DUBLIN AIRPORT LOCAL AREA PLAN

JANUARY 2020

APPENDIX 6

STRATEGIC FLOOD RISK ASSESSMENT & SURFACE WATER MANAGEMENT PLAN

Fingal Development Plan 2017 - 2023

Comhairle Contae Fhine Gall
Fingal County Council

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Abbreviations

AEP................................Annual Exceedance Probability
CFRAM ....Catchment Flood Risk Assessment and Management
daa ....Dublin Airport Authority
DTM ....Digital Terrain Model
FCC................................Fingal County Council
FEM FRAMs ....Fingal East Meath Flood Risk Assessment and Management
GDSDS ....Greater Dublin Strategic Drainage Strategy
GIS.................................Geographical Information System
GSI.................................Geological Surveys Ireland
Ha ....Hectares
IW...................................Irish Water
JBA ....JBA Consulting
LAP ....Local Area Plan
Lidar...............................Light detection and Ranging
mOD...............................Meters above Ordnance Datum
PFRA…………………….. Preliminary Flood Risk Assessment
OPW ....Office of Public Works
RBD ....River Basin District
SAAR ....Standard Annual Average Rainfall (mm)
SWMP............................Stormwater (or Surface water) Masterplan
TUFLOW........................Two-dimensional Unsteady Flow (a hydraulic model)

1 Introduction

JBA Consulting was appointed by Fingal County Council to carry out the Strategic Flood Risk Assessment (SFRA) and Surface Water Management Plan (SWMP) for the Dublin Airport Local Area Plan (LAP).

1.1 Overview

Dublin Airport is a gateway of national strategic importance, the Government's policy is to develop it into a secondary hub, it is the most significant economic entity and largest provider of employment in the County and the region. It has direct links to the national road network (M1 and M50) and is located on the Dublin/Belfast economic corridor which is a key national transport corridor in the NSS. The continued expansion of the Airport itself and transport links to the Airport (Metro Link) are a significant driver for regional and national growth.

This report details the SFRA and SWMP for the area and has been prepared in accordance with the requirements of the DoEHLG and OPW planning guidelines; The Planning System and Flood Risk Management; these guidelines were issued under the Planning and Development Act 2000, and recognise the significance of proper planning to manage flood risk. Recommendations and guidance for surface water management and Sustainable Urban Drainage (SuDS) Design and construction has been provided in the context of relevant legislation and best practices from the UK CIRIA C753 SuDS manual document and the Greater Dublin Strategic Drainage Study (GDSDS) guidelines.

The SFRA and SWMP are presented within the same document because they are closely linked to each other and offer the opportunity to present a coherent strategy for flooding from all sources.

1.2 Scope of study

Under the "Planning System and Flood Risk Management" guidelines, the purpose for the FRA is detailed as being "to provide a broad (wide area) assessment of all types of flood risk to inform strategic land use planning decisions. SFRAs enable a sequential approach, including the Justification Test, allocate appropriate sites for development and identify how flood risk can be reduced as part of the development plan process.

The Fingal County Development Plan 2017-2023 will be the key document for setting out a vision for the development of the Dublin Airport during the plan period.

The main objectives of the SFRA are to:

- Prepare a Stage 2 Flood Risk Assessment for the Dublin Airport Area.
- Prepare a Rainfall Run-off 2D Hydraulic model within the Dublin Airport LAP boundary to assess areas at risk of flooding.
- Provide recommendations for development management for highly and less vulnerable development within Flood Zones A and B.
- Develop policy and objectives to manage flood risk within the LAP.

The main objectives of the SWMP are to:

- Minimise the residual risk where possible at each new development site.
- Ensure that there are no increased flood risks upstream or downstream of new development.
- Consider Sustainable Drainage System options to existing and future developments.
- Maintain the existing greenfield run-off rates or potentially even reduce the amount of surface water entering the drainage system already in place.

1.3 Report Structure

This study considers the development strategy that will form part of the Local Area Plan (LAP) for Dublin Airport. The context of the flood risk at Dublin Airport is considered with specific reference to the flood sources such as; fluvial, pluvial and groundwater flooding.

A three stage assessment of flood risk was undertaken, as recommended in 'The Planning System and Flood Risk Management' guidelines. The first stage is to identify flood risk and is based primarily on findings from the Eastern Catchment Flood Risk Management Study (ECFRAM), Fingal East Meath Flood Risk Management Study (FEM FRAM), the R132 upgrade flood mapping study and the Northern Runway Detailed FRA. The second stage of the SFRA report is to appraise the adequacy existing information, prepare flood zone mapping based on existing information and available data to highlight potential development areas which require a more detailed assessment. The third stage is to carry out a 2D hydraulic rainfall runoff model to assess drainage and overland flow paths across the LAP area.

Section 2 introduces the Dublin Airport LAP, the watercourses and planning policies in place.

Section 3 discusses flooding concepts, flood zones and flood risk as they are incorporated into the planning system and flood risk management.

Section 4 summarises the available data in relation to existing drainage and flooding within the LAP. This section also outlines the main sources of flooding to be considered for the Dublin Airport Area.

Section 5 outlines the results from the 2D TUFLOW rainfall runoff hydraulic model of the LAP area

Section 6 provides guidance and approaches for managing flood risk and details the Surface water Masterplan (SWMP) which will be useful for informing the policies and objectives within the local area plan.

Section 7 reviews the proposed zonings and specific responses to flood risk within the LAP.

And finally, Section 8 outlines ongoing monitoring and future review of the SFRA and SWMP.

2 Dublin Airport LAP Study Area

The lands which are subject to the LAP comprise a total of 1,084Ha. These lands range from agricultural greenfield plots, managed airport grasslands and the airport built environment; including buildings, taxiway, runway and aprons. There is a mix and range of uses within the core built environment of Dublin Airport, in addition to the main airport operations, a number of associated uses have become established including car parking, offices, logistics, aviation related businesses and hospitality. Further discussion on planning policy and zoning is provided in Sections 7 & 8.

The following section outlines the key geographic features of the LAP area.

2.1 Topography

A schematic of the local topography across the LAP area is provided in Figure 2-1.

The ground levels are highest at the south west corner of the site (shown in red). The LAP area gently slopes in an easterly direction with lowest ground levels across the east boundary before the M1 Motorway. A long section was taken from the south west boundary across to the M1. This is shown in Figure 2-1. Spot elevations at each end of the cross section shows an elevation of 81.1mOD at 'A' sloping to an elevation of 50.36 at 'B'. Raised areas along the long profile towards the east boundary at 'B' are showing embankments which have been constructed by the daa to contain out of bank flows from the Cuckoo Stream. One embankment runs along the LAP boundary before the M1 and the section runs along the Swords Road R132 upstream of the M1.

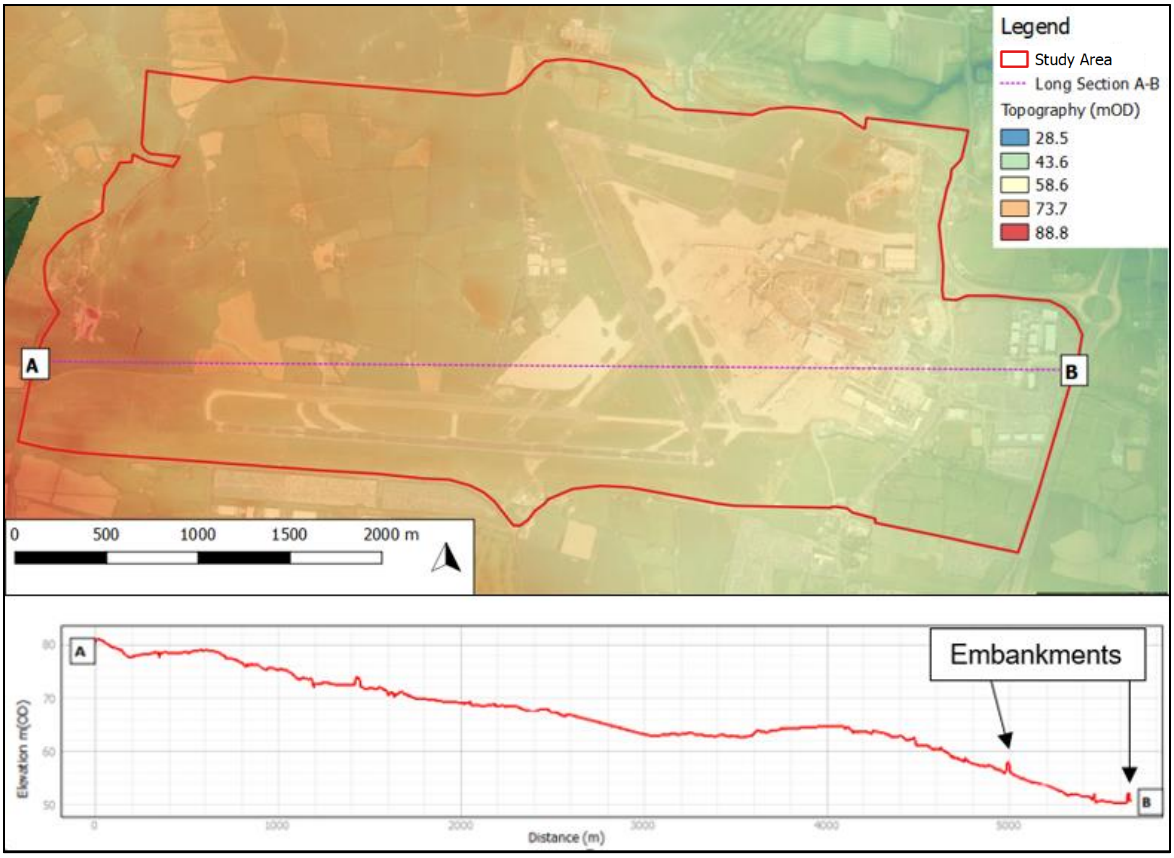


Figure 2-1: Topography of the LAP Area (Lidar height data)

2.2 Watercourses

The Airport and its environs are located within the eastern river basin district, and there are a number of waterbodies which drain the subject lands. The LAP falls within four main river catchments; the Ward River, the Sluice River, The Mayne River and The Santry River. The LAP is subsequently divided into sub-catchment areas which drain specific areas of the Airport through the network of surface water drains. These catchments are outlined in Figure 2-3 below. The relevant watercourses to the study are provided in Figure 2-2, whilst some of the main culverts are included, surface water infrastructure (small field drains and pipes) are not mapped.

