STRATEGIC FLOOD RISK ASSESSMENT

Prepared by JBA on behalf of Clonmel Borough Council & South Tipperary County Council.

Executive Summary

JBA Consulting was commissioned by Clonmel Borough Council (lead authority) to undertake a Strategic Flood Risk Assessment (SFRA), to inform the Clonmel and Environs Development Plan for 2013 to 2019. The purpose of this work is to provide a broad assessment of flood risk to inform strategic land-use planning decisions, in accordance with the Planning System and Flood Risk Management Guidelines; these guidelines were issued under the Planning and Development Act 2000, and recognise the significance of proper planning to manage flood risk.

Flood Policy, Legislation & Flood Mapping

Under the EU Floods Directive, the national Catchment Flood Risk Assessment and Management (CFRAM) programme is being rolled out to review flood risk across the country and produce flood hazard mapping and flood risk management plans. The Suir CFRAM will include Clonmel in its detailed assessment of flood risk, and final delivery of all CFRAM projects is due by the end of 2015. As a pre-cursor to the CFRAM programme, the national Preliminary Flood Risk Assessment (PFRA) study was completed to screen areas for potential flood risk. Under the PFRA study, national broad scale flood maps were produced.

The Clonmel Flood Relief Scheme commenced in 2008 as a multi-stage project. In addition to the scheme design, a hydraulic model was built and flood extent mapping for a 1 in 100 year return period flood event and a more extreme flood extent[1] was produced for the River Suir through Clonmel town.

The information from these and other local studies is a useful source of data for the Strategic Flood Risk Assessment at a Development Plan level. Other available data includes outputs from the Boulic Stream Assessment works, the Regional Flood Risk Appraisal, soil maps, historic records of flooding and site walkovers and consultation with local authority personnel. In addition, JBA have carried out broad scale modelling for the whole of the Clonmel and its environs using in-house JFLOW modelling software. The SFRA appraises all available existing data to produce Flood Zone maps.

Definition of Flood Zones and Flood Risk

Flood Zones are used to indicate the likelihood of a flood occurring. Based on the definitions in the Planning System and Flood Risk Management Guidelines, Flood Zone A indicates a high probability of flooding, Flood Zone B a moderate probability and Flood Zone C a low probability of flooding from fluvial or tidal sources. The Flood Zones are based on an undefended scenario and do not take into account the presence of flood protection structures such as flood walls or embankments. This is to allow for the fact that there is a residual risk of flooding behind the defences due to overtopping or breach and that there may be no guarantee that the defences will be maintained in perpetuity.

[1] The extreme flood zone is approximately equivalent to a flood event with a return period of 1 in 1000 year, and has been used as an indication of the extents of Flood Zone B.

Flood risk is a product of the likelihood (or probability) of a flood occurring and the potential consequences. Therefore, the assessment of flood risk requires an understanding of the sources, the flow path of floodwater and the people and property that can be affected. The main rivers that flow through Clonmel are the River Suir and the Anner River. The Suir has a number of tributaries which flow from the north, including the Boulic Stream and Frenchman's Stream. There are also a number of smaller streams and drains which feed into the Suir from both the north and south, including the Auk and Whitening Streams. There is a well documented history of flooding in Clonmel, with eight significant events having occurred since 2000. Flooding has historically been widespread, with the main rivers and smaller tributaries and drains contributing to the problem. Flooding from surface water and overland flow has also been reported at a number of locations across the study area.

The Clonmel Flood Relief Scheme is nearing completion, and will provide protection to a 1 in 100 year standard from the River Suir through a series of walls, embankments and demountable sections which are put in place following receipt of a flood warning by the local authority. However, the defences will overtop in a more extreme event, and in the event that the demountable sections are not fully erected. This means that all development behind the defences has a residual risk of flooding.

Climate change is one of the biggest potential risks over the lifetime of the defences. The flood zones do not take the impact of climate change into account directly, although an indication of the scale of likely changes is gained from a comparison of the extents of Flood Zone A and B, with Flood Zone B being an indication of the future extent of Flood Zone A. For this reason, it is important that the standard of protection provided by the defences is reviewed over time, and if necessary, increased to ensure the 1 in 100 year standard of protection is maintained.

Flood Management Policies

The SFRA includes a review of the land use zonings in relation to flood risk and also recommends flood risk management policies and objectives. The Planning System and Flood Risk Management Guidelines recommend a sequential approach to the management of flood risk where the preferred option is the avoidance of development in areas of flood risk; where this is not possible development type should be substituted to a less vulnerable or water compatible land use. Proposed development zoning in an area of flood risk has been subject to the Justification Test to demonstrate that development is necessary for strategic growth of the area and that flood risk can be mitigated and managed appropriately; all zoned areas have been reviewed and have passed the Justification Test for Development Plans.

The SFRA also includes a specific review of flood risk to a number of opportunity sites, namely; Fair Oaks, Suir Island, Davis Road, Coleville Road and Kickham Barracks. For each of these sites, specific guidance on the best way to address flood management has been provided.

At site specific level, all development proposals, regardless of location, will require an appropriately detailed flood risk assessment. As a minimum this will include a "Stage 1 -

Identification of Flood Risk"; where flood risk is identified a "Stage 2 - Initial FRA" will be required and depending on the scale and nature of the risk a "Stage 3 - Detailed FRA" may be required. The requirement for all applications to have an accompanying stage 1 assessment is important, as for example a large site located in Flood Zone C may be appropriate in terms of vulnerability, but might be at potential risk of surface water flooding. It follows that, all development proposals for large sites, i.e. an area greater than 0.5Ha will require an appropriately detailed FRA to consider, in particular, the management of surface water.

Any proposal that is considered acceptable in principle shall demonstrate the use of the sequential approach in terms of the site layout and design and where flood risk is identified, in satisfying the Justification Test for Development Management, the proposal will demonstrate that appropriate mitigation and management measures are put in place.

Conclusion

The land use zoning and objectives, as detailed in the Clonmel and Environs Development Plan for 2013 to 2019, have been reviewed against the recommendations set out in the Planning System and Flood Risk Management Guidelines for Planning Authorities. The land use zonings allocations aim to avoid areas of high flood risk and where this is not achieved, but the proposed zoning has passed Parts 1 and 2 of the Justification Test, recommendations have been made on Part 3 of Justification Test, relating to flood risk. Where sites are located on the periphery of the Flood Zones, derived from broad scale modelling, it is noted that a more detailed flood risk assessment (such as the Suir CFRAM or a site specific detailed FRA) may produce improved flood outlines; this would trigger an update of the Flood Zones based on the more detailed and accurate data.

There are a number of triggers which may prompt a review of the SFRA, including the completion of the Suir CFRAM and publication of flood hazard mapping for Clonmel. However, the policy recommendations and guidance contained in this report are designed to work with the more refined information which will be available from the CFRAM, which is expected to include climate change factors, the impact of failure of the demountables and give a graduation of the risk with the Flood Zones, although the extents of the Flood Zones themselves are not expected to change significantly.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF FIGURES

Abbreviations

AEP	Annual Exceedance Probability
CFRAM	Catchment Flood Risk Assessment and Management
DoEHLG	Department of the Environment, Heritage and Local Government
DTM	Digital Terrain Model
EPA	Environmental Protection Agency
FEH	Flood Estimation Handbook
FRA	Flood Risk Assessment
FRMP	Flood Risk Management Plan
FSU	Flood Studies Update
GSI	Geological Survey of Ireland
HEFS	High End Future Scenario
JFLOW	2-D hydraulic modelling package developed by JBA
LA	Local Authority
MRFS	Medium Range Future Scenario
OPW	Office of Public Works
OS	Ordnance Survey
PFRA	Preliminary Flood Risk Assessment
SEA	Strategic Environmental Assessment
SFRA	Strategic Flood Risk Assessment
SPR	Standard percentage runoff
SUDS	Sustainable Urban Drainage Systems
Tp	Time to Peak

1. Study Background

1.1 Commission

JBA Consulting was commissioned by Clonmel Borough Council (lead authority) to undertake a Strategic Flood Risk Assessment (SFRA). This study is to inform the Clonmel and Environs Development Plan 2013-2019.

This report details the SFRA for this area and has been prepared in accordance with the requirements of the DoEHLG and OPW Planning Guidelines, The Planning System and Flood Risk Management[2]; these guidelines were issued under the Planning and Development Act 2000, and recognise the significance of proper planning to manage flood risk.

1.2 Scope of the Study

Under the "Planning System and Flood Risk Management" guidelines, the purpose for the SFRA is detailed as being *"to provide a broad (wide area) assessment of all types of flood risk to inform strategic land-use planning decisions. SFRAs enable the LA to undertake the sequential approach, including the Justification Test, allocate appropriate sites for development and identify how flood risk can be reduced as part of the development plan process".*

The scope of the SFRA as set out by the tender documents is:

- Identify potential sources of flooding and identify data gaps;
- To provide an improved understanding of flood risk issues within the development plan area;
- To carry out a flood risk assessment based on existing datasets and survey work, leading to a suite of flood risk maps that support the application of the sequential approach in areas within the development envelopes, where there may be tension between development pressures and avoidance of flood risk;
- To inform, where necessary, the application of the Justification Test as set out in the DoEHLG guidelines;
- To propose mitigation measures to deal with flood risk to the area proposed for development and assess whether these measures can satisfactorily reduce the risks to an acceptable level while not increasing flood risk elsewhere;
- To produce guidelines on how surface water should be managed and appropriate criteria to be used in the consideration of site-specific flood risk assessments.

1.3 Report Structure

The SFRA considers the broader settlement strategy of the South East Regional Planning Guidelines and the countywide policies and objectives of the South Tipperary and Waterford development plans.

On a more local level, this study considers the development strategy that will form part of the Development Plan for Clonmel and Environs. The context of flood risk in the Clonmel area is considered with specific reference to people, property, infrastructure and the environment. A

[2] DoHELG and OPW (2009) The Planning System and Flood Risk Management: Guidelines for Planning Authorities

range of flood sources are considered including fluvial, pluvial, groundwater, sewer and artificial reservoirs and canals.

A two stage assessment of flood risk was undertaken, as recommended in 'The Planning System and Flood Risk Management' guidelines, for the area that lies within the development boundary of the Development Plan. The first stage is to identify flood risk. Historical records and recent events demonstrate that the Clonmel area has a history of flooding and confirms that a proportion of zoned lands are at flood risk. The second stage and the main purpose of this SFRA report is to appraise the adequacy of existing information, to prepare indicative flood zone maps, based on available data, and to highlight potential development areas that require more detailed assessment on a site specific level. The SFRA also provides guidelines for development within areas at potential risk of flooding, and specifically looks at flood risk and the potential for development within a number of key sites in Clonmel.

Section 2 of this report, provides an introduction to the study area and Section 3 discusses the concepts of flooding, Flood Zones and flood risk as they are incorporated into the Planning System and Flood Risk Management.
In Section 4, the available data related to flooding is summarised and appraised and Section 5 outlines the sources of flooding to be considered, based on the review of available data. This section also considers the flood management assets that are in place, including the Clonmel Flood Relief Scheme and this leads into a discussion of residual risk in Section 6.

Following this, Section 7 provides guidance and suggested approaches to managing flood risk to development; the contents of this section will be of particular use in informing the policies and objectives within the development plan. In Section 8, specific responses to flood risk are discussed in relation to a number of key development sites within Clonmel.

Finally, triggers for the ongoing monitoring and future review of the SFRA are detailed in Section 9.

2. The Study Area

2.1 Introduction

The area of interest comprises the urban area of Clonmel Town and its environs to the north; comprising Marlfield, Ardgeeha Upper (Cashel Road), Boherduff (Fethard Road). The environs also extend south of the river Suir and into County Waterford, in the area between the Dungarvan Road and Coleville Road.

This section of the report will provide an overview of the study area, the drainage catchment, the population and the nature of settlement, to give context to the study.

2.2 Drainage Catchment

Clonmel Town lies within the Suir River catchment which covers approximately 3,000 km^2 and lies predominantly within counties Tipperary, Waterford and Kilkenny.

The main rivers that flow through the town and environs are the River Suir and the Anner River. The Suir has a number of tributaries which flow from the north, including the Boulic Stream and Frenchman's Stream. There are also a number of smaller streams and drains which feed into the Suir from both the north and south, including the Auk and Whitening Streams. The extent of the Suir catchment with respect to Clonmel town and environs is illustrated in figure 2.1 below.

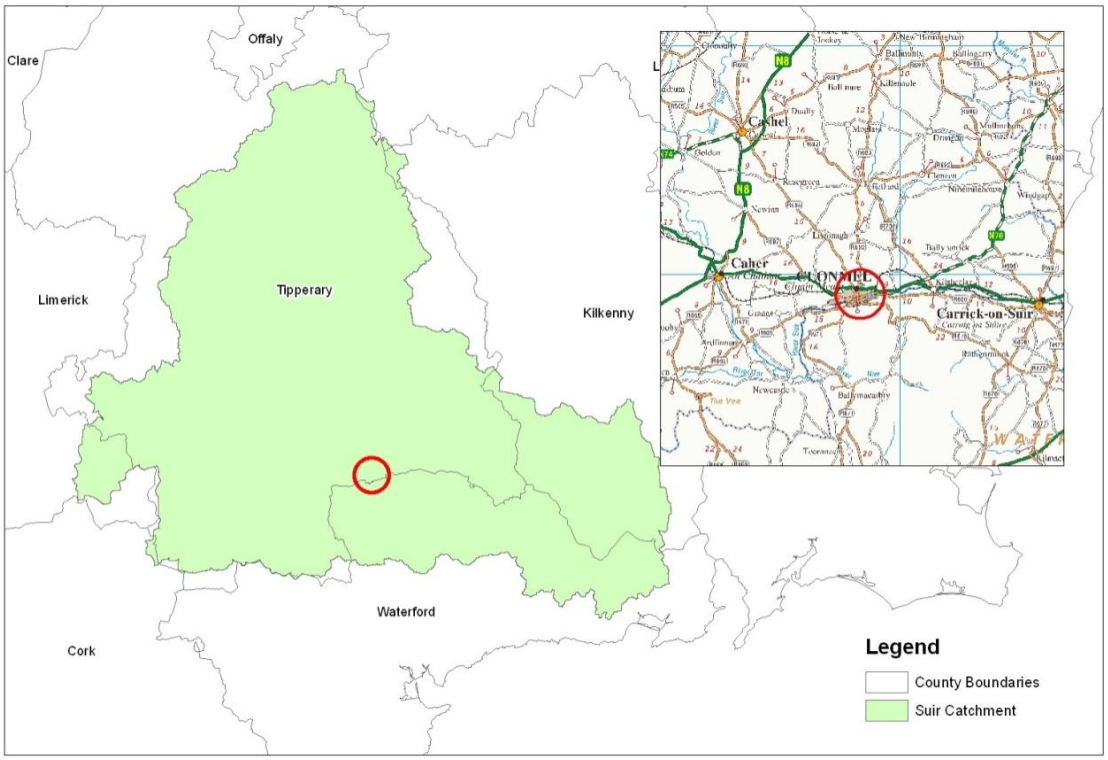


Figure 2.1 Suir River Catchment

2.3 Relevant Planning Authorities

The study area lies within the administration of South Tipperary County Council and Clonmel Borough Council, although the southern environs of Clonmel are within County Waterford. Both South Tipperary and Waterford are within the South East Regional Planning Authority.

The split between the two counties becomes particularly important when strategic planning decisions are being made regarding availability of land at lower risk of flooding and it is noted that Waterford County Council are statutory consultees for planning applications adjoining the administrative boundary.

