



South Western CFRAM Study

Final Report UoM 19

30 May 2017

Mott MacDonald
5 Eastgate Avenue
Eastgate
Little Island
Co Cork T45 EE72
Ireland

T +353 (0)21 480 9800
mottmac.com

The Office of Public Works
Jonathan Swift Street
Trim
Co. Meath

South Western CFRAM Study

Final Report UoM 19

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Directors: C O'Donovan BE MBA CEng
MIET (Managing), J T Murphy BE
HDipMM CEng FIEI CMCILT (Deputy
Managing), D Herlihy BE MSc CEng, K
Howells BSc MBA CEng MICE MCWEM
(British), F McGivern BSc DipEnvEng
CEng MIEI
Innealtóirí Comhairleach (Consulting
Engineers)
Company Secretary: Ian Kilty BA (Hons)
ACA
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Executive summary

The Office of Public Works (OPW) are undertaking six catchment-based flood risk assessment and management (CFRAM) studies to identify and map areas with existing and potential future flood risk across Ireland. Mott MacDonald Ireland Limited has been appointed by the OPW to assess flood risk and develop flood risk management options in the South Western River Basin District.

This final report summarises the content of the project deliverables as they relate to the Lee, Cork Harbour and Youghal Bay River Basin.

Flooding is a significant issue in the following towns in the Lee, Cork Harbour and Youghal Bay River Basin:

- Ballingeary
- Inchigeelagh
- Castlemartyr

In order to manage flood risk in the Lee, Cork Harbour and Youghal Bay River Basin, the following non-structural flood risk management measures are required:

- Planning Control
- Building Regulations
- Consideration of Flood Risk in Local Adaptation Planning
- Sustainable Urban Drainage Systems (SUDS)
- Flood Forecasting and Warning Systems
 - Build on Lower Lee Flood Warning System
- Public Awareness
- Individual Property and Community Flood Resilience
- Voluntary Home Relocation
- Land Use Management and Natural Flood Risk Management Measures
- Emergency Response Planning

The preferred Flood Risk Management Options identified for each of the AFAs in UoM 19 are set out below:

- The preferred option for Ballingeary is and Flood Defences.
- The preferred option for Inchigeelagh is Flood Defences.
- The preferred option for Castlemartyr is Flow Diversions and Flood Defences.

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 Limited 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 Limited have produced a FRMP which sets 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.

1.2 SW CFRAM Study Process

The overarching aims of the SW CFRAM Study were 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 was 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 FRMP sets 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 Munster Blackwater Catchment (UoM 18)
- The Lee / Cork Harbour and Youghal Bay 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)

1.3 Report Structure

The structure of this report is set out as follows:

1. Introduction
2. Project Inception
3. Flood Risk Review
4. Hydrology
5. Hydraulic Modelling and Mapping
6. Development of Flood Risk Management Options
7. Strategic Environmental Assessment
8. Appropriate Assessment
9. Flood Risk Management Plans
10. Lessons Learned
11. Health and Safety
12. Review of Project Scope
13. Non-Reported Deliverables
14. Digital Deliverables

A schedule of the deliverables referred to in this report is included in Appendix A.

2 Project Inception

At the outset of the South Western CFRAM Study Mott MacDonald set out their proposed approach to the study in UoM 19 in an Inception Report. This report included the following:

- Detailed Methodology
- Data & Data Requirements
- Survey Requirements
- Preliminary Hydrological Approach

3 Flood Risk Review

3.1 The Preliminary Flood Risk Assessment

The Preliminary Flood Risk Assessment (PFRA) concluded that there was potential significant risk in the following areas in UoM 19:

- Castlemartyr
- Coachford
- Killeagh
- Ladysbridge
- Mogeely
- Dromanallig

3.2 Flood Risk Review

The flood risk in each of these areas was reviewed by on site surveys, interviews with residents and Local Authority Staff and consultation with the SW CFRAM Steering Group. Following the review, it was concluded that the following areas were Areas for Further Assessment and should be included in the SW CFRAM Study:

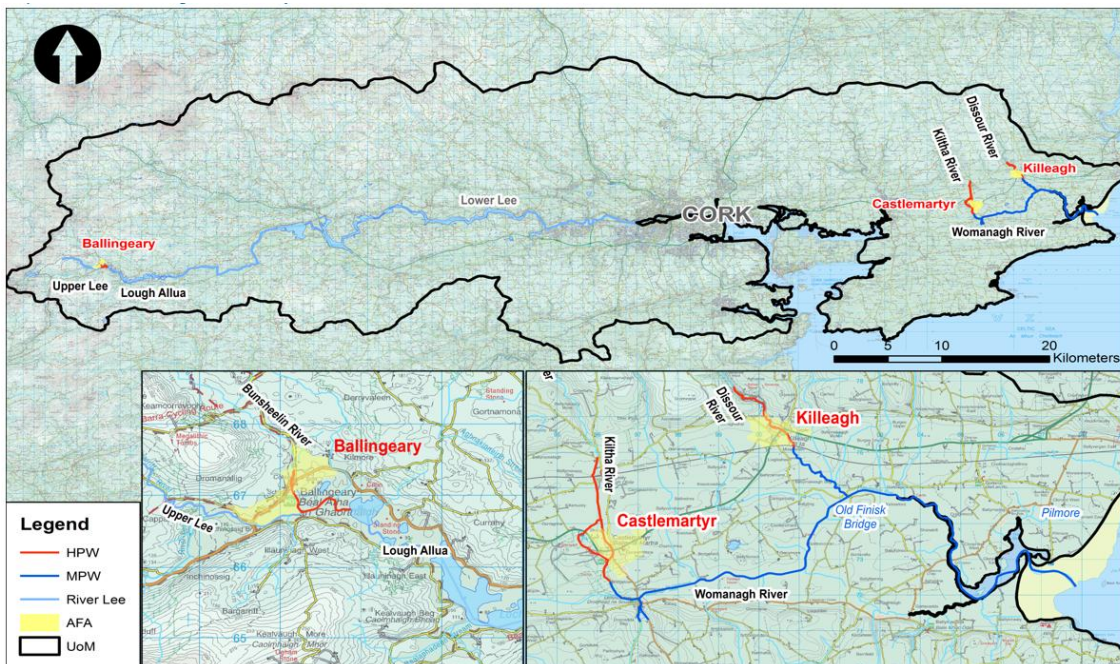
- Castlemartyr
- Killeagh
- Ballingeary
- Inchigeelagh