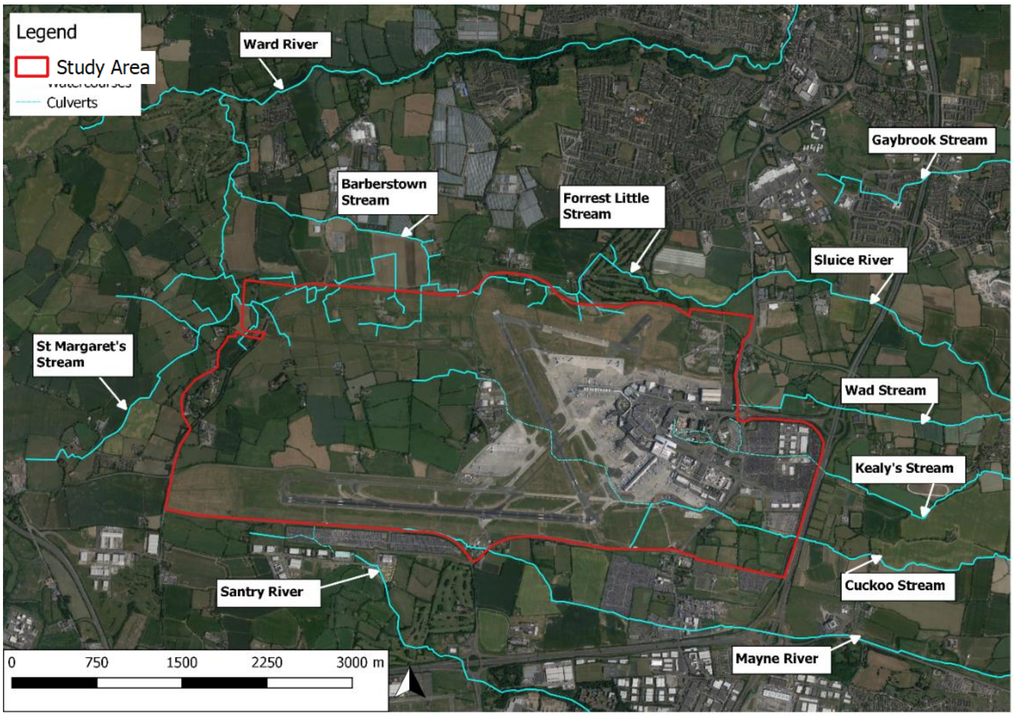


Figure 2-2: Open Channel Watercourses (Source: Bing Satellite)

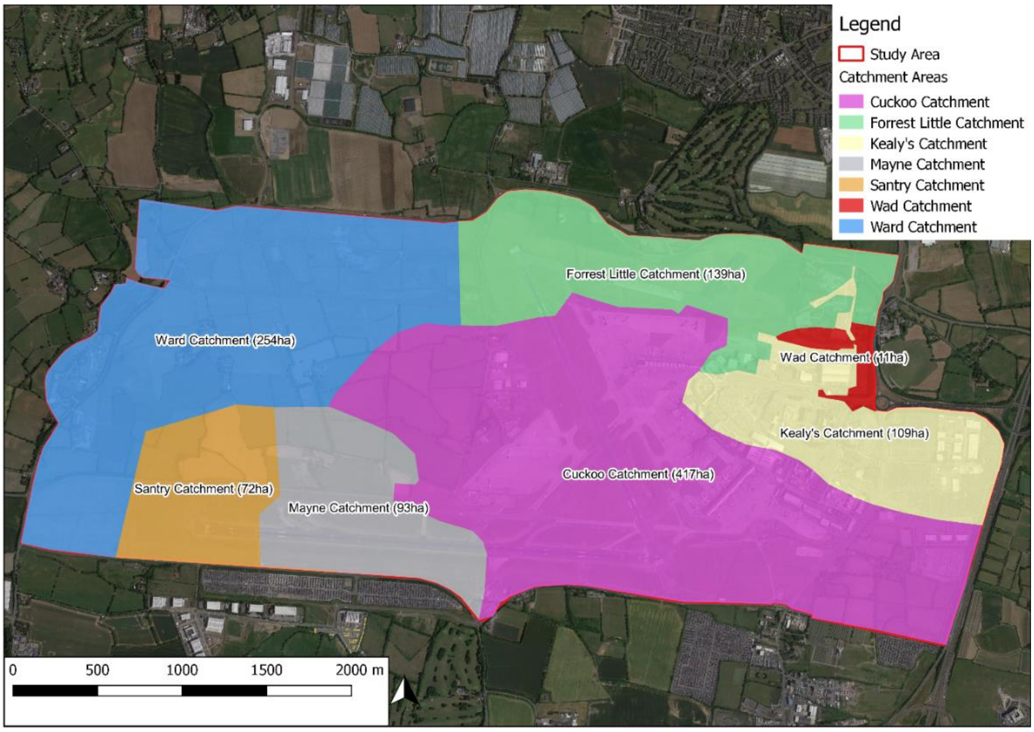


Figure 2-3: Sub-catchment areas within LAP

2.2.1 Cuckoo Stream

The Cuckoo stream is located to the south of the subject lands. It forms part of the Mayne River catchment. It is the largest surface water system within the wider Airport campus and collects runoff from the runways, taxiways, terminals, central and south aprons. The Mayne River discharges into the estuary at Baldoyle Co. Dublin.

2.2.2 Forrest Little Stream

The Forrest Little Stream lies to the north of the Airport lands and lies within the River Ward catchment. The land within this area is relatively undeveloped agricultural lands. Currently the Forrest Little Stream receives mainly unattenuated flows from the Airport paved areas and surrounding fields. A drainage system will however be incorporated for the new north Runway as all paved areas of the runway will be drained into the Forrest Little Stream sub-catchment. The west and central grasslands will drain to St, Margaret's stream, to the west of the LAP boundary.

2.2.3 Barberstown & St Margaret's Stream

The Barberstown Stream and St. Margaret's Stream lie within the Ward River sub-catchment, they drain the north and north eastern periphery of the site which is currently greenfield. Some of the channels overlap with the proposed Northern Runway.

2.2.4 Wad & Kealy's Stream

The Wad stream is located to the north east of the subject lands and drains the north apron of the Airport lands. It forms part of the Sluice River Catchment. Which flows into the Baldoyle estuary at Portmarnock Bridge. The stream is culverted underneath the airport and flows eastwards. A portion of the Wad catchment has been diverted to the Kealy's stream due to previous flooding incidents downstream.

The Kealy's stream is located in the eastern section of the subject lands and drains the internal road network, airport complex carparks landside and the daa controlled long term carpark along the R132. This stream also forms part of the Sluice River Catchment which flows into Baldoyle Estuary at Portmarnock Bridge Co. Dublin.

2.2.5 Field Drainage

Minor field drainage in the form of open channels can be found to the north west grasslands of the wider Airport lands. As can be appreciated from Figure 2-3, these areas predominantly drain to the Ward River sub-catchment but the Santry and Mayne catchments also receive runoff. The ward River is a tributary of the Broadmeadow River which discharges to the Broadmeadow Estuary in Swords Co. Dublin.

2.3 Geology

The Geological Survey of Ireland (GSI) groundwater and geological viewer of the LAP area were reviewed. The subsoil across the hardstanding area of the airport consists of 'made ground' which is to be expected in a built-up urban area. The surrounding rural lands are classified as Tills derived mainly from Limestone (TLs). The underlying bedrock is classified as Tober Colleen formation and Malahide formation. There are no karst features identified within the LAP boundary or surrounding area. The groundwater vulnerability is 'low' across the east and south border. The vulnerability ranges from 'moderate' to 'extreme' along the west and north boundary of the LAP. Groundwater vulnerability is shown in Figure 4-7.

3 The Planning System and Flood Risk Management

3.1 Introduction

Prior to discussing the management of flood risk, it is helpful to understand what is meant by the term. It is also important to define the components of flood risk in order to apply the principles of the Planning System and Flood Risk Management in a consistent manner.

The Planning System and Flood Risk Management: Guidelines for Planning Authorities, published in November 2009, describe flooding as a natural process that can occur at any time and in a wide variety of locations. Flooding can often be beneficial, and many habitats rely on periodic inundation. However, when flooding interacts with human development, it can threaten people, their property and the environment.

This section will firstly outline the definitions of flood risk and the Flood Zones used as a planning tool; a discussion of the principles of the planning guidelines and the management of flood risk in the planning system will follow.

3.2 Definition of 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

The assessment of flood risk requires an understanding of the sources, the flow path of floodwater and the people and property that can be affected. The source-pathway-receptor model, shown in Figure 3-1, illustrates this and is a widely used environmental model to assess and inform the management of risk.

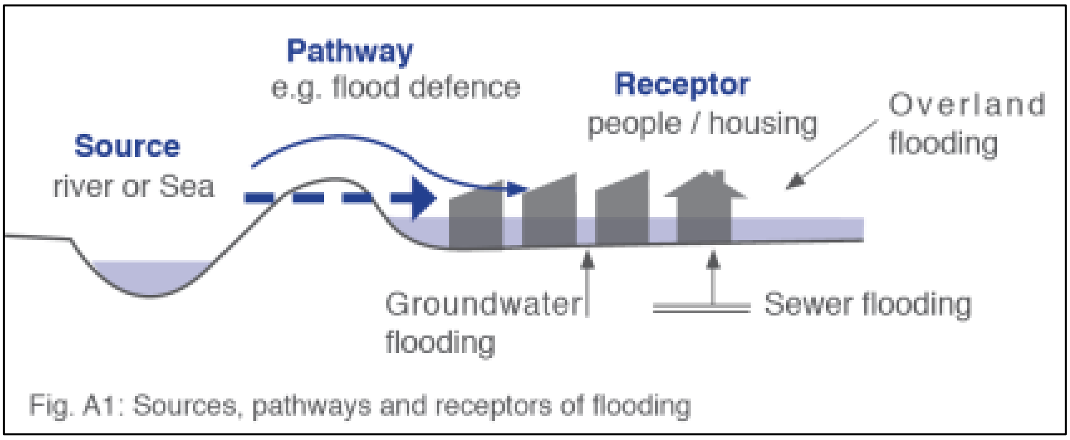


Figure 3-1: Source-Pathway-Receptor Model

(Source: Figure A1 The Planning System and Flood Risk Management Guidelines Technical Analysis)

Principal sources of flooding are rainfall or higher than normal sea levels while the most common pathways are rivers, drains, sewers, overland flow, river and coastal floodplains and their defence assets. Receptors can include people, their property and the environment. All these elements must be presented for flood risk to arise. Mitigation measures, such as defences or flood resilient construction, have little or no effect on sources of flooding but they can block or impede pathways or remove receptors. The planning process is primarily concerned with the location of receptors, raking appropriate account of potential sources and pathways that might put those receptors at risk.

3.2.1 Likelihood of flooding

Likelihood or probability of flooding or a particular flood event is classified by its annual exceedance probability (AEP) or return period (in years). A 1% AEP flood indicates the flood event that will occur or be exceeded on average once every 100 years and has a 1 in 100 chance of occurring in any given year. Return period is often misunderstood to be the period between large flood events rather than the average reoccurrence interval. Annual exceedance probability is the inverse of return period as shown in Table 3-1.

Table 3-1: Probability of flooding

Return Period (Years)	Annual Exceedance Probability (%)
2	50
100	1
200	0.5
1000	0.1

Considering over the lifetime of development, an apparently low frequency or rare flood has a significant probability of occurring. For example:

- A 1% flood has a 22% (1 in 5) chance of occurring at least once in a 25 year period - the period of a typical residential mortgage.
- A 53% (1 in 2) chance of occurring in a 75 year period - a typical human lifetime.

3.2.2 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 the type of development, which are detailed in Table 3.1 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;
- **Water compatible**, including open space, outdoor recreation and associated essential infrastructure, such as changing rooms.

3.3 Definition of Flood Zones

In the 'Planning System and Flood Risk Management', Flood Zones are used to indicate the likelihood of a flood occurring. These Zones indicate a high, moderate or low risk of flooding from fluvial or tidal sources and are defined below in Table 3-2.

It is important to note that the definition of the Flood Zones is based on an **undefended scenario** and does not consider 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 due to overtopping or breach and that there may be no guarantee that the defences will be maintained in perpetuity.

It is also important to note that the Flood Zones indicate flooding from fluvial and tidal sources and do not take other sources, such as groundwater or pluvial, into account, so an assessment of risk arising from such sources should also be made.

