Courtown and Riverchapel Local Area Plan

2015-2021

Strategic Flood Risk Assessment

Appendix 3

Introduction

A Stage 2 Flood Risk Assessment of the Courtown and Riverchapel Local Area Plan 2015-2021 was prepared and is set out in this document. The Local Authority engaged the services of JBA Consulting to assist in its preparation. The Assessment focused on modelling all of the watercourses in and adjoining the plan area. The modelling was carried out at a more detailed level than the previous flood map datasets used by the Local Authority. This also included modelling additional watercourses to those included on the aforementioned flood map datasets. The resulting flood zone map was verified through site walkovers and consultations with Engineers from the Local Authority. The verified flood zone map was then used to inform land use zoning throughout the plan area and necessary policy responses. Based on the zoning and policy responses, it was not considered necessary to carry out a Stage 3 detailed flood risk assessment for any of the identified 'at risk' parcels of land.

The Flood Risk Assessment is divided into two parts.

Part 1 Flood Risk in the Courtown and Riverchapel Area

This part, prepared by JBA Consulting, provides an introduction to the study area and the watercourses in and adjoining the plan area. It reviews existing and available flood map data for the area, historical flooding records and information sourced through consultation with the Local Authority. The report details the hydraulic modelling undertaken and outlines the resulting flood zones for the area. The flood zones are shown on page 12 of JBA's report and on Map No. 1 which is inserted at the back of the SFRA.

Part 2 Flood Risk Management in the Courtown and Riverchapel Local Area Plan area

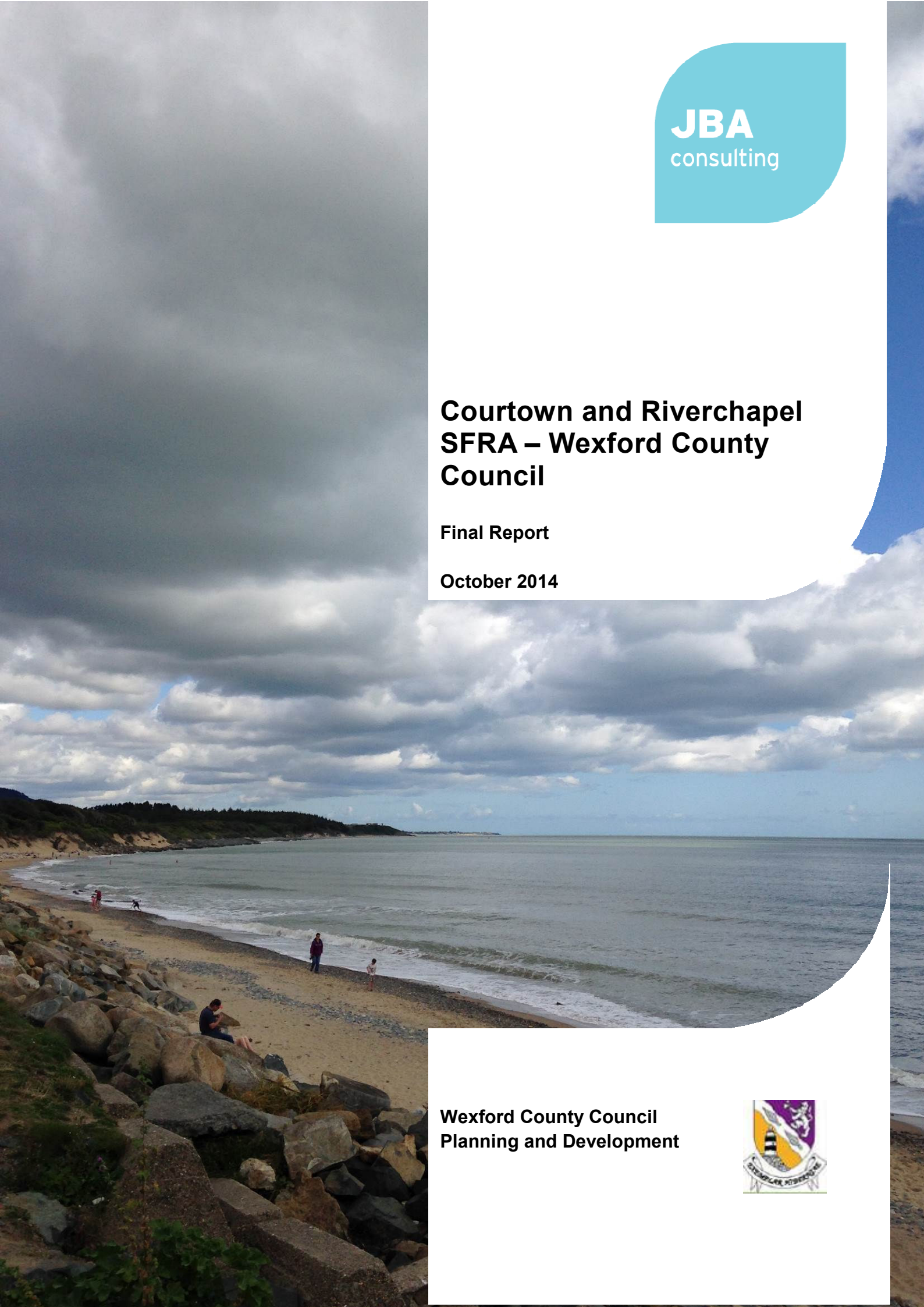
This part discusses how the land use zoning in plan area has addressed flood risk and flood zones identified in Part 1 and discusses how flood risk management will be dealt with at Development Management stage.

Advice Note

Flood hazard and flood risk information is an emerging dataset of information. The flood hazard maps used by the Council may be altered in light of future data and analysis. Therefore, all landowners and developers are advised that Wexford County Council accept no responsibility for losses or damages arising due to assessments of vulnerability to flooding of lands, uses and developments. Owners, users and developers are advised to take all reasonable measures to assess the vulnerability to flooding.

Part 1

Flood Risk in the Courtown and Riverchapel Area



Courtown and Riverchapel SFRA – Wexford County Council

Final Report

October 2014

Wexford County Council
Planning and Development

JBA Consulting

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Revision History

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Contract

This report describes work commissioned by Wexford County Council on 24/07/2014. Joanne Cullinane, Rosalie Scanlon and Ross Bryant of JBA Consulting carried out this work.

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Purpose

This document has been prepared to assist Wexford County Council in the preparation of a Strategic Flood Risk Assessment for the Draft Courtown and Riverchapel Local Area Plan 2014-2020. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

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JBA is aiming to achieve carbon neutrality.

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Abbreviations

2D	Two Dimensional (modelling)
CFRAM	Catchment Flood Risk Assessment and Management
DoEHLG	Department of the Environment, Heritage and Local Government
DTM	Digital Terrain Model
FARL	FEH index of flood attenuation due to reservoirs and lakes
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
FSR	Flood Studies Report
FSU	Flood Studies Update
HEP	Hydrological Estimation Point
ICPSS	Irish Coastal Protection Strategy Study
LAP	Local Area Plan
LiDAR	Light Detection And Ranging
mOD	Meters above Ordnance Datum
OPW	Office of Public Works
PFRA	Preliminary Flood Risk Assessment
Q100	Flow at the 100-year return period
Q1000	Flow at the 1000-year return period
SAAR	Standard Average Annual Rainfall (mm)
SFRA	Strategic Flood Risk Assessment

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1 Introduction

1.1 Commission

JBA Consulting was commissioned by Wexford County Council to undertake hydraulic modelling and to assist in the preparation of a Stage 2 Initial Flood Risk Assessment, in accordance with the Planning System and Flood Risk Management Guidelines ('The Guidelines' DoEHLG/OPW 2009) for the Draft Courtown and Riverchapel Local Area Plan (LAP) 2014-2020 which incorporates the Strategic Flood Risk Assessment (SFRA).

1.2 Scope of Study

The scope of services undertaken by JBA is summarised below in the following tasks:

- Identify and confirm sources of flooding that affect the area of the LAP;
- Review existing and available floodmap data including PFRA flood extents, JBA flood maps, ICPSS data;
- Collect and review any other relevant flood data such as historical flood records, anecdotal evidence, information gathered through consultation with local authority personnel with in-depth knowledge of the area;
- Carry out field work and site walkovers;
- Verify existing flood mapping, using the available and collated data;
- Carry out a hydraulic assessment and 2D hydraulic modelling of all watercourses within the LAP boundary to verify and improve the existing maps;
- Produce updated flood maps for the plan area and the adjoining boundary, including coastal flood mapping (using ICPSS data);
- Produce a report clearly outlining the process involved in producing the flood zone mapping.
- Identify any areas or parcels of land requiring additional, more detailed modelling, to satisfy a Stage 3 FRA. These areas will be decided in consultation with WCC and will be largely dependent on local planning and development pressures.

1.3 Report Structure

This assessment aims to confirm the sources of flooding present in Courtown and Riverchapel, appraise the adequacy of existing information and revise the existing flood zones based on a desktop review, site walkover and consultation with Wexford County Council personnel and additional modelling of all watercourses.

Section 2 provides an introduction to the study area noting the watercourses included for in the assessment. Hydraulic modelling was carried out using JBA's 2 dimensional (2D) hydraulic modelling software; JFlow+®[1]. The calculation of the hydrological inputs and the hydraulic modelling process is discussed in Section 3. Section 4 describes the Stage 2 FRA, including a review of the existing and available flood map data, historical flooding records and information sourced through the consultation with the Local Authority. It provides a summary of flooding sources within the LAP boundary. Finally, Section 5 provides advice on requirements for further work within the LAP to comply with development demands and The Guidelines.

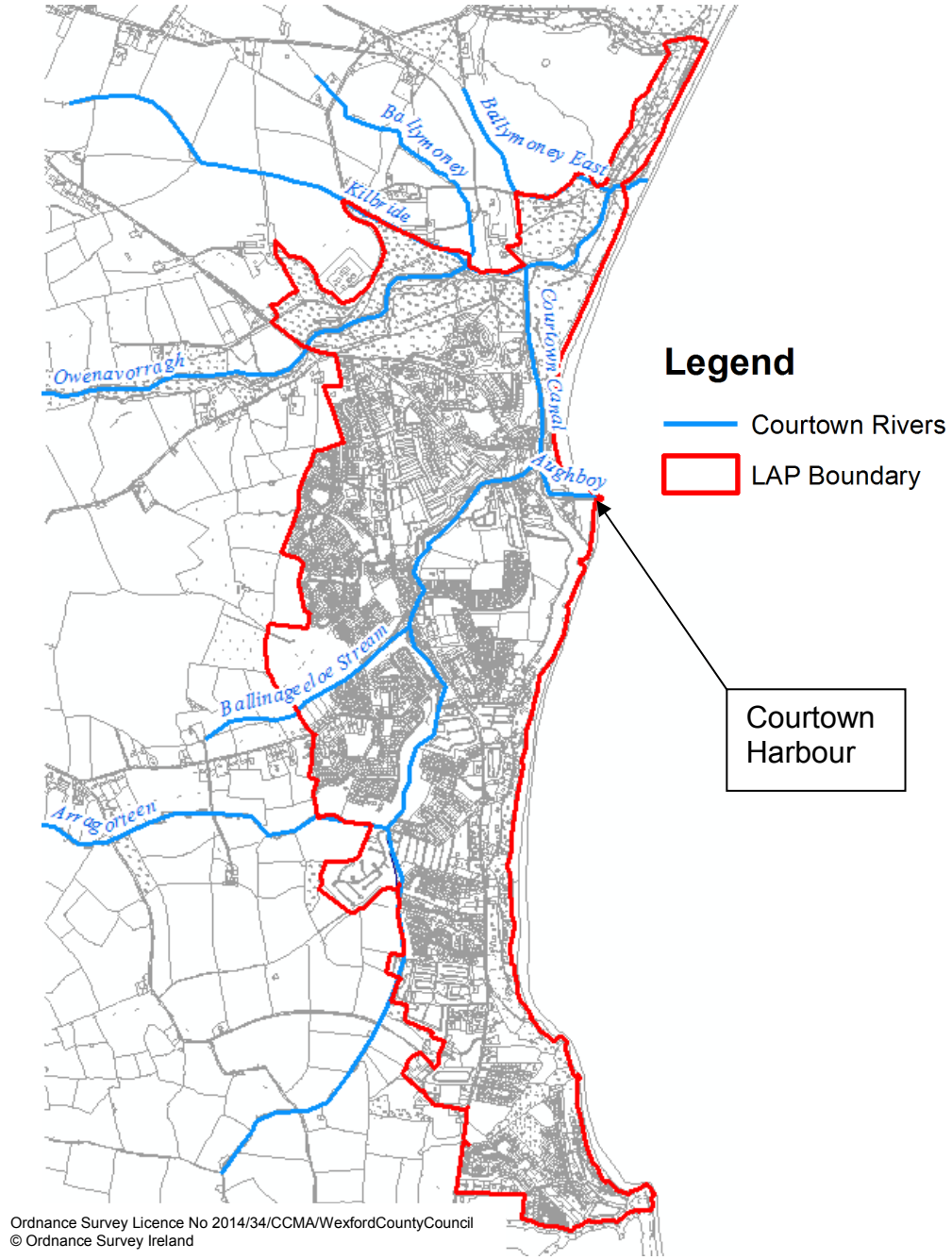
[1] JFlow+® is a registered UK trade mark in the name of Jeremy Benn Associates Limited

2 Courtown and Riverchapel Catchment Area

2.1 Local Area Description

Courtown and Riverchapel are located in the northeast of County Wexford, approximately 6 km east of Gorey. The plan area is bound to the east by coastline and the Irish Sea. The Owenavorragh and Aughboy Rivers enter the Irish Sea at Courtown. Figure 2-1 shows the development boundary extent and the main water courses within the study area.

