Waterman Moylan
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Flood Risk Assessment

Residential Development at Broomfield SHD Lands, Malahide

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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 for a proposed SHD at Broomfield, Back Road, Malahide, Co. Dublin.

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 Location and Description

The subject site is defined as generally greenfield site; however, a portion of the northern site is the former location of a rugby club and has a small area of hardstanding paving and 2 structures. These structures have been heavily vandalised in the form of fire damage and their demolition is included as part of the subject application. The development entrance is from Back Road, 0.5km east of the junction between Back Road and Kinsealy Lane, Malahide Road (R107) is 1.1km to the west, and the Malahide-Donaghmede Road (R124) is 0.5km to the east. It has been requested by Fingal County Council that a further connection to the south site to Kinsealy Lane be provided via the existing Hazelbrook residential development.

The overall proposed development is divided into 2 sites as indicated in *Figure 1* below. The north site is located between the existing Ashwood Hall residential development to the west and the Dublin-Belfast rail line to the east. To the south is agricultural land, the north is bounded by existing properties on Back Road. The southern site is bounded by the Hazelbrook development to the west, Brookfield residential development to the north and agricultural lands to the south and east.

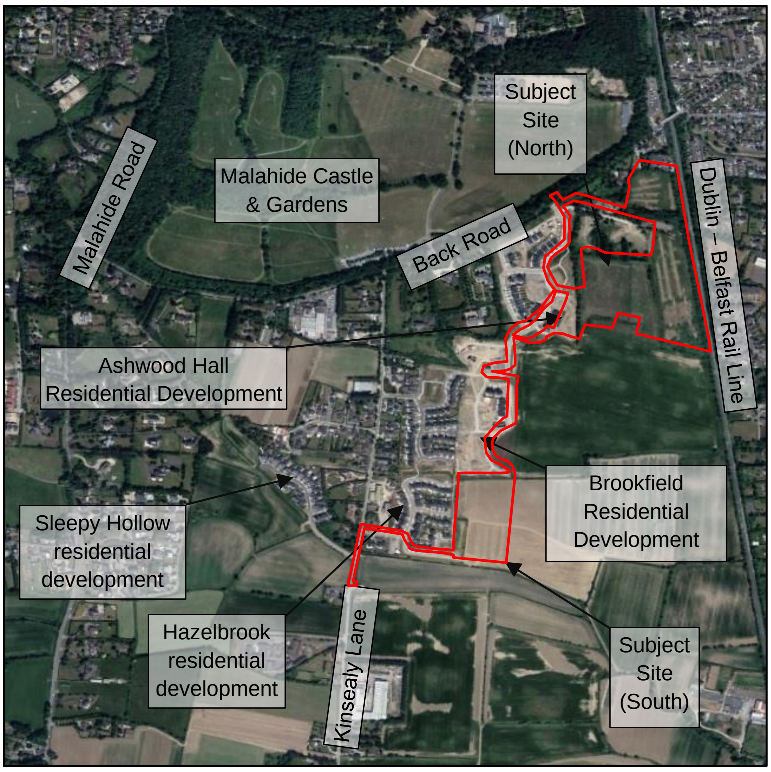


Figure 1 *| Site Location (Source: Google Earth)*

A topographic survey of the area indicated that the north site generally slopes uniformly from north-east to south, from a height of 20.5m to 11.5m, with an existing static ditch system along the southern boundary, due to topography this serves the subject site only. It attenuates and percolates local overland surface water flows and has no outfall. The southern site also slopes from north to south from a height of 6m to 4.7m with localised high points and has an existing ditch system along its north boundary, which flows east to west and connects to the Hazelbrook Stream at Sleepy Hollow. Along the southern boundary Hazelbrook stream flows from west to east.

The cumulative site area is approximately 12.5 ha comprised of the north and south sites.

The existing ditch systems, excluding the static ditch discussed above, join Hazelbrook stream, which outfalls to the Sluice rivers which in turn has an ultimate outfall at Portmarnock Estuary, 2.5km southeast of the site.

1.2 Proposed Development

The proposed development consists of a total of 415 residential units, comprising of 252 houses, 28 duplex units and 135 apartments, as set out in the Schedule of Accommodation in *Table 1* below. Also proposed as part of the development is a 476m² creche.

