Waterman Moylan
Engineering Consultants

Flood Risk Assessment

Proposed Shared Living Strategic Housing Development at Western Way, Dublin 7

November 2020

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Client Name: Western Way Developments Ltd.
Document Reference: 18-039r.007 Flood Risk Assessment
Project Number: 18-039

Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2015 and BS EN ISO 14001: 2015)

Issue	Date	Prepared by	Checked by	Approved by
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Comments

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1. Introduction

1.1 Background of Report

This Flood Risk Assessment has been prepared by Waterman Moylan as part of the documentation in support of a planning application for a proposed shared living development on the site of the disused Hendrons facility at 36-40 Dominick Street Upper, Broadstone, Dublin 7.

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 and Proposed Development

The subject site is located in Broadstone, Phibsborough, Dublin 7, and is bounded by Western Way to the north and west, Palmerston Place to the east and Dominick Street Upper to the south. A portion of the north-eastern perimeter is also bounded by the gardens of neighbouring houses. The site is located prominently on Western Way near to the top of Constitution Hill. Existing ground levels at the site fall from c. 19.8m OD Malin at the south-west to c. 18.4m OD Malin at the north of the site.

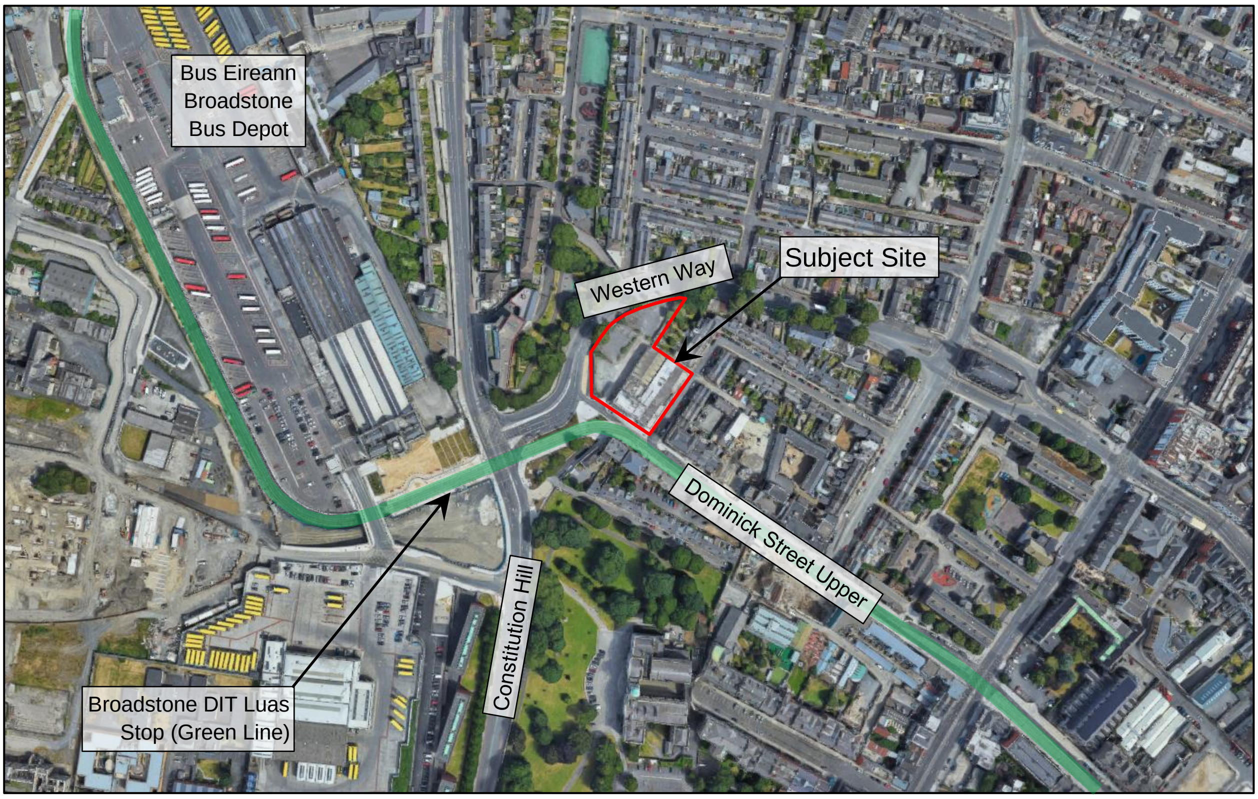


***Figure 1** | Site Location (Source: Google Maps)*

The existing site is approximately 3,285m^2 and is a brownfield site comprising of a carpark along the western side of the site and a building complex, including the disused Hendrons building, to the south-east. Main access to the site is from Dominick Street Upper, with a private gated side access road from

Palmerston Place running between the existing building complex and the neighbouring property to the north.

