Appendix 14B: Flood Risk Assessment

Client:

Irish Water

Project:

Castletroy Wastewater Treatment Plant

Report:

Flood Risk Assessment

BARRY & PARTNERS

Table of Contents

SECTION 1: INTRODUCTION 1
1.1 General 1
1.2 Proposed Development 1
SECTION 2: FLOOD RISK ASSESSMENT METHODOLOGY 3
2.1 Methodology 3
2.2 Data Collection 6
SECTION 3: EXISTING HYDROLOGICAL ENVIRONMENT 7
3.1 Salient Hydrological Features 7
3.2 Existing Geology and Hydrogeology of the Area 7
3.3 Flood Regime of the Area 9
3.4 Existing Flood Studies 10
SECTION 4: FLOOD RISK ASSESSMENT 14
4.1 Introduction 14
4.2 Flood Risk Identification 14
4.3 Flood Risk Assessment 15
SECTION 5: CONCLUSIONS AND RECOMMENDATIONS 23
5.1 Summary of Results 23
5.2 Conclusions and Recommendations 23

APPENDIX 1: SITE LAYOUT DRAWING

APPENDIX 2: OPW SUMMARY LOCAL AREA REPORTS

APPENDIX 3: CFRAMS MAPS

Table of Figures

Figure 1: Location of Proposed Development (Source: Google Maps, annotation by J.B. Barry & Partners) 1
Figure 3: Sequential approach principles in flood risk 3
Figure 4: Sequential approach mechanism in the planning process 4
Figure 5: Hydrological Features of the Area (Source: EPA, annotation by J.B. Barry & Partners) 7
Figure 6: GSI Subsoil Mapping (Source: www.gsi.ie, annotation by J.B. Barry & Partners) 8
Figure 7: GSI Aquifer Vulnerability Mapping (Source: www.gsi.ie, annotation by J.B. Barry & Partners) 9
Figure 8: Location of historic flooding in the vicinity of the proposed site (*Source: www.floodmaps.ie; annotation by J.B. Barry & Partners*) 10
Figure 9: Extract CFRAMS Flood Extent Map 11
Figure 10: Extract of CFRAMS 0.1% AEP Flood Depth Map 11
Figure 11: Extract of CFRAMS 1% AEP Flood Depth Map 12
Figure 12: Limerick City and Suburbs (in Limerick), including Mungret and Annacotty -Flood Map 13
Figure 13: Matrix of Vulnerability versus Flood Zone to illustrate appropriate development 15
Figure 14: Box 5.1 extract from the FRM Guidelines 16
Figure 15: Flood Extent Map with proposed infrastructure 19
Figure 16: Flood Depth Map (1% AEP) with proposed infrastructure 20

SECTION 1: Introduction

1.1 General

J. B. Barry and Partners Limited was commissioned by Irish Water to undertake a site-specific Flood Risk Assessment (FRA) at Castletroy WwTP, Co. Limerick for a planning application for a proposed upgrade of the existing WwTP. The Flood Risk Assessment will inform a Planning Application for the upgrade of an existing wastewater treatment plant. The aim of the FRA is to identify, quantify and communicate to decision makers and other stakeholders the risk of flooding associated with the proposed development.

The FRA has been carried out in accordance with 'The Planning System and Flood Risk Management Guidelines' (hereafter referred to as the FRM Guidelines) published in November 2009 jointly by the then Department of the Environment, Heritage and Local Government, DEHLG, (now the Department of the Environment, Community and Local Government, DECLG) and the Office of Public Works (OPW).

The development site is located at the existing Castletroy WwTP site adjacent to the Lower River Shannon and beside the University of Limerick campus, approximately 3km east of Limerick City as shown in Figure 1 below.

Figure 1: Location of Proposed Development (Source: Google Maps, annotation by J.B. Barry & Partners)

1.2 Proposed Development

The proposed development shall cater for future population growth and industrial development in the area, in line with population projections for Limerick as set out in the National Planning Framework (NPF) Implementation Roadmap and the Southern Region Regional Economic Spatial Strategy (RSES). It will ensure the WwTP continues to comply with requirements of the EPA Wastewater Discharge License, Urban Wastewater Treatment Regulations (UWWTR) and Irish Water Guidelines, while providing appropriate future treatment capacity and stormwater storage for the agglomeration.

The initial upgrade works will cater for the 10-year growth projections up to 77,500 PE including a future IDA load of 5,500 PE. There will also be provision made in the infrastructural development of the plant (tank sizing and pipework) for the 25-year growth projections of 81,100PE. Although the infrastructure will be in place, a planning review will be required before any uplift above 77,500PE can be instated.

The upgrade design includes provision for 20% Headroom allowance, in line with Irish Water guidelines for large urban settlements. It also includes installation of a new Stormwater storage tank that will significantly reduce the annual rate of spills to the Lower River Shannon and make the WwTP compliant with the criteria outlined in the DoEHLG "Procedures and Criteria for Storm Water Overflows, 1995".

The complete site layout plan drawing is provided in Appendix 1 of the report and the main elements of the proposed development are listed as follows:

- Upgrade to the inlet works (screens and pumps);
- A second grit trap will be constructed adjacent to the existing inlet works to provide redundancy and improve performance of the downstream processes.
- Construction of a 4,500m3 capacity storm tank and storm water return pumping station. This will reduce the frequency and volume of storm overflow events and stored stormwater can be returned to the treatment process when rainfall levels subside. The volume includes a 20% allowance for increased flows as a result of climate change.
- Construction of a new forward feed pumping station.
- Construction of a splitter chamber upstream of the proposed primary treatment system.
- Construction of a primary treatment building which will contain filtration units, control panels and equipment.
- Construction of a primary sludge holding tank.
- Construction of a scum pumping station.
- Upgrade of the secondary treatment process with IFAS technology. The existing aeration tank structure will be retained for the internal upgrade.
- Installation of 2 no. chemical bulk storage tanks for phosphorous removal.
- Construction of a new Picket Fence Thickener (PFT).
- Modification to the internal layout of the existing Sludge Dewatering Building to accommodate upgraded dewatering equipment.
- Construction of a flood event pumping station to allow final effluent discharge during high river levels.
- Construction of plinths to support skips which will be used to store dewatered sludge prior to removal off site.
- Construction of storage tank for ground water abstracted on-site from an existing well. Borehole water will be used to supply wash water for treatment and cleaning processes.
- Construction of interconnecting pipework.

SECTION 2: Flood Risk Assessment Methodology

2.1 Methodology

The methodology used for the flood risk assessment for the proposed development is based on 'The Planning System and Flood Risk Management, Guidelines for Planning Authorities' (2009)'. The FRM Guidelines require the planning system at national, regional and local levels to:

- Avoid development in areas at risk of flooding, particularly floodplains, unless there are proven wider sustainability grounds that justify appropriate development;
- Adopt a sequential approach to flood risk management when assessing the location for new development based on avoidance, reduction and then mitigation of flood risk; and
- Incorporate flood risk assessment into the process of making decisions on planning applications and planning appeals.

The sequential approach (see Figure 2 of the FRM Guidelines below) in flood risk management requires the following three steps to identify the necessity for the justification test for a development:

- Step 1: Identification of the Flood Zone at the proposed development site (Section 2.23 of the FRM Guidelines);
- Step 2: Identification of the vulnerability of the type of the proposed development (Table 3.1 of the FRM Guidelines); and
- Step 3: Using the matrix of vulnerability versus Flood Zone (Table 3.2 of the FRM Guidelines), identify the necessity for the justification test for the proposed development.

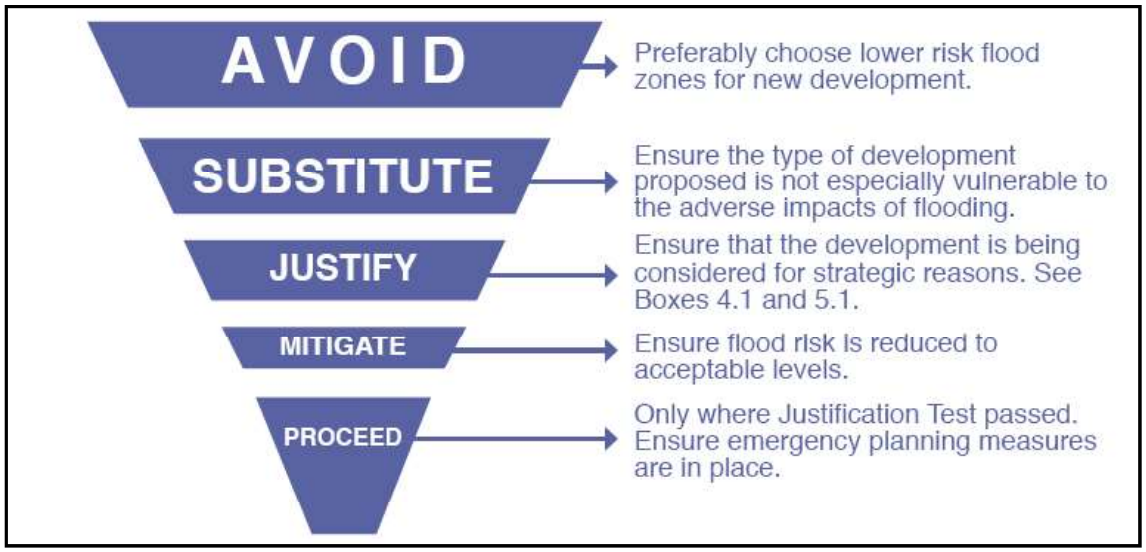


Figure 2: Sequential approach principles in flood risk

While Figure 2 of The FRM Guidelines sets out the broad philosophy underpinning the sequential approach in the flood risk management, Figure 3 of the Guidelines (shown below) describes the mechanism of the sequential approach for use in the planning process.

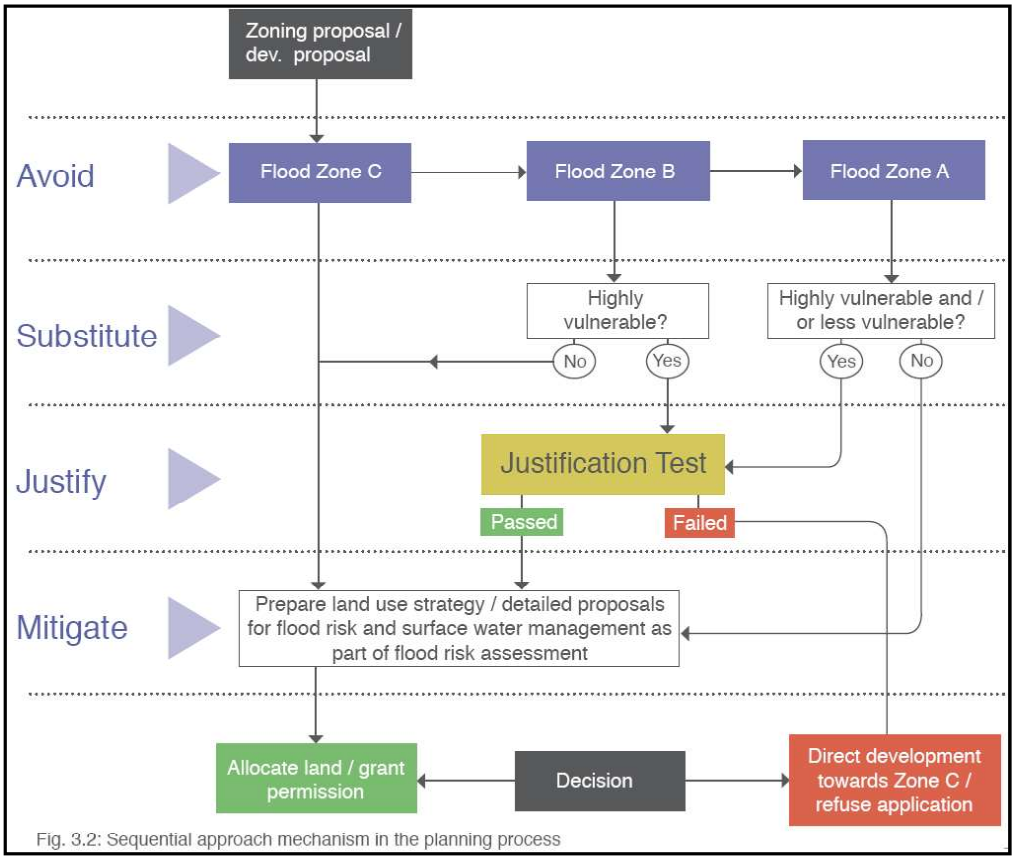


Figure 3: Sequential approach mechanism in the planning process

According to the FRM Guidelines, Flood Zones are graphical areas within which the likelihood of flooding is in a particular range. They are a key tool in flood risk management within the planning process as well as in flood warning and emergency planning. There are three Flood Zones, namely,

- **Flood Zone A –** where the probability of flooding from rivers and the sea is highest (greater than 1% AEP or 1 in 100 year for river flooding or 0.5% or 1 in 200 for coastal flooding);
- **Flood Zone B –** where the probability of flooding from rivers and the sea is moderate (between 0.1% AEP or 1 in 1000 year and 1% AEP or 1 in 100 year for river flooding and between 0.1% AEP or 1 in 1000 year and 0.5% AEP or 1 in 200 year for coastal flooding); and
- **Flood Zone C –** where the probability of flooding from rivers and the sea is low (less than 0.1% AEP or 1 in 1000 for both river and coastal flooding).

Flood Zones A, B and C are based on the current assessment of the 1% AEP and the 0.1% AEP fluvial events and the 0.5% AEP and 0.1% AEP tidal events, without the inclusion of climate change factors. Table 3.1 of the FRM Guidelines (shown below) shows the classification of the vulnerability to flooding of different types of development.

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

*Uses not listed here should be considered on their own merits

Table 3.1 Classification of vulnerability of different types of development

Table 3.2 of the FRM Guidelines (shown below) identifies the types of development that would be appropriate for each Flood Zone and those that would be required to meet the Justification Test. Since water and sewage treatment are classified as 'Highly vulnerable development' the section highlighted in Table 3.2 presents the required actions for each flood zone.

	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 3.2: Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test.

The FRM Guidelines (Chapter 2) outlines the following three stages of flood risk assessment:

Stage 1: Flood risk identification – to identify whether there may be any flooding or surface water management issues relating to the proposed development site that may warrant further investigations.

Stage 2: Initial flood risk assessment – to confirm sources of flooding that may affect the proposed development site, to appraise the adequacy of existing information and to determine what surveys and modelling approach is appropriate to match the spatial resolution required and complexity of the flood risk issues. This stage involves the review of existing studies and hydraulic modelling to assess flood risk and to assist with the development of FRM measures.

Stage 3: Detailed flood risk assessment – to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development, of its potential impacts on flood risk elsewhere and of the effectiveness of any proposed mitigation measures. This will typically involve use of an existing or construction of a hydraulic model across a wide enough area to appreciate the catchment wide impacts and hydrological process involved.

