Waterman Moylan
Engineering Consultants

Flood Risk Assessment, including Statement of Design Consistency

Mixed-use Development at Mooretown Phase 3, Swords, Co. Dublin

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Waterman Moylan Consulting Engineers Limited

Block S, East Point Business Park, Alfie Byrne Road, Dublin D03 H3F4
www.waterman-moylan.ie

Waterman Moylan
Engineering Consultants

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1	18 August 2021	Robert Walpole	Richard Miles	Mark Duignan
2	11 April 2022	Richard Miles	Mark Duignan	Mark Duignan

Comments

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Contents

Figures

Tables

1. Introduction

This Flood Risk Assessment has been prepared by Waterman Moylan as part of the documentation in support of a Strategic Housing Development (SHD) planning application for a proposed mixed-use development on the Mooretown Phase 3 lands, Swords, Co. Dublin.

1.1 Flood Risk Assessment: Statement of Design Consistency

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.

1.2 Site Description

The Phase 3 site is located at Mooretown, Swords, Co. Dublin, just south of the Rathbeale Road, as shown in *Figure 1* overleaf, and is part of the Oldtown-Mooretown LAP lands as shown in *Figure 2*.

The site is currently agricultural land (tillage), approximately 18.378ha in area and is located 2km west of Swords town centre.

The subject site is bounded to the east, west and partially to the south by agricultural land. Also, to the south is the Abbeyvale residential development. To the north is the completed Mooretown School Campus, and future Mooretown Phase 2 (granted planning reference: F16A/0505).

The Mooretown School Access Road has been constructed, and completed, under planning reference number: F14A/0012. The northern portion of the Mooretown Distributor Road from the Rathbeale Road has been constructed under planning reference number F12A/0270. The Mooretown Distributor Road Extension as shown with a blue boundary in *Figure 1*, has received final grant of planning permission, and has an application reference number of: F20A/0096. We also refer you to site layout drawing P1000 accompanying this report.

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

The subject site is Greenfield in nature and slopes from a height of 58m in the southwest corner to 37m in the north-east. The site lies withing the catchment of the Broadmeadow River which outfalls to the Malahide estuary. The estuary is a Special Protection Area (SPA), a candidate Special Area of Conservation (cSAC) a proposed National heritage Area (pNHA) and a RAMSAR site.

