



APPENDIX 8-1

FLOOD RISK ASSESSMENT

Meath County Council - Viewing Purposes Only!

Moygaddy Masterplan Flood Risk Assessment

Technical Report

August 22

2021s1492

Sky Castle Ltd.

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Blackrock

Co. Dublin

Meath County Council - Viewing Purposes Only

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
S3-P01 / 9th July 2022	Initial Issue	Sky Castle Ltd.
A3-C01 / 19th August 2022	Final Issue	Sky Castle Ltd.
A3-C02 / 25th August 2022	Minor Changes	Sky Castle Ltd.

Contract

This report describes work commissioned by Ronan Barrett, on behalf of Sky Castle Ltd, by a letter dated 10 September 2021. Sky Castle Ltd's representative for the contract was Anthony Horan, on behalf of O'Connor Sutton Cronin and Associates (OCSC). Paul Browne, Anastasiya Ilyasova, David Casey and Ross Bryant of JBA Consulting carried out this work.

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Purpose

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Abbreviations

1D	One-Dimensional (modelling)
2D	Two-Dimensional (modelling)
AEP	Annual Exceedance Probability
AFA	Area for Further Assessment
CFRAM	Catchment Flood Risk Assessment and Management
DEHLG.....	Department of the Environment, Heritage and Local Government
FFL.....	Finished Floor Level
FRA.....	Flood Risk Assessment
FSU	Flood Study Updates
GSDSDS	Greater Dublin Strategic Drainage Strategy
GSI.....	Geological Survey Ireland
MCC.....	Meath County Council
MCDP	Meath County Development Plan
MRFS.....	Mid-Range Future Scenario
NCFHM	National Coastal Flood Hazard Mapping
NIFM	National Indicative Fluvial Mapping
OD.....	Ordnance Datum
OPW	Office of Public Works
PFRA	Preliminary Flood Risk Assessment
RPS.....	Record of Protected Structure
SFRA	Strategic Flood Risk Assessment

1 Executive Summary

The Site Specific Flood Risk Assessment (SFRA) has been prepared for the entire land bank of c. 240 acres at Maynooth Environs Moygaddy which forms the Masterplan area owned by Sky Castle Ltd. The development is located in the townland of Moygaddy, Co Meath although some of the road/bridge infrastructure will be located in Co Kildare.

Individual planning applications are to be submitted for

- An office campus
- A Primary Care Centre & Nursing Home
- The Maynooth Outer Orbital Route (MOOR)
- A Strategic Housing Development of 360no Homes, creche, Scout Den, Public Park and Playground,
- Utility connections & road, pedestrian and cycle connections with Maynooth, County Kildare

A review of the available flood maps confirms that both the Ryewater River and the Blackhole Little Stream overtop during the 1% AEP and 0.1% AEP flood events, which results in limited inundation to the Masterplan site. To confirm the flood extents for the Masterplan site a hydraulic model has been developed for the study area.

Based on the findings of the SFRA and hydraulic model, all development proposed is located within Flood Zone C i.e. at a low risk of flooding. Some of the road bridge, pedestrian & cycle and utility connection infrastructure where they cross the Rye Water & Blackhole Little stream, which by their nature, are within Flood Zones A & B.

The new bridge infrastructure has been designed to ensure they have no impact on flooding and therefore, there will be no increase in flood risk resulting from the development. If planning permission is granted, a Section 50 application will be submitted to the OPW for all the proposed bridge structures.

Climate change and residual risks (blockage) have also been assessed for the Masterplan site. The results confirm the development will not be impacted by the predicted impact of climate change nor by the modelled blockage events.

In summary, the FRA was undertaken in accordance with 'The Planning System and Flood Risk Management - Guidelines for Planning Authorities' (2009), and agrees with the core principles contained within

2 Introduction

2.1 Terms of Reference and Scope

JBA Consulting was appointed by Sky Castle Ltd to prepare a comprehensive Site-Specific Flood Risk Assessment (SSFRA) study for the proposed masterplan development of a site located in Moygaddy, Co. Meath. The development of the site will involve the construction of utility road bridge infrastructure connections that will be undertaken in Maynooth, Co. Kildare. The masterplan within Moygaddy has been identified in the Meath County Development Plan 2021-2027 (Masterplan Reference: MP 16).

Under the 'Planning System and Flood Risk Management - Guidelines for Planning Authorities' (DEHLG / OPW, 2009), proposed development must undergo a Flood Risk Assessment (FRA) prior to planning to ensure sustainability and effective management of flood risk. The planning authorities in this instance are Meath County Council (MCC) and Kildare County Council (KCC).

2.2 Flood Risk Assessment; Aims and Objectives

This study is being completed to inform the future design and development of the site as it relates to flood risk. It aims to identify, quantify and communicate to the client the risk of flooding to land, property and people and the measures that would be recommended to manage the risk in order to facilitate the development of the site.

The objects of this FRA are to:

- Identify potential sources of flood risk;
- Confirm the level of flood risk, and identify key hydraulic features;
- Assess the impact the proposed development has on flood risk;
- Develop appropriate flood risk mitigation and management measures, which will allow for the long-term development of the site.

Recommendations for development have been provided in the context of the 'Planning System and Flood Risk Management - Guidelines for Planning Authorities' by the DEHLG / OPW (2009). A review of the likely effects of climate change, and the long-term impacts this may have on development has also been undertaken.

For general information on flooding, the definition of flood risk, flood zones and other terms, refer to 'Understanding Flood Risk' in Appendix A.

2.3 Development Proposal

It is proposed to construct the following developments:

- a residential estate on a c.13.52ha site, as part of a c.96ha masterplan development (MP 16), located in Moygaddy, Co. Meath.
- Maynooth Outer Orbital Road (MOOR)
- 2 road bridges
- 3 pedestrian and cycle bridges

The c.96-hectare Moygaddy masterplan site area is to be subject to a phased development over a 25+ year period, with the initial phasing comprising:

- Maynooth Outer Orbital Road;
- 360nr. residential development, creche and public park (SHD ABP-312213-21)
- Phase 1 Medical i.e., Primary Care Centre and Nursing Home
- Phase 1 Biomedical, Lifesciences and Technology Park i.e., 3nr. Office Blocks

The overall masterplan development provides for a total of 5no bridges across the Ryewater River and Blackhall Little Stream. This consists of 2no. road bridges and 3no pedestrian walkway/cycleway bridges.

The SHD application will be submitted to An Bord Pleanála and each of the other applications are to be submitted to Meath County Council for planning permission under independent applications, with further applications for the remaining masterplan area to be submitted on a phased basis, until all development within Masterplan area is completed. Planning applications will also be submitted to Kildare County Council for the road, bridge, pedestrian/cycle path and utility connection infrastructure within County Kildare.

The masterplan area is aligned with the River Ryewater along its southern boundary, and is also bisected (North – South) by the Blackhall Little Stream, near its centre. All development that is to occur on site is to provide significant sustainable drainage infrastructure that is to be integrated with the intensive landscaping, and comply with Meath County Council's County Development Plan and SuDS policies. All rainfall runoff is to be treated and attenuated on site, with development discharge rates restricted to a flow rate that is less than the greenfield equivalent runoff rate (5.61 l/s/ha). The proposed bridge designs are provided in Appendix B.

Refer to Figure 2-1 or the site location masterplan.

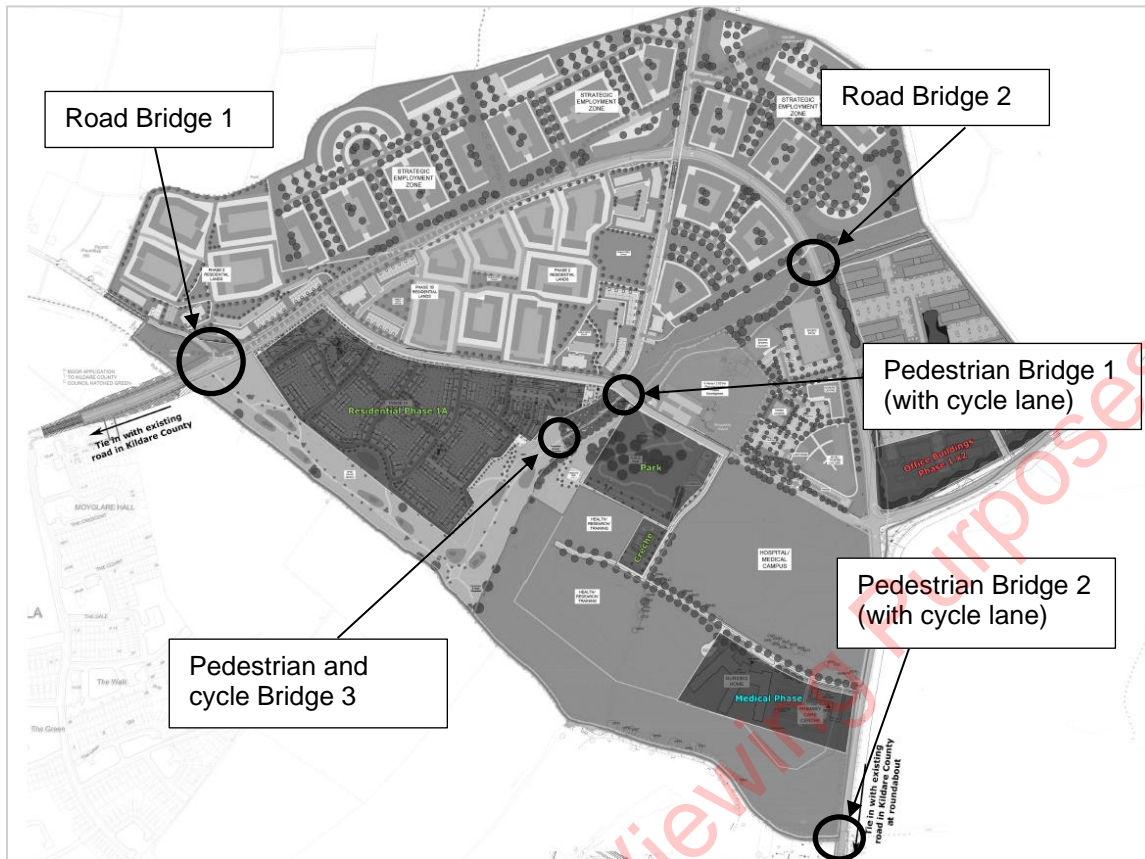


Figure 2-1: Site Location Masterplan (Source: OCSC)

2.4 Report Structure

Section 3 of this report gives an overview of the study location and associated watercourses. Section 4 contains background information and initial assessment of flood risk. The hydraulic model and hydrology are outlined in Section 5. Mitigation measures are outlined in Section 6, while conclusions are provided in Section 7.

3 Site Background

This section describes the watercourses and hydraulic features, topography, geology and wider geographical areas of Moygaddy, Co. Meath and Maynooth, Co. Kildare.

3.1 Location

The proposed site is mainly located in Moygaddy, Co. Meath, but works will also extend across the Ryewater River as part of the bridge/ road construction and to facilitate connections to utility infrastructure. The lands are primarily agricultural greenfields however there are some residential dwellings and farm buildings within the site boundary. A number of local access roads cross the site.

Maynooth town is located to the south of the site across the Ryewater River.

Refer to Figure 3-1 for the existing site overview.

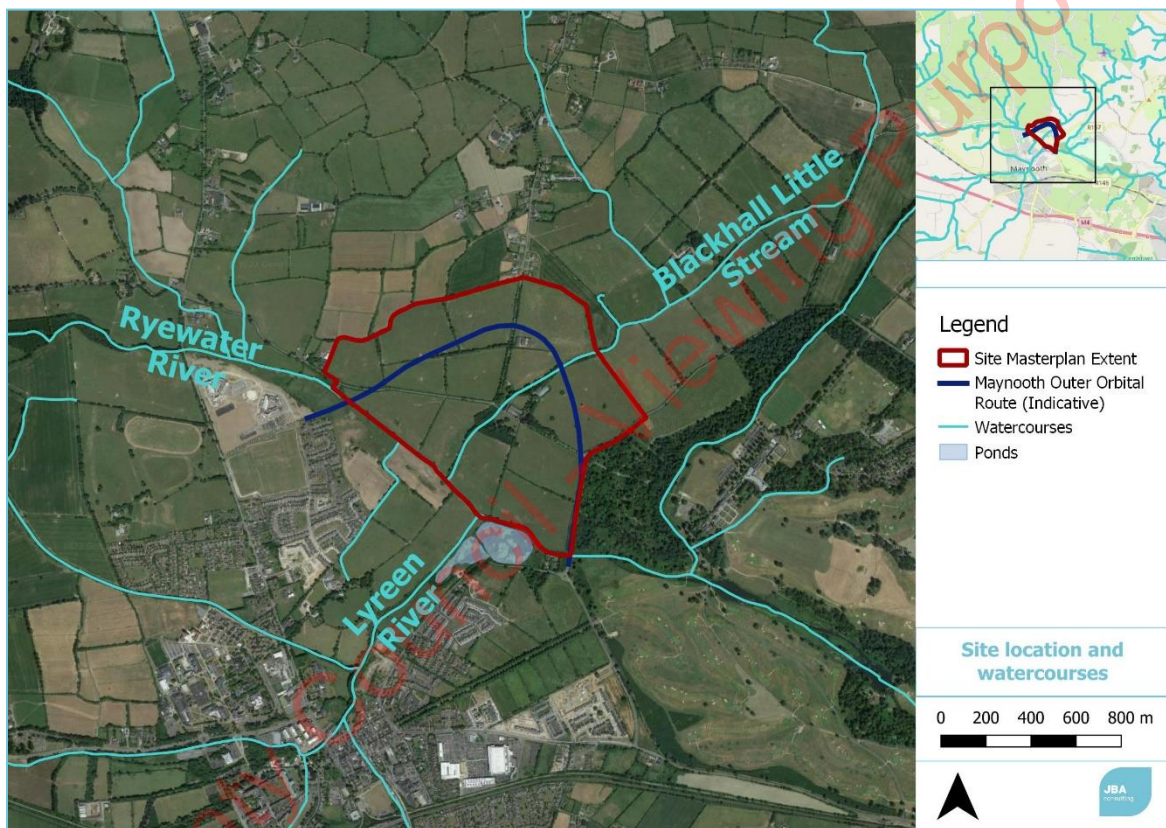


Figure 3-1: Site Location and watercourses

3.2 Site Topography

The masterplan site covers some 96Ha. It consists mainly of open fields. Public topographical data was available for review from the Geological Survey Ireland (GSI), courtesy of the OPW. Digital Terrain Model LiDAR data has been reviewed, which is topographical data that does not include buildings. As expected, the site falls naturally towards the Ryewater and Blackhole Little Stream. These 2 watercourses serve to naturally drain these lands. There is a high point located to the north with an elevation of c.62.66mOD. There is a low point at the southeast corner, located in the Ryewater river channel, with an elevation of c.44.40mOD. Refer to Figure 3-2 for the local topography.