2.2 Data Collection

Data required for the flood risk assessment was obtained from various sources, as described below.

- The historic data was obtained from the National Flood Hazard Mapping website www.floodmaps.ie
- The Subsoil and Aquifer vulnerability data was obtained from the Geological Survey of Ireland website www.gsi.ie
- CFRAM Flood Maps were obtained from the OPW website www.floodinfo.ie
- Castletroy Local Area Plan 2019-2025

SECTION 3: Existing Hydrological Environment

3.1 Salient Hydrological Features

The main hydrological feature of the area is the Lower River Shannon and the River Blackwater, a tributary to the Lower River Shannon. The Lower River Shannon flows in a westerly direction and forms the northern boundary of the site. The confluence with the river Blackwater is immediately downstream of the site. A portion of the Lower River Shannon is diverted through the University of Limerick campus and re-joins the main channel immediately upstream of the development site. Figure 4 below illustrates the main hydrological features associated with the site.

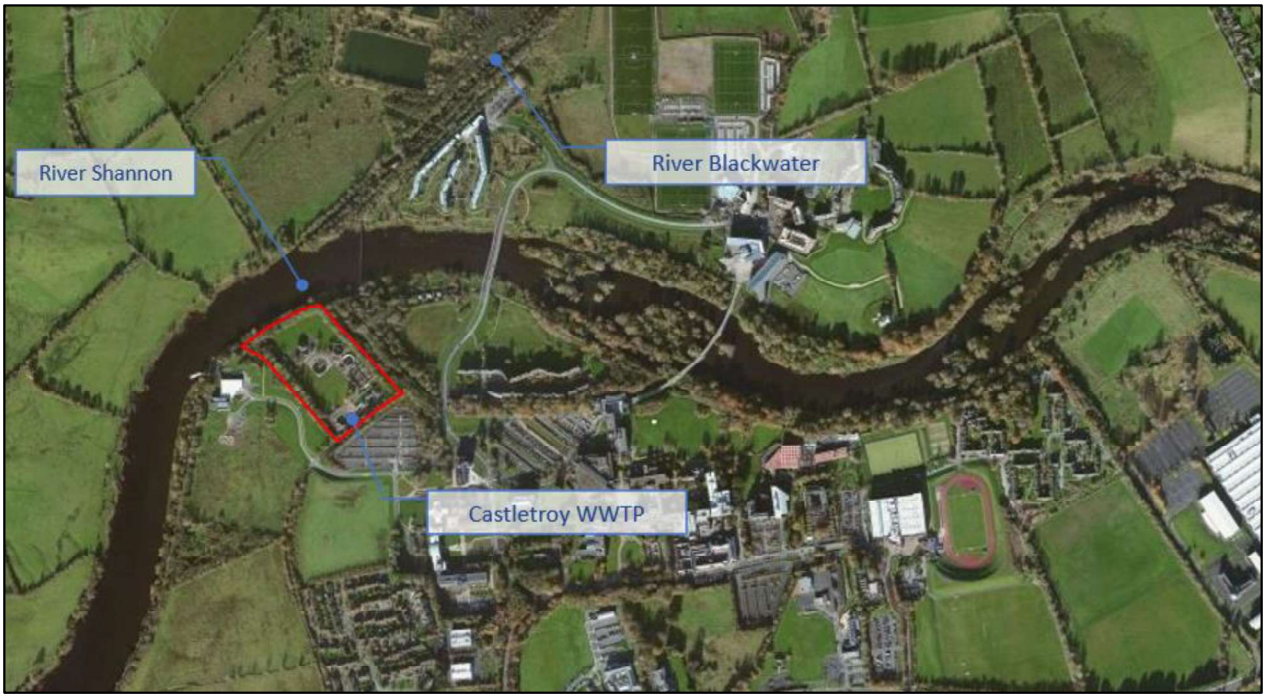


Figure 4: Hydrological Features of the Area (Source: EPA, annotation by J.B. Barry & Partners)

3.2 Existing Geology and Hydrogeology of the Area

The Geological Survey of Ireland (GSI) website provides information on their public online mapping service at www.gsi.ie on subsoil type and aquifer vulnerability. The maps presented in Figure 5 and Figure 6 depict the subsoil type and aquifer vulnerability for the existing/proposed development site. The GSI subsoil mapping Figure 5 indicates that made ground is the predominant ground condition within the environs of the development site with traces of alluvium to the north west of the site due to the proximity to the River Shannon.

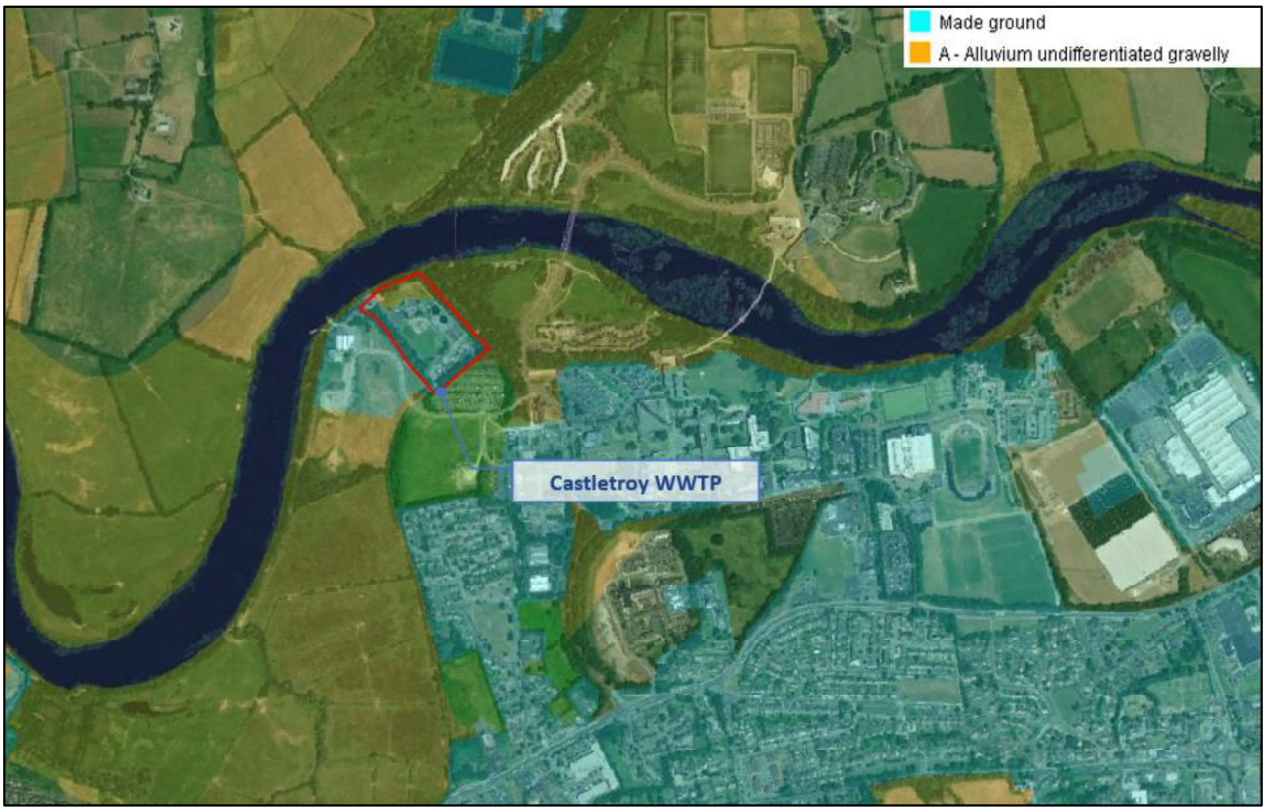


Figure 5: GSI Subsoil Mapping (Source: www.gsi.ie, annotation by J.B. Barry & Partners)

Furthermore, the interactive web-mapping site classifies the aquifer vulnerability in this region as having a low vulnerability rating (Figure 6). The GSI state that "Vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities". The GSI further describes that the vulnerability of groundwater depends on:

(i) The time of travel of infiltrating water (and contaminants);

(ii) The relative quantity of contaminants that can reach the groundwater; and

(iii) The contaminant attenuation capacity of the geological materials through which the water and contaminants infiltrate

Firstly, the vulnerability rating for an area indicates, and is a measure of, the likelihood of contamination. Secondly, the vulnerability map helps to ensure that a groundwater protection scheme is not necessarily restrictive on human economic activity. Thirdly, the vulnerability map help in the choice of preventative measures and enables developments, which have a significant potential to contaminate, to be located in areas of lower vulnerability.

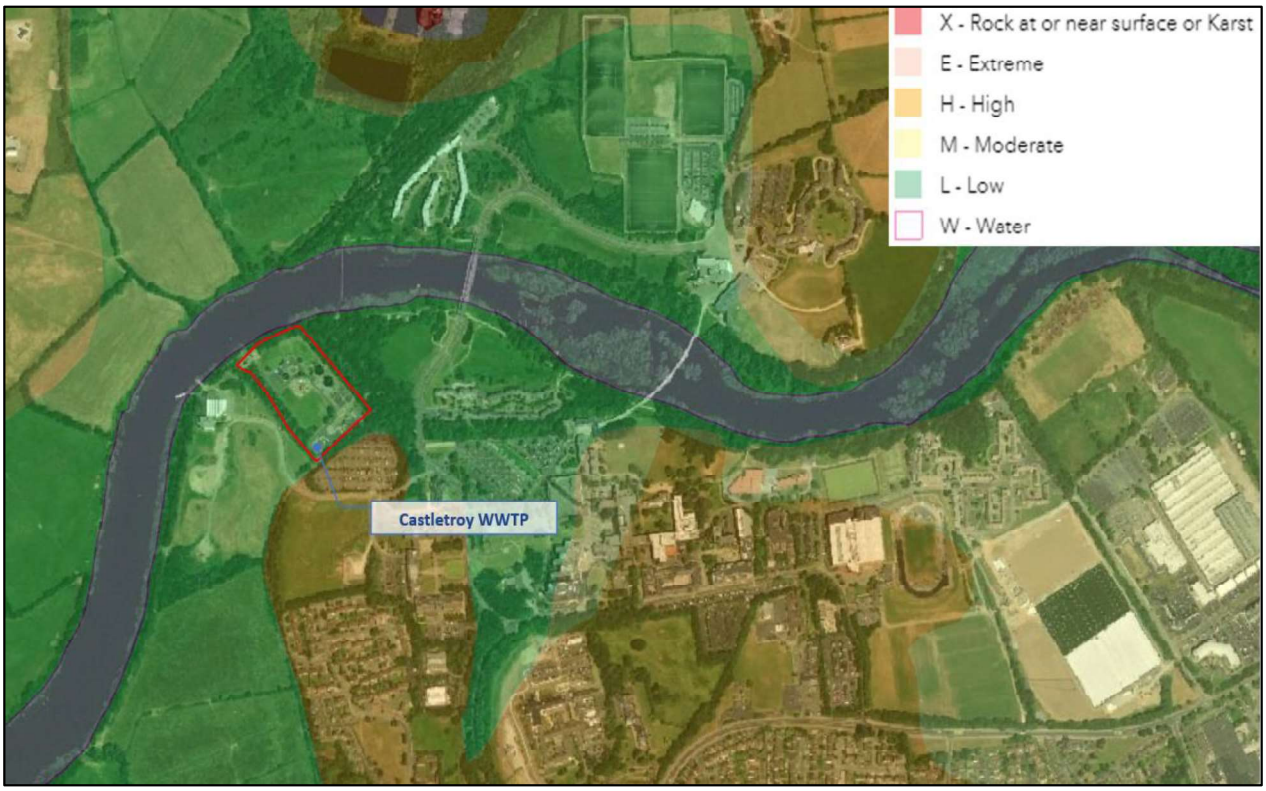


Figure 6: GSI Aquifer Vulnerability Mapping (Source: www.gsi.ie, annotation by J.B. Barry & Partners)

3.3 Flood Regime of the Area

The National Flood Hazard Mapping Website www.floodmaps.ie shows records of historic floods occurring within the vicinity of the proposed development site (Figure 7) and shows that the site has flooded in the past.

The site was flooded severely in November 2009 due to the Lower River Shannon bursting its banks following unprecedented torrential rainfall. A report undertaken by Limerick County Council which investigates the causes and effects of this flood is included in Appendix 2. The report states "*The WwTP experienced flooding, which was very close to making the plant non-operational. A huge effort was undertaken in preventing the plant from flooding. High electricity cost for running of the pump was incurred as a result.*"

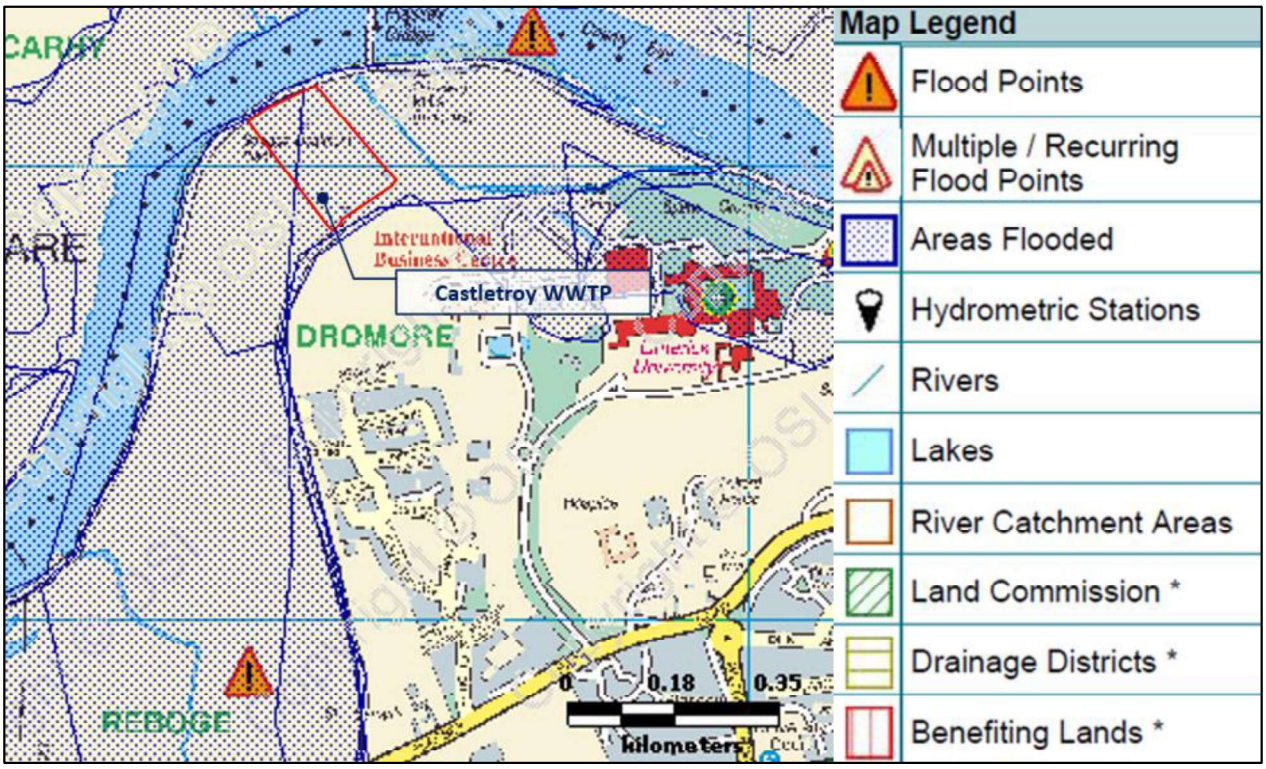


Figure 7: Location of historic flooding in the vicinity of the proposed site (*Source: www.floodmaps.ie; annotation by J.B. Barry & Partners*)

