Flood Risk Assessment

Cherry Orchard Point – Phase 2 of Proposed Development at Sites 4 and 5, Park West Avenue, Dublin 10

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Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
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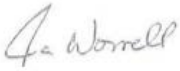
Issue	Date	Prepared by	Checked by	Approved by
1	30 January 2025	P Ingle	I Worrell	

Comments

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We disclaim any responsibility to the Client and others in respect of any matters outside the scope of the above.

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Content

Figures

Tables

1. Introduction

This Flood Risk Assessment has been prepared by Waterman Moylan as part of the planning documentation for the proposed Phase 2 development at Cherry Orchard Point Sites 4 and 5, Park West Avenue, Dublin 10.

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.

This report has further been prepared in accordance with, or cognisant of as appropriate, with the following documents:

- Ordnance Survey Mapping
- Dublin City Council Development Plan (2022-2028).
- Park West & Cherry Orchard LAP.
- Ground investigation details as per the Site Investigation Report.
- Site Specific Topographic Survey.
- Archer Heritage & Planning: Archaeological Testing Report.
- Building Regulations Technical Guidance Document Part H.
- Dublin City Council's SuDS Design and Evaluation Guide.
- Dublin City Council's Green and Blue Roof Guide.
- The SuDS Manual.
- Greater Dublin Strategic Drainage Study.
- Green Roofs Over Dublin: A Green Roof Policy Guidance Paper for Dublin.
- Greater Dublin Regional Code of Practice for Drainage Works.
- OPW Guidelines.
- OPW flood maps.
- Department of Environment Flooding Guidelines.
- Geological Survey of Ireland maps.
- Dublin City Council's Climate Action Plan 2019-2024.
- Strategic Flood Risk Assessment Guidelines.
- OPW Vulnerability Classifications Guidelines.
- OPW National Flood Hazard Maps.
- Dublin City Council's Surface Water Management Plan.

The objective of this site-specific Flood Risk Assessment is to assess all types of flood risk to a development. The assessment investigates potential sources of flood risk and include for the effects of climate change. The assessment examines the impact of the development and the effectiveness of flood mitigation and management procedures proposed. It should also present the residual risks that remain after those measures are put in place. This approach is based on the identification of flood zones for river and coastal flooding. “Flood Zones” are geographical areas used to identify areas at various levels of flood risk. It should be noted that these do not consider the presence of flood defences, as the risks remain of overtopping and breach of the defences.

2. Masterplan Lands

2.1 Cherry Orchard Point Site Location and Description

The subject masterplan development is comprised of 2 no. sites. Site 4 & Site 5 are bisected by Park West Avenue and lie to the west and east of this roadway respectively, as per the blue boundary lines indicated on Figure 2-1: Site Location Map (Source: Google Maps). The proposed Phase 2 Subject Site is located within Site 4 of the masterplan development.

The 2022 and 2024 Site Investigation Report undertaken by Ground Investigations Ireland (GII), included as an appendix to the Preliminary Construction Environmental Management Plan submitted under a separate cover, has determined that Site 4 is combination of Greenfield and Brownfield, with evidence of fill material in the area of the site previously used as a construction compound. Site 5 is predominantly a brownfield site, with fill material found for the same reason.

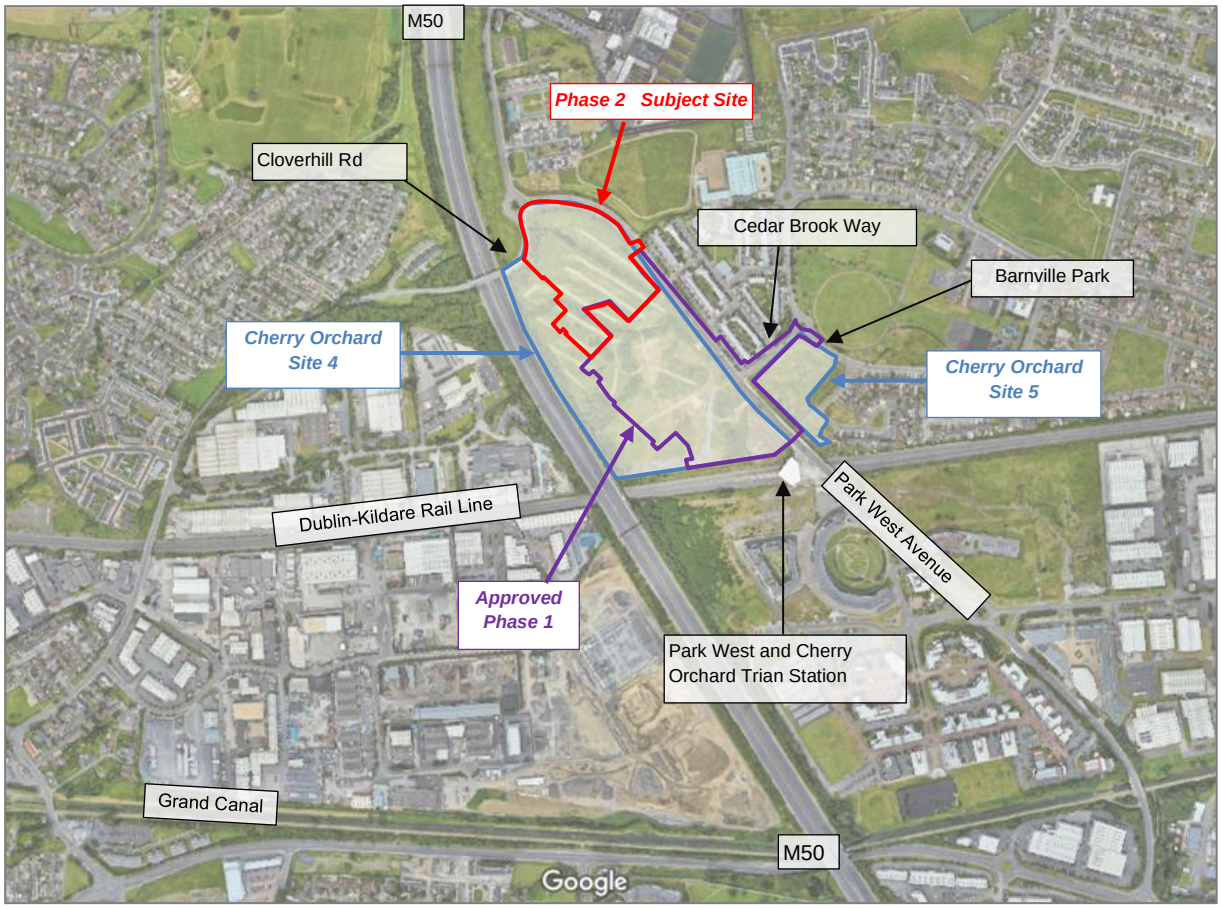

Figure 2-1: Site Location Map (Source: Google Maps)

Site 4 is bound to the west by the M50, to the south by the Dublin-Kildare rail line and the Park West & Cherry Orchard station, and to the east and north by Park West Avenue. Site 5 is bound to the west by Park West Avenue, the northwest by Cedar Brook Way, the northeast and east by Barnville Park, and to the south by the Dublin-Kildare rail line and the residential unit of 62 Barnville Park.

Site 4 is currently access via a secured gate from Park West Avenue. Site 5 is accessed via a similar arrangement from Cedar Brook Way.

The overall masterplan development area as per the blue line boundaries is c. 13.02ha, with Site 4 being c. 11.41 ha and Site 5 being c. 1.61ha. The area of the subject application indicated by the redline boundary, including for works in the public domain, is 3.185ha (31,850m²).

2.2 Indicative Phasing

The indicative phasing of the 4-phase masterplan development is illustrated in Figure 2-2: Indicative Masterplan Development Phasing Layout, below.