3. The Planning System and Flood Risk Management Guidelines

3.1 Introduction

Prior to discussing the management of flood risk, it is helpful to understand what is meant by the term. It is also important to define the components of flood risk in order to apply the principles of the Planning System and Flood Risk Management in a consistent manner.

The Planning System and Flood Risk Management: Guidelines for Planning Authorities, published in November 2009, describe flooding as a natural process that can occur at any time and in a wide variety of locations. Flooding can often be beneficial, and many habitats rely on periodic inundation. However, when flooding interacts with human development, it can threaten people, their property and the environment.

The following paragraphs will outline the definitions of flood risk and the Flood Zones used as a planning tool; a discussion of the principles of the Planning Guidelines and the management of flood risk in the planning system follows.

3.2 Definition of Flood Risk

Flood risk is generally accepted to be a combination of the likelihood (or probability) of flooding and the potential consequences arising. Flood risk can be expressed in terms of the following relationship:

Flood Risk = Probability of Flooding x Consequences of Flooding

The assessment of flood risk requires an understanding of the sources, the flow path of floodwater and the people and property that can be affected. The *source - pathway - receptor model, shown below in*

Figure 3.1, illustrates this and is a widely used environmental model to assess and inform the management of risk.

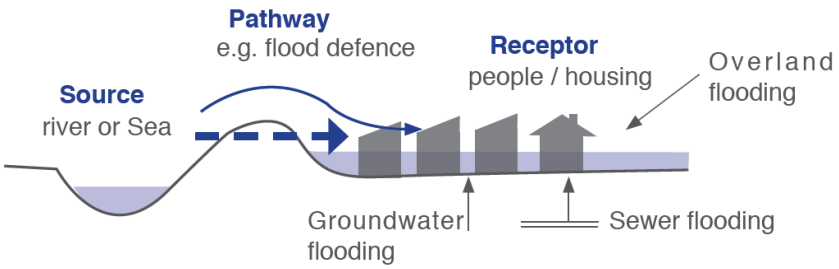


Fig. A1: Sources, pathways and receptors of flooding

Source: Figure A1 The Planning System and Flood Risk Management Guidelines Technical Appendices

Figure 3.1 Source Pathway Receptor Model

Principal sources of flooding are rainfall or higher than normal sea levels while the most common pathways are rivers, drains, sewers, overland flow and river and coastal floodplains and their defence assets. Receptors can include people, their property and the environment.

All three elements must be present for flood risk to arise. Mitigation measures, such as defences or flood resilient construction, have little or no effect on sources of flooding but they can block or impede pathways or remove receptors.

The planning process is primarily concerned with the location of receptors, taking appropriate account of potential sources and pathways that might put those receptors at risk.

3.2.1 Likelihood of Flooding

Likelihood or probability of flooding or a particular flood event is classified by its annual exceedance probability (AEP) or return period (in years). A 1% AEP flood indicates the flood event that will occur or be exceeded on average once every 100 years and has a 1 in 100 chance of occurring in any given year.

Return period is often misunderstood to be the period between large flood events rather than an average recurrence interval. Annual exceedance probability is the inverse of return period as shown in Table 3.1.

Return Period (Years)	Annual Exceedance Probability (%)
2	50
100	1
200	0.5
1000	0.1

Table 3.1 Probability of Flooding

Considered over the lifetime of development, an apparently low-frequency or rare flood has a significant probability of occurring. For example:

- A 1% flood has a 22% (1 in 5) chance of occurring at least once in a 25-year period - the period of a typical residential mortgage;
- And a 53% (1 in 2) chance of occurring in a 75-year period - a typical human lifetime.

3.2.2 Consequences of Flooding

Consequences of flooding depend on the hazards caused by flooding (depth of water, speed of flow, rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure, of the population, presence and reliability of mitigation measures etc).

The 'Planning System and Flood Risk Management' provides three vulnerability categories, based on the type of development, which are detailed in Table 3.1 of the Guidelines, and are summarised as:

- **Highly vulnerable**, including residential properties, essential infrastructure and emergency service facilities;
- **Less vulnerable**, such as retail and commercial and local transport infrastructure;

- **Water compatible**, including open space, outdoor recreation and associated essential infrastructure, such as changing rooms.

3.3 Definition of Flood Zones

In the 'Planning System and Flood Risk Management', Flood Zones are used to indicate the likelihood of a flood occurring. These Zones indicate a high, moderate or low risk of flooding from fluvial or tidal sources and are defined below in Table .
It is important to note that the definition of the Flood Zones is based on an **undefended scenario** and does not take into account the presence of flood protection structures such as flood walls or embankments. This is to allow for the fact that there is a residual risk of flooding behind the defences due to overtopping or breach and that there may be no guarantee that the defences will be maintained in perpetuity.

It is also important to note that the Flood Zones indicate flooding from fluvial and tidal sources and do not take other sources, such as groundwater or pluvial, into account, so an assessment of risk arising from such sources should also be made.

Zone	Description
Zone A High probability of flooding.	This zone defines areas with the highest risk of flooding from rivers (i.e. more than 1% probability or more than 1 in 100) and the coast (i.e. more than 0.5% probability or more than 1 in 200).
Zone B Moderate probability of flooding.	This zone defines areas with a moderate risk of flooding from rivers (i.e. 0.1% to 1% probability or between 1 in 100 and 1 in 1000) and the coast (i.e. 0.1% to 0.5% probability or between 1 in 200 and 1 in 1000).
Zone C Low probability of flooding.	This zone defines areas with a low risk of flooding from rivers and the coast (i.e. less than 0.1% probability or less than 1 in 1000).

Table 3.2 Definition of Flood Zones

3.4 Objectives and Principles of the Planning Guidelines

The 'Planning System and Flood Risk Management' describes good flood risk practice in planning and development management. Planning authorities are directed to have regard to the guidelines in the preparation of Development Plans and Local Area Plans, and for development control purposes.

The objective of the 'Planning System and Flood Risk Management' is to integrate flood risk management into the planning process, thereby assisting in the delivery of sustainable development. For this to be achieved, flood risk must be assessed as early as possible in the planning process. Paragraph 1.6 of the Guidelines states that the core objectives are to:

- "*avoid inappropriate development in areas at risk of flooding;*

- *avoid new developments increasing flood risk elsewhere, including that which may arise from surface run-off;*
- *ensure effective management of residual risks for development permitted in floodplains;*
- *avoid unnecessary restriction of national, regional or local economic and social growth;*
- *improve the understanding of flood risk among relevant stakeholders; and*
- *Ensure that the requirements of EU and national law in relation to the natural environment and nature conservation are complied with at all stages of flood risk management".*

The guidelines aim to facilitate '*the transparent consideration of flood risk at all levels of the planning process, ensuring a consistency of approach throughout the country.*' SFRAs therefore become a key evidence base in meeting these objectives.

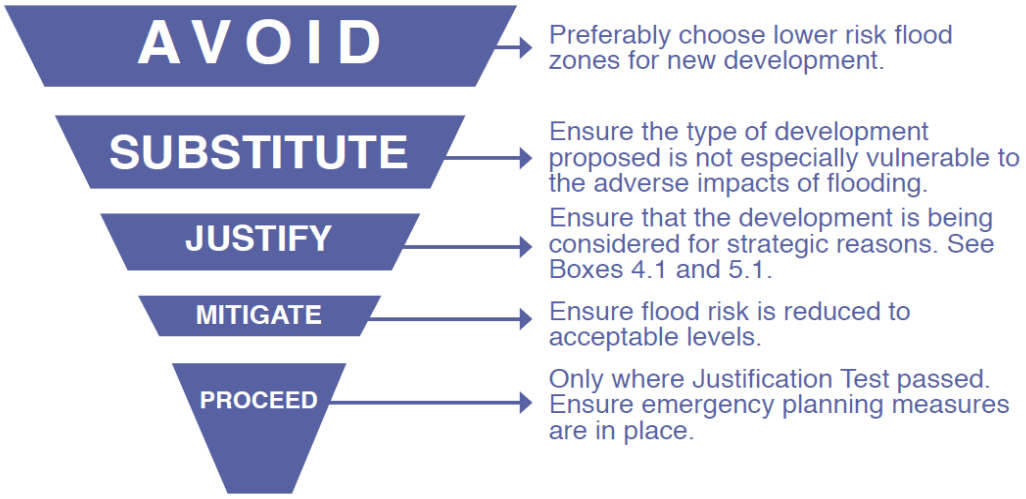
The 'Planning System and Flood Risk Management' works on a number of key principles, including:

- Adopting a staged and hierarchical approach to the assessment of flood risk;
- Adopting a sequential approach to the management of flood risk, based on the frequency of flooding (identified through Flood Zones) and the vulnerability of the proposed land use.

3.5 The Sequential Approach and Justification Test

Each stage of the FRA process aims to adopt a sequential approach to management of flood risk in the planning process.

Where possible, development in areas identified as being at flood risk should be avoided; this may necessitate de-zoning lands within the development plan. If de-zoning is not possible, then rezoning from a higher vulnerability land use, such as residential, to a less vulnerable use, such as open space may be required.



Source: The Planning System and Flood Risk Management (Figure 3.1)

Figure 3.2 Sequential Approach Principles in Flood Risk Management

Where rezoning is not possible, exceptions to the development restrictions are provided for through the Justification Test. Many towns and cities have central areas that are affected by flood risk and have been targeted for growth. To allow the sustainable and compact development of these urban centres, development in areas of flood risk may be considered necessary. For development in such areas to be allowed, the Justification Test must be passed.

The Justification Test has been designed to rigorously asses the appropriateness, or otherwise, of such developments. The test is comprised of two processes; the Plan-making Justification Test, which is undertaken for a number of development opportunity sites in Section 8 of this SFRA, and the Development Management Justification Test. The latter is used at the planning application stage where it is intended to develop land that is at moderate or high risk of flooding for uses or development vulnerable to flooding that would generally be considered inappropriate for that land.

Table 3.3 shows which types of development, based on vulnerability to flood risk, are appropriate land uses for each of the Flood Zones. The aim of the SFRA is to guide development zonings to those which are 'appropriate' and thereby avoid the need to apply the Justification Test.

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (Including essential infrastructure)	**Justification Test**	**Justification Test**	**Appropriate**
Less vulnerable development	**Justification Test**	**Appropriate**	**Appropriate**
Water-compatible development	**Appropriate**	**Appropriate**	**Appropriate**

Table 3.3 Matrix of Vulnerability versus Flood Zone
Source: Table 3.2 of the Planning System and Flood Risk Management

The application of the Justification Test in the context of specific development sites in Clonmel and Environs is discussed in Section 8.

3.6 Scales and Stages of Flood Risk Assessment

Within the hierarchy of regional, strategic and site-specific flood-risk assessments, a tiered approach ensures that the level of information is appropriate to the scale and nature of the flood-risk issues and the location and type of development proposed, avoiding expensive flood modelling and development of mitigation measures where it is not necessary. The stages and scales of flood risk assessment comprise:

- **Regional Flood Risk Appraisal (RFRA)** – a broad overview of flood risk issues across a region to influence spatial allocations for growth in housing and employment as well as to identify where flood risk management measures may be required at a regional level to support the proposed growth. This should be based on readily derivable information and undertaken to inform the Regional Planning Guidelines. The study that covers Clonmel and Environs is the South East RFRA (see Section 0).
- **Strategic Flood Risk Assessment (SFRA)** – an assessment of all types of flood risk informing land use planning decisions. This will enable the Planning Authority to allocate appropriate sites for development, whilst identifying opportunities for reducing

flood risk. This SFRA will revisit and develop the flood risk identification undertaken in the RFRA, and give consideration to a range of potential sources of flooding. An initial flood risk assessment, based on the identification of Flood Zones, will also be carried out for those areas which will be zoned for development. Where the initial flood risk assessment highlights the potential for a significant level of flood risk, or there is conflict with the proposed vulnerability of development, then a site specific FRA will be recommended, which will necessitate a detailed flood risk assessment.

- **Site Specific Flood Risk Assessment (FRA)** – site or project specific flood risk assessment to consider all types of flood risk associated with the site and propose appropriate site management and mitigation measures to reduce flood risk to and from the site to an acceptable level. If the previous tiers of study have been undertaken to appropriate levels of detail, it is highly likely that the site specific FRA will require detailed channel and site survey, and hydraulic modelling.

4. Data Collection and Availability

4.1 Overview

This section of the SFRA will review the availability of data relating to flood risk in Clonmel and Environs. Firstly, the aim is to identify flood risk based on the data available, including historical records, considering all sources of flooding. Table 4.1 summarises the data available and its quality, includes an assessment of confidence in its accuracy (when attempting to incorporate it into the flood zone maps) and gives an indication of how it was used in the SFRA study.

Description	Coverage	Quality	Confidence	Used
Regional Flood Risk Appraisal	**South East Region**	**Moderate (but broad scale)**	**Low**	**Reviewed**
JFLOW® flood zones based on OSI National Height Model	**Full Study Area**	**Moderate**	**Moderate**	**Yes; base data for tributaries (refined using other available data)**
OPW PFRA flood extent maps	**Full Study Area**	**Moderate**	**Moderate**	**Yes; to compliment the JFLOW data on the tributaries**
Alluvial Soil Maps	**Full Study Area**	**Moderate**	**Low**	**Used in the RFRA to provide indicative assessment**
Historic Flood Outlines	**2006, 2008**	**Unknown**	**Unknown**	**Yes indirectly to validate Flood Zones**
Historic Flood Records including photos, aerial photos and reports.	**Broad, spot coverage**	**Various**	**Various**	**Yes indirectly to validate Flood Zones & identify other flood sources**
Clonmel Flood Relief Scheme 1% AEP and Extreme flood extents	**River Suir through Clonmel**	**High**	**High**	**Yes; base data for the Suir**
Boulic Stream Assessment Works	**Boulic Stream**	**High**	**High**	**Yes, for route and capacity of stream**
Walkover Survey	**Selected locations**	**Moderate**	**Low**	**Yes, to validate outlines and flow paths at key locations**

Table 4.1 Available Data

A wide range of data was collected and reviewed for completeness, quality and confidence in its accuracy. One of the key outcomes of the SFRA is to produce a flood zoning map which, along with other planning considerations, will inform land zoning decisions. The quality of outline may vary across the study area depending on the origin and quality of available data. Each dataset and its use are detailed in the following sections. An overview of the development of the Flood Zones Maps, including the way the various data sets have been included in the mapping, is provided in Appendix E. In all cases, the outlines have been reviewed against each other and any additional available data and have been refined where appropriate. In particular the datasets that have been used for this purpose are JFLOW® flood outlines, the draft OPW PFRA flood outlines, records of historic flood events including extents,

design flood levels, local surveyed ground levels, walkover survey and consultation with local area engineers. The resultant Flood Zones for Clonmel and Environs are presented in Appendix E.

4.2 Regional Flood Risk Appraisal

The RFRA for the South East was undertaken as part of the development of the Regional Planning Guidelines for the South East 2010-2022[3].

The RFRA is presented in Appendix 3 of the Environmental Report & Habitats Directive Assessment Report prepared for the Regional Planning Guidelines for the South-East Region 2010-2022. The RFRA gives an overview of the main river catchments in the region, including the Suir. Amongst the resulting recommendations was the need for an integrated approach to catchment management across all relevant local authorities, which would build upon co-operation already established through the Suir CFRAMS with South Tipperary, Kilkenny and Waterford City and County represented on the committee (see Section 0).

The RFRA was translated through a number of policies in the Regional Planning Guidelines, and are reproduced here in Appendix B. The policies reinforce the principles of the Planning Guidelines by recognising the need to avoid, and where possible reduce, development in areas of flood risk, whilst at the same time recognising the need to allow the growth of core towns, including Clonmel.

