

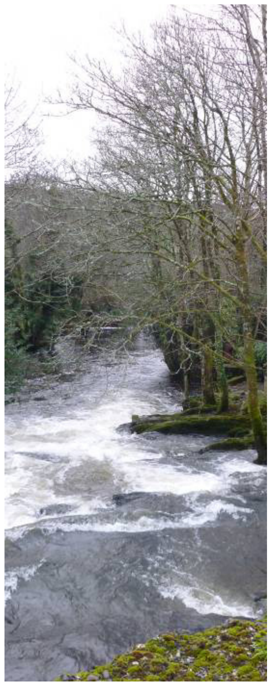

South Western CFRAM Study

Preliminary Options Report UoM 20

July 2016

The Office of Public Works

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Issue and Revision Record

Revision	Date	Originator	Checker	Approver	Description
A	December 2015	TD / RM / JD	B. O'Connor	F. McGivern	Draft Issue
B	February 2016	T. Donovan	B. O'Connor	F. McGivern	Draft Issue
C	May 2016	T. Donovan	B. O'Connor	F. McGivern	Draft Final
D	June 2016	T. Donovan	B. O'Connor	F. McGivern	Final
E	July 2016	J Desmond	T Donovan	F McGivern	Final

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Executive Summary

The Office of Public Works (OPW) is undertaking six catchment-based flood risk assessment and management (CFRAM) studies to identify and map areas across Ireland which are at existing and potential future risk of flooding. Mott MacDonald Ireland Ltd. has been appointed by the OPW to assess flood risk and develop flood risk management options in the South Western River Basin District. This Preliminary Options Report is one of a series of reports being produced as part of the South Western Catchment Flood Risk Assessment and Management Study (SW CFRAM Study). This report details the analysis undertaken to identify the preferred measures and options to manage flood risk in Unit of Management 20 (The Bandon / Skibbereen Catchment) which will form the basis for the Flood Risk Management Plan for this Unit of Management.

The preferred Flood Risk Management Options selected for inclusion in the Flood Risk Management Plan for UoM 20 are set out below.

- Planning Control
- Building Regulations
- SUDS
- Flood Forecasting and Warning Systems
  - Inishannon – build on existing Bandon Flood Early Warning System
- Public Awareness
- Individual Property Flood Resilience
- Land Use Management

The preferred Flood Risk Management Options for each of the AFAs in UoM 20 include those measures listed above and those measures listed below.

The preferred option for Dunmanway as identified in the MCA is Flood Defences. However, this option and all other potential options are not cost beneficial.

The preferred option for Inishannon as identified in the MCA is Flood Defences. As an interim measure, before the preferred option is implemented, the installation of flood forecasting and warning system that ties into the existing Bandon Flood Early Warning System would be of benefit in Inishannon.

The preferred option for Schull as identified in the MCA is the construction of a Culvert on the Schull Stream and Flow Diversion on the Meenvane Stream. The preferred route for the culvert is in the back of gardens along the route of the existing stream as opposed to locating the culvert in the road.

1 Introduction

1.1 Background

Flooding is a natural process that occurs throughout Ireland as a result of extreme rainfall, river flows, storm surges, waves, and high groundwater. Flooding can become an issue where the flood waters interact with people, property, farmland and protected habitats.

Flood risk in Ireland has historically been addressed through the use of structural or engineered solutions (arterial drainage schemes and / or flood relief schemes). In line with internationally changing perspectives, the Government adopted a new policy in 2004 that shifted the emphasis in addressing flood risk towards:

- A catchment-based context for managing risk;
- More pro-active flood hazard and risk assessment and management, with a view to avoiding or minimising future increases in risk, such as that which might arise from development in floodplains;
- Increased use of non-structural and flood impact mitigation measures.

A further influence on the management of flood risk in Ireland is the 'Floods' Directive [2007/60/EC]. The aim of this Directive is to reduce the adverse consequences of flooding on human health, the environment, cultural heritage and economic activity.

The Office of Public Works (OPW) is the lead agency in implementing flood management policy in Ireland. The OPW have commissioned a number of Catchment Flood Risk Assessment and Management Studies in order to assess and develop Flood Risk Management Plans (FRMPs) to manage the existing flood risk and also the potential for significant increases in this risk due to climate change, ongoing development and other pressures that may arise in the future.

Mott MacDonald Ireland Ltd. has been appointed by the OPW to undertake the Catchment-Based Flood Risk Assessment and Management Study (CFRAM Study) for the South Western River Basin District, henceforth referred to as the SW CFRAM Study. Under the project, Mott MacDonald Ireland Ltd. will produce FRMPs which will set out recommendations for the management of existing flood risk in the Study Area, and also assess the potential for significant increases in this risk due to climate change, ongoing development and other pressures that may arise in the future.

1.1 SW CFRAM Study Process

The overarching aims of the SW CFRAM Study are as follows:

- Identify and map the existing and potential future flood hazard;
- Assess and map the existing and potential future flood risk; and,
- Identify viable structural and non-structural options and measures for the effective and sustainable management of flood risk in the South Western River Basin District.

In order to achieve the overarching aims, the study is being undertaken in the following stages:

- Data collection;
- Hydrological analysis;
- Hydraulic analysis;
- Development of flood maps;
- Strategic Environmental Assessment and a Habitats Directive Appropriate Assessment;
- Flood risk assessment of people, economy and environment;
- Development and assessment of flood risk mitigation options; and,
- Development of the Flood Risk Management Plan (FRMP).

The resultant FRMP will set out recommendations for the management of existing flood risk and the potential for significant increases in this risk due to climate change, ongoing development and other pressures that may arise in the future.

The South Western River Basin District is split into five Units of Management (UoM). These Units follow watershed catchment boundaries and do not relate to political boundaries. The Units are as follows;

- The Blackwater catchment (UoM 18)
- The Lee / Cork Harbour Catchment (UoM 19)
- The Bandon / Skibbereen Catchment (UoM 20)
- The Dunmanus / Bantry / Kenmare Bay Catchment (UoM 21)
- The Laune / Maine / Dingle Bay Catchment (UoM 22)

1.2 Report Structure

Table 1.1: Report Structure

Chapter	Key Contents of Chapter
1. Introduction	▪ Context of the Study ▪ The SW CFRAM process and aims ▪ Scope of Work
2. Description of the Unit of Management	▪ Description of study area ▪ Description of Spatial Scales of Assessment
3. Screening of Possible Flood Risk Management Measures	▪ Description of the Screening Process ▪ Outcome of the Screening Process
4. Possible Flood Risk Management Measures	▪ Description of Non-structural FRM measures ▪ Description of Viable Structural measures
5. Development of Potential Flood Risk Management Options for AFAs	▪ Description of Viable FRM Options
6. Environmental Assessment	▪ Assessment of environmental impacts of Viable FRM Options
7. Stakeholder Input	▪ Principal outputs and findings of design hydrology ▪ Preliminary design flows and hydrographs for hydraulic modelling
8. Flood Risk Assessment	▪ Description of the Flood Risk Assessment Process ▪ Description of Receptors ▪ Description of Flood Risk maps
9. Estimate of Costs	▪ Estimate of costs of Viable Options
10. Appraisal of Options	▪ Description of the derivation of Local Weightings ▪ Description of the Multi Criteria Analysis Process
11. Selection of Preferred Options	▪ Description of preferred options

2 Description of the Unit of Management

2.1 Spatial Scales of Assessment

The South Western River Basin District covers an area of approximately 11,160 km^2. The Study Area includes most of County Cork, large parts of Counties Kerry and Waterford, along with small parts of the counties of Tipperary and Limerick. The Study Area contains over 1,800 km of coastline along the Atlantic Ocean and the Celtic Sea. There are five Units of Management within the South Western River Basin District, which are listed below:

- The Blackwater catchment (UoM18)
- The Lee / Cork Harbour Catchment (UoM19)
- The Bandon / Skibbereen Catchment (UoM20)
- The Dunmanus / Bantry / Kenmare Bay Catchment (UoM21)
- The Laune / Maine / Dingle Bay Catchment (UoM22)

Within the CFRAM Study, the screening, assessing and developing of flood risk management methods and options is to be considered on a range of Spatial Scales of Assessment (SSAs) that shall include:

- The Units of Management (UoM)
- Each Sub-Catchment within the Unit of Management
- Areas for Further Assessment (AFAs)
- Individual Risk Receptors (IRRs)

2.2 Spatial Scales of Assessment for Unit of Management 20

Within UoM 20 the River Bandon could be considered as a Sub-Catchment SSA as Dunmanway and Inishannon have been identified as AFA’s. However, hydraulically the AFA’s are far removed and the town of Bandon is located between the AFAs. Bandon is not included in SW CFRAM Study as a separate study has already been undertaken for this town. Therefore, no Sub-Catchment SSAs are considered within UoM 20.

No IRRs have been identified within the South Western RBD and as such are not considered.

Based on the above, UoM 20 is split into 2 Spatial Scales of Assessment (SSAs). These are:

- The Unit of Management (UoM)
- Areas for Further Assessment (AFAs)
  - Clonakilty
  - Dunmanway
  - Inishannon
  - Schull

It should be noted that the development of preliminary options for Clonakilty has been progressed prior to the preparation of this report due to significant flood events in June 2012. The development of preliminary options for Clonakilty are contained in a separate report.

3 Screening of Possible Flood Risk Management Methods

3.1 General

A flood risk management option consists of one or, more commonly, a combination of flood risk management (FRM) methods or measures. The OPW have identified a range of possible FRM methods that could apply to areas at risk from flooding. The screening of possible FRM methods to determine their applicability and viability is carried out in this section.

3.2 Screening of Possible Flood Risk Management Methods

A preliminary assessment was carried out to identify which Flood Risk Management (FRM) methods were applicable to each of the SSAs within UoM 20.

The applicability and viability of each of the FRM methods was considered in terms of the following criteria:

- Applicability to the SSA
- Economic (potential benefits, impacts, likely costs etc.)
- Environmental (potential impacts and benefits)
- Social (impacts on people, society and the likely acceptability of the method) and
- Cultural (potential benefits and impacts upon heritage sites and resources)

The viability of each of the methods was assessed to a preliminary degree only. The purpose of the screening process was to identify the FRM methods that are clearly not applicable or viable within UoM 20. The FRM methods considered and the outcome of the screening process are shown in Table 3.1 below.

Table 3.1: Screening of Possible Flood Risk Management Methods

Measures / Methods	UoM	Sub-Catchment	AFA		
			Dunmanway	**Inishannon**	**Schull**
Do Nothing	Not Viable	N/A	Not Viable	Not Viable	Not Viable
Existing Regime	Not Viable	N/A	Not Viable	Not Viable	Not Viable
Do Minimum	Not Viable	N/A	Not Viable	Not Viable	Not Viable
Non-structural Measures					
• Planning Control	Viable	N/A	Viable	Viable	Viable
• Building Regulations	Viable	N/A	Viable	Viable	Viable
• SUDS	Viable	N/A	Viable	Viable	Viable
• Flood Forecasting	Viable	N/A	Viable	Viable	Not Viable
• Public Awareness	Viable	N/A	Viable	Viable	Viable
• Individual Property Flood Resilience	Viable	N/A	Viable	Viable	Viable
• Land Use Management	Viable	N/A	Viable	Viable	Viable
Structural Measures (Future Risk)					
• Strategic Development Management	Viable	N/A	Viable	Viable	Viable
Structural Measures (Current Risk)					
• Fluvial Storage	Not Viable	N/A	Viable	Not Viable	Viable
• Flow Diversion	Not Viable	N/A	Viable	Not Viable	Viable
• Increase Conveyance	Not Viable	N/A	Viable	Viable	Viable
• Flood Defences	Not Viable	N/A	Viable	Viable	Viable
• Improve existing defences	Not Viable	N/A	Not Viable	Not Viable	Not Viable
• Relocate Properties	Viable	N/A	Not Viable	Not Viable	Not Viable
• Localised protection works	Not Viable	N/A	Viable	Viable	Viable
Channel or Flood Defence Maintenance Works	Viable	N/A	Viable	Not Viable	Not Viable
Other Works	-	N/A	Not Viable	Not Viable	Not Viable

3.3 Screening of UoM scale FRM Methods

3.3.1 Do Nothing / Existing Regime / Do Minimum

These measures are not viable due to the significant flood risk within UoM 20 to the economy and society for extreme events in the current and future scenarios.

3.3.2 Structural Measures (Current Risk)

Structural measures are typically not applicable to UoM scale SSAs due to cost and the likely significant social and environmental impacts of such works. Also, within UoM scale SSAs there are areas and receptors which are less vulnerable to flooding. Structural measures are more appropriate and applicable to AFA scale SSAs.

However, structural measures such as upstream storage and relocation of properties can be viable structural measures on a UoM scale.

3.4 Screening of Sub-Catchment scale FRM Methods

As outlined in Section 2.2 there are no sub-catchments within UoM 20.

3.5 Screening of AFA scale FRM Methods

This section details each of the non-viable measures which have been screened out from further assessment. The remaining viable Flood Risk Management measures are assessed further in Chapter 4 and Chapter 5.

3.5.1 Do Nothing / Existing Regime

These measures are not viable due to the significant flood risk to the economy and society for extreme events in the current scenario and for future scenarios.

3.5.2 Do Minimum (e.g. Infilling of gaps etc.)

Within the AFAs considered there are no identifiable points or locations where minimum works such as infilling of gaps etc. would lead to a reduction in flood risk. Therefore, the do minimum approach is not a viable measure as it is not applicable.

3.5.3 Dunmanway – Improve Existing Defences

The existing flood defences in Dunmanway already provide the required standard of protection to the 1% AEP fluvial event. The flood risk identified in Dunmanway under this study is to areas which are currently undefended. Therefore, improving existing defences is not a viable measure as it is not applicable.

3.5.4 Dunmanway – Relocate Properties

There are 7 residential and 21 non-residential properties at risk from flooding in the 1% AEP flood event in Dunmanway. The potential benefit in Dunmanway is €792,000. It is not economically viable to relocate the at risk properties as to do so would cost more than the €28,000 available for each property.

3.5.5 Inishannon – Fluvial Storage

There are no suitable locations upstream of Inishannon to store the volume required to reduce the flood risk. The peak flow upstream of Inishannon for the 1% AEP event is 398m3/s. To reduce the peak flow to the 10% AEP event (228m3/s) for which Inishannon is still at flood risk would require a storage area of 739,600m2 with a depth of water of 5m.

In addition, a fluvial storage area with control structure would increase rivers levels and flood risk upstream in areas already at significant risk. This measure is not applicable.

3.5.6 Inishannon – Flow Diversion

Due to the magnitude of flows in the River Bandon (398m3/s for the 1% AEP event) and its location within a valley it is not economically feasible to divert flows.

3.5.7 Inishannon – Improve Existing Defences

There are no existing flood defences in Inishannon. This measure is not applicable.

3.5.8 Inishannon – Relocate Properties

There are 24 Nr. residential properties and 17 Nr. non-residential properties at risk from the design event. The scheme benefit is approx. €3.2M. It is not economically viable to relocate properties at a cost of €77k per property.

It would cost considerably more to relocate non-residential properties / businesses which may also suffer from moving away from the town centre. This measure is not economically viable.

3.5.9 Inishannon – Channel or Flood Defence Maintenance Works

Inishannon does not have an existing channel scheme or flood defence scheme to maintain. This measure is not applicable.

3.5.10 Schull – Flood Forecasting

Flood forecasting is unlikely to be an effective measure due to the catchments rapid response to rainfall which is less than 0.5 hours. This measure is not applicable.

3.5.11 Schull – Improve Existing Defences

There are no existing flood defences in Schull. This measure is not applicable.

3.5.12 Schull – Relocate Properties

There are no isolated properties at risk within Schull. There are 25 residential and 22 non-residential properties at risk in Schull. The potential benefit in Schull is €8.9 million. It is not economically viable to relocate this number of properties as the amount available for each property is €189,000 which is less than the market price for residential properties.

3.5.13 Schull – Channel or Flood Defence Maintenance Works

Schull does not have an existing channel scheme or flood defence scheme to maintain. This measure is not applicable.

4 Possible Flood Risk Management Measures

4.1 General

A flood risk management option consists of one or, more commonly, a combination of flood risk management methods / measures. This section assesses the possible flood risk management measures as screened in Table 3.1.

4.2 Non-Structural Measures

Non-structural measures such as Land Use Management, Natural Flood Management, Green Infrastructure etc. are terms used to cover a suite of measures that are intended to reduce flood risk by working with natural systems and, where possible, provide environmental benefits. While in small catchments they can effectively manage flood risk to a certain degree in their own right, in larger catchments they can work in a complimentary way with other measures to achieve flood risk management targets.

Due to the time required to initiate, establish and prove the flood risk management targets of such measures, they are not deemed viable to mitigate the current flood risk and any potential reductions in flood risk should not be considered when developing other options based on structural measures.

Where there is existing flood risk, the implementation of non-structural measures such as Planning Control, SUDS etc. at any spatial scale of assessment will not mitigate flood risk, unless those measures are retrospectively applied. As this is unrealistic and not economically viable, such non-structural measures can only be applied to new development to maintain the status quo of the current flood risk scenario or mitigate future flood risk. The application of non-structural measures such as individual property resilience, public awareness and flood forecasting, to redevelopment or new development may reduce potential damage costs.

The non-structural measures described in this section are complimentary to structural measures and should be implemented as national policy to the SSAs where appropriate. However, at this stage they should not be considered in the development of options based on structural measures.

4.2.1 Planning Control

In November 2009, the Guidelines on the Planning System and Flood Risk Management, jointly developed by DECLG and the OPW, were published under Section 28 of the Planning Acts. These Guidelines provide a systematic and transparent framework for the consideration of flood risk in the planning and development management processes, whereby:

A sequential approach should be adopted to planning and development based on avoidance, reduction and mitigation of flood risk.

A flood risk assessment should be undertaken that should inform the process of decision-making within the planning and development management processes at an early stage.

Development should be avoided in floodplains unless there are demonstrable, wider sustainability and proper planning objectives that justify appropriate development and where the flood risk to such development can be reduced and managed to an acceptable level without increasing flood risk elsewhere (as set out through the Justification test).

The proper application of the Guidelines by the planning authorities is essential to avoid inappropriate development in flood prone areas, and hence avoid unnecessary increases in flood risk into the future. The flood mapping provided as part of the FRMP will facilitate the application of the Guidelines.

In flood-prone areas where development can be justified (i.e., re-development, infill development or new development that has passed the Justification Test), the planning authorities can manage the risk by setting suitable objectives or conditions, such as minimum floor levels or flood resistant or resilient building methods.

A report on the Spatial Planning and Flood Risk has been prepared for the UoM. This report is included in Appendix G.

4.2.2 Building Regulations / Planning Conditions

The risk of damage to properties from flooding can be mitigated by the use of appropriate construction techniques and materials. For example the damage caused to an internal wall of a property by flooding can depend on the materials and methods of its construction. A timber stud partition covered with plasterboard with low level electrical wiring would have to be completely replaced following immersion in flood water. However, a solid concrete block wall covered with tiles and high level electrical wiring on the other hand would only have to be washed down following a flood.

If for a particular town or high flood probability areas, certain building regulations or planning conditions were adopted that ensured structures were flood resilient through specified construction methods, building fabrics and uses, a decrease in the risk of damage could be achieved. The question of whether such regulations or planning conditions could be imposed upon developers, business owners or householders in

flood prone areas would need to be addressed if this were to be brought forward as a flood risk management measure.