3.4 Existing Flood Studies

3.4.1 CFRAM Study

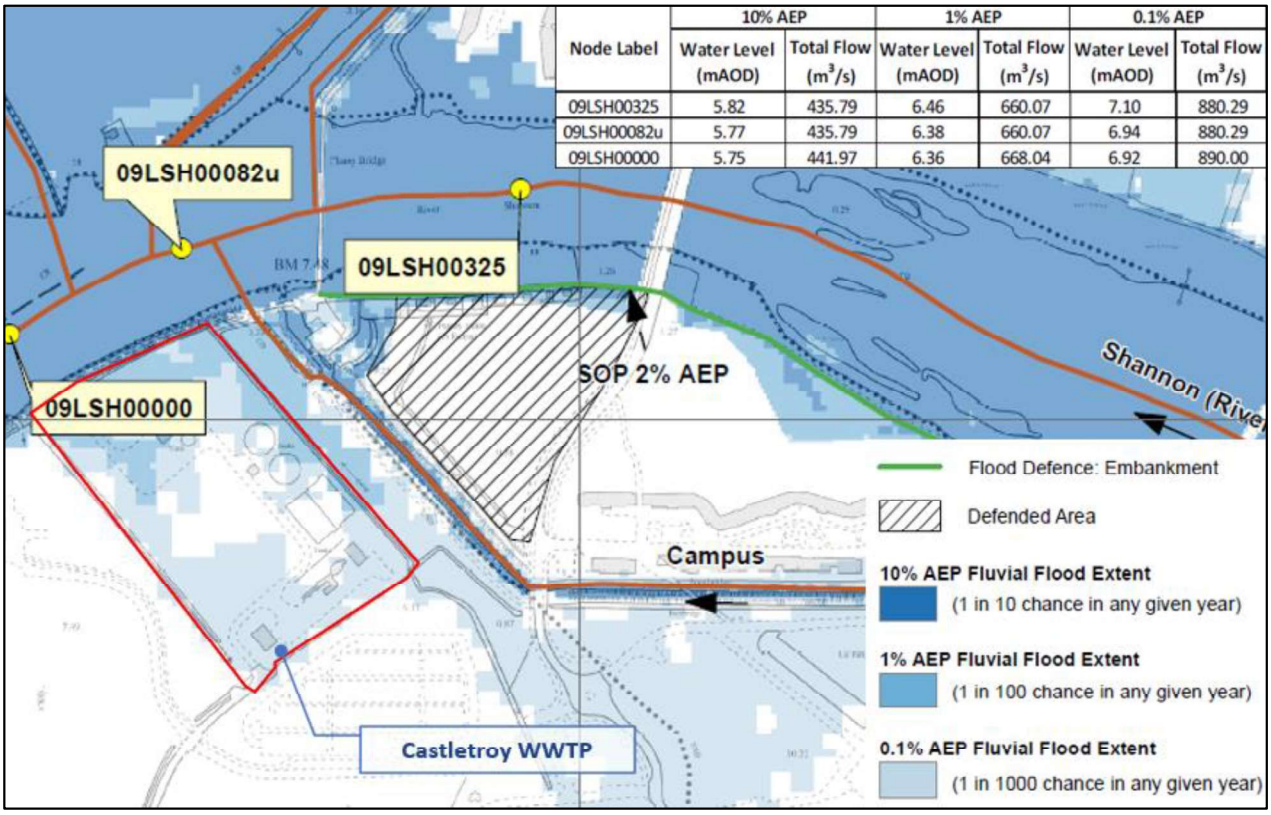
The objective of the Preliminary Flood Risk Assessment (PFRA) was to identify areas where the risk associated with flooding might be significant. These areas were referred to as "Areas for Further Assessment" (AFA's) and required a more detailed assessment to assess the extent and degree of flood risk more accurately. The detailed assessments which focused on AFA's were undertaken through the CFRAM Study. The Castletroy area was deemed an AFA and therefore detailed flood maps of the area were generated through the CFRAM Study.

Figure 8 below is an extract from the Fluvial Flood Extent Map concerning the proposed development site. This map is included in Appendix 3. Observation of the flood extent map extract indicates that portions of the proposed development site lie within the 0.1% and 1% AEP flood extent of the Lower River Shannon and hence lies within **Flood Zone A** where the risk of flooding is highest.

This extract also provides the flood level of the Lower River Shannon in the vicinity of the proposed development site during the 1% and 0.1% AEP fluvial events. There are 2 nodes to the north of the site which are equidistant to the site boundary and the flood levels at the nodes are presented in Table 1 below. It is reasonable to conclude that the flood levels on the site can be calculated by interpolating between these 2 nodes in a pro rata basis.

Table 1: Fluvial Flood Levels at the Site

Node	1% AEP Flood Level	0.1% AEP Flood Level
09LSH00000	+6.36 mOD	+6.92 mOD
09LSH0082u	+6.38 mOD	+6.94 mOD
Castletroy WwTP	+6.37 mOD	+6.93 mOD



Node Label	10% AEP		1% AEP		0.1% AEP	
	Water Level (mAOD)	Total Flow (m^3/s)	Water Level (mAOD)	Total Flow (m^3/s)	Water Level (mAOD)	Total Flow (m^3/s)
09LSH00325	5.82	435.79	6.46	660.07	7.10	880.29
09LSH00082u	5.77	435.79	6.38	660.07	6.94	880.29
09LSH00000	5.75	441.97	6.36	668.04	6.92	890.00

Figure 8: Extract CFRAMS Flood Extent Map

The CFRAM Study also generated Flood Depth maps demonstrating the depth of flood waters during various flood extents. Figure 9 below shows an extract of the 0.1% AEP flood depth map in the vicinity of the site. Observation of this indicates that the depth of water on site during the 0.1% AEP flood ranges from 0m – 1m. The full map is included in Appendix 3.

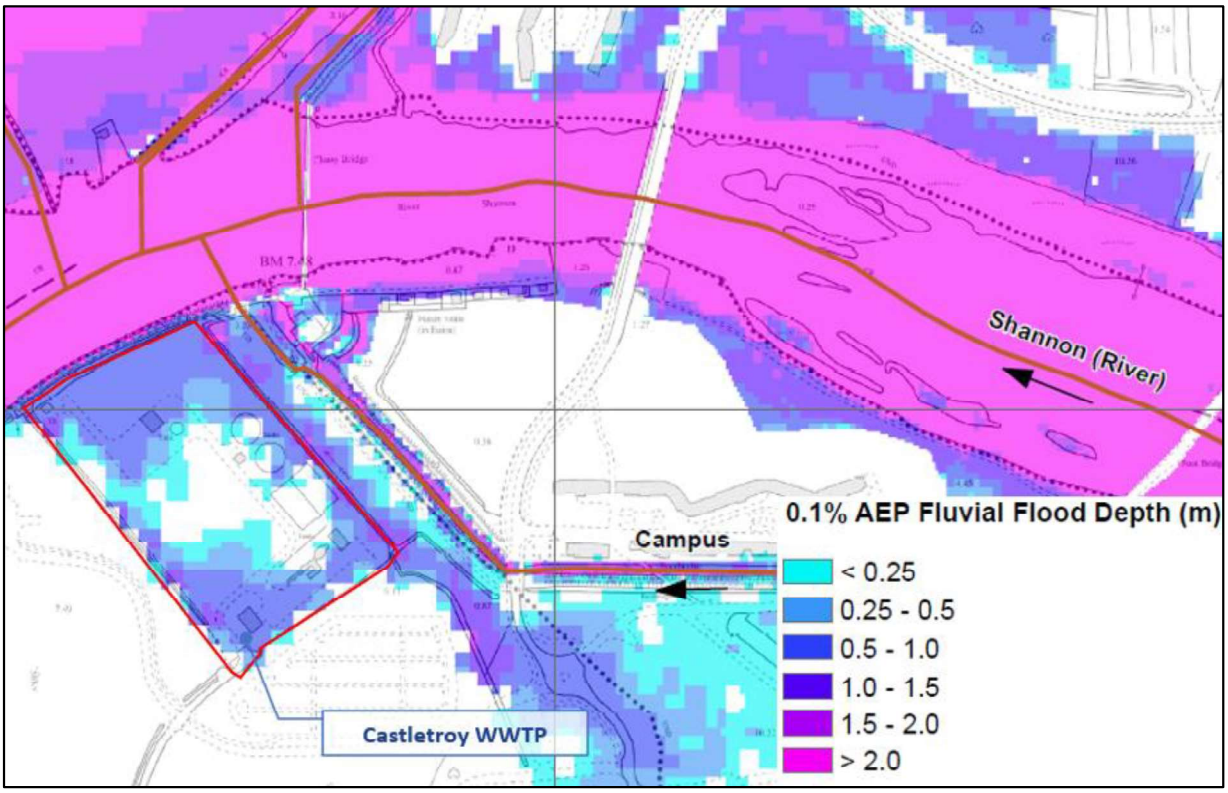


Figure 9: Extract of CFRAMS 0.1% AEP Flood Depth Map

Similarly, Figure 10 below shows an extract of the 1% AEP flood depth map in the vicinity of the site. Observation of this indicates that the depth of water on site during the 1% AEP flood ranges from 0m – 0.25m. The full map is again included in Appendix 3.

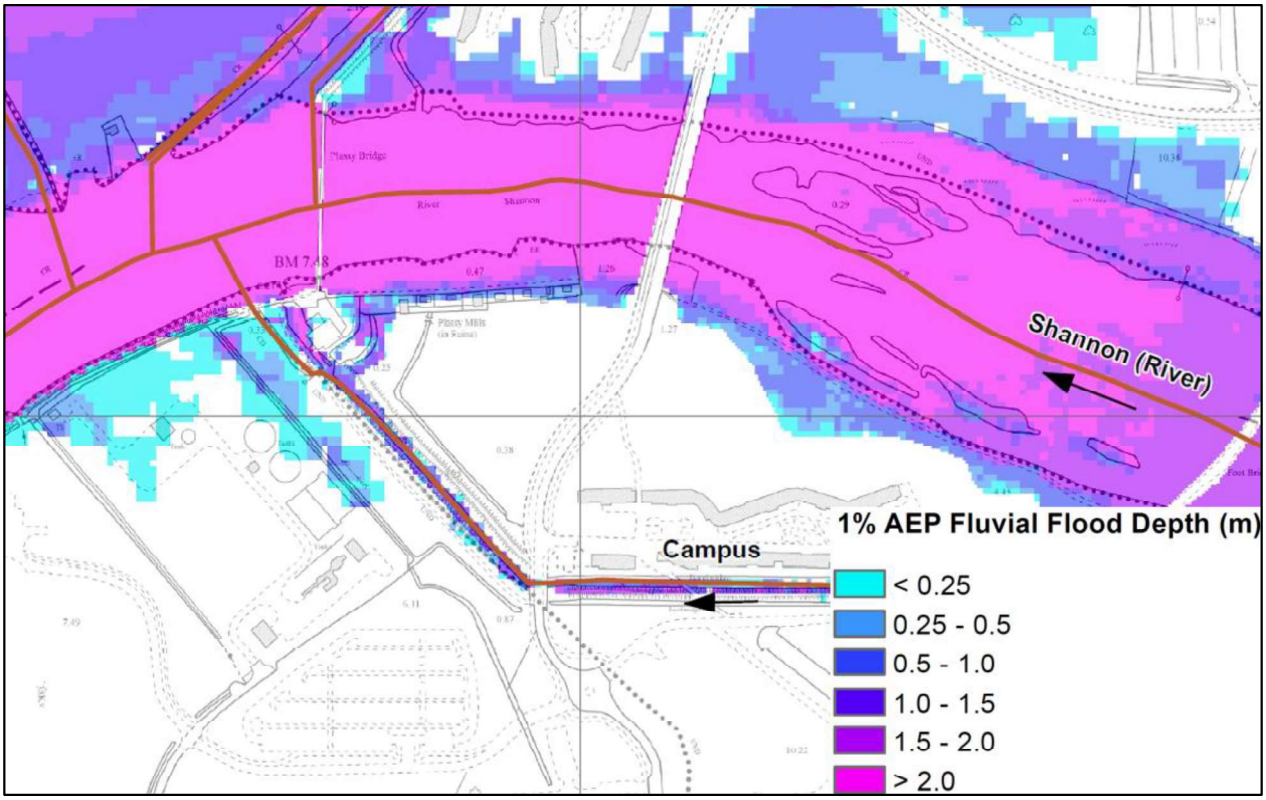


Figure 10: Extract of CFRAMS 1% AEP Flood Depth Map

3.4.2 National Indicative Fluvial Maps

The National Indicative Fluvial Flood maps are 'predictive' flood maps showing indicative areas predicted to be inundated during a theoretical fluvial flood event with an estimated probability of occurrence. The data layer is available on www.floodmaps.ie.

According to the layer information, the maps may be used in the Stage I Flood Risk Assessment (Flood Risk Identification) to identify areas where further assessment would be required if development is being considered within or adjacent to the flood extents shown on the maps. Similarly, the maps may be used to identify whether flood risk might be a relevant issue when considering a planning application, or when discussing a potential application at pre-planning stage.

Indicative fluvial maps are not available for the area of interest.

3.4.3 Limerick Development Plan 2022-2028

The Limerick Development Plan 2022-2028 came into effect on 29th July 2022 and aims to form a coherent development strategy to 2028 and beyond. The approach to flooding, flood risk management and water management is set out in 'Chapter 9 Climate Action, Flood Risk and Transition to Low Carbon Economy' of the Plan. Flood maps are included in 'Volume 2 Settlements' of the Plan and the Strategic Flood Risk Assessment is included in 'Volume 4 Environmental Reports'.

Figure 11 is taken from 'Volume 2a Settlements' and shows the flood map for Limerick City and suburbs. Flood Zone A and B are shown on the map as well as land zoning.

