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Greener Ideas Limited

Proposed Substation, Profile Park, West Dublin

Flood Risk Assessment

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Flood Risk Assessment

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TOBIN Consulting Engineers

Table of Contents

Table of Figures

Table of Tables

Appendices

1.0 INTRODUCTION

TOBIN Consulting Engineers were appointed by Greener Ideas Limited to undertake a Flood Risk Assessment (FRA) for the construction of a new 110kV substation at Profile Park in West Dublin.

Figure 1-1 shows the location of the subject site in Profile Park, 16km from Dublin City Centre. The overall site has an area of 0.53ha site and is relatively flat. The substation area is approximately 0.12ha and has existing ground levels ranging from 73.73mOD along the northern site boundary bordering the adjacent roadway, to 74.14mOD at the southern site boundary. A 100MW gas fired power plant (Planning reference: SD21A/0167) is to be constructed directly east of the proposed substation.

A topographical survey of the proposed development site is provided in Appendix 1.

The purpose of this report is to communicate any potential flood risks to people and future development at the site.

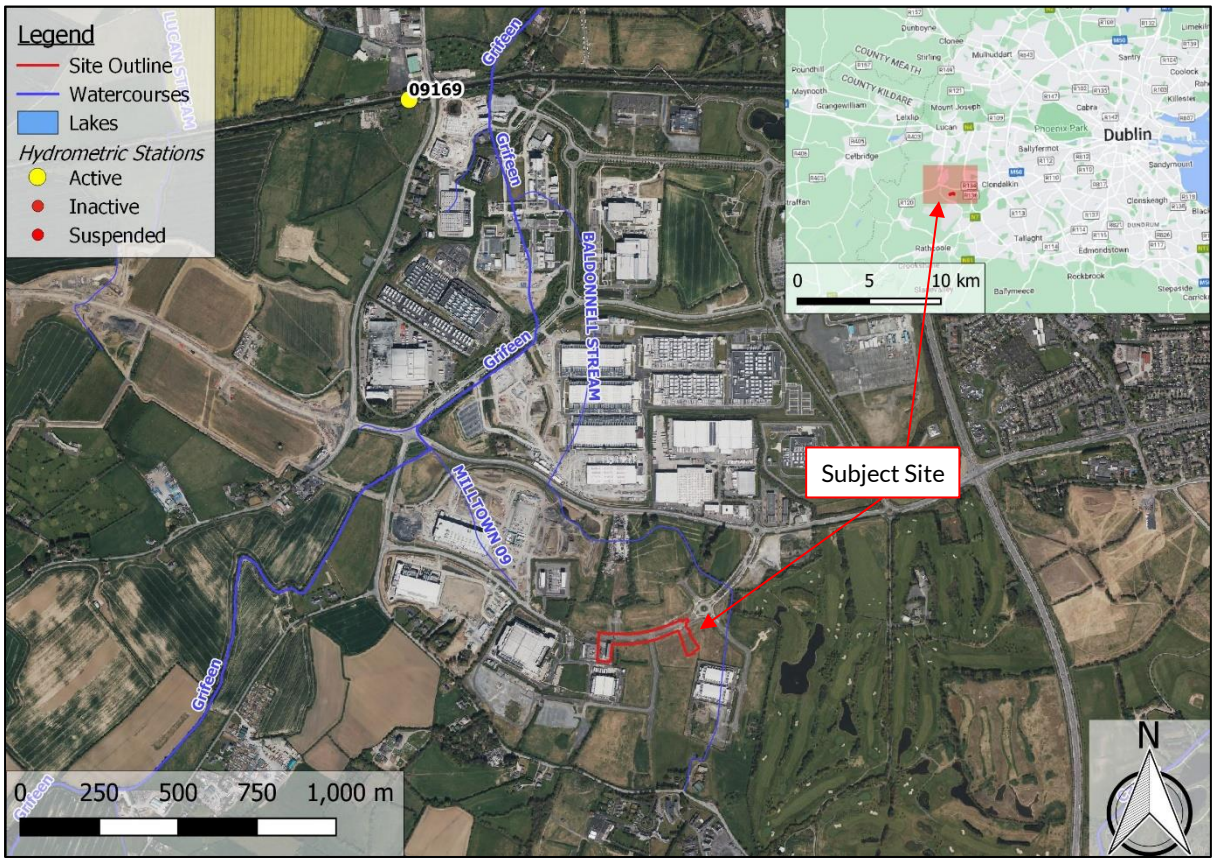


Figure 1-1 Site Location

It was noted that the nearby Baldonnell Stream has been highly modified in the past, with much of its course upstream and downstream of the subject site being culverted. The watercourse also appears to have been rerouted to the eastern boundary of the adjacent site (see Figure 1-2.

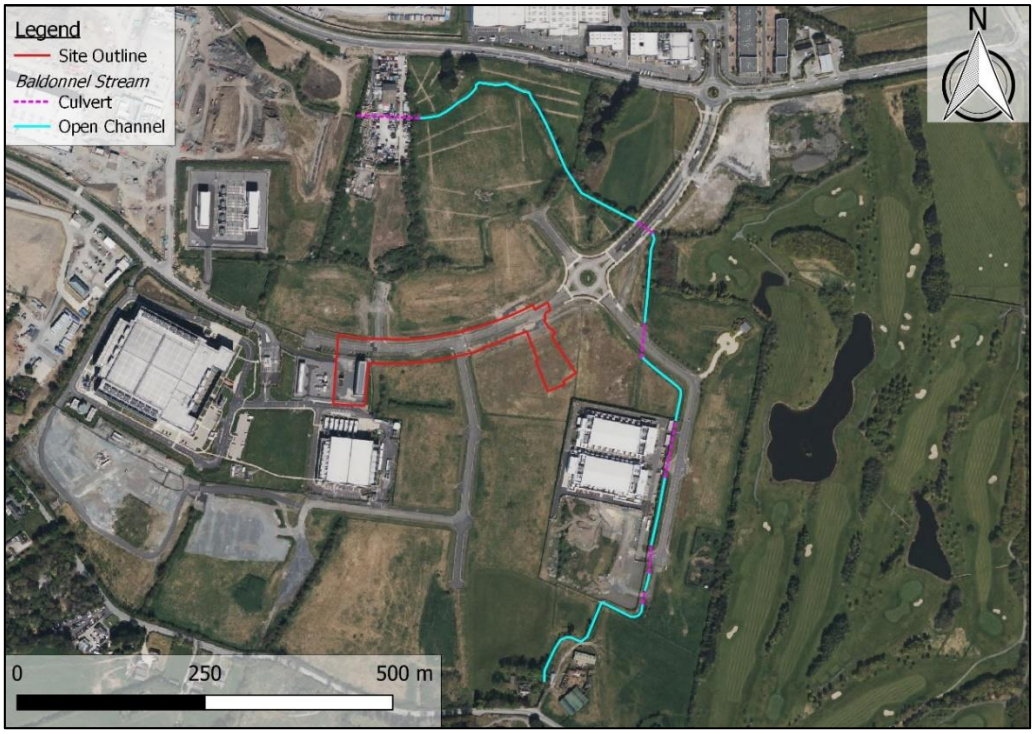


Figure 1-2 Baldonnell Stream

The proposed substation site layout (see Figure 1-3), includes grading ground elevation at the substation from existing levels (73.73mOD to 74.14mOD) to 74.8mOD, removing localised depressions, and incorporating on-site flood and stormwater storage areas.

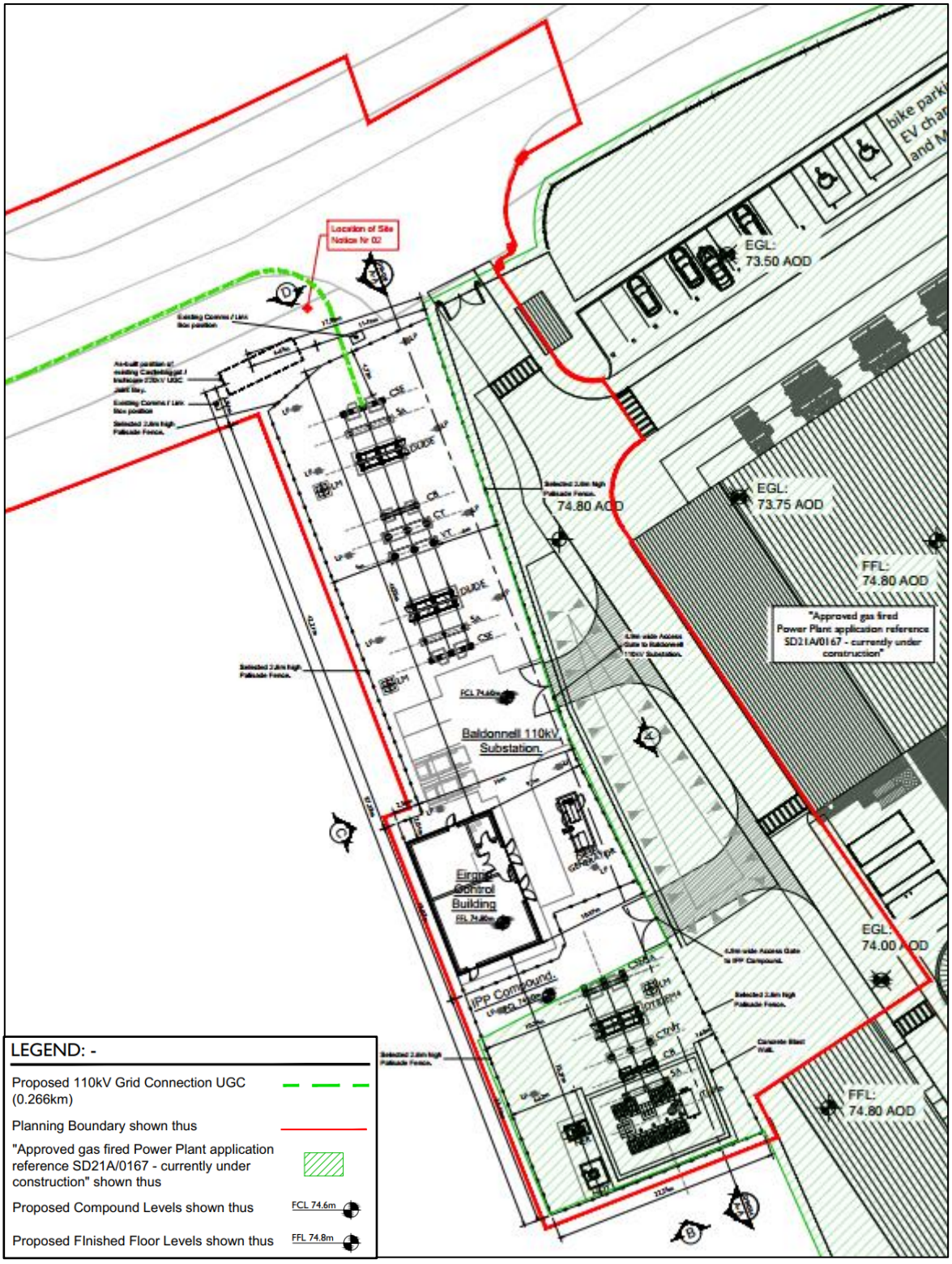


Figure 1-3 Proposed Substation Layout

2.0 FLOOD RISK MANAGEMENT GUIDANCE

This Strategic Flood Risk Assessment was carried out in accordance with the following flood risk management guidance documents:

- The Planning System and Flood Risk Management Guidelines for Planning Authorities
- Flood Risk Management Climate Change Sectoral Adaptation Plan
- South Dublin County Council Development Plan & Strategic Flood Risk Assessment

2.1 The Planning System and Flood Risk Management Guidelines

The Planning System and Flood Risk Management Guidelines for Planning Authorities (PSFRM Guidelines) were published in 2009 by the Office of Public Works (OPW) and Department of the Environment, Heritage and Local Government (DoEHLG). Their aim is to ensure that flood risk is considered in development proposals and the assessment of planning applications.

2.1.1 Flood Zones and Vulnerability Classes

The PSFRM Guidelines discuss flood risk in terms of flood zones A, B, and C, which correspond to areas of high, medium, or low probability of flooding, respectively. The extents of each flood zone are based on the Annual Exceedance Probability (AEP) of various flood events.

The PSFRM Guidelines also categorise different types of development into three vulnerability classes based on their sensitivity to flooding. Substations are considered "highly vulnerable" and are required to be operational during flooding.

Table 2-1 shows a decision matrix that indicates which types of development are appropriate in each flood zone and when the Justification Test (see Section 2.1.2) must be satisfied. The annual exceedance probabilities used to define each flood zone are also provided.

