Kildalkey Road, Trim FRA

Final

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This report describes work commissioned by Loughglynn Developments. Jack Shanahan and Ross Bryant of JBA Consulting carried out this work.

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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
DTM ..... Digital Terrain Model
FFL ..... Finish Floor Levels
FRA ..... Flood Risk Assessment
GDSDS ..... Greater Dublin Strategic Drainage Study
GSI ..... Geological Survey of Ireland
ICWWS ..... Irish Coastal Wave and Water Level Modelling Study
LiDAR ..... Light Detection and Ranging
MCC ..... Meath County Council
MCDP ..... Meath County Development Plan
mOD ..... Metres to Ordnance Datum (Malin Head)
MRFS ..... Mid-Range Future Scenario
NIFM ..... National Indicative Fluvial Mapping
NCFHM ..... National Coastal Flood Hazard Mapping
OPW ..... Office of Public Works
PFRA ..... Preliminary Flood Risk Assessment
RMS ..... Root Mean Square
SFRA ..... Strategic Flood Risk Assessment

1 Introduction

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

1.1 Terms of Reference

JBA Consulting has been appointed to prepare a Flood Risk Assessment (FRA) for a proposed LRD development and a creche located at Kildalkey Road, Trim, Co Meath. Under the 'Planning System and Flood Risk Management - Guidelines for Planning Authorities' (DEHLG / OPW, 2009), proposed development must undergo a Flood Risk Assessment prior to planning to ensure sustainability and effective management of flood risk. The local authority in this instance is Meath County Council (MCC).

1.2 Flood Risk Assessment, Aims & Objectives

This study is being completed to inform the 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 objectives 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 items, refer to Appendix A. Appendix B contains the response to the LRD Opinion.

1.3 Development Proposal

The proposed development comprises a Large-Scale Residential Development (LRD) on lands at Crowpark (1st Division), Kildalkey Road, Trim, Co. Meath.

The scheme provides a total of 183 residential units, comprising 127 houses and 56 apartments. The housing mix includes 19 no. detached 4-bedroom houses, 9 no. semi-detached/end-terrace 4-bedroom houses, 4 no. detached 3-bedroom houses, 43 no. semi-detached/end-terrace 3-bedroom houses, and 52 no. mid-terrace 3-bedroom houses, with building heights from 2 to 2 ½ storeys. The apartment element comprises 56 no. units in two blocks of up to four storeys, including 16 no. one-bedroom and 40 no. two-bedroom units.

The development also includes a crèche facility, new vehicular and pedestrian accesses from Kildalkey Road.

The proposal provides for associated infrastructure and site works, including landscaping, public and communal open space, internal streets and footpaths, car and bicycle parking, bin stores, private open space, boundary treatments, plant and waste management areas, utility infrastructure and a foul sewer connection to the existing network adjoining the OPW offices on Jonathan Swift Street, to be delivered beneath the River Boyne and Trim Pitch & Putt.

The proposed layout is provided in Figure 1-1

Figure 1-1: Development Proposal

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 modelling and assessment is outlined in Section 4 and Flood Risk Mitigation is provided in Section 5. The Justification Test is in Section 6 and the Conclusion in Section 7.

2 Site Boundary

This section describes the watercourses, geology and wider geographical area in Trim, Co. Meath.

2.1 Location

The proposed site is located on a greenfield site along Kildalkey Road, Trim. Kildalkey Road is located to the north of the site, a residential area is located to the east, while the River Boyne is to the south. The west of the site is bounded by a greenfield area. Access to the site can be achieved via Kildalkey Road to the north; refer to Figure 2-1. The gross site area, including the foul sewer route under the River Boyne, is 6.087 hectares. The proposed net site area is approximately 5.648 hectares within the proposed red line boundary.

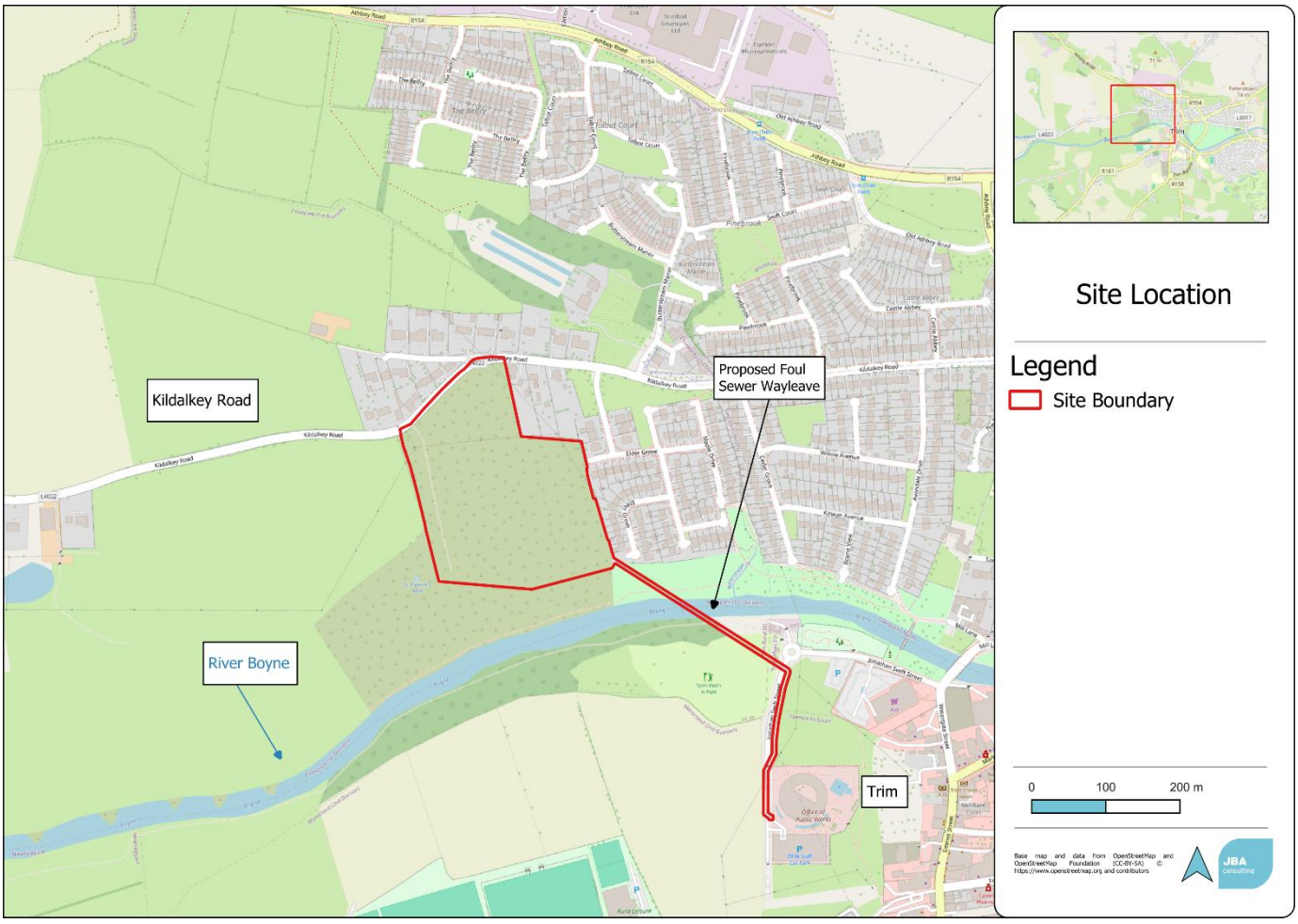


Figure 2-1: Site Location

2.2 Watercourses

The River Boyne is the main watercourse in the area; refer to Figure 2-2. It is located directly south of the site. The River Boyne has a catchment area of approximately 1,359km^2. The river flows in an easterly direction along the site's boundary. A smaller tributary enters the River Boyne on the northern bank, c. 160m downstream of the site. This tributary has a catchment area of c. 2km^2.

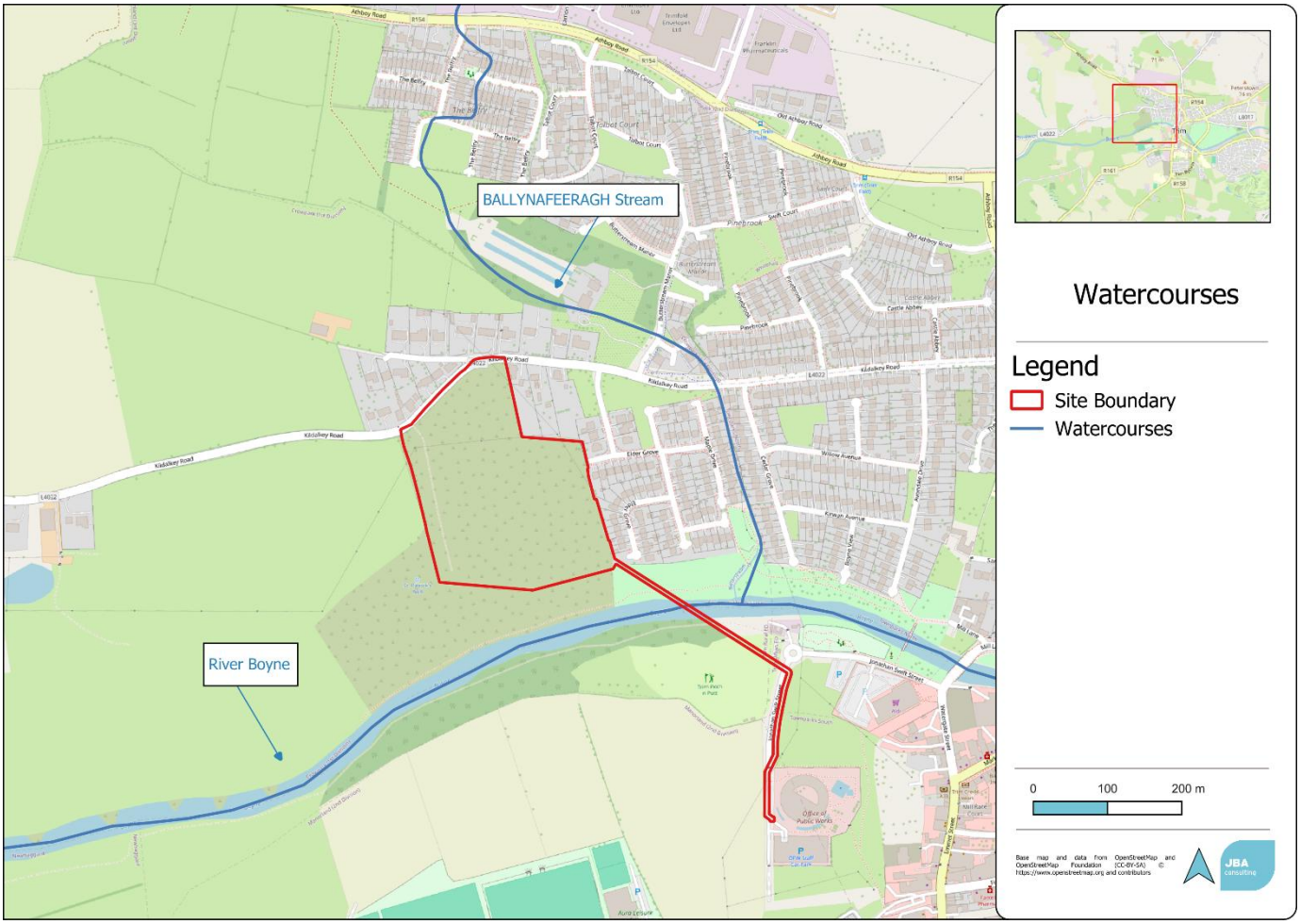


Figure 2-2: Watercourses

2.3 Local Topography

The overall slope of the site and wider area is to the south towards the River Boyne. Site levels range from 65mOD at the northern boundary to 54mOD along the banks of the River Boyne. Figure 2-3 shows the LiDAR data at the site, available from the OPW Open Topographic Data Viewer along with some of the key levels from the topographic survey of the site. The LiDAR was collected in 2011 by FUGRO. The resolution of the LiDAR is 2m and has an RMS within +/- 200mm.