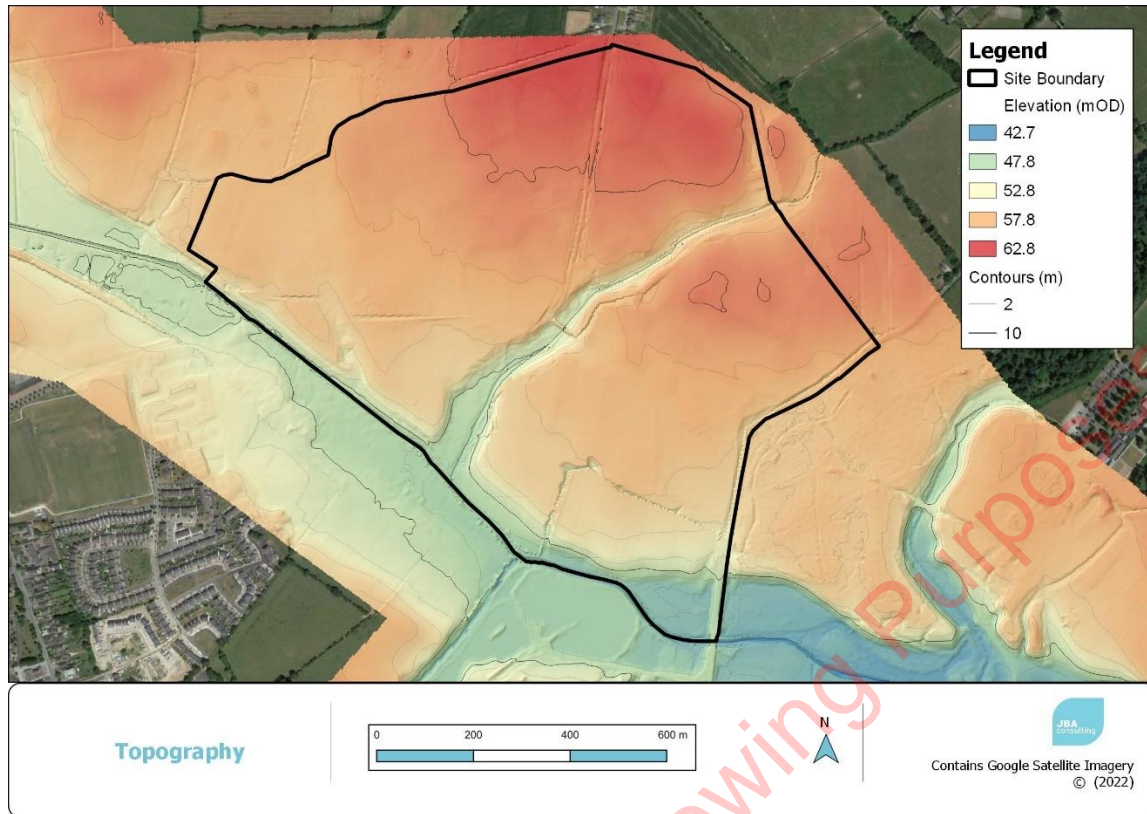


Figure 3-2: Site Topography (Source: site survey)

3.3 Watercourses

There are several watercourses in the area, and these are summarised as follows:

The main local watercourse is the Ryewater, also known as the River Rye. The Ryewater rises in Agher, Co. Meath. It flows through Kilcock, Maynooth and Leixlip before discharging to the River Liffey. The main tributaries of the Ryewater near Maynooth are summarised (amongst others) as follows:

To the north of the Ryewater, the Blackhole Little Stream runs through the site in a NE-NW direction. This stream rises near Cullendragh, Co. Meath and flows for c.10.3km before discharging to the Ryewater.

To the south, the Lyreen River merges with the Ryewater River along the southern boundary of the site. It flows through Maynooth town centre. It is c.12.2km in length and rises near Rathcoffey, Co. Kildare.

Refer to Figure 3-1 for an overview of local watercourses.

3.4 Site Geology

3.4.1 Local Subsoils

The GSI geological maps were available for review. The local subsoils are presented in Figure 3-3. The quaternary sediments present on site are TLs - Limestone till Carboniferous; while Alluvium undifferentiated gravelly is located along the waterbody systems. A thin line of Bedrock outcrop along the left bank of the Blackhole Little Stream at site. The underlying bedrock on-site is identified as 'Lucan Formation' and described as "dark limestone and shale (calp)". There were no karstic features identified on-site.

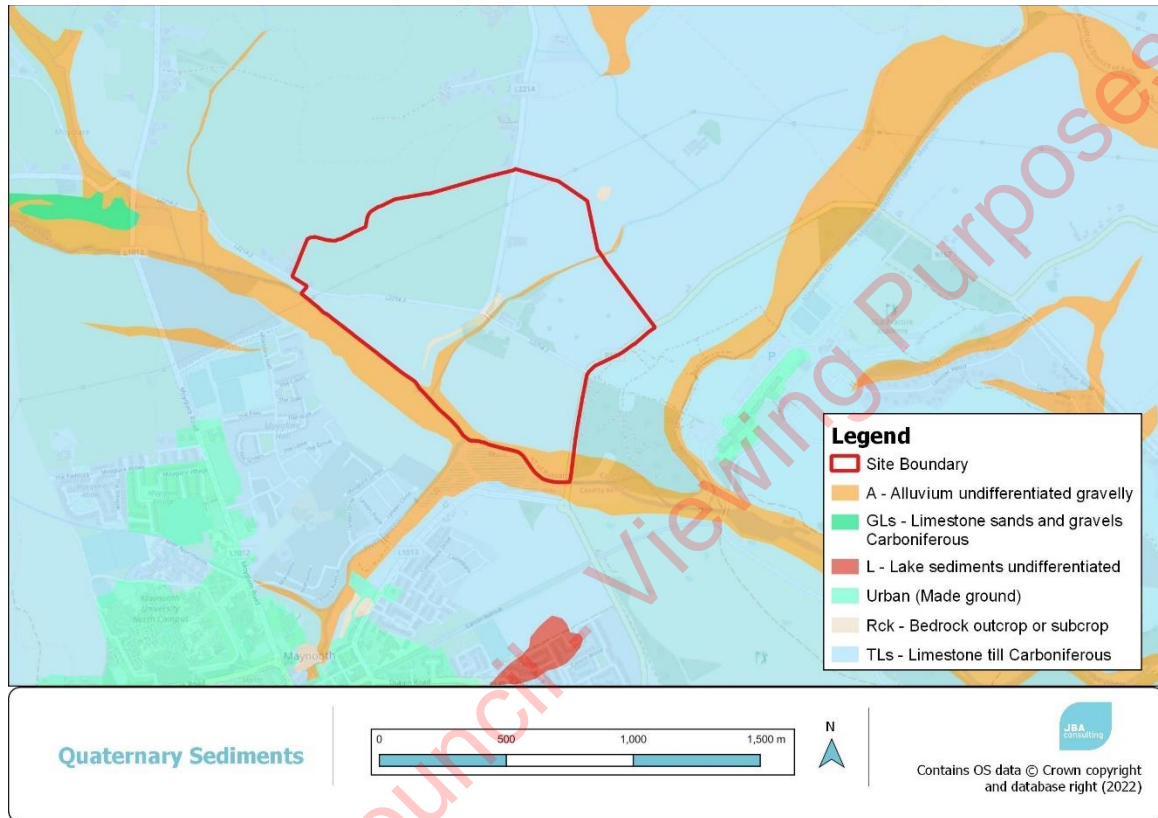


Figure 3-3: Quaternary Sediments (Source: GSI Database)

4 Flood Risk Identification

An assessment of the potential for, and scale of, flood risk at the site is conducted using historic and predictive information. This identifies any sources of potential flood risk to the site and reviews historic information. The findings from the flood risk identification stage of this FRA are provided in the following sections.

4.1 Flood History

A number of sources of flood information were reviewed to establish any recorded flood history at, or near the site. This includes the OPWs national flood information portal, www.floodinfo.ie, and general internet searches.

4.1.1 Floodinfo.ie

The OPW host a national flood information portal, www.floodinfo.ie, which highlights areas at risk of flooding through the collection of recorded data and observed flood events. Refer to Figure 4-1 for an overview of past flood events in the Maynooth / Moygaddy areas.

Two areas of possible groundwater flooding have been identified onsite, at the south-eastern area of the site in close proximity to the Ryewater and an area at the junction between the Blackhole Little Stream and Ryewater River.

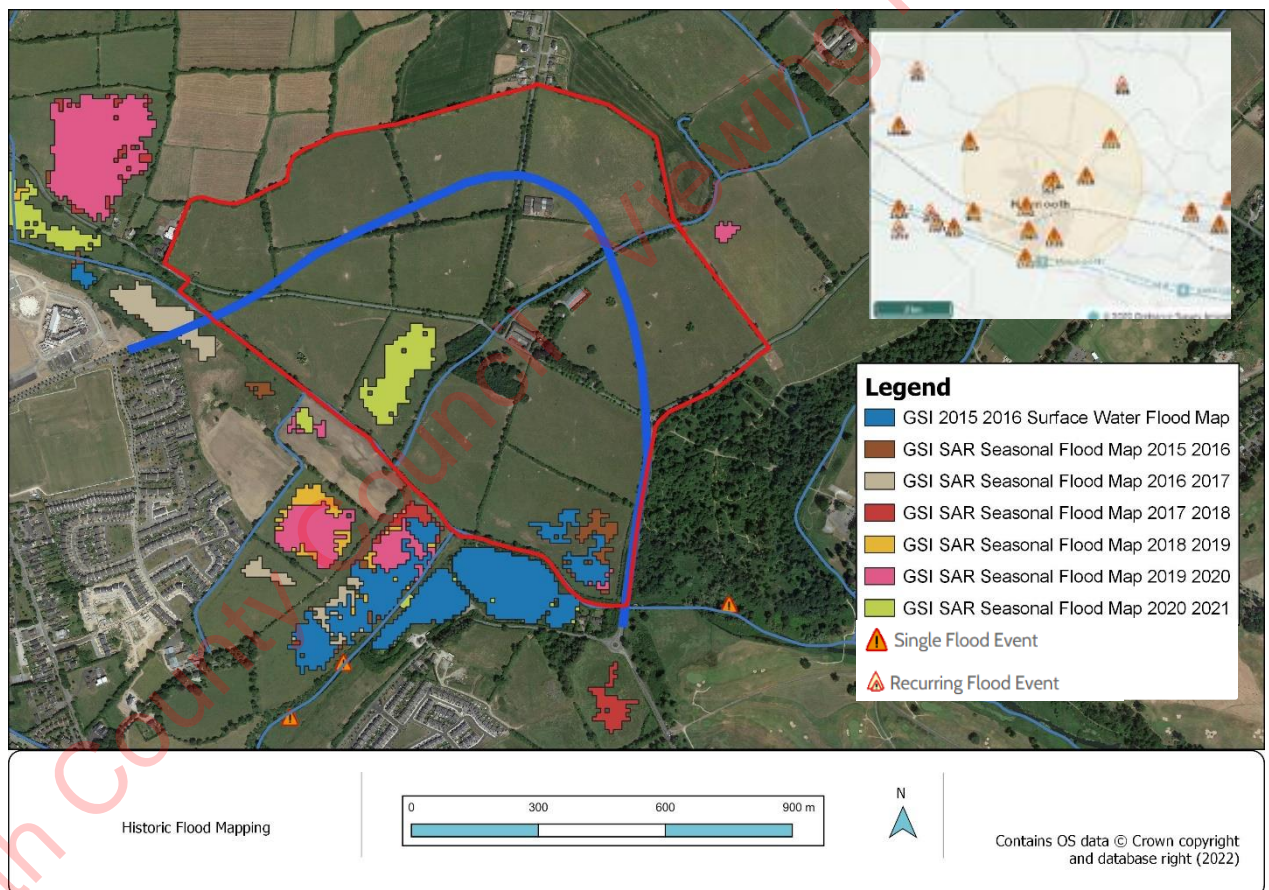


Figure 4-1: Flood History (floodinfo.ie)

Maynooth has been associated with significant flooding in its recent history. A summary of recent flood events is outlined as follows:

- ID-1948 - Lands along the Rye Water were flooded during the November 2000 event
- ID-11489 - Minor flooding along the Lyreen River near the fish ponds during October 2011
- ID-352 -In November 2000, flooding occurred on the Lyreen River at the weir near the fish ponds upstream of the confluence with the Rye Water

- ID-1942 - In June 1993, farmlands were flooded near the M4 motorway culvert and Jackson's Bridge. The flood source was the Lyreen River. Met Éireann estimated the June 1993 event equated to a 1-in-50 year storm;
- ID-1523 - Low lying lands and the R157 Maynooth-Dunbooyne regional road in Co. Meath were flooded in 14th-15th November 2002.
- Surface water flooding from the Winter 2015/2016 flood event was identified at the southeast corner of the masterplan site. This flooding is located to the north east of Lyreen River and three artificial fishing ponds in County Kildare, and the surface water flooding close to the Masterplan boundary itself.

There were no historic or predictive groundwater flooding extents identified within a 2.5km radius of the masterplan site

4.1.2 Internet Searches

An internet search was conducted to gather information about whether the existing site was affected by flooding previously. The search returned no results.

4.2 Predictive Flooding

The local area has been subject to several predictive flood mapping or modelling studies and other related studies and plans:

- Meath County Development Plan 2021-2027 Strategic Flood Risk Assessment;
- Eastern Catchment Flood Risk Assessment and Management (CFRAM) Study;
- National Indicative Fluvial Mapping (NIFM) Study.

The level of detail presented by each method varies according to the quality of the information used and the approaches involved.