4.3 JFLOW® Flood Mapping

JBA developed software, known as JFLOW®[4] to undertake multi-scale two dimensional hydraulic fluvial and tidal flood modelling.

The flood outlines have been used by South Tipperary County Council to identify areas of potential flood risk, and in consequence, these JFLOW® flood extents are used as the base dataset for defining flood risk along the tributaries, and the up and downstream lengths of the River Suir, which were not included in the relief scheme model (see section 4.6). In preparing this SFRA it was recognised that a more detailed level of assessment was required than simply re-using the JFLOW® outlines, so additional flood data has been sought and analysis undertaken.

4.4 OPW PFRA Flood Mapping

The Preliminary Flood Risk Assessment (PFRA) is a national screening exercise that was undertaken to identify areas at potential flood risk. The PFRA is a requirement of the EU Floods Directive.

3 Available at http://www.sera.ie/media/FinalRPG_doc.pdf

[4] JFLOW® is a registered UK trade mark in the name of Jeremy Benn Associates Limited

The PFRA flood outlines consider fluvial, tidal, pluvial and groundwater sources of flooding. Public consultation on the PFRA flood outlines closed on November 2011. The PFRA outlines themselves will not be subject to further update or refinement, but have been used to inform the more detailed assessment that is being undertaken as part of the Catchment Flood Risk Assessment and Management (CFRAM) studies.

4.5 Suir CFRAM Study

The Suir Catchment Flood Risk Assessment and Management Study (Suir CFRAM Study) is being undertaken by the Office of Public Works as part of the Government's catchment-based approach to flood risk management. The study has been designed to deliver on key elements of the national flood policy as well as the EU Directive on the Assessment and Management of Flood Risk.

At the time of preparing the SFRA, outputs from the CFRAM relating to Clonmel were not available, although representatives of the OPW confirmed that the Suir CFRAM Study will identify and map areas of existing and potential future flood risk within the Suir Catchment, including Clonmel, and will develop a strategic long-term plan for the overall management of flood risk within the catchment. The Suir study will build on the work, including modelling, undertaken as part of the Clonmel Flood Relief Scheme, and will also consider some of the tributaries which were not explicitly modelled as part of the scheme.

Detailed flood risk and hazard maps and the management plan will be produced for under the EU Floods Directive, which will be available by the end of 2015.

The policy recommendations and guidance contained in this report are designed to work with the more refined information which will be available from the CFRAM, which is expected to include climate change factors, the impact of failure of the demountables and give a graduation of the risk with the Flood Zones, although the extents of the Flood Zones themselves are not expected to change significantly.

4.6 Flood Relief Schemes

4.6.1 Clonmel Flood Relief Scheme

The Clonmel Flood Relief Scheme commenced in 2008 as a multi-stage project. The first phase of the overall scheme, the Clonmel West scheme, saw the construction of flood defence walls and embankments, storm water sewers and pumping stations to protect the Western shores of Clonmel. Similar works in Clonmel East and North were commissioned in September 2010 and are now nearing completion. Parts of the scheme consist of demountable defences, and the operation of the system is triggered through a flood forecasting and warning system, which is in operation through the catchment.

In addition to the scheme design was a hydraulic model and flood extent mapping for a 1 in 100 year return period flood event and a more extreme flood extent[5]. The model and resulting flood maps were limited to the River Suir and stretched from the downstream end of Marlfield, in the west, to Thomas Bridge in the east. The hydraulic modelling for the scheme demonstrated that the scheme, though constriction of the channel, increased flood risk to undefended land upstream of the Old Bridge but did not have much impact on levels downstream of the Gashouse Bridge.

The flood outlines from this scheme design were used as the base data for the Flood Zones where they were available along the River Suir.

4.6.2 Boulic Stream Assessment Works

Clonmel Borough Council commissioned an assessment of the drainage requirements of zoned and other lands north of the N24 Inner Relief Road and extending outside the Clonmel Borough Boundary[6]. These are lands where development would impact on the existing town drainage system in the existing Northern Sewer including Cashel Road, Fethard Road and the Boulic Stream. The assessment required a detailed study of the flow regime and capacity of the Boulic and Frenchmans Streams. Climate change impacts were taken into account by increasing rainfall volumes.

The recommended flood mitigation option included the creation of a new culvert, provision of attenuation (17,500m^3) at Ballingarrane Lands and unblocking and improving a number of other culverts in the system. The study commenced in 2006, and was largely completed at the time of the SFRA site visit in April 2012; all flood management elements were installed and functioning, but the landscaping of the surrounding area awaited finalisation.

The assessment did not produce flood outlines, but did provide an assessment of the culvert capacities. The off-line attenuation pond is designed to contain the 1 in 100 year flood, and has been assumed to be reliable under normal operating conditions. The improvements to culverts and trash screens have increased the capacity of the whole system to a reported 1 in 100 year standard. Having appraised this information, the flood outlines have been developed on the basis that the 1 in 100 year flow is contained within the attenuation pond and piped system. This has informed the preparation of Flood Zone A. Flood Zone B has been produced on the basis of overland flow paths which would occur as a result of the culvert reaching capacity.

[5] The extreme flood zone is approximately equivalent to a flood event with a return period of 1 in 1000 year, and has been used as an indication of the extents of Flood Zone B.

[6] Drainage Assessment for County Zones Lands, Clonmel - Preliminary Report: Buolic Stream Assessment Works, November 2011, Atkins

4.7 Historic Flood Review

Records of past flooding are useful for looking at the sources, seasonality, frequency and intensity of flooding. Historical records are mostly anecdotal and incomplete, but are useful for providing background information. The flood history of Clonmel Town will be summarised in this section, and referred to in the assessment of flood risk to individual sites.

The OPW hosts a National Flood Hazard Mapping website[7] that makes available information on areas potentially at risk from flooding. This website provides information on historical flood events across the country and formed the basis of the RFRA.

Information is provided in the form of reports and newspaper articles which generally relate to rare and extreme events. Since the establishment of the hazard mapping website, more records are available which identify more frequent and often recurring events. These tend to include memos and meeting records from local authority area engineers, often relating to road flooding. The location of records available on www.floodmaps.ie for Clonmel Town is shown in Figure 4.1. The point records have been shown based on the reported source of the flooding. This gives an overview of the pattern of sources of flooding across the study area, and clearly shows that fluvial flooding is the dominant source in the town centre, with obvious risk arising from the Suir and the Anner. In the town environs flooding tends to be attributed to overland flows, or surface water ponding in low lying areas. However, during a large flood event it is often difficult to identify the individual sources of flooding, so the extent to which water from the Suir and pluvial inputs combine through the town is unknown.

A non-exhaustive list of flood events which have impact on Clonmel and Environs is provided in Table 4.2. This is drawn from a wide variety of sources, including www.floodmaps.ie, the SEA report for the Clonmel Flood Relief Scheme[8] and various newspaper articles. The source of the flooding in the table is drawn from the historical documentation, so may not fully attribute the flooding; for example, major floods which arise from the River Suir would probably have involved other tributaries as well.

[7] www.floodmaps.ie

[8] River Suir Flood Risk Management Plan SEA Scoping Report, RPS, January 2010

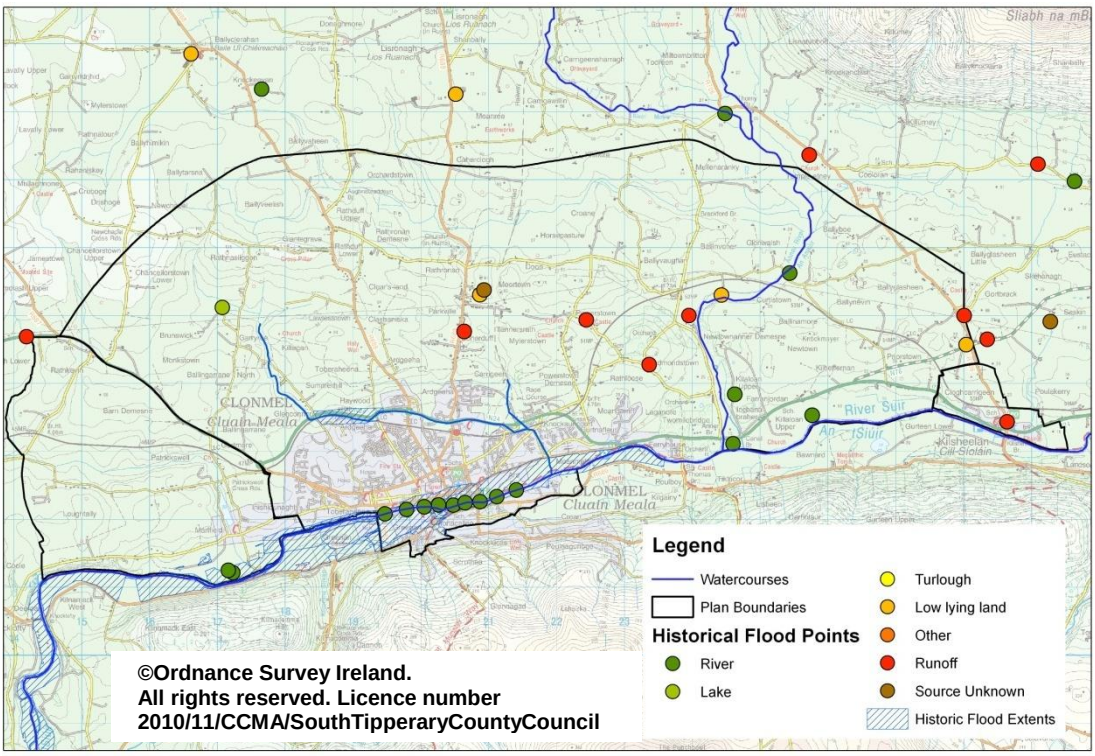


Figure 4.1 Historical Flood Records

Date	Location	Source	Details
Unknown	Carrigeen Business Park	Frenchman's Stream	A culvert blocked below the industrial area to the north of the N24 causing flood water to flood across the site and road.
Unknown (but pre-substantial development on Silversprings Road)	Silversprings Road	Boulic Stream	A possible culvert blockage occurred below the railway line, and water flowed down Silversprings Road, collecting in a low spot at the southerly end.
1946	Clonmel- widespread	River Suir	Highest recorded level at the time of the 2000 event
December 1968	Clonmel - widespread	River Suir	"the worst in living Memory". With an estimated return period of 1 in 40 years.
March 1995	Clonmel - widespread	River Suir	The peak of the flood in March 1995 passed in a matter of hours the peak rainfall was around 35mm which is the average over 24 hours.
January 1996	Clonmel - widespread	River Suir	The peak of the flood in March 1995 passed in a matter of hours the peak rainfalls for both events were similar at around 35mm which is the average over 24 hours.
August1997	Clonmel - widespread	River Suir	Major flooding, causing significant damages in Clonmel.
November 2000	Clonmel - widespread	Auk and Whitening Streams, Boulic Stream, River Anner and the River Suir.	Peak flood levels came within 70mm of the 1946. The estimated return period of the flows is 25-30 years. Over 200 properties were seriously damaged, with a further 60 properties affected. Over 40 houses were evacuated with road closures through the town.
2001	Twomilebridge	River Anner	Minor Road and 3 houses flooded
October 2004	Clonmel - widespread	River Suir	Reported to be the worst since the 1940s. Estimated 1 in 40 year return period.
2007	Clonmel - widespread	River Suir	Approx 25mm lower than the flooding of January 2009
January 2008	Clonmel	River Suir	Approx 25mm lower than the flooding of January 2009. First event following establishment of the Flood Forecasting System and partial completion of the defences.
January / February 2009	Clonmel	River Suir	Estimated to be a 1 in 5 year event. Several streets are under water and

Date	Location	Source	Details
			residents had to be evacuated from their homes.
November 2009	Clonmel	River Suir	Parts of Clonmel near are under several feet of water.
November 2010	Old Bridge area	Auk	Auk broke its banks and flooded houses in the Old Bridge Area; flash flooding caused the culvert screen to block with debris. The culvert has now been upgraded as part of the relief works.
Recurring	Redmondstown	Surface water	Runoff from land floods road after heavy rain. Partially impassable.
Recurring	Mockler's Bridge	Surface water	Runoff from land floods road after heavy rain. Partially impassable.
Recurring	Kilaloan Upper	River Anner	Lands on either side along lower reaches flood regularly.
Recurring	Brunswick	Surface water	Pond overflows causing road to be impassable three or four times a year.
Recurring (but potentially resolved)	Powerstown	Surface water	Historically runoff from land flooded road and 1 house after heavy rain. Remedial works were carried out and no problems in recent years.
Recurring	Sandybanks Clonmel	River Suir	River Suir bursts its banks annually causing extensive flooding
Recurring (but potentially resolved)	Boherduff, Clonmel to Fethard Road	Surface water	Lands flood regularly on west side of R689. Historically road flooded and was partially impassable. Remedial works carried out in 2005.
Recurring	Tannersrath, Clonmel to Fethard Road	Surface water	Natural hollow receives land runoff. Road regularly becomes impassable overnight after heavy rain.
Recurring	Twomilebridge	Rivers Suir and Anner	Confluence of Anner and Suir.
Recurring	Clonwalsh	River Anner	Road floods and becomes impassable on occasion, typically every 4 years.
Recurring	Ballinvoher	River Anner	Low lying area floods regularly. Road sometimes impassable.

Table 4.2 Historical Flood Events

4.8 Specific Local Data (including walkover survey)

A walkover survey was carried out, involving consultation with local authority personnel and taking into account the local topography. This allowed validation and, where justified, amendment of the flood outlines. For example, although the base flood maps for the Anner, which were derived from the JFLOW® flood zones based on OSi National Height Model (as shown in Table 4.1), indicate a considerable proportion of the Bulmers site, on the right bank of the River Anner is at risk of flooding, a visual inspection, backed up by local reports and the extent of the PFRA mapping indicated that bounding road and site is higher than the left bank, which is known to flood. The Bulmers site is therefore not considered to be at flood risk in a 1% or 0.1% AEP event, although the sewerage treatment plant at the Bulmers site does flood on occasions adjacent to the River Suir.

In several cases, flow routes which were questioned from the desktop review were confirmed on site and through the knowledge of the area engineer.

5. Sources of Flooding

This SFRA has reviewed flood risk from fluvial, pluvial and groundwater sources. It also considers flooding from drainage systems, reservoirs and canals and other artificial or man-made systems. The study has also considered residual risk associated with the Clonmel Flood relief scheme.

The focus of the study is on risk from fluvial flooding. There are two main reasons for this decision. Firstly, the review of historical floods shows rivers to be the most common and most damaging. Secondly, Flood Zones in the 'Planning System and Flood Risk Management' are defined on the basis of fluvial, and where appropriate, tidal flood risk. In addition, the SFRA should be based on readily derivable information, and records and indicators for fluvial flood risk are generally more abundant than for other sources of flooding.

5.1 Fluvial Flooding

Flooding of watercourses is associated with the exceedance of channel capacity during higher flows. The process of flooding on watercourses depends on a number of characteristics associated with the catchment including; geographical location and variation in rainfall, steepness of the channel and surrounding floodplain and infiltration and rate of runoff associated with urban and rural catchments. Generally there are two main types of catchments; large and relatively flat or small and steep, both giving two very different responses during large rainfall events.

In a large, relatively flat catchment, flood levels will rise slowly and natural floodplains may remain flooded for several days, acting as the natural regulator of the flow. In small, steep catchments, local intense rainfall can result in the rapid onset of deep and fast-flowing flooding with little warning. Such “flash” flooding, which may only last a few hours, can cause considerable damage and possible threat to life.