Figure 2-1 LAP boundary (green) and rivers (blue lines)



2.2 Watercourses

The main rivers flowing through Courtown and Riverchapel are the Owenavorragh and Aughboy. The Owenavorragh River has a catchment area of approximately 161km^2. It flows in a west to east direction through Courtown and discharges into the Irish Sea at Courtown. Within the plan boundary, the Owenavorragh is joined by three small tributaries from the north; Kilbride,

Ballymoney and Ballymoney East. The catchment is predominantly rural with single residences and farms as well as a number of local and regional roads constituting the main form of development until it reaches Courtown. There is a recording gauge located approximately 2.2km upstream of the LAP boundary at Boleany (Boleany gauge 11001). The Annual Average Rainfall is approximately 930mm in the Owenavorragh catchment with no significant attenuation features. The smaller Aughboy River flows from south or north through Riverchapel before also discharging into the sea at Courtown Harbour, where at this point it has a contributing catchment of 15km^2. The Arragorteen and Ballinageeloe Streams flow from west to east and join the Aughboy upstream of Riverchapel and in Riverchapel respectively.

The Owenavorragh and Aughboy River are linked by the man-made Courtown Canal. Historically, flows between the two were controlled by a weir located at the confluence with the Owenavorragh River. However, the structure has fallen into disrepair. The weir controlled flow through the canal towards the Harbour and confluence with the Aughboy River, allowing for a purge of the canal system which would clear out accumulated sediment. Water appears to be able to flow freely between both rivers via the canal. Today the canal and harbour are regularly dredged to control accumulation of bed material. All the main rivers and their tributaries are shown Figure 2-1.

3 Flood Mapping Methodology

As part of this commission modelling has been completed to satisfy the requirements of the Stage 2 Flood Risk Assessment as defined by The Guidelines. Flood mapping has been undertaken for both fluvial (river) flooding and coastal flooding. The two sources of mapping were then combined to form Flood Zones A and B, as defined by the Planning System and Flood Risk Management Guidelines. This section presents the methodology behind the development of the Flood Zone mapping.

3.1 Extreme Sea Level Flood Mapping

Analysis of the contributing factors to coastal flood risk has been undertaken at a national level through the Irish Coastal Protection Strategy Study (ICPSS)[2] and the results of this study has been applied directly to this assessment. Water levels at Node P22 (see Figure 3-1 for point location) have been projected inland and the flood extent mapped using the LiDAR DTM height model provided by the OPW. Node P22 is directly north of Courtown and node P23 is to the south. Predicted ICPSS levels (mOD Malin) are presented below in Table 3-1.

Table 3-1 ICPSS Levels – nodes 22 & 23 adjacent to Courtown

	Return Period (years)					
Node	**2**	**10**	**20**	**50**	**200**	**1000**
P22	0.94	1.11	1.18	1.27	1.42	1.60
P23	0.93	1.10	1.16	1.25	1.39	1.55

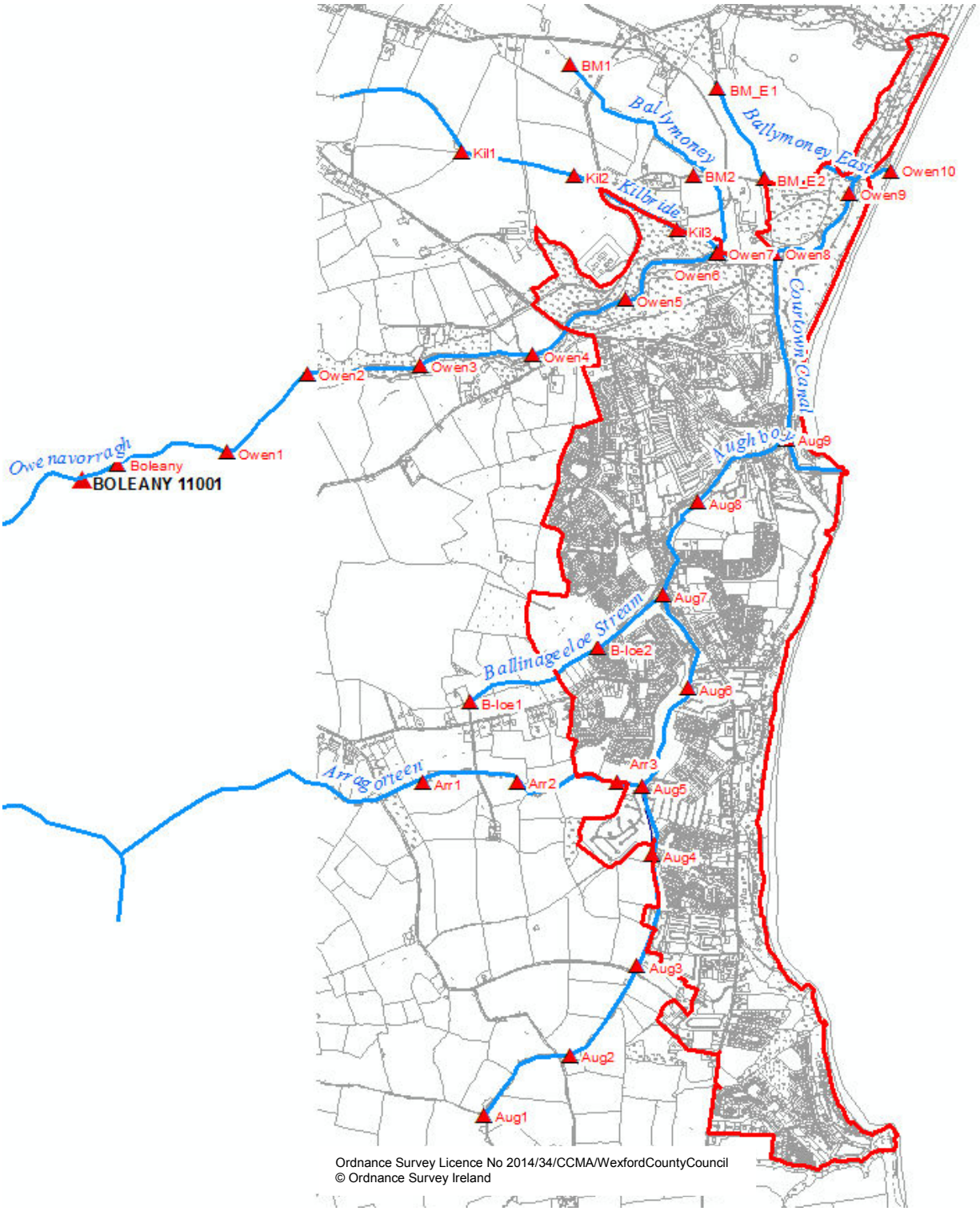
[2] Irish Coastal Protection Strategy Study Phase 2 – South East Coast, OPW June 2010

Figure 3-1 ICPSS Node Locations (ICPSS 2010)

3.2 Fluvial Flood Mapping

The processes involved in the fluvial flood mapping can be divided into two stages: hydrology and hydraulic modelling. These are described in detail below. The aim of the hydrology stage was to generate inflows for use in the hydraulic modelling. To begin, hydrological estimation points (HEPs) were located at approximately 500m spacings along each watercourse as shown in Figure 3-2. A design flow (with a given return period) was estimated at each of these points.

Figure 3-2: Inflow Locations



3.2.1 Choice of Flow Estimation Method

The UK Natural Environmental Research Council carried out a comprehensive flood study across a large number of catchments throughout Britain and Ireland. This investigation involved extensive data analysis and resulted in the

publication of the Flood Studies Report (FSR)[3] which has been widely used for design flow estimation in Ireland and the UK. Since its publication in 1975, significant advancement has been gained in analytical techniques and many more years of data have become available.

The Irish Flood Policy Review Group recommended that a programme of study to develop new methods, and following similar principles to the Flood Estimation Handbook (FEH)[4], has improved the quality and facility of flood estimation for flood risk management in Ireland (OPW, 2004)[5]. This programme of study, the Flood Studies Update (FSU) consists of a number of Work Packages containing extensive research ranging from analysis of meteorological data to flood attenuation analysis and flood estimation for urbanised catchments. The work package most relevant to this study is the Index Flood Estimation (FSU - WP2.3)[6] and is described in the following sections. FSU methodologies have been applied as they are the most up to date methods, are used by the ongoing OPW CFRAM Programme and are currently deemed best practice.

3.2.2 Calculation of the Index Flood and Design Flows

A detailed description of the application of the FSU methodology, including calculation and adjustment of the index flood (using the donor gauge at Boleany), pooled estimation of the growth factors and final derivation of the design hydrographs is presented in Appendix A (methodology), and B (design flow hydrographs).

Table 3-2 overleaf gives the Qmed, Q100 and Q1000 design flows at each HEP.

[3] The Flood Studies Report (1975) Natural Environment Research Council

[4] The Flood Estimation Handbook (1999) Institute of Hydrology

[5] OPW 2004. Report of the Flood Policy Review Group. Office of Public Works, Dublin, 235pp.