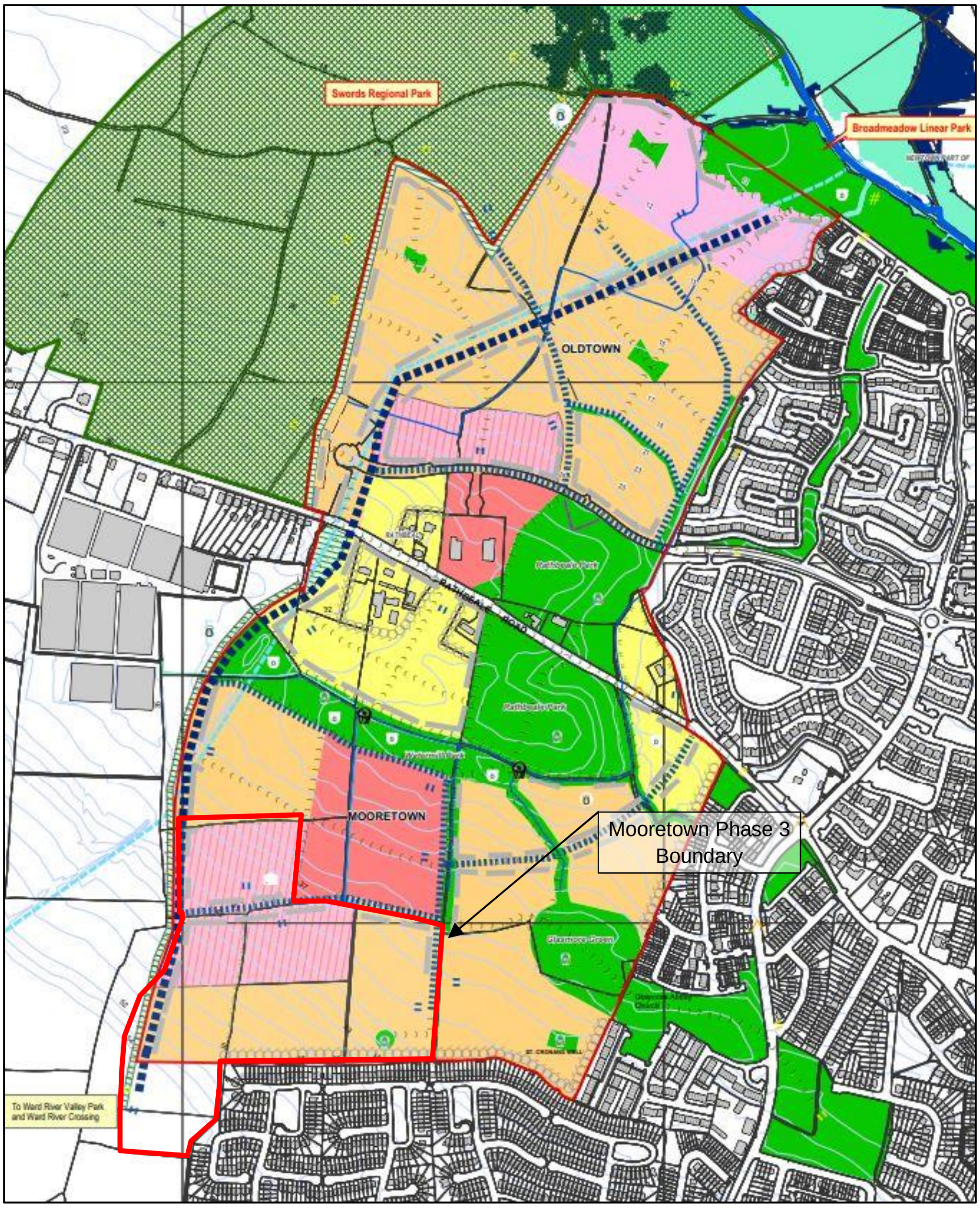

Figure 2 | *Image extracted from the Oldtown-Mooretown LAP 2010*

The site is drained by surface ditches as shown in *Figure 3* overleaf, which in turn flow to the Mooretown Mill Stream, on the eastern border of the Mooretown LAP lands. This Mill Stream flows north to Rathbeale Road where it is culverted by 1200mmØ pipes which traverses the eastern boundary of the oldtown lands before ultimately discharging to the Broadmeadow River.

Neither the Oldtown/Mooretown Lands nor the adjacent Broadmeadow River are part of the SPA or SAC site, however, any development immediately upstream is required to maintain, or improve the quality of surface water to status objectives, as set out in the Water Framework Directive (WFD). These requirements are in place in order to protect and enhance the status of the aquatic ecosystems of the SAC or SPA site. This will require the implementation of SuDS, which are intended to be utilised as part of the development.

Figure 3 | *Existing Surface Water Ditches*

1.3 Proposed Development

The proposed development will consist of 650 units, comprising of: 265 No. houses, 119 No. Duplex/Triplexes units, and 266 No. apartments. A creche, and 946sqm of retail and café uses clustered in a small village centre.

The development will be designed to include all associated site works, boundary treatments, drainage, and service connections.

1.4 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.

1.4.1 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 1 | *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 2 | *3x3 Risk Matrix*

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 3.5km west of the nearest coastline at the Malahide Estuary, as shown in *Figure 4*. This figure is extracted from the OPW's flood information portal, shows that the site is not at risk of coastal flooding for even the 1-in-1,000 year flood event. The Dublin Coastal Protection Project indicates that the 2002 high tide event reached 2.95m OD Malin. The lowest existing ground level on site is approx. 37m, well above the historic high tide event.