A link to a UK guidance document “Improving the Flood Performance of New Buildings” prepared by the Department for Communities and Local Government is provided below.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/7730/flood_performance.pdf

4.2.3 Sustainable Urban Drainage Systems (SUDS)

Sustainable Urban Drainage (SUDS) involves the management of surface water run-off from developments in a manner which attempts to replicate the natural behaviour within catchments and watercourses, which is typically achieved through attenuation.

Within existing urban or developed areas there is typically little space available for the attenuation of storm water flows to a degree which would mitigate or reduce current flood risk. Therefore, it is not considered practical to implement SUDS for the mitigation of current risk at any SSA. However, within all SSAs every new developments (and where possible redevelopment), should apply the principles of SUDS.

A separate Strategic SUDS report has been prepared for UoM 20 outlining potential SUDS measures in the AFAs. These measures focus on areas that are zoned for future development.

4.2.4 Flood Forecasting and Warning

Flood forecasting is a means of providing advanced warning of an impending flood event. A reliable advance warning system allows protective measures to be put in place and protective actions to be carried out in advance of a flood event. These actions and measures can reduce the damage caused in a flood event.

Flood forecasting is not a possible FRM measure at all SSAs. This is because the time between transmitting a flood forecast in which the authorities have reasonable confidence and the arrival of flood waters may not be long enough for people to take effective action to reduce flood damage. The minimum time to take effective action is deemed to be 6 hours. This time limit is set on the basis that once rainfall has been recorded it can take up to 2 hours to run a complex model and get meaningful forecasts. Following this forecast it is assumed that it can take people up to 3 hours to travel to their home or business and take the necessary measures to protect their property from flooding.

Flood forecasting and warning has been identified as a possible FRM measure for the SSAs highlighted in Table 4.1. Table 4.1 highlights the time to peak for the critical event (Fluvial = 1% AEP event / Tidal = 0.5% AEP event) and summarises the infrastructure required to implement a flood forecasting and warning system. The infrastructure required is based upon the layout of the catchment and the arrangement of watercourses that could contribute to flood flows. Gauges are located at critical locations in the catchment so that data on precipitation and rising river levels can be collected and analysed to feed into the forecasting system.

The accuracy of the forecasting system will depend on the number of river level and rain gauges collecting data. The more gauges there are the greater the accuracy of the system. The cost and complexity of the system will also increase with more gauges. This will give more accurate forecasts but it will take longer for the system to generate them.

Table 4.1: SSAs Suitable for Flood Forecasting

Spatial Scale of Assessment	Time to Peak of Event	Infrastructure
AFA		
Dunmanway	> 6 Hours (on Bandon)	Rain gauges River level gauges Build on existing Bandon Flood Early Warning System
Inishannon Fluvial	> 6 Hours	Build on the existing Bandon Flood Early Warning System
Inishannon Tidal	> 6 Hours	Use the existing OPW storm surge forecasting system to predict high tide levels.
UoM		
River Bandon	> 6 Hours	Build on the existing Bandon Flood Early Warning System Use the existing OPW storm surge forecasting system to predict high tide levels.

Source: UoM 20 Hydraulics Report

An equation to estimate the impacts of flood warnings on flood damages has been developed by Green & Penning-Rowsell. This equation determines that the estimated actual flood damage avoided owing to flood warnings is approximately 13% of potential damages.

4.2.4.1 Dunmanway

The infrastructure required for a flood forecasting and warning system in Dunmanway (AFA) is listed in Table 4.2 and the proposed locations are shown in Figures 4.1 and 4.2.

Table 4.2: Dunmanway – Flood Forecasting Infrastructure

Equipment	Quantity
Rain Gauges	6
River Level Gauge (Hydrometric Gauging Station)	4

Figure 4.1: Dunmanway – Dirty River – Proposed Gauges

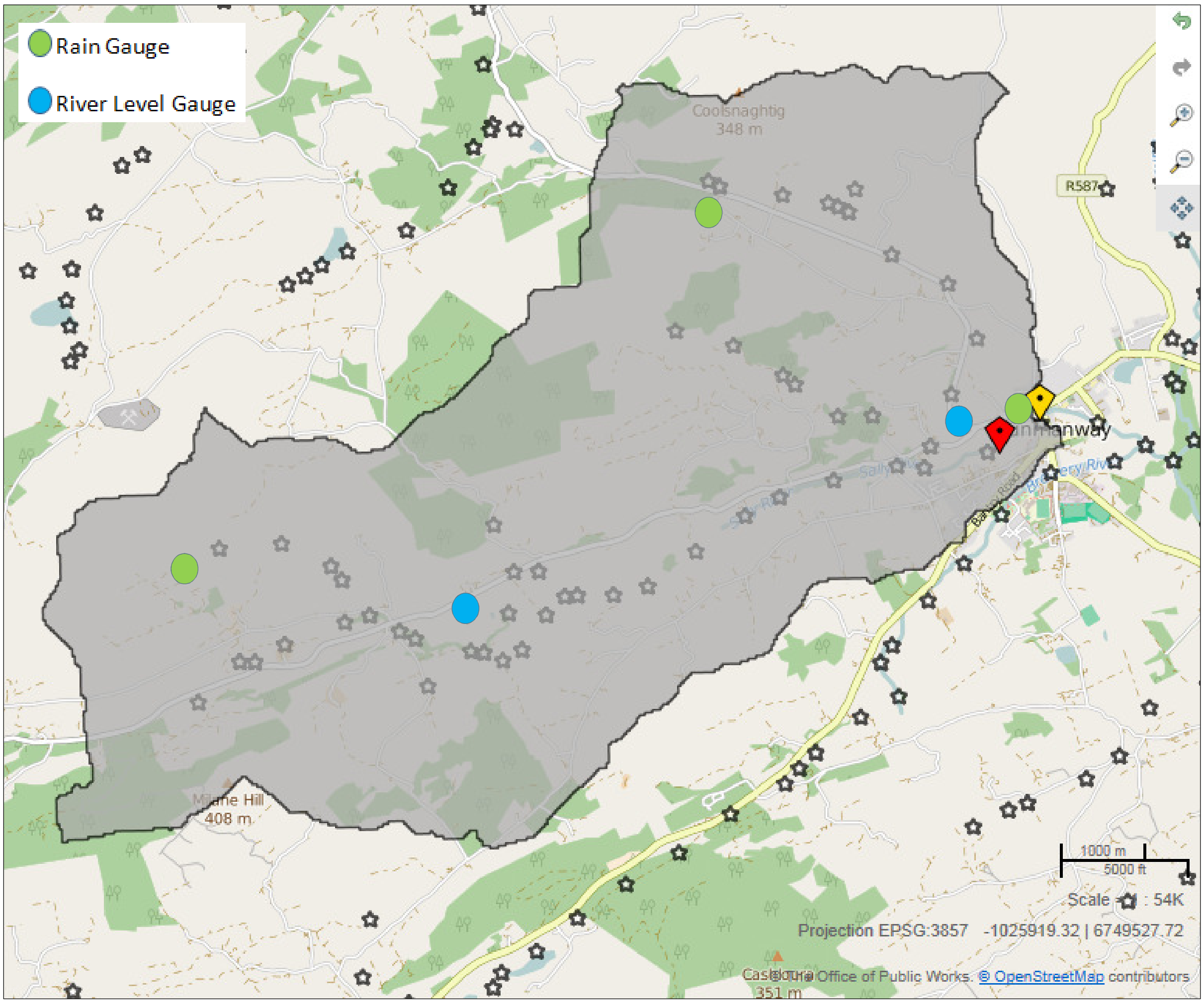
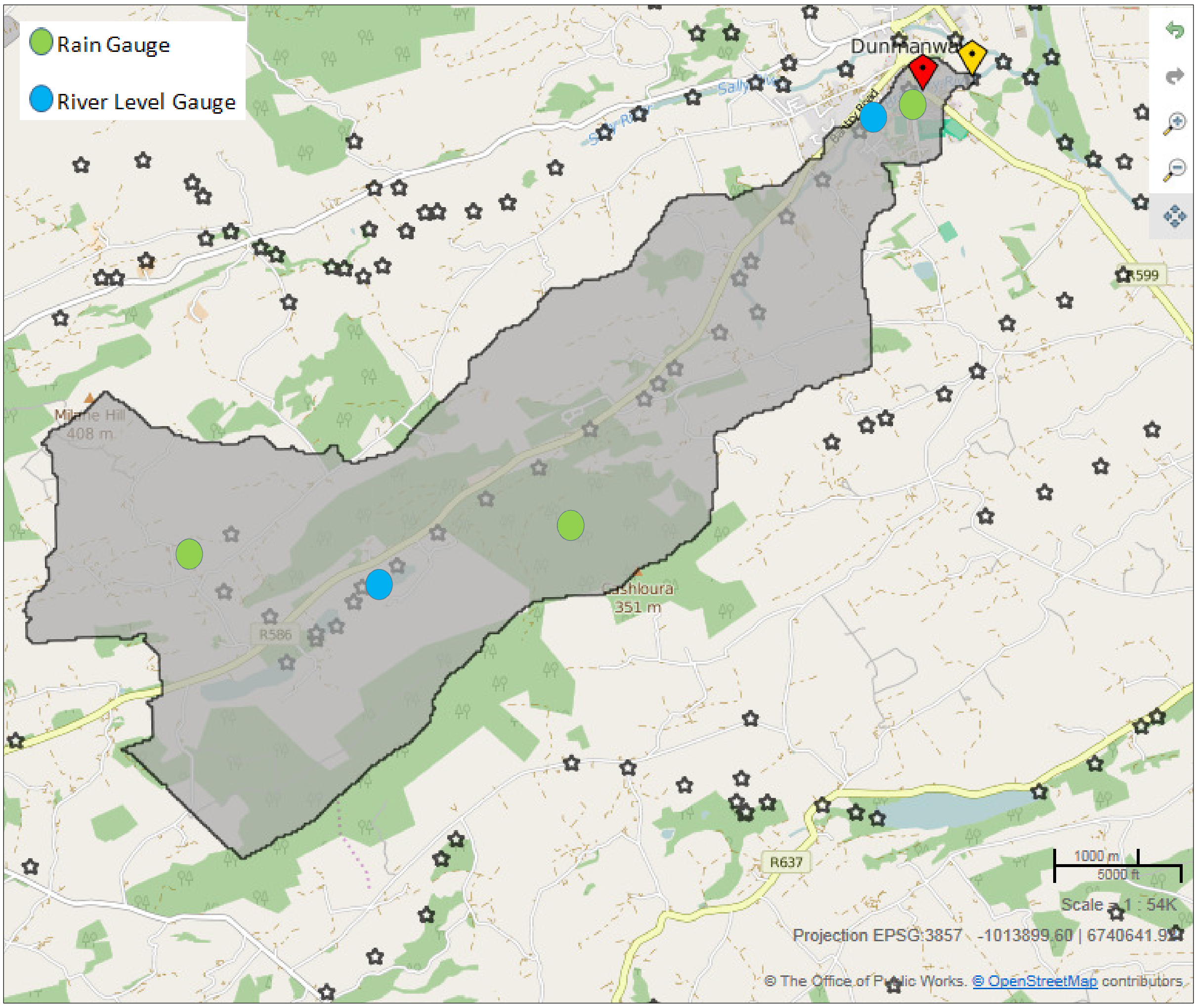


Figure 4.2: Dunmanway – Brewery River – Proposed Gauges



The infrastructure listed and shown above would also be required for a Sub-Catchment scale forecasting system which would build on the existing Bandon Flood Early Warning System (FEWS).

Cost estimates for the proposed flood forecasting and warning systems are included in Section 6.0.

4.2.5 Public Awareness

Many of the measures to mitigate and manage flood risk and the potential consequences for flooding will involve the public at large. It is therefore important that the public is made aware of where to find information, what the information means and what actions the public and business owners can take to reduce the damage that would occur to their properties, possessions and interests in the event of a flood.

Public awareness measures will engender the public's recognition of the potential of the risk of flooding and the potential consequences thereof. Knowing in advance means that actions can be taken in a timely manner.

Measures to increase and promote public awareness include:

- Identifying the areas prone to flooding
- Information on measures to be implemented to reduce and / or manage the risk of flooding
- Measures in place to provide advance warning of flooding
- Establishment of methods to interface with the public and in particular the owners of vulnerable properties, i.e. workshops and meetings, Facebook, Twitter, text messaging, newsprint, websites, etc.

Flood risk maps and flood hazard maps have been produced for the UoM 20 AFAs. The dissemination of this information to the public will increase awareness.

4.2.6 Individual Property Flood Resilience

It is possible to reduce the damage caused by flooding to a property by carrying out works that make the property more flood resilient. Such works could include replacing porous floor and wall coverings with tiles or other non porous finishes or raising electrical sockets to a level above the design flood level. Table 4.3 below shows the number of properties at risk from the 1% (or 0.5% for coastal flooding) AEP flood event in each AFA, the potential benefit achievable in each AFA and the total budget available for flood resilience works in each property. This budget is the benefit for the design event divided by the number of properties at risk. When account is taken of Optimism Bias (40%), preliminaries (32%) and design fees (13%) the total construction cost includes 85% of the available budget relates to non construction costs. This means that only 15% of the total budget is available for the construction of flood resilience measures. This basic flood resilience budget indicates if individual property flood resilience is a viable option in each AFA. It is assumed that a basic budget of €7,500 is required for each property in order for it to be viable.

Table 4.3: Individual Property Flood Resilience

AFA	Residential Properties at Risk	Non-residential Properties at Risk	Capped Benefit €	Total IPFR budget €	Basic IPFP budget €	Viable Y/N
Dunmanway	7	21	791,541	28,269	4,240	N
Inishannon	26	17	3,152,279	73,308	10,996	Y
Schull	25	22	8,917,474	189,733	28,460	Y

This analysis indicates that Individual Property Flood Resilience is a viable option for Inishannon and Schull. This flood risk management measure should be explored further if no structural flood risk management measures are found to be viable for these AFAs.

4.2.7 Land Use Management

Land Use Management can be utilised as a non-structural measure to prevent or reduce the impact of flooding on properties, roads and other critical infrastructure. Land Use Management includes strategies to control overland flow, such as improving agricultural and forestry practices in key catchment areas. Local natural flood management measures such as the creation of wetlands or forestry to retain overland flow could also be adopted.

4.2.8 Emergency Response Planning

Well prepared and executed emergency response plans can significantly reduce the impact of flood events, particularly for human health and welfare.

The Framework for Major Emergency Management was developed in 2005 and was adopted by Government decision in 2006. Its purpose is to set out common arrangements and structures for front line public sector emergency management in Ireland. The Framework is based on the internationally recognized systems approach that, in essence, proposes an iterative cycle of continuous activity through five stages of emergency management:

- Hazard Identification
- Mitigation
- Preparedness
- Response
- Recovery

Under the Framework, Local Authorities are designated as the lead agency for co-ordinating the response to severe weather events, and each Local Authority should have, as a specific sub-plan of its Major Emergency Plan, a plan for responding to severe weather emergencies, whether a major emergency is declared or not. The other principal response agencies should include sub-plans for responding to notifications from the Local Authorities of severe weather warnings.

A Guide to Flood Emergencies (MEM Guidance Document 11, July 2013) has been published to assist the Principal Response Agencies in meeting their responsibilities, under the Framework for Major Emergency Management, and to deliver on the responsibilities of the OPW and the Local Authorities with respect to emergency planning as set out in the Report of the Flood Policy Review Group. The Guide provides advice on the development and implementation of consistently effective flood emergency response and short-term recovery planning by the Principal Response Agencies and others, and includes a template plan.

4.3 Structural Measures

4.3.1 General

As highlighted above, a flood risk management option consists of one or, more commonly, a combination of flood risk management methods / measures. Therefore, please note that some of the following structural measures may be required in combination to provide a potential flood risk management option that will mitigate both fluvial and tidal flood risk.

The possible flood risk management measures for each of the AFAs being considered are detailed in Table 4.4 below.

Table 4.4: Possible Structural Measures

AFA	Dunmanway	Inishannon	Schull
Fluvial Storage	Y	N	Y
Flow Diversion	Y	N	Y
Increase Conveyance	Y	Y	Y
Flood Defences	Y	Y	Y
Improve Existing Defences	N	N	N
Relocate Properties	N	N	N
Localised Protection Works	Y	Y	Y
Other works	N	N	N

Details of the possible flood risk management measures and how they can be combined into potential options are included in Section 5.

5 Development of Potential Flood Risk Management Options for AFAs

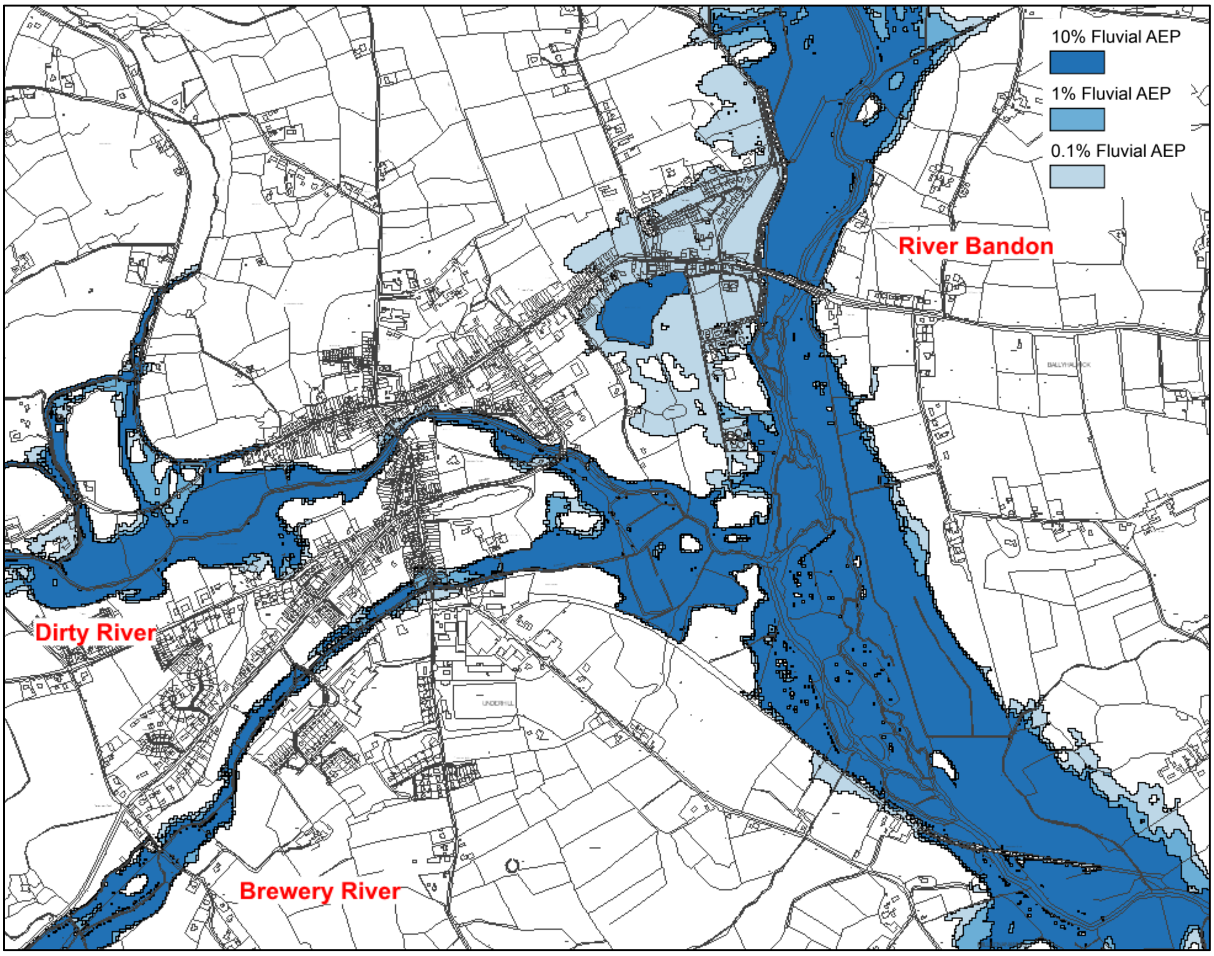
5.1 General

A Flood Risk Management (FRM) option consists of one, or more commonly a combination of FRM measures. This section outlines the development of the potential Flood Risk Management (FRM) options for each of the AFA's within UoM 20.