4.2.1 Meath County Development Plan 2021-2027 Strategic Flood Risk Assessment

In accordance with Section 11 of the Planning and Development Act 2000 (as amended), Meath County Council (MCC) completed a review of the Meath County Development Plan (MCDP) 2013-2019 and subsequently prepared a new MCDP for the period 2021-2027. A Strategic Flood Risk Assessment (SFRA) for the MCDP 2021-2027 was prepared by JBA in accordance with the requirements of 'The Planning System and Flood Risk Management - Guidelines for Planning Authorities' (2009) and Circular PL2/2014 'Flooding Guidelines' by the Department of Housing, Local Government and Heritage. The SFRA provides an assessment of all types of flood risk within the County and assisted MCC in making informed strategic land-use planning decisions and formulate flood risk policies. This flood risk information has enabled MCC to apply 'The Guidelines' sequential approach, and where necessary, the Justification Test, to appraise sites for suitable land zonings and identify how flood risk can be managed as part of the MCDP.

Flood zone mapping for the Moygaddy area was prepared as part of the Maynooth Environs LAP. A review shows that areas along the Rye Water and Blackhole Little Stream are subject to flooding during the 1% (Flood Zone A) and 0.1% (Flood Zone B) AEP fluvial flood events. These areas have accordingly been zoned as 'H1 - High Amenity'. Refer to Figure 4-2.

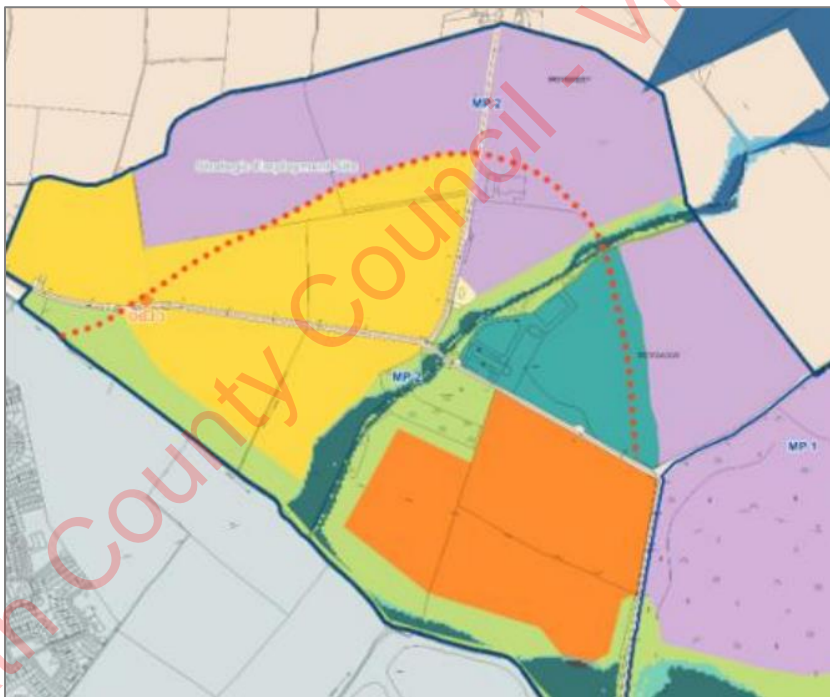


Figure 4-2: Extract from Maynooth County Plan Zoning (Meath SFRA)

4.2.2 Eastern Catchment Flood Risk Assessment and Management (CFRAM) Study

The primary source of data with which to identify flood risk to the site is the Eastern CFRAM study. The Eastern CFRAM study covers c.6,300 sq.km and involves detailed hydraulic modelling of rivers and their tributaries, along with coastal flood modelling. Flood maps are publicly available for the 10%, 1% and 0.1% AEP fluvial flood events, and covers Maynooth Town (amongst others):

Maynooth was identified as an Area for Further Assessment (AFA) as part of the superseded OPW PFRA study. The AFAs were the focus of the CFRAM studies. The flood extents for the Maynooth area were available from the OPW CFRAM WMS online layers. A review shows lands along the Rye Water and Blackhole Little Stream are subject to flooding during the 10%, 1% (Flood Zone A) and 0.1% (Flood Zone B) AEP fluvial flood events. The CFRAM extents are based on the undefended scenario, and therefore do not take account of flood protection structures such as embankments. Refer to Figure 4-3 for the CFRAM fluvial flood extents and Table 4-1 for CFRAM flood levels in Moygaddy. The study also confirms no flooding on the subject site for the 10%, 0.5% and 0.1% AEP from coastal flood events.

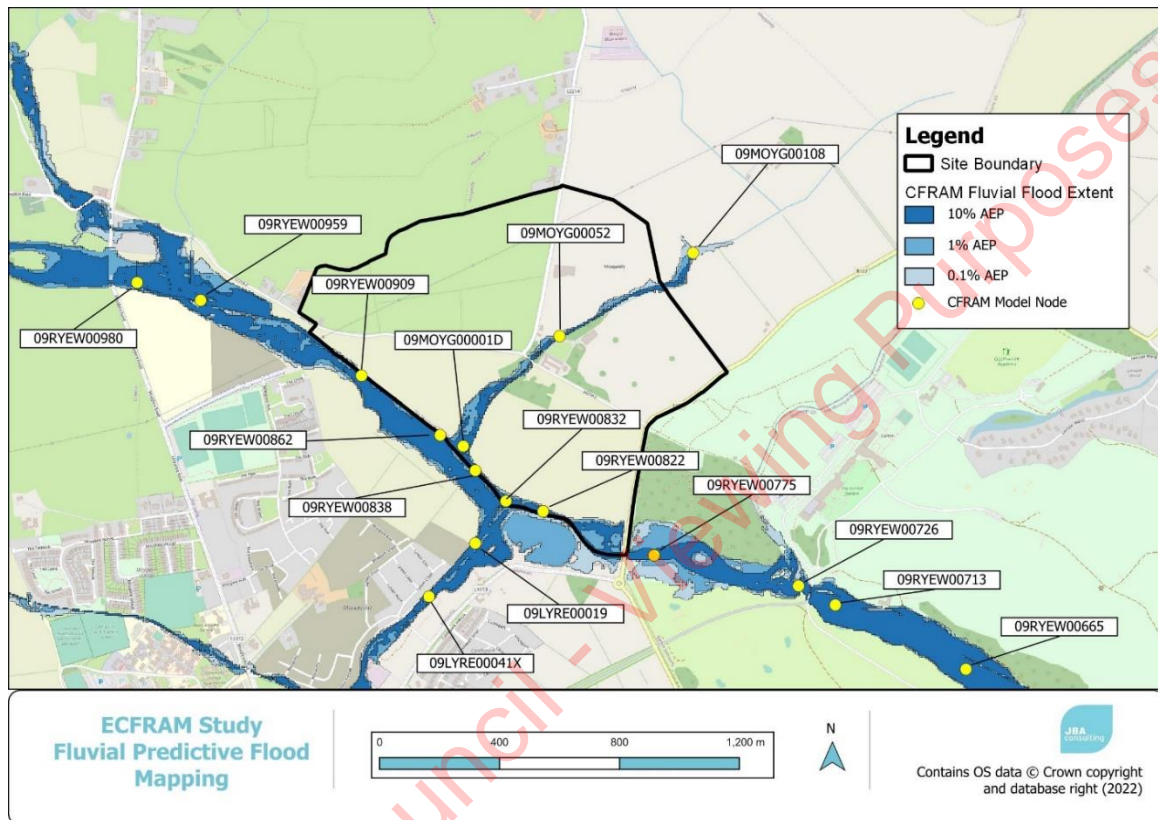


Figure 4-3: ECFRAM Study Fluvial Flood Extents (Source: Floodinfo.ie)

Table 4-1: ECFRAMS Flood Levels (mOD) (Source: Floodinfo.ie)

ECFRAMS Model Node	10% AEP	1%AEP	0.1%AEP
Blackhole Little Stream			
09MOYG00108	57.80	58.21	58.56
09MOYG00052	51.97	52.37	52.80
09MOYG00001D	48.12	48.40	48.52
Ryewater River			
09RYEW00980	51.94	52.12	52.334
09RYEW00959	50.95	51.23	51.29
09RYEW00909	49.70	49.98	50.31
09RYEW00862	47.94	48.19	48.45
09RYEW00838	47.31	47.64	48.04
09RYEW00832	46.89	47.38	47.85
09RYEW00822	46.60	47.04	47.55
09RYEW00775	45.28	45.65	46.11
09RYEW00726	44.64	44.87	45.24
09RYEW00713	44.66	44.88	45.22
09RYEW00665	44.62	44.82	45.11

ECFRAMS Model Node	10% AEP	1%AEP	0.1%AEP
Lyreen River			
09LYRE00019	47.51	47.85	48.08
09LYRE00041X	47.84	48.27	48.68

4.2.3 National Indicative Fluvial Mapping (NIFM) Study.

Data has been produced for catchments greater than 5km² in areas for which flood maps were not produced under the National CFRAM Programme and should be read in this context. The NIFM datasets have been edited to remove overlaps with the datasets produced under the National CFRAM Programme and other flood studies. The NIFM datasets should be read in conjunction with the outputs of the National CFRAM Programme and other studies.

Refer to Figure 4-4 for NIFM flood extents

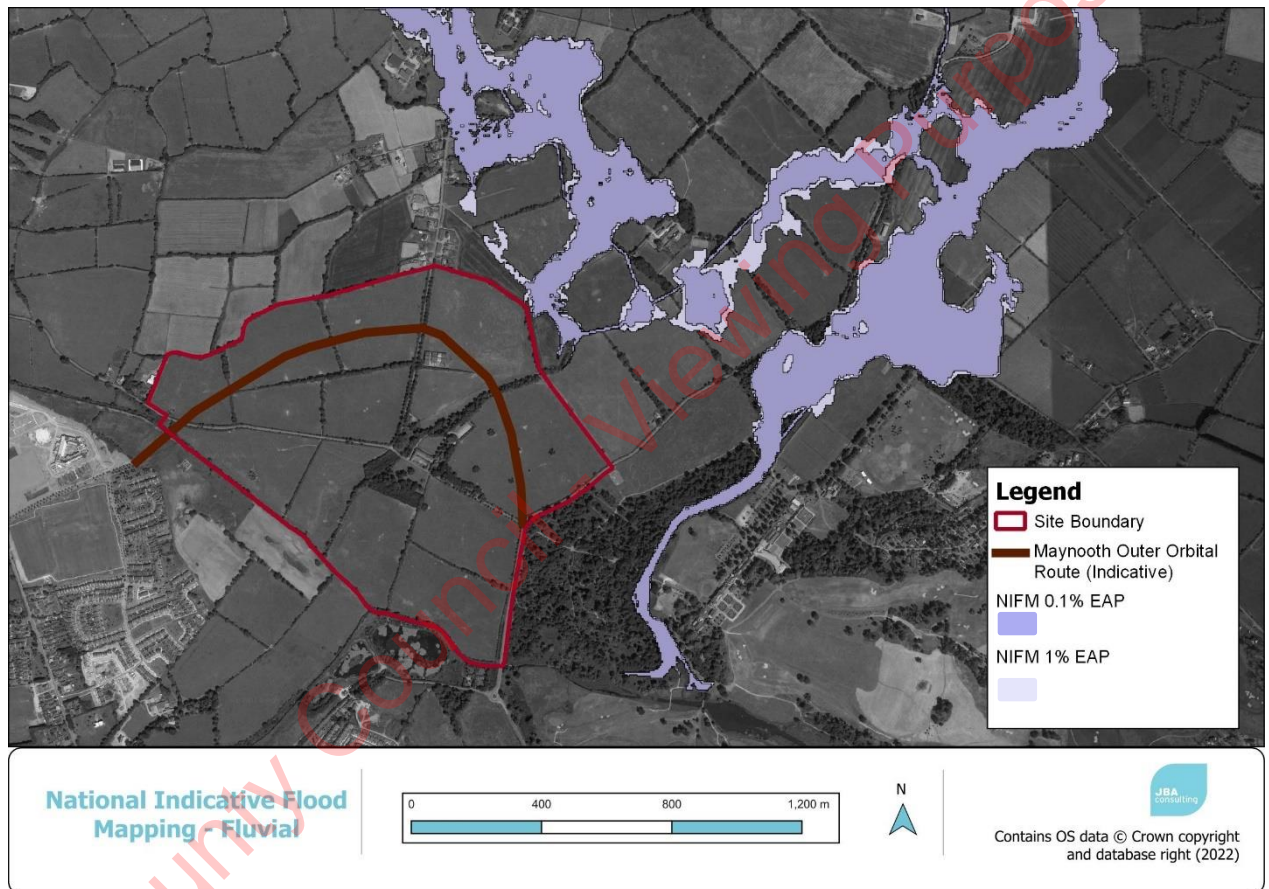


Figure 4-4: NIFM for Moygaddy area (Source: Floodinfo.ie)

4.3 Flood Sources

The initial stage of a site-specific Flood Risk Assessment (FRA) requires the identification and consideration of probable sources of flooding. Following the initial phase of this FRA, it is possible to summarise the level of potential risk posed by each source of flooding. The flood sources are described as follows:

4.3.1 Fluvial / River

There are several watercourses in the area, principally the Ryewater, Blackhole Little Stream and Lyreen River. The Ryewater lies along the Masterplan boundary and discharges to the River Liffey in Leixlip, Co. Kildare. The flood risk is identified as follows:

- The Meath County Development Plan 2021-2027 Strategic Flood Risk Assessment shows that areas of the masterplan site are subject to flooding during the 1% (Flood Zone A) and 0.1% (Flood Zone B) AEP fluvial flood events. The remaining areas are therefore within Flood Zone C;
- The Eastern CFRAM study shows that areas of the masterplan site and the proposed MOOR corridor are located in lands which are subject to flooding during the 10%, 1% (Flood Zone A) and 0.1% (Flood Zone B) AEP fluvial flood events;
- The National Indicative Fluvial Mapping (NIFM) study shows that lands immediately northeast of the masterplan site are subject to flooding during the 1% (Flood Zone A) and 0.1% (Flood Zone B) AEP fluvial flood events, however, the floodwaters do not encroach onto the Masterplan site area.

Based on the identified fluvial flood risk, a hydraulic model has been developed to confirm the Flood Zone A/B flood extents within the site, while also appraising for the potential impacts of climate change and also testing for residual risks (blockage). The hydraulic model is outlined in Section 5, which also includes the flood map outputs.

