Waterman Moylan
Engineering Consultants

Flood Risk Assessment

Strategic Housing Development in Kilnahue, Gorey, Co. Wexford

March 2022

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This document has been prepared and checked in accordance with
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Issue	Date	Prepared by	Checked by	Approved by
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Comments

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1. Introduction

1.1 Context

This Flood Risk Assessment has been prepared by Waterman Moylan as part of the documentation in support of a planning application for a site in Kilnahue, Gorey, Co. Wexford. An application for planning permission was previously submitted in June 2016, planning Reg. Ref. 20160623, and following a subsequent Further Information request planning was granted, with a final decision date of 20 February 2017. However, the application was subsequently refused by An Bord Pleanála on 18 July 2017, reference PL26.248159. The reasons for refusal included inadequate provision of open amenity space in accordance with the Local Area Plan, insufficient residential density and uncertainty regarding road and junction upgrade works at the adjacent Kilnahue Lane and Carnew Road. The subject application addresses these reasons for refusal.

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 at the west of Gorey, Co. Wexford, with access to the site at the north from Gorey Hill/Kilnahue Lane and at the south-west from Carnew Road (R725). The site is bounded by agricultural lands to the west, by Carnew Road (R725), residential properties and agricultural lands to the south and east, and by Gory Hill / Kilnahue Lane to the north. The site location is indicated in the Figure below:

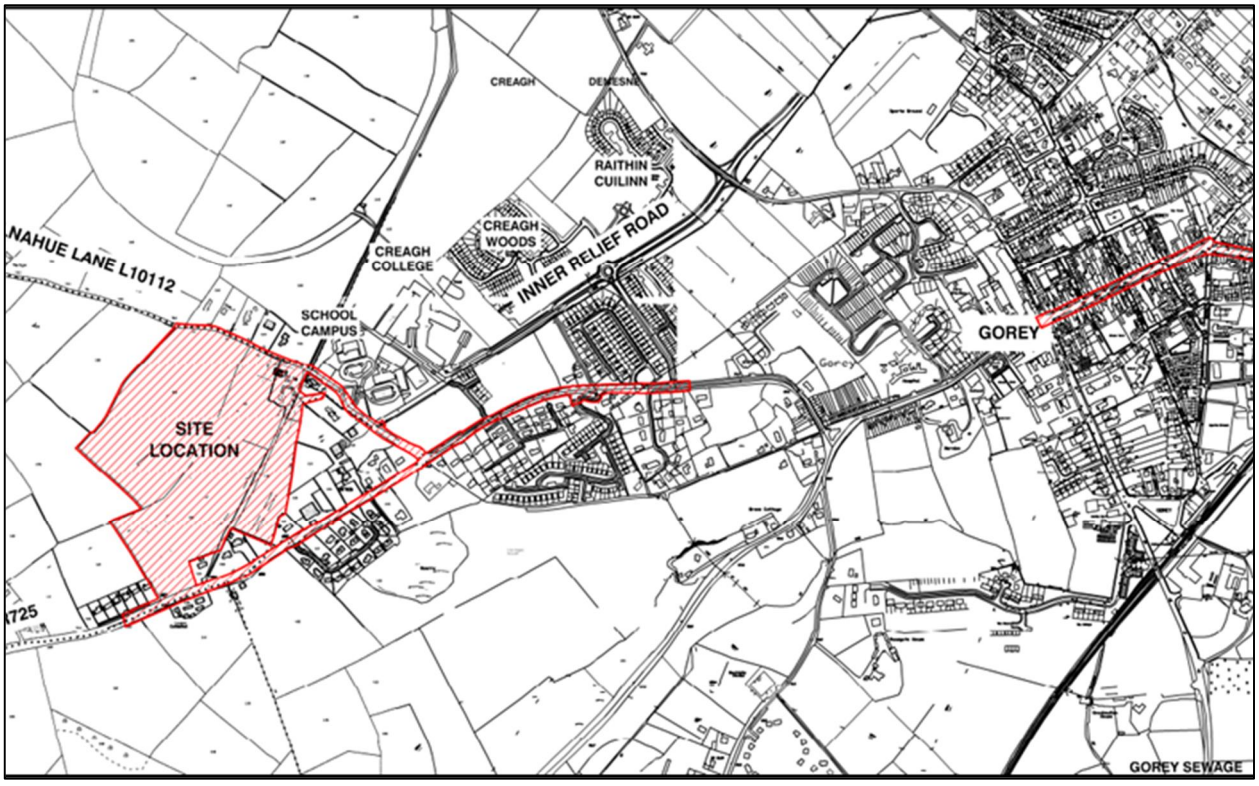

Figure 1 | *Site Location (Image Source: Google Maps)*

The subject site is a greenfield site, currently used for agricultural purposes. Topographic survey data shows that the site falls generally from west to the east, from a high point of approximately 133.5m OD Malin at the west of the site to a low point of approximately 101.5m OD Malin at the east. There is a surface water ditch at approximately 97.50m OD Malin to the east of the site which drains the site to the Banogue River.

The proposed development consists of a total of 421 residential units, comprising of 133 houses, 228 apartment units and 60 duplex units, a crèche, two retail units and community rooms. The schedule of accommodation is set out in the Table below:

Description	1-Bed	2-Bed	3-Bed	4-Bed	Total
Houses	-	-	115	18	133
Apartments	76	145	7	-	228
Duplexes	4	26	30	-	60
Crèche	565m²				-
Retail	210m²				-
Total	**80**	**171**	**152**	**18**	**421**

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

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 ï flooding from high sea levels
- Fluvial ï flooding from water courses
- Pluvial ï flooding from rainfall / surface water
- Groundwater ï flooding from springs / raised groundwater
- Human/mechanical error ï 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 ólikelihoodôand óconsequencesôvalues 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. Tidal Flooding

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 nearest coastline to the subject site is the Irish Sea at Courtown, approximately 6.9km south-west of the site. The pathway for tidal flooding is from the Irish Sea.

2.3 Receptor

Were tidal flood waters to reach the site, the receptors would be low lying portions of the proposed site, including public open spaces and roads.

2.4 Likelihood

Topographic survey levels indicate that the site slopes generally from west to east, from a high point of approximately 133m OD Malin to a low of approximately 102m OD Malin.

The Irish Coastal Protection Strategy Study, Phase II, indicates that the historic high tide event reached 2.95m OD Malin. The subject site is therefore at least 99m above the highest tide event.