5.2 Dunmanway, Co. Cork

Dunmanway is located at the confluence of the River Bandon and its tributaries the Brewery and Dirty Rivers in County Cork. Dunmanway is at risk of fluvial flooding. The AFA and the existing fluvial flood risk are highlighted in Figure 5.1.

Figure 5.1: Dunmanway – Current Scenario Fluvial Flood Extents



5.2.1 Possible FRM Measures

As outlined in Section 3.0, the screening process identified the following possible flood risk mitigation measures:

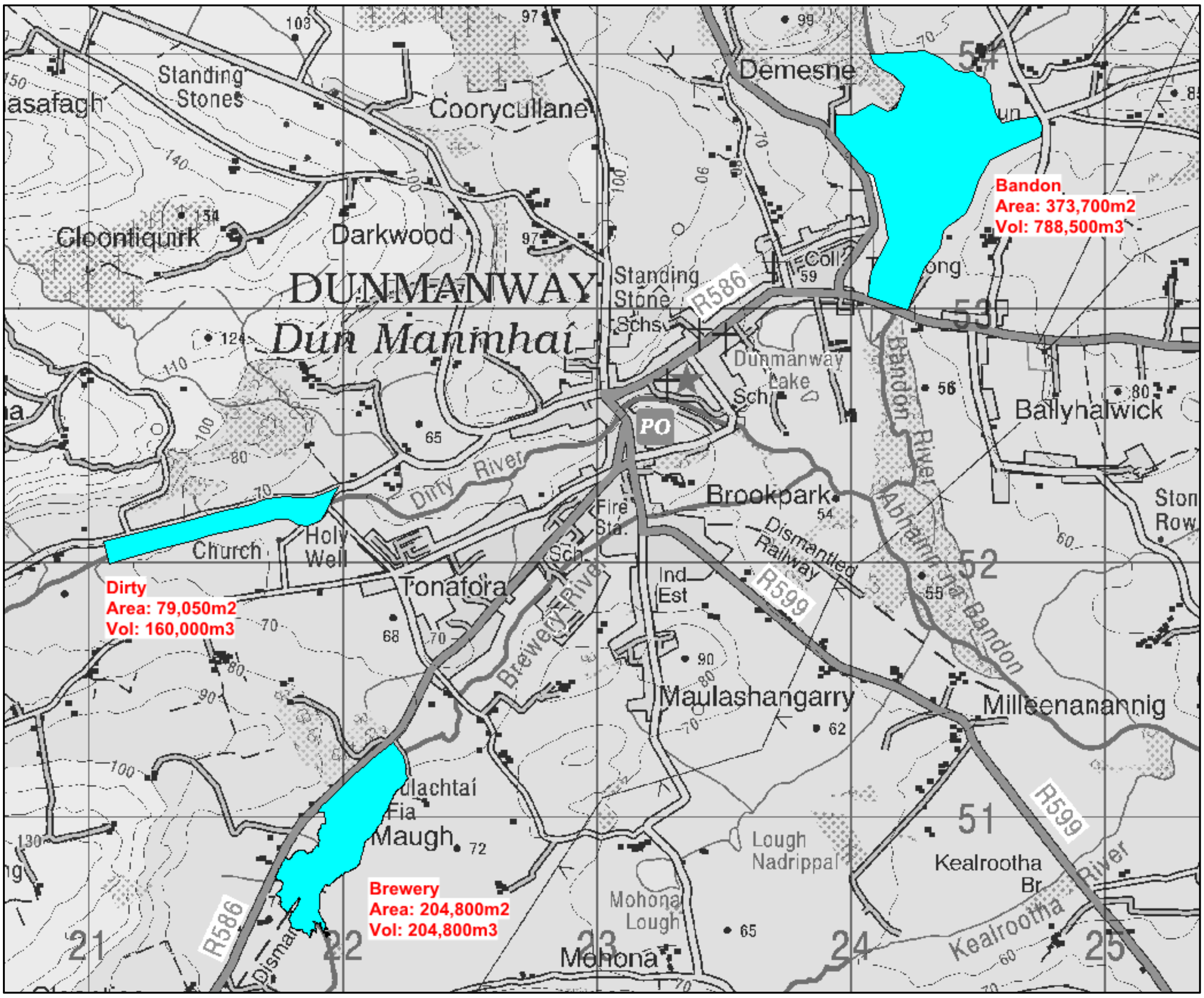
- Storage
- Increase Conveyance
- Flow Diversion
- Flood Defences (Fluvial)

The possible measures were reviewed and assessed further to determine if they were applicable and viable. The measures were modelled individually to determine their effectiveness and impact.

5.2.1.1 Storage

Dunmanway is located at the confluence of the River Bandon and its tributaries the Brewery and Dirty Rivers. Potential locations for the storage of fluvial flows were identified on each of the rivers and an assessment of the available storage capacity was carried out. The locations of the potential storage areas are shown in Figure 5.2.

Figure 5.2: Dunmanway – Location of Storage Areas



The required capacities of the storage areas are derived using the catchment hydrology as applied in the hydraulic modelling. No allowances for uncertainties in the estimate of the index flood flow or flood growth curve have been made.

The peak flow in the Dirty River at the storage location for the 1% AEP event is 17.32m3/s which results in flooding along the watercourse and through the town at Bridge Street. The storage area on the Dirty River is 79,050m2 and has a capacity of approx. 160,000m3 which can limit the outflow to approx. 10.05m3/s. This equates to the peak of the 20% AEP event.

The peak flow in the Brewery River for the 1% AEP event is 13.13m3/s which results in flooding along the watercourse and at Brewery Bridge. The storage area on the Brewery River is 204,800m2 and has a capacity of approx. 204,800m3 which can limit the outflow to approx. 7.75m3/s. This equates to the peak of the 20% AEP event.

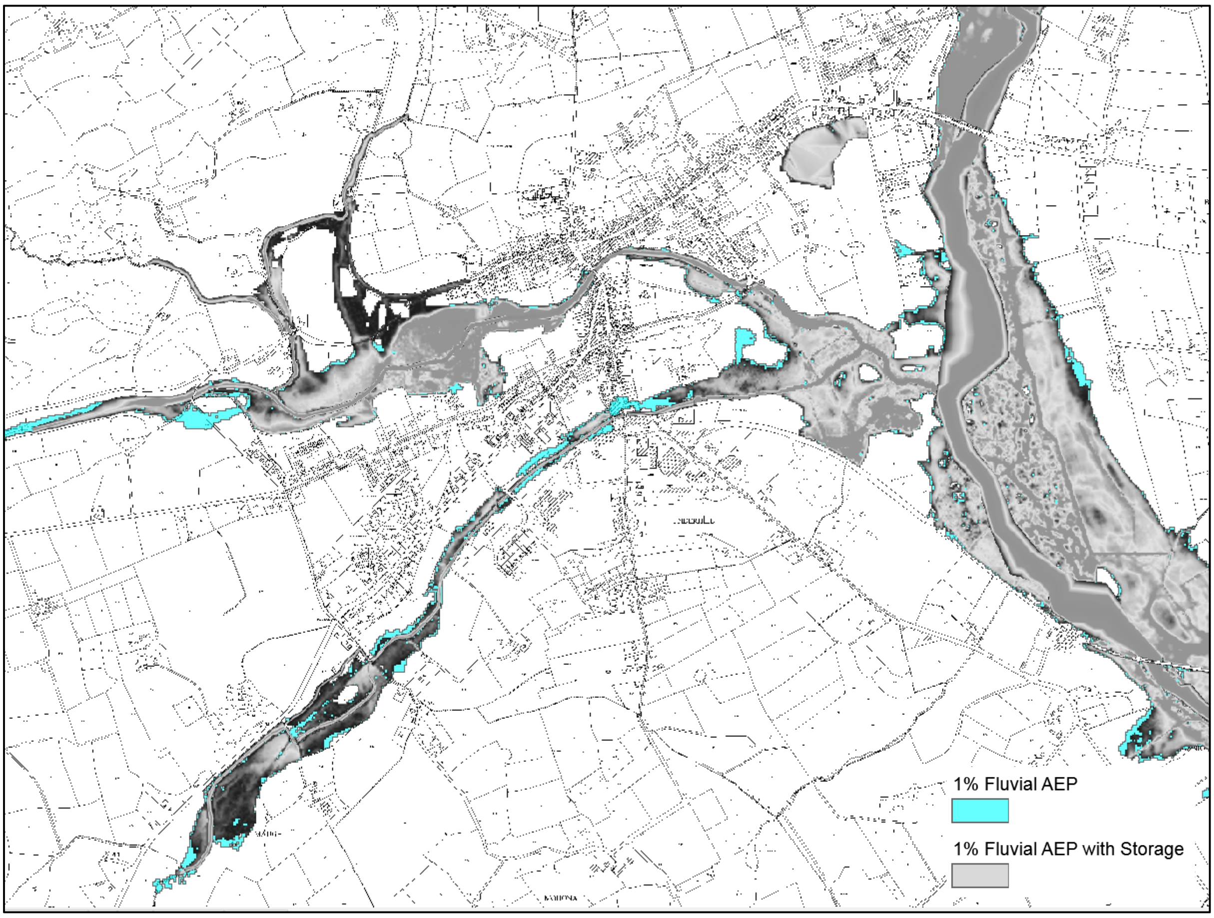
The Dirty and Brewery rivers are tributaries of the River Bandon which can have a backwater impact on the tributaries. In order to maximise the effectiveness of the storage on the Dirty and Brewery rivers, storage was also considered for the River Bandon to reduce the peak flow as much as possible.

The River Bandon has a peak flow of 147.43m3/s for the 1% AEP event immediately upstream of the confluence with the Dirty River. The storage area identified on the Bandon River is 373,700m2 and has a capacity of approx. 788,507m3. This allows for the peak flow to be reduced to 118.77m3/s (2% AEP peak flow) during the design event.

Hydraulic modelling with each of the three storage areas in place was carried out for the 1% AEP event. The key results are as follows:

- A minor reduction in flood extent along the River Bandon with a maximum reduction in water level of 0.002m upstream of the confluence with the tributaries.
- A minor reduction in flood extent along the Dirty River with roads and properties still flooding. A maximum reduction in water level of 0.307m. Properties still flooding at Bridge Street.
- A reduction in flood extent along the Brewery River and no flooding of properties at Brewery Bridge. A reduction in water level of 0.417m.

Figure 5.3: Dunmanway – Reduction in Flood Extent



Based on this assessment storage on the River Bandon has a negligible impact on water levels and is not a viable measure. Storage on the Dirty River does not mitigate the fluvial flood risk and is not deemed to be a viable measure.

Storage on the Brewery River achieves the required standard of protection for the 1% AEP fluvial event along the watercourse and is deemed to be a viable measure.

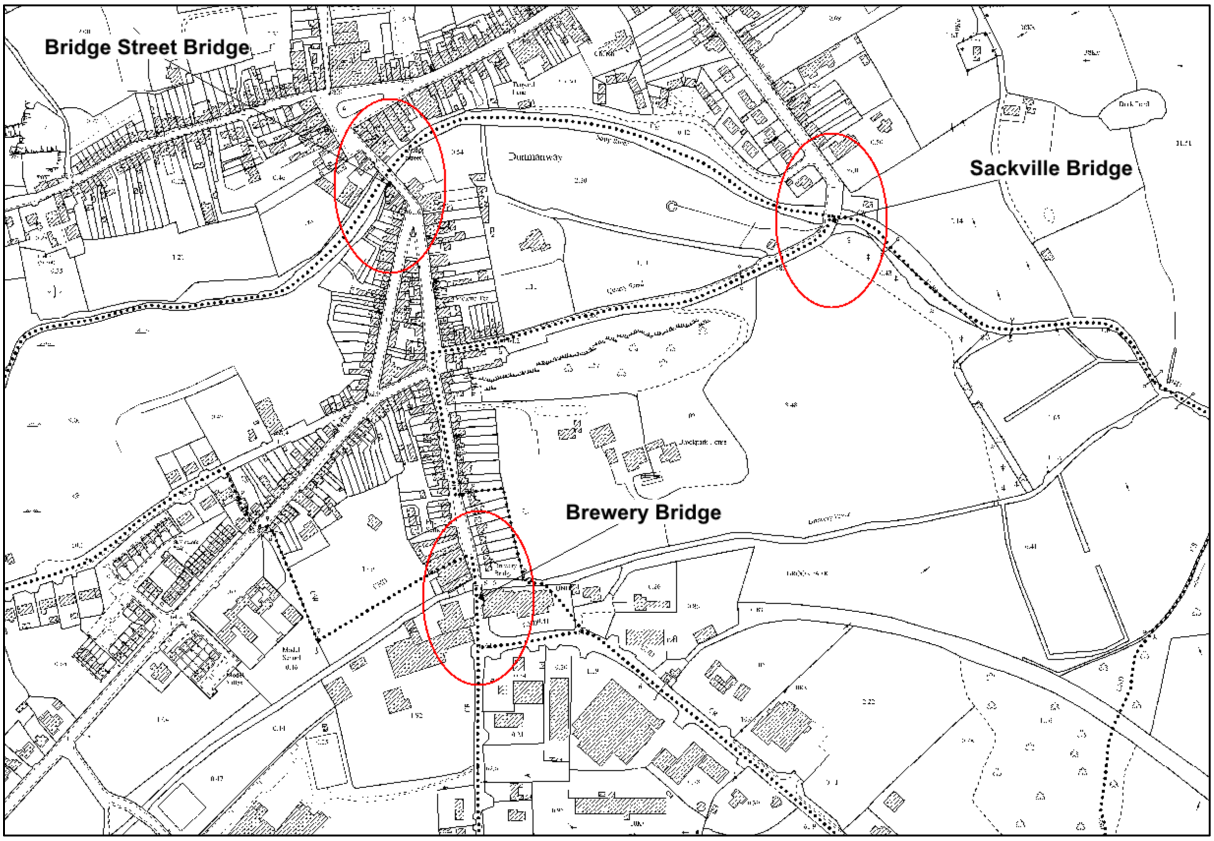
5.2.1.2 Increased Conveyance – Replace Bridges

This measure aims to mitigate the flood risk by improving the conveyance of critical structures. The following bridges have been identified for replacement:

- Brewery Bridge
- Bridge Street Bridge
- Sackville Street Bridge

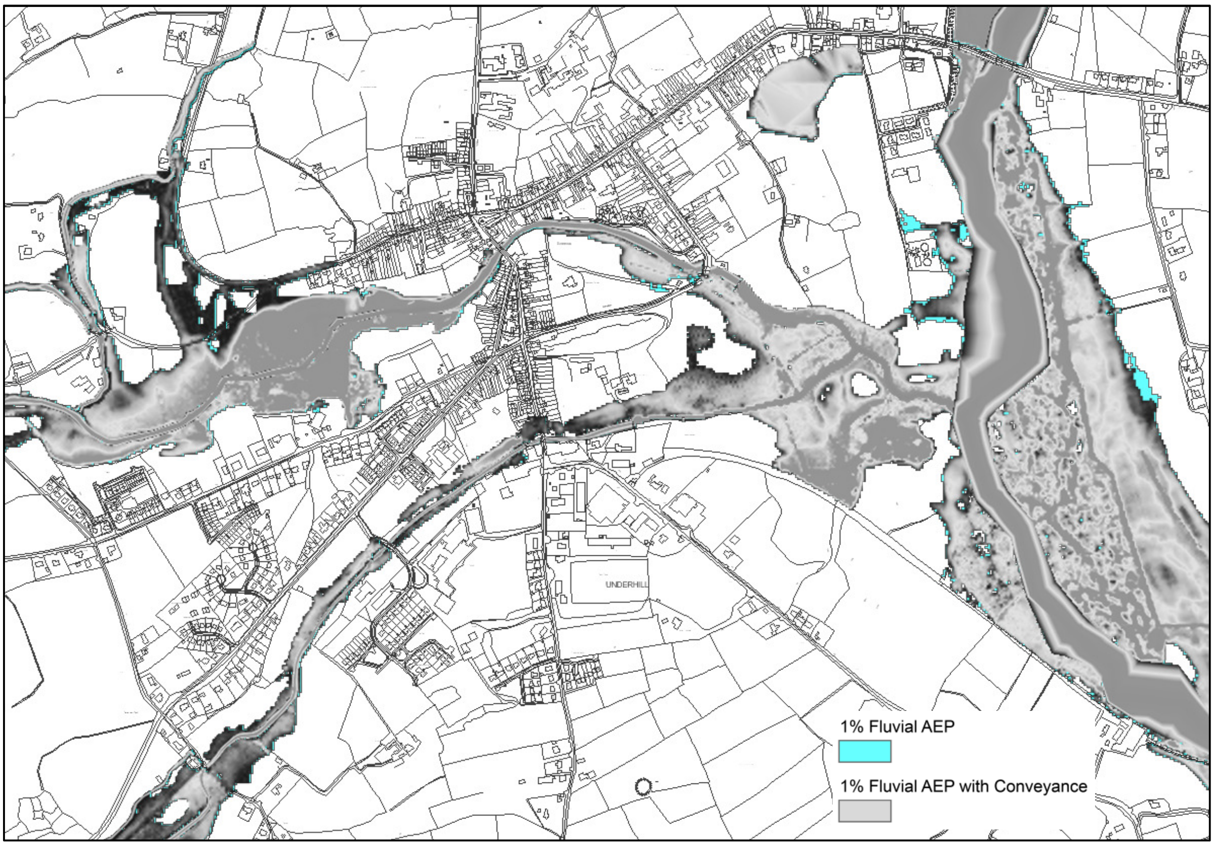
All three bridges are currently arch bridges with piers restricting flow in the channel. This measure aims to achieve the maximum improvement in conveyance by replacing the arch bridges with single span bridges with the soffit level set as high as possible. The removal of these bridges was not considered as they are key infrastructure within the town. Figure 5.4 shows the location of the bridges.

Figure 5.4: Dunmanway – Location of Bridges



The arch bridges in the hydraulic model were all replaced with single span bridges. The model indicated that there was an extremely minor reduction in the 1% AEP flood extent with a maximum reduction in flood depth of 0.01m which occurred on along the Dirty River. Figure 5.5 highlights the minor reduction in flood extent. This measure is not deemed to be a viable measure individually or in combination as the reduction in flood extent / level / risk is minimal.