Table 2-1 Decision Matrix for Determining the Appropriateness of a Development

Flood Zone (Probability)	Annual Exceedance Probability (AEP)	Development Appropriateness		
		Highly Vulnerable	Less Vulnerable	Water Compatible
A (High)	Fluvial & Pluvial Flooding More frequent than 1% AEP	Justification Test	Justification Test	Appropriate
B (Medium)	Fluvial & Pluvial Flooding 0.1% to 1% AEP	Justification Test	Appropriate	Appropriate
C (Low)	Fluvial & Pluvial Flooding Less frequent than 0.1% AEP	Appropriate	Appropriate	Appropriate
Note: Given that coastal flooding is not a potential source of risk to the proposed development, the probabilities for coastal flooding have been omitted from this table.				

2.1.2 The Justification Test

Any proposed development being considered in an inappropriate flood zone (as determined by Table 2-1) must satisfy the criteria of the Justification Test outlined in Figure 2-1 (taken from the PSFRM Guidelines).

Box 5.1 Justification Test for development management (to be submitted by the applicant)

When considering proposals for development, which may be vulnerable to flooding, and that would generally be inappropriate as set out in Table 3.2, the following criteria must be satisfied:

1. The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines.
2. The proposal has been subject to an appropriate flood risk assessment that demonstrates:
   - (i) The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;
   - (ii) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;
   - (iii) The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access; and
   - (iv) The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.

The acceptability or otherwise of levels of residual risk should be made with consideration of the type and foreseen use of the development and the local development context.

Note: See section 5.27 in relation to major development on zoned lands where sequential approach has not been applied in the operative development plan.

Refer to section 5.28 in relation to minor and infill developments.

Figure 2-1 Criteria of the Justification Test

2.2 The Flood Risk Management Climate Change Adaptation Plan

The Flood Risk Management Climate Change Sectoral Adaptation Plan was published in 2019 under the National Adaptation Framework and Climate Action Plan. This plan outlines the OPW's approach to climate change adaptation in terms of flood risk management.

This approach is based on a current understanding of the potential impacts of climate change on flooding and flood risk. Research has shown that climate change is likely to worsen flooding through more extreme rainfall patterns, more severe river flows, and rising mean sea levels.

To account for these changes, the Adaptation Plan presents two future flood risk scenarios to consider when assessing flood risk:

- Mid-Range Future Scenario (MRFS)
- High-End Future Scenario (HEFS)

Table 2-2 indicates the allowances that should be added to estimates of extreme rainfall depths, peak flood flows, and mean sea levels for the future scenarios.

Table 2-2 Climate Change Adaptation Allowances for Future Flood Risk Scenarios

Parameter	Mid-Range Future Scenario (MRFS)	High-End Future Scenario (HEFS)
Extreme Rainfall Depths	+ 20%	+ 30%
Peak River Flood Flows	+ 20%	+ 30%
Mean Sea Level Rise	+ 0.5 m	+ 1 m

2.3 South Dublin County Council Development Plan 2022-2028

The current South Dublin County Council Development Plan provides a strategic framework for planning and sustainable development in South Dublin for 2022 to 2028. Chapter 11 outlines South Dublin County Council's strategy for the management of Infrastructure & Environmental Services, with Section 11.3 outlining the Council's approach to Flood Risk Management, presenting four key objectives:

Policy IE4: Flood Risk

Ensure the continued incorporation of Flood Risk Management into the spatial planning of the County, to meet the requirements of the EU Floods Directive and the EU Water Framework Directive and to promote a climate resilient County.

IE4 Objective 1:
To require site specific flood risk assessments to be undertaken for all new developments within the County in accordance with The Planning System and Flood Risk Management – Guidelines for Planning Authorities (2009) and the requirements of DECLG Circular P12 / 2014 and the EU Floods Directive and Chapter 12: *Implementation and Monitoring* and the policies and objectives of this chapter.

IE4 Objective 2:
To require all developments in the County to be designed and constructed in accordance with the "Precautionary Principle" detailed in the OPW Guidelines.

IE4 Objective 3:
To continue to support and co-operate with the Office of Public Works in measures set out in the relevant Flood Risk Management Plan.

IE4 Objective 4:
To support and facilitate the delivery of flood alleviation schemes in South Dublin County, including the schemes listed, in as environmentally sensitive a way as possible and to ensure that zoning or development proposals do not impede or prevent the progression of these measures:

- Poddle Flood Alleviation Scheme;
- Camac Flood Alleviation Scheme;
- Whitechurch Flood Alleviation Scheme;
- Lucan to Chapelizod Flood Alleviation Scheme.

IE4 SLO 1:
To require the preparation of a site and catchment specific Flood Risk Assessment and Mitigation Strategy, prepared by a qualified person(s), to be submitted with any proposal for development on the 'EE' zoned lands at Moneenalion Commons Upper, Baldonnell (See Development Plan Map).

South Dublin County Council Development Plan mapping identifies the subject site within the Department of Defence Inner Zone[1], and within the area zoned under Objective E—to provide for enterprise and employment related uses[2].

[1] South Dublin County Council Development Plan, Index Map

[2] South Dublin County Council Development Plan, Map 4

2.3.1 Strategic Flood Risk Assessment for South Dublin County Council Development Plan 2022-2028

The South Dublin County Development Plan 2022-2028 was made on 22nd June 2022 and came into effect on 3rd August 2022. A Strategic Environmental Assessment (SEA) Environmental Report was also published, assessing the likely effects of implementing the South Dublin County Council Development Plan on the environment. In support of this assessment, a Strategic Flood Risk Assessment (SFRA) was published under the requirements of The Planning System and Flood Risk Assessment Guidelines for Planning Authorities (2009).

The South Dublin County Council Development Plan SFRA outlines the principal actions when considering flood risk and are summarised below:

- *"Flood hazard and potential risk should be determined at the earliest stage of the planning process..."*
- *"Development should preferentially be located in areas with little or no flood hazard thereby avoiding or minimising the risk...."*
- *"Development should only be permitted in areas at risk of flooding when there are no alternatives, reasonable sites available..."*
- *"Where development is necessary in areas at risk of flooding an appropriate land use should be selected"*
- *A precautionary approach should be applied, where necessary, to reflect uncertainties in flooding datasets and risk assessment techniques..."*
- *"Land required for current and future flood management... should be proactively identified..."*
- *"Flood risk to, and arising from, new development should be managed through location, layout and design incorporating Sustainable Drainage Systems (SuDS) and compensation for any loss of floodplain..."*
- *Strategic environmental assessment (SEA) of regional planning guidelines, development plans and Masterplans should include flood risk as one of the key environmental criteria..."*

Due to the nature of the proposed substation as essential infrastructure, it is accordingly considered "Highly Vulnerable", whereby this assessment must be applied. Highly Vulnerable Developments are not permitted in Flood Zone A or B, and are subject to the Justification Test.

The SFRA also states that: *"There is an increasing likelihood that Irelands climate will be similar to that depicted in the High-End Future climate change scenario by the year 2100. Therefore, it is prudent to* ***consider the HEFS parameters*** *when planning for* ***vulnerable infrastructure*** *and developments."*

Flood zones mapping has been prepared in accordance the PSFRM Guidelines identifying Flood Zones A, B and C. The flood zone maps are largely derived from the Eastern CFRAM and the Dodder CFRAM mapping. Flood extent mapping for areas that are not covered in the CFRAM Studies are supplemented by fluvial mapping from the earlier OPW Preliminary Flood Risk Assessment (PFRA) Report and assessments undertaken as part of existing Local Area Plans. The HEFS scenario is used to delineate flood zones in the SFRA, therefore the HEFS scenario must be used to assess flood risk at the proposed substation.

The SFRA identifies pluvial and fluvial flooding as the primary concerns for the South Dublin plan area. Figure 2-2 shows OPW indicative pluvial flood mapping in the vicinity of the subject

site, as presented in the SFRA. This mapping indicates a portion of the existing road at the location of the underground cable route is liable to 0.1% AEP pluvial flooding.

The SFRA does not indicate any pluvial flooding within the bounds of the proposed substation.

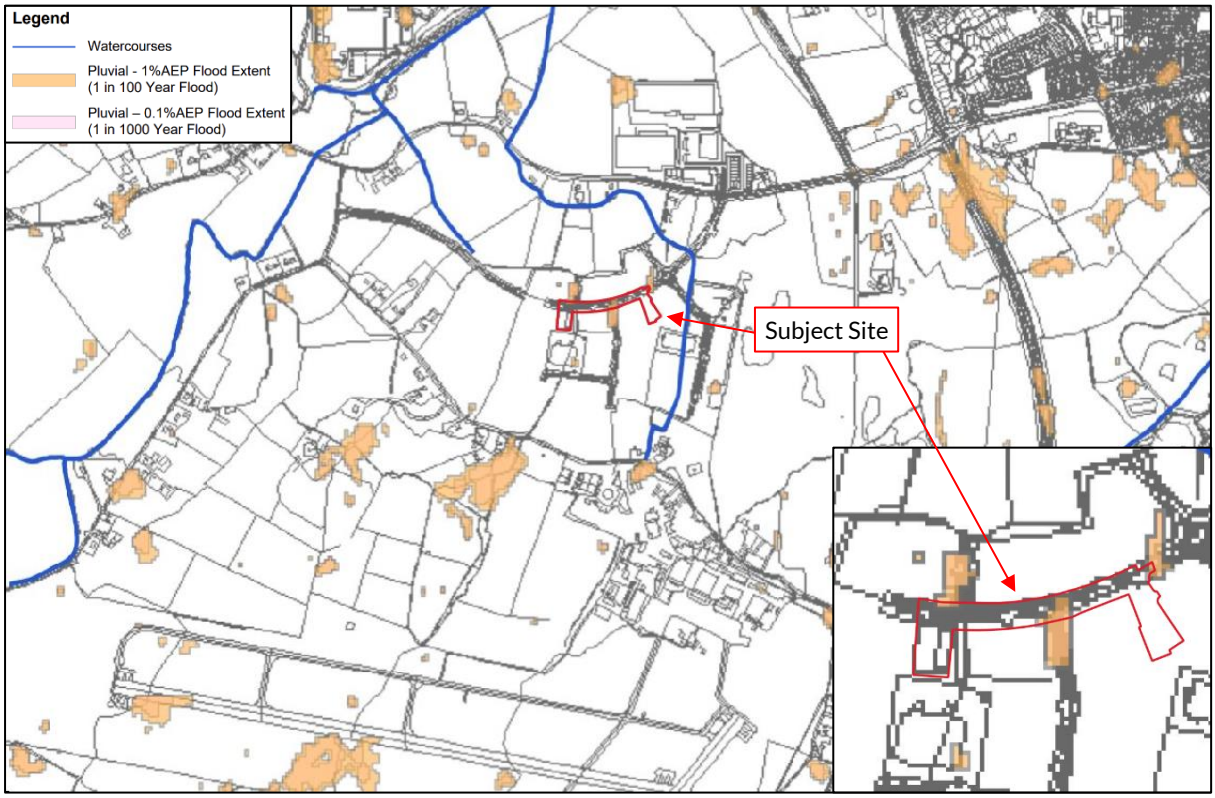


Figure 2-2 Excerpt of South Dublin County Council Strategic Flood Risk Assessment PFRA Indicative Pluvial Flood Zone Mapping, Sheet 1 of 4 (April 2021)

SFRA fluvial flood zone mapping is based upon the Eastern Catchment Flood Risk Assessment and Management (CFRAM) Study and the River Dodder CFRAM Study fluvial flood extents, further discussed in Section 3.3. *The SFRA notes that "flooding from the Camac affects areas between Naas Road and Baldonnel Road (Casement Aerodrome Baldonnel) as well as areas in Corkagh Park and lands west of Grange Castle Road."* The flooding from the Camac eventually flows northwards and towards the subject site.

Figure 2-3 shows an excerpt of SFRA fluvial flood zone mapping for the area. This mapping indicates portions of the site may be liable during a 0.1% AEP fluvial and is therefore located in Flood Zone B. A smaller portion of the site is also indicated as liable to flooding during the 1% AEP fluvial event (Flood Zone A). This is likely a combination of flooding from the Baldonnell Stream and by the overland flow from the Camac via Casement Aerodrome. The overland flow from Casement Aerodrome is addressed further in Section 5.4.1.