Table 3-2: Definitions of Flood Zones

Zone	Description
Zone A High probability of flooding.	This zone defines areas with the highest risk of flooding from rivers (i.e. more than 1% probability or more than 1 in 100) and the coast (i.e. more than 0.5% probability or more than 1 in 200).
Zone B Moderate probability of flooding.	This zone defines areas with a moderate risk of flooding from rivers (i.e. 0.1% to 1% probability or between 1 in 100 and 1 in 1000) and the coast (i.e. 0.1% to 0.5% probability or between 1 in 200 and 1 in 1000).
Zone C Low probability of flooding.	This zone defines areas with a low risk of flooding from rivers and the coast (i.e. less than 0.1% probability or less than 1 in 1000).

3.4 Objectives and Principles of the Planning Guidelines

The 'Planning System and Flood Risk Management' describes good flood risk practice in planning and development management. Planning authorities are directed to have regard to the Guidelines in the preparation of Development Plans and Local Area Plans, and for development control purposes.

The objective of the 'Planning System and Flood Risk Management' is to integrate flood risk management into the planning process, thereby assisting in the delivery of sustainable development. For this to be achieved, flood risk must be assessed as early as possible in the planning process. Paragraph 1.6 of the Guidelines states that the core objectives are to:

- "*avoid inappropriate development in areas at risk of flooding;*
- *avoid new developments increasing flood risk elsewhere, including that which may arise from surface run-off;*
- *ensure effective management of residual risks for development permitted in floodplains;*
- *avoid unnecessary restriction of national, regional or local economic and social growth;*
- *improve the understanding of flood risk among relevant stakeholders; and*
- *ensure that the requirements of EU and national law in relation to the natural environment and nature conservation are complied with at all stages of flood risk management".*

The Guidelines aim to facilitate '*the transparent consideration of flood risk at all levels of the planning process, ensuring a consistency of approach throughout the country.*' SFRAs therefore become a key evidence base in meeting these objectives.

The 'Planning System and Flood Risk Management' works on several key principles, including:

- Adopting a staged and hierarchical approach to the assessment of flood risk;
- Adopting a sequential approach to the management of flood risk, based on the frequency of flooding (identified through Flood Zones) and the vulnerability of the proposed land use.

3.5 The Sequential Approach and Justification Test

Each stage of the FRA process aims to adopt a sequential approach to management of flood risk in the planning process.

Where possible, development in areas identified as being at flood risk should be avoided; this may necessitate de-zoning lands within the plan boundary. If de-zoning is not possible, then rezoning from a higher vulnerability land use, such as residential, to a less vulnerable use, such as open space may be required.

Figure 3-2: Sequential Approach Principles in Flood Risk Management

Source: The Planning System and Flood Risk Management (Fig. 3.1)

Where rezoning is not possible, exceptions to the development restrictions are provided for through the Justification Test. Many towns and cities have central areas that are affected by flood risk and have been targeted for growth. To allow the sustainable and compact development of these urban centres, development in areas of flood risk may be considered necessary. For development in such areas to be allowed, the Justification Test must be passed.

The Justification Test has been designed to rigorously asses the appropriateness, or otherwise, of such developments. The test is comprised of two processes; the Plan-making Justification Test, and the Development Management Justification Test. The latter is used at the planning application stage where it is intended to develop land that is at moderate or high risk of flooding for uses or development vulnerable to flooding that would generally be considered inappropriate for that land.

Table 3-3 shows which types of development, based on vulnerability to flood risk, are appropriate land uses for each of the Flood Zones. The aim of the SFRA is to guide development zonings to those which are 'appropriate' and thereby avoid the need to apply the Justification Test.

Table 3-3: Matrix of vulnerability versus Flood Zone

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (Including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less vulnerable development	Justification Test	Appropriate	Appropriate
Water-compatible development	Appropriate	Appropriate	Appropriate

3.6 Scales and Stages of Flood Risk Assessment

Within the hierarchy of regional, strategic and site-specific flood-risk assessments, a tiered approach ensures that the level of information is appropriate to the scale and nature of the flood-risk issues and the location and type of development proposed, avoiding expensive flood modelling and development of mitigation measures where it is not necessary. The stages and scales of flood risk assessment comprise:

- **Regional Flood Risk Appraisal (RFRA)** – a broad overview of flood risk issues across a region to influence spatial allocations for growth in housing and employment as well as to identify where flood risk management measures may be required at a regional level to support the proposed growth. This should be based on readily derivable information and undertaken to inform the Regional Planning Guidelines.

- **Strategic Flood Risk Assessment (SFRA)** – an assessment of all types of flood risk informing land use planning decisions. This will enable the Planning Authority to allocate appropriate sites for development, whilst identifying opportunities for reducing flood risk. This SFRA will revisit and develop the flood risk identification undertaken in the RFRA and give consideration to a range of potential sources of flooding. An initial flood risk assessment, based on the identification of Flood Zones, will also be carried out for those areas which will be zoned for development. Where the initial flood risk assessment highlights the potential for a significant level of flood risk, or there is conflict with the proposed vulnerability of development, then a site specific FRA will be recommended, which will necessitate a detailed flood risk assessment.
- **Site Specific Flood Risk Assessment (FRA)** – site or project specific flood risk assessment to consider all types of flood risk associated with the site and propose appropriate site management and mitigation measures to reduce flood risk to and from the site to an acceptable level. If the previous tiers of study have been undertaken to appropriate levels of detail, it is highly likely that the site specific FRA will require detailed channel and site survey, and hydraulic modelling.

4 Data Collection

4.1 Historic Flooding

Records of past flooding are useful for looking at the sources, seasonality, frequency and intensity of flooding. Historical records are mostly anecdotal and incomplete but are useful for providing background information.

4.1.1 OPW Floodmaps.ie

The OPW hosts a National Flood Hazard Mapping website that makes available information on areas potentially at risk from flooding. This website provides information on historical flood events across the country and form the basis of the Regional Flood Risk Appraisal.

Information is provided in the form of reports and newspaper articles which generally relate to rare and extreme events. Since the establishment of the hazard mapping website, more records are available which identify more frequent or re-occurring events. These tend to include memos and meeting records from the Local Authority area engineers, often related to road flooding incidents.

4.1.2 Site walkover

A site walkover was undertaken to appraise and validate the identified flood risk and flow paths. The Cuckoo stream is the only accessible watercourse within the Airport lands as the majority of the streams and drainage are sub-surface features.

4.1.3 Summary of historical flood risk

The flood risk history sourced from OPW floodmaps.ie and anecdotal sources is summarised in Table 4-1.

Table 4-1: Historical Flood Events

Date of Event	**Description**
5th - 8th November 2000	R132 Cloghran, Old Airport Road. This road flooded within approximately 300m of the M50 during a heavy rainfall event in November 2000. The section of culvert at this location which conveys flow under the Old Airport Road requires regular maintenance.
13th-15th November 2002	Out of bank flows from the Santry River occurred during a period of heavy rainfall in November 2002. Flooding occurred just north of the M50 along the Old Airport Road. The M50 Ballymun exit was also affected.
Re-Occurring - Stockhole Lane	Re-occurring flooding has been found along Stockhole Lane, east of the LAP Lands across the roadway.
Re-Occurring - Dunbro Lane area	Re-occurring flooding is noted in the Dunbro Lane area. This is discussed more in Table 5-1.

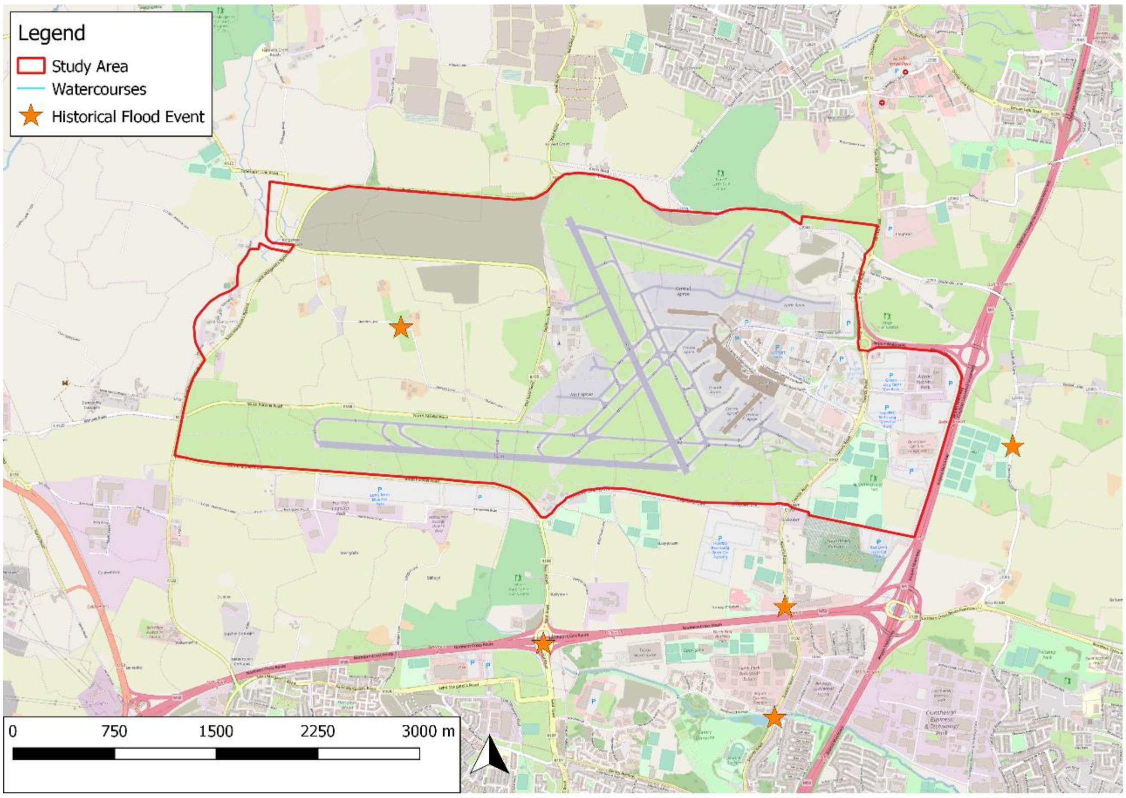


Figure 4-1: Historical Flooding (source: floodmaps.ie, anecdotal evidence and OSM Standard)

4.2 Predictive Flood Mapping

There are several sources of flood mapping data available for the Dublin Airport Area. Table 4-2 lists the core datasets used to compile the flood maps for the Airport LAP. This gives an assessment of the data quality and the confidence of accuracy.

Table 4-2: Flood Data used to compile Flood Zone Mapping

Description	Coverage	Robustness	Comment on usefulness
Eastern CFRAM & FEM FRAM Flood Mapping	Covers the Sluice, Mayne and Broadmeadow Catchments	Moderate / high - high priority watercourse status	Detailed CFRAM model. Site verified by walkover and consultation with Local Authority
OPW PFRA flood extent maps, as verified by CFRAM FRR	Covers all watercourses	Moderate	CFRAM Mapping supersedes all of the PFRA mapping. Used for sensibility check only.
RPS revised Flood mapping (R132 Upgrade)	Cuckoo Stream.	Moderate /high	Mapping supersedes the FEMFRAM/CFRAM flood mapping for the Cuckoo
RPS revised Flood mapping (Northern Runway Detailed FRA)	Forrest Little St Margaret's and Barberstown Streams	Moderate /high	Mapping Supersedes the FEMFRAM/CFRAM flood mapping for the Forrest Little Stream and introduces new mapping for the St Margaret's and Barberstown Streams.
Historical Flood Records	Spot coverage for LAP	Moderate	Highly useful oversight of historical flooding issues provided by the OPW and Local Authority.
Walkover Survey	Cover all significant surface watercourses	Moderate	Walkover used to validate outlines, estimate new outlines and flow paths at key locations. Important in the flood zone process.