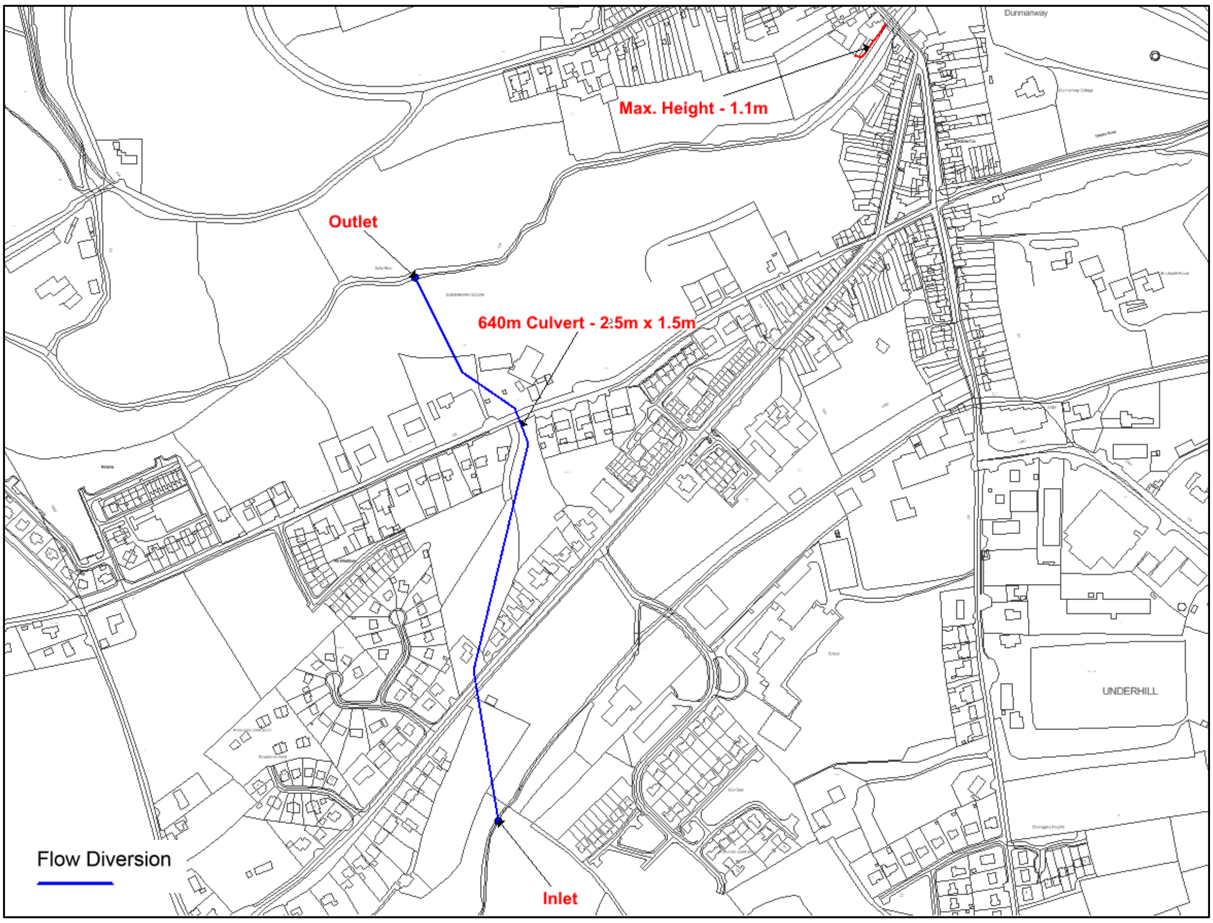
Figure 5.5: Dunmanway – Conveyance – Replacement of Bridges



5.2.1.3 Flow Diversion

This measure aims to mitigate flood risk along the Brewery River by diverting flows to the Dirty River. Figure 5.6 shows the location of the flow diversion culvert.

Figure 5.6: Dunmanway – Location of Flow Diversion Culvert



The peak flow in the Brewery River for the 1% AEP event is 13.13m3/s which results in flooding along the watercourse and at Brewery Bridge. Properties are shown as flooding at Brewery Bridge for the 5% AEP event. It is proposed to divert all flows above 8.82m3/s (peak flow for the 10% AEP event) to the Dirty River. This equates to a peak flow of 4.31m3/s being diverted to the Dirty River during the design event.

The proposed route is 640m long and based on existing bed levels at the inlet and outlet (61.1070m OD / 57.8614m OD) a minimum culvert size of 2.5m x 1.5m. Based on the Lidar data, the proposed route would involve a dig of greater than 6m over the majority of its length.

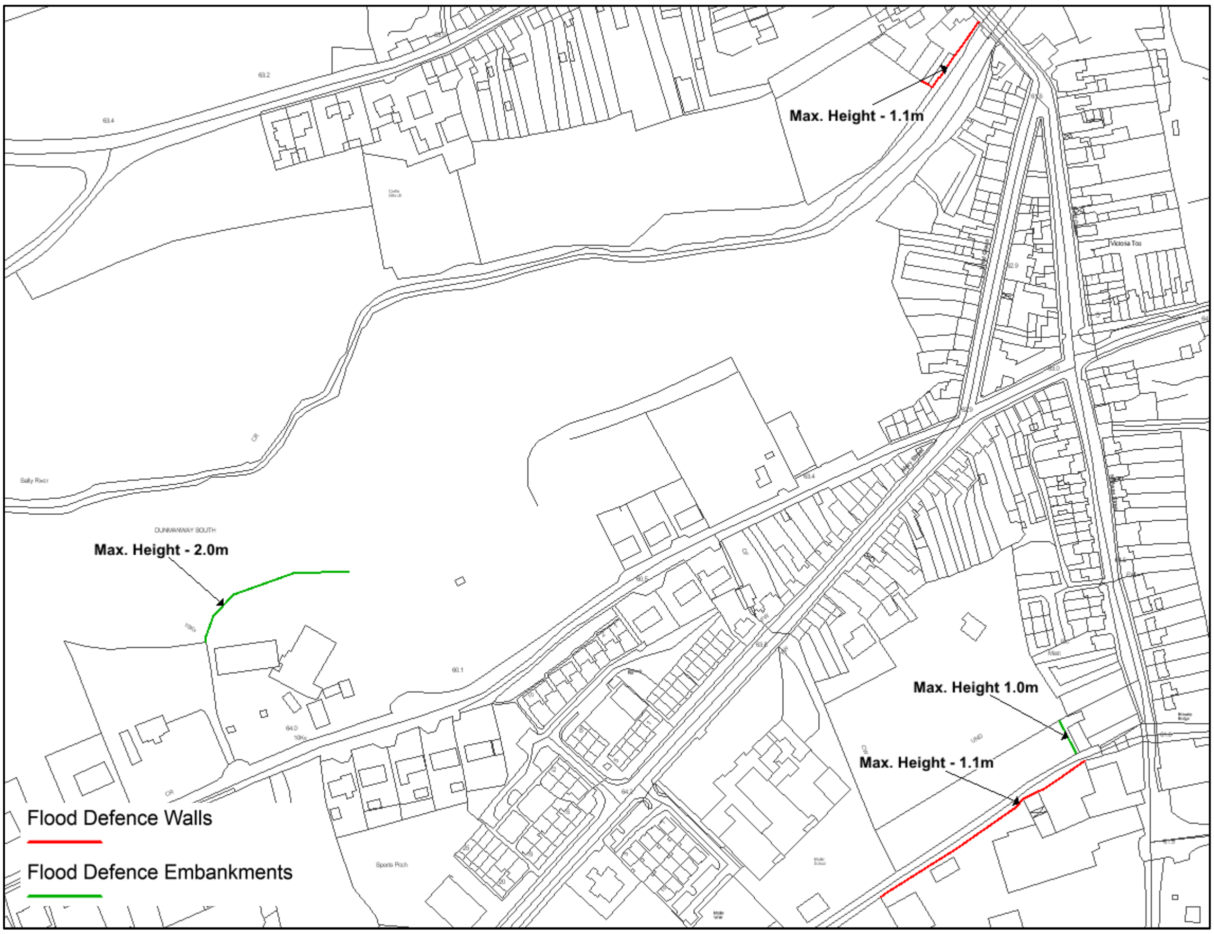
The hydraulic modelling of the proposed diversion indicates that the measure fully mitigates the flood risk along the Brewery River. However, there is a minor increase in flood extent along the Dirty River with a maximum increase in depth of 0.15m. The diversion does not result in the flooding of additional properties on along the Dirty River.

This measure is deemed to be viable for mitigating flood risk along the Brewery River.

5.2.1.4 Flood Defences

This measure considers the mitigation of flood risk through the construction of flood defences. These defences include walls and embankments. The locations and heights of the defences are shown in Figure 5.7.

Figure 5.7: Dunmanway – Flood Defences



The hydraulic modelling of the proposed flood defences indicates that the measure fully achieves the required standard of protection for the1% AEP fluvial event. This measure is deemed to be a viable measure / option.

5.2.2 Potential FRM Measures

Based on the review and hydraulic modelling the following are deemed to be potential FRM measures:

- Storage – Brewery River
- Flow Diversion – Brewery River
- Flood Defences / Localised Protection Works

5.2.3 Potential FRM Options

Based on the assessment of the potential (viable) FRM measures and detailed hydraulic modelling of the combined measures, the following are potential FRM options. Full outline drawings are included in Appendix B for each of the potential options.

- Option 1 – Flood Defences
- Option 2 – Storage on Brewery River / Flood Defences on Dirty River
- Option 3 – Flow Diversion of Brewery River / Flood Defences on Dirty River

5.3 Inishannon, Co. Cork

Inishannon is located along the River Bandon and is at risk of both fluvial and tidal flooding. However, the greater risk is from fluvial flooding. The AFA and the existing flood risk for fluvial and tidal flooding are highlighted in Figures 5.8 and 5.9.

Figure 5.8: Inishannon – Current Scenario Fluvial Flood Extents

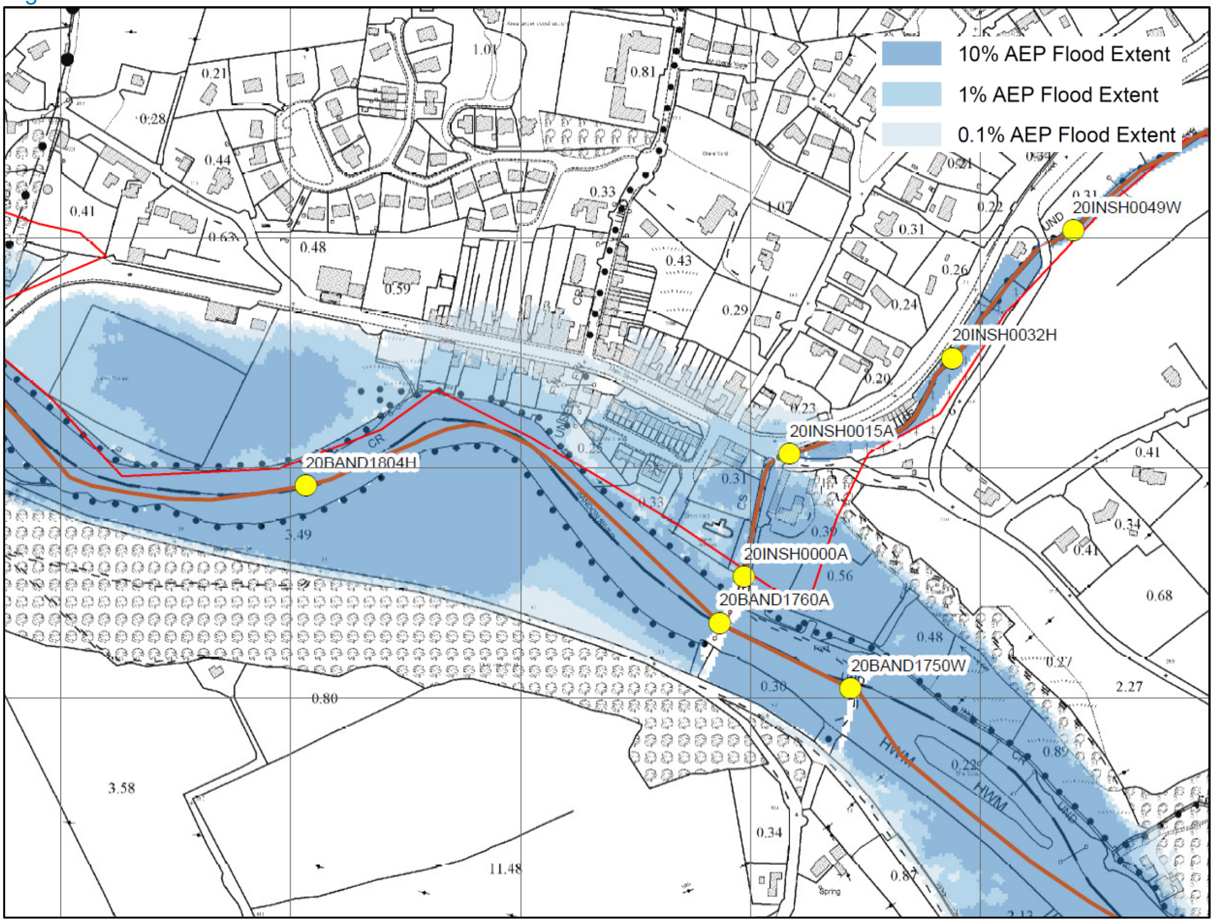
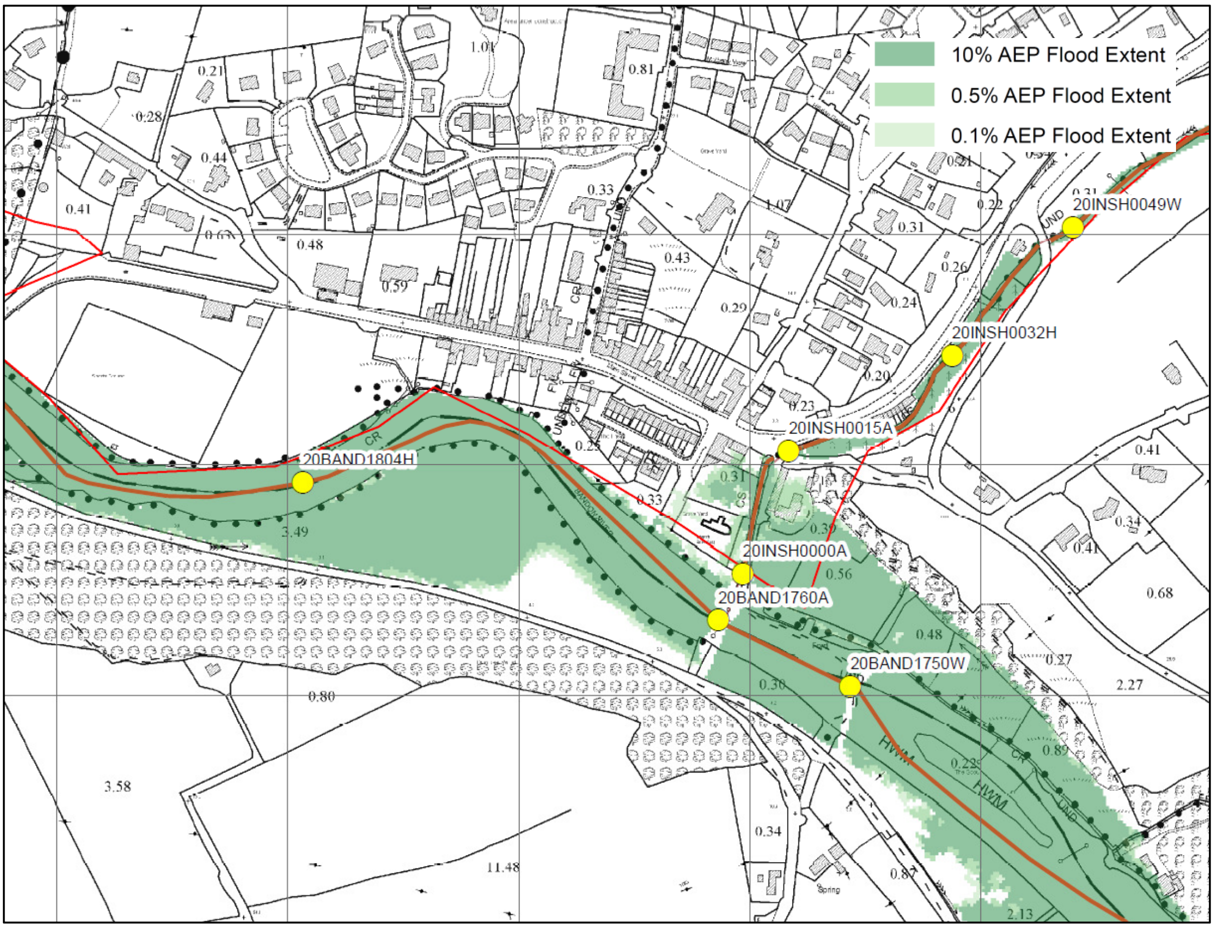


Figure 5.9: Inishannon – Current Scenario Tidal Flood Extents



5.3.1 Possible FRM Measures

As outlined in Section 3.0, the screening process identified the following possible flood risk mitigation measures:

- Increase Conveyance
- Flood Defences (Fluvial / Tidal)

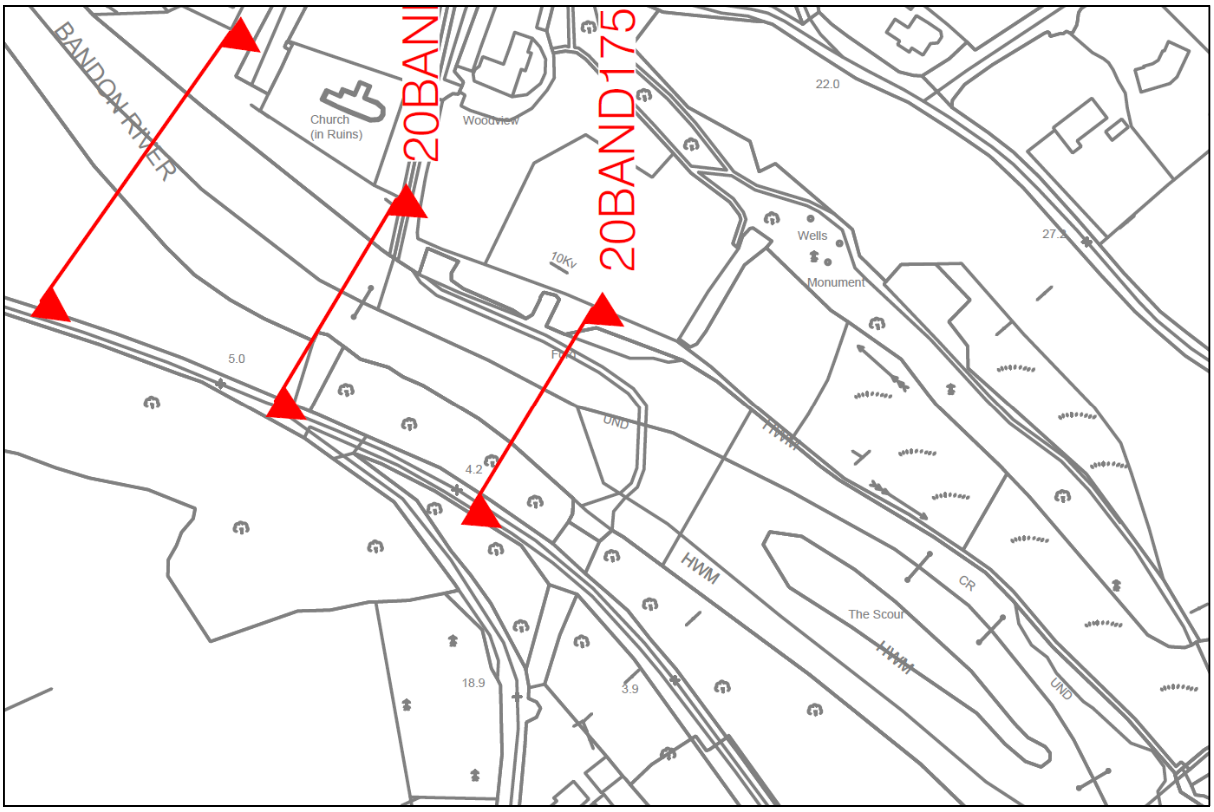
The possible measures were reviewed and assessed further to determine if they were applicable and viable. The measures were modelled individually to determine their effectiveness and impact.