Review of the LiDAR (Figure 2-3) shows that the site slopes from north to south towards the river.

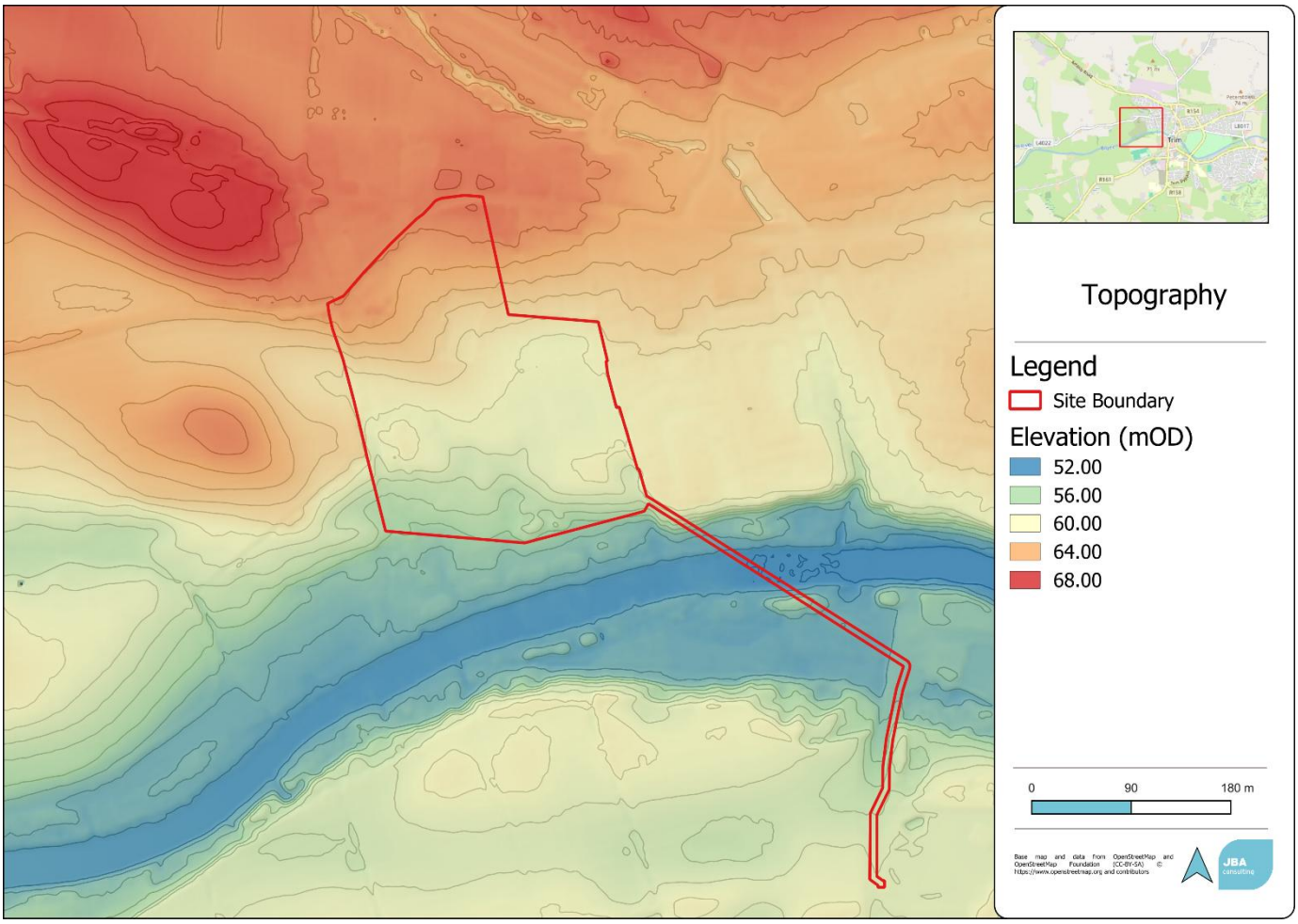


Figure 2-3: Site Topography

2.4 Local Geology

The groundwater and geological maps at the site, as provided by the Geological Survey of Ireland, (GSI), have been studied. The subsoil map for the site and surrounding area is presented in Figure 2-4. The subsoils at the north of the site consist of Deep Well Drained Mineral soils moving to Shallow Well Drained Mineral soils. The subsoils around the proposed foul pipe running east from the site consist of gravels from limestone, alluvium and Till from limestone. The banks of the River Boyne including the southern boundary of the site are composed of Alluvium soils, indicative of a historic floodplain.

The underlying bedrock is the Lucan Formation composed of dark limestones and shale. The groundwater vulnerability is described as High, and the subsoil permeability is Moderate.

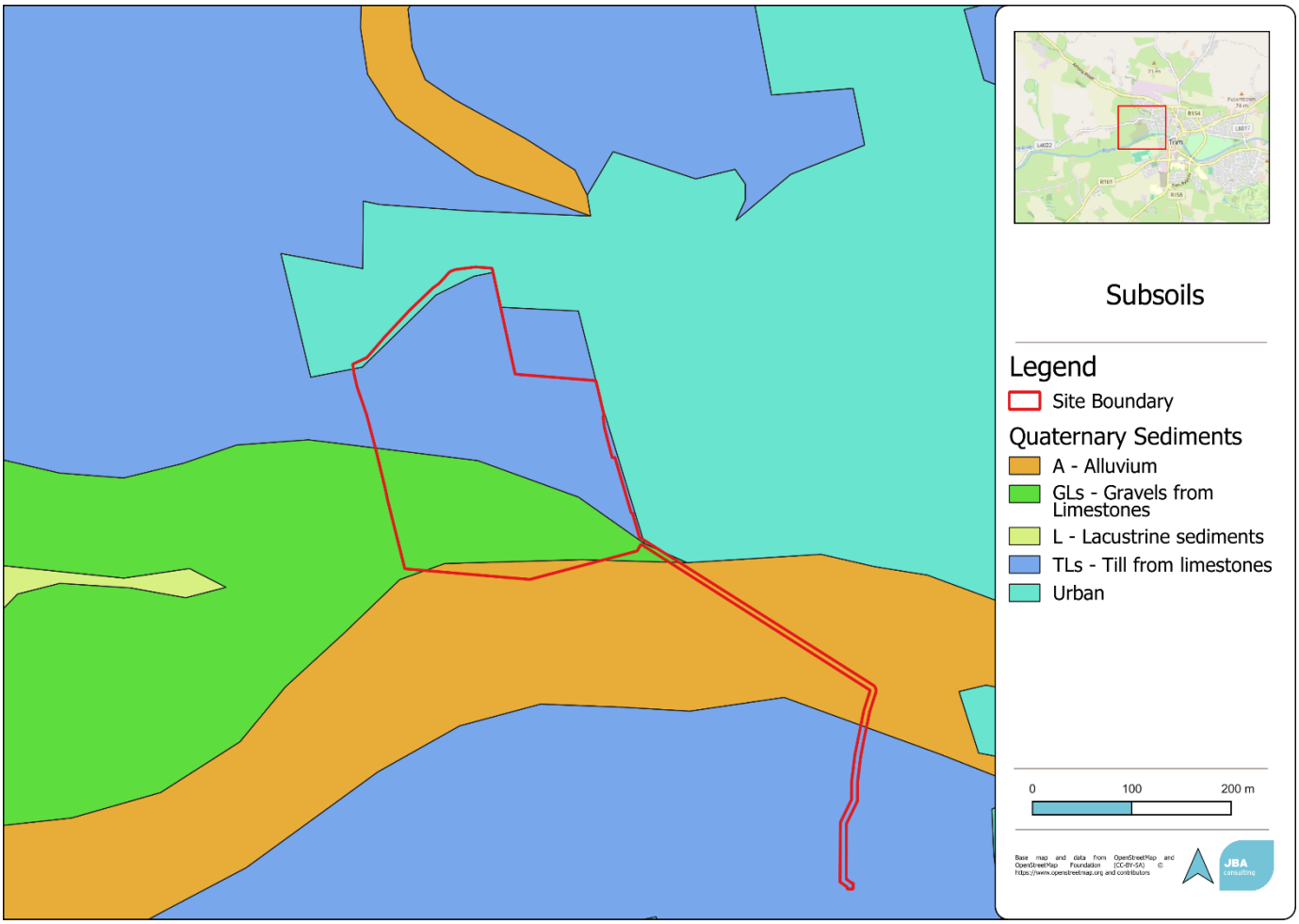


Figure 2-4: Site Subsoils

3 Flood Risk Identification

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

3.1 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 OPW's website, www.floodinfo.ie, and general internet searches.

3.1.1 Floodinfo.ie

The OPW hosts 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. As can be seen in Figure 3-1 below, a number of flood events have been recorded in the area, including a flood event adjacent to the site at Kildalkey Road. A summary of the key flood events is detailed in Table 3-1. It should be noted that the FloodInfo.ie flood event points are not georeferenced to the exact point of a historic flood event, but rather to a general location in the area.

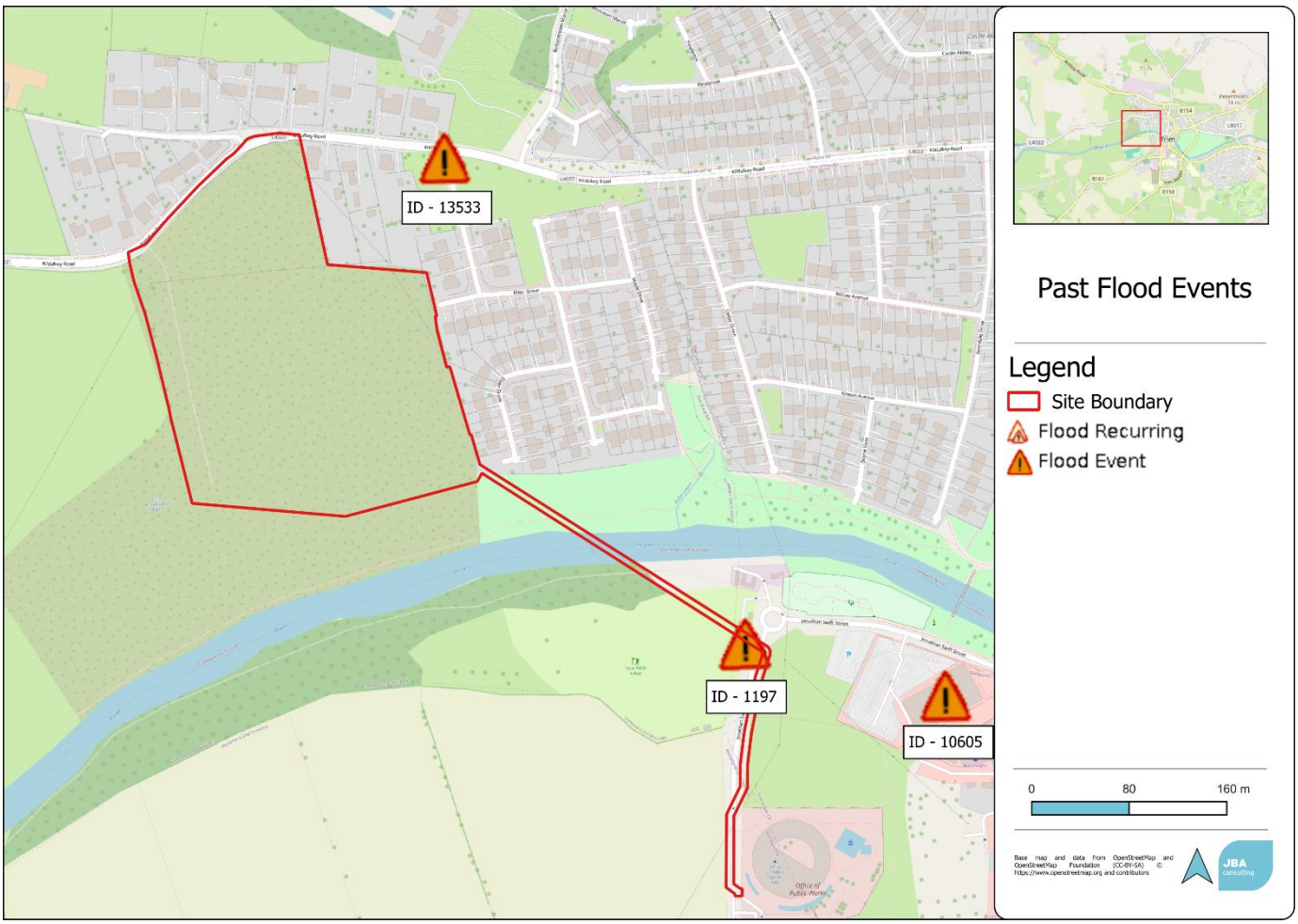


Figure 3-1: Historic Flooding

Table 3-1: FloodInfo.ie Details

Flood ID	Date	Details
10605	August 2008	Pitch & Putt area flooded. No other info on properties flooded. A peak flow of 136.3m3/s was recorded at Trim Hydrometric Station (07005). This was estimated to be between a 50% and 10% AEP flood event.
1197	January 2005	River Boyne overflowed into low lying ground and flooded swimming pool and children play area. Submersible pumps not working at time
13533	January 2017	The source of flooding was noted as "river". No other information was given.

