Waterman Moylan
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Flood Risk Assessment

Proposed Strategic Housing Development at Belcamp, Dublin 17

April 2022

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This document has been prepared and checked in accordance with
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Comments

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1. Introduction

This Flood Risk Assessment has been prepared by Waterman Moylan as part of the documentation in support of proposed Strategic Housing Development (SHD) planning submission in Belcamp, Dublin 17.

This Flood Risk Assessment has been carried out in accordance with the *DEHLG/OPW Guidelines on the Planning Process and Flood Risk Management* published in November 2009. This assessment identifies the risk of flooding at the site from various sources and sets out possible mitigation measures against the potential risks of flooding. Sources of possible flooding include coastal, fluvial, pluvial (direct heavy rain), groundwater and human/mechanical errors. This report provides an assessment of the subject site for flood risk purposes only.

1.1 Site Description

The Belcamp lands are located centrally in the Dublin Fringe area, north of the Northern Cross Route, R139, to the east of the IDA lands, and to the west of the Malahide Road (R107). The total site area is c.67.2 hectares.

The subject site is bounded to the north and west by agricultural lands, to the south by the R139 Regional Road and to the east by an existing mixed-use development, by Phase 1 of the Belcamp development, which is currently under construction by the Applicant, and by the Malahide Road (R107).

The Mayne River flows from west to east through the site. The northern portion of the subject site is within Fingal County Council's jurisdiction, while the southern portion of the site is within Dublin City Council's jurisdiction, with the Mayne River forming the border between the two Local Authorities.

The site location is shown in the Figure below:

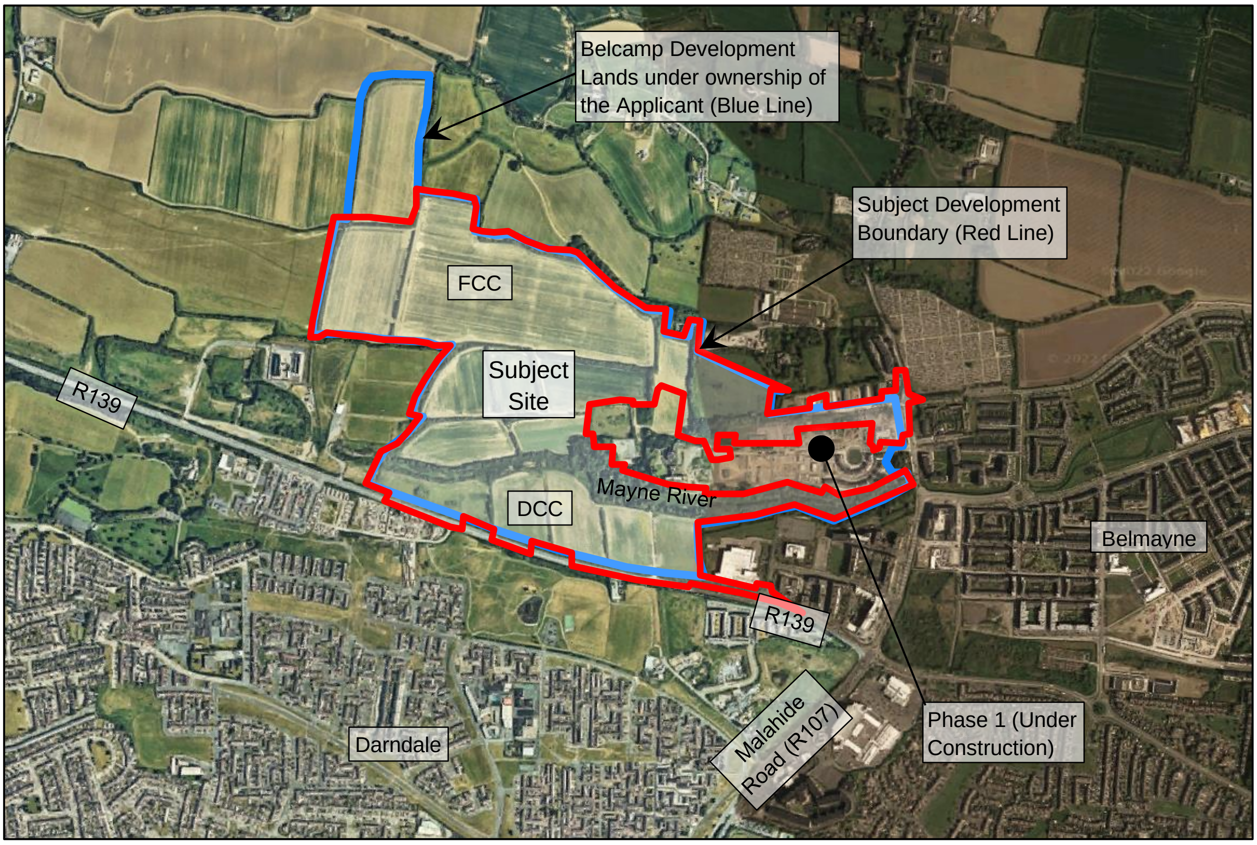

Figure 1 | *Site Location (Source: Google Maps)*

Topographic survey data shows that the southern portion of the site falls generally from south-west to north-east, towards the Mayne River, with a high point of c.35.5m OD Malin at the south-west of the site and a low point of c.26.5m OD Malin at the north-east of the main development area. The strip of land proposed as a greenway continues to fall to a low point of c.17m OD Malin close to the Malahide Road.

The northern portion of the site falls generally from north-west to south-east towards the Mayne River, though some of the lands at the north-east of the site fall to the north-east, away from the river and towards a ditch and culvert at the north-eastern boundary of the site.