The flood zone mapping represents a combination of the above flood sources. The RPS modelling studies for the R132 Upgrade and the Northern Runway FRA resulted in flood mapping which have formed the core sources of the final flood zones within the LAP. CFRAM and FEM FRAM information has largely been superseded because it does not include recently constructed culverts and embankments. There has also been a thorough review of historic flood records. The result is flood zone mapping that presents the best available data for the study area. The following sub-sections review the data sources in more detail.

4.2.1 OPW Preliminary Flood Risk Assessment (PFRA) 2011

The preliminary flood risk assessment (PFRA) is a national screening exercise that was undertaken by the OPW to identify areas at potential flood risk. The PFRA was a requirement of the EU floods Directive and the publication of this work informed the more detailed assessment that is being undertaken as part of the Catchment Flood Risk Assessment and Management (CFRAM) studies. The PFRA study considered flooding from several sources: fluvial, tidal, pluvial and groundwater, resulting in production of a suite of broad scale flood maps.

The PFRA fluvial maps have been superseded by the detailed Eastern CFRAM and FEM FRAM mapping studies. The PFRA mapping remains a useful screening source for pluvial and groundwater flood sources and is displayed below in Figure 4-2.

Review of the PFRA pluvial maps indicates several areas of pluvial risk within the LAP boundary, mainly across the agricultural fields to the west of the Airport. The mapping is indicative in nature and is discussed further in Section 4.3.2, new pluvial flood mapping is undertaken in Section 5 Groundwater flooding is not predicted within the LAP boundary.

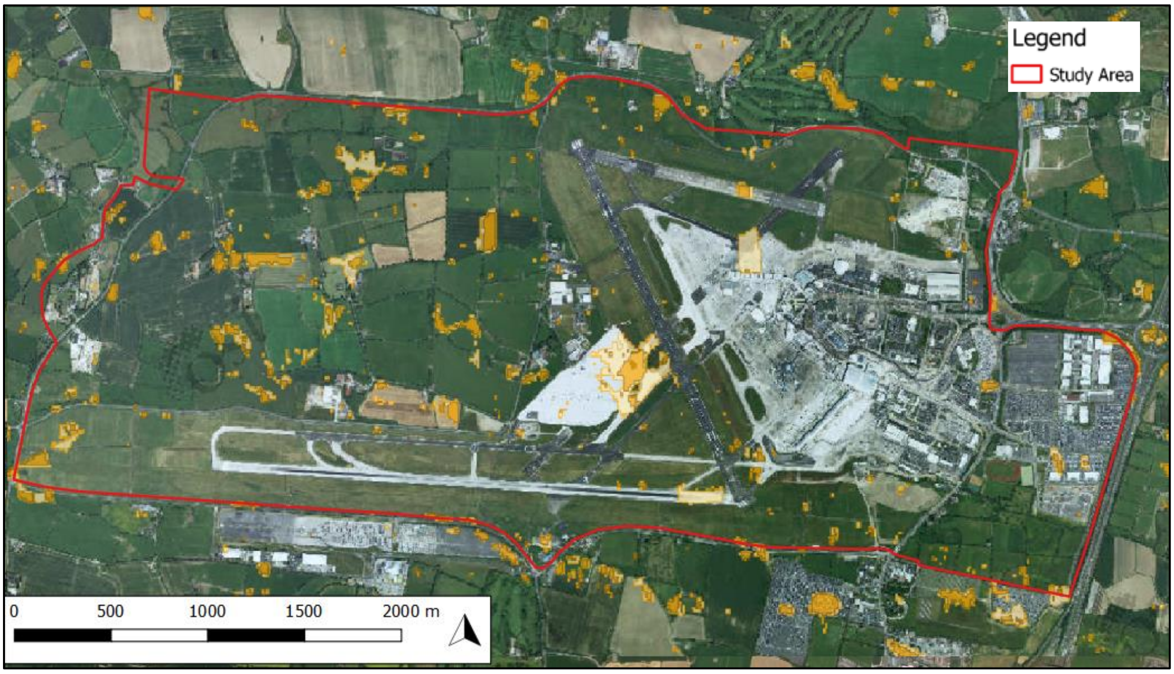


Figure 4-2: PFRA pluvial mapping (Source: myplan.ie)

4.2.2 National CFRAM Programme

Following from the PFRA study, the OPW commenced appointment of consultants to carry out a more detailed flood risk assessment for key flood risk areas. This work is being undertaken under the national CFRAM Programme across seven river basin districts (RBDs) in Ireland.

The Fingal East Meath Flood Risk Assessment & Management study (FEM FRAM) commenced in May 2008 as a pilot study for the CFRAM Programme. Mapping produced as part of the FEM FRAMs for the Dublin Airport Lands were later incorporated into the Eastern CFRAM Programme. The FEM FRAM involves detailed hydraulic modelling of rivers and their tributaries. The Dublin Airport lands were within Hydrometric Area 8 of the Hydraulic models produced. Following the detailed hydraulic modelling, flood maps were produced for the 10% (1 in 10 year), 1% (1 in 100 year) and 0.1% (1 in 1000 year) flood events.

The flood extent mapping from the CFRAM shows flooding during the 1% and 0.1% AEP events from the Cuckoo Stream and the Forrest Little Stream. The Forrest Little Stream flood extents are contained within open greenfield sites along the LAP boundary. The proposed north runway is to be constructed with attenuation systems in place to maintain runoff from the new hardstanding areas to greenfield run-off rates. The flood extents should be considered in the development of the north runway and additional future development within these lands.

The FEM FRAM outlines show a significant portion of the south east lands are found within Flood Zone A and B from the Cuckoo stream overtopping its banks. This condition no longer exists due to upgrade works that include attenuation, bypass culverts and flood embankments. Figure 4-3 below displays the CFRAM mapping and is annotated with comments indicating where key mitigation measures have been installed.

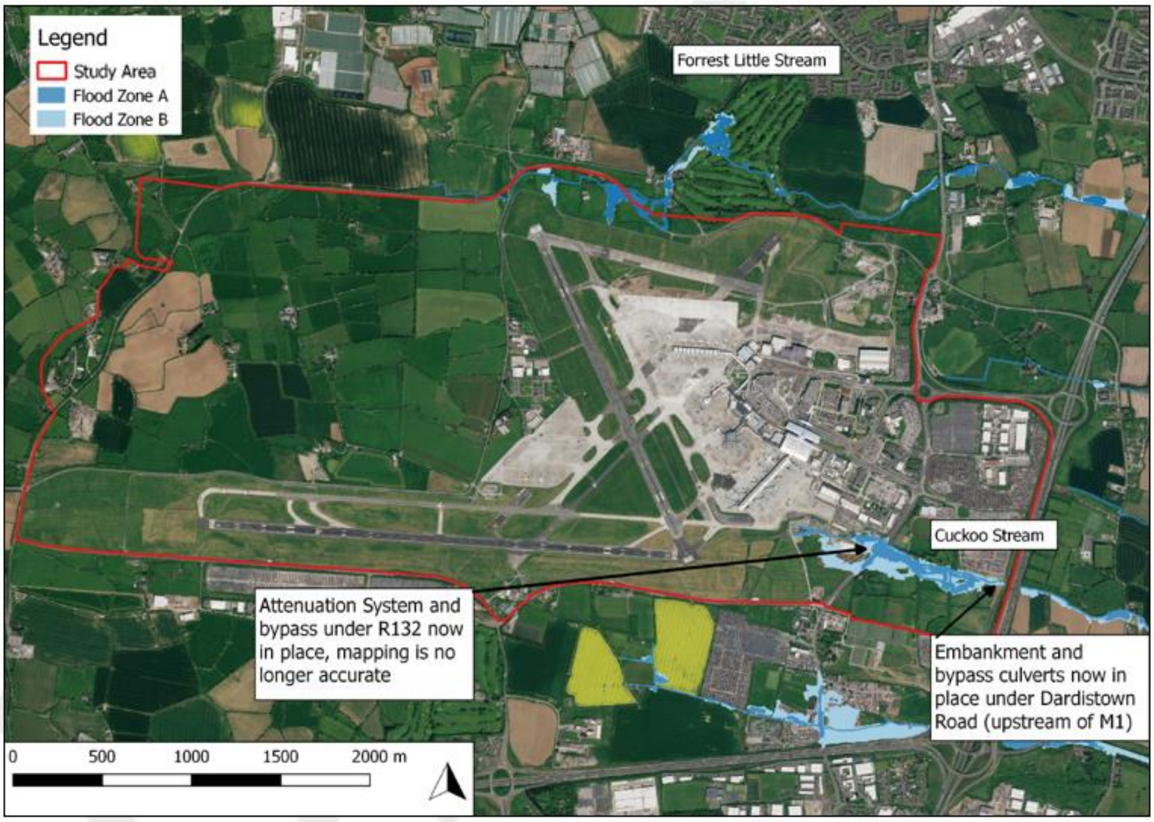


Figure 4-3: CFRAM Flood Zone mapping within Airport LAP

Leading on from the flood mapping the CFRAM programme also developed Flood Risk Management Plans. JBA has reviewed both the draft FEM FRAM and the CFRAM Preliminary Options Reports and found no reference to any flood relief infrastructure within the LAP boundary. The FEM FRAM management plan has been amalgamated into the Eastern CFRAM, the CFRAM Final Flood Risk Management Plan for the Liffey and Dublin Bay River Basin (UOM09) confirms that there are no proposed measures for the Belcamp Park AFA.

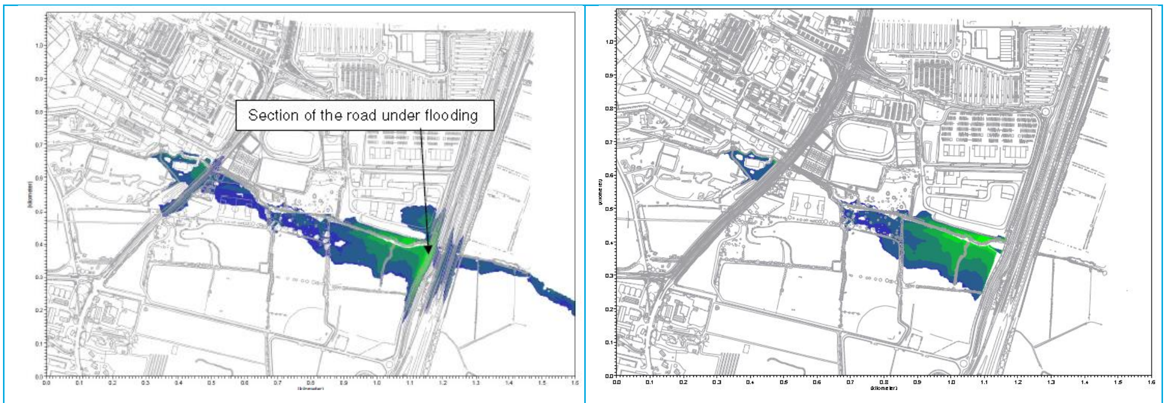
4.2.3 RPS Modelling of Cuckoo Stream (R132 Road Improvement Scheme)

RPS was commissioned by the Dublin Airport Authority (daa) to undertake a flood risk assessment study for the R132 road improvement scheme. Under this commission RPS undertook a detailed hydraulic modelling study for the Cuckoo stream to assess the extent of flooding for the 1 in 100yr and 1 in 1000 year scenarios. The study found that both the R132 and access route parallel to M1 (Dardistown Road) were impacted by the Cuckoo stream and mitigation methods were developed and subsequently installed. These included the following:

- The construction of a new embankment to maximum elevation of 52.1mOD of approximately 350m.

