Site R
Jordanstown Road,
Aerodrome Business Park,
Rathcoole,
Co. Dublin

Flood Risk Assessment

Final Report

May 2021

Exeter Ireland Property IV C Limited,

88 Harcourt Street,

Dublin 2

JBA Project Manager

Bernadette O'Connell
Unit 8, Block 660
Greenogue Business Plaza
Greenogue Business Park
Rathcoole,
Dublin
Co Dublin
IRELAND
D24 CY64

Revision History

Revision Ref / Date Issued	Amendments	Issued to
S3.P01 / 26/05/2021	Draft Report	Exeter Ireland Property IV C Ltd
A3.C01 / 27/05/2021	Final Report	Exeter Ireland Property IV C Ltd

Contract

This report describes work commissioned by Patrick Kavanagh of Kavanagh Burke, on behalf of Exeter Ireland Property IV C Ltd. Daniel Iordache of JBA Consulting carried out this work.

Prepared by ..... Daniel Iordache BEng MEng
Engineer

Reviewed by ..... Ross Bryant BSc MSc CEnv MCIWEM C.WEM
Principal Analyst

Purpose

This document has been prepared as a Final Report for Exeter Ireland Property IV C Ltd. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

JBA Consulting has no liability regarding the use of this report except to Exeter Ireland Property IV C Ltd.

Copyright

Carbon Footprint

A printed copy of the main text in this document will result in a carbon footprint of 66g if 100% post-consumer recycled paper is used and 84g if primary-source paper is used. These figures assume the report is printed in black and white on A4 paper and in duplex.

JBA is aiming to reduce its per capita carbon emissions.

Contents

List of Figures

Abbreviations

AEP	Annual Exceedance Probability
CFRAM	Catchment Flood Risk Assessment and Management
DoEHLG	Department of the Environment, Heritage and Local Government
FFL	Finish Floor Levels
FRA	Flood Risk Assessment
GSI	Geological Survey of Ireland
OPW	Office of Public Works
PFRA	Preliminary Flood Risk Assessment
SDCC	South Dublin County Council
SFRA	Strategic Flood Risk Assessment
WL	Water Level

1 Introduction

Under The Planning System and Flood Risk Management Guidelines for Planning Authorities (DoEHLG & OPW, 2009) the proposed development must undergo a Flood Risk Assessment to ensure sustainability and effective management of flood risk.

1.1 Flood Risk Assessment; Aims and Objectives

This study is being completed to inform the future development of the site as it relates to flood risk. It aims to identify, quantify and communicate to Planning Authority officials and other stakeholders the risk of flooding to land, property and people, and the measures that would be recommended to manage the risk.

The objectives are to:

- Identify potential sources of flood risk;
- Confirm the level of flood risk and identify key hydraulic features;
- Recommend appropriate flood risk mitigation and management measures which will allow for the long-term development of the site.

Recommendations for development have been provided in the context of the OPW / DoEHLG planning guidance, "The Planning System and Flood Risk Management". A review of the likely effects of climate change and the long-term impacts this may have on any development has also been undertaken. For general information on flooding, the definition of flood risk, flood zones and other terms see 'Understanding Flood Risk' in Appendix A.

1.2 Development Proposal

Exeter Ireland Property IV C Limited intend to apply for permission for development at this 5.67 ha site known as Block R, Jordanstown Road, Aerodrome Business Park, Rathcoole, Co. Dublin. The lands are bounded to the east by Blocks A - D Jordanstown Road, Aerodrome Business Park, Rathcoole, Co. Dublin and to the north, south and west by greenfield lands. The R120 Newcastle Village to Rathcoole Road also bounds the site to the south.

The development will comprise the construction of 1 No. warehouse with ancillary office and staff facilities and associated development. The warehouse will have a maximum height of 16 metres with a gross floor area of 22,966 m^3 including a warehouse area (21,113 m^3), ancillary office areas (1,163 m^3) and staff facilities (690 m^3).

The development will also include: the provision of a new vehicular access to the site from Jordanstown Road, including 2 No. additional access gates from this new road to the existing Site E to the north; pedestrian access; 210 No. ancillary car parking spaces; bicycle parking; HGV yards; level access goods doors; dock levellers; access gates; hard and soft landscaping; lighting; boundary treatments; ESB substation; plant; pedestrian access gate at the southern portion of the site from the R120; and all associated site development works above and below ground.

Refer to Figure 1-1 for the site layout.

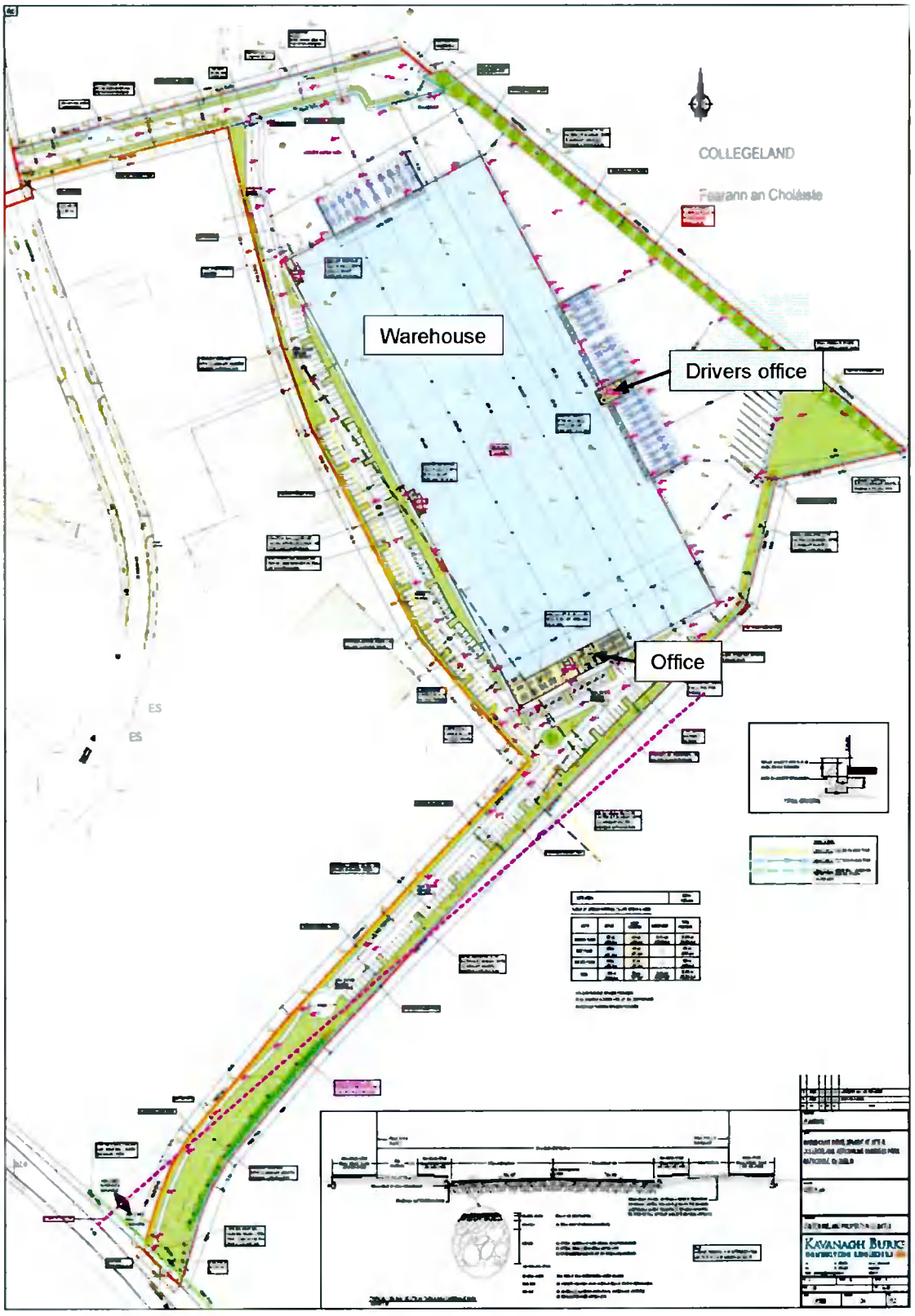


Figure 1-1: Site Layout

1.3 Report Structure

The report is structured as follows:

Section 2 - Provides an overview of the study location and associated watercourses to the site.