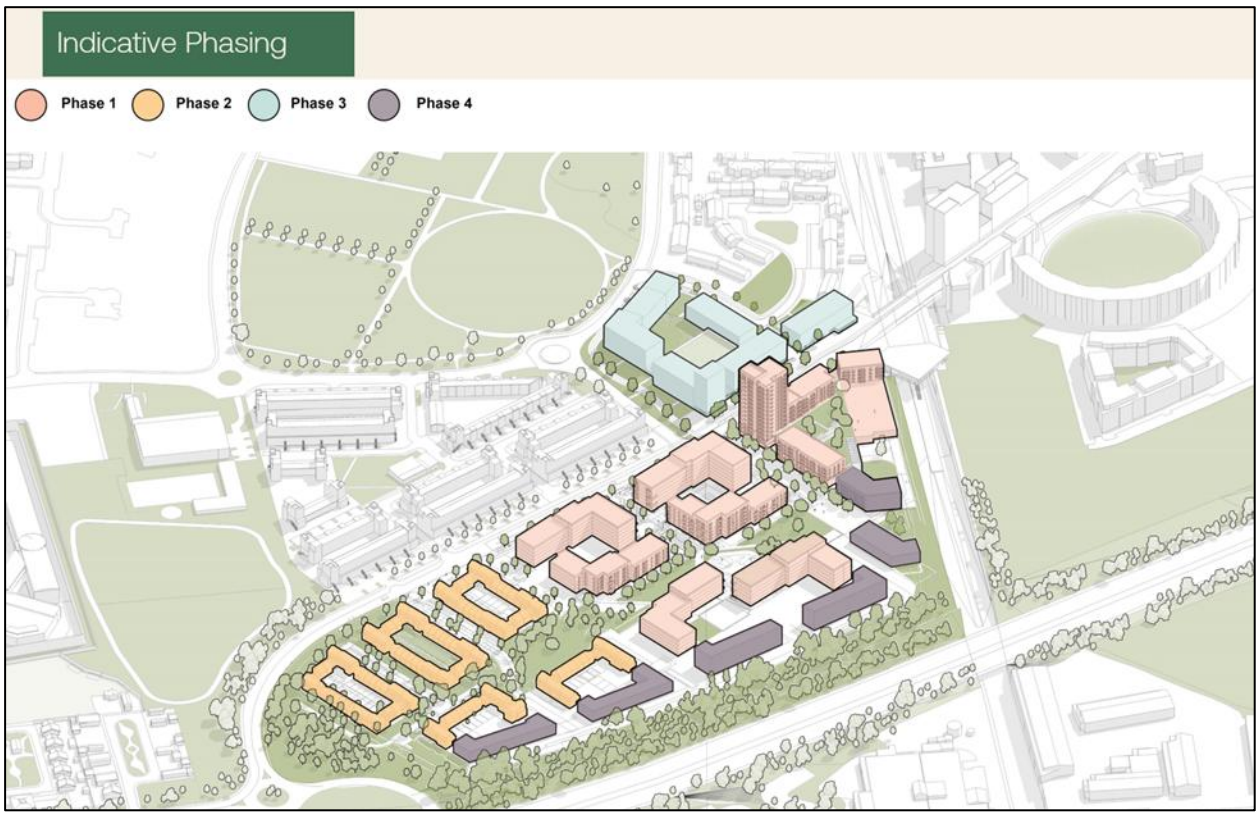

Figure 2-2: Indicative Masterplan Development Phasing Layout

2.3 Proposed Masterplan Development

A description of each of the 4-Phases is included below:

Approved Phase 1

Is a medium and high-density area located on Site 4 which will provide a total of 708 no. residential units ranging in size from studio to 3-bed apartments, a 2,523m² supermarket, a combined area of 373m² for retail over 7 units, a 672m² creche and 1,222m² of community spaces over 13 buildings. It is noted that the trunk foul and surface water drainage, including attenuation storage, to serve phases 2, 3, & 4 are part-provided under the planning application submission for Phase 1.

Phase 1 of Cherry Orchard Point was approved in July 2024 under ABP Ref. ABP-318607-23.

Phase 2 (Subject Site)

The subject development, Cherry Orchard Point - Phase 2, is a low-density housing area located to the north of Site 4 and is proposed to contain 137 no. residential units comprising a mix of apartment/duplex units and houses.

The subject development, Cherry Orchard Point – Phase 2 will be referred to as the "Phase 2" development or subject site within this report.

Phase 3

Is located on Site 5, and comprises 254 residential units, 1,200m² of retail space, with community facilities to be confirmed.

Phase 4

Is located on Site 4 and will consist of the construction of commercial office space over 6 blocks with a total area of c. 16,310m².

2.4 Topographical Details

The Phase 2 Subject Site is located within Site 4 of the masterplan development (refer to Figure 2-1). An updated Site Investigation Report undertaken by Ground Investigations Ireland (GII) in July of 2024 has determined that Site 4 is combination of Greenfield and Brownfield, with evidence of fill material in the area of the site previously used as a construction compound. Site 5 is predominantly a brownfield site, with fill material found for the same reason.

For Site 4, the topographic survey of the area indicates that the low point of the site has a level of 55.70m OD. This is located on the eastern site boundary approximately 140m north of the junction of Park West Avenue and Cedar Brook Way. The remainder of the site generally slopes to this location owing to the embankments and subsequent site grading from the Dublin-Kildare Rail line to the south, M50 to the west, and approach road to the overpass on the M50 to the north. A local high point of the site has a level of 62.65m OD located at the northeast of Site 4.

Site 5 has a central high point with a level of 58.05m OD, and slopes outwards to all boundaries. The boundaries of Site 5 typically have levels between 54.80m and 56.00m, with the higher of these levels being located to the south of Site 5, adjacent to the retaining wall of the Park West Avenue Bridge over the rail lines.

Refer to Figure 2-3: Existing Site Topography of Masterplan Lands for an extract of the topographical survey of the development showing spot elevations throughout Sites 4 and 5.

It is noted that the existing low points of Site 4 are generally located along Park West Avenue on the east and southeast of the site, a secondary isolated low area within the Site 4 boundary is located centrally within the northern portion of the Phase 1 site (55.54m OD).

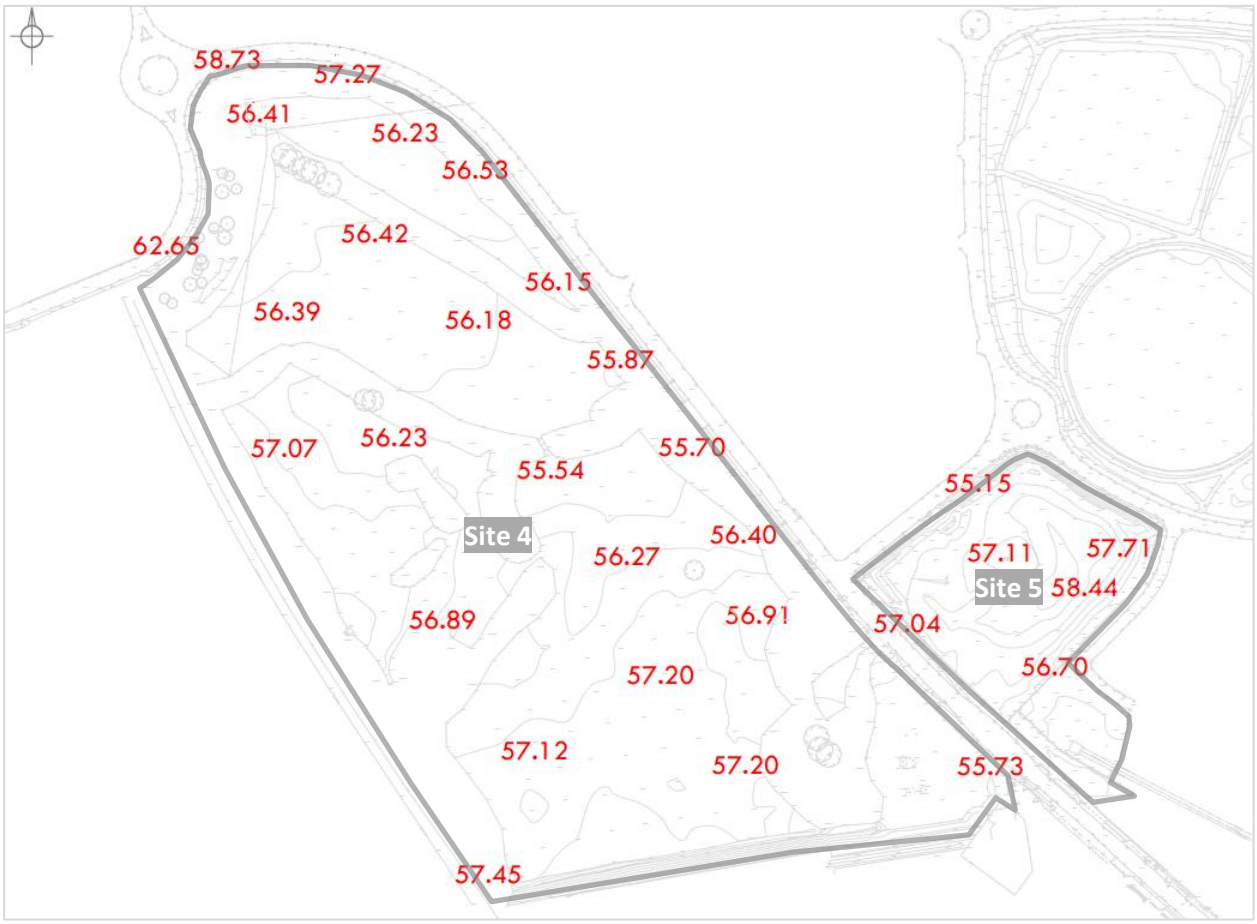

Figure 2-3: Existing Site Topography of Masterplan Lands

3. Proposed Development

3.1 Subject Site Description and Location

The proposed Phase 2 development located on lands at Cherry Orchard, Dublin 10 (known as Development Site 4 in the Park West Cherry Orchard Local Area Plan 2019) is on a site of c. 3.185 hectares.