- Construction of a new overflow channel complete with lateral overflow weir of invert 51.3mOD.
- Provision of three 1350mm diameter pipes to carry flows under the Dardistown Road from the proposed overflow channel back to the Cuckoo Stream immediately downstream of the existing eastern verge embankment.

The flood extents have been remodelled to also include a diversion added from the Cuckoo stream into an additional attenuation system prior to flowing under the R132 Swords Road via a culvert. This diversion was put in place to control out of bank flows onto the R132. Figure 4-3 is annotated with the locations of the mitigation works. The work was undertaken after the publication of the FEM FRAM mapping and presented updated mapping of the current and proposed scenario. Since the study the works have been completed and the post-mitigation scenario now supersedes the FEM FRAM mapping as the current condition.



Pre-Mitigation 1% AEP + 20% climate change	Post-Mitigation 1% AEP + 20% climate change

Figure 4-4 Flood Extent Map - Cuckoo Stream Pre & Post Mitigation (extract from RPS study)

4.2.4 RPS Flood Risk Assessment for North Runway (Nov 2016)

RPS were commissioned to complete a detailed FRA[1] for the runway site. The daa was granted planning consent for a new North Runway in 2007. At the time planning consent was granted, an FRA was not required to be submitted.

The RPS FRA has been undertaken for the permitted development that received consent in 2007 (Planning Register Reference Number: F04A/1755, An Bord Pleanála Reference Number: PL 06F.217429).

The FRA revisits the Forrest Little Stream, which was modelled as part of the FEM FRAM study and provides an updated representation of the stream that will supersede the former study. It also introduces flood mapping for St Margaret's Stream and Barberstown Stream which impact the runway site. The existing scenario mapping has been included as part of the Flood Zone mapping for the wider LAP site.

After defining the existing condition the FRA goes on to investigate mitigation measures to alleviate flooding and allow the appropriate development of the key piece of infrastructure.

1 Flood Risk Assessment for North Runway, RPS November 2016 (MDE0951Rp0022).

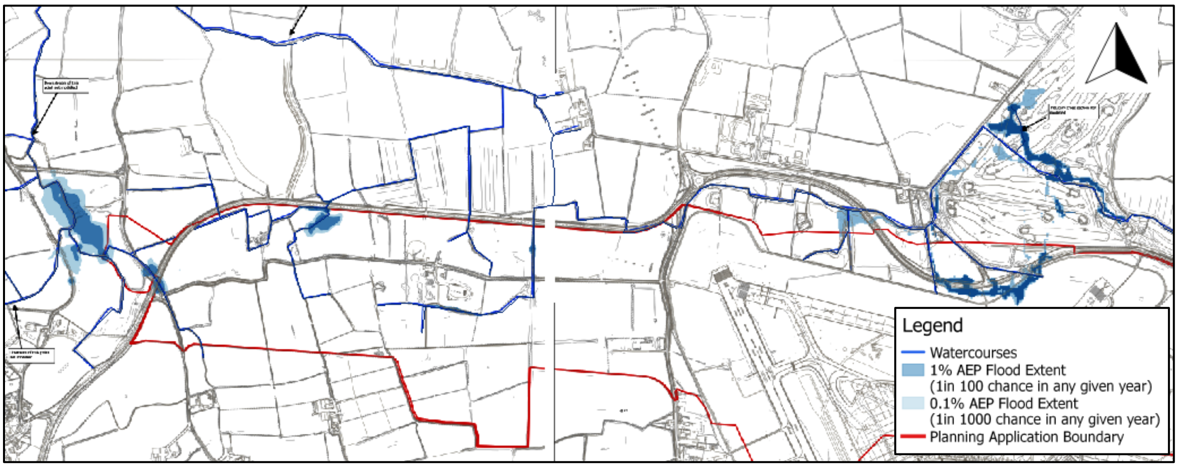


Figure 4-5 RPS North Runway Flood Mapping (existing scenario)

4.2.5 Final Flood Zone Mapping

Final Flood Zone mapping has been compiled based on the combined flood extents from the FEMFRAMS, Eastern CFRAM and R132 Improvement Scheme, this is presented over the page in Figure 4-6.

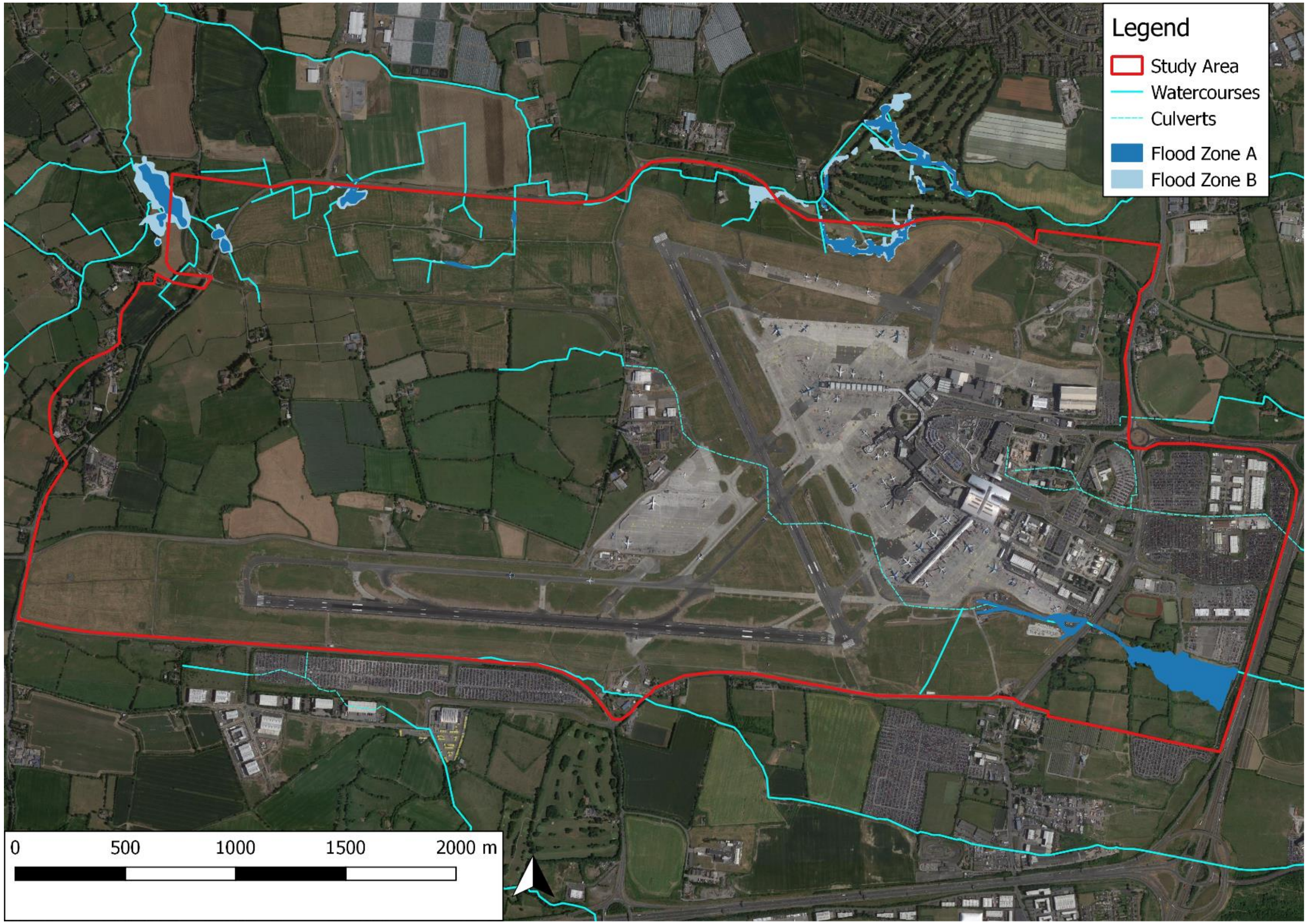


Figure 4-6: Fluvial Flood Zones within Airport LAP

4.3 Sources of flooding

A review of the historical event data and predictive flood information has highlighted a number of sources of potential flood risk to the area. These are discussed in the following sections.

4.3.1 Fluvial

The main source of historical flooding is caused by fluvial flooding. The area within the Airport LAP is affected mainly by the Cuckoo Stream to the south east of the Airport lands and the Forrest Little Stream to the north.

The principal risk to the LAP land is from the Cuckoo stream, this is because it has the greatest potential to impact existing development. Risk from the Forrest Little Stream (within the LAP boundary) is low as the land within this area is undeveloped agricultural lands and the flood extents do not encroach on the runway operations. Currently the Forrest Little Stream receives mainly unattenuated flows from the Airport paved areas and surrounding fields. In the future a drainage system will be incorporated for the new runway that will attenuate and discharge into the Forrest Little Stream sub-catchment, this will reduce peak runoff into the catchment and reduce risk downstream to sensitive areas impacted by the Sluice River.

The Cuckoo stream was modelled as part of the FEM FRAM study, a pilot study for the Eastern CFRAM. Flood extent mapping showed out of bank flows to the south east of the LAP area during the 1% and 0.1% AEP events. However, since the FEM FRAM study was published, upgrades and mitigation measures have been constructed in order to mitigate out of bank flows from the Cuckoo Stream on both the R132 and Dardistown Road (immediately upstream of M1). Overflow culverts divert high flows from the channel into underground attenuation storage to avoid flooding across the R132. An embankment and bypass culverts have also been built upstream of the Dardistown Road. Flood risk and residual risk is now appropriately managed by the mitigation measures.

The various sources of flood mapping have been combined to provide the best available dataset for the Flood Zone mapping, this is presented in Figure 4-6. Information from the various flooding studies is summarised in Table 4-2. Given the high level of detailed studies that have contributed to the final Flood Zone information it is not recommended that any further detailed studies on fluvial flooding are required as part of the Dublin Airport LAP. A formal review of flood risk from the specific areas of the LAP is provided in Section 8.

4.3.2 Pluvial

Flooding of land from surface water runoff (pluvial flooding) is caused by intense rainfall events lasting several hours. The indicative pluvial map provided on myplan.ie displays the OPW PFRA study. An excerpt from the Airport lands are shown in Figure 4-2 The map has been used to identify development areas at risk of pluvial/surface water flooding.

The map shows isolated areas of pluvial flooding but does not include any consideration of overland flow routes, ground conditions or any drainage systems that have been put in place. As such it does not present any significant pluvial risk to the key airside and landside built development and road network. This is a clear underestimation of risk and is therefore not helpful when considering the SWMP. The indicative mapping is therefore limited in its usefulness and as part of the SFRA & SWMP the LAP lands will undergo remodelling with results presented in Section 5.

4.3.3 Groundwater

Groundwater flooding is caused by the emergence of water originating from the subsurface and is particularly common in karst landscapes. This source of flooding can persist over several weeks and can pose a significant but localised issue that has attracted an increasing amount of public concern in recent years. In most cases groundwater flooding cannot be easily managed, or lasting solutions engineered.

The Draft PFRA groundwater flood maps which entails an evidence-based approach and considered the hydrogeological environment, such as the presence of turloughs, shows no risk within the Dublin Airport LAP.

