Strategic Flood Risk Assessment

January 2018

As part of the preparation of the Proposed Variation No. 6,
Limerick County Development Plan 2010-2016 (as extended)

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Proposed Variation No. 6 to the Limerick County Development Plan 2010-2016 (as extended)

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1.0 INTRODUCTION

1.1 Background

AECOM Ltd / Roughan O'Donovan Ltd were commissioned by Limerick City & County Council to carry out a strategic flood risk assessment (SFRA) for Variation No. 6 of the Limerick County Development Plan 2010-2016 (as extended). The proposed Variation No. 6 relates primarily to the inclusion of the text provisions relating to future road development(s) in the County. The Variation requires the insertion of additional text under Chapter 8: Transport and Infrastructure, of the Limerick County Development Plan 2010-2016 (as extended) to facilitate the development of the Foynes to Limerick Road Improvement Scheme.

The sources of information on Flood Risk along the proposed route are summarised as follows:

- OPW Preliminary Flood Risk Assessment Mapping
- OPW Hydrometric Site – Waterlevel.ie
- OPW Arterial drainage and Land benefitting mapping
- Historical Flooding Floodmaps.ie
- Site specific Topographic Survey
- OPW Flood Studies update web-site portal for estimating flood flows
- Shannon CFRAMS Inception and draft Reports
- Final Draft CFRAM mapping for the River Shannon at Limerick (June 2016)
- Hydraulics Report – Unit of Management 24 – June 2016 (Final)
- Hydrology Report – Unit of Management 24 – July 2016 (Final)
- Preliminary Options Report – Unit of Management 24 – July 2016 (Final)

1.2 Reasons for Proposed Variation

Considering the national, regional and local policy context, the reasons for the proposed Variation are:

(i) To strengthen the policy support for the Foynes to Limerick Road Improvement Scheme.

(ii) To provide clarity in relation to specific intention of Limerick City and County Council in relation to a Bypass for Adare.

(iii) To ensure consistency with the other policy documents (e.g. Building on Recovery, MWASP, MWRPGs, National Ports Policy, Shannon Integrated Framework Plan, etc.) beyond the 2010-2016 period.

(iv) To replace the National Roads Authority (NRA) with Transport Infrastructure Ireland (TII) in the amended policies/ objectives.

(v) To relieve chronic traffic congestion and improve travel time eastwards and westwards on the N21.

(vi) To facilitate the design, reservation of land for and commence construction of a new road between the N21 at Rathkeale to the N69 at Foynes to the required standards.

2.0 DESCRIPTION OF PROPOSED ROUTE

The proposed route of the scheme is divided into two main links as follows:

- Foynes to Rathkeale – The road proposal runs east from a new junction at the existing N69 south of Foynes to a new junction at Ballyclogh, continuing east before terminating at a new junction at Askeaton. From the new junction at Ballyclogh, the scheme also runs south to a new junction at Rathkeale.
- Rathkeale to Adare – At Rathkeale the scheme commences west of the existing N21/R518 junction on the N21 Rathkeale Bypass and heads in a north easterly direction towards Adare. The scheme bypasses Adare to the north and joins on to the existing M20 at the Attyflin junction. Figure 2.1 provides an overview of the proposed route.

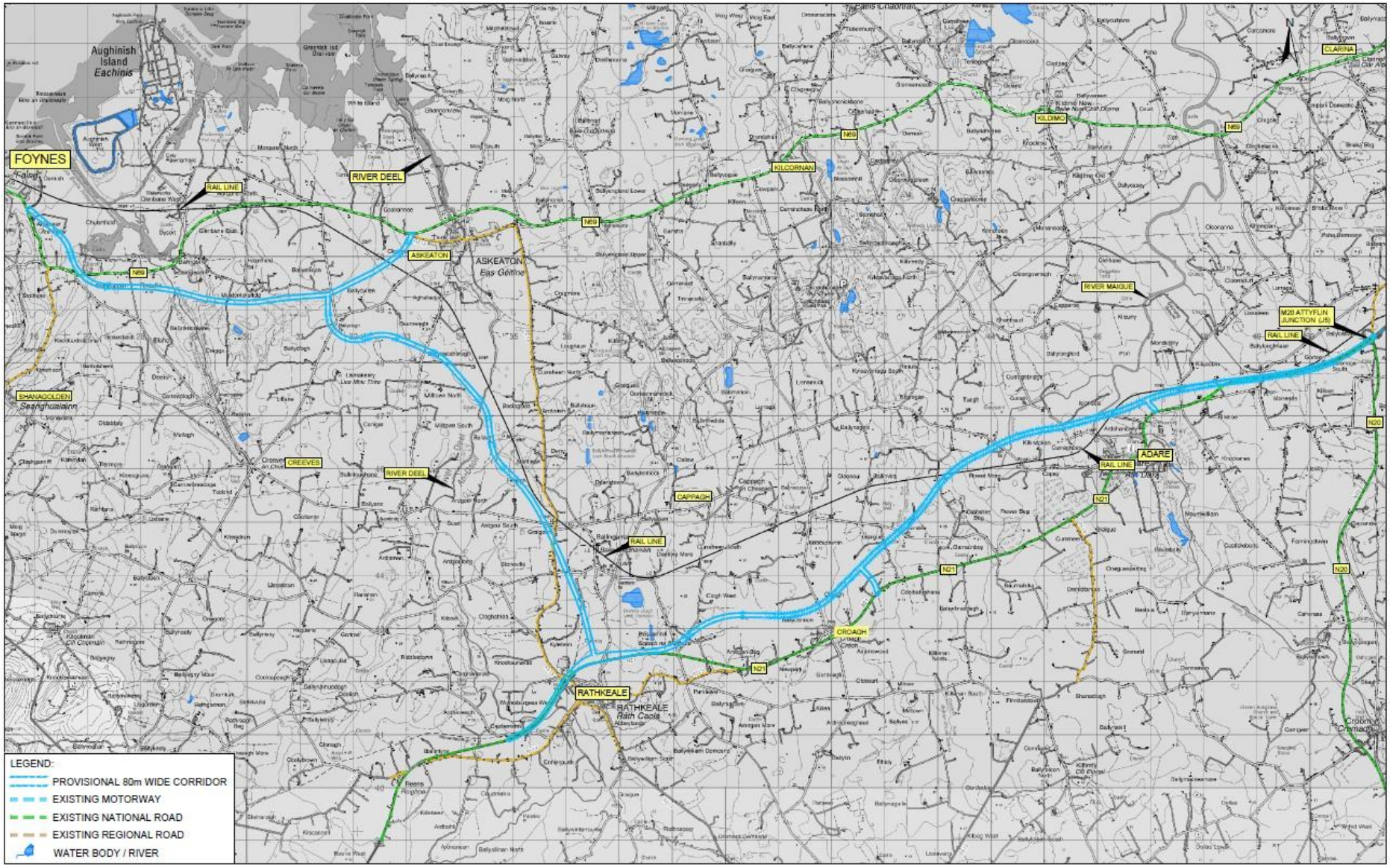


Figure 2.1 Proposed Foynes to Limerick Road Alignment

3.0 FLOOD RISK MANAGEMENT POLICY

3.1 EU Floods Directive

The European Floods Directive 2007/60/EC on the assessment and management of flood risk aims to reduce and manage the risks that floods pose to human health, the environment, cultural heritage and economic activity. This directive applies to both inland waters and coastal waters across the whole territory of the EU.

The directive requires all member states to undertake a national preliminary flood risk assessment in order to identify areas where significant flood risk exists or might be considered likely to occur and to prepare flood hazard and flood risk maps for such areas by December 2013. The Directive required the preparation of catchment-based Flood Risk Management Plans (FRMPs), which set out flood risk management objectives, actions and measures. Catchment based flood risk management plans have been prepared for selected Flood Risk Areas throughout Ireland under the National CFRAM (Catchment Flood Risk Assessment and Management) studies. These Flood Risk Management Plans include measures to reduce the probability of flooding and its potential consequences. Implementation of the EU Floods Directive is required to be coordinated with the requirements of the EU Water Framework Directive and current River Basin Management Plans.

3.2 National Flood Policy review

3.2.1 Background

Historically management of flooding was implemented by drainage commissioners and focused on the protection and improvement of land for agricultural purposes and this is reflected in the various Drainage Acts passed (1842, 1867, 1925, 1928 and 1945).

The Brown Commission (Report of the Drainage Commission 1938-1940) which examined flooding and improvement of land through drainage resulted in the development of the Arterial Drainage Act, 1945. The Brown Commission recommended the establishment of a single national drainage authority with a remit to embark on a national drainage programme. The Office of Public Works (OPW) became the Statutory Authority responsible for implementing arterial drainage schemes nationally.

The emphasis of the 1945 act was improvement of agricultural land and following the act a priority list of river basins was set out and a programme of drainage works commenced and continued up until the early 1990's. This drainage act was amended in 1995 to allow the OPW to implement localised flood relief schemes for reliving flooding in urban areas. This amendment recognised that urban flooding had become a significant problem and signalled a departure away from arterial drainage of lands with no new arterial drainage schemes being implemented.

The various drainage districts and arterial drainage schemes, together with local flood relief schemes carried out under the drainage act continue to be maintained today by the OPW and Local Authorities.

3.2.2 Report of the Flood Policy Review Group

In 2003 a review of the National Flood Policy was carried out by a review group of relevant stakeholders. The review focuses on fluvial (river) and tidal flooding and concentrates on the roles of the state agencies in these areas. The scope of the review included the following:

- Causes, extent and impacts of the flooding problem
- Current roles and responsibilities of the main state bodies
- International best practice
- Future flood policy
- Proposals for future organisational structures and responsibilities
- Resource requirements and strategic programme

The review group prepared a report in December 2003 that was approved by government and published in September 2004. The adopted policy has many specific recommendations, including:

- Minimise the national level of exposure to flood damage through identification and management and future flood risks in an integrated, proactive and river basin based approach
- The Office of Public Works is to be the lead agency in delivering this policy
- All future expenditure in the area of flood relief will need to satisfy strict prioritisation criteria
- A two-pronged approach to flood management is to be pursued with a greater level of importance attributed to non-structural flood relief measures supported where necessary by traditional structural flood relief measures
- River basin flood management plans to be developed along with comprehensive Flood Hazard Maps and all information made available to the Dept. of the Environment, Heritage and Local Government to inform future planning and development processes

Programmes of necessary hydrological research were identified and included the update of the Flood Studies Report and river basin (hydrological) modelling, analysis of potential impact of climate change on flood frequency and severity and Meteorological forecasting.

3.3 National CFRAM

The OPW is the lead agency for flood risk management and part of its responsibility is the coordination and implementation of Government Policy on the management of flood risk in Ireland. The SI No. 122 on the European Communities (Assessment and Management of Flood Risks) 2010 identifies the Commissioners of Public Works as the competent authority with overall responsibility for the implementation of the Floods Directive (2007/60/EC).

In order to comply with the Floods Directive (2007) and the National Flood Policy Review Group (2004) a national Catchment Flood Risk Assessment and Management (CFRAM) programme commenced in 2011 and flood risk and hazard draft mapping completed in 2015 and the draft catchment management plans and the Strategic Environmental Assessment (SEA) process completed in 2016. This followed preparatory studies involving the Preliminary Flood Risk Assessment mapping and AFA (areas for further assessment) identification and followed a number of Pilot Catchment studies including the Lee Catchment FRAMS (commenced 2006), the River Dodder FRAMS (commenced 2007) and the Fingal East Meath FRAMS (commenced 2008) to refine the approach and methodologies to be adopted. The areas deemed to be at significant risk are identified as AFAs and more detailed assessment on the extent and degree of flooding was undertaken in the CFRAM studies and involved detailed survey hydrological and hydraulic modelling, flood

mapping, preparation of flood risk management plans and supporting Strategic Environmental Assessments.

3.4 Planning Guidelines Concerning Flood Risk Management

3.4.1 Background

In November 2009, the OPW and DoEHLG jointly published the Planning System and Flood Risk Management - Guidelines for Planning Authorities which are aimed at ensuring a more consistent, rigorous and systematic approach to fully incorporate flood risk assessment and management into the planning system.
The core objectives set out in these guidelines are to:

- Avoid inappropriate development in areas of flood risk
- Avoid new developments that may increase flood risk elsewhere
- Ensure effective management of residual risks for developments permitted in floodplains
- Avoid unnecessary restriction of national, regional or local economic growth
- Improve the understanding of flood risk among the relevant stakeholders
- Ensure that the requirements of EU and National law in relation to the natural environment and nature conservation are compiled with at all stages of flood risk management.

The key principles to be adopted by regional and local authorities, developers and their agents are to:

- Avoid the risk, where possible
- Substitute less vulnerable uses, where avoidance is not possible
- Justify that the need for the development is a strategic need, where avoidance and substitution are not possible
- Mitigate and manage the risk

Decision Making Process

Management of flood hazard and potential risks in the planning system is based on:

1. Sequential Approach
2. Justification Test

3.4.2 Sequential Approach

The aim of the sequential approach is to guide new development away from areas at risk from flooding into areas at low risk of flooding. The approach makes use of flood risk zones and classifications of vulnerability of property to flooding but ignores the presence of flood protection structures. The sequential approach should be applied to all stages of the planning process, particularly at the plan making stage.

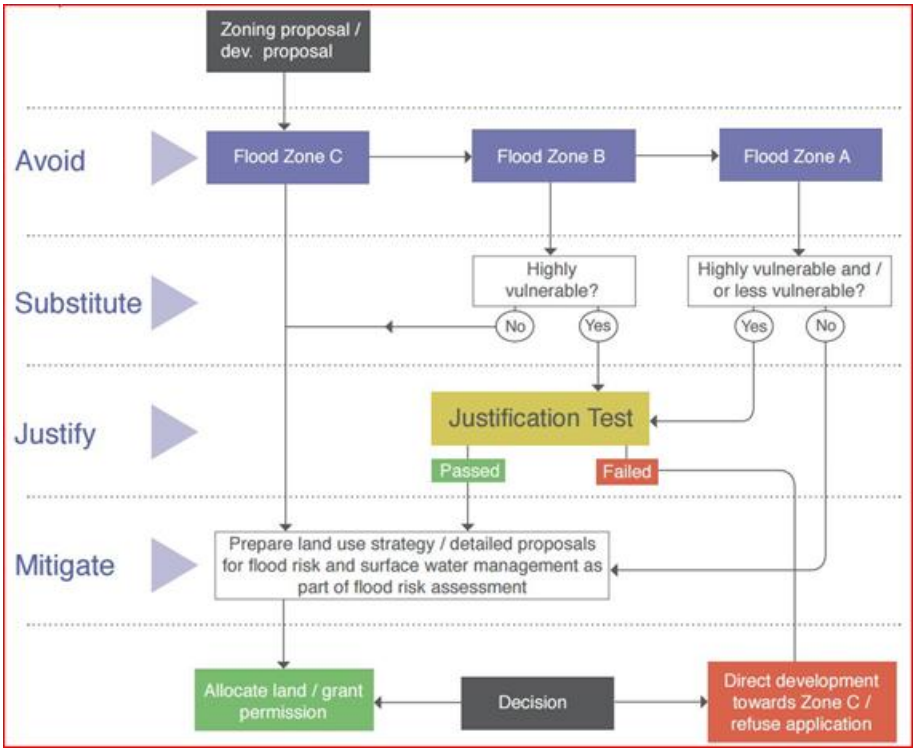


Figure 3.1 Sequential Approach Mechanism in the Planning Process (Fig. 3.2 from Flood Risk Management Guidelines)

The Sequential Approach is based on the following principles:

AVOID
Preferably choose lower flood risk zones for new developments

SUBSTITUTE
Ensure proposed development type is not especially vulnerable to the adverse impacts of flooding

JUSTIFY
Ensure that the development being considered is for strategic reasons

MITIGATE
Ensure that flood risk is reduced to acceptable levels

PROCEED
Only where Justification Test passed. Ensure emergency planning measures are in place.

3.4.3 Flood Risk Zones

Definitions of flood risk zones in the planning guidelines are based on probability of occurrence with defined three flood risk zones (High, Moderate and Low). These flood zones are as follows:

- Zone A High Probability – Highest risk of flooding: More than 1% probability of river flooding and more than 0.5% probability of tidal flooding. Development should be avoided and/or only considered through application of a justification test. Most types of development would be considered inappropriate in this zone. Development in this zone should be avoided and/or only considered in exceptional circumstances, such as in city and town centres, or in the case of essential infrastructure that cannot be located elsewhere, and where the justification test has been applied.
- Zone B Moderate Probability: Between 1 and 0.1% probability of river flooding or between 0.5 and 0.1% probability of coast flooding. Development should only be considered in this zone if adequate land or sites are not available in Zone C or if development in this zone would pass the Justification Test. Highly vulnerable development would generally be considered inappropriate in this zone, unless the requirements of the Justification Test can be met. Less vulnerable development and water-compatible development might be considered appropriate in this zone. In general however, less vulnerable development should only be considered in this zone if adequate lands or sites are not available in Zone C and subject to a flood risk assessment to the appropriate level of detail to demonstrate that flood risk to and from the development can or will adequately be managed.
- Zone C Low Probability: Less than 0.1% probability of river or coastal flooding. Development in this zone is appropriate from a flood risk perspective (subject to assessment of flood hazard from sources other than rivers and the coast) but would need to meet the normal range of other proper planning and sustainable development considerations.

These flood zones are determined on the basis of the probability of river and coastal flooding only and should be prepared by suitably qualified experts with hydrological experience. The derivation of these zones is broadly in line with those in common usage internationally. They are based on the current assessment of the 1% and the 0.1% fluvial events and the 0.5% and 0.1% tidal events, without the inclusion of climate change factors.

The provision of flood protection measures in appropriate locations, such as in or adjacent to town centres, can significantly reduce flood risk. However, the presence of flood protection structures should be ignored in determining the flood zones. This is because areas protected by flood defences still carry a residual risk of flooding from overtopping or breach of the defences and the fact that there may be no guarantee that the defences will be maintained in perpetuity. The likelihood and extent of this residual risk needs to be considered, together with the potential impact on proposed uses, at both development plan and development management stages, as well as in emergency planning. The finished floor levels within protected zones will need to take account of both urban design considerations and the residual risk remaining.

3.4.4 Development Type Vulnerability Classification

In determining the suitability of the Development within the various flood zones the vulnerability class of the development is taken into consideration. Three categories of vulnerability are considered as described in Table 3.1 and Figure 3.2 below:

Table 3.1 Classification of Vulnerability 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 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 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 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

Vulnerability Class	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

Figure 3.2 Requirement for Justification Test based on Vulnerability Group and Flood Zone Category

3.4.5 Justification Test

Further sequentially based decision making should be applied when undertaking the Justification Test for development that needs to be in flood risk areas for reasons of proper planning and sustainable development:

1. within zone or site, development should be directed to areas of lower flood probability,
2. where impact of the development on adjacent lands is considered unacceptable the justification of the proposal or zone should be reviewed,
3. where the impacts are acceptable or manageable, appropriate mitigation measures within the site and if necessary elsewhere should be considered.