The form of the floodplain, either natural or urbanised, can influence flooding along watercourses. The location of buildings and roads can significantly influence flood depths and velocities by altering flow directions and reducing the volume of storage within the floodplain. Critical structures such as bridge and culverts can also significantly reduce capacity creating pinch points within the floodplain. These structures are also vulnerable to blockage by natural debris within the channel or by fly tipping and waste.

In Clonmel town the main source of flooding is the River Suir, as can be seen from historical records. The River Anner and Boulic Stream also contributes to fluvial flood risk and are influenced by water levels in the Suir, as are the Auk and the Whitening Streams, which flow from the south into the Suir. The Suir catchment is large covering approximately 3,000km^2 and is relatively slow responding. This allows adequate time for a flood warning system, which was installed in 2009, and allows for the erection of the demountable defences. The Boulic Stream however is quite flashy and river levels peak in a matter of hours, this poses challenges for adequate flood warning and successful flood management.

Flood risk to specific potential development sites is discussed in Section 8, and has been used to inform the zoning objectives for the Clonmel and Environs Development Plan. Where development is proposed within Flood Zones A or B, the Justification Test must be applied, and passed.

5.2 Flooding from Flood Defence Overtopping or Breach

The flood defence works along the River Suir are designed to a 1% AEP (100 year) standard of protection. There is a residual risk associated with failure of these defences due to overtopping or breach, or failure to erect sections of the defences. The areas benefiting from defences are presented along with Flood Zone Maps in Appendix E and indicate the areas of residual risk.

With climate change, the frequency, pattern and severity of flooding are expected to change and become more damaging. Climate change and increased river flows will impact on the level of protection of the scheme in future years.

The Planning Guidelines require that an initial assessment of risk is made without consideration of flood defences when defining Flood Zones A and B. Residual risk and its impact are discussed in more detail in Section 6.

5.3 Pluvial Flooding

Flooding of land from surface water runoff is usually caused by intense rainfall that may only last a few hours. The resulting water follows natural valley lines, creating flow paths along roads and through and around developments and ponding in low spots, which often coincide with fluvial floodplains. Any areas at risk from fluvial flooding will almost certainly be at risk from surface water flooding.

The PFRA study considered pluvial flood risk and produced a national set of pluvial flood maps. The indicative pluvial map from the PFRA study is presented in Figure 5.1 below. In addition, JBA have completed broad scale pluvial modelling based on a 10m national OSI DTM. This was reviewed and compared with the PFRA pluvial maps to identify development areas at particular risk of surface water and pluvial flooding.

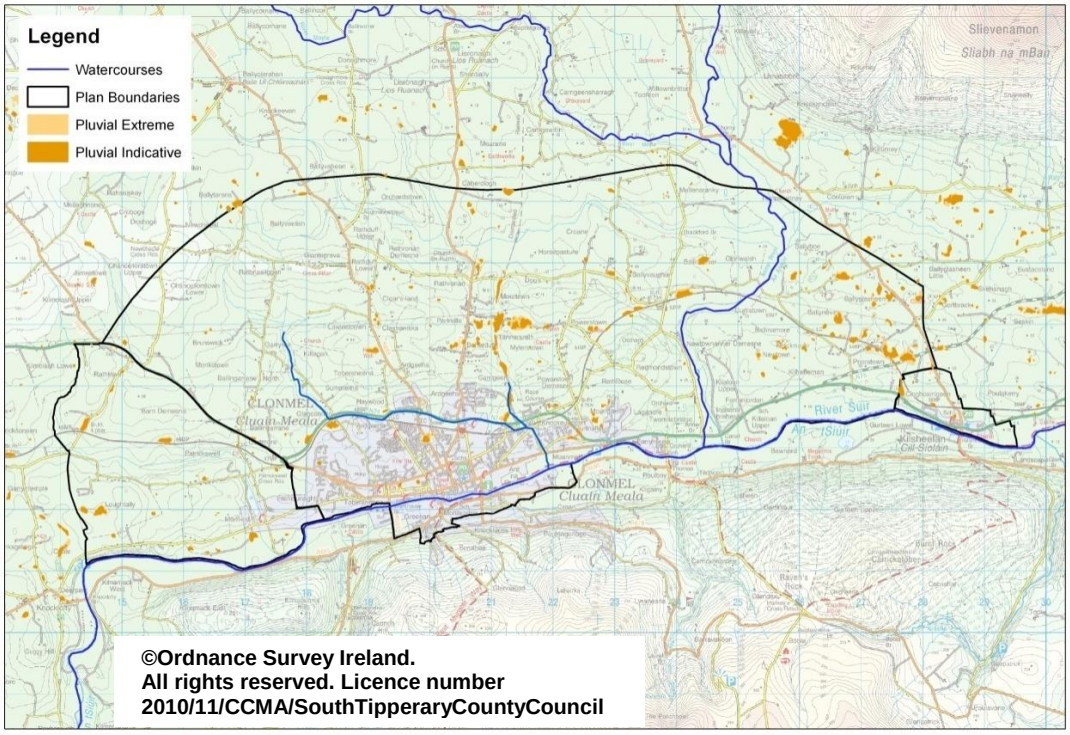


Figure 5.1 PFRA Indicative Pluvial Flood Map[9]

SFRAs require a strategic assessment of the likelihood of surface water flooding for which overland routing is suitable and appropriate. This includes consideration of the following:

- Are there zoned lands which may need to accommodate and retain surface water flow routes?
- Are there zoned lands which might discharge upstream of an area vulnerable to surface water flooding?

The review of historical flood extents, and the PFRA pluvial mapping, indicates that the centre of Clonmel is not particularly vulnerable to surface water flooding. The events recorded in the town have been attributed to fluvial flooding, whilst those in the environs, where development pressures are low, are more likely to arise from surface water sources. However, during a large flood event it is often difficult to identify the individual sources of flooding, so the extent to which water from the rivers and pluvial sources combine is unknown. On this basis, whilst the potential for surface water flow paths or ponding should not necessarily impede or restrict development; applications in such areas need to consider drainage thoroughly to ensure risks do not increase in the future. Any development proposals must not impact negatively on flood risk elsewhere. A detailed drainage assessment should be undertaken for specific applications. Using the available datasets a preliminary assessment of the potential for specific zoned lands to contribute, or be vulnerable to surface water flooding, should be undertaken based on local ground topography on a site by site basis.

Recommendations for drainage design are provided in Section 0 and a preliminary assessment of the potential for specific zoned lands to contribute or to be vulnerable to surface water flooding has been undertaken (see Section 8).

[9] Source: OPW, PFRA Study Draft Data, licensed to South Tipperary County Council

5.4 Flooding from Drainage Systems

Flooding from artificial drainage systems occurs when flow entering a system, such as an urban storm water drainage system, exceeds its discharge capacity, it becomes blocked or it cannot discharge due to a high water level in the receiving watercourse.

Flooding in urban areas can also be attributed to sewers. Sewers have a finite capacity which, during certain load conditions, will be exceeded. In addition, design standards vary and changes within the catchment areas draining to the system, in particular planned growth and urban creep, will reduce the level of service provided by the asset. Sewer flooding problems will often be associated with regularly occurring storm events during which sewers and associated infrastructure can become blocked or fail. This problem is exacerbated in areas with under-capacity systems. In the larger events that are less frequent but have a higher consequence, surface water will exceed the sewer system and flow across the surface of the land, often following the same flow paths and ponding in the same areas as overland flow.

Foul sewers and surface water drainage systems are spread extensively across the urban areas with various interconnected systems discharging to treatment works and into local watercourses.

The surface water drainage network is currently being upgraded to improve the capacity of the underground drainage network. This work includes the construction of combined storm overflows at a number of locations.

Maintenance activities, i.e. cleaning gullies, repairing pipes, clearing debris, are vital in order to manage this risk. Recent works in the town as part of the Clonmel Flood Relief Scheme have upgraded the surface water drainage network.

5.5 Groundwater Flooding

Groundwater flooding is caused by the emergence of water originating from underground, and is particularly common in karst landscapes. This can emerge from either point or diffuse locations. The occurrence of groundwater flooding is usually very local and unlike flooding from rivers and the sea, does not generally pose a significant risk to life due to the slow rate at which the water level rises. However, groundwater flooding can cause significant damage to property, especially in urban areas and pose further risks to the environment and ground stability.

Groundwater flooding can persist over a number of weeks and poses a significant but localised issue that has attracted an increasing amount of public concern in recent years. In most cases groundwater flooding cannot be easily managed or lasting solutions engineered although the impact on buildings can be mitigated against through various measures.

Groundwater vulnerability, derived by the Geological Survey of Ireland (GSI), shown below in Figure 5.2 is based on a number of parameters including:

- Sub-soils that overlie the groundwater;
- Type of recharge - whether point or diffuse;
- Thickness of the unsaturated zone through which the contaminant moves.

The more vulnerable the groundwater is to contamination (i.e. passage of contaminants down through the soil), the more chance there is of the groundwater rising to the surface and causing flooding.

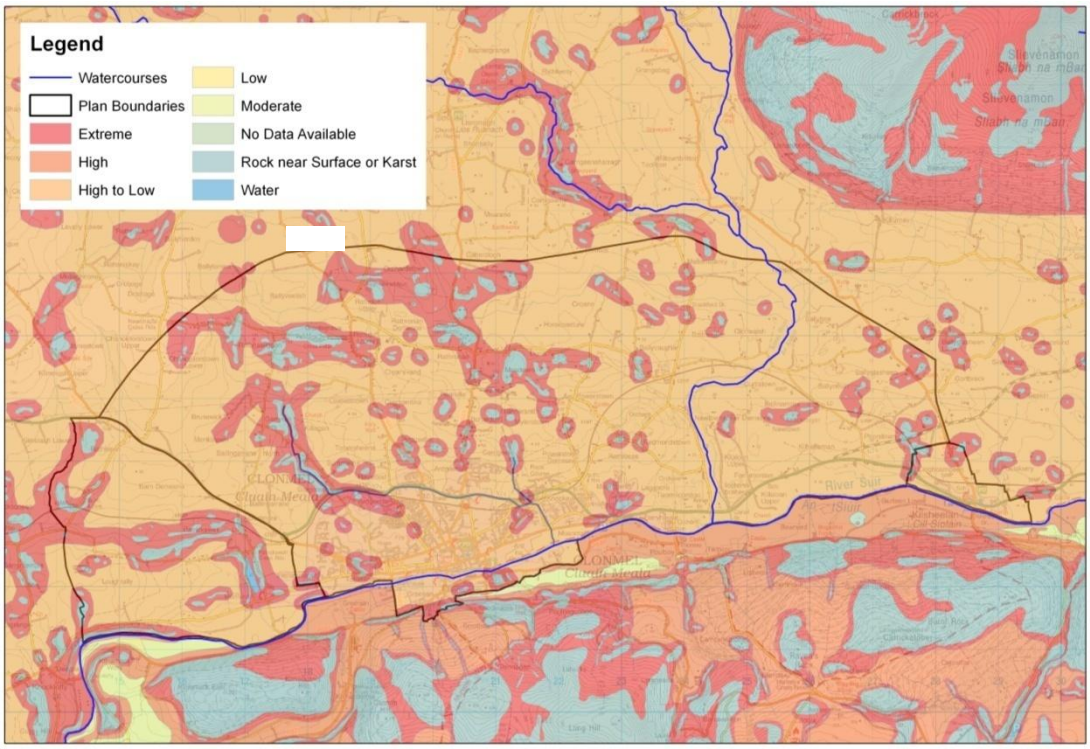


Figure 5.2 Groundwater Vulnerability[10]

The GSI mapping indicates that the Clonmel Urban Area mainly over lies groundwater of 'high to low' vulnerability; the exact classification is uncertain as only an interim assessment was undertaken through the GSI studies. In the environs there are also pockets of 'extreme' vulnerability and exposed rock.

The National PFRA Study considered flooding from groundwater sources. The draft PFRA groundwater flood maps, which provide an indication of vulnerability to groundwater flooding, did not show any significant risk in the Clonmel urban area. These maps are based on an appraisal of groundwater vulnerability and correlation to reports of historic groundwater flooding. Based on the findings of the PFRA study, and the groundwater vulnerability in the town, the risk of groundwater flooding is not considered significant enough to warrant further investigation in this SFRA.

10 Source: Department of Communications, Marine and Natural Resources. Copyright DCMNR and Government of Ireland.

5.6 Flooding from Reservoirs and other Artificial Sources

Reservoirs can be a major source of flood risk, particularly when the impoundment volume is large and they are located upstream of development areas. Whilst the probability of dam failure or breach occurring is very small, the consequences of such an event can be devastating, thereby presenting a risk of flooding which has to be considered. Clonmel does not have any large reservoirs or artificial detention basins. The Ardnagassaun Reservoir (4500 cu m (PCC Tanks)) is located to the south of the town; in the unlikely event of catastrophic failure a small number of existing houses may be affected. However, the land in this area is not zoned for development so does not need to be considered further as part of this assessment.

Although the Boulic attenuation pond may be considered to be a reservoir, as an off-line structure it does not hold a permanent supply of water. Its operation during flood conditions is considered as part of the development of the Flood Zone maps.

5.7 Climate Change

Climate change should be considered when assessing flood risk and in particular residual flood risk. Areas of residual risk are highly sensitive to climate change impacts as an increase in flood levels will increase the likelihood of defence failure.

The 'Planning System and Flood Risk Management' recommends that a precautionary approach to climate change is adopted due to the level of uncertainty involved in the potential effects. A significant amount of research into climate change has been undertaken on both a national and international front. This section will briefly examine some of the key findings of the research to date.

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 and its first report in 1990 justified concern about the effects of climate change on a scientific basis. The more recent IPCC Fourth Assessment Report 2007[11] concludes that climate change is unequivocal. It projects a global average sea level rise of between 0.18m and 0.59m for different SRES emissions scenarios, up to the end of the century. (SRES refers to the IPCC Special Report on Emissions Scenarios, published in 2000. The scenarios explore different demographic, economic and technological forces and resultant greenhouse gas emissions.)

More specific advice on the expected impacts of climate change and the allowances to be provided for future flood risk management in Ireland is given in the OPW draft guidance12. Two climate change scenarios are considered. These are the Mid-Range Future Scenario (MRFS) and the High-End Future Scenario (HEFS). The MRFS is intended to represent a "likely" future scenario based on the wide range of future predictions available. The HEFS represents a more "extreme" future scenario at the upper boundaries of future projections.

[11] Inter-Governmental Panel on Climate Change (IPCC), 4th assessment report. "Climate Change 2007".
[12] OPW Assessment of Potential Future Scenarios, Flood Risk Management Draft Guidance, 2009

Based on these two scenarios the OPW recommended allowances for climate change are given in the table below.

Criteria	MRFS	HEFS
Extreme Rainfall Depths	+20%	+30%
Flood Flows	+20%	+30%
Mean Sea Level Rise	+500mm	+1000mm
Land Movement	-0.5mm / year*	-0.5mm / year*
Urbanisation	No General Allowance - Review on Case by Case Basis	No General Allowance - Review on Case by Case Basis
Forestation	-1/6 Tp**	-1/3 Tp** +10% SPR***

Notes:
* Applicable to the southern part of the country only (Dublin - Galway and south of this)
** Reduce the time to peak (Tp) by a third; this allows for potential accelerated runoff that may arise as a result of drainage of afforested land
*** Add 10% to the Standard Percentage Runoff (SPR) rate; this allows for increased runoff rates that may arise following felling of forestry

Table 5.1 Allowances for Future Scenarios (100 Year Time Horizon)

The Flood Relief Scheme did not directly model the impact of climate change on design levels, and the other sources of flood mapping also focused on the current extents of the current 1 in 100 and 1 in 1000 year flood levels, rather than potential future extents. Therefore, the Flood Zone maps do not directly take climate change into account, but climate change flood extents can be assessed by using the Flood Zone B outline as a surrogate for 'Flood Zone A with allowance for the possible impacts of climate change', as suggested in the 'Planning System and Flood Risk Management'.