Description	1-bed	2-bed	3-bed	4-bed	5-bed	Total
House	-	-	192	48	12	252
Duplex	8	14	6	-	-	28
Apartment	37	93	5	-	-	135
Total	45	107	203	48	12	415

Table 1 **|** *Schedule of Accommodation*

The development includes all associated site works, undergrounding of overhead lines, boundary treatments, drainage, and service connections.

1.3 Background to the Report

This Flood Risk Assessment report follows the guidelines set out in the *DEHLG/OPW Guidelines on the Planning Process and Flood Risk Management* published in November 2009.

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.

1.3.1 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.

1.3.2 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.

1.3.3 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*

1.3.4 Flood Risk Management

After a risk has been assessed, flood risk management is the next stage. Flood risk management aims to minimize the risks to people, properties and the environment arising from flooding.

1.3.5 Residual Risk

The residual risk is the risk which remains after all risk avoidance, substitution and mitigation measures have been implemented.

2. Tidal

2.1 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.

2.2 Pathway

The site is approximately 1.6km south of the nearest coastline at the Malahide Estuary. The Dublin Coastal Protection Project indicated that the 2002 high tide event reached 2.95m OD Malin. The lowest proposed finished floor level at the development is to be constructed at 5.85m OD Malin, well above the historic high tide event.

The Fingal East Meath Flood Risk Assessment and Management Study (FEM FRAMS) and 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. An extract of Tidal Flood Extent Map No. E09MAL_EXCCD_F0_39 is shown in *Figure 2* below:

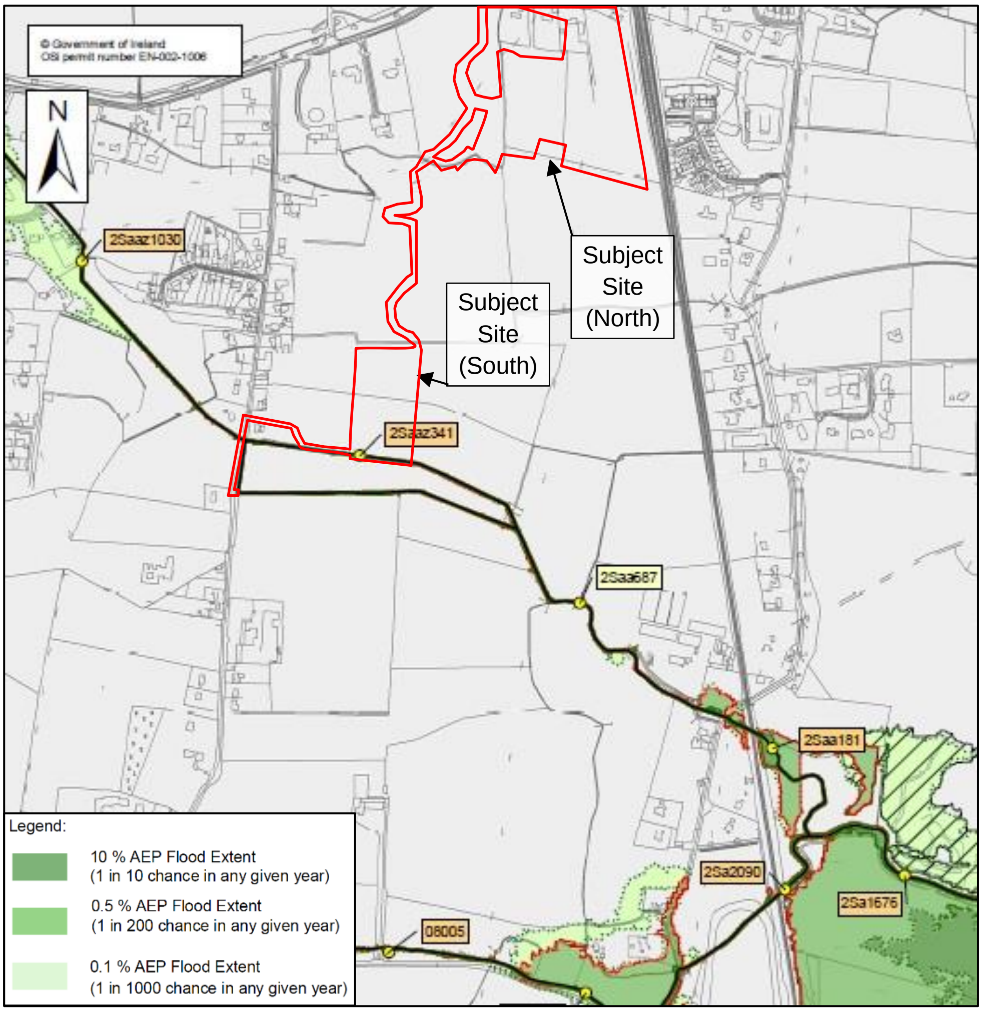


Figure 2 | *Extract from the FEM FRAMS Tidal Flood Extents Map*

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 1.6 kilometres inland from the Irish Sea, that there is at least a 2.9m level difference between the lowest proposed building floor level (5.85m) and the record high tide event 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.