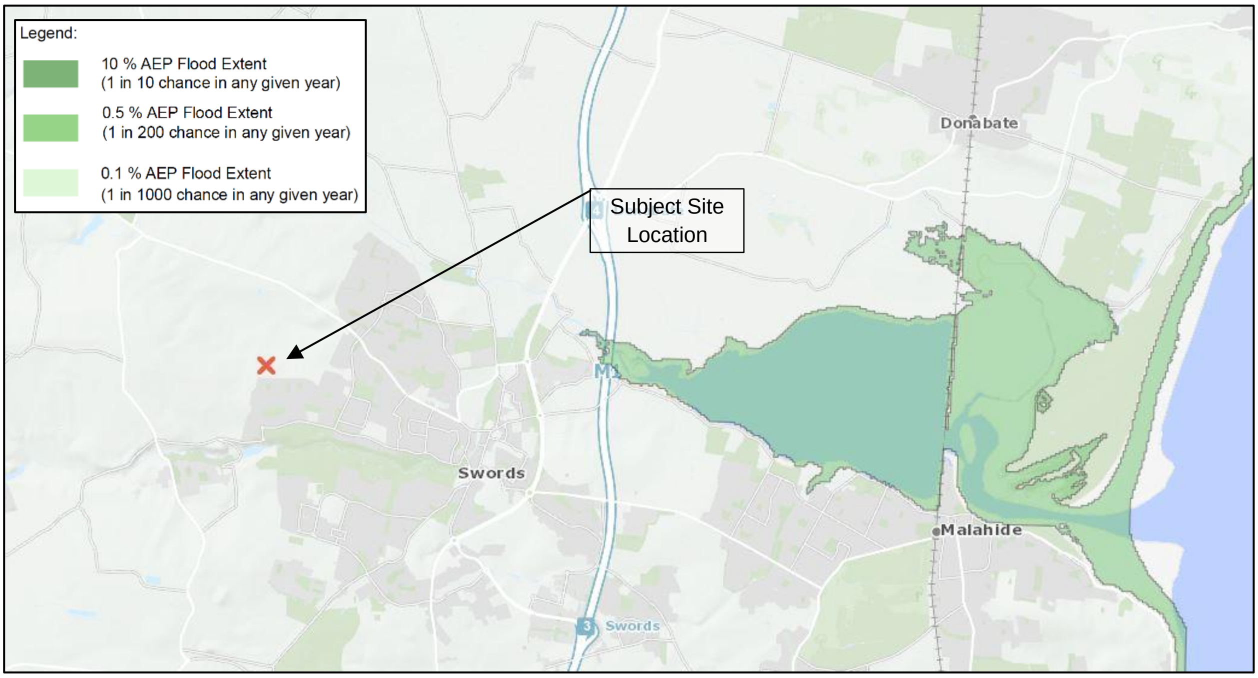

Figure 4 **|** *Extract from the FEM FRAMS Tidal Flood Extents Map*

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 3.5 kilometres inland from the Irish Sea, that there is at least a 34m level difference between the proposed buildings 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. A risk from tidal flooding is therefore extremely low and no flood mitigation measures need to be implemented in this regard.

3. Fluvial

3.1 Source

Fluvial flooding occurs when a river / water course'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 Broadmeadow River catchment.

The Fingal East Meath Flood Risk Assessment and Management Study (FEM FRAMS) maps, available on the OPW's National Flood Information Portal and extracted below, shows that none of the subject site falls within the 0.1% AEP (1-in-1,000 year) flood plain.

The nearest node point, reference number: 4Wa3870, located on the River Ward, will have a 1-in-1,000 year flood event water height of 31.16m, well below the lowest height of 37m on the subject lands. The River Ward is a tributary of Broadmeadow River joining immediately prior to the Broadmeadow's outfall. There is no identified risk of flood from the Mill Stream on the eastern boundary of the site.