[6] Flood Studies Update Programme Work -Package WP-2.3 "Index Flood Estimate", Final Report NUI Galway, OPW 2009

Table 3-2: HEP Design Flows

HEP Reference	Watercourse	Qmed (m^3/sec)	Q100 (m^3/sec)	Q1000 (m^3/sec)
Boleany	Owenavorragh	42.31	87.12	123.00
Owen1	Owenavorragh	42.24	86.97	122.79
Owen2	Owenavorragh	42.48	87.47	123.49
Owen3	Owenavorragh	42.85	88.23	124.56
Owen4	Owenavorragh	43.04	88.62	125.12
Owen5	Owenavorragh	43.05	88.64	125.15
Owen6	Owenavorragh	43.39	89.34	126.13
Owen7	Owenavorragh	44.74	92.12	130.06
Owen8	Owenavorragh	44.90	92.45	130.52
Owen9	Owenavorragh	44.93	92.51	130.61
Owen10	Owenavorragh	45.10	92.86	131.11
Kil1	Unnamed (Kilbride)	0.31	1.03	1.22
Kil2	Unnamed (Kilbride)	0.40	1.33	1.57
Kil3	Unnamed (Kilbride)	0.43	1.43	1.69
BM1	Unnamed (Ballymoney)	0.24	0.80	0.94
BM2	Unnamed (Ballymoney)	0.53	1.76	2.09
BM_E1	Unnamed (Ballymoney East)	0.04	0.13	0.16
BM_E2	Unnamed (Ballymoney East)	0.17	0.56	0.67
Aug1	Aughboy	1.41	4.59	8.15
Aug2	Aughboy	1.56	5.07	9.02
Aug3	Aughboy	1.62	5.27	9.37
Aug4	Aughboy	1.78	5.79	10.29

HEP Reference	Watercourse	Qmed (m^3/sec)	Q100 (m^3/sec)	Q1000 (m^3/sec)
Aug5	Aughboy	2.73	8.88	15.78
Aug6	Aughboy	2.63	8.56	15.20
Aug7	Aughboy	2.93	9.53	16.94
Aug8	Aughboy	3.19	10.38	18.44
Aug9	Aughboy	3.29	10.70	19.02
Arr1	Arragorteen	0.79	2.57	4.57
Arr2	Arragorteen	0.89	2.90	5.15
Arr3	Arragorteen	0.92	2.99	5.32
B-loe1	Ballinagelloe Stream	0.11	0.36	0.64
B-loe2	Ballinagelloe Stream	0.18	0.59	1.04

3.3 LiDAR DTM

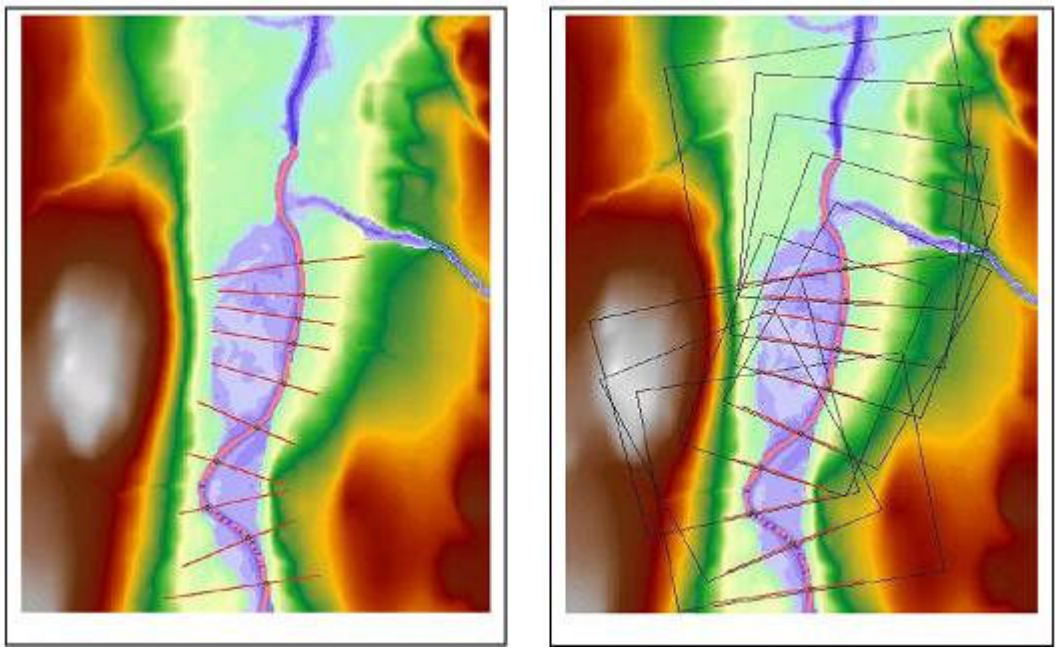
LIDAR data (ground height to Malin Head datum) has been commissioned by OPW for the CFRAM Programme and has been supplied for use in this study. The highly detailed data has been provided in filtered format in a 2m grid resolution. The LIDAR was flown between November 2011 and August 2012.

3.4 Hydraulic Modelling

Once design flows and hydrograph had been calculated, cross sections were generated at each HEP. The cross sections are used by JBA's 2 dimensional hydraulic modelling software, JFlow+®, to define the area of DTM over which to route the flow. Each inflow point creates a box, the width and orientation of which are determined by the cross section. Once generated, cross sections were manually checked, to ensure suitable alignment and extension across the floodplain.

Figure 3-3, shows an example of cross sections generated along a river reach, and the boxes generated by JFlow+® to route the inflows across the DTM.

Figure 3-3 Example JFlow+® Cross Sections and Box Sizes



Once the design flows had been developed, the flood maps were generated by simulating overland flooding, using the JFlow+® model. JFlow+® is a JBA-developed, multi-scale 2 dimensional hydraulic model that is fully hydrodynamic and solves the full shallow water equations to route flood volumes across the surface of a DTM. The model is well suited to solving flood depths across the floodplain, is used internationally by JBA and is approved for use by the OPW. JFlow+® does not take into account the specific hydraulics of in-channel flow and as a result flood levels cannot be provided, but flood extent can. In general, with the revised flow estimates discussed in Section 3.2.1, the JFlow+® model will provide an improved estimation of flood extent and depth across the floodplain compared to the OPW PFRA mapping techniques and with higher resolution DTM (such as the LiDAR used in this study) also provides a greater accuracy than the JFlow+® maps previously used by Wexford County Council (see Section 4.3).

JFlow+® results were subjected to several iterations of manual checking and model re-running to remove anomalous results and irregular flow patterns. The flood extents have also been subject to ground truthing during the site walkover discussed in Section 4.2. The maps have also been discussed and reviewed by Wexford County Council Engineers and Planners. The results have been

compared to known flood locations from historic events where they exist and the results indicate agreement.

3.4.1 Model Quality and Review

JFlow+® uses the DTM and inflows as its only inputs, and as such, results are only as good as the DTM and flow estimates. Specifically, interactions of weirs, bridges, culverts, sluices and other structures are not considered in these large-scale flood maps. The aim of the Flood Zone maps contained within this study is to provide a dataset which will inform the planning decisions to be made under the draft Courtown and Riverchapel LAP 2014-2020. More detailed hydraulic modelling may be required at a later date to enable planning decisions for specific developments in areas shown to be within Flood Zone A or B, this is discussed further in Section 5.

It should be noted that JFlow+® is a tool for wide-scale flood mapping, and is not the same as a detailed hydraulic model. Detailed models are typically based on topographic cross section survey data and 1D hydraulic modelling or 1D/2D linked hydraulic modelling, such as being completed under the South Eastern CFRAM study. The results of the South Eastern CFRAM study, once formally published, will represent a more detailed approach to flood mapping of watercourses within the LAP boundary. As such it will be necessary to review the Flood Zone mapping once the final deliverables are provided by the OPW.

4 Stage 2 Flood Risk Assessment

4.1 Historic Flood Review

Information on past flood events have been catalogued from a review of the OPW floodmaps.ie website, consultation with Wexford County Council Planners and Engineers and from an internet search.

Incidences of recorded property flooding in Courtown and Riverchapel are rare and generally tend to impact a small number of properties per flood event. Table 4-1 below provides a summary of recorded events.

Table 4-1 Summary of Historic Flood Events in Courtown and Riverchapel

Date	Description (Source)	Flood Source
November 2000	River Aughboy flooded at Riverchapel Bridge, flooding the R742 and damaging property (www.floodmaps.ie and consultation with Wexford County Council)	Fluvial/Surface Water
August 2014	Surface water flooding to three properties in the Riverchapel Close area (consultation with Wexford County Council).	Surface water

It is noted that the location of the R742 flooding at Riverchapel Bridge has now been subject to mitigation works through the installation of a gulley along the laneway. No further flooding has been recorded at this location.

4.2 Site Visit

A site visit was conducted on Tuesday 19th August 2014 by JBA and Wexford County Council staff. The visit allowed for the ground-truthing of the revised JBA Flood Zone mapping, familiarisation of JBA staff with the area, and an interview with Wexford County Council staff regarding historic flooding.

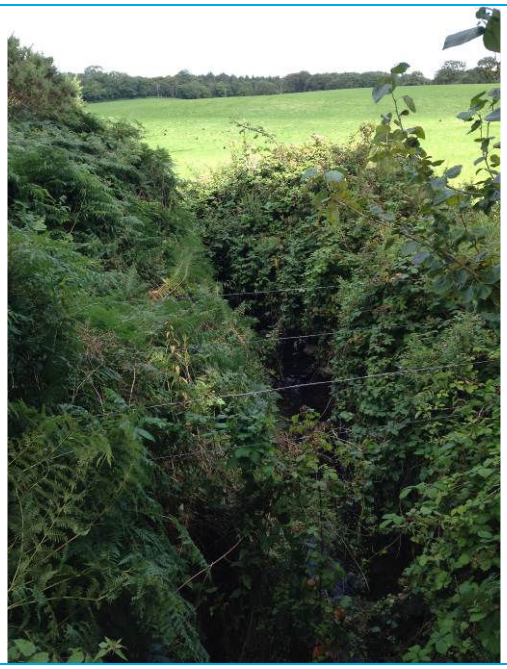
Selected photographs from the site visit are presented in the figure below.

Figure 4-1 Site Visit Photographs

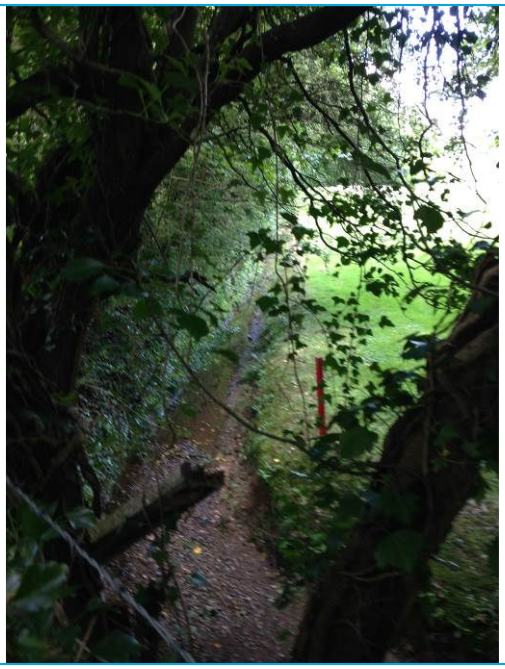
Upstream view from R742 Riverchapel Bridge, Aughboy River.

Upstream view of floodplain at confluence between the Arragorteen Stream and the Aughboy River.

Downstream view of River Aughboy floodplain, Parknacross.



Upstream view, Ballmoney Stream



Upstream view Ballymoney East Stream

4.3 Existing Flood Study Information

A number of existing flood mapping datasets have been compiled for the Courtown and Riverchapel area, although it should be noted that the quality of the mapping varies between the studies. Table 4-2 below lists the currently available flood mapping and provides comment on the data and quality.

The existing datasets below have been used to inform the preparation of the new JBA Flood Zone mapping which is discussed in further detail within Section 3.

Information provided from the South Eastern CFRAM has not yet been formally published and is still undergoing the process of consultation and refinement, the data is therefore draft and cannot yet be used to provide a Stage 2 FRA for Courtown and Riverchapel.

Table 4-2 Flood data used to compile final Flood Zone mapping

Description	Coverage	Quality & Confidence	Use / Comment
OPW PFRA flood extent maps	Does not cover some smaller watercourses	Moderate	To help inform site walkover.
Irish Coastal Protection Strategy Study (ICPSS)	Full - Coastal	Moderate	Levels used to derive coastal flood extent.
Previous Wexford JBA Flood Zone Mapping (JFlow®)	Does not cover some smaller watercourse	Moderate	To help inform site walkover.
OPW South Eastern CFRAM Draft Flood Mapping	Full - Fluvial	Moderate	Results still at draft stage – used to inform site walkover. Draft hydrology & modelling reports used to inform calculations and OPW DTM used to compile mapping.

Continued over page.

Description	Coverage	Quality & Confidence	Use / Comment
Site walkover, Historical Flood Records and Consultation with Wexford CoCo Engineers	Full – Coastal and Fluvial	Various	Used to validate Flood Zones & identify other flood sources.
Revised JBA Fluvial Mapping August 2014 (JFlow+®)	Full Fluvial	Moderate /Good	As described in Section 3

4.4 Flood Zone Mapping Results

The key output from the Stage 2 FRA is the mapping showing the extent of the revised Flood Zone A and B for the entire plan area. The Flood Zone mapping is presented in Figure 4-2 below and has been developed from modelling, data review, site walkover and consultation with Local Authority Engineers and Planners.