4 Hydrology

4.1 Sub-Catchments & Coastlines

The Lee, Cork Harbour and Youghal Bay UoM can be split into sub-catchments covering the AFAs as shown in Figure 1.

Figure 1: The Lee, Cork Harbour and Youghal Bay UoM



Source: UoM 19 Hydrology Report

4.1.1 Womanagh Catchment

The Womanagh River stretches from its source at Carrigour to its tidal outfall at Pilmore into Youghal Bay. The Womanagh is relatively flat with a typical gradient of 1 in 900 in the upper reaches, reducing to over 1 in 20,000 in the tidal reaches. The Kiltia River flows from Springfields/Mogeely southwards through Castlemartyr to join the Womanagh near Ladysbridge. Within Castlemartyr, a spring at Little Island diverts water from the Kiltia via the Castle, through the lake to re-join downstream of the town. Immediately upstream of Little Island a land drain crosses under the Kiltia which drains lands to the west. This land drain runs parallel to the river for a short distance before entering a swallow hole in an adjacent field. From discussions on site with Local Authority staff it is believed that this swallow hole is connected to the Dower River through a cave system. The Dower River is heavily dominated by karst and flows through swallow holes, creating a dry valley in its upper reaches. The Dower River and Ladysbridge Stream join the Womanagh before the Dissour River. The Dissour River flows from Kilcronatmountain southwards through Glenane Beg Ravine before flowing through Killeagh town and joining the River Womanagh at Finisk Old Bridge.

4.1.2 Ballingeary / Inchigeelagh AFA

The Upper Lee flows from its source near Rosslougha in an easterly direction to the south of Ballingeary at Inchinossig Bridge and continues towards Cork. The Bunsheelin River flows through Ballingeary from the North to join the upper River Lee downstream of Inchinossig Bridge. The River Lee then flows in an easterly direction into Lough Allua and downstream to Inchigeelagh. The Bunsheelin River has a steep gradient of 1 in 35, reducing to 1 in 130 before entering the flat-water body of Lough Allua.

4.1.3 Coastal Features

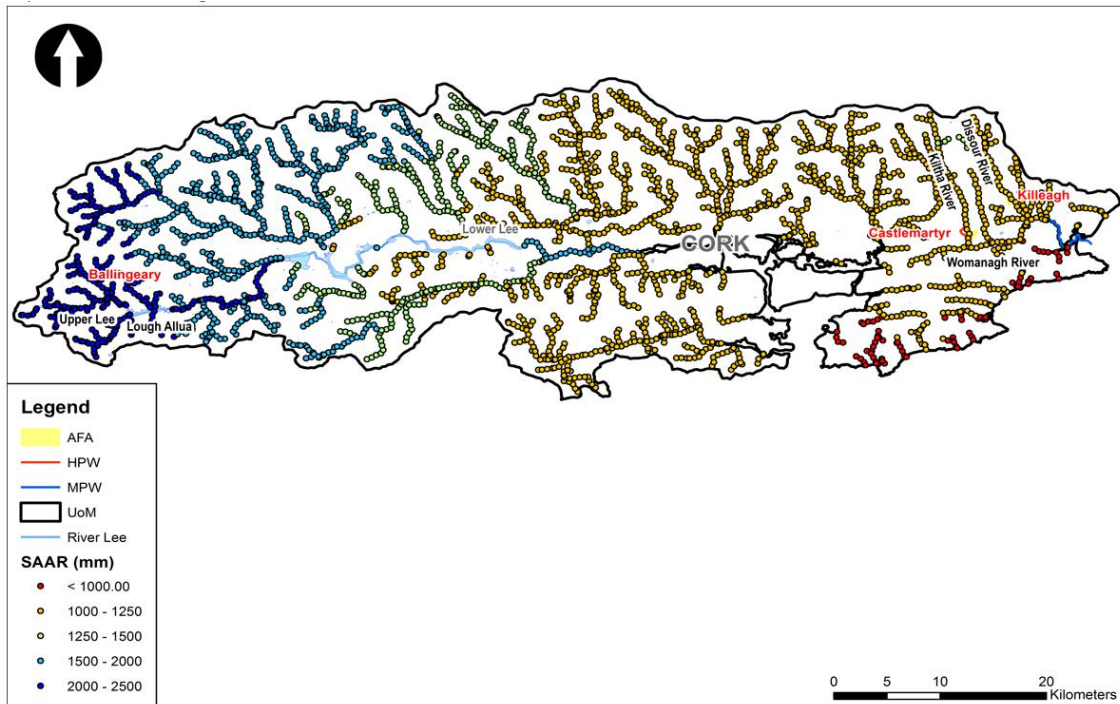
The Womanagh River can be considered tidal downstream of Finisk Old Bridge, some 10km inland. The tidal channel is embanked above the low-lying tidal floodplain downstream of Finisk Old Bridge limiting the width of the channel to 30m. Once these embankments are overtopped, it would be difficult for flood waters to return to the channel as the floodplain is typically lower than the river. Downstream of Crompaun Bridge, the tidal channel widens to a more estuarine feature over 300m wide with several low-flow loop channels until its tidal outfall at Pilmore. There are large intertidal flats in the estuarine area which are inundated on most tides. The spit features at the tidal outfall protect inland areas from extreme wave action. The Ireland Coastal Water level and Wave Study 2013 (ICWWS) did not identify any areas vulnerable to wave overtopping. Therefore, flooding arising from wave overtopping has not been considered further.