6. Residual Risk

Residual risk is the risk that remains after measures to control flood risk have been carried out. Residual risk can arise from overtopping of flood defences and / or from the breach from structural failure of the defences.

The concept of residual risk is explained in the Planning System and Flood Risk Management guidelines as follows:

"*Although flood defences may reduce the risk of flooding, they cannot eliminate it. A flood defence may be overtopped by a flood that is higher than that for which it was designed, or be breached and allow flood water to rapidly inundate the area behind the defence. In addition, no guarantee can be given that flood defence will be maintained in perpetuity. As well as the actual risk, which may be reduced as a result of the flood defence, there will remain a residual risk that must be considered in determining the appropriateness of particular land uses and development. For these reasons, flooding will still remain a consideration behind flood defences and the flood zones deliberately ignore the presence of flood defences*."

6.1 Types of Residual Risk

6.1.1 Residual Risk due to Overtopping

Overtopping of flood defences will occur during flood events greater than the design level of the defences. The defences in Clonmel have been designed to a 1% AEP level of protection, with a freeboard of 300 or 500mm, depending on construction type. During any event greater than a 1% AEP, overtopping will occur. This is likely to cause more limited inundation of the floodplain than if defences had not been built, but the impact will depend on the duration, severity and volume of floodwater. However, and more critically, overtopping can destabilise a flood defence, cause erosion and make it more susceptible to breach or fail.

Overtopping may become more likely in future years due to the impacts of climate change. In Clonmel the defences have been designed to a 1% AEP standard of protection without the inclusion of possible climate change impacts, such as more frequent and higher river flows.

6.1.2 Residual Risk due to Breach or Structural Failure

Breach or structural failure of flood defences is hard to predict and is largely related to the structural condition and type of flood defence. 'Hard' flood defences such as solid concrete walls are less likely to breach than 'soft' defence such as earth embankments.
Breach will usually result in sudden flooding with little or no warning and presents a significant hazard and danger to life. There is likely to be deeper flooding in the event of a breach than due to overtopping. The volume and impact of flooding will depend on a number of factors including:

- Size and number of breaches

- The time that the breach develops; a breach that develops early will allow more floodwater through, however a breach that develops near the peak of the event will be more hazardous.
- How long the breach remains open, leaving those in the floodplain vulnerable to secondary flood peaks on a watercourse or the next high tide cycle for areas on the coast or in estuaries.

6.1.3 Residual Risk due to Operational Failure

A flood defence system may also fail if it is dependent on flow control structures such as sluices, barriers and flap gates since there is always the possibility operational failure. Similarly if a defence system includes temporary or demountable sections, such as through much of Clonmel, it may fail due to forecasting errors, access or technical difficulties with the demountable system.

Along with the flood relief works undertaken in Clonmel, works were carried out to upgrade the existing surface water drainage network and to allow adequate drainage of the land behind the defences. This includes a number of storm overflow chambers and pumping stations. There is a residual risk associated with the operational failure of these flow control structures.

6.2 Scales of Residual Risk

In the event of defence overtopping or breach on relatively narrow flood plains, such as that of the Suir through Clonmel, inundation levels across the floodplain are likely to be the same, or very nearly the same, as levels in the river channel. In the area immediately behind the defences, known as the 'rapid inundation zone' flood depths and velocities will be highest, particularly in the time immediately following the onset of overtopping or breach. There may be little time for warning or reacting to the failure of the defence. In the area of floodplain furthest from the river, water levels will rise more gradually and reach lower depths and velocities. Being nearest to higher and dry land, evacuation opportunities from this area are also greatest.

Where an area is protected by a demountable defence, either fully or in part, the residual risks are greater than where land is behind a fixed defence. It is therefore important that risks, and the impact of defence failure, is considered in relation to the whole flood cell, rather than the land immediately behind one section of defence. This is particularly relevant in Clonmel, where the Flood Relief Scheme consists of a number of flood cells which are each protected by a combination of fixed and demountable defences.

The relief scheme in Clonmel is currently nearing completion, and is therefore in good condition and unlikely to fail due to structural deficiencies. The standard of protection and condition of the defences will be dependent on regular inspection and maintenance over its entire lifetime. The current level of residual risk behind the defences is low due to the fact that the defences have been recently designed and constructed.

The scale of residual risk is difficult to predict and requires detailed modelling to estimate the flood extents from a range of different scenarios, defended and undefended. As part of the Clonmel flood relief scheme and the Suir CFRAM, detailed modelling is being carried out, which should include an investigation into residual risk. Once complete, this data will be available for plan making decisions at a local authority level.

Understanding the residual risks is critical to application of the Flooding Guidelines in these defended areas. Even though the area is defended, it is important to be able to guide more vulnerable development to the lower residual risk areas, and to assess how the urban form of the development maybe impacted by these risks. Without detailed modelling, the following assumptions have been made in order to assess the residual risk.

- Worst case scenario would be flood extent equal to that of an undefended scenario for a particular return period.
- Flood depths in this narrow floodplain can be accurately assumed to be similar to the predicted flood levels from the scheme modelling.
- Flow velocities and hence hazard will be greatest immediately adjacent to the flood defences.

Development in areas benefiting from defences must consider long-term flood risk management policies and plans. On a site specific level, emergency response plan should be prepared taking into account the overall plan for the area and the implications for adding further demands on the blue light services.

Flood mitigation and management measures to deal with flood risk are discussed in Section 7.

7. Flood Management and Mitigation

Following the Planning Guidelines, development should always be located in areas of lowest flood risk first, and only when it has been established that there are no suitable alternative options should development (of the lowest vulnerability) proceed. This applies to residual risk within defended areas as well as those located on undefended floodplains. In such instances, consideration of suitable flood risk mitigation and site management measures is necessary. It may be technically feasible to mitigate or manage flood risk at site level. However the potential impacts on the surrounding community must also be considered. A strategic approach to the management of flood risk is particularly important in Clonmel due to the presence of the flood relief scheme.

The detailed assessment that will be undertaken as part of the Suir CFRAM will quantify residual risk and feed into the management options for the area. The CFRAM will result in the publication of a Flood Risk Management Plan that will include management and mitigation options to deal with flood risk in the future. The recommendations in the following section are based on current readily available information, but in certain situations may require some additional and more detailed assessment to be carried out. Once the CFRAM has been completed, the information will be available for the use of developers to inform site specific flood risk assessments; thereby reducing (but not necessarily eliminating) the need for individual applicants to undertake detailed modelling.

7.1 Development Management and Flood Risk

In order to guide both applicants and planning officials through the process of planning for, and mitigating flood risk, the key features of a range of development scenarios have been identified (relating the flood zone, development vulnerability and presence or absence of defences). For each scenario, a number of considerations relating to the suitability of the development are summarised below.

It should be noted that this section of the SFRA begins from the point that all land zoned for development has passed the Justification Test for Development Plans[13], and therefore Part 1 of the Justification Test for Development Management.

In all cases, the 'ideal' situation should be the starting point for development; this is the situation in which finished floor levels are set to the most conservative level, which varies for the different scenarios. Under certain circumstances it may be appropriate for a lower design standard to be applied, provided the applicant has quantified and accepted a higher level of flood risk. In these circumstances a detailed modelling study and flood risk assessment will need to be undertaken. Further details of each of these scenarios is provided in Appendix A.

[13] A zoning objective may cover a range of vulnerabilities, so although the Justification Test has been applied, and passed, not all uses which are appropriate on planning grounds may be appropriate on flood risk grounds, hence the need to work through the Justification Test for Development Management on a site by site basis.

7.1.1 Development in Flood Zone C and consideration of Surface Water in all areas

All proposed development, including that in Flood Zone C, must consider the impact of surface water flood risks on drainage design.

Drainage design is divided between sites within the Critical Drainage Areas (CDA), and sites outside these areas. Further details of these, including a map showing the CDA, are provided in Section 0.

7.1.2 Highly vulnerable development in Flood Zone A or B

Undefended areas - It is not appropriate for new, highly vulnerable development to be located in Flood Zones A or B, particularly where there are no flood defences, and such proposals will not pass the Justification Test. Instead, a less vulnerable use should be considered.

Defended areas - In areas of renovation and regeneration, including town centre areas, it is not necessarily desirable to exclude highly vulnerable development altogether. However, extremely careful consideration must be given to the position and design of these areas. The level of risk acceptance with may be considered is also dependant on the presence of flood defences.

7.1.3 Less vulnerable development in Flood Zone A or B

This category includes less vulnerable development in all forms, including refurbishment or infill development, and new development both in defended and undefended situations.

The Planning Guidelines allow for minor development (including refurbishment, change of use and extensions) within areas at risk of flooding with a commensurate assessment of flood risk. The presence or absence of flood defences also informs the level of flood mitigation recommended for less vulnerable developments in areas at risk of flooding. In contrast with highly vulnerable development, there is greater scope for the developer of less vulnerable uses to accept flood risks and build to a lower standard of protection. At all times however, the risks of flooding should be balanced against public and occupier safety first, and build cost savings to the developer after.

Major developments may also be located in areas with a higher likelihood of flooding, provided the risks are understood, and accepted; this may allow construction to a finished floor level which is lower than the 'ideal' starting point.

7.2 'Green Corridor'

It is recommended that, where possible, and particularly where there is greenfield land adjacent to the river, a 'green corridor', is retained. This will have a number of benefits, including:

- Retention of all, or some, of the natural floodplain;
- Potential opportunities for amenity, including riverside walks and public open spaces;
- Maintenance of the connectivity between the river and its floodplain, encouraging the development of a full range of habitats;

- Natural attenuation of flows will help ensure no increase in flood risk downstream;
- Retention of clearly demarcated areas where development is not appropriate on flood risk grounds, and in accordance with the Planning System and Flood Risk Management.

The width of this corridor should be determined by the available land, and topographically constraints, such as raised land and flood defences, but would ideally span the fully width of the floodplain.

7.3 Management of Surface Water

Development has the potential to cause an increase in impermeable area and an associated increase in surface water runoff rates and volumes. This can lead to potential increase in flood risk downstream due to overloading of existing drainage infrastructure.

Managing surface water discharges from new development is crucial in managing and reducing flood risk to other development downstream. The management of surface water is an important concern for large development sites and a flood risk assessment should be completed to consider surface water issues. This should be done at a scale which is appropriate to the location and size of the development area.

7.3.1 Overland Flow Routes

Underground drainage systems have a finite capacity and regard should be given to events larger than the design capacity of the network. This should be considered along with potential surface water flows that may enter a development site from the surrounding area. Master planning should ensure that existing flow routes are maintained, through the use of green infrastructure. Where possible, and particularly in areas of new development, floor levels should at a minimum be 300mm above adjacent roads and hard standing areas to reduce the consequences of any localised flooding. Where this is not possible, an alternative design appropriate to the location may be prepared.

7.3.2 Sustainable Drainage Systems (SUDS)

A specific requirement of the EU Water Framework Directive is that surface water discharge is controlled and managed so that any impact on its receiving environment is mitigated. This can be achieved through the use of Sustainable Drainage Systems (SUDS). SUDS can reduce the rate of runoff through a combination of infiltration, storage and conveyance (slowing down the movement of water). Sustainable drainage can be achieved through the use of green infrastructure such green roofs and pervious pavements, rainwater harvesting, soakaways, swales and detention basins, ponds and wetlands.

The effectiveness of flow management scheme within a single site is heavily limited by the land use and site characteristics including (but not limited to) topography, geology and available

area. As such, surface water design and management must be carried out at a site specific level for any proposed development.

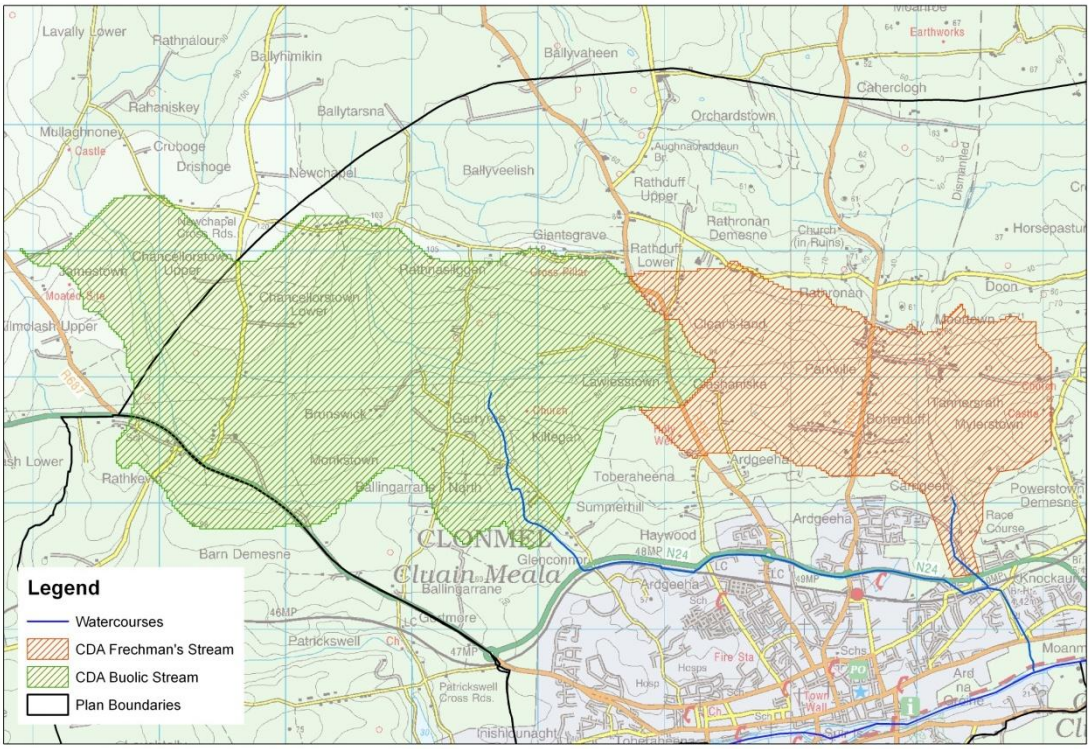


Figure 7.1 Critical Drainage Areas of the Boulic and Frenchman's Streams

7.3.3 Run-off rates

Regard should be given to the storm water management policy currently in use, and it is recommended that, as a minimum, development in greenfield locations limit post-development discharge to greenfield run-off rates. Consideration should also be given to un-developed flow paths and catchment areas to ensure additional pressure is not put on the existing drainage network.

Both the Boulic Stream and Frenchman's Stream have significant lengths of culverted watercourse in the lower reaches. In addition, the Boulic Stream benefits from the newly constructed attenuation basin. Specific consideration should be given to the catchments draining to both of these watercourses.

The attenuation basin and downstream culverts on the Boulic Stream have been designed to accommodate the current 1% AEP flow volumes and climate change was incorporated into the scheme design as an increase in rainfall rates. Any development in the catchment upstream of the basin, will change both the rates and volume of runoff, and potentially cause exceedance of the attenuation basin and culvert capacity.