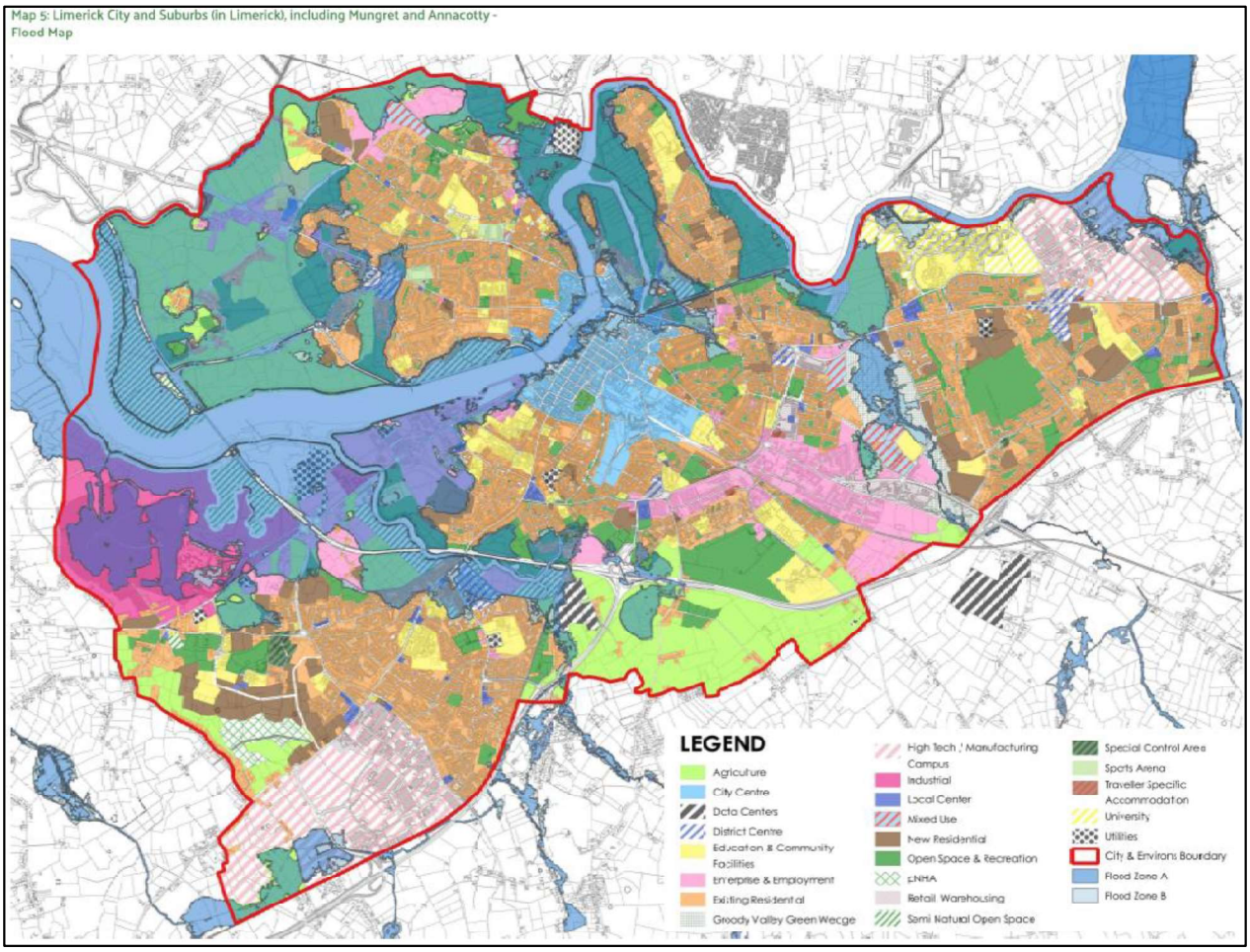


Figure 11: Limerick City and Suburbs (in Limerick), including Mungret and Annacotty -Flood Map

Strategic Flood Risk Assessment

In the preparation of the Plan, in accordance with The Planning System and Flood Risk Management, Guidelines for Planning Authorities, a Strategic Flood Risk Assessment (SFRA) was prepared by Limerick City and County Council to assess flood risk within the plan area. The SFRA is set out in Volume 4 of the Plan. The precautionary approach has largely been employed to land use zoning to avoid directing development towards areas at risk of flooding.

Areas identified as being at risk of flooding, which were put forward for land use zoning, were subject to assessment through a justification test, to determine its suitability for inclusion and have only been considered, where they were determined to be within or adjoining the core of the City Centre. No Justification Test for development of Castletroy WwTP was included in the SFRA due to the existing nature of the site.

The site is shown in Figure 8 to be partially located within Flood Zone A and Flood Zone B. The remainder of the site within located in Flood Zone C.

SECTION 4: Flood Risk Assessment

4.1 Introduction

As outlined in Section 2 of this report the FRM guidelines identifies three stages of Flood Risk Assessment namely;

- Stage 1: Flood Risk Identification
- Stage 2: Initial Flood Risk Assessment
- Stage 3: Detailed Flood Risk Assessment

4.2 Flood Risk Identification

According to the FRM Guidelines, flood risk identification is the process for deciding whether a plan or project requires further investigation. This is a desk based exercise based on existing information. All the existing information is described in Section 3 and the identification of flood risk from each of the five sources of flooding (coastal, fluvial (river), groundwater, pluvial (rainfall) and from artificial drainage systems) is considered.

Coastal Flood Risk

The development site is not located beside the coast and the Lower River Shannon is not tidally influenced at this location, therefore the proposed development site lies outside of the 0.1% AEP coastal flood event and hence is located within **Flood Zone C** for Coastal flood risk, where the risk of flooding is low.

Fluvial Flood Risk

The CFRAMS maps in Appendix 3 all indicate that a portion of the site lies within the 1% AEP fluvial flood extent. Therefore, the proposed development site lies within Fluvial **Flood Zone A –** high flood risk.

Groundwater Flood Risk

The aquifer vulnerability map (refer to Figure 6) classifies the site as having a low vulnerability rating which indicates a low water table and hence a low risk of groundwater related flooding. There is no historical evidence of groundwater flooding at the site and the PFRA Map indicates a low risk of groundwater related flooding. There is no indication on the maps of any springs or wells on this site.

GSI Groundwater Flooding Probability Maps do not highlight flooding in the area. There is no historical evidence of groundwater flooding at the sites. Groundwater risk is therefore not considered to be significant.

Pluvial Flood Risk

There have been no recorded instances of pluvial flooding events at the site. Pluvial flood risk is therefore not considered to be significant. Notwithstanding this, it is important to consider appropriate mitigation measures. During extreme rainfall events the application of SuDS principles will ensure surface water is managed sufficiently and sustainably discharged to the drainage network.

Artificial Drainage Systems Flood Risk

It was noted that there have been instances of surcharging at the final inspection chamber causing localised flooding on site. The existing v-notch weir at the final effluent inspection chamber does not operate correctly due to surcharging at high river level. A flood event pumping station and raising of the final effluent inspection chamber are proposed as part of the project to overcome this issue.

4.3 Flood Risk Assessment

The Flood Risk Assessment has identified that there is a flood risk to the site. Under the sequential approach identified in the FRM Guidelines a three-step approach is required to confirm the appropriateness of the development in terms of flood risk.

Step 1: Identification of the Flood Zone at the proposed development site

Using the Flood Zone criteria from the FRM Guidelines and as defined in Section 2 previously, the flood zones for each of the sites were determined.

- **Flood Zone A –** where the probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 year for river flooding or 0.5% or 1 in 200 for coastal flooding);
- **Flood Zone B –** where the probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 100 year and 1% or 1 in 1000 year for river flooding and between 0.1% or 1 in 1000 year and 0.5% or 1 in 200 year for coastal flooding); and
- **Flood Zone C –** where the probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding).

As discussed in Section 4.2 above, the proposed development site lies partially within both **Flood Zone A** and **Flood Zone B –** where risk of flooding is high and moderate respectively.

Step 2: Identification of the vulnerability of the type of the proposed development (Table 3.1 of the FRM Guidelines)

The different types of proposed infrastructure are then assigned a vulnerability classification according to the definitions in 'Table 3.1 – Classification of vulnerability of different types of development' of the FRM Guidelines.

As described in Section 1.2 above, the proposed development consists of wastewater treatment infrastructure. This is classified as 'highly vulnerable development'.

Step 3: Using the matrix of vulnerability versus Flood Zone (Table 3.2 of the FRM Guidelines), identify the necessity for the justification test for the proposed development

The proposed development site is located in Flood Zone A and Flood Zone B and is categorised as Highly Vulnerable Development. Table 3.2 of the FRM guidelines and Figure 3.2 – Sequential approach mechanism in the planning process (FRM guidelines) stipulates that a justification test is required for such a development. Figure 12 below highlights the matrix of vulnerability versus flood zone.

	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 3.2: Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test.

Figure 12: Matrix of Vulnerability versus Flood Zone to illustrate appropriate development

The proposed development is an upgrade to an existing wastewater treatment plant, the nature of which requires it to be located near a watercourse. Section 5.28 of the FRM Guidelines states that minor development, such as small extensions to houses, and most changes of use of existing buildings and or

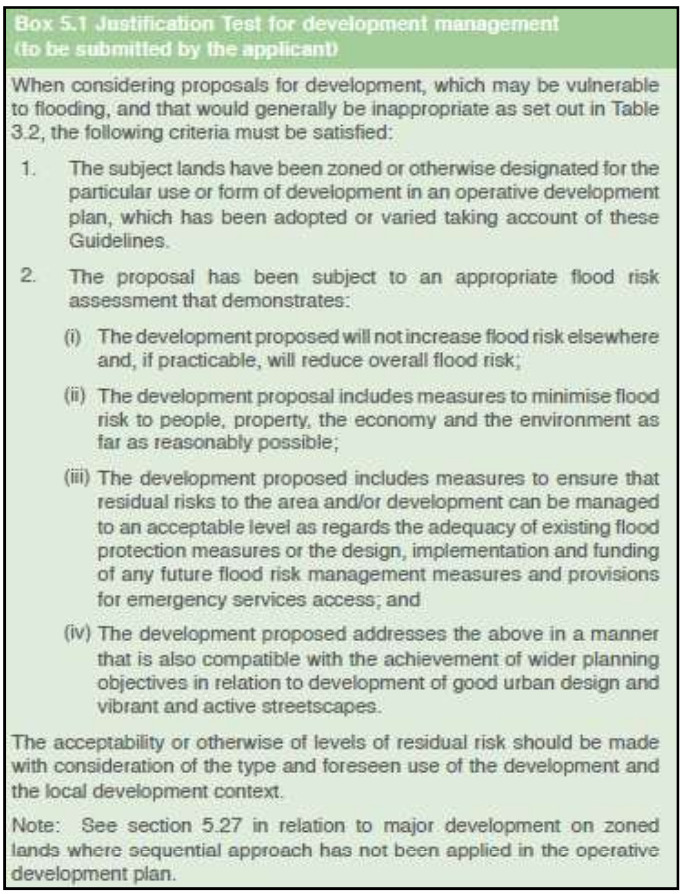
extensions and additions to existing commercial and industrial enterprises, are unlikely to raise significant flooding issues, unless they obstruct important flow paths, introduce a significant additional number of people into flood risk areas or entail the storage of hazardous substances. Since such applications concern existing developments, the sequential approach cannot be used to locate them in lower-risk areas and the Justification Test will not apply.

While some minor developments are proposed, several new structures are proposed within the site. A Justification Test has been undertaken on the overall development to assess the flood risk and demonstrate that the proposed development would not have an adverse impact on flooding within the site and that the risk to neighbouring lands will not increase.

4.3.1 Justification Test

According to the FRM Guidelines, the Justification Test has been designed to rigorously assess the appropriateness, or otherwise, of particular developments that are being considered in areas of moderate or high flood risk (Flood Zones A and B; respectively).

The FRM Guidelines outlines in Box 5.1 (shown in the five criteria, namely Criterion 1, 2(i), 2(ii), 2(iii), and 2(iv), all of which must be satisfied under the Justification Test as it applies to development management. These justification criteria have been addressed in the following paragraphs.



Box 5.1 Justification Test for development management (to be submitted by the applicant)

When considering proposals for development, which may be vulnerable to flooding, and that would generally be inappropriate as set out in Table 3.2, the following criteria must be satisfied:

1. The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines.
2. The proposal has been subject to an appropriate flood risk assessment that demonstrates:
   - (i) The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;
   - (ii) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;
   - (iii) The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access; and
   - (iv) The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.

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

Note: See section 5.27 in relation to major development on zoned lands where sequential approach has not been applied in the operative development plan.

Figure 13: Box 5.1 extract from the FRM Guidelines

Criterion 1: The subject land has been designated for this particular use

The Limerick Development Plan 2022 -2028 (LDP) came into effect on the 29th of July 2022 and is the principal planning strategy document for the development of Limerick City and County. The subject site is zoned for 'Utilities' as previously designated under the revoked Castletroy Local Area Plan 2019-2025. The relevant policies and objectives are therefore summarised below.

The strategic vision of the LDP is as follows: '*Limerick – A Green City Region on the Waterfront - By 2030, Limerick will become a green City region on the Shannon Estuary connected through people and places. This will be achieved through engagement, innovation and resilient urban development and self-sustaining rural communities*'.

This is underpinned by 10 interlinked strategic objectives. Strategic Objective 1 sets out to: "*Grow Limerick's economy and create opportunity through maximising the potential for development through the promotion and enhancement of the competitive advantages of Limerick, including its strategic location, connectivity and accessibility to international markets, a skilled workforce and a high quality of life...*".

Alongside this, Strategic Objective 7 aims to: "*Protect, enhance and ensure the sustainable use of Limerick's key infrastructure, through the provision of support to utility providers including water supplies and wastewater treatment facilities, energy supply including renewables, broadband and transportation. This plan will also foster the linkages to transition from linear model to a circular model which keeps resources in use for as long as possible*".

Objective IN 06 Water Services states that it is an objective of the Council to:

a) Support Irish Water in the provision of water and wastewater infrastructure and services in accordance with the Service Level Agreement, until such time as the Agreement is terminated.

b) Collaborate with Irish Water in the protection of water supply sources to avoid water quality deterioration and reduce the level of treatment required in the production of drinking water, in accordance with Article 7(2) of the WFD. Protection and restoration of drinking water at the source can have co-benefits for biodiversity and climate change.

c) Liaise with Irish Water during the lifetime of the Plan to secure investment in the pro-vision, extension and upgrading of the piped water distribution network and wastewater pipe network across Limerick City and County, to serve existing population and future population growth and sustain economic growth, in accordance with the requirements of the Core and Settlement Strategies.

e) Ensure that development proposals connecting to the public water and/or wastewater networks, now or in the future comply with Irish Water Standard Details and Codes of Practice. Where relevant ensure developments comply with the EPA Code of Practice for Domestic Waste Water Treatment Systems 2021.

