Ardee, Co. Louth
Site Specific Flood Risk Assessment

Technical Report

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Ballsbridge,

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Contract

This report describes work commissioned by The Ardee Partnership, Embassy House, Ballsbridge, Dublin 4, by an email dated 24/07/2020. Ben Murphy, Caoimhe Downing 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
CFRAM ..... Catchment Flood Risk Assessment and Management
DoEHLG ..... Department of the Environment, Heritage and Local Government
FARL ..... FEH index of flood attenuation due to reservoirs and lakes
FB ..... Freeboard
FFL ..... Finish Floor Levels
FRA ..... Flood Risk Assessment
FSR ..... Flood Studies Report
FSU ..... Flood Studies Update
GSI ..... Geological Survey of Ireland
LHB ..... Left Hand Bank
OPW ..... Office of Public Works
PFRA ..... Preliminary Flood Risk Assessment
RFI ..... Request for Further Information
RHB ..... Right Hand Bank
RR ..... Rainfall-Runoff
SAAR ..... Standard Average Annual Rainfall (mm)
SFRA ..... Strategic Flood Risk Assessment
SSFRA ..... Site Specific Flood Risk Assessment
URBEXT ..... FEH index of fractional urban extent
WL ..... Water Level

1 Introduction

Under the Planning System and Flood Risk Management Guidelines for Planning Authorities (DoEHLG & OPW, 2009) proposed development must undergo a Flood Risk Assessment prior to planning to ensure sustainability and effective management of flood risk

1.1 Terms of Reference and Scope

JBA Consulting was appointed by The Ardee Partnership to prepare a Site Specific Flood Risk Assessment (SSFRA) for a site south of Ardee town centre, Co. Louth.

1.2 Flood Risk Assessment; Aims and Objectives

This study is being completed to inform the future 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. This will be achieved by hydraulic modelling of the Rathgory Tributary, Mullameelan River and Rathgory River which flows through, adjacent to and south of the subject site respectively.

The objectives of the SSFRA are to:

- Identify potential sources of flood risk;
- Confirm the level of flood risk and identify key hydraulic features;
- Assess the impact that 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 OPW/DECLG planning guidance, "The Planning System and Flood Risk Management". 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 see 'Understanding Flood Risk' in Appendix A.

1.3 Development Proposal

The proposed development site extends to c. 13.03 ha at Bridgegate, Rathgory & Mulladrillen, Drogheda Road, Ardee, County Louth and adjoins Phases 1-3 at Bridgegate (under construction) on lands to the west, accessed from the N2 Drogheda Road. The proposals overlap the boundary of permitted development Reg. Ref.: 10174; ABP Ref: PL15.238053 (as amended) at the western boundary and will supersede granted development in this area which consists of 31 no. dwellings, crèche and community building and public open space.

The proposed development will consist of;

- The construction of 272 no. residential units comprising a mix of 206 no. 2, 3 and 4 bedroom houses (all 2 storeys) including 50 no. 2-bedroom houses (Type 1), 145 no. 3-bedroom houses (Types 2, 3, 6) and 11 no. 4-bedroom houses (Types 4, 5) all with private open space and car parking, alongside 66 no. duplex units (all 3 storeys) including 17 no. 1-bedroom units (Types D5, D8), 24 no. 2-bedroom units (Types D1, D3, D6) and 25 no. 3-bedroom units (Types D2, D4, D7), all with private open space in the form of terrace at upper floor level and external garden space, with 499 sqm of communal open space serving Duplex Blocks A-B (48 no. units) (served by 2 no. bin and bike stores [each c. 51 sqm] adjacent) at Bridgegate Avenue, providing a total residential gross floor area of c. 28,168.9 sqm;
- A part 1, part 2 no. storey crèche (c. 484.1 sqm) and playground and a single storey community building (c. 165 sqm) located adjacent at a central community hub (with bin and bike store [c. 23 sqm]) accessed from Bridgegate Avenue served by car parking located on Bridgegate Green and Bridgegate Avenue;

- A landscaped Public Park located in the northern part of the site extending to c. 3.6 ha accessed from the community hub and between duplex Blocks B & C at Bridgegate Avenue, with 2 no. pedestrian links to permitted public park adjoining to the west and 1 no. pedestrian footpath extending to the northern perimeter at Hale Street, with a reservation for a future link road to lands to the east facilitated in the northern section of the park;
- A series of landscaped public open spaces provided throughout the site with Public Open Space 01 (c. 1.05 ha) and Public Open Space 2 (c. 0.43 ha) located within the linear park (including riparian corridor) adjacent to the Rathgory Tributary with Public Open Space 03 (c. 0.29 ha) centrally located in the southern part of the site; open spaces will provide a mix of hard and soft landscaping, pedestrian and cycle access (cycle lanes provided at POS 1 and POS 2) and a range of activities including fitness spaces, kickabout area, amphitheatre and nature based play areas;
- Provision of shared surfaces, landscaped streetscapes including planting and landscaping at two neighbourhood streets in the southern part of the site, with roads provided to site boundaries to the east, south and west to facilitate possible future connections;
- All landscaping including planting to consolidate treelines and hedgerows forming existing site boundaries with agricultural lands to the east and Cherrybrook residential development to the west and all boundary treatments;
- Roads and access infrastructure taken from Bridgegate Avenue (permitted under Reg. Ref.: 10/174; ABP Ref: PL15.238053 [as amended]), the provision of a bus stop on the south side of Bridgegate Avenue adjacent to community hub and provision of cycle lanes at this location (continued through Public Open Space 01); a total of 480 no. car parking spaces (362 no. serving houses, 84 no. serving duplexes, 23 no. serving crèche and community building and 11 no. visitor and public open spaces), a total of 296 no. bicycle parking spaces (204 no. spaces serving duplexes [60 visitor spaces], 32 no. spaces at the community hub and 60 no. visitor spaces);
- Provision of 2 no. ESB substations, all associated drainage and services infrastructure (surface water, foul and water supply), public lighting, SUDS drainage and works to facilitate the development.

Figure 1-1: Site layout

The proposed development will also include the diversion of the existing channel, Rathgory Tributary, and the inclusion of two new culverts. The proposed channel alignment and location of the two proposed culverts are shown in Figure 1-2 and the proposed channel form is shown in Figure 1-3. The proposed channel cross section includes a low flow channel to accommodate the 50% AEP event flow which has a width of 1.8m and a height of approximately 0.2m. A 20m riparian zone has been provided, 10m either side of the top of banks. As agreed with the OPW a 5m strip has also been provided to allow for OPW access for maintenance of the channel, please see attached Appendix B. The 20m riparian zone is also in accordance with Inland Fisheries Ireland: 'Planning for Watercourses in the Urban Environment: A Guide to the Protection of Watercourses through the use of Buffer Zones, Sustainable Drainage Systems, Instream Rehabilitation, Climate / Flood Risk and Recreational Planning' which recommends that for small channels such as the Rathgory Tributary which are less than 10m in width a buffer zone of at least 20m be used.

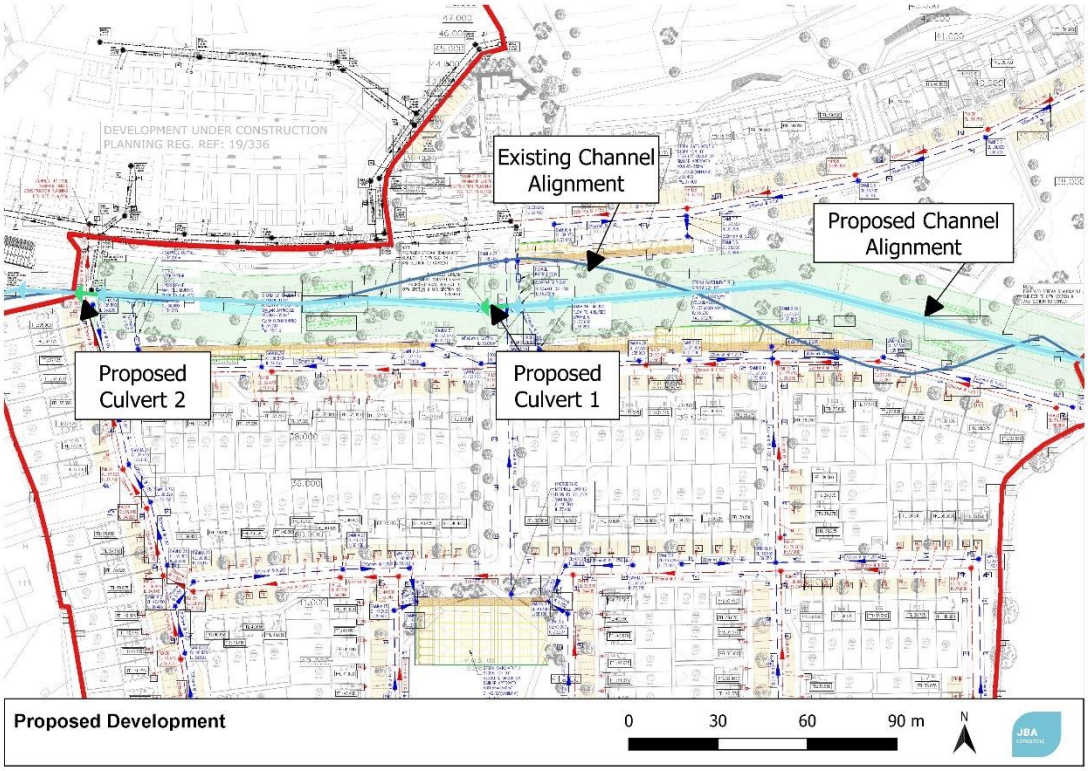


Figure 1-2: Proposed Upgrades to Watercourse as part of development

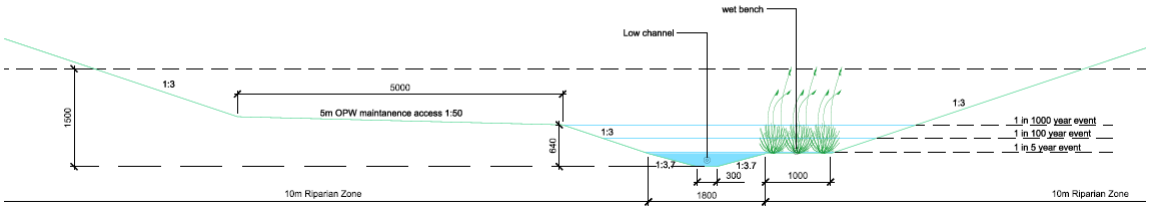


Figure 1-3: Proposed Channel Cross Section

1.4 Report Structure

Section 2 of this report gives an overview of the study location and associated watercourses. Section 3 contains background information and initial assessment of flood risk. The detailed flood risk assessment, including hydrology and modelling, is outlined in Section 4. Site-specific mitigation measures are provided in Section 5, while conclusions are provided in Section 6.

2 Site Background

2.1 Location

The site is located in Ardee, Co. Louth. It is bordered to the north by De la Salle Crescent housing estate. Greenfields border the site to the east, south and northwest. Cherrybrook housing estate is located to the southwest. The site is c. 1km south of Ardee town centre. The site location and watercourses are shown in Figure 2-1.

