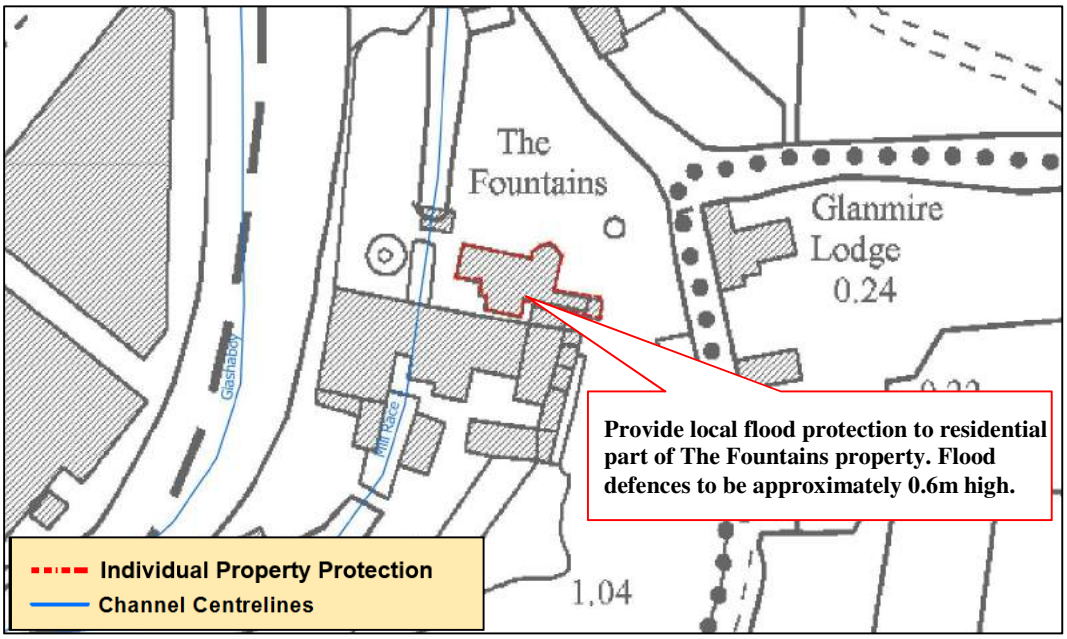


Table 19: Option 6A - IPP Only – Description of Works

Location	Channel	Chainage (m)	Description	Comments
Barry's Terrace	Glashaboy	1300	New individual property protection measures, approximately 0.6m high, to be installed locally around singular property.	Ownership, maintenance and liability would need to be addressed. There may be technical issues with providing this type of measure to a protected structure (Fountains Mill). Structural assessments would need to be carried out to confirm suitability at each of the two property
The Fountains Mill	Glashaboy	1690	New individual property protection measures, approximately 0.6m high, to be installed locally around The Fountains Mill buildings.	

4.8.2 Option 6B – Do Nothing

The 'Do Nothing' option is retained as alternative to Option 6A. The option of providing IPP may not be feasible as outlined below;

- IPP has not been provided as part of a flood relief scheme to date.
- Ownership, maintenance and liability would all need to be addressed.
- Architectural Heritage would need to be addressed for the protected structure (Fountains Mill).
- Technical issues in terms of wall stability and floor construction and potential groundwater seepage.
- Operational/ practical issues with providing IPP to a derelict may result in this option becoming unfeasible.

5 Economic Assessment of Shortlisted Options

5.1 Cost Estimate of Shortlisted Options

Viable flood alleviation options for the Glashaboy River are considered as follows;

- Direct defences.
- Conveyance improvements.
- Combination of direct defences and conveyance improvements.

This section assesses the cost of each flood alleviation option.

5.2 Methodology

When building up cost estimates for a scheme of this nature, it is important that the expected whole life costs of the works and its management are developed and not just the capital cost for this project:

- Construction costs, including the Contractor's general items and overheads.
- Archaeology and Environmental mitigation costs.
- Contingency/ Optimism Bias.
- Site Investigation and survey costs
- Land purchase and compensation costs.
- Allowance for Art.
- Maintenance costs.

The following costs were excluded:

- Value Added Tax.
- Cost of OPW/CCC staff time on the project.

5.3 Construction Costing Method

Base costs for construction elements of the scheme were obtained from the following sources:

- Estimates and tendered rates from historic and similar civil engineering contracts.
- Published cost databases, including the NRA unit cost database and the draft OPW unit cost database.

The following assumptions have been made when compiling the construction cost estimates:

- Normal working week for construction personnel and plant.

- No exceptional adverse weather.

5.4 Environmental/Archaeological Monitoring, Mitigation Works and Improvement Works

Environmental and archaeological monitoring will be required during the construction of the works. It is also likely that some environmental mitigation and improvement works will be necessary. A provisional allowance of 10% has been included in the cost estimate.

5.5 Contingency/Optimism Bias

There is a tendency for project appraisers to be overly optimistic when preparing project cost estimates for flood risk management schemes. The aim of adding an optimism bias is to allow a contingency on cost estimates to cater for unknowns and help ensure that the project budget is robust.

An allowance for optimism bias of 20% of the estimated construction costs (including add-on costs) has been included in the total project cost estimate. This percentage was deemed reasonable following discussions with CCC/OPW and given the level of assessment that the scheme has undergone.

5.6 Site Investigation and other Surveys

A site investigation, topographic survey, archaeological survey and CCTV drainage survey will all need to be carried out for the scheme. The total cost of these investigation and surveys is estimated to be approximately €200,000 and has been included in the cost estimate.

5.7 Design and Site Supervision Costs

An allowance of 10% of the construction cost has been made for design and site supervision costs.

5.8 Land Purchase and Compensation

OPW has advised that 15% should be added to the costs of the scheme to allow for:

- Land purchases and compensation.
- Planning, highway and other third party costs.
- Administration and legal costs associated with land exchanges, statutory approvals, planning applications, service diversions, highway adoptions etc.
- Loss of revenue to adjacent or affected buildings.

5.9 Maintenance Work Costs

The estimated net present value of the maintenance of the scheme has also been included in the project cost estimate. Allowances for the following items have been included in the estimate:

Table 20: Scheme Maintenance Items Cost

Element	Maintenance Task	Predicted Average Frequency
Embankments	Mowing	6 months
Floodwalls	Sealant replacement	5 years
	Repointing mortar joints in cladding (say 25% of area)	25 years
Filter drains	Visual Inspection	5 years
	CCTV survey	10 years
	Granular Fill Replacement	20 years
Flap Valves	Inspection	5 years
	Replacement	25 years
Pumping Stations	Inspections, condition assessments, repairs and replacements of parts, removal of blockages and telemetry checks	5 years
	Electrical Works Replacement	20 years
	Running costs (electricity)	Annual
Sealed service ducts	Inspection	5 years
	Replacement	5 years
Culverts	Clearing of silt	10 years
	Full CCTV survey	10 years
Trash Screens	Cleaning of debris	Every 2 months or after a flood event
Deepened channel	Inspection	5 years
	Removal of excessive deposition	10 years
Entire Scheme	Periodic inspection after major flood events greater than 1 in 25 years	10 years

As a cross-check, the maintenance cost was also estimated as 1% of construction costs by a present value factor of 21.48.

5.10 Allowance for Art

The “per cent for art” scheme is compulsory for all major public works contracts. For this size of project, the required allowance for art is 1% of the capital cost up to a maximum of €51,000. Therefore the maximum allowance of €51,000 has been included in the cost estimate.

5.11 Summary of Costs

Detailed cost build-ups are contained in Appendix A. Table 21 and Table 22 summarise the total costs for each of the viable options

Table 21: Summary of Costs - Area 1, 3, 4, 5 and 6

	Area 1: Sallybrook Ind. Estate	Area 3: Meadowbrook Housing Est.	Area 4: Butlerstown / Glenmore					Area 5: O'Callaghan Park to Glanmire Bridge		Area 6: Downstream of Glanmire Bridge	
	Option 1A Direct Defences	Option 3A Direct Defences	Option 4.1A – New culvert on Butlerstown	Option 4.1B – Direct Defences on Butlerstown	Option 4.1C – Overland Flow Management	Option 4.2A – Overland Flow	Option 4.2B – Culvert replacement-	Option 5A – Direct Defences, IPP	Option 5B – Direct Defences only	Option 6A IPP	Option 6B Do Nothing
Gross Construction Cost Estimate	1,022,377	893,501	123,032	102,373	8,000	98,503	947,377	189,374	173,374	32,000	-
Prelims 15%	153,357	134,025	18,455	15,356	1,200	14,775	142,107	28,406	26,006	4,800	-
Unmeasured Items 20%	204,475	178,700	24,606	20,475	1,600	19,701	189,475	37,875	34,675	6,400	-
Subtotal	1,380,209	1,206,227	166,093	138,203	10,800	132,979	1,278,959	255,655	234,055	43,200	-
Archaeology & Environmental	138,021	120,623	16,609	13,820	1,080	13,298	127,896	25,566	23,406	4,320	-
Baseline Construction Cost Total	1,518,230	1,326,850	182,702	152,023	11,880	146,277	1,406,855	281,221	257,461	47,520	-
Contingency/ Optimism Bias 20%	303,646	265,370	36,540	30,405	2,376	29,255	281,371	56,244	51,492	9,504	-
Construction Cost Subtotal	1,821,876	1,592,220	219,243	182,428	14,256	175,532	1,688,226	337,465	308,953	57,024	-
Fees and Supervision 10%	197,370	172,490	23,751	19,763	1,544	19,016	182,891	36,559	33,470	6,178	-
Construction + Fees Subtotal	2,019,246	1,764,710	242,994	202,191	15,800	194,548	1,871,117	374,024	342,423	63,202	-
Land Acquisition 15%	273,281	238,833	32,886	27,364	2,138	26,330	253,234	50,620	46,343	8,554	-
Art	10,200	10,200	10,200	10,200	Included in Option 4.2B	10,200	10,200	10,200	10,200	10,200	-
Site Investigation & Surveys	40,000	40,000	40,000	40,000		40,000	40,000	40,000	40,000	40,000	-
Totals	2,342,728	2,053,743	326,080	279,755	17,939	271,078	2,174,551	474,843	438,966	121,955	-
Maintenance	391,339	342,009	47,093	39,185	3,062	37,704	362,631	72,487	66,363	12,249	-
Project Cost Total	2,734,067	2,395,752	373,174	318,940	21,001	308,782	2,537,181	547,331	505,329	134,204	-

Table 22: Summary of Costs - Area 2

	Area 2: Hazelwood Shopping Centre					
	Option 2A – Direct Defences Only (€)	Option 2B - Dredging (€)	Option 2C -Raising Avenue Bridge (€)	Option 2D – New Culvert at Avenue Bridge (€)	Option 2E – Shopping Centre New Footbridge (€)	Option 2F – Shopping Centre New Road Bridge (€)
Gross Construction Cost Estimate	1,380,268	1,189,113	1,405,649	1,238,162	1,156,202	1,315,027
Prelims 15%	207,040	178,367	210,847	185,724	173,430	197,254
Unmeasured Items 20%	276,054	237,823	281,130	247,632	231,240	263,005
Subtotal	1,863,362	1,605,302	1,897,626	1,671,519	1,560,872	1,775,287
Archaeology & Environmental	186,336	160,530	189,763	167,152	156,087	177,529
Baseline Construction Cost Total	2,049,699	1,765,832	2,087,388	1,838,671	1,716,960	1,952,816
Contingency/ Optimism Bias 20%	409,940	353,166	417,478	367,734	343,392	390,563
Construction Cost Subtotal	2,459,638	2,118,999	2,504,866	2,206,405	2,060,351	2,343,379
Fees and Supervision 13%	266,461	229,558	271,360	239,027	223,205	253,866
Construction + Fees subtotal	2,726,099	2,348,557	2,776,226	2,445,432	2,283,556	2,597,245
Land Acquisition 15%	368,946	317,850	375,730	330,961	309,053	351,507
Art	10,200	10,200	10,200	10,200	10,200	10,200
Site Investigation & Surveys	40,000	40,000	40,000	40,000	40,000	40,000
Subtotal	3,145,245	2,716,607	3,202,156	2,826,593	2,642,809	2,998,952
Maintenance including 20% Optimism Bias (NPV)	528,330	455,161	538,045	473,936	442,564	503,358
Project Cost Total	3,673,575	3,171,767	3,740,202	3,300,529	3,085,372	3,502,309

6 Multi-Criteria Assessment of the Shortlisted Options

6.1 Introduction

The effectiveness of each of the viable options can be measured in terms of how it achieves a set of flood risk management objectives. This section describes the detailed multi-criteria analysis (MCA) of the shortlisted options which was carried out to evaluate the performance of each option in terms of predefined objectives. As part of this process, each objective was given a global and local weighting. Each option was then scored relative to the present day situation (baseline condition), based on how well they met the objectives. The output from this stage was a total weighted score for each option. The option with the highest score is deemed to be most desirable, subject to professional judgement exercised by the project's designers/ steering group, as appropriate.

The determination of suitable local weightings and scorings for each of the criteria were determined through a workshop forum held with key representatives of OPW, Cork City Council, Cork County Council, Arup and JBA Consulting (environmental consultants for the scheme).

This ensured that the combined expertise and experience of all relevant specialists and disciplines were brought to bear in a transparent fashion in the scoring of each option.

6.2 Flood Risk Management Objectives and Weightings

The flood risk management objectives were categorised as follows:

- Technical
- Economic
- Social
- Environmental

The categories were sub-divided into objectives (refer Table 23). Each objective has been weighted to reflect their importance and/or sensitivity, and to ensure that the objectives most relevant to the location under consideration were given priority in the decision-making process.

Two types of weighting were used:

Global weighting (ranging between 5 and 30) which applied a weighting, fixed by the OPW at a national level, to each objective used. The global weights are shown in Table 23.

Local weighting (ranging between 0 and 5) which was specific to the importance of each objective in the location where the option was being considered. The local weightings are shown in Table 24.

Table 23: Flood Risk Management Objectives and Global Weightings

Category	Objective	Global Weighting
Technical	Operationally Robust	20
Technical	Health and Safety Risk	20
Technical	Sustainability	20
Economic	Reduce Economic Damage	30
Economic	Transport Infrastructure	10
Economic	Utility Infrastructure	10
Economic	Agriculture	10
Social	Risk to Residents	30
Social	Risk to High Vulnerability Properties	10
Social	Social Infrastructure	5
Social	Local Employment	10
Social	Risk to Social Amenity Sites	5
Environmental	WFD Objectives	15
Environmental	Habitats and Birds Directives	15
Environmental	Flora and Fauna	5
Environmental	Fisheries	5
Environmental	Landscape Character	10
Environmental	Cultural Heritage – Architectural	5
Environmental	Cultural Heritage – Archaeology	5

Table 24: Local Weightings

Importance	Local Weighting
Major/International Importance	5
Significant / National Importance	4
Medium / Regional Importance	3
Minor / Local Importance	2
Negligible Importance	1
Not Relevant	0

6.3 Scoring

Each option was then scored relative to the present day situation (baseline condition), based on how well they met the objective. The scores used ranged between 5 and -999, as shown Table 25 below.

Table 25: MCA Scoring

Impact	Score
Fully Achieving Aspirational Target	5
Partially Achieving Aspirational Target	3
Exceeding Basic Requirement	1
Meeting Basic Requirement (No Change)	0
Just failing minimum target	-1
Partly failing minimum target	-3
Fully failing minimum target	-999

A description of the minimum targets and aspirational targets for each objective are included in Appendix B.

6.4 MCA Assessment

A total weighted score was then calculated for each objective as the sum of the weighted scores across the 19 flood risk management objectives. This MCA score reflected the performance of the option in terms of the study's objectives.

The weighted score was calculated as follows:

WS = GW x LW x S

Where:

WS = Weighted Score

GW = Global Weighting

LW = Local Weighting

S = Score

The total MCA score was the sum of the scores for each objective.

The detailed MCA assessment is included in Appendix B.

6.5 MCA Workshop

As part of the MCA assessment, a workshop was held between the project environment team, engineering team and CCC/OPW. At the workshop, the various options were reviewed holistically and MCA scores were agreed. These have been reviewed and updated in light of the changes to the measures, however the principle scoring has been retained.

6.6 Summary

Table 26 and Table 27 present summary results of the MCA process.

Findings for Option 1A and Option 3A are presented for information purposes only as there are no comparative options available.

Option 6B consists of a 'Do-Nothing' scenario, which cannot be assessed and Option 6A is also presented for information purposes.

Findings for Option 2A to 2F suggest that all options provide comparatively similar MCA scores. The only exception is Option 2B, which consists of dredging measures and scores significantly lower due to the significant potential environmental impacts.

In Area 4.1, Option 4.1C results in the highest MCA scores. This option consists of overland flow management and only requires local work to a boundary wall to maintain the existing flood flow path. As a result there is only minimal potential environmental impact, little technical challenge and relatively low costs.

Findings for Area 4.2 show significantly higher MCA scores for the conveyance improvement option (Option 4.2B) in comparison to the option of overland flow management (Option 4.2A). The main reason is the significant reduction in residual risk associated with Option 4.2B due to the upgrade of three culverts that are posing pinch points in the existing condition. Option 4.2A on the other hand is associated with significant residual risk, due to the ongoing risk of culvert blockage. It should be noted that there is considerable cost associated with Option 4.2B, which results in a lower MCA over cost ratio. However, this option is preferred as it was found to be most acceptable by stakeholders due to reasons outlined above.

Both options for Area 5 contain direct defences along The Grove. Option 5A also contains IPP measures for St Patrick's Mill, whereas Option 5B does not contain measures for St Patrick's Mill. The MCA scores do not provide a clear distinction between the two options. It should be noted that there are significant technical difficulties with providing IPP to the protected structure, which is why the Option Selection score is favourable for the defence only option (Option 5B).

Table 26: MCA Summary Results - Option 1A to 3A

Option	**1A**	**2A**	**2B**	**2C**	**2D**	**2E**	**2F**	**3A**
Description	**Direct Defences**	**Direct Defences**	**Dredging**	**Raising Avenue Bridge**	**New Culvert - Avenue Bridge**	**Shopping Centre New Foot Bridge**	**Shopping Centre New Road Bridge**	**Direct Defences**
MCA Benefit Score	1395	1755	1085	1915	1765	1615	1815	1855
Option Selection Benefit Score	2395	2455	1185	3015	2765	2515	2815	2955
Total Capital Costs (€m)*	2.73	3.67	3.17	3.74	3.30	3.09	3.50	2.40
MCA Benefit/ Cost Ratio	0.51	0.48	0.34	0.51	0.53	0.52	0.52	0.77

Table 27: MCA Summary Results – Option 4.1A to 6B

Option	4.1A	4.1B	4.1C	4.2A	4.2B	5A	5B	6A	6B
Description	New culvert Butlerstown	Direct Defences Butlerstown	Overland Flow Management	Overland Flow Management Glenmore	Culvert Upgrade - Glenmore	Direct Defences and IPP	Direct Defences only	IPP Only	Do Nothing
MCA Benefit Score	450	240	524	695	1200	1175	1065	250	NA
Option Selection Benefit Score	1150	1340	1924	1495	2400	1575	1865	250	NA
Total Capital Costs (€m)*	0.37	0.32	0.02	0.31	2.54	0.55	0.51	0.13	0.00
MCA Benefit/Cost Ratio	1.21	0.75	25.0	2.25	0.47	2.15	2.11	1.86	NA

6.7 MCA Conclusion

MCA scores for Area 1, 3 and 6 are presented for information purposes only as no comparative solutions were available.

The remaining areas allowed for a comparative assessment. The MCA process was therefore used to aid identification of a preferred option for these areas only.

The MCA score of almost all options for Area 2 was found to be fairly similar. The only exception is Option 2B, which consists of dredging measures and this option scores significantly lower due to the potentially significant negative environmental impact.

For Area 4.1, the MCA score of Option 4.1C was found to be higher and the Benefit/Cost Ratio would also be substantially more favourable and this is also the preferred option.