Section 8.5.3 of the LDP notes that:

Irish Water's current wastewater treatment capacity register for County Limerick dated March 2022, states that there is capacity available in 41 no. of the 53 no. waste water treatment plants (WwTPs). These include Bunlicky and Castletroy WwTPs, which serve the Limerick City Metropolitan Municipal District. These WwTPs require some upgrading and it is envisaged by Irish Water that with the completion of these upgrades, there will be sufficient spare capacity to accommodate the projected growth in Limerick City and Suburbs (in Limerick), Mungret and Annacotty as set out in the RSES and the Core Strategy, over the lifetime of the Plan, subject to planning and other approvals.

Objective IN O9 Public Waste Water states that it is an objective of the Council to:

a) Ensure adequate and appropriate wastewater infrastructure is available to cater for existing and proposed development, in collaboration with Irish Water, to avoid any deterioration in the quality of receiving waters and to ensure that discharge meets the requirements of the Water Framework Directive.

Chapter 12 of the LDP sets out the land use zoning strategy. The objective in relation to the 'Utilities' zoning that pertains to the subject site is to:

'To provide for the infrastructural needs of transport and other utility providers'.

The stated purpose of this zoning *'…provides for and preserves land for the provision of services such as electricity and gas networks, telecommunications, the treatment of water and wastewater etc'.*

At a local level, until 29th of July 2022, the future planning of the Castletroy area was governed by the provisions of the Castletroy Local Area Plan 2019-2025. However, with the adoption of the LDP the Local Area Plan (LAP) has now lapsed. The LAP, however, does note generally that the provision of adequate water supply and wastewater treatment utilities is crucial to the continued expansion of Castletroy.

The Clare County Development Plan 2017-2023, as varied and extended, sets out an overall strategy for the proper planning and sustainable development of the functional area of Clare County Council over its life. The vision for the area is shaped by key defined goals which includes Goal VII – to support *"strong economic growth and a high quality of life for all residents through the provision of efficient and robust physical infrastructure whilst having regard to environmental responsibilities and complying with European and National legislation".*

The proposed development is located within the site boundary of an operational wastewater treatment plant. It is considered that development of the wastewater treatment plant to provide appropriate wastewater infrastructure fulfils Criterion 1 of the Justification Test.

Criterion 2: The proposal has been subject to an appropriate flood risk assessment

To satisfy the four sub-criteria (namely 2(i), 2(ii), 2(iii), 2(iv)) under this criterion, as set out in Box 5.1 of the FRM Guidelines, a detailed flood risk assessment has been undertaken.

A detailed and appropriate flood risk assessment has been undertaken under the four sub-criteria of Criterion 2 of the Justification Test, as described below:

- Sub-criterion 2 (i) – Detailed flood risk assessment
- Sub-criterion 2 (ii) – Flood risk mitigation measures
- Sub-criterion 2 (iii) – Residual risks
- Sub-criterion 2 (iv) – Wider planning objectives

Each sub criterion is addressed in the following sections.

Sub Criterion 2(i) – Detailed Flood Risk Assessment

As mentioned above, a portion of the proposed development lies within the 1% and 0.1% AEP floodplain of the River Shannon. Development on a floodplain has the potential to increase flood risk elsewhere by:

- Increasing the rate and volume of runoff from reduced permeable areas
- A decrease in the volume of available flood storage

It is an objective of the Council (Objective CAF O20) to require a Site-Specific Flood Risk Assessment (FRA) for all planning applications in Flood Zones A and B and consider all sources of flooding (for example coastal/tidal, fluvial, pluvial or groundwater), where deemed necessary. The detail of these Site-Specific FRAs (or commensurate assessments of flood risk for minor developments) will depend on the level of risk and scale of development. A detailed Site-Specific FRA should quantify the risks, the effects of selected mitigation and the management of any residual risks. The assessments shall consider and provide information on the implications of climate change with regard to flood risk in relevant locations.

The findings of the CFRAM study were used to inform site design and layout and the need for other mitigation measures. It was not deemed necessary to undertake additional hydraulic modelling to inform the detailed flood risk assessment.

CFRAM flood extent mapping was georeferenced into GIS software to assess the impact of the proposed structures on the flood area. Proposed structures are denoted in red in Figure 14 and were used to

calculate the area of each structure within Flood Zone A and B. The impact of the overall development on the loss of flood plain could therefore be assessed.

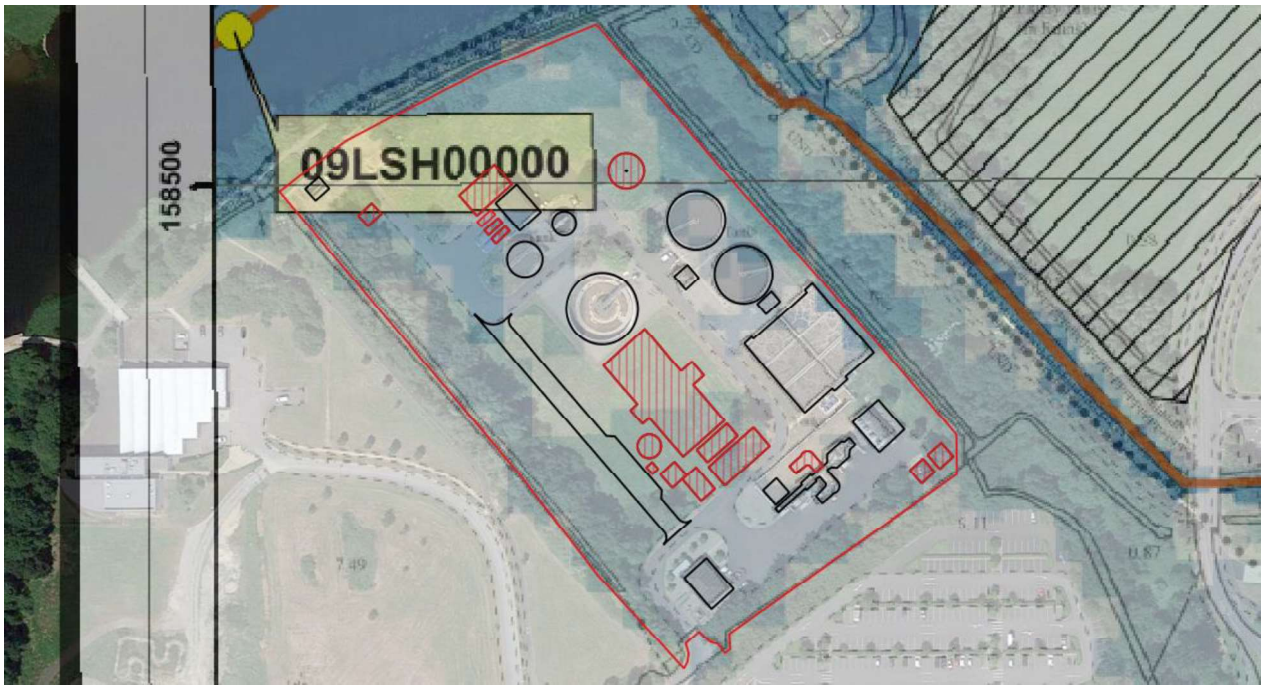


Figure 14: Flood Extent Map with proposed infrastructure

The areas of the proposed development located in Flood Zone A and Flood Zone B was calculated and are shown in Table 2 below.

Table 2: Area of structures located in Flood Zone A and Flood Zone B

		Flood Zone A		Flood Zone B
Structure	**Unit**	**10% AEP**	**1% AEP**	**0.1% AEP**
Storm Tank	m^2	0	0	388
Splitter Chamber	m^2	0	0	55
Filtration Building	m^2	0	0	121
Forward Feed Pumping Station	m^2	0	0	53
Odour Control Unit (Primary Treatment)	m^2	0	0	28
Pumping Station (borehole)	m^2	0	0	13
Primary Sludge Holding Tank	m^2	0	0	50
Grit Trap	m^2	0	0	0
Chemical Bulk Tanks (2 no.)	m^2	0	0	71
Picket Fence Thickener	m^2	0	0	43
Odour Control Unit (Sludge Building)	m^2	0	0	46
Sludge Skip Plinths (3 no.)	m^2	0	35	16
Flood Event Pumping Station	m^2	0	38	0
Total Area	**m^2**	**0**	**73**	**884**

A similar exercise was undertaken using CFRAM Flood Depth mapping with the purpose of calculating the impact of the proposed structures on flood storage volumes. The process was undertaken using the 1% Flood Depth map shown in Figure 15 in relation to the proposed infrastructure.

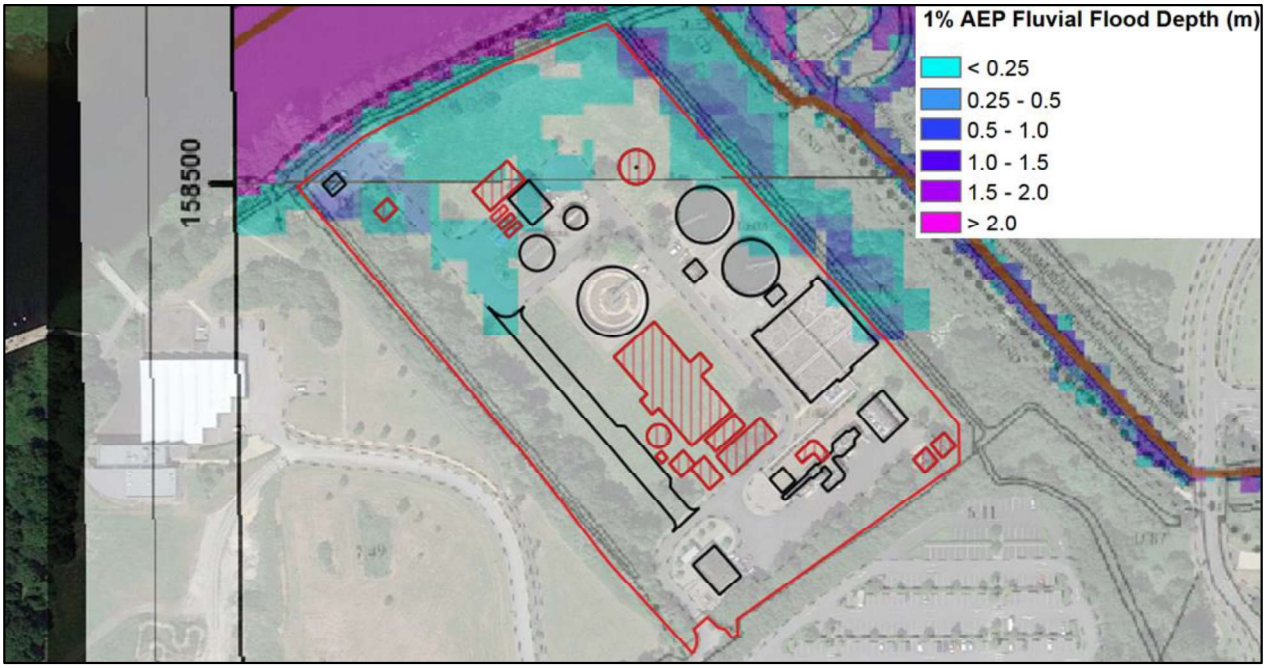


Figure 15: Flood Depth Map (1% AEP) with proposed infrastructure

The area of all proposed structures within each flood depth extent was calculated using GIS software. The results are shown in Table 3 below using the minimum, maximum and average flood depths for each range from the CFRAM map.

Table 3: Impact on Flood Storage Volume (1% AEP)

		Flood Depth					
		Min	Max	Avg	Min	Max	Avg
Structure	**Unit**	**0.00**	**0.25**	**0.13**	**0.25**	**0.50**	**0.38**
Storm Tank	m^2	0	0	0	0	0	0
Splitter Chamber	m^2	0	0	0	0	0	0
Filtration Building	m^2	0	0	0	0	0	0
Forward Feed Pumping Station	m^2	0	0	0	0	0	0
Odour Control Unit (Primary Treatment)	m^2	0	0	0	0	0	0
Pumping Station (borehole)	m^2	0	0	0	0	0	0
Primary Sludge Holding Tank	m^2	0	0	0	0	0	0
Grit Trap	m^2	0	0	0	0	0	0
Chemical Bulk Tanks (2 no.)	m^2	0	0	0	0	0	0
Picket Fence Thickener	m^2	0	0	0	0	0	0
Odour Control Unit (Sludge Building)	m^2	33	33	33	0	0	0
Sludge Skip Plinths (3 no.)	m^2	38	38	38	0	0	0
Flood Event Pumping Station	m^2	39	39	39	0	0	0
Total Area	m^2	110	110	110	0	0	0
Total Volume	**m^3**	**0**	**28**	**14**	**0**	**0**	**0**

It can be seen from Table 3 that a maximum of 28m^3 flood storage volume will be removed from site due to the proposed infrastructure during a 1% AEP flood event. As recommended in the FRM Guidelines, a volume of flood plain equal to that lost to the proposed development should be created. Further, the equal volume should apply at all levels between the lowest point on the site and the design flood level. Compensatory storage is proposed to be provided along the western of the site as shown in Appendix 3.

The use of appropriate drainage measures will mitigate the impacts of additional surface runoff from new infrastructure. Excess surface runoff arising from the development site will be attenuated and discharged at the greenfield discharge rate. Therefore, it is considered that there will be no increased surface runoff from the development in comparison to that of pre-development condition.

With this, it is considered that the proposed development satisfies sub-criterion 2(i) of the Justification Test.

Sub Criterion 2(ii) – Flood Risk Mitigation Measures

As discussed in Section 4.2, the main risk of flooding at the site is from fluvial flooding. It was identified that a portion the site is at risk of flooding due to the 1% AEP fluvial flood extent from the adjacent River Shannon.

It is observed from Figure 8 and Appendix 3 that the 1% AEP fluvial flood levels at node '09LSH00000' and '09LSH0082u' are **+6.36mOD** and **+6.38mO** respectively. From Table 1 it was concluded that the flood levels on the site can be calculated by interpolating between these 2 nodes in a pro rata basis. This results in a 1% AEP flood level of **+6.37mOD**.

According to the FRM Guidelines, the minimum floor level for a new development should be set above the 1% AEP fluvial flood level and should include an allowance for climate change and freeboard. With a freeboard allowance of 0.40m and an allowance of 0.20m for the effects of climate change, this gives the minimum required finished floor level (FFL) (in accordance with the FRM Guidelines) of the development as **+6.97mOD**. This FFL is also higher than the 0.1% AEP fluvial flood level of **+6.93mOD** as shown in Table 1. The top of all tanks and structures will also be constructed above the design flood level of +6.97mOD.

With this, the proposed development satisfies Sub-criterion 2(ii) of the Justification Test.

Sub Criterion 2(iii) – Residual Risks

With the implementation of flood risk mitigation measures recommended above, it is considered that the risk of flood damage to the proposed infrastructure and to operators will be minimised.

The proposed development will have no direct access to any nearby watercourse with the boundary of the site being fenced off from the Lower River Shannon. It is considered that the proposed development satisfies sub-criterion 2(iii) of the Justification Test.