4.2 Rainfall Distribution

Figure 2 shows the variation in Standard Average Annual Rainfall (SAAR) across UoM19. Rainfall tends to be greater in the west and decreases towards the east. This corresponds with the dominant wind direction in the South West where storms tend to track west to east.

Ballingeary has high annual rainfall, over 2000mm, because the regular westerly storms deposit much of their rainfall over the higher relief of the Shehy Mountains which drains to Ballingeary and Lough Allua. Conversely, the Womanagh catchment has relatively low rainfall, less than 1200mm, as it has much lower topography and is located within a rain shadow of the western mountains. Furthermore, the permeable karstic geology reduces the amount of rainfall reaching the rivers in this catchment.

Figure 2: Standard Annual Average Rainfall



4.3 Recommendations for Future Analysis.

The following recommendations were drawn from the hydrological analysis for future analysis in the catchment:

- The installation of long-term water level and flow gauges along the watercourses in Ballingearry, combined with water level gauges in Lough Allua. This observed data would enable verification of the rainfall-runoff modelling and the exact conditions that lead to flooding at Ballingearry.
- In the immediate future, concurrent level monitoring in Ballingearry and along Lough Allua during a prolonged flood event would provide useful verification and calibration information.
- Flow gaugings and the reinstatement of the Castlemartyr river level gauge may be beneficial to develop improved flow estimates on the Kiltha.
- The %AEP estimates for total tide plus surge levels should be reviewed periodically at Ballycotton as a longer period of data becomes available.

Full details of all the available and reviewed data for the UoM are available in the UoM 19 Hydrology Report.

5 Hydraulic Modelling and Mapping

Four hydraulic models were developed for High Priority and Medium Priority Watercourses in UoM19 covering four Areas for Further Assessment and three intervening reaches of Medium Priority Watercourses. The hydraulic assessment and flood mapping for the remainder of UoM19 was completed as part of the Lee Pilot CFRAM Study in 2013.

The river channels were modelled using 1D ISIS software to calculate flows and head loss at hydraulic structures. The 2D TUFLOW software was used to simulate the multi-directional flows across the urban floodplains of Castlemartyr and Killeagh. The 1D and 2D components of the models are hydrodynamically linked such that water can flow between the river and floodplain during the event to simulate the observed flood mechanisms. A 1D approach was taken in Ballingeary and Inchigeelagh because the floodplain flow was deemed to be parallel to and fully connected with the channel flow. The layout of the models is shown in Figure 3.

The Ballingeary, Inchigeelagh and Castlemartyr models were calibrated to the flood events of 19th November 2009 at Ballingeary, Inchigeelagh and Castlemartyr AFAs. The Killeagh and Womanagh models were not calibrated due to a lack of flood reports, extents, levels and gauge information. However, sensitivity tests were undertaken on flow, downstream level and Manning's 'n' for all models.

The calibrated and tested models were then run for eight flood probabilities under the current design scenario, eight flood probabilities under the mid-range future scenario, and three flood probabilities under the high-end future scenario from both fluvial and coastal sources. Each scenario considers the joint probability between fluvial sources of both the main river and tributaries in Ballingeary, Inchigeelagh, and Womanagh; and between fluvial and coastal sources on the Womanagh. Joint probability between different fluvial sources was not considered for Castlemartyr and Killeagh because there are no tributaries within the Areas for Further Assessment.