For Area 4.2, the option of upgrading culverts (Option 4.2B) results in a higher MCA score and is preferred due to reduced residual risk. This option also allow overland flow management to be adopted as part of the climate change adaptation (see Section 7.4.1).

The MCA scores of the two options for Area 5 were found to be similar. Option 5B is preferred due to significant technical difficulties associate with Option 5A.

In Area 6, the Option 6B 'Do Nothing' did not allow for MCA scoring and findings from Option 6A is presented for information only.

7 Development of Preferred Option

The extent and severity of the flood risk in the study area was first established through a hydrology study, hydraulic modelling, flow monitoring and consultation with affected landowners.

A range of potential flood risk management measures were reviewed as part of an initial screening exercise.

A number of potentially viable flood risk management options were then developed to outline design level, including hydraulic modelling, outline design and costings.

The benefits of defending to the design standard of 1 in 100 years fluvial / 1 in 200 year tidal was then established to inform a detailed cost benefit analysis.

Significant public consultation was carried out throughout the project and is considered to be and have been a vitally important part in the evolution of the proposed scheme and the ultimate decision on a preferred option. This consultation consisted of two public consultation days both at early Constraints Stage and at Emerging Preferred Options Stage as well as statutory consultation with all relevant stakeholders, extensive face to face landowner consultation and active and regular formal residents meetings. The feedback from this consultation process has been carefully considered and taken on board in finalising the scheme, and it is noteworthy that this feedback has resulted in some significant changes from the emerging preferred option initially exhibited in March 2015.

In Sallybrook (Area 1) the location of defences have been moved east to allow retention of a number of mature trees.

At Hazelwood (Area 2) the emerging preferred option did contain a pedestrian bridge with direct defences. This has now been upgraded to a road bridge in combination with a flood relief culvert and direct defences. The area of Meadowbrook now also contains a foul water pumping station to address sewerage flooding.

Overland flow management was considered as the emerging preferred option at Copper Valley Vue and Brooklodge Grove (Area 3). This has now been changed to conveyance improvements by means of culvert upgrades. In addition, the culvert upstream from the M8 motorway crossing is also being replaced.

In Area 4.1, overland flood route originating from the Butlerstown Stream was found to pose flood risk to a large warehouse unit located south of Sarsfield GAA club. This warehouse had been demolished during the course of the study and a Lidl retail outlet was subsequently constructed and opened in summer 2016. Finished floor levels of this development are above the design flood level and thereby provide sufficient flood protection. In order to maintain overland flood flow routes a boundary wall located along the Lidl Car Park requires modification and these works are proposed as part of Option 4.1C. The alternative options for this area consist of improving flow conveyance (Option 4.1A) or direct defences (Option 4.1B) and both of these have been ruled out based on feedback from public consultation and findings from the MCA analysis and BCR.

At Saint Patrick's Mill (Area 5) and The Fountains (Area 6) Individual Property Protection measures were considered as part of the emerging preferred route. These have now been omitted due to Heritage constraints at the Mill buildings, and operational difficulties at the derelict property at Barry's Terrace.

Directed defences are now provided for properties at The Grove (Area 5).

Direct defences had previously been provisionally included for the area of Barry's Terrace at the Emerging Public Information Day. However, following detailed surveys of the property floor levels and finalisation of the modelling of tidal flood risk, only one derelict property is confirmed to be at tidal flood risk. Therefore, direct defences are no longer necessary or viable at this location.

The options were also holistically reviewed by the project team as they were developed, and relevant issues were discussed within the Steering Group.

A final decision on the preferred option was made based on a holistic evaluation of the following key aspects:

- Findings of Cost Benefit Analysis
- Findings of Multi-Criteria Analysis
- Consideration of the key core messages which arose during the stakeholder consultation process
- Consideration of Key Risks
- Consideration of Climate Change Adaptability
- Combined professional judgement of the steering group members

The following sections summarise the critical issues with each potential option, along with reasons for ruling the options out where relevant.

7.1 Costs

Detailed budget estimate costs for each option were prepared for the purpose of feeding into the cost-benefit analysis and for comparing the relative costs of the various options.

7.2 Environmental Appraisal

An Environmental appraisal of all of the viable options has been carried out and summary findings are presented as follows.

There are no viable alternatives for Area 1 therefore it is determined that Option 1A is preferred. The same applies to Options 3A, 5A and 6A. No significant negative environmental impacts have been identified for the options in these areas.

In Area 2, Option Hazelwood 2B Conveyance improvements (Dredging) shows the greatest potential for negative impacts on the Glashaboy River and its protected habitats and species. All the remaining options are determined to have largely similar environmental impacts.

In Area 4.1 both, Option 4.1A and 4.1B were found to result in comparable MCA scores. Option 4.1C however provides a higher MCA score and is therefore preferred.

In Area 4.2, Option 4.2B (culvert replacement) is preferred flow is maintained in-bank, with reduced likelihood of blockage.

In Area 5 and 6 the addition of IPP was found to score negatively due to cultural heritage impacts, as both mill buildings are protected structures. Operational problems with erecting IPP at the derelict building at Barry's Terrace is also a negative.

For more detailed information on the environmental appraisal please refer to the Environmental Assessment of the Flood Risk Management Options Report (Arup November, 2016).

7.3 Public and Stakeholder Feedback

As part of the selection of the preferred option, the views of the public and stakeholders were taken into account.

A detailed description of the public consultation process, and summaries of the various submissions can be found in the Environmental Constraints Study Report, and the report on "Glashaboy (Glanmire/Sallybrook) Flood Relief Scheme Public Information Day No.2" (Arup, 2015).

The engagement of the public and stakeholders was very strong from the outset of the project, and the project team are grateful for all submissions.

While it is not possible to list each individual instance where public feedback has influenced the choice of preferred option, it is noted that the public feedback was particularly important for Area 2 (Hazelwood) and Area 3 (Meadowbrook).

In Area 2, there was a strong feeling that it is important to maintain the road link between the two halves of the shopping centre, in order to ensure that businesses would not be impacted.

In Area 3, many issues were highlighted including the pluvial flood risk from the hill to the west of the estate, and the significance of the blockage risk at Riverstown Bridge, as well as risk of sewerage flooding.

In Area 4.2, following the December 2015 flooding, which was affected by substantial blockage, the preferred option was reviewed to upgrade the critical culverts at Glenmore Bridge and Copper Valley Vue.

In Area 5, historical evidence of property flooding was provided for properties located at The Grove and measures in the form of direct defence and IPP were considered for residential properties located at The Fountains, albeit that the IPP measures were not ultimately adopted.

7.4 Climate Change Adaptability

In considering the merits of the scheme, it is important that the short term proposals are considered in the context of a longer term strategy which is flexible and adaptive to changes in the climate and its potential impact on flood risk.

The Glashaboy System through Glanmire is predominantly a constrained system in an urbanised environment. This constrains the available options both in the short and the long term. The existing system has insufficient in-bank conveyance capacity both in the short and longer term.

The options considered are located in six discrete areas, each of which consist of individual measures, which can be categorised as variations of the following approaches:

- Increase conveyance by replacement of existing restrictions and/ or provision of dredging through the at-risk area;
- Direct defences to protect property in the at-risk area against out of bank flooding;
- Tidal barrage as part of the Cork City Scheme. Tidally affected areas of Glanmire would benefit from this scheme.

7.4.1 Conveyance Improvements

As noted above, the existing Glanmire System is heavily constrained through the urban areas of Glanmire and in particular at Hazelwood.

To increase the capacity of the system to pass larger flows, local conveyance measures should be undertaken at the various throttles in the system. This could be done on a phased basis with priority given to replacing those structures which limit conveyance the most, and which can be practically undertaken at reasonable cost in the shorter term.

In terms of the Glanmire area, the significant throttles at Hazelwood Shopping Centre can reasonably be replaced in the short term, whereas the bridge at Hazelwood Avenue just upstream is proposed to be retained, while flow conveyance is proposed to be increased by providing a flood relief culvert in this location under the current scheme. As part of a long term solution, replacement of Hazelwood Avenue Bridge has been considered.

Dredging was ruled out for the current scheme due to the potential negative environmental impacts. However, this option should be reconsidered under the climate change scenario as it would offer significant potential to reduce water levels along the areas of Hazelwood and Meadowbrook.

Conveyance improvements are also proposed in the area of Copper Valley Vue (Glenmore Stream). The option of overland flow management/ providing storage are therefore retained as possible climate change adaptation measures.

7.4.2 Direct Defences

As noted above, the existing Glashaboy system is heavily constrained through the urban areas of Glanmire. The scale of flood defences to be constructed depends on both the design flow and any restriction in conveyance along the affected length.

Defence walls are typically designed so that they can be extended in the future to take account of the potential effects of climate change.

In this particular scheme, it is envisaged that defence heights through Sallybrook could be reasonably extended in the future to take account of climate change.

Similarly, defences downstream of Glanmire Bridge could reasonably be constructed to take account of climate change in the future.

The defence heights at Meadowbrook could also be extended as required.

7.4.3 Tidal Barrage

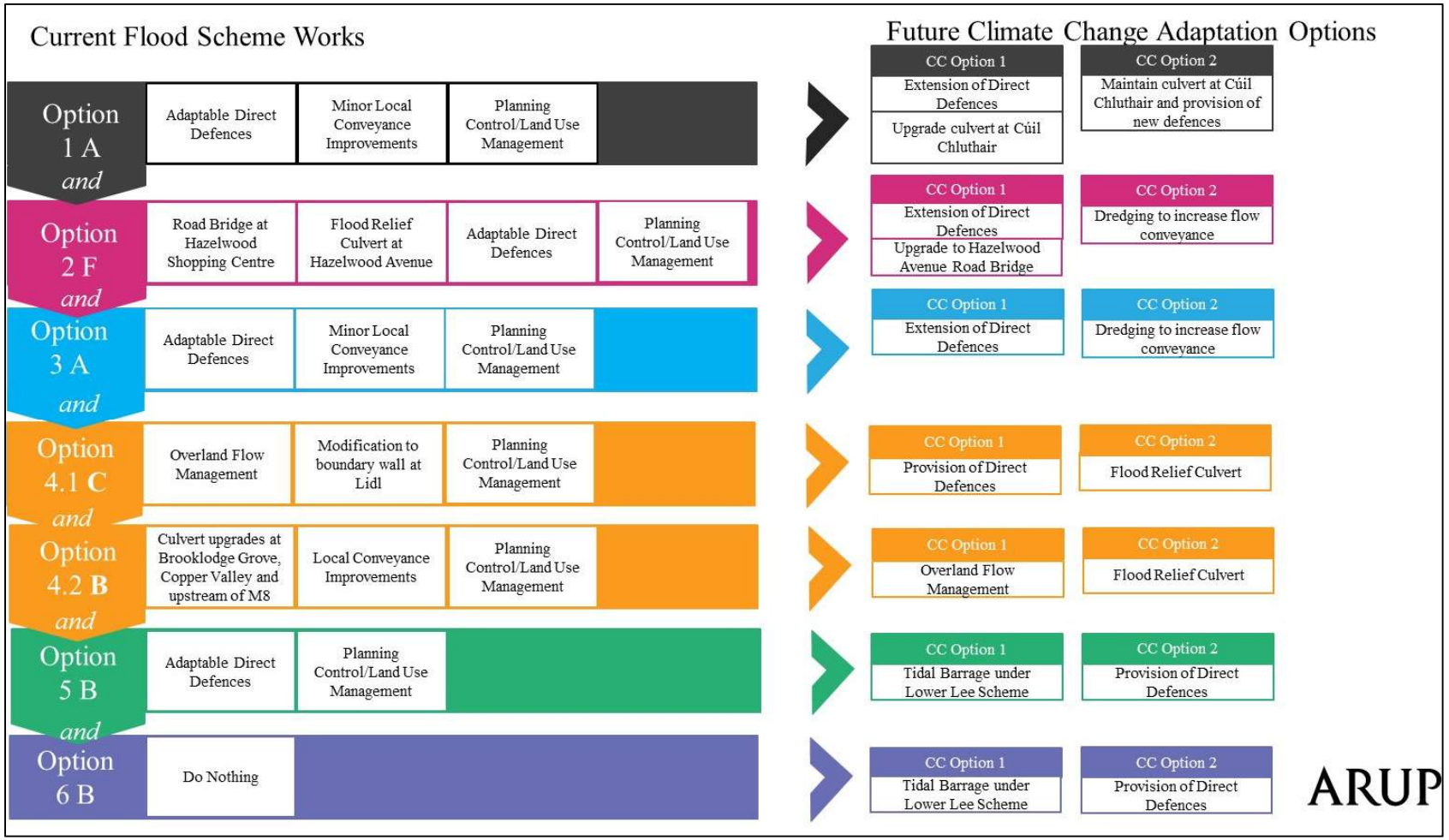
The management of tidal flood risk in the climate change scenario could also be addressed by the construction of a tidal barrage at either side of Great Island

This option is being considered as part of the climate change adaptation strategy for the Lower Lee Flood Relief Scheme and this would benefit Area 5 and Area 6, which are located in the tidal reach of the Glashaboy River.

7.5 Climate Change Adaptation Strategy

The climate change adaptation strategy options are summarised in Figure 29 below.

Figure 29: Climate Change Adaptation Strategy Options



7.6 Preferred Option

Based on the above assessment, the recommended preferred option is as follows:

Table 28: Summary of Preferred Option – Areas at Risk

Area No	Location	Description of Preferred Option
1	Sallybrook Industrial Estate	1A – Direct Defences Culvert upgrade at Bleach Hill Stream
2	Hazelwood Shopping Centre	2F – Flood Relief Culvert at Hazelwood Avenue, and Raised Road Bridge to replace existing Shopping Centre Bridge Culvert Upgrades at Springmount and Cois Na Gleann
3	Meadowbrook Housing Estate	3A – Direct Defences
4	Butlerstown	4.1 C –Overland Flow Management
	Glenmore	4.2 B – Culvert Upgrades at Brooklodge Bridge , Copper Valley Vue and upstream of the M8 motorway
5	Glanmire Bridge to O'Callaghan Park	5B –Direct Defences at The Grove
6	Downstream of Glanmire Bridge	6B – Do Nothing

7.7 Economic Assessment of Preferred Option

The cost benefit analysis has been prepared only for the preferred option. The reason for this is because of the nature of the scheme, which does not contain one overall measure. Also, Area 1 and Area 3 consist of a single solution only.

7.7.1 Overview

The benefit to be derived from the flood protection works is the reduction in risk of flooding to land and property. This risk is quantified as the expected damage to property that would occur over the lifetime of the scheme.

The adopted approach assesses the damages for the Glashaboy study area as a whole. It is recognised that individual properties and areas may have a positive or negative impact on the overall scheme based on their individual valuation of benefit and the cost. These differences are spread across the scheme to give a comprehensive assessment.

The damages assessment has not made allowance for the additional depths of flooding caused by climate change, whilst climate change provision has been included in the scheme where feasible. This introduces an element of conservatism into the cost benefit analysis.

7.7.2 Guidance

The analysis has been carried out in accordance with the OPW guidance document "Lower Lee, Douglas and Glashaboy Flood Relief Schemes: Economic Damage Assessment and Cost Benefit Analysis (Rev B)". This guidance document sets out a common approach to the calculation of monetised economic flood damages and the economic benefits of flood risk management options, and for undertaking a cost-benefit analysis.

Flood damage data has been assessed from the "The Benefits of Flood and Coastal Risk Management: A Manual of Assessment Techniques (2014)" published by the Flood Hazards Research Centre at Middlesex University. This document is often referred to as the "Multicoloured Manual" (MCM).

The calculation of flood damage for both residential and commercial properties can be classified into two broad categories, namely tangible damages and intangible damages, both of which are described in the following sub-sections.

7.7.3 Tangible Damages

These can be quantified in monetary terms, such as the reduction in flood damage costs from improvements in the standards of flood protection. Tangible damages are divided into the direct and indirect.

Direct tangible damages result from the physical contact of flood water with property. The damage magnitude may be taken as the cost of the property restoration to its condition prior the flood event, or its loss in market value if restoration is not worthwhile. Direct damages are a function of many variables including the physical make-up of the property and the characteristics of the flood event, including the depth and duration of flooding.

The unit damages for non-residential properties has used the MCM "initial appraisal" approach. This is because the MCM 2014 "full-scale appraisal" only includes damages broken down by social class. As per OPW guidance, social class is to be excluded from damages assessment for this project.

Fluvial and tidal damages have been added together to give the total damage for the properties. It is assumed that the tidal damages are only relevant downstream of Glanmire bridge.

Indirect tangible damages are losses caused by disruption of physical and economic linkages to the local/national economy. Examples include the costs of emergency services of a flood event, and the interruption of traffic flows.

MCM 2014 estimates the cost of emergency services as between 5.6% and 10.7% of the direct tangible damages (direct tangible damages are referred to as the "Principal Direct Damages" (PDD) in the OPW guidance note). OPW guidance directs that an allowance of 8.1% of the PDD be included in the damages assessment to account for emergency services. OPW guidance states that this allowance is deemed to include evacuation costs.

An allowance of 20% of the PDD has been included to account for damage to infrastructural utility assets.

The cost of interruption of traffic flows is more difficult to determine, therefore as a conservative assumption, this element of the indirect tangible damages has been ignored.

As per OPW guidance, loss of business costs for commercial properties, damage to roads, damage to parked cars, environmental damage, personal evacuation costs, temporary accommodation and extra heating costs have also been ignored.

The damage costs associated with risk to life have also been excluded as per OPW guidance. This has been excluded, as loss of life due to flood events is very rare in Ireland.

7.7.4 Intangible Damages

These are difficult to quantify in monetary terms as they include human stress and anxiety, inconvenience and ill health associated with frequent, repeat flooding.

In accordance with typical OPW practice, the flood damage assessment undertaken for the scheme has used the PDD as a guide to estimating the Intangible Damages. The guidance distinguishes between residential and non-residential properties;

- For residential properties, the intangible flood damages are set equal to the total direct property damage;
- For commercial properties, it is assumed that the intangible flood damages are set equal to the total direct property damage. This assumption is valid as it is noted that the majority of commercial properties in Glanmire are categorised as small family-owned.

7.7.5 Thresholds of Flooding

The threshold of flooding is that level at which flooding will start to occur.

For this scheme, the threshold of flooding for each property is determined based on the 2D hydraulic model results, and the assumed / surveyed floor level for each property. Note that where no threshold survey information was available, it was assumed that the ground floor level of each property is 150mm above the Lidar ground level.

7.7.6 Damages Assessment GIS Tool

Arup have developed an in-house GIS tool which was used to support the calculation of flood damages for the study area. The tool creates a single dataset of all residential and commercial properties in the study area and estimates the flood depths for the various return periods at each property using the 2D hydraulic model results. The tool then assigns flood damages to each property using the flood damage data in the MCM.

The datasets used by the tool are:

Geodirectory dataset – for determining the building type and use. In Geodirectory, the economic activity associated with each property is held as a NACE code (Nomenclature of Economic Activities). NACE is the European statistical classification of economic activities. Where discrepancies were found, the properties were inspected on site or through use of "street view" imagery freely available online;

OSi NTF dataset – for calculating the area of the commercial properties;

2D hydraulic modelling results – water levels to OD Malin for eight separate return period events are used by the tool to determine the extent and level of flooding in Glanmire. Subtraction of the property threshold level from the water level yields the depth of flooding at each property for all the return period events;

Lidar data – for estimating the ground level of all the properties in Glanmire. It has been assumed that the threshold level of all the properties is 150mm above the Lidar ground level.

It was noted that some discrepancies exist between the Geodirectory and NTF datasets.