Section 3 - Contains background information and the initial assessment of flood risk.

Section 4 - Gives an overview of the technical to Flood Risk Assessment (FRA).

Section 5 - The FRA conclusions are highlighted.

2 Site Background

2.1 Location

The proposed development comprises part of the Greenogue Business Park which is located approximately 1km north of Rathcoole Village and approximately 1.6km south-east of Newcastle Village, as shown in Figure 2-1.

The specific site is currently a greenfield site used for agricultural (crop) purposes. It is located off Jordanstown Road which provides the main access route, on the southern fringe of Greenogue Business Park.

Agricultural lands extend to the north, west and to the south from the site. The Baldonnel Casement Aerodrome is located to the north-east, while commercial and industrial warehouse facilities lie to the west (Greenogue Business Park).

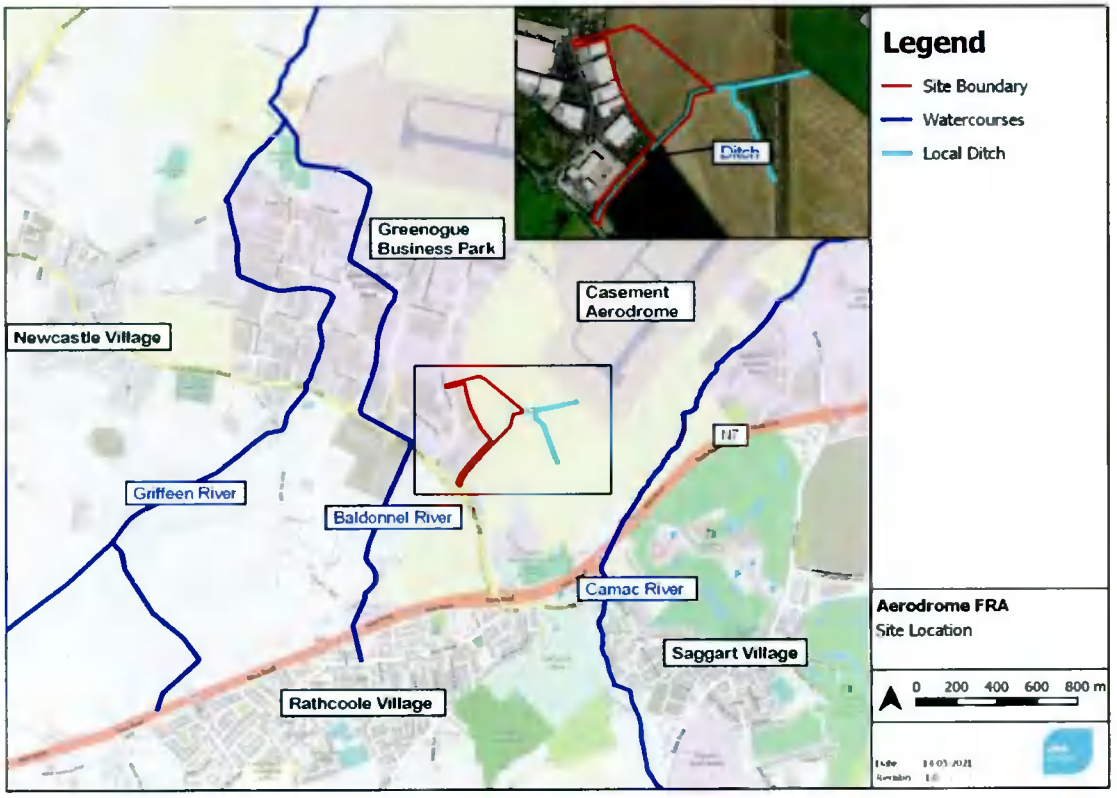


Figure 2-1: Site Location & Hydrological Environment

2.2 Watercourses

As shown in Figure 2-1, the Griffeen River, the Baldonnel Stream and the Camac River are the three main local watercourses in the area, while a ditch flows along the south-eastern site boundary.

The Camac River is located south-east of the proposed development. It flows northwards via culvert under the N7 approximatively 800m from the site. It then continues in a north-easterly direction away from the site and Greenogue Business Park.

The Baldonnel Stream flows northwards in an open channel approximatively 300m west of the site. It then flows via culvert along the Newcastle Road before returning to open channel along College Road within the business park, where it flows in a northerly direction.

The Griffeen River flows from south-west to north-east and lies approximately 800m to the west of the site. It joins with the Baldonnel Stream downstream of the Greenogue Business Park.

2.3 Site Topography

The topography across the site ranges from approximately 99mOD to 92 mOD, with a slope from south-east to north-west. The ditch presented in Figure 2-1 is bounding the site to the south-east, with bed levels approximatively 1m lower than the site topography, according to recent site survey undertaken in April 2021.

The site topography is displayed in Figure 2-2 and photos of the site ditch in Figure 2-3.

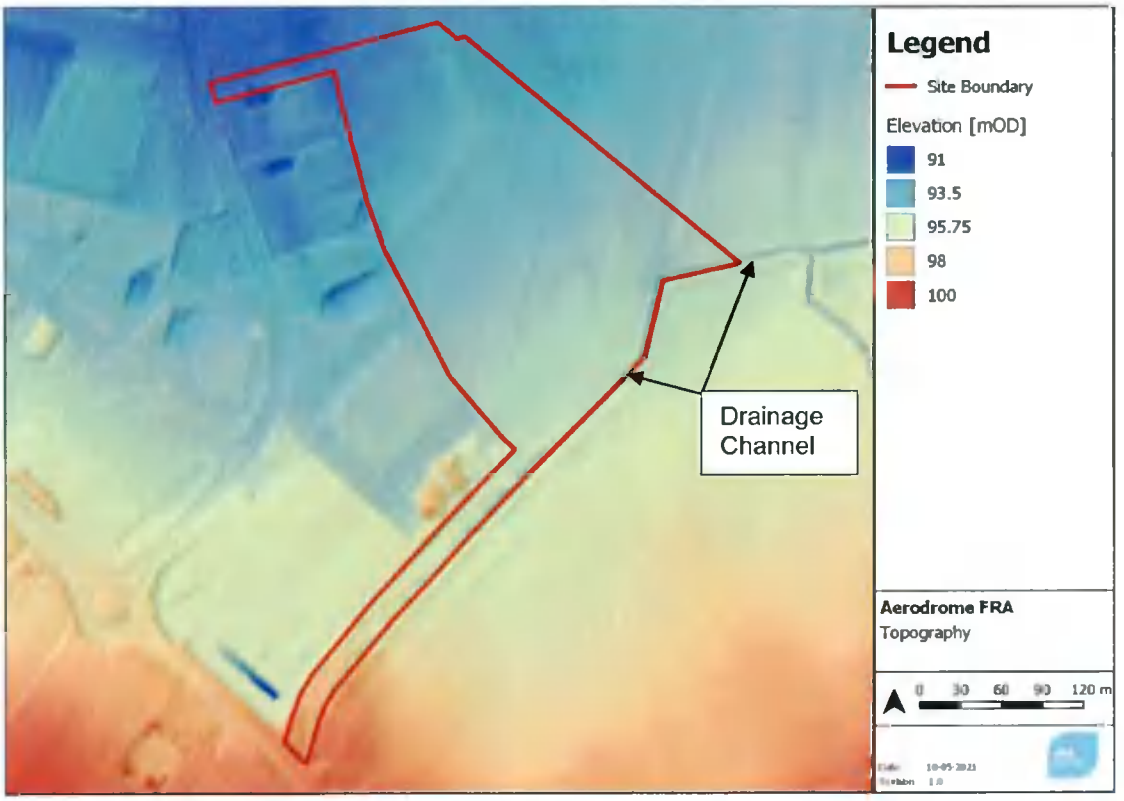


Figure 2-2: Site Topography

Figure 2-3: Drainage Ditch

2.4 Site Geology

The Geological Survey of Ireland (GSI) groundwater and geological maps indicate that the subsoil within the site is largely made of moderate permeability Limestone Till and Outcrops. The underlying bedrock is classified as Calp which consists of dark grey to black limestone and shale.