5.1 Hydraulic Recommendations

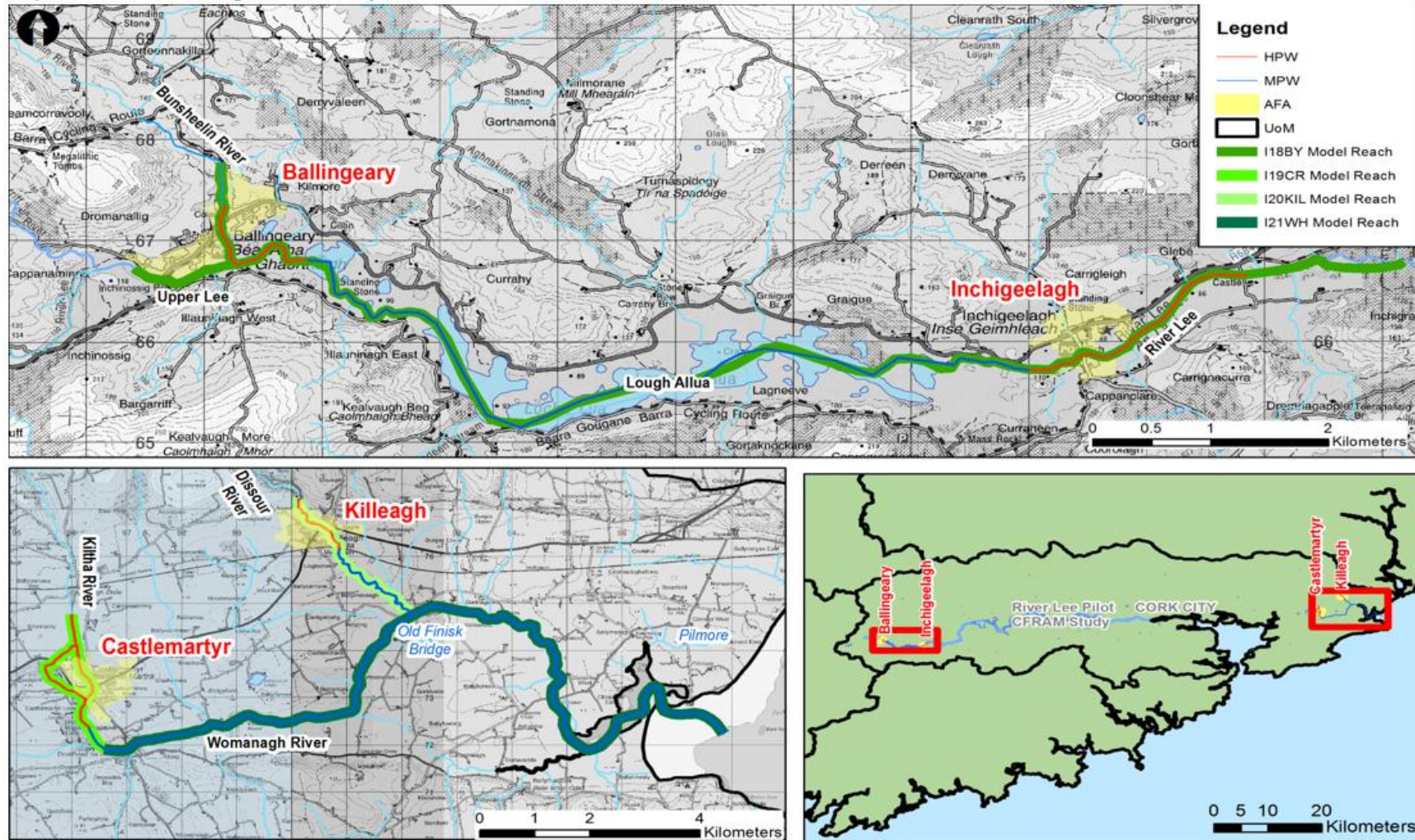
The following recommendations were drawn from the key findings of the Hydraulics Report:

- The uncertainty and sensitivity to peak flow and duration estimates should be considered in the sizing and operation of any flood management measures in Ballingeary and Inchigeelagh.
- The uncertainty in the total tide plus surge levels should also be considered in the development of any flood embankment/walls to protect against coastal flooding along the Womanagh.
- Increased maintenance of channels as an independent measure is unlikely to manage flood risk at the 1%AEP for any of the AFAs assessed. It may be more effective for more frequent events and/or in combination with other measures.
- The capacity of Inchigeelagh Bridge, Ballingeary Bridge and Castlemartyr Bridge should be carefully considered for increased conveyance options to reduce flood risk upstream, as these have been shown to be critical during the calibration and sensitivity tests.
- It is recommended that longer-term level data is obtained for Lough Allua to better assess the relationship between rainfall, the capacity of the Lough and flooding in Ballingeary and Inchigeelagh.

- It is recommended that post-flood surveys are continued for all significant future flood events where properties and/or infrastructure are affected. Data should be collected shortly after the event and include: sources of flooding, timing of overtopping, any actions taken and at what time, blockages of structures, flood levels in the channel and on the floodplain and accompanying photographs.
- It is recommended that surface water flooding and the interaction of flooding with the urban drainage network is investigated in Ballingeary, given the history of pluvial flooding along Ardan Seamus O'Shea.

Full details of the hydraulic modelling and mapping are included in the Hydraulics Report for UoM 19.

Figure 3: Model layout



6 Development of Flood Risk Management Options

6.1 Option Development

The process undertaken to develop flood risk management options for each AFA is set out in the Preliminary Options Report.

In the first instance, a screening and preliminary assessment was carried out to identify which Flood Risk Management (FRM) measures were applicable to each of the Spatial Scales of Assessment (SSA) within UoM 19. The SSAs identified for UoM 19 were the UoM and the AFAs.

The applicability and viability of each of the FRM measures 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 measures was assessed to a preliminary degree only. The purpose of the screening process was to identify the FRM measures that are clearly not applicable or viable within UoM 19.