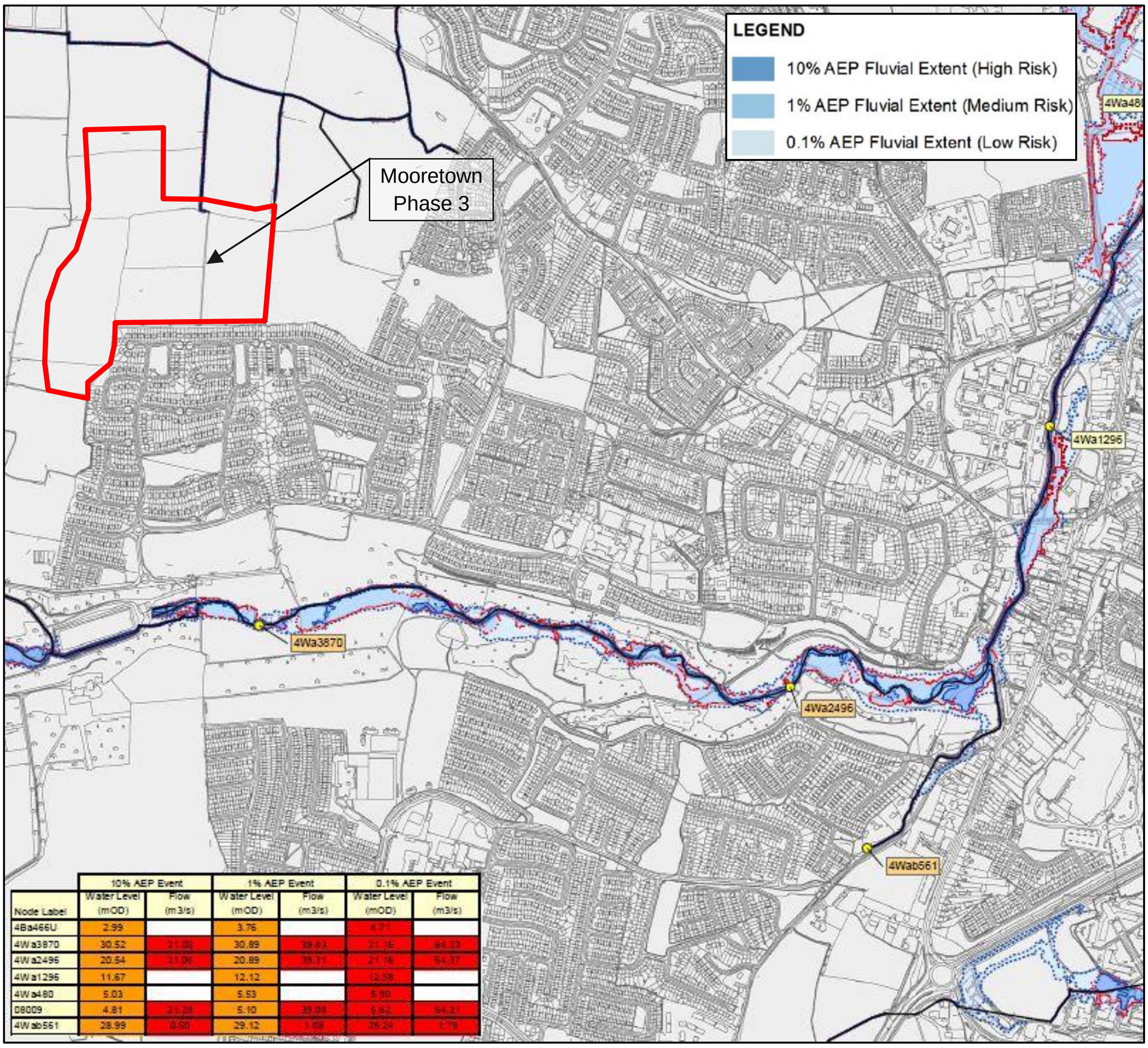

Figure 5 | *Extract from the FEM FRAMS Fluvial Flood Extents Map e08swo_exfcd_32*

3.3 Likelihood

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

3.4 Consequence

The consequence of fluvial flooding would be some minor inundation 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 low and the consequence is low.

3.6 Flood Risk Management

The development has been designed to provide overland flood routing through the road network and ultimately to the Mill Stream, which ultimately drains to the Broadmeadow River as described in Section 1.1. The overland flood routing is shown in full on drawing number: 21-011-P1500, which is extracted overleaf in *Figure 6*.

The proposed development has designed finished floor levels generally over 200mm above the local road network to minimise the risk of flooding from overland flows.

There are no localised low points occurring in the road network. The result of this is a significant reduction in the risk of flooding for the subject site.

To minimise the risk of downstream flooding, surface water outflow from the site is limited to its equivalent green-field run-off rate via a flow control manhole. The surface water outfall detention basins and ponds have been designed to attenuate flood volumes for a 1 in 100-year event minimising the risk of downstream flooding.