5.3.1.1 Increase Conveyance – Removal of Old Ford Crossing and Channel Island

Immediately downstream of the town the capacity of the channel is reduced by the old ford crossing and a significant island within the channel known as The Scour. These are shown in Figure 5.10.

This measure aims to improve channel capacity by removing the old ford crossing and the island within the channel.

Figure 5.10: Inishannon – Increase Conveyance – Removal of Old Ford Crossing and Channel Island

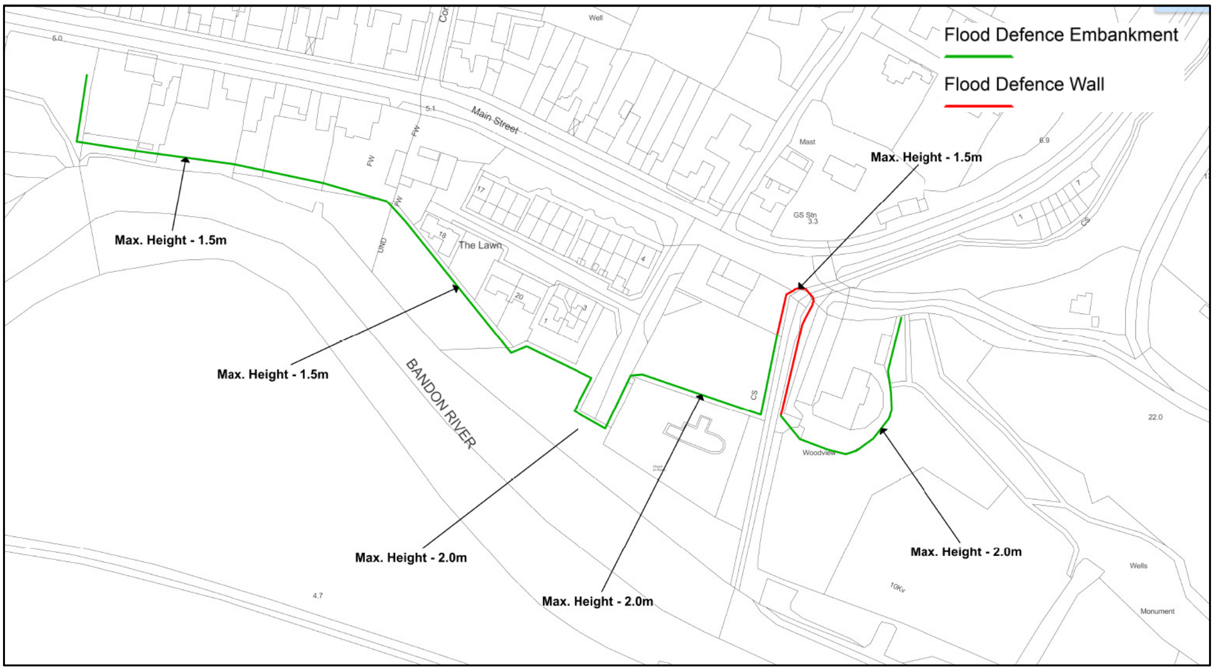


The island and the old ford crossing were removed from the hydraulic model which determined that there was no significant reduction in flood extent, depth or duration. This is due to the crossing and island being drowned by the MHWS tide. The maximum decrease in water level was 0.0812m at the old crossing. This measure is not deemed to be a viable measure individually or in combination as the reduction in flood extent / level / risk is minimal.

5.3.1.2 Flood Defences

This measure considers the mitigation of flood risk through the construction of flood defences. These defences include walls and embankments. The locations and maximum height of the defences is shown in Figure 5.11.

Figure 5.11: Inishannon – Flood Defences



The hydraulic modelling of the proposed flood defences as outlined in Figure 5.11 indicates that the measure fully achieves the required standard of protection for the 1% AEP fluvial event and the 0.5% AEP tidal event. This is deemed to be a viable measure / option.

5.3.2 Potential FRM Measures

Based on the review and hydraulic modelling the following are deemed to be potential FRM measures:

- Flood Defences

5.3.3 Potential FRM Options

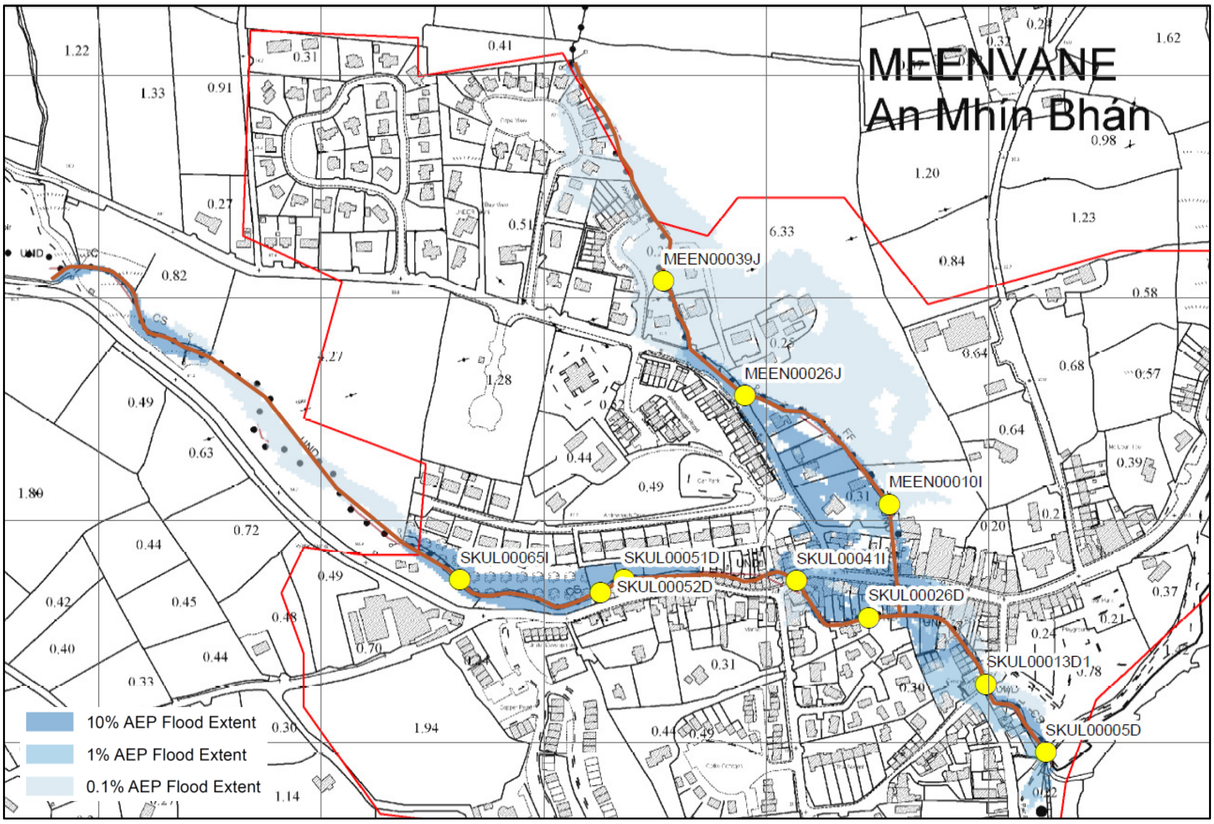
Based on the assessment of the potential (viable) FRM measures and detailed hydraulic modelling of the combined measures, the following are potential FRM options. Full outline drawings are included in Appendix B for each of the potential options.

- Option 1 – Flood Defences

5.4 Schull, Co. Cork

Schull is located on the coast at the confluence of the Schull and Meenvane streams and is at risk of fluvial flooding. Due to its elevation, Schull is not at risk of tidal flooding. The AFA and the existing fluvial flood risk are highlighted in Figure 5.12.

Figure 5.12: Schull – Current Scenario Fluvial Flood Extents



5.4.1 Possible FRM Measures

As outlined in Section 3.0, the screening process identified the following possible flood risk mitigation measures:

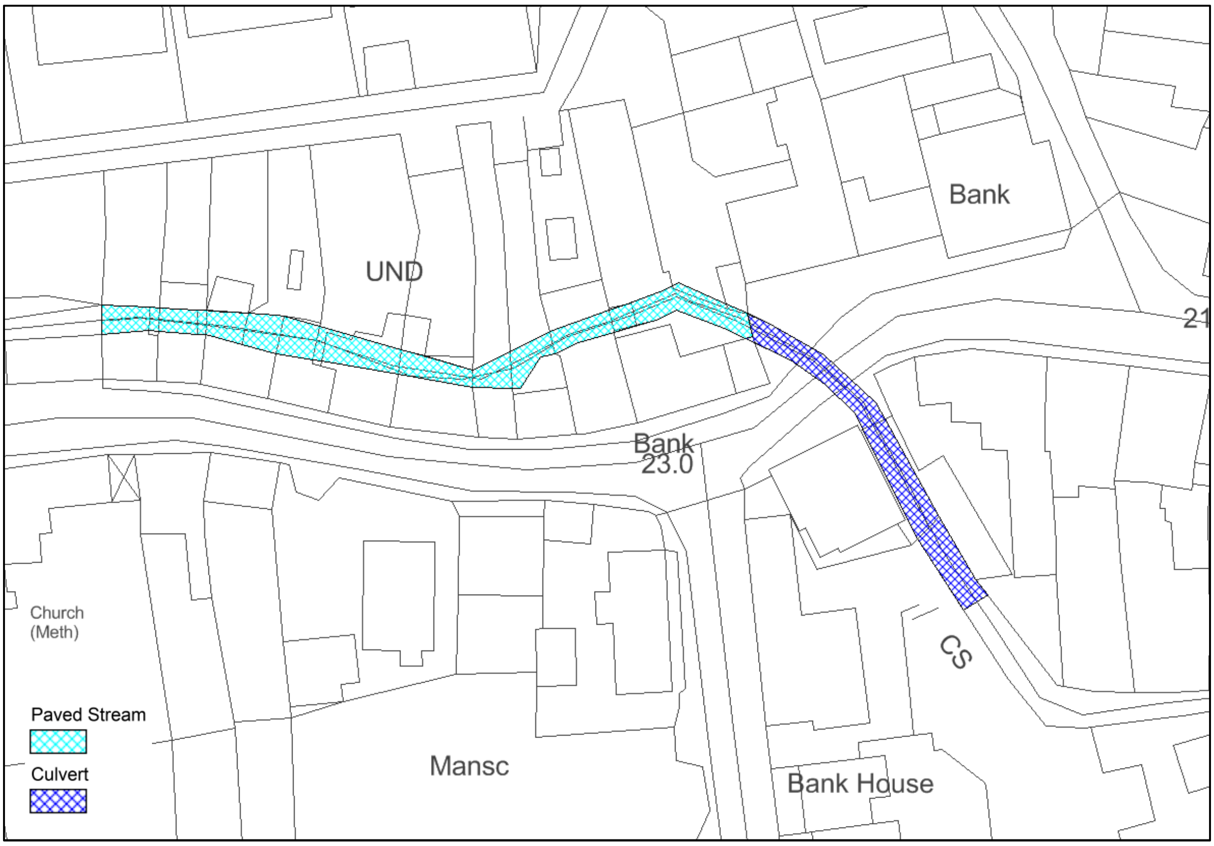
- Increase Conveyance
- Storage
- Flood Defences

The possible measures were reviewed and assessed further to determine if they were applicable and viable. The measures were modelled individually to determine their effectiveness and impact.

5.4.1.1 Increase Conveyance – Schull Stream (Paved Area & Culvert)

The culvert on the Schull Stream crosses Main Street at the Bunratty Inn. This culvert has developed from an existing bridge crossing and has effectively been extended 80m upstream by landowners paving over the stream to the rear of their properties. This is shown in Figure 5.13. There are also a number of manholes along this section. The paving and manholes are not watertight and flows exit these structures when the culvert capacity is reached and the structures are subject to surcharging.

Figure 5.13: Schull – Increase Conveyance – Schull Stream (Paved Area & Culvert)



It was not possible to gain access to the culvert to carry out a detailed survey. The hydraulic model assumes that the inlet dimensions (2.05m wide x 1.0m high) at the paved section are constant throughout. However, the manhole and culvert coefficients have been calibrated to reproduce the existing flooding up through the paving and along Main Street.

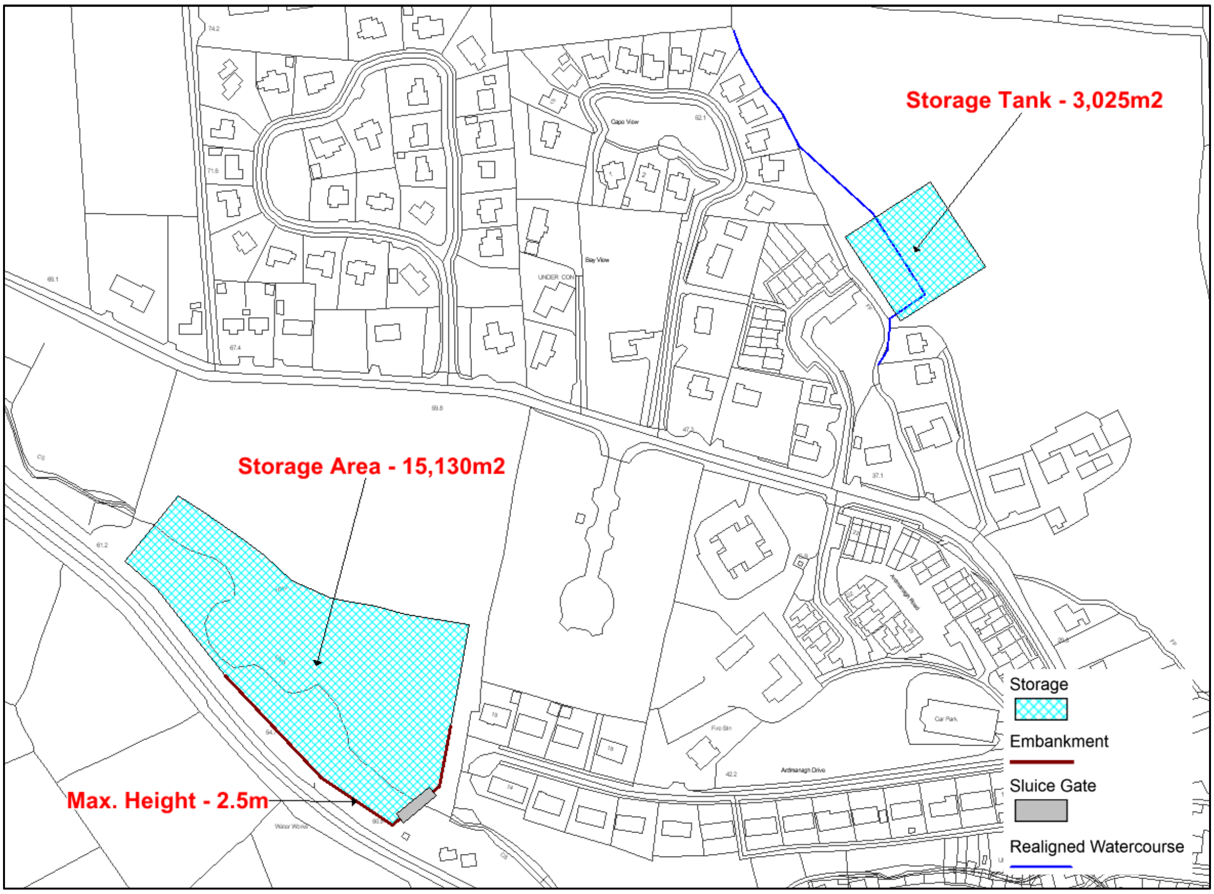
This measure aims to mitigate the flood risk by increasing conveyance through the culvert. In the hydraulic model the capacity of the existing culvert and paved section was doubled. However, the results indicate that there is still surcharging and flooding at the Bunratty Inn.

Due to site restrictions and the proximity of the culvert to a number of buildings it is extremely unlikely that any works could be carried out to achieve the increased capacity simulated in the hydraulic model. Therefore, conveyance is not deemed to be a viable measure.

5.4.1.2 Storage

Schull is located at the confluence of the Schull and Meenvane streams. An assessment of the storage required to mitigate the flood risk on both watercourses was carried out and suitable locations for storage identified. The locations and size of the storage areas are shown in Figure 5.14.

Figure 5.14: Schull – Storage Areas



The required capacities of the storage areas are derived using the catchment hydrology as applied in the hydraulic modelling. No allowances for uncertainties in the estimate of the index flood flow or the flood growth curve have been made.

The peak flow in the Meenvane Stream for the 1% AEP event is 1.9m3/s which results in flooding along the watercourse and through the town. The proposed storage area has a capacity of 12,000m3 and can reduce the peak flow for the 1% AEP event to 0.9m3/s. This equates to the peak flow for the 50% AEP event.

On Meenvane Stream there are no suitable locations to utilise the topography for storage. Therefore, it will be necessary to construct a storage / attenuation tank. The proposed tank is 3,025m2 (55mx55m) and 4m deep with an invert level of 42m OD Malin. The tank is located on a slope which will require excavation of approx. 5m at the upstream side. The tank will operate like a backdrop manhole where the inlet and outlets will tie in with existing bed levels. The stream will be diverted into the tank at the upstream end at approx. 46m OD Malin and drop 4m within the tank where it will discharge to the watercourse at the existing bed level of 42m OD Malin. This approach is required due to the slope of the stream and the site.

The peak flow in the Schull Stream for the 1% AEP is 4.2m3/s which results in flooding of the town. The proposed storage area is 15,130m2 and has sufficient capacity to reduce the peak flow to 1.5m3/s. This is less than the peak flow for the 50% AEP event.

The proposed location for storage on the Schull Stream aims to utilise the existing topography. However, it will require excavation within the proposed area to lower ground levels to ensure there is sufficient capacity. The existing ground level at the downstream end is 48.5m OD Malin and 54.5m OD Malin at the upstream end. There is a small area to the north of the proposed site where the existing ground level is 58.6m OD Malin. The proposed storage area has an invert level of 48.5m OD Malin with a top of water level of 50.5m OD Malin an embankment level of 51.0m OD Malin. The maximum embankment height is 2.0m.