A Flood Risk Management (FRM) option consists of one, or more commonly a combination of FRM measures. Potential Flood Risk Management (FRM) options for each of the AFA's within UoM 19 were developed.

The effectiveness and potential impacts of each of the potential options was assessed using a Multi Criteria Analysis (MCA). This MCA process assigned 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 was used to guide the decision on which particular option was the preferred option to manage flood risk in a particular area.

6.2 Cost Estimates

The basic construction cost of each 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 total cost of the option was calculated by adding costs for the following to the basic construction cost:

- Optimism Bias; A percentage add-on was applied to take account of issues unknown at preliminary design stage. This percentage was evaluated separately for each measure.
- Preliminaries
- Design fees
- Archaeology

- Environmental mitigation
- Compensation and land acquisition
- Site investigations and
- Maintenance costs.

6.3 Benefit Evaluation

6.3.1 Economic damage caused by flooding

The potential economic damage that could be caused by the flood event scenarios was calculated for every property in each of the UoM 19 AFAs. The damage to a property is related to the type, area and 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. The area under the curve is the Annual Average Damage (AAD).

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.

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

6.3.2 Benefit calculation

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).

6.4 Flood Risk Assessment

Flood risk mapping for the UoM 19 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 number of receptors at risk from the various flooding scenarios are listed in the Preliminary Options Report. The Flood Risk Maps for the UoM are included in an Annexe to the Preliminary Options Report: Annex I, Flood Risk Maps.

6.5 Preferred Options

The preferred Flood Risk Management Options selected for inclusion in the Flood Risk Management Plan for UoM 19 are set out below.

- Planning Control
- Building Regulations
- Consideration of Flood Risk in Local Adaptation Planning
- Sustainable Urban Drainage Systems (SUDS)
- Flood Forecasting and Warning Systems
 - Build on Lower Lee Flood Warning System
- Public Awareness
- Individual Property and Community Flood Resilience
- Voluntary Home Relocation
- Land Use Management and Natural Flood Risk Management Measures
- Emergency Response Planning

Planning control and development management can be a viable flood risk management measure. Using flood hazard information developed as part of the CFRAM study, it was possible to identify areas that are zoned for development that are at risk of flooding. The Spatial Planning and Flood Risk Report identifies such areas in UoM 19 and makes recommendations to manage flood risk in these areas for the consideration of the local authorities and the OPW.

As part of the CFRAM study, the applicability of SUDS was assessed for each AFA. It was found that SUDS is not applicable to existing developed areas in these AFAs, as the required area for storage of surface water flows is not available. However, SUDS is applicable to areas that have been zoned by local authorities for future development. By adopting a SUDS approach for containing surface water within new developments, flooding events can be mitigated by storing surface water on-site. The Strategic Sustainable Urban Drainage System Report for UoM19 outlines natural drainage patterns in each of the AFAs and identifies the volume of storage to be provided for areas zoned for future development.

The preferred Flood Risk Management Options selected for inclusion in the Flood Risk Management Plan for each of the AFAs in UoM 19 are set out below:

- The preferred option identified for Ballingearry is and Flood Defences.
- The preferred option for Inchigeelagh is Flood Defences.
- The preferred option for Castlemartyr is Flow Diversions and Flood Defences.

7 Strategic Environmental Assessment

7.1 The SEA Directive

Strategic Environmental Assessment is required under the EU Council Directive 2001/42/EC on the Assessment of the Effects of Certain Plans and Programmes on the Environment, more commonly known as the “SEA Directive” which has been transposed into Irish law by the following regulations:

- European Communities (Environmental Assessment of Certain Plans and Programmes) Regulations, 2004 (S.I. 435 of 2004) and the
- Planning and Development (Strategic Environmental Assessment) Regulations, 2004 (S.I. 436 of 2004).

Strategic Environmental Assessment (SEA) is a formal, systematic evaluation of the likely significant environmental effects of implementing a plan or programme, prior to a decision being made to adopt a plan or programme.

SEA in Ireland is based on Directive 2001/42/EC (Assessment of the Effects of Certain Plans and Programmes on the Environment), more commonly known as the “SEA Directive” which has been transposed into Irish law by the European Communities (Environmental Assessment of Certain Plans and Programmes) Regulations, 2004 (S.I. 435 of 2004) and the Planning and Development (Strategic Environmental Assessment) Regulations, 2004 (S.I. 436 of 2004).

These regulations were replaced in 2011 by the European Communities (Environmental Assessment of Certain Plans and Programmes) (Amendment) Regulations, 2011 (S.I. No. 200 of 2011) and the Planning and Development (Strategic Environmental Assessment) (Amendment) Regulations 2011 (S.I. No. 201 of 2011).

The main objective of the SEA Directive is to:

“Provide for a high level of protection for the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development.”