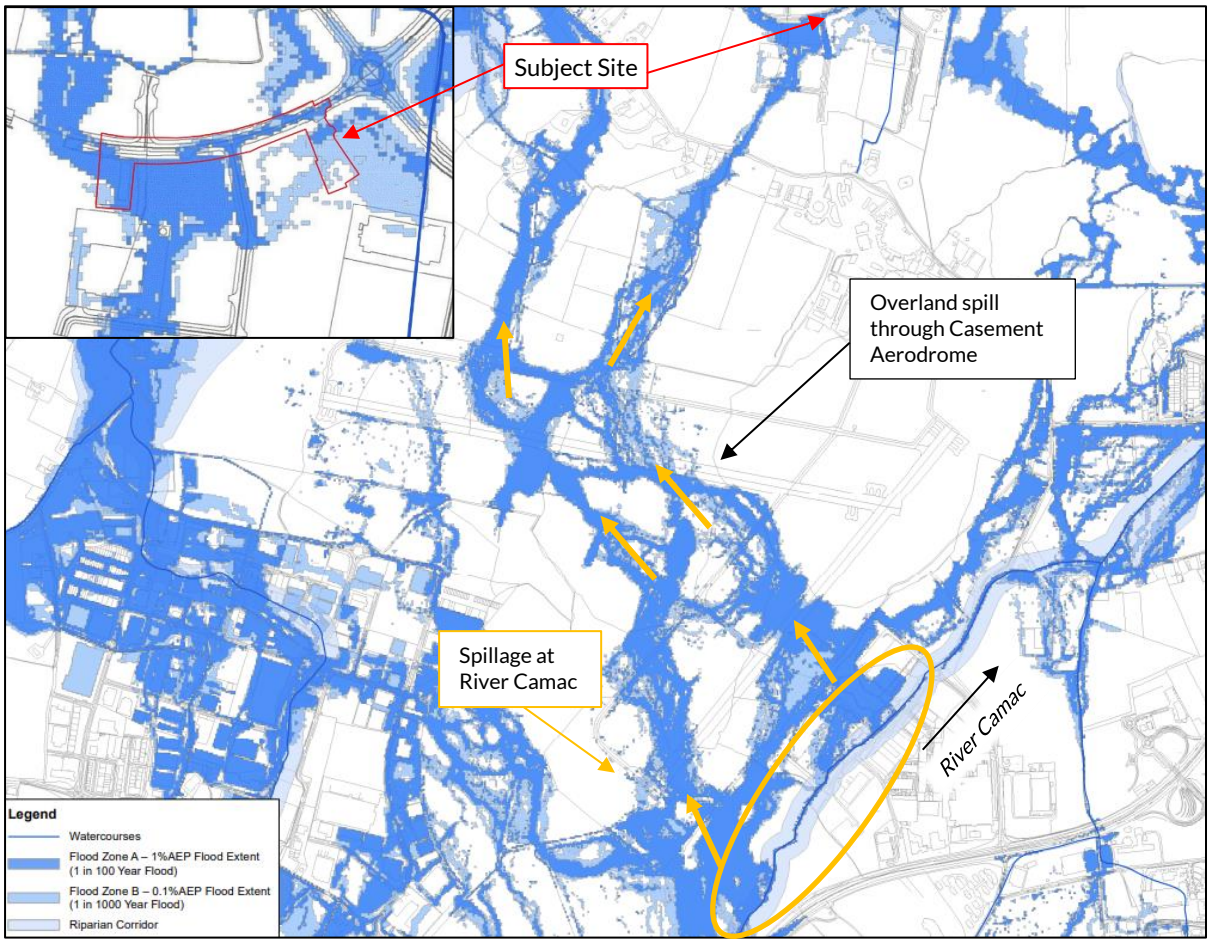


Figure 2-3 Excerpt of South Dublin County Council Strategic Flood Risk Assessment, Flood Zone Mapping, Sheets 4 & 8 (April 2021)

3.0 INITIAL FLOOD RISK ASESSMENT

3.1 Past Flood Events

The OPW's National Flood Information Portal[3] provides past flood event mapping with records of flooding reports, meeting minutes, photos, and/or hydrometric data.

Based on the flood map shown in Figure 3-1, no historical flooding has been recorded within 1km of the subject site. Historic flooding was recorded approximately 1.1km northwest of the proposed development site (Flood ID: 3320—Peamount R134 R120 junction Nov 2000). A South Dublin County Council report noted significant rainfall was experienced on 5th and 6th November 2000, with serious flooding experienced in the Griffeen Catchment area[4].

A recurring flood event at Barney's Lane, Baldonnel (ID: 1214) has been identified approximately 1.8km from the subject site.

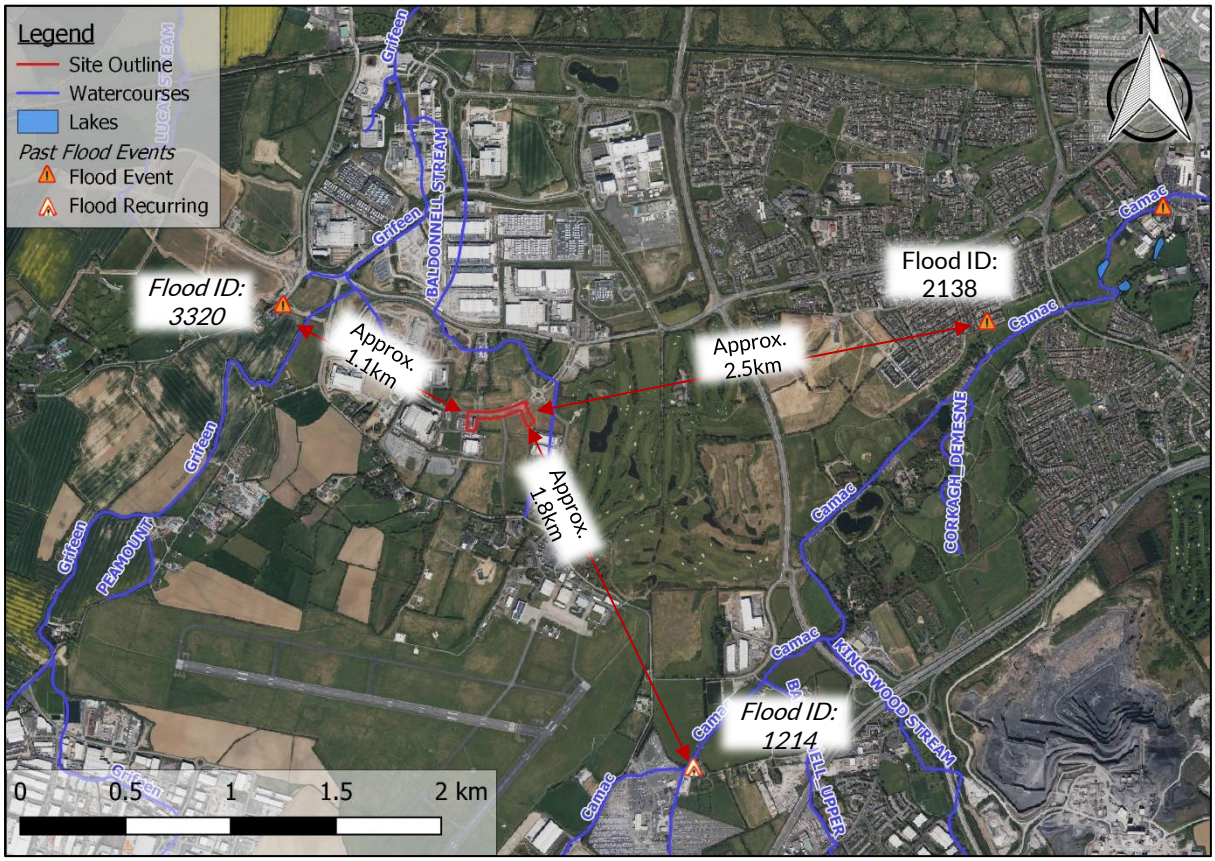


Figure 3-1 OPW Flood Map of Past Flood Events

[3] floodinfo.ie

[4] South Dublin County Council Report on Flooding 5th & 6th November, 2000

3.2 OPW Preliminary Flood Risk Assessment (PFRA) Study

In 2009, the OPW produced a series of maps to assist in the development of a broad-scale FRA throughout Ireland. These maps were produced from several sources.

The OPW's National Preliminary Flood Risk Assessment (PFRA) Overview Report from March 2012 noted that *"the flood extents shown on these maps are based on broad-scale simple analysis and may not be accurate for a specific location"*[5].

Limitations on potential sources of error associated with the PFRA maps include:

- Assumed channel capacity (due to absence of channel survey information)
- Absence of flood defences and other drainage improvements and channel structures (bridges, weirs, culverts)
- Local errors in the national Digital Terrain Model (DTM)

Figure 3-2 Indicative Flood Mapping from OPW PFRA Study

Modelling of the Baldonnell Stream does not extend to the subject site, and results indicate the site is not liable to flooding from neighbouring watercourses.

Improved hydraulic modelling was carried out through the Catchment Flood Risk Assessment and Management Study (CFRAM) in 2015 (discussed in Section 3.2) and is considered more accurate than the PFRA study as it utilised surveyed river geometry and was subject to greater model calibration.

[5] The National Preliminary Flood Risk Assessment (PFRA) Overview Report, OPW (March 2012)

3.3 Catchment Flood Risk Assessment and Management Study

In 2015, the OPW produced flood maps[1] as part of the Catchment Flood Risk Assessment and Management (CFRAM) Study. The flood extents in these maps are based on detailed modelling of Areas for Further Assessment identified by the National Preliminary Flood Risk Assessment.

As shown in Figure 3-3, the CFRAM study indicates that a portion of the site may be at risk from fluvial flooding during a 1-in-1000-year (0.1% AEP) HEFS event.

Based on a review of the CFRAM hydraulics report[6], the Camac and Griffeen Rivers were both surveyed and modelled. The Baldonnell Stream, however, does not appear to have been modelled explicitly. While the flood mapping indicates some flooding along its course, this is the result of overland spill from the Camac across the model's 2D domain (5m cell size). The additional capacity of the stream channel and culverts (not rectified in the terrain model) would likely contain flows, alleviating or reducing flood risk.

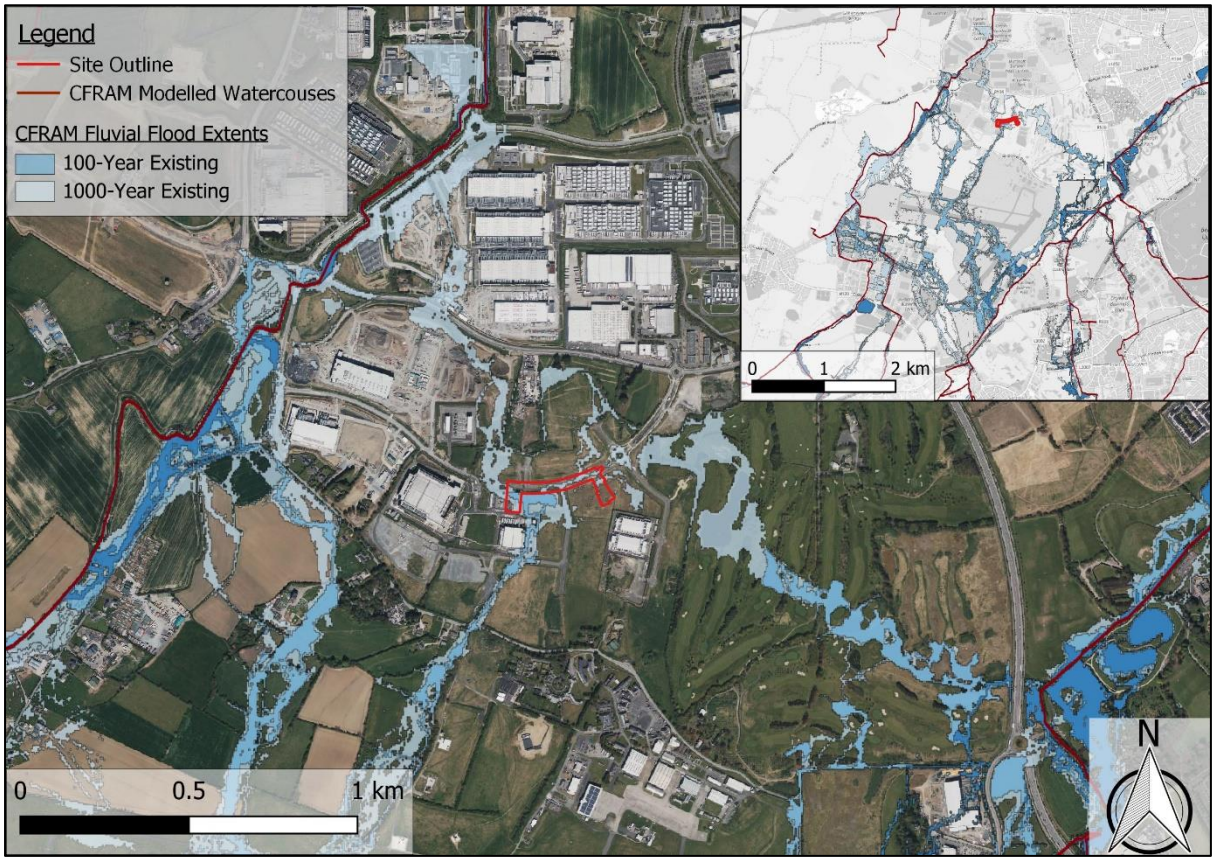


Figure 3-3 CFRAM Current Fluvial Model and Flood Extents in Vicinity of Subject Site

The Eastern CFRAM study also included an assessment of the likely impact of climate change on flood risk in the area. The flood extents for a High-End Future Scenario are shown in Figure 3-4. Based on the findings of the study the proposed substation is liable to fluvial flooding during a 0.1% AEP HEFS fluvial flood event.