Utilising hydraulic model outputs site-specific mitigation measures to manage the ongoing fluvial risk are outlined in Section 6. Residual risk is further discussed in Section 6.3.

4.3.2 Tidal / Coastal

Maynooth and Moygaddy are located inland and are not impacted by predictive and historic tidal flooding, as confirmed by the Eastern CFRAM and National Coastal Flood Hazard Mapping (NCFHM) 2021 studies.

The risk of tidal flooding has been screened out at this stage.

4.3.3 Pluvial / Surface Water

Pluvial, or surface water, flooding is the result of rainfall-generated flows that arise before runoff can enter a watercourse or sewer. It is usually associated with high-intensity rainfall events. Flood risk from pluvial sources exists in all areas. Adequate surface water drainage systems will assist with the alleviation and management of pluvial flooding risk.

It is noted that there were instances of surface water flooding from the Winter 2015/2016 flood event at the southeast corner of the masterplan site. This event represented the largest groundwater flood on record. This flood map encompasses fluvial (rivers) and pluvial (rain) flooding in non-urban areas and has been developed under the GWflood¹ project as a by-product of the historic groundwater flood map. It was not clear at the time of writing this report whether the flooding in the southeast corner was fluvial or pluvial-related.

Site-specific mitigation measures to manage the pluvial flooding risk are outlined in Section 6. Residual risk is further discussed in Section 6.3.

4.3.4 Groundwater

Review of the historic flooding and GSI datasets outlined in Section Figure 4-1 provides some indication that historic groundwater flooding has occurred within the masterplan site. However, the confidence rating given to the occurrence of the event is 'Low'. Following review of the topography of the affected areas are partially elevated to the Ryewater and Blackhole Little Stream flood plains. If groundwater flooding was to occur onsite it will be contained within the low-lying flood plains.

1 GWflood project (2016-2019) (gsi.ie)

No development is proposed within these areas therefore, the flood risk from groundwater flooding has been screened out at this stage.

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5 Hydraulic Model

5.1 Hydrology Assessment

To assist in the estimation of potential flood risk to the proposed development within the Masterplan Area, from each of the Ryewater River, Moygaddy Stream and Lyreen River, this section provides flow estimates for the 1% and 0.1% AEP flood event flows.

5.1.1 Catchment Characteristics

The catchment characteristics for the HEPs have been transferred from corresponding node from FSU database. The physical characteristics of the catchment influence the hydrology, this includes catchment size (AREA), soil type, steepness and the average annual rainfall. The values have been reviewed and the URBEXT value was updated, using the latest CORINE 2018 land use data set and information from myplan.ie. Table 4-1 outlines the parameters calculated for the site catchment. Figure 5-2 overpage details the catchment area.

Table 5-1: Catchment Characteristics (source: OPW FSU)

Descriptor	HEP_1	HEP_2	HEP_3	HEP_4a	HEP_4b	HEP_5	HEP_6
FSU Node	09_301_2	09_1857_2	09_1863_2	09_1241_1	09_1060_3	09_611_3	09_1260_3
Area	59.141	70.314	71.806	17.086	18.00	87.635	193.858
SAAR	805.71	804.55	803.76	807.87	805.46	768.16	785.64
FARL	1	1	1	1	1	1	1
BFI Soil	0.474	0.474	0.475	0.444	0.442	0.473	0.477
URBEXT	0.037	0.031	0.034	0	0	0.045	0.048
MSL	15.108	16.173	16.674	8.992	10.314	16.684	19.465
S1085	2.114	1.832	1.971	6.193	5.444	1.794	2.468
Stream Frequency	29	35	37	7	9	37	99
DrainD	0.806	0.833	0.837	1.096	1.125	0.699	0.809
ArtDrain2	0.2818	0.245	0.2455	0	0	0	0.1116
Soil (number)	2(25%), 4(75%)	2(25%), 4(75%)	2(35%), 4(65%)	2(50%), 4(50%)	2(55%), 4(45%)	2(90%), 4(10%)	2(65%), 4(35%)
M5-2day	54	54	54	54	54	54	54
r	0.33	0.33	0.33	0.33	0.33	0.33	0.33

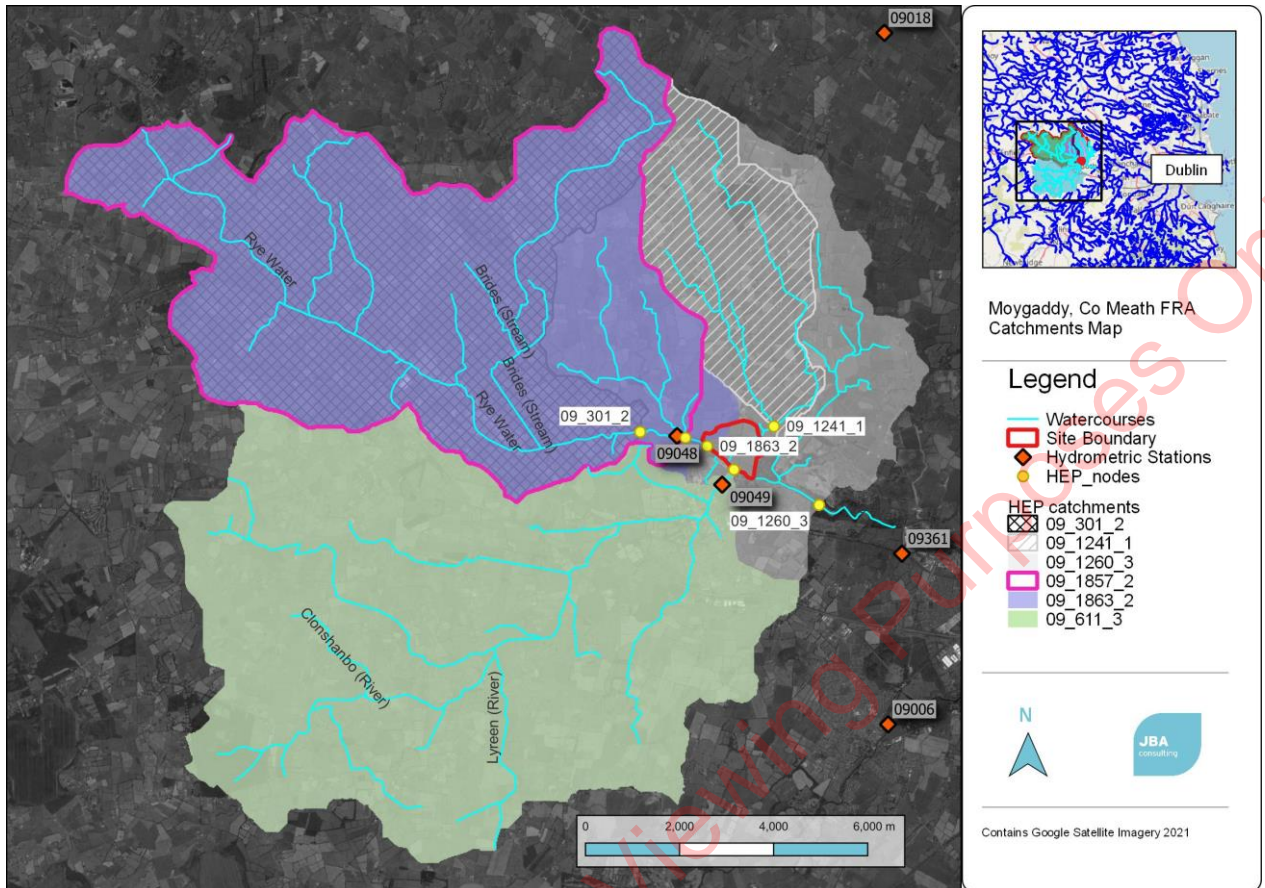


Figure 5-1: Catchment Area

5.1.2 Flow estimation

The flow estimations for the Ryewater River, Blackhole Little Stream and Lyreen Stream are provided in Table 5-2. The FSU (Flood Studies Update) method was selected as it produced more conservative flows and is considered the most applicable method based on the catchment size and characteristics.

Table 5-2: Design Flows (m³/s)

Site code	Flood peak (m ³ /s) for the following return periods (% AEP)						
	50%	20%	10%	5%	2%	1%	0.1%
HEP_1	17.19	26.64	31.97	37.13	43.83	48.82	66.35
HEP_2	20.01	29.21	35.41	41.41	49.02	54.62	73.63
HEP_3	20.75	30.29	36.72	42.94	50.83	56.64	76.35
HEP_4a	6.35	9.85	11.82	13.72	16.20	18.04	24.53
HEP_5	13.71	21.25	25.49	29.61	34.95	38.93	52.91
HEP_6	46.44	71.98	86.37	100.30	118.42	131.88	179.25

5.1.3 Climate Change

Current OPW guidance requires that the effects of climate change be considered when assessing flood risk. The expected increase in peak flows, rainfall and tidal level is provided in the draft OPW guidance which provides allowances for two different climate change scenarios. These are the Mid-Range Future Scenario (MRFS) and the High-End Forecast Scenario (HEFS). The recommended allowances for climate change are given in Table 5-3 below. The potential implications for the proposed development within the Masterplan Area from climate change are discussed further in Section 5.1.3.

Table 5-3: OPW Climate Change Guidance

	MRFS	HEFS
Extreme Rainfall Depths	+20%	+30%
Flood Flows	+20%	+30%
Mean Sea Level Rise	+500mm	+1000m

5.2 Hydraulic Model

To provide a detailed assessment of flood risk within the Masterplan site area, a 1D-2D ESTRY-TUFLOW hydraulic model was constructed. It allows for the modelling of river channels, streams, floodplains and hydraulic structures to predict water levels for a range of scenarios (see Figure 5-2 for the hydraulic model structure). The hydraulic model was developed in the following stages:

- A 1D-2D ESTRY-TUFLOW model of the Ryewater River and Blackhole Little Stream was created using a DTM and available surveyed data;
- The Lyreen River was represented in the 2d model.
- Existing structures were inserted into the model based on survey data and a baseline condition was established, in the vicinity of the site. Refer Figure 5-2 for the existing structure in the vicinity of the masterplan site;
- Hydraulic simulations were run to derive the existing flood extents for the 1% and 0.1% AEP flood events;
- The post-development design has been assessed against a climate change scenario (MRFS);
- Residual risks have been tested to assess the residual risk for the site.



Figure 5-2: Model Schematisation

5.2.1 Site Survey

The flood model of the Ryewater River and Blackhole Little Stream has been based on OPW sourced site survey data (2013). This was supplemented and updated by site specific river survey data undertaken during July 2021 by Murphy Surveys.

A comprehensive site survey was undertaken of the site and wider lands during September 2021. This survey data was incorporated into the model to ensure that the model is based on accurate and up to date data.

5.3 Model Results

The model results are presented in the following sections that focus on the confirmation of Flood Zone A & B, while also providing the post-development flood extents for the various development areas.

5.3.1 Delineation of Flood Zone A and B

The model results show the Masterplan area is not impacted by fluvial inundation during both the 1% and 0.1% AEP fluvial flood events. The flood extents identified in parts of the masterplan site are presented in Figure 5-3 and indicative flood levels are presented in Table 5-4. The complete output from the model is presented in Appendix D.

The outputs from hydraulic model have been compared to the CFRAM model outputs (Figure 4-3) and the results show a good agreement between the two studies. This provides confidence in the produced flood extents and also suggest a well-defined flood plain.

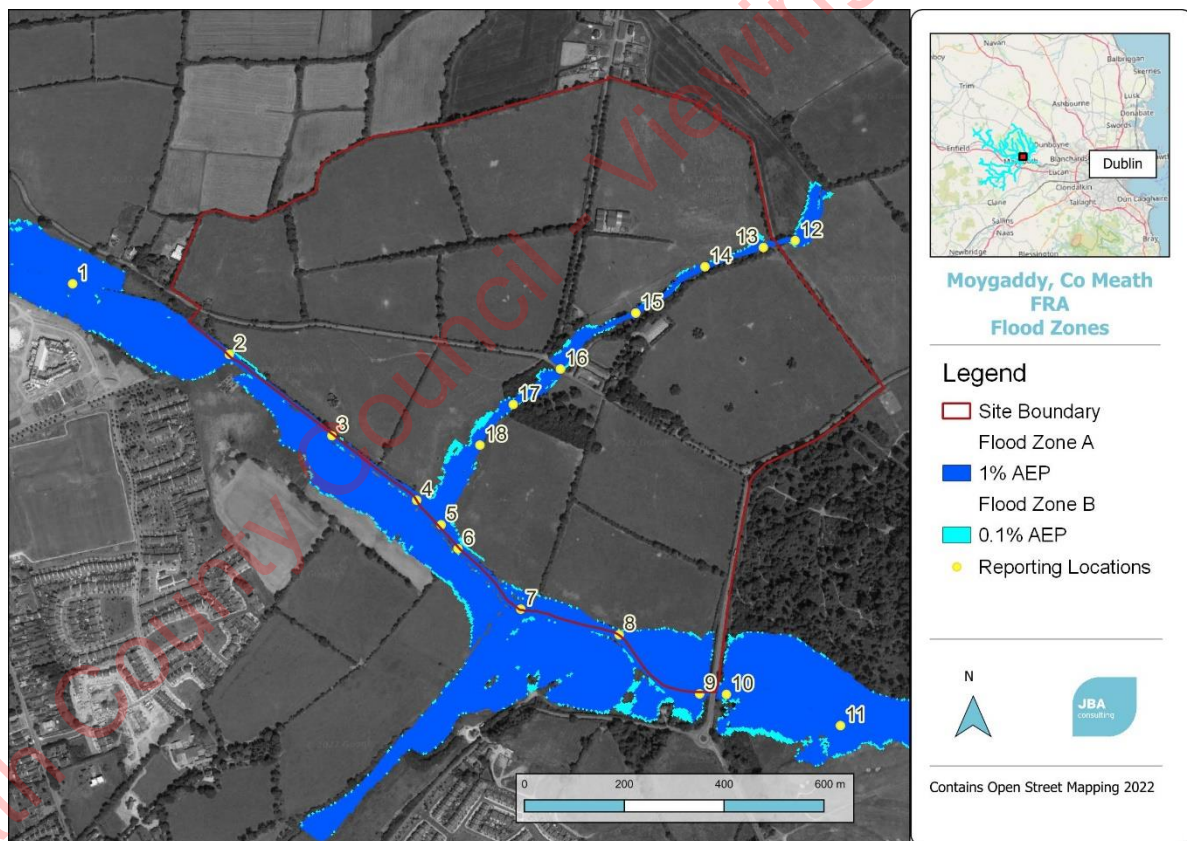


Figure 5-3: 1% and 0.1% AEP fluvial flood extents - pre-development scenario

5.4 Post-Development Model Results

The post-development model results are presented in the following sections. As no development is proposed within Flood Zone A/B the post-development model only includes the proposed bridge structures outlined in Section 5.4.1.