7.2 The SEA Process

The SEA process requires the assessment and evaluation of the FRMP measures to identify the potential significant effects of the options on the receiving environment and to identify the preferred options and appropriate mitigation and monitoring required to offset potential impacts. This assessment has been done as part of an overall Multiple Criteria Analysis where the SEA Objectives are utilised to assess the measures proposed in the FRMP for the UoM. The principle steps in the assessment process are as follows:

Flood Management Option Development and Assessment: The SEA process has been fully integrated into the overall appraisal process for the identification of flood risk management options. Based on a detailed understanding of the flood risk identified for each Area of Further Assessment (AFA) a number of different flood alleviation risk management options were developed. Each of these options was then assessed based on a multi-criteria option assessment (MCA) process. The MCA used a suite of project objectives, which include the SEA objectives to rate each of the proposed plan options. This assessment was then used to identify the preferred flood risk management options. In order to facilitate a more accurate assessment a semi-quantitative approach was adopted whereby each plan option was assessed against the

SEA objectives and sub-objectives having regard to the indicators, basic requirements and aspirational targets:

- **Indicator:** The indicators are parameters, measurable and numeric, where possible, by which the success of an option in meeting a particular objective is gauged;
- **Basic Requirements:** A basic requirement is set for each objective as a measure to gauge whether the proposed option meets a minimum standard with regard to each objective. The Basic requirement is a measure below which the proposed objective would have a negative effect.
- **Aspirational Targets:** This is a target set for each objective and defines the perfect outcome with regard to the potential impact of the objective.

Each option was scored against the objectives and sub-objectives based on the scoring matrix. Once a score was defined for each objective then a global weighting was applied which defined the perceived importance of the objective in question. Furthermore, local conditions were also considered for each AFA whereby a local weighting was applied based on an understanding of the local conditions relevant to the objective in question.

Following the identification of preferred flood risk management options from the MCA process, the next stage of the study comprised the development of an overall flood risk management strategy which would comprise a combination of flood prevention measures, flood protection measures and flood preparedness.

8 Appropriate Assessment

8.1 The Habitats Directive

In accordance with Article 6(3) of the Habitats Directive (92/43/EEC), Appropriate Assessment is required where a plan or project not directly connected with or necessary to the management of a Natura 2000 site(s), may give rise to significant effects upon a Natura 2000 site(s). The requirement for Article 6 Assessments has been transposed into Irish law by the European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477 of 2011), herein referred to as the 'Regulations'. Natura 2000 sites include Special Protection Areas (SPAs), Special Areas for Conservation (SACs), which have been adopted by the European Union (EU), but not yet formally designated by the governments of Member States, as well as candidate SPAs and SACs. In accordance with the Regulations, Natura 2000 sites are herein referred to as European sites.

8.2 Natura Sites

The **Castlemartyr** AFA boundary does not overlap with any Natura 2000 site boundary. Flood risk management options in Castlemartyr are proposed for the Kiltia River. The Kiltia River (which flows through Castlemartyr) is hydrologically connected to Ballymacoda Bay SPA and Ballymacoda (Clonpriest and Pillmore) SAC via the Womanagh. The Ballymacoda Bay SPA and Ballymacoda (Clonpriest and Pillmore) SAC are located approximately 10km east of Castlemartyr.

The **Ballingeary** AFA boundary does not overlap with any Natura 2000 site boundary. Flood risk management options in Ballingeary are proposed for the River Lee, and its tributary Bunsheelin River. The River Lee is hydrological connected to the Gearagh SAC and Gearagh SPA, located approximately 15km downstream.

The **Inchigeelagh** AFA boundary does not overlap with any Natura 2000 site boundary. Flood risk management option in Inchigeelagh is proposed for the River Lee. The River Lee is hydrologically connected to the Gearagh SAC and Gearagh SPA.

8.3 Potential Impacts on Qualifying Features for AFAs within UoM 19

8.3.1 Castlemartyr AFA

There are no potential impacts for the flood risk management works in the Castlemartyr AFA. The AFA boundary does not overlap with any Natura 2000 site boundary.

8.3.2 Ballingeary AFA

There are no potential impacts for the flood risk management works in the Ballingeary AFA. The AFA boundary does not overlap with any Natura 2000 site boundary.

8.3.3 Inchigeelagh AFA

The Inchigeelagh AFA boundary does not overlap with any Natura 2000 site boundary. The AFA boundary does not overlap with any Natura 2000 site boundary.

8.4 Significance of Impacts for AFA within UoM 19

No likely impacts have been determined on the Natura 2000 sites from the implementation of viable options in the Castlemartyr, Ballingearry and Inchigeelagh AFAs.

No likely significant effects on Natura 2000 sites are reasonably foreseeable as a result of the implementation of flood risk management measures in UoM 19 of the SWRBD catchment area.

9 Flood Risk Management Plan

The Flood Risk Management Plan is a public facing document that outlines the process undertaken as part of the CFRAM Study and sets out the flood risk management policies, strategies, actions and measures to be implemented by the OPW, Local Authority and other relevant bodies.

9.1 Public Consultation

Following publication of the Draft Plan and associated SEA Environmental Report (SEA ER) and Appropriate Assessment (AA) in July 2016, a series of public consultation events took place to give members of the public an opportunity to discuss the contents of the plan with members of the study team.

Table 1: Public Consultation Days

Location	Date	Venue	Nr. of Attendees
Mallow	29/8/16	The Hibernian Hotel	22
Cappoquin	30/8/16	The Community Centre	8
Cork City	31/8/16	Cork County Hall	24
Skibbereen	1/9/2016	The Library Building	18

9.2 Selected Feedback on the Plan

Observations on the plan, the SEA ER and the AA were received by OPW. Some selected feedback on the documents are summarised below:

9.2.1 Ballingearry

Some stakeholders were of the opinion that the removal of obstructions from the channel between Ballingearry and Lough Allua would improve the flood risk in the town.