As noted previously, some of this flooding may be alleviated by local drainage channels and culverts (including the Baldonnell Stream) which were not considered in the CFRAM study.

[6] Eastern CFRAM UoM09 Hydraulics Report (9th August 2017)

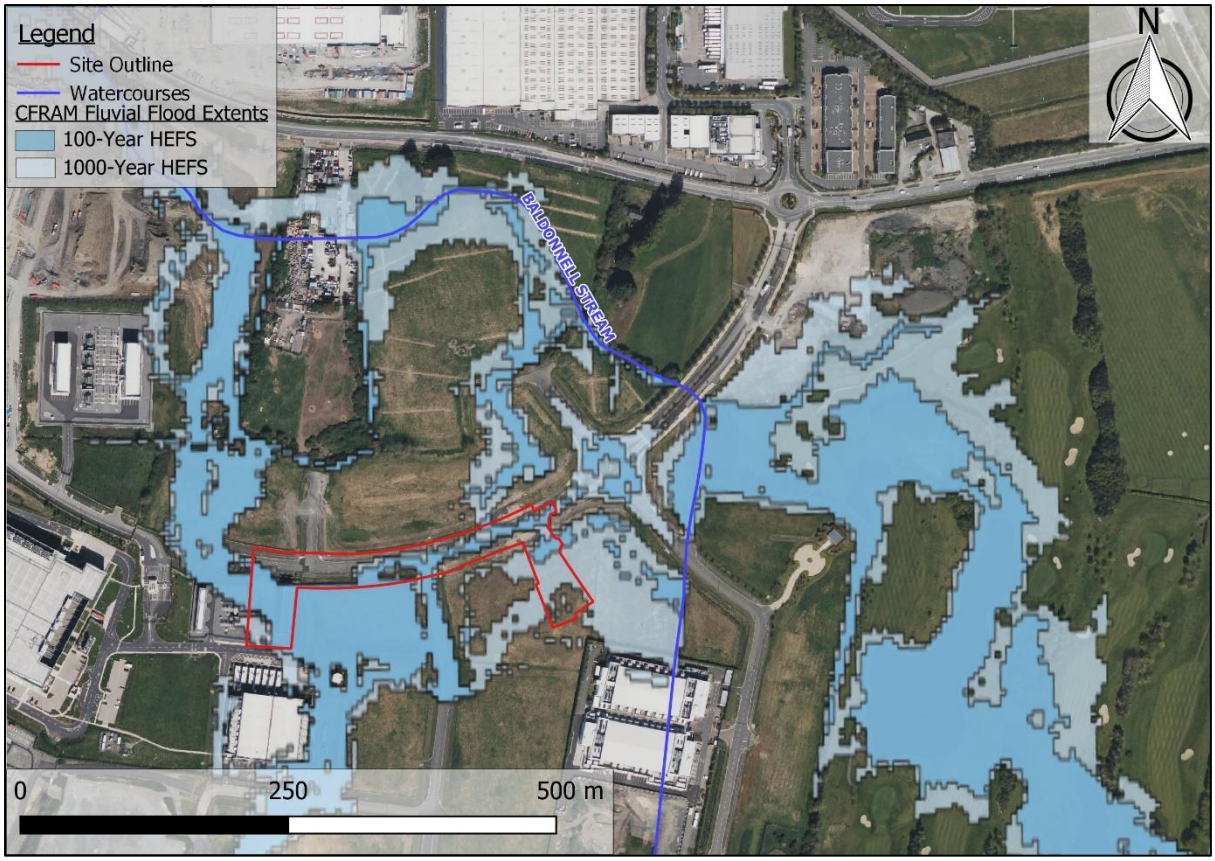


Figure 3-4 CFRAM HEFS Fluvial Flood Extents

This mapping indicates portions of the site may be liable during a 0.1% AEP fluvial event and is therefore located in Flood Zone B according to the South Dublin County Development Plan, which takes into account the HEFS scenario for climate change. This is likely a combination of flooding from the Baldonnell Stream and by the overland flow from the Camac via Casement Aerodrome. The overland flow from Casement Aerodrome is addressed further in Section 3.5.

By superimposing the 0.1% AEP HEFS fluvial extents over the existing ground elevations, a conservative design flood level of approximately 74.00mOD was ascertained. This leaves a freeboard of approximately 0.80mOD to the proposed finished flood level of 74.80mOD. The substation is the only area within the subject site that is deemed as “Highly Vulnerable” and therefore freeboard is required. An underground cable is proposed for the remainder of the site and as such, will not create additional flood risk and is deemed water compatible.

3.4 Geological Survey Ireland Mapping

The Geological Survey Ireland (GSI) provides mapping[7] with data related to Ireland's subsurface. Based on the map shown in Figure 3-5, there are no karst features (caves, springs, turloughs, etc.) in the surrounding 1km area. The St. Columbs Well (spring) is located approximately 6.7km northwest of the subject site and is the nearest karst feature.

Therefore, the subject site is not estimated to be at risk of groundwater flooding.

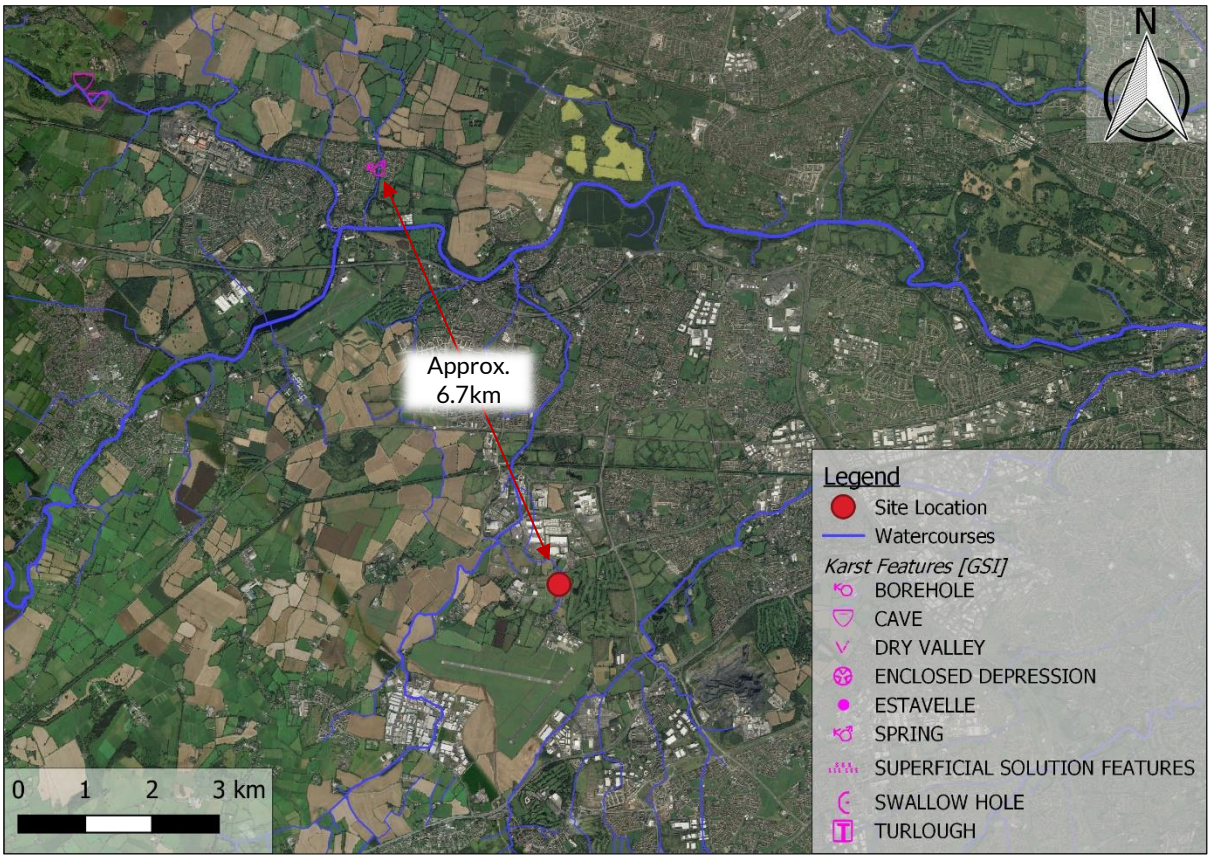


Figure 3-5 GSI Mapping of Karst Features

[7] https://www.gsi.ie/en-ie/data-and-maps/Pages/default.aspx

4.0 SITE SPECIFIC HYDRAULIC ANALYSIS

Due to the proximity of the Baldonnell Stream to the proposed development, and the potential for fluvial flood risk highlighted by the Eastern CFRAM study, a site-specific hydraulic assessment was required.

4.1 Flow Estimation

As shown in Figure 1-1, the natural course of the Baldonnell Stream passed through the subject site. This stream appears to have been rerouted to the eastern boundary of the site, likely as part of the development immediately upstream.

The catchment area for the stream at the subject site was estimated at 0.86 km^2 based on the OPW's FSU dataset and the topography of the area. See Figure 4-1.

Figure 4-1 Catchment Delineation

The 100- and 1000-year flow in the watercourse was estimated based on catchment descriptors, see Table 4-1. Four different methodologies were considered:

- Flood Studies Update (FSU) method
- The Centre for Ecology and Hydrology Flood Estimation Handbook (FEH) method
- The Institute of Hydrology Report No. 124 (IH124) method
- The Modified Rational Method (MRM)

Table 4-1 Summary of Catchment Descriptors

Descriptor	Units	Baldonnell Stream	Source
Catchment	-	Liffey	EPA
Catchment Area	km^2	0.864	FSU/TOBIN
Method applicability			
FSU	-	NO	
FEH	-	YES	
IH124	-	YES	
MRM	-	YES	
Catchment Descriptors			
BFI_{SOIL}	-	0.520	FSU
SAAR	mm	714.82	FSU/MET
FARL	-	1.000	FSU
DRAIND	km/km^2	0.721	FSU
S1085	m/km	0.100	FSU/DEM
ARTDRAIN2	-	0.200	FSU
URBEXT	-	0.359	FSU
S1		0	WRAP
S2		1	WRAP
S3		0	WRAP
S4		0	WRAP
S5		0	WRAP
i_{10}	mm/hr	21.40	MET
i_{100}	mm/hr	43.20	MET
i_{1000}	mm/hr	76.60	MET
CWI	-	90.0	graph
URBAN	fraction	0.10	user
UCWI (winter)	-	133.5	graph

EV1 growth factors (1.90 and 2.41 as defined by the FSR for the East) were applied to the estimation of Q_{bar} to predict the 100- and 1000-year flows, respectively.

In accordance with the Climate Change Sectorial Adaption Plan and the South Dublin County Development Plan SFRA, the proposed development was assessed against a Mid-Range Future Scenario (MRFS) and High-End Future Scenario (HEFS) which includes a 20% and 30% increase in flow respectively.

The largest flows from each methodology were compared, and the largest was conservatively adopted as the design flow. See Table 4-2.

Table 4-2 Estimated Flows

Description	Units	Value
Method adopted	-	MRM
100-year Flow	m^3/s	0.74
1000-year Flow	m^3/s	1.32
100-year MRFS Flow	**m^3/s**	**0.89**
1000-year MRFS Flow	**m^3/s**	**1.58**
100-year HEFS Flow	**m^3/s**	**1.11**
1000-year HEFS Flow	**m^3/s**	**1.97**

4.2 Hydraulic Model Construction

A site-specific hydraulic model of the site area was developed using the latest version (5.0.7) of the Hydraulic Engineering Centre's River Analysis System (HEC-RAS) software. HEC-RAS is designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels. The three primary inputs into the HEC-RAS model are summarised below:

- Geometric Data: Cross-sectional survey of watercourse, culverts and bridges
- Inflow Data: 100 and 1,000 year existing, MRFS and HEFS design flows
- Boundary Data: Normal depth downstream boundary

An overview of the hydraulic model is shown in Figure 4-2.