A justification test is required where a planning authority is considering the future development of areas at a high or moderate risk of flooding, for uses or development vulnerable to flooding that would generally be inappropriate as set out above within the flood zones. In such cases the planning authority must be satisfied that it can clearly demonstrate on a solid evidence base that the zoning or designation for development will satisfy the justification test outline in Box 4.1 of the guidelines as presented below in Figure 3.3.

Box 4.1: Justification Test for development plans

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 3.3 Justification Test for Development Pplans

3.4.6 Flood Risk Assessment

A staged approach to flood risk assessment that covers both the likelihood of flooding and the potential consequences is recommended in carrying out a Flood Risk Assessment (FRA). The stages of appraisal and assessment are:

1. Stage 1 Flood Risk Identification
2. Stage 2 Initial Flood Risk Assessment
3. Stage 3 Detailed Flood Risk Assessment

Stage 1 Flood risk identification – to identify whether there may be any flooding or surface water management issues related to either the area of regional planning guidelines, development plans and local area plans (LAPs) or a proposed

development site that may warrant further investigation at the appropriate lower level plan or planning application levels.

Stage 2 Initial flood risk assessment – to confirm sources of flooding that may affect a plan area or proposed development site, to appraise the adequacy of existing information and to scope the extent of the risk of flooding which may involve preparing indicative flood zone maps. Where hydraulic models exist the potential impact of a development on flooding elsewhere and of the scope of possible mitigation measures can be assessed. In addition, the requirements of the detailed assessment should be scoped.

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 or land to be zoned, of its potential impact on flood risk elsewhere and of the effectiveness of any proposed mitigation measures.

All stages may not be needed in the FRA in order to inform the decision making process and often a Stage 2 assessment is sufficient at the strategic level to inform the decision making process. This will depend on the level of risk, the level of conflict with the proposed development and the scale of mitigation measure being proposed. For the purposes of applying the sequential approach, once a flood risk has been identified it can be avoided. Where development is planned in flood risk areas, a detailed assessment may be carried out within the FRA, so that the potential for development of the lands and their environmental and flood impact can be assessed.

- This Flood Risk Assessment has been carried out to support Variation No. 6 to Limerick County Development Plan (2010-2016) with the following key tasks identified: Identify the nature of flood risk (type and source) within the study area of the Foynes to Limerick Road Improvement Scheme in county Limerick
- Provide an improved understanding of flood risk issues along the proposed alignment within County Limerick
- Assess the flood risk to the Foynes to Limerick Road Improvement Scheme associated with the following proposed river crossings:
    - River Deel Crossing at Boolaglass (Foynes to Rathkeale Link Road)
    - River Deel Crossing at Rathkeale (Rathkeale Bypass (N21))
    - Robertstown River (Foynes to Rathkeale Link Road)
    - River Maigue Crossing (Rathkeale to Adare Road (N21))
    - River Greanagh Crossing (Rathkeale to Adare Road (N21))
- Assess the potential flood impact of the Foynes to Limerick Road Improvement Scheme
- Apply Sequential and Justification test to the Foynes to Limerick Road Improvement Scheme.

4.0 CLIMATE CHANGE AND FLOOD RISK

4.1 Introduction

There is a high degree of uncertainty in relation to the potential effects of climate change, and therefore a precautionary approach is required. Examples of precautionary approach include:

- Recognising that significant changes in the flood extent may result from an increase in rainfall or tide level and accordingly adopting a cautious approach to zoning lands in these potential transitional areas.
- Ensuring that the finish levels of structures are sufficient to cope with the effects of climate change over the life time of the development.
- Ensuring that proposed structures to protect against flooding (e.g. defence walls, flood embankments) are capable of adaptation to the effects of climate change when there is more certainty about the effects (e.g. foundations of flood defence designed to allow future raising of flood wall to combat climate change).

4.2 Climate Change Allowance for Fluvial Flood Flows

Climate change scenarios suggest for UK and Ireland fluvial floods in the 2080's increasing by up to 10% (low and medium low scenarios) or by up to 20% (medium high and high scenarios). Present recommendations are to include in the design flow a 20% increase in flood peaks over 50 years return period as a result of climate change. This scenario based on the Irish growth curve will result in a present day 100 year flood becoming a 25-year flood in approximately 50 years' time. The extent and expected levels of flooding are derived based on these flows.

Other predicted climate change effects for the UK are:

- A 4mm to 5 mm per annum rise in mean sea level
- Additional intensity of rainfall of 20%
- An additional 30% Winter rainfall by the 2080's
- A reduction of 35%/45% rainfall in Summer
- The 1 in 100 year rainfall storm to increase by 25%

DEFRA Guidance

In the UK research is ongoing to assess regional variations in flood allowances and the rate of future change. Current research thus far does not provide any evidence for the rate of future change let alone consider regional variations in such a rate. The UK Flood and Coastal Defence Appraisal Guidance (DEFRA, 2006) gives the climate change ranges as per Table 4.1 below and as a pragmatic approach it is suggested that 10% should be applied up to 2025, rising to 20% beyond 2025.

In Ireland general practice is to use a medium range climate change allowance for flood flows of 20% over the next 100 years. This rate has been adopted by the OPW for all of its Catchment Flood Risk Assessment and Management Studies (Lee, Dodder, Tolka CFRAMs, Shannon, West, etc.).

Table 4.1 UK Flood and Coastal Defence Appraisal Guidance (DEFRA, 2006)

UK Flood and Coastal Appraisal Guidance (DEFRA, 2006)				
Parameter	**1990 – 2025**	**2025 - 2055**	**2055 - 2085**	**2085 - 2115**
Peak rainfall intensity (preferably for small catchments)	+5%	+10%	+20%	+30%
Peak river flow (preferably for larger catchments)	+10%	+20%		

4.3 Sea Level Rise

Scientists predict that global sea level rise will have two main causes. Firstly, as the oceans heat up the water expands. At present this thermal expansion accounts for about half of the observed increase in sea level. The other cause is melting land ice from glaciers and ice caps. The rate of melt and the volumes of water locked within these sources are uncertain and this is a cause for concern.

In recent years, ice shelves have broken off huge ice sheets in Antarctica and Greenland. The ways in which they are melting is only now beginning to be understood fully enough to allow estimates of how fast this melt is occurring and how much this will affect sea levels. If they melt as fast as is now thought to be possible, sea levels could rise dramatically over the next century, flooding many of the world's major cities and much of the world's most productive farmland. Consequently, guidance on sea level rise allowances for flood risk management is continually changing as more scientific research is published with allowances likely to increase as opposed to decrease in future years.

The biggest threat to coastal flood risk areas is from sea level rise. Global mean sea levels are predicted to increase from a combination of thermal expansion of the water column and melt from the glaciers and reduction of liquid water storage on land. The Intergovernmental Panel on Climate Change Third Assessment Report (*IPPC TAR)* that preceded the published *IPCC Fourth Assessment Report* (2007) has been used as the basis of future sea level projections for Ireland. A best estimate increase of 480 mm to year 2100 has been suggested by Sweeney et al (2003) and used in the *Greater Dublin Strategic Drainage Study* (GDSDS 2005). This value was not directly challenged in the 2007 *IPCC* report, with a range of 0.2 - 0.51m given for the prudent Medium-High A2 emission scenario.

The UK DEFRA (2006) publication suggests for the UK and globally that significantly higher rates of sea level rise, particularly towards the end of the century, than the 500mm allowance that is currently considered.

Table 4.2 The UK Flood and Coastal Defence Appraisal Guidance (DEFRA, 2006) Regional Net Sea Level Rise Allowances

Region	**Assumed vertical Land Movement (mm/yr)**	**Net Sea-Level Rise (mm/yr)**				**Previous Allowances**
		1990-2025	**2025-2055**	**2055-2085**	**2085-2115**	
East of England	-0.8	4.0	8.5	12.0	15.0	6mm/yr constant
South West and Wales	-0.5	3.5	8.0	11.5	14.5	5mm/yr constant

Region	Assumed vertical Land Movement (mm/yr)	Net Sea-Level Rise (mm/yr)				Previous Allowances
		1990-2025	2025-2055	2055-2085	2085-2115	
NW & NE England, Scotland	+0.8	2.5	7.0	10.0	13.0	4 mm/yr constant

The latest IPCC fifth Assessment Report (2014) has investigated the current and future trends in global mean sea level rise (GMSLR) and have concluded with a high level of confidence under various emission scenarios considered (four modelled RCPS (Representative Concentration Pathways) that thermal expansion of the sea due to warming will increase Global mean sea level by between 0.15 to 0.3m by 2100. This report predicts at medium confidence the contribution of glacier mass loss to GMSLR for the four RCP scenarios. The global glacier volume is projected to decrease by 15 to 55% for RCP2.6, and by 35 to 85% for RCP8.5 and in between these rates for the other two RCP scenarios. RCP2.6 is representative for scenarios leading to very low greenhouse gas concentration level, it is a so called "peak" scenario with radiative forcing reaching a peak level of 3.1 W/m^2 mid-century and returning back to 2.6W/m^2 by 2100. RCP8.5 is characterised by increasing greenhouse gas emissions overtime leading to high greenhouse gas concentrations by 2100.

Projections of GMSLR by 2100 under the high RCP8.5 scenario are 0.53 to 0.98m with rises of 8 – 16mm/annum during 2081 to 2100 and under the low RCP2.6 scenario are a rise is 0.28 to 0.61mm.

Observations of GMSLR show that from 1901 to 1990 1.5mm per annum mean rise and from 1993 to 2010 the mean rise was 3.2mm per annum.

The IPCC concluded that it is very likely that sea level will rise in more than about 95% of the ocean area. About 70% of the coastlines worldwide are projected to experience sea level change within 20% of the global mean sea level change. GMSLR during 1901–2010 can be accounted for by ocean thermal expansion, ice loss by glaciers and ice sheets, and change in liquid water storage on land. It is very likely that the 21st-century mean rate of GMSLR under all RCPs will exceed that of 1971–2010, due to the same processes. It is virtually certain that global mean sea level rise will continue for many centuries beyond 2100, with the amount of rise dependent on future emissions.

The Irish Coastal Protection Strategy Study prepared by RPS on behalf of the OPW (RPS, 2010) uses a Mid-Range Future Scenario (MRFS) reflecting changes that are within the typical range projected for mean sea level rise of 500mm. The glacial isostatic adjustment for land movement along the west coast is projected to be very minor. An allowance of 500mm mean sea level rise to the year 2100, which accounts for a 500mm increase in mean sea level and no increase for isostatic land movement adjustment was included in that study to simulate a potential mid-range future climate change scenario.

The Flood Risk Planning Guidelines recommends a precautionary approach to climate change effects in respect to flooding due to the high level of uncertainty in predicting its effects. It recommends the following in this respect:

- Caution in zoning lands in these potential transitional areas that would be impacted if climate change predictions occur

- Ensuring that the level of structures designed to protect against flooding are sufficient over the lifetime of the design to cope with the effects of climate change
- Ensuring that structures to protect against flooding and the development are capable of adaption to the effects of climate change when there is more certainty as to the effects.

Notwithstanding the above precautionary principle, the flood risk zones defined in the Flood Risk Planning Guidelines are based on the present-day assessment of the 100 year (1%) and 1000 year (0.1%) return period for fluvial flooding and the 200 year and 1000 year for tidal flooding (without climate change) for defining flood risk zones A, B and C.

The OPW provide specific guidance as to the allowances in their publication entitled "Assessment of Potential Future Scenarios, Flood Risk Management Draft guidance, 2009 and these allowances are summarised in Table 4.3.

Table 4.3 Climate Change Allowances for Future Scenarios 100 year

Criteria	Mid-Range Future Scenario MRFS	High-End Future Scenario HEFS
Mean Sea Level Rise	+500mm	+1000mm
Land Movement	-0.5mm/year	-0.5mm/year
Extreme Rainfall Depths	+20%	+30%
Flood Flows	+20%	+30%

4.3.1 Summary

The recommended climate change allowance in respect of impact assessment and setting of safe finish levels is based on the medium range scenarios of 20% fluvial flood increase and 0.5m sea level rise plus adjustment for isostatic tilting of the land mass (typically +50mm). Such an approach meets the current OPW practices in respect to Section 50 approval and CFRAM mapping.

For the purposes of inclusion of climate change the 1000year flow and flood level projections are used to represent the 100year flood with climate change. In respect to Flood Risk Zones and in keeping with the Flood Risk Management Planning Guidelines 2009 the flood risk zones A, B and C are defined based on present day estimates (i.e. no climate change allowance included) of the 100year and 1000year fluvial flood levels and 200year coastal flood levels. The use of climate change allowance figures confers an additional margin of safety over those which were used to arrive at the Flood Risk Zones in the Flood Risk Management Planning Guidelines 2009.

5.0 HYDROLOGY OF PROPOSED ROUTE

The proposed road development is located within the Shannon River Basin District (RBD) (Hydrometric Area 24) and specifically the Shannon Estuary South Unit of Management (UoM). The hydrology of the proposed road corridor is dominated by the River Shannon and its associated network of tributaries. The south bank of the Shannon Estuary is located within close proximity of the proposed road development at Foynes.

The proposed road development crosses a number of rivers, streams and their tributaries across the length of the route. The drainage within the area is principally in a south to north direction flowing towards the Shannon Estuary. The main watercourses in the area include the River Deel and River Maigue. Other watercourses include Robertstown (Shanagolden) River, Ahacronane River, Lismakeery Stream, Greanagh River and Clonshire River.

The streams and river catchments intercepted by the proposed Foynes to Limerick Road Improvement Scheme Route Corridor are presented in Figure 5.1.

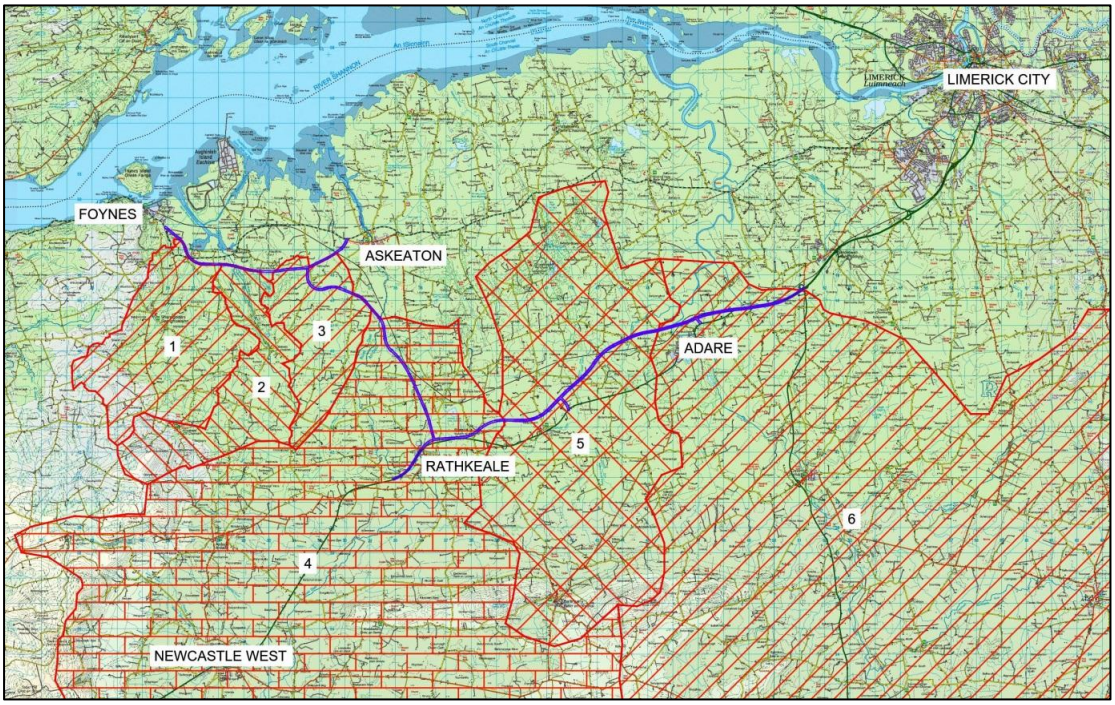


Figure 5.1 Watercourse Catchments

The characteristics of these watercourses are summarised below:

1. Robertstown River

   The Robertstown River (also known as the Shanagolden Stream) is a minor stream with a catchment area of approximately 31km^2 which rises in the hills to the south west of Shanagolden village. The 100 year flow is estimated at 18.3m^3/s. he stream discharges into the Robertstown Creek which is a tidal inlet of the Shannon Estuary.

2. Ahacronane River

   The Ahacronane River has a catchment area of approximately 23km^2 and begins in the hills near Kilcolman, flowing north through Creeves before also

discharging into the Robertstown Creek. The 100 year flow is estimated at 17.1m^3/s.

3. Lismakeery Stream

   The Lismakeery Stream rises near Kilquane and flows north towards Lismakeery and Ballycullen before discharging to the Shannon Estuary at Tomdeely North. It has a catchment area of approximately 18km^2 and the 100 year flow is estimated at 9.9m^3/s.

4. River Deel

   The River Deel rises in the Mullaghareirk Mountains near Dromina. It flows roughly in a north-westerly direction through the mountains, where it is joined by numerous tributaries, including the Finglasha River and the Ahavarragh Stream which drains the lands upstream of Dromcolliher. Downstream of Newcastle West, the River Deel is joined by the rivers Arra, Dooally and Daar, which drain the steep topography of the Knockanimpaha Mountains which bound the west of the catchment.

   Downstream of this confluence the River Deel flows north east, through agricultural plains and roughly follows the direction of the N21 towards and through the centre of Rathkeale. Flowing north from Rathkeale the Deel flows through Askeaton, and on to the Shannon Estuary. Where the River Deel enters the Shannon Estuary, the catchment area is approximately 597km^2. The 100 year flow at Rathkeale is estimated at 184.6m^3/s.

   The River Deel catchment drainage scheme was completed in 1968 and focused on improved drainage for agricultural purposes.

5. Greanagh River/Clonshire River

   The River Greanagh and Clonshire catchments drain an area of approximately 122km^2. The source of the Greanagh catchment originates to the north of Ballingarry. It flows north towards the townland of Rower More, where it meets the River Clonshire. The River Greanagh then joins the River Maigue just north of Adare. The 100 year flow is estimated at 33.1m^3/s.

   A drainage improvement scheme has been undertaken on the lower reaches of the Greanagh with flood embankments, back drains and flapped outlets present however it is not known when this was undertaken (likely 1960s/1970s).

6. River Maigue

   The River Maigue catchment drains an area of approximately 1122km^2. The source of the catchment originates in the Ballyhoura Mountains (County Cork). From North Cork, the River Maigue flows east until it joins the River Loobagh and then continues north from Bruree. Upstream of Croom, the Camoge River joins the River Maigue from the east. Downstream of Croom, the River Maigue flows to the northwest towards Adare and is joined by the Greanagh River. Tides become influential once the river crosses through Adare. The 100 year flow at Castleroberts (just upstream of Adare) is estimated at 246.3m^3/s.

   Multiple drainage improvement schemes have been undertaken throughout the catchment area. In the lower reaches of the Maigue, flood embankments, back drains and flapped outlets are present which was undertaken between 1973 and 1986.