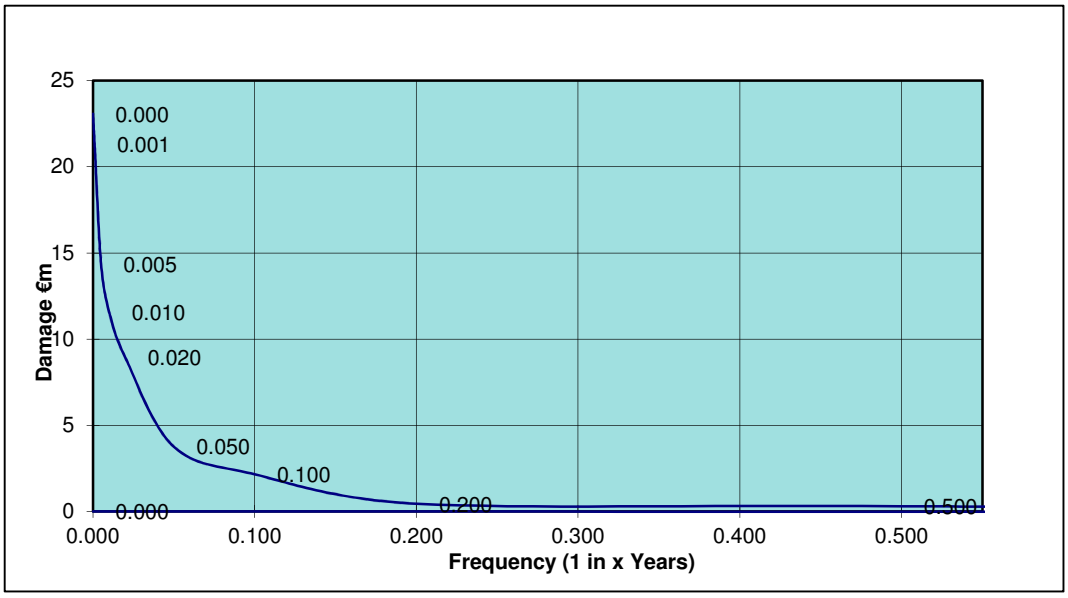
The FHRC damage figures have been converted from UK Sterling to Euro by means of Purchasing Power Parity (PPP) as per OPW guidance. As the damages data in the MCM is dated 2014, it was deemed to be unnecessary to adjust for inflation.

Capping values for both residential and commercial properties were determined using the residential property price register and commercial leases register. Following OPW guidance the commercial capping values were calculated as ten times the current rateable value of the property.

7.7.7 Damage Analysis Results

A graph of damage against frequency is prepared for each return period with increasing numbers of properties affected and properties affected to a greater extent. Figure 30 shows the damage-frequency graph for Glashaboy. The Present Value Damage is equal to the area beneath the curve.

Figure 30: Damage-Frequency Graph for Glashaboy



The various elements of the flood damages are shown in Table 29 below.

Table 29: Summary of Flood Damages

Category	Damage for 1%AEP Event (€m)	Annual Average Damage (€m)	Uncapped Present Value Damage (50 year time horizon) (€m)	Capped Present Value Damage (50 year time horizon) (€m)
Direct Residential	2.311	0.124	2.754	2.754
Direct Non-Residential	2.767	0.279	6.193	4.877
Principal Direct Damages	5.078	0.403	8.947	7.631
Intangible	5.078	0.403	8.947	7.631
Emergency Services	0.411	0.033	0.725	0.725
Utilities	1.016	0.081	1.789	1.789
Total	11.582	1.323	2.754	2.754

7.8 Cost Benefit Analysis

7.8.1 Present Value Costs

The present value costs provide an indication of the cost today of the works over their lifetime.

7.8.2 Capital Works Costs

The present value of costs is based on a 50-year design life that is capable of protecting against a 1 in 100 year flood event. The capital works costs are calculated as described in Section 5.1.

Capital costs taken from above are added into the cost benefit analysis (CBA) on the basis that 15% will be expended in 2017 (Year 0), 70% in 2018 (Year 1) and 15% in 2019 (Year 2).

7.8.3 Maintenance Costs

The maintenance cost has been spread over the 50 year life span of the scheme, starting in Year 2 (2019), coinciding with the completion of the scheme.

7.8.4 Economic Comparison

OPW advised that the appropriate discount rate to be applied should be 4%.

7.9 Cost Benefit Analysis Summary

The option presented at the second public information day (PID2) contained a footbridge in this location. Feedback from local stakeholders however, suggested that this solution would not be acceptable due to access and egress limitations. As a result a road bridge is now being proposed at this location, which would provide a more acceptable solution to local stakeholders.

Detailed cost-benefit calculations are contained in Appendix A and Table 30 represents the CBA based on a discount rate of 4% showing a BCR of 1.317 for the preferred option (Section 7.6).

Table 30: Cost Benefit Analysis Summary

	Do Nothing	**Preferred Option**
Present Value Costs	-	11.314
Present Value Damage	17.776	2.876
Present Value Benefit	-	14.899
Net Present Value	-	3.585
Benefit Cost Ratio	-	1.317

7.10 Sensitivity Analysis

The control of all risks is impossible and therefore the economic robustness of the scheme has been investigated using sensitivity analysis. In order to investigate the least credible level of benefits the following assumption has been made:-

5% reduction in flood damage benefits;

3% discount rate;

5% discount rate.

Table 31: Sensitivity Analysis for 5% Reduction in Benefit

	Preferred Option
Present Value Costs	11.314
Present Value Benefit	2.876
Net Present Value	14.154
Benefit Cost Ratio	1.251

Table 32: Sensitivity Analysis for 3% Discount Rate

	Preferred Option
Present Value Costs	11.407
Present Value Benefit	18.115
Net Present Value	6.708
Benefit Cost Ratio	1.588

Table 33: Sensitivity Analysis for 5% Discount Rate

	Preferred Option
Present Value Costs	11.224
Present Value Benefit	12.436
Net Present Value	1.212
Benefit Cost Ratio	1.108

7.11 Conclusion of Economic Assessment

Benefits and costs for the preferred option were compared with those of the "Do Minimum" case to determine the Benefit Cost Ratio for the proposed scheme. The baseline BCR is 1.32.

A number of sensitivity tests were undertaken to confirm the robustness of the assessment. The most onerous sensitivity test was that of adopting a 5% discount rate.

This analysis confirms that the scheme is cost beneficial under all scenarios tested.

8 Further Development of Preferred Option

8.1 Detailed Freeboard Analysis

Once the preferred option was chosen, a detailed freeboard analysis was undertaken of the preferred option to establish the sensitivity of the proposed solution to uncertainty in hydrological estimation, hydraulic modelling etc. and to incorporate an appropriate freeboard to ensure that the proposed solution is suitably resilient.

This process is outlined below.

8.2 CFRAM Guidance Note 22

CFRAM Guidance Note 22 was developed under the Western CFRAM Contract for the Office of Public Works (2014), adopts a sensitivity analysis to determine the amount of uncertainty in the model results and provide an estimate of freeboard.

The key steps are as follows:

1. Prepare screening assessment from knowledge of model build and its calibration.
2. Undertake sensitivity tests on hydrological parameters.
3. Undertake sensitivity tests on core hydraulic parameters.
4. Undertake additional hydraulic testing where necessary.
5. Assess which test or combination is to be used in the estimation of freeboard allowances.

Knowledge of the model build and calibration suggested that the primary risk area would be in the area of Meadowbrook and Hazelwood. As a consequence increasing the tidal boundary to the MRFS would be negligible and has not been undertaken as part of the analysis.

The screening assessment suggests that the design water levels are sensitive to the hydrological boundaries and core hydraulic parameters. They are therefore assessed for sensitivity testing.

8.2.1 Hydrological Uncertainty

As flow is typically the most critical of all the sensitivity tests it is important to consider the quality of data available and also to recognise the level of uncertainty inherent in the selected design flows. The overall adjustment factor is based on a combination of uncertainty in the index flood and growth curve.

Considering the design flow estimation in detail, it was felt that an overall adjustment factor of 23.5% would be appropriate. For further details, please refer to the Hydrology Report and Addendum.

8.2.2 Findings of Hydraulic Modelling of Increased Flows From Sensitivity Test

Flow is the dominant uncertainty but is the least easily defined, and is a key driver in design of the scheme. Findings of the hydraulic analysis showed that the hydraulic pinch points are at

- Culvert under Brooklodge Grove at entrance to Copper Valley Vue
- Hazelwood Avenue Bridge
- Hazelwood Shopping Centre Bridge, which is being replaced
- Riverstown Bridge

8.2.3 Structure Coefficient Sensitivity

The CFRAM guidance recommends the assessment of afflux at critical structures which are likely to be sensitive to changes in model coefficients. To account for the sensitivity of afflux at bridges the Cv values were reduced from 1.0 to 0.7 to test reduction in velocity at its effect on water levels.

8.3 Results of Detailed Freeboard Analysis

Following detailed hydraulic modelling, the initial allowance of 500mm freeboard is being revised to take account of uncertainties in hydrology, roughness, bridge afflux, super-elevation, tidal uncertainty and also allowance for uncertainty in construction.

Six different areas are being assessed, which correlate to the areas of works and findings show a total freeboard ranging from 0.36m at Sallybrook and Butlerstown to 0.86m at Hazelwood.

There are also two short sections located on one bank of the river which are subject to super-elevation, estimated at around 0.3m. One of these sections with a length of 67m is located at Meadowbrook, with the other at Sallybrook having a length of 98m.

For the majority of sections the initially adopted allowance of 500mm freeboard is sufficient to cover the uncertainty in the assessment.

More detail on the freeboard analysis can be found in the Final Hydraulics Report. (JBA, November 2016).The preferred option has been updated to take account of the detailed freeboard analysis.

8.4 Flooding during December 2015

December 2015 was the wettest month on records in many areas of Ireland, particularly in the Southwest where rainfall amounts were approximately three times the monthly average.

Significant flooding resulted across much of the country. County Cork was badly affected with major flood events on many rivers such as the Blackwater, Bandon, Glashaboy, Owenacurra and many others.

Please refer to the Arup Report 'Glanmire December 2015 Flood Report' (March 2016) for more detailed information.

8.4.1 Data Gathering

During the event, a staff member from the locality observed the event taking photographs and providing useful observations. Arup subsequently visited the affected areas of Glashaboy catchment on 14 January 2016 to meet with residents and examine areas which had been affected by flooding in the recent event. Subsequently, a wrack mark survey was carried out which further aided in the assessment of the flood mechanisms and estimation of the approximate return period of the event.

8.4.2 Return Period Estimation

An analysis was completed of the possible return periods for the river flow at various flooded locations by comparison of the actual flood levels and extents with the output of the Glashaboy FRS hydraulic modelling. This analysis was somewhat limited by the level of accuracy in estimating flood levels during the event and also by the limitations of the modelling undertaken to replicate the antecedent catchment conditions for this particular event. It can therefore only be used as an approximation.

The analysis suggests that the return period for river flows in the Glashaboy Rivers was likely to be between a 1 in 2 year and 1 in 5 year event.

It should be noted that there is evidence of higher levels (than estimated for the above return periods) in some areas however local affects are considered to be the major factor at these locations.

8.4.3 Flood Mechanisms at Glanmire

The primary cause of flooding at the Groves was fluvial flooding from the Glashaboy, exacerbated by a partial blockage at Glanmire Bridge. The high water level upstream of Glanmire Bridge resulted in flooding along the road and into the properties at the Grove via the local foul drainage network.

Flooding at Meadowbrook was primarily caused by inundation of the drainage system, which was caused by high water levels in the Glashaboy River and preventing discharge of the storm water.

Flooding at Copper Valley Vue was likely caused by restricted conveyance capacity due to partial blockage of the Brooklodge Grove Road culvert. Water levels built-up upstream of the culvert and overtopped onto Brooklodge Grove Road, from where water ran to the low point, flooding a number of properties at Copper Valley Vue. Anecdotal evidence also suggests that flood waters overtopped the Glenmore Stream upstream of the M8 motorway crossing, flowing down Brooklodge Grove Road and posing additional flood risk to properties located along the road and also to properties at Copper Valley Vue.

The pumping undertaken by CCC had a beneficial effect in Meadowbrook Estate and resulted in prevention of properties being flooded. The measures taken by local residents at Copper Valley Vue, knocking the downstream the bridge parapet of the entrance bridge to allow diverted fluvial water re-entre the Glenmore Stream was also beneficial in reducing the number of properties flooded and the depth to which they were flooded at Copper Valley Vue.

8.5 Review of Preferred Option

The December 2015 flood event caused flooding in a number of areas at Glanmire. The preferred option in each of these areas was further reviewed in light of 2015 event and the following sub-sections provide findings. Further information on the December 2015 event is presented in the Glanmire December 2015 Flood Report.

8.5.1 Area 2 - Hazelwood

Anecdotal evidence suggests that the main road between Riverstown and Glanmire junction was flooded and impassable during this event. Flood water was also reported to have inundated some of the businesses in the Hazelwood centre to a depth of approximately 25mm, including Café Beva.

Both the flood water on the R639 and the reported flooding in the Hazelwood Centre was likely due to a combination of pluvial and fluvial flooding. Fluvial flooding was suggested to have originated from the Springmount stream at its crossing point with the R639. The preferred option (Option 2F) contains a culvert upgrade at this location, which addresses the fluvial flood risk experienced. It also contains a culvert upgrade at the Cois Na Gleann Stream.

8.5.2 Area 3 - Meadowbrook

The preferred option for Meadowbrook Estate comprises a new flood defence wall on the right bank and a new surface water collector drain and two pump systems, one to address pluvial flooding and the other to address foul water flooding.

Works to direct surface runoff from the Old Youghal Road away from Meadowbrook and into O'Callaghan Park are also proposed and this addresses the pluvial flood risk.

As part of the preferred option ineffective drainage lines will be removed and replaced where necessary, and non-return flap valves placed on all drainage outfalls.

It is concluded that the mechanisms that occurred in December 2015 were of the type anticipated and would be catered for by the proposed scheme.

8.5.3 Area 4.2 - Brooklodge Grove/Copper Valley Vue

The emerging preferred option previously exhibited for Copper Valley Vue, (prior to the December 2015 flood event), consisted of overland flow management in combination with providing a flood relief culvert and minor defences and road ramps. This option was reviewed in light of the 2015 flood event, which was exacerbated due to partial blockage of the Brooklodge Grove Culvert and flood waters overtopping on Brooklodge Road upstream of the M8 motorway crossing.

This review concluded that while the option of overland flow management would still be viable, it could not cater for the significant risk of blockage in this area. Another significant drawback of this option is that it would not alleviate the relatively frequent road flooding at Brooklodge Grove, which is estimated to occur during the 1 in 5 year event.

In discussion with the Steering Group, it was decided that the alternative of maintaining flood water in bank should be explored further and that the proposed option should cater for the significant risk of culvert blockage in this area.

Further hydraulic analysis was carried out at Copper Valley, Brooklodge Grove and upstream of the M8 motorway and modelling results show that the existing culverts would need to be replaced, as presented in Section 4.6.2. This option would also significantly reduce the risk of blockage in this area and thereby significantly reduce the residual risk.

8.5.4 Area 5 - The Grove, Glanmire

The scheme as presented at the Public Information Day did not include measures to protect properties at the Grove, as they were not within the 1 in 100 year flood extent. However, the fact that these properties flooded in the 2012 event and again during the December 2015 event, resulted in further analysis to quantify the flood risk and mechanisms in this area. Anecdotal information from the December 2015 event allowed for better model calibration in this area. Please refer to the Hydraulics Report and Glanmire December 2015 Flood Report for further detail on the flood characteristics in this area.

As a result of the revised modelling, the area of the Grove has now been included in the Glanmire FRS and measures consist of providing direct defences along the Glashaboy River in combination with local drainage and stormwater pumping to alleviate pluvial flood risk.

9 Conclusions and Recommendations

As set out above, the scheme has evolved and changed throughout the initial stages of the scheme as a result of stakeholder feedback and following review of anecdotal information from the Dec 2015 flood event which occurred during the scheme design development.

Extensive consultation has been carried out in parallel with the development of the preferred options with all of the identified stakeholder.

The sensitivity/ freeboard analysis undertaken identified that the Glashaboy system is particularly sensitive to increases in flow at particular pinch points in the system, namely at Riverstown Bridge and along Hazelwood Shopping Centre.

This meant that additional conveyance improvements and defence heights greater than the general scheme freeboard were required to ensure the resilience of the preferred option.

These additional measures involved refinement of the preferred option considered at Options Assessment stage and result in increased costs and a reduction in the Benefit Cost Ratio.

Notwithstanding the above, the basis for selection of the preferred option remains valid and the proposed scheme remains cost beneficial in all analysis, including the various sensitivity analysis.

Appendix A

Economic Assessment of Options

A1 Cost Estimates

Order of Magnitude of Costs

Job No: 234334-00
Made By: DS
Date: 17 November 2016

Item	Description	Measured Items	15% Prelims 15%	20% Unmeasured Items 20%	Subtotal €	10% Archaeology & Environmental	Baseline Construction Cost Total €	20% Contingency/ Optimism Bias	Construction Cost Subtotal	13% Fees and Supervision	Construction + Fees Subtotal	15% Land Acquisition	1% or Cap at €51,000 Art	200,000 Site Investigation & Surveys	Totals €	NPV Maintenance	Project Cost Total
	Glashaboy Flood Relief Option																
	Construction Costs																
1	**Area 1: Sallybrook Ind Estate**																
	Option 1A	1,022,377	153,357	204,475	1,380,209	138,021	**1,518,230**	**303,646**	**1,821,876**	197,370	2,019,246	273,281	10,200	40,000	**2,342,728**	**€391,339**	2,734,067
2	**Area 2: Hazelwood Shopping Centre**																
	Option 2A	1,380,268	207,040	276,054	1,863,362	186,336	2,049,699	409,940	2,459,638	266,461	2,726,099	368,946	10,200	40,000	3,145,245		
	Option 2B	1,189,113	178,367	237,823	1,605,302	160,530	1,765,832	353,166	2,118,999	229,558	2,348,557	317,850	10,200	40,000	2,716,607		
	Option 2C	1,405,649	210,847	281,130	1,897,626	189,763	2,087,388	417,478	2,504,866	271,360	2,776,226	375,730	10,200	40,000	3,202,156		
	Option 2D	1,238,162	185,724	247,632	1,671,519	167,152	1,838,671	367,734	2,206,405	239,027	2,445,432	330,961	10,200	40,000	2,826,593		
	Option 2E	1,156,202	173,430	231,240	1,560,872	156,087	1,716,960	343,392	2,060,351	223,205	2,283,556	309,053	10,200	40,000	2,642,809		
	Option 2F	1,315,027	197,254	263,005	1,775,287	177,529	**1,952,816**	**390,563**	**2,343,379**	253,866	2,597,245	351,507	10,200	40,000	**2,998,952**	**€503,358**	3,502,309
3	**Area 3: Meadowbrook Housing Estate**																
	Option 3A	893,501	134,025	178,700	1,206,227	120,623	**1,326,850**	**265,370**	**1,592,220**	172,490	1,764,710	238,833	10,200	40,000	**2,053,743**	**€342,009**	2,395,752
4	**Area: 4 Butlerstown/Glenmore**																
	Option 4.1A	123,032	18,455	24,606	166,093	16,609	182,702	36,540	219,243	23,751	242,994	32,886	10,200	40,000	326,080		
	Option 4.1B	102,373	15,356	20,475	138,203	13,820	152,023	30,405	182,428	19,763	202,191	27,364	10,200	40,000	279,755		
	Option 4.1C	8,000	1,200	1,600	10,800	1,080	**11,880**	**2,376**	**14,256**	1,544	15,800	2,138	included in Option 4.2B		**17,939**	**€3,062**	21,001
	Option 4.2A	98,503	14,775	19,701	132,979	13,298	146,277	29,255	175,532	19,016	194,548	26,330	10,200	40,000	271,078		
	Option 4.2B	947,377	142,107	189,475	1,278,959	127,896	**1,406,855**	**281,371**	**1,688,226**	182,891	1,871,117	253,234	10,200	40,000	**2,174,551**	**€362,631**	2,537,181
5	**Area 5: O'Callaghan Park to Glanmire Bridge**																
	Option 5A	189,374	28,406	37,875	255,655	25,566	281,221	56,244	337,465	36,559	374,024	50,620	10,200	40,000	474,843		
	Option 5B	173,374	26,006	34,675	234,055	23,406	**257,461**	**51,492**	**308,953**	33,470	342,423	46,343	10,200	40,000	**438,966**	**€66,363**	505,329
6	**Area 6: Downstream of Glanmire Bridge**																
	Option 6A	32,000	4,800	6,400	43,200	4,320	47,520	9,504	57,024	6,178	63,202	8,554	10,200	40,000	121,955		
	Option 6B	0	0	0	0	0	**0**	**0**	**0**	0	0	0	0	0	**0**	**€0**	0
Sum of preferred Option		**4,359,657**	**653,949**	**871,931**	**5,885,537**	**588,554**	**6,474,091**	**1,294,818**	**7,768,909**	**841,632**	**8,610,541**	**1,165,336**	**51,000**	**200,000**	**10,026,877**	**€1,668,762**	**€11,695,639**