The Environmental Impact Statement (EIS) for the Northern Runway carried out an assessment of the soils, geology and hydrogeology. The assessment found no evidence of existing groundwater flooding or potential for significant flooding.

The Geological Surveys of Ireland (GSI) actively maintain and develop national and project based spatial datasets derived from internal programmes relating to land mapping, groundwater, geotechnical, landslides, Quaternary, Geological heritage, minerals, INFORMAR and Tellus.

An extract from GSI website relating to groundwater vulnerability is shown in Figure 4-7. The Dublin Airport LAP lands lies within a catchment where groundwater vulnerability ranges from 'Low' to 'Extreme'.

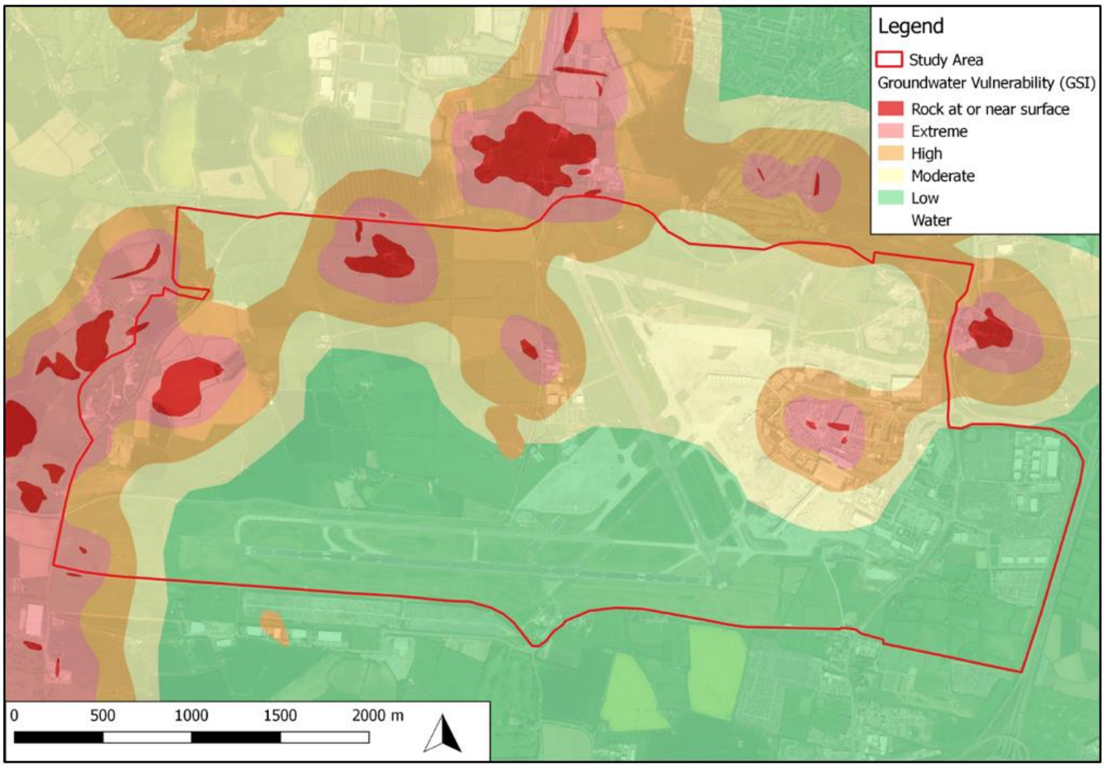


Figure 4-7: Groundwater Vulnerability (Source: GSI Data Viewer)

4.4 Climate Change - Key Guidance

The Planning System and Flood Risk Management guidelines recommends that a precautionary approach to climate change is adopted due to the level of uncertainty involved in the potential effects. Both GDSDS and OPW provide guidance on allowances and mitigation approaches for climate change. These are summarised below.

4.4.1 Greater Dublin Strategic Drainage Study

The Greater Dublin Strategic Drainage Study (GDSDS) highlights that the issue of climate change is a major importance. The GDSDS advises that climate change criteria are applied for the design of drainage systems for new development. This criteria is also provided as part of the Final County Council Development Plan which advised that "all new development must allow for climate change as set out in the GDSDS Technical Document Volume 5 Climate Change". Table 4-3 outlines the criteria.

Table 4-3: GDSDS Climate Change Factors for Drainage Design

Climate Change Category	Characteristics
River Flows	20% increase in flows for all return periods up to 100 years
Rainfall	10% increase in depth (factor all intensities by 1.1)*
Sea Level	400+mm rise (see Climate Change policy document for seal levels as a function of return period).
* whilst this value is recommended and older parts of the LAP applied 10% climate change to attenuation facilities for surface water, all new attenuation infrastructure is designed to account for 20% increase in rainfall depth.	

4.4.2 OPW Draft Climate Change Guidance

Current OPW guidance requires that the effects of climate change are considered when assessing flood risk. Draft OPW guidance[2] recommends that a number of approaches are considered. These include the following:

- Sensitivity Based Approach – This requires an assessment of the likely impacts of climate change on flood risk, comparing existing and future scenarios.
- Adaptive Approach – Flood risk management measures are designed and implemented to account for existing flood risk with provision for adaptation in the future to account for the effects of climate change.
- Assumptive Approach – Flood risk management measures are designed and implemented assuming a certain degree of climate change impact.
- No Physical Provision – this entails making no physical provision for the impacts of climate change in the design of flood risk management measures.

Two climate change scenarios are considered. These are the Mid-Range Future Scenario (MRFS) and the High-End Future Scenario (HEFS). Based on these two scenarios the recommended allowances for climate change are given in the table below.

Table 4-4 Allowances for Future Scenarios (100 year time horizon)

	MRFS	HEFS
Extreme Rainfall Depths	+ 20%	+ 30%
Flood Flows	+ 20%	+ 30%
Mean Sea Level Rise	+ 500 mm	+ 1000 mm
Land Movement	- 0.5 mm / year[1]	- 0.5 mm / year[1]
Urbanisation	*No General Allowance – Review on Case-by-Case Basis*	*No General Allowance – Review on Case-by-Case Basis*
Forestation	- 1/6 Tp[2]	- 1/3 Tp[2] + 10% SPR[3]

Note 1: Applicable to the southern part of the country only (Dublin – Galway and south of this)

Note 2: Reduce the time to peak (Tp) by a third: This allows for potential accelerated runoff that may arise as a result of drainage of afforested land

Note 3: Add 10% to the Standard Percentage Runoff (SPR) rate: This allows for increased runoff rates that may arise following felling of forestry.

4.4.3 Summary

The GDSDS is less conservative than the OPW draft guidance and does not include a high end scenario. However, current design standards for surface water attenuation within the LAP assume either a 10% (for older infrastructure) or 20% (for all new infrastructure) increase in rainfall depth due to climate change and are designed to store the 1% AEP rainfall event, which is beyond the standard recommended by the GDSDS.

The approach for the mitigation of climate change impacts has therefore been bespoke, taking into account both GDSDS and OPW requirements and extending the standard for the design of storm water systems. Further comment on the recommended design considerations for climate change is provided in Section 6.4 and 7.2.3 in these sections the recommendation is made to extend the climate change rainfall depths to 30% for key infrastructure (runways, aprons, terminal buildings and key road infrastructure) this is in line with the High End Future Scenario (HEFS).

Fluvial climate change mapping is presented over the page in Figure 4-8. Following OPW guidance Flood Zone B, which represents the 0.1% AEP extent, is used as a proxy for the 1% AEP flood event with climate change. The exception is the Cuckoo Stream where the flood outline includes 1% AEP climate change impacts. Pluvial climate change mapping is presented in Section 5.

2 Reference: OPW, Assessment of Potential Future Scenarios for Flood Risk Management, Draft Guidance, 2009

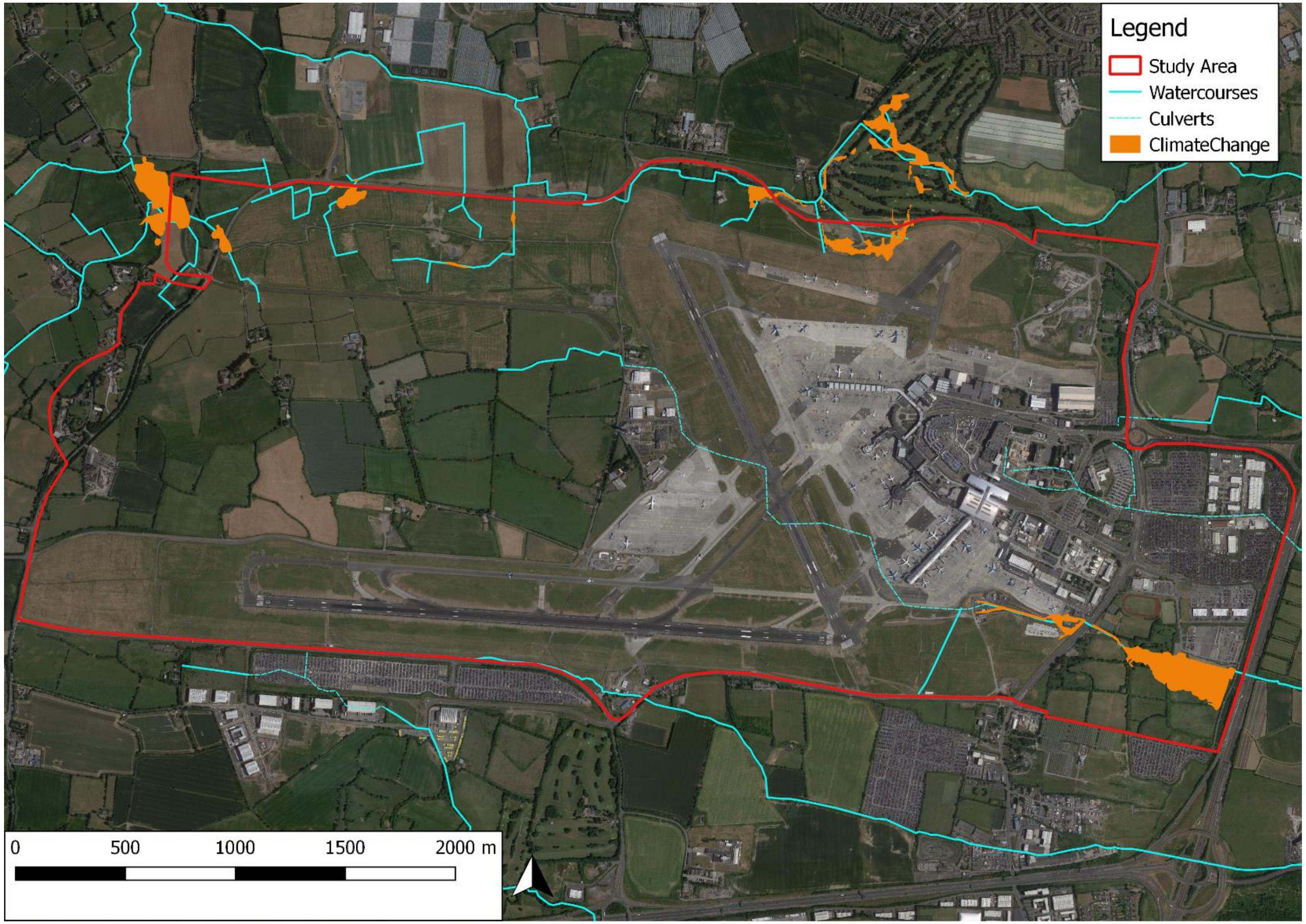


Figure 4-8 Fluvial Climate Change Map

5 Pluvial Modelling

Following on from data collection and risk identification, this section will assess the likelihood of flooding across the LAP lands using a pluvial hydraulic model. The current pluvial mapping available for the area from the PFRA flood maps is indicative in nature and does not include structures such as buildings and boundary walls which will inhibit the natural flow path, nor does it include infiltration or losses to the drainage network. The hydraulic model will provide higher resolution on the pluvial flood risk, improving upon the PFRA output. The pluvial flood map is displayed over the page in Figure 5-1.