The Phase 2 Subject Site is bound by Cloverhill Road to the north, Cedar Brook Avenue and Park West Avenue to the east, the consented Phase 1 development (Bord. Ref: ABP-318607-23) to the south, and the M50 motorway to the west. The development will consist of the construction of a residential scheme containing 137no. residential dwellings (comprising 31no. 2-bedroom units, and 106no. 3-bedroom units) through a mixture of houses, duplex units and own-door apartments. The proposed development will include a new access road connecting to the entrance point at Park West Avenue as permitted under the Phase 1 scheme, new internal streets, landscaped public and communal open space, a new pedestrian connection to Cloverhill Road and all associated site and development works. The proposed development represents Phase 2 of the overall planned development for Development Sites 4 and 5 of the LAP lands. Phase 1 of the overall planned development was granted permission in July 2024 (Bord. Ref: ABP-318607-23). The proposed development (GFA of c. 13,280sqm) involves the construction of 137no. dwellings in a mix of houses, duplexes and own-door apartments ranging in height from 2 to 3 storeys comprising 31no. two-bed units (9no. two-bed three-person and 22no. two-bed four-person) and 106no. three-bed units (13,015 sqm total residential floor area), and all ancillary accommodation including bike and bin stores and ESB substation (265sqm total GFA). The proposed development also includes the provision of 2,133sqm landscaped public open space, in addition to 2,050sq.m of public open space as consented under the Phase 1 permission (Bord. Ref: ABP-318607-23).

The total public open space provided for Phase 2 totals 4,183 sqm (12.34% of the net site/development area (3,390ha) of Phase 2 lands). Communal open space for the duplex and apartment units is provided across three dedicated communal amenity areas (602sq.m in total area) with private open space to serve the proposed units to be delivered through a mixture of rear gardens and terraces.

The proposed development will also involve the provision of 141no. car parking spaces at curtilage and street level throughout the development, of which 7no. are accessible spaces and 71no. EV charging points (representing 50% of the total parking spaces). A total of 306no. bicycle parking spaces, of which 18no. are visitor spaces accommodated through a mixture of bike stores and external cycle parking stands. A total of 7no. motorbike parking spaces are also provided. Vehicular, pedestrian and cycle access routes to serve the proposed development are provided via the consented Phase 1 entrance to the east of the site along Park West Avenue with further connections provided to the north and to the south to the permitted Phase 1 scheme. Provision is also made for the installation of a signalised access junction with associated traffic lights and below ground infrastructure and the relocation of bus stop and shelter along Park West Avenue. The need to provide a signalised junction requires minor alterations to the entrance to the development including adjustment to the paving as previously permitted under the Phase 1 scheme (no further amendments to that permission are proposed under this application.) The proposed development also includes the provision of off-street cycle lanes along Park West Avenue that will provide direct connectivity to the Rail Station to the southeast and Cherry Orchard Park to the east.

The development will also provide for all associated ancillary site development works including site clearance, boundary treatment, associated public lighting, internal roads and pathways, bin and bike stores, ESB substation, hard and soft landscaping, play equipment, and all associated works and infrastructure to facilitate the development including connection to foul and surface water drainage and water supply.

Refer to Figure 3-1: Location of Phase 2 within the Masterplan Development for the location of the subject development.

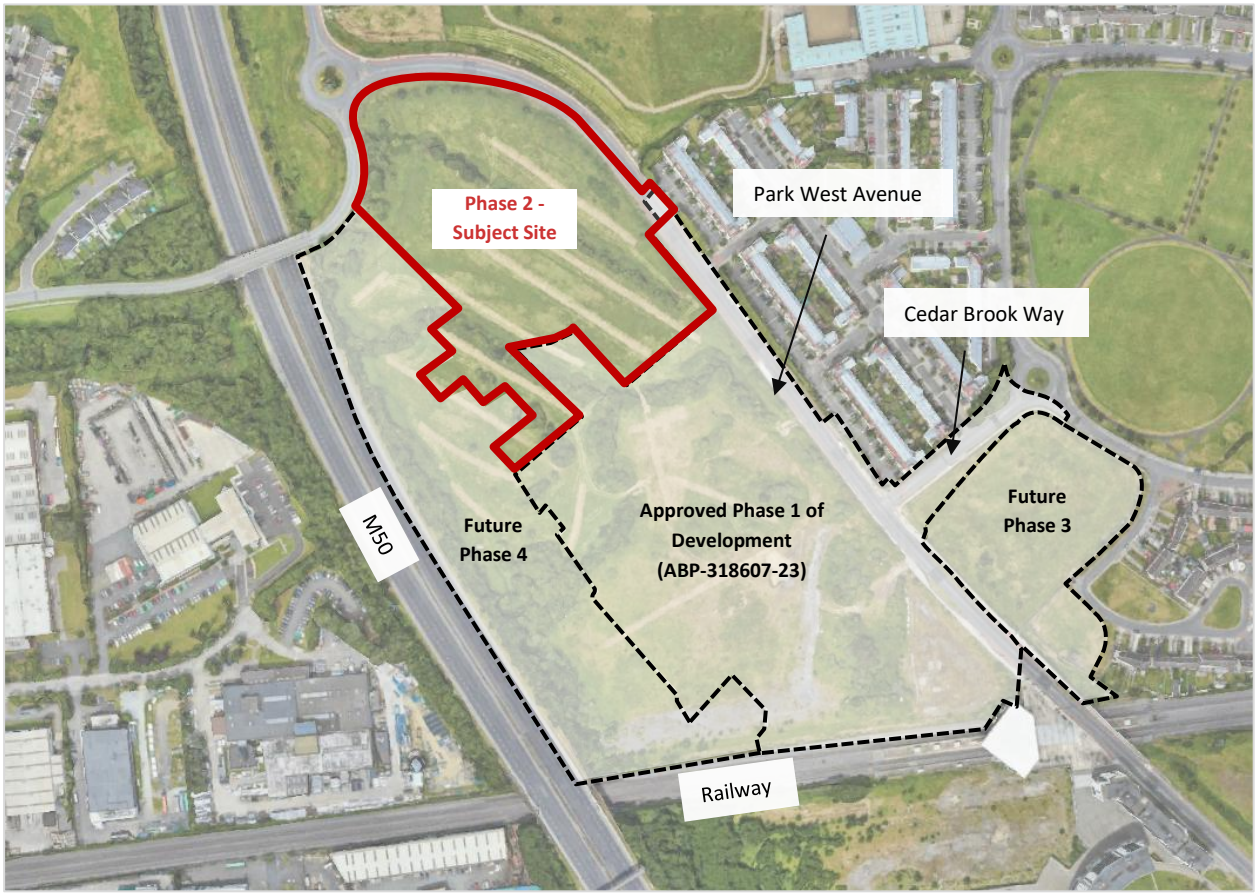

Figure 3-1: Location of Phase 2 within the Masterplan Development

3.2 Site Investigation Details and Infiltration Rates

Site investigations for the masterplan lands (including the Phase 2 Subject Site) were undertaken in 2022 by Ground Investigations Ireland (GII), the technical Ground Investigation report was completed in November 2022, and the Waste Analysis Classification report was completed in October 2022. An updated site investigation report was undertaken by GII in July 2024 for the masterplan lands (including the Phase 2 Subject Site) with an updated Waste Analysis Classification Report completed in August 2024. The current 2024 reports will be referenced here within and are submitted as part of this application as an appendix to the Preliminary Construction Environmental Management Plan.