6.0 FLOOD RISK ASSESSMENT OF PROPOSED CORRIDOR AS RELATES TO PROPOSED AMENDMENT

6.1 STAGE 1 Flood Risk Identification

The purpose of Stage 1 – Flood Risk Identification is to establish whether a flood-risk issue exists or may exist in the future. If there is a potential flood risk issue then, in accordance with 'The Planning System and Flood Risk Management – Guidelines for Planning Authorities (DOEHLG 2009)', the flood risk assessment procedure should move to 'Stage 2 – Initial flood risk assessment'. If no potential flood risk is identified during Stage 1 then the overall flood risk assessment can be concluded.

The following information and data was collated as part of the screening assessment for the proposed road corridor.

6.1.1 OPW Flood Hazard Maps

The OPW Flood Hazard Maps Website (www.floodmaps.ie) was consulted in relation to available historical or anecdotal information on any flooding incidences or occurrence in the vicinity of the proposed road corridor. It is important to note that Floodmaps.ie is managed by OPW and Local Authorities and is not an exhaustive archive of flood events.

Figure 6.1 shows mapping from the Flood Maps Website, which indicates that there are historical records of flooding occurring along the River Maigue in Adare south of the crossing location. The most recent flood event occurred in 2014 because the arches of the N21 masonry bridge in Adare town centre restricted rising waters. Approximately 2-3km of the N21 road was affected by the floodwaters. There is record that this zone has flooded in the past. Recurring floods have occurred in Islandea; these floods were caused by tidal and rainfall runoff and overtopping of the embankments.

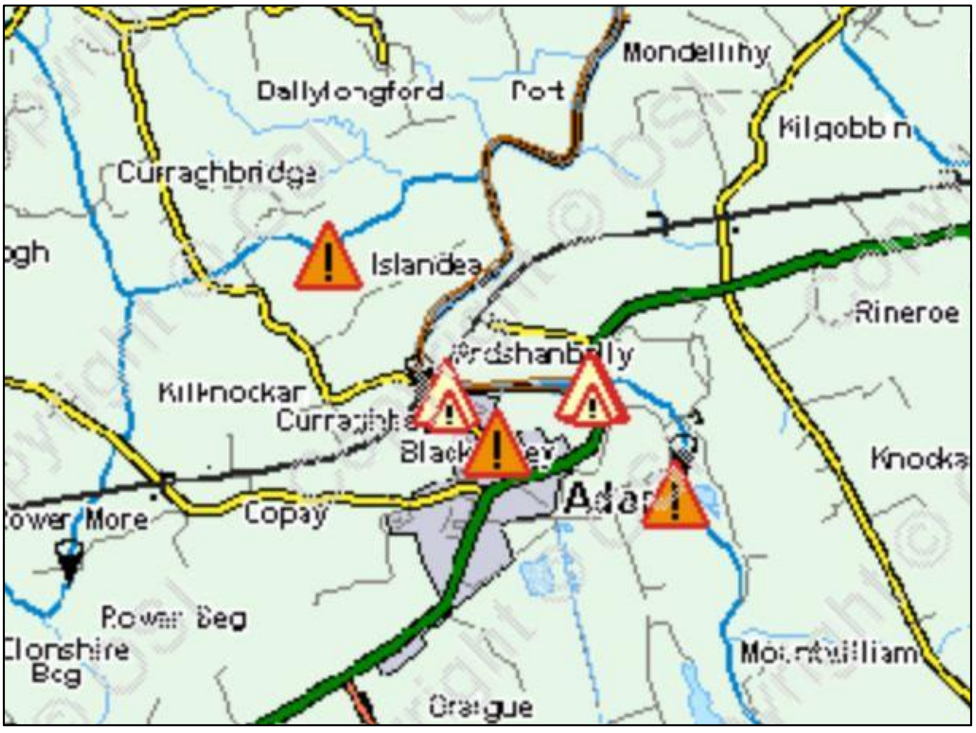


Figure 6.1 Historical Flood Records (Adare)

There are no historical records of flooding occurring in the immediate study area for the proposed River Greanagh crossing. There is an historical record of a flood event at Curraghbridge/Islandea, downstream from the proposed crossing location. The report indicates that flooding occurred behind the OPW embankments; however no details specifying the cause or the date are given.

The River Deel has no recorded flood events in the vicinity of the proposed crossing point at Boolaglass; see Figure 6.2 below. Major events are known to have occurred in the Deel catchment that affected Askeaton, Dromcolliher, Newcastle West and Rathkeale in the winter of 1968, August 1997 and August 2008.

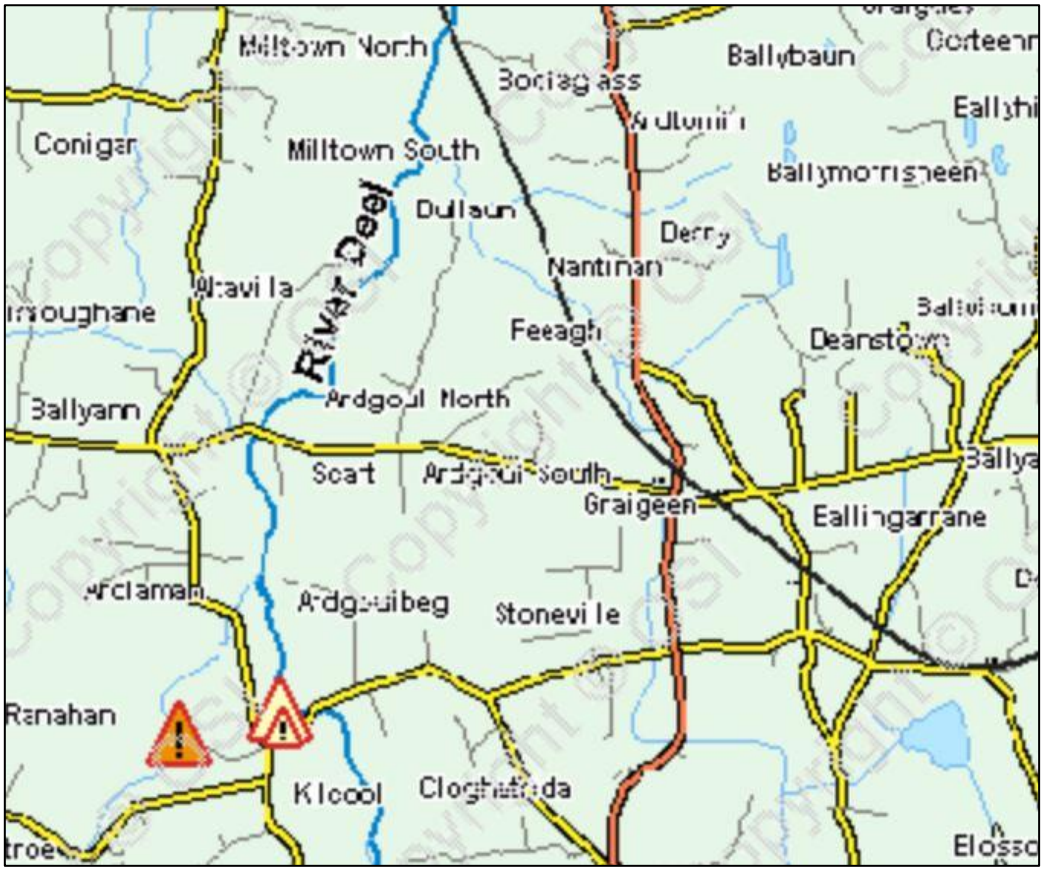


Figure 6.2 Historical Flood Records (River Deel at Boolaglass)

Flooding in Rathkeale from the River Deel is also indicated in the OPW Flood Hazard Viewer at a number of locations as illustrated in Figure 6.3 below. The accompanying reports highlight flooding at the Deel Bridge in Rathkeale in the winter of 1968/69 due to periods of heavy rainfall.

Figure 6.3 Historical Flood Records (River Deel at Rathkeale)

The OPW Flood Hazard Viewer reports indicate that there have been regular flood events in the Robertstown area, near the proposed Robertstown river crossing site. The flooding has been caused by the combination of tides, intense rainfall, and south westerly winds. These are illustrated in Figure 6.4 below. No additional information was available on the flooding incident recorded on the Ahacronane River.

Figure 6.4 Historical Flood Records (Robertstown)

The flood records indicate that the road at Point 1 shown in Figure 6.5 floods regularly at times of heavy rainfall and runoff when combined with the inadequate capacity of the stream downstream of the N69. Older records attribute the flooding at this point to a combination of very high tides, very intense rainfall and south-westerly winds.

The flood records for Point 2 in Figure 6.5 record that two houses flood at times of very high tides, very intense rainfall and south-westerly winds. The records note that some parts of the nearby channel are embanked but the embankments have fallen in to disrepair and a number of breaches exist.

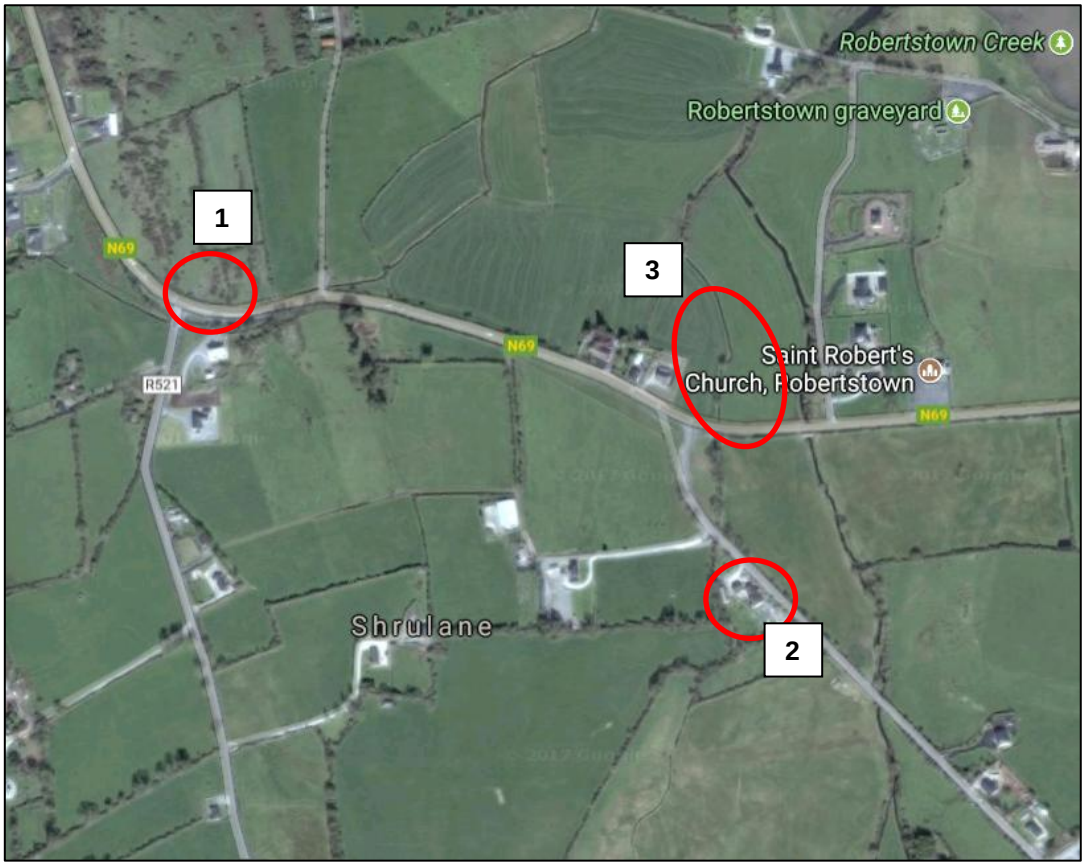


Figure 6.5 Location of Historic Flooding at Robertstown

It is noted that instances of nearly annual flooding / historic flooding have occurred in the area to the west of St. Roberts Church, Robertstown, Point 3, however no details on such events are held within the Floodmaps.ie data source. No other incidents along the proposed road corridor are presented in this data source.

6.1.2 Hydrometric Data

Existing sources of hydrometric data from the OPW (www.waterlevel.ie) were investigated. This investigation has determined that there are nearby active permanent hydrometric gauging stations located at Adare Quay (24062) and Adare Manor (24009) on the River Maigue. There is also a gauging station further upstream at Castleroberts (24008). There is an active permanent hydrometric gauging station located at Normoyle's Bridge (24067) on the River Greanagh which is approximately 900m southwest of the proposed river crossing location. These are illustrated in Figure 6.6 below.

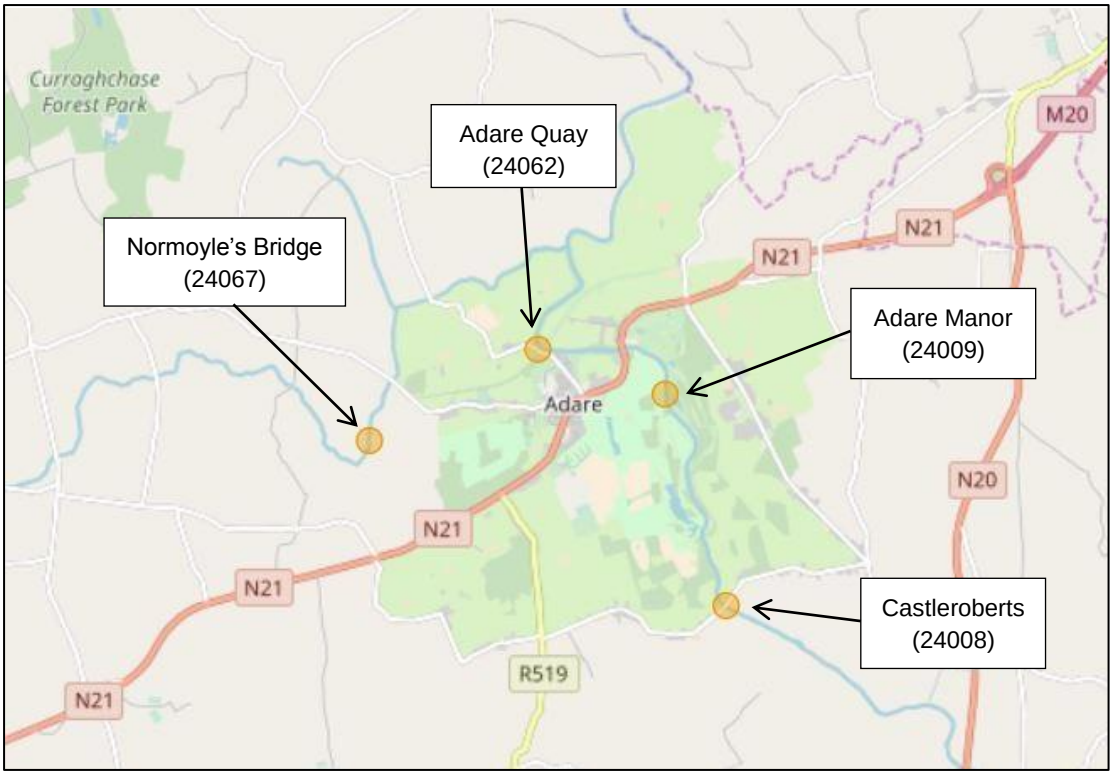


Figure 6.6 Gauging Stations in Vicinity of the River Maigue and River Greanagh Crossings

Figure 6.7 Gauging Stations in Vicinity of the River Deel Crossing

A number of gauging stations are present on the River Deel with the closest active permanent hydrometric gauging station located at Rathkeale (24013) which is

approximately 6km upstream of the proposed River Deel crossing as shown above in Figure 6.7. No active gauging stations are present in the Robertstown crossing area.

6.1.3 OPW Land Benefitting Mapping

It is known that arterial drainage schemes have been undertaken within the Deel, Greanagh and Maigue catchments from the 1960s to 1980s which involved the construction of flood embankments, back drains and flapped outlets along with dredging and straightening of the main channels. The works on the River Deel created benefit for approximately 11,900 acres with the works on the Maigue and Greanagh creating benefit for approximately 30,500 acres. Figure 6.8 below is a map extracted from the OPW Arterial Drainage viewer (https://maps.opw.ie/drainage/map/).

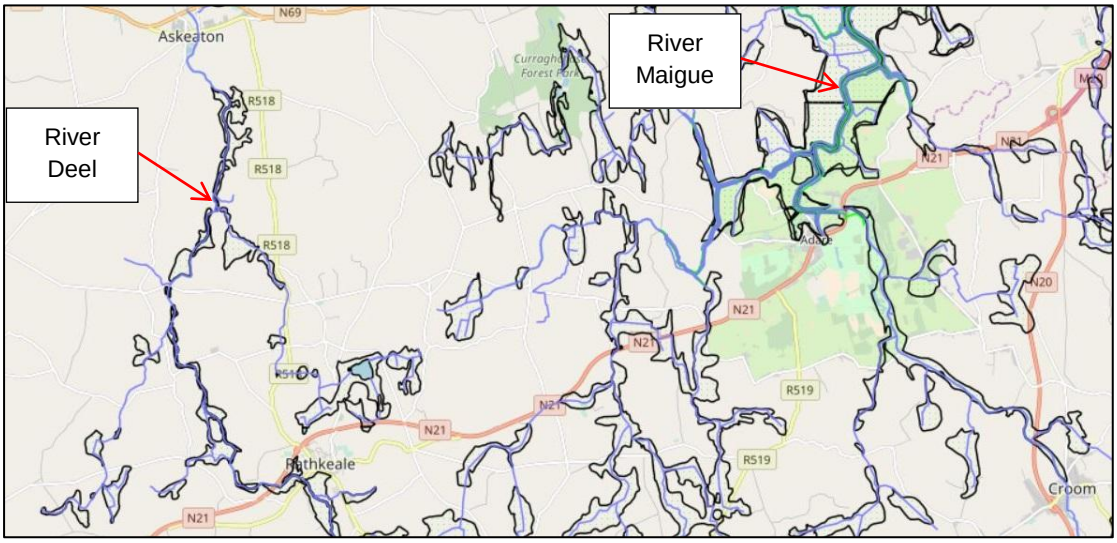


Figure 6.8 OPW Benefitting Lands

The nature of such works results in areas, which while defended, are at risk of significant flooding should maintenance of the drainage features lapse.

6.1.4 PFRA Mapping

Preliminary flood risk maps for Limerick are available from the OPW PFRA (Preliminary Flood Risk Assessment) mapping produced in 2010 as part of the initial CFRAM Nationwide study and preliminary flood risk mapping of fluvial and coastal sources prepared by JBA Consulting for Planning Authorities. These studies are preliminary using DTM (Digital Terrain Model) LiDAR (Light Detection and Ranging) datasets and represent screening information of appropriate quality for input to a Strategic Flood Risk Assessment Study.