3.1.2 Internet Searches

An internet search was conducted to gather information about whether the site and surrounding area were affected by flooding previously. A tweet from Meath CoCo stated on 22/11/2017 that there was "Severe flooding on the Kildalkey Road on approach to Trim". No additional information was available online.

3.2 Predictive Flooding

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

- Eastern Catchment Flood Risk Assessment and Management (CFRAM) study;
- Strategic Flood Risk Assessment (SFRA) for Meath County Development Plan (DP) 2021-2027

3.2.1 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 Catchment Flood Risk Assessment and Management Study (Eastern CFRAM Study). The Eastern CFRAM Study commenced in 2011.

The CFRAM study consists of detailed hydraulic modelling of the River Boyne and its tributaries, and flood extent maps for the fluvial scenarios have been completed. The relevant flood maps are available on the OPW website www.floodinfo.ie and an extract of the flood map covering the site is presented in Figure 3-2.

The site is shown to be partially inundated in the 0.1% AEP flood event.

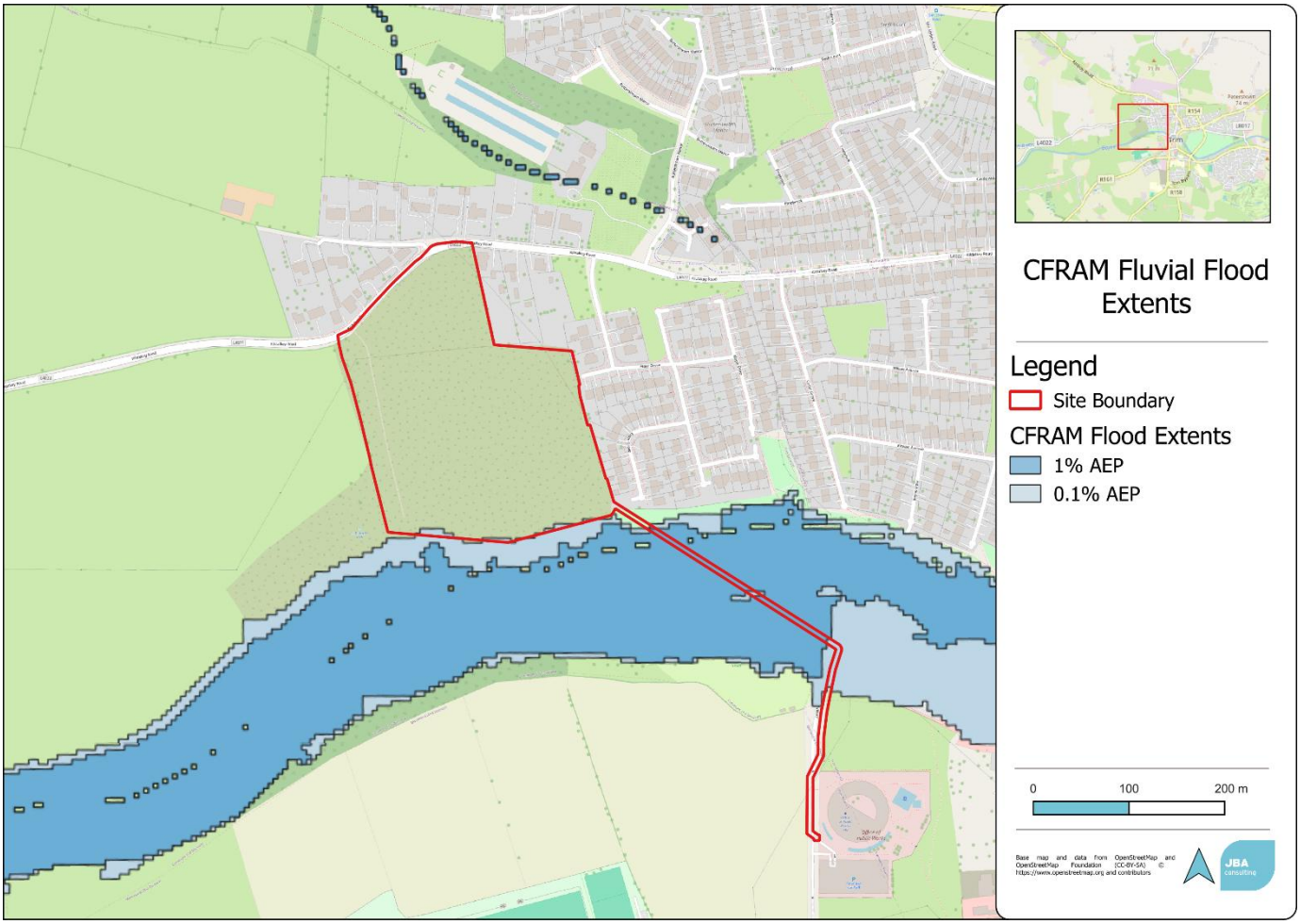


Figure 3-2: CFRAM Flood Extents

3.2.2 Strategic Flood Risk Assessment for Meath County Development Plan 2021-2027

In accordance with Section 11 of the Planning and Development Act 2000 (as amended), Meath County Council has prepared a Meath County Development Plan (MCDP) for the period 2021-2027. A Strategic Flood Risk Assessment (SFRA) for the MCDP 2021-2027 was prepared by JBA Consulting 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.

An extract from the MCDP web mapping application is shown in Figure 3-3. The site is zoned A2 - New Residential minor sections in the south as F1-Open Space and H1 -

High Amenity in the Development Plan. The SFRA has reviewed a number of datasets which record historical and/or predicted flood extents. The main source of flood information is the Eastern CFRAM study, which was used to inform the flood risk and flood zones in the area, with some exceptions.

The Land Use Zoning Objectives for Trim were reviewed as part of the SFRA. The JT notes that any further development of the land would require an FRA in accordance with INF POL 14-29 of the MCDP.

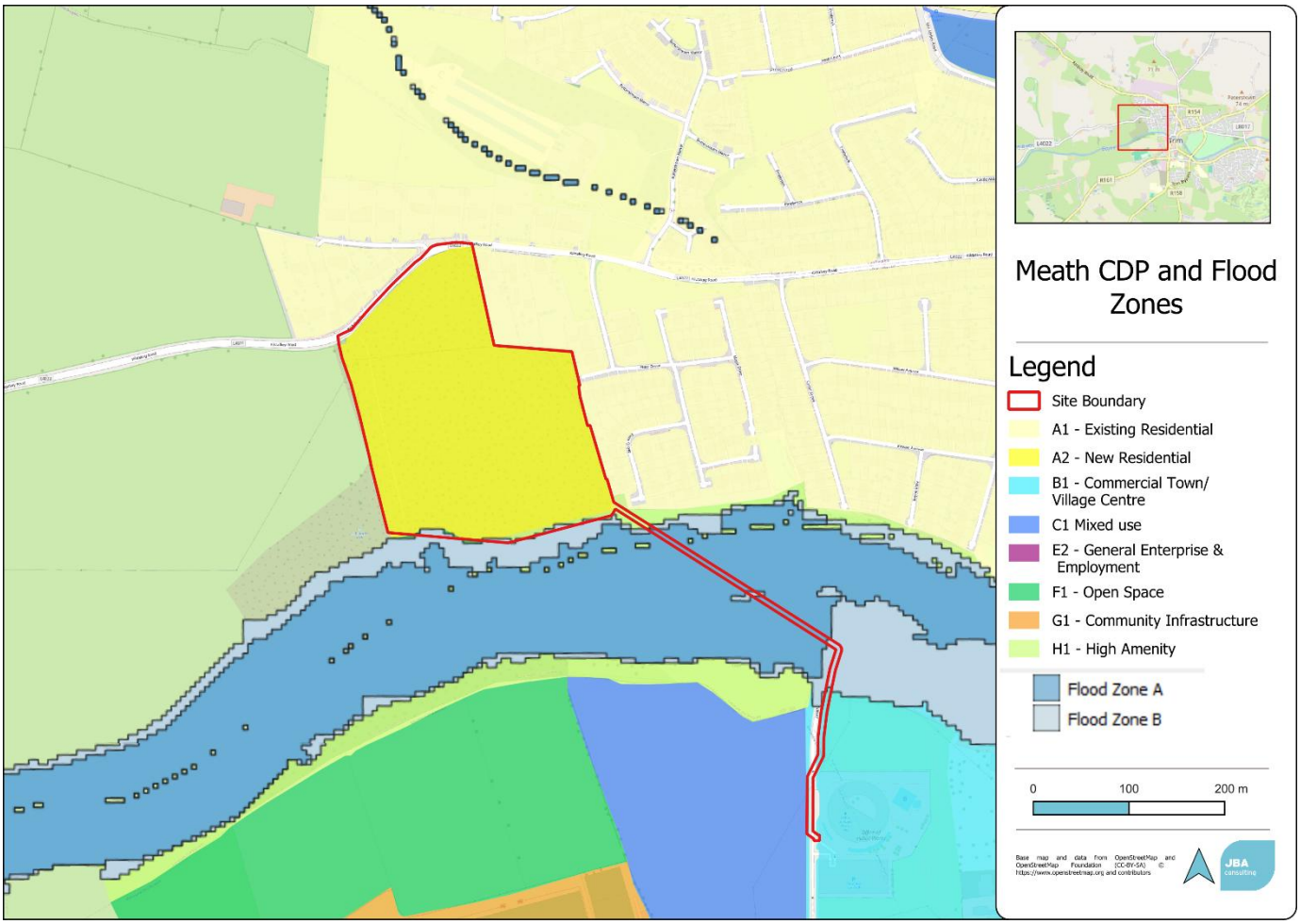


Figure 3-3: Meath County Development Plan Map Viewer Extract

3.3 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 below.

3.3.1 Fluvial

The main watercourse is the River Boyne. The CFRAM study has identified the site as being partially within Flood Zone B. However, the CFRAM does not provide enough information in terms of flood levels at the site and a more detailed model is required to accurately estimate the flood risk at the site and to allow for the determination of appropriate mitigation measures in order to reduce flood risk and ensure there are no impacts on surrounding properties. This is discussed in detail in Section 4.

3.3.2 Coastal

The site is not identified as being at risk of tidal flooding from the CFRAM coastal flood maps.

3.3.3 Pluvial

Pluvial, or surface water, flooding is the result of rainfall-generated flows that arise before run-off can enter a watercourse or sewer. It is usually associated with high intensity rainfall.

Adequate storm water drainage systems will be required to ensure the pluvial flood risk is kept to a minimum.

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 normally dry. Although the GSI groundwater vulnerability mapping indicated a high risk to groundwater at the site, there is no record of historic groundwater flooding in the area. GSI Historic Groundwater Mapping shows no flooding within the site or the surrounding area. However, flooding was recorded less than a kilometre to the west of the site in the 2015/2016 Surface Water Flooding map.