Figure 4-2 JBA Flood Zone Mapping

4.5 Summary of Flood Sources

4.5.1 Fluvial

There is a limited history of flooding of residential or commercial buildings in Courtown and Riverchapel and this is reflected in the revised Flood Zone mapping discussed in Sections 3 and 4.

The Owenavorragh River is the largest watercourse within the LAP and generates some significant inundation of its floodplain, however there has been very limited development within areas likely to flood and the risk to existing development is therefore low. The Aughboy River is much smaller than the Owenavorragh, but its sinuous route through the centre of the developed area means that it poses a higher risk to surrounding developed lands. For the most part, existing development within Courtown and Riverchapel has avoided areas at high probability of flooding. Where development has not been able to avoid the historic floodplain there has been some significant raising of land, particularly through the mobile home parks upstream of Riverchapel. This results in a reduction of flood extent, and therefore flood risk through some areas, but it also serves to reduce overall floodplain storage volume and interrupt the natural regime of the river. Some intermittent channel embankments also exist through these areas which serve to disconnect the channel from the floodplain, but in these cases the intermittent configuration can still be impacted from flood levels upstream. As such the embankments can be bypassed and have limited effectiveness.

OPW PFRA and the previous flood mapping held by Wexford County Council were incomplete in coverage and were not completed up to a Stage 2 FRA standard of detail as specified by The Guidelines. The current analysis has been upgraded to include for all watercourses within the LAP boundary and has been completed to a Stage 2 FRA standard of detail.

Climate change may result in increased flood extents and therefore caution should be taken when zoning lands in transitional areas. In general, Flood Zone B, which represents the 0.1% AEP extent, can be taken as an indication of the

extent of the 1% AEP flood event with climate change. In steep valleys an increase in water level will relate to a very small increase in extent, however in flatter low-lying basins a small increase in water level can result in a significant increase in flood extent.

4.5.2 Pluvial/Surface Water

Flooding of land from surface water runoff is usually caused by intense rainfall that may only last a few hours. Areas at risk from fluvial flooding will almost certainly be at risk from surface water flooding. The indicative pluvial map from the OPW PFRA study has been used to identify development areas at particular risk of surface water and pluvial flooding.

Based on the PFRA mapping, the risk of pluvial flooding is generally low although some isolated areas are predicted to have a higher probability of pluvial flooding. Most of the higher risk areas are within undeveloped lands, but some areas of housing are impacted and this is verified by the two confirmed instances of flooding attributable to this source (see Table 4-1).

Overall the risk of flooding from this source is not widespread and management of risk can be addressed by individual works. For new development, adhering to policies on the management of surface water will ensure the risk will be adequately managed.

4.5.3 Coastal

Courtown and Riverchapel are mainly impacted though high sea levels extending up the Owenavorragh and Aughboy Rivers, there is limited flooding of the coastal margin by the current scenario sea levels and the dominant source of flood risk to the settlement is from fluvial flooding.

In the future, as sea levels rise with the predicted impacts of climate change issues related to flooding in and around the harbour and erosion along the coastal margin will increase. However, given the rapid increase in topographic levels when travelling inland the sensitivity to climate change is not considered to be severe.

4.5.4 Groundwater

There have been no instances of groundwater flooding identified within Courtown and Riverchapel.

5 Flood Risk Management

The Planning Guidelines on FRM recommend a sequential approach to spatial planning, promoting avoidance rather than justification and subsequent mitigation of risk; this is achieved through the application of policies and objectives within the LAP.

5.1 Land Use Zoning and Additional FRA

The purpose of zoning is to indicate to property owners and members of the public the types of development which the Planning Authority considers most appropriate in each land parcel.

Zoning is designed to reduce conflicting uses within areas, to protect resources and ensure that land suitable for development is used to the best advantage of the community as a whole.

The zoning objectives can be related to the vulnerability classifications in The Guidelines; highly vulnerable, less vulnerable and water compatible. The vulnerability of the land use, coupled with the Flood Zone in which it lies, guides the need for application of the Justification Test and detailed Stage 3 FRA.

5.1.1 Existing Development at Risk of Flooding

For existing development it is not feasible to alter the wider land use zoning objective and in many cases will not be possible to re-locate the existing development to an area at lower risk of flooding. For this reason, changes to existing development, including small scale infill, small extensions, rebuilding of houses and most changes of use will require careful consideration, and are addressed through an update to the Planning Guidelines[7].

As part of the Development Plan Making process, Section 4.27a provides for cases where existing, highly vulnerable development is located within Flood Zone A or B, and it is foreseeable that additional development, such as small scale infill housing, extensions or changes of use that could increase the risk or

[7] PL 2-14 Circular on Flooding August 2014,DoECLG

number of people in the flood prone area, will occur. In these cases, where the land use zoning has been considered as part of development plan preparation (including use of the Justification Test as appropriate) and it is considered that the existing use zoning is still appropriate, the development plan must specify the nature and design of structural or non-structural flood risk management measures required prior to future development in such areas.

The strategy for flood management in areas of existing development is implemented during the Development Management process through Section 5.28 of the Planning Guidelines. A commensurate assessment of risk is required, with the aim of demonstrating there are no adverse impacts and the proposal will not impede access to a watercourse, floodplain or flood protection and management facility. If required, the FRA must also show that appropriate mitigation measures can be put in place and that residual risks can be managed to acceptable levels, and must have reference to the recommendations and guidance which has resulted from applying Section 4.27a.

5.1.2 New Development in Flood Zone A or B

It is not appropriate for new, highly vulnerable development to be located in Flood Zones A or B, unless the Plan Making Justification Test in Section 4 of the Planning Guidelines has been satisfied, the risks are understood, and accepted. Instead, and in preference, a less vulnerable or water compatible use should be substituted.

Less vulnerable development zoning objectives may be applied in Flood Zone B. In Flood Zone A, less vulnerable uses are permitted provided the Plan Making Justification Test has been satisfied. In contrast with highly vulnerable development, there is greater scope for the developer of less vulnerable uses to accept flood risks and develop within Flood Zone A or B. At all times however, the risks of flooding should be balanced against public and occupier safety first. Water compatible land uses are appropriate in all Flood Zones, and land within Flood Zone A should be zoned as such in preference to applying the Justification Test.

In meeting the requirements of the Justification Test the design of structural or non-structural flood risk management measures are prerequisites to development and to ensure that flood risk to other locations will not be increased, or if practicable, will be reduced. In most cases this will trigger a Stage 3 FRA.

Appendices

A FSU Flow Estimation Methodology

A.1.1 Calculation of Qmed using FSU

At ungauged sites, the value of Qmed can be obtained from catchment descriptor data through the application of a regression model. As part of the FSU, a multivariate regression equation was developed on the basis of data from 199 gauged catchments, linking Qmed to a set of catchment descriptors.

$Qmed_{rural}=1.237x10^{-5}AREA^{0.937}BFIsoils^{-0.922}SAAR^{1.306}FARL^{2.21}DRAIND^{0.341}xS1085^{0.185}(1+ARTDRAIN2)^{0.408}$

Where: AREA is the catchment area (km^2).

BFIsoils is the base flow index derived from soils data

SAAR is long-term mean annual rainfall amount in mm

FARL is the flood attenuation by reservoir and lake

DRAIND is the drainage density

S1085 is the slope of the main channel between 10% and 85% of its length measured from the catchment outlet (m/km).

ARTDRAIN2 is the percentage of the catchment river network included in the Drainage Schemes

The Factorial Standard Error (FSE) of $Qmed_{rural}$ in the above equation is 1.36.

Table A-1 provides flow estimates for Qmed as derived from the FSU catchment characteristic method at each of the inflow points. Prior to the commencement of this study the OPW published its FSU website (http://opw.hydronet.com) and the inflow points were selected to correspond to the FSU nodes and Qmed values were determined directly at each point.

The Qmed estimate is multiplied by a growth factor derived either from the national, regional or pooled growth curve to arrive at the T – year flood estimate.

Table A-1: Qmed at HEPs

HEP Reference	Watercourse	Easting	Northing	Qmed (m^3/sec) from FSU	Comments
Boleany	Owenavorragh	317143	156109	24.67	
Owen1	Owenavorragh	317613	156160	24.63	
Owen2	Owenavorragh	317961	156498	24.77	
Owen3	Owenavorragh	318447	156534	24.99	
Owen4	Owenavorragh	318930	156581	25.10	
Owen5	Owenavorragh	319331	156818	25.10	
Owen6	Owenavorragh	319728	157020	25.30	
Owen7	Owenavorragh	319751	157011	26.09	Applied below confluence
Owen8	Owenavorragh	319974	157019	26.18	
Owen9	Owenavorragh	320298	157277	26.20	
Owen10	Owenavorragh	320473	157373	26.30	
Kil1	Unnamed (Kilbride)	318624	157455	0.31	
Kil2	Unnamed (Kilbride)	319111	157351	0.40	
Kil3	Unnamed (Kilbride)	319552	157118	0.43	
BM1	Unnamed (Ballymoney)	319091	157832	0.24	
BM2	Unnamed (Ballymoney)	319623	157354	0.53	
BM_E1	Unnamed (Ballymoney East)	319728	157726	0.04	

HEP Reference	Watercourse	Easting	Northing	Qmed (m^3/sec) from FSU	Comments
BM_E2	Unnamed (Ballymoney East)	319931	157338	0.17	
Aug1	Aughboy	318720	153302	1.41	
Aug2	Aughboy	319091	153560	1.56	
Aug3	Aughboy	319383	153948	1.62	
Aug4	Aughboy	319443	154425	1.78	
Aug5	Aughboy	319492	155550	2.73	Applied below confluence
Aug6	Aughboy	319600	155144	2.63	
Aug7	Aughboy	319491	155543	2.93	
Aug8	Aughboy	319644	155946	3.19	
Aug9	Aughboy	320024	156218	3.29	
Arr1	Arragorteen	318457	154738	0.79	
Arr2	Arragorteen	318864	154739	0.89	
Arr3	Arragorteen	319298	154735	0.92	
B-loe1	Ballinageeloe Stream	318661	155085	0.11	
B-loe2	Ballinageeloe Stream	319212	155315	0.18	

A.1.2 Data transfer from gauged catchments to estimate Qmed at ungauged sites (Donor Catchment Analysis)

The FSU recommends that use is made of donor catchments to improve estimates of the index flood at ungauged sites. Based on the methodology of the FSU the catchment characteristics-based estimate of Qmed at each subject site

is scaled by the ratio of observed and estimated Qmed values at the donor site, so that;

$Qmed_A = Qmed(estimated)_A * Qmed(measured)_B/Qmed(estimated)_B$

Where subscript A refers to the subject site and subscript B refers to the donor site.

A donor catchment assessment was undertaken using the Boleany Gauge (11001). The South Eastern CFRAM draft hydrology report found a Qmed adjustment factor of 1.715. This large difference of Qmed estimated and Qmed measured has a significant effect on Qmed and therefore analysis was carried out in the CFRAM study to investigate the suitability of the Qmed adjustment factor for the smaller tributaries. It was found that whilst it was applicable to estimation points on the same watercourse it was not the case for other rivers and tributaries. Other hydrologically similar and gauged sites geographically close were analysed and these pointed to a Qmed estimate in a similar range to Qmed measured. It was decided to proceed with Station 11001 as a pivotal station for the main Owenavorragh only but not for the smaller tributaries since they are less hydrologically similar in terms of area and profile despite being geographically close. Table A-2 shows the adjusted (where applicable) Qmed Values. These are the final Qmed values that are multiplied by the Q100 and Q1000 growth factors as described in Section 4.1.4.