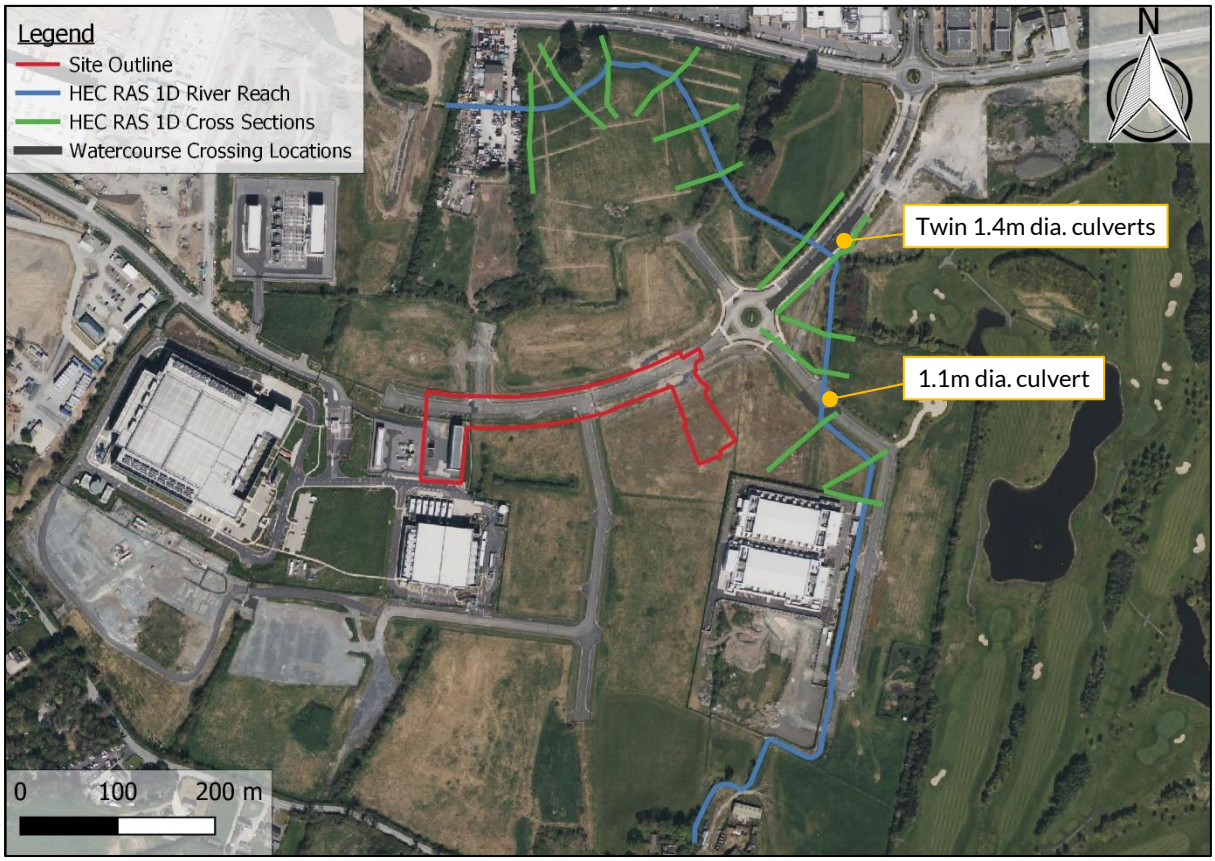


Figure 4-2 HEC-RAS Model Configuration

The Baldonnell Stream channel and floodplain in the vicinity of the proposed site were surveyed by TOBIN in March 2021. The hydraulic model includes two existing watercourse crossing structures: a 1.1m diameter circular culvert located directly adjacent to the subject site, and two 1.4m dia. circular culvert barrels conveying the watercourse beneath Profile Park Road to the north, approximately 150m downstream.

Conservative roughness values of 0.04 and 0.06 were applied to the channel and floodplain, respectively, based on a review of site photography and channel conditions.

The model was used to run four unsteady flow scenarios: the 100-year and 1000-year floods, with and without climate change. These events were simulated over a 3-day duration with 1-minute computational timesteps. The results of the hydraulic modelling are given in Section 4.3.

4.3 Hydraulic Model Results

Modelling of the Baldonnell Stream in the vicinity of the subject site indicates the watercourse is not predicted to burst its banks under existing flow conditions. As such, the subject site is not estimated to be liable to flooding for the current 0.1% AEP fluvial flood event, and is located in Flood Zone C.

Figure 4-3 shows the 100- and 1000-year water surface levels estimated in the Baldonnell Stream using the hydraulic model.

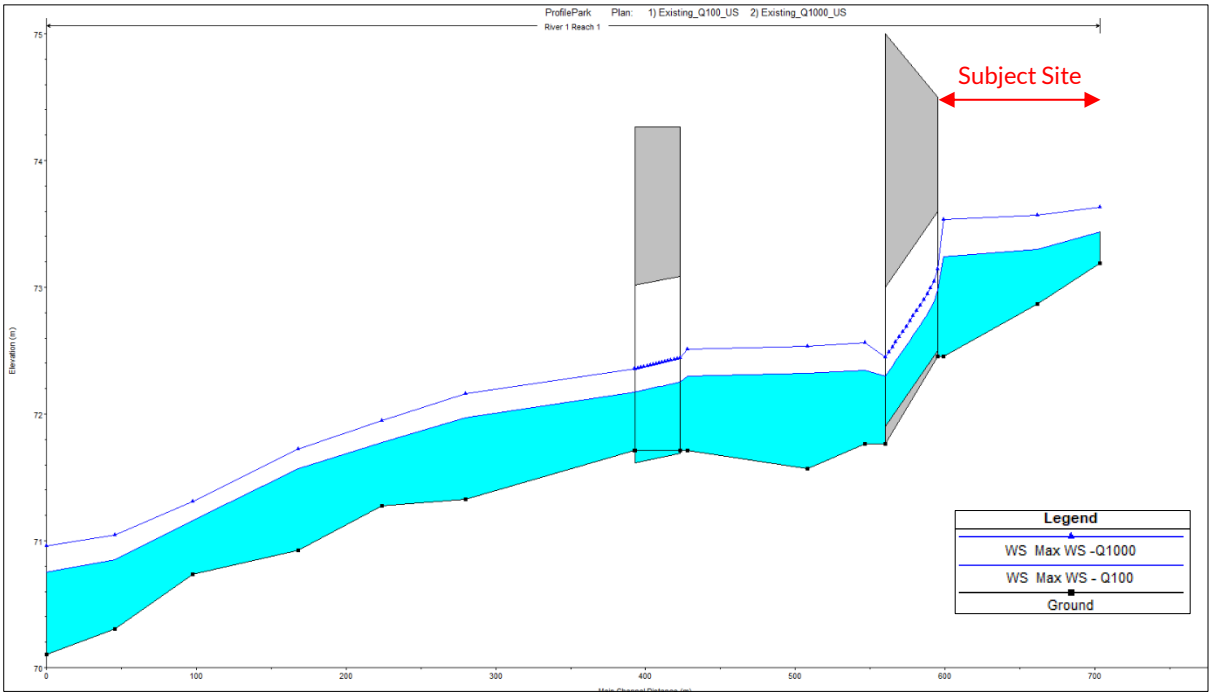


Figure 4-3 Predicted Maximum Water Surface Elevation [100- & 1000- Year without climate change]

In accordance with the Climate Change Sectorial Adaption Plan and the South Dublin County Development Plan SFRA, the proposed development was assessed against a High-End Future Scenario (HEFS) which includes a 50% increase in flow.

The water surface level for the 0.1% AEP HEFS fluvial event is estimated at 73.845mOD, while existing ground elevations at the subject site range from approximately 73.73mOD to 74.14mOD. Figure 4-4 shows the 1000-year HEFS flood extents estimated in the vicinity of the subject site using the hydraulic model.

Based on the results of the hydraulic model, it is estimated that a part of the site may be liable to flooding during the 1000-year HEFS scenario due to surcharging of the adjacent culvert.

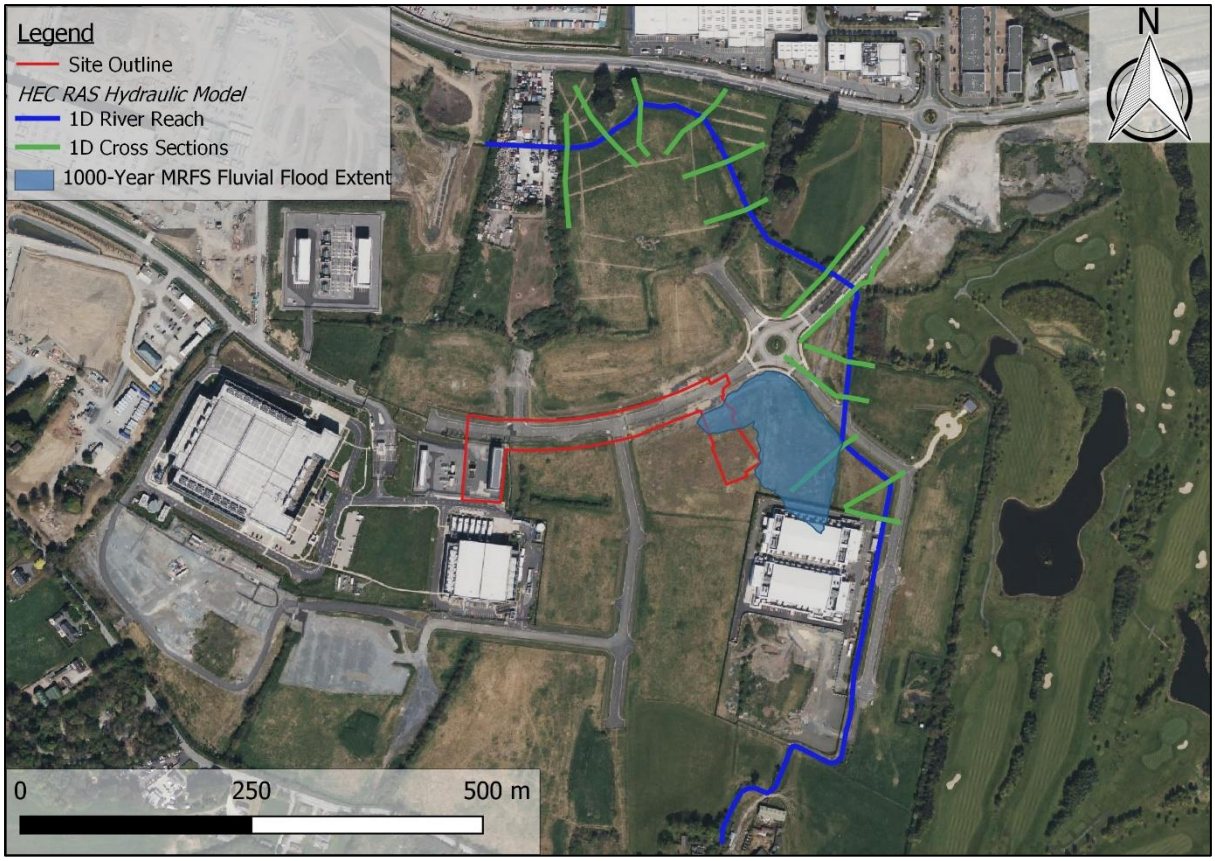


Figure 4-4 Predicted 1000- Year HEFS Fluvial Flood Extent

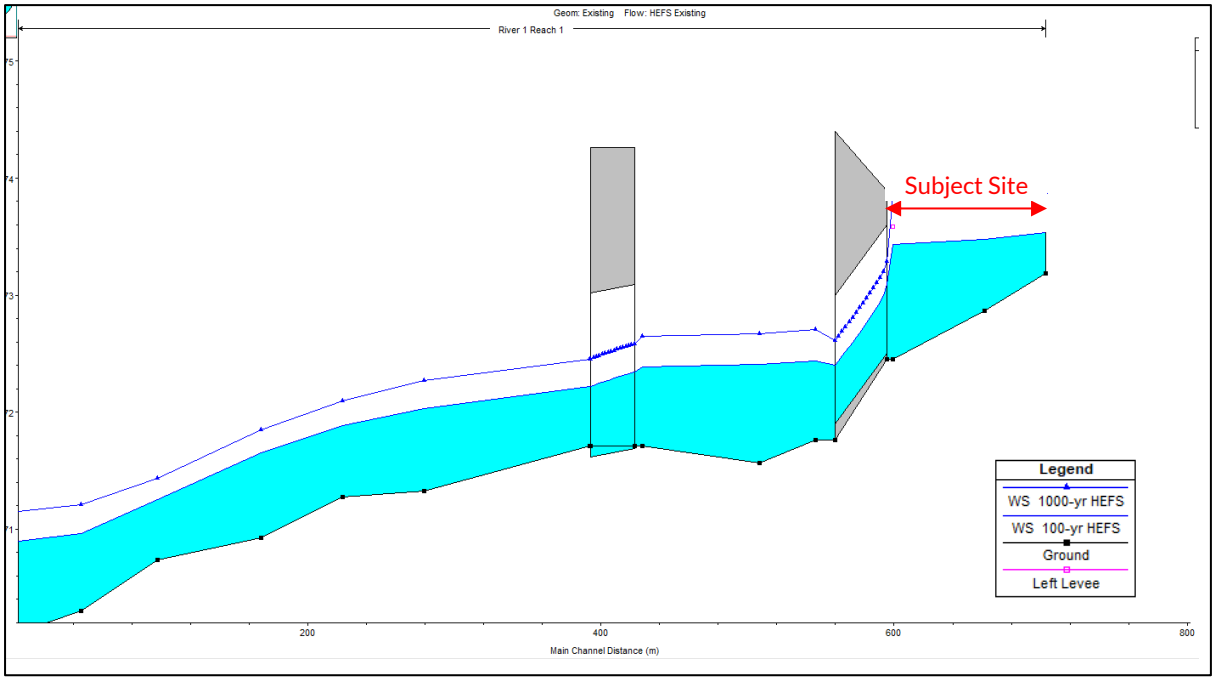


Figure 4-5 Predicted Maximum Water Surface Elevation [100- & 1000- Year HEFS]

4.4 Flood Mitigation Strategy

4.4.1 Site Grading

As part of the substation development, it is proposed to raise ground levels to 74.80mOD or higher. This provides 0.80m of freeboard above the 0.1% AEP HEFS flood levels predicted by site-specific hydraulic modelling. The adjacent power plant (approved under planning reference: SD21A/0167) also proposes raising ground levels to 74.80mOD or higher, which in turn, will sever the flow path of flood waters from the Baldonnell Stream to the site of the proposed substation. In this proposed scenario, the need for compensation storage at the substation is eliminated as flood waters from the Baldonnell Stream will be unable to encroach the subject site.