The bedrock at the site location is shallow therefore, the groundwater vulnerability is deemed 'Extreme.' The groundwater vulnerability classifications reflect the potential risk of groundwater infiltrations through the bedrock and risk of groundwater contamination from the site. There is no evidence of karst features at the site or in the surrounding area, which would commonly be linked to groundwater flooding.

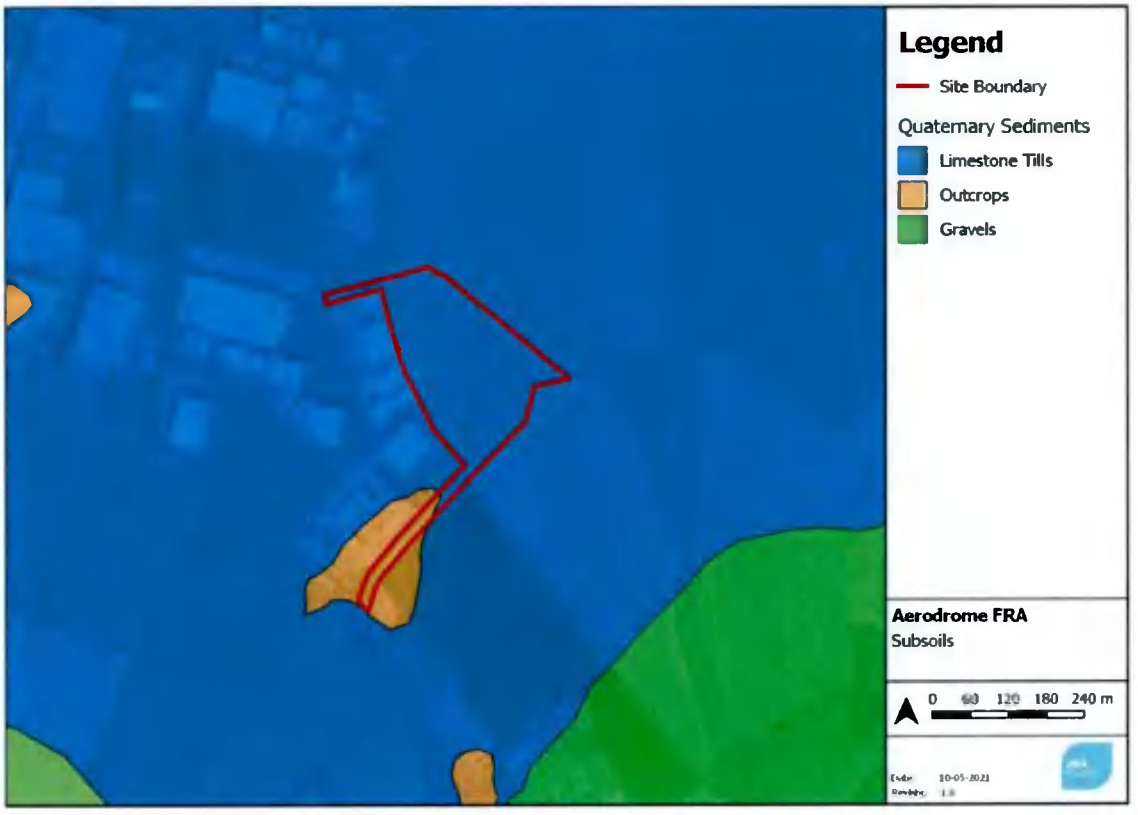


Figure 2-4: Quaternary Sediments

3 Flood Risk Identification

An assessment of the potential and scale of flood risk at the site was conducted using historical and predictive information. This identifies any sources of potential flood risk to the site and reviews historic flood information. The findings from the flood risk identification stage of the assessment are provided in the following sections.

3.1 Flood History

A number of sources of flood information were reviewed to establish any recorded flood history at, or near the site. This includes the OPW's website, www.floodmaps.ie and general internet searches.

3.1.1 Floodmaps.ie

The OPW host a National Flood hazard mapping website, www.floodmaps.ie, which highlights areas at risk of flooding through the collection of recorded data and observed flood events. See Figure 3-1 for historic flood events in the area, which are listed below.

Review of this mapping shows no instances of historical flooding at the specific site location. However, there are several recorded flood events in the wider regional area.

- (a) 24th October 2011 - Flooding occurred in Greenogue Business Park to commercial unit 525. Heavy rainfall resulted in pluvial flooding at the site, this event also caused significant inundation to adjacent road networks. This site is located approximately 1 km north of the proposed development,
- (b) November 2000 - Overtopping of the Griffeen River following heavy rainfall causing flooding along Aylmer Road (70-year return event). Flooding was located approximately 1.7km northwest of the development site,
- (c) Aylmer Road - Re-occurring flooding occurring from the Griffeen River,
- (d) Newcastle Co Dublin - Re-occurring flooding near Newcastle Village approximately 1.2 km from the proposed development site,
- (e) Rathcoole Bridge - Re-occurring flooding along Rathcoole bridge affecting the Dublin bound slip road traffic to Rathcoole off the N7. This did not impact the site which is north of Rathcoole Village.