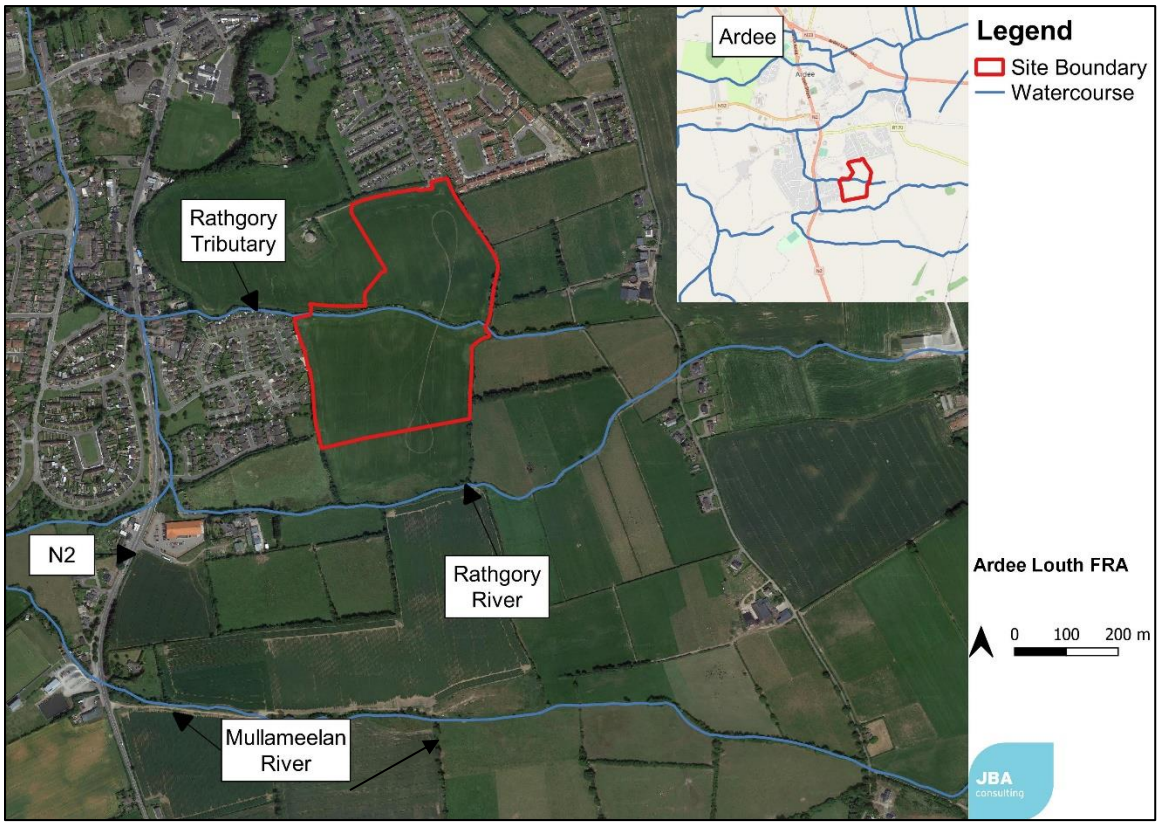


Figure 2-1: Site location and river network (Source; Google Satellite, 2020)

2.2 Watercourses

The Rathgory River and the Mullameelan River are the main hydrological features in the area which are located immediately south and c. 425m south of the site respectively. The Rathgory River rises in the townland of Rathgory, east of the site and flows westwards along the southern boundary. The Mullameelan River flows from east to west, south of the site location. A small tributary known as the Rathgory Tributary flows from east to west through the site.

2.3 Site Topography

The general topography of the area is shown in Figure 2-2 below. Review of Figure 2-2 of confirms that in the local area there is a fall to west towards the Rathgory Tributary. This is confirmed by an existing site survey. The site falls from its northern boundary (approx. 54m OD) to its western boundary where the Rathgory tributary leaves the site (approx. 36m OD). There is also a fall from the southern boundary (approx. 45m OD) to where the Rathgory tributary leaves the site.

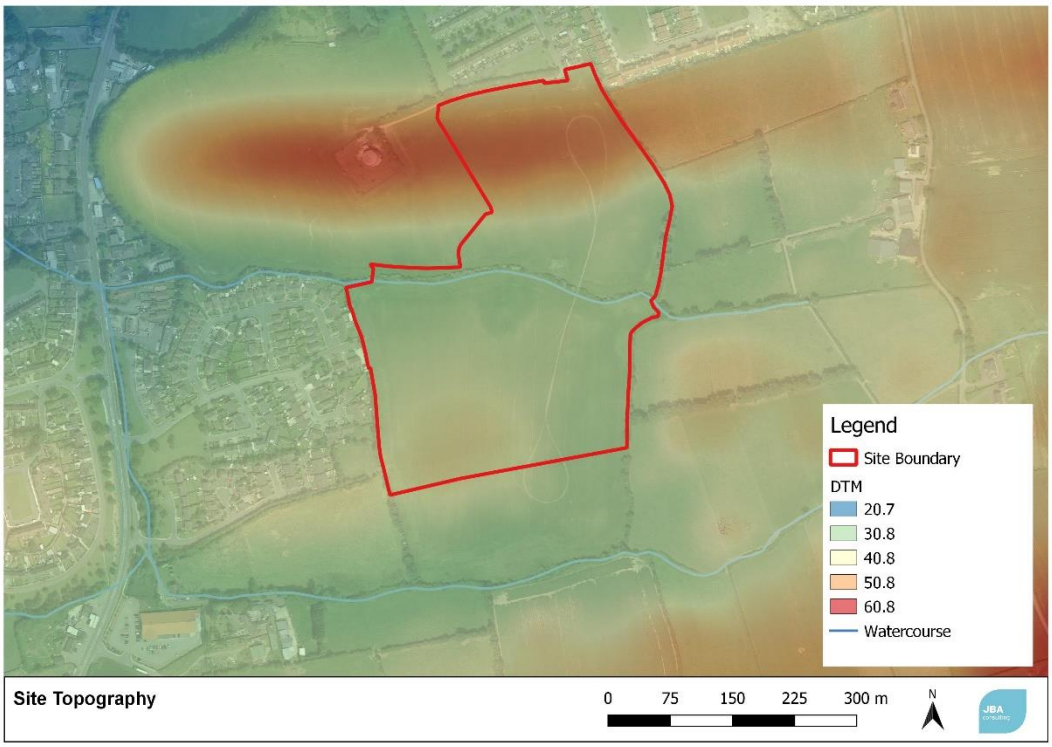


Figure 2-2: Site Topography

2.4 Site Geology

The Geological Survey of Ireland (GSI) groundwater and geological maps of the site were reviewed. The subsoil present under the site is predominantly deep well drained mineral soil.

As seen in Figure 2-3, alluvial mineral soils are present south of the site which indicate previous flooding. The underlying bedrock is classified as the Clontail Formation which is described as calcareous red-mica greywacke. The western boundary of the site is intersected by the Navan Beds formation which is described as dark limestone, mudstone, sandstone.

The associated groundwater vulnerability is classified as 'Moderate' to 'Extreme' for the site which indicates that a high risk to the groundwater under the site and a bedrock depth of between 3 - 10m. These classifications are based on relevant hydrogeological characteristics of the underlying geological materials.

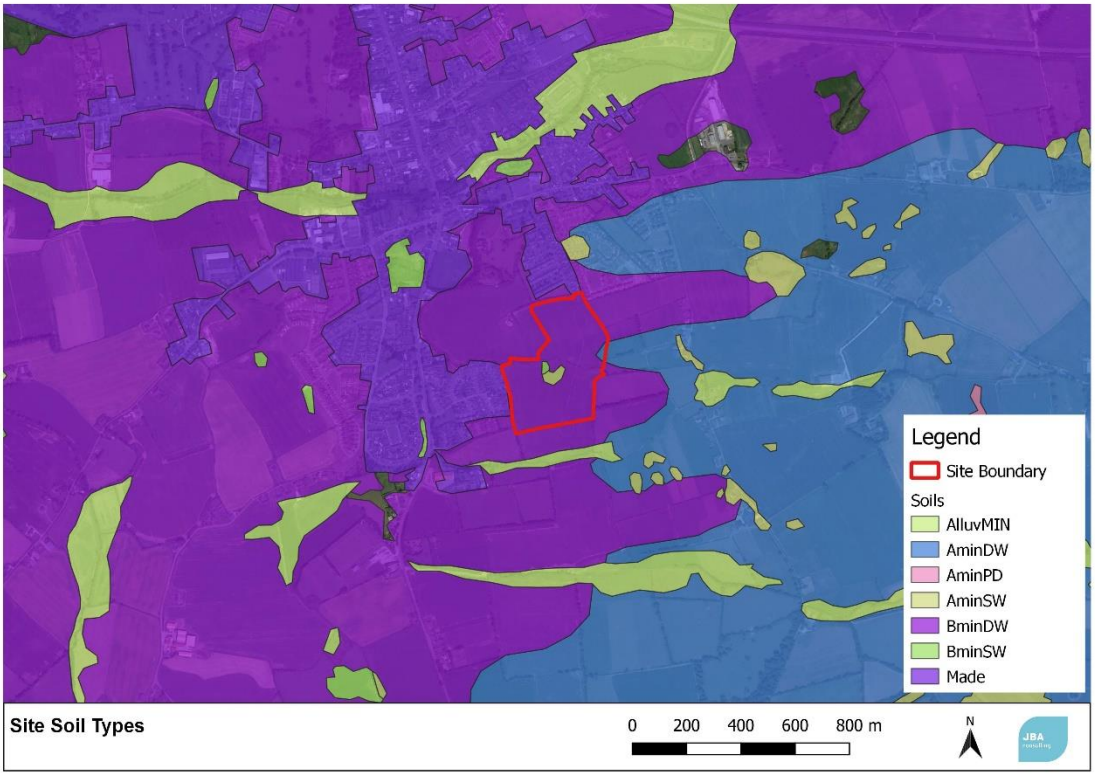


Figure 2-3: Ardee soils type (Source; GSI Database)

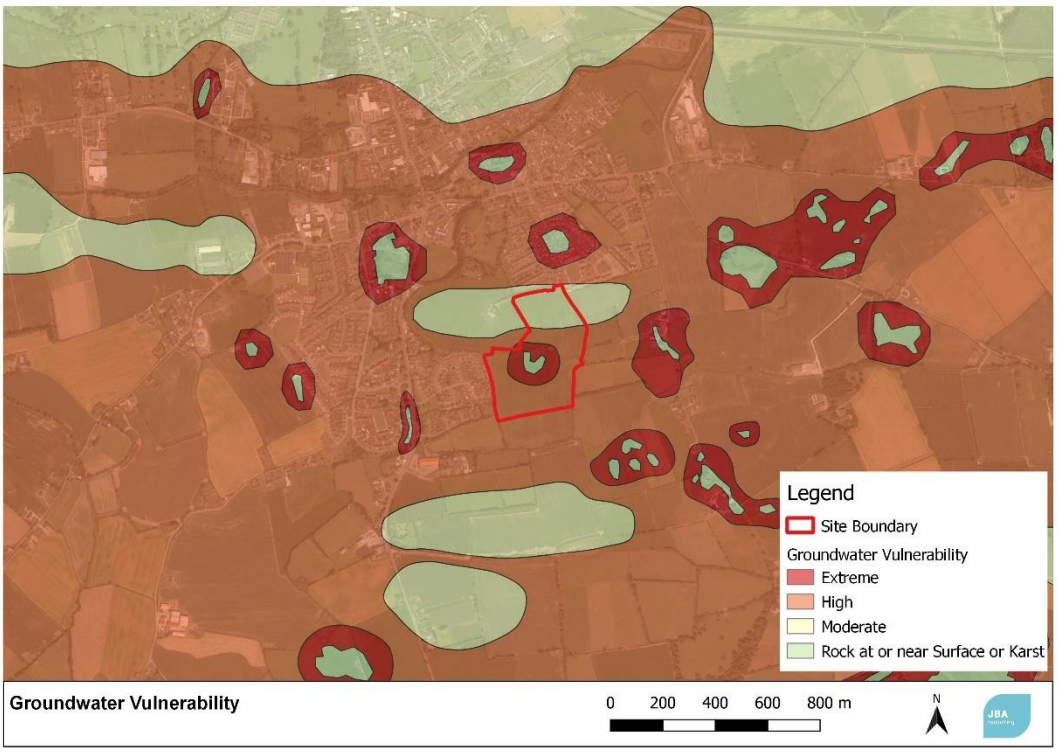


Figure 2-4: Groundwater vulnerability (Source; GSI Database)

3 Flood Risk Identification

An assessment of the potential and scale of flood risk at the site was conducted using historical and predictive information. This identifies any sources of potential flood risk to the site and reviews historic flooding information. The findings from the flood risk identification stage of the assessment are provided in the following sections. Further detail on the Planning Guidelines and technical concepts are provided in Appendix A.