Order of Magnitude of Costs			Job No:		234334-00
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Project Title	**Glashaboy Flood Relief**		Date:		**10 November 2016**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Area 1: Option 1A				
C10_C04 & C02	Divert existing channel, extinguish existing culvert	Item	1	1,000.00	1,000.00
C10_C03 & C01	Backfill open sections of culvert	m	65	175.00	11,375.00
C10.1_B01	Existing Channel to be realigned and culverted (900mm dia.)	m	158	450.00	71,100.00
C01_L01	Flood defence wall (0.6m high)	m	54	690.54	37,289.03
C01_L01	Flood defence wall (0.8m high)	m	159	745.84	118,588.16
C01_L01	Flood defence wall (0.9m high)	m	82	827.90	67,887.80
C01_L01	Flood defence wall (1m high)	m	56	845.05	47,322.80
C01_L01	Flood defence wall (1.3m high)	m	64	1,188.64	76,073.12
C01_L01	Flood defence wall (1.7m high)	m	137	1,560.86	213,838.16
C10	Add road/yard reinstatement for wall length	m	552	250.00	138,000.00
C01_E01	Flood defence embankment 1m high	m	168	458.37	77,006.16
C01_E01	Flood defence embankment 1.6m high	m	102	694.50	70,839.00
C01_L02	Drainage connections (non return valves)	No.	5	1,500.00	7,500.00
C09_B01	Culvert upgrade (1.6m x 1.2m)	m	9	2,684.22	24,157.99
C01_P01	Pumping Station and Local Drainage	Item	1	40,000.00	40,000.00
C01_F01	Boundary fence around sallybrook house	m	130	80.00	10,400.00
C08_S01	Flow control structure to restrict flows in the Mill Race (including penstock)	Item	1	10,000.00	10,000.00
	Total				
	Total				**1,022,377.22**

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Project Title	**Glashaboy Flood Relief**		Date:		**10 November 2016**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Area 2: Option 2A				
	Flood defence wall (.6m high)	m	80	690.54	55,243.00
	Flood defence wall (1.1m high)	m	80	928.21	74,257.00
	Flood defence wall (1.5m high)	m	300	1,269.59	380,876.25
	Drainage connections (non return valves)	No.	7	1,500.00	10,500.00
	Flood defence wall (1.5m high)	m	110	1,269.59	139,654.63
	Culvert upgrade (1.75m x .9m)	m	35	1,918.67	67,153.39
	Removal of in-channel flow obstruction and level channel bed	m	26	300.00	7,800.00
	Raise level of existing roads	m2	1,512	120.00	181,440.00
	Modification to boundary wall and gate due to road regrading	Item	1	5,000.00	5,000.00
	Culvert upgrade (2.75m x .9m)	m	26	2,982.47	77,544.18
	Removal of existing pipes (1.2m x .7m)	m	22	400.00	8,800.00
	Remove existing well housing structure	No.	1	2,000.00	2,000.00
	Stengthen existing bridge	No.	2	150,000.00	300,000.00
	Pumping Station and Local Drainage	Item			40,000.00
	Alterations to carpark (wearing course, linemarking and drainage	Item			30,000.00
	Total				**1,380,268.44**
	Area 2: Option 2B				
	Dredge river (8.5m wide x 1m depth)	m3	5,610	65.00	364,650.00
	Culvert upgrade (1.75m x .9m)	m	35	1,918.67	67,153.39
	Removal of in-channel flow obstruction and level channel bed	m	26	300.00	7,800.00
	Raise level of existing roads	m2	1,512	120.00	181,440.00
	Modification to boundary wall and gate due to road regrading	Item	1	5,000.00	5,000.00
	Culvert upgrade (2.75m x .9m)	m	26	2,982.47	77,544.18
	Removal of existing pipes (1.2m x .7m)	m	22	400.00	8,800.00

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Project Title	**Glashaboy Flood Relief**		Date:		**10 November 2016**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Contd.				
	Remove existing well housing structure	No.	1	2,000.00	2,000.00
	Drainage connections (non return valves)	No.	7	1,500.00	10,500.00
	Stengthen and underpin existing bridges	No.	2	150,000.00	300,000.00
	Stengthen existing river banks (sheet piling)	m2	680	170.00	115,600.00
	Concrete stitch	m3	43	110.00	4,675.00
	Stengthen existing river banks - reslope	m	930	15.00	13,950.00
	Alterations to carpark (wearing course, linemarking and drainage	Item			30,000.00
	Total				**1,189,112.57**
	Area 2: Option 2C				
	Flood defence wall (.6m high)	m	80	690.54	55,243.00
	Flood defence wall (1m high)	m	130	845.05	109,856.50
	Flood defence wall (1.1m high)	m	80	928.21	74,257.00
	Flood defence wall (1.5m high)	m	110	1,269.59	139,654.63
	Drainage connections (non return valves)	No.	7	1,500.00	10,500.00
	Culvert upgrade (1.75m x .9m)	m	35	1,918.67	67,153.39
	Culvert upgrade (2.75m x .9m)	m	26	2,982.47	77,544.18
	Removal of in-channel flow obstruction and level channel bed	m	26	300.00	7,800.00
	Raise level of existing roads	m2	1,512	120.00	181,440.00
	Modification to boundary wall and gate due to road regrading	Item	1	5,000.00	5,000.00
	Removal of existing pipes (1.2m x .7m)	m	22	400.00	8,800.00
	Remove existing well housing structure	No.	1	2,000.00	2,000.00
	Remove existing Hazlewood bridge	Item	1	25,000.00	25,000.00
	Replace existing Hazlewood bridge	m2	225	1,800.00	405,000.00
	Raise level of existing roads	m2	1,280	130.00	166,400.00
	Pumping Station and Local Drainage	Item			40,000.00

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Project Title	**Glashaboy Flood Relief**		Date:		**10 November 2016**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Contd.				
	Alterations to carpark (wearing course, linemarking and drainage				30,000.00
	Total				**1,405,648.69**
	Area 2: Option 2D				
	Flood defence wall (.6m high)	m	80	690.54	55,243.00
	Flood defence wall (1.1m high)	m	80	928.21	74,257.00
	Flood defence wall (1.4m high)	m	210	1,269.59	266,613.38
	Flood defence wall (1.5m high)	m	110	1,269.59	139,654.63
	Drainage connections (non return valves)	No.	7	1,500.00	10,500.00
	Culvert upgrade (1.75m x .9m)	m	35	1,918.67	67,153.39
	Removal of in-channel flow obstruction and level channel bed	m	26	300.00	7,800.00
	Raise level of existing roads	m2	1,512	120.00	181,440.00
	Modification to boundary wall and gate due to road regrading	Item	1	5,000.00	5,000.00
	Culvert upgrade (2.75m x .9m)	m	26	2,982.47	77,544.18
	Removal of existing pipes (1.2m x .7m)	m	22	400.00	8,800.00
	Remove existing well housing structure	No.	1	2,000.00	2,000.00
	New culvert (5.5m x 1.75m)	m	18	6,671.07	120,079.23
	New Channel	m	47	682.50	32,077.50
	Stengthen existing bridge	No.	1	150,000.00	150,000.00
	Pumping Station and Local Drainage	Item			40,000.00
	Total				**1,238,162.30**
	Area 2: Option 2E				
	Flood defence wall (.7m high)	m	233	723.44	168,560.94
	Flood defence wall (1.2m high)	m	150	950.61	142,591.88
	Flood defence wall (1.5m high)	m	110	1,269.59	139,654.63
	Drainage connections (non return valves)	No.	7	1,500.00	10,500.00

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Project Title	**Glashaboy Flood Relief**		Date:		**10 November 2016**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Contd.				
	Culvert upgrade (1.75m x .9m)	m	35	1,918.67	67,153.39
	Removal of in-channel flow obstruction and level channel bed	m	26	300.00	7,800.00
	Raise level of existing roads	m2	1,512	120.00	181,440.00
	Modification to boundary wall and gate due to road regrading	Item	1	5,000.00	5,000.00
	Culvert upgrade (2.75m x .9m)	m	26	2,982.47	77,544.18
	Removal of existing pipes (1.2m x .7m)	m	22	400.00	8,800.00
	Remove existing well housing structure	No.	1	2,000.00	2,000.00
	New culvert (5.5m x 1.75m)	m	18	6,671.07	120,079.23
	New Channel	m	47	682.50	32,077.50
	Remove existing bridge	m2	150	100.00	15,000.00
	New foot bridge	m2	60	1,800.00	108,000.00
	Pumping Station and Local Drainage	Item			40,000.00
	Alterations to carpark (wearing course, linemarking and drainage				30,000.00
	Total				**1,156,201.73**
	Area 2: Option 2F				
C06_L03	Flood defence wall (.6m high)	m	18	690.54	12,429.68
C07_L01	Flood defence wall (.8m high)	m	49	745.84	36,546.04
C01_L03, C01_L04 & C06_L02	Flood defence wall (.9m high)	m	139	827.90	115,078.10
C01_L03	Flood defence wall (.9m high) incl. sandstone finish	m	24	917.90	22,029.60
C01_L02	Flood defence wall (1.8m high) (incl sandstone both sides)	m	159	1,800.86	286,337.14
C06_B01	Culvert upgrade (1.75m x .9m)	m	35	1,918.67	67,153.39
C07_B01	Culvert upgrade (2.75m x .9m)	m	26	2,982.47	77,544.18
C01_B02	New culvert (5.5m x 1.75m)	m	18	6,671.07	120,079.23

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Project Title	**Glashaboy Flood Relief**		Date:		**10 November 2016**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Contd.				
C01_B03	Remove and dispose existing bridge	m2	150	100.00	15,000.00
C07_R01, C01 R03 & C06_R01	Raise level of existing roads	m2	1,512	120.00	181,440.00
C01_B03	Replace existing road bridge	m2	126	1,750.00	220,675.00
C01_F02 & F03	Boundary fence around open channel	m	94	40.00	3,760.00
					0.00
C01_R01 & R02	Flood relief channel 5.5m wide to be constructed with engineered grassed slopes	m	94	682.50	64,155.00
C06_C01	Removal of in-channel flow obstruction and level channel bed	m	26	300.00	7,800.00
C06_F01	Modification to boundary wall and gate due to road regrading	Item	1	5,000.00	5,000.00
C01_P02	Pumping Station and Local Drainage	Item	1	40,000.00	40,000.00
C01_L02	Non return valves	Item			10,000.00
C01_R03	Alterations to carpark (wearing course, linemarking and drainage	Item			30,000.00
	Total				**1,315,027.35**

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Project Title	**Glashaboy Flood Relief**		Date:		**10 November 2016**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Area 3: Option 3A				
C01_L07	Flood defence wall (0.5m high) incl. sandstone	m	11	750.54	8,255.91
C01_L05 & C01_L06	Flood defence wall (1m high)	m	115	845.05	97,180.75
C06_L01	Flood defence wall (1.1m high)	m	81	928.21	75,185.21
C01_L06	Flood defence wall (1.2m high)	m	60	950.61	57,036.75
C01_L05 & C01_L06	Flood defence wall (1.5m high)	m	120	1,269.59	152,350.50
C01_L05	Flood defence wall (2m high)	m	176	1,560.86	274,711.80
C01_P03 & C01_P04	Pumping station - Surface Water and Foul	No.	2	60,000.00	120,000.00
No Tag No.	Carrier drain (225mm)	m	127	120.00	15,240.00
C01_C01 & C01_C02	West Bridge Arch and East Bridge Arch opened by removal of manhole and vegetation	item	1	5,000.00	5,000.00
C01_R04	Regrade foothpath	m2	180	75.00	13,500.00
C01_R04	Meadowbrook Road recambering	m	119	573.45	68,240.55
C01_R04	Riverstown Bridge parapet to be repaired and have handrail added to the top of the parapet	m	34	200.00	6,800.00
	Total				**893,501.48**

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Project Title	**Glashaboy Flood Relief**		Date:		**10 November 2016**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Area 4.1: Option 4A **Buttlerstown**				
	Existing culvert to be cleared of debris	no	2	1,000.00	2,000.00
	New culvert (4.5m x 2.5m)	m	11	4,721.07	51,931.75
	New Channel	m	40	1,727.50	69,100.00
	Total				123,031.75
	Area 4.1: Option 4B **Butlerstown**				
	Existing culvert to be cleared of debris	no	2	1,000.00	2,000.00
	New flood defence embankment	m	150	253.15	37,972.50
	Reinstatement of road	m2	480	130.00	62,400.00
	Total				102,372.50
	Area 4.1: Option 4C **Butlerstown**				
C04_F01	Modification of existing bounday wall to allow overland flow to pass through it	item	1	5,000.00	5,000.00
C05_R04	Landscaping and regrading of groundworks to facilitate overland flow on Brooklodge Grove	item	1	3,000.00	3,000.00
	Total				8,000.00

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Project Title	**Glashaboy Flood Relief**		Date:		**10 November 2016**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Area 4.2: Option 4A **Copper Vally**				
	Remove silt and debris	Item	1	1,000.00	1,000.00
	Table top ramp	m2	145	75.00	10,875.00
	Remove parapet wall	m	55	35.00	1,925.00
	New Crash Barrier	m	40	110.00	4,400.00
	New railings	m	15	65.00	975.00
	New embankment (0.5m high)	m	73	150.90	11,015.70
	New culvert (2.8m x 1.6m)	m	13	2,362.47	30,712.09
	New Channel	m	40	940.00	37,600.00
	Total				**98,502.79**
	Area 4.2: Option 4B **Copper Valley**				
C05_B01, C05_B02	New culvert (10m x 1.95m)	m	22	10,334.00	227,348.00
C05_B03	New culvert (8m wide x 2.6m high)	m	27	10,006.60	270,178.27
C05_C01	Channel to be deepened to facilitate insatllation of culvert - incl. in rate for new culvert	m	14		
C05_C03	Channel widening - 3m wide	m	20	321.25	6,425.00
C05_C02 & C05_C04	Channel widening - 5m wide	m	101	477.75	48,252.75
	Bank Regrading - incl in rate for new channel	m2	150		incl
CO5_R01, C05_R02 , C05_R03 & C05_R05	Road regrading	m	330	575.51	189,919.62
CO5_L01 & C05_L02	Repairs to existing wall	m	246	237.60	58,449.60
C05_L03	Flood defence wall (0.5m high) incl. sandstone cladding	m	88	690.54	60,767.30
CO5_L01	Flood defence wall (1.2m high) incl. sandstone cladding	m	43	1,070.61	46,036.34
C05_P01	Pumping station - Surface Water	No.	1	40,000.00	40,000.00
	Total				**947,376.87**

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Project Title	**Glashaboy Flood Relief**		Date:		**10 November 2016**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Area 5: Option 5A **Grove Area**				
	Flood defence wall (1.2m high)	m	101	1,140.74	115,214.24
	Pumping Station and Local Drainage	Item	1	40,000.00	40,000.00
	Right of way - legal fees	Item	1	10,000.00	10,000.00
	Regrade access track	m2	204	40.00	8,160.00
	St Patricks Mill				
	Demountable barriers	No.	3	2,000.00	6,000.00
	Non return valves	m	3	1,500.00	4,500.00
	Seal services	Item	1	5,500.00	5,500.00
	Total				**189,374.24**
	Area 5: Option 5B **Grove Area**				
C01_L08	Flood defence wall (1.2m high)	m	101	1,140.74	115,214.24
C01_P05	Pumping Station and Local Drainage	Item	1	40,000.00	40,000.00
C01_G02	Right of way - legal fees	Item	1	10,000.00	10,000.00
C01_R05	Regrade access track	m2	204	40.00	8,160.00
	St Patricks Mill				
	Do Nothing				-
	Total				**173,374.24**

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Project Title	**Glashaboy Flood Relief**		Date:		**10 November 2016**
Number	Item Description	Unit	Quantity	Rate €	Total €
	Area 6: Option 6A				
	The Foutains				
	Demountable barriers	No.	3	2,000.00	6,000.00
	Non return valves	m	3	1,500.00	4,500.00
	Seal services	Item	1	5,500.00	5,500.00
	Barrv's Terrace				
	Demountable barriers	No.	3	2,000.00	6,000.00
	Non return valves	m	3	1,500.00	4,500.00
	Seal services	Item	1	5,500.00	5,500.00
	Total				32,000.00
	Area 6: Option 6B				
	The Foutains				
	Do Nothing				-
	Barrv's Terrace				
	Do Nothing				-
	Total				**0.00**

A2 Cost Benefit Analysis

Glashaboy CBA
3% Discount Rate

Client/Authority		Prepared (date)	09/11/2016
Cork County Council / Office of Public Works		Printed	
Project name		Prepared by	KB/DS
Glashaboy Flood Relief Scheme		Checked by	WS
Project reference		Checked date	17/11/2016
Base date for estimates (year 0)	Jan-2017		
Scaling factor (e.g. £m, £k, £)	Euro, m	(used for all costs, losses and benefits)	
Discount rate	3.0%		

Costs and benefits of options

	Costs and benefits Euro, m				
	Do Nothing	Preferred Scheme Option			
PV costs PVc	0.000	11.407			
PV damage PVd	21.519	3.404			
PV damage avoided		18.115			
PV assets Pva	-	0.000			
PV asset protection benefits		0.000			
Total PV benefits PVb		18.115			
Net Present Value NPV		6.708			
Average benefit/cost ratio		1.588			

Brief description of options:

Do Nothing	No Maintenance of Defences
Emerging Preferred Option	Standard of Protection 1 in 100 year fluvial / 1 in 200 year tidal

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting

2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
   PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
   PV benefits calculated as PV damage avoided + PV asset protection benefits
3) Incremental benefit/cost ratio is calculated as:
   (PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Glashaboy CBA
4% Discount Rate

Client/Authority		Prepared (date)	09/11/2016
Cork County Council / Office of Public Works		Printed	
Project name		Prepared by	KB/DS
Glashaboy Flood Relief Scheme		Checked by	WS
Project reference		Checked date	17/11/2016
Base date for estimates (year 0)	Jan-2017		
Scaling factor (e.g. £m, £k, £)	Euro, m	(used for all costs, losses and benefits)	
Discount rate	4.0%		

Costs and benefits of options

	Costs and benefits Euro, m				
	Do Nothing	Preferred Scheme Option			
PV costs PVc	0.000	11.314			
PV damage PVd	17.776	2.876			
PV damage avoided		14.899			
PV assets Pva	-	0.000			
PV asset protection benefits		0.000			
Total PV benefits PVb		14.899			
Net Present Value NPV		3.585			
Average benefit/cost ratio		1.317			

Brief description of options:

Do Nothing	No Maintenance of Defences
Emerging Preferred Option	Standard of Protection 1 in 100 year fluvial / 1 in 200 year tidal

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting

2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
PV benefits calculated as PV damage avoided + PV asset protection benefits

3) Incremental benefit/cost ratio is calculated as:
(PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Glashaboy CBA
5% Discount Rate