9.3 Changes made to the Plan following Public Consultation

No changes were made to the plan following the receipt of observations on the draft plan.

10 Lessons Learned

10.1 Stakeholder Consultation and Engagement.

Through the delivery of the South Western CFRAM Study in UoM 19 we have concluded that further iterations of the CFRAM studies could benefit from a revised approach to stakeholder consultation and engagement. Some of the difficulties encountered are listed below:

- People affected by flooding or flood risk management measures did not know about the study or consultation events.
- People felt that their suggested FRM measures had not been considered.
- People attending consultation on Preliminary Options felt that the team had already made their minds up as to what the preferred option was.
- Stakeholders adopted an adversarial approach to their review of the project deliverables.

We would recommend that expert advice is sought in developing a methodology and programme of public and stakeholder engagement to ensure that in future studies, there is a better buy in from the stakeholders. Early stakeholder participation would be of benefit in this. In order to achieve buy-in, it would be necessary to demonstrate that the input of stakeholders has been considered and forms part of the analysis. The best way to do this may be through workshops.

Some of the constraints that the OPW currently has to operate within include the environmental and economic feasibility. These constraints, and the parts they play in the decision-making process act as barriers to meaningful public consultation and engagement. Careful consideration should be given to how the conflicting objectives of public will, the environment and the cost benefit ratio, can be resolved to improve the consultation and engagement process.

The consultation and engagement of environmental stakeholders may be improved with targeted workshops. At these, environmental experts could engage directly with environmental stakeholders (SWAN, NPWS).

11 Health and Safety

11.1 Safety, Health and Welfare at Work Regulations 2013

The South Western CFRAM study includes the preparation of designs that could lead to construction work. In accordance with the 2013 Construction Regulations the OPW are obliged to appoint a Project Supervisor for the Design Process (PSDP). The PSDP is tasked with co-ordinating the work of designers on a project to ensure that they fulfil their duties in respect of the Construction Regulations. The PSDP is also required to prepare a Safety and Health Plan that includes the following:

- A general description of the project
- A description of other work activities ongoing at the site
- A description of the works which will involve particular risks to the safety and health of those constructing the works and
- Information from designers in respect of the decisions they made to mitigate the risk to persons constructing, operating, maintaining and demolishing the works

Mott MacDonald Ireland were appointed by OPW to carry out this role.

The particular risks associated with the preferred options include the following:

- Falling from height
- Drowning
- Electrocutation
- Burial under earthfalls
- Engulfment in swampland
- Chemical and biological agents
- Heavy prefabricated components
- Interaction with traffic

In addition, Mott MacDonald Ireland, as designers, are obliged under the regulations to consider how their designs can be constructed, operated, maintained and demolished safely. As designers Mott MacDonald Ireland are obliged to design out risk in their designs where possible. Decisions made by designers in this regard are documented in Designer's hazard elimination and management record sheets which are appended to the Preliminary Health and Safety Plan for the UoM.

12 Review of Project Scope

12.1 Hydrology

In viewing the hydrology of an entire catchment, it should be recognised that, for various reasons, the extreme peak flow will not always increase as you progress downstream. In future studies, greater weight should be permitted to single site analysis in areas where there is a significant flood risk.

12.2 Hydraulic Modelling

In future studies, it should be recognised that there is little value in modelling steep watercourses that do not give rise to flood risk in their upper reaches. Steep rivers can carry significant volumes of water without giving rise to flood risk. It can be very difficult to construct stable models of steep rivers.

Greater flexibility should be allowed in future studies for consultants to use other methods to calculate flood depths. In certain AFAs it could have been possible to use simple calculations to determine flood depth.

Based on the screening carried out during this study, future studies should include the impact of blockage at high risk structures. This data may not necessarily be reproduced on the flood extent maps but these maps should highlight that there could be a blockage issue and refer to supplementary flood extent maps.

Future studies should focus on more user friendly digital deliverables as opposed to pdf drawings. In particular, GIS deliverables and web mapping could speed up, and reduce the cost of, the delivery of flood data.

13 Non-Reported Deliverables

This section contains summaries of deliverables that have not previously been reported in SW CFRAM Deliverables.

13.1 Defence Asset Condition Survey

The condition of flood defence assets in AFAs and identified in the project brief was ascertained by on-site inspection. The condition of the assets was recorded in the Flood Defence Asset Database.

13.2 Uncertainty Mapping

The uncertainty associated with the flood extents for various models is shown on the uncertainty mapping. The mapping was carried out as per the methodology set out in the RPS Document “Methodology for Uncertainty Mapping Dodder CFRAMS”. The uncertainty associated with flood extents is associated with uncertainty in the hydrology and in the hydraulic modelling.

The uncertainty related to the hydrology for an area was scored based on the method used to derive extreme flows. The scores for hydrology are shown in Table 2.

Table 2: Hydrological Uncertainty

Method		Score
Catchment Descriptors - FSR	FSR Rainfall Runoff	4
Catchment Descriptors - FEH	FEH Rainfall Runoff	3
Short record (<10 years)	Calibrated Rainfall Runoff	2
Long record (\geq 10 years)		1

The uncertainty related to the hydraulic modelling for an area was scored based on the complexity of the models. The scores for hydraulic modelling are shown in Table 3.