3.1 Flood History

A number of sources of flood information were reviewed to establish whether there was any recorded flood history at or near the site location. This includes the OPW's website, www.floodmaps.ie and general internet searches.

3.1.1 Floodmaps.ie

The OPW host a national flood hazard mapping database that is now incorporated into www.floodmaps.ie, which highlights areas at risk of flooding through the collection of recorded data and observed flood events. Review of the flood events in the area confirm that there has been no identified historic flood event recorded within the site. The following past flood events in the surrounding area are shown Figure 3-1.

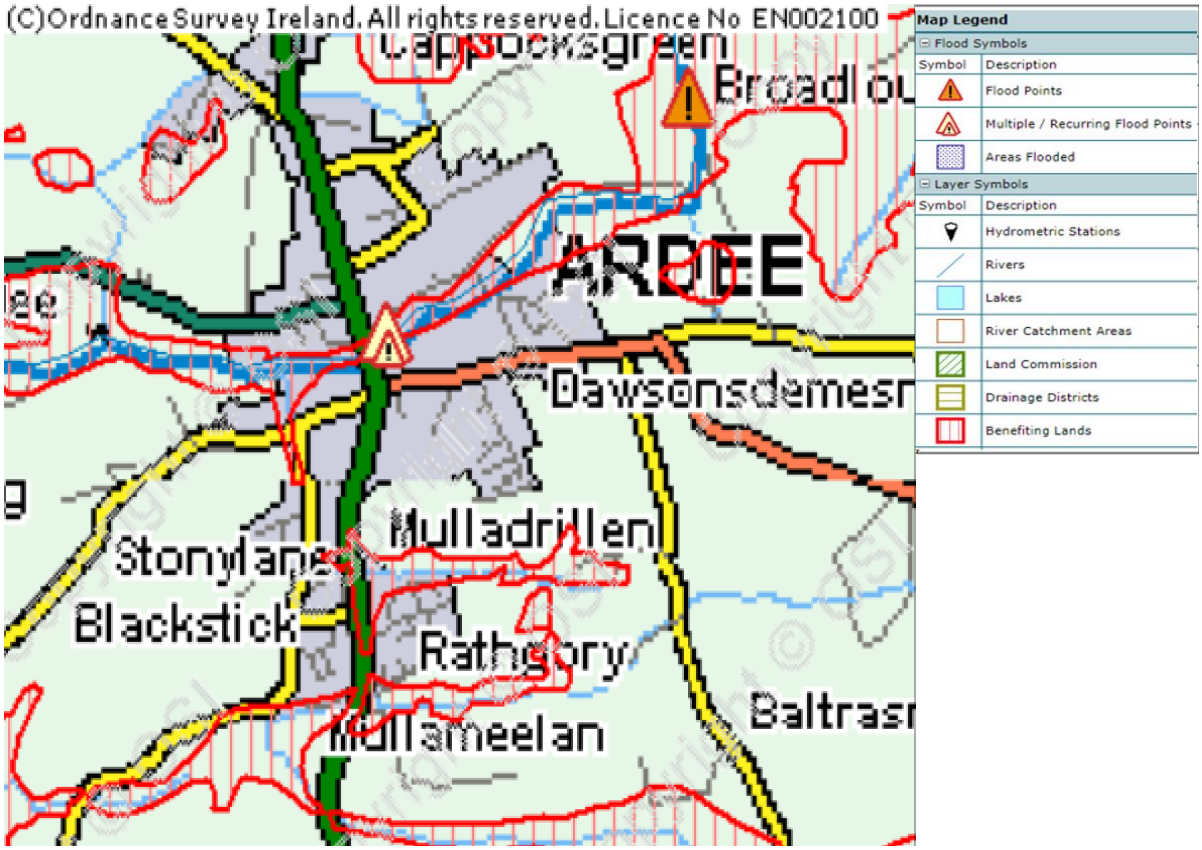


Figure 3-1: Floodmaps.ie

Review of Figure 3-1 shows no instances of recurring or historic floods within the site boundary but there are several in close vicinity;

- Flooding of the River Dee downstream of Ardee town November 1968. This event was caused by heavy rainfall.
- Recurring flood event Ardee - Ardee bog floods on a regular basis acting as attenuation for main channel. Significant lands flooded and occasional flooding of roads, agricultural buildings and 5 houses. There is also localised flooding on streams primarily related to development and culverting which leads to flooding of roads and lands.

3.1.2 OPW Arterial Drainage

The Rathgory tributary flowing through the site is an OPW maintainable channel (C2[14A]). This channel is part of the Glyde and Dee Arterial Drainage Scheme, which is managed under the 1945 Arterial Drainage Act.

The site is partially located in an area that is “Benefiting Land” (see Figure 3-2 below). Benefiting Land Maps is a dataset prepared by the Office of Public Works identifying land that might benefit from the implementation of Arterial (Major) Drainage Schemes (under the Arterial Drainage Act 1945) and indicating areas of land subject to flooding or poor drainage.

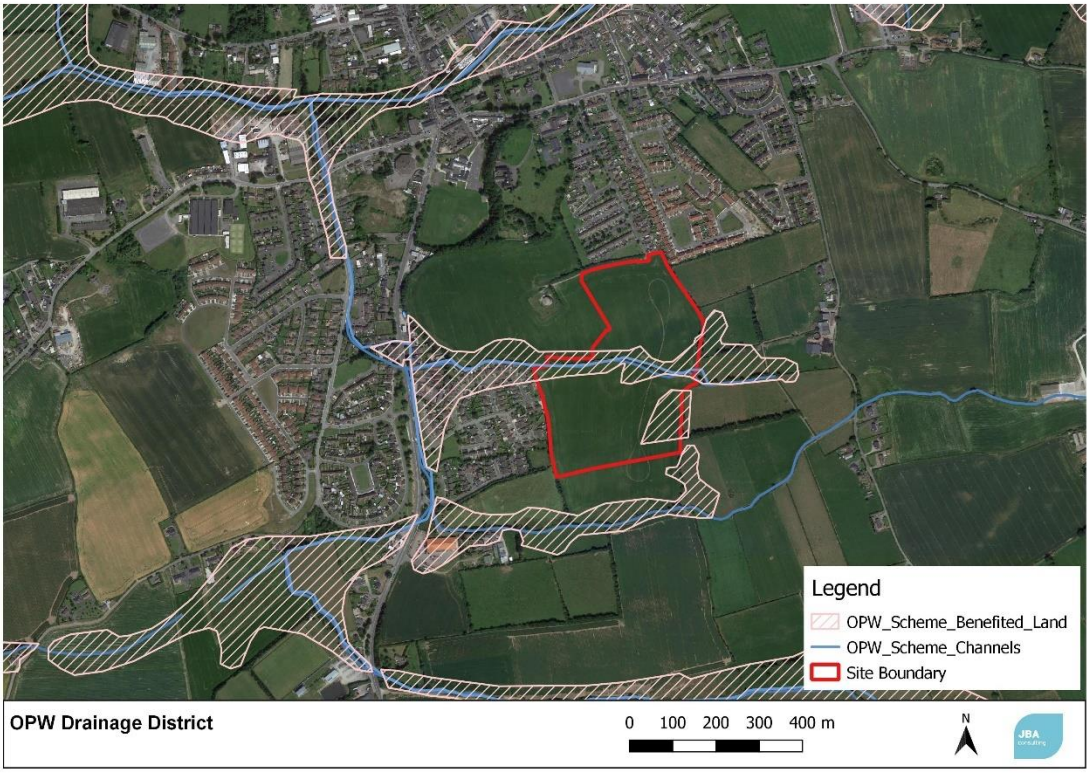


Figure 3-2: OPW Drainage District

3.1.3 Internet Searches

An internet search was conducted to gather information about whether the site was affected by flooding previously. No flooding incidents were recorded at the site or the surrounding area.

3.1.4 Correspondence with Louth County Council

Two flood events were reported by LCC in recent years:

- On the N2 in 2019
- At Stoney Lane in 2015

Flooding in 2015 ensued when a screen located upstream of Stoney Lane was blocked and this resulted in flooding of Riverside Apartments up to a depth of approximately 500mm. Refer to Figure 3-3 for location of Riverside Apartments and Stoney Lane in relation to the proposed site. Stoney lane is located approximately 600m west of the site and Riverside Apartments are located approximately 800m north west of the site.