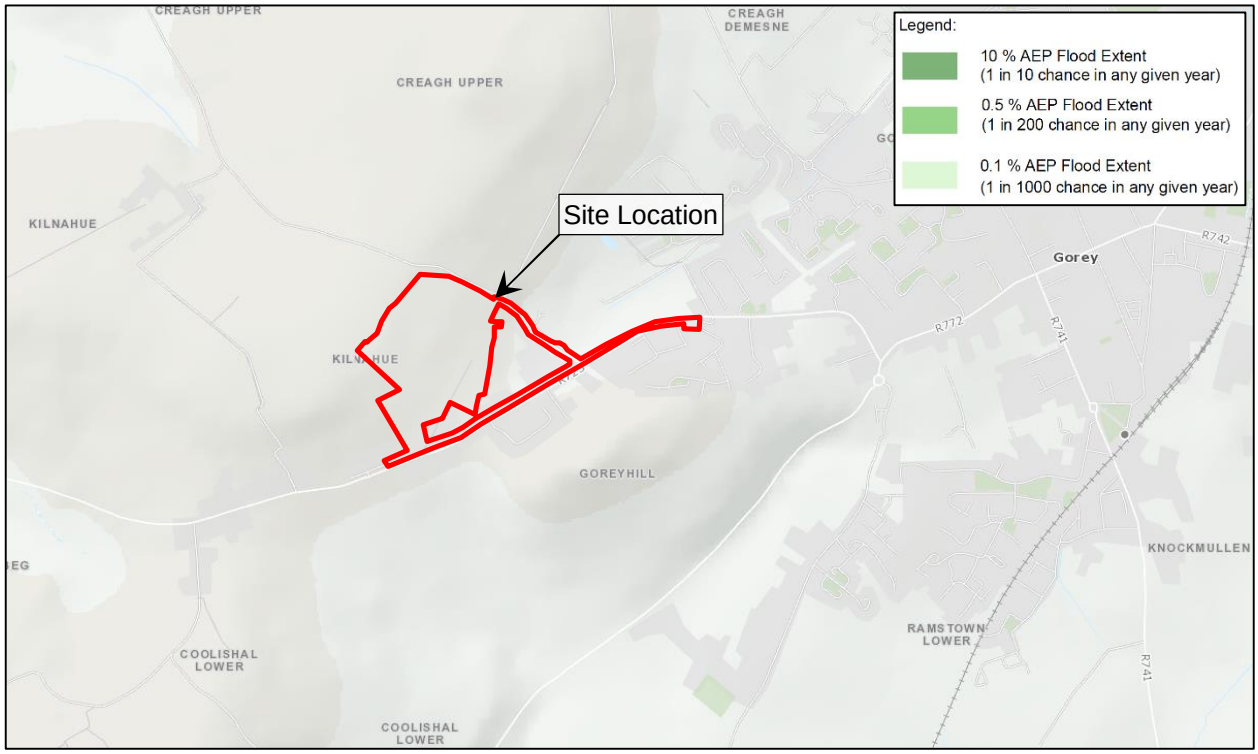

***Figure 2** | Extract of OPW's Coastal Flood Extents Map*

The Office of Public Works (OPW) have developed national flood maps as part of the Catchment Flood Risk Assessment and Management (CFRAM) Programme, which have been consulted as part of this flood risk assessment and are extracted above. High probability flood events, as indicated on the 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).

These maps do not indicate any tidal flood risk in the vicinity of the site, and the Banoge River is not influenced by the tide this far upstream.

Given that the site is located 6.9 kilometres inland from the nearest coastline and that there is at least a 99m level difference between the subject lands and the high tide, it is evident that a pathway does not exist between the source and the receptor. A risk from tidal flooding is therefore negligible and no flood mitigation measures need to be implemented.

3. Fluvial Flooding

3.1 Source

Fluvial flooding occurs when a riverôs 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 site falls within the catchment area of the River Banoge, approximately 2.1km to the east of the proposed development. There is a ditch at approximately 97.50m OD Malin to the east of the site, which drains to an existing drainage channel located along Kilnahue Lane. Approximately 100m short of the Kilnahue Lane/Carnew Road junction, the channel turns to run parallel to Carnew Road collecting the runoff from the surrounding greenfield lands, subsequently running parallel to Pearsonôs Brook Road and ultimately discharging to the Banoge River.

Another roadside ditch is located along Carnew Road, falling eastwards. West of the subject site the ditch runs along the southern side of Carnew Road, crossing to the northern side of Carnew Road approximately 60m west of the site entrance. Runoff from the subject site currently drains to the existing drainage channel to the north-east of the site along Kilnahue Lane rather than to the ditch along Carnew Road.

Fluvial flood extent maps, developed as part of the Catchment Flood Risk Assessment and Management (CFRAM) Study and made available on the OPWôs 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:

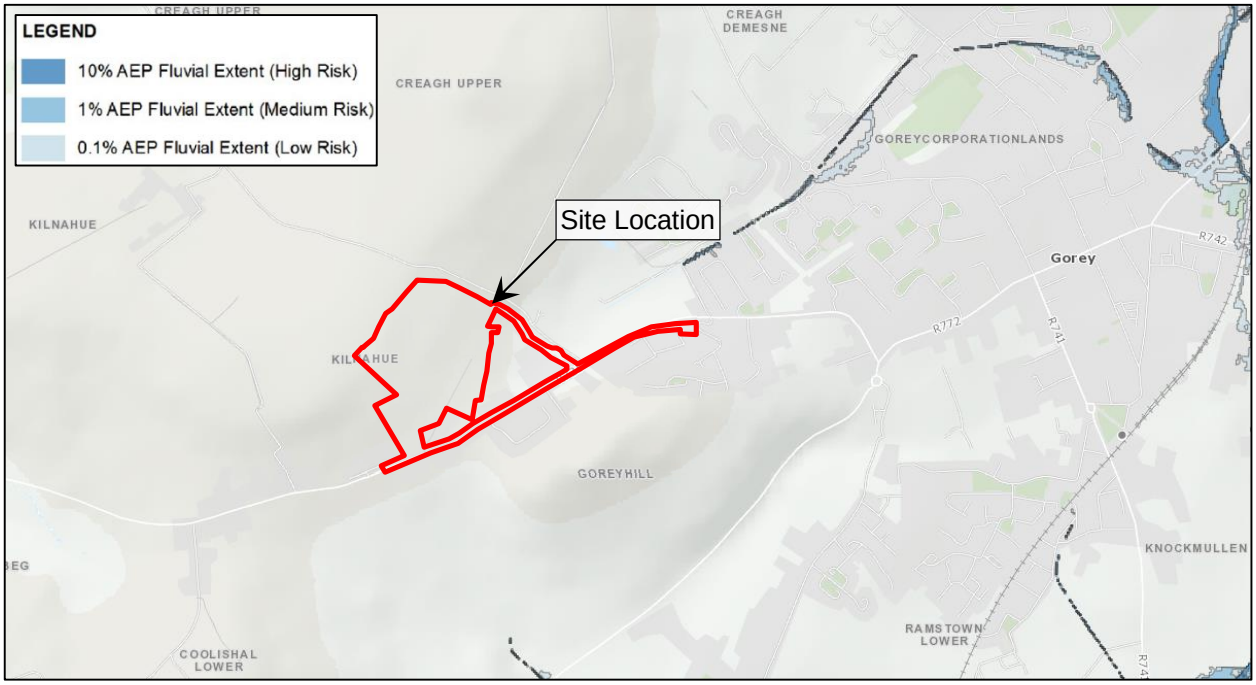

Figure 3 *| Extract of OPW's Fluvial Flood Extents Map*

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 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.

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 Flooding

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 ï 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 ï 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 ï 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:

4.3.2 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 5 years. Thus, the likelihood is high.

4.3.3 Surcharging from the existing surrounding drainage system:

The Office of Public Works (OPW) records for predictive and historic flood maps and benefiting land maps have been consulted with regard to recorded flood events in the vicinity of the subject site, and are extracted below. There are recurring flood events at Gorey Garden City and at the Gorey Arklow Road railway bridge, while a single flood event occurred at Esmonde Street in August 1986.

These historic flood events are all more than 1.5km east of the subject site. Furthermore, each of these events are the result of fluvial flooding from the Banoge River. There are no recorded flood events attributed to surcharging from the surrounding drainage system.

Topographic survey levels indicate that the site slopes generally from west to east. West of the site are agricultural lands. With minimal hardstanding area upstream of the site and no historic flood events in the area attributed to surcharging from the surrounding drainage system, the likelihood is considered low.