Table A-2: Final Qmed Values (Owenavorragh Adjusted)

HEP Reference	Watercourse	Easting	Northing	Qmed Adjusted (m^3/sec) from FSU	Comments
Boleany	Owenavorragh	317143	156109	42.31	
Owen1	Owenavorragh	317613	156160	42.24	
Owen2	Owenavorragh	317961	156498	42.48	
Owen3	Owenavorragh	318447	156534	42.85	
Owen4	Owenavorragh	318930	156581	43.04	
Owen5	Owenavorragh	319331	156818	43.05	
Owen6	Owenavorragh	319728	157020	43.39	
Owen7	Owenavorragh	319751	157011	44.74	Applied below confluence
Owen8	Owenavorragh	319974	157019	44.90	
Owen9	Owenavorragh	320298	157277	44.93	
Owen10	Owenavorragh	320473	157373	45.10	
Kil1	Unnamed (Kilbride)	318624	157455	0.31	
Kil2	Unnamed (Kilbride)	319111	157351	0.40	
Kil3	Unnamed (Kilbride)	319552	157118	0.43	
BM1	Unnamed (Ballymoney)	319091	157832	0.24	
BM2	Unnamed (Ballymoney)	319623	157354	0.53	

HEP Reference	Watercourse	Easting	Northing	Qmed Adjusted (m^3/sec) from FSU	Comments
BM_E1	Unnamed (Ballymoney East)	319728	157726	0.04	
BM_E2	Unnamed (Ballymoney East)	319931	157338	0.17	
Aug1	Aughboy	318720	153302	1.41	
Aug2	Aughboy	319091	153560	1.56	
Aug3	Aughboy	319383	153948	1.62	
Aug4	Aughboy	319443	154425	1.78	
Aug5	Aughboy	319492	155550	2.73	Applied below confluence
Aug6	Aughboy	319600	155144	2.63	
Aug7	Aughboy	319491	155543	2.93	
Aug8	Aughboy	319644	155946	3.19	
Aug9	Aughboy	320024	156218	3.29	
Arr1	Arragorteen	318457	154738	0.79	
Arr2	Arragorteen	318864	154739	0.89	
Arr3	Arragorteen	319298	154735	0.92	
B-loe1	Ballinagelloe Stream	318661	155085	0.11	
B-loe2	Ballinagelloe Stream	319212	155315	0.18	

A.1.3 Determination of Flood Frequency Curves

The method for estimation of peak flows using an index flood method involves two stages. The first stage of the method involves estimating Qmed and in the second stage a flood growth curve is estimated. The growth curve is a dimensionless version of the flood frequency curve which defines how the flood magnitude grows as the probability reduces, i.e. for more extreme design floods. The design flood for a particular exceedance probability is then simply calculated as the product of Qmed and the value of the growth curve for that probability (known as the growth rate).

Detailed analysis was carried out as part of the South Eastern CFRAM on the estimation of flood frequency curves. During the study 92 gauging stations in the South East of the country were analysed. Single site analysis was carried out on these stations and GLO distribution was found to be the most appropriate distribution. As part of the South Eastern CFRAM there are 87 HEPs in the CFRAM area. Flood frequency curves were developed for these points using the GLO distribution. The 87 growth curves were then group according to area and it was found for areas of less than 10km^2 a median of growth curve could be applied. This median was found by grouping all HEPs with an area less than 10km^2. However, there was too significant a variance between growth curves for HEPs with area greater than 10km2 so individual growth curves have to be used at each HEP.

For this study the watercourses can be divided between the Owenavorragh and its tributaries and the Aughboy River and its tributaries. The growth factors for the Owenavorragh and its tributaries can be seen in Table A-3: Owenavorragh Growth Curves. As the smaller tributaries growth factors were considerably different to those of the main channel individual growth curves were maintained.

Table A-3: Owenavorragh Growth Curves

Owenavorragh River and Triburaties		
Location	**Q100**	**Q1000**
Owenavorragh	2.059	2.907
Kilbride	3.322	3.935
Ballymoney	3.322	3.935
Ballymoney East	3.322	3.935

Table A-4 shows the growth curves found by the South Eastern CFRAM along various points of the Aughboy River and its tributaries. As all the growth factors were considerably close it is applicable to apply a median growth factor throughout the course of the watercourse. This was found to be 3.253 for the 100-year event and 5.781 for the 1000-year event.

Table A-4: Aughboy River Growth Factors

Aughboy River and Tributaries		
Location	**Q100**	**Q1000**
Aug1	3.319	5.922
Aug5	3.287	5.872
Arr1	3.263	5.813
B-loe1	3.182	5.727
Aug1	3.333	6.000
Aug9	3.175	5.494
Courtown Harbour	3.211	5.640
Median Growth Curve	**3.253**	**5.781**

A.1.4 Inflow Hydrographs

The FSR Rainfall Runoff hydrograph shape was adopted as the basis of the hydrograph shape on all watercourses, with the hydrograph being scaled to match the relevant peak flow estimates. A hydrograph was developed for the Owenavorragh, Arragorteen, Aughboy and Kilbride catchments. Ballymoney and Ballymoney East were found to be hydrologically similar to the catchment of

the Kilbride so the hydrograph developed for Kilbride was applied here. Likewise, the Arragorteen hydrograph was applied to the Ballinageeloe.

A.1.5 Design Flows

Design flows can be calculated by multiplying the Qmed by the relevant growth curve. In turn the relevant hydrographs were then applied to the design flows to give the design hydrographs needed to run JFlow+®. Detailed design flows and hydrographs can be found in Appendix B.

B Design Flows and Design Hydrographs

Owenavorragh Catchment – Q100

Interval	Unit Hydrograph	Boleany	Owen 1	Owen 2	Owen 3	Owen 4	Owen 5	Owen 6	Owen 7	Owen 8	Owen 9	Owen10
0	0.107	10.03	10.02	10.07	10.16	10.20	10.21	10.29	10.47	10.32	10.49	10.59
1	0.107	10.09	10.07	10.13	10.22	10.26	10.26	10.34	10.53	10.38	10.55	10.65
2	0.108	10.21	10.19	10.25	10.34	10.39	10.39	10.47	10.66	10.51	10.68	10.78
3	0.111	10.42	10.40	10.46	10.56	10.60	10.60	10.69	10.88	10.73	10.90	11.00
4	0.114	10.74	10.72	10.79	10.88	10.93	10.93	11.02	11.21	11.05	11.24	11.34
5	0.119	11.20	11.18	11.24	11.34	11.39	11.39	11.48	11.69	11.52	11.71	11.82
6	0.126	11.83	11.81	11.87	11.98	12.03	12.03	12.13	12.35	12.17	12.37	12.48
7	0.135	12.67	12.65	12.72	12.83	12.89	12.89	12.99	13.23	13.04	13.25	13.37
8	0.146	13.78	13.76	13.84	13.95	14.02	14.02	14.13	14.38	14.18	14.41	14.54
9	0.162	15.22	15.20	15.29	15.42	15.48	15.49	15.61	15.89	15.67	15.92	16.07
10	0.181	17.08	17.05	17.15	17.30	17.38	17.38	17.52	17.83	17.58	17.87	18.03
11	0.207	19.46	19.43	19.54	19.71	19.79	19.80	19.95	20.32	20.03	20.35	20.54
12	0.239	22.47	22.44	22.57	22.76	22.86	22.86	23.04	23.46	23.13	23.51	23.72
13	0.279	26.26	26.22	26.37	26.60	26.72	26.72	26.93	27.42	27.03	27.47	27.72
14	0.328	30.84	30.79	30.97	31.24	31.38	31.38	31.63	32.20	31.74	32.26	32.55
15	0.383	36.09	36.03	36.24	36.55	36.71	36.72	37.01	37.68	37.14	37.75	38.09
16	0.444	41.83	41.76	42.00	42.37	42.55	42.56	42.89	43.67	43.05	43.76	44.15
17	0.509	47.91	47.83	48.11	48.52	48.74	48.74	49.13	50.02	49.31	50.11	50.56
18	0.575	54.18	54.09	54.41	54.88	55.12	55.13	55.56	56.56	55.76	56.68	57.18
19	0.643	60.51	60.41	60.76	61.28	61.55	61.56	62.05	63.17	62.27	63.29	63.86

20	0.709	66.75	66.64	67.03	67.61	67.90	67.92	68.45	69.69	68.70	69.83	70.45
21	0.773	72.77	72.66	73.08	73.71	74.03	74.04	74.63	75.98	74.90	76.13	76.80
22	0.833	78.42	78.30	78.75	79.43	79.78	79.79	80.42	81.87	80.71	82.03	82.76
23	0.887	83.53	83.39	83.87	84.60	84.97	84.98	85.65	87.20	85.96	87.37	88.15
24	0.933	87.90	87.76	88.26	89.03	89.42	89.43	90.14	91.77	90.46	91.95	92.77
25	0.970	91.32	91.17	91.69	92.49	92.89	92.91	93.64	95.33	93.98	95.52	96.37
26	0.992	93.46	93.31	93.85	94.66	95.08	95.09	95.84	97.57	96.19	97.77	98.64
27	1.000	94.17	94.02	94.56	95.38	95.80	95.82	96.57	98.32	96.92	98.51	99.39
28	0.994	93.58	93.43	93.97	94.78	95.20	95.22	95.97	97.70	96.31	97.89	98.77
29	0.976	91.92	91.77	92.30	93.10	93.51	93.52	94.26	95.96	94.60	96.15	97.01
30	0.949	89.38	89.24	89.75	90.53	90.93	90.94	91.66	93.32	91.99	93.50	94.33
31	0.915	86.15	86.01	86.50	87.25	87.63	87.65	88.34	89.93	88.66	90.11	90.91
32	0.874	82.31	82.17	82.65	83.36	83.73	83.74	84.40	85.93	84.71	86.10	86.86
33	0.829	78.04	77.92	78.37	79.04	79.39	79.40	80.03	81.48	80.32	81.64	82.36
34	0.780	73.45	73.33	73.76	74.39	74.72	74.73	75.32	76.68	75.59	76.83	77.52
35	0.729	68.62	68.50	68.90	69.49	69.80	69.81	70.36	71.63	70.61	71.77	72.41
36	0.675	63.60	63.50	63.86	64.42	64.70	64.71	65.22	66.40	65.45	66.53	67.12
37	0.621	58.47	58.38	58.71	59.22	59.48	59.49	59.96	61.04	60.17	61.16	61.71
38	0.566	53.28	53.19	53.50	53.96	54.20	54.21	54.63	55.62	54.83	55.73	56.23
39	0.512	48.18	48.10	48.38	48.80	49.01	49.02	49.41	50.30	49.59	50.40	50.85
40	0.459	43.22	43.15	43.40	43.78	43.97	43.97	44.32	45.12	44.48	45.21	45.61
41	0.408	38.43	38.37	38.59	38.92	39.09	39.10	39.41	40.12	39.55	40.20	40.56
42	0.359	33.85	33.79	33.99	34.28	34.43	34.44	34.71	35.34	34.83	35.40	35.72
43	0.314	29.53	29.48	29.65	29.91	30.04	30.04	30.28	30.83	30.39	30.89	31.16
44	0.271	25.54	25.50	25.65	25.87	25.98	25.98	26.19	26.66	26.28	26.72	26.95
45	0.234	22.00	21.97	22.09	22.29	22.38	22.39	22.56	22.97	22.64	23.02	23.22
46	0.203	19.10	19.07	19.18	19.35	19.43	19.43	19.59	19.94	19.66	19.98	20.16

47	0.178	16.80	16.77	16.87	17.01	17.09	17.09	17.23	17.54	17.29	17.57	17.73
48	0.159	14.99	14.97	15.05	15.18	15.25	15.25	15.37	15.65	15.43	15.68	15.82
49	0.144	13.59	13.57	13.64	13.76	13.82	13.83	13.93	14.19	13.98	14.21	14.34
50	0.133	12.51	12.49	12.56	12.67	12.73	12.73	12.83	13.06	12.87	13.09	13.20
51	0.124	11.69	11.67	11.74	11.84	11.89	11.90	11.99	12.21	12.03	12.23	12.34
52	0.118	11.08	11.07	11.13	11.23	11.28	11.28	11.37	11.57	11.41	11.60	11.70
53	0.113	10.65	10.63	10.69	10.78	10.83	10.83	10.92	11.11	10.96	11.14	11.23
54	0.110	10.34	10.32	10.38	10.47	10.52	10.52	10.60	10.80	10.64	10.82	10.91
55	0.108	10.14	10.13	10.19	10.27	10.32	10.32	10.40	10.59	10.44	10.61	10.71
56	0.107	10.03	10.02	10.07	10.16	10.20	10.21	10.29	10.47	10.32	10.49	10.59
57	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Owenavorragh Catchment – Q1000