The scope of the works undertaken in the 2024 Site Investigation Report included the following:

- 118 no. Trial Pits undertaken to a maximum depth of 3.6m BGL
- 5 no. Soakaways undertaken to determine a soil infiltration value to BRE digest 365
- 6 no. Slit trenches undertaken to determine existing services.
- 5 no. Window Sample Boreholes undertaken to recover soil samples

- 33 no. Cable Percussion boreholes undertaken to a maximum depth of 4.0m BGL
- 14 no. Rotary Core Boreholes undertaken to a maximum depth of 10.1m BGL
- Geotechnical & Environmental Laboratory testing
- Report with recommendations

Trial Pits

The trial pits were excavated using a 8T, 13T tracked or JCB 3CX excavator at the locations shown in the exploratory hole location plan in Appendix 1 of the Site Investigation Report. Notes were made of any services, inclusions, pit stability, groundwater encountered, and the characteristics of the strata encountered and are presented on the trial pit logs which are provided in Appendix 2 of the Site Investigation Report.

Soakaway Testing

The soakaway testing was carried out in selected trial pits at the locations shown in the exploratory hole location plan in Appendix 1 of the Site Investigation Report. These pits were carefully excavated and filled with water to assess the infiltration characteristics of the proposed site. The pits were allowed to drain and the drop in water level was recorded over time as required by BRE Digest 365. The pits were logged prior to completing the soakaway test and were backfilled with arising's upon completion. The soakaway test results are provided in Appendix 4 of the Site Investigation Report.

Slit Trenches

The slit trenches were excavated using 3T tracked excavator at the locations shown in the exploratory hole location plan in Appendix 1 of the Site Investigation Report. The slit trenches were sampled, logged and photographed by a Geotechnical Engineer/Engineering Geologist prior to backfilling with arisings. Notes were made of any services, inclusions, pit stability, groundwater encountered, and the characteristics of the strata encountered and are presented on the slit trench records which are provided in Appendix 3 of the Site Investigation Report.

Window Sampling

The window sampling was carried out at the locations shown in the location plan in Appendix 1 of the Site Investigation Report using a Tecopsa SPT Tec 10 percussion drilling rig. The window sampling consists of a 1m long steel tube with a cutting edge and an internal plastic liner which is mechanically driven into the ground utilising a 50kg weight falling a height of 500mm. Geotechnical or environmental soil samples can be recovered from each of the liners following logging. The window sample records are provided in Appendix 5 of the Site Investigation Report.

Cable Percussion Boreholes

The Cable Percussion Boreholes were drilled using a Dando 2000 drilling rig with regular in-situ testing and sampling undertaken to facilitate the production of geotechnical logs and laboratory testing. The standard method of boring in soil for site investigation is known as the Cable Percussion method. Standard Penetration Tests were carried out in the boreholes. The results of these tests, together with the depths at which the tests were taken are shown on the accompanying borehole records of the Site Investigation Report. The cable percussion borehole logs are provided in Appendix 6 of the Site Investigation Report.

Rotary Coring

The rotary coring was carried out by a track mounted T44 Beretta rig at the locations shown on the location plan in Appendix 1 of the Site Investigation Report. The rotary boreholes were completed from the ground surface or alternatively, where noted on the individual borehole log, from the base of the cable percussion borehole where a temporary liner was installed to facilitate follow-on rotary coring. The rotary borehole logs are provided in Appendix 7 of the Site Investigation Report.

Refer to Figure 3-2: Site Investigation Locations in Phase 2 for an extract of the 2024 GII Site Investigation test location map showing test locations in and around the subject site, Phase 2 of the Masterplan Lands.

Figure 3-2: Site Investigation Locations in Phase 2

Soakaway Design

The 2024 GII Site Investigation Report stated the following:

"*At the locations of SA A, SA B, SA C, SA D, and SA E the water level dropped too slowly to allow calculation of 'f' the soil infiltration rate. These locations are therefore not recommended as suitable for soakaway design and construction.*"

It is noted that the above referenced soakaway test locations refer to all 5 no. tests undertaken within the Masterplan Lands, 2 no. of which are located within the Phase 2 subject site, SA A and SA B.

Furthermore, the GII Site Investigation Report undertaken in 2022 contained similar findings regarding the infiltration rates of the Cherry Orchard Point Masterplan Lands, and for which were included in the approved Phase 1 parent EIAR, stating the following:

"Infiltration rates of f = 7.303 x 10^{-6} *m/s, 6.95 x* 10^{-6} *m/s and 7.262 x* 10^{-6} *m/s respectively were calculated for the soakaway locations ST06, ST10, and ST11. At the locations of ST01, ST02, ST03, ST04, ST05, ST07, ST08, & ST09, the water level dropped too slowly to allow calculation of "f", the soil infiltration rate. These locations are therefore not recommended as suitable for soakaway design and construction."*

4. Flood Risk

4.1 Introduction

The flood risk assessment of a development should be carried out in accordance with the Planning System and Flood Risk Management Guidelines for Planning Authorities (2009), published by the Department of Environment, Heritage and Local Government in conjunction with the Office of Public Works (EHLG/OPW). This document will be referred to as the 'Guidelines (EHLG/OPW)' in this report.

The types of possible flooding to be considered in the identification and assessment of flood risk are described in Chapter 2 of the Guidelines (EHLG/OPW) and are summarised below:

- Coastal – flooding from higher sea levels than normal
- Fluvial – flooding from watercourses
- Pluvial – flooding from heavy rainfall/surface water
- Ground Water – flooding from springs / raised groundwater
- Human/mechanical error – flooding due to human or mechanical error

Each type 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. An illustration of this model can be seen in Figure 4-1, taken directly from the Guidelines (EHLF/OPW).

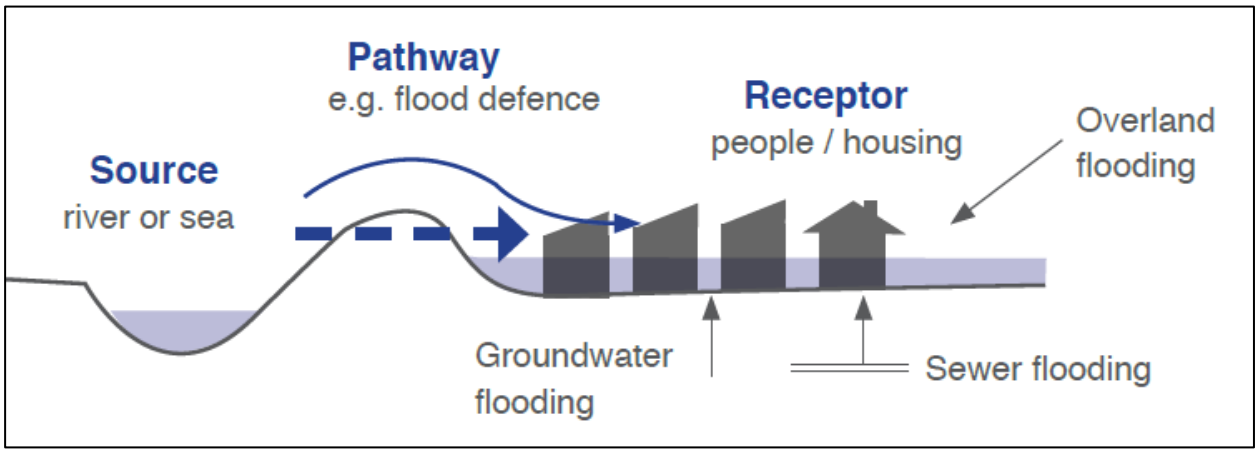

Figure 4-1: Source-Pathway-Receptor S-P-R Model

A flood risk assessment combines these above components and maps or describes the risks on a spatial scale so that the consequences can then be analysed.

The likelihood and the consequences of flooding (overall risk) fall into three categories; low, moderate and high, as described in the Guidelines (EHLF/OPW) and set out in Table 4-2.