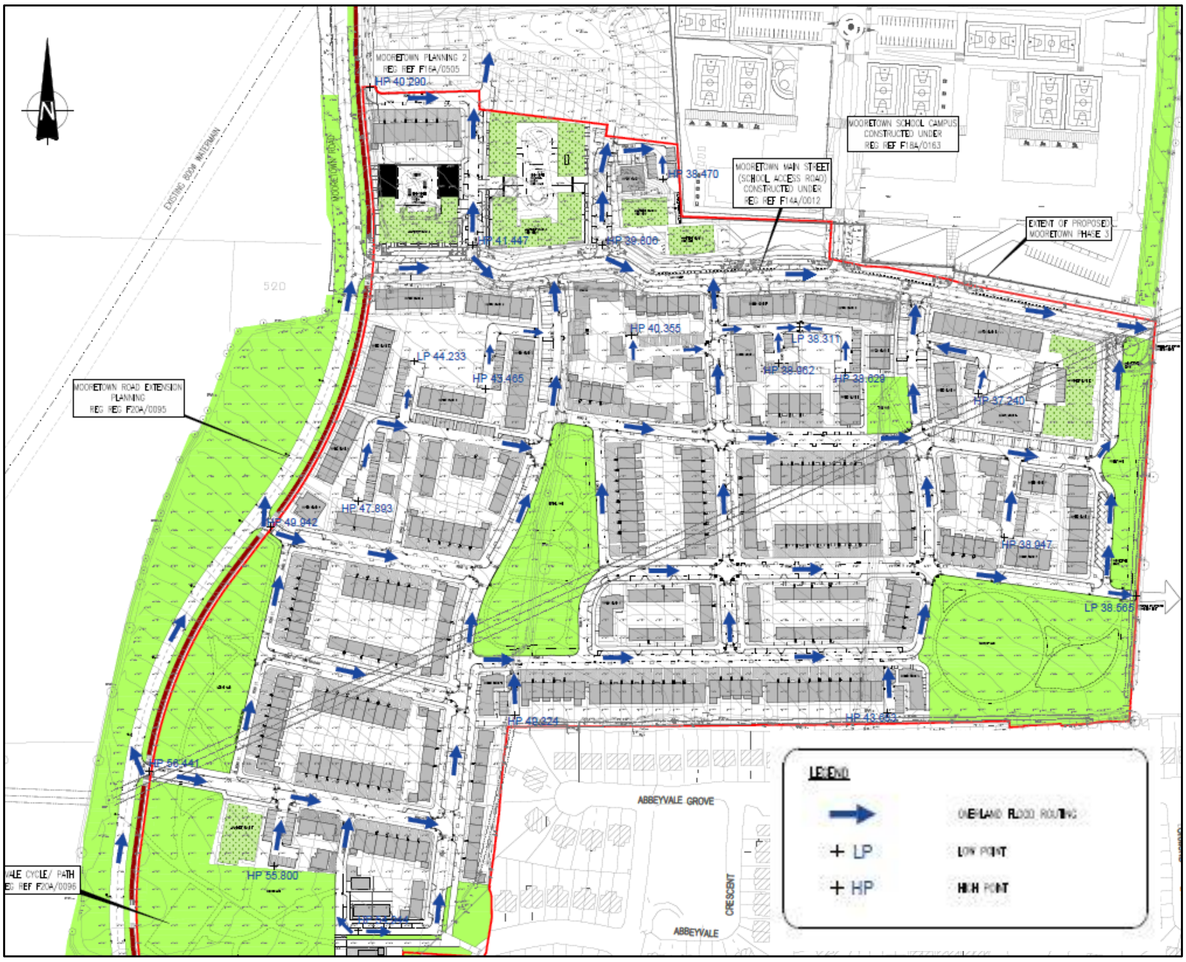

***Figure 6** | Overland Flood Route Extract*

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 3** | 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 on-line portal was again consulted to ascertain the details of any local historic flood events. *Figure 7* overleaf, shows that there is no record of a previous flood event at the subject site, with the nearest historic flood event occurring approx. 1.3km away to the east. Information on this flood event shows that it occurred in November 1982. The report notes that 64% of the average monthly rainfall volume for November fell within a 12-hour period, which was compounded by heavy rainfalls in the preceding days which had led to ground saturation. This specific flood event was of a residential unit's rear garden and was due to a blockage of the local surface water drainage network. Drainage engineers attended the location and remediated the blockage. No flood events at this location have been recorded since.