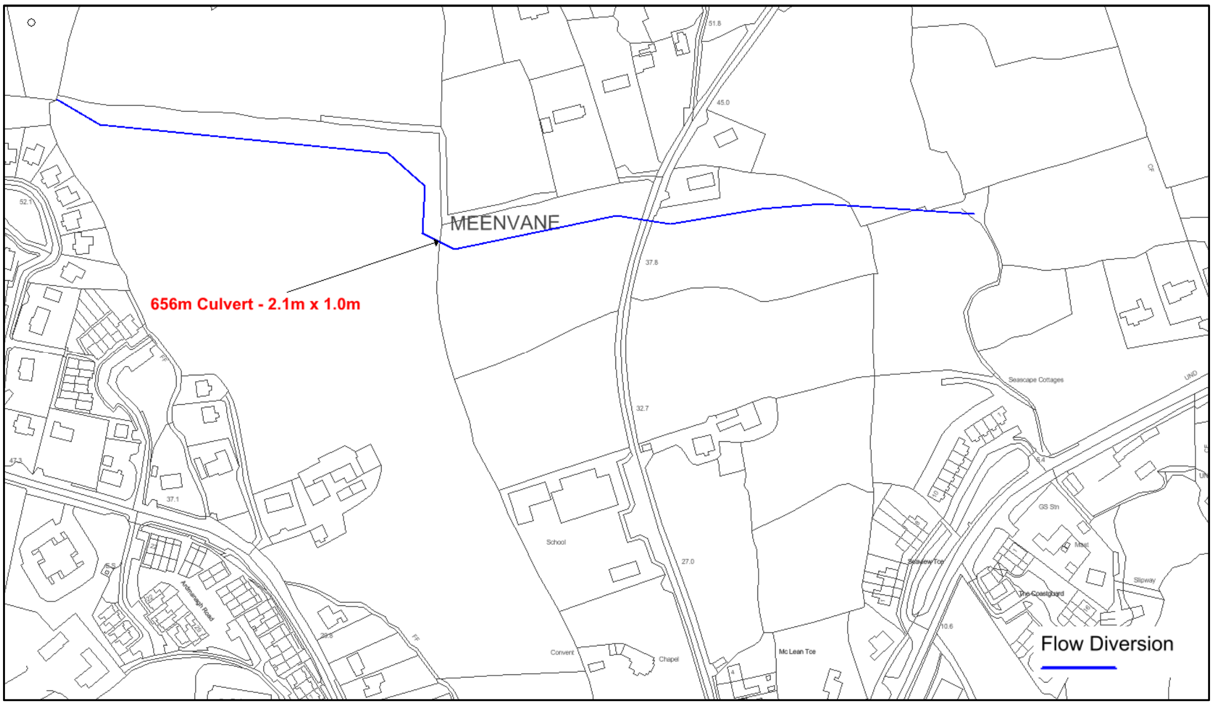
Hydraulic modelling of the storage areas was carried out which resulted in no flooding through the town. Due to the slope of the Meenvane and the type of storage, there is no impact on water levels upstream. The proposed storage area on the Schull Stream is located within 200m of the upper extent of the modelled watercourse. As a result the impact of the storage area upstream cannot be confirmed. However, based on site visits and the existing ground profile it is unlikely that storage would have any significant impact upstream.

Based on this assessment, storage on the Schull and Meenvane streams are viable measures.

5.4.1.3 Flow Diversion

This measure aims to mitigate the flood risk by diverting the flow from the Meenvane Stream away from the town discharging to a separate water course. Figure 5.15 shows the location and proposed route of the flow diversion culvert.

Figure 5.15: Schull – Flow Diversion Culvert



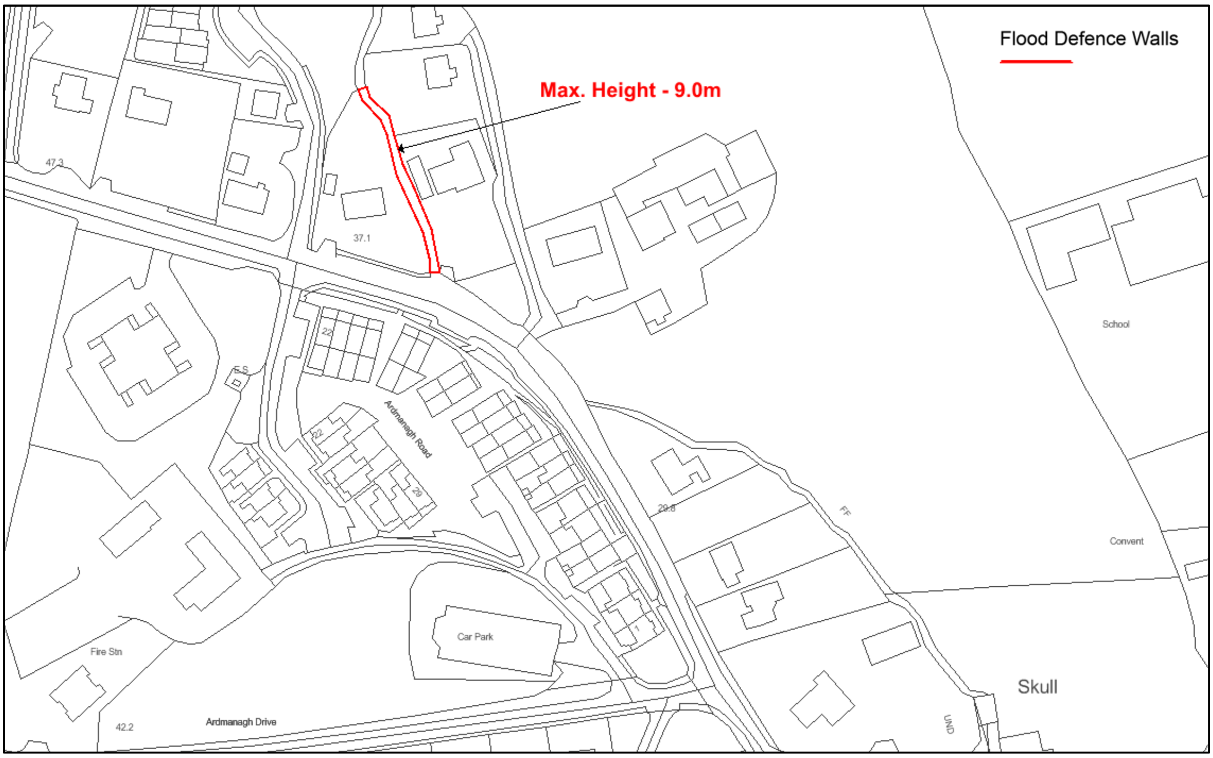
The peak flow in the Meenvane Stream for the 1% AEP event is 1.9m3/s which results in flooding along the watercourse and through the town. It is proposed to divert the stream to a separate watercourse using a 2.1m wide by 1.0m high culvert. The proposed route has been selected to minimise the amount of excavation required while also reducing the impact on landowners. The average depth of excavation is 2.5m with a maximum depth of 5m. The 656m culvert will discharge to an existing watercourse which may require some regrading works.

The flow diversion is deemed to be a viable measure.

5.4.1.4 Flood Defences – Meenvane Stream

This measure aims to protect properties through the construction of flood defences. These defences include walls along the Meenvane Stream. The locations and heights of the flood defence walls are shown in Figure 5.16.

Figure 5.16: Schull – Flood Defences



The hydraulic modelling of the proposed flood defences as outlined in Figure 5.16 indicates that the measure does mitigate flooding on the Meenvane Stream and as a result, reduces flooding in the town.

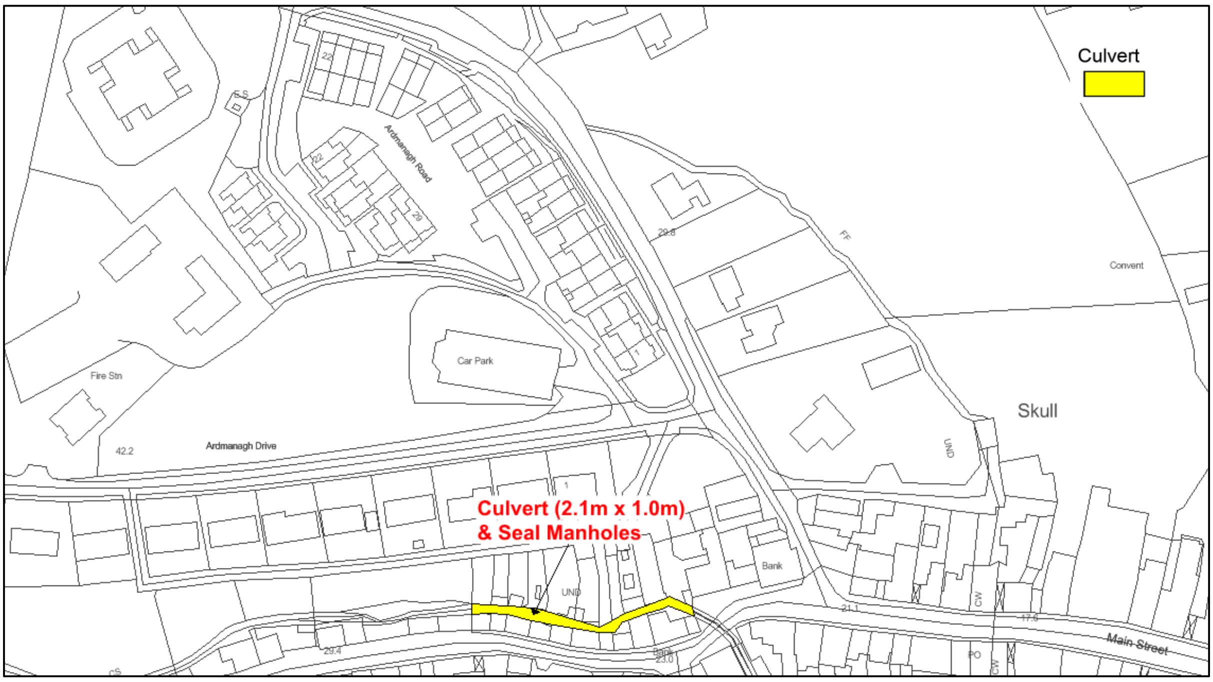
This measure does not reduce flooding on the Schull Stream which continues to flood the town. Therefore, this measure is not deemed viable individually but in combination with works on the Schull Stream it could form a viable option.

However, the required walls are 9.0m high. Such defences along a narrow stream are not technically or socially feasible and are not deemed viable.

5.4.1.5 Culvert – Schull Stream

This measure aims to mitigate the flooding along the Schull Stream and through the town by replacing the paved areas to the rear of properties with a new culvert. The location of the culvert is shown in Figure 5.17.

Figure 5.17: Schull – Culvert

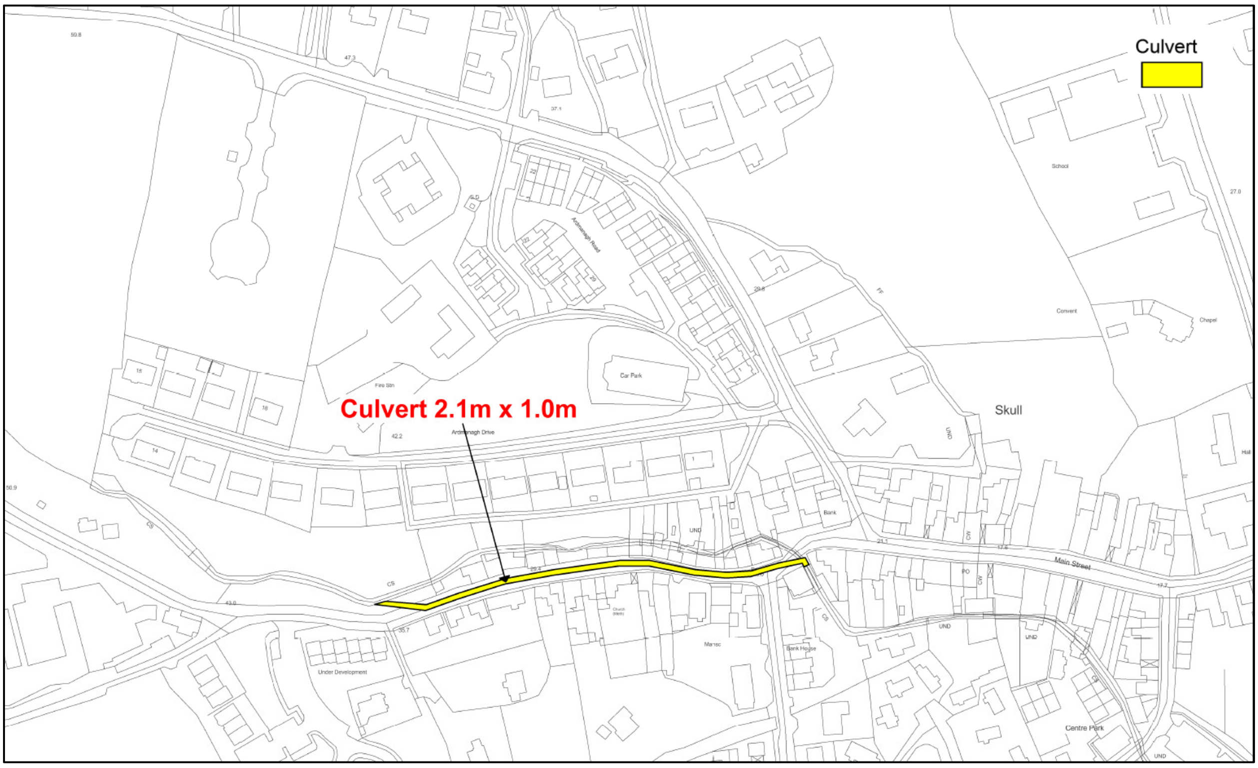


The culvert on the Schull Stream has developed from an existing bridge crossing and has effectively been extended 80m upstream by landowners paving over the stream to the rear of their properties. There are also a number of manholes along this section. The paving and manholes are not watertight and are subject to surcharging. It is proposed to replace the paved section with a culvert (2.1m x 1.0m) and seal the existing manholes to prevent surcharging.

The hydraulic modelling of the proposed culvert as outlined in Figure 5.17 indicates that the measure removes flooding along the Schull Stream and reduces flooding through the town. The proposed culvert has no impact on flooding or water levels in the upstream reach of the Schull Stream. However, this measure does not reduce flooding on the Meenvane Stream which continues to flood the town. This measure is not deemed viable individually, however in combination with works on the Meenvane Stream it could form a viable option.

As an alternative to the culvert route proposed in Figure 5.17, which is to the rear of properties, a proposed route along the main street was also examined.

Figure 5.18: Schull – Flood Defences – Alternative Culvert Route



5.4.2 Potential FRM Measures

Based on the review and hydraulic modelling the following are deemed to be potential FRM measures:

- Storage – Schull Stream
- Storage – Meenvane Stream
- Flood Defences – Meenvane
- Culvert – Schull Stream
- Flow Diversion – Meenvane Stream

5.4.3 Potential FRM Options

Based on the assessment of the potential (viable) FRM measures and detailed hydraulic modelling of the combined measures, the following are potential FRM options. Full outline drawings are included in Appendix B for each of the potential options.

- Option 1 – Storage
- Option 2 – Storage (Schull Stream) / Flow Diversion (Meenvane Stream)
- Option 3 – Culvert (Schull Stream – Route 1) / Storage (Meenvane Stream)
- Option 4 – Culvert (Schull Stream – Route 1) / Flow Diversion (Meenvane Stream)
- Option 5 – Culvert (Schull Stream – Route 2) / Storage (Meenvane Stream)
- Option 6 – Culvert (Schull Stream – Route 2) / Flow Diversion (Meenvane Stream)

6 Environmental Assessment

6.1 General

Refer to Appendix C for Draft SEA Options Appraisal Report and Appendix D for Draft Habitats Directive Screening (for Appropriate) Assessment.

7 Stakeholder Input

7.1 Draft Flood Mapping Public Consultation Days

Public Consultation Days (PCDs) were held in Unit Of Management (UoM) 20 between December 2014 and February 2015. The purpose of the PCDs were to present the public with the Draft Flood Maps that have been prepared as part of the South Western CFRAM Study, to seek their feedback on those maps and on the Flood Risk management Objectives that apply to this area.

Details of the Public Consultation days held in the UoM 20 AFAs are shown in Table 7.1 below.

Table 7.1: Draft Flood Mapping PCDs

AFA	Date	Venue	Nr of Attendees
Dunmanway	10th of February 2015	Parkway Hotel	1
Inishannon	13th of February 2015	Parish Hall, Inishannon	1
Schull	17th of February 2015	The Parish Hall, Schull	6

7.2 Flood Risk Management Measures

At the Draft Flood Mapping PCDs, attendees were asked to indicate what they thought should be done to manage flood risk in their AFAs. The responses are shown in Table 7.2 below.

Table 7.2: Flood Risk Management – Public Opinion

AFA	What needs to be done to manage flood risk?
Innishannon	Dredging. Flood plain management
Dunmanway	Channel maintenance. Maintenance of lake outlet, especially reed growth
Schull	Bigger pipes Keep river and culverts clean Keep drains clean
	Attention to river and pipes at top end of town
	Maintenance of drains and water tables
	Culvert maintenance

7.3 Preliminary Options PCDs

Stakeholder workshops were held on 3 and 4 November to discuss the proposed options with Local Authority Staff.

On 1 and 2 December 2015 PCDs were held to display various Flood Risk Management Options in each of the UoM 20 AFAs under consideration. Details of the PCDS are shown in Table 7.3 below.

Table 7.3: Details of Public Consultation Days

AFA	Date	Venue	Nr of Attendees
Dunmanway	1st December 205	The Parkway Hotel	1
Inishannon	1st December 2015	The Parish Hall	6
Schull	2nd December 2015	The Parish Hall	6

At the Preliminary Options PCDs Attendees were asked to indicate their preference for the Flood Risk Management Options under consideration in each of the UoM 20 AFAs. Their responses are summarised in Table 7.4 below.

Table 7.4: Public Preference for Potential Options

AFA	Option	Nr of Preferences Received	Rank
Dunmanway	Flood Defences	1	2
	Storage and Flood Defences	1	1
	Flow diversion and Flood Defences	1	4
	Do Nothing	1	3
Inishannon	Flood Defences	2	1
	Do Nothing	2	2
Schull	Storage	1	5
	Storage and Flow Diversion	1	3
	Culvert and Storage	1	2
	Culvert Diversion and Culvert	7	1
	Do Nothing	2	4

8 Flood Risk Assessment

8.1 General

Flood risk mapping for the UoM 20 AFAs and Medium Priority Watercourses (MPWs) has been undertaken as part of this Study. The mapping includes the receptors that are at risk from flooding in the following categories:

- Society
- The Environment
- Cultural Heritage
- The Economy

The Flood Risk Maps for UoM 20 are included in an Annexe to the Preliminary Options Report: Annex I, Flood Risk Maps.

8.2 Receptors

Examples of the receptors in each of these categories are included in Table 8.1 below:

Table 8.1: Flood Risk Receptors

Category	Receptor
Society	People Homes Fire Stations Garda Stations Hospitals Care centres
The Environment	Protected Areas Pollution Sources
Cultural Heritage	Protected Archaeological Sites Protected Buildings
The Economy	Business Premises Roads Railway Ports Utilities

The numbers of receptors at risk from flooding in each AFA and each MPW are listed in tables 8.3 to 8.12 below. These numbers were calculated by counting the number of receptors that existed in a location that had a positive depth of flooding. These tables indicate the receptors at risk from the current scenario, the Mid-Range Future Scenario (MRFS) and the High End Future Scenario (HEFS) and are split into the Annual Exceedance Probability of the flooding concerned.

Annual Exceedance Probability, henceforth referred to as AEP, is a term used throughout this report and the wider CFRAM studies to refer to the rarity of a flood event. The probability of a flood relates to the likelihood of an event of that size or larger occurring within any one year period. For example, a one in hundred year flood has a one chance in a hundred of occurring in any given year; 1:100 odds of occurring in any given year; or a 1% likelihood of occurring. This is described as a 1% annual exceedance probability (AEP) flood event.

Table 8.2 converts the 'return periods' to %AEP for key flood events as a reference to previous studies.