1.2 Proposed Development

The proposed development comprises a total of 473 houses, 274 duplexes and 1,780 apartment units in 18 no. blocks, all on a c.67.2 Ha site, as set out in the Table below:

	Description	1-Bed	2-Bed	3-Bed	4-Bed	Total Residential	Commercial Space
Dublin City Council	Block 1	94	139	40	-	273	-
	Block 2	71	73	16	-	160	-
	Block 3	96	176	25	-	297	925.8m² (Café/Retail and Childcare)
	Block 4	70	178	37	-	285	-
	Block 5	37	51	8	-	96	-
	Block 6	19	80	20	-	119	-
	DCC Subtotal	***387***	***697***	***146***	***0***	***1,230***	***925.8m²***
Fingal County Council	Houses	-	16	385	72	473	-
	Duplexes	24	40	210	-	274	-
	Block A	8	15	-	-	23	-
	Block B	8	15	-	-	23	-
	Block C	7	20	-	-	27	-
	Block D	22	15	5	-	42	1,020.5m² Pub/Restaurant & Retail
	Block F	44	56	3	-	103	1,162.0m² Café/Bar/Restaurant & Retail
	Block G	29	36	-	-	65	140.0m² Retail
	Block H	20	26	-	-	46	-
	Block J	16	24	-	-	40	472.0m² Retail
	Block L	20	26	-	-	46	-
	Block M	24	32	-	-	56	-
	Block N	26	25	5	-	56	-
	Block P	5	18	-	-	23	-
	Crèche	-	-	-	-	-	606.7m² Childcare
	Clubhouse	-	-	-	-	-	97.0m² Changing Rooms
	FCC Subtotal	***253***	***364***	***608***	***72***	***1,297***	***3,498.2m²***
TOTAL		**640**	**1,061**	**754**	**72**	**2,527**	**4,424.0m²**

Table 1 | *Schedule of Accommodation*

All of the proposed houses/duplexes are in the northern portion of the site, within Fingal County Council, and there are 550 apartment units proposed in this portion of the site, with 1,230 apartment units proposed in the southern portion of the site, within Dublin City Council.

The eastern portion of the site, between the Mayne River to the north and existing development to the south, is proposed to be used as a greenway. It will serve as a connection for pedestrians and cyclists between the subject site and the Malahide Road (R107).

There is a large open space proposed at the north-west of the site, in addition to several smaller open spaces throughout the development.

1.3 Guidelines and Resources

The Department of Environment, Heritage and Local Government (DEHLG) and the Office of Public Works (OPW) published the adopted version of the document “The Planning System and Flood Risk Management Guidelines for Planning Authorities” in November 2009.

These Guidelines provide guidance on flood risk and development. A precautionary approach is recommended when considering flood risk management in the planning system. The core principle of the guidelines is to adopt a risk-based sequential approach to managing flood risk and to avoid development in areas that are at risk. The sequential approach is based on the identification of flood zones for river and coastal flooding.

This approach is based on the identification of flood zones for river and coastal flooding. “Flood Zones” are geographical areas used to identify areas at various levels of flood risk. There are three flood zones defined:

- Flood Zone A: (high probability of flooding) is for lands where the probability of flooding is greatest (greater than 1% or 1 in 100 for river flooding and 0.5% or 1 in 200 for coastal flooding).
- Flood Zone B: (moderate probability of flooding) refers to lands where the probability of flooding is moderate (between 0.1% or 1 in 1,000 and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 and 0.5% or 1 in 200 for coastal flooding).
- Flood Zone C: (low probability of flooding) refers to lands where the probability of flooding is low (less than 0.1% or 1 in 1000 for both river and coastal flooding).

Once a flood zone has been identified, the guidelines set out the different types of development appropriate to each zone. Exceptions to the restriction of development due to potential flood risks are provided for through the use of the Justification Test, where the planning need and the sustainable management of flood risk to an acceptable level must be demonstrated. This recognises that there will be a need for future development in existing towns and urban centres that lie within flood risk zones, and that the avoidance of all future development in these areas would be unsustainable.

Planning Authorities are required to introduce flood risk assessment as an integral and leading element of their development planning functions. Volume 7 of the Dublin City Development Plan 2016-2022 provides a Strategic Flood Risk Assessment for the area. A Strategic Flood Risk Assessment was also prepared as part of the Fingal Development Plan 2017-2023. Both of these SFRAs were prepared and informed by the DEHLG/OPW 2009 Guidelines for Planning Authorities.

The following guidelines and resources were referred to in preparing this flood risk assessment:

- The Planning System and Flood Risk Management Guidelines for Planning Authorities, 2009 (DEHLG/OPW)
- Dublin City Development Plan 2016-2022, Volume 7: Strategic Flood Risk Assessment
- Strategic Flood Risk Assessment for the Fingal Development Plan 2017-2023

- Fingal East Meath Flood Risk Assessment and Management Study (FEMFRAMS)
- The OPW's National Flood Hazard Map
- Geological Survey Ireland (GSI) datasets

1.4 Assessment Methodology

This Flood Risk Assessment report follows the guidelines set out in the Guidelines on the Planning Process and Flood Risk Management. The components to be considered in the identification and assessment of flood risk are as per Table A1 of the above guidelines:

- Tidal – flooding from high sea levels
- Fluvial – flooding from water courses
- Pluvial – flooding from rainfall / surface water
- Groundwater – flooding from springs / raised groundwater
- Human/mechanical error – flooding due to human or mechanical error

Each component will be investigated from a Source, Pathway and Receptor perspective, followed by an assessment of the likelihood of a flood occurring and the possible consequences.

1.4.1 Assessing Likelihood

The likelihood of flooding falls into three categories of low, moderate and high, which are described in the OPW Guidelines as follows:

Flood Risk Components	**Likelihood: % chance of occurring in a year**		
	Low	***Moderate***	***High***
Tidal	*Probability < 0.1%*	*0.5% > Probability > 0.1%*	*Probability > 0.5%*
Fluvial	*Probability < 0.1%*	*1% > Probability > 0.1%*	*Probability > 1%*
Pluvial	*Probability < 0.1%*	*1% > Probability > 0.1%*	*Probability > 1%*

Table 2 | *From Table A1 of "DEHLG/OPW Guidelines on the Planning Process and Flood Management"*

For groundwater and human/mechanical error, the limits of probability are not defined and therefore professional judgment is used. However, the likelihood of flooding is still categorized as low, moderate and high for these components.