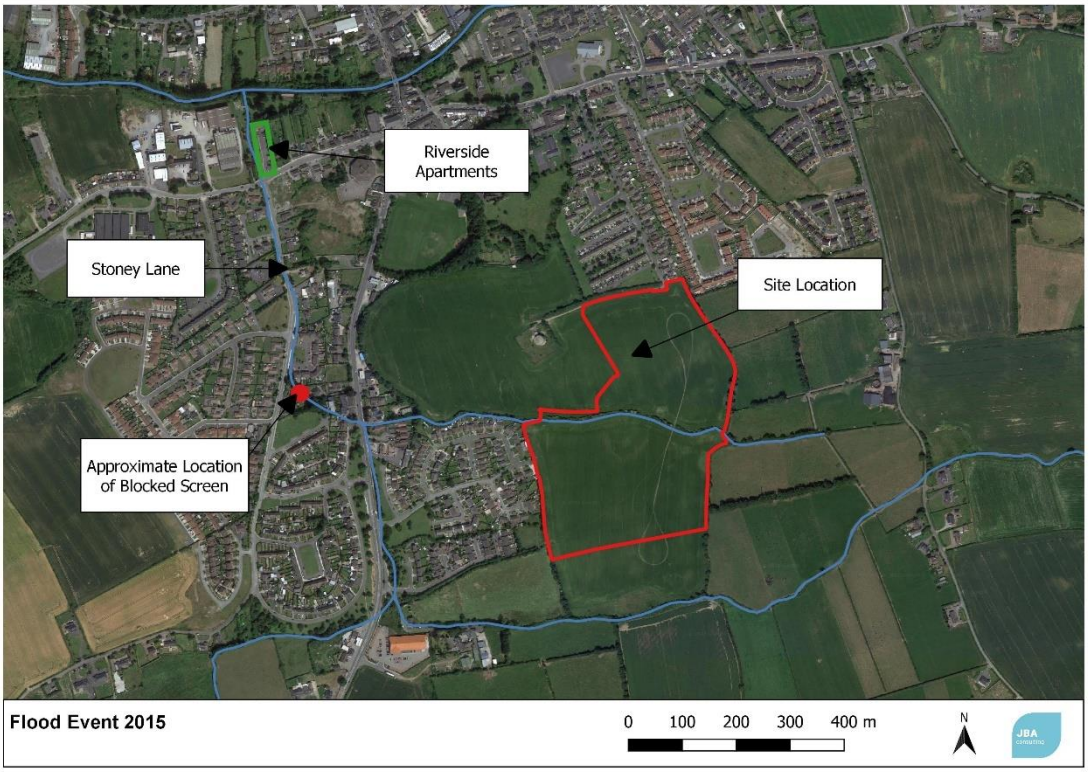


Figure 3-3: Key locations for 2015 flood event

3.2 Predictive Flooding

The area has been a subject of two predictive flood mapping or modelling studies and other related studies and plans:

- OPW Preliminary Flood Risk Analysis (PFRA)
- North Western Neagh Bann Catchment Flood Risk Assessment and Management Study

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

3.2.1 OPW Preliminary Flood Risk Analysis

The Preliminary Flood Risk Assessment (PFRA) is a requirement of the EU Flood Directive (2007/60/EC). One of the PFRA deliverables is flood probability mapping for various sources: pluvial (surface water), groundwater, fluvial and tidal. The PFRA is a preliminary or 'indicative' assessment and analysis has been undertaken to identify areas potentially prone to flooding. The OPW PFRA study has been superseded by the latest CFRAM mapping.

3.2.2 North Western Neagh Bann CFRAM

The primary source of data to which to identify flood risk to the site is the North Western Neagh Bann CFRAM Study. The North Western Neagh Bann CFRAM Study commenced in 2012. Flood maps have since been finalised for Ardee and an extract of the flood map covering the site is presented in Figure 3-4.

The CFRAM consists of detailed hydraulic modelling of rivers and their tributaries. The Rathgory River, Mullameelan River and the Rathgory Tributary have been modelled under the North Western Neagh Bann CFRAM and flood extent maps for the fluvial scenario have been generated. The relevant flood maps are available through the CFRAM website (http://www.floodinfo.ie/map/floodmaps/).

Review of Figure 3-4 confirms that there is a risk of fluvial flooding in the eastern boundary of the site. The majority of the site is located in Flood Zone C with exception of lands to the east where

there is significant out of bank flooding. This area of the site located in Flood Zone B (0.1% AEP event).

Table 3-1 gives the modelled water levels for the 10% AEP, 1% AEP and the 0.1% AEP events at the model nodes within and downstream of the site. The node most relevant to the development site is 0605A000057. It is noted that there is some cross catchment flow resulting in flooding on the proposed development site that does not originate directly from the stream flowing through the site, this is highlighted in Figure 3-4.

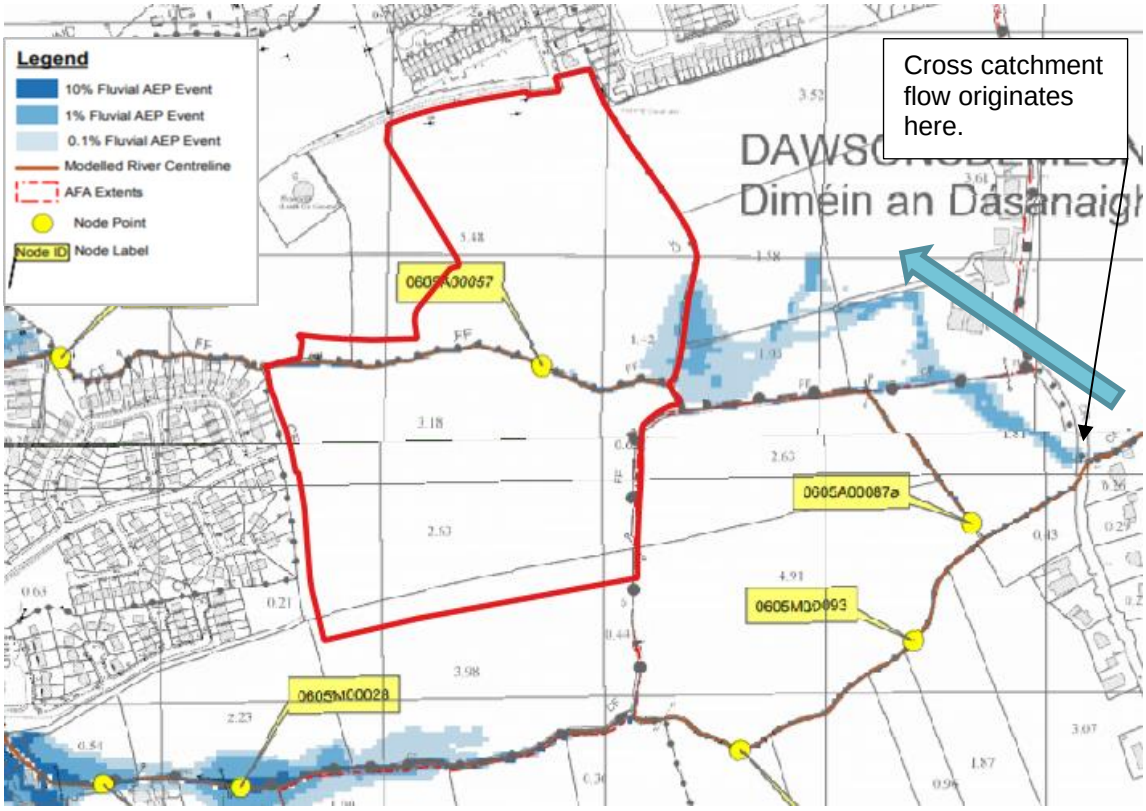


Figure 3-4: North Western Neagh Bann CFRAM Fluvial Flood Map (Source: Floodinfo.ie)

Table 3-1: Water level and flows results extracted from North Western Neagh Bann CFRAMS

Node	Water Level (OD)10% AEP	Flow (m^3/s)10% AEP	Water Level (OD)1% AEP	Flow (m^3/s)1% AEP	Water Level (OD)0.1% AEP	Flow (m^3/s)0.1% AEP
0605A000057	36.00	N/A	36.09	N/A	36.30	N/A
0605A000010	31.73	0.22	32.17	0.38	32.31	0.88

3.3 Sources of flooding

The initial stage of a Flood Risk Assessment requires the identification and consideration of probable sources of flooding. Following the initial phase of this Flood Risk Assessment, it is possible to summarise the level of potential risk posed by each source of flooding. The flood sources are described below

3.3.1 Fluvial

The main watercourses in the area are the Rathgory River, Mullameelan River and the Rathgory Tributary. There has been a history of flooding in the area surrounding Ardee, according to floodmaps.ie, but no flood events have been reported within the site boundary. The Rathgory Tributary flows through the site and is OPW Arterial Drainage channel C2(14A). The channel is

predicted to convey flows up to the 0.1% AEP event and the land holding is principally located in Flood Zone C. Cross catchment flow from the Rathgory River approaches from the south east and causes ponding of water (Flood Zone A/B) within the eastern margin of the site. The cross catchment flow is most likely caused by a culvert under a local road to the south east of the site.

The level of detail provided by the CFRAM mapping is not sufficient to fully inform the site development and further recommendations are made in Section 4.

3.3.2 Tidal

The development site is located inland so tidal flood risk has therefore been screened out at this stage.

3.3.3 Pluvial

Pluvial flooding is the result of rainfall-generated overland flows that arise before run-off can enter a watercourse or sewer. It is particularly sensitive to increases in hard-standing ground/urbanised areas and is usually associated with rainfall events of high intensity. A number of sources have been researched such as floodmaps.ie. Based on review of the available information there is no recorded pluvial flooding at the site.

3.3.4 Groundwater

Groundwater flooding results from high sub-surface water levels that impact upper levels of the soil strata and overland areas that are usually dry. In summary, there is no known risk of groundwater flooding in this area.

4 Flood Risk Assessment

To assist in the estimation of potential flood risk to the proposed development from the channel, this section will provide flow estimates and assess the impacts of the diverted channel and the capacity of the proposed culverts on site as part of the detailed assessment.

4.1 Hydrology

4.1.1 Catchment Characteristics

The physical characteristics of the catchments influence the hydrology; these include catchment size, soil type, steepness and also average rainfall. The following table lists the parameters pertinent to the hydrology calculations discussed in the following sections:

Table 4-1: Key Catchment Characteristics

Descriptor	Site M (M1+M4)	Site M-1	Site M-2	Site M-3	Site R (R1+R2)	Site R1	Site RT
Area (km²)	5.59	4.88	0.11	0.66	1.32	0.76	0.34
SAAR (mm)	769.09	769.09	794.68	794.59	790.56	790.56	794.68
BFI Soil	0.6245	0.6245	0.6249	06304	0.6334	0.6334	0.6268
MSL (km)	5.03	4.30	0.32	0.77	2.46	1.3	0.80
S1085 (km/km)	10.36	2.81	5.43	9.64	7.58	14.37	7.45
r	30	30	30	30	30	30	30

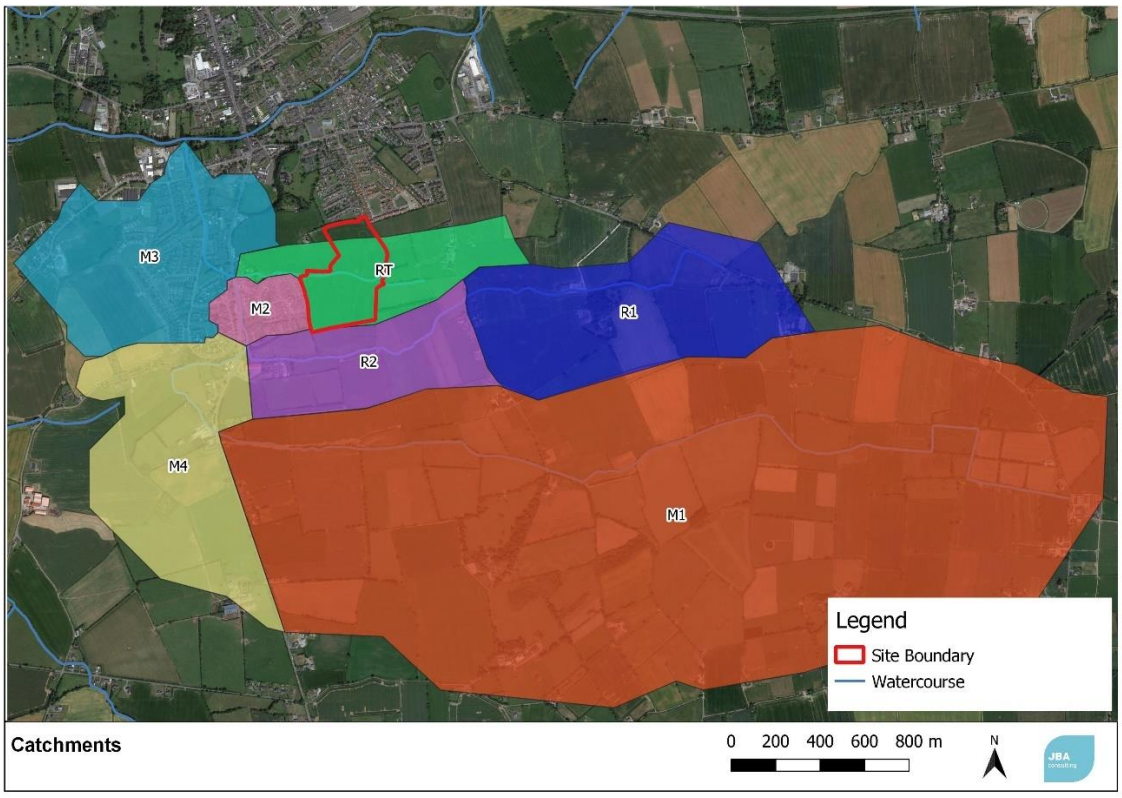


Figure 4-1: Catchment Locations

4.1.2 Flow Estimation

Flood Studies Update (FSU), Flood Studies Update Small Catchments (FSU SC), Flood Studies Report Rainfall Runoff (FSR RR) and IH 124 method. All have been compared with the CFRAM flows. The table below describes the 1% AEP flows which were determined for each of the catchments using the methods above. It is estimated that the flow from in the catchments is smaller than that estimated as part of the CFRAM study, however the CFRAM flows are more conservative and will therefore be used as part of this study. The final flows for each catchment are shown in Table 4-3.