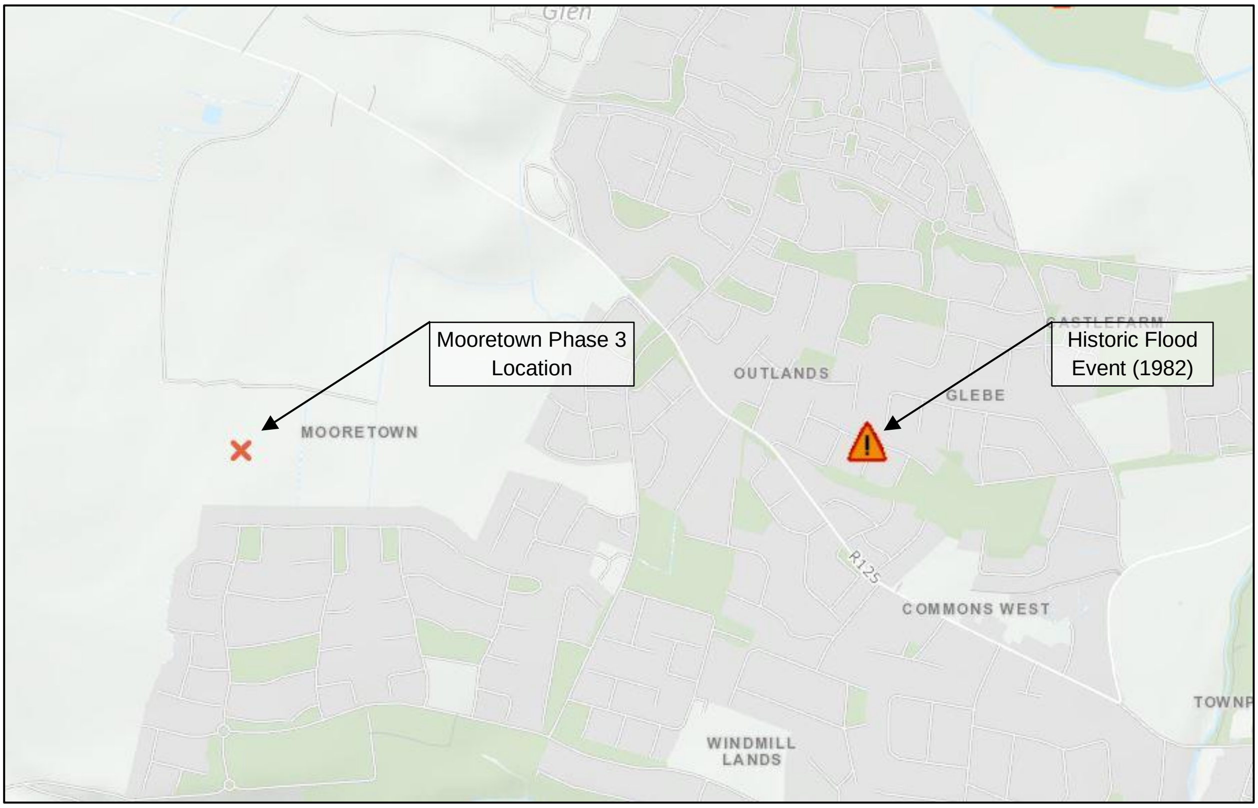

Figure 7 | *Local Flood Event History Extracted from OPW's National Flood Hazard Maps*

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 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 open spaces 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 the dry detention basin/ponds 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. Please refer to the Engineering Assessment Report, submitted under a separate cover, which details in full the Surface Water drainage strategy for the overall Mooretown Development.

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 figure in Section 3.6 above) towards the Mill Stream and towards the dry detention basin and attenuation pond. The risk to the surrounding buildings is mitigated by setting finished floor levels at least 200mm above the adjacent road channel line.

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

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 m moderate to high groundwater vulnerability.