Any development proposals within the Boulic catchment should pay particular attention when discharging into the critical drainage area (see Figure 7.1), and into the pipe system which

discharges into the culverts adjacent to, and south of the N24. In these areas, it should be ensured that runoff is limited to greenfield rates (see Appendix C) and depending on the scale of development may need to overcompensate for the increased volume of runoff entering the detention basin. A detailed FRA will be required to demonstrate no impact on flood risk areas downstream. This may require a higher level of on-site retention than for sites in other catchments.

The Greater Dublin Strategic Drainage Study[14] provides comprehensive guidance on the design of drainage systems, which are applicable across the country. It is recommended that drainage design for any site is carried out in accordance with the GDSDS, and in particular the following compliance requirements for development in greenfield lands are noted:

- Demonstrate compliance with limiting discharge requirements for flow rates and volumes;
- Demonstrate no flooding nuisance for the 30yr events;
- Demonstrate no property flooding for the 100yr (1% AEP events);
- Show 100 year (1% AEP) site routing and temporary storage for high intensity events;
- Show that temporary 100 year (1% AEP) flooding is retained on site.

7.4 Flood Management Action Plans

There are various levels of flood management plans produced by a number of public bodies and these include the overall strategy for the river catchment, the emergency response plan of the local authority and the flood risk management plan at a site specific level.

Strategic Flood Risk Management Plan - this will be informed by the detailed assessment of the Clonmel area which will follow completion of the Suir CFRAM, and the documentation associated with the flood relief scheme. The formulation of a management plan is particularly important in Clonmel because of the presence of the flood defences. The management plan must consider residual risk and an effective emergency response should the defences fail due to overtopping or breach.

Major Emergency Response Plan[15] - this is prepared by the local authority and is specific to the authority and the resources available. South Tipperary Local Authority has prepared a Major Emergency Plan that deals with severe weather scenarios, including flooding, and the document incorporates a 'Flood Plan' in Appendix A. It is essential that the flood plan is reviewed to ensure the operation and evacuation procedures associated with the demountable defences are included, along with the specific roles and responsibilities of those issuing alerts, erecting the defences and carrying out any related duties.

[14] Greater Dublin Strategic Drainage Study (2005) http://www.greaterdublindrainage.com/

[15] South Tipperary Local Authority, Major Emergency Plan (2008), http://www.southtippcoco.ie/en/fire/emergencyplanning/

Site Specific FRMP - this will be specific to the development and associated activities. A site specific FRMP, which may include an emergency plan, will be required for any development proposal that is granted approval in an area of flood risk.

7.5 Flood Mitigation Measures at Site Design

For any development proposal in an area at moderate or high risk of flooding that is considered acceptable in principle, it must be demonstrated that appropriate mitigation measures can be put in place and that residual risks can be managed to acceptable levels.

To ensure that adequate measures are put in place to deal with residual risks, proposals should demonstrate the use of flood-resistant construction measures that are aimed at preventing water from entering a building and that mitigate the damage floodwater causes to buildings. Alternatively, designs for flood resilient construction may be adopted where it can be demonstrated that entry of floodwater into buildings is preferable to limit damage caused by floodwater and allow relatively quick recovery.

Various mitigation measures are outlined below and further detail on flood resilience and flood resistance are included in the Technical Appendices of the Planning Guidelines, The Planning System and Flood Risk Management[16].

It should be emphasised that measures such as those highlighted below should only be considered once it has been deemed 'appropriate' to allow development in a given location. The Planning Guidelines do not advocate an approach of engineering solutions in order to justify the development which would otherwise be inappropriate.

7.5.1 Site Layout and Design

To address flood risk in the design of new development, a risk based approach should be adopted to locate more vulnerable land use to higher ground while water compatible development i.e. car parking, recreational space can be located in higher flood risk areas. Highly vulnerable land uses (i.e. residential housing) should be substituted with less vulnerable development (i.e. retail unit).

The site layout should identify and protect land required for current and future flood risk management. Waterside areas or areas along known flow routes can be used for recreation, amenity and environmental purposes to allow preservation of flow routes and flood storage, while at the same time providing valuable social and environmental benefits.

7.5.2 Ground Levels

Modifying ground levels to raise land above the design flood level is a very effective way of reducing flood risk to the particular site in question. However, in most areas of fluvial flood risk, conveyance or flood storage would be reduced having an adverse effect on flood risk

[16] The Planning System and Flood Risk Management Guidelines for Planning Authorities, Technical Appendices, November 2009

elsewhere. Therefore, there is a general requirement that compensatory storage is provided on a level for level basis where raising ground levels is proposed. This requirement can be relaxed in areas behind defences, where the flood storage has already been lost and assessed through the design of the flood relief scheme.

7.5.3 Raised Defences

Construction of raised defences (i.e. flood walls and embankments) traditionally has been the standard response to flood risk. However, this is not a preferred option as a residual risk remains. Compensatory storage must be provided where raised defences remove floodplain storage.

In some cases, collection of developer contributions may be appropriate to allow construction or improvement of flood defences that would benefit the development site and the local community.

7.5.4 Building Use and Finished Floor Levels

Raising finished floor levels within a development is an effective way of avoiding damage to the interior of buildings (i.e. furniture and fittings) in times of flood.

Assigning a water compatible use (i.e. garage / car parking) to the ground floor level of a building is an effective way of raising vulnerable living space above design flood levels. It can however have an impact on the place making outcomes.

7.5.5 Resilient and Resistance Measures in Building Design

Depending on the scale of residual risk, resilient and resistance measures may be an appropriate response but this will mostly apply to less vulnerable development.

Design can include for wet-proofing of a building to make it flood resilient and reduce the impact of flooding. For example, use of water-resistant materials such as tiles on floors and walls that can be easily washed down and sanitised after a flood event, and the installation of electrical sockets and other circuits at higher levels, with power wires running down from ceiling level rather than up from floor level.

Flood resistance measures can also be incorporated such as the provision of temporary and permanent flood barriers, but would not be considered acceptable as the primary means of managing flood risk. Permanent barriers, in the form of steps (or ramps) at doorways, rendered brick walls and toughened glass barriers, can help prevent flood water entering buildings. Alternatively, temporary barriers can be fitted into doorways and windows, with discrete permanent fixings that keep architectural impact to a minimum. However, flood warning becomes a very important issue when dealing with temporary or demountable defences.

8. Specific Responses to the Justification Test

Within the Development Plan, three Opportunity Sites were identified for future development and included were in Flood Zones A and/or B. These three opportunity sites were subject to the Justification Test for Development Plans (see Figure 8.1). This has been undertaken in an iterative process, and has involved consultation between the Clonmel Borough Council and South Tipperary County Council, JBA Consulting and RPS as part of the Strategic Environmental Assessment and Appropriate Assessment and the overall preparation of the Clonmel & Environs Development Plan 2013.

In all cases, the sites were determined to have passed the Justification Test for Development Plans, but within a number of the sites specific recommendations have been made regarding zones of mixed use vulnerability and phasing of development within zoned areas as they relate to flood risk, including four opportunity sites, which have been identified for future development and which include areas in Flood Zones A or B were subject to the Justification Test. In all cases, the sites have passed the Justification Test for Development Plans, but within a number of the sites specific recommendations have been made regarding zones of mixed use vulnerability and phasing of development within zoned areas as they relate to flood risk.

Where, as part of the preparation and adoption or variation and amendment of a development/local area plan[1], a planning authority is considering the future development of areas in an urban settlement that are at moderate or high risk of flooding, for uses or development vulnerable to flooding that would generally be inappropriate as set out in Table 3.2, all of the following criteria must be satisfied:

1 The urban settlement is targeted for growth under the National Spatial Strategy, regional planning guidelines, statutory plans as defined above or under the Planning Guidelines or Planning Directives provisions of the Planning and Development Act, 2000, as amended.

2 The zoning or designation of the lands for the particular use or development type is required to achieve the proper planning and sustainable development of the urban settlement and, in particular:

- (i) Is essential to facilitate regeneration and/or expansion of the centre of the urban settlement[2];
- (ii) Comprises significant previously developed and/or under-utilised lands;
- (iii) Is within or adjoining the core[3] of an established or designated urban settlement;
- (iv) Will be essential in achieving compact and sustainable urban growth; and
- (v) There are no suitable alternative lands for the particular use or development type, in areas at lower risk of flooding within or adjoining the core of the urban settlement.

3 A flood risk assessment to an appropriate level of detail has been carried out as part of the Strategic Environmental Assessment as part of the development plan preparation process, which demonstrates that flood risk to the development can be adequately managed and the use or development of the lands will not cause unacceptable adverse impacts elsewhere.

N.B. The acceptability or otherwise of levels of any residual risk should be made with consideration for the proposed development and the local context and should be described in the relevant flood risk assessment.

Figure 8.1 -Justification Test for Development Plans
Source: Box 4.1 The Planning System and Flood Risk Management

The land use zonings and specific development objectives (including infrastructural objectives) contained in the Development Plan have been considered having regard to this SFRA and the Planning System and Flood Risk Management Guidelines for Planning Authorities. The Justification Test for Development Plans has formed part of the consideration, and where plan led decisions are required to satisfy the Justification Test, these have been made by the Local Authority.

Specific consideration for the opportunity sites has been given to ensure *the criteria laid out under the Justification Test for Development Plans have been met.* The outcome of the Justification Test review process for parts 1 and 2, as undertaken by the Council, is shown in Table 8.1. Part 3 of the Justification Test is addressed through this report.

Justification Test for Opportunity Sites with Flood Zones A and/or B	Opportunity Site 1: Suir Island	Opportunity Site 2: Kickham Barracks	Opportunity Site 3: Davis Road
The urban settlement is targeted for growth	Clonmel is identified as a County Town in the NSS, a Regional Town in the Retail Guidelines and identified specifically in the RPG's for growth.	Clonmel is identified as a County Town in the NSS, a Regional Town in the Retail Guidelines and identified specifically in the RPG's for growth.	Clonmel is identified as a County Town in the NSS, a Regional Town in the Retail Guidelines and identified specifically in the RPG's for growth.
The zoning or designation of the lands for the particular use or development type is required to achieve the proper planning and sustainable development of the urban settlement	The Clonmel Arms site is a town centre site that has been vacant for a number of years and previously accommodated a hotel. Suir Island is intended to act as an amenity and recreational hub for the town centre. The proposals are in the interests of the proper planning and sustainable development of Clonmel town centre.	Kickham Barracks is a substantial town centre site that has only recently been vacated by the Department of Defence and requires a specific set of objectives in order to realise a comprehensive redevelopment of this brownfield site.	The proposals and objectives for Davis Road have been influenced by the SFRA and recognise the current uses on the site and seeks to remove the potential for vulnerable uses to occupy the site.
Is essential to facilitate regeneration and/or expansion of the centre of the urban settlement;	The proposals will facilitate the regeneration of the Clonmel Arms site, and following flood defence works, reclaim Suir Island as an amenity feature for the town.	The site is seen as crucial to form linkages between the town centre and the Showgrounds shopping centre.	The site has witnessed sprawl of retail functions and proposals seek to curtail uses so as to underpin the importance of the town centre proper.
Comprises significant previously developed and/or under-utilised lands;	The site comprises the now vacant Clonmel Arms site and the under utilised Suir Island.	The site is a former army barracks that was vacated in March 2012 and is now available for potential redevelopment.	The site contains vacant and occupied buildings and is generally brownfield.
Is within or adjoining the core of an established or designated urban settlement	The Clonmel Arms site is distinctly town centre and the expansion of the zoning to encompass Suir Island (which is adjacent) brings amenity and recreation into the town centre function.	The site is very central.	The site is adjacent to the town centre and on the eastern approach road into the town of Clonmel.
Will be essential in achieving compact and sustainable urban growth	Clonmel Arms is a brownfield town centre site	Kickham Barracks is a town centre brownfield site suitable for redevelopment.	Davis Road is brownfield suitable for improved developments
There are no suitable alternative lands for the particular use or development type, in areas at lower risk of flooding within or adjoining the core of the	Brown field site and amenity/recreation hub in a town centre location cannot be achieved elsewhere.	The site is a unique large town centre site and the proposals for same could not be achieved elsewhere.	The proposals for the site eliminate vulnerable uses and streamline the potential uses.

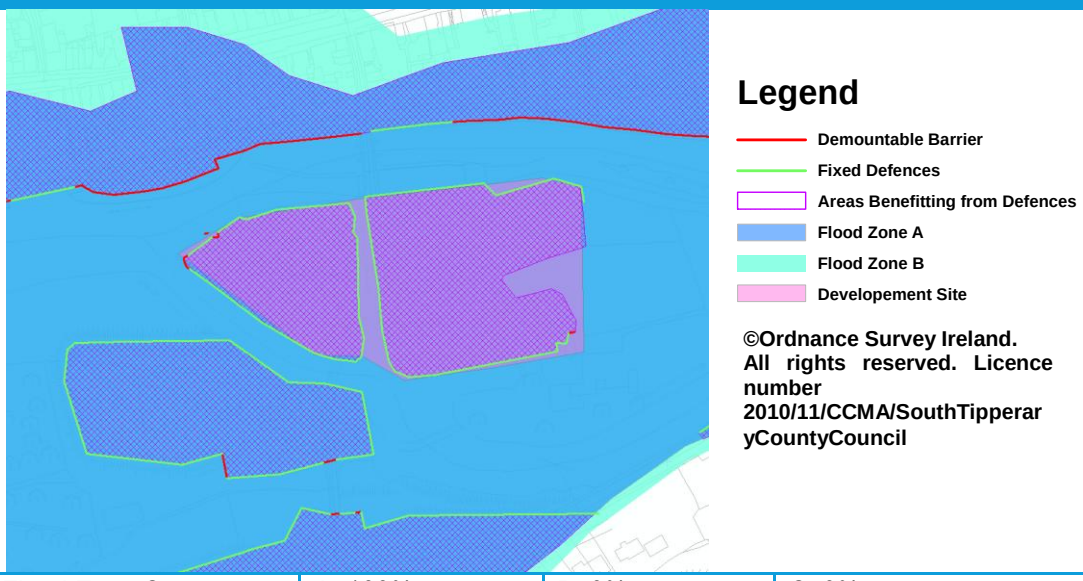
urban settlement.			
A flood risk assessment to an appropriate level of detail has been carried out	See Section 8.1 of the SFRA	See Section 8.2 of the SFRA	See Section 8.3 of the SFRA.

Table 8.1 Justification Test for Opportunity Sites with Flood Zones A/B

Details of the flood risk within the opportunity sites and the consequences of the application the Planning Guidelines are provided in table format below. The application of the sequential approach and where necessary, justification test, is an iterative process that is assessed in conjunction with the planning authorities; this process, for each of the opportunity sites, is informed by this section.

In addition, a fourth site, the Coleville Road, has been subject to more detailed review to allow the councils to make an informed decision with regard to zoning the land, and an overview of this review is provided in Section 8.4.

8.1 Opportunity Site 1: Suir Island

Site Area:	5.5Ha		
			
Flood Zone Coverage	A: 100%	B: 0%	C: 0%
Benefitting from Defences (flood relief scheme works)	The site is protected in the main by fixed defences. There are five sections of demountable defence which provide full protection to the west end of the island when erected. The east end is undefended		
Sensitivity to Climate Change	High. The site is fully within Flood Zone A and although the defences have designed to be adapted for climate change in the future, they are only set to the current 1 in 100yr level.		
Residual Risk	Should the defences overtop, or the demountable elements not be erected, flood risk to the site would be high.		
Historical Flooding	The site is shown to be wholly within the recorded outline for the flood events which occurred in 1996 and 2000.		
Surface Water	Site located behind flood defences. FRA required to consider surface water management and discharge to the Suir, particularly during (but not limited to) flood events.		