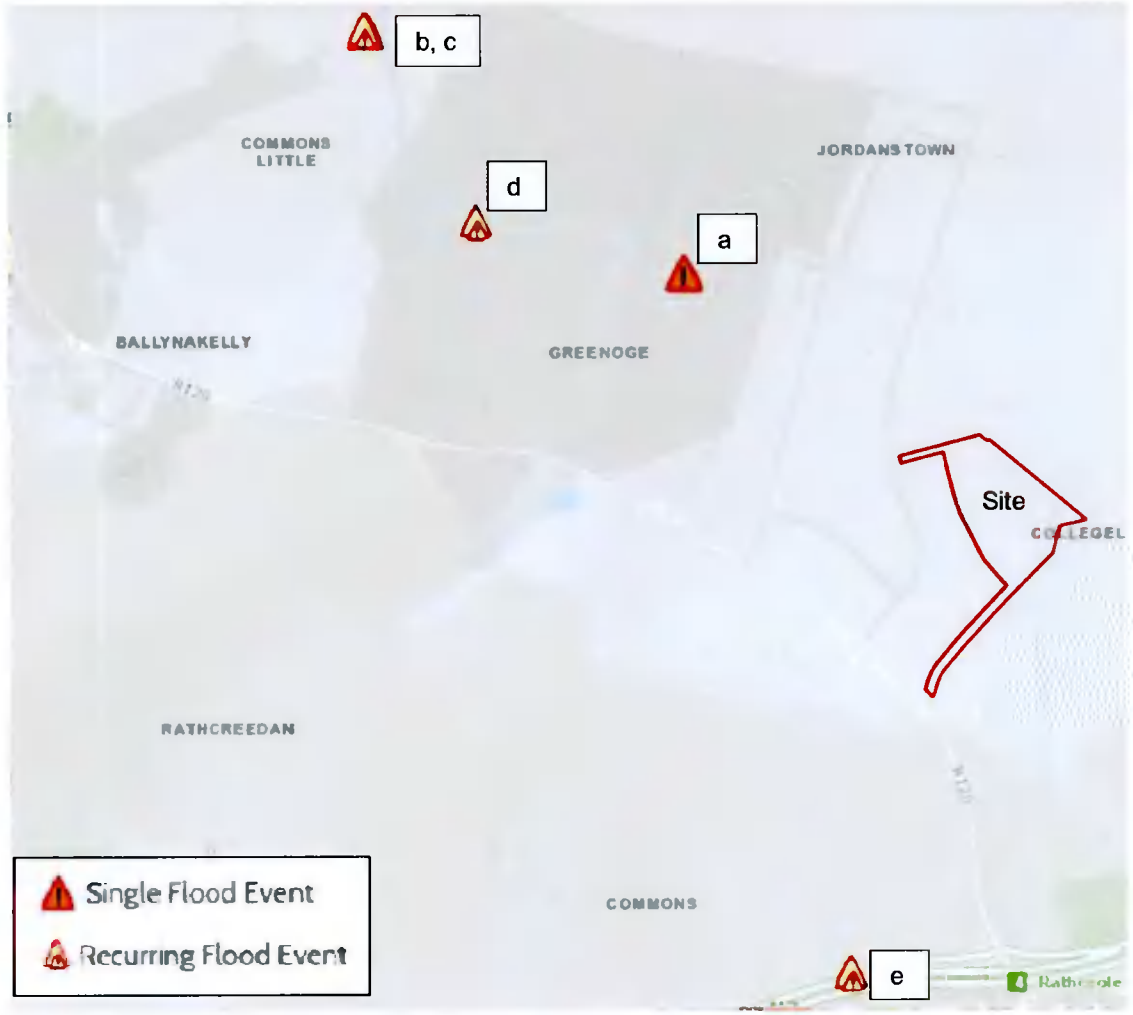


Figure 3-1: Historical Flooding (source: floodmaps.ie)

3.1.2 Internet Searches

An internet search was conducted to gather information about whether or not the site was affected by flooding previously. While there were no results for flooding affecting the site itself, there were reports confirming of flooding in the areas mentioned above.

3.2 Predictive Flooding

Greenogue Business Park has been subject to three predictive flood mapping and modelling studies.

- OPW Preliminary Flood Risk Assessment (PFRA), 2011;
- Eastern Catchment Flood Risk Assessment and Management Study (CFRAM), January 2016;
- The SDCC Strategic Flood Risk Assessment (SFRA), July 2016.

The level of detail presented in each method varies according to the quality of the information used and the approaches involved. The Eastern CFRAM is the most detailed assessment of the flood extents and supersedes the flood outlines presented by the OPW PFRA study.

3.2.1 OPW Preliminary Flood Risk Assessment (PFRA)

The Preliminary Flood Risk Assessment (PFRA) is a requirement of the EU Flood Directive (2007/60/EC). One of the PFRA deliverables is flood probability mapping for various sources: pluvial (surface water), groundwater, fluvial and tidal. The PFRA is a preliminary or 'indicative' assessment and analysis has been undertaken to identify areas potentially prone to flooding. The OPW PFRA study has largely been superseded by the CFRAM programme.

The PFRA mapping is in the process of being updated and have been removed from public viewing. At the time of writing the updated maps have not been made available.

3.2.2 Eastern Catchment Flood Risk Assessment and Management Study (CFRAM)

The Eastern CFRAM study is the most detailed mapping undertaken in the Dublin region. It commenced in June 2011 with final flood maps issued during 2016. The study involves detailed hydraulic modelling of rivers and their tributaries. The Baldonnel Stream, Griffeen River and Camac River were all modelled in the CFRAM study which resulted in flood mapping for the 10%, 1% and 0.1% AEP fluvial events. An extract of the flood map covering the site is presented in Figure 3-2.

The CFRAM flood mapping identifies cross catchment flows from the River Camac enter within Greenogue Business Park. The overland flow from the Camac watercourse follows the natural fall in topography in a north west direction toward the proposed development, with some spill occurring onto the south-east corner of the site during the 0.1% and 1% AEP flood events.

Whilst a second flow route is shown along the western site boundary during the 0.1% AEP event, the flooding mapped is limited to ponding of water disconnected to the main overland flowpaths, which indicates shallow depths, as presented in Figure 3-3. This disconnection of the flood extents is the result of shallow flood depths having been filtered out of the flood maps

The Baldonnel Stream is not shown to pose a flood risk to the site. As the topography slopes to the north-west, any spill and overland flooding from the Baldonnel Stream flows away from the site.