Table 4-2: Flow Estimation 1% AEP Comparison

	1% AEP flow (m^3/s)				
Site code	FSU SC	FSR RR	IH 124	Rational	CFRAM
M1	0.71	2.48	1.01	1.93	2.77
M4	0.09	0.56	0.18	0.24	1.37
M2	0.03	0.04	0.01	0.33	
M3	0.12	0.3	0.07	1.17	
R1	0.12	0.56	0.23	0.6	0.47
R2	0.01	0.08	0.06	0.06	0.43
RT	0.067	0.11	0.02	0.033	0.033

Table 4-3: Final Flows

River Channels	Flood peak (m^3/s) for the following AEP Events (%)						
	50%	20%	10%	5%	2%	1%	0.1%
M-1	0.97	1.22	1.42	1.72	2.16	2.48	3.53
R1	0.22	0.28	0.32	0.39	0.49	0.56	0.79
R1+R2	0.26	0.38	0.48	0.58	0.74	0.88	1.55
RT	0.1	0.14	0.18	0.21	0.27	0.33	0.58
Total Catchment	1.6	2.32	2.87	3.48	4.44	5.30	9.37

4.1.2.1 Section 50 Hydrology

For the Section 50 consent the Factorial Standard of Error (FSE) and climate change factor must be applied for to the 1% AEP flow estimate before analysing in the hydraulic model. The FSE for the FSU method which was used in the CFRAM hydrological estimation is 1.85.

4.2 Hydraulics

A TUFLOW-ESTRY model (Version 2020-01-AA) has been developed for this study. The River channel would not be well represented in 1D so a 1D /2D model could provide river channel and overland flow paths in the area. ESTRY was selected for this model due to the presence of long culverts.

The watercourses were modelled with two inflow points, each at the upstream point of the Mullameelan river channel and the Rathgory River Channel. Inflow polygons were used to represent the top up inflow into the Mullameelan channel from the three downstream sub-catchments (M2, M3 and M4), to represent the top up inflow along the Rathgory River (R2) and to represent the inflow from the Rathgrory Tributary (RT). The downstream boundary is based on the CFRAM levels in the River Dee.

4.3 Model Build

The hydraulic model has been run with a baseline (pre-development) scenario and a post-development scenario. This was completed to determine the existing flood extents and also determine the effects of the proposed development on the flood extents.

4.4 Baseline Modelling

4.4.1 1% and 0.1% AEP Events

The 1% AEP Event was run to determine to extents of Flood Zone A in the existing scenario. The flood extents for the 1% AEP are shown in Figure 4-2. There is some inundation of the site along the eastern border from the overland flow from the Rathgory River.

The 0.1% AEP Flood event was run for the existing scenario to establish Flood Zone B. The flood extents for the 0.1% AEP are also shown in Figure 4-2 below.

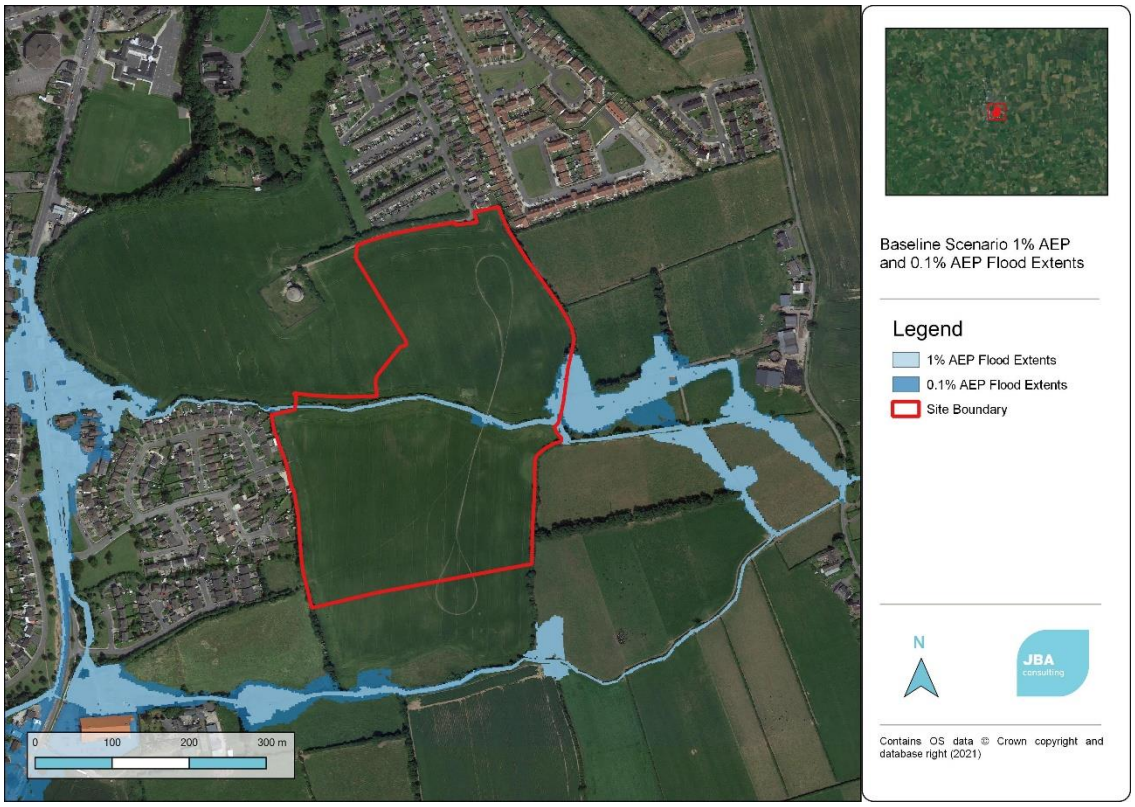


Figure 4-2: Baseline Scenario 1% AEP and 0.1% AEP Flood Extents

4.4.2 Climate Change

Climate change effects were included in the model through a 20% increase in the 1% AEP flows. The flood extents for the 1% AEP and the 1% AEP plus the effects of climate change are shown in Figure 4-3.

Figure 4-3: Baseline Scenario 1% AEP and 1% AEP plus Climate Change Flood Extents

4.4.3 Comparison with CFRAM

Figure 4-4 compares the flood extents developed by the model with the flood extents developed as part of the CFRAM study. The model predicts a higher volume of overflow from the Rathgory River entering the Rathgory Tributary which leads to higher water level and flow through the river in the site. The water level modelled from this study is approximately 100mm greater than the CFRAM water level along the Rathgory Tributary within the site. At the downstream end of the Rathgory Tributary (in the vicinity of node point 0605A00010) the modelled water level is approximately 800mm higher than the modelled CFRAM water level. This is because this study has used updated CCTV survey of the culvert connection from the Rathgory Tributary to the Mullameelan River to inform the model build, which was unavailable at the time of the CFRAM. The modelled water level at this point it therefore more representative of the existing condition. Table 4-4 compares the water level from the CFRAM with the modelled water level from this study at two points along the Rathgory Tributary. Figure 4-4 compares flood extents from the CFRAM with flood extents from this study.

Table 4-4: Comparison of CFRAM and modelled water level

Node	1% AEP Water Level (mOD)		0.1% AEP Water Level (mOD)	
	CFRAM	Model	CFRAM	Model
0605A00057	36.09	36.19	36.30	36.38
0605A00010	32.17	33.02	32.31	33.07

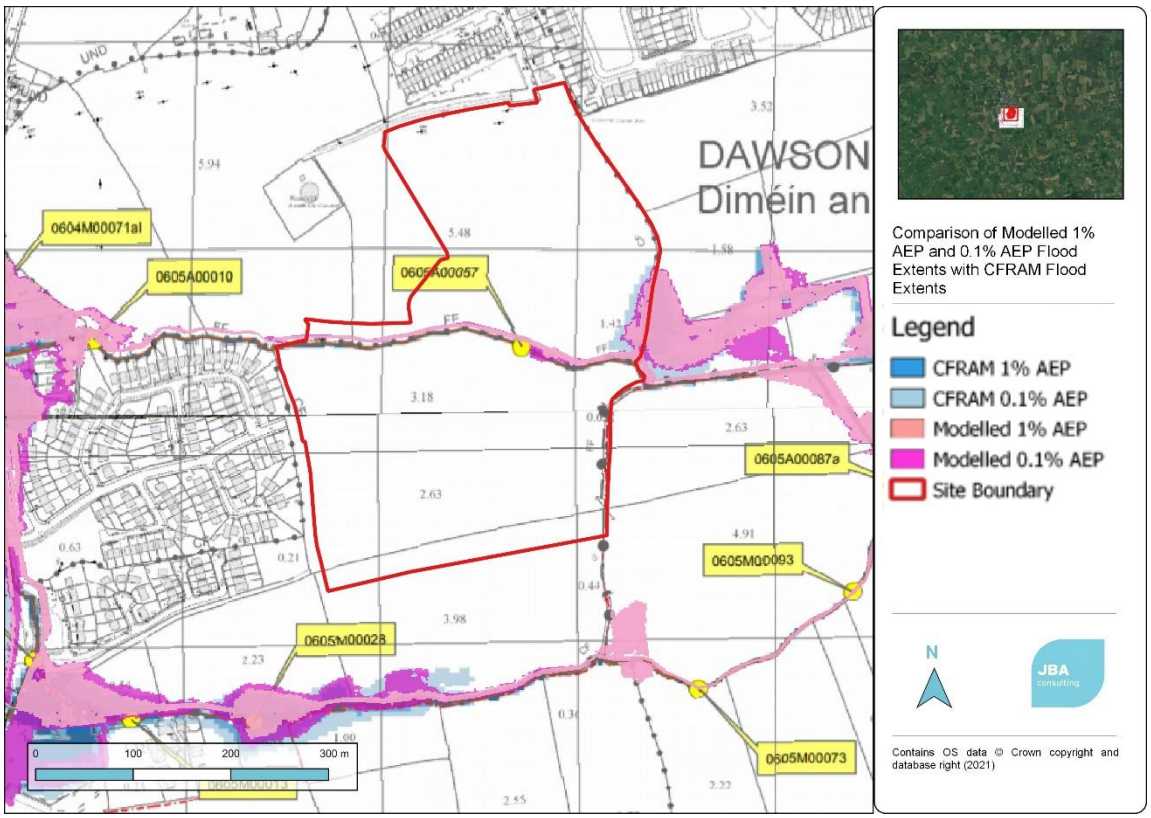


Figure 4-4: Comparison of model with CFRAM flood extents

4.5 Post Development Scenario

The post development scenario involves the diversion of the existing channel and the inclusion of two culverts as described in Section 1.3.