The ultimate aim of a flood risk assessment is to establish the risk of flooding for a subject site, this can be assessed using two components, summarised below:

Flood Risk = Likelihood of flooding X Consequences of flooding

4.1.1 Assessing Likelihood

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

Table 4-1: Guidelines for Assessing Likelihood

LIKELIHOOD	LOW	MODERATE	HIGH
Coastal	Probability < 0.1%	0.5% > probability > 0.1%	Probability > 0.5%
Fluvial	Probability < 0.1%	1.0% > probability > 0.1%	Probability > 1.0%
Pluvial	Probability < 0.1%	1.0% > probability > 0.1%	Probability > 1.0%

Note: Probability denotes the likelihood of occurrence in a given year.

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

4.1.2 Assessing Consequence

There is no 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 to determine a value for consequences. Consequences will also be categorized as low, moderate, and high.

4.1.3 Assessing Risk

Based on the determined 'likelihood' and 'consequences' values of a flood event and the above equation of Flood Risk = Likelihood of flooding X Consequences of flooding, the 3x3 Risk Matrix seen in Table 4-2 will then be used to determine the overall risk of a flood event.

Table 4-2: 3x3 Risk Matrix

		NSEQUENCES		
		W	DERATE	GH
ELIHOOD	W	tremely Low Risk	w Risk	derate Risk
	DERATE	w Risk	derate Risk	gh Risk
	GH	derate Risk	gh Risk	tremely High Risk

4.2 Flood Zones

Flood zones are used to identify the likelihood, and therefore vulnerability, of flooding in a particular area. The zones are geographical areas with associated ranges of the likelihood of flooding and are essential in the creation of flood risk management plans. According to the Guidelines (DEHLG/OPW) flood zones can be categorised into 3 types or levels of flood zones, namely:

Table 4-3: Flood Zone Types according to the Guidelines (DEHLF/OPW)

Type	Description	Probability of flooding
Zone A	Where the probability of flooding from rivers and the sea is highest	Greater than 1% (1:100 year) for fluvial flooding, or greater than 0.5% (1:200 year) for coastal flooding
Zone B	Where the probability of flooding from rivers and the sea is moderate	Between 0.1% (1:1000 year) & 1% (1:100 year) for fluvial flooding, and 0.1% (1:1000 year) & 0.5% (1:200 year) for coastal flooding
Zone C	Where the probability of flooding from rivers and the sea is low	Less than 0.1% (1:1000 year) for both fluvial and coastal flooding

Flood zone maps are used to establish the level of flooding for a site, an example of this can be seen in the indicative map shown in Figure 4-2.

Figure 4-2: Indicative flood zone map extract from the Guidelines (DEHLF/OPW)

4.3 Sequential Approach and Justification Test

4.3.1 Sequential Approach

A sequential approach to planning is a vital tool in ensuring that development, particularly new development, is first and foremost directed towards the land that is at low risk of flooding. Sequential approaches are already established and working effectively in other areas in the plan-making and development management processes. The sequential approach principles are described in Figure 4-3, taken from the Guidelines (DEHLF/OPW). The sequential approach should be applied to all stages of the planning and development management process, particularly the planning stage. The mechanism for use of the sequential approach can be seen in Figure 4-4.

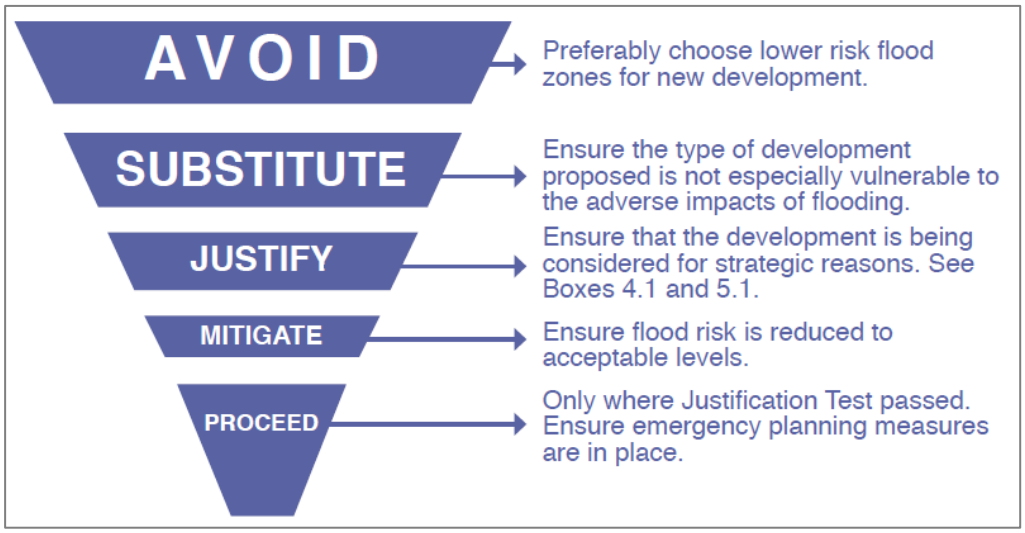

Figure 4-3: Sequential Approach Principles in Flood Risk Management

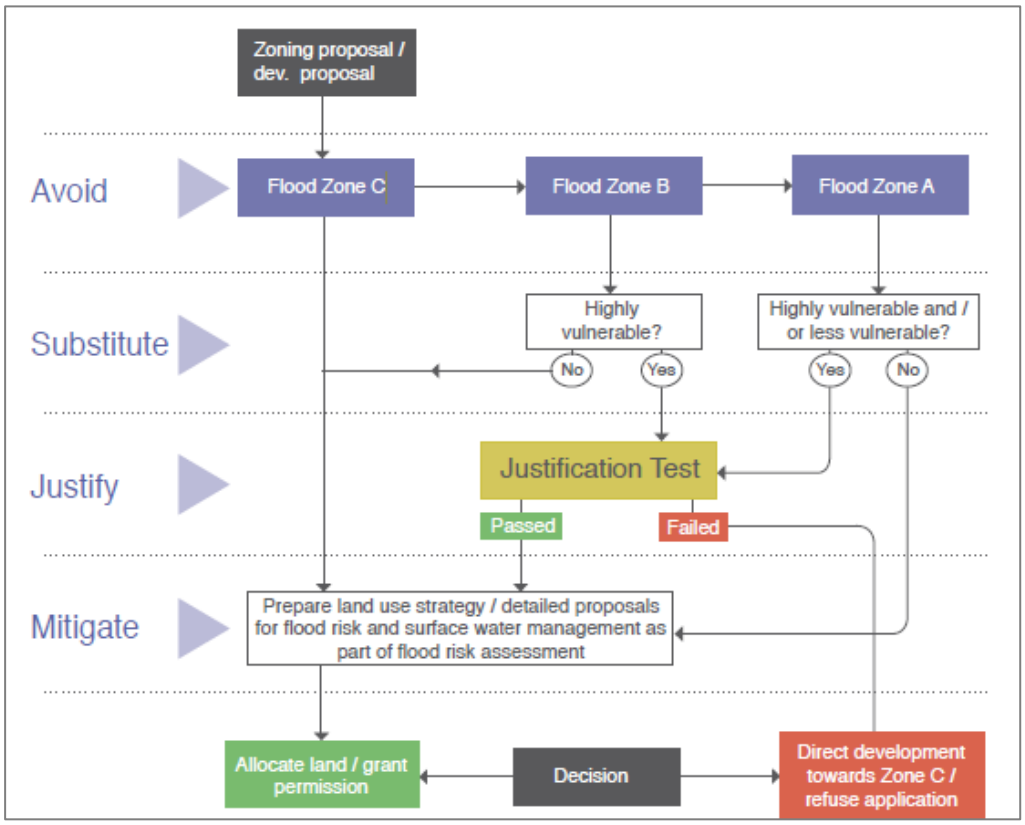

Figure 4-4: Sequential Approach Mechanisms

If the subject site does not fall within the 'Avoid' or 'Substitute' tiers of the sequential approach principle, a Justification test is required.

4.3.2 Justification Test

A matrix of vulnerability versus flood zone clearly outlines which types of development require a Justification Test. The vulnerability of a site is categorized into 3 levels, highly vulnerable, less vulnerable, and water compatible. Figure 4-5 taken from the Guidelines (DEHLG/OPW) illustrates these categories.