From consideration of the likelihoods and the possible consequences a risk is evaluated. Should such a risk exist, mitigation measures will be explored, and the residual risks assessed.

1.4.2 Assessing Consequence

There is not a defined method used to quantify a value for the consequences of a flooding event. Therefore, in order to determine a value for the consequences of a flooding event, the elements likely to be adversely affected by such flooding will be assessed, with the likely damage being stated, and professional judgement will be used in order to determine a value for consequences. Consequences will also be categorized as low, moderate, and high.

1.4.3 Assessing Risk

Based on the determined 'likelihood' and 'consequences' values of a flood event, the following 3x3 Risk Matrix will then be referenced to determine the overall risk of a flood event.

		Consequences		
		Low	***Moderate***	***High***
Likelihood	**Low**	*Extremely Low Risk*	*Low Risk*	*Moderate Risk*
	Moderate	*Low Risk*	*Moderate Risk*	*High Risk*
	High	*Moderate Risk*	*High Risk*	*Extremely High Risk*

***Table 3* |** *3x3 Risk Matrix*

2. Sequential Test

2.1 General

A sequential approach to planning is a key tool in ensuring that a development, particularly any new development, is first and foremost directed towards land that is at low risk of flooding. The sequential approach is set out in "The Planning System and Flood Risk Management Guidelines for Planning Authorities, 2009" and is referred to in the Dublin City Council Development Plan 2016-2022, Volume 7: Strategic Flood Risk Assessment (SFRA) and in the Strategic Flood Risk Assessment for the Fingal Development Plan 2017-2023. The sequential approach is illustrated in the Figure below:

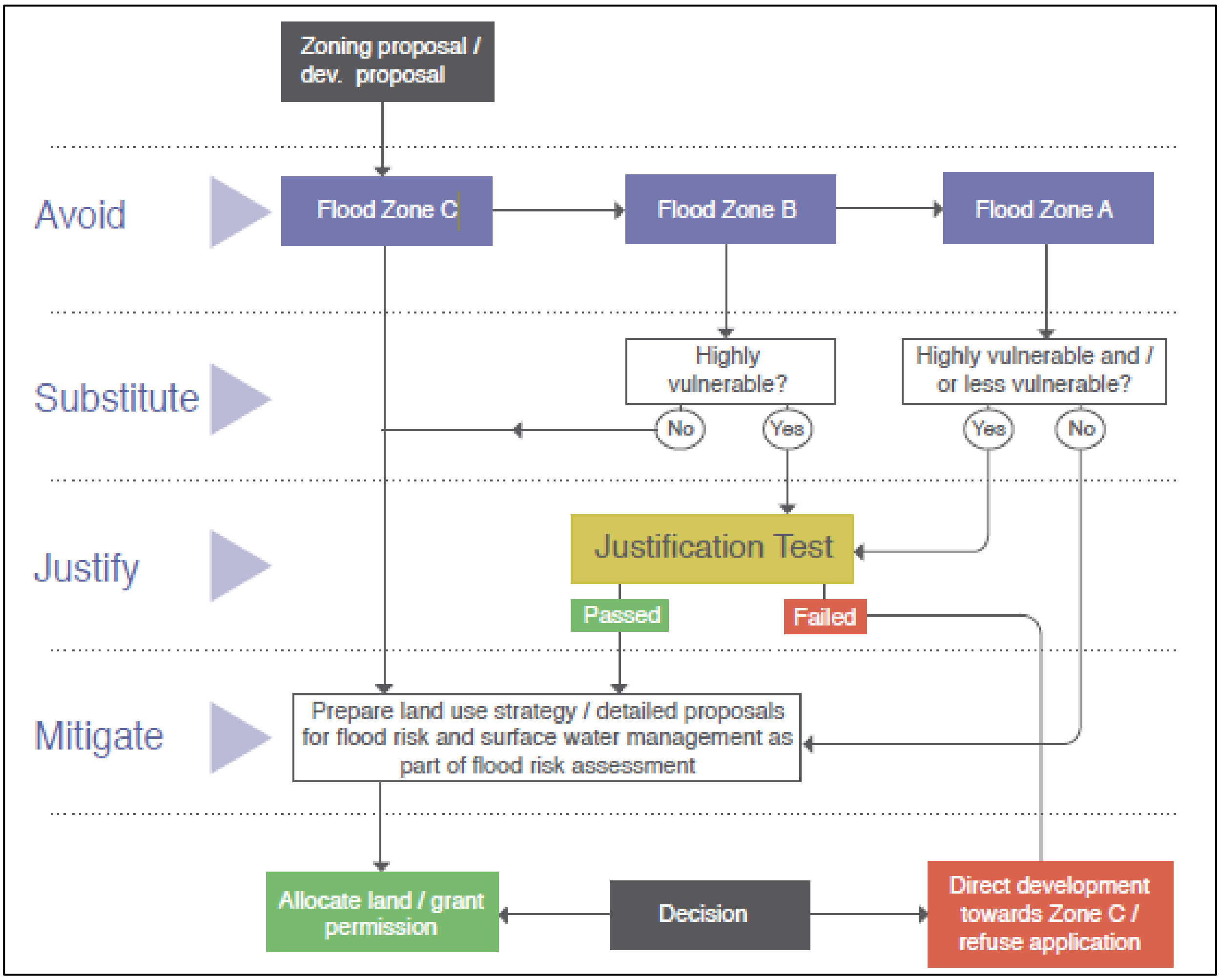

Figure 2 | *Sequential Approach (Extract from Dublin City Council Development Plan 2016-2022 SFRA)*

2.2 Establish Flood Zone

The first step of the sequential test is to establish the flood zone within which the site lies.