The stormwater outflow from the proposed development was included in the design scenario model through applying the stormwater system outflow hydrographs from the Windes Stormwater system model developed by CS Consulting which is detailed in the Engineering Report.

4.5.1 Section 50 Assessment

4.5.1.1 Culvert 1

For Culvert 1, a proposed culvert of dimension of 1.5 x 1.8m is required to meet the design standards.

An orifice size of 1.2m x 1.8m results in an air gap of 535mm through the culvert, i.e. a maximum water level of 35.6mOD in the culvert. Although the required air gap can be achieved with a 1.2m orifice height following best practice it is proposed to install the culvert a minimum of 300mm below ground level to allow for sedimentation. The maximum water level from the section 50 flows is shown in Figure 4-5 below with and without the proposed culvert in place. The afflux resulting from the proposed culvert is 115mm.

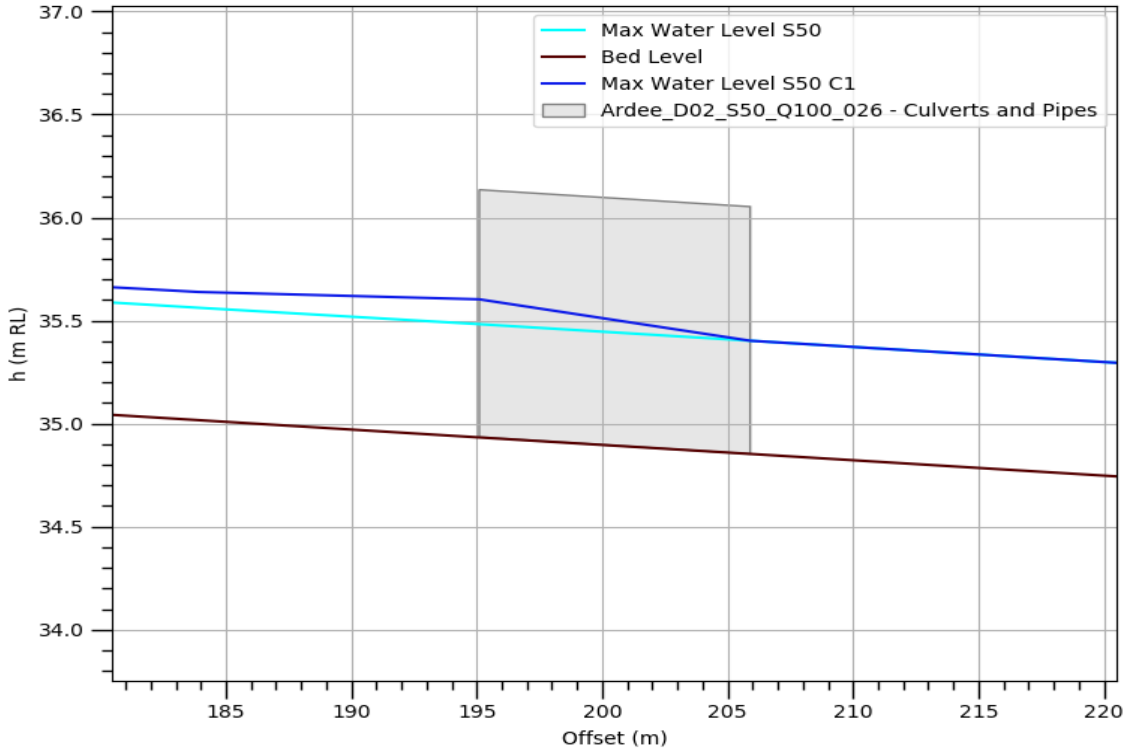


Figure 4-5: Maximum Water Level through Culvert 1

4.5.1.2 Culvert 2

For Culvert 2, a proposed culvert of dimension of 1.5 x 1.8m is required to meet the design standards.

An orifice size of 1.2m x 1.8m results in an air gap of 530mm through the culvert, i.e. a maximum water level of 34.56mOD in the culvert. Although the required air gap can be achieved with a 1.2m orifice height following best practice it is proposed to install the culvert minimum 300mm below ground level to allow for sedimentation. The maximum water level from the section 50 flows is shown in Figure 4-6 below with and without the proposed culvert in place. The afflux resulting from the proposed culvert is 100mm.

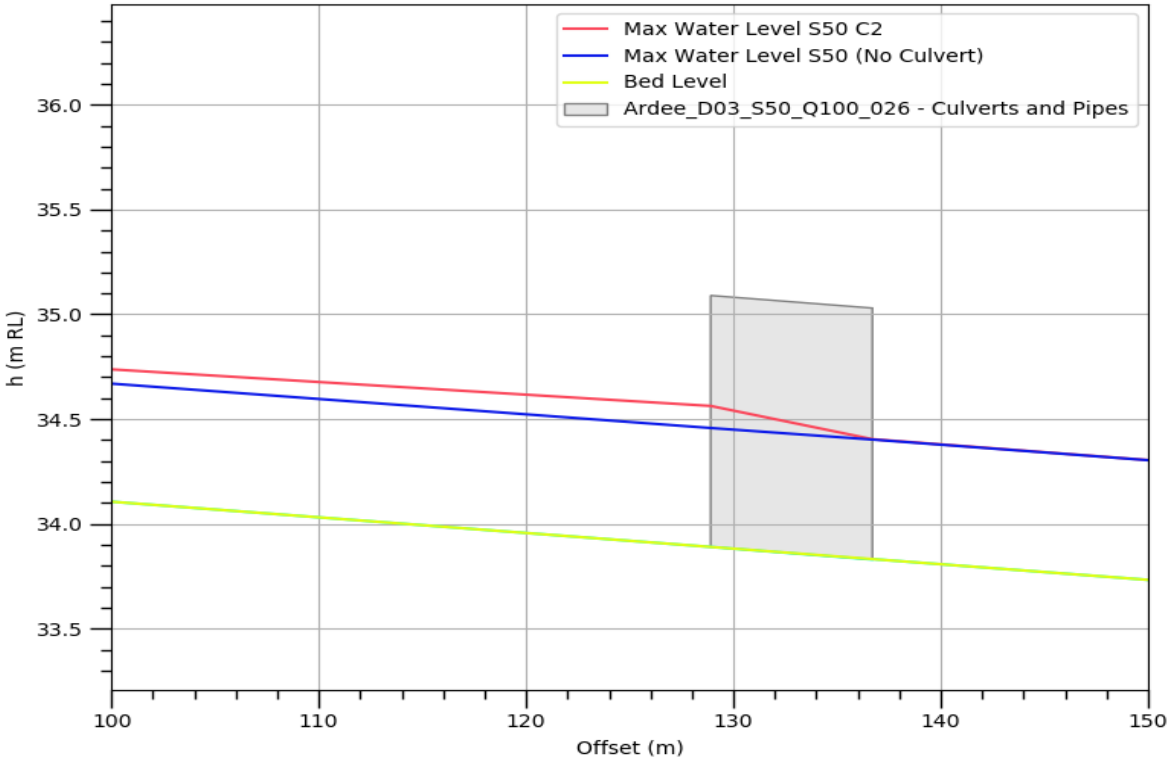


Figure 4-6: Maximum Water Level through Culvert 2

4.5.2 1% and 0.1% AEP Events

The 1% AEP event was run for the proposed development scenario. The flood extents for the 1% AEP pre and post development flood extents are shown in Figure 4-8. The flood extents within the site change due to the realignment of the channel. However, there is no increase in flood extents as a result of the proposed development. The maximum water level modelled on site is 36.79mOD.

The 0.1% AEP flood event was also run for the post development scenario to establish Flood Zone B are shown in Figure 4-7. The 0.1% AEP maximum water level on site is 37.03mOD

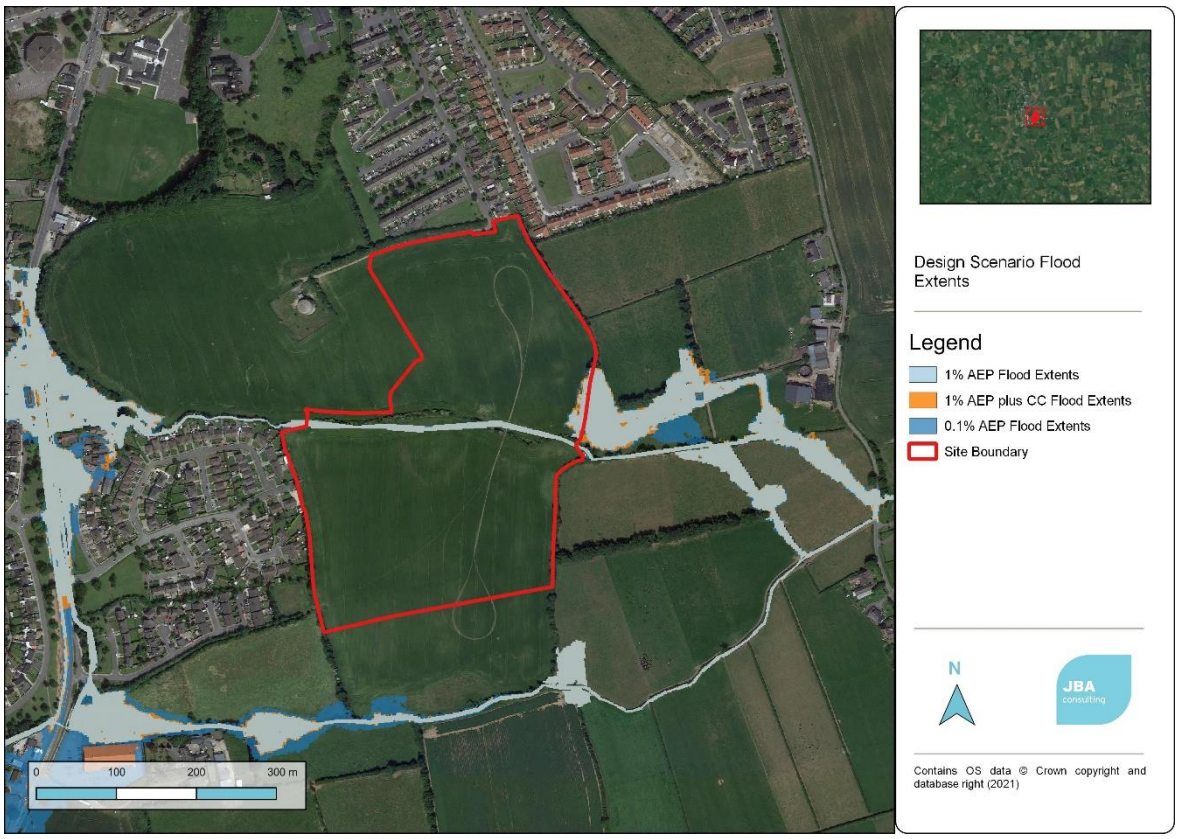


Figure 4-7: Proposed Scenario Flood Extents

4.5.3 Climate Change

The 1% AEP plus climate change effects was also run for the proposed scenario. The flood extents are shown in Figure 4-7. The 1% AEP plus climate change maximum water level in the vicinity of the new store was modelled to be 36.83mOD

4.5.4 Impacts of the development

The impacts of the development were determined by comparing the design scenario 1% AEP water level and flood extents with the existing scenario 1% AEP water level and flood extents. Figure 4-8. below shows the difference between the design scenario and the existing scenario water levels. There is no increase in flood extents off site, and only a small change in extents within the site boundary due to channel re alignment.