Sub Criterion 2(iv) – Wider Planning Objectives

CAF O2 Partnership with Service Providers of the LDP states that is an objective of the Council to work with other bodies and organisations, as appropriate, to help protect critical infrastructure, including water and wastewater, within Limerick, from risk of flooding. Any subsequent plans shall consider, as appropriate any new and/or emerging data, including, when available, any relevant information contained in the CFRAM Flood Risk Management Plans and as recommended in the SFRA for the Plan.

Section 1.4.1 of Volume 2a includes the following text under *Water Services Infrastructure*:

"The Castletroy Wastewater Treatment Plan is also operating within its design capacity of 45,000 P.E. At present there is significant spare capacity available at Bunlicky WwTP however the spare capacity at Castletroy WwTP is limited. Projects are underway to increase capacity at both Bunlicky and Castletroy WwTPs and will be completed within the lifetime of the Plan, subject to statutory approvals."

Further, the section also notes that Irish Water is preparing a Drainage Area Plan (DAP) to be completed in 2024 for the Limerick City and Castletroy agglomerations. Limerick City and County Council will collaborate with Irish Water to ensure planned growth in the strategic growth areas and elsewhere in the city is taken account of in this study.

The development will address the above measures in a manner that is compatible with the wider planning objectives in relation to the proposed development. Therefore, it is considered that the development also satisfies Sub-criterion 2(iv) of the Justification Test.

SECTION 5: Conclusions and Recommendations

5.1 Summary of Results

A flood risk assessment for the proposed upgrade of Castletroy WwTP, Limerick has been undertaken in accordance with the methodology recommended in the FRM Guidelines. The following is a summary of the flood risk assessment:

- The proposed development consists of the upgrade of the existing Castletroy WwTP. New infrastructure will be required to be constructed within greenfield areas of the existing site. The type of development is defined as 'Highly Vulnerable Development (including essential infrastructure)'.
- The Lower River Shannon forms the northern boundary of the site.
- The National Indicative Fluvial Maps indicates that portions of the existing site partially lies within Flood Zone A and B. The national flooding website www.floodmaps.ie shows records of historic flooding at the site.
- The CFRAMS map indicates that a portion of the current site lies within Flood Zone A and Flood Zone B. The map indicates that the 1% AEP fluvial flood level at the site is +6.37mOD and 0.1% AEP fluvial flood level is +6.93mOD.
- The proposed storm water tank will be constructed on the open green area of the site which is largely classified as Flood Zone C. The remainder of this structure is in Flood Zone B.
- The new primary treatment building, splitter chamber, primary sludge holding tank, odour units, picket fence thickener, forward feed pumping station, and borehole pumping station and storage tank will be constructed in Flood Zone B.
- The sludge storage skips and flood event pumping station will be constructed in both Flood Zone A and B.
- All highly essential infrastructure will be constructed at an elevation higher than the 1% AEP flood level with a suitable freeboard. The design flood level will be +6.97mOD.
- The proposed development is expected to cause minimal loss of flood plain storage and will be compensated for elsewhere on the site. Limited space is available near the watercourse to provide compensatory storage within Flood Zone C. Therefore, storage will be provided with Flood Zone A and B.
- Following the procedures as set out in the FRM Guidelines, it was deemed that the site satisfied all criteria and thus satisfied the Justification Test.
- The flood event pumping station proposed as part of the development will provide resilience to the operation of the plant during periods of high river levels by ensuring treated final effluent can be discharged to the watercourse.

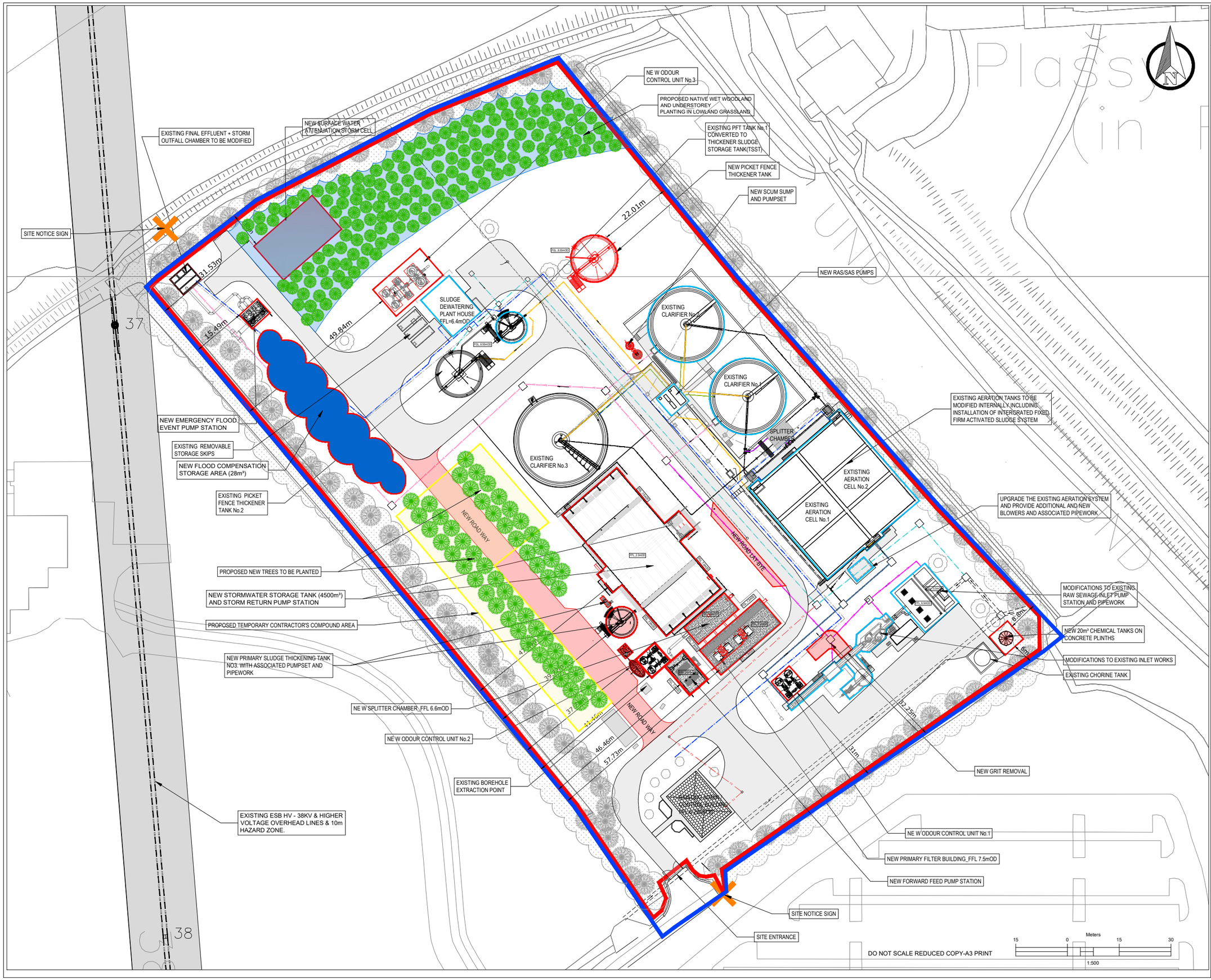
5.2 Conclusions and Recommendations

It is recommended to construct new development where feasible within Flood Zone C of the current site, and that all highly essential infrastructure be constructed at an elevation higher than the 1% AEP flood level with a suitable freeboard and an allowance for the effects of climate change. This will protect the proposed development against flooding and to preserve the existing flood plain as to avoid flooding elsewhere.

Where it is not possible to locate new infrastructure in Flood Zone C due to physical or hydraulic constraints, it is recommended that compensatory storage is provided for floodplain lost during the 1% AEP flood so as not to increase flood risk elsewhere. The FRM Guidelines states that to provide compensatory storage, a volume of flood plain equal to that lost to the proposed development should be created and to ensure that flood flow routes are protected.

Appendix 1:

Site Layout Drawing



Notes:
1. All levels are in metres and relate to O.S. Datum MALIN.
2. This drawing is reproduced from digital maps:
O.S. MAPS - Scale 1:2,500
O.S. MAPS - Scale 1:1,000
Discovery Series - Scale 1:50,000
3. All Maps are referenced to IRISH TRANSVERSE MERCATOR (I.T.M.)
4. Ordnance Survey Ireland Licence No. EN 0003022
©Government of Ireland.

MAPPING
OS SHEETS: 4683-A,4683-C,
DISCOVERY SERIES; OS1614_D
TOWN LAND : DROMORE

SITE LOCATION CO-ORDINATE
X-560717.1877 Y-658463.5332

LEGEND

SITE BOUNDARY OUTLINED IN RED

LANDS IN CONTROL OF THE APPLICANT OUTLINED IN BLUE

SITE AREA = 3.166Ha

PROPOSED UPGRADE WORKS

PROPOSED NEW WORKS & PIPEWORK

ESB HV - 38KV & HIGHER VOLTAGE OVERHEAD LINES"

NOTE:
MAXIMUM FLOOD LEVEL IS +6.93MOD

REFER TO 20701-JBB-00-XX-DR-Z-01202_ SITE LOCATION MAP FOR FULL EXTENT OF SITE NOTICE LOCATIONS.

Rev.	Suit.	Description	Drawn	Ch'kd	Date
C01	A1	ISSUED FOR EIAR	LA	PJ	28.02.23

Client:
Irish Water
Colvill House
24-26 Talbot Street
Dublin 1
Tel:1890 278 278
Int: +353-1-707 2828
Email:info@water.ie
Web: www.water.ie

Consultant:
J. B. Barry and Partners Limited
Consulting Engineers
Classon House
Dundrum Business Park
Dundrum Road
Dublin 14
Tel: +353-1-4851400
email: info@jbbarry.ie
website: www.jbbarry.ie

Project:
CASTLETROY WASTEWATER TREATMENT PLANT

Drawing Title
PROPOSED SITE LAYOUT PLAN

Drawn by :	LHA	Date :	DEC.2022
Checked by :	PH	Date :	DEC.2022
Approved by :	PJ	Date :	DEC.2022
Internal Project REF :	20701		
Scales :	1:500 @ A1		
Stage :	EIAR		

Drawing No. :	Revision	Suitability Code
20701-JBB-00-XX-DR-Z-1204	C01	A1

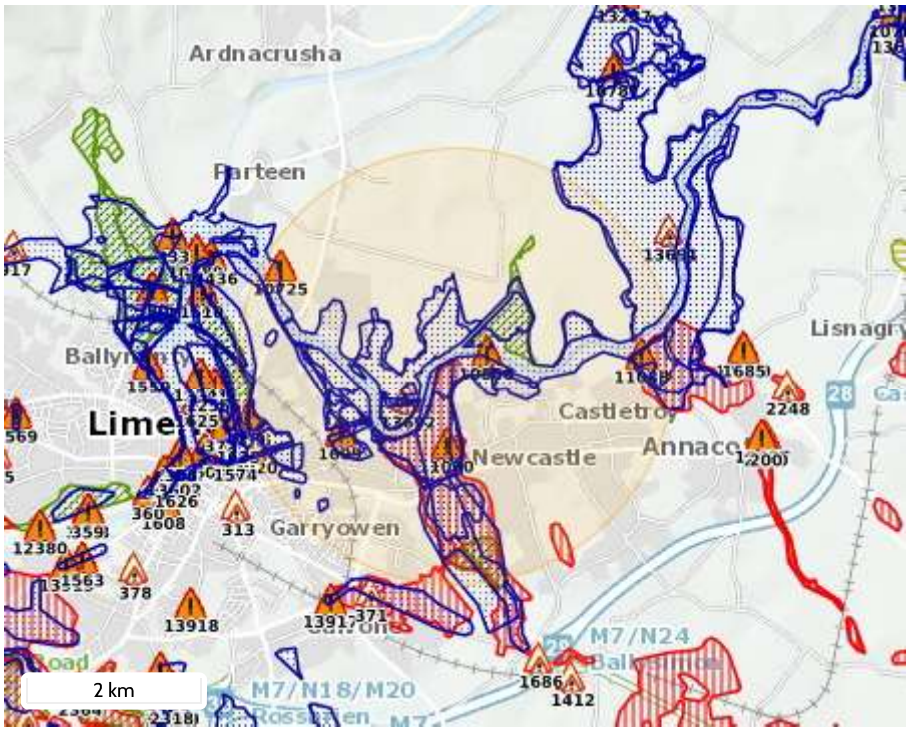
Appendix 2:

OPW Summary Local Area Reports

Past Flood Event Local Area Summary Report

Report Produced: **16/11/2022 16:40**

This Past Flood Event Summary Report summarises all past flood events within 2.5 kilometres of the map centre.



Map Legend

- Single Flood Event
- Recurring Flood Event
- Past Flood Event Extents
- Drainage Districts Benefited Lands*
- Land Commission Benefited Lands*
- Arterial Drainage Schemes Benefited Lands*

* Important: These maps do not indicate flood hazard or flood extent. Their purpose and scope is explained on Floodinfo.ie