Figure 6.9,

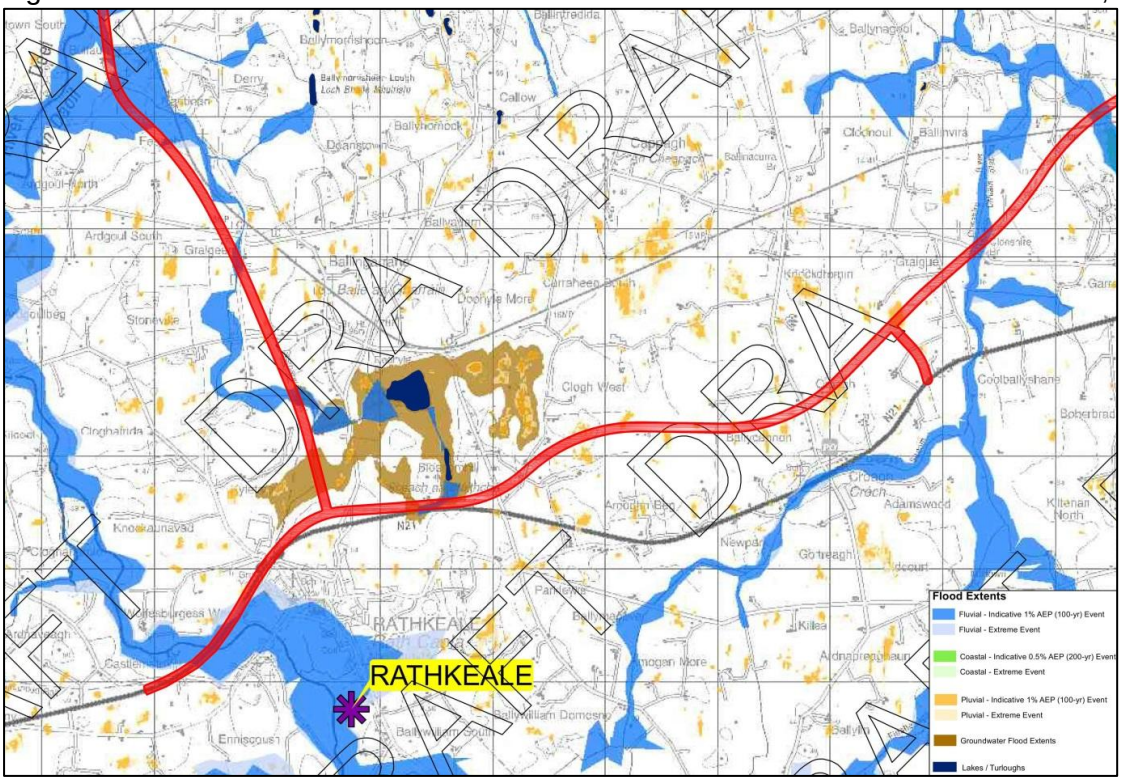


Figure 6.10 and Figure 6.11 below show the proposed route corridor (in red) overlaid on the PFRA mapping and helps to identify areas which may be subject to flooding. The proposed route corridor passes through and close to areas of fluvial and coastal along with localised areas of pluvial and groundwater flooding.

The purple asterisks on these figures indicate a "Probable Area for Further Assessment" (AFA) which formed part of the outcome of the PFRA process. These are typically urban areas which are seen as having a high risk of flooding and therefore required a more in-depth study than that undertaken as part of the PFRA process.

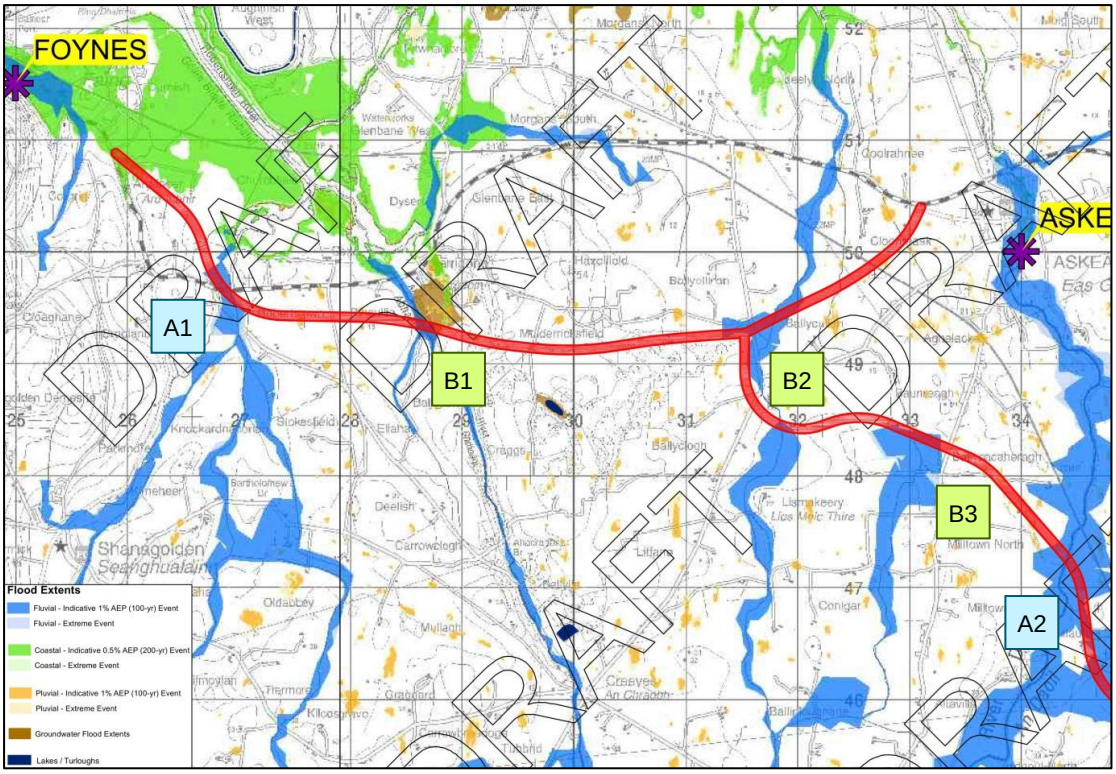


Figure 6.9 PFRA Map Extract with Proposed Road Corridor (Foynes)

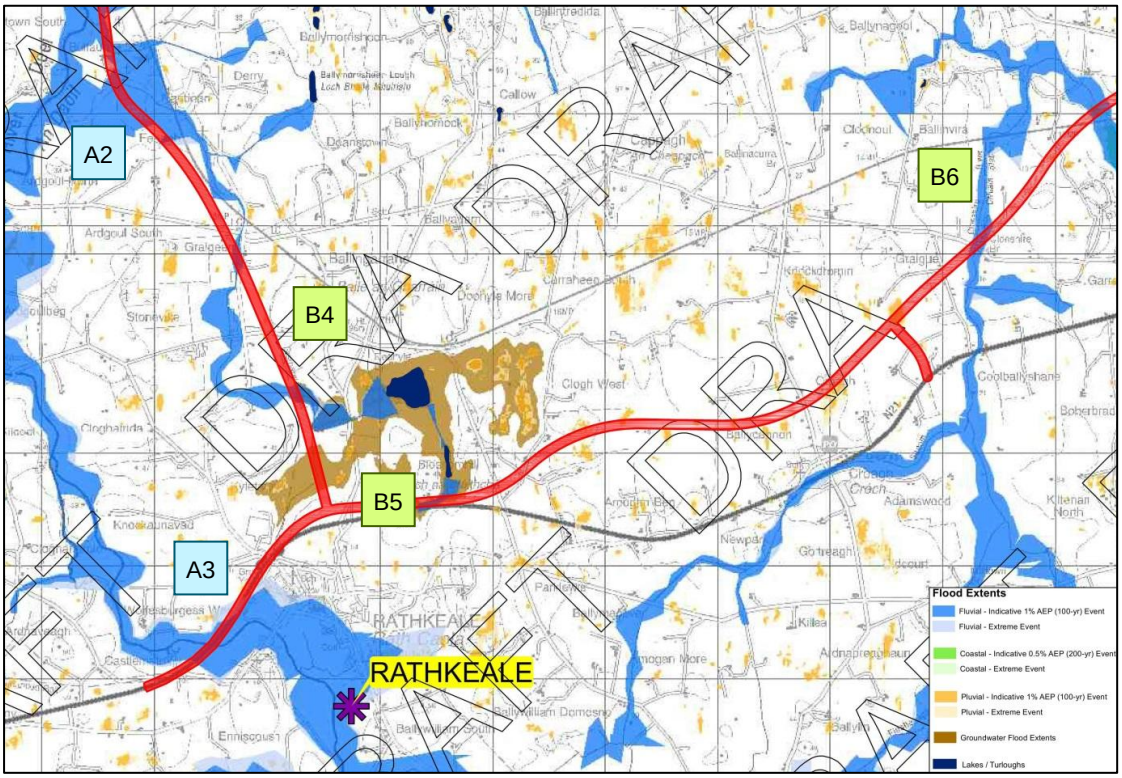


Figure 6.10 PFRA Map Extract with Proposed Road Corridor (Rathkeale)

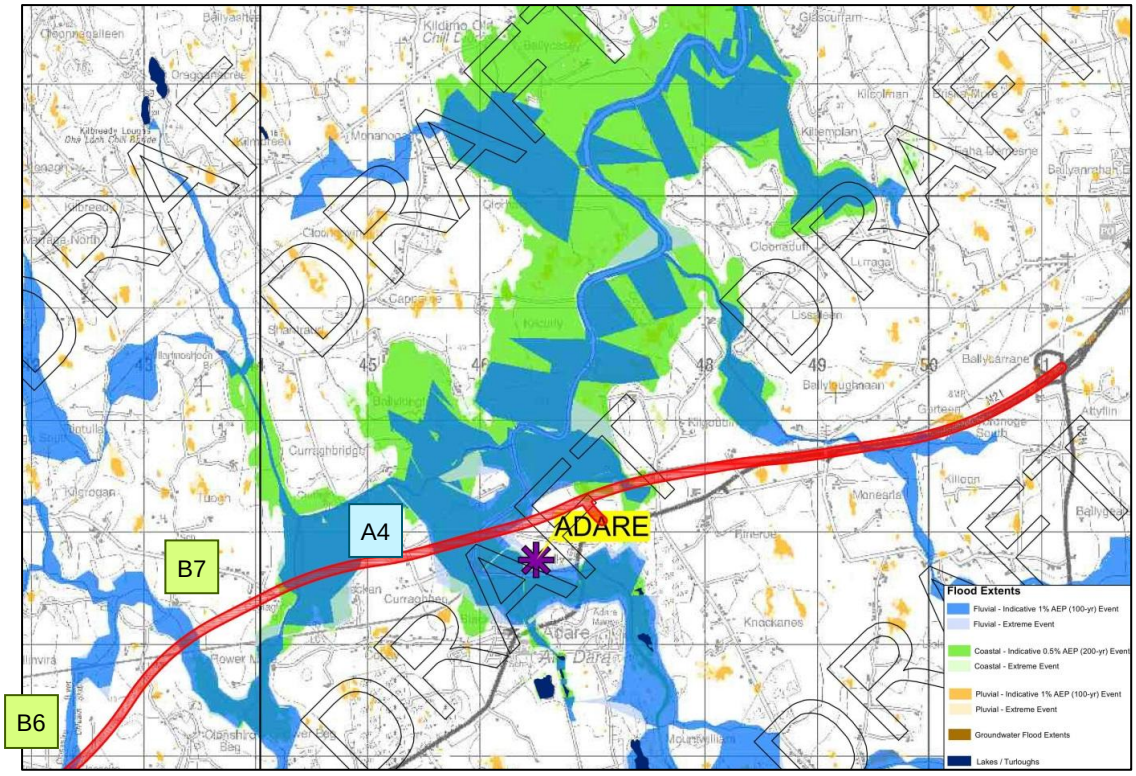


Figure 6.11 PFRA Map Extract with Proposed Road Corridor (Adare)

The areas of potential impact are summarised in Table 6.1 below. The primary areas of impact would appear to be in the vicinity of the Robertstown crossing (A1), Deel crossings (A2 & A3) and the Greanagh and Maigue crossings (A4).

Table 6.1 Impact Summary (PFRA)

Reference	Watercourse	Scheme Location	Flooding Source	Comment
A1	Robertstown	N69, Ch2350 - 2900	Fluvial	Site Specific FRA required
A2	Deel	N69, Ch23800 - 25500	Fluvial	Site Specific FRA required
A3	Deel	N21, Ch49900 - 50000	Fluvial	Site Specific FRA required
A4	Greanagh & Maigue	N21, Ch60650 - 63000	Fluvial, Coastal	Site Specific FRA required
B1	Ahacronane	N69, Ch4350 - 4650	Fluvial	Mitigated through normal road design procedures[1]
B2	Lismakeery	N69 @ Ballyclogh Rbt N69, Ch20900 - 21100	Fluvial	Mitigated through normal road design procedures[1]
B3	Lismakeery Tributary	N69, Ch22000 - 22500	Fluvial	Mitigated through normal road design procedures[1]
B4	Deel Tributary	N69, Ch28150 - 28300	Fluvial	Mitigated through normal road design procedures[1]

Reference	Watercourse	Scheme Location	Flooding Source	Comment
B5	N/A	N21 @ N69 Junction	Groundwater	Large area encountered but already drained by OPW arterial drainage scheme
B6	Greanagh Tributary	N21, Ch58000 - 58300	Fluvial	Mitigated through normal road design procedures[1]
B7	Greanagh Tributary	N21, Ch59600 - 59800	Fluvial	Mitigated through normal road design procedures[1]

1 – Normal mitigation measures include culverting of watercourses and ditches to accommodate the scheme. The construction of culverts will require OPW Section 50 Approval prior to commencement of construction. The flood risk associated with the secondary areas is seen as minor in comparison with the primary areas.

6.1.5 CFRAM Mapping

Currently more detailed flood risk maps for identified vulnerable urban areas have been prepared by the OPW through the various CFRAM studies, including the Shannon CFRAM which is relevant to this study (final draft versions published July 2016). The extent of the fluvial mapping available for the study area is shown in Figure 6.12 below. It should be noted that there are also corresponding coastal maps available of the same extents for Adare, Askeaton and Foynes.

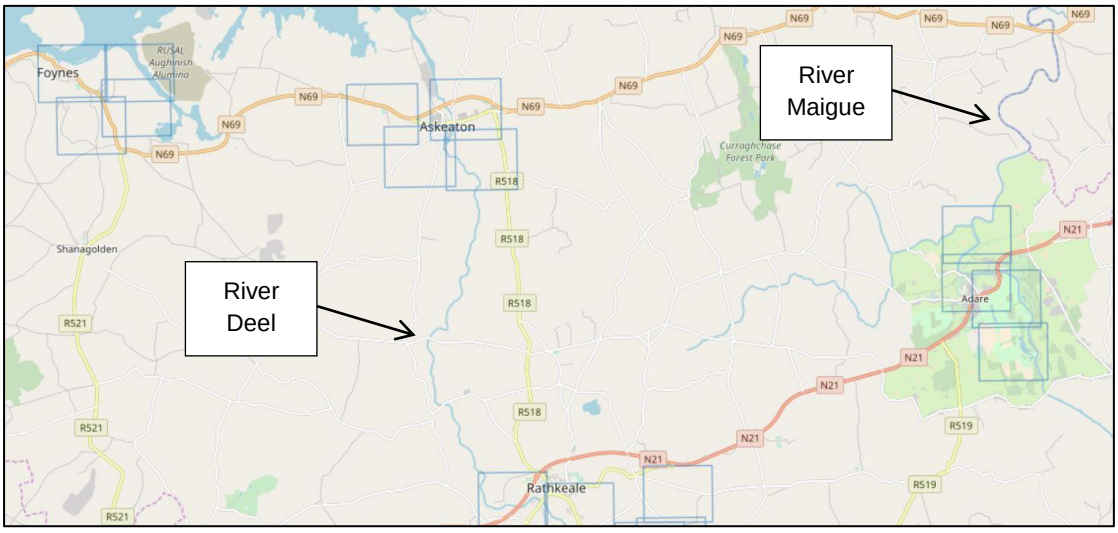
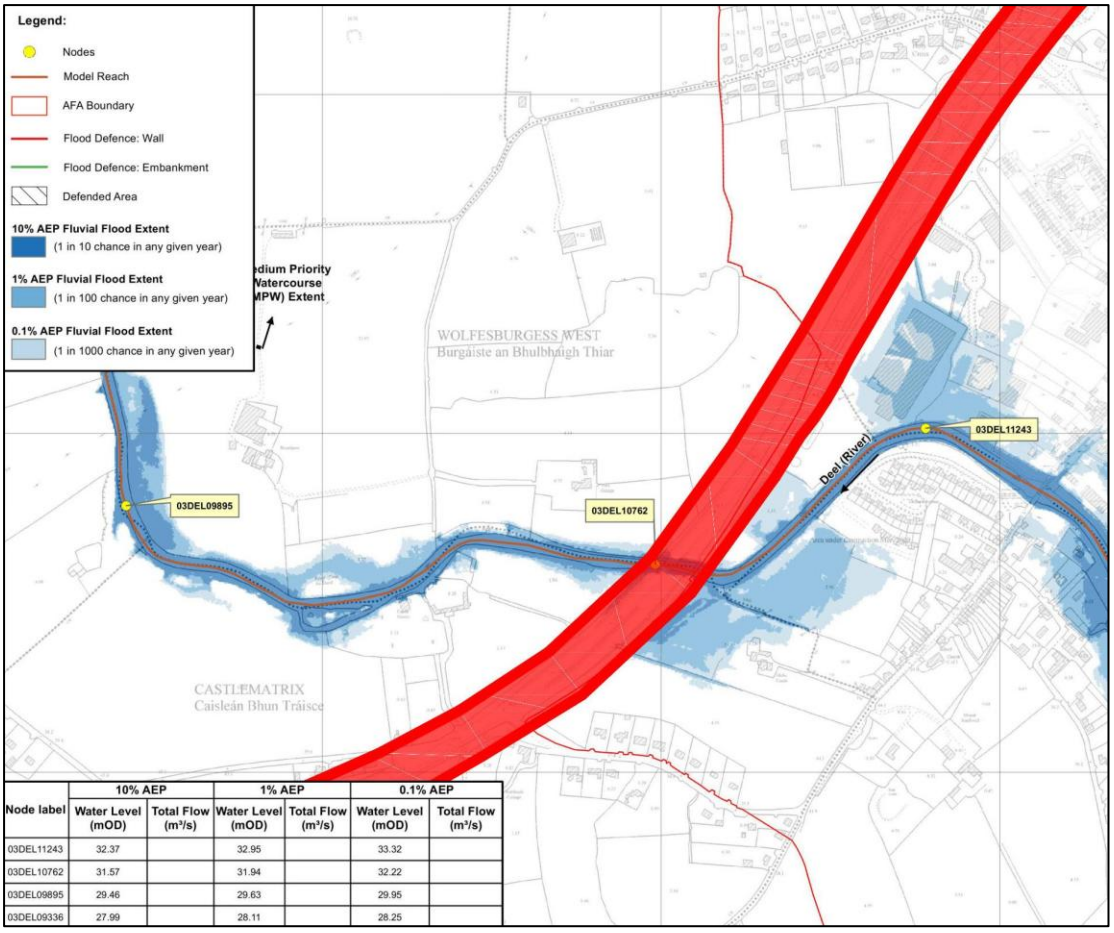


Figure 6.12 CFRAM Mapping Locations within the Study Area

At this stage of the CFRAM process all the identified flood risk study areas have final draft flood inundation mapping prepared and published on the OPW CFRAM website and also Final DRAFT Flood Risk Management Plans. The Final CFRAM reports and mapping are expected to be published in January 2018 once approved by the Minister.