The resulting flood map is presented in Figure 5-5 and levels in Table 5-4.

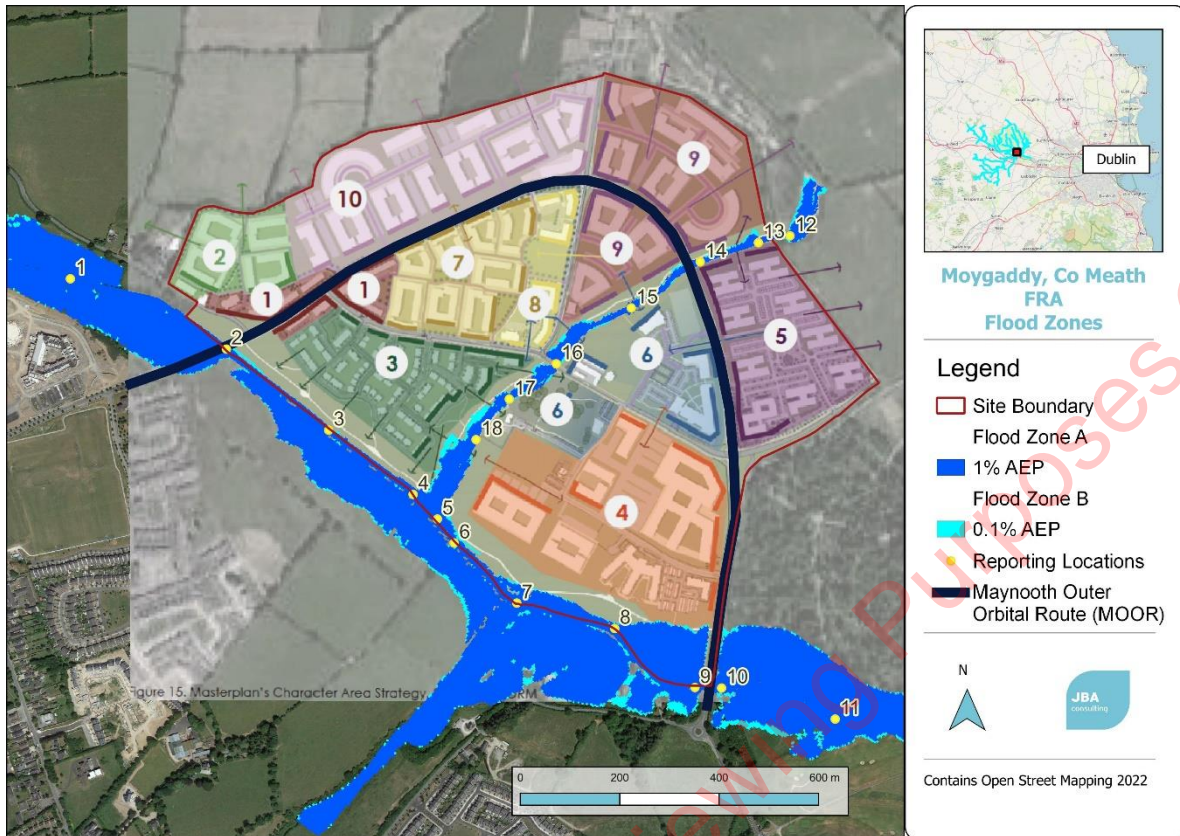


Figure 5-4: 1% and 0.1% AEP fluvial flood extents - post-development scenario

Table 5-4: Flood Levels (mOD)

Reporting Location	1%AEP	0.1%AEP	1% AEP MRFS
1	50.98	51.01	51.00
2	50.17	50.30	50.25
3	49.33	49.39	49.37
4	48.52	48.63	48.58
5	48.72	48.63	48.72
6	48.20	48.36	48.29
7	47.77	47.99	47.90
8	47.12	47.36	47.26
9	46.59	46.90	46.77
10	46.24	46.43	46.35
11	45.68	45.93	45.83
12	56.73	56.91	56.83
13	56.25	56.41	56.34
14	55.22	55.40	55.32
15	54.07	54.15	54.13
16	52.78	53.44	53.04
17	50.34	50.48	50.43
18	49.39	49.53	49.47

5.4.1 Post-Development Bridge Structures

As part of the dynamic modelling exercise a specific scenario has been developed to assess the potential impact of with the proposed bridges in place and the results are presented in the following section. The proposed bridges which are integral to the development of the Masterplan site is presented in Figure 5-5.

Note: that the results presented in the following section are the 1% and 0.1% AEP flood events. All bridge structures will undergo a Section 50 application post granting of planning which will be assessed in accordance with the Section 50 design standards.

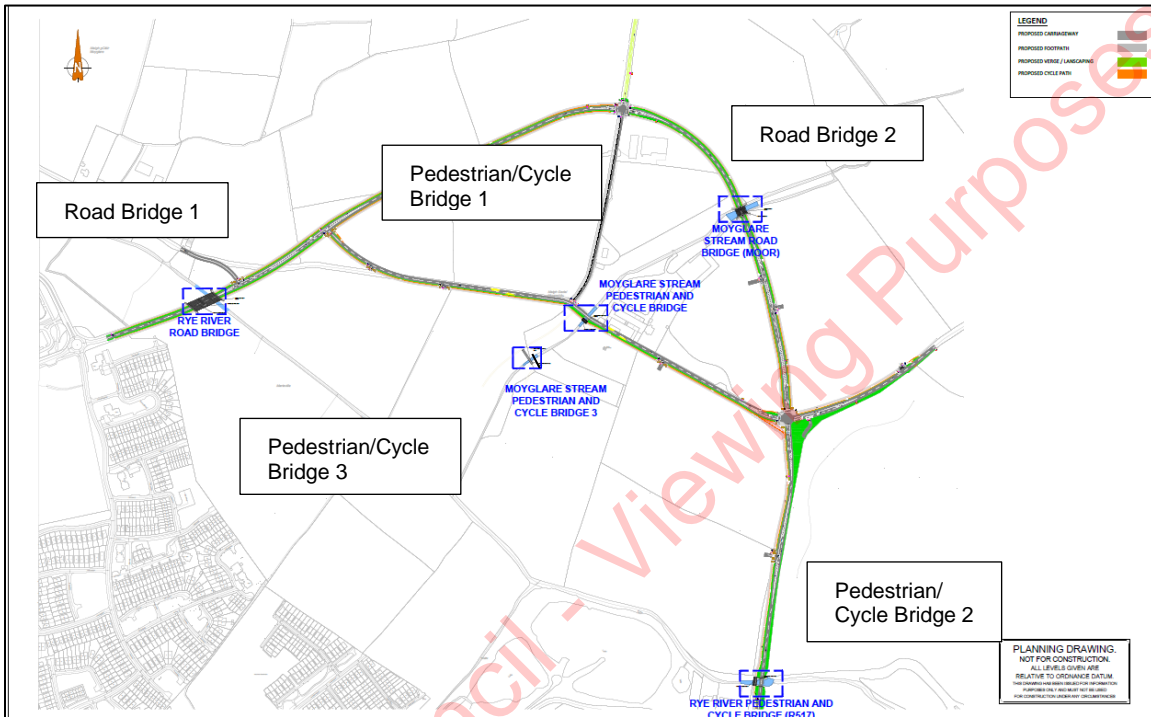


Figure 5-5: Bridge Structures

5.4.1.1 Road Bridge 1

This proposed bridge forms part of the MOOR and it will link the subject land with County Kildare at Moygaddy. This new road bridge will also have a pedestrian and cycle facilities. The proposed bridge soffit level has been set at 51.7mOD which provides a minimum freeboard of 1.10m above the 0.1% AEP flood level. The bridge design is provided in Figure 5-6.

The bridge design is based a multi-span design consisting of two 25m span sections.

The post-development flood levels are presented in Figure 5-6.

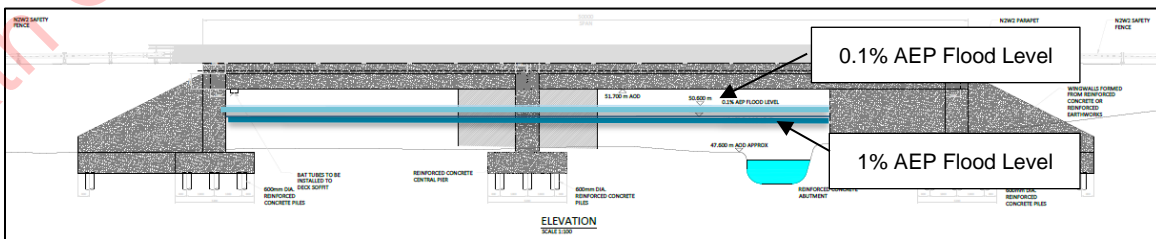


Figure 5-6: Post-development Flood Levels for Road Bridge 1

Post-development modelling has been undertaken of the proposed Road Bridge 1 structure. The results confirm that the bridge has been designed to convey the 1% AEP and 0.1% AEP flood events without increasing flood risk upstream and downstream of the site. The flood levels are presented in Figure 5-6.

Note: The bridge has been designed to the OPW's Section 50 design standards and an application will be submitted to the OPW following granting of planning.

5.4.1.2 Road Bridge 1

This proposed bridge forms part of the MOOR and it will link the Western and Eastern half of the subject Masterplan lands by providing a crossing over the Blackhole Little Stream. The proposed bridge soffit level has been set at 48.3mOD which provides a minimum freeboard of 1.36m above the 0.1% AEP flood level.

The model confirms that there is no impact on level during the 1% AEP or 0.1% AEP events. The post-development flood levels are presented in Figure 5-7.

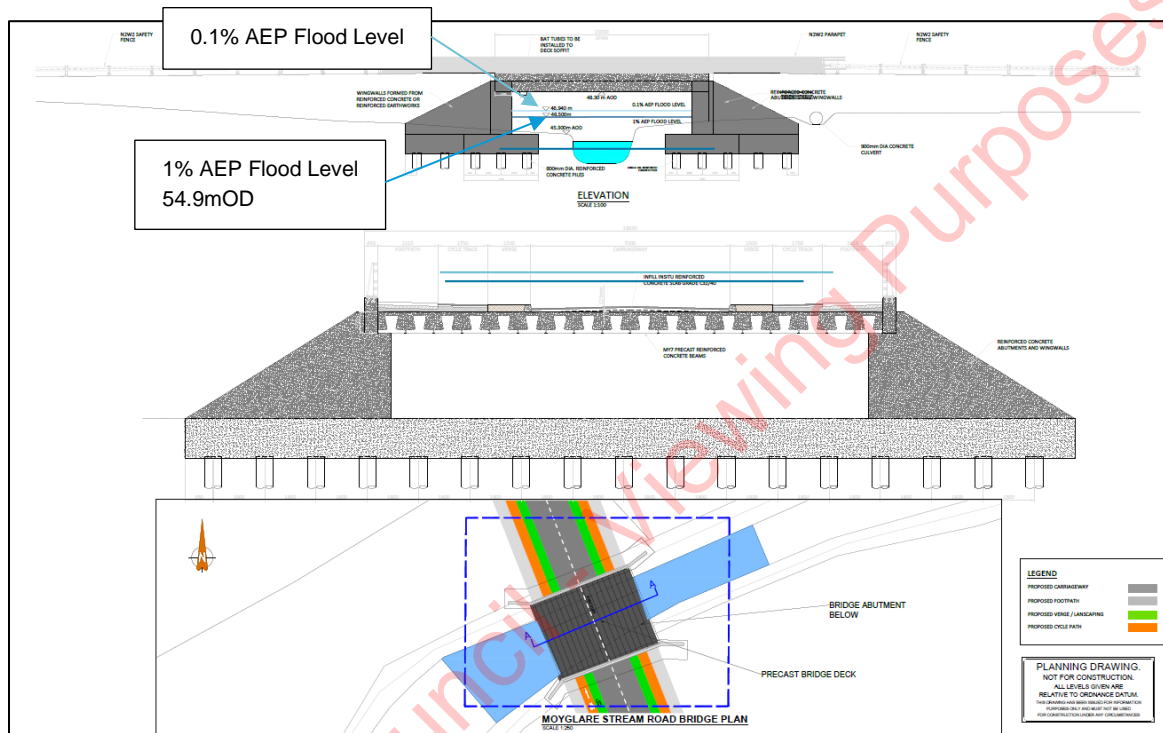


Figure 5-7: Proposed Bridge Layout- Road Bridge 2

5.4.2 Pedestrian Bridge 1 (with Cycle Lane)

The existing road bridge on the L2214 local road which crosses the Blackhole Little Stream does not have existing pedestrian or cycle facilities.

As part of the proposed development within the Masterplan area, it is proposed that a new pedestrian and cycle bridge will be installed to the south of the existing road bridge.