Table 8.2: Flood Probabilities

% Annual Exceedance Probability (%AEP)	Odds of a Flood Event in Any Given Year	Chance of a Flood Event in Any Given Year or Previous 'Return Period'
50%	1:2	1 in 2
20%	1:5	1 in 5
10%	1:10	1 in 10
5%	1:20	1 in 20
2%	1:50	1 in 50
1%	1:100	1 in 100
0.5%	1:200	1 in 200
0.1%	1:1000	1 in 1000

Table 8.3 below lists the number of Inhabitants at risk from fluvial flooding in each AFA.

Table 8.3: Risk to Society: Nr. of Inhabitants

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Clonakilty	0	126	140	297	350	420	456	546	22	258	291	353	454	487	532	571	330	529	580
Dunmanway	6	6	6	6	20	20	31	258	6	6	14	20	20	87	263	311	20	325	238
Inishannon	3	6	6	6	53	67	73	134	6	14	53	67	76	98	137	143	67	129	143
Schull	11	53	53	70	70	70	118	123	70	70	70	123	123	129	154	168	123	160	190

Table 8.4 below indicates the number of Residential Properties at risk from fluvial flooding in each AFA.

Table 8.4: Risk to Society: Nr. of Residential Properties

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Clonakilty	0	45	50	106	125	150	163	195	8	92	104	126	162	174	190	204	118	189	207
Dunmanway	2	2	2	2	7	7	11	92	2	2	5	7	7	31	94	111	7	116	85
Inishannon	1	2	2	2	19	24	26	48	2	5	19	24	27	35	49	51	24	46	51
Schull	4	19	19	25	25	25	42	44	25	25	25	44	44	46	55	60	44	57	68

Table 8.5 below lists the number of high vulnerability properties at risk from fluvial flooding in each AFA. High vulnerability properties include Hospitals, Nursing Homes, Schools, Prisons, Camping / Halting sites.

Table 8.5: Risk to Society: Nr. of High Vulnerability Properties

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Clonakilty	0	1	1	1	2	5	5	5	1	1	1	2	5	5	5	5	1	5	5
Dunmanway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inishannon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Schull	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 8.6 below lists the number of Social Amenity Sites at risk from fluvial flooding in each AFA

Table 8.6: Risk to Society: Nr of Social Amenity Sites

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Clonakilty	0	3	4	6	6	11	11	12	2	6	6	7	11	11	12	12	6	12	12
Dunmanway	0	0	0	0	0	0	0	5	0	0	0	0	0	0	5	6	0	6	2
Inishannon	0	0	0	0	0	0	1	3	0	0	0	0	1	2	3	3	0	2	3
Schull	0	0	1	1	1	1	2	2	1	1	1	2	2	2	2	2	2	2	2

Table 8.7 below lists the number of properties on the National Inventory of Architectural Heritage at risk from fluvial flooding in each AFA

Table 8.7: Risk to Cultural Heritage: Nr. of NIAH Buildings

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Clonakilty	0	11	16	48	54	67	139	148	6	35	45	60	84	101	111	148	48	88	148
Dunmanway	0	0	0	0	0	0	2	5	0	0	0	0	1	3	6	8	0	3	9
Inishannon	0	1	3	6	7	9	9	18	4	6	7	11	13	13	18	18	9	18	18
Schull	0	8	9	9	9	9	10	13	9	9	10	11	12	14	14	15	14	14	15

Table 8.8 below lists the number of Archaeological Monuments at risk from fluvial flooding in each AFA.

Table 8.8: Risk to Cultural Heritage: Nr. of RMPs

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Clonakilty	0	0	0	1	1	3	3	3	1	1	2	3	3	3	3	3	1	3	3
Dunmanway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inishannon	1	1	1	3	6	7	7	7	1	3	5	6	7	7	7	8	7	7	8
Schull	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 8.9 below lists the number of Non-Residential Properties at risk from fluvial flooding in each AFA

Table 8.9: Risk to the Economy: Nr. of Non-Residential Properties

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Clonakilty	1	37	40	94	105	142	159	201	22	83	92	108	155	172	192	240	102	180	241
Dunmanway	11	11	13	14	18	21	23	68	11	14	15	20	23	27	69	74	20	79	59
Inishannon	0	2	4	4	15	17	26	39	4	13	15	16	26	29	39	42	17	37	42
Schull	2	19	22	22	22	22	31	32	22	23	24	32	32	33	35	37	32	35	40

Table 8.10 below lists the number of Roads at risk from fluvial flooding in each AFA

Table 8.10: Risk to the Economy: Nr. of Roads

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Clonakilty	0	2	6	8	10	10	10	10	2	6	6	8	10	10	10	10	8	10	10
Dunmanway	0	0	2	4	5	6	6	8	0	2	2	4	5	7	8	8	8	8	8
Inishannon	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	4
Schull	0	0	0	3	3	3	3	3	4	4	3	3	3	4	4	4	4	4	4

Table 8.11 below lists the number of Utilities at risk from fluvial flooding in each AFA

Table 8.11: Risk to the Economy: Nr. of Utilities

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
AFA	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	1%	0.1%
Clonakilty	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Dunmanway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Inishannon	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Schull	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

In addition to fluvial flood risk, Clonakilty and Inishannon in UoM 20 are at risk from tidal flooding. Table 8.12 and 8.13 below list the receptors at risk from tidal flooding in these AFAs.

Table 8.12: Tidal Flood Risk – Clonakilty

	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
Receptor	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	0.5%	0.1%
Inhabitants	87	109	112	199	277	325	339	400	333	336	400	417	445	456	465	507	487	585	582
Residences	31	39	40	71	99	116	121	143	119	120	143	149	159	163	166	181	174	209	208
High Vulnerability Properties	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2
Archaeological sites	3	3	3	5	6	6	6	6	6	6	6	6	6	6	7	7	7	11	10
Architectural Sites	6	10	12	21	23	33	35	54	36	48	52	57	69	69	77	78	80	99	99
Non-residential properties	34	35	37	56	72	85	95	138	95	110	135	146	154	159	174	185	206	226	227
Roads	5	5	7	9	10	11	13	13	10	12	15	15	15	15	15	16	20	21	23
Utilities	0	0	0	0	0	0	0	1	0	0	1	1	1	1	1	1	1	1	2

Table 8.13: Tidal Flood Risk – Inishannon

Receptor	Current Scenario								Mid-Range Future Scenario								High End Future Scenario		
	50%	20%	10%	5%	2%	1%	0.5%	0.1%	50%	20%	10%	5%	2%	1%	0.5%	0.1%	10%	0.5%	0.1%
Inhabitants	3	3	6	6	6	6	6	6	6	6	8	8	14	22	28	50	56	67	70
Residences	1	1	2	2	2	2	2	2	2	2	3	3	5	8	10	18	20	24	25
High Vulnerability Properties	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Archaeological sites	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Architectural Sites	0	1	1	1	2	3	4	5	5	5	6	6	6	6	6	7	7	9	9
Non-residential properties	1	2	2	2	2	2	3	4	4	4	11	11	12	12	12	14	14	16	20
Roads	1	2	2	2	2	2	3	4	4	4	11	11	12	12	12	14	14	16	20
Utilities	0	0	0	1	1	1	1	1	11	1	1	1	1	1	1	1	1	1	1

8.3 Flood Risk Maps

Flood Risk Maps have been prepared to represent the various receptors at risk from flooding in each of the AFAs and MPWs. These maps are described in the following sections below.

8.3.1 Inhabitants Maps

Maps have been prepared to represent the number of people at risk from flooding of various frequencies. The number of people per house was taken from CSO data. For UoM 20 the average occupancy is 2.8 people per house. For each AEP flood extent the number of residential properties at risk was counted and multiplied by that occupancy. The numbers of people at risk are represented as a density per hectare on the maps.

8.3.2 Economic Activity Maps

The types of economic activity at risk from flooding in UoM 20 are shown on the economic activity risk map. The types of activities considered are:

- Property
- Infrastructure
- Rural Land Use
- Economic

8.3.3 Economic Risk Density Maps

Maps have been prepared to represent the economic risk from flooding of various frequencies. The economic risk is represented on the maps as a density of the Annual Average Damage value per hectare.

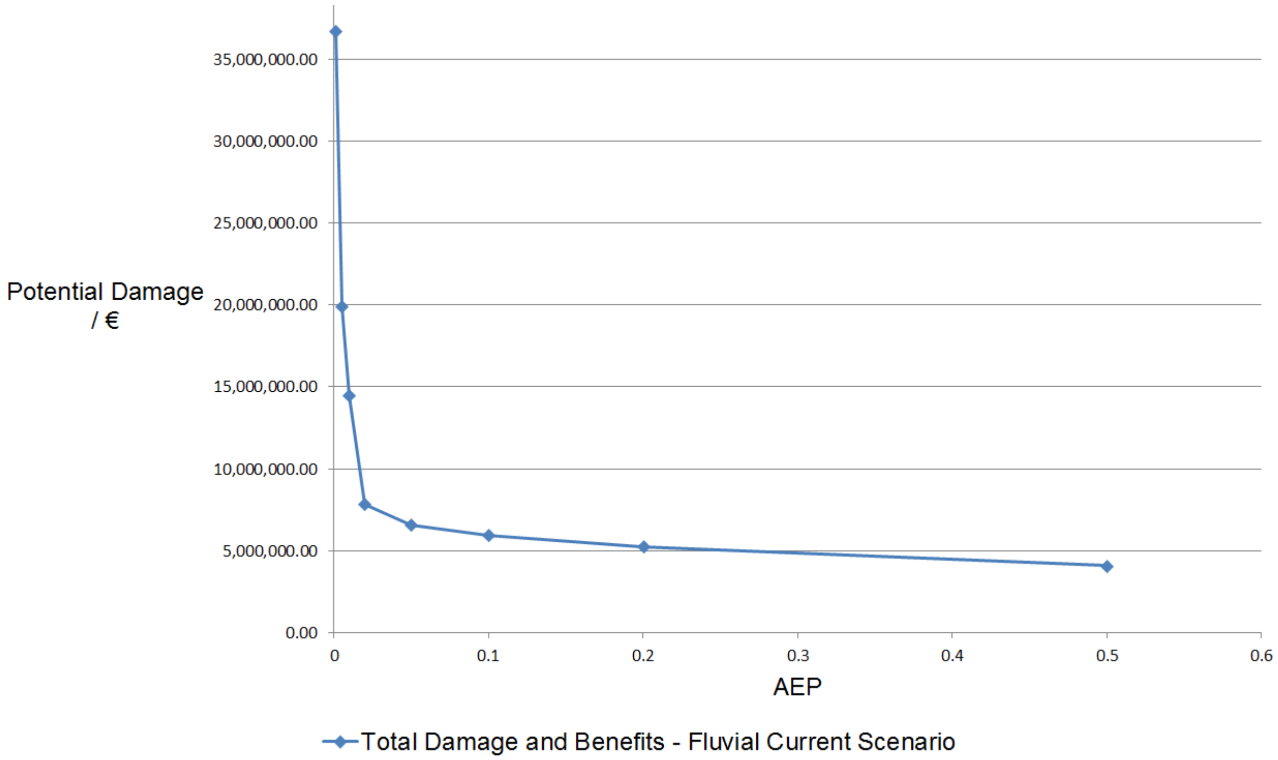
8.3.3.1 Annual Average Damage

The potential economic damage that could be caused by flooding was calculated for every property in each of the UoM 20 AFAs. The damage to a property is related to the type, use and/or area and the predicted depth of flooding within the property. It is possible to calculate the damage that could arise from a series of floods of different Annual Exceedance Probability (AEP). Using these damage values the Annual Average Damage for the AFA can be calculated by measuring the area under the Damage / Probability Curve.

For each property, the depth of flooding was extracted from the hydraulic model for the full range of design scenarios (i.e. 50% AEP to 0.01% AEP for both fluvial and tidal flooding). Using the research from the FHRC Multi-coloured Handbook, damage costs were calculated for each property for the range of scenarios.

The damage costs are based on property type and/or area. The total damages for each design scenario were summed and plotted on the annual average flood loss curve which is shown in Figure 8.1. The area under the curve is the Annual Average Damage (AAD).

Figure 8.1: Typical Damage / Probability Curve (Annual Average Flood Loss Curve)



The Annual Average Damage for each AFA is listed in Table 8.14 below.

Table 8.14: Annual Average Damage €

AFA	Current Scenario €	Mid-Range Future Scenario €	High End Future Scenario €
Clonakilty	6,575,567	16,936,945	23,962,864
Dunmanway	1,016,801	1,371,822	2,297,187
Inishannon	198,822	1,017,731	1,969,123
Schull	639,879	1,260,437	1,812,405

8.3.3.2 Present Value Damage (PVd)

The Present Value Damage (PVd), based on a scheme that will have to be renewed after 50 years and a discount rate of 4%, has also been calculated. The PVd is calculated for each individual property in order to allow capping of PVd values where the PVd exceeds the current market value of the property.

Where a property's estimated potential damage for an event of 0.1% AEP is equal to or exceeds €0.5M, a threshold survey was carried out as a spot check on the ground level as determined by the DTM. Where a discrepancy was noted, the damage assessment was updated and damages recalculated. Spot checks were also carried out on properties where the PVd of a property is 1% or more of the total PVd for the AFA.

Table 8.15 lists all properties with damages for the 0.1% AEP event exceeding €0.5M or with a PVd greater than 1% of the Total AFA PVd

Table 8.15: List of properties with damages exceeding €0.5M or a PVd greater than 1% of the Total AFA PVd

AFA	Property Type	Object ID	Fluvial Damages 0.1% AEP €	Tidal Damages 0.1% AEP €	PVd - 1% of Total
Dunmanway	Semi	507544	42,359.80	0.00	2.07%
	Semi	507771	55,030.92	0.00	2.89%
	Semi	508004	37,214.50	0.00	1.90%
	Semi	508486	38,500.82	0.00	2.80%
	Semi	508488	56,891.55	0.00	2.76%
	Terrace	507728	44,934.68	0.00	10.45%
	Mill	507572	360,248.58	0.00	3.91%
	Office	508174	29,550.48	0.00	25.07%
	RetailWH	507982	192,945.37	0.00	1.09%
	School	507900	352,320.02	0.00	1.99%
	Shop	508675	213,879.87	0.00	2.59%
	Warehouse	507739	22,273.51	0.00	14.42%
	Warehouse	508066	44,334.62	0.00	3.39%
	Warehouse	508105	49,188.68	0.00	2.14%
Inishannon	Bungalow	1520445	103,668.96	0.00	1.66%
	Bungalow	1734950	99,700.99	0.00	1.41%
	Bungalow	1736752	101,684.98	0.00	1.64%
	Bungalow	1736753	103,668.96	0.00	1.71%
	Bungalow	1736754	106,062.27	0.00	1.84%
	Detached	1736812	121,364.56	72,667.84	10.54%
	Semi	1520461	75,392.88	0.00	1.40%
	Semi	1736818	42,359.80	25,571.88	16.88%
	Shop	1736758	194,336.09	0.00	2.52%
	Shop	1736857	602,384.04	201,558.55	40.44%

AFA	Property Type	Object ID	Fluvial Damages 0.1% AEP €	Tidal Damages 0.1% AEP €	PVd - 1% of Total
	Shop	1736881	348,374.13	0.00	1.02%
	Storage	1735048	71,055.60	16,283.58	3.30%
Schull	Bungalow	3332306	23,952.00	0.00	2.88%
	Detached	3332307	34,252.50	0.00	3.18%
	Detached	3332561	68,309.81	0.00	3.63%
	Detached	3332596	89,870.70	0.00	4.59%
	Detached	3332601	24,234.50	0.00	2.47%
	Semi	3332066	57,511.76	0.00	3.34%
	Semi	3332077	34,421.03	0.00	1.83%
	Semi	3332078	31,627.56	0.00	2.34%
	Semi	3332253	50,409.04	0.00	2.70%
	Semi	3332781	28,834.10	0.00	1.34%
	Terrace	3332177	20,248.44	0.00	1.40%
	Terrace	3332212	19,141.78	0.00	1.39%
	Terrace	3332383	34,171.52	0.00	1.33%
	Terrace	3332607	22,803.69	0.00	1.36%
	Terrace	3332612	30,469.45	0.00	1.46%
	Terrace	3332631	38,758.80	0.00	1.37%
	Terrace	3332728	30,469.45	0.00	1.37%
	Bank	3332672	33,550.63	0.00	2.90%
	Library	3332573	46,838.67	0.00	1.75%
	Pub	3332169	52,687.12	0.00	2.74%
	Pub	3332196	37,496.31	0.00	1.42%
	Pub	3332729	61,557.99	0.00	3.05%
	Restaurant	3332723	29,626.80	0.00	1.04%
	Restaurant	3332783	41,615.54	0.00	2.75%
	Shop	3332060	6,778.02	0.00	1.01%
	Shop	3332061	19,841.63	0.00	2.68%
	Shop	3332162	118,855.13	0.00	6.96%
	Shop	3332211	73,044.35	0.00	4.18%
	Shop	3332220	18,615.24	0.00	1.12%
	Shop	3332223	35,012.62	0.00	2.49%
	Shop	3332638	50,475.98	0.00	3.23%
	Shop	3332782	111,753.26	0.00	9.84%

Following the survey spot check, adjustments were made as required and property damages were capped. For Residential properties, the damages were capped at the market value of the property and non-residential properties were capped at ten times the rateable value of the property. The capping process

was carried out in line with Guidance Note 27. Market values for residential properties were determined within each AFA. Typical capping values for residential properties are as follows:

- Detached = €250k - €300k
- Semi-detached = €150k - €250k
- Terrace = €100k - €150k

The annual average damage and present value damages for each of the AFAs is listed in Table 8.16. The benefit of a flood risk management option (Scheme) was also calculated which is the damage avoided by implementing a scheme to the required Standard of Protection (SOP).

Table 8.16: Summary of Damages & Benefit of Scheme Benefit

AFA	AAD €	PVd	Capped PVd	Benefit of Scheme (Damage Avoided) €
Dunmanway	77,539.46	1,665,717.03	1,312,637.79	791,841.01
Inishannon	198,822.23	4,271,135.82	4,073,636.74	3,152,279.82
Schull	639,879.03	13,745,999.46	9,561,227.17	8,917,474.13

Table 8.17 lists the benefit or damage avoided by implementing a flood forecasting and warning system.

Table 8.17: Benefit of Implementing a Flood Forecasting & Warning System

Spatial Scale of Assessment	Infrastructure	Benefit € (13% of PVd)
AFA		
Dunmanway	Rain gauges River level gauges Build on existing Bandon Flood Early Warning System	216,543.21
Inishannon Fluvial	Build on the existing Bandon Flood Early Warning System	454,984.89
Inishannon Tidal	Use the existing OPW storm surge forecasting system to predict high tide levels.	100,262.76
Sub-Catchment		
Dunmanway / Bandon / Innishannon	Rain gauges and river level gauges to cover the Brewery and Dirty River in Dunmanway Build on existing Bandon Flood Early Warning System Use the existing OPW storm surge forecasting system to predict high tide levels.	771k +
UoM		
River Bandon	Build on the existing Bandon Flood Early Warning System Use the existing OPW storm surge forecasting system to predict high tide levels.	771k +

Source: UoM 20 Hydraulics Report

The benefit of implementing a flood forecasting and warning system at the sub-catchment and UoM scale is likely to be greater than shown in Table 8.17 as it has the potential to reduce damages along MPWs and other watercourses not assessed as part of this study. However, there is a corresponding cost increase due to additional gauges etc.

8.3.4 General Risk Maps

General Risk Maps have been prepared for each of the watercourses modelled in UoM 20. These maps show the receptors at risk and the flood extents for three AEPs. The general risk maps are categorised by Flood Risk Receptor type. That is;

- Society
- The Environment
- Cultural Heritage
- The Economy

The AEPs of flooding shown on the general Risk Maps are the 10% AEP, the 1% AEP and the 0.1% AEP.