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

4 Flood Risk Assessment

As outlined in Section 3.3 by the Eastern CFRAM Study, there is fluvial risk to the site. In order to assess the impacts of the proposed site layout and implement mitigation measures that ensure flood risk to the development is effectively managed, it is necessary to remodel this area. This will also provide clarification of the Flood Zone extents at a site-specific level and allow development scenarios to be tested. The following sections will detail the process of flow estimation, hydraulic modelling and present the results of the flood risk to the development.

4.1 Hydrology Estimation

JBA Consulting has undertaken a detailed hydrological analysis to determine peak flow rates and hydrographs for the River Boyne. Flows and hydrographs have been estimated based on a hydrological analysis of the River Boyne and a smaller Tributary using appropriate methods. Two Hydrological Estimation Points (HEPs) were required on the River Boyne (one at the upstream and one at the downstream of the model reach) and a single point inflow was required for the tributary entering the Boyne upstream of the site. Figure 4-1 below shows the location of the HEPs.

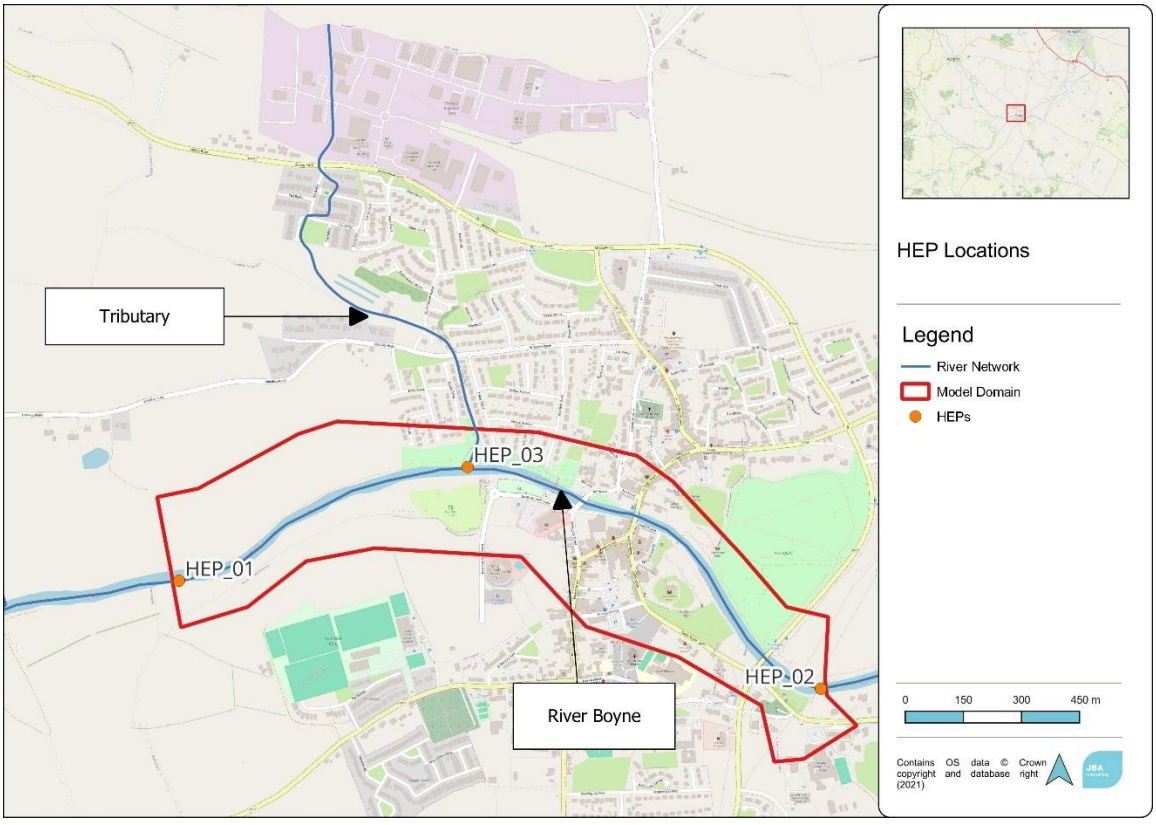


Figure 4-1: HEP Locations

4.1.1 Peak Flow Estimation

For the two River Boyne HEPs the 50% AEP peak flow was estimated using standard FSU methods and with reference to the observed flow data at Trim Gauging Station, located a short distance downstream of the site boundary. The 1% AEP and 0.1% AEP peak flows were subsequently derived using GLO distribution growth curve factors developed from a pooling group analysis for the Trim Gauging Station location.

For the tributary HEP, the catchment is approx. 2km² so flow estimation methods for smaller catchments were used (i.e., the FSU Small Catchments equation (SC), the IH124 method, and the FSR Rainfall Runoff method). The IH124 method was selected as the preferred method as it provided the most conservative estimate of the assessed methods.

Refer to Table 4-1 for the final design flows.

Table 4-1: Design Flows

HEP	Purpose	1% AEP (m3/s)	0.1% AEP (m3/s)
HEP_01	Boyne Point Inflow	221	234
HEP_02	Boyne Check Flow	224	237
HEP_03	Tributary Point Inflow	0.96	1.29

4.1.2 Inflow hydrographs

The Hydrograph shape for the River Boyne was estimated using the FSU portal with the Trim gauge as the pivotal site. For the tributary, the hydrograph shape was based on the FSR Rainfall Runoff hydrograph. The tributary hydrograph was delayed, peaking at the same time as the River Boyne hydrograph. The two hydrographs for the 1% AEP event are shown in Figure 4-2 below.

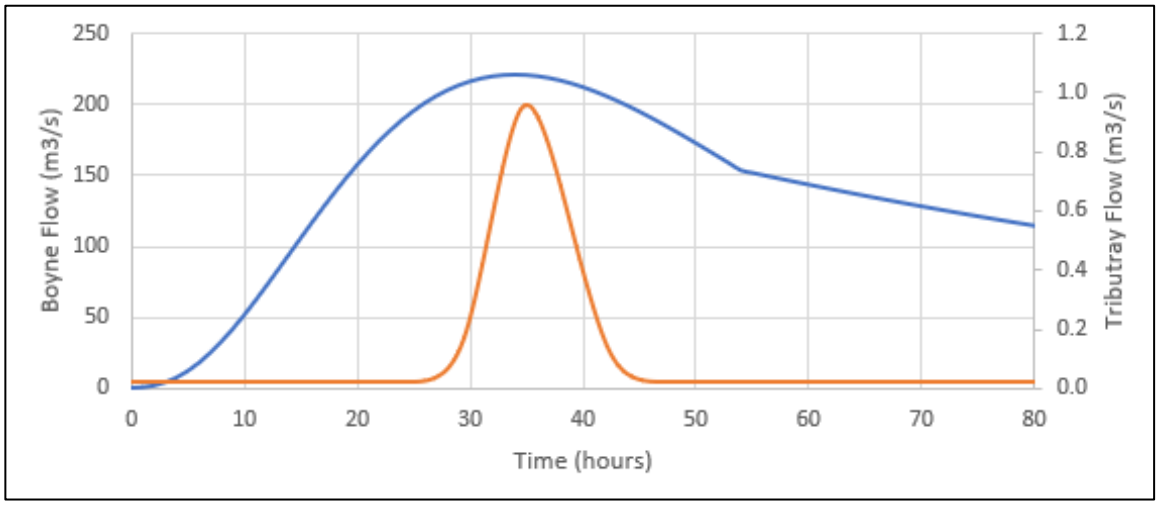


Figure 4-2: Inflow Hydrographs

4.2 Hydraulics

4.2.1 Hydraulic Modelling Overview

The hydraulic modelling for this study was completed using a TUFLOW - Estry 'linked-model'. A linked-model allows flow in the river channel and structures to be represented using 1D modelling equations (Estry) and allows any out-of-bank volumes to be represented by 2D routing equations (TUFLOW).

The hydraulic modelling was carried out in the following stages:

- A new 1D (Estry) model of the River Boyne has been created using the OPW survey data collected by Murphy Surveys in April 2012 as part of the CFRAM study.
- A 2D (TUFLOW) model grid enclosing the study area has been created. LiDAR with a 2m resolution was captured in 2011 and formed the basis of the 2D grid, supplemented with a topographic survey of the site carried out for the client.
- 1D and 2D components were linked along the bank crest lines along with the deactivation of the floodplains from the 1D domain and of the channels from the 2D domain.
- Design simulations have been run to derive the existing flood risk extents.

The model schematisation is shown in Figure 4-3 below.

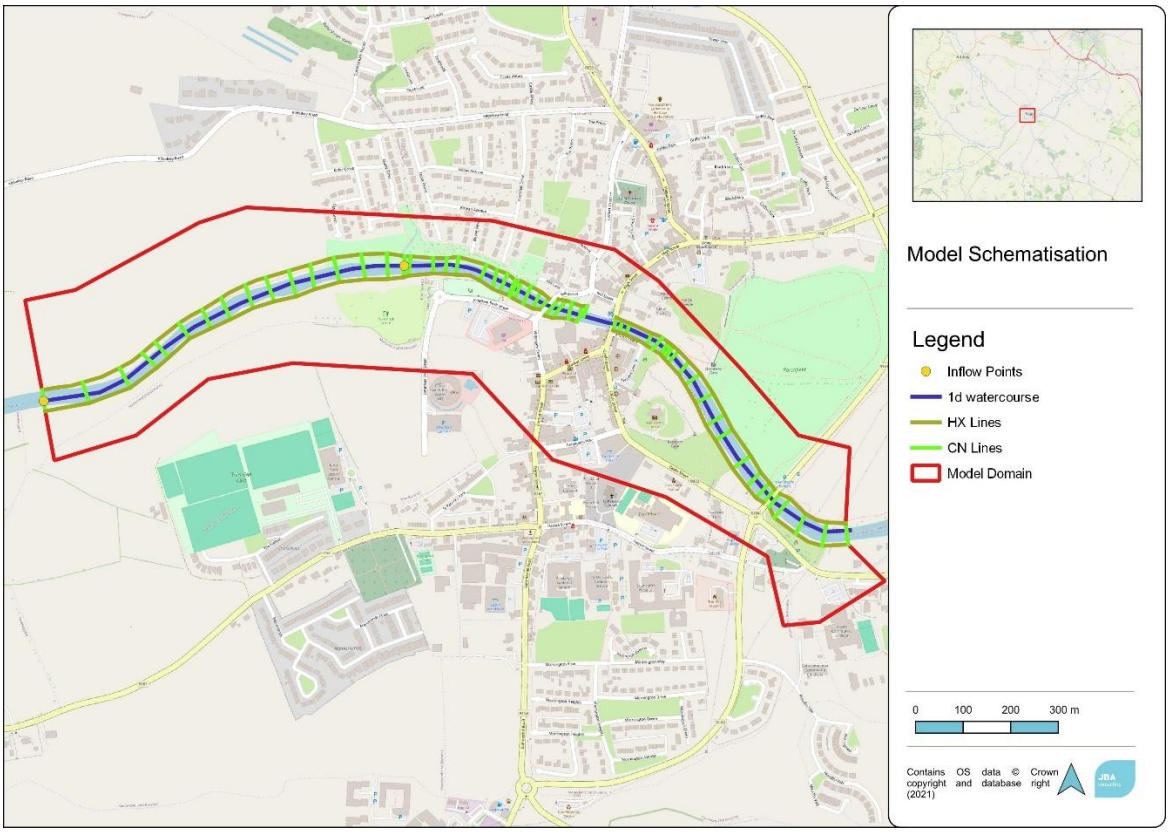


Figure 4-3: Model Schematic

4.2.2 Baseline Extents

The baseline scenario was tested to define fluvial flood extents for the 1% AEP and the 0.1% AEP events. These correspond to Flood Zone A and Flood Zone B, respectively. Following a review of Figure 4-4, the site is located in Flood Zone C, with the exception of the foul sewer which has to pass under the River Boyne. There is a risk of flooding south of the site during the 1% and 0.1% AEP flood events; however, this flooding is confined to open space and the foul sewer will be buried. The residential development is located in Flood Zone C.