The modelled flood levels are as follows: 1%AEP is 52.82mOD and 0.1% AEP - 53.37mOD. The model confirms that there is no impact on flood level during the 1% AEP or 0.1% AEP events. The post-development flood levels are presented in Figure 5-8

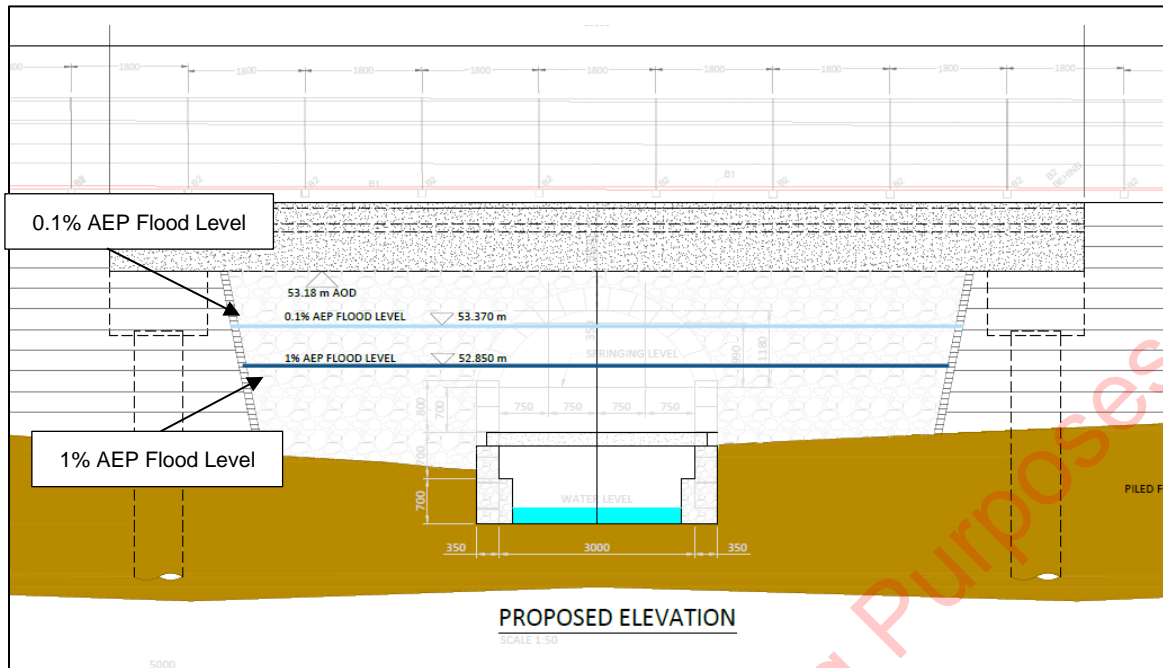


Figure 5-8: Post-development Flood Levels for Pedestrian Bridge 1

As the proposed pedestrian and cycle bridge will be located on the downstream face of the existing road bridge, it has no impact on the hydraulic flow regime and therefore has no impact on the existing flood levels.

5.4.3 Pedestrian Bridge 2 (with cycle lane)

To enhance connectivity and permeability between the Masterplan lands and Maynooth town, a new pedestrian and cycle bridge is proposed to the west of the existing Kildare Bridge.

The 'Pedestrian Bridge 2' is located upstream of the Kildare Bridge, the existing bridge structure over the Ryewater River along the R157. The main flow restriction in the area is caused by the existing Kildare Bridge.

A single span bridge is proposed which is wider than the existing multi-span arch bridge. Refer to Figure 5-9.

The existing 1% and 0.1 % AEP flood event level are 46.57mOD and 46.94mOD respectively. The proposed bridge soffit level has been set at 48.3mOD which provides a minimum freeboard of 1.36m above the 0.1% AEP flood level.

The model confirms that post-construction of the new bridge there is no impact on level during the 1% AEP or 0.1% AEP events. The post-development flood levels are presented in Figure 5-9. Some minor infilling is required in order to facilitate construction of the earthen embankments within Flood Zone A/B.

Furthermore, due to the single span nature of the bridge it will not increase the risk of blockage occurring in the area, nor is there any impact on flood levels upstream of the bridge for both the 1% AEP and 0.1% AEP flood events. The post-development flood levels are presented in Figure 5-9.

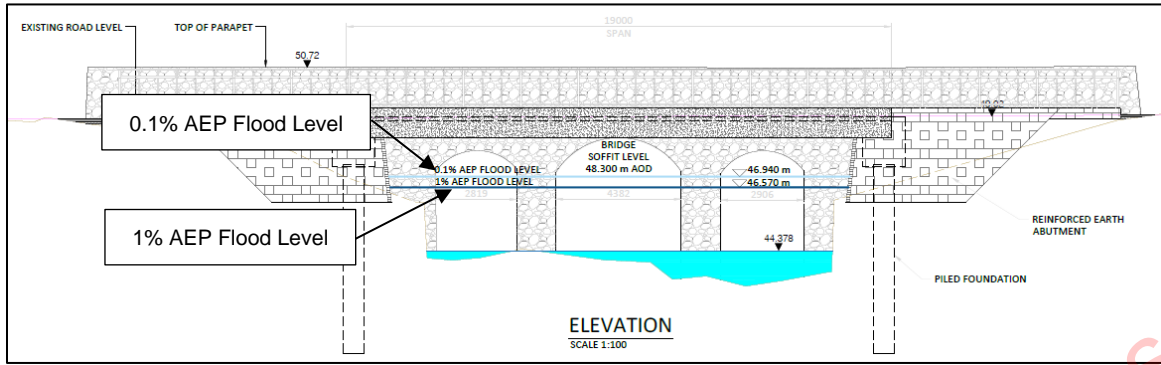


Figure 5-9: Post-development Flood Levels for Pedestrian Bridge 2

5.4.4 Pedestrian Bridge 3

In order to enhance permeability and connectivity between the proposed residential development to the west of the Blackhole Little Stream and the east, a second pedestrian and cycle bridge will be installed. The Pedestrian Bridge 3 provides local walkway access across the Blackhole Little. Refer to Figure 5-10 for the location of the bridge. The bridge will be of lightweight construction with a span of 30m.

The modelled 1% AEP and 0.1% AEP flood levels at the bridge are 50.20mOD and 50.35mOD respectively.

The bridge will undergo a Section 50 application to the OPW post-planning.

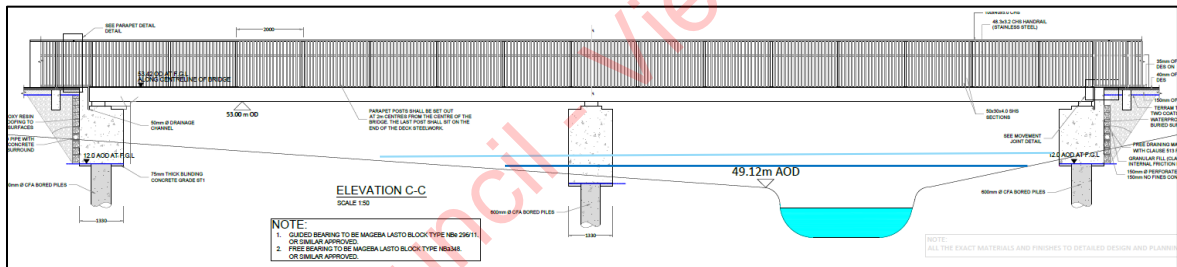


Figure 5-10: Pedestrian and cycle Bridge 3 Location

5.5 Office (Areas 5, 9 and 10)

With reference to Figure 2-1, the Office space covers Area 5 (Eastern), 9 (Central) and 10 (western) sections of the masterplan. Areas 5 and 9 are located adjacent to the Blackhole Little Stream. Review of Figure 5-11 confirms that all the office area are located in Flood Zone C.

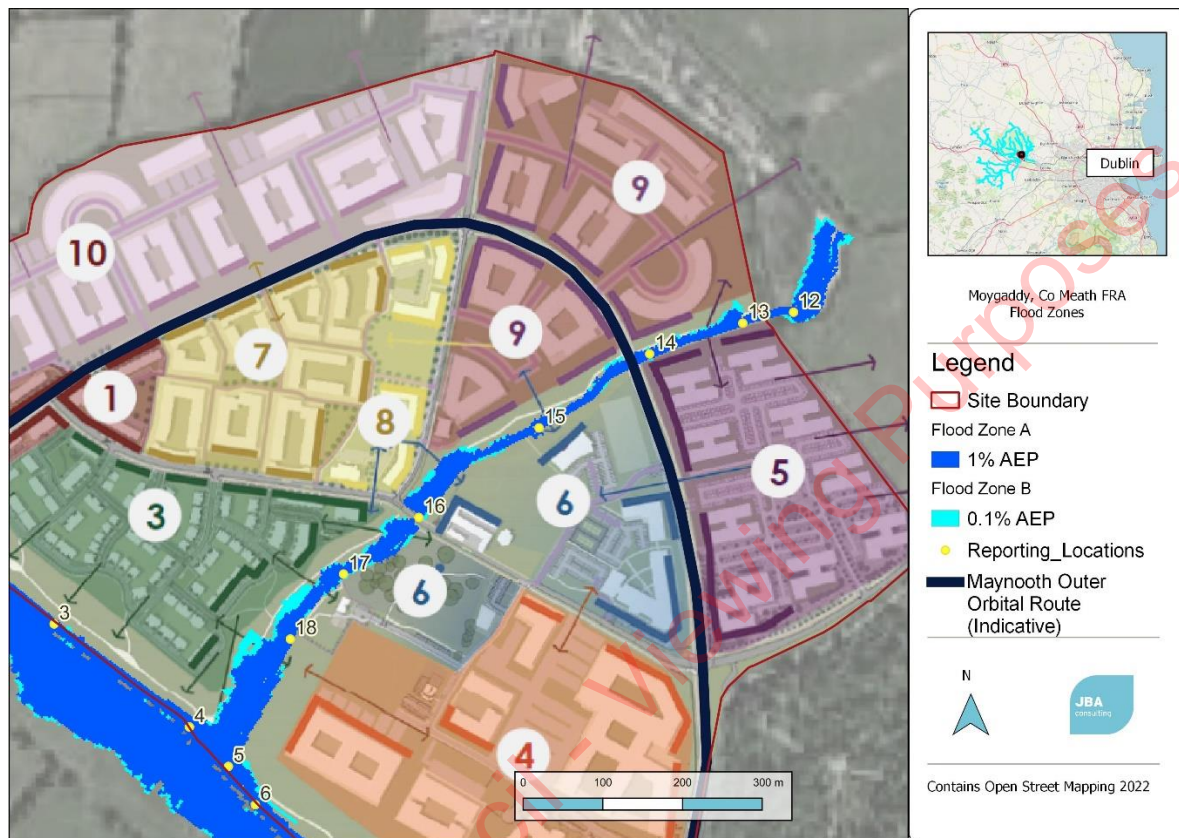


Figure 5-11: Office Areas (5,9 & 10)- Flood Zone

5.6 Primary Care & Nursing Home

The Primary Care & Nursing Home is located in Area 4 of the Masterplan. The Blackhole Little Stream runs along the site to the west and the Ryewater to the south. All areas of the development have been located on Flood Zone C, refer to Figure 5-12 for the flood extents in proximity to the Primary Care & Nursing Home.



Figure 5-12: Primary Care & Nursing Home- Flood Zone

5.7 MOOR

The Maynooth Outer Orbital Route (MOOR) is the main road infrastructure that connects the development to the wider Maynooth area. The majority of the MOOR is located in Flood Zone C, however it does cross the Ryewater and Blackhole Little Stream. Where the MOOR infrastructure crosses the Ryewater/ Blackhole Little Stream a bridge structure will be provided with the soffit level placed above the 1% AEP and 0.1% AEP flood levels. Figure 5-13 provides the flood extents along the MOOR route.

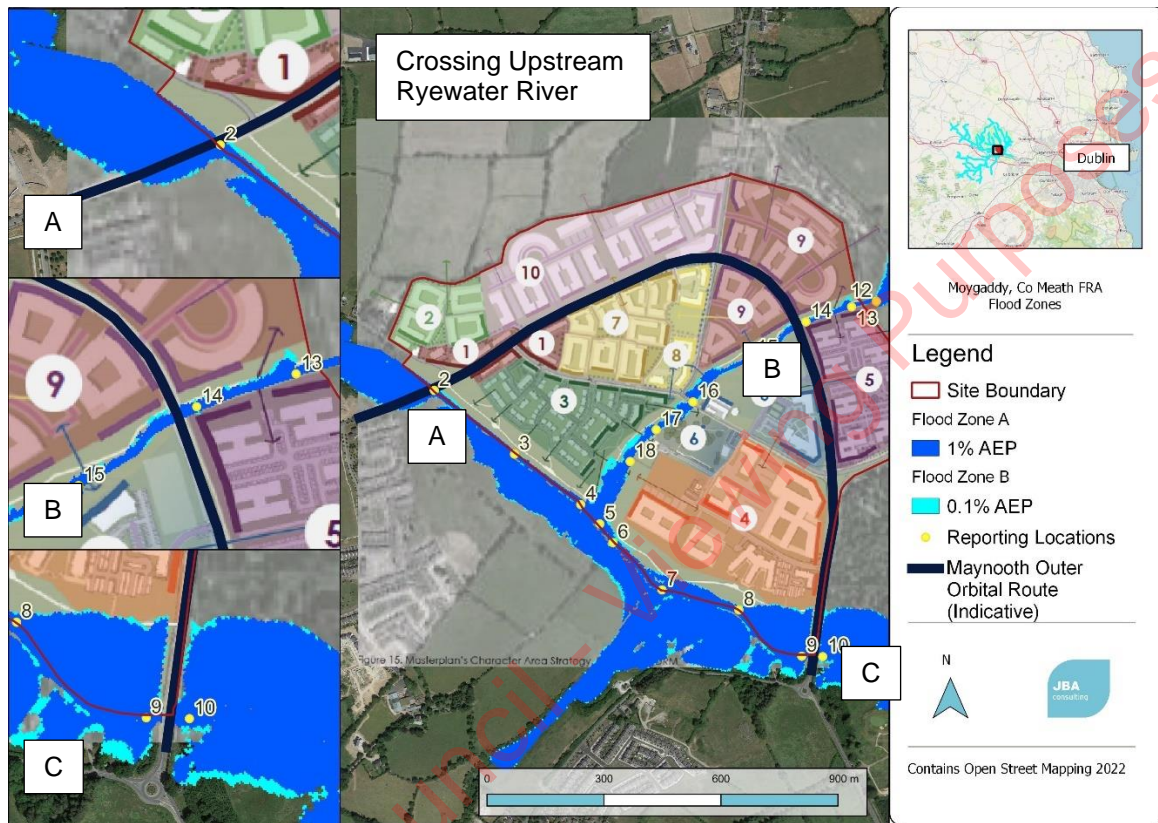


Figure 5-13: MOOR- Flood Zone

5.8 SHD application for 360 Homes, Creche, Scout Den, Public Park & playground

The SHD will consist of 360no Homes, creche, Scout Den, Public Park and Playground, located in zones 3, 6 and 4. The locations are provided in Figure 5-14.