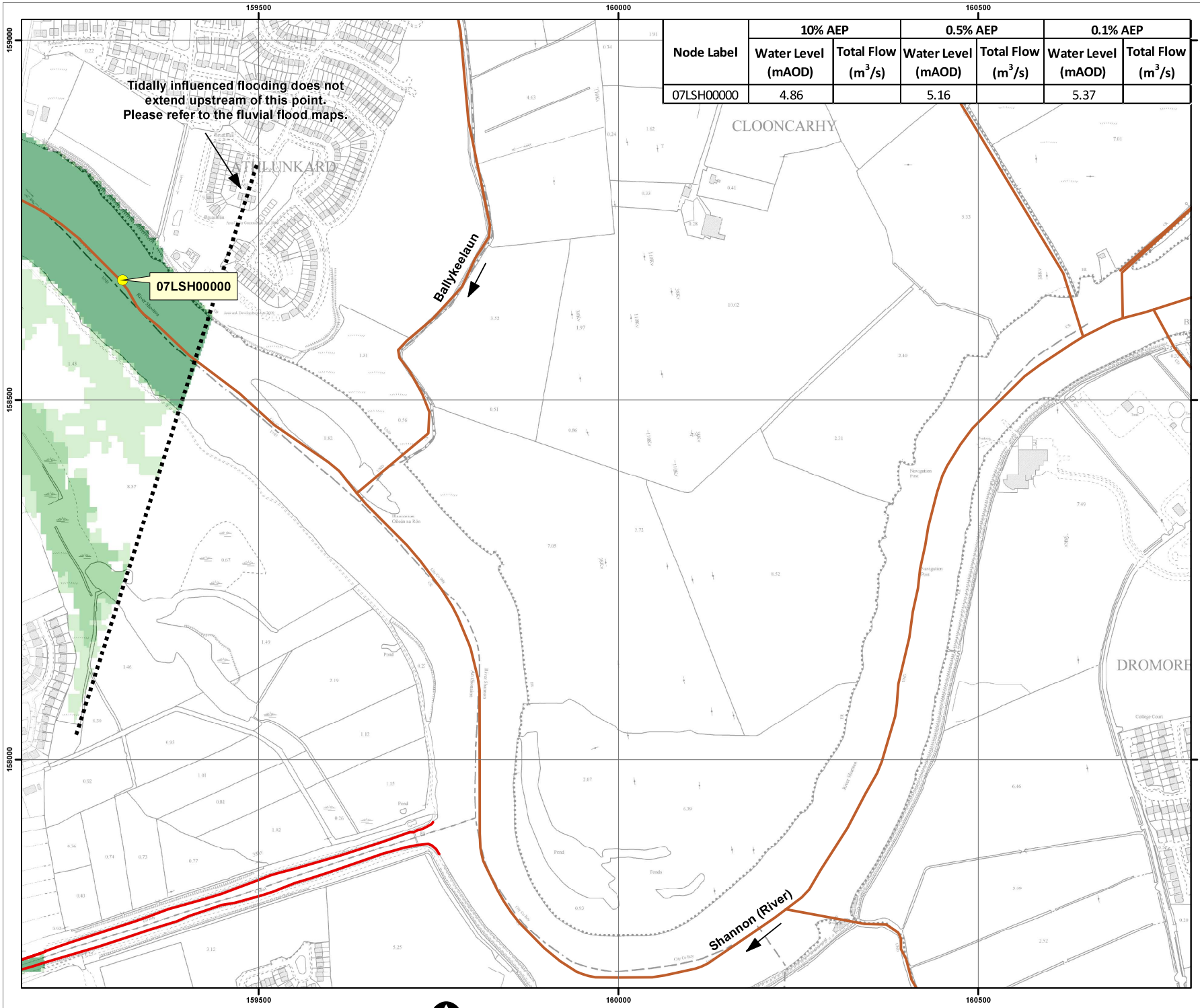
21 Results

	Name (Flood_ID)	Start Date	Event Location
1.	Corbally R463 Limerick Dec 1999 (ID-317)	25/12/1999	Area
	Additional Information: Reports (5) Press Archive (1)		
2.	Shannon Fields Limerick Dec 1999 (ID-318)	25/12/1999	Area
	Additional Information: Reports (2) Press Archive (1)		
3.	Clare St Limerick Dec 1999 (ID-312)	25/12/1999	Area
	Additional Information: Reports (3) Press Archive (1)		
4.	Kilmurry Road Limerick Dec 1999 (ID-322)	25/12/1999	Area
	Additional Information: Reports (2) Press Archive (1)		
5.	Groody Dec 1999 (ID-319)	25/12/1999	Area
	Additional Information: Reports (3) Press Archive (1)		
6.	Shannon Lower Feb 1990 (ID-127)	01/02/1990	Area
	Additional Information: Reports (6) Press Archive (15)		

	Name (Flood_ID)	Start Date	Event Location
7.	Shannon December 1954 (ID-3) **Additional Information:** Reports (4) Press Archive (16)	01/12/1954	Area
8.	Corbally St Mary's Pk Limerick Dec 1999 (ID-311) **Additional Information:** Reports (10) Press Archive (2)	25/12/1999	Area
9.	Healy's Field O'Briens Pk Limerick Dec 1999 (ID-310) **Additional Information:** Reports (3) Press Archive (1)	25/12/1999	Area
10.	Corbally Limerick Feb 2002 (ID-369) **Additional Information:** Reports (4) Press Archive (0)	27/02/2002	Exact Point
11.	Shannon Corbally Limerick Recurring (ID-298) **Additional Information:** Reports (2) Press Archive (7)	n/a	Approximate Point
12.	Corbally Limerick Feb 1997 (ID-1605) **Additional Information:** Reports (4) Press Archive (0)	10/02/1997	Approximate Point
13.	Reboge Limerick Feb 1997 (ID-1609) **Additional Information:** Reports (3) Press Archive (0)	10/02/1997	Approximate Point
14.	St Patrick's Road Well Field Limerick Dec 1999 (ID-321) **Additional Information:** Reports (2) Press Archive (1)	25/12/1999	Area
15.	Flooding at Castletroy to Limerick on 01/02/2020 (ID-13692) **Additional Information:** Reports (0) Press Archive (0)	01/02/2020	Approximate Point
16.	Shannon Banks 23/11/2009 (ID-10725) **Additional Information:** Reports (1) Press Archive (0)	23/11/2009	Exact Point
17.	Castletroy, Limerick, 19th to 24th November 2009 (ID-11088) **Additional Information:** Reports (1) Press Archive (0)	19/11/2009	Approximate Point
18.	University of Limerick Area November 2009 (ID-10880) **Additional Information:** Reports (2) Press Archive (0)	19/11/2009	Approximate Point
19.	Shannon Limerick Dec.2006 (ID-10396) **Additional Information:** Reports (2) Press Archive (0)	01/12/2006	Area
20.	Shannon Ballyvollane Dec.2006 (ID-10397) **Additional Information:** Reports (3) Press Archive (0)	01/12/2006	Area
21.	Plassey to Groody/Shannon Confluence 19th to 24th November 2009 (ID-11090) **Additional Information:** Reports (1) Press Archive (0)	19/11/2009	Approximate Point

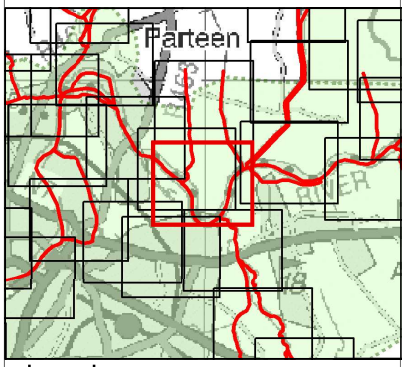
Appendix 3:

CFRAMS Maps



Node Label	10% AEP		0.5% AEP		0.1% AEP	
	Water Level (mAOD)	Total Flow (m^3/s)	Water Level (mAOD)	Total Flow (m^3/s)	Water Level (mAOD)	Total Flow (m^3/s)
07LSH00000	4.86		5.16		5.37	

Location Plan:



Legend:

- Nodes
- Model Reach
- AFA Boundary
- Flood Defence: Wall
- Flood Defence: Embankment
- Defended Area

10% AEP Coastal Flood Extent
(1 in 10 chance in any given year)

0.5% AEP Coastal Flood Extent
(1 in 200 chance in any given year)

0.1% AEP Coastal Flood Extent
(1 in 1000 chance in any given year)

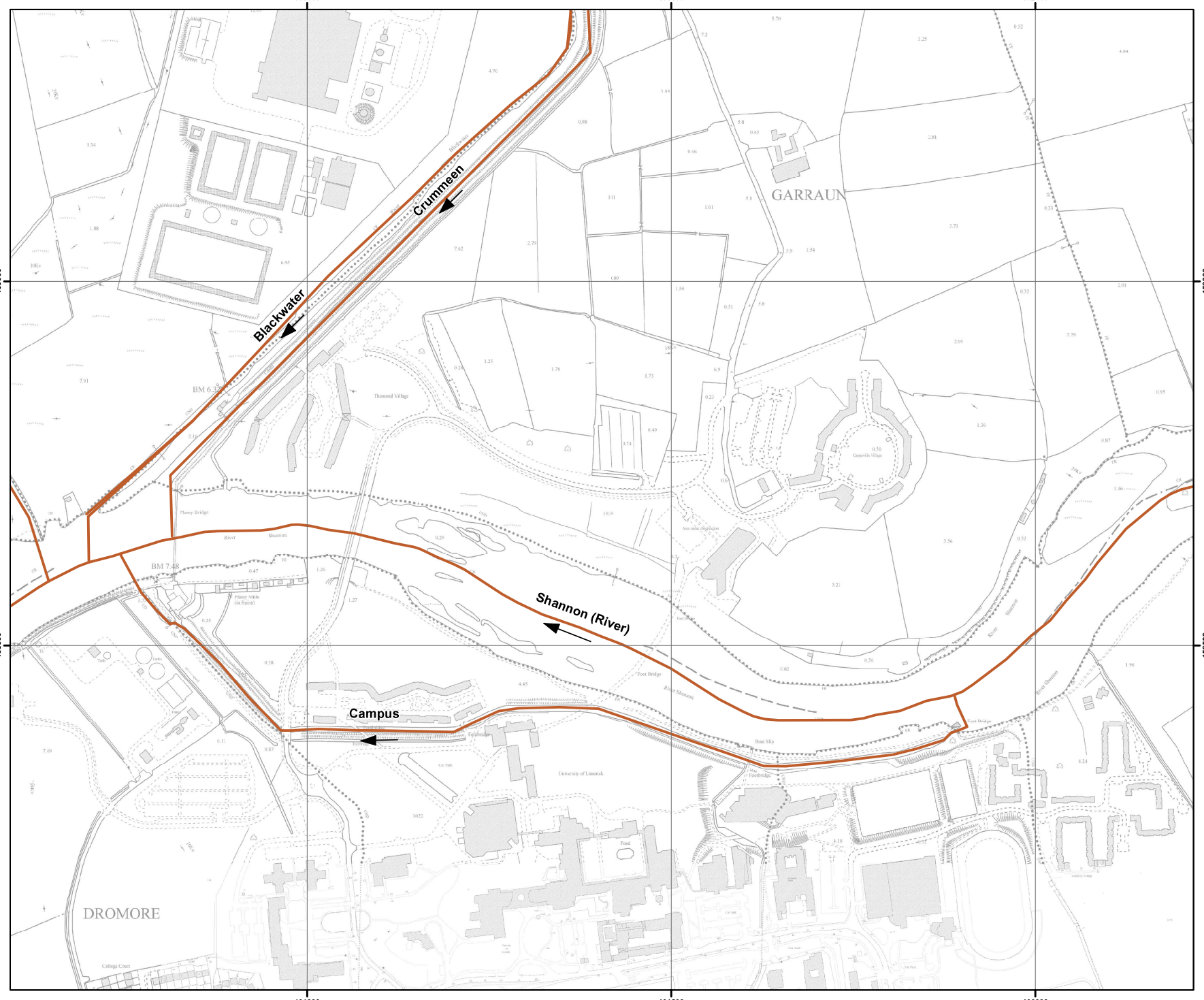
IMPORTANT USER NOTE:
THE VIEWER OF THIS MAP SHOULD REFER TO THE DISCLAIMER, GUIDANCE NOTES AND CONDITIONS OF USE THAT ACCOMPANY THIS MAP.

The Office of Public Works
Jonathan Swift Street
Trim
Co. Meath
C15 NX36

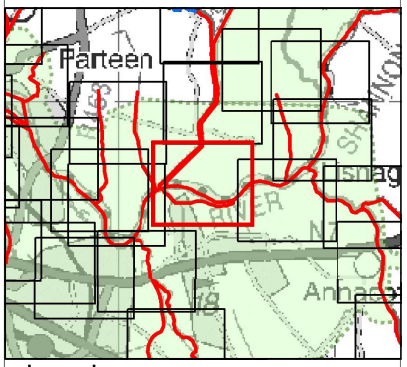
Merrion House
Merrion Road
Dublin 4
D04 R2C5

Project:	SHANNON CFRAM STUDY
Map Type:	EXTENT
Source:	COASTAL - TIDAL
Area:	LIMERICK
Scenario:	EXISTING
Drawn by: EH	Date: June 2016
Checked by: KM	Date: June 2016
Reviewed by: MC	Date: June 2016
Approved by: PS	Date: June 2016
Map No.:	S2526LIK_EXCCD_F1_15
Sheet: 15 of 65	Revision: 0
Map Scale: 1: 5000	Plot Scale: 1:1 @ A3

0 50 100 200 300 400 500 Meters



Location Plan:



Legend:

- Nodes
- Model Reach
- AFA Boundary
- Flood Defence: Wall
- Flood Defence: Embankment
- Defended Area

10% AEP Coastal Flood Extent
(1 in 10 chance in any given year)

0.5% AEP Coastal Flood Extent
(1 in 200 chance in any given year)

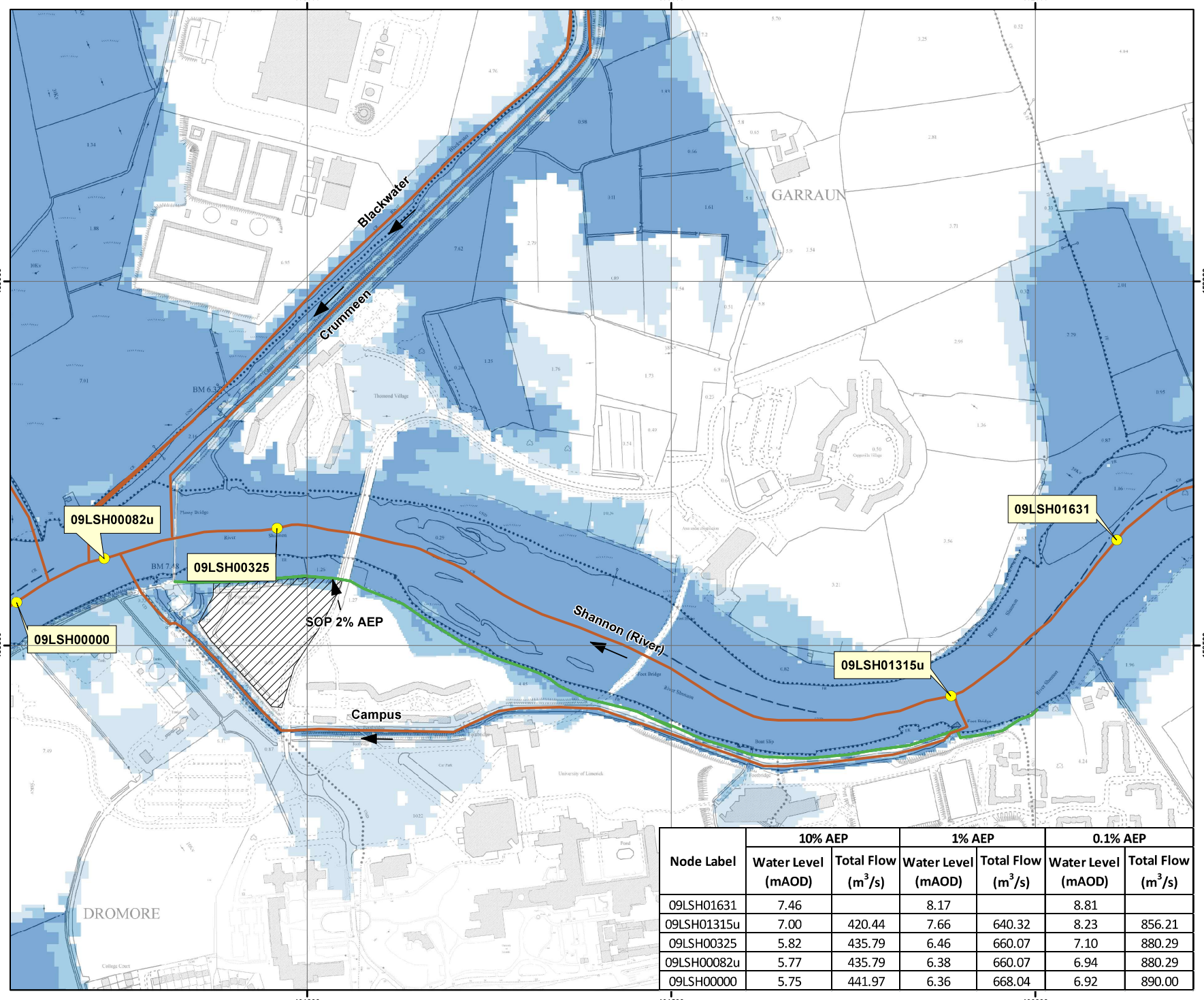
0.1% AEP Coastal Flood Extent
(1 in 1000 chance in any given year)

IMPORTANT USER NOTE:
THE VIEWER OF THIS MAP SHOULD REFER TO THE DISCLAIMER, GUIDANCE NOTES AND CONDITIONS OF USE THAT ACCOMPANY THIS MAP.