The majority of the subject site is in Flood Zone C, as it is outside the 1-in-1,000-year flood zone for both tidal and fluvial flooding. However, the Mayne River traverses the site, and there is a small area along the northern and southern banks that is defined as a fluvial flood zone, as shown in the Figure below:

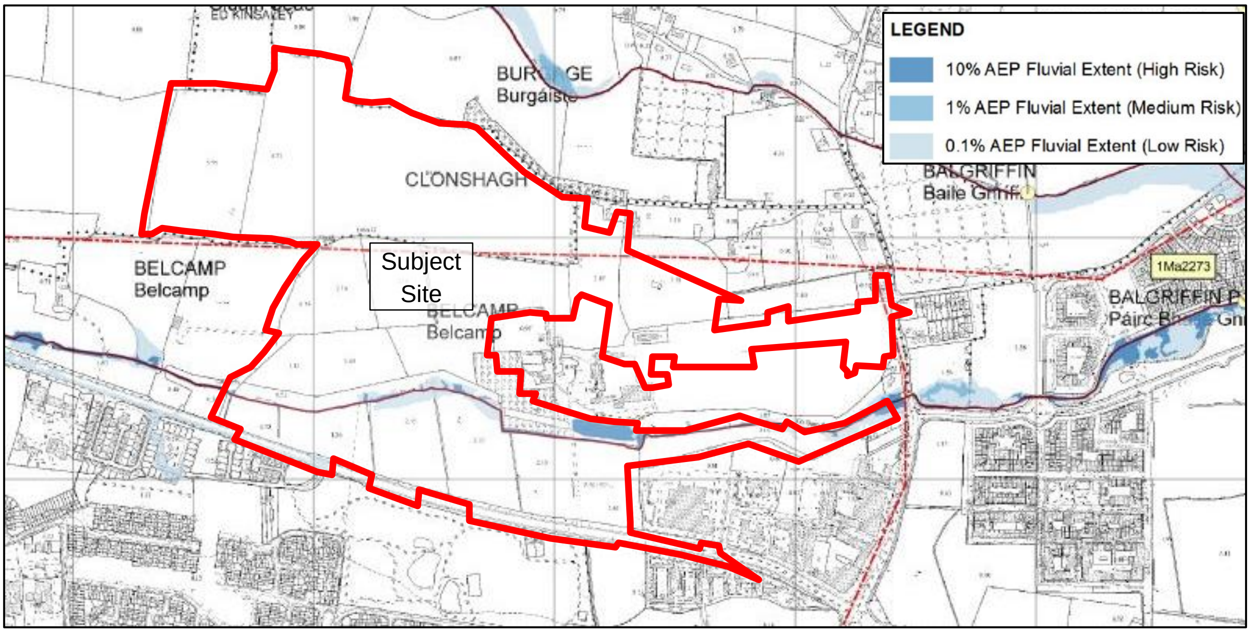

Figure 3 *| Extract from the FEM FRAMS Fluvial Flood Extents Map (Ref: e09bel_exfcd_f1_42)*

A structure-free riparian corridor of 25m has been provided each side of the Mayne River, with only paths and culverts proposed within this envelope. In most places a more generous corridor is provided, exceeding 25m either side of the bank edge, and a minimum of 25m either side of the river centreline is provided throughout.

Figure 4 *| Proposed Riparian Corridor*

2.3 Establish Vulnerability Class

The next step is to establish the vulnerability class of the proposal. The Table below, taken from the OPW's "Planning and Flood Risk Management Guidelines for Planning Authorities, 2009" document, lists the vulnerability classes assigned to various land uses and types of development:

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

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

Table 4 | *Vulnerability Classification of Different Types of Development*

The proposed development comprises construction of residential dwellings, including apartments, duplexes and houses, and commercial units including childcare facilities, retail, and bar/café/restaurant units.

The Table below outlines the matrix of vulnerability based on the Flood Zone:

Description	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less vulnerable development	Justification Test	Appropriate	Appropriate
Water-compatible development	Appropriate	Appropriate	Appropriate

Table 5 **|** *Vulnerability Matrix*

Although residential development is classified as highly vulnerable and commercial elements are classified as less vulnerable, the proposed riparian corridor ensures that all of the vulnerable development is within Flood Zone C. No essential infrastructure is proposed within the fluvial flood zone; Belcamp Parkway is proposed to be bridged over the flood zone well above the 1-in-10-year flood level.

Given that the vast majority of the site is within Flood Zone C, and given that a riparian corridor is proposed along those areas in Flood Zones A and B with no development proposed in these areas, no justification test is required for the development.

3. Tidal

3.1 Source

Tidal flooding occurs when normally dry, low-lying land is flooded by seawater. The extent of tidal flooding is a function of the elevation inland flood waters penetrate, which is controlled by the topography of the coastal land exposed to flooding.

3.2 Pathway

The site is approximately 3.3km west of the nearest coastline at Baldoyle Bay. The Dublin Coastal Protection Project indicated that the 2002 high tide event reached 2.95m OD Malin. The lowest existing ground level on the site is 17.80m OD Malin, well above the historic high tide event.

The Fingal East Meath Flood Risk Assessment and Management Study (FEM FRAMS) maps available on the OPW's National Flood Information Portal have been consulted as part of this assessment. These maps include tidal flood mapping, which outlines existing and potential flood hazard and risk areas which are being incorporated into a Flood Risk Management Plan. The site location, as indicated by the red x as per the extract in *Figure 2* below, shows that the site is not at risk from flooding for even up to the 1-in-1,000 year tidal flood event.

***Figure 5** | Extract from the FEM FRAMS Tidal Flood Extents Map*

High probability flood events, as shown in the above map, are defined as having approximately a 1-in-10 chance of occurring or being exceeded in any given year (10% Annual Exceedance Probability), medium probability flood events are defined as having an AEP of 0.5% (1-in-200 year storm), while low probability events are defined having an AEP of 0.1% (1-in-1,000 year storm). The map indicates that the subject development is not at risk of flooding for the 1-in-1,000 year event.