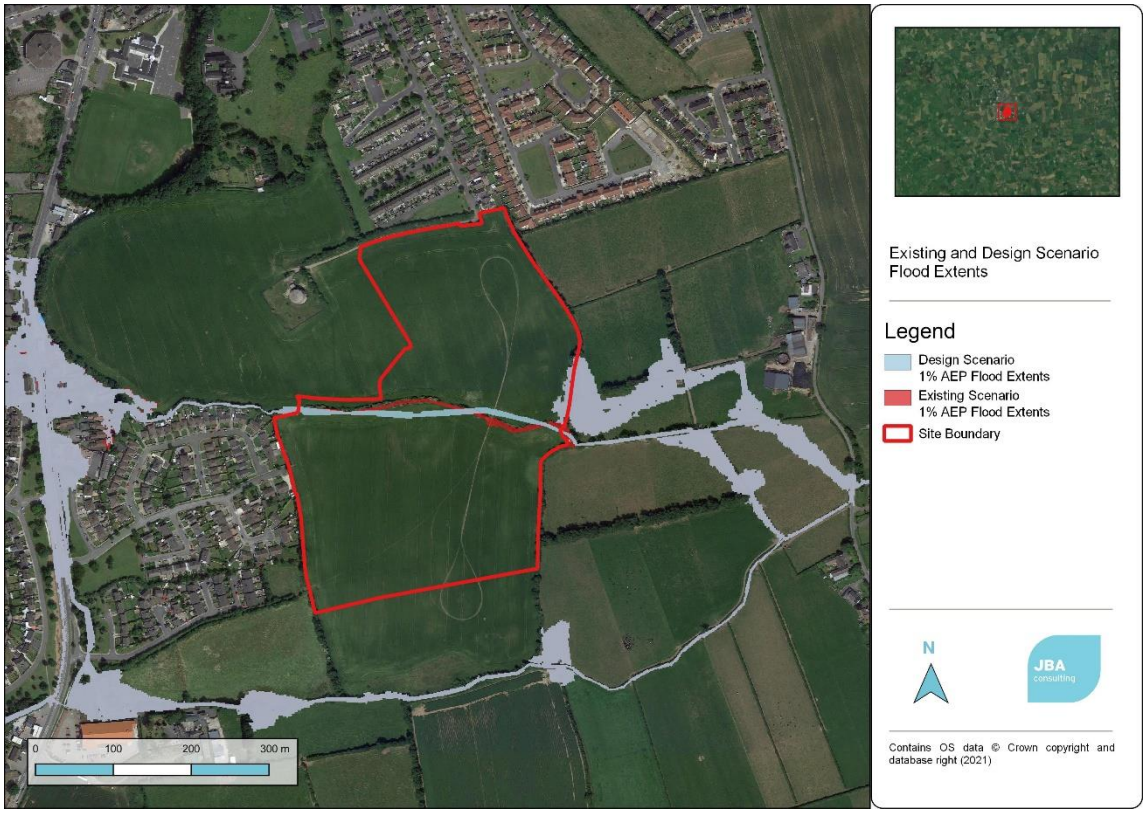


Figure 4-8: Existing and proposed scenario 1% AEP Flood Extents

5 Flood Risk Assessment and Mitigation Measures

5.1 Flood Risk

The main watercourses in the area are the Rathgory Tributary, the Mullameelan River and the Rathgory River. Having reviewed the available sources of flooding information outlined in Section 3, there is no identified historic flooding within the site but there are recorded events within the surrounding area and the CFRAM Study indicates the site is at risk of fluvial flooding.

Following detailed survey, hydrological assessment and hydraulic modelling of the Rathgory Tributary, the Mullameelan River and the Rathgory River, flood extents on the subject site for the 1% and 0.1% AEP flood events were developed. These flood extents indicate that there is a section of the east of the site is located in the 1% AEP flood extent and 0.1% AEP flood extent.

Figure 5-1: Site Layout with flood extents

5.2 Flood Risk Mitigation Measures

In response to the risk identified from fluvial flooding, mitigation measures are required to minimise the flooding onsite and are outlined below.

5.2.1 The Site Layout

In accordance with the Louth County Development Plan Flood Risk Policy IU24 the sequential approach has been applied and all buildings have been located within Flood Zone C. The risk of inundation of the building footprints has therefore been minimised. The area of the site located within Flood Zone A/B is open space i.e. water compatible. The development has been demonstrated to have no impact on neighbouring lands.

Access to the development is via Bridgegate Avenue from the west. The site access is in Flood Zone C and therefore at low risk of flooding.

5.2.2 Finished Floor Level

Finished floor levels for the development have been indicated on the site layout plan. The recommended minimum FFL, which is the design flood level for the development which is the fluvial 1% AEP climate change water level of, plus a freeboard allowance of 0.5m. The required minimum

FFL grades through the site as the maximum water level grades through the site. All FFL are in excess of the minimum FFL and have a freeboard of at least 1.25m above 1% AEP climate change water level.

The FFL of all buildings on site are at least 150mm above hardstanding and no FFLs are lower than local surrounding road levels.

5.2.3 Channel Profile

The OPW channel C2(14A) is being adjusted in terms of centreline and cross-sectional area. This will be subject to Section 9 consent under the Arterial Drainage Act (1945) and the OPW has been consulted during the design process. The resulting design allows for a 5m access strip adjacent to the channel, the profile itself has been amended to allow a low flow channel sized to the 50% AEP and a berm of 1m width to convey flows in excess of the 50% AEP event. Low-level cluster planting has also been agreed with OPW, see Appendix B. Overall, the aim of the enhancements is to increase biodiversity and water quality. An indicative cross section is provided below in Figure 5-2.

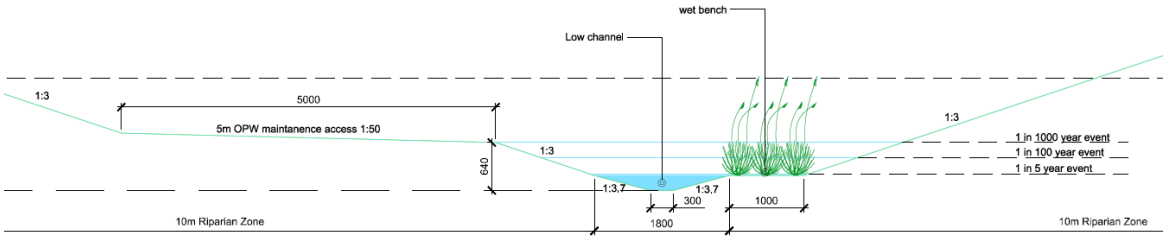


Figure 5-2 Typical Stream Detail

5.2.4 Surface Water

The proposed works onsite involves the development of residential buildings, access roads and associated works. This will change the site from a greenfield site to a predominantly hardstanding area and will therefore result in increased stormwater runoff if not mitigated.

A stormwater system will be incorporated within the development design to manage surface water run-off from the site and eliminate localised ponding and has been designed and detailed by CS Consulting. The stormwater attenuation system is being designed to GDSDS requirements. The surface water system will include new road gullies and storm water pipes which will remove potential for surface water ponding. The surface water attenuation system includes 4 attenuation tanks, with capacities of 1340m³, 350m³, 358m³ and 903m³. The attenuation tanks have been designed to retain a 1 in 100-year event, with a 20% allowance for climate change. The proposed surface water attenuation has been designed to limit any outflow to the existing Greenfield Runoff Rates. There are 3 outflow points from the attenuation system into the Rathgory Tributary limited to runoffs of 9.4l/s, 2.0l/s and 4.6l/s.

The overall impact of restricting flows to greenfield rates is a small reduction in the peak flow by approximately 5% of the Rathgory Tributary compared to existing conditions. This ensures that there are no negative impacts to the downstream system, this is illustrated by Figure 5-3 over page which compares the existing condition to the design scenario for the 1% AEP flood event.

Comments from Louth County Council under the SHD pre application consultation stage reference concern about downstream flooding on the Rathgory River that could be exacerbated by any development further upstream in the catchment. The work undertaken in the SSFRA and by the CS Consulting stormwater design is intended to demonstrate that there is no additional surface water runoff from the development, that the development appropriately manages flood risk from all sources and that the peak flow downstream is reduced, reducing the flood risk downstream.

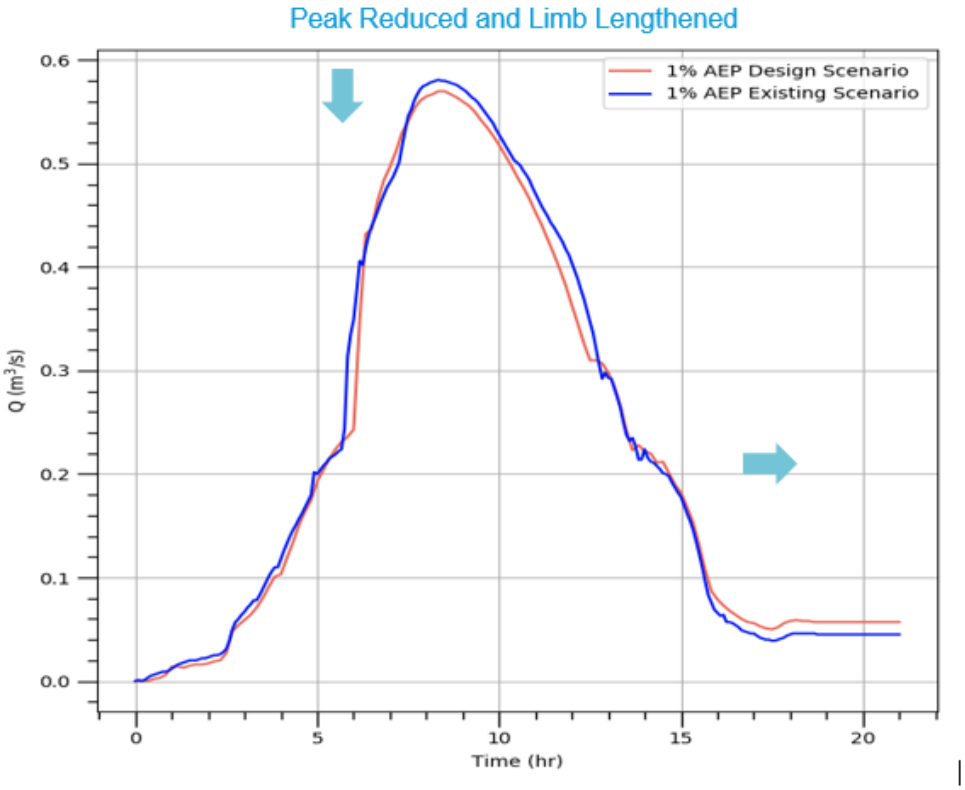


Figure 5-3 Pre and post development hydrograph, downstream of site

5.3 Residual Risk

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

- Climate Change,
- Failure of on-site surface water attenuation system.