3. Fluvial

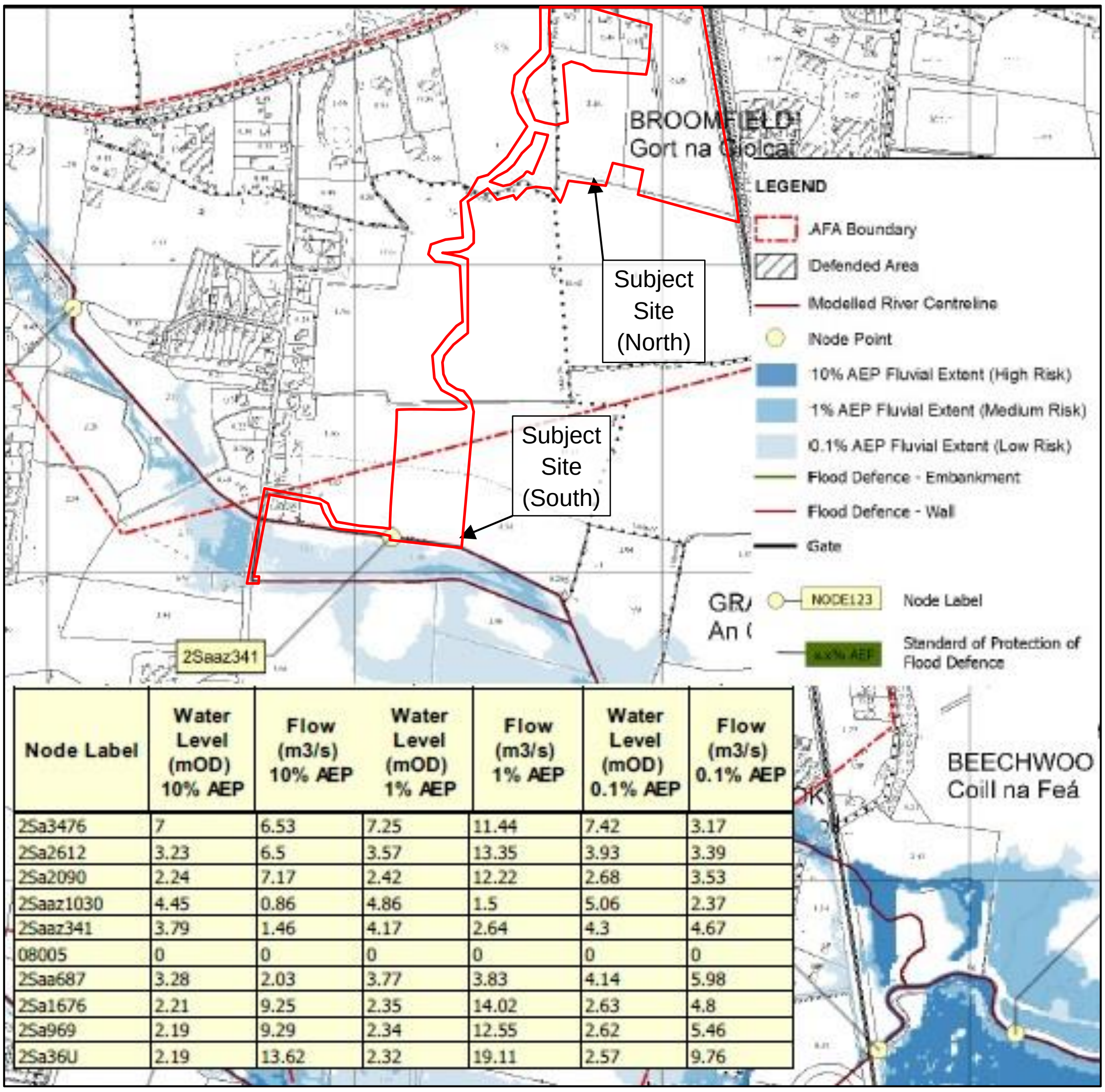
3.1 Source

Fluvial flooding occurs when a water course / 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.

3.2 Pathway

The subject site is located within the Sluice River catchment. The ditch systems on the site boundaries outfall to Hazelbrook Stream, a tributary of the Sluice River.

The Fingal East Meath Flood Risk Assessment and Management Study (FEM FRAMS) maps, and those available on the OPW's National Flood Information Portal as extracted below, indicate that none of the subject sites will experience fluvial flooding for even a 0.1% AEP (1-in-1,000 year) event. Analysis of the nearest upstream node point on the Hazelbrook Stream, 2Saaz341, indicates that the projected water level for the 0.1%AEP (1 in 1000 year) is 4.3mOD. The lowest Finished Floor Level on site is 5.85mOD providing 1.55m freeboard from the upstream 1 in 1000 flood level.



Node Label	Water Level (mOD) 10% AEP	Flow (m3/s) 10% AEP	Water Level (mOD) 1% AEP	Flow (m3/s) 1% AEP	Water Level (mOD) 0.1% AEP	Flow (m3/s) 0.1% AEP
2Sa3476	7	6.53	7.25	11.44	7.42	3.17
2Sa2612	3.23	6.5	3.57	13.35	3.93	3.39
2Sa2090	2.24	7.17	2.42	12.22	2.68	3.53
2Saaz1030	4.45	0.86	4.86	1.5	5.06	2.37
2Saaz341	3.79	1.46	4.17	2.64	4.3	4.67
08005	0	0	0	0	0	0
2Saa687	3.28	2.03	3.77	3.83	4.14	5.98
2Sa1676	2.21	9.25	2.35	14.02	2.63	4.8
2Sa969	2.19	9.29	2.34	12.55	2.62	5.46
2Sa36U	2.19	13.62	2.32	19.11	2.57	9.76

Figure 3 **|** *Extract from the FEM FRAMS Fluvial Flood Extents Map*

A review of the available historic records does not indicate that there have been any instances of flooding at the site or in the surrounding area. An extract below, taken from the OPW's online historic event map: floodmap.ie, shows that the nearest flood event took place 1km away from the site, at the junction of Streamstown Lane & Malahide Road due to overbank ditch flow in October 2002.

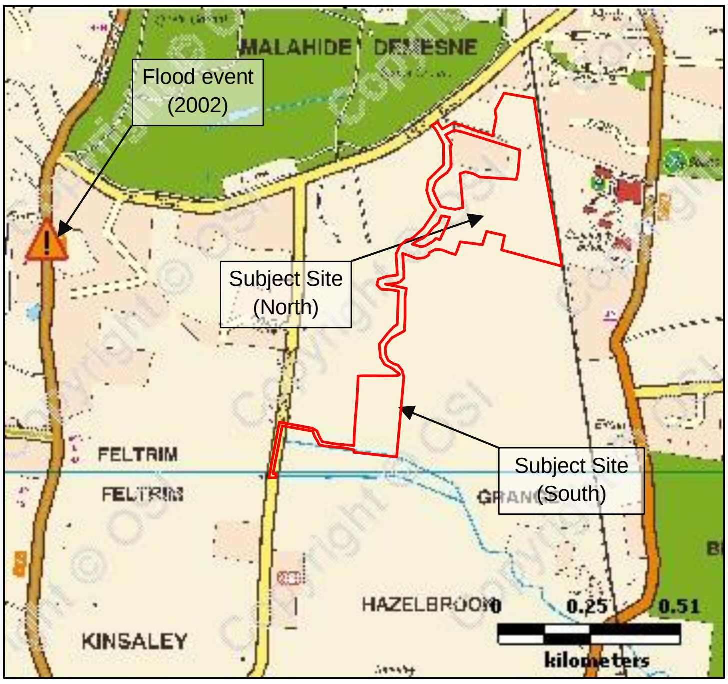


Figure 4 | *Extract from historic flood event map (Source: floodmap.ie)*

3.3 Likelihood

Given that the site is outside of the 1-in-1,000 year flood plain the likelihood of fluvial flooding is extremely low.