Table 4-2 overpage provides the flood levels for the 1% and 0.1% AEP flood events across the development.

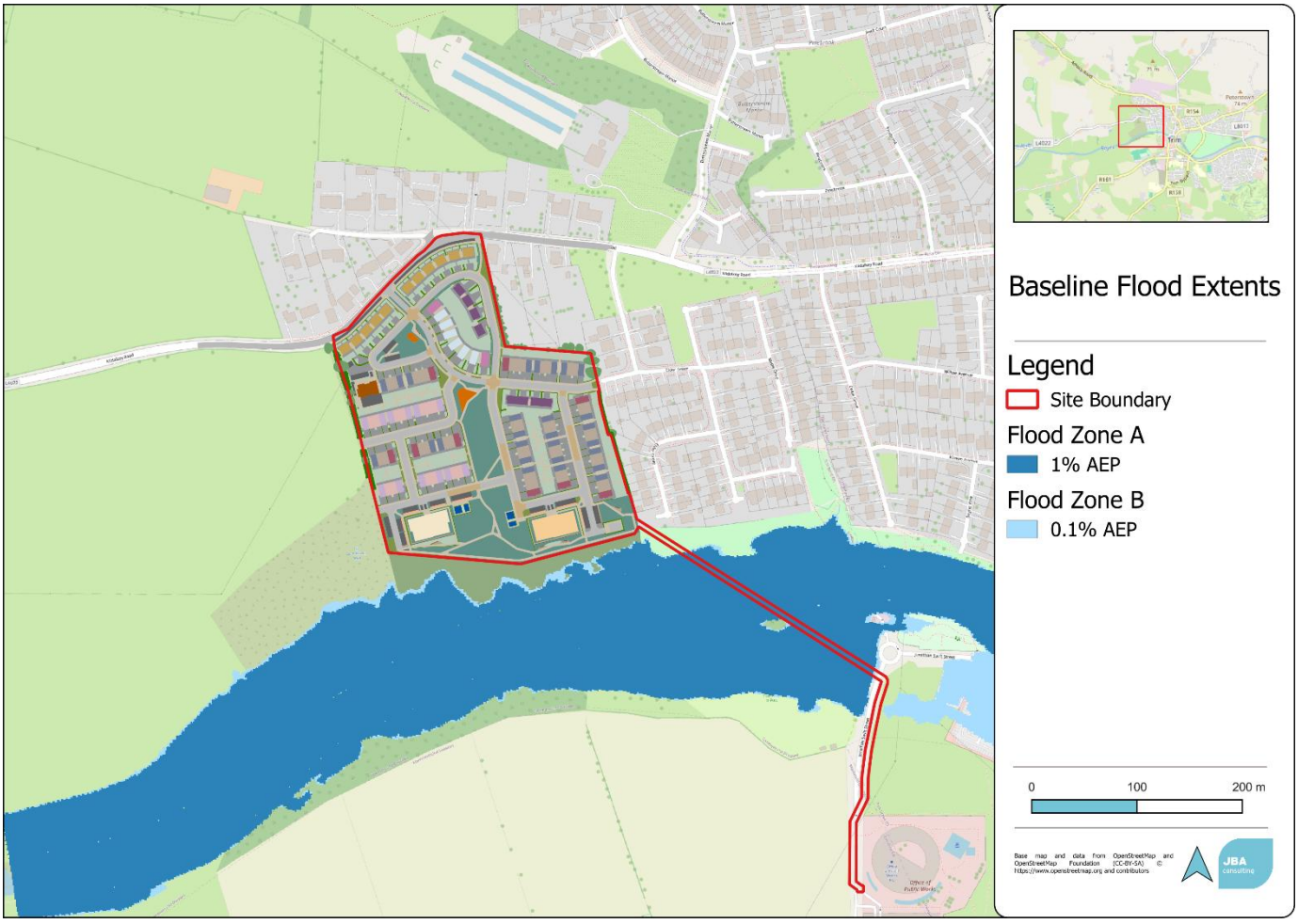


Figure 4-4: Baseline Flood Extents

Table 4-2 1% and 0.1% AEP Water Levels

Node	1% AEP Water Level (mOD)	0.1% AEP Water Levels
0701_05958	54.47	54.59
0701_05963	54.50	54.62

Node	1% AEP Water Level (mOD)	0.1% AEP Water Levels
0701_05968	54.52	54.64
0701_05973	54.56	54.67
0701_05978	54.59	54.71
0701_05983	54.62	54.74
0701_05988	54.64	54.76

4.2.3 Climate Change Analysis

The hydraulic modelling also includes an assessment of the flood extents in accordance with future climate change conditions in line with OPW guidance, with the Medium-Range Future Scenario (MRFS) representing an increase in existing flows by 20%, and the High-End Future Scenario (HEFS) representing an increase in flows by 30%. The modelled flood extents are shown in Figure 4-5 and Figure 4-6.

An increase in flood extents can be seen under the MRFS climate change scenario, and again under the HEFS climate change scenario; however, the site is located outside these extents. The MRFS and HEFS flood extents inundate the open green space south of the site.

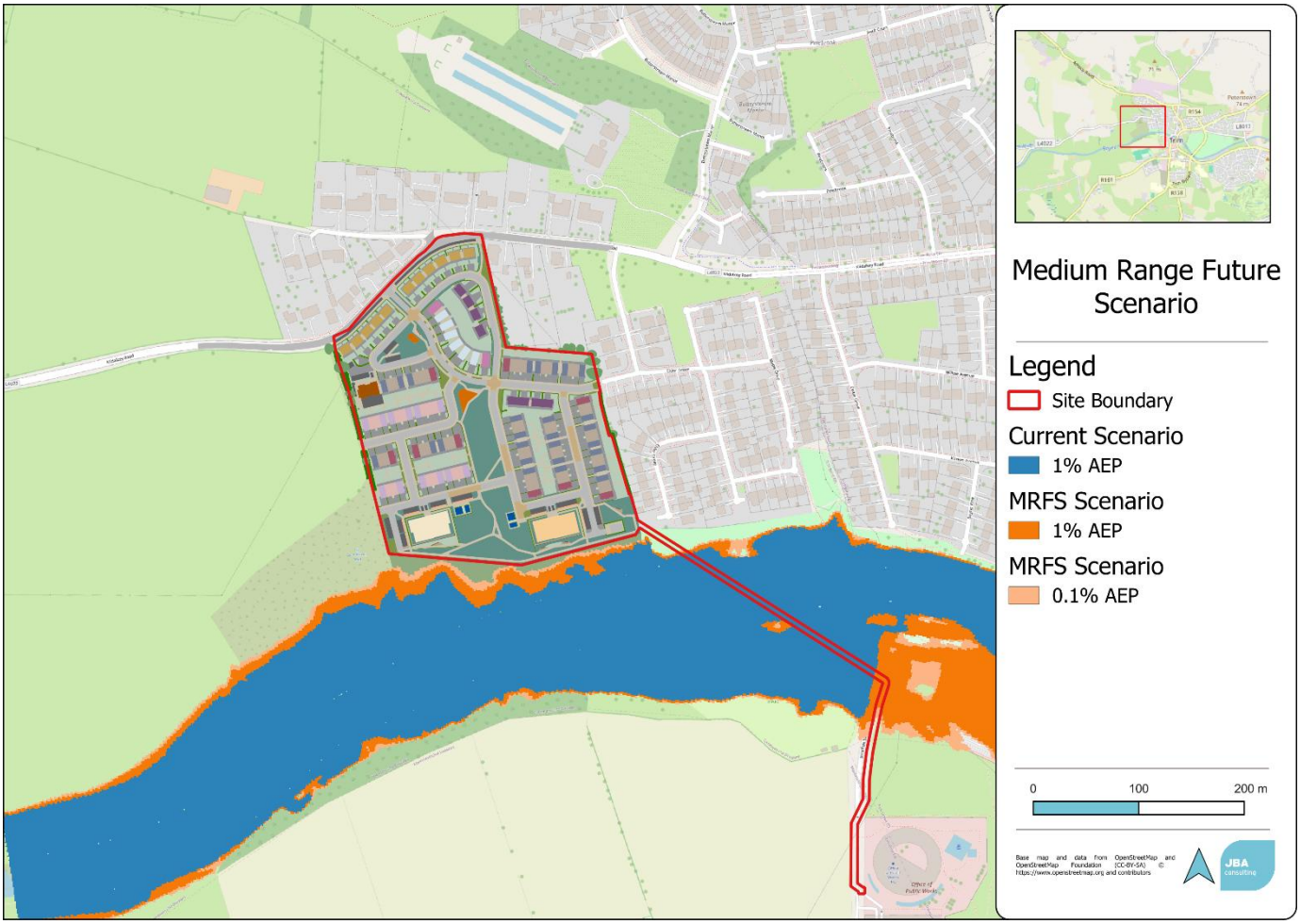


Figure 4-5: MRFS Flood Extents

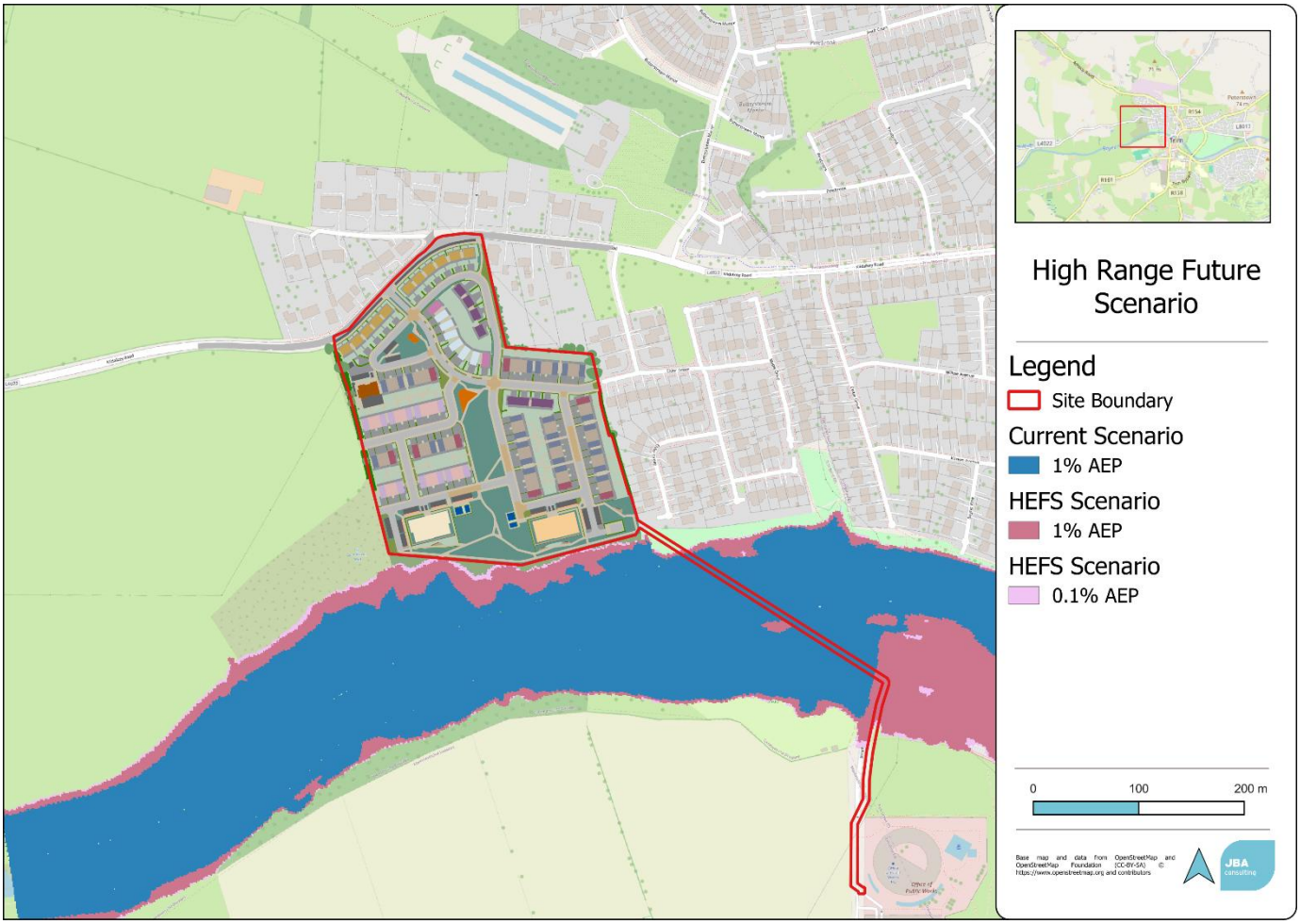


Figure 4-6: HEFS Flood Extent

4.2.4 Comparison with the CFRAM Study

A comparison was completed between the JBA model and the CFRAM model. The flows and water levels are shown in Table 4-3 below and the flood extents are shown in Figure 4-7. As seen in the figure, the model results are different to those derived from the less detailed CFRAM model. The flood extents under the High-End Future Scenario (HEFS) were also examined as shown in Figure 4-8.