Commentary on Flood Risk:

This is a site with some existing development to the western end, and overgrown scrubland to the east. The site lies wholly within Flood Zone A, but is provided protection to the 1 in 100 year event by defences. The height of defences on Suir Island is in the region 1.6 to 1.8m from ground level (reference - Suir River (Clonmel North) Drainage Scheme Flood Protection Scheme Details A5243-N554 (2010). In a 1 in 100 year event there is approximately 500mm of freeboard. In the event that the defences are overtopped, a direct projection of water levels would give depths in-excess of the height of the defences. Such direct inundation would not occur instantaneously, even in the event that the defences breach, or demountable sections are not erected. However, based on historical flood records considerable depths of flooding are likely to occur in a relatively short timeframe, so it is important to evacuate the island when significant flood warnings are issued (i.e. when the demountable barriers are erected).

On the basis of the size of the site and current and potential future flood risk, new development on the site should consist of water compatible uses. Refurbishment of existing development should be undertaken in such a way as to minimise flood risks, including

change to a less vulnerable use and installation of property level protection measures. Water compatible uses may be allowed to complete the masterplanning of the site, and opportunities for environmental enhancement through natural and man-made parkland and amenity space should be sought.

Should new development be proposed for the island, it should be accompanied by a site scale detailed management plan, which would build upon the outputs of the flood relief scheme, but should also include an examination of hazard, velocity and time of inundation, and should propose suitable management and mitigation measures, along with an emergency plan in the event of defence failure. This will be informed by the CFRAM outputs as they become available. It is particularly important that the capability of blue-light services to manage the additional risks be addressed. Ideally, this management plan should be informed by a similar plan, or set of procedures, for the whole town.

8.2 Opportunity Site 2: Kickham Barracks

Site Area:	4 ha

Approximate Flood Zone Coverage	A: 45%	B: 47%	C: 8%
Benefitting from Defences (flood relief scheme works)	Although set some distance from the River Suir, the site is protected by a combination of fixed and demountable defences.		
Sensitivity to Climate Change	High: There is a significant difference between the extents of Flood Zones A and B, indicating that climate change could increase the extents of Flood Zone A to those currently shown for Flood Zone B. In addition, although the defences have designed to be adapted for climate change in the future, they are only set to the current 1 in 100yr level.		
Residual Risk	Should the defences overtop, or the demountable elements not be erected, flood risk to the site would be high.		
Historical Flooding	The 2000 and 1996 flood events extended to the southern limits of the site, but are not shown to have encroached into the Barracks.		
Surface Water	Site located behind flood defences. FRA required to consider surface water management and discharge to the Suir, particularly during (but not limited to) flood events.		

Commentary on Flood Risk:

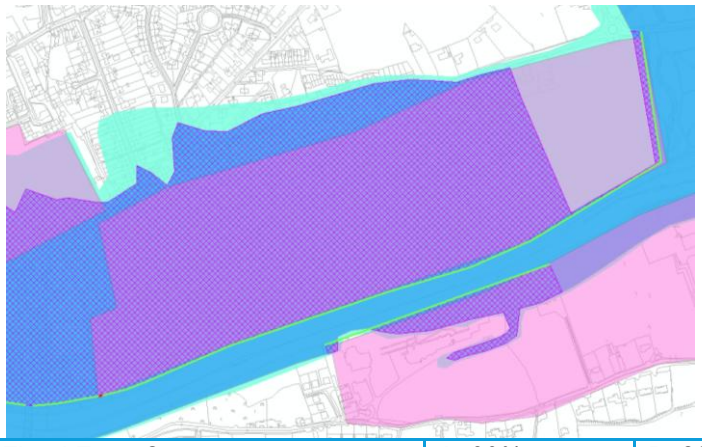
The site is an existing built environment within / adjacent to the core of the town. A little under half the area is within Flood Zone A, for which there is protection provided by the defences. Much of the remainder of the site is within Flood Zone B. As the site is on the extreme edge of

the floodplain, and is behind defences, residual risks associated with overtopping or other failure of the defences will be low; inundation times will be relatively low, and depths of flooding will be limited. Development across the site should be allocated sequentially, and within Flood Zone C, then B preferentially, but should not be so rigidly applied that development is constrained to unsustainable levels or does not deliver the mix of development type required. Flood Zone B is appropriate for less vulnerable uses (without working through the Justification Test), such as offices, eateries and education.

Flood risk to residential development can be managed, provided pre-development flood depths are less than 0.6m in the 1% AEP flood event, and the threshold levels can be raised above the 1% flood level. This is something that can be assessed at the development management stage of the site planning, and will be achievable in some parts (if not all) of Flood Zone B, and potentially in some parts of Flood Zone A. One of the requirements for the residential developments should be the availability of evacuation routes to higher ground, which means the front of the site would (probably) not be appropriate for residential uses – the site specific detailed FRA would show this.

An assessment of the impact of climate change on the development would also need to be undertaken, either through a Climate Change Adaptation Strategy for Clonmel, or on a site specific basis..

8.3 Opportunity Site 3: Davis Road

Site Area:	21 Ha		
Catchment:	River Suir		
Site Location: 			
Flood Zone Coverage	A: 80%	B: 20%	C: 0%
Benefitting from Defences (flood relief scheme works)	The site is protected in the main by fixed defences along its length. However the scheme protecting the right bank of the Suir includes several lengths of demountable defences upstream of the site.		
Sensitivity to Climate Change	High. The site is fully within Flood Zone A and although the defences have designed to be adapted for climate change in the future, they are only set to the current 1 in 100yr level.		
Residual Risk	Should the defences overtop, or the demountable elements not be erected, flood risk to the site would be high.		
Historical Flooding	The site is shown to be wholly within the recorded outline for the flood events which occurred in 2000.		
Surface Water	Site located behind flood defences. FRA required to consider surface water management and discharge to the Suir, particularly during (but not limited to) flood events.		

Commentary on Flood Risk:

This is an existing developed site that is proposed for redevelopment, and also includes areas of brown and greenfield land. This site is in Flood Zone A, with a high risk of flooding and is located behind flood defences which have been constructed along the River Suir.

The site is located within a flood cell which is protected by a combination of fixed and demountable defences. If the defences operate as designed, flood risk is primarily dealt with by the defences, which offer protection from the 1 in 100 year event, although overtopping would occur in events greater than this. In a worst case scenario, and based on current ground levels and the 1 in 100 year flood levels from the scheme, flood depths across the site could range from approximately 1m at the road, to in excess of 2m behind the defences. However, the area benefits from a flood warning system so early preparedness and evacuation is possible if required. Given the location and strategic importance of the site, development should be carried in accordance with the recommendations in Section 7 of this report, but certain compromises may be accepted, provided they are informed by an appropriately detailed assessment.

It is recommended that development at this site be restricted to water compatible or less vulnerable uses, and finished floor levels are set at an initial minimum level which would equate to the 1 in 100 year level; this varies along the length of the site, so needs to be determined on a case by case basis. To reach this floor level, land raising would need to be carried out. As the area is behind defences (under normal operating conditions), compensatory storage would NOT need to be provided; nor would there be a requirement to include a freeboard allowance.

The masterplanning stage of development management should include by a site scale detailed flood risk assessment and management plan. The FRA must consider the impact of climate change and residual flood risk (including non-erection of demountables and overtopping of walls) and management of such risk, on a site specific level.

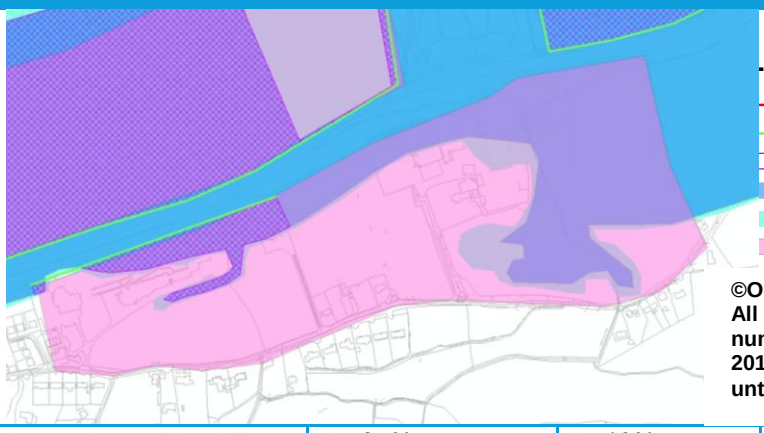
The FRA should build upon the outputs of the flood relief scheme, but should also include an examination of hazard, velocity and time of inundation, and should propose suitable management and mitigation measures, along with an emergency plan in the event of defence failure. It is important that this plan also considers the risk to other sites, and the management of same. Ideally, this management plan should be informed by a similar plan, or set of procedures, for the whole town. The plan should identify areas within the site of highest risk (for example, due to depth or speed of flooding), and should inform the allocation of development within the site based on vulnerability and hazard (rather than just flood extent). Appendix B of the Planning System and Flood Risk Management provides more guidance.

On the basis of this assessment, it may be determined that a lower finished floor level for non-residential use could be permitted, to a minimum of 600mm below the 1 in 100 year level. This would be the case if management of the residual flood risk was accepted by the developer, and the proposed development was based on flood resilient design.

8.4 Opportunity Site 4: Fair Oaks

Site Area:	2.3Ha		
			
Approximate Flood Zone Coverage	A: <1%	B: 9%	C: 90%
Benefitting from Defences (flood relief scheme works)	The site is not protected by defences, but sits on elevated ground.		
Sensitivity to Climate Change	Low; there is little difference between Flood Zones A and B so the impact of climate change on flood extents is likely to be limited.		
Residual Risk	Currently none.		
Historical Flooding	The river side portion of the site is shown to be in the recorded outline for the flood event which occurred in 2000. The extent of this event is similar to the flood zones, as mapped.		
Surface Water	Urbanised site adjacent to the River Suir. FRA required to consider surface water management at the site.		
Commentary on Flood Risk: This is a site with some existing development. The majority of this site is within Flood Zone C with a very low (less than 0.1%) probability of flooding. The site boundary encroaches on Flood Zones A and B. From a flood risk management point of view development at this site is appropriate, but following the principles of the Planning Guidelines, is best avoided in Flood Zone B where less vulnerable or water compatible uses, such as a green corridor or amenity strip, should be encouraged.			

8.5 Development Site 4: Coleville Road

Site Area:	26.69 Ha		
			
Approximate Flood Zone Coverage	A: 35%	B: 10%	C: 55%
Benefitting from Defences (flood relief scheme works)	The site does not benefit from defences. However, it lies on the left bank, opposite an area protected by the flood relief scheme. In producing the Flood Zone Maps; modelling undertaken as part of the scheme design has shown the scheme has not worsened the extents of flooding in this location.		
Sensitivity to Climate Change	Relatively low; in the main there is little difference between the extents of Flood Zone A and B so climate change is unlikely to have a big impact on the extents of flooding, although depths may increase over time.		
Residual Risk	Currently none.		
Historical Flooding	The site is shown to be within the recorded outline for the flood events which occurred in 2000.		
Surface Water	Partially urbanised site adjacent to the River Suir. FRA required to consider surface water management at the site, and retention of greenfield runoff rates for currently undeveloped lands.		

Commentary on Flood Risk:
Part of this site consists of existing development, with some of this existing development in Flood Zone A. Much of the remainder of the site is undeveloped green space. Land use across the site should be appropriate to the scale of flood risk and under-utilised or undeveloped areas in Flood Zones A or B should be maintained as open space, which could include a green corridor alongside the river.

Refurbishment of existing development should be undertaken in such a way as to minimise flood risks, including change to a less vulnerable use and installation of property level protection measures.

9. SFRA Review and Monitoring

There are a number of key outputs from possible future studies and datasets, which should be incorporated into any update of the SFRA as availability allows. A list of potential triggers for an SFRA review is provided in Table 9.1. Not all future sources of information should trigger an immediate full update of the SFRA; however, new information should be collected and kept alongside the SFRA until it is updated.

One of the main benefits of the CFRAM study outputs will be a greater availability of flood risk data and maps; this information will not necessarily trigger a review of the development plan, but will provide a significant resource for developers looking to complete flood risk assessments for individual sites, or masterplanning of larger areas.

Trigger	Source	Possible Timescale
Catchment Flood Risk Assessment and Management (CFRAM) Mapping	OPW under the Floods Directive	2013
Catchment Flood Risk Assessment and Management (CFRAM) Studies	OPW	2015
Flood maps of other sources, such as canal breach and drainage networks	Various	Unknown
Significant flood events	Various	Unknown
Changes to Planning and / or Flood Management Policy	DoEHLG / OPW	Unknown
Detailed FRAs which focus specifically on assessment and quantification of residual risks	Various	Unknown
Scheme 'as-built' drawings and reports	OPW	Upon completion of the scheme
Additional Flood Defence Feasibility / Design Reports	Likely to be local authority and the OPW	Unknown

Table 9.1 SFRA Review Triggers

Appendix A

Flood Zone Mapping - Development and Data

A. Flood Zone Mapping - Development and Data

This appendix details the data sets which were used in the creation of the Flood Zone maps, including the use made of each source of data, and the validation checks carried out. These Flood Zones inform planning decisions leading to the application of the Justification Test where applicable.

A.1 Flood Mapping

A.1.1 Clonmel Flood Relief Scheme

The Clonmel Flood Relief Scheme produced flood levels and extent maps for the 1 in 100 year return period flood event and a more extreme flood extent[17]. The model and resulting flood maps were limited to the River Suir and stretched from the downstream end of Marlfield, in the west, to Thomas Bridge in the east, but where available, these extents formed the basis of the Flood Zone Maps. This is primarily due to the level of detail which was involved in constructing the hydraulic model, which included detailed channel survey and hydrological assessment of flows.

A.1.2 PFRA Indicative Fluvial Flood Mapping & Methodology

Flood flow estimates were calculated at nodes every 500m intervals along the entire river network. (The river network is the EPA 'blue-line' network, which, for the most part, matches the rivers mapped at the 1:50,000 scale Discovery Series OS mapping). This flow estimation was based on the OPW Flood Studies Update research programme. An assumption was made that the in-channel flow equates to the mean annual flood and so the out of bank flow for a particular AEP event was determined by deducting the mean annual flood from the flood flow estimate for that probability event.

Using the OPW's 5m national digital terrain model (DTM) cross sections were determined at 100m spacings. Manning's equation, a hydraulic equation for normal flow, was used to calculate a flood level which was then extrapolated across the DTM to determine the flood extent. This exercise was completed for all river catchments greater than 1km^2.

This methodology does not take into account defences, channel structures or channel works. Potential sources of error in the mapping include local errors in the DTM or changes to the watercourse flow route due to an error in mapping or new development.
The PFRA mapping was completed as part of a desk based study and was put on display for public consultation and comment. The maps are available at www.cfram.ie.

A.1.3 JFLOW® Indicative Fluvial Flood Mapping & Methodology

The JFLOW® fluvial flood mapping process involved two stages, hydrology and hydraulic modelling. JBA Consulting developed in-house software tools to interpolate catchment descriptors from a number of environmental datasets and produced an automated method for calculating design flows. The method used to calculate flows was based on the Flood Estimate Handbook (FEH)[18] Statistical Method and is in line with the methods of the Flood Studies Update (FSU) which is currently under development. Index flows were generated at 300m intervals along the entire river network. Annual Maximum flow data from the OPW Hydrodata[19]

[17] The extreme flood zone is approximately equivalent to a flood event with a return period of 1 in 1000 year, and has been used as an indication of the extents of Flood Zone B.