Client/Authority		Prepared (date)	09/11/2016
Cork County Council / Office of Public Works		Printed	
Project name		Prepared by	KB/DS
Glashaboy Flood Relief Scheme		Checked by	WS
Project reference		Checked date	17/11/2016
Base date for estimates (year 0)	Jan-2017		
Scaling factor (e.g. £m, £k, £)	Euro, m	(used for all costs, losses and benefits)	
Discount rate	5.0%		

Costs and benefits of options

	Costs and benefits Euro, m				
	Do Nothing	Preferred Scheme Option			
PV costs PVc	0.000	11.224			
PV damage PVd	14.909	2.472			
PV damage avoided		12.436			
PV assets Pva	-	0.000			
PV asset protection benefits		0.000			
Total PV benefits PVb		12.436			
Net Present Value NPV		1.212			
Average benefit/cost ratio		1.108			

Brief description of options:

Do Nothing	No Maintenance of Defences
Emerging Preferred Option	Standard of Protection 1 in 100 year fluvial / 1 in 200 year tidal

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting

2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
PV benefits calculated as PV damage avoided + PV asset protection benefits

3) Incremental benefit/cost ratio is calculated as:
(PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Glashaboy CBA

5% Reduction in Benefit

Client/Authority		Prepared (date)	09/11/2016
Cork County Council / Office of Public Works		Printed	
Project name		Prepared by	KB/DS
Glashaboy Flood Relief Scheme		Checked by	WS
Project reference		Checked date	17/11/2016
Base date for estimates (year 0)	Jan-2017		
Scaling factor (e.g. £m, £k, £)	Euro, m	(used for all costs, losses and benefits)	
Discount rate	4.0%		

Costs and benefits of options

	Costs and benefits Euro, m				
	Do Nothing	Preferred Scheme Option			
PV costs PVc	0.000	11.314			
PV damage PVd	17.776	2.876			
PV damage avoided		14.154			
PV assets Pva	-	0.000			
PV asset protection benefits		0.000			
Total PV benefits PVb		14.154			
Net Present Value NPV		2.840			
Average benefit/cost ratio		1.251			

Brief description of options:

Do Nothing	No Maintenance of Defences
Emerging Preferred Option	Standard of Protection 1 in 100 year fluvial / 1 in 200 year tidal

Notes:

1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting

2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
   PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
   PV benefits calculated as PV damage avoided + PV asset protection benefits
3) Incremental benefit/cost ratio is calculated as:
   (PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Appendix B

Multicriteria Assessment of Options

B1 MCA Objectives and Targets

Core Criteria	Objective	Sub objective	Code	Indicator	Basic Requirement	Aspirational Target
Technical	Ensure flood risk management options are operationally robust	"	1.A.	Level of operational risk of option - Degree of reliance on mechanical, electrical or electronic systems, or on human intervention, action or decision, for the option to operate or perform successfully	Moderate to high, but manageable, degree of operational risk, i.e., an option with a high degree of reliance on mechanical, electrical or electronic systems, or on human intervention, action or decision, but which, with the allocation of adequate resources, could be operated with an acceptable degree of risk of failure	No operational risk, i.e., no reliance on mechanical, electrical or electronic systems, or on human intervention, action or decision for the option to operate or perform successfully
	Minimise health and safety risk in construction and operation of the flood risk management option	"	1.B	Degree of health and safety risk during construction and operation	Moderate to high, but acceptable and manageable, level of health and safety risk during either construction or operation	Negligible risk to health and safety during either construction or operation
	Ensure flood risk can be managed effectively and sustainably into the future	"	1.C	Sustainability and adaptability of the flood risk management measure in the face of potential future changes, including the potential impacts of climate change	Option to provide for, or be adaptable to, the MRFS in terms of maintaining the standard of protection at acceptable cost	Option to provide for, or be adaptable to, the HEFS in terms of maintaining the standard of protection at negligible cost
Economic	Reduce economic damage	"	2.A	Annual Average Damage (AAD) expressed in Euro / year, calculated in accordance with the economic risk assessment methods, but with no allowance for social / intangible benefits	AAD is not increased	100% reduction in AAD
	Minimise risk to transport infrastructure	"	2.B	Number and type of transport routes at risk from flooding	No increase in risk to transport infrastructure	Reduce risk to transport infrastructure to zero
	Minimise risk to utilities infrastructure	"	2.C	Number and type of infrastructure assets at risk from flooding	No increase in risk to utility infrastructure	Reduce risk to utility infrastructure to zero
	Minimise risk to agriculture	"	2.D	Agricultural production	No increase in the negative impact of flooding on agricultural production	Provide the potential for enhanced agricultural production
Social	Minimise risk to human health and life	(i) residents	3.A.(i)	Annual Average Number of residential properties at risk from flooding	Number of properties at risk is not increased	100% reduction in number of residential properties at risk
	"	(ii) high vulnerability properties	3.A.(ii)	Number and type of high vulnerability properties at risk from flooding	Number of high vulnerability properties at risk not increased	100% reduction in number of high vulnerability properties at risk
	Minimise risk to community	(i) social infrastructure	3.B.(i)	Number of social infrastructure assets at risk from flooding in a 0.1% AEP Event	Number of social infrastructure assets at risk not increased	100% reduction in number of social infrastructure assets at risk
	"	(ii) local employment	3.B.(ii)	Number of non-residential (i.e., commercial) properties at risk not increased.	Number of non-residential properties at risk not increased	100% reduction in number of non-residential properties at risk
	Minimise risk to, and where possible enhance, social amenity sites	"	3.C	Number of social amenity sites at risk from flooding in a 1% AEP Event	Number of social amenity sites at risk not increased	100% reduction in number of flood-sensitive social amenity sites at risk. Enhancement or creation of social amenity sites
Environmental	Support the objectives of the WFD	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives	4.A	-	Provide no constraint to the achievement of water body objectives.	Contribute to the achievement of water body objectives
	Support the objectives of the Habitats and Birds Directives	Avoid detrimental effects to, and where possible enhance, Natura 200 network, protected species and their key habitats, recognising relevant landscape features and stepping stones.	4.B	-	No deterioration in the conservation status of designated sites as a result of flood risk management measures.	Improvement in the conservation status of designated sites as a result of flood risk management sites.
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	Avoid damage to, and where possible enhance, legally protected sites / habitats and other sites / habitats of national, regional and local nature conservation importance	4.C	-	No deterioration in the condition of existing sites due to the implementation of flood risk management option.	Creation of new or improvement in condition of existing sites due to the implementation of flood risk management option
	Protect and where possible enhance fisheries resource within the catchment	Maintain existing and where possible create new fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species	4.D	-	No loss of integrity of fisheries habitat. Maintenance of upstream accessibility.	No loss of fisheries habitat. Improvement in habitat quality/quantity. Enhanced upstream accessibility
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	Protect, and where possible enhance, visual amenity, landscape protection zones and views into/from designated scenic areas within the zone of influence	4.E	-	No significant impact on landscape designation (protected site, scenic route/amenity, natural landscape form) within zone of visibility of measures. No significant change in the quality of existing landscape characteristics of the receiving environment.	No change to the existing landscape form. Enhancement of existing landscape or landscape feature
	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods.	(i) Avoid damage to or loss of features of architectural value and their setting, and improve their protection from extreme floods where this is beneficial	4.F.(i)	-	No increase in the risk to architectural features at risk from flooding. No detrimental impacts from flood risk management measures on architectural features.	Complete removal of all relevant architectural features from the risk of harm by extreme floods. Enhanced protection and value of architectural features importance arising from the implementation of the selected measures.
	"	(ii) Avoid damage to or loss of features of archaeological value and their setting, and improve their protection from extreme floods where this is beneficial	4.F.(ii)	-	No increase in the risk to archaeological features at risk from flooding. No detrimental impacts from flood risk management measures on archaeological features.	Complete removal of all relevant archaeological features from the risk of harm by extreme floods. Enhanced protection and value of archaeological features importance arising from the implementation of the selected measures.

MCA Scoring performance	
Fully Achieving Aspirational Target	5
Partially Achieving Aspirational Target	3
Exceeding Basic Requirement	1
Meeting Basic Requirement (No Change)	0
Just Failing Basic Requirement	-1
Partially Failing Basic Requirement	-3
Totally Failing Basic Requirement (Illegal/Unacceptable	-999

B2 MCA Scoring Sheets

Multicriteria Analysis - Flood Risk Management Area 1

Core Criteria	Objective	Sub objective	Global Weighting	Local Weighting	Local Weighting Rationale	FRS OPTION 1A - Direct Defences with conveyance improvements at Bleach Hill Stream		
						SCORING	Rationale	MCA SCORE
Technical	Ensure flood risk management options are operationally robust	"	20	5	As per GN28 Guidance	4	Negligible operational risk - Protection from fluvial design flood risk by improving conveyance through provision of a larger culvert. Risk of blockage to culvert during flood flows.	400
	Minimise health and safety risk in construction and operation of the flood risk management option	"	20	5	As per GN28 Guidance	3	Risks are manageable for construction of direct defences. Deep excavations and the risk of working near water during construction and maintenance stages.	300
	Ensure flood risk can be managed effectively and sustainably into the future	"	20	5	As per GN28 Guidance	3	Direct defences can be designed to account for future adaption	300
			60				**Technical Score**	**1000**
Economic	Reduce economic damage	"	30	5	TBC - Awaiting damages assessment	5	Fixed direct defences to provide full protection from fluvial design flood risk	750
	Minimise risk to transport infrastructure	"	10	1	Moderate threshold of flooding on regional road R639	4	Fixed direct defences to provide full protection to all transport routes within AFA from fluvial design flood risk.	40
	Minimise risk to utilities infrastructure	"	10	1	Moderate threshold of flooding to medium priority gas assets	5	Fixed direct defences to provide full protection from fluvial design flood risk.	50
	Minimise risk to agriculture	"	10	3	Professional judgement applied to scoring	-3	Partial increase in agricultural area flooded upstream of Glanmire GAA grounds.	-90
			60				**Economic Score**	**750**
Social	Minimise risk to human health and life	(i) residents	30	5	Professional judgement applied to scoring	5	Fixed direct defences to provide full protection from fluvial design flood risk	750
	"	(ii) high vulnerability properties	10	0	No high vulnerable properties within the affected area	0	No high vulnerable properties within affected area	0
	Minimise risk to community	(i) social infrastructure	5	0	No social infrastructure assets located within the affected area	0	No social infrastructure assets located within the affected area	0
	"	(ii) local employment	10	5	Significant quantity of commercial properties are located within the affected area. Professional judgement applied to scoring.	5	Fixed direct defences to provide full protection from fluvial design flood risk	250
	Minimise risk to, and where possible enhance, social amenity sites	"	5	2	Low threshold of flooding to Glanmire GAA playing pitches. Professional judgement applied to scoring.	0	No net increase in the number of social amenity sites at risk from flooding	0
			60				**Social Score**	**1000**
Environmental	Support the objectives of the WFD	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives	15	5	As per GN28 Guidance	-2	Fixed direct defences and improved channel conveyance have the potential for negative impacts on the waterbody. The Glashaboy River through Sallybrook reach is designated as Good status. A new moderate sized culvert will be required to the north of Grandons; however, there will likely be positive impacts due to a reduction of pollution due to reduced flood risk. Excavation, disruption and restoration of natural banks may cause negative impacts.	-150
	Support the objectives of the Habitats and Birds Directives	Avoid detrimental effects to, and where possible enhance, Natura 200 network, protected species and their key habitats, recognising relevant landscape features and stepping stones.	15	5	Professional judgement applied to scoring	-1	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC located downstream of the proposed options for the flood relief scheme. The potential to impact on the Natura 2000 sites is mainly through the temporary impacts of pollution/sediment downstream during construction. This may have a negative impact on the habitats of the SPA that support the bird interests for which the designation is cited. It may also impact on the habitats of the Great Channel Island SAC, however this is less likely given the distance of the SAC from the proposed works but potential impacts cannot be ruled out. Operational impacts include the impacts on fisheries and aquatic invertebrates that may indirectly impacts on bird species of Cork Harbour SPA . There is also potential for disturbance and spread of invasive species, mainly Japanese Knotweed during the course of the works.	-75
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	Avoid damage to, and where possible enhance, legally protected sites / habitats and other sites / habitats of national, regional and local nature conservation importance	5	5	Professional judgement applied to scoring	-3	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option at Sallybrook. The main impacts relate to the defence walls and the exclusion of the mill race and its associated species and habitat which is likely to be an important wildlife corridor in an urban setting. This measure will also result in the removal of some riparian edges along the Glashaboy which are likely to be important to species such as Otter and bats. There is also potential for pollution/sediment release locally to the river, disturbance to species at a local level and the spread of invasive species, mainly Japanese Knotweed during the course of the works.	-75
	Protect and where possible enhance fisheries resource within the catchment	Maintain existing and where possible create new fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species	5	5	As per GN28 Guidance	-1	Glashaboy is an important river for fisheries. This option may impact on river flows due to flood defences and these may affect fisheries habitat. The potential spread of Japanese Knotweed may also impact on fisheries through increased sediment release due to bank erosion when the weed dies off in winter. Consultation with Inland Fisheries has indicated that they cannot conclude the impacts to fisheries until the more detailed design is available.	-25
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	Protect, and where possible enhance, visual amenity, landscape protection zones and views into/from designated scenic areas within the zone of influence	10	2	Largely industrial area where visual impact may be of lower importance. Professional judgement applied to scoring.	0	Flood defence wall is relatively low in height and once built will be in character with the built character of the area at this location.	0
	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods.	(i) Avoid damage to or loss of features of architectural value and their setting, and improve their protection from extreme floods where this is beneficial	5	2	Considered to be of significant importance due to the presence of mills within the affected area. Professional judgement applied to scoring.	-1	Curtilage of Protected Structures RPS00390 paper mill and RPS 00389 cloth mill will be changed by works to mill races	-10
	"	(ii) Avoid damage to or loss of features of archaeological value and their setting, and improve their protection from extreme floods where this is beneficial	5	2	Professional judgement applied to scoring.	-2	The setting of two Recorded Monuments RMP CO063-069 and RMP CO063-094 will be changed by works to the mill races. Construction of flood defence walls adjacent to the River Glashaboy an Area of Archaeological Potential (AAP1) will impact the river.	-20
			60				**Environmental Score**	**-355**

MCA Benefit Score	**1395**
Option Selection Benefit Score	**2395**
Total Capital Costs (M€)	**2.73**
MCA Benefit/Cost Ratio	**0.51**

Prepared By:DR
Checked By:WS
Issued: Nov 2016

Multicriteria Analysis - Flood Risk Management Area 2

Core Criteria	Objective	Sub objective	Global Weighting	Local Weighting	Local Weighting Rationale	FRS OPTION 2A - Direct Defences (with conveyance improvements on Cois na Gleann Stream)			FRS OPTION 2B - Conveyance improvements (Dredging)		
						SCORING	Rationale	MCA SCORE	SCORING	Rationale	MCA SCORE
Technical	Ensure flood risk management options are operationally robust	"	20	5	As per GN28 Guidance	5	No operational risk - fixed direct defences to provide full protection from fluvial design flood risk.	500	3	Low operational risk - may require substantial maintenance requirements to regularly dredge channel	300
	Minimise health and safety risk in construction and operation of the flood risk management option	"	20	5	As per GN28 Guidance	1	Risks are moderate but manageable for construction of direct defences. Deep excavations and the risk of working near water during construction and especially, during emergency maintenance to remove any potential blockage.	100	1	Significant health and safety risk during dredging works. However, the H&S risk is acceptable and manageable. Risk in working near the river during flood events.	100
	Ensure flood risk can be managed effectively and sustainably into the future	"	20	5	As per GN28 Guidance	1	Direct defences can be designed to account for future adaption	100	-3	Sustainability of dredging is subject to the geomorphological nature of the river.	-300
			60				**Technical Score**	**700**		**Technical Score**	**100**
Economic	Reduce economic damage	"	30	5	Damage assessment as per MCM and Gn28	5	Fixed direct defences to provide full protection from fluvial design flood risk	750	5	Conveyance improvements to provide full protection from fluvial design flood risk	750
	Minimise risk to transport infrastructure	"	10	5	Low threshold of flooding of regional road R639	4	Fixed direct defences to provide protection from fluvial design flood risk	200	4	Conveyance improvements to provide protection from fluvial design flood risk	200
	Minimise risk to utilities infrastructure	"	10	3	Low threshold of flooding of gas assets. Professional judgement applied to scoring.	4	Fixed direct defences to provide protection from fluvial design flood risk	120	4	Conveyance improvements to provide protection from fluvial design flood risk	120
	Minimise risk to agriculture	"	10	1	Low impact of flooding on agricultural land - professional judgement.	0	Extent and depth of flooding on agricultural land increased immediately upstream of Hazelwood Ave. Bridge.	0	0	Slight reduction in flooding of land area upstream of Hazelwood Ave. Bridge	0
			60				**Economic Score**	**1070**		**Economic Score**	**1070**
Social	Minimise risk to human health and life	(i) residents	30	5	Professional judgement applied to scoring	5	Fixed direct defences to provide full protection from fluvial design flood risk	750	5	Conveyance improvements to provide full protection from fluvial design flood risk	750
	"	(ii) high vulnerability properties	10	1	No high vulnerable properties within the affected area	0	No high vulnerable properties within affected area	0	0	No high vulnerable properties within affected area	0
	Minimise risk to community	(i) social infrastructure	5	2	Low threshold of flooding of Glanmire Library within the affected area.	5	Fixed direct defences to provide full protection from fluvial design flood risk.	50	5	Conveyance improvements to provide full protection from fluvial design flood risk	50
	"	(ii) local employment	10	5	Hazelwood is an important hub for local employment with a range of offices, restaurants, shops and other places of employment with a low threshold of flooding (Q2). Professional judgement applied to scoring.	5	Fixed direct defences to provide full protection from fluvial design flood risk.	250	5	Conveyance improvements to provide full protection from fluvial design flood risk	250
	Minimise risk to, and where possible enhance, social amenity sites	"	5	2	Low threshold of flooding of social amenity site. Professional judgement applied to scoring.	-1	Partial flooding of sports ground/playground upstream of Hazelwood Ave. Bridge.	-10	2	Partial flooding of sports ground/playground upstream of Hazelwood Ave. Bridge.	20
			60				**Social Score**	**1040**		**Social Score**	**1070**
Environmental	Support the objectives of the WFD	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives	15	5	As per GN28 Guidance	-1	Fixed direct defences and improved channel conveyance have the potential for negative impacts on the waterbody. The Glashaboy River reach through Hazelwood is designated as Good status. Excavation, disruption and restoration of natural banks may cause negative impacts.	-75	-5	Improvement of channel conveyance has the potential for negative impacts on the chemical status of the waterbody. Ongoing dredging may be required within this section of channel.	-375
	Support the objectives of the Habitats and Birds Directives	Avoid detrimental effects to, and where possible enhance, Natura 200 network, protected species and their key habitats, recognising relevant landscape features and stepping stones.	15	5	Professional judgement applied to scoring	-1	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC located downstream of the proposed Hazelwood Option 1A for the flood relief scheme. The potential to impact on the Natura 2000 sites is mainly through the temporary impacts of pollution/sediment downstream during construction. This may have a negative impact on the habitats of the SPA that support the bird interests for which the designation is cited. It may also impact on the habitats of the Great Channel Island SAC, however this is less likely given the distance of the SAC from the proposed works but potential impacts cannot be ruled out. Operational impacts include the impacts on fisheries and aquatic invertebrates that may indirectly impacts on bird species of Cork Harbour SPA . There is also potential for disturbance and spread of invasive species, mainly Japanese Knotweed during the course of the works.	-75	-5	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC located downstream of the proposed measures for Hazelwood Option 2B for the flood relief scheme. The potential to impact on the Natura 2000 sites is mainly through the temporary impacts of pollution/sediment downstream as a result of dredging and through channel alterations, habitat loss and impact on species also. This will then have indirect impacts on the birds of the SPA. The possible need for on-going maintenance will also have longterm impacts for the river and the SPA. Given the current Good ecological status of the Glashaboy downstream of Hazelwood and the importance of the river for fisheries, and for the birds of the SPA, impacts of dredging may be significant.	-375
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	Avoid damage to, and where possible enhance, legally protected sites / habitats and other sites / habitats of national, regional and local nature conservation importance	5	5	Professional judgement applied to scoring	-1	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option at Hazelwood 2A due to the defence walls at Hazelwood Shopping Centre south of Hazelwood Bridge. There is also potential for pollution/sediment release locally to the river, disturbance to species at a local level and the spread of invasive species, mainly Japanese Knotweed during the course of the works.	-25	-5	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option at Hazelwood 2A due to the defence walls at Hazelwood Shopping Centre south of Hazelwood Bridge. There is also potential for pollution/sediment release locally to the river, disturbance to species at a local level and the spread of invasive species, mainly Japanese Knotweed during the course of the works.	-125
	Protect and where possible enhance fisheries resource within the catchment	Maintain existing and where possible create new fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species	5	5	As per GN28 Guidance	-1	The Glashaboy is an important river for fisheries. This option however is unlikely to significantly affect river flows and fisheries. The potential spread of Japanese Knotweed may also impact on fisheries through increased sediment release due to bank erosion when the weed dies off in winter. Consultation with Inland Fisheries has indicated that they cannot conclude the impacts to fisheries until the more detailed design is available. However, this option is not considered to have as a significant effect on fisheries as the dredging option at Hazelwood (2B).	-25	-5	The Glashaboy is an important river for fisheries. This option may significantly affect river habitats, flows and fisheries. The potential spread of Japanese Knotweed may also impact on fisheries through increased sediment release due to bank erosion when the weed dies off in winter. Consultation with Inland Fisheries has indicated that they cannot conclude the impacts to fisheries until the more detailed design is available. However, Inland Fisheries commented that this option is not a desirable option and alternative options should be considered in its place.	-125
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	Protect, and where possible enhance, visual amenity, landscape protection zones and views into/from designated scenic areas within the zone of influence	10	5	Considered to significantly important. Views and interpretation of flood defences (high walls at Hazelwood) can lead to concern amongst residents. Professional judgement applied to scoring	-3	Flood defence wall varies in height up to 2.1m high along existing roads. Once built, it will be in character with the urban fabric of the area at this location but reduces views of green areas.	-150	-1	Dredging operations will require removal of riverside vegetation which are an attractive and important visual feature in this area.	-50
	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods.	(i) Avoid damage to or loss of features of architectural value and their setting, and improve their protection from extreme floods where this is beneficial	5	1	Professional judgement applied to scoring.	0	No effect on architectural heritage	0	0	No effect on architectural heritage	0
	"	(ii) Avoid damage to or loss of features of archaeological value and their setting, and improve their protection from extreme floods where this is beneficial	5	1	Professional judgement applied to scoring.	-1	Setting of Glashaboy River AAP1 will be changed by construction of flood defence wall and reconstruction of existing embankment.	-5	-1	Dredging the Glashaboy River AAP1 will modify the river bed.	-5
			60				**Environmental Score**	**-355**		**Environmental Score**	**-1055**
							MCA Benefit Score	**1755**		**MCA Benefit Score**	**1085**
							Option Selection Benefit Score	**2455**		**Option Selection Benefit Score**	**1185**
							Total Capital Costs (M€)	**3.67**		**Total Capital Costs (M€)**	**3.17**
							MCA Benefit/Cost Ratio	**0.48**		**MCA Benefit/Cost Ratio**	**0.34**