Vulnerability class	Land uses and types of development which include*:
Highly vulnerable development (including essential infrastructure)	Garda, ambulance and fire stations and command centres required to be operational during flooding; Hospitals; Emergency access and egress points; Schools; Dwelling houses, student halls of residence and hostels; Residential institutions such as residential care homes, children's homes and social services homes; Caravans and mobile home parks; Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility; and Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.) in the event of flooding.
Less vulnerable development	Buildings used for: retail, leisure, warehousing, commercial, industrial and non-residential institutions; Land and buildings used for holiday or short-let caravans and camping, subject to specific warning and evacuation plans; Land and buildings used for agriculture and forestry; Waste treatment (except landfill and hazardous waste); Mineral working and processing; and Local transport infrastructure.
Water-compatible development	Flood control infrastructure; Docks, marinas and wharves; Navigation facilities; Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location; Water-based recreation and tourism (excluding sleeping accommodation); Lifeguard and coastguard stations; Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific warning and evacuation plan).
*Uses not listed here should be considered on their own merits	

Figure 4-5: Vulnerability Classes

The resulting matrix of vulnerability vs. flood zone, taken from the Guidelines (DEHLG/OPW), illustrates which type of developments require a Justification Test, and can be seen below.

- **The Subject Site's Vulnerability Class**

As this subject site falls within the 'Highly-vulnerable development' category according to Figure 4-5, when assessing the matrix vs. vulnerability of the development – with a Flood Zone C development – it is considered to be an "appropriate" development and therefor does not require a Justification Test be completed. Refer to Table 4-4 for the matrix of vulnerability vs. flood zone relevant to the subject site.

Table 4-4: Matrix of vulnerability vs. flood zone - Justification Test

Type	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development	Justification Test	Justification Test	Appropriate
Less vulnerable development	Justification Test	Appropriate	Appropriate
Water compatible development	Appropriate	Appropriate	Appropriate

Thus, it is considered an appropriate development and **does not require a Justification Test** or further flood mitigation measures other than what is described in this report.

Details pertaining to the Flood Zone of the subject site, Flood Zone C, is discussed in detail in the sections to follow within this report.

5. Coastal Flooding – Irish Sea

5.1 Source

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

5.2 Pathway

The site is approximately 13.1km southwest 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 lowest proposed finished floor level at the Phase 2 development is to be constructed at 56.45m OD Malin, well above the historic high tide event.

The Office of Public Works provides flood mapping on their website floodinfo.ie. An extract of the tidal flood mapping is shown below in Figure 5-1: Extract from Coastal Flood Extent Mapping (Source: floodinfo.ie). The map extract indicates that the nearest extent of coastal flooding is located at Islandbridge on the River Liffey, c. 4.7km east from the subject site.

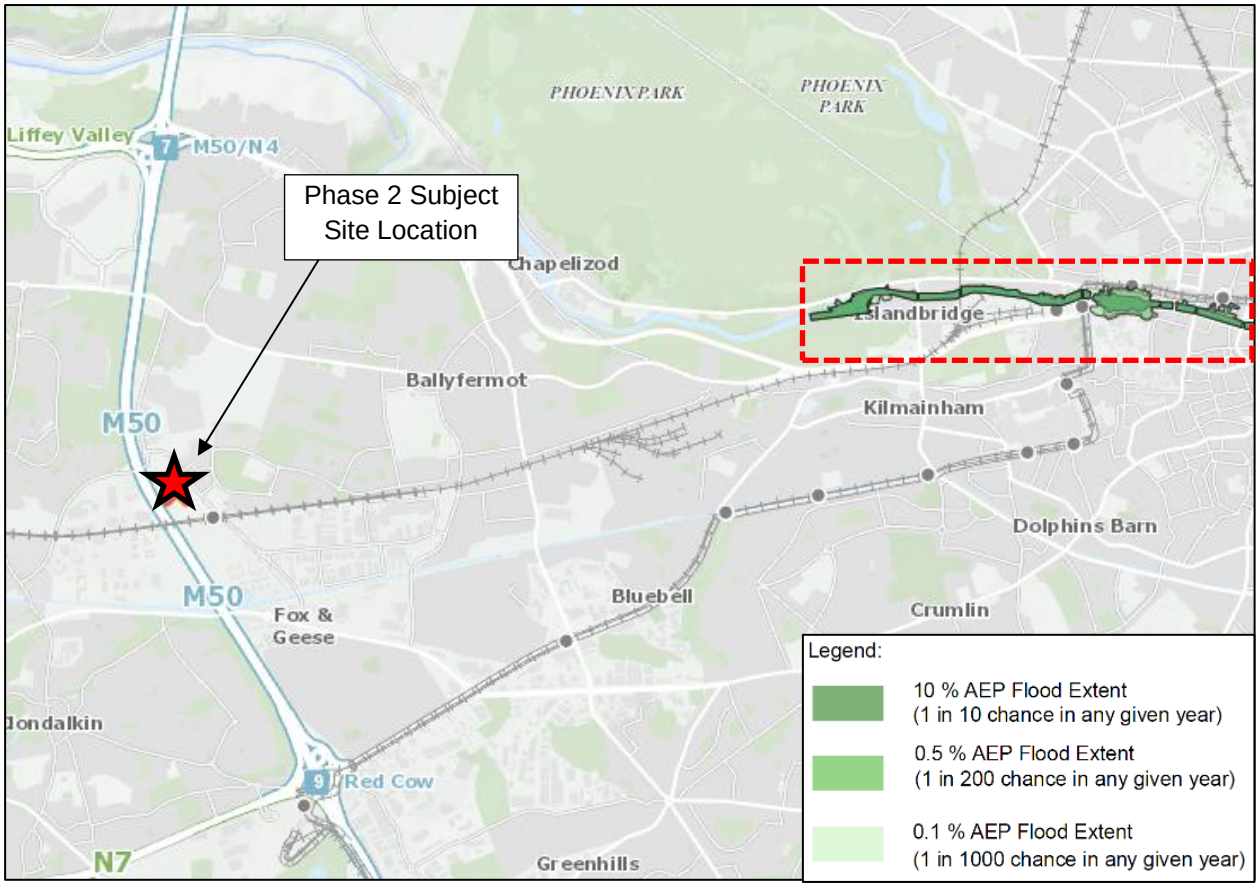

Figure 5-1: Extract from Coastal Flood Extent Mapping (Source: floodinfo.ie)

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 c.13.1 kilometres inland from the Irish Sea, c.4.7 kilometres from the nearest location at risk of coastal flooding, and that there is at least a 53.50m level difference between the lowest proposed building floor level (56.45m) 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.

5.3 Likelihood

As no practical pathway for coastal flooding to the subject site exits, there is negligible likelihood of flooding from coastal sources.

5.4 Consequence

The consequence of possible coastal flooding of the subject site would include flooding of open green spaces areas and internal roads, however with no viable pathway for flooding and negligible likelihood, this is inconsequential.

5.5 Risk

There is a negligible risk of coastal flooding.

5.6 Flood Risk Management

No flood risk management measures are required for a negligible risk of coastal flooding.

6. Fluvial Flooding

6.1 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.

6.2 Pathway

The subject site is located within the Blackditch Stream catchment. The Blackditch stream is a tributary of the Camac River which outfalls to the River Liffey at Heuston Station. There are no direct hydrological links (surface water drainage systems or natural watercourses) between the subject sites and the Blackditch stream. The is potential for indirect hydrological connectivity whereby during heavy rainfall events, surface water runs overground to the surface water gullies in the adjacent road networks.

Similar to the tidal map discussed in the previous section, Figure 6-1: Extract from Fluvial Flood Extent Mapping (Source: floodinfo.ie) below, shows an extract of the extent of potential fluvial flooding in the vicinity of the site. This extract indicated that the site is not at risk of flooding for even the 1 in 1,000-year flood event.