9 Estimates of Cost

9.1 Flood Forecasting and Warning Systems

The cost of the flood forecasting and warning systems were calculated using the rates and methods contained in the Unit Cost Database developed by the OPW for use in the CFRAM studies. The estimates in Table 9.1 include costs for specifications, site surveys, gauging and telemetry equipment, forecast model setup and development along with training, operation and maintenance. In addition, in order to take account of the high level nature of the estimate and include for unseen costs, optimism bias is included in these estimates. The costs are exclusive of VAT. Full details of the costs are included in Appendix A.

Table 9.1: Estimate of Costs – Flood Forecasting and Warning Systems

SSA	Infrastructure	Benefit € (13% of PVd)	Estimated Cost / €
AFA			
Dunmanway	6 Nr. Rain Gauges 4. Nr. River Level Gauges (Hydrometric Station)	216,543.21	778,025.00
Inishannon Fluvial	Build on the existing Bandon Flood Early Warning System	454,984.89	< 400k
Inishannon Tidal	Use the existing OPW storm surge forecasting system to predict high tide levels.	100,262.76	<100k
Sub-Catchment			
Dunmanway / Bandon / Innishannon	Rain gauges and river level gauges to cover the Brewery and Dirty River in Dunmanway Build on existing Bandon Flood Early Warning System Use the existing OPW storm surge forecasting system to predict high tide levels.	771k +	> 800k
UoM			
River Bandon	Build on the existing Bandon Flood Early Warning System Use the existing OPW storm surge forecasting system to predict high tide levels.	771k +	> 800k

From Table 9.1 it can be seen that flood forecasting is not a viable measure for Dunmanway.

Details of the existing forecasting systems are not readily available to fully assess the additional infrastructure required to include Inishannon. However, based on the damages avoided and economies of scale, building on the existing systems for Inishannon is likely to be a viable measure.

Extending the flood forecasting and warning system to a sub-catchment and UoM scale is not viable as demonstrated by the cost of setting up a system for Dunmanway alone.

9.2 Structural Options

The cost of each viable option was calculated using the rates contained in the Unit Cost Database developed by the OPW for use in the CFRAM studies. This database contains rates for constructing various types of flood risk management measures depending on their height (depth), length and location.

The estimates in Table 9.2 below include costs for construction, maintenance, operation, land acquisition, and professional fees. In addition, in order to take account of the high level nature of the estimate and include for unseen costs, optimism bias is included in these estimates. The costs are exclusive of VAT. Full details of the costs are included in Appendix A.

Table 9.2: Estimate of Costs for Potential Options

AFA	Option	Estimated Cost / €	Benefit of Scheme €
Dunmanway	Flood Defences	991,163.19	791,841.01
	Storage (Brewery River) / Flood Defences (Dirty River)	1,687,249.54	
	Flow Diversion (Brewery River) / Flood Defences (Dirty River)	3,782,471.47	
Inishannon	Flood Defences	1,493,273.46	3,152,279.82
Schull	Storage	12,846,068.49	8,917,474.13
	Storage (Schull) / Flow Diversion (Meenvane)	9,930,492.53	
	Culvert (Schull – Route 1) / Storage (Meenvane)	5,645,832.71	
	Culvert (Schull – Route 1) / Flow Diversion (Meenvane)	3,119,159.47	
	Culvert (Schull – Route 2) / Storage (Meenvane)	5,645,832.71	
	Culvert (Schull – Route 2) / Flow Diversion (Meenvane)	3,119,159.47	

As highlighted in Table 9.2 there is no cost beneficial option for Dunmanway and two of the potential options for Schull are also not cost beneficial.

10 Appraisal of Options

The effectiveness and potential impacts of each of the potential options is assessed using a Multi Criteria Analysis, (MCA). This MCA process assigns a score for each option that relates to how effective that option is in terms of achieving set goals under a set of objectives. The MCA can then be used to guide the decision on which particular option is the preferred option to manage flood risk in a particular area.

10.1 Flood Risk Management Objectives

The effectiveness of each of the potential options is measured in terms of how it achieves a set of Flood Risk Management Objectives. These objectives are split into a number of categories. These are:

- Technical
- Economic
- Social
- Environmental

Some of these objectives are further split into sub-objectives, where this is not the case the sub objective is the same as the objective. The Objectives and Sub objectives are shown in Table 10.1 below.

Table 10.1: Flood Risk Management Objectives

Criteria		Objective		Sub-Objective
1 Technical	a	Ensure flood risk management options are operationally robust	i)	Ensure flood risk management options are operationally robust
	b	Minimise health and safety risks associated with the construction, operation and maintenance of flood risk management options	I)	Minimise health and safety risks associated with the construction, operation and maintenance of flood risk management options
	c	Ensure flood risk management options are adaptable to future flood risk, and the potential impacts of climate change	i)	Ensure flood risk management options are adaptable to future flood risk, and the potential impacts of climate change
2 Economic	a	Minimise economic risk	i)	Minimise economic risk
	d	Minimise risk to transport infrastructure	i)	Minimise risk to transport infrastructure
	c	Minimise risk to utility infrastructure	i)	Minimise risk to utility infrastructure
	d	Minimise risk to agriculture	i)	Minimise risk to agriculture
3 Social	a	Minimise risk to human health and life	i)	Minimise risk to human health and life of residents
			ii)	Minimise risk to high vulnerability properties
	b	Minimise risk to community	i)	Minimise risk to social infrastructure and amenity
			ii)	Minimise risk to local employment
4 Environmental	a	Support the objectives of the WFD	i)	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives.

Criteria		Objective		Sub-Objective
	B	Support the objectives of the Habitats Directive	i)	Avoid detrimental effects to, and where possible enhance, Natura 2000 network, protected species and their key habitats, recognising relevant landscape features and stepping stones.
	c	Avoid damage to, and where possible enhance, the flora and fauna of the catchment	i)	Avoid damage to or loss of, and where possible enhance, nature conservation sites and protected species or other know species of conservation concern.
	d	Protect, and where possible enhance, fisheries resource within the catchment	i)	Maintain existing, and where possible create new, fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species.
	e	Protect, and where possible enhance, landscape character and visual amenity within the river corridor	i)	Protect, and where possible enhance, visual amenity, landscape protection zones and views into / from designated scenic areas within the river corridor.
	f	Avoid damage to or loss of features, institutions and collections of cultural heritage importance and their setting	i)	Avoid damage to or loss of features, institutions and collections of architectural value and their setting.
			ii)	Avoid damage to or loss of features, institutions and collections of archaeological value and their setting.

:Source ; GN28

10.2 Global and Local Weightings

In order to take account of the relative importance of some objectives in comparison other objectives, each sub-objective is given a Global Weighting. These global weightings are set at a national level and are the same across all of the CFRAM Studies.

The Global Weightings for each sub objective are shown in Table 10.2 below.

Table 10.2: Global Weighting of Flood Risk management Objectives

Objective Ref	Sub Objective	Global Weighting
1(a)(i)	Ensure flood risk management options are operationally robust	20
1(b)(i)	Minimise health and safety risks associated with the construction, operation and maintenance of flood risk management options	20
1(c)(i)	Ensure flood risk management options are adaptable to future flood risk, and the potential impacts of climate change	20

Objective Ref	Sub Objective	Global Weighting
2(a)(i)	Minimise economic risk	24
2(b)(i)	Minimise risk to transport infrastructure	10
2(c)(i)	Minimise risk to utility infrastructure	14
2(d)(i)	Minimise risk to agriculture	12
3(a)(i)	Minimise risk to human health and life of residents	27
3(a)(ii)	Minimise risk to high vulnerability properties	17
3(b)(i)	Minimise risk to social infrastructure and amenity	9
3(b)(ii)	Minimise risk to local employment	7
4(a)(i)	Provide no impediment to the achievement of water body objectives and, if possible, contribute to the achievement of water body objectives.	16
4(b)(i)	Avoid detrimental effects to, and where possible enhance, Natura 2000 network, protected species and their key habitats, recognising relevant landscape features and stepping stones.	10
4(c)(i)	Avoid damage to or loss of, and where possible enhance, nature conservation sites and protected species or other know species of conservation concern.	5
4(d)(i)	Maintain existing, and where possible create new, fisheries habitat including the maintenance or improvement of conditions that allow upstream migration for fish species.	13
4(e)(i)	Protect, and where possible enhance, visual amenity, landscape protection zones and views into / from designated scenic areas within the river corridor.	8
4(f)(i)	Avoid damage to or loss of features, institutions and collections of architectural value and their setting.	4
4(f)(ii)	Avoid damage to or loss of features, institutions and collections of archaeological value and their setting.	4

Source: GN28

In order to take cognisance of the local perspective on the relative importance of objectives, each sub objective is also given a local weighting. Local weightings vary from 0 for not locally important to 5 for very important locally.

During the Draft Flood Mapping Public Consultation Day (PCD) the public were invited to consider each of the sub-objectives and provide a weighting on its importance. The local weightings listed below, which have been used in the MCA, are based on an assessment of the importance of these sub-objectives which has been informed by the input of the public at the PCD.

The Local Weighting for each FRM objective is shown in Table 10.3 below. The table also outlines the manner in which the Local weighting is derived. In some instances the Local Weighting is determined through local consultation. In other instances they are calculated based upon the number of receptors affected. The data used for calculating the local weighting are included in Appendix F1.

Table 10.3: Local Weighting

Sub Objective	Dunmanway	Inishannon	Schull	Calculation method
1(a)(i)	5	5	5	Constant
1(b)(i)	5	5	5	Constant
1(c)(i)	5	5	5	Constant
2(a)(i)	5	2.04	5	AAD / €75,000
2(b)(i)	5	4.15	5	Based on calculated assessment, adjusted by professional judgement
2(c)(i)	1.25	5	0	Based on calculated assessment, adjusted by professional judgement
2(d)(i)	0	1.25	2.92	By professional judgement assisted by local advice
3(a)(i)	2.4	2.24	5	Based on calculated assessment, adjusted by professional judgement
3(a)(ii)	0	0	0	Based on calculated assessment, adjusted by professional judgement
3(b)(i)	0.13	0.18	2.63	Based on calculated assessment, adjusted by professional judgement
3(b)(ii)	5	5	5	Based on calculated assessment, adjusted by professional judgement
4(a)(i)	5	5	5	Constant
4(b)(i)	4	0	5	By professional judgement assisted by local advice
4(c)(i)	4	4	5	By professional judgement assisted by local advice
4(d)(i)	5	2	1	By professional judgement assisted by local advice
4(e)(i)	0	3	4	By professional judgement assisted by local advice
4(f)(i)	1	0	3	By professional judgement assisted by local advice
4(f)(ii)	1	3	3	By professional judgement assisted by local advice

Source: GN 28

10.3 MCA Scoring

Each sub objective has a basic requirement and an aspirational target associated with it. The basic requirement for each sub objective equates to a no change scenario. That is the status quo before the FRM option is adopted. The aspirational target in most cases is set to the highest achievement that is reasonably possible against the sub-objective in implementing the FRM option. The performance of each FRM option is measured against the basic and aspirational targets for each sub objective and assigned a score in accordance with the principals in Table 10.4 below.

Table 10.4: MCA Scoring

Option Performance	Score
Meets Aspirational Target	5
Partially Achieving Aspirational Target	Score in proportion to performance
Meeting Basic Requirement (No Change)	0
Just Failing Basic Requirement	Score in proportion to performance
Fully Failing Basic Requirement	-5
Totally Failing Basic Requirement (Option Illegal or Totally Unacceptable)	-999

In the MCA the technical objectives measure if an option is robust in terms of operation. Higher scores are allocated to options that do not rely on mechanical, electrical or human intervention to operate effectively. Examples of such interventions include sluice gates, storm water over pumping, or erection of demountable barriers. The technical objectives also consider if the options can be constructed safely and if they can be adapted to future changes.

The adaptability of each option to the possible impacts of climate change is assessed through a qualitative decision tree. This involves identifying what flood risk management measures might be required in the future, what is required now and ensuring that decisions made now are adaptable to permit an effective and efficient transition to the management of potential future flood risk. The decision tree is a graphical representation of how the option can be adapted over time and of the scores given to each option. The decision trees are included in Appendix C.

The scoring for a given option reflects the cost and the degree of difficulty and potential impacts of future adaptions that would be necessary to maintain the Standard of Protection of the option under the MRFS and/or HEFS, whereby the greater the cost, difficulty and impact, the lower the score. The decision tree and scores for each SSA are included in Appendix E. The scores from the decision trees are used in the MCA.

The measurement of the performance of the options against the objective to avoid economic damage is measured in terms of the percentage of economic damage avoided by that option. Certain receptors in Coastal AFAs are at risk from fluvial and tidal flooding. On the basis of historical flood records it can be

said that these flooding mechanisms are independent of each other. For this reason when assessing the potential damage to properties in Coastal AFAs this report considers that the total potential damage is equal to the total potential fluvial damage added to the total potential tidal damage. Similarly when assessing the damage avoided by a particular option the total damage avoided is equal to the total fluvial damage plus the total tidal damage avoided. When calculating the percentage reduction in damage for a particular option this is calculated relative to the total potential damages in the town. The economic objectives also measure the performance of the option in terms of reducing the risk to transportation routes, utility infrastructure and agricultural land.

The social objectives in the MCA include the reduction of flood risk to people, high vulnerability properties such as hospitals and fire stations and to social infrastructure and amenities. Under social objectives the MCA also measures the performance of the option to reduce the risk to local employment in relation to the number of non-residential properties at risk.

Under the Environmental criteria the MCA measures the performance of the option under environmental headings such as:

- Promote achievement of good status in waterbodies
- Avoiding damage to protected habitats
- Minimising the risk of environmental pollution
- Avoid damage to the flora and fauna of the catchment
- Avoid damage to fisheries habitats
- Protect landscape character and visual amenity within the river corridor
- Avoid damage to features of architectural value
- Avoid damage to features of archaeological importance

Once all of the options have been analysed with reference to their performance against each of the sub-objectives the MCA score for each criteria can be calculated. This is done by multiplying the score for each sub objective by the Global and the local Weighting and then by summing the weighted scores for all the sub objectives under that criteria.

The **MCA Benefit Score** is calculated by adding the weighted score for the Economic, Social and Environmental Criteria together. This score represents the net benefits of the option.

The **Option Selection MCA Score** is calculated by adding the weighted scores of all the criteria together. This score includes the technical score and therefore includes all of the aspects that should be taken into account in considering the preferred option for a given location.

The **Total Construction Cost €** is the cost of the FRM option as outlined in Section 6.

The **MCA Benefit – Cost Ratio** is calculated by dividing the **MCA Benefit Score** by the cost of the option. This is a numerical but non monetised ratio that indicates the overall benefits that can be delivered per euro of investment.

The **Economic Benefit €** is the cost of the damage avoided for the FRM Option.

The **Economic Benefit – Cost Ratio** is calculated by dividing the cost of the damage avoided by adopting the FRM Option by the cost of the option. This is the traditional method used by OPW in assessing the economic case for proceeding with a flood relief scheme. In general terms a flood relief scheme would be considered economically viable if the benefit cost ratio is greater than 1.

10.4 Measures Being Undertaken under Other Policy Areas

Flood related measures being undertaken under other policy areas have the potential to have an impact on flood risk in the UoM. The relevant policy areas may relate to EU Directives 85/337/EEC (EIA Directive), 96/82/EC (Seveso II Directive), 2001/42/EC (SEA Directive) and 2000/60/EC (Water Framework Directive).

11 Selection of Preferred Options

11.1 Preferred Flood Risk Management Options – UoM

The preferred Flood Risk Management Options selected for inclusion in the Flood Risk Management Plan for UoM 20 are set out below:

- Planning Control
- Building Regulations
- SUDS
- Flood Forecasting and Warning Systems
  - Inishannon – build on existing Bandon Flood Early Warning System (FEWS)
- Public Awareness
- Individual Property Flood Resilience
- Land Use Management

11.2 Preferred Flood Risk Management Options – AFAs

11.2.1 MCA Scores

The Scores achieved by each viable option under consideration are listed in Table 11.1 below. The rank of each option is determined by the MCA Benefit Cost Ratio. Details of the MCA undertaken for each AFA are contained in Appendix F.

Table 11.1: MCA Scores for Potential Options

AFA / Option	Cost Estimate €	Capped Scheme Benefit €	MCA Benefit Score	Option Selection MCA Score	MCA Benefit Cost Ratio (Millions)	Economic Benefit Cost Ratio	Initial Rank
Dunmanway							
Do Nothing	-	-	-195.00	-195.00	0.00	0.00	4
Flood Defences	991,163.19	791,841.01	719.35	1819.35	725.76	0.80	1
Storage & Flood Defences	1,687,249.54	791,841.01	854.35	1854.35	506.36	0.47	2
Flow Diversion & Flood Defences	3,782,471.47	791,841.01	524.35	1424.35	138.63	0.21	3
Inishannon							
Do Nothing	-	-	-440.00	-440.00	0.00	0.00	2
Flood Defences	1,493,273.46	3,152,279.82	729.17	1992.17	530.49	2.11	1
Schull							
Do Nothing	-	-	-48.00	-48.00	0.00	0.00	5
Storage	12,846,068.49	8,917,474.13	1009.01	1959.01	78.55	0.69	4
Storage & Flow Diversion	9,930,492.53	8,917,474.13	1009.01	1809.01	101.61	0.90	3
Culvert & Storage	5,645,832.71	8,917,474.13	1148.01	1998.01	203.34	1.58	2
Culvert & Flow Diversion	3,119,159.47	8,917,474.13	1073.01	1773.01	344.00	2.86	1

11.2.2 Feedback Provided on Options

At the public consultations for Preliminary Flood Risk Management Options the public were asked to rank the potential options in terms of their preference. The feedback received is included in Table 11.2 below.

Table 11.2: Public Preference for Potential Options

AFA	Option	Nr of Preferences Received	Rank
Dunmanway	Flood Defences	1	2
	Storage and Flood Defences	1	1
	Flow Diversion and Flood Defences	1	4
	Do Nothing	1	3
Inishannon	Flood Defences	2	1
	Do Nothing	2	2
Schull	Storage	1	5
	Storage and Flow Diversion	1	3
	Culvert and Storage	1	2
	Culvert and Flow Diversion	7	1
	Do Nothing	2	4

The selection of the preferred Flood Risk Management Option for each of the AFAs is based on the MCA and the feedback provided during the public consultation. The preferred options for each of the AFAs are listed below:

11.2.2.1 Dunmanway

The preferred option identified in the MCA is Flood Defences. There was limited feedback provided at the Dunmanway PCD which indicated that the public preference was for Flood Storage and Flood Defences. However, there is no cost beneficial option for Dunmanway.

11.2.2.2 Inishannon

The preferred option identified in the MCA is Flood Defences. There was limited feedback provided at the Inishannon PCD which indicated that the public agreed with the preferred option indicated in the MCA. As an interim measure, before the preferred option is implemented, the installation of flood forecasting and warning system that ties into the existing Bandon Flood Early Warning System would be of benefit in Inishannon.

11.2.2.3 Schull

The preferred option identified in the MCA is the construction of a Culvert on the Schull Stream and Flow Diversion on the Meenvane Stream. The feedback provided at the Schull PCD indicated that the public agreed with the preferred option indicated in the MCA. At the PCD the attendees were given the choice of two culvert routes. The preferred route was in the back of gardens along the route of the existing stream as opposed to locating the culvert in the road.