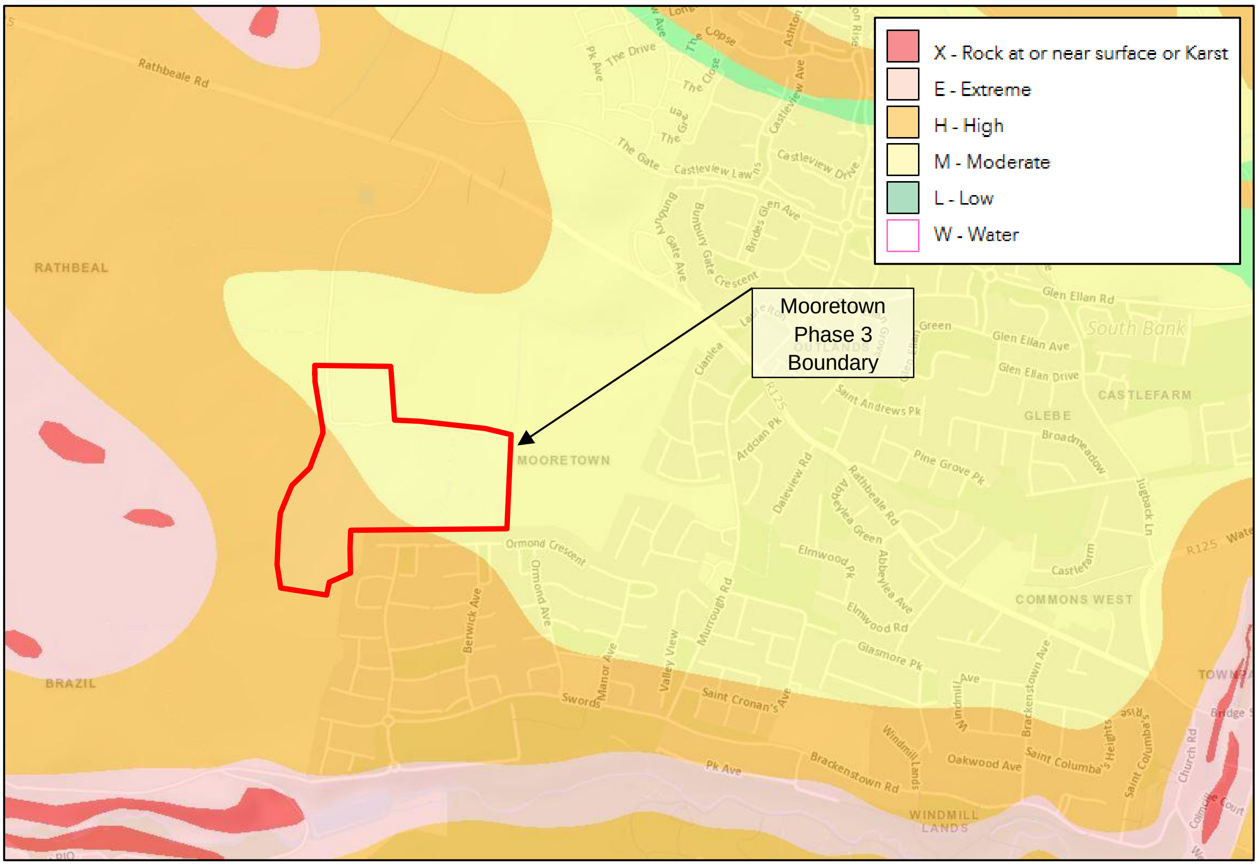

Figure 8 | *Extract of Groundwater Vulnerability Map*

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

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

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 Section 3.6.

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, the Mill Stream, which is a tributary of the Broadmeadow River, which in turn outfalls to the Malahide Estuary.

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 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) will need to be regularly maintained and where required cleaned out. 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 Broadmeadow River, fluvial flooding from Mill Stream & River Ward, pluvial flooding, ground water and failures of mechanical systems. *Table 4*, 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*	*Extremely low*	*None*	Extremely low
Fluvial	*The River Ward & Mill Stream*	*Proposed development*	*Low*	*Low*	*Extremely Low*	*Setting of floor levels & freeboard, overland flood routing, no localised low points*	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*	*High*	*Moderate*	*High*	*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 4 | *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