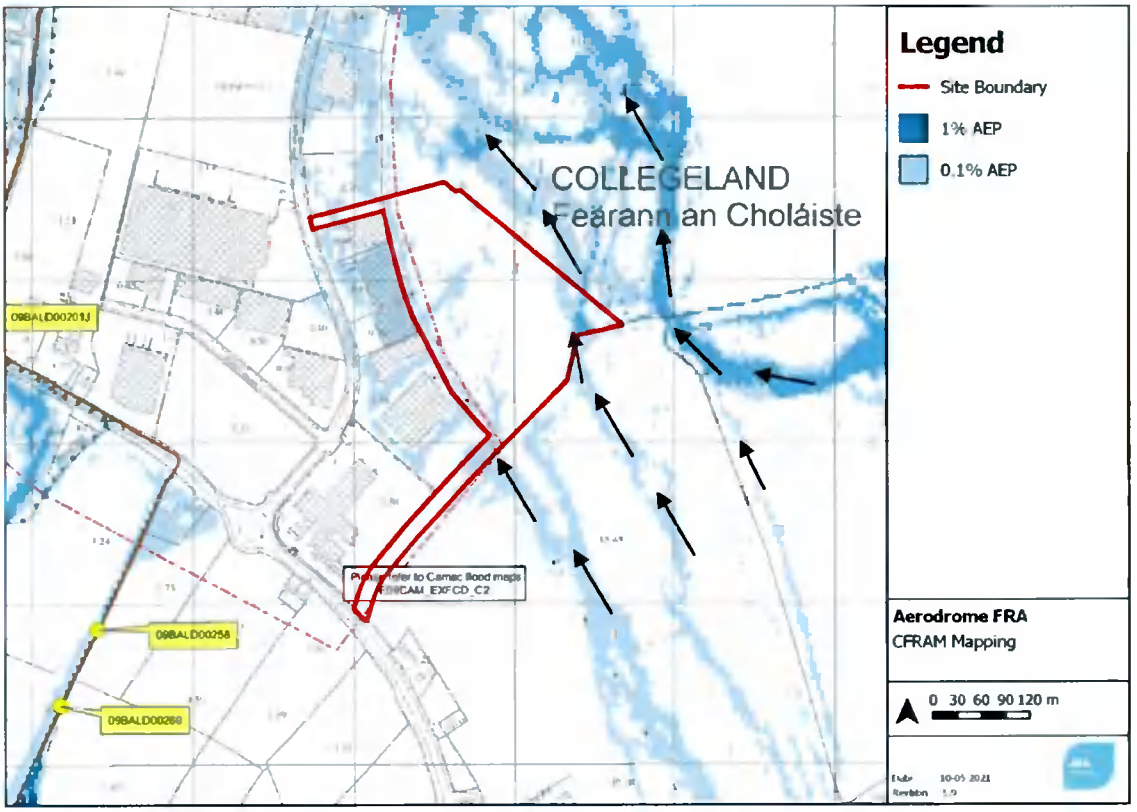


Figure 3-2: CFRAM Flood Extents

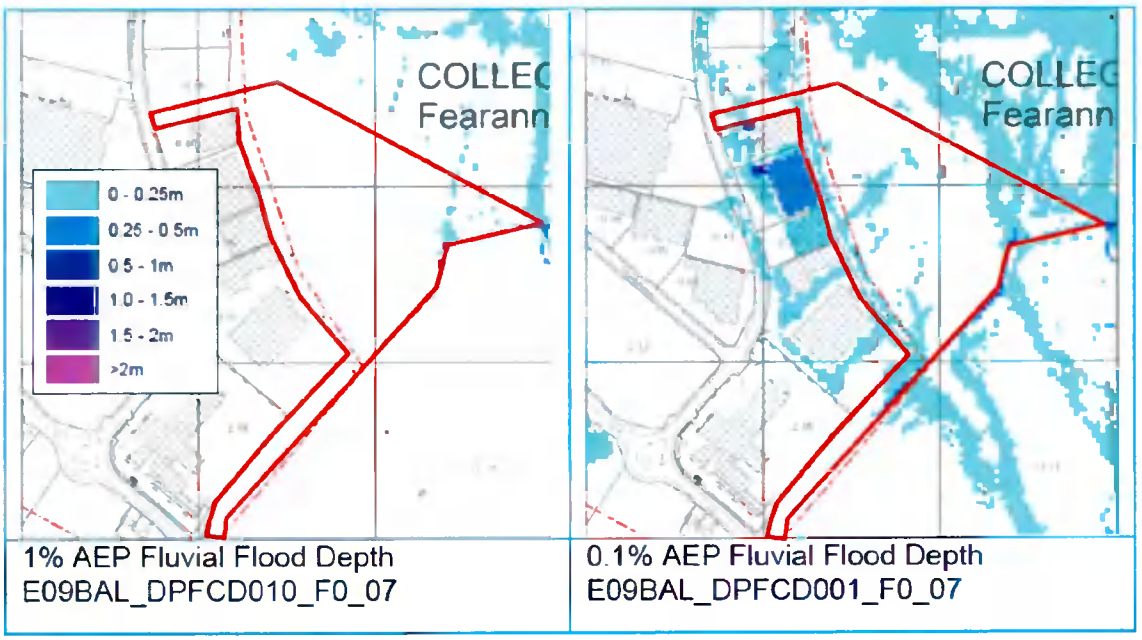


Figure 3-3: CFRAM Flood Depths

3.2.3 Strategic Flood Risk Assessment for South Dublin County Council Development Plan 2016-2022

The SFRA for the South Dublin County Development Plan (2016-2022) assists SDCC in making strategic land-use planning decisions by providing information about flood risk within the County. The assessment is based on the Eastern CFRAM Study flood mapping discussed in Section 3.2.2 and therefore, presents the same flood outlines. CFRAM flood maps were used as part of the SFRA, which includes the Greenogue Business Park.

3.3 Flood Sources

The initial stage of a Flood Risk Assessment requires the identification and consideration of probable sources of flooding. These sources are described below.

3.3.1 Fluvial

Fluvial flooding is the dominant source of potential flood risk, a very small area of the eastern fringe is within Flood Zone A (approx. 600m^2) and approximately 20% of the site is in Flood Zone B (moderate risk of flooding), as predicted by the Eastern CFRAM flood mapping.

The Griffeen River and Baldonnel watercourses are not considered to be a source of flood risk to the site.

The source of fluvial flooding identified for the site is the overland flows from the Camac River. This source of flood risk will be further assessed in Section 4 using a site-specific flood model that represents the overland flow from the Camac River and that includes the ditch running along the south-eastern boundary of the site.

3.3.2 Pluvial/Surface Water

Pluvial or surface water flooding is the result of rainfall-generated flows that arise before run-off can enter a watercourse or sewer. In any development, the poor design of a surface water system can influence the specific surface water flood risk to a site. To manage the potential generation of surface water runoff by a proposed development on the site, careful consideration should be given to the overall site design.

A review of the LiDAR data for the site confirms there are no isolated depressions that would be at risk of surface water ponding. The general slope across the site ensures that any significant rainfall will runoff in a north westerly direction towards the local drainage system.

The risk to the site of pluvial flooding will be further assessed in Section 4.

3.3.3 Groundwater

There are no karst features in the area which would indicate areas at risk of groundwater flooding. The overall vulnerability at the proposed development to groundwater is deemed low. As such, groundwater is not a likely source of flood risk to the site and has been screened out of this assessment.

3.3.4 Tidal

Greenogue Business Park is inland approximately 18.5km from the coastline. Coastal flooding is not considered a source of flood risk to the site.

4 Flood Model Assessment

Following on from the data collection and risk identification, this section will assess the likelihood of flooding at the site in more detail using a hydraulic model. This will provide clarification of the anticipated Flood Zone extents, updating the information provided by the Eastern CFRAM. The information will then be used to configure the site layout and implement mitigation measures that ensure flood risk is effectively managed.

The following sections will detail the process of flow estimation, hydraulic modelling and present the results.

4.1 Hydrology

The cross-catchment flow for the Camac was not explicitly derived using hydrological methods but rather the CFRAM flood extents were replicated by applying a hydrograph to the area to the east of the business park.

The hydrograph was calibrated to a peak of 0.41m^3/s for the 1% AEP event, which resulted in a flood extent on the eastern side of Greenogue Business Park - in line with the output of the CFRAM process. The same process was applied for deriving the 0.1% AEP event flood map.

4.2 Hydraulic Model

4.2.1 Model Set-up

The hydraulic modelling was carried out in the following stages:

- A 2D (TUFLOW) model grid enclosing the study area was created;
- The ditch located along the south-eastern boundary of the site was included in the model using recent survey data information;
- The Camac overland flows were represented in the 2D hydraulic model;
- Design simulations were run to derive the 'existing risk' flood extents;
- The hydraulic model was then altered to account for the proposed development. This involved 'stamping' the 2D domain with proposed finished floor levels and allowing for proposed mitigation measures.

4.3 Model Results and Flood Mechanism

The flood extents are displayed in Figure 4-1, showing there is minor flooding at the eastern corner of the site for the 1% AEP event (Flood Zone A) and the 0.1% AEP event (Flood Zone B), placing the majority of the site within Flood Zone C. The hydraulic modelling confirms the overland flows from the Camac River are shallow and are easily conveyed by the site ditch. The flows are then diverted in a northerly direction across the eastern corner of the site.

The results for the 1% AEP event are similar with the CFRAM study. However, CFRAM mapping identifies higher flood extents within the site boundary for the 0.1% AEP event, as the local ditch was modelled using only LiDAR data which does not capture the full channel capacity due to obstruction caused by vegetation.

As stated previously, the JBA model used survey data information for the site ditch, allowing for a better representation of the channel within the model.