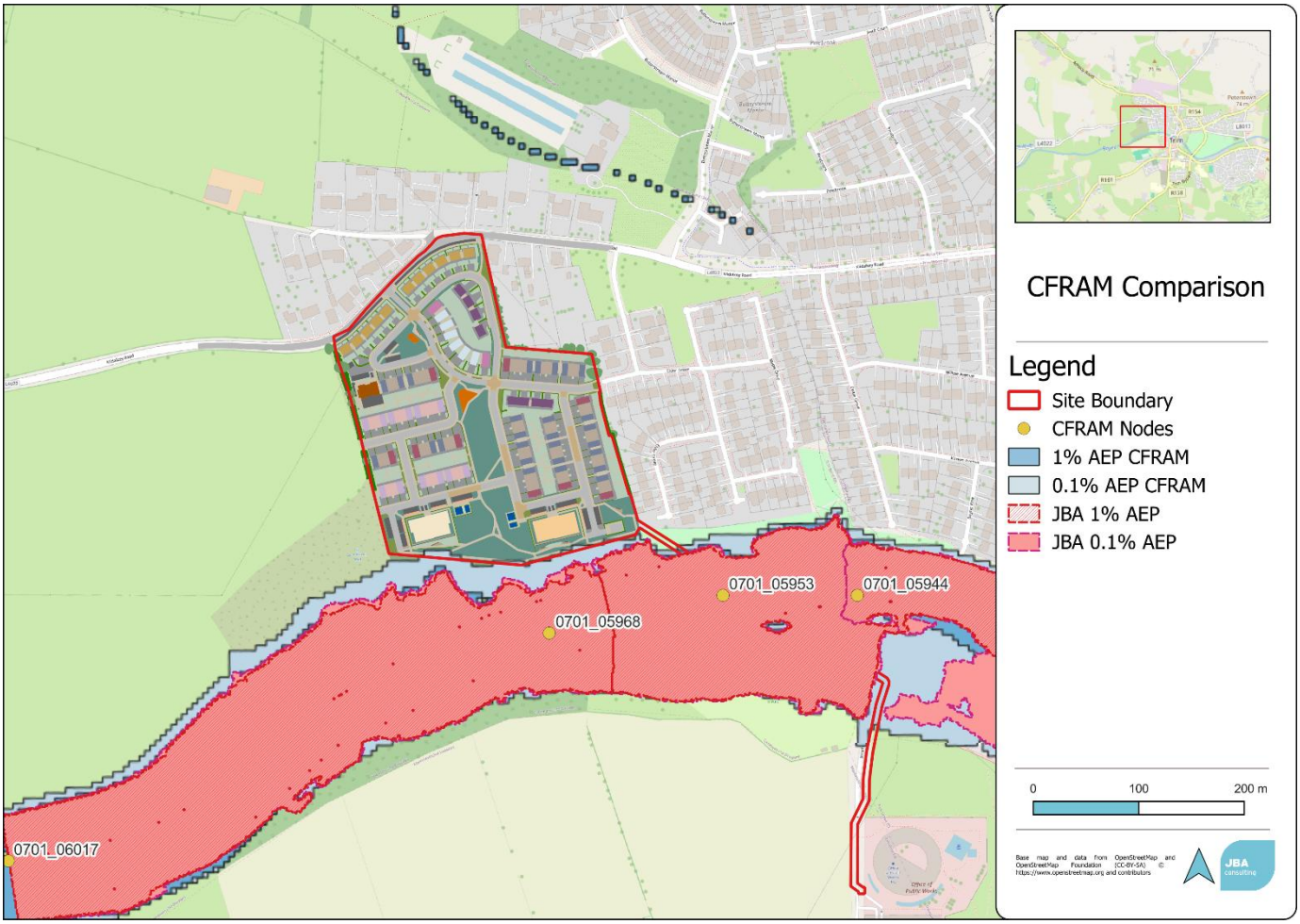


Figure 4-7: CFRAM Flood Extent Comparison

Table 4-3: CFRAM Node Comparison 1% AEP

Node	Water Level (mOD)	
	CFRAM	JBA Model
0710_06017	54.95	54.93
0710_05968	54.62	54.54
07010_05953	54.51	54.44
0710_05944	54.45	54.36
0710_05906	54.00	53.94

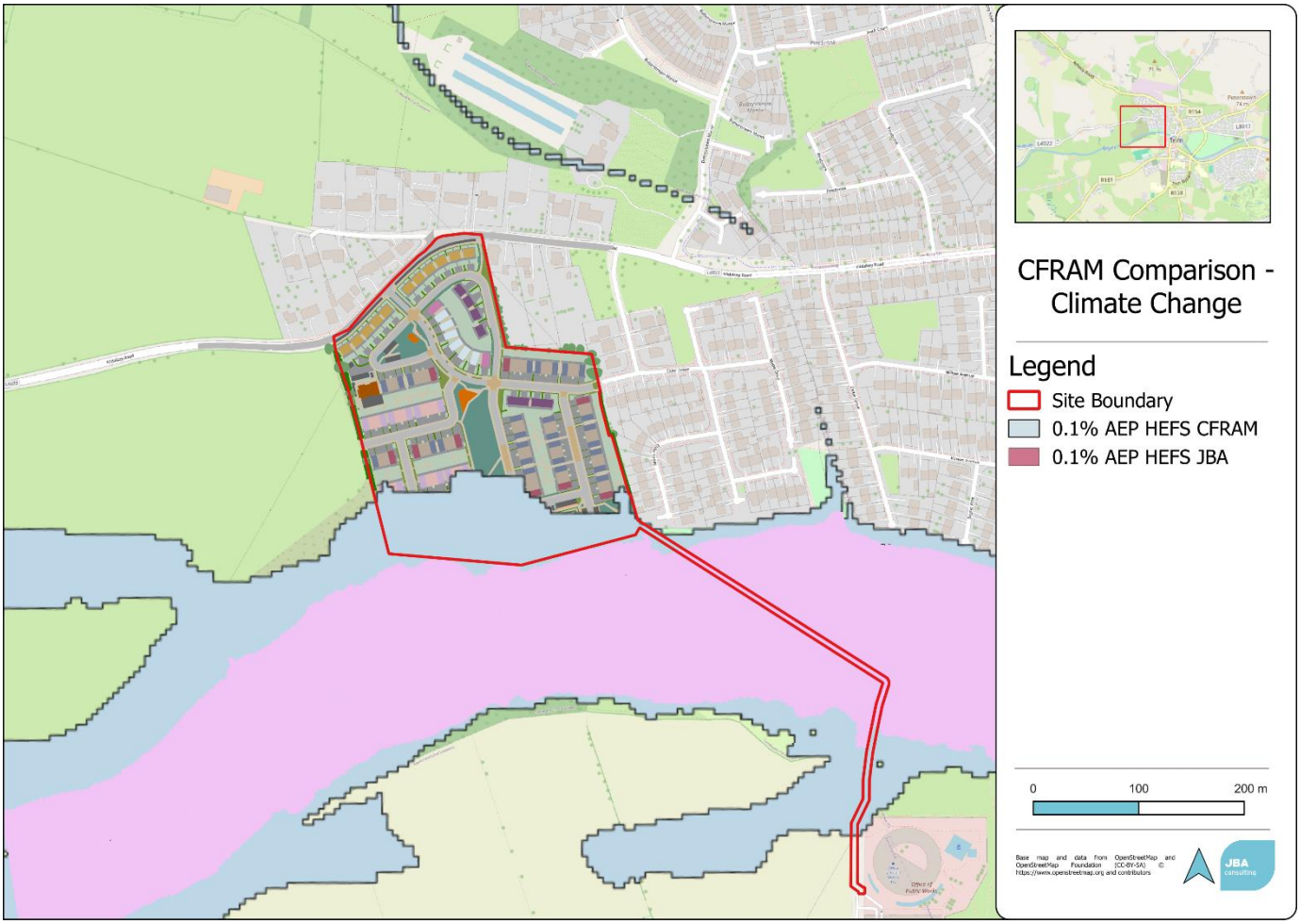


Figure 4-8: Model Comparison - HEFS

The CFRAM represents an over-estimation of flooding in Trim relative to this study. This can be attributed to several factors which are discussed as follows.

1. Structure Representation
2. General modelling units and parameters cannot always fully represent the head loss which can occur at atypical or complex structures. Both the Bridge Street arch bridge location and the pedestrian bridge crossing downstream of the site are shown to be extremely sensitive to the modelling units and have a controlling influence on local water levels. The resulting influences may be expected to cause flooding to local receptors, including the site. Due to the sensitivity of these structures to water levels at the site, the representation of the structures was considered in great detail. The bridge design selected for the arch bridge was based on the new BArch unit which was included in the 2023-02 TUFLOW Release. The approach is based on the 'Afflux at Arch Bridges'[1]. This BArch unit now replaces older methods of representing an arch bridge, such as the Mike 21 unit used in the CFRAM study. The pedestrian bridge upstream was represented

using BB Bridge in Estry, rather than an irregular structure used in the CFRAM study.

3. Grid Size
4. The CFRAM study used a 5m grid size in the 2D domain. The JBA model utilises a 2m grid size. The smaller grid size allows for a more accurate representation of the floodplain and overland flow routes using the LiDAR data, which also has a 2m resolution.
5. Supplementary Topographic Survey and detail
6. In addition to the OPW survey and LiDAR which were used in the CFRAM study, a topographic survey of the local area was provided by the client. This allowed for a more detailed representation of the existing ground levels in the vicinity of the site, and to account for any changes in topography since the CFRAM survey was captured, and for new developments in the area.
7. Flow Estimates
8. The flows used in the model are different to those derived from the simpler CFRAM model. The CFRAM represents an over-estimation of flooding in Trim relative to this study. **This study also utilised a longer gauge record from the Trim gauge**. Further detail on flow is provided in Section 4.1.1.

Each of the factors mentioned above have allowed for a more detailed and accurate representation of the flood mechanism in Trim. The model created for this study supersedes the CFRAM model.

5 Flood Risk Mitigation

5.1 Flood Risk

The main watercourse in the area is the River Boyne. The watercourse to the east of the site is culverted and does not pose a risk to the site. Having reviewed the available sources of flooding information outlined in Section 3, there is a history of flooding in the Trim area, but the site has not previously been subject to flooding. A review of the CFRAM flood extents shows that the site is not subject to flooding during the 1% and 0.1% AEP fluvial events, only the line of the buried foul sewer interacts with Flood Zones A/B. To accurately assess the flood risk at the site, a detailed analysis was required.

Following detailed survey, hydrological assessment and hydraulic modelling of the area, flood extents on the subject site for the 1% and 0.1% AEP flood events were developed. These flood extents indicate that the site is located in Flood Zone C (<0.1% AEP) and at low risk of flooding. The maximum modelled flood event, the 0.1% AEP HEFS, was also assessed. The residential areas remain protected in this scenario. Refer to Figure 5-1.