[18] Flood Estimation Handbook, Institute of Hydrology, 1999

[19] www.opw.ie/hydro

website were used to adjust the index flows by allocating 'donor' gauges, whereby local gauges are used to compare and adjust index flows for a given catchment. Pooled data was used to generate growth curves and determine flood flows for different return periods.

JFLOW®, a two dimensional hydraulic modelling software, developed in-house by JBA Consulting, was used to simulate overland flooding. Cross sections were generated at each inflow point to define the extent of the area over which to route the flow. A similar assumption was made relating to the channel capacity as for the PFRA study. The flow hydrograph calculated at each estimation point was routed over a digital terrain model and this was the OSI national 10m height model. This process was completed for all river catchments greater than 10km^2.

JFLOW® results were subject to several iterations of manually checking and model re-runs. However the accuracy of the flood mapping is directly correlated to the DTM and individual flow structures such as bridges, culverts, weirs and sluices are not explicitly modelled.

A.1.4 Boulic Stream

Owing to the considerable level of engineering works which have been carried out on the Boulic Stream, including diversions and culverts, a section of the JFLOW flood mapping was rerun for this watercourse. The assessment of flood relief measures at the Boulic Stream did not produce flood outlines, but did provide an assessment of the culvert capacities. The off-line attenuation pond is designed to contain the 1 in 100 year flood, and has been assumed to be reliable under normal operating conditions. The improvements to culverts and trash screens have increased the capacity of the whole system to a reported 1 in 100 year standard. Having appraised this information, the flood outlines have been developed on the basis that the 1 in 100 year flow is contained within the attenuation pond and piped system. This has informed the preparation of Flood Zone A.

The study did not consider the 1 in 1000 year flood event, so flows were drawn from the JFLOW mapping inputs. Flood Zone B, as derived from the rerun JFLOW model, has been produced on the basis of overland flow paths which would occur as a result of the culvert reaching capacity.

A.2 Validation

The above data sets were validated in a number of ways, both as part of the desktop review and through site walkover:

- Where data sets overlapped, the extents were compared against each other, and against the local topography.
- Historical flood reports and outlines were used to validate the computer driven outputs.
- In cases where differences between the various data sources were identified, these were highlighted and targeted as areas for walkover. This enabled the impact of local topography and on or off-line features (such as culverts and walls) to be assessed and a judgement on the most appropriate outline to be made.
- The knowledge of local engineers provided further validation of a number of historical flow paths, and also the context of improvements to the channel infrastructure.

A.3 Summary

On the River Suir, both the scheme outlines, the PFRA and JFLOW® methods produced similar flood extents, and the choice of which to use was determined by the extent of the scheme limits. In most other areas, the PFRA and JFLOW also agreed, and the JFLOW outline was generally used as the secondary choice of data. A number of exceptions were:

- On the right bank of the Anner (at the Bulmers site), where, based on local topography and historical flood information, the PFRA outline was used, and this was aligned with high levels along the road.
- Frenchman's Stream, as it flows into culvert below the N24. The JFLOW outline showed a flow route to the west, but anecdotal evidence suggested the route to the east (as shown in the PFRA) was the path taken during a previous flood event.
- Upstream limits of Boulic Stream - the JFLOW outline did not extend as far upstream as the PFRA. Where both were available, they were similar in extent, so the PFRA outline was used in the upper part of the reach, and for the minor tributary entering on the left bank.

Appendix B

Regional Planning Guidelines for the South East

B. Regional Planning Guidelines for the South East

B.1 Flood Management Policies

The policies contained within the Regional Planning Guidelines for the South East which relate to flood risk management are:

PPO 9.1 It is an objective of the Regional Planning Guidelines that in the preparation and review of future Development Plans and Local Area Plans local authorities will:

- Identify and consider at the earliest stages in the planning process flood hazard and potential risk.
- Identify flood risk areas on Development Plan and Local Area Plan maps.
- Review existing Development Plans and Local Area Plans to ensure that the issue of Flood Risk has been addressed in a manner consistent with the 2009 Planning and Flood Risk Management Guidelines.
- Where lands are already zoned for housing or other vulnerable development in the flood risk areas, local authorities should undertake a re-examination of the zoning in accordance with the sequential approach.
- Include policies which ensure that flood risk areas targeted for development following the sequential approach are planned, designed and constructed to reduce and manage flood risk and be adaptable to changes in climate.
- Include policies to ensure that flood risk and impact are considered as a key element in the assessment of future waste and mineral planning strategies and developments.
- Include policies that ensure that the location of key infrastructures will be subject to Flood Risk Assessment.
- Include policies for the inclusion of Sustainable Drainage Systems (SUDS) in future developments in accordance with the 2009 Department Guidelines on Planning and Flood Risk Management.

PPO 9.2 Flood risk should be managed pro-actively at all stages in the planning process by avoiding development in flood risk areas where possible and by reducing the causes of flooding to and from existing and future development.

PPO 9.3 New development should be avoided in areas at risk from flooding. Alongside this, the Regional Flood Risk Appraisal recognises the need for continuing investment and development within the urban centres of flood vulnerable designated growth towns and Waterford City and for this to take place in tandem with the completion of CFRAM studies and investment in sustainable and comprehensive flood protection and management.

PPO 9.4 Development Plans and Local Area Plans should include a Strategic Flood Risk Assessment and all future zoning of land for development in areas at risk of flooding should follow the sequential approach set out in the 2009 Department Guidelines on Planning and Flood Risk Management.

PPO 9.5 Local authorities should take the opportunities presented when including policies and actions in Development Plans/LAPs (such as flood plain protection and SUDS) to optimise improvements in biodiversity and amenity for existing and future developments.

PPO 9.6 Key infrastructure suppliers should assess current elements and stress test future projects against flood risk, where this has not been previously undertaken.
PPO 9.7 Local authorities should pursue the following actions/indicators required for Regional Flood Risk Appraisal in their area:

1. 100% completion, in co-operation with all local authorities in the South-East, of CFRAM studies covering the region by 2016, including a review of long term flood risk management options and consideration of appropriate land use policies.
2. All local authorities should have completed SFRAs for all Development Plans and Local Area Plans by 2016.
3. The proportion of new housing land located in lands classified as Flood Zone A or B should decrease to a minimal level during the lifetime of the Regional Planning Guidelines.
4. Inclusion in Development Plans of policies and objectives that require non-sensitive uses and designs which provide flood protection for ground floors of buildings in flood vulnerable locations within existing urban centres.

Appendix C

Development Management Measures

C. Development Management Measures

C.1 Overview

This section have been designed to guide local authority planning officers and those working through the planning processes through some of the key considerations involved in applying flood management and mitigation measures in development management.

C.2 Development in Flood Zone C and consideration of Surface Water in all areas

All proposed development, including that in Flood Zone C, must consider the impact of surface water flood risks on drainage design. In this regard, all the other development scenarios must pass through this process before completing the planning and development process.

Drainage design should be divided between sites within the Critical Drainage Areas (CDA), and sites outside these areas. Further details of these, including a map showing the CDAs, are provided in Section 0.

The drainage design should ensure no increase in flood risk to the site, or the downstream catchment. Considerable detail on the process and design of SUDS is provided in the Great Dublin Strategic Drainage Study, and more details and guidance are available on the 'Irish SUDS: Guidance and Tools' website[20]; these documents should be referred to alongside this document.

The greenfield runoff rate for sites outside the CDA is 6l/s/ha, and all new development should attenuate discharge flows to this rate. For sites within CDA, the calculation of allowable discharge rates is more complex, as the volume and phasing of flows becomes critical to ensure downstream culvert capacity is not exceeded. In this regard, Criterion 4 of the GDSDS should be applied.

The incorporation of SUDS into drainage design is detailed in Policy INF 10 of the Development Plan, and in this regard the developer should justify the non-use of SUDS for any site greater than 0.5ha. On sites smaller than 0.5ha, SUDS are recommended, but the developer may decide not to use them.

Once the drainage system has been designed it is important that exceedence is tested for, and in this regard, Criterion 3 of the GDSDS should be applied.

C.3 Highly vulnerable 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, particularly where there are no flood defences, and such proposals will not pass the Justification Test, even where the zoning objective would seem to indicate a particular use is acceptable. Instead, a less vulnerable use should be considered.

In areas of renovation and regeneration, including town centre areas, it is not necessarily desirable to exclude highly vulnerable development altogether. However, extremely careful consideration must be given to the position and design of these areas. The level of risk

[20] http://www.irishsuds.com/

acceptance is only possible due to the presence of flood defences along the River Suir which deliver the minimum 1 in 100 year standard of protection.
Key points for consideration in terms of new, highly vulnerable development in defended areas are:

- The 1 in 100 year flood level for the preliminary steps in the assessment are based on a direct projection of in-channel levels derived from the Clonmel Flood Relief Scheme model. These levels are likely to be conservative (i.e. higher than would occur in a flood event), but allow development proposals to be assessed without the need for detailed modelling and assessment to be undertaken.
- Where a site is defended, it must be to at least a 1 in 100 year standard of protection (SoP). If the SoP is lower, the site should be considered to be undefended.
- If the site is defended, and a freeboard allowance has been incorporated into the design of the defences, there is no requirement for the finished floor level of the development to include freeboard as well. In Clonmel, the defences include freeboard.
- The impact of climate change on water levels has not been quantified through the scheme modelling. Instead, it is recommended that a level of 600mm is adopted as the default allowance to be included when setting finished floor levels. Further modelling could be undertaken to improve this estimate.
- The emergency procedures in the event of a flood are critical; evacuation routes are preferable, and should be provided to higher ground. If evacuation is not possible, containment may be considered, and the associated issues that this presents, such as duration of stay and the potential for rescue, must be addressed. If neither option is possible, then the development proposal cannot go ahead.

Having determined the finished floor, the design should be reviewed against wider place making outcomes, including the level of surrounding properties, utilities and landscaping. If the design is in keeping, it may proceed through the planning process. If the design is not in keeping, a further review may take place which will be guided by the presence or absence of defences.

In a defended situation, it is preferable to substitute a lower vulnerability use, and may be possible to assess the potential for a lower finished floor level. In an undefended situation it is not appropriate to consider a lower finished floor level, so a less vulnerable use must be appraised.

In a defended situation, if a less vulnerable use is not desirable, a lower finished floor level for the highly vulnerable use may be considered, but this will require a detailed site specific flood risk assessment, which must assess climate change and residual risk through hydraulic modelling. The detailed modelling may result in a revised water level for the 1 in 100 year at the site, and will allow one of three outcomes:

- Design out flood risk - FFL set to modelled 1 in 100 year, plus climate change;
- Accept a tolerable level of risk and provide a safe refuge - FFL can be below the modelled 1 in 100 year, plus climate change, but flood depths in a 1 in 100 year event may not exceed 600mm;
- Risk not accepted - if the modelled flood level is still too high, and risks determined to be too great, then the proposed development may not proceed, and a less vulnerable use should be considered.

C.4 Less vulnerable development in Flood Zone A or B

This includes less vulnerable development in all forms, including refurbishment or infill development, and new development both in defended and undefended situations.
The Planning Guidelines allow for minor development (including refurbishment, change of use and extensions) within areas at risk of flooding with a commensurate assessment of flood risk. The presence or absence of flood defences also informs the level of flood mitigation recommended for less vulnerable developments in areas at risk of flooding. In contrast with highly vulnerable development, there is greater scope for the developer of less vulnerable uses to accept flood risks and build to a lower standard of protection. At all times however, the risks of flooding should be balanced against public and occupier safety first, and build cost savings to the developer after.

Major developments may also be located in areas with a higher likelihood of flooding, provided the risks are understood, and accepted. The desirable finished floor levels are 1 in 100 year, plus climate change, and then works through the following steps which may allow a lower finished floor level to be used:

- Defended or undefended sites - the difference between a site in a defended and undefended location is that a lower desired finished floor level is acceptable provided the defences have included a freeboard; this does not need to be included again in the FFL of a defended site. However, an allowance for climate change should be included. In an undefended site, freeboard (typically of 300mm) and climate change should both be addressed.
- The impact of climate change on water levels has not been quantified through the scheme modelling. Instead, it is recommended that a level of 600mm is adopted as the default allowance to be included when setting finished floor levels.
- Having determined the desired FFL, it may be that a lower level (as low as I in 100 year flood level) could be constructed to if the risks of climate change are accepted into the development. This acceptance should reflect emergency planning and business continuity within the development. It may reflect the design life of the development, the proposed use, the vulnerability of items to be kept in the premises, the insurability of the development, the occupants and users, emergency plan and inclusion of flood resilience and recovery measures.
- In a defended site, further acceptance of flood risks may allow the FFL to be set below the 1 in 100 year level, but should not allow depths of flooding greater than 600mm. This step will require a detailed assessment of risks at the site specific scale, including residual risk, flood depths and inundation times.
- It should be noted that in a defended site, compensatory storage is not required. In an undefended site, compensatory storage should be provided to the 1 in 100 year level.

Appendix D

Greater Dublin Strategic Drainage Strategy

D. Greater Dublin Strategic Drainage Strategy

D.1 The GDSDS Criteria

The following table comes from the GDSDS New Development Policy Document[21] and summarises the criteria for the design of drainage systems. There is a considerable library of guidance on all aspects of drainage design associated with the GDSDS, and it is recommended that the study and subsequent updates are reviewed in conjunction with any design works.

The GDSDS notes that, in principle these criteria should be applied to all sites, but certain practical aspects (throttle sizes for achieving low flow rates) mean that these criteria can be relaxed in certain instances.

[21] Greater Dublin Strategic Drainage Study, March 2005, Regional Drainage Policies - Technical Documents Volume 2: New Development

Criteria	Sub-criteria	Return Period (Years)	Design Objective
Criterion 1: River water quality protection	1.1	<1	Interception storage of at least 5mm of rainfall where runoff to the receiving water can be prevented
	1.2	<1	Where initial runoff from at least 5mm of rainfall cannot be intercepted, treatment of runoff (treatment volume) is required. Retention pond (if used) to have minimum pool volume equivalent to 15mm rainfall.
Criterion 2: River regime protection	2.1	1	Discharge rate equal to 1 in 1 year greenfield site peak runoff rate or 2l/s/ha, whichever is the greater. Site critical duration storm to be used to assess attenuation storage volume.
	2.2	100	Discharge rate equal to 1 in 100 year greenfield site peak runoff rate. Site critical duration storm to be used to assess attenuation storage volume.
Criterion 3: Level of service (flooding) for the site	3.1	30	No flooding on site except where specifically planned flooding is approved. Summer design storm of minimum 30 minutes.
	3.2	100	Planned flood routing and temporary flood storage accommodated on site for short high intensity storms. Site critical duration events.
	3.3	100	No internal property flooding. Floor levels at least 500mm above maximum river level and adjacent on-site storage retention.
	3.4	100	No flooding of adjacent urban areas. Overland flooding managed within the development.
Criterion 4: River flood protection (criterion 4.1, or 4.2 or 4.3 to be applied)	4.1	100	"Long-term" floodwater accommodated on site for development runoff volume which is in excess of the greenfield runoff volume. Long-term flood storage drained by infiltration on a designated flooding area brought into operation by extreme events only 100 year, 6 hour duration storm to be used for assessment of the additional volume of runoff.
	4.2	100	Infiltration storage provided equal in volume to "long term" storage. Usually designed to operate for all events. 100year, 6 hour duration storm to be used for assessment of the additional volume of runoff
	4.3	100	Maximum discharge rate of QBAR or 2 l/s/ha, whichever is the greater, for all attenuation storage separate "long term" storage cannot be provided.

Appendix E

Flood Zone Maps

Clonmel and Environs Flood Zones