The proposed development comprises demolition of the existing warehouse buildings and no. 36 Dominick Street Upper and retention of the Hendrons Building as part of an overall redevelopment of the site to accommodate a build-to-rent shared living scheme and publicly accessible neighbourhood uses (including café/shop, gym and yoga studios). The scheme will include; 280 no. shared living rooms (281 no. bed-spaces), internal and external amenity space over 5 no. blocks ranging in height from 5 no. storeys to 9 no. storeys, secure bicycle parking, site-wide landscaping, ESB substation and switch-room and site development works all on the 0.3285 hectare site.

The entrance to the development is via Dominick Street to an open courtyard between the blocks, with the main entrances to the buildings opening out to the courtyard.

The existing building complex on the site includes a basement. The development will include a lower ground floor level which sits below the level of the adjacent footpath, and a partial basement to house a communication room, plant room and storage space.

1.3 Assessment Methodology

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.

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.

1.3.1 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.

1.3.2 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 2.85km west of the nearest coastline at Dublin Bay. The Dublin Coastal Protection Project indicated that the 2002 high tide event reached 2.95m OD Malin. The proposed finished floor level of the development is to be constructed at a minimum level of 17.425m OD Malin, with the proposed partial basement floor level at 14.500m OD Malin, well above the historic high tide event.

The River Liffey is located approximately 1km to the south of the subject site and is tidal at this location. Coastal Flood Extent Maps, developed as part of the Eastern Flood Risk Assessment and Management (FRAM) Study, have been consulted as part of this assessment. The relevant flood map for the River Liffey (*E09LIF_EXCCD_F1_03*; Page 3 of 8; dated 9 May 2017) is extracted below:

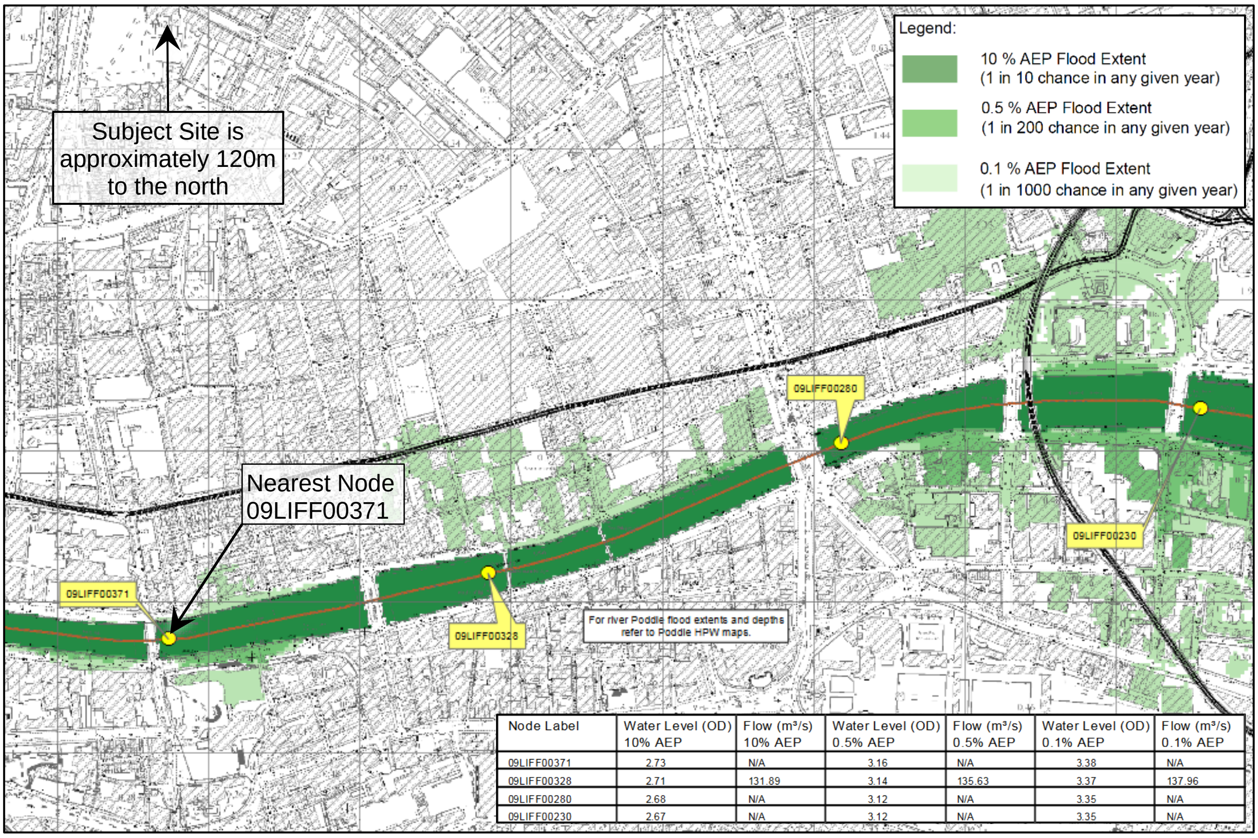


Figure 2 **|** *Extract of Liffey Tidal Flood Extents Map (No. E09LIF_EXCCD_F1_03)*

The Coastal Flood Extent maps outline areas at risk of tidal flooding. 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.

The map indicates that the subject development is not at risk of flooding during a 1-in-1,000 year event. The map also includes node points with modelled water levels. The tidal flood level at the nearest node (09LIFF00371) is 3.38m OD Malin during a 1 in 1,000-year event, which provides a freeboard in excess of 17m.

Given that the site is located 2.85 kilometres inland from the Irish Sea, that there is at least a 11.65m level difference between the partial basement 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. A risk from tidal flooding is therefore extremely low and no flood mitigation measures need to be implemented.