Given that the site is located 3.3 kilometres inland from the Irish Sea, that there is at least a 14.85m level difference between the lowest existing ground level and the high tide, and given that the site is outside of the 1-in-1,000 year flood plain, it is evident that a pathway does not exist between the source and the receptor. The risk from tidal flooding is therefore extremely low and no flood mitigation measures need to be implemented.

4. Fluvial

4.1 Source

Fluvial flooding occurs when a river's flow exceeds its capacity, typically following excessive rainfall, though it can also result from other causes such as heavy snow melt and ice jams.

4.2 Pathway

The subject site is located within the Mayne River catchment.

Fluvial flood extent maps, developed as part of the Catchment Flood Risk Assessment and Management (CFRAM) Study and made available on the OPW's National Flood Information Portal, have been consulted as part of this assessment. These maps outline existing and potential flood hazard and risk areas which are being incorporated into a Flood Risk Management Plan. An extract of the map is shown in the Figure below:

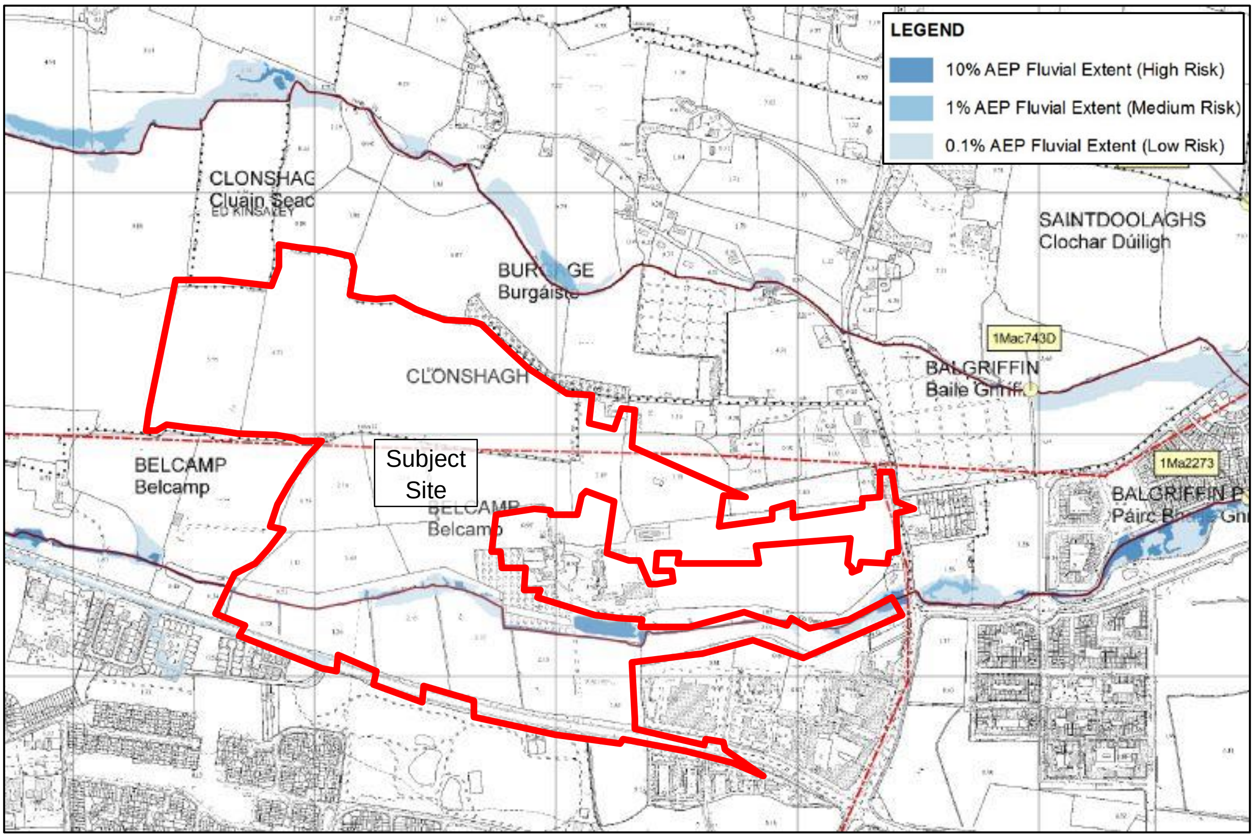

Figure 6 | *Extract from the FEM FRAMS Fluvial Flood Extents Map (Ref: e09bel_exfcd_f1_42)*

The map indicates that small portions of the site along the banks of the Mayne River may be subject to fluvial flooding. However, no development is proposed in the areas of the site within the flood zones, as set out in Section 2 above.

The OPW's National Flood Hazard Map, extracted below, has been consulted to identify recorded instances of flooding in the vicinity of the site. This map indicates that the closest recorded flood event occurred 700m east of the site boundary, downstream along the Mayne River, at Balgriffin Park in June 1993. This flooding was due to heavy rainfall and caused extensive damage to a residential property. The local authority has since placed defence assets to alleviate the issue and no flooding has been recorded since.

Further downstream, at the Mayne River's outfall to Baldoyle Bay, is a location with recurring floods. FCC meeting minutes from December 2005 (Ref: P4D403A-F140-014-004) advise that flooding in this area at Mayne River Bridge is due to the incapacity of the bridge during times of high tides and extreme rainfall events occurring withing the Mayne River Catchment. It further notes that a Flood Relief Scheme was completed in 2001, and no instances of flooding have been recorded at this location since.