The Office of Public Works
Jonathan Swift Street
Trim
Co. Meath
C15 NX36

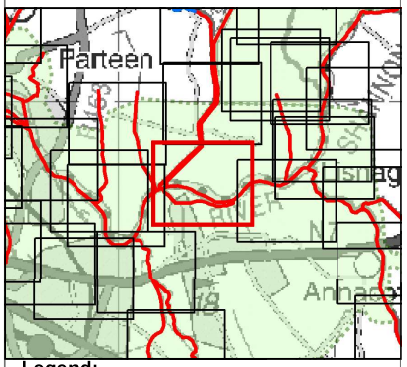
Merrion House
Merrion Road
Dublin 4
D04 R2C5

Project:	SHANNON CFRAM STUDY
Map Type:	EXTENT
Source:	COASTAL - TIDAL
Area:	LIMERICK
Scenario:	EXISTING
Drawn by: EH	Date: June 2016
Checked by: KM	Date: June 2016
Reviewed by: MC	Date: June 2016
Approved by: PS	Date: June 2016
Map No.:	S2526LIK_EXCCD_F1_10
Sheet: 10 of 65	Revision: 0
Map Scale: 1: 5000	Plot Scale: 1:1 @ A3



Node Label	10% AEP		1% AEP		0.1% AEP	
	Water Level (mAOD)	Total Flow (m^3/s)	Water Level (mAOD)	Total Flow (m^3/s)	Water Level (mAOD)	Total Flow (m^3/s)
09LSH01631	7.46		8.17		8.81	
09LSH01315u	7.00	420.44	7.66	640.32	8.23	856.21
09LSH00325	5.82	435.79	6.46	660.07	7.10	880.29
09LSH00082u	5.77	435.79	6.38	660.07	6.94	880.29
09LSH00000	5.75	441.97	6.36	668.04	6.92	890.00

0 50 100 200 300 400 500 Meters



Legend:

- Nodes
- Model Reach
- AFA Boundary
- Flood Defence: Wall
- Flood Defence: Embankment
- Defended Area

10% AEP Fluvial Flood Extent
(1 in 10 chance in any given year)

1% AEP Fluvial Flood Extent
(1 in 100 chance in any given year)

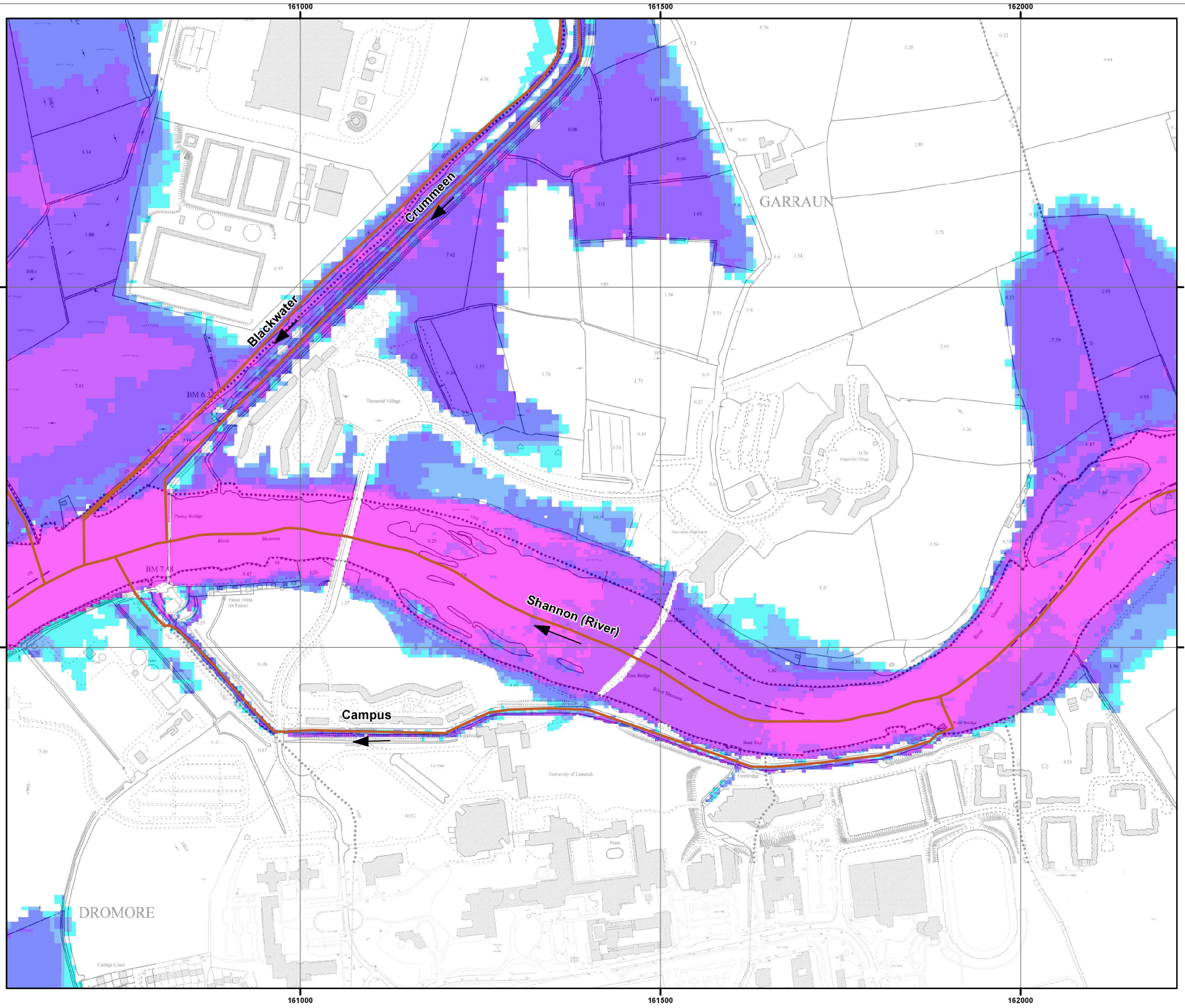
0.1% AEP Fluvial Flood Extent
(1 in 1000 chance in any given year)

IMPORTANT USER NOTE:
THE VIEWER OF THIS MAP SHOULD REFER TO THE DISCLAIMER, GUIDANCE NOTES AND CONDITIONS OF USE THAT ACCOMPANY THIS MAP.

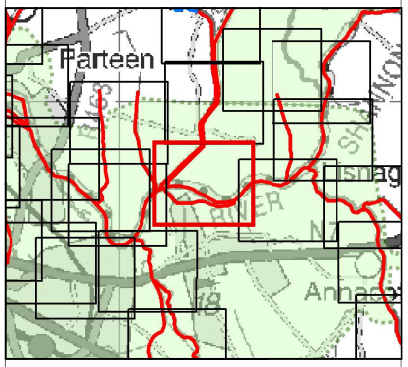
The Office of Public Works
Jonathan Swift Street
Trim
Co. Meath
C15 NX36

Merrion House
Merrion Road
Dublin 4
D04 R2C5

Project:	SHANNON CFRAM STUDY
Map Type:	EXTENT
Source:	FLUVIAL
Area:	LIMERICK
Scenario:	EXISTING
Drawn by:	Date: June 2016
Checked by:	Date: June 2016
Reviewed by:	Date: June 2016
Approved by:	Date: June 2016
Map No.:	S2526LIK_EXFCD_F1_10
Sheet: 10 of 59	Revision: 0
Map Scale: 1: 5000	Plot Scale: 1:1 @ A3



Location Plan:



Legend

- AFA Boundary
- Model Reach

1% AEP Fluvial Flood Depth (m)

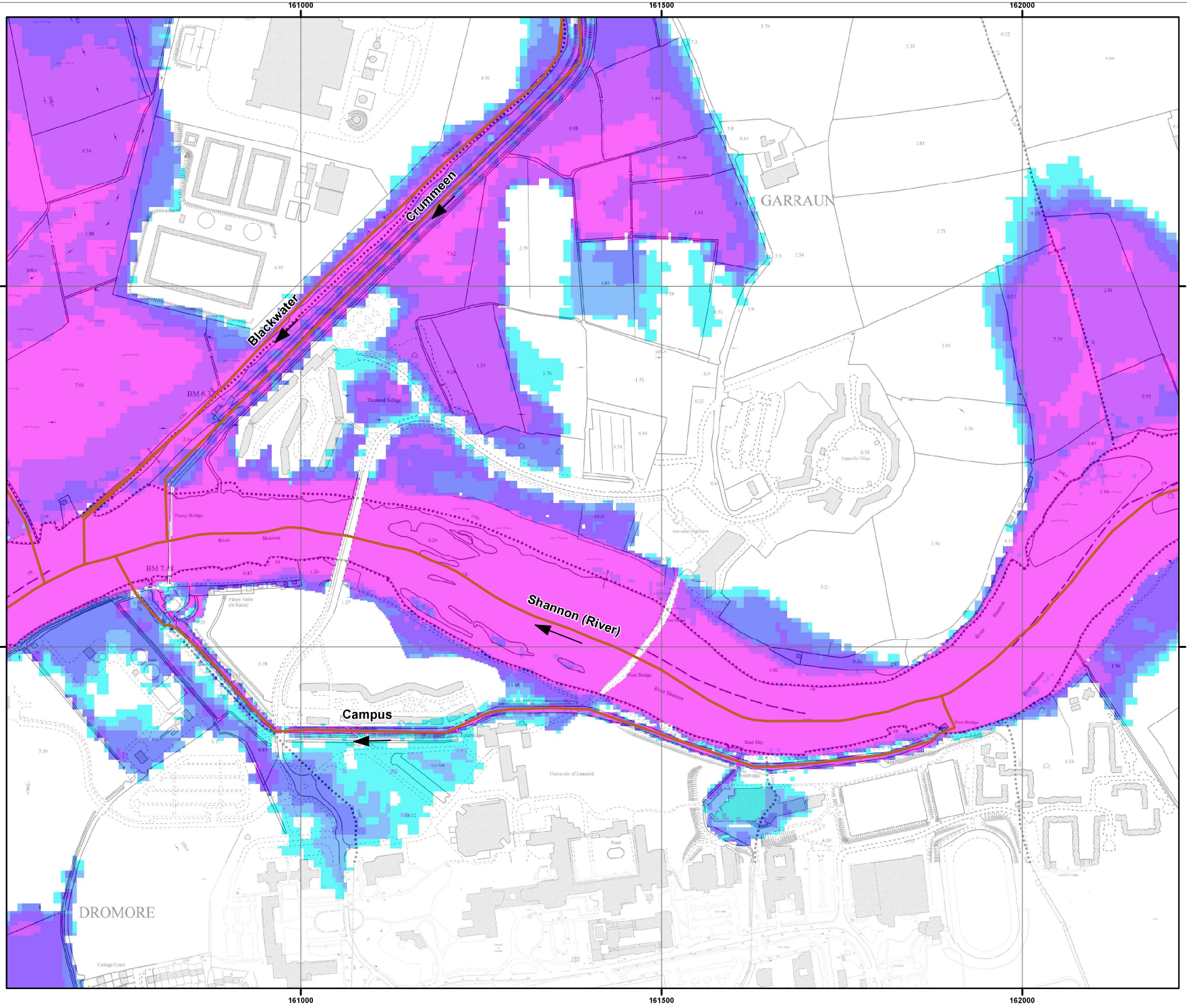
- < 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- > 2.0

IMPORTANT USER NOTE:
THE VIEWER OF THIS MAP SHOULD REFER TO THE DISCLAIMER, GUIDANCE NOTES AND CONDITIONS OF USE THAT ACCOMPANY THIS MAP.

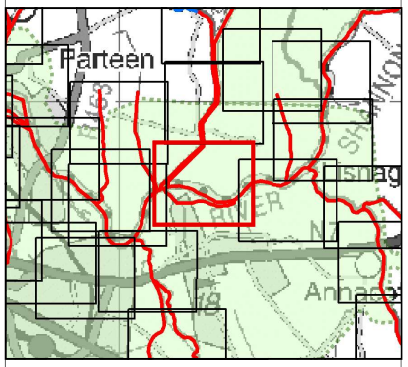
The Office of Public Works
Jonathan Swift Street
Trim
Co. Meath
C15 NX36

Merrion House
Merrion Road
Dublin 4
D04 R2C5

Project:	SHANNON CFRAM STUDY
Map Type:	DEPTH
Source:	FLUVIAL
Area:	LIMERICK
Scenario:	EXISTING
Drawn by: AC	Date: June 2016
Checked by: KM	Date: June 2016
Reviewed by: MC	Date: June 2016
Approved by: PS	Date: June 2016
Map No.:	S2526LIK_DPFCD010_F1_10
Sheet: 10 of 65	Revision: 0
Map Scale: 1: 5000	Plot Scale: 1:1 @ A3



Location Plan:



Legend

- AFA Boundary
- Model Reach

0.1% AEP Fluvial Flood Depth (m)

- < 0.25
- 0.25 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- > 2.0

IMPORTANT USER NOTE:
THE VIEWER OF THIS MAP SHOULD REFER TO THE DISCLAIMER, GUIDANCE NOTES AND CONDITIONS OF USE THAT ACCOMPANY THIS MAP.

OPW
The Office of Public Works
Jonathan Swift Street
Trim
Co. Meath
C15 NX36

JACOBS
Merrion House
Merrion Road
Dublin 4
D04 R2C5

Project:	SHANNON CFRAM STUDY
Map Type:	DEPTH
Source:	FLUVIAL
Area:	LIMERICK
Scenario:	EXISTING
Drawn by: AC	Date: June 2016
Checked by: KM	Date: June 2016
Reviewed by: MC	Date: June 2016
Approved by: PS	Date: June 2016
Map No.:	S2526LIK_DPFCD001_F1_10
Sheet: 10 of 65	Revision: 0
Map Scale: 1: 5000	Plot Scale: 1:1 @ A3