Final Draft CFRAM flood mapping is available for the proposed River Deel crossing point at Rathkeale; refer to Shannon CFRAM drawing S24RAE_EXFCD_F1_02 (published June 2016). Extracts from this mapping is presented in Figure 6.13 below:



Node label	10% AEP		1% AEP		0.1% AEP	
	Water Level (mOD)	Total Flow (m³/s)	Water Level (mOD)	Total Flow (m³/s)	Water Level (mOD)	Total Flow (m³/s)
03DEL11243	32.37		32.95		33.32	
03DEL10762	31.57		31.94		32.22	
03DEL09895	29.46		29.63		29.95	
03DEL09336	27.99		28.11		28.25	

Figure 6.13 River Deel (Rathkeale) CFRAM Fluvial Extents

This mapping gives an estimated 100year and 1000year present day (i.e. without climate change) fluvial flood level for a model hydraulic reference node located directly downstream of the route corridor crossing location of 31.94m OD Malin and 32.22m OD Malin respectively.

Final Draft CFRAM flood mapping is also available for the proposed River Maigue crossing point; refer to Shannon CFRAM drawings S24ADE_EXFCD_F1_01 and S24ADE_EXFCD_F1_02 (published June 2016). Extracts from this mapping is presented in Figure 6.14 and Figure 6.15.

This mapping gives an estimated 100year and 1000year present day (i.e. without climate change) fluvial flood level for a model hydraulic reference node located directly downstream of the route corridor crossing location of 4.05m OD Malin and 4.46m OD Malin respectively. The 200 year coastal flood level at the same node is 4.41m OD.

The CFRAM maps presented for the Maigue River show extensive flooding on both sides of the watercourse. The CFRAM mapping also indicates an embankment protection flood defence along both banks of the River.

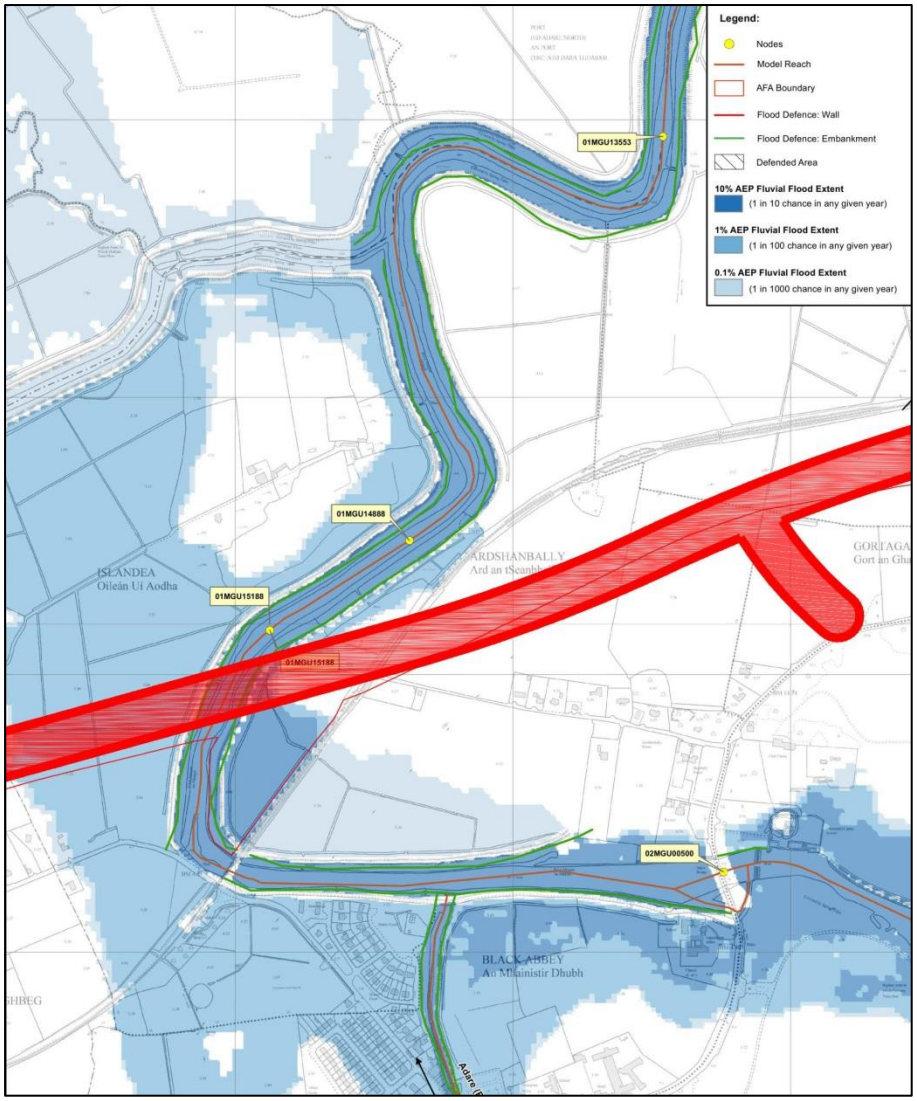


Figure 6.14 River Maigue CFRAM Fluvial Extents

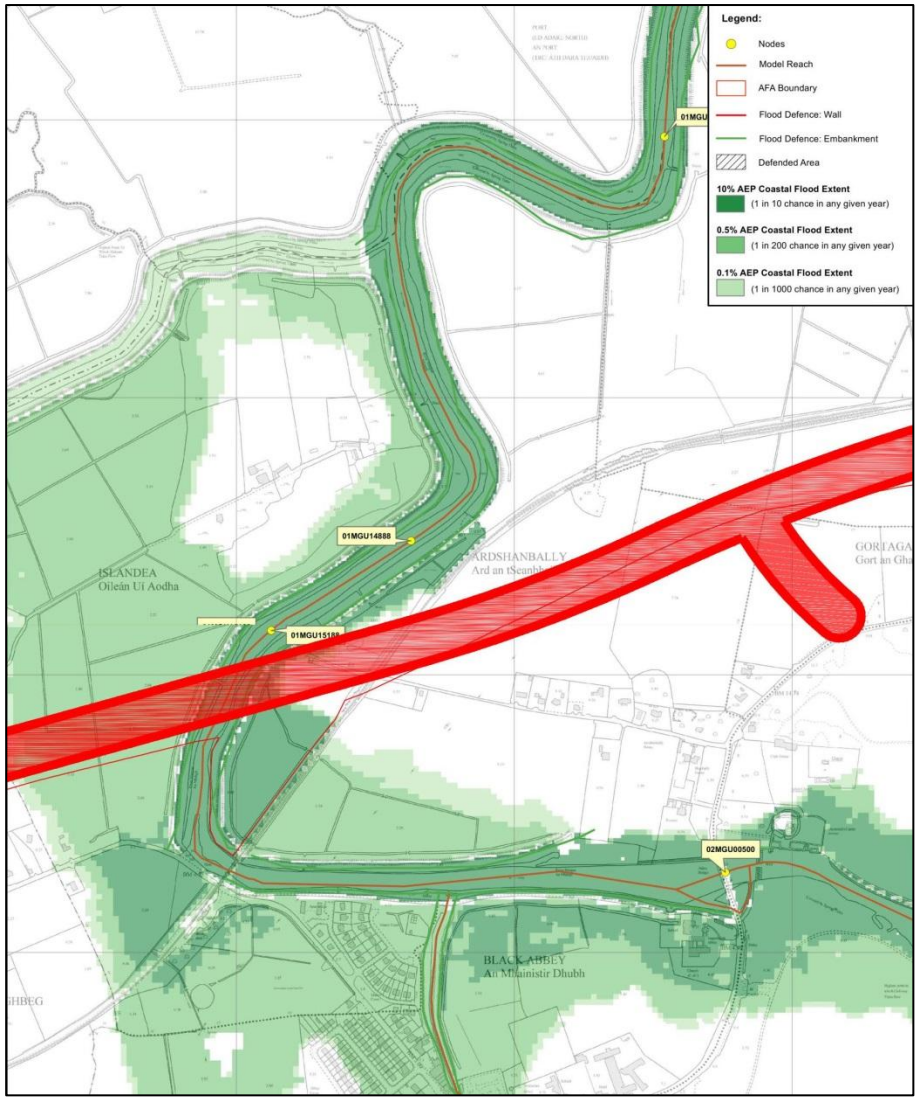


Figure 6.15 River Maigue CFRAM Coastal Extents

The other proposed river crossings of the Foynes to Limerick Road Improvement Scheme are not covered on any coastal or fluvial CFRAM flood extent maps as the crossing points are not located within an AFA (Area for Further Assessment) in the Shannon Basin CFRAM study area.

6.1.6 ICPSS Study

The Irish Coastal Protection Strategy Study (IPCSS) was undertaken between 2005 and 2011 to produce an overview of coastal flood hazards at a strategic level. The findings of this study were then incorporated in to the OPW PFRA mapping. The proposed road corridor falls within the extents of the South West Coast (Bantry Bay to Ballyvaghan Bay) study area.

The only section of the proposed road corridor which is impacted by potential coastal flooding is the section to the north of Adare in the vicinity of the River Maigue and River Greanagh crossings. Figure 6.16 below is an extract from the 0.5% AEP (annual exceedance probability) depth map produced as part of the ICPSS study. All other sections are sufficiently far inland to have no impact from coastal events.

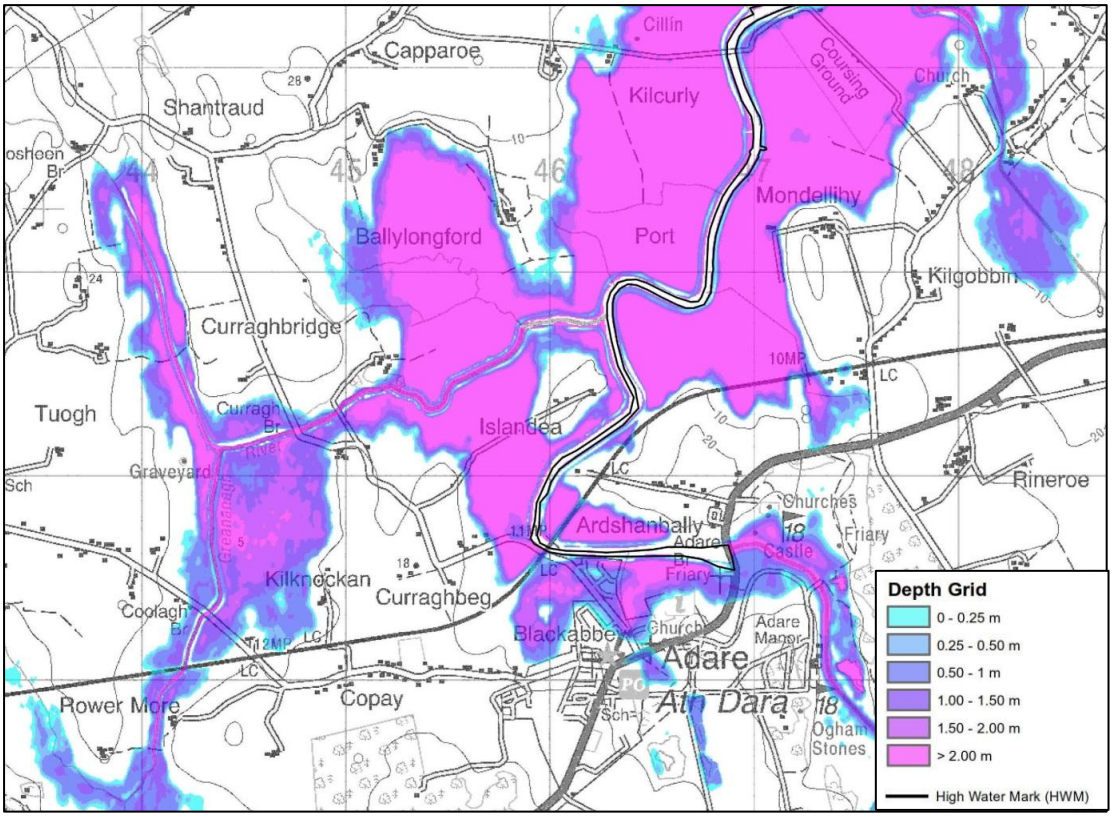


Figure 6.16 ICCPS Study 0.5% AEP Depth Map for Adare

6.2 STAGE 2 Initial Flood Risk Assessment

The Strategic Flood Risk Assessment for the proposed road corridor, in the context of the proposed Variation 6 to the Limerick County Plan identifies the following key sources of flood risk that are to be crossed by the proposed road corridor:

1. Robertstown River
2. River Deel at Boolaglass
3. River Deel at Rathkeale
4. River Maigue & River Greanagh

6.2.1 Robertstown Crossing

The proposed crossing point on the Robertstown River is through an area of localised floodplain with a known history of flooding, particularly during very high tides, intense rainfall, and south westerly winds as outlined in Section 6.1.1. This area was not covered by the current CFRAM mapping and therefore in order to determine the flood level a linked 1D-2D flood model was constructed using InfoWorks ICM hydraulic modelling software.

InfoWorks ICM is widely used for 1D and 1D-2D linked hydraulic modelling and represents the watercourse in 1D with the surrounding floodplain area as a 2D TIN surface. The data used to construct the model was the topographical and river channel survey procured as part of the road scheme development.

Hydrological data for the watercourse and an adjacent minor tributary was derived through the use of the OPW Flood Studies update web-site portal for estimating flood flows. The peak Q100 & Q1000 flows for both watercourses are as given in Table 6.2 below:

Table 6.2 Robertstown Estimated Flood Flows

Watercourse	Q100 Peak Flow (m^3/s)	Q1000 Peak Flow (m^3/s)
Robertstown River (B1)	17.22	21.42
Minor Tributary (B1A)	1.09	1.34

Flood simulations were conducted for the Robertstown study based on these flows. The predicted flood levels upstream of the proposed crossing points at cross section B1_0457 & B1A_0204 are as given in Table 6.3 below with the flood extents map for the Q100 event shown in Figure 6.17.

Table 6.3 Robertstown Predicted Flood Levels

Watercourse	Cross Section	Q100 Flood Level (mOD)	Q1000 Flood Level (mOD)
Robertstown River	B1_0457	6.83	6.94
Minor Tributary	B1A_0204	6.17	6.22

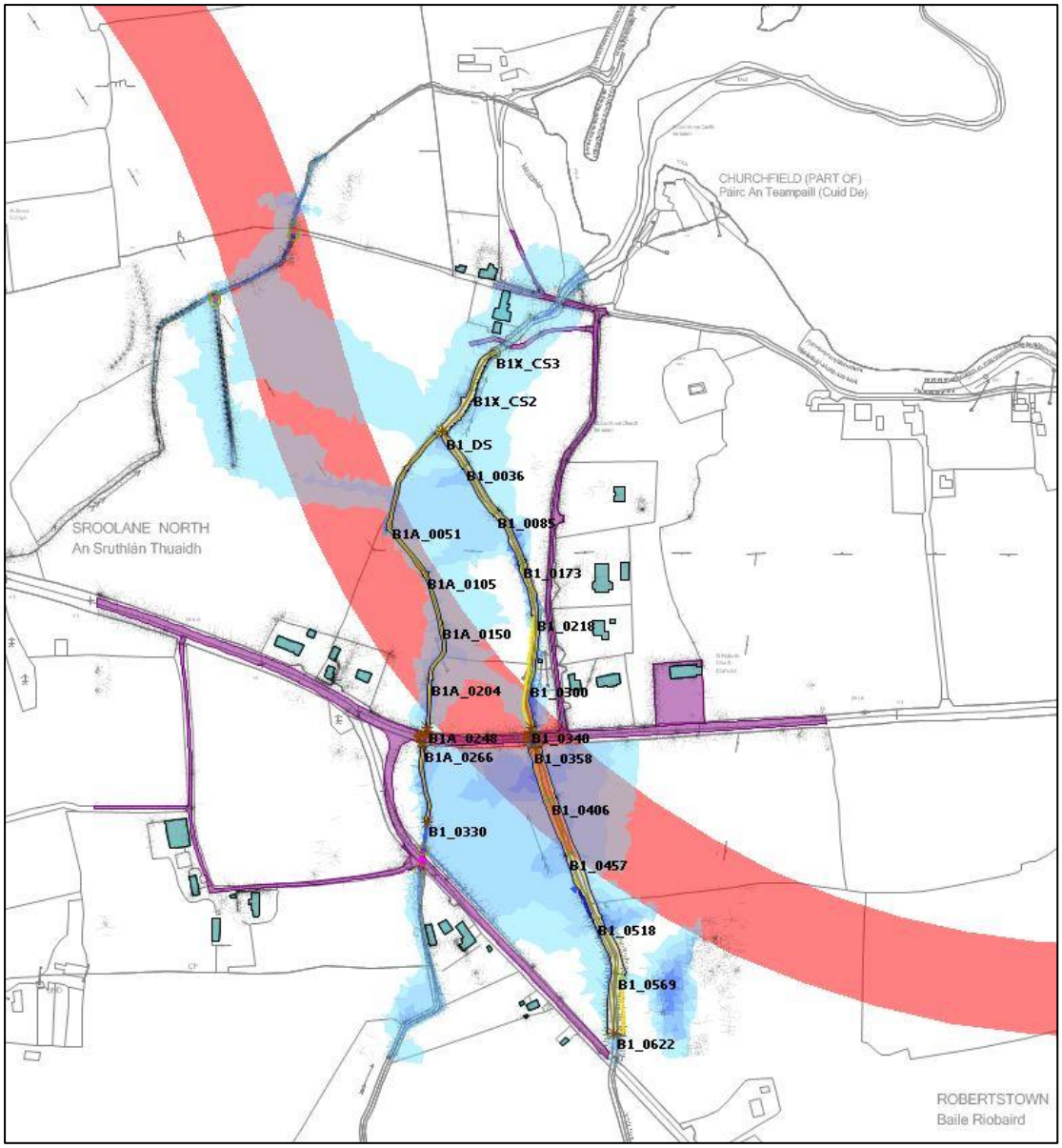


Figure 6.17 Robertstown Existing Q100 Flood Extents

The assessment found that a significant area of floodplain existed upstream and downstream of the current N69 however this flood plain is of a shallow depth of approximately 0.6m maximum and average depth of approximately 0.3m.

Given that the road corridor has to pass over the current N69 at this location it will be at a sufficient elevation to prevent any restriction in flow in the watercourses. However the large embankment required to achieve this road level does have impacts on the floodplain. Therefore local flood compensation works and/or additional flood connectivity culverts may be required to mitigate this potential increase in flood level. Mitigation could also be achieved through the construction of a multi-span structure to maintain conveyance and limit potential loss of flood storage. As the depth of the existing flood extents are shallow there is less impact from potential loss due to the construction of the road embankment.

It is understood that an open multi-span structure is also being considered in this area for environmental and amenity purposes.

6.2.2 River Deel at Boolaglass

While the River Deel was included within the CFRAM studies, the area through which the proposed road corridor passes at Boolaglass sits within a Medium Priority Watercourse extent and therefore no flood mapping has been produced as part of the CFRAM process.