The areas are follows;

- Area 2 - South-West Residential Zone
- Area 3 - Southern Residential Area
- Area 6 - Moygaddy Central - Local Services, Leisure & Tourism
- Area 7 - Central Residential Area and
- Area 8 - Transitional residential Area

Review of Figure 5-14 confirms that development under the SHD areas are all located in Flood Zone C and are not impacted by any of the modelled flood events.

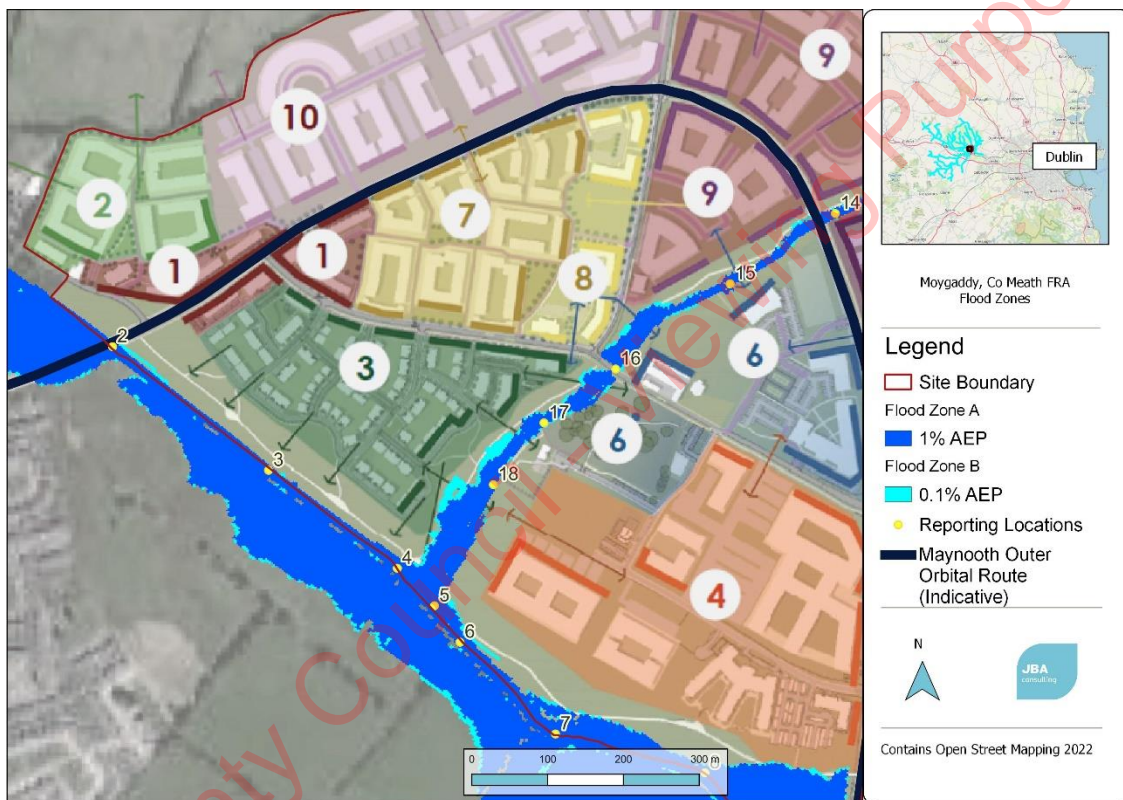


Figure 5-14: SHD Flood Zone

6 Flood Risk Assessment

6.1 Flood Risk

A review of the available historic and predictive flood risk information contained in Section 4 confirms that the majority of the Masterplan site is located in Flood Zone C and it has not been identified as being at risk from flooding during the 0.1% AEP fluvial event. Localised areas of flood extent are in proximity to the Blackhole Little Stream and Ryewater River, however these areas are zoned as high amenity and no development is proposed in these areas save for bridge infrastructure.

The flood extents have been confirmed by the development of a hydraulic model based on up-to-date survey information.

The proposed residential properties, creche, public park & scout den which are subject to a SHD planning application will be located in Flood Zone C, and not at risk of a 0.1% AEP flood event. Further mitigating measures and analyses is undertaken in Section 6.

The proposed bridges will not be impacted by the 1% AEP and 0.1% AEP flood events and will not increase the flood risk elsewhere. A Section 50 assessment for each bridge structure will be prepared following the granting of planning.

6.1.1 Finished Floor Levels (Fluvial / River Flood Risk)

Based on a review of the available and predictive information, all residential development within the masterplan area will be located wholly within Flood Zone C. Therefore, site-specific mitigation measures are not required to manage the ongoing fluvial risk.

For any residential dwelling located in proximity to the Ryewater River or Blackhole Little Stream, the minimum FFL needs to be set 300mm above the 1% AEP climate change (MRFS) flood event.

With reference to Figure 5-3 which provides the monitoring point locations, the minimum FFLs along the Ryewater River and Blackhole Little Stream is provided in Table 6-1, also refer to Appendix D. The provided minimum FFL will also protect against the 0.1% AEP flood event.

Table 6-1: Minimum FFLs (mOD)

Reporting Location	1% AEP MRFS	
1	51.03	51.33
2	50.50	50.8
3	48.63	48.93
4	48.60	48.9
5	56.83	57.13
6	56.34	56.64
7	55.32	55.62
8	53.10	53.4
9	48.34	48.64
10	47.95	48.25
11	46.84	47.14
12	46.39	46.69

6.1.2 Surface Water Drainage Systems (Pluvial / Rainfall Flood Risk)

The existing masterplan site is greenfield in nature. A stormwater system has been designed by OCSC for the purposes of each individual planning application and specific design measures will be included within the proposed development to manage surface water flows. It is recommended that the system is designed in accordance with the Greater Dublin Strategic Drainage Strategy (GSDSDS) guidance document and the Meath County Development Plan 2021-2027 and associated SFRA. This recommends a minimum allowance for climate change of 20% increase in rainfall depths / intensities for the 100-year Mid-Range Future Scenario (MRFS) event. We note that OSCS have acknowledged that these criteria are incorporated into their designs.

6.2 Climate Change

In accordance with the OPW guidelines, it is necessary to assess the risk associated with climate change. The masterplan site has been assessed in accordance with the Mid-Range Future Scenario (MRFS) for 1% AEP. FFL have been set to be a minimum of 300mm above the peak water level reported for the MRFS scenario

6.3 Residual Risk

Residual risks are defined as risks that remain after all risk avoidance, substitution and mitigation measures have been taken. This flood risk assessment identifies the following as the main sources of residual risk to the development proposal:

- Blockage of Bridge structures,
- Failure of the surface water drainage systems (pluvial risk).

As part of the FRA assessment, all proposed and existing bridges that could impact upon the masterplan site will be tested for blockage (66%). For the larger road bridge (Road Bridge 1) a more realistic blockage value of 33% has also been adopted. The purpose is to ensure that any development within the masterplan site will not be impacted during a blockage scenario. The result of the modelling confirms that the provided minimum FFLs in Table 6-1 is sufficient to protect the development from the identified residual risks.

To protect against the potential failure of the stormwater system it is recommended that a threshold of 150mm is provided from the ground floor level to the surrounding hardstanding area.

The climate change assessment for the masterplan site has been based on the assessment outlined in Section 5.1.3. The minimum FFL onsite is based on the 1% AEP MRFS climate change event.

7 Conclusion

JBA Consulting has undertaken a site-specific Flood Risk Assessment (FRA) for the masterplan site located in the townland of Moygaddy, Co Meath. The existing site is greenfield in nature.

A review of the available sources of flooding indicates there are no instances of historic flooding on-site, and the site is at a low risk of fluvial / river flooding.

This FRA has determined that the site is predominantly located within Flood Zone C. Localised areas in proximity to the Blackhole Little Stream and Ryewater River are within Flood Zone A, however as these areas are zoned High Amenity, it is noted that no development is proposed in these areas save for bridge & utility infrastructure. The residential, office, nursing home and primary care development will be located in Flood Zone C., therefore does not require site-specific mitigation measures to manage the risk of fluvial flooding.

Climate change has been assessed for the development for the Mid-Range Future Scenario (MRFS). At a minimum, all FFLs onsite will be placed 300mm above the 1% AEP MRFS climate change and the relevant minimum FFLs have been provided for the various model nodes along the Ryewater River and Blackhole Little Stream.

Residual risks have been assessed for the development such as the potential blockage of existing and proposed bridges that could impact upon the site. The results confirm that the proposed minimum FFLs provided are sufficient to protect against the identified residual risks.

The various proposed bridge structures have been included within the model and the results confirm that they will not be impacted by the modelled 1% AEP and 0.1% AEP flood events, and nor will they increase flood risk elsewhere. A Section 50 application will be submitted for each structure to the OPW following the granting of planning.

This FRA was undertaken in accordance with 'The Planning System and Flood Risk Management - Guidelines for Planning Authorities' (2009), and agrees with the core principles contained within.

Appendices

A Appendix - Understanding Flood Risk

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

Flood Risk = Probability of Flooding x Consequences of Flooding

A.1 Probability of Flooding

The likelihood or probability of a flood event (whether tidal or fluvial) is classified by its Annual Exceedance Probability (AEP) or return period years, a 1% AEP flood 1 in 100 chance of occurring in any given year. In this report, flood frequency will primarily be expressed in terms of AEP, which is the inverse of the return period, as shown in the table below and explained above. This can be helpful when presenting results to members of the public who may associate the concept of return period with a regular occurrence rather than an average recurrence interval and is the terminology which will be used throughout this report.

Table: Conversion between return periods and annual exceedance probabilities

Return period (years)	Annual exceedance probability (%)
2	50
10	10
50	2
100	1
200	0.5
1000	0.1

A.2 Flood Zones

Flood Zones are geographical areas illustrating the probability of flooding. For the purpose of the Planning Guidelines, there are 3 types of levels of flood zones, A, B and C.

Zone	Description
Flood Zone A	Where the probability of flooding is highest, greater than 1% (1 in 100) from river flooding or 0.5% (1 in 200) for coastal/ tidal Flooding
Flood Zone B	Moderate probability of flooding, between 1% and 0.1% from rivers and between 0.5% and 0.1% from coastal/ tidal.
Flood Zone C	Lowest probability of flooding, less than 0.1% from both rivers and coastal/ tidal.

It is important to note that the definition of the flood zones is based on an undefended scenario and does not take into account the presence of flood protection structures such as flood walls or embankments. This is to allow for the fact that there is a residual risk of flooding behind the defences will be maintained in perpetuity.



A.3 Consequences of Flooding

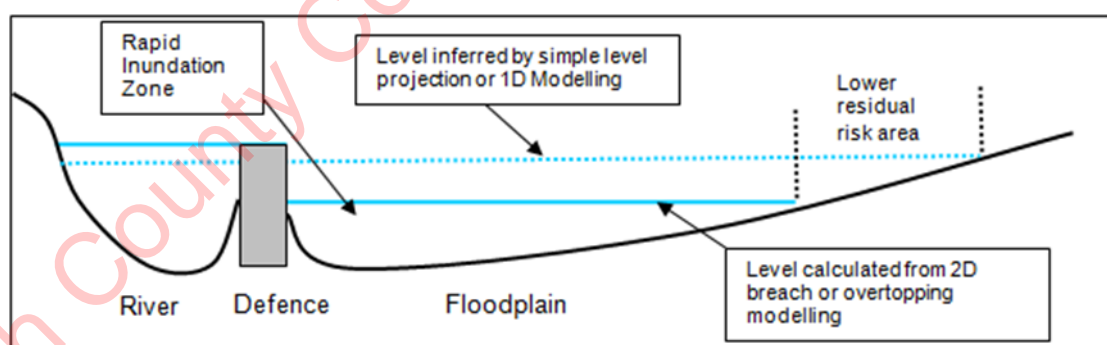
Consequences of flooding depend on the Hazards caused by flooding (depth of water, speed of flow. Rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure of the population, presence and reliability of mitigation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

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

- **Highly vulnerable**, including residential properties, essential infrastructure and emergency service facilities
- **Less vulnerable**, such as retail and commercial and local transport infrastructure, such as changing rooms.
- **Water compatible**, including open space, outdoor recreation and associated essential infrastructure, such as changing rooms.