Multicriteria Analysis - Flood Risk Management Area 2

Core Criteria	Objective	Sub objective	Global Weighting	Local Weighting	Local Weighting Rationale	FRS OPTION 2C - Combination (Direct Defences and Conveyance) Arrangement 1			FRS OPTION 2D - Combination (Direct Defences and Conveyance) Arrangement 2		
						SCORING	Rationale	MCA SCORE	SCORING	Rationale	MCA SCORE
Technical	Ensure flood risk management options are operationally robust	"	20	5	As per GN28 Guidance	5	No operational risk - defence measures do not rely on systems or intervention.	500	5	No operational risk - defence measures do not rely on systems or intervention.	500
	Minimise health and safety risk in construction and operation of the flood risk management option	"	20	5	As per GN28 Guidance	3	Moderate health and safety risk during construction works. However, the H&S risk is acceptable and manageable. Risk in working near the river during flood events.	300	3	Moderate health and safety risk during construction works. However, the H&S risk is acceptable and manageable. Risk in working near the river during flood events.	300
	Ensure flood risk can be managed effectively and sustainably into the future	"	20	5	As per GN28 Guidance	3	Defence works can be designed to account for future adaption	300	2	Defence works can be designed to account for future adaption	200
			60				**Technical Score**	**1100**		**Technical Score**	**1000**
Economic	Reduce economic damage	"	30	5	Damage assessment as per MCM and Gn28	5	Defence works to provide full protection from fluvial design flood risk.	750	5	Defence works to provide full protection from fluvial design flood risk.	750
	Minimise risk to transport infrastructure	"	10	5	Low threshold of flooding of regional road R639	4	Defence works to provide protection from fluvial design flood risk.	200	4	Defence works to provide protection from fluvial design flood risk.	200
	Minimise risk to utilities infrastructure	"	10	3	Low threshold of flooding of gas assets. Professional judgement applied to scoring.	4	Defence works to provide protection from fluvial design flood risk.	120	4	Defence works to provide protection from fluvial design flood risk.	120
	Minimise risk to agriculture	"	10	1	Low impact of flooding on agricultural land - professional judgement.	0	Extent and depth of flooding on agricultural land unchanged immediately upstream of Hazelwood Ave. Bridge.	0	0	Extent and depth of flooding on agricultural land increased immediately upstream of Hazelwood Ave. Bridge.	0
			60				**Economic Score**	**1070**		**Economic Score**	**1070**
Social	Minimise risk to human health and life	(i) residents	30	5	Professional judgement applied to scoring	5	Defence works to provide full protection from fluvial design flood risk.	750	5	Defence works to provide full protection from fluvial design flood risk.	750
		(ii) high vulnerability properties	10	1	No high vulnerable properties within the affected area	0	No high vulnerable properties within affected area	0	0	No high vulnerable properties within affected area	0
	Minimise risk to community	(i) social infrastructure	5	2	Low threshold of flooding of Glanmire Library within the affected area.	5	Defence works to provide full protection from fluvial design flood risk.	50	5	Defence works to provide full protection from fluvial design flood risk.	50
	"	(ii) local employment	10	5	Hazelwood is an important hub for local employment with a range of offices, restaurants, shops and other places of employment with a low threshold of flooding (Q2). Professional judgement applied to scoring.	5	Defence works to provide full protection from fluvial design flood risk.	250	5	Defence works to provide full protection from fluvial design flood risk.	250
	Minimise risk to, and where possible enhance, social amenity sites	"	5	2	Low threshold of flooding of social amenity site. Professional judgement applied to scoring.	0	Partial flooding of sports ground/playground upstream of Hazelwood Ave. Bridge.	0	0	Partial flooding of sports ground/playground upstream of Hazelwood Ave. Bridge.	0
			60				**Social Score**	**1050**		**Social Score**	**1050**
Environmental	Support the objectives of the WFD	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives	15	5	As per GN28 Guidance	-1	Defence works have the potential to negatively impact on the ecological status of the waterbody through works beside and within the channel. Negative impacts due to works within the channel associated with upgrading Cois na Gleann culvert and raising Hazelwood Avenue Bridge are likely.	-75	-1	Defence works have the potential to negatively impact on the ecological status of the waterbody through works beside and within the channel. Negative impacts due to works within the channel associated with upgrading Cois na Gleann culvert and raising Hazelwood Avenue Bridge are likely.	-75
	Support the objectives of the Habitats and Birds Directives	Avoid detrimental effects to, and where possible enhance, Natura 200 network, protected species and their key habitats, recognising relevant landscape features and stepping stones.	15	5	Professional judgement applied to scoring	-1	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC located downstream of the proposed measures for Option 2C Hazelwood of the flood relief scheme . The potential to impact on the Natura 2000 sites is mainly through the temporary impacts of pollution/sediment downstream during construction. This may have a negative impact on the habitats of the SPA that support the bird interests for which the designation is cited. It may also impact on the habitats of the Great Channel Island SAC, however this is less likely given the distance of the SAC from the proposed works but potential impacts cannot be ruled out. There is also potential for disturbance and spread of invasive species, mainly Japanese Knotweed during the course of the works.	-75	-1	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC located downstream of the proposed options for Option 2D Hazelwood of the flood relief scheme . The potential to impact on the Natura 2000 sites is mainly through the temporary impacts of pollution/sediment downstream during construction. This may have a negative impact on the habitats of the SPA that support the bird interests for which the designation is cited. It may also impact on the habitats of the Great Channel Island SAC, however this is less likely given the distance of the SAC from the proposed works but potential impacts cannot be ruled out. There is also potential for disturbance and spread of invasive species, mainly Japanese Knotweed during the course of the works.	-75
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	Avoid damage to, and where possible enhance, legally protected sites / habitats and other sites / habitats of national, regional and local nature conservation importance	5	5	Professional judgement applied to scoring	-1	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option at Hazelwood 2C due to the defence walls at Hazelwood Shopping Centre south of Hazelwood Bridge that may cause fragmentation of the riparian habitat and wildlife corridor in this very built up area. There is also potential for pollution/sediment release locally to the river during the bridge widening works which will include the widening of the channel above low flow levels. There may also be disturbance to species at a local level and the spread of invasive species, mainly Japanese Knotweed during the course of the works.	-25	-1	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option at Hazelwood 2D due to the defence walls at Hazelwood Shopping Centre south of Hazelwood Bridge that may cause fragmentation of the riparian habitat and wildlife corridor in this very built up area. However, the provision of a side channel and flood relief culvert would help to provide access under the road and through the area with the exception of during very high floods. There is also potential for pollution/sediment release locally to the river during the excavation of a new channel. There may also be disturbance to species at a local level and the spread of invasive species, mainly Japanese Knotweed during the course of the works.	-25
	Protect and where possible enhance fisheries resource within the catchment	Maintain existing and where possible create new fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species	5	5	As per GN28 Guidance	-1	The Glashaboy is an important river for fisheries. This option however is unlikely to significantly affect river flows and fisheries. The potential spread of Japanese Knotweed may also impact on fisheries through increased sediment release due to bank erosion when this weed dies off in winter. Consultation with Inland Fisheries has indicated that they cannot conclude the impacts to fisheries until the more detailed design is available. However, this option is not considered to have as a significant effect on fisheries as the dredging option at Hazelwood (2B).	-25	-3	As noted above the Glashaboy is an important river for fisheries. This option however is unlikely to significantly affect river flows and fisheries. The potential spread of Japanese Knotweed may impact on fisheries through increased sediment release due to bank erosion when this weed dies off in winter. Consultation with Inland Fisheries has indicated that they cannot conclude the impacts to fisheries until the more detailed design is available. However, they did indicate that this is not a favoured option.	-75
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	Protect, and where possible enhance, visual amenity, landscape protection zones and views into/from designated scenic areas within the zone of influence	10	5	Considered to significantly important. Views and interpretation of flood defences (high walls at Hazelwood) can lead to concern amongst residents. Professional judgement applied to scoring	0	Flood defence wall is relatively low in height and once built will be in character with the urban character of the area at this location.	0	-2	Flood defence wall is relatively low in height and once built will be in character with the urban character of the area at this location, but removal of vegetation for the new culvert will increase landscape and visual impact.	-100
	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods.	(i) Avoid damage to or loss of features of architectural value and their setting, and improve their protection from extreme floods where this is beneficial	5	1	Professional judgement applied to scoring.	0	No effect on architectural heritage	0	0	No effect on architectural heritage	0
	"	(ii) Avoid damage to or loss of features of archaeological value and their setting, and improve their protection from extreme floods where this is beneficial	5	1	Professional judgement applied to scoring.	-1	Setting of Glashaboy River AAP1 will be changed by construction of flood defence wall and reconstruction of existing embankment.	-5	-1	Setting of Glashaboy River AAP1 will be changed by construction of flood defence wall and reconstruction of existing embankment. Construction of relief channel will modify the bed of the river, AAP1.	-5
			60				**Environmental Score**	**-205**		**Environmental Score**	**-355**
							MCA Benefit Score	**1915**		**MCA Benefit Score**	**1765**
							Option Selection Benefit Score	**3015**		**Option Selection Benefit Score**	**2765**
							Total Capital Costs (M€)	**3.74**		**Total Capital Costs (M€)**	**3.30**
							MCA Benefit/Cost Ratio	**0.51**		**MCA Benefit/Cost Ratio**	**0.53**

Multicriteria Analysis - Flood Risk Management Area 2

Core Criteria	Objective	Sub objective	Global Weighting	Local Weighting	Local Weighting Rationale	FRS OPTION 2E - Combination (Direct Defences and Conveyance) Arrangement 3			FRS OPTION 2F - Combination (Direct Defences and Conveyance) Arrangement 4		
						SCORING	Rationale	MCA SCORE	SCORING	Rationale	MCA SCORE
Technical	Ensure flood risk management options are operationally robust	"	20	5	As per GN28 Guidance	5	No operational risk - defence measures do not rely on systems or intervention.	500	5	No operational risk - defence measures do not rely on systems or intervention.	500
	Minimise health and safety risk in construction and operation of the flood risk management option	"	20	5	As per GN28 Guidance	2	Moderate health and safety risk during construction works. However, the H&S risk is acceptable and manageable. Risk in working near the river during flood events.	200	3	Moderate health and safety risk during construction works. However, the H&S risk is acceptable and manageable. Risk in working near the river during flood events.	300
	Ensure flood risk can be managed effectively and sustainably into the future	"	20	5	As per GN28 Guidance	2	Defence works can be designed to account for future adaption	200	2	Defence works can designed to account for future adaption.	200
			60				**Technical Score**	**900**		**Technical Score**	**1000**
Economic	Reduce economic damage	"	30	5	Damage assessment as per MCM and Gn28	5	Defence works to provide full protection from fluvial design flood risk.	750	5	Defence works to provide full protection fom fluvial design flood risk.	750
	Minimise risk to transport infrastructure	"	10	5	Low threshold of flooding of regional road R639	2	Defence works to provide protection from fluvial design flood risk.	100	4	Defence works to provide full protection from fluvial design flood risk.	200
	Minimise risk to utilities infrastructure	"	10	3	Low threshold of flooding of gas assets. Professional judgement applied to scoring.	4	Defence works to provide protection from fluvial design flood risk.	120	4	Defence works to provide protection from fluvial design flood risk.	120
	Minimise risk to agriculture	"	10	1	Low impact of flooding on agricultural land - professional judgement.	0	Extent and depth of flooding on agricultural land increased immediately upstream of Hazelwood Ave. Bridge.	0	0	Extent and depth of flooding on agricultural land increased immediately upstream of Hazelwood Ave. Bridge.	0
			60				**Economic Score**	**970**		**Economic Score**	**1070**
Social	Minimise risk to human health and life	(i) residents	30	5	Professional judgement applied to scoring	5	Defence works to provide full protection from fluvial design flood risk.	750	5	Defence works to provide full protection from fluvial design flood risk.	750
	"	(ii) high vulnerability properties	10	1	No high vulnerable properties within the affected area	0	No high vulnerable properties within affected area	0	0	No high vulnerable properties within affected area	0
	Minimise risk to community	(i) social infrastructure	5	2	Low threshold of flooding of Glanmire Library within the affected area.	5	Defence works to provide full protection from fluvial design flood risk.	50	5	Defence works to provide full protection from fluvial design flood risk.	50
	"	(ii) local employment	10	5	Hazelwood is an important hub for local employment with a range of offices, restaurants, shops and other places of employment with a low threshold of flooding (Q2). Professional judgement applied to scoring.	3	Defence works to provide full protection from fluvial design flood risk.	150	5	Defence works to provide full protection from fluvial design flood risk.	250
	Minimise risk to, and where possible enhance, social amenity sites	"	5	2	Low threshold of flooding of social amenity site. Professional judgement applied to scoring.	0	Partial flooding of sports ground/playground upstream of Hazelwood Ave. Bridge.	0	0	Partial flooding of sports ground/playground upstream of Hazelwood Ave. Bridge.	0
			60				**Social Score**	**950**		**Social Score**	**1050**
Environmental	Support the objectives of the WFD	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives	15	5	As per GN28 Guidance	-1	Defence works have the potential to negatively impact on the ecological status of the waterbody through works beside and within the channel.	-75	-1	Defence works have the potential to negatively impact on the ecological status of the waterbody through works beside and within the channel. Replacement of Hazelwood Shopping Centre bridge is likley to impact negatively on the waterbody	-75
	Support the objectives of the Habitats and Birds Directives	Avoid detrimental effects to, and where possible enhance, Natura 200 network, protected species and their key habitats, recognising relevant landscape features and stepping stones.	15	5	Professional judgement applied to scoring	-1	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC located downstream of the proposed options for Option 2E Hazelwood of the flood relief scheme. The potential to impact on the Natura 2000 sites is mainly through the temporary impacts of pollution/sediment downstream during construction. This may have a negative impact on the habitats of the SPA that support the bird interests for which the designation is cited. It may also impact on the habitats of the Great Channel Island SAC, however this is less likely given the distance of the SAC from the proposed works but potential impacts cannot be ruled out. There is also potential for disturbance and spread of invasive species, mainly Japanese Knotweed during the course of the works.	-75	-1	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC located downstream of the proposed options for Option 2F Hazelwood of the flood relief scheme. The potential to impact on the Natura 2000 sites is mainly through the temporary impacts of pollution/sediment downstream during construction. This may have a negative impact on the habitats of the SPA that support the bird interests for which the designation is cited. It may also impact on the habitats of the Great Channel Island SAC, however this is less likely given the distance of the SAC from the proposed works but potential impacts cannot be ruled out. There is also potential for disturbance and spread of invasive species, mainly Japanese Knotweed during the course of the works.	-75
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	Avoid damage to, and where possible enhance, legally protected sites / habitats and other sites / habitats of national, regional and local nature conservation importance	5	5	Professional judgement applied to scoring	-1	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option at Hazelwood 2E due to the defence walls at Hazelwood Shopping Centre south of Hazelwood Bridge that may cause fragmentation of the riparian habitat and wildlife corridor in this very built up area. However, the provision of a side channel and flood relief culvert would help to provide access under the road and through the area with the exception of during very high floods. There is also potential for pollution/sediment release locally to the river during the excavation of a new channel. There may also be disturbance to species at a local level and the spread of invasive species, mainly Japanese Knotweed during the course of the works.	-25	-1	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option at Hazelwood 2F due to the defence walls at Hazelwood Shopping Centre south of Hazelwood Bridge that may cause fragmentation of the riparian habitat and wildlife corridor in this very built up area. However, the provision of a side channel and flood relief culvert would help to provide access under the road and through the area with the exception of during very high floods. There is also potential for pollution/sediment release locally to the river during the excavation of a new channel. There may also be disturbance to species at a local level and the spread of invasive species, mainly Japanese Knotweed during the course of the works.	-25
	Protect and where possible enhance fisheries resource within the catchment	Maintain existing and where possible create new fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species	5	5	As per GN28 Guidance	-3	The Glashaboy is an important river for fisheries. This option however is unlikely to significantly affect river flows and fisheries. The potential spread of Japanese Knotweed may impact on fisheries through increased sediment release due to bank erosion when this weed dies off in winter. Consultation with Inland Fisheries has indicated that they cannot conclude the impacts to fisheries until the more detailed design is available. Given the similarity of this option to Option 2D it is unlikely that this will be favoured by fisheries.	-75	-3	The Glashaboy is an important river for fisheries. This option however is unlikely to significantly affect river flows and fisheries. The potential spread of Japanese Knotweed may impact on fisheries through increased sediment release due to bank erosion when this weed dies off in winter. Consultation with Inland Fisheries has indicated that they cannot conclude the impacts to fisheries until the more detailed design is available. Given the similarity of this option to Option 2D and 2 E it is unlikely that this will be favoured by fisheries.	-75
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	Protect, and where possible enhance, visual amenity, landscape protection zones and views into/from designated scenic areas within the zone of influence	10	5	Considered to significantly important. Views and interpretation of flood defences (high walls at Hazelwood) can lead to concern amongst residents. Professional judgement applied to scoring	-1	Flood defence wall is relatively low in height and once built will be in character with the urban character of the area at this location, but removal of vegetation for the new culvert amd reconstruction of existing embankment will increase landscape and visual impact.	-50	-1	Flood defence wall is relatively low in height and once built will be in character with the urban character of the area at this location, but removal of vegetation for the new culvert amd reconstruction of existing embankment will increase landscape and visual impact.	-50
	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods.	(i) Avoid damage to or loss of features of architectural value and their setting, and improve their protection from extreme floods where this is beneficial	5	1	Professional judgement applied to scoring.	0	No effect on architectural heritage	0	0	No effect on architectural heritage	0
	"	(ii) Avoid damage to or loss of features of archaeological value and their setting, and improve their protection from extreme floods where this is beneficial	5	1	Professional judgement applied to scoring.	-1	Setting of Glashaboy River AAP1 will be changed by construction of flood defence wall and reconstruction of existing embankment. Construction of relief channel will modify the bed of the river, AAP1.	-5	-1	Setting of Glashaboy River AAP1 will be changed by construction of flood defence walls and reconstruction of existing embankment and associated works. Construction of the flood relief channel and replacement Hazel Shopping Centre Bridge will modify the bed of the river, AAP1.	-5
			60				**Environmental Score**	**-305**		**Environmental Score**	**-305**
							MCA Benefit Score	**1615**		**MCA Benefit Score**	**1815**
							Option Selection Benefit Score	**2515**		**Option Selection Benefit Score**	**2815**
							Total Capital Costs (M€)	**3.09**		**Total Capital Costs (M€)**	**3.50**
							MCA Benefit/Cost Ratio	**0.52**		**MCA Benefit/Cost Ratio**	**0.52**