The hydraulic model was updated to assess the impact of raising ground levels on floodplain storage and flood risk elsewhere.

Based on the results of the hydraulic analysis, it is predicted that increasing site elevations at the adjacent power plant will increase water levels up to 0.014m at the subject site during a 1000-year HEFS event, see Figure 4-6. It is estimated that the effects of this will be imperceptible elsewhere in the catchment, where downstream impacts of proposed flood mitigation works are considered negligible due to the existing downstream constraint of the adjacent 1.1m diameter culvert.

As there is no flooding predicted on site for the existing 1000-year event, or events of lower magnitude, due to severance of flow paths, site grading will have no impact on floodplain storage or flood risk elsewhere in these scenarios.

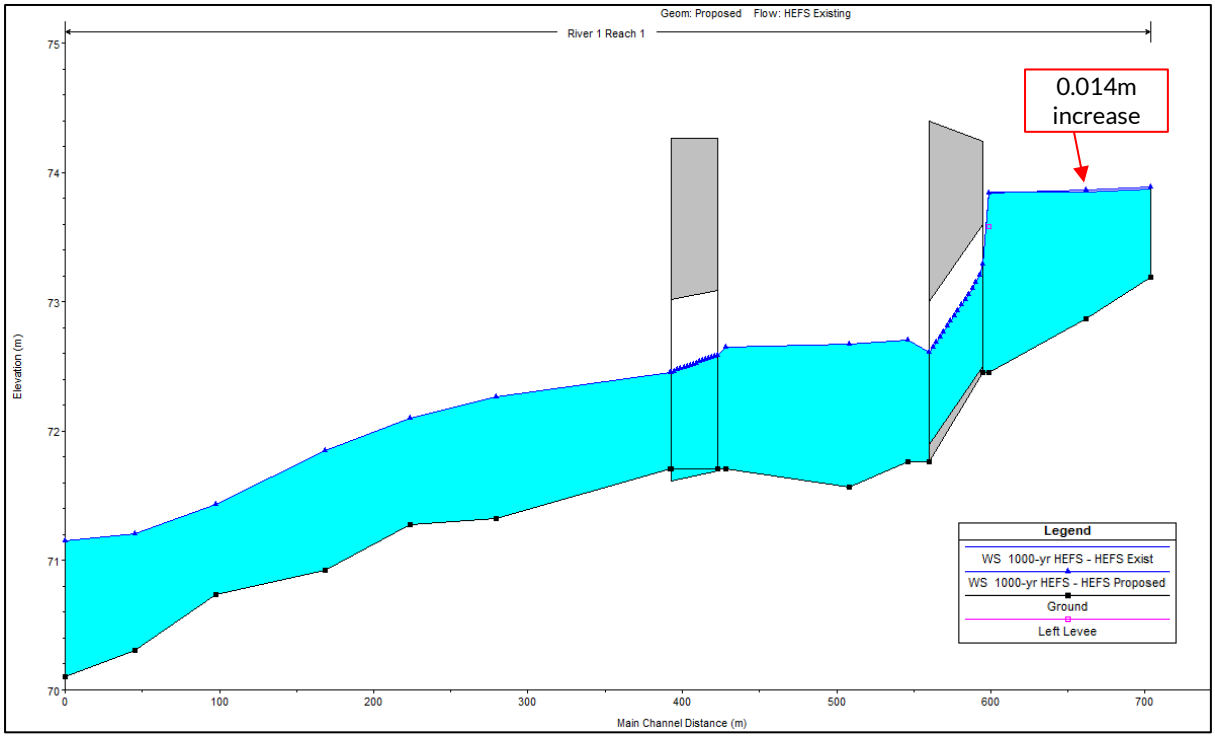


Figure 4-6 Predicted Maximum Water Surface Elevation with Site Regrading [1000- Year HEFS Existing and Proposed]

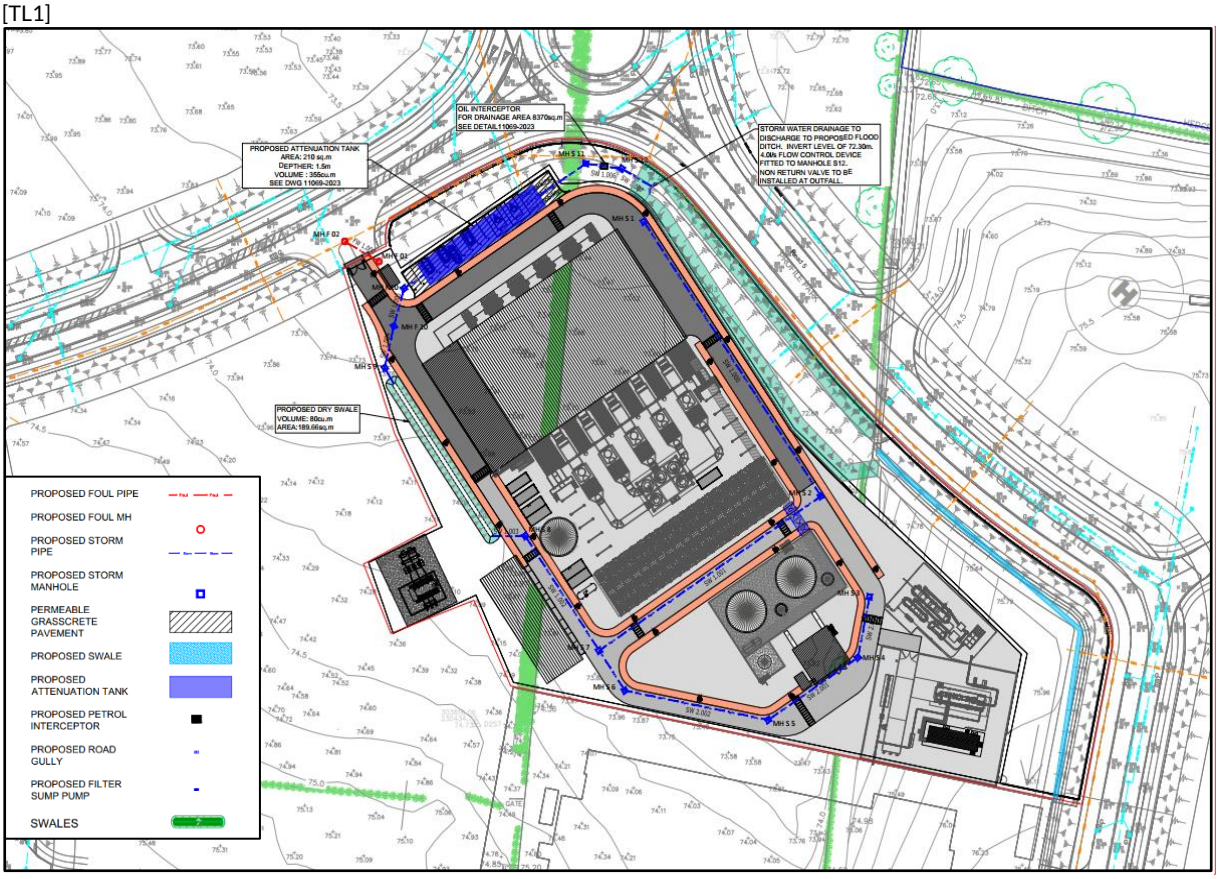
4.4.2 Compensation Storage

The adjacent power plant site was approved for planning under the proposal to regrade ground levels to remove the development from the 0.1% AEP MRFS fluvial flood extents. Based on existing and proposed site topography and the design flood level, approximately 803m^3 of floodplain storage was predicted to be displaced by the site regrading.

The PSFRM Guidelines classify compensatory flood storage into Direct and Indirect methods, where Direct methods are preferred and "*re-grade land and provide a direct replacement for the lost storage volume*"[8], while Indirect methods *"rely on water entering a defined storage area which then releases it at a slower rate*".

As per Figure 4-7, direct, volumetric compensation flood storage is provided within the adjacent power plant site through the design of a grassed flood storage area to provide open attenuation on site. The storage area provides 1034m^3 of floodplain storage, introducing an additional 231m^3 within the subject site and reducing overall flood risk. Care was taken in the design of compensatory flood storage to ensure connectivity with the floodplain, maintenance of existing channel banks, and efficacy of the proposed drainage system.

[TL1]



[TL2]

Figure 4-7 Proposed Direct Flood Compensation at the adjacent Power Plant Site

The hydraulic model was updated to assess the impact of the provision of floodplain storage on flood risk elsewhere.

[8] The Planning System and Flood Risk Management Guidelines for Planning Authorities, Technical Appendices, OPW (November 2009)

Based on the design of the site and results of hydraulic analysis, it is predicted that the site grading and compensation storage at the adjacent power plant will maintain the hydraulic regime of the stream, constraining flows to the banks and leaving water levels unchanged in the existing 1000-year events. In the 1000-year MRFS event, flows will spill over the maintained channel bank, filling the dedicated flood storage area, while constraining flood flows away from vulnerable areas and access routes.

Based on the results of hydraulic analysis, the dedicated flood storage will provide a benefit to flood risk on site and elsewhere, reducing maximum water surface elevations by up to 0.061m.

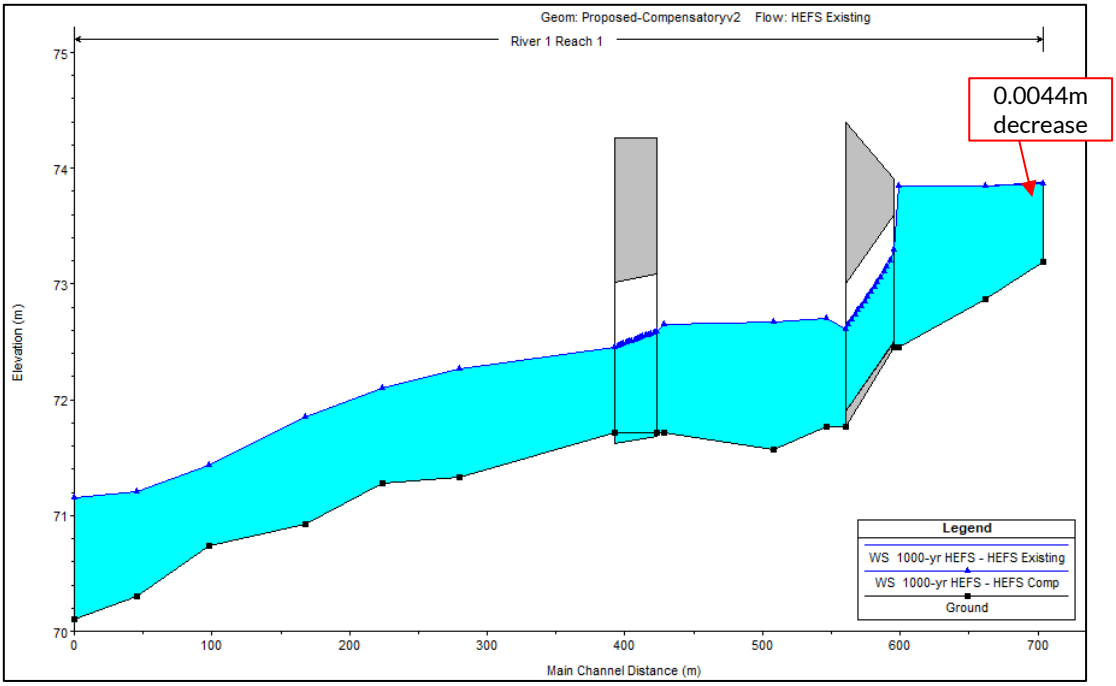


Figure 4-8 Predicted Maximum Water Surface Elevation with Compensation Storage [1000-Year HEFS Existing and Proposed at adjacent Power Plant Site]

The adjacent power plant also proposed raising ground levels to 74.80mOD or higher, which in turn, will sever the flow path of flood waters from the Baldonnell Stream to the site of the proposed substation. In this scenario, the need for compensation storage is eliminated as flood waters from the Baldonnell Stream will be unable to encroach the subject site.