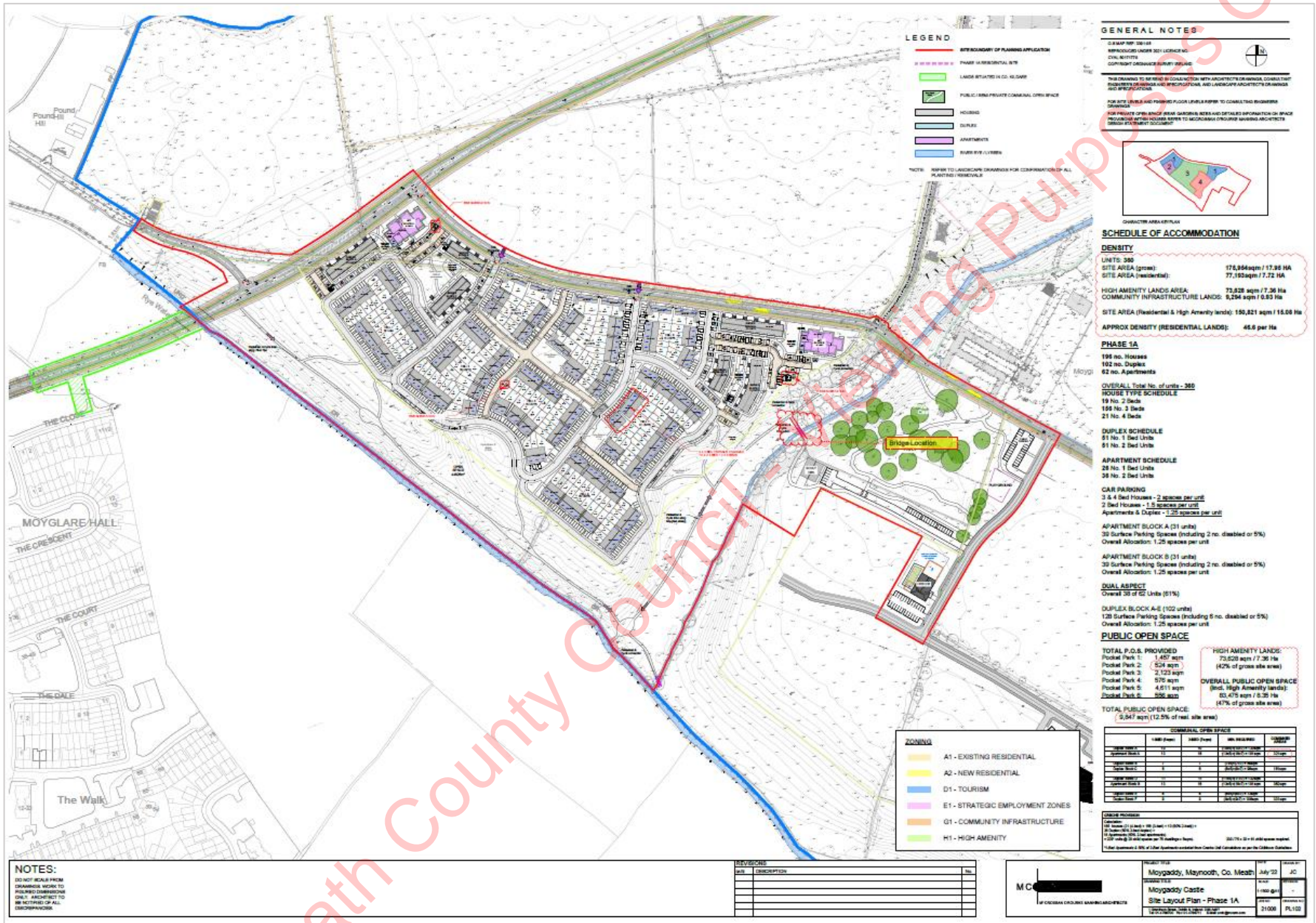
A.4 Residual Risk

The presence of flood defences, by their very nature, hinder the movement of flood water across the floodplain and prevent flooding unless river levels rise above the defence crest level or a breach occurs. This is known as residual risk:



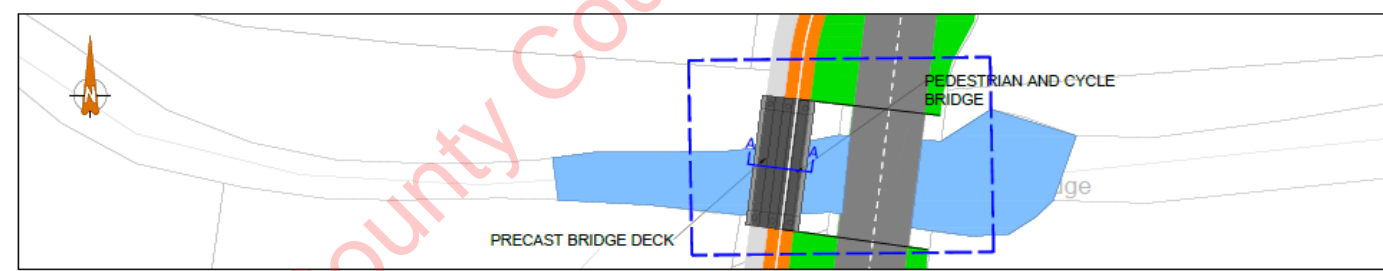
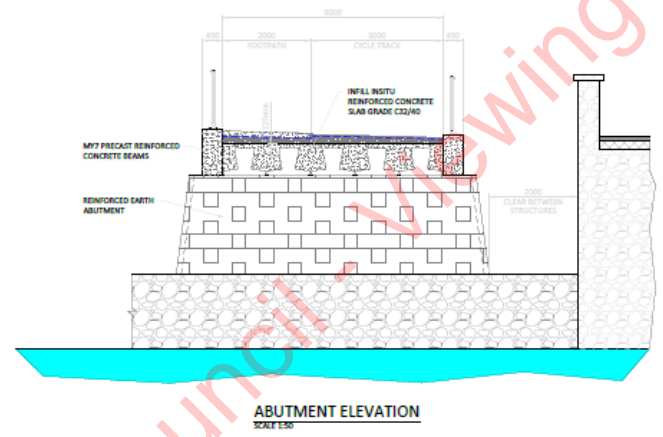
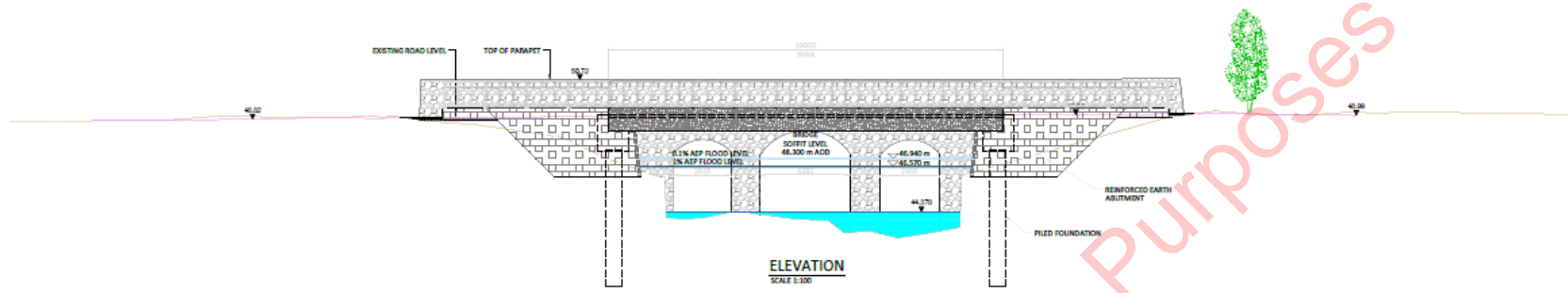
B Site Layout

Meath County Council - Viewing Purposes Only!



C Bridge Design

Meath County Council - Viewing Purposes Only!



LEGEND

PROPOSED CARRIAGEWAY	[Grey Box]
PROPOSED FOOTPATH	[Light Grey Box]
PROPOSED CYCLE PATH	[Orange Box]

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001	18.08.21	ISSUED FOR PERMITS	001	01.04	
002	22.04.21	SUBMITTED FOR PLANNING	002	01.04	
003	26.07.21	FOR INFORMATION	003	01.04	
004	12.02.22		004	01.04	

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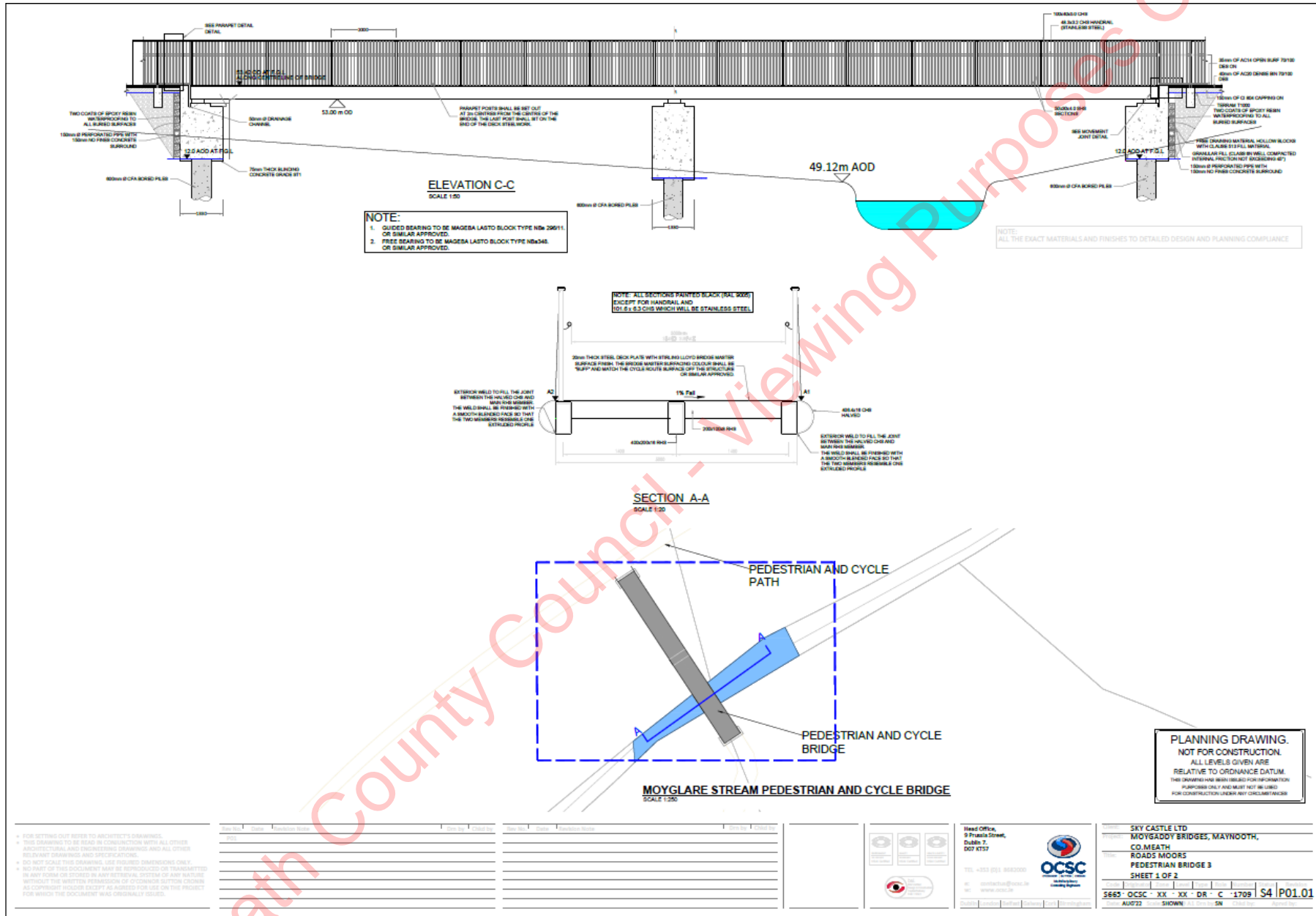
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D Hydraulic Model Results

D.1 1D Model Flows

Table A- 1: Modelled Existing Scenario 1D Peak Levels (mOD) from Present Day (Current) events on Ryewater River

Node	1% AEP	0.1% AEP	1% AEP MRFS
862b.1	48.5152	48.6282	48.5815
944.1	50.9766	51.0124	50.9993
926.1	50.5178	50.5798	50.5539
1R04.1	50.4107	50.5111	50.47
1R04.2	50.3814	50.4927	50.4479
1R05.2	50.3564	50.4755	50.4283
1R06a.1	50.3298	50.4533	50.4047
1R06a.2	50.2768	50.4052	50.3548
1R07.2	50.1678	50.3007	50.2487
1R08.1	50.0948	50.2187	50.1701
1R08.2	49.6562	49.7362	49.7036
1R09.1	49.3313	49.3949	49.3681
1R09.2	49.0241	49.063	49.0412
000X.2	48.3987	48.5057	48.471
862a.2	48.3637	48.4859	48.431
850.1	48.1991	48.3551	48.2904
838.1	47.8758	48.0756	47.9978
832.1	47.7711	47.9857	47.904
822.1	47.5025	47.7656	47.6649
1R12.1	47.1217	47.3575	47.2606
1R12.2	46.992	47.2148	47.1204
801.1	46.751	47.0156	46.9024
790.1	46.5862	46.9049	46.7731
788A.1	46.525	46.8323	46.7074
788.1	46.3524	46.5492	46.4657
785.1	46.2398	46.4267	46.35
775.1	45.9914	46.1723	46.097
1R16.1	45.9104	46.1181	46.0309
1R16.2	45.6814	45.9283	45.8257
742.1	45.314	45.5813	45.4728
735.1	45.1852	45.464	45.3478
733D.1	45.4462	45.431	45.3118
733.1	45.4247	45.4295	45.3102
732.1	45.0994	45.3965	45.2742
726.1	44.9494	45.2635	45.1306
723A.1	44.8749	45.1848	45.0538
723.1	44.7445	44.9908	44.8895
720.1	44.7103	44.9516	44.8525
713.1	44.6887	44.9267	44.8291

Table A- 2: Modelled Existing Scenario 1D Peak Levels (mOD) from Present Day (Current events) on Moygaddy Stream

Node	1% AEP	0.1% AEP	1% AEP MRFS
108.1	58.2463	58.3764	58.3247
097W.1	57.691	57.7888	57.7507
097W.2	56.8717	57.0403	56.974
097X.2	56.7292	56.909	56.8345
91.1	56.2464	56.4096	56.338
2R13.1	56.0133	56.2031	56.1248
2R12.1	55.2243	55.3971	55.3247
2R11.1	54.7584	54.9523	54.8727
2R10.1	54.1255	54.2294	54.1837
2R09.1	54.0677	54.1547	54.1251
2R08.1	53.3826	53.5292	53.4443
2R08.2	52.8672	53.4229	53.0742
2R07.1	52.7953	53.4476	53.0198
2R06W.1	52.7823	53.4424	53.0386
2R05.1	0	0	0
2R04.1	51.3359	51.4777	51.4104
2R03.1	51.0603	51.2278	51.1539
29.1	50.3436	50.4805	50.4256
28.1	50.2802	50.4117	50.3589
19.1	49.3925	49.529	49.4734
19.2	48.8728	48.9851	48.9408
2R02.2	48.7254	48.8481	48.803
2R01.1	48.505	48.6139	48.5759
000W.1	48.6324	48.6105	48.6732
000W.2	48.7191	48.6272	48.7213

E Flood Zones

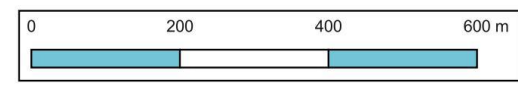
Meath County Council - Viewing Purposes Only!



Legend

- Masterplan Extents
- Maynooth Outer Orbital Route (Indicative)
- Flood Zone A
- 1% AEP
- Flood Zone B
- 0.1% AEP

**Moygaddy, Co Meath FRA
Flood Zones**

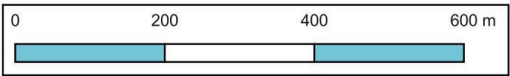


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- Legend**
- Masterplan Extents
 - Maynooth Outer Orbital Route (Indicative)
 - Flood Zone A
 - 1% AEP MRFS

**Moygaddy, Co Meath FRA
Flood Zone A with Climate
Change**



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