Interval	Unit Hydrograph	Boleany	Owen 1	Owen 2	Owen 3	Owen 4	Owen 5	Owen 6	Owen 7	Owen 8	Owen 9	Owen10
0	0.107	14.16	14.14	14.22	14.34	14.41	14.41	14.52	14.79	14.58	14.81	14.95
1	0.107	14.24	14.22	14.30	14.42	14.49	14.49	14.60	14.87	14.66	14.90	15.03
2	0.108	14.42	14.39	14.48	14.60	14.66	14.67	14.78	15.05	14.84	15.08	15.21
3	0.111	14.71	14.69	14.77	14.90	14.97	14.97	15.09	15.36	15.14	15.39	15.53
4	0.114	15.16	15.14	15.23	15.36	15.43	15.43	15.55	15.83	15.61	15.86	16.00
5	0.119	15.81	15.78	15.87	16.01	16.08	16.09	16.21	16.50	16.27	16.54	16.68
6	0.126	16.70	16.67	16.76	16.91	16.98	16.99	17.12	17.43	17.18	17.46	17.62
7	0.135	17.88	17.86	17.96	18.11	18.19	18.20	18.34	18.67	18.41	18.71	18.87
8	0.146	19.45	19.42	19.53	19.70	19.79	19.79	19.95	20.31	20.02	20.35	20.53
9	0.162	21.49	21.46	21.58	21.77	21.86	21.87	22.04	22.44	22.12	22.48	22.68
10	0.181	24.12	24.08	24.22	24.43	24.53	24.54	24.73	25.18	24.82	25.23	25.45
11	0.207	27.47	27.43	27.59	27.82	27.95	27.95	28.17	28.68	28.27	28.74	28.99
12	0.239	31.73	31.68	31.86	32.13	32.27	32.28	32.53	33.12	32.65	33.19	33.48
13	0.279	37.08	37.02	37.23	37.55	37.72	37.73	38.02	38.71	38.16	38.79	39.13
14	0.328	43.55	43.48	43.73	44.10	44.30	44.31	44.65	45.46	44.82	45.55	45.96
15	0.383	50.95	50.87	51.16	51.60	51.83	51.84	52.25	53.19	52.44	53.30	53.77
16	0.444	59.06	58.96	59.30	59.81	60.07	60.09	60.56	61.65	60.78	61.77	62.32
17	0.509	67.64	67.53	67.92	68.50	68.80	68.82	69.36	70.61	69.61	70.75	71.38
18	0.575	76.49	76.37	76.81	77.47	77.81	77.83	78.44	79.86	78.72	80.01	80.73
19	0.643	85.43	85.29	85.78	86.52	86.90	86.91	87.60	89.18	87.91	89.36	90.15
20	0.709	94.24	94.09	94.63	95.45	95.87	95.88	96.64	98.39	96.99	98.58	99.46
21	0.773	102.74	102.5	103.17	104.06	104.52	104.53	105.36	107.26	105.74	107.47	108.43

			8									
22	0.833	110.72	110.54	111.17	112.14	112.63	112.65	113.54	115.59	113.94	115.81	116.85
23	0.887	117.92	117.73	118.41	119.44	119.96	119.98	120.93	123.11	121.36	123.35	124.45
24	0.933	124.10	123.90	124.61	125.69	126.24	126.26	127.26	129.55	127.71	129.81	130.97
25	0.970	128.92	128.71	129.45	130.57	131.14	131.17	132.20	134.59	132.68	134.86	136.06
26	0.992	131.95	131.74	132.50	133.64	134.23	134.25	135.31	137.76	135.80	138.03	139.26
27	1.000	132.96	132.74	133.51	134.66	135.25	135.27	136.34	138.80	136.83	139.08	140.32
28	0.994	132.12	131.91	132.67	133.82	134.40	134.43	135.49	137.93	135.97	138.21	139.44
29	0.976	129.77	129.56	130.31	131.44	132.01	132.04	133.08	135.48	133.56	135.75	136.96
30	0.949	126.19	125.99	126.71	127.81	128.37	128.39	129.41	131.74	129.87	132.00	133.18
31	0.915	121.62	121.42	122.12	123.18	123.72	123.74	124.72	126.97	125.16	127.22	128.35
32	0.874	116.20	116.01	116.68	117.69	118.21	118.23	119.16	121.31	119.59	121.55	122.63
33	0.829	110.18	110.00	110.64	111.59	112.08	112.10	112.99	115.03	113.39	115.26	116.28
34	0.780	103.70	103.53	104.13	105.03	105.49	105.51	106.34	108.26	106.72	108.48	109.44
35	0.729	96.87	96.71	97.27	98.11	98.54	98.56	99.34	101.13	99.69	101.33	102.23
36	0.675	89.79	89.65	90.16	90.94	91.34	91.36	92.08	93.74	92.41	93.93	94.76
37	0.621	82.55	82.41	82.89	83.61	83.97	83.99	84.65	86.18	84.95	86.35	87.12
38	0.566	75.22	75.10	75.53	76.18	76.52	76.53	77.13	78.53	77.41	78.68	79.38

39	0.512	68.02	67.91	68.31	68.90	69.20	69.21	69.76	71.02	70.01	71.16	71.79
40	0.459	61.02	60.92	61.27	61.80	62.07	62.08	62.57	63.70	62.80	63.83	64.40
41	0.408	54.25	54.17	54.48	54.95	55.19	55.20	55.63	56.64	55.83	56.75	57.26
42	0.359	47.78	47.71	47.98	48.40	48.61	48.62	49.00	49.89	49.18	49.98	50.43
43	0.314	41.69	41.62	41.86	42.22	42.41	42.41	42.75	43.52	42.90	43.61	43.99
44	0.271	36.06	36.00	36.21	36.52	36.68	36.69	36.97	37.64	37.11	37.72	38.05
45	0.234	31.06	31.01	31.19	31.46	31.60	31.61	31.85	32.43	31.97	32.49	32.78
46	0.203	26.97	26.92	27.08	27.31	27.43	27.44	27.65	28.15	27.75	28.21	28.46
47	0.178	23.72	23.68	23.82	24.02	24.13	24.13	24.32	24.76	24.41	24.81	25.03
48	0.159	21.17	21.13	21.25	21.44	21.53	21.54	21.71	22.10	21.78	22.14	22.34
49	0.144	19.18	19.15	19.26	19.43	19.51	19.52	19.67	20.03	19.74	20.07	20.25
50	0.133	17.66	17.63	17.73	17.89	17.97	17.97	18.11	18.44	18.18	18.47	18.64
51	0.124	16.51	16.48	16.58	16.72	16.79	16.79	16.93	17.23	16.99	17.27	17.42
52	0.118	15.65	15.62	15.71	15.85	15.92	15.92	16.05	16.34	16.11	16.37	16.52
53	0.113	15.03	15.01	15.09	15.22	15.29	15.29	15.41	15.69	15.47	15.72	15.86
54	0.110	14.60	14.58	14.66	14.79	14.85	14.85	14.97	15.24	15.02	15.27	15.41
55	0.108	14.32	14.30	14.38	14.50	14.57	14.57	14.69	14.95	14.74	14.98	15.11
56	0.107	14.16	14.14	14.22	14.34	14.41	14.41	14.52	14.79	14.58	14.81	14.95
57	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Kilbride, Ballymoney, Ballymoney East Catchments – Q100

Interval	Unit Hydrograph	BM_E1	BM_E2	BM1	BM2	Kil1	Kil2	Kil3
0	0.033	0.00	0.00	0.02	0.05	0.03	0.04	0.04
0.25	0.034	0.00	0.00	0.02	0.05	0.03	0.04	0.04
0.5	0.036	0.00	0.00	0.03	0.06	0.03	0.04	0.05
0.75	0.041	0.00	0.00	0.03	0.07	0.04	0.05	0.05
1	0.048	0.00	0.00	0.04	0.08	0.05	0.06	0.06
1.25	0.059	0.01	0.00	0.04	0.09	0.06	0.07	0.08
1.5	0.074	0.01	0.00	0.05	0.12	0.07	0.09	0.10
1.75	0.096	0.01	0.00	0.07	0.16	0.09	0.12	0.13
2	0.127	0.01	0.01	0.09	0.21	0.12	0.16	0.17
2.25	0.169	0.01	0.01	0.12	0.27	0.16	0.21	0.22
2.5	0.226	0.02	0.01	0.17	0.37	0.22	0.28	0.30
2.75	0.3	0.03	0.01	0.22	0.48	0.29	0.37	0.40
3	0.386	0.03	0.02	0.28	0.62	0.37	0.47	0.51
3.25	0.48	0.04	0.02	0.35	0.78	0.46	0.59	0.64
3.5	0.579	0.05	0.03	0.42	0.94	0.55	0.71	0.77
3.75	0.678	0.06	0.03	0.50	1.10	0.65	0.83	0.90
4	0.775	0.07	0.04	0.57	1.25	0.74	0.95	1.03
4.25	0.865	0.07	0.04	0.63	1.40	0.83	1.06	1.14
4.5	0.943	0.08	0.04	0.69	1.52	0.90	1.15	1.25
4.75	1.006	0.09	0.05	0.74	1.63	0.96	1.23	1.33
5	1.045	0.09	0.05	0.77	1.69	1.00	1.28	1.38

5.25	1.055	0.09	0.05	0.77	1.71	1.01	1.29	1.40
5.5	1.04	0.09	0.05	0.76	1.68	0.99	1.27	1.38
5.75	1.004	0.09	0.05	0.74	1.62	0.96	1.23	1.33
6	0.954	0.08	0.05	0.70	1.54	0.91	1.16	1.26
6.25	0.892	0.08	0.04	0.65	1.44	0.85	1.09	1.18
6.5	0.822	0.07	0.04	0.60	1.33	0.79	1.00	1.09
6.75	0.746	0.06	0.04	0.55	1.21	0.71	0.91	0.99
7	0.667	0.06	0.03	0.49	1.08	0.64	0.81	0.88
7.25	0.586	0.05	0.03	0.43	0.95	0.56	0.72	0.78
7.5	0.506	0.04	0.02	0.37	0.82	0.48	0.62	0.67
7.75	0.428	0.04	0.02	0.31	0.69	0.41	0.52	0.57
8	0.354	0.03	0.02	0.26	0.57	0.34	0.43	0.47
8.25	0.285	0.02	0.01	0.21	0.46	0.27	0.35	0.38
8.5	0.221	0.02	0.01	0.16	0.36	0.21	0.27	0.29
8.75	0.166	0.01	0.01	0.12	0.27	0.16	0.20	0.22
9	0.124	0.01	0.01	0.09	0.20	0.12	0.15	0.16
9.25	0.094	0.01	0.00	0.07	0.15	0.09	0.11	0.12
9.5	0.072	0.01	0.00	0.05	0.12	0.07	0.09	0.10
9.75	0.056	0.00	0.00	0.04	0.09	0.05	0.07	0.07
10	0.046	0.00	0.00	0.03	0.07	0.04	0.06	0.06
10.25	0.039	0.00	0.00	0.03	0.06	0.04	0.05	0.05
10.5	0.035	0.00	0.00	0.03	0.06	0.03	0.04	0.05
10.75	0.033	0.00	0.00	0.02	0.05	0.03	0.04	0.04
11	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Kilbride, Ballymoney, Ballymoney East Catchments – Q1000