Using current ground elevations at both the approved power plant and proposed substation, the 0.1% AEP HEFS event from the Baldonnell Stream is expected to inundate a portion of the subject site. Using the modelled design level of 73.85mOD, approximately 42.3m^3 of water will be displaced by the development, should the flow path not be severed at the adjacent site as outlined by existing CFRAM mapping and site-specific modelling using existing ground levels.

Using the CFRAM 0.1% AEP HEFS extents and by analysing the local topography, a more conservative design level of 74.00mOD was achieved and would displace approximately 117.20m^3.

With an additional 231m^3 of floodplain storage available at the power plant site, and severance of a flow path from the Baldonnell Stream, the proposed development will have no impact on flow paths or floodplain storage from the Baldonnell stream, and no additional compensatory measures are proposed within the limited footprint of the substation site. [TL3][ML4]

5.0 DETAILED FLOOD RISK ASESSMENT

The PSFRM Guidelines classify substations as "essential infrastructure", and therefore "highly vulnerable" in terms of sensitivity to flooding. Such facilities are required to be operational during a flood event. As such, the proposed development should be constructed in flood zone C—where there is less than a 0.1% Annual Exceedance Probability (AEP) of pluvial and fluvial flooding—or assessed under the PSFRM Justification Test (see Section 2.1.2).

A High-End Future Scenario (HEFS) has also been considered as part of this assessment to allow for the likely effects of climate change.

5.1 Pluvial Flooding

Previous flood studies which covered the area (OPW PFRA and South Dublin SFRA) indicated that the proposed development site is not at risk of pluvial flooding (see Figure 2-2).

The landscaping and topography of the developed site will provide safe exceedance flow paths and prevent surface water ponding to minimise residual risks associated with an extreme flood event or a scenario where the stormwater drainage system becomes blocked.

Surface water arising at the site will be managed by a dedicated stormwater drainage system designed in accordance with Sustainable Drainage Systems (SuDS) principles, limiting discharge from the site to greenfield runoff rates.

Therefore, the proposed development at the site is not estimated to be at risk of pluvial flooding.

5.2 Groundwater Flooding

Based on Geological Survey Ireland (GSI) subsurface mapping, there are no karst features (caves, springs, turloughs, etc.) of concern to the proposed site location (see Figure 3-5).

Further, the 2016-2022 South Dublin County SFRA notes that "*ground water flooding is not a risk for South Dublin County*". There is no mention of groundwater flood risk in the current South Dublin SFRA.

Therefore, the proposed development at the site is not estimated to be at risk of groundwater flooding.

5.3 Coastal Flooding

The proposed site in Profile Park is located inland, over 15km from the sea. The subject site (existing ground levels 73.73mOD or higher) is over 70m above the nearest 0.1% AEP HEFS coastal flood level estimated by the Eastern CFRAM study at Merrion (approx. 3.3mOD)[9].

Further, based on previous flood studies for the area (OPW PFRA, ICPSS, Eastern CFRAM, and South Dublin SFRA), the proposed development site is not at risk of coastal flooding.

[9] Eastern CFRAM Study, Map No. E09SAN_EXCCD_F2_02 (14 November 2017)

5.4 Fluvial Flooding

The River Griffeen flows through the area of the proposed development, with several small tributaries flowing to the main watercourse, including the Baldonnell Stream which runs through the subject site. There are no historical flood reports in the vicinity of the subject site.

The Eastern CFRAM study includes models of the Camac and Griffeen Rivers; however, the Baldonnell Stream has not been explicitly modelled. CFRAM modelling notes that the site may be liable to the 0.1% AEP fluvial flood event (see Figure 3-3) as a result of an overland spill from the Camac River, without accounting for the capacity of the Baldonnel Stream or other local drainage channels.

Site-specific hydraulic modelling was carried out by TOBIN to quantify the risk of flooding associated with the proposed development, and the Baldonnell Stream.

Based on the initial findings of the study, the subject site is liable to fluvial flooding in an extreme 0.1% AEP HEFS event (see Figure 4-4); however, the Baldonnell Stream is confined to its banks in an existing 0.1% AEP and 1% AEP MRFS event.

Proposed site elevations (≥74.80mOD) provide more than 0.95m freeboard above the predicted 0.1% AEP HEFS flood level (73.845mOD), removing the proposed development from the floodplain, and has imperceptible impacts on flood risk upstream/downstream of the subject site. Proposed infrastructure and access routes are elevated (FFL of 74.8mOD) to provide more than 1m freeboard above the predicted 0.1% AEP HEFS flood level at the site.

Based on the findings of site-specific hydraulic modelling, it is estimated that the risk of fluvial flooding associated with the development is minimal when accounting for proposed site elevations; however, under unimproved conditions and a HEFS, the site is estimated to be at risk of fluvial flooding in the 0.1% AEP HEFS event.

Accordingly, the site has been assessed under the PSFRM Justification Test to assess suitability.

5.4.1 Flood Mitigation Measures at Mountpark Baldonnell

A potential method of flooding at the subject site identified in the CFRAM mapping, and a review of modelled flow paths is from overland flow from Casement Aerodrome. The River Camac breaches it's left bank at Mountpark Baldonnell, where it flows towards Casement Aerodrome. The topography at the aerodrome causes floodwaters to flow northwards into low lying areas, and eventually towards the subject site. CFRAM mapping suggests that a neighbouring property south of the subject site obstructs the flow path of the floodwater, which in turn leads to floodwaters encroaching the subject site. The watercourse shown in Figure 5-1 is not delineated by the EPA and was not explicitly modelled in the Eastern CFRAM study.

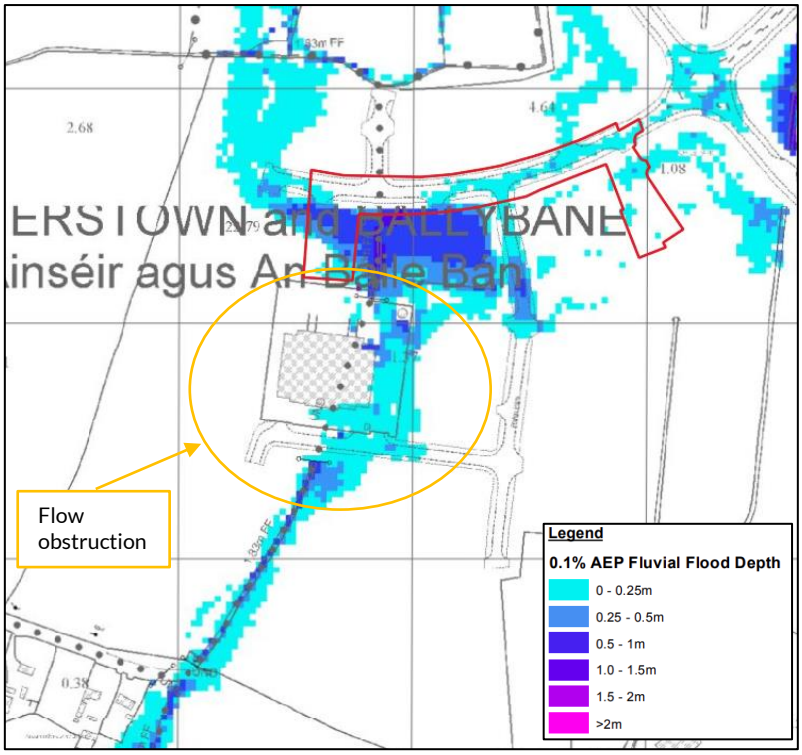


Figure 5-1 Excerpt from Eastern CFRAM Flood Depth Map at Subject Site for 0.1% AEP Fluvial Event[10]

A recently developed site at Mountpark Baldonnell consists of 7 no. logistics/warehouse units[11], included the construction of flood mitigation measures as permitted under SD20A/0215 and SD20A/0319. The measures generally act as a relief/bypass route for the River Camac in times of flood.

These measures include a series of stepped swales, connected by culverts at the swale invert level but also controlled by spillways at a higher level. The entire system discharges back into the Camac through a new outlet. Surface water drainage system from the development outfalls into the swale system and sufficient storage volume is available to store the design surface water event to transfer fluvial flood volumes collected from the Camac, via the main spillway from one swale to the next. The total effective storage volume provided within the system is approximately 148,611m^3.

The flood mitigation measures at Mountpark help reduce flood risk at the adjacent Casement Aerodrome, in all scenarios. In the pre-development scenario flooding is shown to extend to the runway in the 10% AEP event. In the post-development scenario, flooding is only predicted to occur for events with an AEP greater than 1% in the present-day scenario (Figure 5-2). Although the 0.1% AEP MRFS and HEFS scenarios were not modelled for the development at Mountpark, the flood extents at the Profile Park substation are predicted to be significantly reduced as much of the southerly flow caused by the Camac spill will be retained by the swales at Mountpark. The flood mapping from the Mountpark FRA does not extend to the substation site, therefore the updated flood extents at the substation are not known.

[10] Eastern CFRAM 0.1% AEP Fluvial Flood Depth (Maps No. E09CAM_DPFCD001_F1_13)

[11] Mountpark Baldonnell Phase 2- Units F and G Flood Risk Assessment (Planning Reference SD21A/0230). RPS (2021)

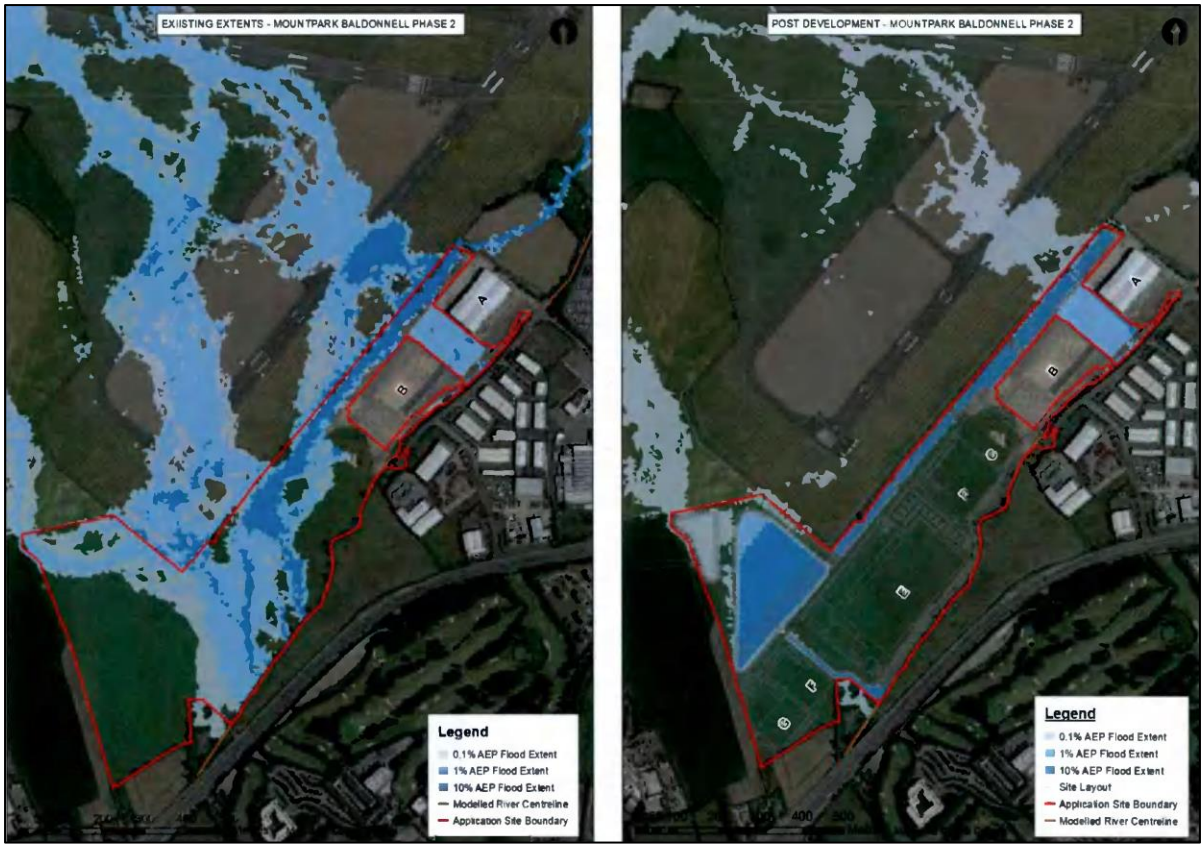


Figure 5-2 Comparison of existing & post development flood extents for the 10%, 1% and 0.1% AEP Present Day flood events at Mountpark, Baldonnell