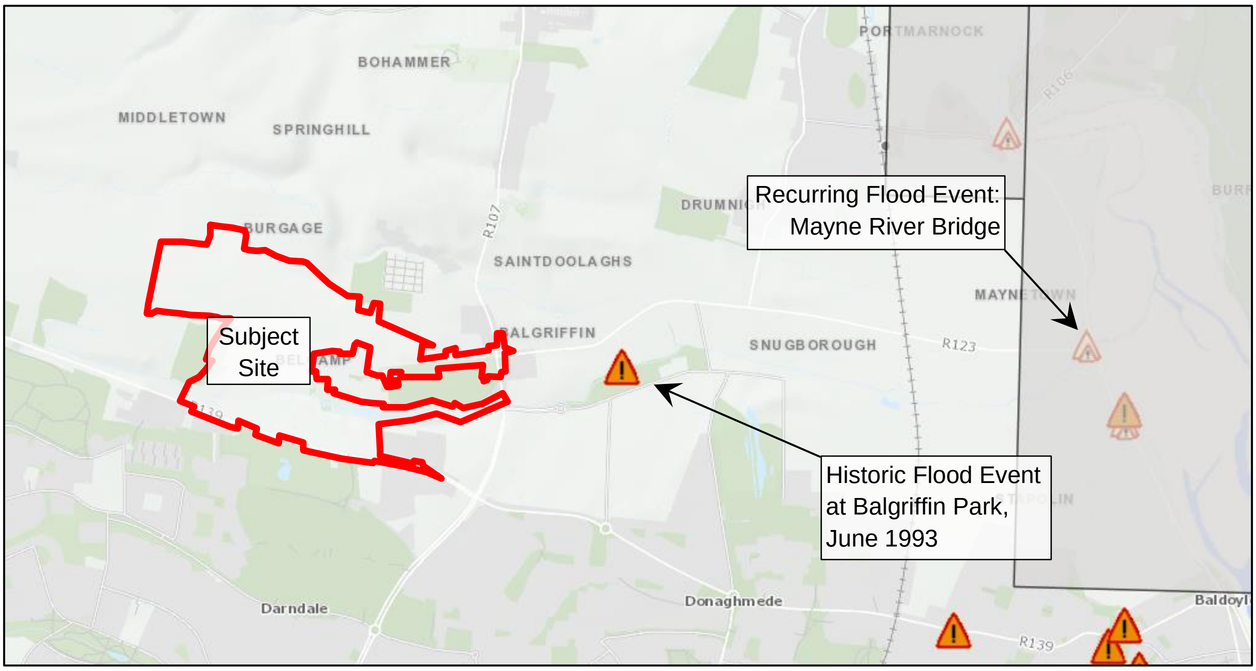

Figure 7 | *Historic Flood Event Map*

4.3 Likelihood

Given that the majority of the site is outside of the 1-in-1,000 year flood plain, that there have been no recorded flood events at the site or in its immediate vicinity, and that no properties are proposed within the small pockets identified as flood plains, the likelihood of fluvial flooding is low.

4.4 Consequence

The consequence of fluvial flooding would be some minor damage to open spaces. Therefore, the consequences of fluvial flooding occurring at the proposed development is considered low.

4.5 Risk

There is an extremely low risk of fluvial flooding as the likelihood is low and the consequence is low.

4.6 Flood Risk Management

The development layout and road level/gradient design have factored in overland flood routing to direct any fluvial flood waters towards open spaces and to the Mayne River, and away from buildings. Finished floor levels (FFLs) for units will be a minimum of 200mm above the adjacent road channel lines.

Refer to accompany for Overland Flood Route drawing, 19-114-P2120.

4.7 Residual Risk

The residual risk of fluvial flooding is considered extremely low.

5. Pluvial

5.1 Source

Pluvial flooding occurs when heavy rainfall creates a flood event independent of an overflowing water body. Pluvial flooding can happen in any urban area, including higher elevation areas that lie above coastal and river floodplains.

5.2 Pathway & Receptors

During periods of extreme prolonged rainfall, pluvial flooding may occur through the following pathways:

	Pathway	Receptor
1	Surcharging of the proposed internal drainage systems during heavy rain events leading to internal flooding	Proposed development – properties and roads
2	Surcharging from the existing surrounding drainage system leading to flooding within the subject site by surcharging surface water pipes	Proposed development – properties and roads
3	Surface water discharging from the subject site to the existing drainage network leading to downstream flooding	Downstream properties and roads
4	Overland flooding from surrounding areas flowing onto the subject site	Proposed development – properties and roads
5	Overland flooding from the subject site flowing onto surrounding areas	Downstream properties and roads

Table 6 | *Pathways and Receptors*

5.3 Likelihood

The likelihood of each of the 5 pathway types are addressed individually as follows:

5.3.1 Surcharging of the proposed on-site drainage systems:

The proposed on-site surface water drainage sewers have been designed to accommodate flows from a 5-year return event, which indicates that on average the internal system may surcharge during rainfall events with a return period in excess of five years. Therefore, the likelihood surcharging of the on-site drainage system is considered high.

5.3.2 Surcharging from the existing surrounding drainage system:

The OPW's National Flood Hazard Maps, as discussed in section 3.2, does not indicate any history of flood events immediately upstream of the subject site (the nearest historic upstream flood was during 2002, west of the M50 and 2.8km away from the subject site at Dardistown).

With no history of flooding in the area due to surcharging, the likelihood of such flooding occurring is considered low.

5.3.3 Surface water discharge from the subject site:

Due to the increase in hard standing area as a result of the proposed development, there is an increased likelihood of surface water discharge from the site leading to downstream flooding. As such, the likelihood can be considered moderate.

5.3.4 Overland flooding from surrounding areas:

With no recorded flood events in the immediate area that could have an impact on the subject site, as per the OPW records referred to above, it is considered that there is a low likelihood of flooding from surrounding areas.

5.3.5 Overland flooding from the subject site:

Due to the increase in hard standing area as a result of the proposed development, there is an increased likelihood of overland flooding from the site leading to downstream flooding. As such, the likelihood can be considered moderate.