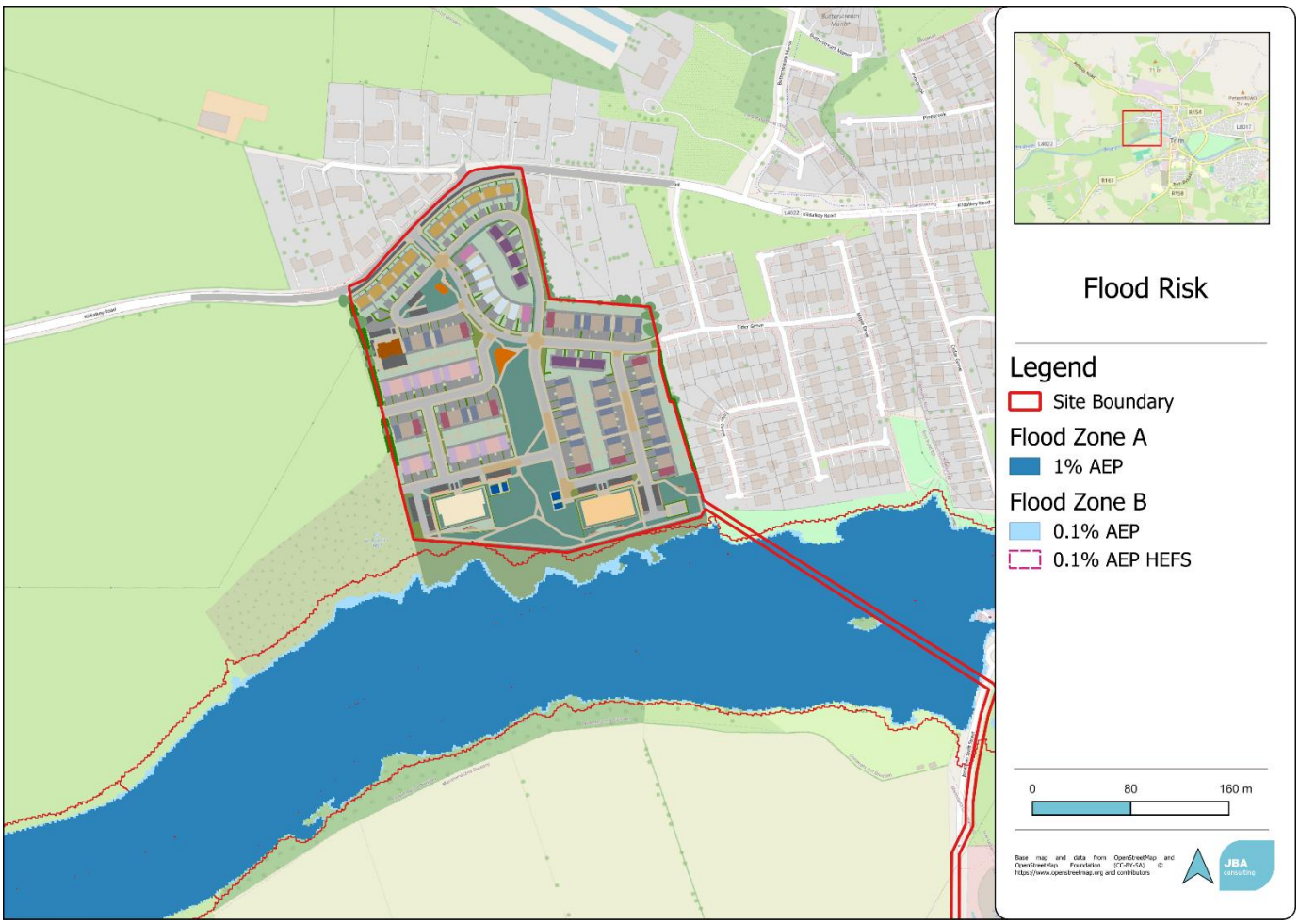


Figure 5-1: Flood Risk

The proposed development has been designed in line with the Sequential Approach where lands in Flood Zone A and B within the site boundary have been left as undeveloped lands. Flood Zone B for the High-End Future Scenario encroaches on lands zoned as F1 - Open Space, and H1 - High Amenity which are water compatible developments. All residential development zoned A2 - New Residential is contained within Flood Zone C in all scenarios assessed.

5.2 Mitigation Measures

5.2.1 Foul Sewer Wayleave

A new foul sewer connection will be constructed connecting from the pumping station within the site boundary (no dig involved) to the existing foul water network adjoining OPW offices on Jonathan Swift Street underneath the River Boyne and Trim Pitch & Putt. All the elements of the pumped line are below ground and will be buried at least 3m below the riverbed itself. The pipe will have no impact on flood risk to the site; refer to Figure 2-1 for the location of the foul sewer wayleave.

5.2.2 Finished Floor Levels (FFLs)

As per the SFRA guidance, the FFLs have all been placed above the 1% AEP Flood level with an allowance for freeboard and climate change. The climate change scenario has been used for setting the FFL for the development. For less vulnerable developments the MRFS has been used plus an allowance for freeboard. For higher vulnerability developments the FFL has been set above the HEFS water levels plus freeboard. The usual required minimum freeboard is 300mm. Due to the slope of the local topography, the peak water levels vary across the site. Water levels decrease as they move downstream (east).

The FFLs of dwellings nearest to the river (and freeboard) are shown in Table 5-1. The proposed finished floor levels for the site are at a minimum approx. 3m higher than the 1% AEP climate change (HEFS) flood level which represents significant freeboard allowance.

Table 5-1: Proposed Freeboard

Model Node	HEFS 1% AEP Water Level (mOD)	Finished Floor Level (mOD)	Freeboard (m)
0701_05958	55.14	59.90	4.76
0701_05963	55.16	59.15	3.99
0701_05968	55.17	59.15	3.98
0701_05973	55.20	59.15	3.95
0701_05978	55.22	58.90	3.68
0701_05983	55.25	58.90	3.65
0701_05988	55.27	58.60	3.33

5.2.3 Access and Egress

Access to the site is possible in the 1% and 0.1% AEP events along Kildalkey Road. Vehicular and pedestrian access can be maintained through the wider residential development during 1% and 0.1% AEP events.

5.2.4 Surface Water Design

A surface water infrastructure strategy has been developed for the site. The surface water strategy for the proposed development incorporates a high level of treatment from Sustainable Urban Drainage features. As per the MCDP, INF OBJ 15 requires "the use of SuDS in accordance with the Greater Dublin Regional Code of Practice for Drainage Works for new developments (including extensions)".

The management train will form a key component of the surface water design for the proposed site, with a focus on rainwater source control. Coordination with the Landscape Architect and Architect will ensure an integrated approach. The proposed strategy for surface water drainage includes the following elements:

- Permeable Paving: Used in all parking areas. Surface water runoff from roof areas, roads and footpaths will be directed through the sub-base of the permeable paving.
- Linear Swales: Incorporated in open spaces where ground topography allows.
- Soakaways: Designed to attenuate excess surface water runoff from the development and allow for infiltration in lieu of surface water runoff exiting the site

The surface water drainage for the development has been designed with individual soakaways for each house unit and surface water from the public areas will be divided into four catchments, each discharging via gravity into separate underground soakaways. The proposed houses in the north will drain into the soakaway located at the centre of the site. Part of the proposed houses in the centre will drain into the soakaway to the south. The apartment block in the southwest will drain into the southwest soakaway, and the apartment block in the southeast will drain into the southeast soakaway.

The proposed houses in the north will drain into the surface water network and outfall to a soakaway located at the centre of the site. Refer to the engineer's report for further information.

5.2.5 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 source of residual risk to the proposed development:

- Failure of on-site surface water attenuation/infiltration system
- Bridge Blockage

In the event of a failure in the on-site surface water attenuation/infiltration system, overland flow would generally be directed towards the undeveloped area to the south of the site without accumulating in any low points throughout the site. Some runoff at the west of the site would flow towards undeveloped lands to the west of the proposed development.

The R161 Bridge downstream of the site comprises 4 arches, each with a maximum width of approximately 5.19m. Although there is no history of blockage of this structure, due to its location, the effects of blockage were investigated. Watergate Street Bridge was not assessed since it is a single span more recent design and does not represent a significant blockage risk.

For the R161 Bridge two scenarios were tested, a 33% blockage and a 66% blockage. The 66% blockage is considered to be an extreme and unlikely scenario, given there is little vegetation near the structure that could provide debris to the channel and there is no record of any blockage occurring at this structure.

The 33% blockage scenario, while still unlikely, represents a more realistic risk. Flooding occurs as a result of blockage; however, it is confined to the open Space/High Amenity area south of the site and not within the redline boundary. The bridge is shown in Figure 5-2 below. The 33% blockage scenario flood risk map is presented in Figure 5-3 below.

Figure 5-2 - R161 Old bridge - Blockage Test (CFRAM Survey)

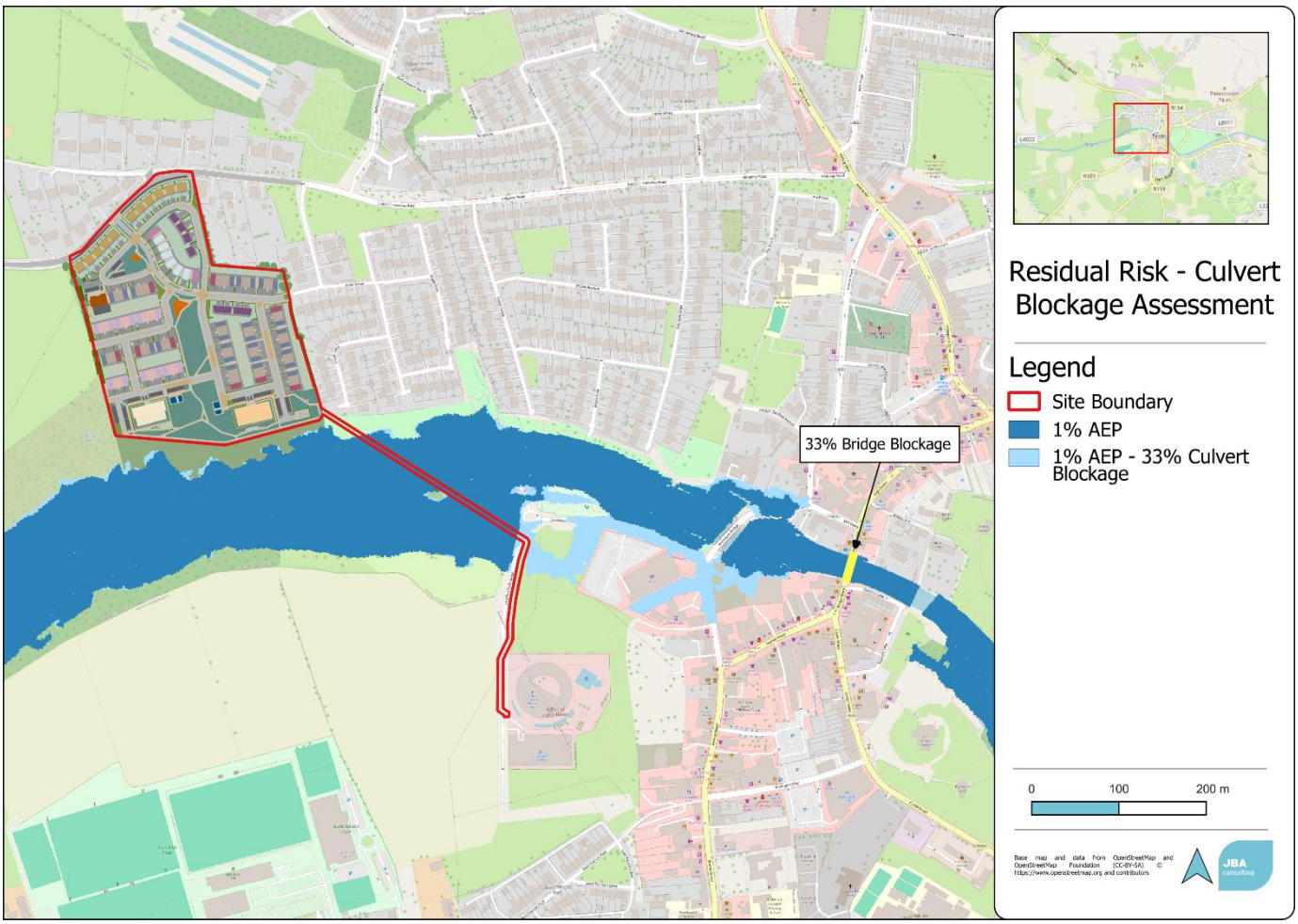


Figure 5-3 - Residual risk - Bridge Blockage

6 Justification Test

6.1 Strategy

The planning guidance appropriate to this development is, "The Planning System and Flood Risk Management" and sets out a framework within which the planning authority should consider proposals for new development in areas of flood risk. This framework is called the Justification Test for Development Management.