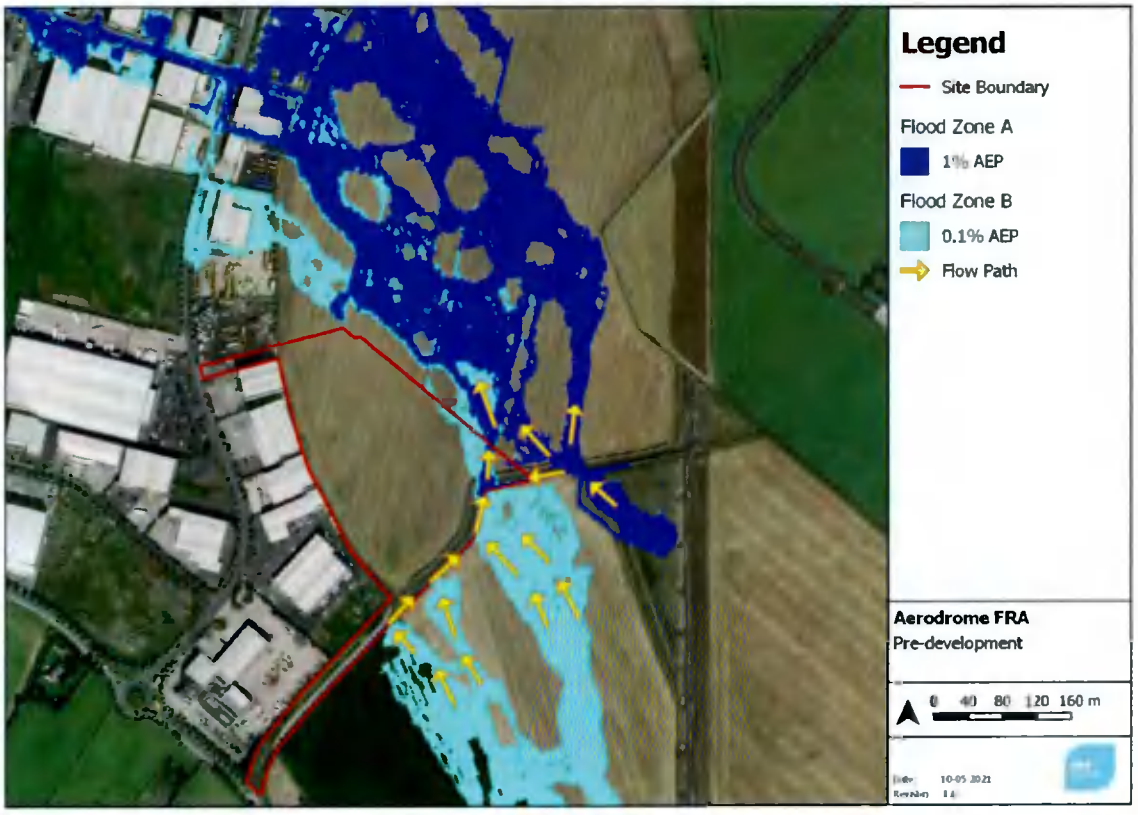


Figure 4-1: Pre-Development Flood Extents

4.4 Post Development Flood Extents

As outlined in Section 1.2, the proposed development involves the construction of a warehouse unit and associate office space. The baseline 1% and 0.1% AEP flood extents have been overlaid on the proposed design as provided in Figure 4-2.

Whilst some inundation occurs within the site boundary, the proposed buildings on site (warehouse, office, drivers office) are not at flood risk during the 1% and 0.1% AEP flood events, the inundation onto the site only affects the eastern corner of the site.

As outlined further in Section 5.1.2, the flow path through the site during the 1% AEP event has been maintained in the post development design. The existing ground levels have been maintained which allows the unrestricted flow of flood waters through the site without increasing flood risk elsewhere.

Figure 4-2 also provides the reporting locations through the site that will be used to assess the impact on flood levels from the proposed development, while the water levels across the site for the 1% and 0.1% AEP events are presented in Table 4-1.

Appendix C provides additional analysis of the impact from the proposed development from the baseline flood events, the pre- and post-development flood levels and impacts from the 1% AEP and 0.1% AEP events being provided. Review of the tables in Appendix C confirm that there is no increase in flood risk for the 1% AEP and 0.1% AEP flood events downstream of the site.

Table 4-1: Modelled Water Levels

Reporting location	1% AEP	0.1% AEP
1	94.65	94.80
2	94.65	94.77
3	94.65	94.75
4	94.52	94.59

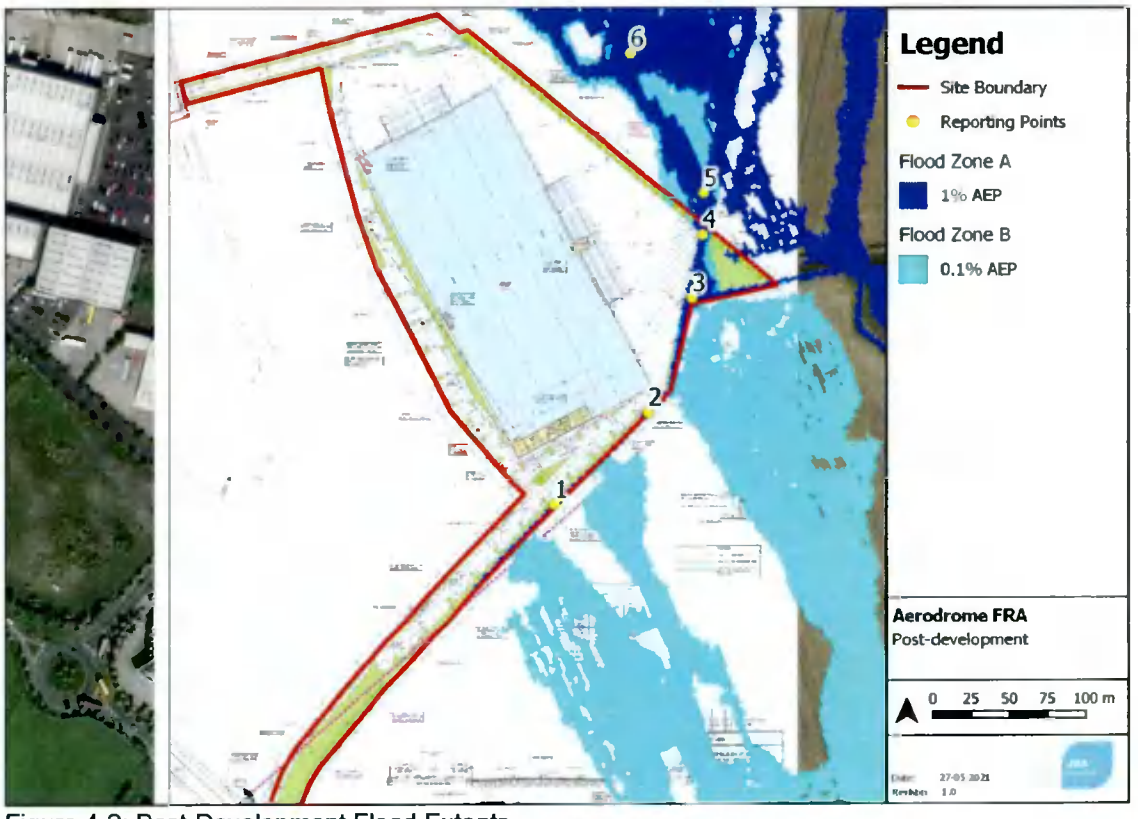


Figure 4-2: Post-Development Flood Extents

5 Flood Risk Assessment and Mitigation

5.1 Flood Risk/Mitigation Measures

From reviewing the available sources of flooding outlined in Section 3, minor flooding is expected in the eastern corner of the site for the 1% AEP (Flood Zone A), while flooding across the site is more significant at the 0.1% AEP event (Flood Zone B) resulting from the Camac overland flows. This is based on the Eastern CFRAM flood mapping.

The hydraulic model has been updated based on the site walkover and recent survey information of the site drainage ditch.

The JBA hydraulic model confirms that the majority of the site is located in Flood Zone C, and at a low risk of inundation. The overland flows are conveyed by the site ditch, being then diverted downstream across the eastern corner of the site.

The warehouse building is located in Flood Zone C based on the JBA model.

In order to manage sustainability and longevity of the flood risk at the site, the following mitigation measures were assessed.