5.4 Consequence

Surface water flooding would result in damage to roads and landscaped areas and could impact the ground floor levels of buildings. The consequences of pluvial flooding are considered moderate.

5.5 Risk

The risk of each of the 5 pathway types is addressed individually as follows:

5.5.1 Surcharging of the proposed on-site drainage systems:

With a high likelihood and moderate consequence of flooding the site from surcharging the on-site drainage system, the resultant risk is high.

5.5.2 Surcharging from the existing surrounding drainage system:

With a low likelihood and moderate consequence of flooding the site from the existing surface water network, the resultant risk is low.

5.5.3 Surface water discharge from the subject site:

With a moderate likelihood and moderate consequence of surface water discharge from the subject site, the resultant risk is moderate.

5.5.4 Overland flooding from surrounding areas:

With a low likelihood and moderate consequence of overland flooding from the surrounding areas, the resultant risk is low.

5.5.5 Overland flooding from the subject site:

With a moderate likelihood and moderate consequence of overland flooding from the subject site, the resultant risk is moderate.

5.6 Flood Risk Management

The following are flood risk management strategies proposed to minimise the risk of pluvial flooding for each risk:

5.6.1 Surcharging of the proposed on-site drainage systems:

The risk of flooding is minimised with adequate sizing of the on-site surface water network and SuDS devices. Open grassed areas with low level planting and green sedum roofing on apartment blocks will ensure that these areas act as soft scape and will significantly slow down and reduce the amount of surface water runoff from the site. Permeable paving in private driveways and parking courts and filter drains around the perimeter of the apartment blocks will provide some treatment volume, with underlying perforated pipes connecting to the storm water sewer network.

These proposed source and site control devices will intercept and slow down the rate of runoff from the site to the on-site drainage system, reducing the risk of surcharging.

Furthermore, a hydro-brake for each catchment will limit runoff to the equivalent greenfield rate. Excess storm water from the main catchment is to be attenuated, with sufficient volume for the 1-in-100 year storm (accounting for a 20% increase due to climate change), to limit the runoff from the site and minimise the discharge rate into receiving waters.

5.6.2 Surcharging from the existing surrounding drainage system:

The risk of flooding due to surcharging of the existing surface water network is minimised with overland flood routing (refer to the Overland Flood Routing as discussed in Section 3.6 above) towards the Mayne River and open spaces. The risk to the surrounding buildings is mitigated by setting finished floor levels at least 200mm above the adjacent road channel line.

5.6.3 Surface water discharge from the subject site:

Surface water discharge from the subject site is intercepted and slowed down through the use of source control devices, as described in Section 4.6.1 above, minimising the risk of pluvial flooding from the subject site. Sufficient attenuation storage is provided for the 1-in-100 year storm, accounting for a 20% increase due to climate change. Outflow volumes are limited to existing greenfield levels by use of a Hydrobrake.

5.6.4 Overland flooding from surrounding areas:

Overland flood routing and raised finished floor levels will provide protection for the proposed buildings, as described in Section 4.6.2 above.

5.6.5 Overland flooding from the subject site:

The risk of overland flooding from the subject site is minimised by providing SuDS features to intercept and slow down the rate of runoff from the site to the existing surface water sewer system, as described in Section 4.6.1 above. Sufficient attenuation is provided for the 1-in-100 year storm, accounting for a 20% increase due to climate change. Thus, even under extreme storm conditions, the surface water can be attenuated without causing flooding downstream.

5.7 Residual Risk

As a result of the design measures detailed above in Section 4.6, there is a low residual risk of flooding from each of the surface water risks.

6. Groundwater

6.1 Source

Groundwater flooding occurs when the water table rises above the ground surface. This typically happens during periods with prolonged rainfall which exceeds the natural underground drainage system's capacity.

6.2 Pathway

The pathway for groundwater flooding is from the ground. Note that although groundwater flooding is typically considered to be when the water table rises above the ground surface, basements, underground services and building foundations could also be affected by high water tables that do not reach the ground surface.

6.3 Receptor

The receptors for ground water flooding would be underground services, roads, and the ground floor of buildings.

6.4 Likelihood

Geological Survey Ireland (GSI) produces a wide range of datasets, including groundwater vulnerability mapping. From the GSI groundwater vulnerability map, extracted below, the site lies within an area with low to moderate groundwater vulnerability.