Since the proposed development is considered as vulnerable to the impacts of flooding and within the red line boundary there is Flood Zone A/B, a Justification Test (JT) must be applied and passed to satisfy the Guidelines. It is noted that the only part of the red line boundary that extends into Flood Zone A/B is the foul connection under the River Boyne, all other built development is in Flood Zone C.

In the following text, each of the criteria within the JT is responded to as they relate to the proposed development. For ease of reading, where the responses are supported by technical detail, which is contained in later parts of the report, an appropriate chapter has been referenced.

6.2 Justification Test Part 1

The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of the planning guidelines.

The Meath County Development Plan 2021-2027 and the accompanying SFRA which reviewed the zoning, has designated a 'New Residential' zoning to the proposed site. This denotes the intention "to provide for new residential communities with ancillary community facilities, neighbourhood facilities and employment uses as considered appropriate for the status of the centre in the Settlement Hierarchy".

The site is zoned predominantly as New Residential - A2 (yellow). The Open Space and High Amenity lands south of the site will be retained.

Conclusion: The Meath County Development Plan and SFRA, zoned the site as 'New Residential' and is in accordance with the Planning Guidelines.

6.3 Justification Test: Part 2

The proposal has been subject to an appropriate flood risk assessment that demonstrates:

(i) the development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;

The planned residential development phases are located in Flood Zone C and areas within the site boundary designated as Flood Zone A/B relate to the foul connection under the River Boyne - which is buried below ground and will not result in any changes to existing ground levels. All rainwater will be incorporated into a stormwater management system to retain surface water onsite which is discharged to groundwater and will not increase flood risk elsewhere.

ii) the development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;

The proposed FFL of all buildings on site will be raised above the 1% AEP + HEFS event with a 300mm freeboard to minimise the flood risk. All access routes are located in Flood Zone C and therefore above the 0.1% AEP event. An appropriately designed stormwater system discharges to groundwater - details under separate cover.

(iii) The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access.

Flood risk to properties on site has been minimised by setting the proposed FFLs above the 1% AEP plus climate change flood level plus a freeboard of circa 3m. The proposed development will therefore be protected against the potential impacts of climate change. Stormwater exceedance is also managed appropriately.

(iv) The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.

Refer to the accompanying planning application, design documentation and engineers report in relation to good urban design.

7 Conclusions

JBA Consulting was appointed by Loughglynn Developments to prepare a site-specific Flood Risk Assessment (FRA) for the proposed development of a site located in Trim, Co. Meath.

Having reviewed the available information there is no evidence of historic flooding affecting the site itself, but there is a history of flooding in Trim town. The River Boyne is the nearest potential source of flooding which is located directly south of the site boundary.

A hydraulic model completed for the proposed site confirms that the site is located within Flood Zone C, with only the foul connection being within Flood Zone A/B as it has to pass under the River Boyne, the connection itself is buried and has no negative impacts on the floodplain.

All residential and associated works are located in Flood Zone C. The area south of the site will be retained as Open Space/High Amenity.

Finished Floor Levels have been raised by greater than 3m above the predicted 1% AEP climate change flood level. This ensures that the site will not be impacted by predicted increases in flood flows due to climate change.

A stormwater system has been incorporated into the proposed development to manage pluvial flood risk within the site, details of this are provided under separate cover.

Adopting the above approach will ensure that the areas at risk are sequentially avoided for highly or less vulnerable development, that the floodplain is preserved and that there is no increase in risk elsewhere.

The assessment was undertaken in accordance with 'The Planning System and Flood Risk Management', the Justification Test has been applied and passed and the FRA is in agreement with the core principles contained within.

A Appendices

A.1 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.1.1 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

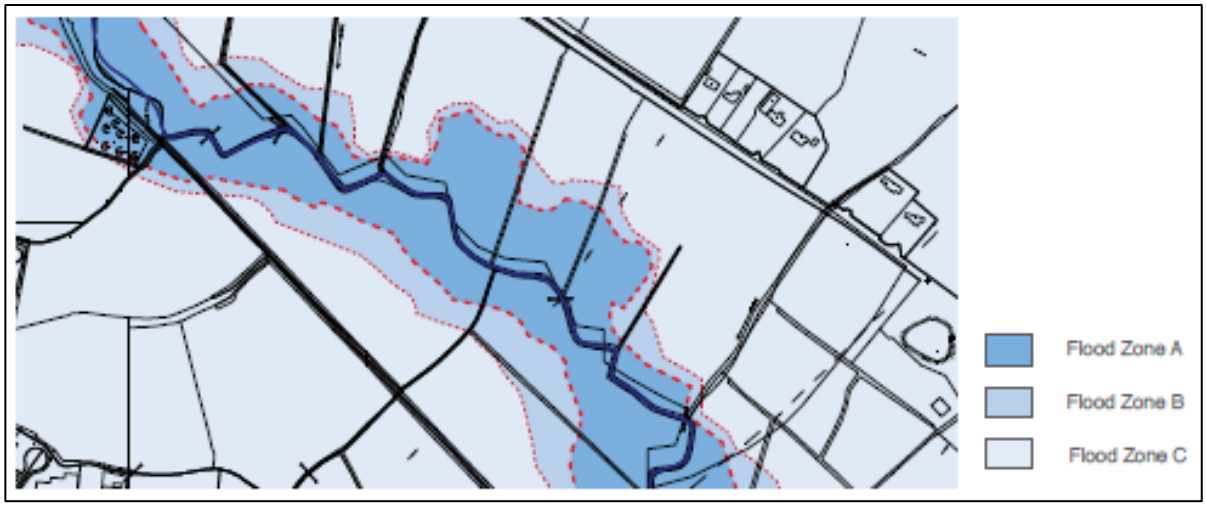
Return period (years)	Annual exceedance probability (%)
2	50
10	10
50	2
100	1
200	0.5
1000	0.1

A.1.2 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.1.3 Consequences of Flooding

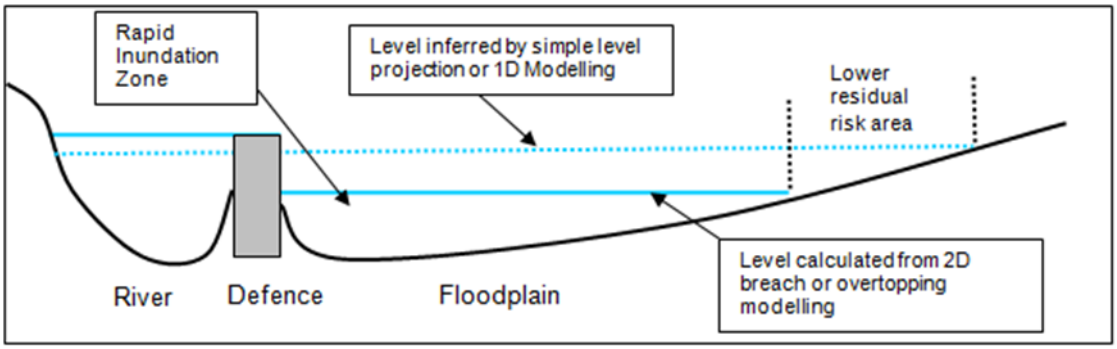
Consequences of flooding depend on the Hazards caused by flooding (depth of water, speed of flow. Rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure of the population, presence and reliability of mitigation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

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

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

A.1.4 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 - LRD Opinion Responses

B.1 5(b)

The Applicant shall confirm that the flooding events which occur currently on or adjacent to the site will not be exacerbated as a result of the proposed development.

The proposed development will not exacerbate existing flooding mechanisms on or adjacent to the site. As outlined in Section 6.3 of the Justification test, the development has been designed such that it will not result in an increase in flood risk elsewhere. The proposed development does not obstruct flow paths, increase flood levels, or displace floodwater, which would adversely affect surrounding areas. Any flooding that could occur, will be confined to the Open Space south of the site.

B.2 5(c)

The Applicant shall submit a detailed assessment of all the existing drainage ditches and watercourses that surround the subject site and the surrounding zoned lands that will confirm catchment areas, flow directions, existing culvert details. A detailed topographical survey of the existing drainage ditches and watercourses shall be carried out and be submitted as part of the planning application.

All drainage ditches and watercourses surrounding the site have been assessed as part of the FRA. Details of the existing watercourses, drainage features and flow directions are presented in Section 2.2 and information related to the proposed sewer wayleave running east from the site is provided in Section 5.2.1 and the **Engineers report** submitted as part of the planning application.

The catchment characteristics have been assessed and detailed as part of the hydrological study in Section 4.1. A detailed survey of the watercourses has been carried out by Murphys in 2012 as part of the CFRAM Study, as well as a detailed topographical study available from the OPW, Refer to Section 4.2.1 for more information**.**

In addition, the proposed drainage strategy and is illustrated on the drainage layout drawings submitted as part of the planning application and prepared by **Waterman Moylan.**

B.3 5(d)

The Applicant shall carry out a thorough assessment on existing watercourses, including hydraulic modelling and blockage scenarios.

A detailed hydraulic assessment of the existing watercourses has been undertaken as part of the FRA. This assessment included the development of a 1D/2D hydraulic model of the River Bounce. The Hydraulic modelling methodology is presented in Section 4.2 of the FRA.

In addition, a residual flood risk has been assessed through a 33% blockage test. As detailed in Section 5.2.5, the 33% blockage scenario was modelled to assess the potential impacts of partial blockage of the old bridge downstream of the site. The resulting flood extents are confined to the Open Space/High Amenity areas south of the site, thus, not affecting the proposed development site.

B.4 5(e)

The Applicant shall assess potential flows from surrounding zoned lands.

The potential contribution of flows from surrounding zoned lands has been assessed as part of the catchment assessment and hydraulic modelling undertaken for the proposed development. The contributing catchment areas and hydrological inputs are described in Section 4 of the FRA. The **drainage layout drawing** submitted as part of the planning application has further detailed how contributing flows from neighbouring lands will not adversely affect the existing drainage patterns.

B.5 5(f)

The flooding consultant shall provide confirmation that the proposed surface water system does not increase flood risk for the proposed development or the surrounding lands.

The proposed surface water drainage system has been designed to not increase flood risk within the proposed development or elsewhere. A summary of the proposed surface water management strategy is provided in Section 5.2.4 of the FRA, which outlines the strategy and elements of the proposed design. Further details of the surface water design are detailed in the Engineers report completed by **Waterman Moylan** submitted as part of the planning application.

B.6 5(g)

Justification Test to be applied to the proposed development.

A Justification Test has been undertaken for the proposed development in accordance with the requirements of the *Planning System and flood risk Management Guidelines for Planning Authorities (2009).* The Justification test is presented in Section 6 of the FRA. The assessment confirms that the proposed development satisfies the criteria of the Justification Test.

B.7 5(h)

Detailed overland flow plans to be provided for assessment.

The management of overland flow routing has been assessed in Section 5.2.5 of the FRA. This assessment demonstrates that, overland flow will generally be directed towards the undeveloped Open Space lands south of the site and any runoff from the western section of the site will naturally discharge toward lands west of the site. Refer to the surface water drainage layout completed by **Waterman Moylan** and submitted as part of the planning application.

B.8 5(i)

The Applicant shall submit an SSFRA to address the above-mentioned issues

The issues discussed above have all been detailed as part of the SSFRA and/or accompanying Engineers reports.

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