5.1.1 Finished Floor Levels

The proposed finished floor level is 95.20mOD. This exceeds the 1% AEP climate change event plus 500mm freeboard which comes to 94.66mOD. The FFLs are also 150m higher than the ground levels for pluvial flood risk mitigation.

5.1.2 Landscaping

As displayed in Figure 4-2, the flows across the site will be slightly diverted towards the eastern corner of the site through landscaping. The natural ground levels will be maintained in this area of the site. Furthermore, the kerb levels along this flow path will prevent any inundation of the site.

No increase in water levels occurs downstream of the site during the 1% and 0.1% AEP events, as presented in Appendix C.

5.1.3 Access and Egress

The primary access route onto the proposed development is from the Jordanstown Road, west of the site. The entrance of the site is on higher ground and it is situated within Flood Zone C.

5.1.4 Drainage Design/Pluvial Flood Risk

The pluvial flood risk within the site will be managed by the provision of a stormwater system which will capture runoff from hardstanding areas. The site profile will be modified as part of the proposed development.

The increase in the hardstanding area onsite could potentially increase the surface water runoff from the site, if not mitigated. Surface water flow from hardstanding areas will be managed by the proposed stormwater system which has been designed in accordance with SDCC policy and the GDSDS.

An attenuation storage tank has been provided with a volume of 3,883m3 while the discharge rate from the stormwater system has been limited the greenfield runoff rate of 10.2l/sec.

To minimise the risk of pluvial flooding, a threshold of at least 150mm is required from the FFL to the external ground levels for the proposed buildings on site.

5.2 Residual Risk

5.2.1 Climate Change

The model was run with a 20% increase of the flows for the 1% AEP event in order to test the impact of the climate change scenario (MRFS) on the proposed development. The results show the site is not at flood risk for the MRFS scenario, the minimum freeboard provided being 500mm, as presented in Table 5-1. The flood extents for the 1% AEP MRFS event are presented in Appendix B.

Table 5-1: 1% AEP MRFS Levels and Freeboard

Reporting location	1% AEP MRFS [mOD]	FFL [mOD]	Freeboard [m]
1	94.66	95.16	0.50
2	94.66	95.16	0.50
3	94.66	95.16	0.50
4	94.53	95.16	0.63

5.2.2 Culvert blockage

According to the CFRAM mapping, the N7 is not overtopped during the 1% AEP event, but the blockage of the culvert under N7 might produce spilling over the Motorway that would flow towards the site location, similarly with the 0.1% AEP event. However, considering the 0.1% AEP overland flows are collected by the site channel, it is very likely the same would happen in the eventuality of a blockage during the 1% AEP event. Therefore, the blockage of the culvert under N7 is unlikely to pose a flood risk to the proposed development.

6 Conclusion

JBA consulting has undertaken a detailed Flood Risk Assessment (FRA) of the proposed site on Jordanstown Road, Aerodrome Business Park, Rathcoole, Co. Dublin. The proposed development is a light warehouse unit.

A review of the available historic information confirms that the site has not experienced historic flooding. However, the area has been subject to predictive flood modelling under the OPW Eastern CFRAM study. The resulting flood maps indicate flooding occurs at the eastern corner of the site during the 1% and 0.1% AEP events, while other areas of the site are shown to be affected for the 0.1% AEP event. The source of fluvial flooding identified for the site is the overland flows from the Camac River.

A site-specific hydraulic model has been developed for the study area that includes a local ditch with relatively high conveyance capacity (minimum 1m deep, 4 m wide) which runs along the south-eastern boundary.

The model has been used to confirm the 1% AEP and 0.1% AEP flood extents onsite and to appraise climate change events. Review of the results confirm that the majority of the site is within Flood Zone C. A minor section of the site along the eastern corner is located within Flood Zone A/B. No buildings will be located in this area and the flow path will be maintained, therefore it is not necessary to undertake the Justification Test.

The proposed design has been appraised against the following flood events: 1% AEP, 0.1% AEP, climate change. Review of the results confirm there is a low risk of inundation to proposed buildings on site during any flood event. The resulting FFL's provide a minimum freeboard of 500mm above the 1% AEP MRFS event.

The primary access route onto the proposed development is from the Jordanstown Road. The entrance of the site is on higher ground and it is situated within Flood Zone C.

Residual risk has also been assessed which includes partial blockage of the culvert under N7. Review of the results confirm that the proposed development will not be impacted from the blockage scenarios.

The Flood Risk Assessment was undertaken in accordance with 'The Planning System and Flood Risk Management' guidelines and confirms that the proposed development is appropriate from a flood risk perspective and is in agreement with the core principles of the planning guidelines

Appendices

A Understanding Flood Risk

Flood Risk is generally accepted to be a combination of the likelihood (or probability) of flooding and the potential consequences arising. Flood Risk can be expressed in terms of the following relationship:

Flood Risk = Probability of Flooding x Consequences of Flooding

A.1 Probability of Flooding

The likelihood or probability of a flood event (whether tidal or fluvial) is classified by its Annual Exceedance Probability (AEP) or return period years, a 1% AEP flood 1 in 100 chance of occurring in any given year. In this report, flood frequency will primarily be expressed in terms of AEP, which is the inverse of the return period, as shown in the table below and explained above. This can helpful when presenting results to members of the public who may associate the concept of return period with a regular occurrence rather than an average recurrence interval and is the terminology which will be used throughout this report.

Table: Conversion between return periods and annual exceedance probabilities

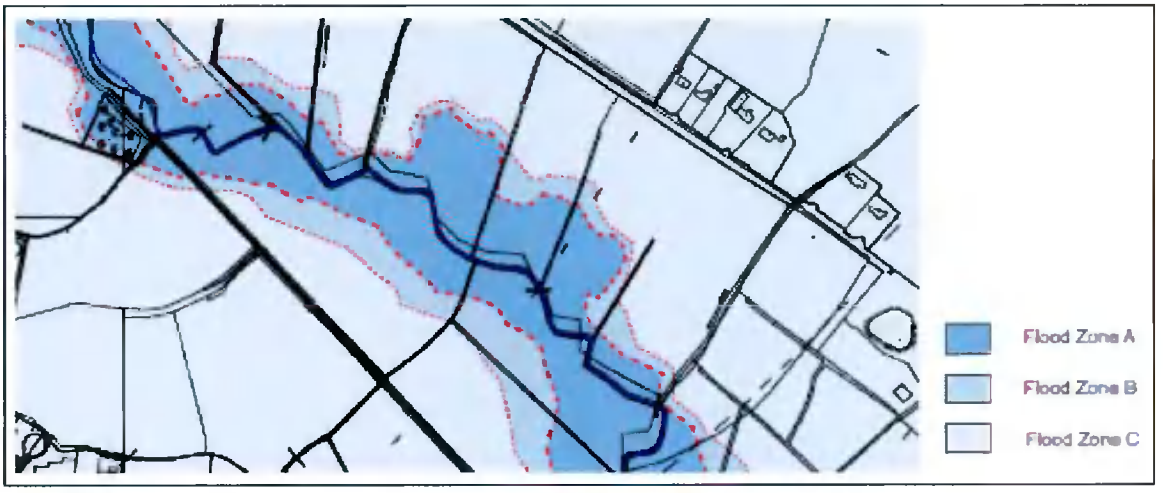
Returnperiod (years)	Annual exceedance probability (%)
2	50
10	10
50	2
100	1
200	0.5
1000	0.1

A.2 Flood Zones

Flood Zones are geographical areas illustrating the probability of flooding. For the purpose of the Planning Guidelines, there are 3 types of levels of flood zones, A, B and C.