Table 3: Hydraulic Complexity

	Model Description	Score
Simple	Few inflows, branches and structures	0
Medium	Some inflows, branches and structures	1
Complex	Reservoir units, many inflows, and/or many branches	2

Large increases in flow for different AEP flood events gives rise to an increase in uncertainty. To take account of this a third score is used, the Return Period Score.

The uncertainty Scores for UoM 19 are shown in Table 4.

Table 4: Uncertainty Scores

Model	Hydrology Score	Hydraulic Complexity
Ballingeary	3	1
Castlemartyr	3	0
Killeagh	3	0
Womanagh	2	1

The uncertainty line for a flood extent is calculated based on the design flow, the design flood extent, the next extreme flood extent and the uncertainty score.

14 Digital Deliverables

Details of deliverables that have been issued in interactive digital formats are described below.

14.1 Defence Asset Condition Database

The condition of flood defence assets in AFAs and identified in the project brief was ascertained by on-site inspection. The condition of the assets was recorded in the Flood Defence Asset Database which is an Excel spreadsheet with hyperlinks to photographs of the assets.

14.2 River Channel and Structure Survey

AutoCAD drawings of the river channel and structure surveys specified to facilitate the construction of hydraulic models were issued to OPW. Watercourses were given a 6-digit reach code to identify them. The watercourses surveyed in UoM 19 are listed in Table 5.

Table 5: Surveyed Watercourses

Watercourse	Reach Code
Bunsheelin	19BUNS
Kiltha River	19KILR
Killeagh	19EAGH
Kiltha	19KILT
Ladysbridge	19LADE
Ladysbridge	19LADY
Womanagh River	19WOMA

14.3 Hydraulic Models

The hydraulic models built as part of the South Western CFRAM study were issued to the OPW on a hard disk drive. Separate models were built to prepare flood maps, to analyse flood defence failure and to develop options. These models are contained in folders called DESIGN, BREACH and OPTION. The models relating to the AFAs and MPWS are listed in Table 6 below.

Table 6: Hydraulic Models

Model Number	Name	Location
18	Ballingeary	Ballingeary AFA
19	Castlemartyr	Castlemartyr AFA to Ladysbridge
20	Killeagh	Killeagh AFA to the Womanagh
21	Womanagh	The Womanagh from Ladysbridge to Ballymacoda Bay
22	Inchigeelagh Mapping	Inchigeelagh AFA

14.4 Flood Maps

Flood maps were prepared and delivered in pdf and in GIS format.

Table 7: Flood maps

Map Nr	Map Type	GIS format	Probabilities mapped per scenario		
			Current	MRFS	HEFS
1	Flood Extent	Polygon	All	All	10,1,0.1
2	Flood Zone	Polygon	1, .01	1, .01	N/A
3	Flood Depth	Raster Grid	All	10,1,0.1	N/A
4	Flood Velocity	Raster Grid	All		N/A
5	Risk to Life	Raster Grid	10,1,0.1		N/A
6	Defence Failure Extent	Polygon	1 Scenario		N/A
	Defence Failure Depth	Raster Grid	1 Scenario		N/A
	Defence Failure Velocity	Raster Grid	1 Scenario		N/A
7	Specific Risk, Inhabitants	Raster Grid	10,1,0.1	10,1,0.1	N/A
8	Specific Risk, Type of Activity	Raster Grid	10,1,0.1	10,1,0.1	N/A
9	Specific Risk, Economic Risk	Raster Grid	.01	.01	N/A
10	General Risk, Social	Point	10,1,0.1	10,1,0.1	N/A
11	General Risk, Environment	Point	10,1,0.1	10,1,0.1	N/A
12	General Risk, Cultural Heritage	Point	10,1,0.1	10,1,0.1	N/A
13	General Risk, Economy	Point	10,1,0.1	10,1,0.1	N/A

Appendices

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A. Schedule of Reports

Table 8: Schedule of Reports

Report Name	Report Nr
Inception Report	296235-IWE-CCW-R04
Flood Risk Review	296235-IWE-CCW-R01
Hydrology Report	296235-IWE-CCW-R15
Hydraulics Report	296235-IWE-CCW-R18
Draft Flood Mapping Consultation Report	296235-IWE-CCW-CR1901
Preliminary Flood Risk Management Options Report	296235-IWE-CCW-R23
Planning and Development Report	296235-IWE-CCW-R38
Strategic Sustainable Urban Drainage Report	296235-IWE-CCW-R43
Preliminary Safety and Health Plan	296235-IWE-CCW-H-2002
Preliminary Options Consultation Report	296235-IWE-CCW-CR1902
Strategic Environmental Assessment Scoping Report	296235-IWE-CCW-ES01
Strategic Environmental Assessment Option Appraisal Report	296235-IWE-CCW-ES02
Strategic Environmental Assessment Environmental Report	296235-IWE-CCW-ES03
Strategic Environmental Assessment Non-Technical Summary	296235-IWE-CCW-ES08
Strategic Environmental Assessment Statement	296235-IWE-CCW-ES013
Appropriate Assessment Screening	296235-IWE-CCW-EA02
Flood Risk Management Plan	296235-IWE-CCW-R33
Draft FRMP Consultation Report	296235-IWE-CCW-CR1803
Defence Asset Database Handover Report	296235-IWE-CCW-R53