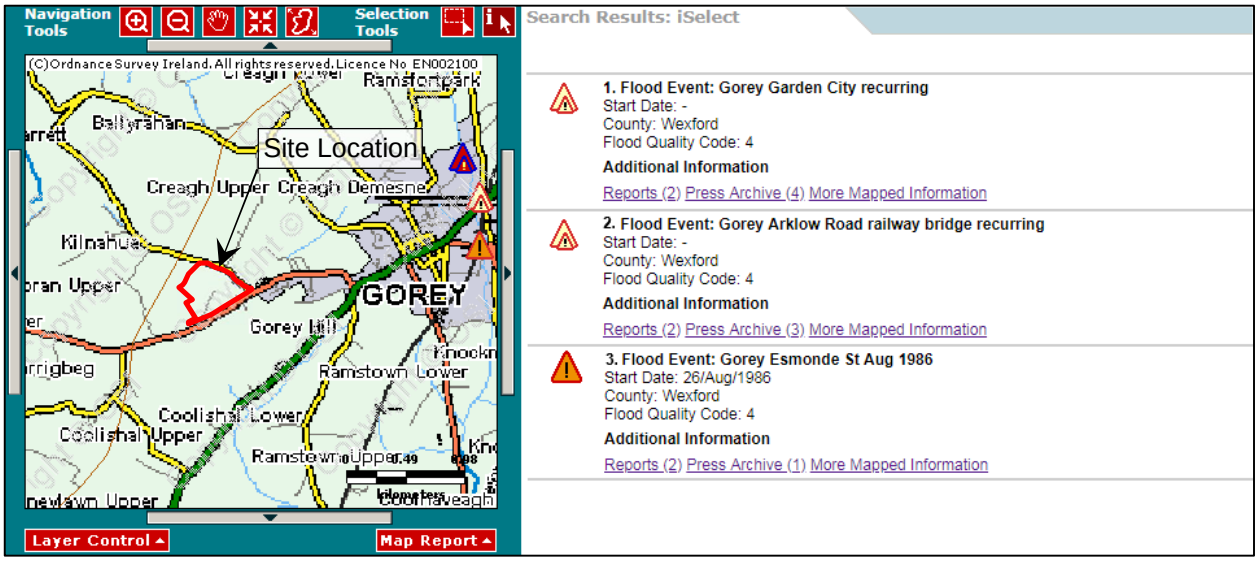

***Figure 4** | OPW Land Benefiting Maps and Historic Flood Maps*

4.3.4 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.

4.3.5 Overland flooding from surrounding areas:

As noted in Section 4.3.2 above, the OPW records for predictive and historic flood maps and benefiting land maps have been consulted with regard to recorded flood events in the vicinity of the subject site. With no recorded flood event in the immediate area that could have an impact on the subject site, it is considered that there is a low likelihood of flooding from surrounding areas.

4.3.6 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. Flooding from the site could impact downstream properties and roads. 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 permeable paving in private driveways will ensure that portions of the site act as soft scape, significantly slowing and reducing the amount of surface water runoff.

Furthermore, a hydro-brake provides a greenfield runoff limited to 2l/s/Ha, with excess storm water to be attenuated in two underground tanks located in the public open space at the north-east of the development. This will limit the runoff from the site and minimise the discharge rate into receiving waters.

These proposed source and site control devices will intercept and significantly slow down the rate of runoff to the on-site drainage system, reducing the risk of surcharging. 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 to the proposed buildings from surcharging of the existing surface water network is mitigated by setting finished floor levels at least 200mm above the adjacent road channel line.

Overland flood routing has also been incorporated into the development. The overland flood route directs flood water towards open spaces and away from buildings. Refer to the Overland Flood Routing Drawing included in Appendix A of this report.

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. Raised finished floor levels and overland flood routing 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.

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 systemôs 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, buildings and road 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, rock is at or near the surface, or there is Karst topography, at the north-west portion of the site, while the remainder of the site has high or extreme groundwater vulnerability.