Interval	Unit Hydrograph	BM_E1	BM_E2	BM1	BM2	Kil1	Kil2	Kil3
0	0.033	0.00	0.00	0.03	0.06	0.04	0.05	0.05
0.25	0.034	0.00	0.00	0.03	0.06	0.04	0.05	0.05
0.5	0.036	0.00	0.00	0.03	0.07	0.04	0.05	0.06
0.75	0.041	0.00	0.00	0.04	0.08	0.05	0.06	0.06
1	0.048	0.00	0.00	0.04	0.09	0.05	0.07	0.08
1.25	0.059	0.01	0.00	0.05	0.11	0.07	0.08	0.09
1.5	0.074	0.01	0.00	0.06	0.14	0.08	0.11	0.12
1.75	0.096	0.01	0.01	0.08	0.18	0.11	0.14	0.15
2	0.127	0.01	0.01	0.11	0.24	0.14	0.18	0.20
2.25	0.169	0.02	0.01	0.15	0.32	0.19	0.24	0.27
2.5	0.226	0.02	0.01	0.20	0.43	0.26	0.33	0.36
2.75	0.3	0.03	0.02	0.26	0.57	0.34	0.43	0.47
3	0.386	0.04	0.02	0.33	0.74	0.44	0.56	0.61
3.25	0.48	0.05	0.03	0.42	0.92	0.54	0.69	0.75
3.5	0.579	0.06	0.03	0.50	1.11	0.66	0.84	0.91
3.75	0.678	0.07	0.04	0.59	1.30	0.77	0.98	1.06
4	0.775	0.08	0.04	0.67	1.48	0.88	1.12	1.22
4.25	0.865	0.09	0.05	0.75	1.66	0.98	1.25	1.36
4.5	0.943	0.10	0.05	0.82	1.81	1.07	1.36	1.48
4.75	1.006	0.10	0.06	0.87	1.93	1.14	1.46	1.58
5	1.045	0.11	0.06	0.91	2.00	1.18	1.51	1.64
5.25	1.055	0.11	0.06	0.92	2.02	1.19	1.53	1.65

5.5	1.04	0.11	0.06	0.90	1.99	1.18	1.50	1.63
5.75	1.004	0.10	0.06	0.87	1.92	1.14	1.45	1.58
6	0.954	0.10	0.05	0.83	1.83	1.08	1.38	1.50
6.25	0.892	0.09	0.05	0.77	1.71	1.01	1.29	1.40
6.5	0.822	0.08	0.05	0.71	1.57	0.93	1.19	1.29
6.75	0.746	0.08	0.04	0.65	1.43	0.85	1.08	1.17
7	0.667	0.07	0.04	0.58	1.28	0.76	0.96	1.05
7.25	0.586	0.06	0.03	0.51	1.12	0.66	0.85	0.92
7.5	0.506	0.05	0.03	0.44	0.97	0.57	0.73	0.79
7.75	0.428	0.04	0.02	0.37	0.82	0.49	0.62	0.67
8	0.354	0.04	0.02	0.31	0.68	0.40	0.51	0.56
8.25	0.285	0.03	0.02	0.25	0.54	0.32	0.41	0.45
8.5	0.221	0.02	0.01	0.19	0.42	0.25	0.32	0.35
8.75	0.166	0.02	0.01	0.14	0.32	0.19	0.24	0.26
9	0.124	0.01	0.01	0.11	0.24	0.14	0.18	0.20
9.25	0.094	0.01	0.01	0.08	0.18	0.11	0.14	0.15
9.5	0.072	0.01	0.00	0.06	0.14	0.08	0.10	0.11
9.75	0.056	0.01	0.00	0.05	0.11	0.06	0.08	0.09
10	0.046	0.00	0.00	0.04	0.09	0.05	0.07	0.07
10.25	0.039	0.00	0.00	0.03	0.07	0.04	0.06	0.06
10.5	0.035	0.00	0.00	0.03	0.07	0.04	0.05	0.05
10.75	0.033	0.00	0.00	0.03	0.06	0.04	0.05	0.05
11	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Aughboy Catchment – Q100

Interval	Unit Hydrograph	Aug1	Aug2	Aug3	Aug4	Aug5	Aug6	Aug7	Aug8	Aug9
0	0.155	0.25	0.27	0.28	0.31	0.48	0.46	0.51	0.56	0.57
1	0.163	0.26	0.29	0.30	0.33	0.50	0.48	0.54	0.59	0.60
2	0.185	0.29	0.32	0.34	0.37	0.57	0.55	0.61	0.66	0.68
3	0.229	0.36	0.40	0.42	0.46	0.70	0.68	0.75	0.82	0.85
4	0.311	0.49	0.55	0.57	0.62	0.96	0.92	1.02	1.11	1.15
5	0.455	0.72	0.80	0.83	0.91	1.40	1.34	1.50	1.63	1.68
6	0.699	1.11	1.23	1.27	1.40	2.15	2.06	2.30	2.50	2.58
7	1.066	1.70	1.87	1.94	2.14	3.28	3.15	3.51	3.82	3.94
8	1.510	2.40	2.65	2.75	3.02	4.64	4.46	4.97	5.41	5.58
9	1.973	3.14	3.47	3.60	3.95	6.06	5.83	6.49	7.07	7.30
10	2.404	3.82	4.22	4.38	4.81	7.38	7.10	7.91	8.61	8.89
11	2.739	4.36	4.81	5.00	5.49	8.41	8.09	9.01	9.81	10.13
12	2.893	4.60	5.08	5.28	5.79	8.89	8.54	9.52	10.36	10.70
13	2.829	4.50	4.97	5.16	5.67	8.69	8.35	9.31	10.13	10.46
14	2.606	4.15	4.58	4.75	5.22	8.00	7.70	8.58	9.33	9.64
15	2.292	3.65	4.03	4.18	4.59	7.04	6.77	7.54	8.21	8.47
16	1.926	3.06	3.38	3.51	3.86	5.91	5.69	6.34	6.90	7.12
17	1.539	2.45	2.70	2.81	3.08	4.73	4.54	5.06	5.51	5.69
18	1.167	1.86	2.05	2.13	2.34	3.58	3.45	3.84	4.18	4.31
19	0.820	1.31	1.44	1.50	1.64	2.52	2.42	2.70	2.94	3.03
20	0.526	0.84	0.92	0.96	1.05	1.62	1.55	1.73	1.88	1.95

21	0.339	0.54	0.60	0.62	0.68	1.04	1.00	1.11	1.21	1.25
22	0.234	0.37	0.41	0.43	0.47	0.72	0.69	0.77	0.84	0.86
23	0.179	0.28	0.31	0.33	0.36	0.55	0.53	0.59	0.64	0.66
24	0.155	0.25	0.27	0.28	0.31	0.48	0.46	0.51	0.56	0.57
25	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Aughboy Catchment – Q1000

Interval	Unit Hydrograph	Aug1	Aug2	Aug3	Aug4	Aug5	Aug6	Aug7	Aug8	Aug9
0	0.155	0.44	0.49	0.50	0.55	0.85	0.82	0.91	0.99	1.02
1	0.163	0.46	0.51	0.53	0.58	0.89	0.86	0.96	1.04	1.07
2	0.185	0.52	0.58	0.60	0.66	1.01	0.97	1.08	1.18	1.22
3	0.229	0.65	0.72	0.74	0.82	1.25	1.20	1.34	1.46	1.51
4	0.311	0.88	0.97	1.01	1.11	1.70	1.63	1.82	1.98	2.04
5	0.455	1.29	1.42	1.48	1.62	2.49	2.39	2.66	2.90	2.99
6	0.699	1.97	2.18	2.26	2.49	3.81	3.67	4.08	4.45	4.59
7	1.066	3.01	3.33	3.46	3.80	5.82	5.60	6.24	6.79	7.01
8	1.510	4.27	4.71	4.90	5.38	8.24	7.93	8.83	9.61	9.92
9	1.973	5.58	6.16	6.40	7.02	10.77	10.36	11.54	12.56	12.97
10	2.404	6.79	7.50	7.79	8.56	13.12	12.61	14.06	15.30	15.79
11	2.739	7.74	8.55	8.88	9.75	14.95	14.38	16.02	17.44	18.00
12	2.893	8.18	9.03	9.38	10.30	15.79	15.19	16.92	18.42	19.01
13	2.829	8.00	8.83	9.17	10.07	15.44	14.85	16.54	18.01	18.59
14	2.606	7.37	8.14	8.45	9.28	14.23	13.68	15.24	16.59	17.13
15	2.292	6.48	7.16	7.43	8.16	12.51	12.03	13.40	14.59	15.06
16	1.926	5.44	6.01	6.24	6.85	10.51	10.11	11.26	12.26	12.65
17	1.539	4.35	4.80	4.99	5.48	8.40	8.07	9.00	9.79	10.11
18	1.167	3.30	3.64	3.78	4.15	6.37	6.12	6.82	7.43	7.67
19	0.820	2.32	2.56	2.66	2.92	4.48	4.31	4.80	5.22	5.39
20	0.526	1.49	1.64	1.71	1.87	2.87	2.76	3.08	3.35	3.46

21	0.339	0.96	1.06	1.10	1.21	1.85	1.78	1.98	2.16	2.23
22	0.234	0.66	0.73	0.76	0.83	1.28	1.23	1.37	1.49	1.54
23	0.179	0.51	0.56	0.58	0.64	0.98	0.94	1.05	1.14	1.18
24	0.155	0.44	0.49	0.50	0.55	0.85	0.82	0.91	0.99	1.02
25	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Arragorteen and Ballinagelloe Catchments – Q100

Interval	Unit Hydrograph	Arr1	Arr2	Arr3	B-loe1	B-loe2
0	0.106	0.13	0.15	0.16	0.02	0.03
0.5	0.109	0.14	0.16	0.16	0.02	0.03
1	0.114	0.14	0.16	0.17	0.02	0.03
1.5	0.123	0.16	0.17	0.18	0.02	0.04
2	0.137	0.17	0.20	0.20	0.02	0.04
2.5	0.158	0.20	0.23	0.23	0.03	0.05
3	0.189	0.24	0.27	0.28	0.03	0.05
3.5	0.232	0.29	0.33	0.34	0.04	0.07
4	0.292	0.37	0.42	0.43	0.05	0.08
4.5	0.375	0.47	0.54	0.55	0.07	0.11
5	0.486	0.62	0.69	0.72	0.09	0.14
5.5	0.629	0.80	0.90	0.93	0.11	0.18
6	0.796	1.01	1.14	1.17	0.14	0.23
6.5	0.979	1.24	1.40	1.44	0.17	0.28
7	1.169	1.48	1.67	1.72	0.21	0.34
7.5	1.360	1.72	1.94	2.00	0.24	0.39
8	1.544	1.95	2.20	2.28	0.27	0.45
8.5	1.712	2.17	2.44	2.52	0.30	0.49
9	1.857	2.35	2.65	2.74	0.33	0.54
9.5	1.967	2.49	2.81	2.90	0.35	0.57
10	2.026	2.57	2.89	2.99	0.36	0.58

10.5	2.029	2.57	2.90	2.99	0.36	0.59
11	1.986	2.51	2.83	2.93	0.35	0.57
11.5	1.906	2.41	2.72	2.81	0.34	0.55
12	1.798	2.28	2.57	2.65	0.32	0.52
12.5	1.671	2.12	2.39	2.46	0.29	0.48
13	1.530	1.94	2.18	2.26	0.27	0.44
13.5	1.380	1.75	1.97	2.03	0.24	0.40
14	1.224	1.55	1.75	1.80	0.22	0.35
14.5	1.066	1.35	1.52	1.57	0.19	0.31
15	0.912	1.15	1.30	1.34	0.16	0.26
15.5	0.764	0.97	1.09	1.13	0.13	0.22
16	0.625	0.79	0.89	0.92	0.11	0.18
16.5	0.496	0.63	0.71	0.73	0.09	0.14
17	0.384	0.49	0.55	0.57	0.07	0.11
17.5	0.298	0.38	0.42	0.44	0.05	0.09
18	0.234	0.30	0.33	0.35	0.04	0.07
18.5	0.189	0.24	0.27	0.28	0.03	0.05
19	0.157	0.20	0.22	0.23	0.03	0.05
19.5	0.134	0.17	0.19	0.20	0.02	0.04
20	0.120	0.15	0.17	0.18	0.02	0.03
20.5	0.111	0.14	0.16	0.16	0.02	0.03
21	0.106	0.13	0.15	0.16	0.02	0.03
21.5	0.000	0.00	0.00	0.00	0.00	0.00