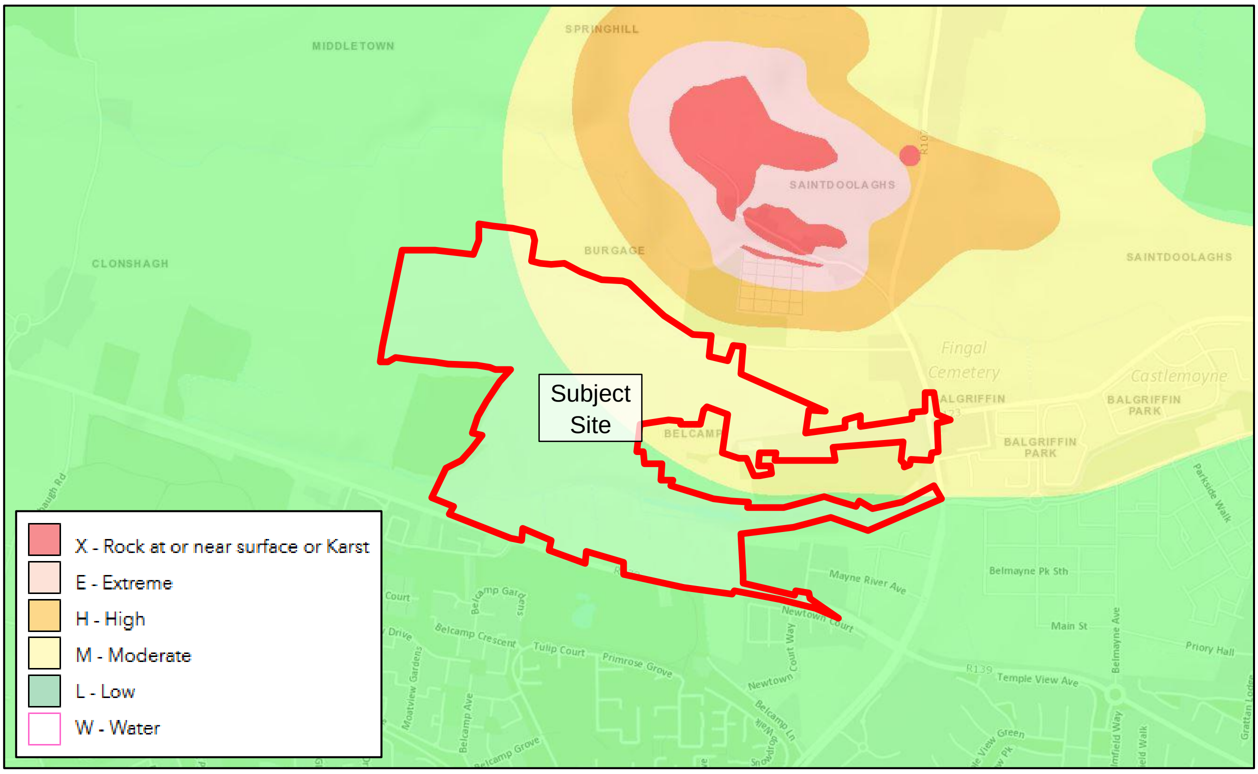

Figure 8 **|** *Extract of Groundwater Vulnerability Map*

With the site falling within an area with low to moderate groundwater vulnerability, the likelihood of groundwater rising through the ground and causing potential flooding on site during prolonged wet periods is moderate.

6.5 Consequence

The consequence of ground water flooding would be some minor temporary seepage of ground water through the ground around the proposed buildings. Underground services could be inundated from high water tables. Therefore, the consequence of ground water flooding occurring at the proposed development is considered moderate.

6.6 Risk

With a moderate likelihood and moderate consequences of flooding due to groundwater, the risk is considered moderate.

6.7 Flood Risk Management

Finished floor levels have been set above the road levels, as described in Section 3.6, to ensure that any seepage of ground water onto the development does not flood into the buildings. In the event of ground water flooding on site, this water can escape from the site via the overland flood routing, also described in Section 3.6.

The buildings' design will incorporate suitable damp-proof membranes to protect against damp and water ingress from below ground level.

6.8 Residual Risk

There is a low residual risk of flooding from ground water.

7. Human/Mechanical Errors

7.1 Source

The subject site will be drained by an internal private storm water drainage system, which discharges to the existing natural surface water network, the Mayne River, which in turn outfalls to Baldoyle Bay.

The internal surface water network is a source of possible flooding were it to become blocked.

7.2 Pathway

If the proposed private drainage system blocks this could lead to possible flooding within the private and public areas.

7.3 Receptor

The receptors for flooding due to human/mechanical error would be the ground floor levels of buildings, the roads and the open landscaped areas around the site.

7.4 Likelihood

There is a high likelihood of flooding on the subject site if the surface water network were to become blocked.

7.5 Consequence

The surface water network would surcharge and overflow through gullies and manhole lids. It is, therefore, considered that the consequences of such flooding are moderate.

7.6 Risk

With a high likelihood and moderate consequence, there is a high risk of surface water flooding should the surface water network block.

7.7 Flood Risk Management

As described in Section 3.6, finished floor levels have been designed to be above the adjacent road network, which will reduce the risk of flooding if the surface water network were to block. In the event of the surface water system surcharging, the surface water can still escape from the site by overland flood routing, as also described in Section 3.6, without causing damage to the proposed buildings.

The surface water network (drains, gullies, manholes, AJs, attenuation system including lakes and hydrobrake flow control systems) will need to be regularly maintained and where required cleaned out. A suitable maintenance regime of inspection and cleaning will be incorporated into the safety file/maintenance manual for the development.

7.8 Residual Risk

As a result of the flood risk management outlined above, there is a low residual risk of overland flooding from human / mechanical error.

8. Conclusions and Recommendations

The subject lands have been analysed for risks from tidal flooding from the Irish Sea and the Mayne River, fluvial flooding from the Mayne River, pluvial flooding, ground water and failures of mechanical systems. *Table 5*, below, presents the various residual flood risks involved.

Source	Pathway	Receptor	Likelihood	Consequence	Risk	Mitigation Measure	Residual Risk
Tidal	*Irish Sea & Mayne River*	*Proposed development*	*Extremely low*	*None*	*Extremely low*	*None*	Extremely low
Fluvial	*Mayne River*	*Proposed development*	*Low*	*Low*	*Extremely Low*	*Setting of floor levels & freeboard, overland flood routing*	Extremely Low
Pluvial	*Private & Public Drainage Network*	*Proposed development, downstream properties and roads*	*Ranges from high to low*	*Moderate*	*Ranges from high to low*	*Appropriate drainage, SuDS and attenuation design, setting of floor levels, overland flood routing*	Low
Ground Water	*Ground*	*Underground services, ground level of buildings, roads*	*Moderate*	*Moderate*	*Moderate*	*Appropriate setting of floor levels, flood routing, damp proof membranes*	Low
Human/ Mechanical Error	*Drainage network*	*Proposed development*	*High*	*Moderate*	*High*	*Setting of floor levels, overland flood routing, regular inspection of SW network*	Low

Table 7 | *Summary of the Flood Risks from the Various Components*

As indicated in the above table, the various sources of flooding have been reviewed, and the risk of flooding from each source has been assessed. Where necessary, flood risk management/mitigation measures have been proposed. As a result of the proposed mitigation measures, the residual risk of flooding from any source is low.

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