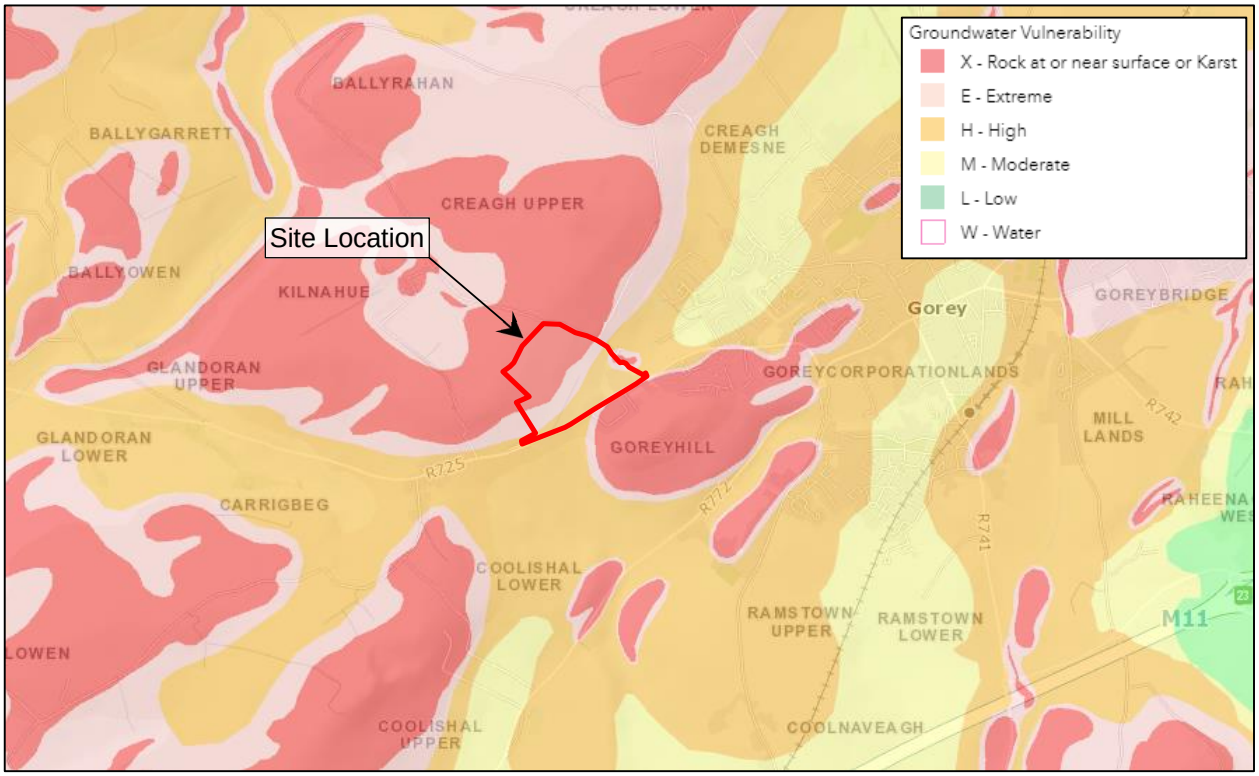

Figure 5 *| Groundwater Vulnerability Map*

It is possible for ground water to rise and cause potential flooding on site during prolonged wet periods. Thus, the likelihood of groundwater flooding is considered 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 and landscaped areas. Underground services could also 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 consequence of groundwater flooding, the resultant risk is high.

5.7 Flood Risk Management

Finished floor levels have been set at least 200mm above the adjacent road channel line to ensure that any seepage of ground water onto the development does not flood into the houses. In the event of ground water flooding on site, this water can escape from the site via overland flood routing.

To alleviate the risk to buildings, all service ducts and voids in ground floor walls shall be properly sealed to prevent the ingress of groundwater. The buildingsô 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 lands will be drained by an internal private storm water drainage system connected to the existing surface water network. 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 proposed housing units and roads.

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

In the event of the surface water system surcharging, much of the surface water can still escape from the site by overland flood routing, as described in Section 4.6.2, without causing damage to the proposed buildings. The risk to the surrounding buildings is mitigated by setting finished floor levels at least 200mm above the adjacent road channel line.

The surface water network (drains, gullies, manholes, AJs, SuDS devices, attenuation system) will need to be regularly maintained and where required cleaned out. A suitable maintenance regime of inspecting 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 flooding from the Irish Sea, fluvial flooding, 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*	*Proposed roads and open spaces*	*Extremely Low*	*None*	*Extremely Low*	*None*	Extremely Low
Fluvial	*Banoge River, surrounding ditch system*	*Proposed roads and open spaces*	*Extremely Low*	*None*	*Extremely Low*	*None*	Extremely Low
Pluvial	*Private and Public Drainage Network and Overland*	*Proposed roads & buildings, and downstream properties and roads*	*Ranges from Low to High*	*Moderate*	*Ranges from Low to High*	*Appropriate drainage and SuDS design, overland flood routing and setting of floor levels*	Low
Ground-water	*Ground*	*Underground Services, Roads & Buildings*	*High*	*Moderate*	*High*	*Appropriate setting of floor levels, flood routing, damp proof membranes*	Low
Human/ Mechanical Error	*Drainage network*	*Proposed Roads & Buildings*	*High*	*Moderate*	*High*	*Overland flood routing, setting of floor levels and 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.

Appendices

A. Overland Flood Routing Drawing

UK and Ireland Office Locations