5.1 Direct Rainfall Model

Pluvial modelling has been undertaken for the lands within LAP boundary. A 2D TUFLOW direct rainfall model was developed to determine the impact of intense short duration rainfall (1% AEP 1hr duration) and longer prolonged events (1% AEP, 6hr duration and 0.5%, 6hr duration) within the LAP.

The purpose of the modelling was to:

- Provide a detailed analysis of pluvial flooding.
- Have a better understanding of the contribution to flooding by run-off.
- To determine the impact of any proposed development.

5.1.1 Surface water flooding approach

Depth Duration and Frequency (DDF) data is used to provide the one hour and six hour event duration for the 100 year and 200 year storm events. The data was translated using the flood studies report approach to generate storm profiles (rainfall depth over time. The peak rainfall depth calculated for the 1% AEP (100 year) event was 34.1mm and 59.7mm for the 1hr and 6hr duration respectively. The peak rainfall depth calculated for the 0.5% AEP (200 year) event 6hr duration was 69.4mm.

A 12mm/hour constant drainage rate has been applied to the model to account for the existing drainage network serving the airport lands. This value is considered accepted practice as researched for the 2010 England and Wales Flood Map for Surface Water. This value is used in conjunction with a percentage run off or a factor that is applied to the rainfall in order to derive 'effective rainfall'. A factor of 1.0 is used for urban area and 0.4 for rural sites, to represent infiltration.

The two dimensional modelling software TUFLOW was used to develop a direct rainfall model. This approach applies a defined rainfall event over a 2D grid to determine flow paths, velocity of flow and areas where water ponds. A grid resolution of 1m was sampled from the Lidar data. Roughness layers were applied to the grid which attributed specific roughness values to areas of different surface classes such as roads, buildings, woodland etc. This enables the model to more accurately represent flow paths, depths and velocity.

5.1.2 Climate Change Sensitivity

Climate change sensitivity was reviewed through the modelling of two additional 1% AEP 1hr rainfall event models for a +20% and +30% increase in rainfall depth. This represents the OPW MRFS and HEFS future scenarios as discussed in Section 4.4.

5.2 Results

Both the 1hr and 6hr rainfall events were modelled to indicate what would happen in a short duration (1hr) event where the drainage network is overwhelmed and a longer event (6hr) to look at vulnerability to topographic ponding and accumulation.

In reviewing the mapping there were negligible differences found between the two durations and to minimise complexity the mapped results only include the 1 hour event, which is displayed in Figure 5-1 over page. Climate change mapping is presented in Figure 5-1 and Figure 5-2 presents a combination of pluvial and fluvial flooding.

Figure 5-1: Pluvial flood depths - 1% AEP 1 hour event

Figure 5-2: Pluvial flood depths - 1% AEP 1 hour event + 30% climate change (HEFS)

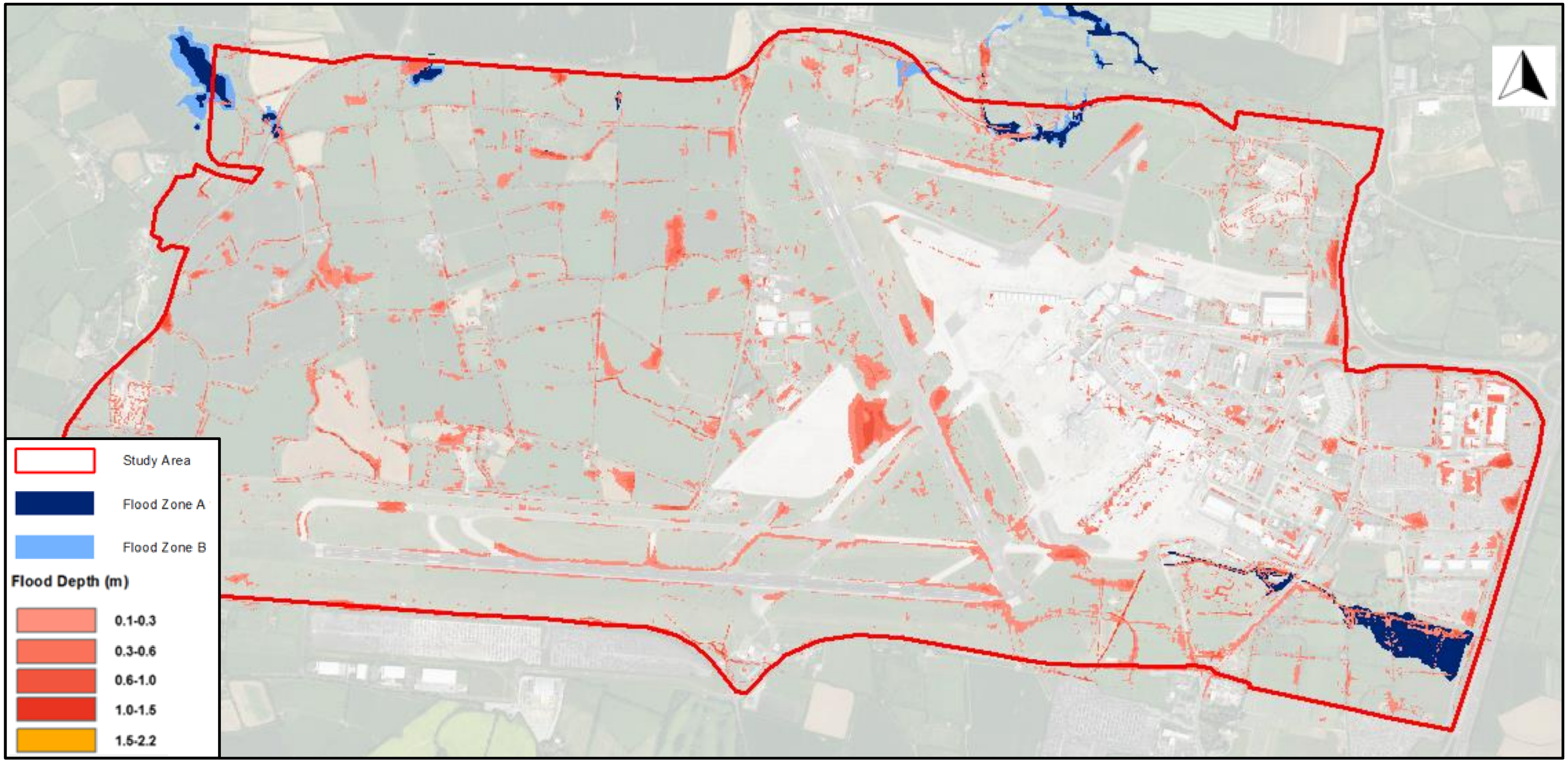


Figure 5-3 Pluvial flood depths - 1% AEP 1 hour event and fluvial Flood Zone A & B

5.2.1 Existing Scenario Impacts (1% AEP 1 hour event)

The following table summarises the pluvial modelling impacts for key areas.

Table 5-1 Pluvial Impact Summary

Area & Map Extract	Comment
 Greenfield area & proposed Northern Runway Site	• In the greenfield lands to the west of the LAP area the pluvial mapping indicates a series of topographic low spots which accumulate flow. • The mapping also clearly identifies flow paths from a network of surface water drains. The surface water drains are not represented explicitly within the pluvial model and would serve to drain the lands to an outfall. • Anecdotal evidence from the Dunbro Lane area (see points A and B) point to re-occurring fluvial/surface water drainage flooding problems. Evidence provided by FCC after consultation with local residents. • Any future development in this area would need to consider the surface water issue further, but it should not be a barrier to development. Connecting the system of drainage ditches will be important to effective drainage of these lands. • Proactive maintenance required to ensure road drainage ditches to remain free of overgrown hedging and debris, particularly at locations A and B in the map opposite. • Road crossing pipes to be periodically jetted out and maintained to prevent blockage. • Investigate need to replace or upsize some existing road crossings particularly at location A in the map opposite. Any adjustment to the pipe sizing would need to be accompanied by a suitably detailed FRA.

<table>
<tr><th>Area & Map Extract</th><th>Comment</th></tr>
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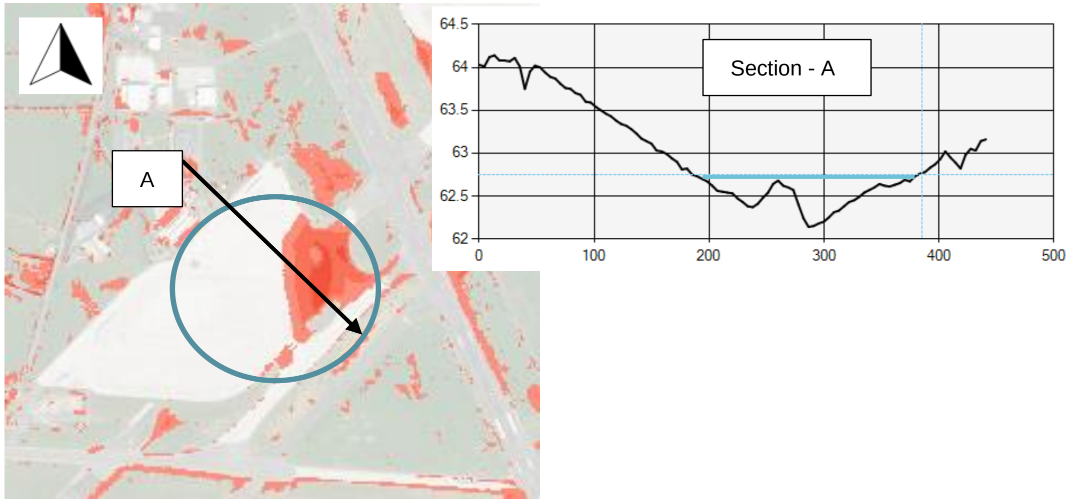

Phase 6 Apron (A, B & C)
</td><td>

- There is some significant ponding in the Phase 6 Apron (A, B, C) where there is a steady fall to the south east (see Section A).
- This area is within the Cuckoo Stream catchment and is in the general location of the Phase 6 local attenuation. Further work may be required to mitigate ponding in this area.
- The vertical alignment of the runways is generally raised above surrounding lands and the pluvial flood extents therefore show flooding ponding either side of the runways. Together with the Phase 6 Apron this presents a barrier to shallow overland flow and separates a significant proportion of the Cuckoo Catchment from the eastern part of the airside and landside area.
- Positive drainage of these flooded lands maybe needed to prevent damage of the runway foundations.

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- Pluvial flooding to the rural Cuckoo catchment picks up flooding around the main channel and some potential local surface water field drains to the east of the R132 (A).
- The R132 itself is predicted to accumulate flow however the road is subject to a new surface water system that may mitigate accumulations more then displayed, but there is a potential risk. Flooding to the corner of the Car Rental car park (B). Part of a taxiway (C) is also subject to a topographic low spot and has associated flooding.