Zone	Description
Flood Zone A	Where the probability of flooding is highest, greater than 1% (1 in 100) from river flooding or 0.5% (1 in 200) for coastal/ tidal Flooding
Flood Zone B	Moderate probability of flooding, between 1% and 0.1% from rivers and between 0.5% and 0.1% from coastal/ tidal.
Flood Zone C	Lowest probability of flooding, less than 0.1% from both rivers and coastal/ tidal.

It is important to note that the definition of the flood zones is based on an undefended scenario and does not take into account the presence of flood protection structures such as flood walls or embankments. This is to allow for the fact that there is a residual risk of flooding behind the defences will be maintained in perpetuity.



A.3 Consequences of Flooding

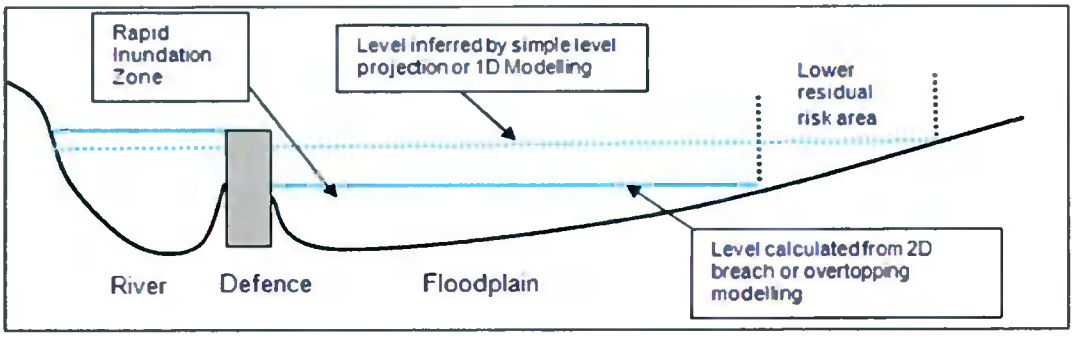
Consequences of flooding depend on the Hazards caused by flooding (depth of water, speed of flow. Rate of onset, duration, wave-action effects, water quality) and the vulnerability of receptors (type of development, nature, e.g. age-structure of the population, presence and reliability of mitigation measures etc.)

The 'Planning System and Flood Risk Management' provides three vulnerability categories, based on type of development, nature, which are detailed in Table X of the Guidelines, and are summarised as:

- **Highly vulnerable**, including residential properties, essential infrastructure and emergency service facilities
- **Less vulnerable**, such as retail and commercial and local transport infrastructure, such as changing rooms.
- **Water compatible**, including open space, outdoor recreation and associated essential infrastructure, such as changing rooms.

A.4 Residual Risk

The presence of flood defences, by their very nature, hinder the movement of flood water across the floodplain and prevent flooding unless river levels rise above the defence crest level or a breach occurs. This known as residual risk:

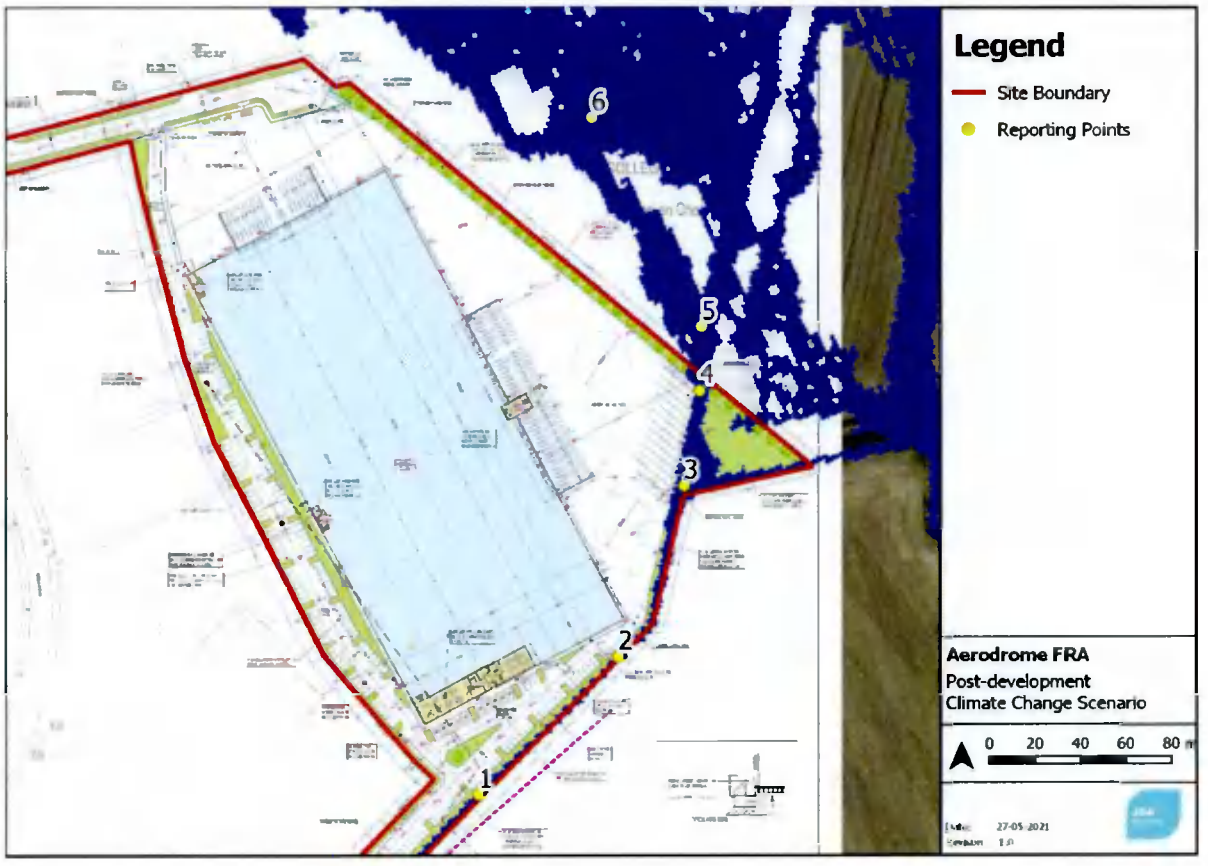


A.5 Sequential approach

A core principal of the Flood Risk Assessment and associated guidelines is the application of the Sequential Approach. The aim of the Sequential Approach is to ensure that that appropriate development is undertaken in areas at risk of flooding.

- Avoid - Avoid development in areas at risk of flooding; Preferably choose lower risk flood zones for new development, if this is not possible, consider substituting a land use that is less vulnerable to flooding.
- Substitution - Only when both avoidance and substitution cannot take place should consideration be given to mitigation and management of risks. Ensure the type of development proposed is not especially vulnerable to the adverse impacts of flooding
- Justification Test - Inappropriate types of development that would create unacceptable risks from flooding should not be planned for or permitted. Exceptions to the restriction of development due to potential flood risks are provided for through the use of a Justification Test, where the planning need and the sustainable management of flood risk to an acceptable level must be demonstrated.
- Proceed - only where the Justification Test has been passed can the development proceed. Need to ensure that emergency planning measures are in place.

B 1% AEP Climate Change (MRFS) - Flood Extents



C Impact Table

Model Node	1% AEP			0.1% AEP		
	Pre-Development Impact	Post-Development		Pre-Development Impact	Post-Development	
5	94.33	94.33	0	94.38	94.38	0
6	93.48	93.48	0	93.50	93.50	0

Offices at
Dublin
Limerick

Registered Office
24 Grove Island
Corbally
Limerick
Ireland

t: +353 (0) 61 345463
e:info@jbaconsulting.ie

JBA Consulting Engineers and Scientists Limited
Registration number 444752

JBA Group Ltd is certified to:
ISO 9001:2015
ISO 14001:2015
OHSAS 18001:2007

Visit our website
www.jbaconsulting.ie