Multicriteria Analysis - Flood Risk Management Area 3

Core Criteria	Objective	Sub objective	Global Weighting	Local Weighting	Local Weighting Rationale	FRS OPTION 3A - Direct Defences (with conveyance improvements on Springmount Stream)		
						SCORING	Rationale	MCA SCORE
Technical	Ensure flood risk management options are operationally robust	"	20	5	As per GN28 Guidance	5	No operational risk - fixed direct defences to provide full protection from fluvial design flood risk.	500
	Minimise health and safety risk in construction and operation of the flood risk management option	"	20	5	As per GN28 Guidance	2	Risks are manageable for construction of direct defences. Deep excavations and the risk of working near water during construction and especially, during emergency maintenance to remove any potential blockage.	200
	Ensure flood risk can be managed effectively and sustainably into the future	"	20	5	As per GN28 Guidance	4	Direct defences can be designed to account for future adaption	400
			60				**Technical Score**	**1100**
Economic	Reduce economic damage	"	30	5	Damage assessment as per MCM and Gn28	5	Fixed direct defences to provide full protection from fluvial design flood risk	750
	Minimise risk to transport infrastructure	"	10	2	Professional judgement applied to scoring	4	Fixed direct defences to provide protection from fluvial design flood risk	80
	Minimise risk to utilities infrastructure	"	10	5	Low threshold of flooding of gas assets	4	Fixed direct defences to provide protection from fluvial design flood risk	200
	Minimise risk to agriculture	"	10	0	No negative impact on affected area	0	No negative impact on affected area	0
			60				**Economic Score**	**1030**
Social	Minimise risk to human health and life	(i) residents	30	5	Professional judgement applied to scoring	5	Fixed direct defences to provide full protection from fluvial design flood risk.	750
	"	(ii) high vulnerability properties	10	0	No impact on affected area.	0	No impact on affected area.	0
	Minimise risk to community	(i) social infrastructure	5	2	Moderate/high threshold of flooding on affected area. Professional judgement applied to scoring.	5	Fixed direct defences to provide full protection from fluvial design flood risk.	50
	"	(ii) local employment	10	5	Meadowbrook is an important hub for local employment. Professional judgement applied to scoring.	5	Fixed direct defences to provide full protection from fluvial design flood risk.	250
	Minimise risk to, and where possible enhance, social amenity sites	"	5	0	No impact on affected area.	0	No impact on affected area.	0
			60				**Social Score**	**1050**
Environmental	Support the objectives of the WFD	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives	15	5	As per GN28 Guidance	0	Likely to be construction phase impacts; however, flood defences may also lead to positive impacts due to reduction in the risk of pollution.	0
	Support the objectives of the Habitats and Birds Directives	Avoid detrimental effects to, and where possible enhance, Natura 200 network, protected species and their key habitats, recognising relevant landscape features and stepping stones.	15	5	Professional judgement applied to scoring	-1	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC located downstream of the proposed options for Option 3A Meadowbrook of the flood relief scheme . The flood defence wall along this stretch of the river and the pumping station discharging to the Glashaboy River further south may cause alterations to water flows and insteam habitats, thereby impacting on fisheries and aquatic invertebrates. There is potential to indirectly impact on Cork Harbour SPA as these form the prey items for some of the bird interests of the SPA. The potential to impact on the Natura 2000 sites may also occur through the temporary impacts of pollution/sediment downstream during construction. This may have a negative impact on the habitats of the SPA that support the bird interests for which the designation is cited. It may also impact on the habitats of the Great Channel Island SAC, however this is less likely given the distance of the SAC from the proposed works but potential impacts cannot be ruled out. There is also potential for disturbance and spread of invasive species, mainly Japanese Knotweed during the course of the works.	-75
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	Avoid damage to, and where possible enhance, legally protected sites / habitats and other sites / habitats of national, regional and local nature conservation importance	5	5	Professional judgement applied to scoring	-2	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option at Meadowbrook 3A due to the defence walls along the river edge that may cause fragmentation of the riparian habitat and wildlife corridor in this very built up area that links to the woodland and parkland just south of Meadowbrook. There is also potential for pollution/sediment release locally to the river during the excavation of a new channel. There may also be disturbance to species at a local level and the spread of invasive species, mainly Japanese Knotweed during the course of the works.	-50
	Protect and where possible enhance fisheries resource within the catchment	Maintain existing and where possible create new fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species	5	5	As per GN28 Guidance	-2	The Glashaboy is an important river for fisheries. This option may affect river flows and water quality and therefore fisheries. The potential spread of Japanese Knotweed may impact on fisheries through increased sediment release due to bank erosion when this weed dies off in winter. Consultation with Inland Fisheries has indicated that they cannot conclude the impacts to fisheries until the more detailed design is available.	-50
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	Protect, and where possible enhance, visual amenity, landscape protection zones and views into/from designated scenic areas within the zone of influence	10	2	Existing flood defences already in place at Meadowbrook. Professional judgement applied to scoring.	-1	Increase in wall height and extent will introduce new built element in an attractive green space. Wall treatment and retention of trees will help to mitigate.	-20
	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods.	(i) Avoid damage to or loss of features of architectural value and their setting, and improve their protection from extreme floods where this is beneficial	5	2	Professional judgement applied to scoring.	-1	Flood defence wall will be abutting the Protected Structure Riverstown Bridge RPS 00394	-10
	"	(ii) Avoid damage to or loss of features of archaeological value and their setting, and improve their protection from extreme floods where this is beneficial	5	2	Professional judgement applied to scoring.	-2	Setting of Glashaboy River AAP1 will be changed by construction of flood defence wall. Flood defence wall will be abutting the Recorded Monument RMP CO064-111.	-20
			60				**Environmental Score**	**-225**

MCA Benefit Score	**1855**
Option Selection Benefit Score	**2955**
Total Capital Costs (M€)	**2.40**
MCA Benefit/Cost Ratio	**0.77**

Multicriteria Analysis - Flood Risk Management Area 4.1 Butlerstown

Core Criteria	Objective	FRS OPTION 4.1A - Conveyance Improvements			FRS OPTION 4.1B - Direct Defences			FRS OPTION 4.1C - Overland Flow Management		
		SCORING	Rationale	MCA SCORE	SCORING	Rationale	MCA SCORE	SCORING	Rationale	MCA SCORE
Technical	Ensure flood risk management options are operationally robust	3	Low operational risk - defence measures do not rely on systems or intervention. Maintenance within the channel and at the culvert required to lower risk of blockage.	300	4	Low operational risk - defence measures do not rely on systems or intervention. Maintenance within the channel and at the culvert required to lower risk of blockage.	400	4	Low operational risk - maintaining overland flow does not rely on systems or intervention.	400
	Minimise health and safety risk in construction and operation of the flood risk management option	1	Risks are moderate but manageable for construction of defences. Deep excavations and the risk of working near/in water during construction and especially, during emergency maintenance to remove any potential blockage.	100	3	Risks are manageable for construction of direct defences. Deep excavations and the risk of working near water during construction and especially, during emergency maintenance to remove any potential blockage.	300	5	Only local works to boundary wall required.	500
	Ensure flood risk can be managed effectively and sustainably into the future	3	Increase in onveyance can be achieved by providing additional flood relief culverts	300	4	Direct defences can be designed to account for future adaption	400	5	Overland flow management could be subsittuted with other measures as required.	500
			Technical Score	**700**		**Technical Score**	**1100**		**Technical Score**	**1400**
Economic	Reduce economic damage	2	Damage at Butlerstown moderate	300	2	Damage at Butlerstown moderate	300	2	Damage at Butlerstown moderate	300
	Minimise risk to transport infrastructure	-1	Risk is moderate due to potential culvert blockage but affecting local road only	-50	-2	Risk is moderate due to potential culvert blockage but affecting local road only	-100	-3	Risk is moderate due to overland flow routing	-150
	Minimise risk to utilities infrastructure	0	NA	0	0	NA	0	0	NA	0
	Minimise risk to agriculture	0	No impact on affected area	0	0	No impact on affected area	0	0	No impact on affected area	0
			Economic Score	**250**		**Economic Score**	**200**		**Economic Score**	**150**
Social	Minimise risk to human health and life	4	Conveyance improvements to provide full protection from fluvial design flood risk.	600	3	Direct defences to provide full protection from fluvial design flood risk.Some residual risk due to elevate water levels	450	3	Some residual risk due to overland flow routes during extreme events	450
	"	0	No high vulnerable properties within affected area	0	0	No high vulnerable properties within affected area	0	0	No high vulnerable properties within affected area	0
	Minimise risk to community	1	Conveyance improvements to provide full protection from fluvial design flood risk.	5	1	Fixed direct defences to provide full protection from fluvial design flood risk.	5	0	No risk to properties within overland fow path	0
	"	1	Conveyance improvements to provide full protection from flooding at the Maltings Site (Distillery) located to the south of Sarsfield GAA Club. Access to Riverstown House also to be maintained through provision of flood defences.	50	1	Direct defences to provide full protection from flooding at the Maltings Site (Distillery) located to the south of Sarsfield GAA Club. Access to Riverstown House also to be maintained through provision of flood defences.	50	-1	Access to the Maltings Site (Distillery) located to the south of Sarsfield GAA Club and Riverstown House may not be possible due to overland flow routing during flood event	-50
	Minimise risk to, and where possible enhance, social amenity sites	0	Conveyance improvements to provide full protection from flooding to Sarsfield GAA Club. However, the amenity grounds surrounding Riverstown House may still be subject to flooding.	0	0	Direct defences to provide full protection from flooding to Sarsfield GAA Club. However, the amenity grounds surrounding Riverstown House may still be subject to flooding.	0	0	Access to Sarsfield GAA Club and Riverstown House may not be accessible during extreme flood events.	-1
			Social Score	**655**		**Social Score**	**505**		**Social Score**	**399**
Environmental	Support the objectives of the WFD	-2	Disruption to natural banks likley to impact negatively on the waterbody.	-150	-2	Fixed direct defences may have negative impacts due to disruption to natural banks.	-150	0	Proposed works consist of modifying boundary wall located adjacent to the river banks of the Butlerstown Stream.	0
	Support the objectives of the Habitats and Birds Directives	-3	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC (located downstream of the proposed options) for Butlerstown Glenmore Option 4A of the flood relief scheme. The potential to impact on the Natura 2000 sites are mainly through the temporary impacts of pollution/sediment downstream during construction of the flood relief channel and culverts and also the replacement of channel walls. This may have a negative impact on the habitats of the SPA that support the bird interests for which the designation is cited. It may also impact on the habitats of the Great Channel Island SAC, however this is less likely given the distance of the SAC from the proposed works but potential impacts cannot be ruled out. There is also potential for disturbance and spread of invasive species, mainly Japanese Knotweed during the course of the works.	-225	-3	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC (located downstream of the proposed options) for Butlerstown Glenmore Option 4A of the flood relief scheme. The potential to impact on the Natura 2000 sites are mainly through the temporary impacts of pollution/sediment downstream during construction of the flood relief channel and culverts and also the replacement of channel walls. This may have a negative impact on the habitats of the SPA that support the bird interests for which the designation is cited. It may also impact on the habitats of the Great Channel Island SAC, however this is less likely given the distance of the SAC from the proposed works but potential impacts cannot be ruled out. There is also potential for disturbance and spread of invasive species, mainly Japanese Knotweed during the course of the works.	-225	0	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC (located downstream of the proposed options) for Butlerstown Glenmore Option 4A of the flood relief scheme. The potential to impact on the Natura 2000 sites are mainly through the temporary impacts of pollution/sediment downstream during modification of the boundary. This may have a negative impact on the habitats of the SPA that support the bird interests for which the designation is cited. It may also impact on the habitats of the Great Channel Island SAC, however this is less likely given the distance of the SAC from the proposed works but potential impacts cannot be ruled out. There is also potential for disturbance and spread of invasive species, mainly Japanese Knotweed during the course of the works. Overall the potential impact is envisaged to be relatively small.	0
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	-2	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option Butlerstown Glenmore mainly through the temporary impacts of pollution/sediment downstream during construction of the flood relief channel and culverts and also the replacement of channel walls. There may also be disturbance to species at a local level due to works and the potential spread of invasive species, mainly Japanese Knotweed during the course of the works.	-50	-2	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option Butlerstown Glenmore mainly through the temporary impacts of pollution/sediment downstream during construction of the flood relief channel and culverts and also the replacement of channel walls. There may also be disturbance to species at a local level due to works and the potential spread of invasive species, mainly Japanese Knotweed during the course of the works.	-50	-1	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option Butlerstown Glenmore mainly through the temporary impacts of pollution/sediment downstream during construction of modification to the boundary wall. There may also be disturbance to species at a local level due to works and the potential spread of invasive species, mainly Japanese Knotweed during the course of the works. It is noted that this risk is minimised due to access from the Lidl car park area.	-25
	Protect and where possible enhance fisheries resource within the catchment	-1	The Glashaboy is an important river for fisheries. This option however is unlikely to significantly affect river flows and fisheries. The potential spread of Japanese Knotweed may impact on fisheries through increased sediment release due to bank erosion when this weed dies off in winter.	-25	-1	The Glashaboy is an important river for fisheries. This option however is unlikely to significantly affect river flows and fisheries. The potential spread of Japanese Knotweed may impact on fisheries through increased sediment release due to bank erosion when this weed dies off in winter.	-25	0	The Glashaboy is an important river for fisheries. This option however will not affect river flows and fisheries.	0
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	0	Flood defence measures are relatively small in scale and once built, will be in character with the urban nature of the surrounding area.	0	0	Flood defence measures are relatively small in scale and once built, will be in character with the urban nature of the surrounding area.	0	0	NA	0
	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods.	0	No effect on architectural heritage	0	-1	Construction of flood defence embankment to southwest of Riverstown House will change the curtilage and setting of the Protected Structure RPS00395	-5	0	NA	0
	"	-1	Construction of flood relief channel and culvert will change the Butlerstown River AAP2.	-5	-2	Construction of embankment to the southwest of Riverstown House Recorded Monument RMP CO064-051 will change the setting of the monument. Setting of Butlerstown River AAP2 will be changed by construction of embankment.	-10	0	NA	0
			Environmental Score	**-455**		**Environmental Score**	**-465**		**Environmental Score**	**-25**
			MCA Benefit Score	**450**		**MCA Benefit Score**	**240**		**MCA Benefit Score**	**524**
			Option Selection Benefit Score	**1150**		**Option Selection Benefit Score**	**1340**		**Option Selection Benefit Score**	**1924**
			Total Capital Costs (M€)	**0.37**		**Total Capital Costs (M€)**	**0.32**		**Total Capital Costs (M€)**	**0.02**
			MCA Benefit/Cost Ratio	**1.21**		**MCA Benefit/Cost Ratio**	**0.75**		**MCA Benefit/Cost Ratio**	**25**