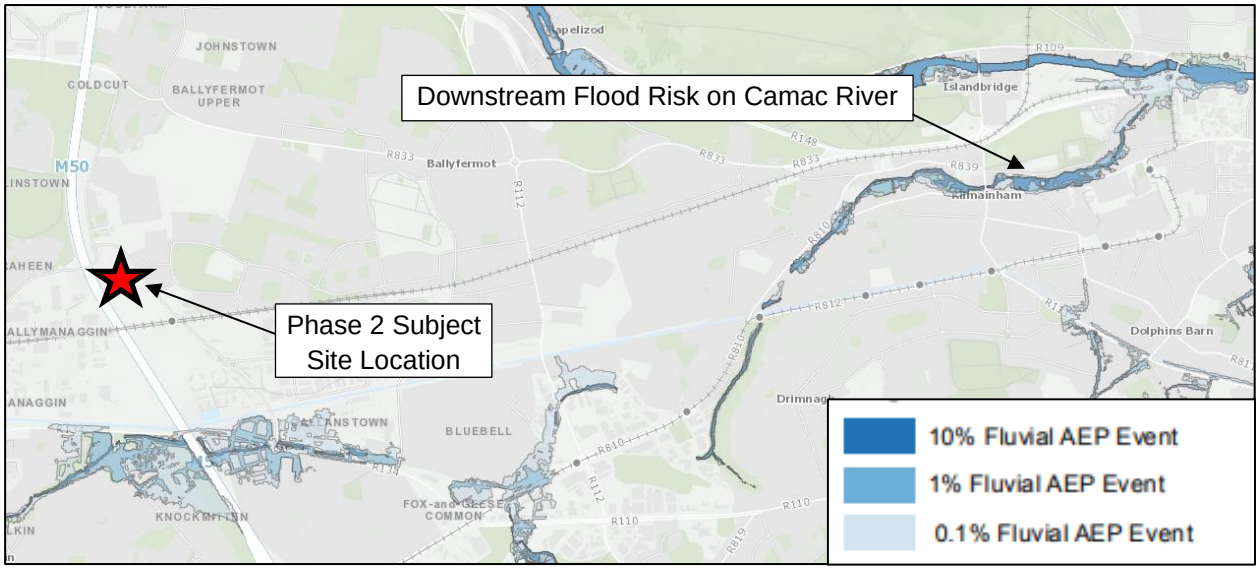

Figure 6-1: Extract from Fluvial Flood Extent Mapping (Source: floodinfo.ie)

The above figure indicates the potential for pluvial flooding to the south of the site across the grand canal on the Camac River. A closer study of the fluvial flood map ref: e09cam_exfcd_f1_17, an extract of which is included as Figure 6-2: Extract from Flood Map: e09cam_exfcd_f1_17 below, as retrieved from the OPW website, shows the relevant flood node points along the flood route of the Camac River.

The nearest flood node point to the site has a corresponding node reference of 09CAMM007501. The tabulated data for this node point informs that the water level of the 0.1% AEP (1 in 1,000 year storm), will be 51.08m OD. This is 5.37m below the lowest proposed finished floor level on the subject site (56.45m). The node point is located c. 975m south of the Phase 2 Subject Site.

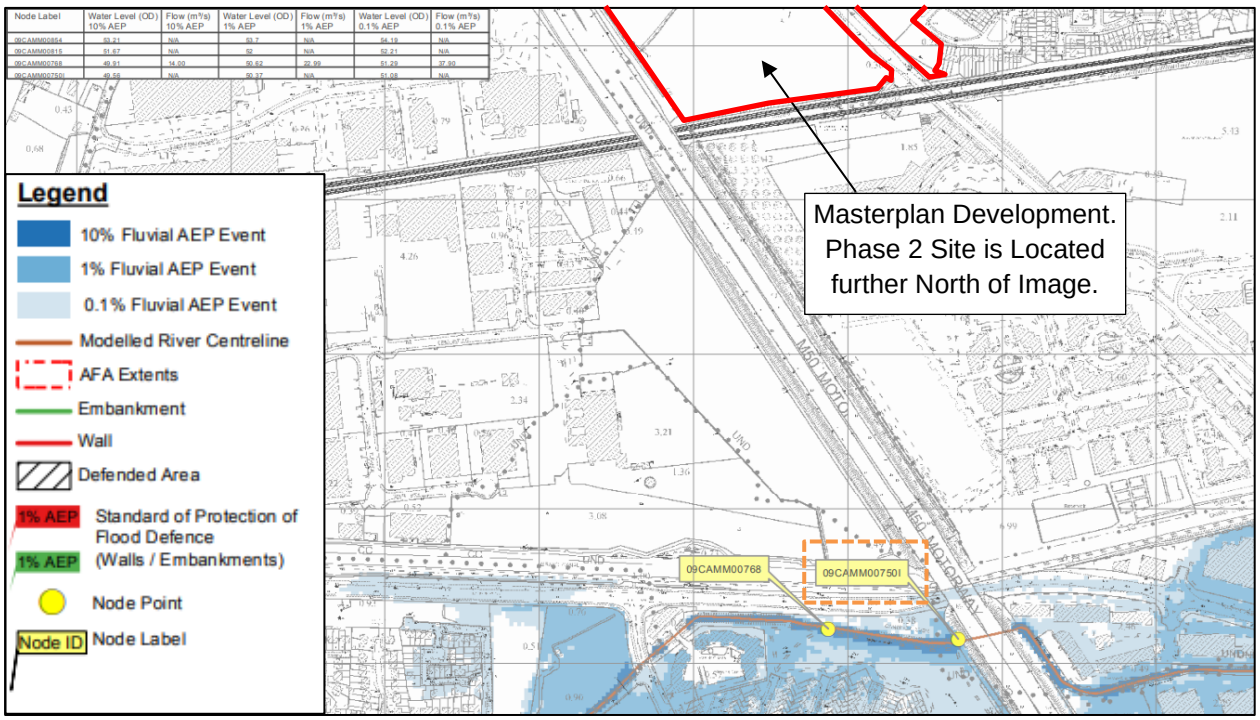

Figure 6-2: Extract from Flood Map: e09cam_exfcd_f1_17

The OPW website further provides details of historic flood events. Figure 6-3: Extract from historic flood event map (Source: floodinfo.ie) overleaf, shows an extract of the historic flood events map for the vicinity of the site. Recorded flood events in the vicinity of the site are in the location of the identified flood plains on the Camac River, south of the Grand Canal as noted earlier.

6.3 Likelihood

As the potential pathway is c. 975m in length and the difference in elevation between the potential flood node and the lowest FFL of the subject site is 5.37m, the likelihood for fluvial flooding to the subject site is considered to be low.

6.4 Consequence

The consequence of possible fluvial flooding of the subject site would include flooding of open green spaces areas and internal roads, this consequence is considered to be low.

6.5 Risk

There is an extremely low risk of coastal flooding.

6.6 Flood Risk Management

No flood risk management measures are required for an extremely low risk of fluvial flooding.

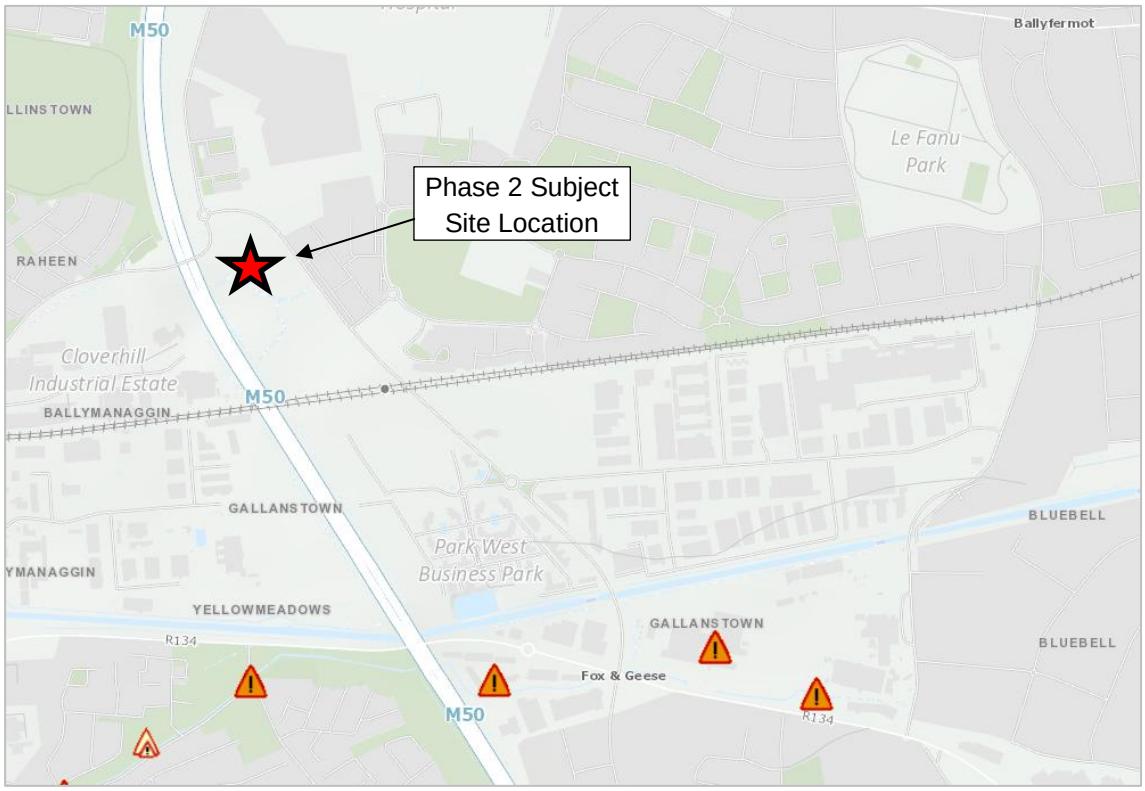

Figure 6-3: Extract from historic flood event map (Source: floodinfo.ie)

6.7 Likelihood

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

6.8 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.