3.4 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.

3.5 Risk

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

3.6 Flood Risk Management

The finished floor levels throughout the development have generally been set at least 300mm above the level of the adjacent road channel line.

Should fluvial flooding occur, surface water can flow overland towards the attenuation areas and ditch networks via open spaces as shown in the following flood routing figures and in full on Drawing Number: 18-091-P210 Overland Flood Route.

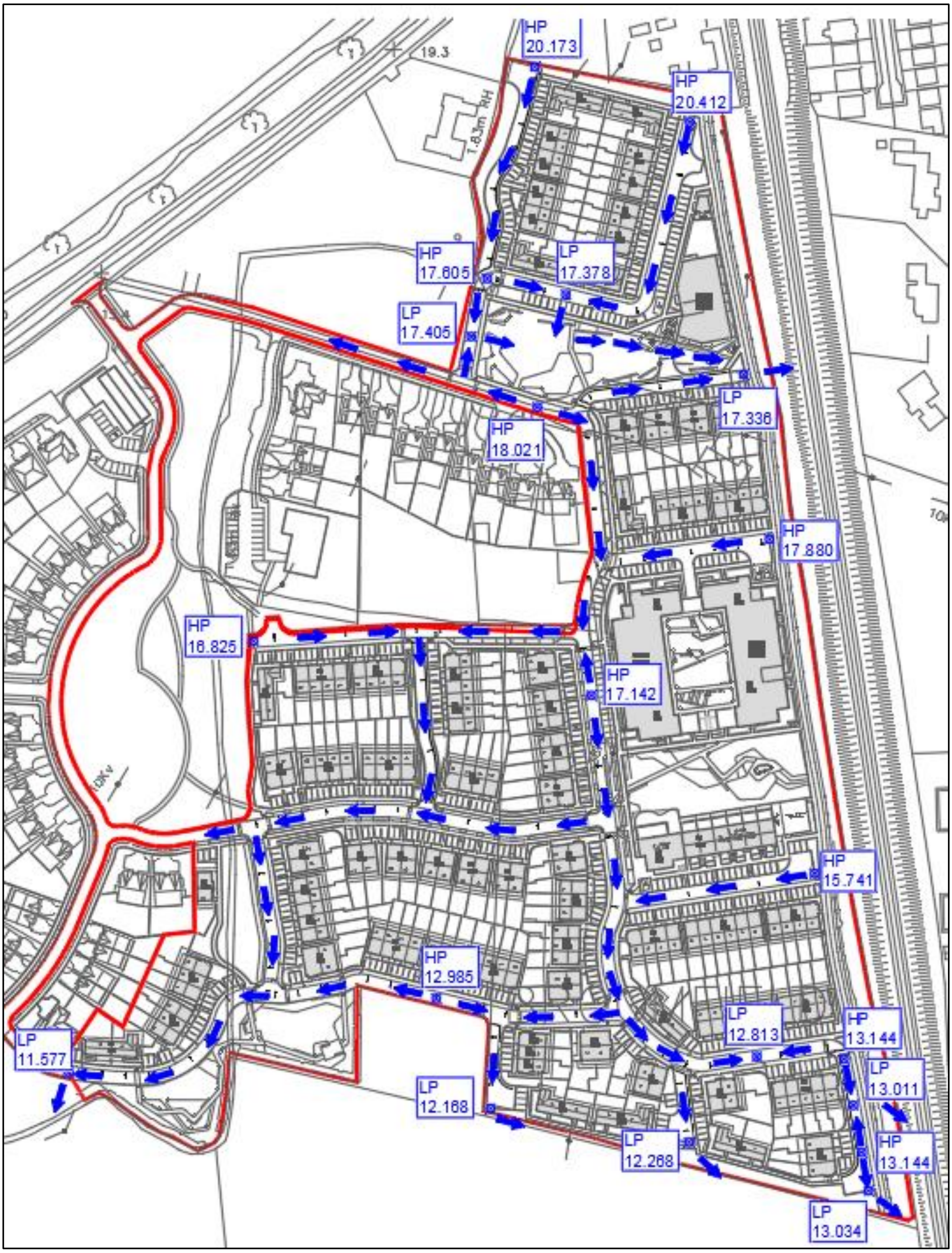


Figure 5 | *Overland Flood Route North Site*

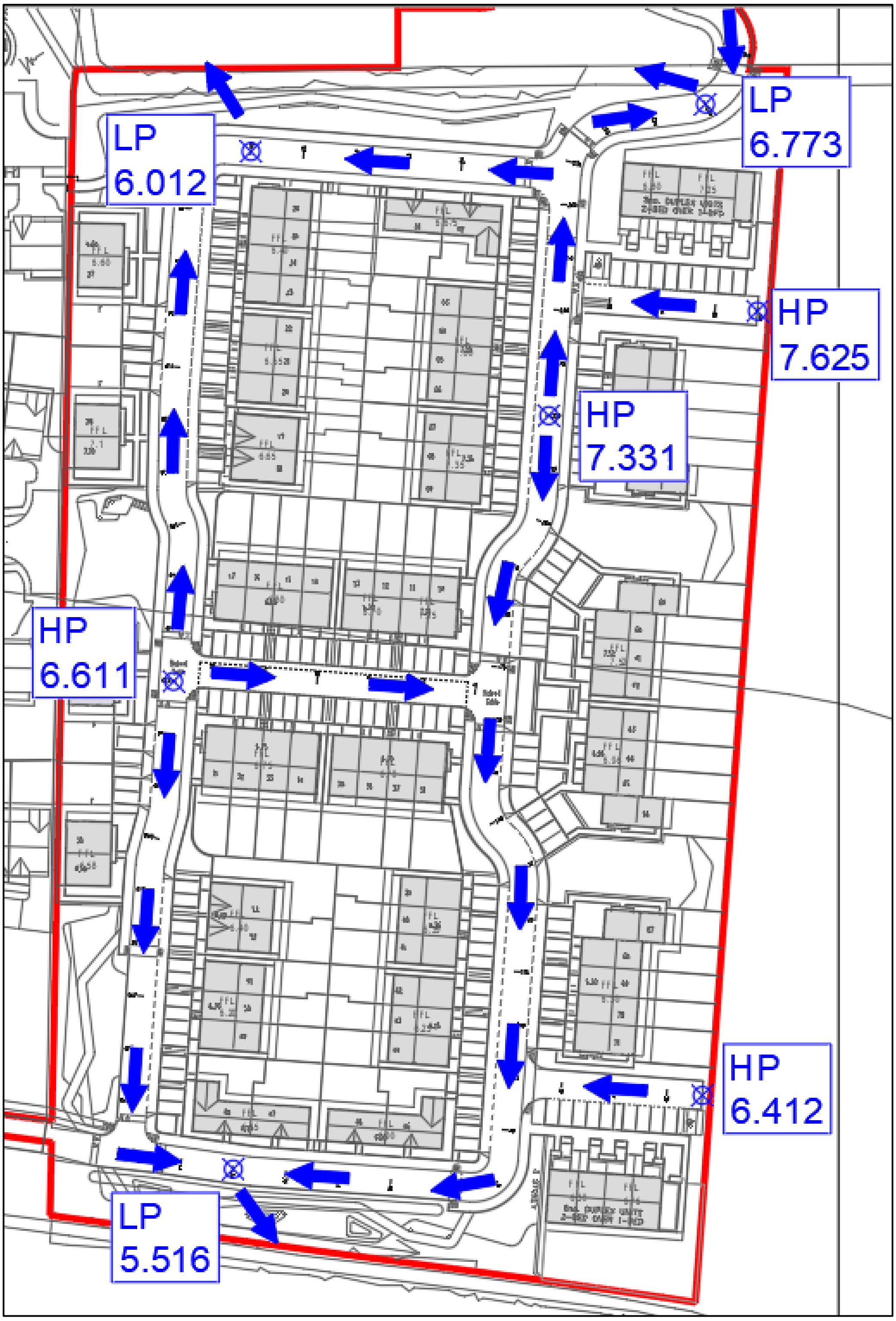


Figure 6 | *Overland Flood Route South Site*

3.7 Residual Risk

The residual risk of fluvial flooding is considered extremely low.