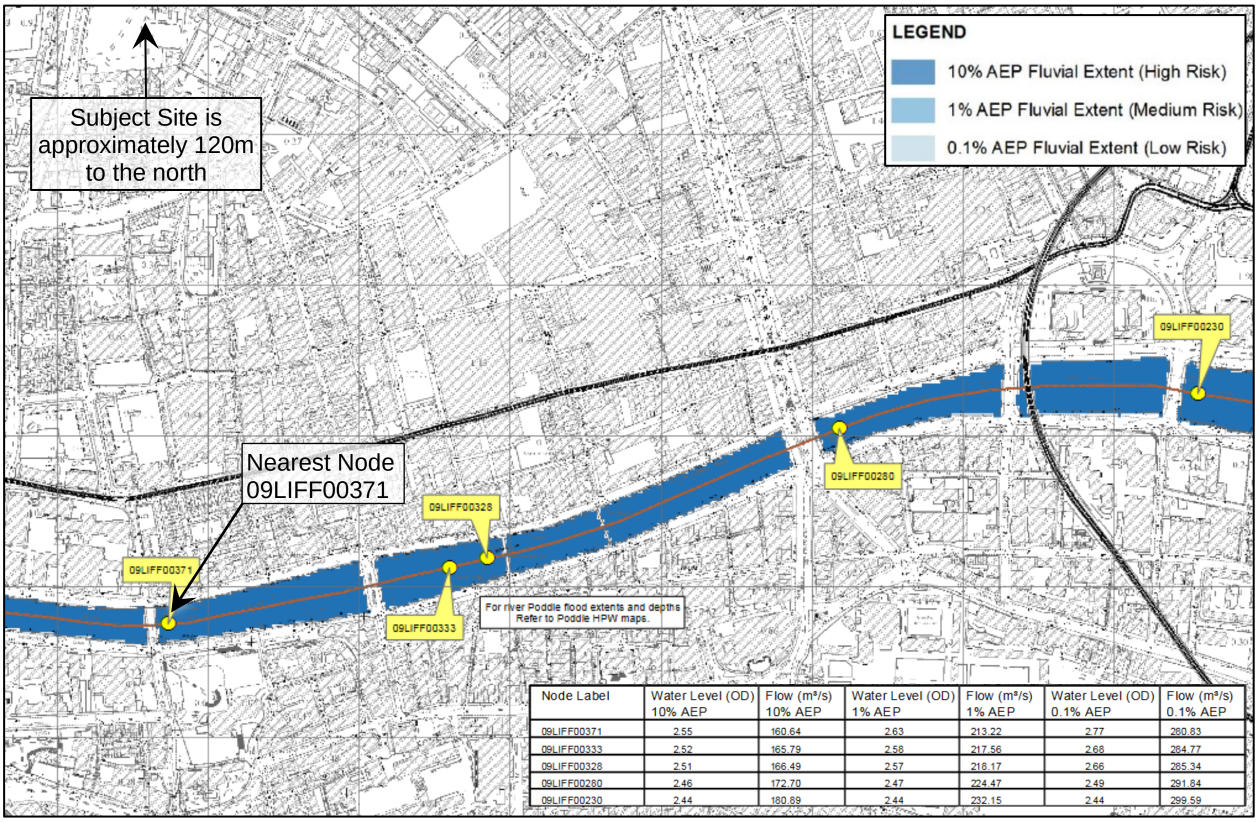
3. Fluvial

3.1 Source

Fluvial flooding occurs when a 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

As noted above, the River Liffey is located approximately 1km to the south of the subject site. Fluvial Flood Extent Maps, developed as part of the Eastern Flood Risk Assessment and Management (FRAM) Study maps include fluvial flood mapping, have been consulted as part of this assessment – the relevant fluvial flood extent map for the site (*E09LIF_EXFCD_F1_03*; Page 3 of 8; dated 9 May 2017) is extracted below.



Node Label	Water Level (OD) 10% AEP	Flow (m³/s) 10% AEP	Water Level (OD) 1% AEP	Flow (m³/s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m³/s) 0.1% AEP
09LIFF00371	2.55	160.64	2.63	213.22	2.77	280.83
09LIFF00333	2.52	165.79	2.58	217.56	2.68	284.77
09LIFF00328	2.51	166.49	2.57	218.17	2.66	285.34
09LIFF00280	2.46	172.70	2.47	224.47	2.49	291.84
09LIFF00230	2.44	180.89	2.44	232.15	2.44	299.59

Figure 3 | *Extract of Liffey Fluvial Flood Extents Map (No. E09LIF_EXFCD_F1_03)*

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 1% (1-in-100 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 site is outside of the 0.1% AEP (1-in-1,000 year) flood plain. The map also includes node points with modelled water levels. The fluvial flood level at the nearest node (09LIFF00371) is 2.77m OD Malin during a 1 in 1000-year event, which provides a freeboard in excess of 11.7m to the partial basement floor level.

Given the level difference between the subject lands and the flood event water level 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 fluvial flooding is therefore extremely low and no flood mitigation measures need to be considered.

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 existing drainage system is a combined public sewer which serves the area around the subject site. The OPW's National Flood Hazard Maps, extracted below, have been consulted to identify recorded instances of flooding in the vicinity of the site. The nearest recorded flood event is approximately 1.6km south-west of the site, with no recorded flooding in the immediate vicinity of the site.

Figure 4 **|** *OPW National Flood Hazard Mapping*

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:

The existing site is effectively 100% paved. The proposed development will be designed to incorporate best drainage practice, including landscaped areas and tree pits. Sustainable drainage design will restrict run-off, and the use of permeable paving, swales, fitter drains, attenuation storage and other measures will be incorporated to reduce run-off. As a result of the proposed development there will therefore be a decreased likelihood of surface water discharge from the subject site causing downstream flooding.

As noted above, there are no recorded flood events in the vicinity of the site. With no recorded flood events prior to the development, and a reduced likelihood as a result of the development, the likelihood can be considered low.

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:

As noted in Section 4.3.3, above, the existing site is effectively 100% paved, and through the inclusion of SuDS features such as permeable paving, swales, fitter drains and attenuation storage the development as designed will increase the permeable area of the site. As such, there will be no increase in hardstanding area as a result of the proposed development. There is no likelihood of increased overland flooding from the site leading to downstream flooding. The likelihood is considered low.