6.9 Risk

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

6.10 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. An appropriate overland flood route is also designed into the development to convey surface water runoff along the internal roads network, away from buildings.

6.11 Residual Risk

The residual risk of fluvial flooding is considered extremely low.

7. Pluvial

7.1 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.

7.2 Pathway & Receptors

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

Table 7-1: Pathways and Receptors

	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

7.3 Likelihood

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

7.3.1 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.

7.3.2 Surcharging from the existing surrounding drainage system:

The OPW's National Flood Hazard Maps, as discussed in the above sections, has been consulted to identify recorded instances of flooding in the vicinity of the site. The nearest recorded flood events occurred on the Camac River on the south side of the Grand Canal, approximately 0.38km south and approximately 5.37m below the existing ground level of the site, 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.

7.3.3 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 discussed in the above sections, the Camac River, in an area well downstream of the subject site, is at risk of flooding. As such, the likelihood can be considered high.

7.3.4 Overland flooding from surrounding areas:

As noted in Section 7.3.2, it is considered that there is a low likelihood of flooding from surrounding areas.

7.3.5 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.

7.4 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.

7.5 Risk

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

7.5.1 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.

7.5.2 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.

7.5.3 Surface water discharge from the subject site:

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

7.5.4 Overland flooding from surrounding areas:

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

7.5.5 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.

7.6 Flood Risk Management

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

7.6.1 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, private and public bio-retention rain gardens, and roadside swales will collect, slow and convey surface water runoff from the site to the ultimate outfall location. Permeable paving below all parking 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 surface water runoff from the catchment is to be attenuated in a large pluvial cube attenuation system located to the south of Phase 2, within the approved Phase 1 development. This attenuation system has been designed to accommodate the 1-in100-year extreme storm event with 20% climate change allowance.

As per DCC requirements the runoff rate is to be limited by design to a maximum of 2 l/s/ha. This is below the current greenfield runoff rate.

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

7.6.2 Surcharging from the existing surrounding drainage system:

The risk of flooding due to surcharging of the existing surface water network is minimised with appropriate overland flood routing. The risk to the surrounding buildings is mitigated by generally setting finished floor levels at least 300mm above the adjacent road levels where possible or practicable. 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.

7.6.3 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, 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.

7.6.4 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.

7.6.5 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. 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. The attenuation volumes have been calculated to account for the maximum permitted flow rate allowed by DCC of 2 l/s/ha, which is lower than the current greenfield runoff rate.

7.7 Residual Risk

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

8. Groundwater

8.1 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.

8.2 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 foundations could also be affected by high water tables that do not reach the ground surface.

8.3 Receptor

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

8.4 Likelihood

Groundwater vulnerability mapping is available online via the Public Data Viewer Series. This is extracted below to Figure 8-1: Groundwater Vulnerability Map below. This shows that the site lies within an area of high vulnerability. There is no indication of wells or springs on, or in the vicinity of the site, as also advised by the same data maps.

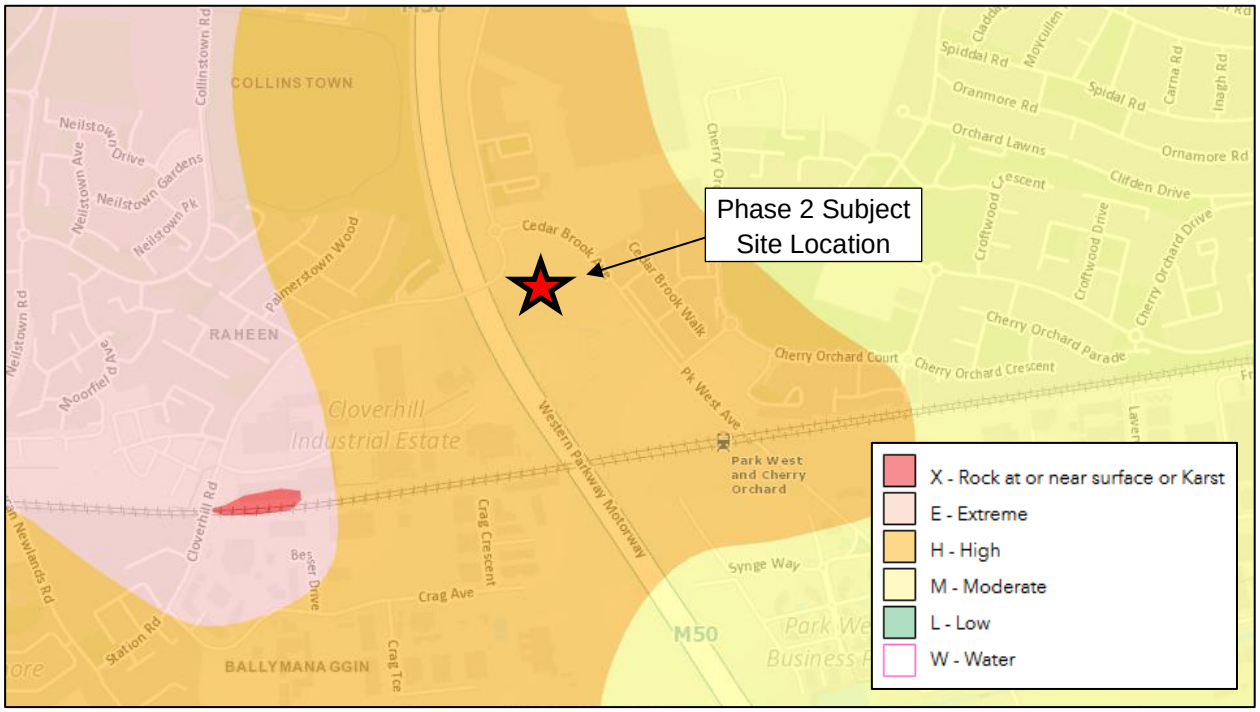

Figure 8-1: Groundwater Vulnerability Map

8.5 Consequence

The consequence of ground water flooding would be some minor temporary seepage of ground water through the ground around the proposed residential units and 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.

8.6 Risk

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

8.7 Flood Risk Management

Finished floor levels have been set above the road levels where possible to ensure that any seepage of ground water onto the development does not flood into the residential units or buildings. In the event of ground water flooding on site, this water can escape from the site via the overland flood routing.

8.8 Residual Risk

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

9. Human/Mechanical Errors

9.1 Source

The subject site will be drained by an internal private storm water drainage system, which will discharge to the public surface water infrastructure.

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

9.2 Pathway

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

9.3 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.

9.4 Likelihood

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

9.5 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.

9.6 Risk

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

9.7 Flood Risk Management

Finished floor levels have been designed to be above the adjacent road network where possible, 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 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 basins and 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.

9.8 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.

10. Conclusions and Recommendations

The subject lands have been analysed for risks from tidal flooding from the Irish Sea, fluvial and pluvial flooding, ground water, and failures of mechanical systems. Table 10-1: Summary of the Flood Risks from the Various Components below, presents the various residual flood risks involved.

Table 10-1: Summary of the Flood Risks from the Various Components

Source	Pathway	Receptor	Likelihood	Consequence	Risk	Mitigation Measure	Residual Risk
Coastal	*Irish Sea (River Liffey)*	*Proposed development*	*Extremely low*	*None*	*Negligible*	*None*	Negligible
Fluvial	*Blackditch Stream & River Camac*	*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, areas around units*	*High*	*Moderate*	*High*	*Appropriate setting of floor levels, appropriate flood routing*	Low
Human/ Mechanical Error	*Drainage network*	*Proposed development*	*High*	*Moderate*	*High*	*Setting of floor levels, overland flood routing, regular inspection of SW network*	Low

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