InfoWorks ICM modelling software was used to create a hydraulic model of the River Deel and its tributaries in the vicinity of the proposed crossing. The data used to construct the model was the topographical and river channel survey procured as part of the road scheme development.

Hydrological data for the watercourse and adjacent minor tributaries was derived through the use of the OPW Flood Studies update web-site portal for estimating flood flows along with the FSR method for the smaller watercourses. The peak Q100 & Q1000 flows for these watercourses are as given in Table 6.4 below. The CFRAM data was analysed for the River Deel however it was not possible to find any information which was applicable to this particular reach.

The CFRAM hydrology report highlights that while there are gauging stations within the remits of the model there is a major reduction in peak flows experienced between an upstream gauging station at Rathkeale (24013) and a downstream gauging station at Inchirouke More (24029) of up to 48m3/s for a 1% AEP event. It outlines that while floodplain storage occurs this alone could not be attributed to such a large reduction and suggests that highly permeable sub-soils or karst features may be responsible.

Table 6.4 River Deel and Tributaries Estimated Flows

Watercourse	Q100 Peak Flow (m^3/s)	Q1000 Peak Flow (m^3/s)
River Deel (B5)	172.35	211.97
Minor Tributary (B5A)	6.79	8.83
Minor Tributary (B5B)	0.15	0.20
Minor Tributary (B5C)	0.62	0.82

Flood simulations were conducted for the Deel study based on these flows. The predicted flood levels upstream of the proposed crossing points at cross sections B5_0767, B5A_0327, B5B_0027 and B5C_0247 are as given in Table 6.5 below with the flood extents map for the Q100 event shown in Figure 6.18.

Table 6.5 Deel Predicted Flood Levels

Watercourse	Cross Section	Q100 Flood Level (mOD)	Q1000 Flood Level (mOD)
River Deel (B5)	B5_0767	19.90	20.15
Minor Tributary (B5A)	B5A_0327	20.25	20.45
Minor Tributary (B5B)	B5B_0027	20.17	20.29
Minor Tributary (B5C)	B5C_0247	20.31	20.53

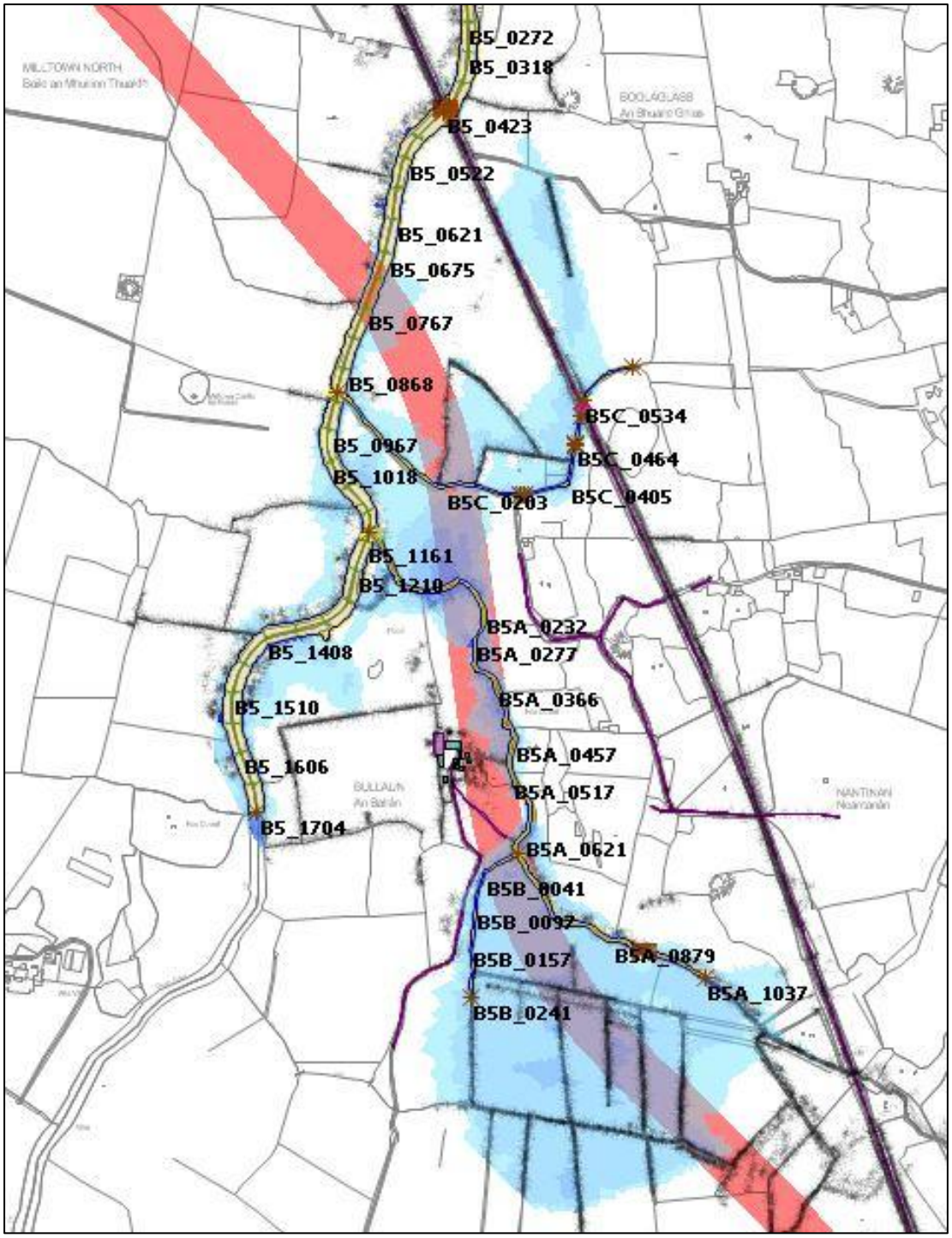


Figure 6.18 Deel Existing Q100 Flood Extents

At the proposed crossing location of the River Deel there is only minor out of bank flooding prevalent. It is understood that the proposed bridge will have its abutments set back from the bank to allow for maintenance tracks at this location and therefore is likely to have limited impact on the flooding regime at this location. This also means that the bridge soffit level will be sufficiently high as it also has to accommodate vehicles beneath the crossing point.

The area of primary concern is approximately 900m south of the proposed River Deel crossing point with a large area of flooding extending for a distance of 600m through which the proposed road corridor passes. Part of this area is very flat in nature with

a network of land drainage ditches which suggests improvements have been undertaken in the past to try and improve the drainage of the area. The average flood depth in this area is approximately 0.5m.

As the road corridor crosses a number of these ditches it is proposed to culvert these beneath the scheme embankment and provide toe drainage at the base of the embankment. These culverts allow the opportunity to maintain flood connectivity across the road corridor however there will also be a net loss of floodplain storage which may require mitigation through the use of flood compensation should final assessment of the proposed route corridor result in unacceptable increases in flood levels.

It is noted that the River Deel is an OPW arterial watercourse. Any alterations will require the relevant approvals from OPW; culverting works should obtain Section 50 approval in accordance with The Arterial Drainage Act 1945; works to relocate watercourses should also receive Section 9 approval in accordance with the Arterial Drainage (Amendment) Act 1995.

6.2.3 River Deel at Rathkeale

The River Deel crossing at Rathkeale is included within the recent CFRAM studies as outlined in Section 6.1.5. No flow information is included on the CFRAM drawings however the predicted flood levels are reproduced in Table 6.6 below and can be found on Figure 6.13:

Table 6.6 River Deel CFRAM Flood Levels

Node Reference	Q100 Flood Level (mOD)	Q1000 Flood Level (mOD)
03DEL10762	31.94	32.22

At a minimum it is anticipated that the existing bridge at this crossing location on the Rathkeale Bypass will be widened on its downstream side maintaining the current soffit and finished road levels, along with the structure opening width as relates to flooding. Additional measures such as culverting or flood relief arches can be provided on the approach embankments to the amended bridge if required.

The CFRAM mapping indicates the presence of out of channel flooding immediately downstream of the existing bridge however any increase in the width of the approach embankment into this area will be minimal and therefore have a negligible impact.

6.2.4 River Maigue and River Greanagh

The River Maigue is included within the recent CFRAM studies however the area through which the proposed road corridor crosses is within a Medium Priority Watercourse reach and therefore there is only limited information available. There is no existing flood mapping available for the River Greanagh.

A review of the PFRA mapping suggests that there is significant interaction between the River Maigue and River Greanagh to the north/downstream of the proposed route corridor. With this in mind it was decided that building a single model containing both watercourses would be more appropriate.

InfoWorks ICM modelling software was used to create a hydraulic model of the River Maigue and Greanagh in the vicinity of the proposed crossing.

Hydrological data for the watercourses was derived through the use of the OPW Flood Studies update web-site portal for estimating flood flows. The peak Q100 & Q1000 flows for these watercourses are as given in Table 6.7 below with the flow estimated for the CFRAM model provided for comparison. No flow information is available from the CFRAM Hydrology Report for the Greanagh or Clonshire Rivers. The estimated flow using the FSU (Flood Studies Update) method is similar to that used in the CFRAM study for the River Maigue (3.6% less for the Q100 and and 2.6% less for the Q1000 respectively).

Table 6.7 River Maigue and River Greanagh Estimated Flows

Watercourse	Q100 Peak Flow (m^3/s)		Q1000 Peak Flow (m^3/s)	
	ICM Model	CFRAM Model	ICM Model	CFRAM Model
River Maigue (B13)	246.33	255.47	309.22	317.36
River Greanagh (B12)	27.10	N/A	34.43	N/A
Clonshire River (B12A)	6.03	N/A	9.05	N/A

Flood simulations were conducted for the Maigue study based on these flows. The predicted flood levels upstream of the proposed crossing points at cross sections B12_2749 and B13_1533 are as given in Table 6.8 below with the flood extents map for the Q100 event shown in Figure 6.19.

Table 6.8 River Maigue & Greanagh Predicted Fluvial Flood Levels

Watercourse	Cross Section	Q100 Flood Level (mOD)		Q1000 Flood Level (mOD)	
		ICM Model	CFRAM Model	ICM Model	CFRAM Model
River Maigue (B13)	B13_1533	4.24	4.05	4.37	4.46
River Greanagh (B12)	B12_2749	4.10	N/A	4.18	N/A

As can be seen in Table 6.8 the levels produced by the ICM model constructed for this study are slightly higher than the level given in the CFRAM mapping. This is potentially due to variations in the flow data used but more likely due to differences in the tidal level applied at the model downstream boundary. The median (2year return period tide level) tidal level for the gauge at Adare Quay (taken from waterlevels.ie) was used for the ICM model and was taken as a constant level. It is not known what tidal conditions were applied to the CFRAM model. This difference in level ultimately means that the ICM model produced can be considered as more conservative and therefore is acceptable for use.

Note that the flood model constructed is for fluvial events only and does not model extreme coastal events. The information provided on the CFRAM maps for coastal flood events has been deemed satisfactory for use. The coastal flood level is of significance to ensure that the road is constructed to a suitable level to prevent inundation during extreme coastal events, and this will be achieved in the proposed design. There is no requirement however to provide mitigation measures due to infilling of coastal floodplain and it is therefore not necessary to assess the impact of the proposed road on the coastal flooding regime. Also, as the extent of the impacted coastal flood plain is small in comparison with the entire coastal flood plain extents (see Figure 6.16) any potential impact will be negligible.

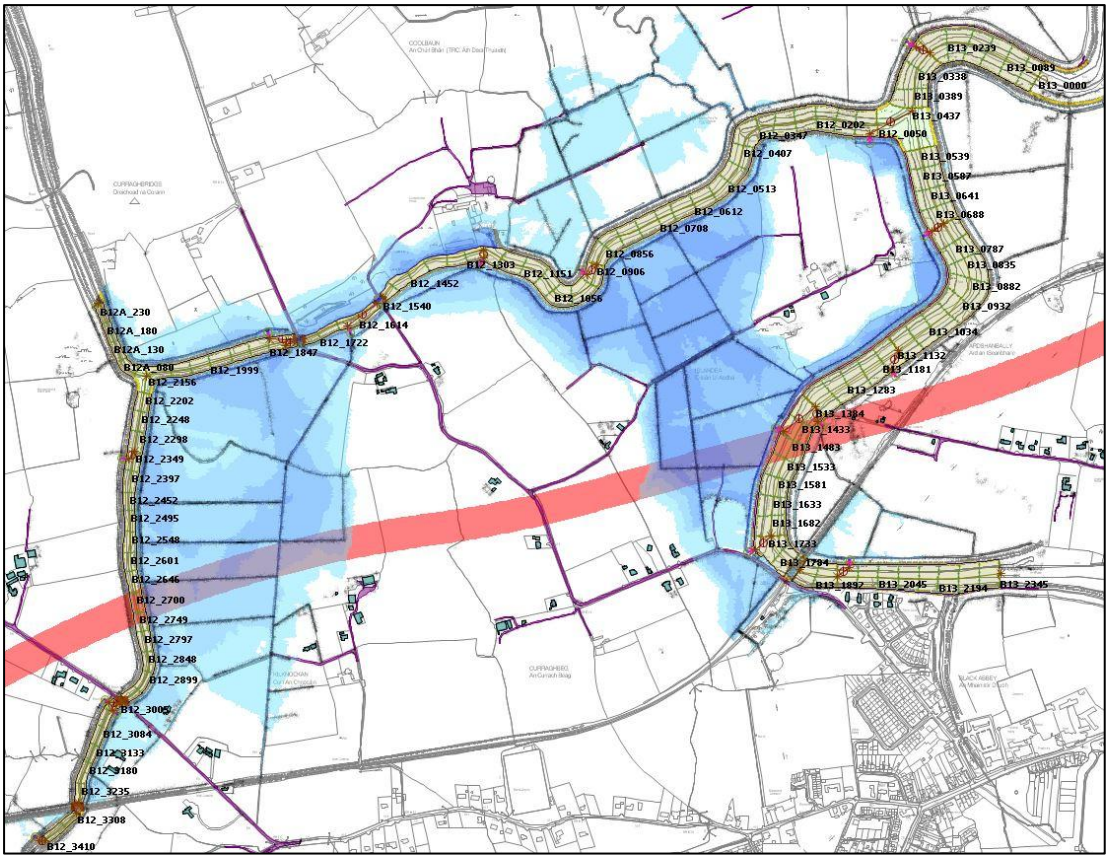


Figure 6.19 Maigue & Greanagh Q100 Flood Extents

There are two main areas of fluvial flooding in the Maigue study area through which the proposed road corridor passes:

1. West of River Maigue, approximately 350m length
2. East of Greanagh, approximately 550m length

The area to the west of River Maigue crossing point is a significant area of floodplain and is of average depth of 1.5-2.0m which has the potential to displace flood waters through the construction of the road embankment. Mitigation will include provision of a bridge configuration where the deck will be sufficiently high to have a negligible impact on the conveyance of water in the river. The bridge abutments will also be set back from the river bank so as not to constrict the flow. Provision of connectivity culverts in the approach embankments, together with flood compensation areas, will also be considered in order to provide further mitigation if required.

The area to the east of the Greanagh is much shallower floodplain than that associated with the Maigue crossing with an average depth of approximately 0.5m. The construction of the approach embankment on the eastern side of the proposed crossing still has the potential to displace flood waters and lead to worsening elsewhere therefore the construction of flood compensation areas and connectivity culverts may be required in order to mitigate the loss of floodplain. The bridge should also be set a sufficient level so as not to impede flow with a freeboard allowance for the passage of floating debris material. The bridge abutments should also be set back from the river bank so as not to constrict the flow.

It is noted that there are flood embankments along both banks of the Greanagh and Maigue for most of the length of the study area. To the rear of these flood embankments are back drains which discharge to the river at regular intervals

through flapped outlets to prevent back flow during high tides. It is important that this regime is maintained so as not to cause any worsening in these areas. The back drain outlets and flap valves have been included within the 2D part of the ICM modelling which was carried out.

The proposed road scheme will ensure that access to existing flood embankments, back drains and flapped outfalls is maintained during construction. The proposals will also ensure that future access to these features is not impaired or obstructed by the construction of the scheme. Any alterations to these features will require the relevant approvals from OPW; culverting works should obtain Section 50 approval in accordance with The Arterial Drainage Act 1945; works to relocate watercourses should also receive Section 9 approval in accordance with the Arterial Drainage (Amendment) Act 1995.

6.3 Proposed Draft CFRAM Flood Protection Measures

The proposed CFRAM Flood Protection Measures for the Adare Area are presented in the CFRAM Preliminary Options Report for Unit of Management 24 (July 2016). The recommended measures to protect the Adare area involve the construction of flood walls, embankments and a flood gate. The recommended flood defence measures for the Route Corridor area are presented in Figure 6.20.

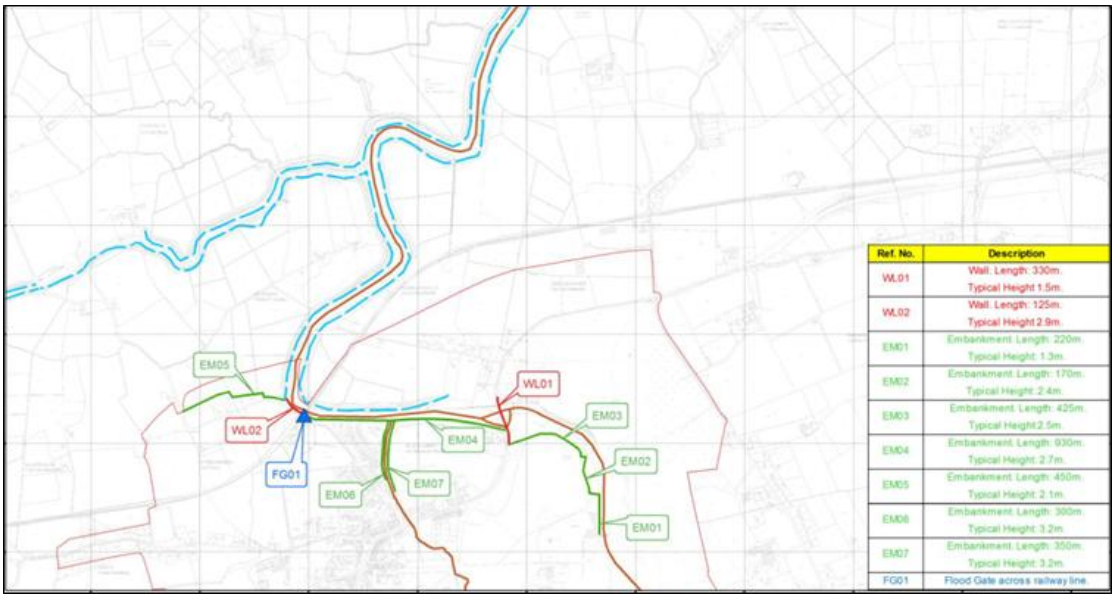


Figure 6.20 Proposed Flood Alleviation Options in Adare

These flood defences are designed to protect the various existing at-risk residential and commercial buildings and road access from flooding by the River Maigue and Adare River. The CFRAM Study in the Adare area identified 88 residential dwellings and 32 commercial buildings at risk of flooding from the 100year flood.