4.4 Consequence

Surface water flooding could impact the partial basement and lower ground floor levels, which includes plant, communication and storage rooms, the gym including reception, storage and changing rooms, a TRX/yoga/pilates studio, bicycle storage, residential units, laundry rooms, living/kitchen/dining rooms as well as the surrounding landscaped areas. The consequences of pluvial flooding are considered high.

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 a high consequence of flooding the site from surcharging the on-site drainage system, the resultant risk is extremely high.

4.5.2 Surcharging from the existing surrounding drainage system:

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

4.5.3 Surface water discharge from the subject site:

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

4.5.5 Overland flooding from the subject site:

With a low likelihood and high 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 pathway:

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 permeable paving in the courtyard will ensure that portions of the site act as soft scape, significantly slowing and reducing the amount of surface water runoff. Planter boxes and planted areas will also take surface water runoff from the down pipes fronting onto the courtyard. Permeable paving provides some treatment volume.

Sedum roofing is proposed for approximately 30% of the roof area. The paved areas on the roof will drain to the planted areas. The substrate and the plant layers in a green roof absorb large amounts of rainwater and release it back into the atmosphere by transpiration and evaporation, thus significantly reducing surface water runoff during storm events.

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 or similar approved flow control device will provide a greenfield runoff limited to 2l/s, with excess storm water to be attenuated in a privately managed and maintained underground tank to limit the runoff from the site and minimise the discharge rate into receiving waters.

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:

In order to mitigate the risk of the lower ground floor flooding due to water backing up into the new onsite drainage system, non-return valves will be provided in the last manholes on site to prevent the public sewers from surcharging into the private drainage system.

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.

4.6.4 Overland flooding from surrounding areas:

The risk from overland flooding from surrounding areas is low. The partial basement and lower ground floor levels will be suitably tanked to prevent ingress of water.

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.

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 the underground services, the partial basement and lower ground floor of the building and open areas within the proposed development.

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 low groundwater vulnerability.