Multicriteria Analysis - Flood Risk Management Area 4.2

Core Criteria	Objective	Global Weighting	Local Weighting	Local Weighting Rationale	FRS OPTION 4.2A - Overland Flow Management			FRS OPTION 4.2B - Culvert Upgrade		
					SCORING	Rationale	MCA SCORE	SCORING	Rationale	MCA SCORE
Technical	Ensure flood risk management options are operationally robust	20	5	As per GN28 Guidance	3	Low operational risk - defence measures do not rely on systems or intervention. Maintenance within the channel and at the culvert may be required.	300	4	Low operational risk - defence measures do not rely on systems or intervention. Maintenance within the channel and at the culvert may be required.	400
	Minimise health and safety risk in construction and operation of the flood risk management option	20	5	As per GN28 Guidance	1	Deep excavations and the risk of working near/in water during construction and especially, during emergency maintenance to remove any potential blockage. H & S risk during a flood event due to overland flow at Brooklodge Grove Bridge.	100	3	Deep excavations and the risk of working near water during construction and especially, during emergency maintenance to remove any potential blockage.	300
	Ensure flood risk can be managed effectively and sustainably into the future	20	5	As per GN28 Guidance	4	Limited adaptability of road ramps and direct defences to account for climate change	400	5	Additional measure could be implemented to take account of climate change	500
		60				**Technical Score**	**800**		**Technical Score**	**1200**
Economic	Reduce economic damage	30	5	Damage assessment as per MCM and Gn28	4	Overland flow on L3010 road. Economic damage significantly reduced (incl culver blockage up to 50%)	600	5	No overland flow and economic damage significantly reduced (incl. culvert blockage of more than 50%)	750
	Minimise risk to transport infrastructure	10	5	Professional judgement applied to scoring	-3	Brooklodge Grove Bridge likely to be impassable during a flood event.	-150	-1	Some risk of blockage remains.	-50
	Minimise risk to utilities infrastructure	10	5	Low threshold of flooding of gas assets. Professional judgement applied to scoring.	-1	Likely to be negative impacts regarding access to utilities at Brooklodge Grove Bridge during a flood event.	-50	0	No impact on infrastructure	0
	Minimise risk to agriculture	10	0	No impact on affected area	0	No impact on affected area	0	0	No impact on affected area	0
		60				**Economic Score**	**400**		**Economic Score**	**700**
Social	Minimise risk to human health and life	30	5	Professional judgement applied to scoring	3	Conveyance improvements to provide full protection from fluvial design flood risk. Some H&S risk remains during the flood event due to overland flow.	450	5	Conveyance improvements to provide full protection from fluvial design flood risk.	750
	"	10	0	No high vulnerable properties within the affected area	0	No high vulnerable properties within affected area	0	0	No high vulnerable properties within affected area	0
	Minimise risk to community	5	1	Low threshold of flooding on affected area. Professional judgement applied to scoring.	1	Some restriction may apply during flood event due to overland flow management.	5	5	Conveyance improvements to provide full protection from flooding	25
	"	10	5	Professional judgement applied to scoring.	1	Some restriction may apply during flood event due to overland flow management.	50	5	Conveyance improvements to provide full protection from flooding	250
	Minimise risk to, and where possible enhance, social amenity sites	5	3	No significant amenity sites within the affected area.	0	NA	0	0	NA	0
		60				**Social Score**	**505**		**Social Score**	**1025**
Environmental	Support the objectives of the WFD	15	5	As per GN28 Guidance	-1	Works to upgrade the culvert at Brooklodge Grove/Copper Valley Bridges.	-75	-5	Works to upgrade the culverts at Brooklodge Grove/Copper Valley Bridges.	-375
	Support the objectives of the Habitats and Birds Directives	15	5	Professional judgement applied to scoring	-1	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC (located downstream of the proposed options) for Butlerstown Glenmore Option 4A of the flood relief scheme. The potential to impact on the Natura 2000 sites are mainly through the temporary impacts of pollution/sediment downstream during construction of the flood relief channel and culverts and also the replacement of channel walls. This may have a negative impact on the habitats of the SPA that support the bird interests for which the designation is cited. It may also impact on the habitats of the Great Channel Island SAC, however this is less likely given the distance of the SAC from the proposed works but potential impacts cannot be ruled out. There is also potential for disturbance and spread of invasive species, mainly Japanese Knotweed during the course of the works.	-75	-1	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC (located downstream of the proposed options) for Butlerstown Glenmore Option 4A of the flood relief scheme. The potential to impact on the Natura 2000 sites are mainly through the temporary impacts of pollution/sediment downstream during construction of the flood relief channel and culverts and also the replacement of channel walls. This may have a negative impact on the habitats of the SPA that support the bird interests for which the designation is cited. It may also impact on the habitats of the Great Channel Island SAC, however this is less likely given the distance of the SAC from the proposed works but potential impacts cannot be ruled out. There is also potential for disturbance and spread of invasive species, mainly Japanese Knotweed during the course of the works.	-75
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	5	5	Professional judgement applied to scoring	-1	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option Butlerstown Glenmore mainly through the temporary impacts of pollution/sediment downstream during construction of the flood relief channel and culverts and also the replacement of channel walls. There may also be disturbance to species at a local level due to works and the potential spread of invasive species, mainly Japanese Knotweed during the course of the works.	-25	-1	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option Butlerstown Glenmore mainly through the temporary impacts of pollution/sediment downstream during construction of the flood relief channel and culverts and also the replacement of channel walls. There may also be disturbance to species at a local level due to works and the potential spread of invasive species, mainly Japanese Knotweed during the course of the works.	-25
	Protect and where possible enhance fisheries resource within the catchment	5	5	As per GN28 Guidance	-1	The Glashaboy is an important river for fisheries. This option however is unlikely to significantly affect river flows and fisheries. The potential spread of Japanese Knotweed may impact on fisheries through increased sediment release due to bank erosion when this weed dies off in winter.	-25	-1	The Glashaboy is an important river for fisheries. This option however is unlikely to significantly affect river flows and fisheries. The potential spread of Japanese Knotweed may impact on fisheries through increased sediment release due to bank erosion when this weed dies off in winter.	-25
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	10	2	Professional judgement applied to scoring	0	Flood defence measures are relatively small in scale and once built, will be in character with the urban nature of the surrounding area.	0	0	Flood defence measures are relatively small in scale and once built, will be in character with the urban nature of the surrounding area.	0
	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods.	5	1	No physical effects on designated architectural features	0	No effect on architectural heritage	0	0	No effect on architectural heritage	0
	"	5	1	No physical effects on designated architectural features	-2	Construction of relief channel and replacing channel railing with crash barriers will change the Glenmore River AAP3.	-10	-5	Construction of relief channel and culvert upgrade will change the Glenmore River AAP3.	-25
		60				**Environmental Score**	**-210**		**Environmental Score**	**-525**
						MCA Benefit Score	**695**		**MCA Benefit Score**	**1200**
						Option Selection Benefit Score	**1495**		**Option Selection Benefit Score**	**2400**
						Total Capital Costs (M€)	**0.31**		**Total Capital Costs (M€)**	**2.54**
						MCA Benefit/Cost Ratio	**2.25**		**MCA Benefit/Cost Ratio**	**0.47**

Multicriteria Analysis - Flood Risk Management Area 5

Core Criteria	Objective	Sub objective	Global Weighting	Local Weighting	Local Weighting Rationale	FRS OPTION 5A - Direct Defences at The Grove and IPP St. Patricks Mill			FRS OPTION 5B - Direct Defences at The Grove only		
						SCORING	Rationale	MCA SCORE	SCORING	Rationale	MCA SCORE
Technical	Ensure flood risk management options are operationally robust	"	20	5	As per GN28 Guidance	1	Low operational risk overall. Local stormwater pump would require operation and there is some risk associated with this. IPP difficult to operate without flood warning system in place.	100	3	Low operational risk overall. Local stormwater pump would require operation and there is some risk associated with this.	300
	Minimise health and safety risk in construction and operation of the flood risk management option	"	20	5	As per GN28 Guidance	1	Risks are manageable for construction of direct defences. Risk during the operation stage. Deep excavations and the risk of working near water during construction. IPP risk of erecting during event and technical challenges of implementing due to potential seepage and poor/ old wall construction	100	2	Risks are manageable for construction of direct defences. Risk during the operation stage. Deep excavations and the risk of working near water during construction.	200
	Ensure flood risk can be managed effectively and sustainably into the future	"	20	5	As per GN28 Guidance	2	Direct defences can be designed to account for future adaption. IPP unlikely to be adaptable to climate change	200	3	Direct defences can be designed to account for future adaption	300
			60				**Technical Score**	**400**		**Technical Score**	**800**
Economic	Reduce economic damage	"	30	5	Damage assessment as per MCM and Gn28	4	Fixed direct defences to provide full protection from fluvial design flood risk. No significant difference with IPP	600	4	Fixed direct defences to provide full protection from fluvial design flood risk	600
	Minimise risk to transport infrastructure	"	10	5	Professional judgement applied to scoring	5	R639 protected from flooding. No change with IPP	250	5	R639 protected from flooding. No change with IPP	250
	Minimise risk to utilities infrastructure	"	10	5	A number of infrastructure assets are located within the affected area	0	NA	0	0	NA	0
	Minimise risk to agriculture	"	10	2	Low impact of flooding on agricultural land - professional judgement.	-1	Flood defences likely to be constructed on agricultural land. No change with IPP.	-20	-1	Flood defences likely to be constructed on agricultural land	-20
			60				**Economic Score**	**830**		**Economic Score**	**830**
Social	Minimise risk to human health and life	(i) residents	30	5	Professional judgement applied to scoring	4	Direct defences to provide full protection from fluvial design flood risk. Protection provided for residential part of St Patricks Mill.	600	3	Direct defences to provide full protection from fluvial design flood risk. St Patricks Mill remains at risk.	450
	"	(ii) high vulnerability properties	10	0	No impact on affected areas	0	No impact on affected areas	0	0	No impact on affected areas	0
	Minimise risk to community	(i) social infrastructure	5	0	No social infrastructure assets located within the affected area	0	No impact on affected areas	0	0	No impact on affected areas	0
	"	(ii) local employment	10	1	Professional judgement applied to scoring.	5	Direct defences to provide full protection from fluvial design flood risk	50	5	Direct defences to provide full protection from fluvial design flood risk	50
	Minimise risk to, and where possible enhance, social amenity sites	"	5	3	Considerable number of amenity sites within the affected area. Professional judgement applied to scoring.	-3	Flooding of Glanmire football pitches near St. Patrick's Mills likely to occur	-45	-3	Flooding of Glanmire football pitches near St. Patrick's Mills likely to occur	-45
			60				**Social Score**	**605**		**Social Score**	**455**
Environmental	Support the objectives of the WFD	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives	15	5	As per GN28 Guidance	-1	IPP are not considerred to impact on this objective but there may be some impact from direct defences at The Grove.	-75	-1	There may be some impact from direct defences at The Grove.	-75
	Support the objectives of the Habitats and Birds Directives	Avoid detrimental effects to, and where possible enhance, Natura 200 network, protected species and their key habitats, recognising relevant landscape features and stepping stones.	15	5	Professional judgement applied to scoring	-1	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC (located downstream of the proposed options) for Butlerstown Glenmore Option 4A of the flood relief scheme. The potential to impact on the Natura 2000 sites are mainly through the temporary impacts of pollution/sediment downstream during construction of the flood relief channel and culverts and also the replacement of channel walls. This may have a negative impact on the habitats of the SPA that support the bird interests for which the designation is cited. It may also impact on the habitats of the Great Channel Island SAC, however this is less likely given the distance of the SAC from the proposed works but potential impacts cannot be ruled out. There is also potential for disturbance and spread of invasive species, mainly Japanese Knotweed during the course of the works.	-75	-1	There is potential for negative impacts on Natura 2000 sites of Cork Harbour SPA and Great Channel Island SAC (located downstream of the proposed options) for Butlerstown Glenmore Option 4A of the flood relief scheme. The potential to impact on the Natura 2000 sites are mainly through the temporary impacts of pollution/sediment downstream during construction of the flood relief channel and culverts and also the replacement of channel walls. This may have a negative impact on the habitats of the SPA that support the bird interests for which the designation is cited. It may also impact on the habitats of the Great Channel Island SAC, however this is less likely given the distance of the SAC from the proposed works but potential impacts cannot be ruled out. There is also potential for disturbance and spread of invasive species, mainly Japanese Knotweed during the course of the works.	-75
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	Avoid damage to, and where possible enhance, legally protected sites / habitats and other sites / habitats of national, regional and local nature conservation importance	5	5	Professional judgement applied to scoring	-1	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option at The Grove mainly through the temporary impacts of pollution/sediment downstream during construction of direct defences. There may also be disturbance to species at a local level due to works and the potential spread of invasive species, mainly Japanese Knotweed during the course of the works.	-25	-1	There are a number of protected species that occur in the catchment including Otter, Eel, Atlantic Salmon, Brown Trout, Kingfisher and bat species. All of these species and other locally important species/ habitats could be potentially impacted by the proposed option at The Grove mainly through the temporary impacts of pollution/sediment downstream during construction of direct defences. There may also be disturbance to species at a local level due to works and the potential spread of invasive species, mainly Japanese Knotweed during the course of the works.	-25
	Protect and where possible enhance fisheries resource within the catchment	Maintain existing and where possible create new fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species	5	5	As per GN28 Guidance	-1	The Glashaboy is an important river for fisheries. This option however is unlikely to significantly affect river flows and fisheries. The potential spread of Japanese Knotweed may impact on fisheries through increased sediment release due to bank erosion when this weed dies off in winter.	-25	-1	The Glashaboy is an important river for fisheries. This option however is unlikely to significantly affect river flows and fisheries. The potential spread of Japanese Knotweed may impact on fisheries through increased sediment release due to bank erosion when this weed dies off in winter.	-25
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	Protect, and where possible enhance, visual amenity, landscape protection zones and views into/from designated scenic areas within the zone of influence	10	5	Visual impact and amenity is considered to be of high importance within the affected area.	0	Flood defence measures are relatively small in scale and once built, will be in character with the urban nature of the surrounding area.	0	0	Flood defence measures are relatively small in scale and once built, will be in character with the urban nature of the surrounding area.	0
	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods.	(i) Avoid damage to or loss of features of architectural value and their setting, and improve their protection from extreme floods where this is beneficial	5	2	Considered to be of significant importance due to the presence of St. Patrick's Mill within the affected area. Professional judgement applied to scoring.	-3	IPP difficult to provide to protected structure	-30	0	No effect on architectural heritage	0
	"	(ii) Avoid damage to or loss of features of archaeological value and their setting, and improve their protection from extreme floods where this is beneficial	5	2	Considered to be of significant importance due to the presence of St. Patrick's Mill within the affected area. Professional judgement applied to scoring.	-3	Construction of direct defences and IPP to St Patrick's Mill	-30	-2	Construction of direct defences	-20
			60				**Environmental Score**	**-260**		**Environmental Score**	**-220**
							MCA Benefit Score	**1175**		**MCA Benefit Score**	**1065**
							Option Selection Benefit Score	**1575**		**Option Selection Benefit Score**	**1865**
							Total Capital Costs (M€)	**0.55**		**Total Capital Costs (M€)**	**0.51**
							MCA Benefit/Cost Ratio	**2.15**		**MCA Benefit/Cost Ratio**	**2.11**

Multicriteria Analysis - Flood Risk Management Area 6

Core Criteria	Objective	Sub objective	Local Weighting Rationale	FRS OPTION 6A - IPP at The Fountains and Barry's Terrace			Do Nothing		
				SCORING	Rationale	MCA SCORE	SCORING	Rationale	MCA SCORE
Technical	Ensure flood risk management options are operationally robust	"	As per GN28 Guidance	0	IPP difficult to operate without flood warning system in place. Need human intervention to operate.	0	NA		-
	Minimise health and safety risk in construction and operation of the flood risk management option	"	As per GN28 Guidance	0	IPP risk of erecting during event and technical challenges of implementing due to potential seepage and poor/ old wall construction	0	NA		-
	Ensure flood risk can be managed effectively and sustainably into the future	"	As per GN28 Guidance	0	IPP unlikely adaptable to climate change	0	NA		-
					Technical Score	**0**		**Technical Score**	**NA**
Economic	Reduce economic damage	"	Damage assessment as per MCM and Gn28	1	Providing IPP would reduce economic damage to affected properties. Lack of forecasting system would limit this however.	150	NA		-
	Minimise risk to transport infrastructure	"	Professional judgement applied to scoring	0	NA	0	NA		-
	Minimise risk to utilities infrastructure	"	Professional judgement applied to scoring	0	NA	0	NA		-
	Minimise risk to agriculture	"	No negative impact on affected area	0	NA	0	NA		-
					Economic Score	**150**		**Economic Score**	**NA**
Social	Minimise risk to human health and life	(i) residents	Professional judgement applied to scoring	1	Providing IPP would reduce risk to affected properties. Lack of forecasting system would limit this however.	150	NA		-
	"	(ii) high vulnerability properties	No impact on affected areas	0	NA	0	NA		-
	Minimise risk to community	(i) social infrastructure	No impact on affected areas	0	NA	0	NA		-
	"	(ii) local employment	Professional judgement applied to scoring.	0	NA	0	NA		-
	Minimise risk to, and where possible enhance, social amenity sites	"	No impact on affected area.	0	NA	0	NA		-
					Social Score	**150**		**Social Score**	**NA**
Environmental	Support the objectives of the WFD	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives	As per GN28 Guidance	0	Direct defences likely to cause negative impacts to natural banks. Direct defences to prevent flood event from polluting river and downstream reaches.	0	NA		-
	Support the objectives of the Habitats and Birds Directives	Avoid detrimental effects to, and where possible enhance, Natura 200 network, protected species and their key habitats, recognising relevant landscape features and stepping stones.	Professional judgement applied to scoring	0	Natura 2000 sites of Cork Harbour SPA is located directly adjacent to the proposed property at Barry's Terrace and The Fountains. Construction work would consist of local works only and no impact is envisaged on the SPA. Great Channel Island SAC located downstream of the proposed options for the flood relief scheme. There is no inchanne works proposed as part of IPP. The SPA support the bird interests for which the designation is cited. Disturbance to bird interests of the SPA may be experienced during the construction of IPP, however this is period is very short and not significant. No operational impacts are envisaged	0	NA		-
	Avoid damages to, and where possible enhance, the flora and fauna of the catchment	Avoid damage to, and where possible enhance, legally protected sites / habitats and other sites / habitats of national, regional and local nature conservation importance	Professional judgement applied to scoring	0	as above	0	NA		-
	Protect and where possible enhance fisheries resource within the catchment	Maintain existing and where possible create new fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species	As per GN28 Guidance	0	as above	0	NA		-
	Protect and where possible enhance, landscape character and visual amenity within the zone of influence.	Protect, and where possible enhance, visual amenity, landscape protection zones and views into/from designated scenic areas within the zone of influence	Visual impact and amenity is considered to be of high importance within the affected area.	0	NA	0	NA		-
	Avoid damage to or loss of features of cultural heritage importance and their setting, and improve their protection from extreme floods.	(i) Avoid damage to or loss of features of architectural value and their setting, and improve their protection from extreme floods where this is beneficial	Considered to be of significant importance due to the presence of The Fountains Mills within the affected area. Professional judgement applied to scoring.	-2	Curtilage of Protected Structure RPS00485 corn mill will be changed by works to the mill race.	-20	NA		-
	"	(ii) Avoid damage to or loss of features of archaeological value and their setting, and improve their protection from extreme floods where this is beneficial	Considered to be of significant importance due to the presence of The Fountains Mills within the affected area. Professional judgement applied to scoring.	-3	Construction of flood defence walls adjacent to the River Glashaboy AAP1 will change the river.The setting of Recorded Monument RMP CO075-002001- will be changed by works to the mill race.	-30	NA		-
					Environmental Score	**-50**		**Environmental Score**	**NA**
					MCA Benefit Score	**250**		**MCA Benefit Score**	**NA**
					Option Selection Benefit Score	**250**		**Option Selection Benefit Score**	**NA**
					Total Capital Costs (M€)	**0.13**		**Total Capital Costs (M€)**	**0.00**
					MCA Benefit/Cost Ratio	**1.86**		**MCA Benefit/Cost Ratio**	**NA**

B3 Multicriteria Summary Analysis

Glashaboy River (Glanmire/Sallybrook) Flood Relief Scheme	OPTION 1A Direct Defences with conveyance improvements at Bleach Hill Stream	OPTION 2A Direct Defences (with conveyance improvements on Cois na Gleann Stream)	OPTION 2B Conveyance improvements (Dredging)	OPTION 2C Combination (Direct Defences and Conveyance) Arrangement 1	OPTION 2D Combination (Direct Defences and Conveyance) Arrangement 2	OPTION 2E Combination (Direct Defences and Conveyance) Arrangement 3	OPTION 2F Combination (Direct Defences and Conveyance) Arrangement 4	OPTION 3A Direct Defences (with conveyance improvements on Springmount Stream)	OPTION 4.1A Conveyance Improvements	OPTION 4.1B Direct Defences	OPTION 4.1C Overland Flow Management	OPTION 4.2A Overland Flow Management	OPTION 4.2B Culvert Upgrade	OPTION 5A Direct Defences with IPP	OPTION 5B Direct Defences only	OPTION 6A IPP at The Fountains and Barry's Terrace	OPTION 6B Do Nothing
Technical Score	**1000**	700	100	1100	1000	900	1000	**1100**	700	1100	**1400**	800	**1200**	400	**800**	0	**NA**
Economic Score	**750**	1070	1070	1070	1070	970	1070	**1030**	250	200	**150**	400	**700**	830	**830**	150	**NA**
Social Score	**1000**	1040	1070	1050	1050	950	1050	**1050**	655	505	**399**	505	**1025**	605	**455**	150	**NA**
Environmental Score	**-355**	-355	-1055	-205	-355	-305	-305	**-225**	-455	-465	**-25**	-210	**-525**	-260	**-220**	-50	**NA**
MCA Benefit Score	**1395**	1755	1085	1915	1765	1615	1815	**1855**	450	240	**524**	695	**1200**	1175	**1065**	250	**NA**
Option Selection Benefit Score	**2395**	2455	1185	3015	2765	2515	2815	**2955**	1150	1340	**1924**	1495	**2400**	1575	**1865**	250	**NA**
Total Capital Costs (M€)	**2.73**	3.67	3.17	3.74	3.30	3.09	3.50	**2.40**	0.37	0.32	**0.02**	0.31	**2.54**	0.55	**0.51**	0.13	**0.00**
MCA Benefit/Cost Ratio	**0.51**	0.48	0.34	0.51	0.53	0.52	0.52	**0.77**	1.21	0.75	**25.0**	2.25	**0.47**	2.15	**2.11**	1.86	**NA**