4. Pluvial

4.1 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.

4.2 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 4 | *Pathways and Receptors*

4.3 Likelihood

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

4.3.1 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.

4.3.2 Surcharging from the existing surrounding drainage system:

The OPW's National Flood Hazard Maps, as discussed in section 3.2, has been consulted to identify recorded instances of flooding in the vicinity of the site. The nearest recorded flood event occurred approximately 1.1km west of the site in 2002, with no recorded flooding in the immediate vicinity of the site.

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

4.3.3 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.

4.3.4 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.

4.3.5 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.

4.4 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.

4.5 Risk

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

4.5.1 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.

4.5.2 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.

4.5.3 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.

4.5.4 Overland flooding from surrounding areas:

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

4.5.5 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.

4.6 Flood Risk Management

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

4.6.1 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 in underground tanks / crate systems 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. Smaller catchments for the apartments will be attenuated in underground attenuation tanks which will remain under private management, with sufficient volume also for the 1-in-100 year storm.

As a result of these proposed measures, the likelihood of surcharging of the proposed on-site drainage systems is low.

4.6.2 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 figures in Section 3.6 above) towards the local ditch system / Hazelbrook Stream / Open space. The risk to the surrounding buildings is mitigated by generally setting finished floor levels at least 300mm above the adjacent road channel line. In areas where an overland flood route to ditches or open space from low points has not been possible, the nearby highpoint of the road crest has been set below the surrounding FFL's, thus ensuring that should any localised flooding occur, that it will be limited to the road surface and that adjacent units will not experience flooding.

4.6.3 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.

4.6.4 Overland flooding from surrounding areas:

The risk from overland flooding from surrounding areas is low. Overland flood routing and raised finished floor levels will provide protection for the proposed buildings, as described in Section 4.6.2 above.

4.6.5 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.

4.7 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.

5. Groundwater

5.1 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.

5.2 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, underground services and building foundations could also be affected by high water tables that do not reach the ground surface.

5.3 Receptor

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

5.4 Likelihood

With no history of springs on the site and with the site being moderately flat with surrounding ditch / water course networks, the likelihood of groundwater rising through the ground and causing potential flooding on site during prolonged wet periods is moderate.

5.5 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.

5.6 Risk

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

5.7 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 Sections 3.6. & 4.6.2.

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

5.8 Residual Risk

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

6. Human/Mechanical Errors

6.1 Source

The subject site will be drained by an internal private storm water drainage system, which discharges to the existing natural surface water network, these ditches outfall to Hazelbrook Stream.

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

6.2 Pathway

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

6.3 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.

6.4 Likelihood

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

6.5 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.

6.6 Risk

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

6.7 Flood Risk Management

As described in Sections 3.6 & 4.6.2, finished floor levels have been designed to be generally 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) will need to be regularly maintained and where required cleaned out. Monitoring should be carried out of the water levels in the attenuation tanks at times of extreme rainfall events. A suitable maintenance regime of inspection and cleaning should be incorporated into the safety file/maintenance manual for the development.

6.8 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.

7. Conclusions and Recommendations

The subject lands have been analysed for risks from tidal flooding from the Irish Sea and the surrounding tributary surface water ditch system of Hazelbrook stream, fluvial flooding from the existing ditch system & Hazelbrook Stream, 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 (Malahide Estuary)*	*Proposed development*	*Extremely low*	*None*	*Negligible*	*None*	Negligible
Fluvial	*Hazelbrook Stream (tributary of the Sluice River)*	*Proposed development*	*Low*	*Low*	*Extremely Low*	*Setting of floor levels, 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 5 | *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, mitigation measures have been proposed. As a result of the proposed mitigation measures, the residual risk of flooding from any source is low.

UK and Ireland Office Locations