Arragorteen and Ballinagelloe Catchments – Q1000

Interval	Unit Hydrograph	Arr1	Arr2	Arr3	B-loe1	B-loe2
0	0.106	0.24	0.27	0.28	0.03	0.05
0.5	0.109	0.24	0.28	0.28	0.03	0.06
1	0.114	0.26	0.29	0.30	0.04	0.06
1.5	0.123	0.28	0.31	0.32	0.04	0.06
2	0.137	0.31	0.35	0.36	0.04	0.07
2.5	0.158	0.36	0.40	0.41	0.05	0.08
3	0.189	0.42	0.48	0.49	0.06	0.10
3.5	0.232	0.52	0.59	0.61	0.07	0.12
4	0.292	0.66	0.74	0.77	0.09	0.15
4.5	0.375	0.84	0.95	0.98	0.12	0.19
5	0.486	1.09	1.23	1.27	0.15	0.25
5.5	0.629	1.42	1.60	1.65	0.20	0.32
6	0.796	1.79	2.02	2.09	0.25	0.41
6.5	0.979	2.20	2.48	2.56	0.31	0.50
7	1.169	2.63	2.97	3.06	0.37	0.60
7.5	1.360	3.06	3.45	3.56	0.43	0.70
8	1.544	3.47	3.92	4.04	0.48	0.79
8.5	1.712	3.85	4.34	4.49	0.54	0.88
9	1.857	4.18	4.71	4.86	0.58	0.95
9.5	1.967	4.43	4.99	5.15	0.62	1.01
10	2.026	4.56	5.14	5.31	0.63	1.04

10.5	2.029	4.57	5.15	5.32	0.64	1.04
11	1.986	4.47	5.04	5.20	0.62	1.02
11.5	1.906	4.29	4.84	4.99	0.60	0.98
12	1.798	4.05	4.56	4.71	0.56	0.92
12.5	1.671	3.76	4.24	4.38	0.52	0.86
13	1.530	3.44	3.88	4.01	0.48	0.78
13.5	1.380	3.11	3.50	3.62	0.43	0.71
14	1.224	2.76	3.11	3.21	0.38	0.63
14.5	1.066	2.40	2.70	2.79	0.33	0.55
15	0.912	2.05	2.31	2.39	0.29	0.47
15.5	0.764	1.72	1.94	2.00	0.24	0.39
16	0.625	1.41	1.59	1.64	0.20	0.32
16.5	0.496	1.12	1.26	1.30	0.16	0.25
17	0.384	0.86	0.97	1.01	0.12	0.20
17.5	0.298	0.67	0.75	0.78	0.09	0.15
18	0.234	0.53	0.59	0.61	0.07	0.12
18.5	0.189	0.42	0.48	0.49	0.06	0.10
19	0.157	0.35	0.40	0.41	0.05	0.08
19.5	0.134	0.30	0.34	0.35	0.04	0.07
20	0.120	0.27	0.30	0.31	0.04	0.06
20.5	0.111	0.25	0.28	0.29	0.03	0.06
21	0.106	0.24	0.27	0.28	0.03	0.05
21.5	0.000	0.00	0.00	0.00	0.00	0.00

Part 2

Flood Risk Management in the Courtown and Riverchapel Local Area Plan 2015-2021

1.1 The Sequential Approach

Having identified the flood zones within the plan area the next step was to apply the sequential approach to land use planning in the area. The Guidelines require a sequential approach to planning and flood risk management as it is considered a key tool in ensuring that development, particularly new development, is directed towards land that is at low risk of flooding. The philosophy underpinning the sequential approach in flood risk management is:

Avoid	Preferably chose lower risk flood zone for new development.
Substitute	Ensure the type of development proposed is not especially vulnerable to the adverse impacts of flooding.
Justify	Ensure that the development is being considered for strategic reasons.
Mitigate	Ensure flood risk is reduced to acceptable levels.

1.2 Vulnerable Uses

The Guidelines classify the vulnerability of different types of development and match this vulnerability to the appropriate flood zone. This is set out in Table A.

Table A: Vulnerability and Type of Development

Vulnerability Class	Land uses and types of development which include*:
Highly vulnerable development (including essential infrastructure)	• Garda, ambulance and fire stations and command centres required to be operational during flooding; • Hospitals; • Emergency access and egress points; • Schools; • Dwelling houses, student halls of residence and hostels; • Residential Institutions such as residential care homes, children's homes and social services homes; • Caravans and mobile home parks; • Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility; and • Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO and IPPC sites etc) in the event of flooding.
Less Vulnerable Development	• Buildings used for: retail, leisure, warehousing, commercial, industrial and non-residential institutions; • Land and buildings used for holiday or short-let caravans and camping subject to specific warning and evacuation plans; • Land and buildings used for agriculture and forestry; • Waste treatment (except landfill and hazardous waste); • Mineral working and processing; and • Local transport infrastructure
Water-compatible development	• Flood control infrastructure; • Docks, marinas and wharves; • Navigation facilities; • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring

	a waterside location; • Water-based recreation and tourism (excluding sleeping accommodation); • Lifeguard and coastguard stations; • Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and • Essential ancillary sleeping or residential accommodation for staff required by uses in this category(subject to specific warning and evacuation plan)

* Uses not listed in this table should considered on their own merits

1.3 Application of the Sequential Approach

The flood zone map produced by JBA Consulting was overlaid on the plan area and reviewed in the context of both existing and proposed land uses. This identified areas where vulnerable developments, both existing and proposed, were at risk of flooding. In response to this, and through the application of the sequential approach, a 'Leisure and Amenity' land use zoning has been applied to the extent of both Flood Zone A and B in the plan area essentially removing vulnerable uses from Flood Zone A and B.

The objective of this zoning is to 'provide for water-compatible leisure and amenity uses'. Its purpose is to provide for amenity and open space. Uses which can be considered in this zoning include water-based recreation and tourism (excluding sleeping accommodation), amenity open space, outdoor sports and recreation and essential facilities such as changing rooms. Uses will need to comply with Table 3.1 Table 3.1 Classification of Vulnerability of Different Types of Uses of the Guidelines.

This zoning objective runs along the entire length of all watercourses in the plan area. The benefit of this zoning is two-fold. It will address the flood risk issues in the area and also it will also contribute to the provision of a green buffer zone which will assist in protecting the integrity of the watercourses and their associated habitats.

1.4 South-Eastern Catchment Flood Risk and Management Plan

In 2011, the OPW carried out a Preliminary Flood Risk Assessment (PFRA) which was a national screening exercise to identify areas of potential significant flood risk (referred to as Areas for Further Assessment or AFAs). Courtown is an AFA and the OPW are currently preparing flood zone maps for the area. This will then be followed by the preparation and publication of a Flood Risk Management Plan for the area in 2015/2016.

The Local Authority will review the Local Area Plan and Strategic Flood Risk Assessment once the Flood Risk Management Plan is agreed and published, and if deemed necessary, amend the local area plan to comply with it.

1.5 Flood Risk Management at Development Management Stage

1.5.1 Flood Risk Assessments

Screening for flood risk will be carried out for all development proposals in accordance with the Planning System and Flood Risk Management-Guidelines for Planning Authorities (DEHLG and OPW, 2009) as amended by Circular PL2/2014 and any other future update to the Guidelines.

Pre-application discussions will be important in identifying the broad range of issues affecting a site and present an opportunity for the Local Authority to make clear to the applicant that an appropriate flood risk assessment should be carried out as part of the application preparation process and to highlight the objectives of the Local Area Plan and the parent Wexford County Development Plan in relation to flood risk and the available information on flood zones.

1.5.2 Site-specific Flood Risk Assessment

Planning applications for development proposals within or incorporating areas at moderate (Flood Zone B) to high (Flood Zone A) risk of flooding will be required to be accompanied by a site specific and appropriately detailed flood risk assessment. In Flood Zone C the need for an appropriately detailed site specific flood risk assessment will be assessed based on a number of factors including, inter alia, the proximity to Flood Zone A or B, the topography of the subject lands and adjoining lands and the nature and vulnerability of the development proposal.

The required site-specific flood risk assessment shall be carried out by a suitable qualified and indemnified professional and in accordance with the requirements of the Planning System and Flood Risk Management Guidelines for Planning Authorities (Department of Environment, Heritage and Local Government and Office of Public Works, 2009), as amended by Circular PL2/2014 and any other future update to the Guidelines.

The detailed site-specific flood risk assessment should quantify the risks and the effects of any necessary mitigation, together with the measures needed or proposed to manage residual risks. A site-specific flood risk assessment should provide the information detailed in The Planning System and Flood Risk Management (and Technical Appendices) Guidelines for Planning Authorities (DEHLG and OPW, 2009) but in general should include:

- Plans showing the site, the development proposal and its relationship with watercourses and structures which may influence local hydraulics;
- Surveys of site levels and cross-sections relating relevant development levels to sources of flooding and likely flood water levels;
- Assessments of:
    - All potential sources of flooding;
    - Flood alleviation measures already in place;
    - The potential impact of flooding on the site and elsewhere;
    - How the layout and form of the development can reduce those impacts, including arrangements for safe access and egress;
    - Proposals for surface water management according to sustainable drainage principles;
    - The effectiveness and impacts of any necessary mitigation measures;
    - The residual risks to the site after the construction of any necessary measures and the means of managing those risks; and
    - A summary sheet which describes how the flood risks have been managed for occupants of the site and its infrastructure.
    -

1.5.3 Application of the Justification Test in Development Management

Where the Local Authority is considering proposals for new development in areas at high or moderate risk of flooding that include types of development that are vulnerable to flooding and that would generally be inappropriate as set out in Table 3.2 of the Guidelines, the Authority must be satisfied that the development satisfies all of the criteria of the Justification Test as it applies to development management. Section 5.15 of the Guidelines outlines all of the criteria that must be satisfied in the Justification Test. This is shown in Table B.

Table B: Justification Test for Development Management

Justification Test for Development Management
When considering proposals for development, which may be vulnerable to flooding, and that would generally be inappropriate as set out in Table 3.2, the following criteria must be satisfied: 1. The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of the guidelines. 2. The proposal has been subject to an appropriate flood risk assessment that demonstrates: (i) the development proposed will not increase flood risk elsewhere, and if practicable, will reduce overall flood risk, (ii) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible; (iii) The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services; and (iv) The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and

vibrant and active streetscapes.

The acceptability or otherwise of levels of residual risk should be made with consideration of the type and foreseen use of the development and the local development context.

1.5.4 Applications for Minor Proposals in Areas of Flood Risk

In accordance with Section 5.28 of the Guidelines (as amended by Circular PL2/2014, applications for minor development, such as small scale infill, small extensions to houses or the rebuilding of houses, and most changes of use of existing buildings and or extensions and additions to existing commercial and industrial enterprises, are unlikely to raise significant flooding issues, unless they obstruct important flow paths, introduce a significant additional number of people into flood risk areas or entail the storage of hazardous substances. Since such applications concern existing buildings or developed areas, the sequential approach cannot be used to locate them in lower-risk areas and the Justification Test will not apply. However, a commensurate assessment of the risk of flooding should accompany such applications to demonstrate that they would not have adverse impacts or impede access to a watercourse, floodplain or flood protection and management facilities. These proposals should follow best practice in the management of health and safety for users and residents of the proposal.

1.6 Conclusion

Land use management and spatial planning is a key tool in flood risk management. The Planning System and Flood Risk Management: Guidelines for Planning Authorities (DEHLG and OPW, 2009) aims to deliver sustainable development that minimises the risk of flooding to people and property by the avoidance of inappropriate development in areas at risk of flooding.

The Stage 2 Flood Risk Assessment has been prepared in accordance with the Guidelines and the land use zoning and objectives in the Local Area Plan have been applied in line with the recommendations set out in the Guidelines. All lands in Flood Zone A and Flood Zone B, whether developed or Greenfield, have been zoned for Leisure and Amenity, which is a water-compatible land use zoning. It is considered

that a fair balance has been struck between avoiding flood risk and facilitating necessary development, enabling future development to avoid areas of highest risk.

Legend

- Flood Zone A
- Flood Zone B

N
W E
S

TOMSILLA LOWER
KILBRIDE
COURTOWN
BALLINATRAY LOWER
BALLYDANE
BALLINAGEELOGE
SEAMOUNT
BALLINATRAY UPPER
DOUGHAL
KNOCKRICE
KILLEGRAN
BALLYBRACKEN
BALLINAGRANN LOWER
PARKNACROSS
BALLYLISK
ST GEORGE'S CHANNEL

Strategic Flood Risk Assessment
Courtown and Riverchapel
Local Area Plan 2015 - 2021

Title: Flood Zones	
Drawn by: NK	Checked by: PD
Date: 02.02.2015	Map No: 1