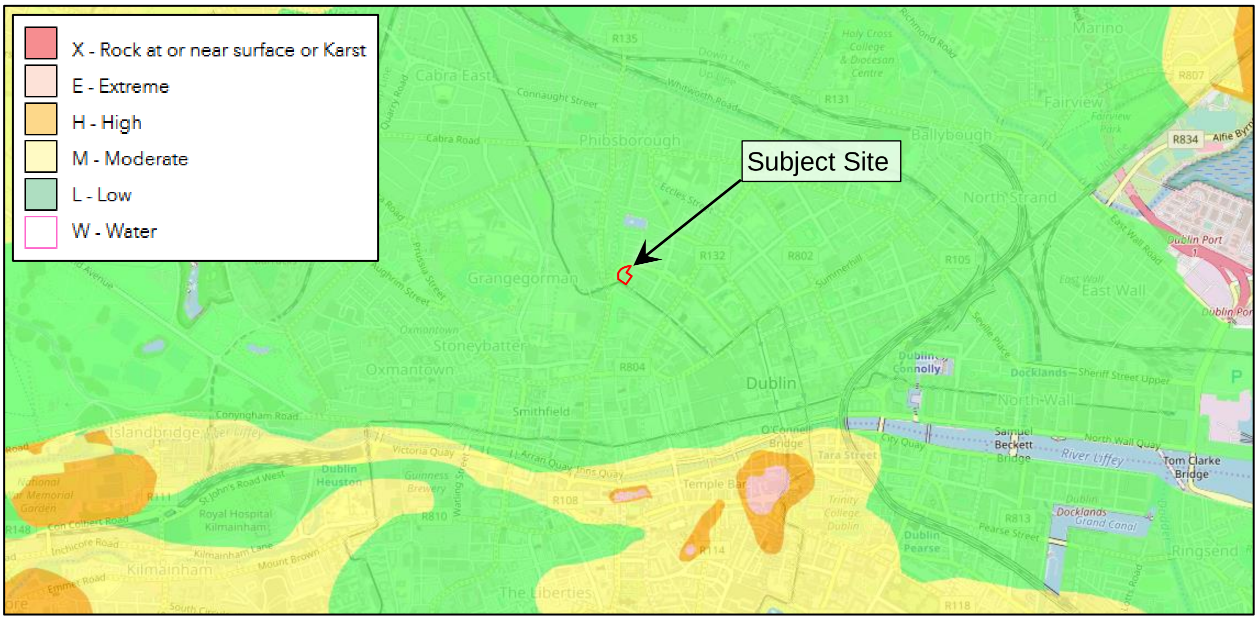


***Figure 5** | Groundwater Vulnerability Map*

The site also lies within an area of low subsoil permeability, as shown on the GSI Groundwater Subsoil Permeability map extracted below:

Figure 6 | *Groundwater Subsoil Permeability*

If the lowest excavations of a below ground development extend below the perched water seepages, the development could form a barrier to groundwater flow, particularly if it is contiguous with adjacent basements producing a cumulative impact.

The partial basement and the proposed lower ground floor are adjacent to the existing road (set back at least 1m from the site boundary) and to an open courtyard. Thus, in this instance the proposed partial basement is not contiguous, as it sits away from potential neighbouring basements.

Site investigation were carried out at the site by Ground Investigation Ireland in August 2019. The investigations included seven trial pits, up to 3m deep. No groundwater was encountered at any of the trial pits, which were to a maximum depth of 3.0m, while the excavations for the lower ground floor will extend to c. 1.2m below ground level.

With the entire site falling within an area with low groundwater vulnerability, and with no groundwater encountered during site investigations, the likelihood of groundwater rising through the ground and causing potential flooding on site during prolonged wet periods is low.

5.5 Consequence

The consequence of ground water flooding would be some minor temporary seepage of ground water through the ground around the proposed building and landscaped areas. Underground services could be inundated from high water tables. Over time, groundwater could seep into the lower ground floor. Therefore, the consequence of ground water flooding occurring at the proposed development is considered moderate.

5.6 Risk

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

5.7 Flood Risk Management

The building's design will incorporate suitable damp proof membranes to protect against damp and water ingress from below ground level. To mitigate the risks of groundwater entering the partial basement or lower ground floor they must be adequately waterproofed. Any penetrations through the partial basement or lower ground floor wall or slab must also be appropriately sealed to prevent ingress of groundwater.

If the partial basement is determined to extend beneath the water table level, a granular blanket can be installed surrounding the structure. This will allow groundwater to seep around the building, maintaining any long-term sub-surface perched water movement. This will minimise the effect that the proposed partial basement will have on the local water table, mitigating the risk to surrounding areas including basements in the vicinity of the site.

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 connected to the existing combined sewer network. The internal surface water network is a source of possible flooding were it to become blocked.

6.2 Pathway

If the public drainage network in the vicinity of the site were to block this could lead to possible flooding within the private areas, the partial basement and the lower ground floor. If the proposed private drainage system blocks this could also lead to possible flooding within the private areas, the partial basement and the lower ground floor.

6.3 Receptor

The receptors for flooding due to human/mechanical error would be the basement, the lower ground floor of the building and the open landscaped areas around the building.

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 4.6, non-return valves will be provided in the last manholes on site to prevent the public sewers from surcharging into the private drainage system if the surface water network were to block.

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 Dublin Bay and from the River Liffey, fluvial flooding from the River Liffey, 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	*Dublin Bay or River Liffey*	*Proposed development*	*Extremely low*	*None*	*Negligible*	*None*	Negligible
Fluvial	*River Liffey*	*Proposed development*	*Extremely low*	*None*	*Negligible*	*None*	Negligible
Pluvial	*Private & Public Drainage Network*	*Proposed development, downstream properties and roads*	*Ranges from low to high*	*High*	*Ranges from low to extremely high*	*Appropriate drainage, SuDS and attenuation design, non-return valves*	Low
Ground Water	*Ground*	*Underground services, basement and ground level of building*	*Low*	*Moderate*	*Low*	*Damp proof membranes, adequate waterproofing at the basement and lower ground floor level, sealing of all openings in the lower ground floor, installation of granular blanket around building*	Low
Human/ Mechanical Error	*Drainage network*	*Proposed development*	*High*	*Moderate*	*High*	*Non-return valves, 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