Figure 6.21 below illustrates the proposed road corridor location in relation to proposed flood embankment EM05.

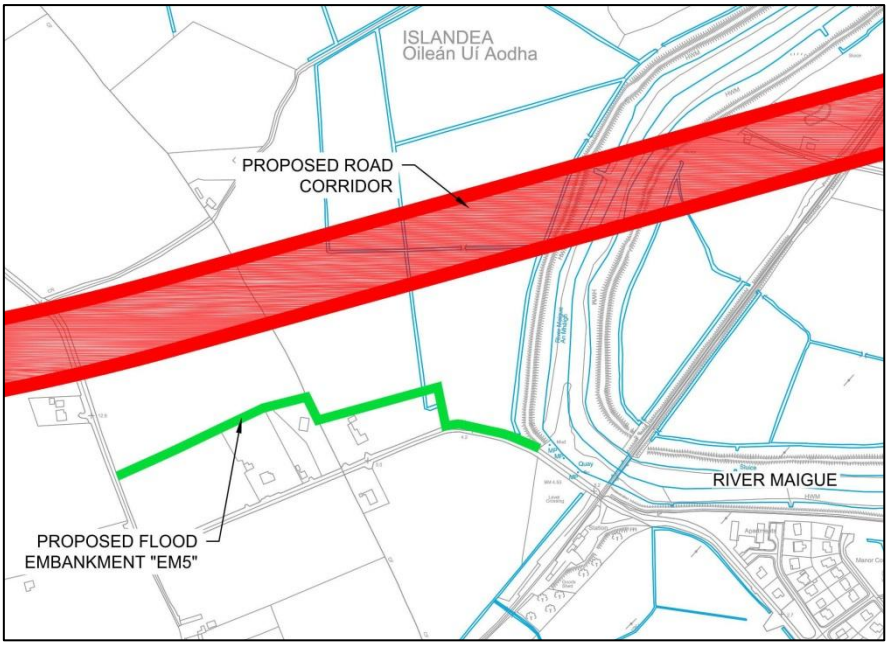


Figure 6.21 Comparison of Flood Alleviation and Road Schemes

The design of the Foynes to Limerick Road Improvement Scheme will not impact the implementation of these flood protection measures or reduce the standard of protection proposed. Should the road scheme proceed to planning stage in advance of the implementation of the CFRAM flood protection measures, an integrated approach will be adopted in the design so that no lesser a degree of protection is provided than that proposed in the CFRAM proposals. For the avoidance of doubt, the proposed road scheme will not be dependent on the implementation of the CFRAM Flood Protection Measures to mitigate flood impacts.

7.0 JUSTIFICATION TEST

Section 3 above outlines the process for assessment of flood risk in accordance with the Planning System and Flood Risk Management Guidelines for Planning Authorities (November 2009). Section 3.4 of this report refers to Chapter 4 of the Guidelines - Flooding and Spatial Planning - and outlines the Justification Test to be applied for the preparation of development plans. The requirements of Box 4.1, reproduced as Figure 3.3 in Section 0 above, have been applied as follows:

7.1 Policy Context

The Limerick County Development Plan 2010-2016 (As extended) nestles within a clear hierarchy of spatial planning policy documents. This hierarchy of strategies, policies, plans follows a format which commences with high level International and/or EU documents feeding progressively downwards into national, regional, local plans and policies. The SFRA of the proposed Variation is informed and carried out in the context of this policy context. There are various policies from European, national and local policy context relevant to this Variation. These documents identify the need for a higher quality access road to Shannon-Foynes Port and Adare. Some of the key documents relevant to the proposed Variation are discussed below as follows:

European Policy Context

- Trans-European Transport Network (TEN-T) Policy

National Policy Context

- Roads Act 2015
- Ireland 2040 Our Plan Draft National Planning Framework (2017)
- Building on Recovery: Infrastructure and Capital Investment 2016 – 2021
- Harnessing our Ocean Wealth (2012)
- National Ports Policy (2013)

Regional Policy Context

- Mid-West Regional Planning Guidelines 2010-2022
- Mid-West Area Strategic Plan (MWASP) 2012 – 2030
- Strategic Integrated Framework Plan for the Shannon Estuary 2013 – 2020
- Mid-West Area Strategic Plan (MWASP) 2012 – 2030
- Strategic Integrated Framework Plan for the Shannon Estuary 2013 – 2020
- Shannon-Foynes Port Company Masterplan – Vision 2041 (2013)

Local Policy Context

- Limerick County Development Plan 2010 – 2016
- Adare Local Area Plan 2015-2021
- Askeaton Local Area Plan 2015-2021
- Rathkeale Local Area Plan 2012-2018 (as extended)

In accordance with requirement of Box 4.1, section 1 of 'The Guidelines' a review of the relevant plans and policies has been considered in the following sections below.

7.1.1 Trans-European Transport Network (TEN-T) Policy

European Union Regulation No. 1315/2013 establishes guidelines for the development of a Trans-European Transport Network. The regulations identify projects of common interest, and specify the requirements to be complied with for the management of the infrastructure of the TEN-T. The Trans-European Transport (TEN-T) Network consists of the infrastructure for railway transport, inland waterway transport, road transport, maritime transport, air transport and multimodal transport. The Port of Shannon – Foynes is identified in Part 2 of Annex II of the directive as a Core Port forming part of the European Union TEN-T Transportation Network, and lies approximately 35km west of Limerick City on the River Shannon Estuary. For suitable road access to the Port, the route between Foynes, Limerick and Dublin has been identified as part of the Core Road Network within the TEN-T system. The EU TEN-T Regulations provide standards that the core road network must meet by 2030.

The Port of Shannon – Foynes is identified as a Tier 1 Core Port forming part of the European Union TEN-T Transportation Network, and lies approximately 35km west of Limerick City on the River Shannon Estuary. For suitable road access to the port, the route between Foynes, Limerick and Dublin has been identified as part of the Core Road Network within the TEN-T system. The EU TEN-T Regulations provide standards that the core road network must meet by 2030. These standards are identified in the Ten-T Policy for Roads.

Figure 7.1 shows the extent of both the Core and Comprehensive Networks in relation to roads, ports and airports within Ireland, including the Foynes to Limerick connection. The overall requirement of TEN-T in this case is to provide an improved connection from the existing motorway network in the vicinity of Limerick City to Foynes which will support the planned growth of Shannon Foynes Port.

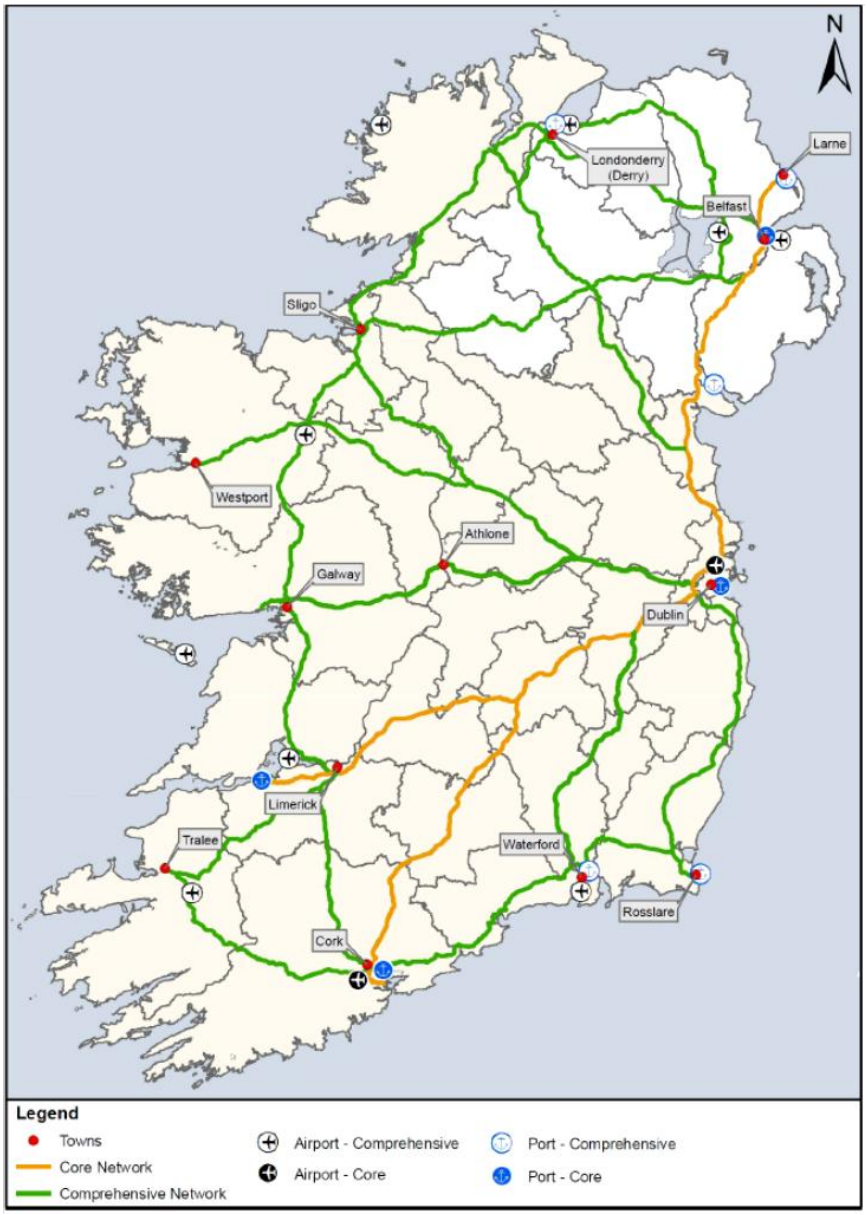


Figure 7.1 Ten-T Core and Comprehensive Road Network Ireland

The existing national road network in the Limerick Region that may form parts of the TEN-T Network is shown in Figure 7.2 below and includes the following routes:

- N69 national secondary road between Tarbert and Limerick City; and
- N21 national primary road between Abbeyfeale and Attyflin.

These national routes may be augmented or modified in future improvement schemes to fulfil the requirements of the TEN-T Network.

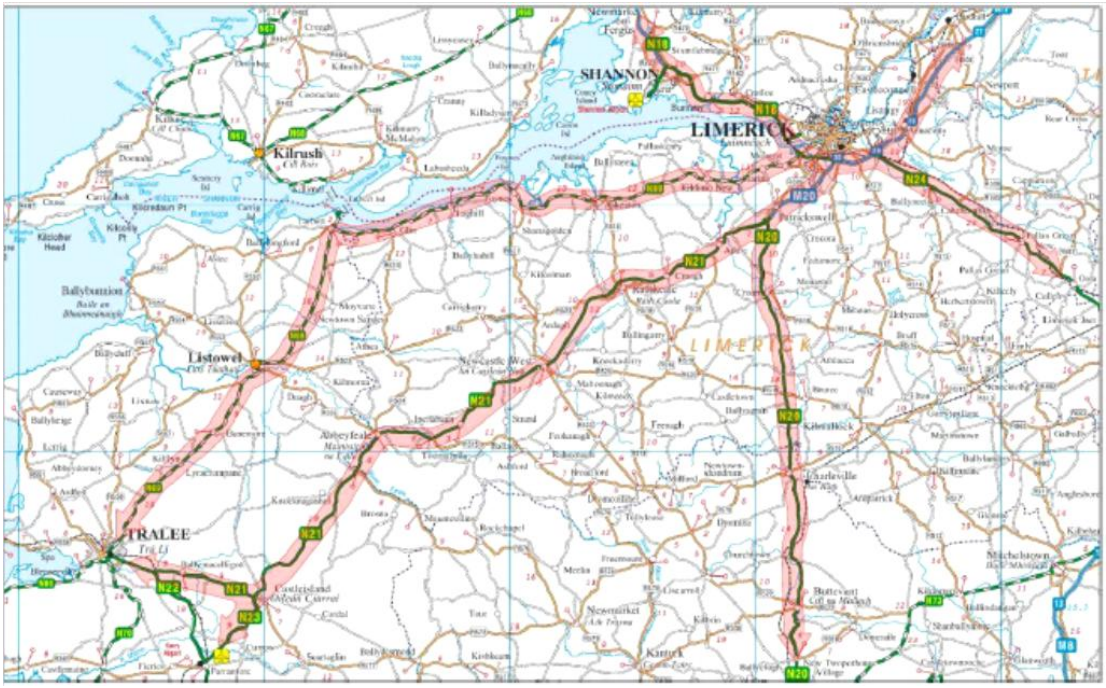


Figure 7.2 National Roads in Limerick Region

In terms of geographical location the N69 and N21 road corridors are within 10 kilometres of one another in the vicinity of Askeaton and Rathkeale.

7.2 National Policy Context

7.2.1 Ireland 2040 Our Plan Draft National Planning Framework (2017)

As a strategic development framework, 'Ireland 2040 - Our Plan' sets the long-term context for our country's physical development and associated progress in economic, social and environmental terms and in an island, European and global context. Ireland 2040 will be followed and underpinned by supporting policies and actions at sectoral, regional and local levels.

Limerick City is identified as one of the five main cities in Ireland as part of the draft National Planning Framework (NPF) and the largest city in the Mid-West. It is identified as one of the four regional cities in Ireland along with Cork, Galway and Waterford with Dublin as the Capital. High Quality International Connectivity to the Shannon-Foynes port is identified as a national strategic outcome.
Key future growth enablers for Limerick include:

- Enhanced road connectivity to Shannon- Foynes Port, including local by-passes.
- Enhanced regional connectivity through improved average journey times by road to Cork and Waterford.

7.2.2 National Spatial Strategy 2002-2020

The NPF will replace the National Spatial Strategy (NSS). The NSS recognised that the Limerick-Shannon gateway would need enhancement at national and international level to improve the performance of the Mid-West Region. This would be required to lever additional investment for the overall region, through its critical mass, strategic location, capacity for innovation and development and connections within the national transport framework. The development of the Foynes - Limerick

road would contribute to the aim of improving connectivity from the region to the national and international transport network.

7.2.3 Building on Recovery: Infrastructure and Capital Investment 2016 – 2021

The plan provides €6 billion for investment in the roads network €1.6 billion is allocated to new projects including those targeted at removing bottlenecks, which included the N69 Shannon to Foynes Road and the Adare Bypass.

7.2.4 Harnessing our Ocean Wealth (2012)

'Harnessing Our Ocean Wealth: An Integrated Marine Plan for Ireland' (IMP) was published in July 2012 by the Department of Agriculture, Food and the Marine. It sets out a roadmap for the government's vision, high level goals and integrated actions across policy, governance and business for the marine sector.

Harnessing Our Ocean Wealth recognises that the country's ocean wealth will be a key element of our economic recovery and sustainable growth, generating benefits for all our citizens. The initiative also recognises the contribution the 'blue economy' can make to global economic growth and the need for appropriate policies, strategies and funding mechanisms to achieve this objective while setting the following targets for Ireland by 2020:

- Double the value of our ocean wealth to 2.4% of GDP by 2030.
- Increase the turnover from our ocean economy to €6.4bn by 2020.

To achieve these targets the plan identifies that enabling infrastructure (e.g. ports, piers, the electricity grid and research initiatives) is essential for harnessing our ocean wealth at national, regional and local levels.

Future growth opportunities identified within the plan which will enable the growth of the port of Foynes include offshore oil and gas activity, cruise tourism and offshore renewable energy.

Harnessing Our Ocean Wealth identifies key actions that need to be taken including:

1. Maximising the utilisation of existing state maritime infrastructure through multipurpose usage and sharing, in support of operational programmes, research, test, demonstration and monitoring.
2. Carrying out national, regional and local initiatives aimed at tapping into the potential of new and existing coastal infrastructure to develop sustainable products, services and jobs. This would encourage investment along the coast. Initiatives include supporting major national seaports in the implementation of their master plans to provide additional capacity and greater draught using their own resources.

The road transport network provided by the Foynes to Limerick Road Improvement scheme will support the aims and targets of Harnessing Our Ocean Wealth by improving transport connectivity between the port and the core road network.

7.2.5 National Ports Policy (2013)

The core objective of the National Ports Policy is to facilitate a competitive and effective market for maritime transport services. The long-term international trend in ports and shipping is toward increased consolidation of resources in order to achieve optimum efficiencies of scale. This has knock-on effects in terms of vessel size, the depths of water required at ports and the type and scale of port hinterland transport

connections. In recognition of this, the National Ports Policy introduces clear categorisation of the ports sector into:

- Ports of National Significance (Tier 1)
- Ports of National Significance (Tier 2), and
- Ports of Regional Significance

Ports of National Significance (Tier 1) are ports that are responsible for 15% to 20% of overall tonnage through Irish ports, and have clear potential to lead the development of future port capacity in the medium and long term, when and as required.

The three ports which fulfil these criteria are:

- Dublin Port;
- Port of Cork; and
- Shannon-Foynes Port.

Shannon-Foynes Port is the largest bulk port in the country and handles approximately 20% of all seaborne trade in the State. The port's dominance in the dry-bulk sector is particularly pronounced, with a market share of around 63% in this sector. The National Ports Policy has as a key strategic objective the continued commercial development of Shannon Foynes Port Company, and clearly identifies as a matter of reasonable priority the improvement of the road and rail freight connections.

The European Union TEN-T network policy recognises that for inclusion in the Core Network, ports must enjoy significant volumes of freight and/or passenger traffic, have a high level of international connectivity and, by 2030, be connected to the core European rail and road network.

The National Ports Policy notes that efficient hinterland connections are critically important to any port's ability to facilitate large volumes of traffic. It states that all TEN-T core ports must have a connection to both TEN-T core road and rail networks, while recognising that:

> *"The vast majority of Ireland's freight movements to and from ports are via road. As acknowledged in the European Commission's White Paper, Roadmap to a Single European Transport Area – Towards a Competitive and Resource-Efficient Transport System, it is likely that "freight movements over short and medium distances (below some 300km) will to a considerable extent remain on trucks" (Commission of the European Communities 2011c)."*

The provision of the improved Foynes to Limerick Road Improvement Scheme will support the Tier 1 status of Shannon-Foynes Port under the National Ports Policy.

7.3 Regional Policy Context

7.3.1 Mid-West Regional Planning Guidelines 2010-2022

The Mid-West Regional Planning Guidelines (RPGs) 2010-2022 provide a planning framework for the future physical, economic and social development of the Mid-West Region. These guidelines reflect other national social, economic and environmental policies which affect the Mid-West Region, as well as a range of existing regional strategies.

Specific regional priorities include:

- *"The N21 road link from Tralee via Newcastle West to Limerick City to facilitate access to the City from that zone of the Region. In the event of funding for the provision of a motorway link between Tralee and Newcastle West not being provided in the immediate future, by-passes will be required as a matter of immediate priority for Adare, Abbeyfeale and Newcastle west;*
- *The N69 road link between Askeaton and Adare to provide effective access to road freight traffic from Foynes to the N20/21 (linking Limerick with Cork and Tralee)."*

The guidelines also recognise that the following roads should be regarded as regional priorities considered crucial for the Region's long-term integration:

- *The condition and standard of the N69 between Foynes and Limerick City to provide efficient access to the ports; and*
- *Upgraded road links along the Shannon Estuary in order to facilitate employment and tourism development."*

7.3.2 Mid-West Area Strategic Plan (MWASP) 2012 – 2030

The Mid-West Area Strategic Plan (MWASP) is a strategic planning, land use and transportation strategy for the Mid- West region and includes the County Councils of Limerick, North Tipperary and Clare along with Limerick City Council. MWASP provides for a Comprehensive integrated plan for Land Use Planning and Transportation in the Mid-West Region over an 18 year period. The MWASP sets out a series of economic, land-use and transport recommendations including a proposed transportation investment programme, a public transport feasibility report, spatial and economic strategies and recommendations to achieve balanced regional development and an enhanced quality of life for the citizens of the Mid-West region.