5.3.1 Climate Change

In accordance with the OPW guidelines, it is necessary to assess the risk associated with climate change, which under the medium range future scenario (MRFS) corresponds with an increase in flows of 20% for the 1% AEP flood event, or a 0.5m increase in tide levels. The surface water system has been designed with a 20% allowance in the attenuation tank volume to account for climate change.

5.3.2 Stormwater

Failure of the stormwater system could include exceedance of the attenuation tank capacity, or blockage of the surface water gullies.

In the event of exceedance or blockage of the system the expected flow path of the surface water is shown by the blue arrows in Figure 5-4. The ground levels ensure than any overland flow is directed towards the channel and the green area surrounding the channel does not pond in the vicinity of the properties.

Figure 5-4: Overland Flow routes (CS Consulting Drawing Ref: ARDEE-CSC-00-XX-DR-C-1017)

6 Conclusion

JBA Consulting has undertaken a Site Specific Flood Risk Assessment for the proposed residential development in Ardee, Co. Louth. The work undertaken in the SSFRA and by the CS Consulting stormwater design has demonstrated that there is no additional surface water runoff from the development, the peak flow downstream is reduced and that the design appropriately manages flood risk from all sources.

There are no instances of historic flooding on site but there are recorded events in the surrounding area. The Rathgory Tributary flows though the site and the Rathgory River and the Mullameelan River are located immediately south and c. 425m south of the site respectively. According to OPW Fluvial Flood Map the 1% AEP flood event (1 in 100 year) and the 0.1% AEP flood event (1 in1000 year) partially inundates the eastern border of part of the site.

The detailed hydrological and hydraulic analysis indicates that the eastern border of the site is located in Flood Zone A.

Risk to the site is managed in accordance with the Louth County Development Plan guidance. Floor levels are set to the 1% AEP climate change water level, plus a freeboard allowance of at least 1.25m. Further, the finished floor level provide a minimum of 150mm above surrounding ground levels to provide protection against pluvial flooding. All residential buildings have also been located in Flood Zone C, further minimising the risk of inundation. The part of the site within Flood Zone A/B is kept as a meadow/open space and the riparian corridor is also provided. Overall there is a small decrease in the peak flood flows downstream of the site and there are no negative impacts elsewhere.

The stormwater system has been designed to manage surface water runoff from the site. The attenuation tank is designed to retain a 1 in 100-year flood event with a 20% allowance for climate change. The proposed stormwater attenuation system has been designed to limit any outflow from the site to the existing Greenfield Runoff Rate.

Residual risks have been identified as potential impacts of climate change and potential failure of the stormwater system.

The proposed culverts have been designed in accordance with Section 50 (of the Arterial Drainage Act) requirements and the channel design will similarly be subject to Section 9 requirements. The OPW has been consulted through the design process to agree the channel design requirements. Louth County Council have also been engaged throughout the design process following the tripartite meeting with An Bord Pleanála

As a result of the mitigation details discussed above, it is concluded that the development proposal is in compliance with the core principles of the Planning System and Flood Risk Management Guidelines and has been subject to a commensurate assessment of risk.

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 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

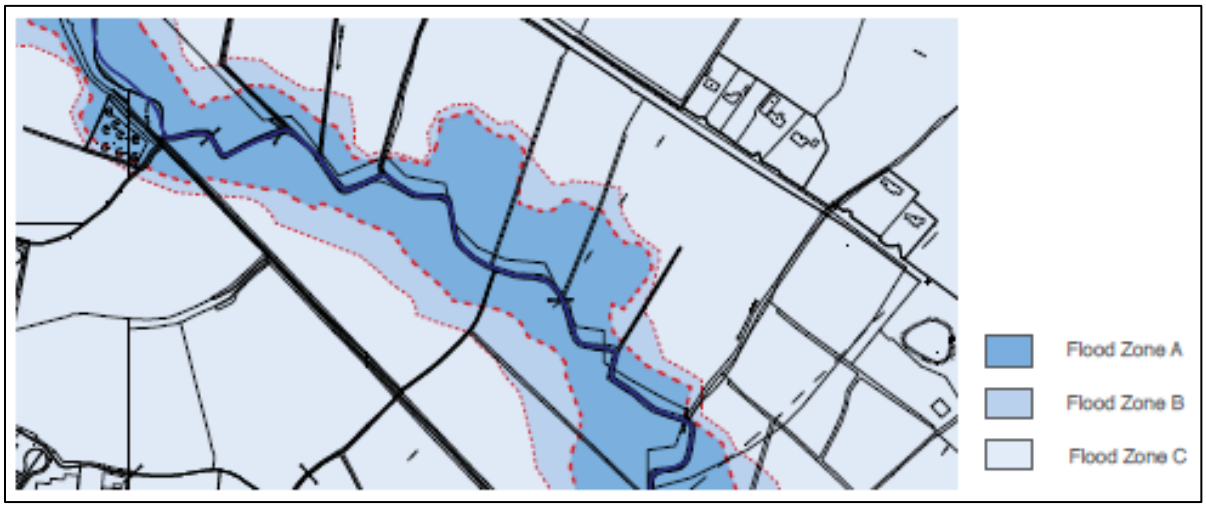
Return period (years)	Annual exceedance probability (%)
2	50
10	10
50	2
100	1
200	0.5
1000	0.1

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, les 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

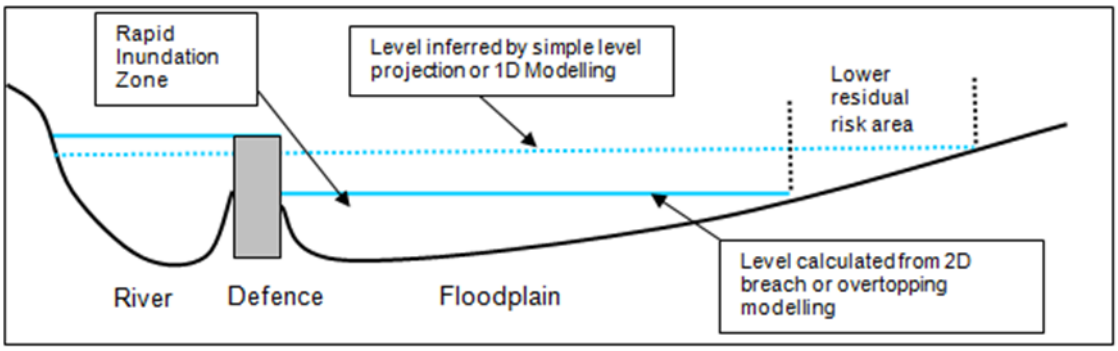
Consequences of flooding depend on the Hazards caused by flooding (depth of water, speed of flow. Rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure of the population, presence and reliability of mitigation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

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

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



B Appendix - Correspondence with OPW

OPW Oifig na nOibreacha Poiblí Office of Public Works

Mr. Ross Bryant
JBA Consulting,
Unit 24,
Grove Island,
Corbally,
Limerick, V94 312N.
Ross.Bryant@jbaconsulting.ie

Our Ref: 141-2021

Re: Proposed Ardee Housing Development – Future Channel Maintenance

Dear Mr Bryant,

I refer to your correspondence where JBA Consulting Engineers have consulted with the Office of Public Works (OPW) regarding the issue of access allowance for continued maintenance of channel C2(14A) which runs through this proposed development in Ardee, Co. Louth. This channel is part of the Glyde and Dee Arterial Drainage Scheme and under the 1945 Arterial Drainage Act, this office is responsible for the maintenance of this channel.

It has been agreed in principle an unobstructed allowance for OPW mechanical plant in a strip of flat ground adjacent to the channel, as per that attached and identified in Figure 5-2 Typical Stream Detail from the Ardee Co Louth Flood Risk Assessment, Technical Report.

Yours sincerely,

_____

Karen Donovan
Engineering Services Administration Unit
17th May 2021

excess of the minimum FFL and have a freeboard of at least 1.25m above 1% AEP climate change water level.

The FFL of all buildings on site are at least 150mm above hardstanding and no FFLs are lower than local surrounding road levels.

5.2.3 Channel Profile

The OPW channel C2(14A) is being adjusted in terms of centreline and cross sectional area. This will be subject to Section 9 consent under the Arterial Drainage Act (1945) and the OPW has been consulted during the design process. The resulting design allows for a 5m access strip adjacent to the channel, the profile itself has been amended to allow a low flow channel sized to the 50% AEP and a berm of 1m width to convey flows in excess of the 50% AEP event. JBA is currently agreeing the final details with the OPW, but it is likely that some low level cluster planting may also be permitted. Overall the aim of the enhancements is to increase biodiversity and water quality. An indicative cross section is provided below in Figure 5-2.

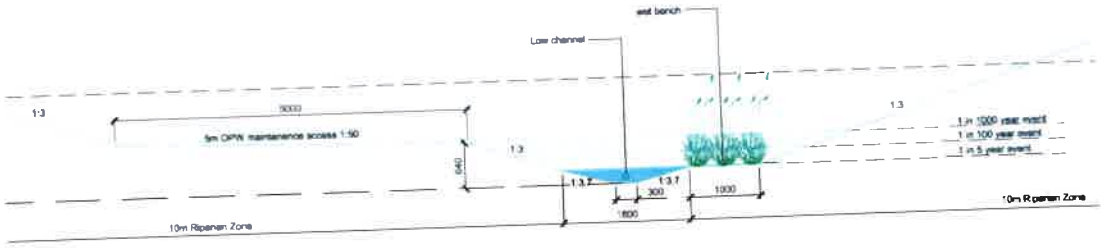


Figure 5-2 Typical Stream Detail

5.2.4 Surface Water

The proposed works onsite involves the development of residential buildings, access roads and associated works. This will change the site from a greenfield site to a predominantly hardstanding area and will therefore result in increased stormwater runoff if not mitigated.

A stormwater system will be incorporated within the development design to manage surface water run-off from the site and eliminate localised ponding and has been designed and detailed by CS Consulting. The stormwater attenuation system is being designed to GDSDS requirements. The surface water system will include new road gullies and storm water pipes which will remove potential for surface water ponding. The surface water attenuation system includes 4 attenuation tanks, with capacities of 1340m³, 350m³, 358m³ and 950m³. The attenuation tanks have been designed to retain a 1 in 100-year event, with a 20% allowance for climate change. The proposed surface water attenuation has been designed to limit any outflow to the existing Greenfield Runoff Rates. There are 3 outflow points from the attenuation system into the Rathgory Tributary limited to runoffs of 9.4l/s, 2.0l/s and 4.8l/s.

The overall impact of restricting flows to greenfield rates is a small reduction in the peak flow of the Rathgory Tributary compared to existing conditions. This ensures that there are no negative impacts to the downstream system, this is illustrated by Figure 5-3 over page which compares the existing condition to the design scenario for the 1% AEP flood event.

Comments from Louth County Council under the SHD application reference concern about downstream flooding on the Rathgory River that could be exacerbated by any development further upstream in the catchment. The work undertaken in the FRA and by the CS Consulting stormwater design is intended to demonstrate that there is no additional surface water runoff from the development and that the development appropriately manages flood risk from all sources.

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