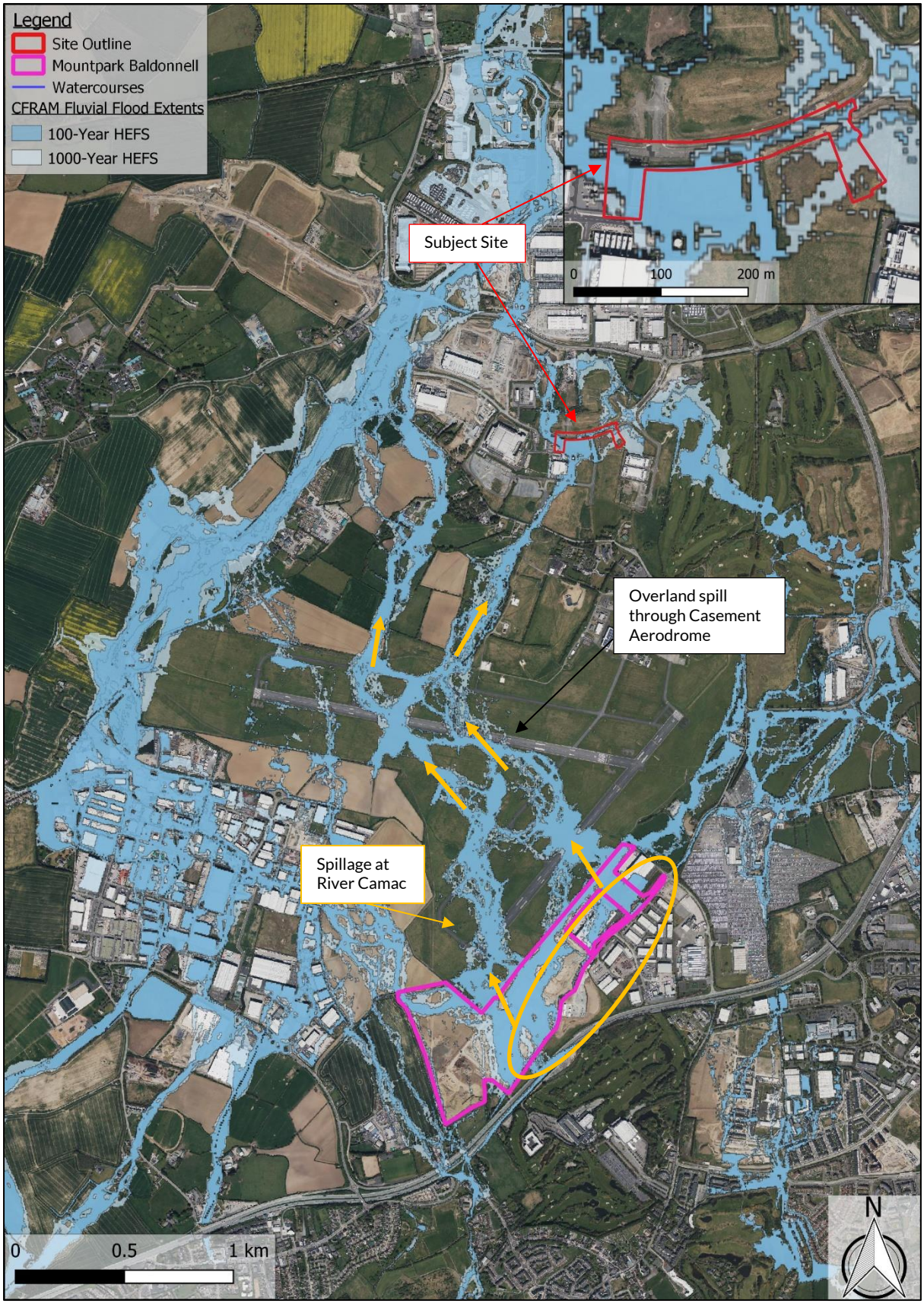


Figure 5-3 CFRAM HEFS Fluvial Extents from Mountpark to Profile Park

Flood extents at the subject site is only hydrologically connected to the Camac spill in the 0.1% MRFS and 0.1% HEFS. With the mitigation measures in place at Mountpark, flooding from the Camac at the subject site seems unlikely. The post-development spill pattern for the current 0.1% AEP event from the Camac in Figure 5-2 resembles the pre-development spill pattern of the 1% AEP event. Therefore, it is plausible to suggest that the post-development 0.1% AEP HEFS extents are comparable with the pre-development 1% AEP HEFS mapping, where flooding at the subject site is not hydrologically linked with the Camac spillage. It is therefore assumed that the Baldonnell Stream is the only potential factor of fluvial flooding at the subject site.

5.5 Impact of the Development Elsewhere

It is predicted that the proposed development is not at risk of flooding during a 1000-year HEFS. Identified flood risk at the subject site has effectively been mitigated by completed or approved construction since preparation of the CFRAM study. An assessment of local hydrology and site-specific modelling, outlined in this report, demonstrates that accordingly the subject site is not at risk of flooding during the 0.1%AEP HEFS fluvial flood event. Therefore, the development will not affect floodplain storage or obstruct the flow path of any existing watercourses.

Hydraulic modelling demonstrates an imperceptible impact on flood levels upstream/downstream in a 1000-year HEFS fluvial event. Flows from the subject site are limited by the adjacent 1.1m diameter culvert, whereby in conjunction with the provision of compensatory storage at the adjacent power plant site to the east, it is therefore predicted the proposed development will not impact flood risk elsewhere in the catchment and decreases flood risk to the subject site.

Surface water arising from within the site will be managed by an on-site storm water drainage system and on-site attenuation. On this basis, it is predicted that the proposed substation will not contribute to flood risk elsewhere in the area.

5.6 The Justification Test

The PSFRM Guidelines classify substations and essential infrastructure as “highly vulnerable”, in terms of sensitivity to flooding. As such, the proposed development should be constructed in Flood Zone C—where there is less than a 0.1% Annual Exceedance Probability (AEP) of flooding, including added allowances for a High-End Future Scenario (HEFS) to account for the likely effects of climate change on extreme rainfall depths and peak flood flows—or assessed for suitability through the Justification Test.

As outlined in Section 5.4, portions of the subject site are within Flood Zone B. Accordingly, the proposed development has been assessed against the criteria of the Justification Test (see Figure 2-1):

1. The site is zoned for enterprise and employment related uses and is therefore considered suitable for the proposed development.
2. The site has been subject to this detailed FRA, which demonstrates:
    (i) The proposed development is not predicted to have an impact on flood risk elsewhere in the locality (see Section 5.5).
    (ii) It is predicted that the proposed development will not impede the flow of surface water during extreme flood events. The layout of the development will minimise the flood risk to people, property, the economy, and the environment.

(iii) Residual risks to the site and to the proposed development during an extreme flood event can be managed to an acceptable level through a dedicated stormwater drainage system and effective landscaping and topography.
(iv) The proposed substation is compatible with the wider planning objectives of the area, which promote sustainable growth and development.

The proposed development satisfies the PSFRM criteria of the Justification Test.

6.0 CONCLUSIONS

TOBIN Consulting Engineers were appointed by Greener Ideas Limited to undertake a Flood Risk Assessment (FRA) for the construction of a new 110kV substation at Profile Park, West Dublin.

The Planning System and Flood Risk Management (PSFRM) Guidelines (OPW/DoEHLG, 2009) classify substations as essential infrastructure, and "highly vulnerable" in terms of their sensitivity to flooding. The proposed development should therefore be built in Flood Zone C, where there is less than a 0.1% Annual Exceedance Probability (AEP) of flooding, or assessed for suitability through the PSFRM Justification Test.

Pluvial Flooding:

Pluvial flood risk has not been noted by existing flood mapping.

Surface water arising at the site will be managed by a dedicated stormwater drainage system designed in accordance with SuDS, limiting discharge from the site to greenfield runoff rates. On this basis, it is predicted that the development of the site will not increase the risk of flooding elsewhere in the catchment.

The landscaping and topography of the site will provide safe exceedance flow paths and prevent surface water ponding to minimise residual risks associated with extreme flooding or blockage of the stormwater drainage system.

It is therefore estimated that the risk of pluvial flooding associated with the proposed development is minimal.

Groundwater Flooding:

There is no evidence to suggest groundwater as a potential source of flood risk to the proposed development site.

Coastal/Tidal Flooding:

The site is not at risk of coastal flooding due to its elevation and distance inland.

Fluvial Flooding:

The Baldonnell Stream, a tributary of the Griffeen River, is located east of the proposed substation and adjacent to the approved power plant.

Previous flood studies in the area (CFRAM and PFRA) modelled the Griffeen and Camac Rivers, however the Baldonnell Stream was not explicitly modelled. CFRAM modelling of the area shows the site as liable to fluvial flooding, without accounting for the conveyance capacity of the Baldonnell Stream.

The River Camac breaches it's left bank at Mountpark Baldonnel, where it flows towards Casement Aerodrome. The topography at the aerodrome causes floodwaters to flow northwards into low lying areas, and eventually towards the subject site. CFRAM mapping suggests that a neighbouring property south of the subject site obstructs the flow path of the floodwater, which in turn leads to floodwaters encroaching the subject site. A recently developed site at Mountpark Baldonnell includes flood mitigation measures which generally act

as a relief/bypass route for the River Camac in times of flood. Post-development flood mapping by RPS, suggests that >1% AEP flows are completely contained within the several swales present at the development or within the Camac itself. Although not explicitly mapped as part of the Mountpark FRA, it is assumed that the severity of the 0.1% HEFS event at the substation is significantly reduced with the presence of the retention swales.

It is suggested that the post-development 0.1% AEP HEFS extents are comparable with the pre-development 1% AEP HEFS mapping, where flooding at the subject site is not hydrologically linked with the Camac spillage. It is therefore assumed that the Baldonnell Stream is the only factor of fluvial flooding at the subject site, following the completed works and corresponding study.

To quantify the risk of fluvial flooding from the Baldonnell Stream, a site-specific hydraulic model was prepared. Based on the results of this model, it is estimated that the Baldonnell Stream will not burst its banks under existing flow conditions; however, the subject site may be impacted due to climate change (0.1% AEP High End Future Scenario).

Proposed site regrading (proposed elevations ≥74.80mOD) provide more than 0.80m freeboard above the predicted 0.1% AEP HEFS flood level, removing the proposed development from the future floodplain.

The adjacent power plant, granted planning permission, also proposed raising ground levels to 74.80mOD or higher, which in turn, will sever the flow path of flood waters from the Baldonnell Stream to the site of the proposed substation. In this scenario, the need for compensation storage is eliminated as flood waters from the Baldonnell Stream will be unable to encroach the subject site.

Using current ground elevations at both the approved power plant and proposed substation, the 0.1% AEP HEFS event from the Baldonnell Stream is expected to inundate a small portion of the subject site. Using the modelled design level of 73.85mOD, approximately 42.3m^3 of water will be displaced by the development. Using the CFRAM 0.1% AEP HEFS extents and by analysing the local topography, a more conservative design level of 74.00mOD was achieved and would displace approximately 117.20m^3. With an additional 231m^3 of floodplain storage available at the approved power plant, and severance of a flow path from the Baldonnell Stream, no additional compensatory measures need to be implemented.

Based on the result of site-specific modelling, and a detailed assessment of existing flood mapping, it is predicted that the development will have an imperceptible impact on flood risk upstream/downstream of the subject site, and that the risk of fluvial flooding associated with the development will be minimal.

The development satisfies the criteria of the PSFRM's Justification Test.

Appendix 1 - Drawings

Topographical Survey

LEGEND :

1. OPEN DRAIN :
2. PIPED CULVERT :

NOTES:

1. FIGURED DIMENSIONS ONLY TO BE TAKEN FROM THIS DRAWING.
2. ALL DRAWINGS TO BE CHECKED BY THE CONTRACTOR ON SITE
3. ENGINEER/EMPLOYERS REPRESENTATIVE, AS APPROPRIATE, TO BE INFORMED BY THE CONTRACTOR OF ANY DISCREPANCIES BEFORE ANY WORK COMMENCES
4. THE CONTRACTOR SHALL UNDERTAKE A THOROUGH CHECK FOR THE ACTUAL LOCATION OF ALL SERVICES/UTILITIES, ABOVE AND BELOW GROUND, BEFORE ANY WORK COMMENCES
5. ALL LEVELS SHOWN RELATE TO ORDNANCE SURVEY DATUM AT MALIN HEAD

Rev	Date	Description	By	Chkd.
0	16/04/2021	ISSUED FOR REVIEW	JM	McC

Client: centrica

Project: PROFILE PARK

Title: SITE TOPOGRAPHY

Scale @ A1:	1:1500	
Prepared by: JM	Checked: MMcC	Date: MAR' 2021
Project Director:	BRIAN CARROLL	
Drawing Status:	DRAFT	

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