Key Objectives from the Plan that support the development of the Foynes to Limerick road include the following:

- Identify and promote investment in key infrastructural projects identified to serve the needs of the region including new roads and improvements to the National Secondary and Regional road network, rail, air, port, infrastructure and water services. Such proposals to include an equitable distribution of resources throughout the region; and
- Support opportunities that the Shannon Estuary Integrated Framework Plan can sustainably deliver, through optimising the deep water berthage opportunities and the infrastructural, commercial and recreational resources which prevail in the estuary and its surrounds."

Specific recommendations with regard to major road corridors within the plan are as follows:

National Road Recommendations		
3.	N21	Review the corridor improvements and connection to Newcastle West, giving consideration to N69 connection (refer to point 9 below)
9.	N69	Primary access route to Shannon-Foynes Port requires complete upgrade and consideration of connection with M21 (refer to point 3 above)
13.	N69	Upgrade the road access to Foynes Port to motorway standard

Adare is recognised as one of the regions key tourist strengths and attraction for tourist in the region.

7.3.3 Strategic Integrated Framework Plan for the Shannon Estuary 2013 – 2020

The Strategic Integrated Framework Plan (SIFP) sets out an overall strategy for the proper sustainable growth, development and environmental management of the Shannon Estuary Region for the next 30 years. The plan was commissioned by Clare County Council, Kerry County Council, the then separate Limerick City and County Councils, Shannon Development and Shannon Foynes Port Company.

In terms of transportation infrastructure the plan recognises the importance of quality transport corridors for port activity and the economic growth of the Estuary and notes in particular the following:

> *"The N69 is a particularly important route, and is highlighted as being a strategic transport corridor providing key connections and linkages between key settlements, the Port of Foynes, the Gateway of Limerick / Shannon and the wider region. The NRA has instructed Limerick City and County Council to progress the Foynes to Limerick Major Road Improvement Scheme. Limerick City and County Council has therefore recently announced a major upgrade scheme for the N69 connecting the Port of Foynes with the M7/N18 at Limerick. The proposal for a high quality road aims to provide improved access to the Port and supports the envisaged expansion of its capacity and usage outlined in the National Ports Policy 2013."*

7.3.4 Shannon-Foynes Port Company Masterplan – Vision 2041 (2013)

Vision 2041, Shannon-Foynes Port Company's Masterplan, published in February 2013, sets out the strategy for development of the Shannon Estuary ports, with Foynes port as one of the key drivers for further development and expansion.

Shannon Foynes Port Company is the largest dry bulk port in the country offering its customers unrivalled economies of scale. Shannon- Foynes Port Company handles the largest vessels entering Irish waters and handled some 10,179 million tonnes of cargo passing through its six port facilities on the Shannon Estuary in 2016. The Shannon-Foynes Port Company's ambition to provide a new deepwater berth (circa 15m draught) at Foynes and the continued expansion of existing infrastructure at Foynes in order to capitalise on the trend toward larger vessels will all lead to increases in traffic at the port. The Shannon Foynes Annual Report 2016 states continued growth is strongly dependent on good quality road and rail connection. It also states the implementation of the preferred route for the Foynes to Limerick Scheme is critical infrastructure required for the development of the Shannon Foynes Port Company and its hinterland.

Provision of improved road access to Shannon - Foynes Port will provide a key support for the growth of the port and associated industries. The Tier 1 Port status indicates the national and regional importance of the port as a major factor in the economic life of the Mid-West Region and the national economy. Growth of the port is currently constrained by the poor quality road access that discourages industrial and commercial development relative to the opportunities associated with the port.

7.4 Local Policy Context

7.4.1 Limerick County Development Plan 2010 – 2016 (as extended)

The current Limerick County Development Plan 2010-2016 (as extended) identifies the need for Limerick City and County Council to prepare a Strategic Flood Risk Assessment (SFRA) for relevant areas of County Limerick. Section 8.3.6 of the Limerick County Development Plan 2010-2016 contains the objectives relating to flood risk for the County.

The Limerick County Development Plan 2010 - 2016 (as extended) includes transport and development objectives to ensure that the transportation, infrastructure, natural and energy resources shall be developed in a sustainable and efficient manner to promote the social and economic wellbeing of the county and its population. The plan recognises the importance of linkages throughout the County and beyond as key features in achieving balanced regional development objectives. Regarding transport policies the implementation of national and EU regulations is recognised under the following:

Policy CP 01:	To implement relevant European, national and regional regulations, guidelines and strategies at County level.
Policy CP 03:	To provide for an enhanced quality of life for all, based on high quality, sustainable residential, working and recreational environments and transportation networks.

The Adare Bypass is identified as a *"Proposed National Road Improvement for the period 2010-2016"* as per Table 8.3 of the Plan. Other policies and objectives in the Plan relevant to the future development of the Adare Bypass include;

"Objective IN O18: New national routes and development management." This objective relates to prohibiting the creation of any new access onto all major national road improvement projects. These take account of existing, new and planned projects after construction to include the N20, N21, N24, N7 Adare-Annacotty to name but a few. The planned projects, after construction include but are not limited to the M20 Limerick-Cork N21 and the Adare by-pass.

7.4.2 Adare Local Area Plan 2015-2021

The Adare LAP 2015-2021 identifies the issue of the serious traffic congestion in the village. It also notes that Adare is served by a limited capacity road network with many roads meeting in the village centre contributing to congestion problems as well as on-street parking on both sides of Main Street. The LAP identifies that there are also serious capacity issues at the junction of Station Road and Main Street. It states the need for a complete bypass for the village is a priority of the LAP. The bypass is also identified as an opportunity that would improve the town centre environment.

Objective T1: Adare Bypass It is an objective of the Council to provide a bypass for Adare to relieve traffic congestion in the village for the convenience and safety of road users.

A Stage One Flood Risk Assessment has been undertaken in support of the Adare LAP (Contained in Appendix 2 – Flood Risk Assessment of the LAP). Where lands have been zoned for development on areas identified on flood maps as potentially at risk to flooding, justification tests for zoning have been carried out. These indicate substantial areas of land along the River Maigue and the Droichidín stream are located in the Flood Zone. In this zone most development is considered vulnerable to flooding. As a response the LAP designates most vacant lands located in the Flood zone as open space or agricultural use.

The LAP states *"All flood risk assessments should have regard to national flood hazard mapping, predicted changes in flood events resulting from climate change and the River Shannon Catchment Flood Risk and Management Plan Studies (CFRAM) when completed by the OPW." Objective IN 5: Flood Risk Management* details the requirements be considered by all future developments that have been located in areas that have flooded.

7.4.3 Askeaton Local Area Plan 2015 - 2021

The Askeaton LAP states; Askeaton is located approximately 25km west of Limerick city, just south of the N69 Limerick to Tralee road. It is approximately 10km north of the town of Rathkeale. The Strategic Regional Road R518 connects Askeaton to Rathkeale and determines the eastern boundary of the LAP. Askeatons' hinterland is a lowland rural area. The town is located on the banks of the River Deel which dissects the town north-south direction. The town is 5km downstream of the Shannon Estuary which is designated the Lower River Shannon Special Area of Conservation (SAC) and the River Shannon and River Fergus Special Protection Area (SPA) by the National Parks and Wildlife Service, due to its estuarine ecology which is considered to be of European ecological significance.

Askeaton has a rich and varied history which is intrinsically influenced by the River Deel and the Shannon Estuary. It contains a rich built fabric and traditional streetscape, of national recognition as a medieval town. However, the Plan identifies a number of weakness to future development including; traffic congestion that is experienced at times along Main Street, the high number of vacant commercial and residential units that give a poor image of the town and flood risk identified in the town.

The LAP supports the implementation of the Midwest Regional Planning Guidelines 2010-2022 (RPGs) whereby it states 'The N69 road link between Askeaton and Adare to provide access to road freight traffic from Foynes to the N20/N21 (linking Limerick with Cork and Tralee).' It goes on to state: *"It is important that the capacity and the safety of the national and regional road network is protected or enhanced to provide faster and efficient access to other settlements, the wider Midwest region. An improved road network would improve freight access between the ports at Limerick city and Foynes and would facilitate employment and tourism development. It would also compliment the Shannon Integrated Framework Plan 2013 – 2020 which identifies lands just outside this LAP boundary a Strategic Development Location (SDL) on the Estuary which are considered suitable for the development of major sustainable industrial development, including the possibility as a remote location for marine/port related activity."*

A Stage 1 flood risk assessment has been prepared for Askeaton LAP and is included as Appendix 2 of the LAP. The LAP designates any land located in the flood zone as open space or agricultural use. The Plan states that "when the final OPW CFRAM map for Askeaton is available the local area plan shall be amended if there are significant discrepancies between the JBA flood risk map and the finalised CFRAM map."

7.4.4 Rathkeale Local Area Plan 2012- 2018 (as extended)

The Rathkeale LAP comprises a framework for the planned, coordinated and sustainable development of the town, including the conservation and enhancement of its natural and built environment. The LAP provides guidance as to how this development can be achieved and what new developments are needed. Good transport links are outlined as being important in achieving the LAP vision, with objectives included for the development of the towns transport.

A stage 1 flood risk assessment has been prepared for Rathkeale and is included as appendix 2 of the LAP. OPW preliminary flood risk indicative maps are available for Rathkeale under the OPW's CFRAM study. The maps indicate that the south western part of the town along the Deel River is in Flood Zone A. Most development is considered vulnerable to flooding. As a response to this issue the LAP designates

any lands located in Flood zone A as open space or agricultural use. The Planning Authority requires future planning applications in areas at risk of flooding to be supported by a comprehensive flood risk assessment.

7.5 Policy Review Summary

The policy review above demonstrates that the proposed Variation supports and contributes towards development that supports existing European, national, regional and local policy. This review identifies the rationale for the proposed Variation is already contained within current policy documents and will facilitate the growth of County Limerick particularly the Shannon Foynes Port, Adare and through the improvement in transport links, road safety and connectivity to these areas and the mid-west region

The proposed variation will relieve chronic traffic congestion and improve travel time eastwards and westwards on the N21 particularly in Adare. It will also facilitate the design, reservation of land for construction of a new road between the N21 at Rathkeale to the N69 at Foynes to the required standards. It is clear to see that the proposed variation will ensure consistency with the other policy documents for example Building on Recovery, MWASP, MWRPGs, National Ports Policy, and local area plans in the County beyond the 2010-2016 period.

7.6 Designation of Lands to Achieve Proper Planning and Sustainable Development

The proposed development of the Foynes to Limerick Road Improvement Scheme (i.e. the subject of Variation No. 6) addresses the relevant specific requirements of Box 4.1 of the Guidelines as follows (and using the same numbering system);

Item 1:

The proposed variation will facilitate provision of high quality road to the port of Foynes which will contribute to the completion of the TEN-T network in Ireland. This will permit continued development of the port and the wider Shannon estuary region. The variation will also facilitate improved connectivity across County Limerick and the mid-west region which will act as a driver for enhanced economic activity and employment generation.

The variation also facilitates expansion and proper growth of urban settlements as identified under the National Spatial Strategy, regional planning guidelines, statutory plans as defined above.

Item 2:

(i) It is essential to facilitate regeneration and/or expansion of the centre of the urban settlement;

The proposed Variation is essential to facilitate the expansion and continued growth of the Shannon Foynes Port, Adare, Rathkeale and villages and towns currently affected by persistent traffic congestion and road safety issues along both the N69 and N21. The proposed Variation will improve journey time reliability, road based transport links which will improve connectivity to and from these areas and relieve chronic traffic congestion;

(ii) Comprises significant previously developed and/or under-utilised lands

The proposed road scheme will be developed, in the main, on under-utilised lands which can accommodate the infrastructural provision envisaged.

(iii) Is within or adjoining the core of an established or designated urban settlement

The proposed road scheme adjoins a number of established and designated settlements. Limerick City acts as Gateway for the Mid-west region and the Shannon Foynes Port is a port of national significance. The proposed Variation will link the urban settlements of Foynes, Askeaton, Rathkeale and Adare, all of which are established settlements, centred around employment, residential, retail and community uses.

(iv) Will be essential in achieving compact and sustainable urban growth;

The proposed Variation will be essential to achieving compact and sustainable urban growth. It will facilitate the provision of road infrastructure to allow existing settlements along both the N69 and N21 to grow in a compact and sustainable manner without the risk of chronic traffic congestion and improving road safety. It will improve journey time reliability along the N21 corridor to and from the Mid-west. It will also allow for improvements to be made in the public realm, particularly to the historic village core of Adare.

The proposed Variation will provide clarity in relation to specific intention of Limerick City and County Council in relation to a Bypass for Adare. It will also ensure consistency with the other policy documents (e.g. Building on Recovery, MWASP, MWRPGs, National Ports Policy, etc.) beyond the 2010-2016 period.

(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.

The proposed Variation is considered to be the most suitable alternative that best meets the objectives of the proposed Variation. A Route Selection Report was carried out in 2016 that assessed a number of potential routes using a balanced methodology by applying the criteria included in the Common Appraisal Framework (DTTaS, 2016) of Economy, Safety, Environment, Accessibility and Integration. The selection process represents a detailed, robust, sequential approach, with the principle of avoidance of flood risk zones applied where possible, and which balances engineering, environmental and economic constraints so as to select the most suitable route corridor. This assessment established that there were no suitable alternative lands in areas of lower risk of flooding.

Item 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. This issue is expanded upon in Section 7.7 below.

7.7 Flood Risk Assessment

The required strategic flood risk assessment has been carried out and is described elsewhere in this document. This demonstrates that the flood risk associated with the proposed Foynes to Limerick Road Improvement Scheme can be adequately and feasibly managed and the use or development of the lands to construct the Foynes to Limerick Road Improvement Scheme will not cause unacceptable adverse impacts, either to the infrastructure proposed or elsewhere.

The flood risk assessment concludes that a road within the proposed variation area can be constructed which can be designed not to exacerbate flood risk and will have a low residual flood risk. This can be achieved through suitable mitigation by appropriate sizing and configuration of bridge and culvert crossings of rivers, floodplains and streams intercepted by the road, together with suitable design of road drainage in accordance with the requirements of Sustainable Drainage Systems (SuDS) and flood compensation areas.

The proposed CFRAM Flood Protection Measures for the Adare area are presented in the CFRAM Preliminary Options Report for Unit of Management 24 (July 2016). The Foynes to Limerick Road Improvement Scheme will not impact the implementation of these protection measures or reduce the design standard of the proposed protection and will not obstruct access to existing and proposed defences. Furthermore, the proposed Foynes to Limerick Road Improvement Scheme will not be dependent on the implementation of the Flood Protection Measures to mitigate flood impacts.

The conclusion of the flood risk assessment is that the proposal to progress the Foynes to Limerick Road Improvement Scheme project passes the justification test set out in the Flood Risk Management Planning Guidelines (Nov 2009), given the clear strategic nature of the proposed road transport development, the sequential approach involved in the route corridor selection process and the findings from the flood risk assessment that flood risk to the proposed road development can be adequately managed and mitigated for and that the construction and operation of the road can be engineered not to cause unacceptable adverse flood impacts elsewhere.

8.0 CONCLUSIONS

The flood risk assessment identified three principal flood risk areas along the proposed corridor within the Limerick County Development area in which the proposed corridor has the potential to encroach Flood Zones A and B (High and Moderate flood risk areas). These identified flood risk areas are:

1. Robertstown
2. River Deel (Boolaglass and Rathkeale)
3. River Maigue & River Greanagh

Bridge crossings will be required at each of the above locations to accommodate the road scheme. The extent of known flooding history at each of the above crossing locations has been assessed and a determination of likely extreme flooding has been carried out. Based on this knowledge the potential encroachment on floodplain lands has been quantified and the requirement for multi-span structures, flood connectivity culverts through embankments and flood compensation areas have been identified This will ensure that any changes to the existing flood regime will be kept to an acceptable level.

The proposed CFRAM Flood Protection Measures for the Adare area are presented in the CFRAM Preliminary Options Report for Unit of Management 24 (July 2016). The Foynes to Limerick Road Improvement Scheme will not impact the implementation of these protection measures or reduce the design standard of the proposed protection. Furthermore, the proposed Foynes to Limerick Road Improvement Scheme will not be dependent on the implementation of the Flood Protection Measures to mitigate flood impacts.

8.1 Mitigation Measures

1. All watercourse crossings both culverts and bridges should be designed not to impede the flood conveyance through the structure and not cause any significant change in flood levels, flow depths and velocities that would result in any noticeable increase in flood risk or erosion/accretion either locally in the vicinity of the crossing or more remotely both in the upstream and downstream reaches.
2. Approval for all watercourse crossings will be obtained from the OPW under Section 50 of the Arterial Drainage Act 1945 in advance of tender and construction of the proposed scheme.
3. Road runoff storm outfall discharges to receiving watercourses should be designed not to exacerbate flooding by increasing peak flow rates. Mitigation of such impact from storm outfalls may require flood attenuation storage with the outflow controlled to greenfield runoff rates, particularly for the smaller watercourses where the contribution effect will be largest.
4. The proposed road should be set at a minimum level that provides sufficient freeboard above the estimated 100year flood level with suitable allowance for prediction errors and climate change. The recommended Climate change allowance is a 20% increase in flood flow magnitude, which for Ireland is generally equivalent to the current 1000year flood becoming the future 100year flood. Such design standards will ensure that the proposed road project will have a low flood risk over its design life and sufficiently elevated for its storm drainage system to function appropriately during flood events.
5. Where effective (conveying) overbank flood areas have been identified flood conveyance needs to be retained by providing sufficient overbank openings

through bridge spans as not to significantly impede flood flows and produce an unacceptable increased in upstream flood level and flood risk to properties and lands.

6. Where strategic floodplain storage is lost through the construction of the road embankments, adequate volumes of flood compensation should be provided where possible. Consideration should also be given to the provision of flood connectivity culverts through embankments to prevent the impedance of overland flows.
7. River crossings should have a bridge soffit level with sufficient clearance above the 100year flood level to allow the passage of floating debris. This is typically accounted for through the addition of freeboard as outlined in point 4 above.

A Justification Test has been carried out in accordance with The Planning System and Flood Risk Management Guidelines for Planning Authorities (November 2009). The conclusion of the flood risk assessment carried out is that the proposal to progress the Foynes to Limerick Road Improvement Scheme project passes this justification test given the clear strategic nature of the proposed road transport development, the sequential approach involved in the route corridor selection process and the findings from the flood risk assessment that flood risk to the proposed road development can be adequately managed and mitigated for and that the construction and operation of the road can be engineered not to cause unacceptable adverse flood impacts elsewhere.

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