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Area & Map Extract	Comment
Cuckoo Rural Catchment	
 Main Airport Terminals, Airport Central and eastern car parks	• Pluvial flooding in the area covering the main airport terminals, Airport Central and the eastern car parks principally creates conveyance pathways from main roads and also features some significant accumulation zones. • There are numerous areas within the eastern car parking zone (A) that feature isolated topographic depressions that are predicted to accumulate flow. • Airport Central (circled B) will be subject to significant redevelopment and is principally subject to risk from conveyance and some accumulation along road routes (up to 0.7m deep). However, there are also some accumulation zones on or adjacent to buildings. These risks can be further managed by the implementation of the appropriate surface water drainage strategy during redevelopment. • Other areas of significant car park accumulation occurs in area C where the car park meets the R132 embankment. • Some road accumulation is also predicted around Terminal 2 (D - up to 0.8m deep).

5.2.2 Climate Change Impacts

A flood depth comparison was carried out between the existing 1% AEP 1hr pluvial model and the +20% and +30% climate change pluvial model results. There is a moderate increase in flood extent to all main accumulation zones (such as around Apron 6 and other areas subject to significant ponding). This impact is to be expected from an increase an increase in volume. Conveyance routes by their nature, are not represented by a significant change in depth.

5.3 Summary

Pluvial modelling has provided a more detailed appraisal of pluvial conveyance and accumulation zones. The mapping considers variable runoff rates from rural/urban landcover and also considers a nominal storm water drainage rate for the urban area. The impacts highlight several areas where risk is high and can be used to guide potential management and mitigation. Potential reduction of pluvial ponding along road routes may involve the installation of conduits (swales or pipes to storage tanks) for the flow paths/ponding so that the impacts on the road infrastructure can be managed. Further guidance on the reduction and management of storm water is provided in Section 6.

6 Storm Water Management

6.1 Existing Drainage Network

As outlined in Section 2.2, the Dublin Airport LAP study area, c.1,084ha, comprises a number of catchments which are currently drained by various open drains/streams to local watercourses external to the site boundary, namely the Ward River, the Sluice River, the Mayne River and the Santry River. The individual drainage catchments are as indicated in Figure 6-1 below.

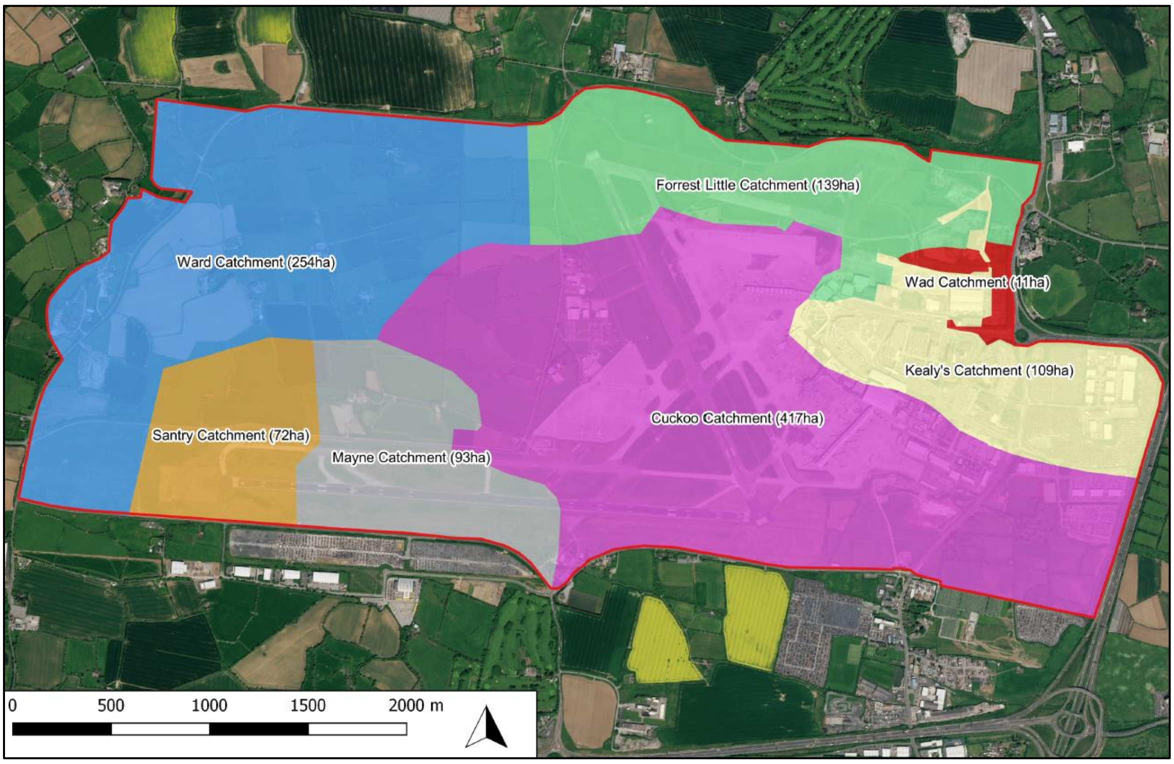


Figure 6-1: Sub-catchment areas within LAP

It is understood that attenuation, for the most part, is provided to currently developed / hard-standing areas with exception of the Forrest Little, Mayne and Santry catchments.

Whereas various pollution retention facilities are provided, they are primarily catering for runoff from the runway aprons, taxiways etc (de-icing etc) and as such, surface water runoff from other hardstanding areas, namely access roads and surface car-parking do not have any formal treatment prior to downstream discharge.

6.1.1 Kealy's Stream Catchment:

The Kealy's stream drains the eastern areas of the Airport and a hanger originally within the Wad catchment, which was subsequently diverted into the Kealy's stream due to flooding issues downstream of the Wad Stream.

The Kealy's stream catchment primarily comprises impermeable surfacing from existing paved and roofed surfaces. Underground attenuation facilities provide temporary storage at the Eastlands Carpark, refer Figure 6-2. The original system put in place was designed to contain the 1 in 30 year storm event with the 1 in 100 year storm event stored above ground within the airport carpark. In 2007, this was upgraded to provide additional underground storage for the 1 in 100 year event (14,500m^3).

Historically, the discharge rate from the Kealy's catchment was set at 4.5l/s/ha, however, as part of the Terminal 2 and Eastlands Carpark developments, the discharge rate from both sub-catchments were reduced to 2l/sec/ha, the result of which is a reduced rate of flow in Kealy's Stream to that previous.

To accommodate for future developments and the construction of Terminal 2 (T2), additional underground attenuation was constructed within the Eastlands carpark (17,000m^3). At present, a total of 31,500m^3 storage is provided for the Kealy's catchment.

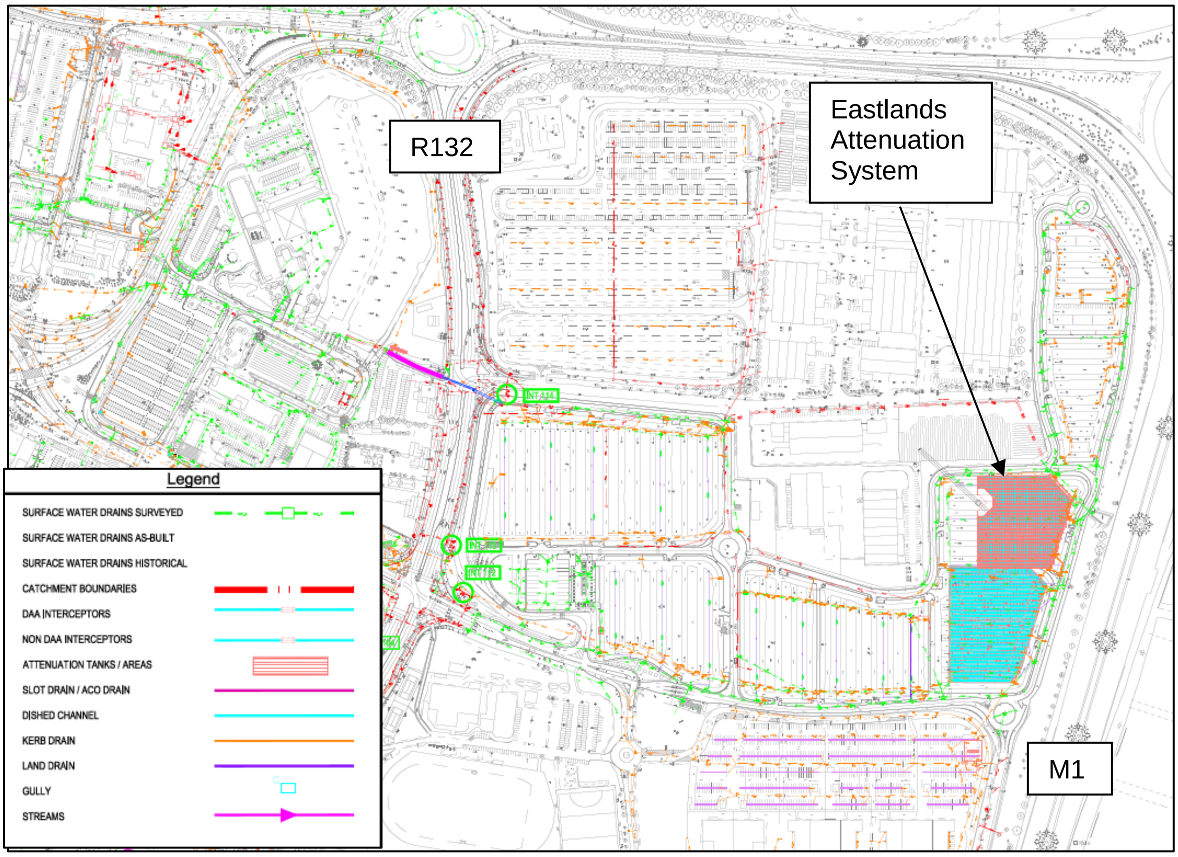


Figure 6-2: Eastlands Attenuation - Kealy's Catchment (Source: G00-1012-002 daa surface water map)

6.1.1.1 Drain Down Time

Based on 31,500m^3 storage and a discharge rate of 490.5l/sec (4.5l/sec/ha x 109ha), the time to empty is calculated as 18 hours. This is a significant draw down time and will only get longer with climate change. Implications for the capacity of the attenuation facility being exceeded should be assessed with any mitigation works undertaken or at least the risk of same being considered by the daa.

The probability of subsequent storms, whereby, the attenuated volume will not have emptied completely prior to the onset of further rainfall should be considered. Any appraisal should be cognisant that the Eastland attenuation system is located in an area that is already susceptible to pluvial flooding, refer Figure 5-1, and surface water storage may therefore be reduced.

The primary requirements for attenuation volumes is a function of the total area of roads and public open spaces contributing surface water run-off. In reality, it is expected that the provision of SuDS devices at source (i.e. via swales and other SuDS devices as discussed in Section 6.4.3) the requirement for attenuation volume at Eastlands will reduce. SuDS measures must be incorporated into new developments to reduce the demand on downstream infrastructure. Proper design and implementation of SuDS measures at source will further improve the hydraulic resilience of downstream infrastructure. This coupled with the potential volume reduction due to infiltration is likely to maintain the drain down times at acceptable limits.

6.1.2 Cuckoo Stream Catchment:

An existing 'global' underground attenuation facility storage capacity of 20,500m^3 is located along the Cuckoo stream downstream of the Cuckoo culvert, refer Figure 6-3. This is the main facility for attenuating flows from the Cuckoo sub-catchment. The Cuckoo Stream drains the airside facilities including aprons, piers, taxiways and the existing runways for the Airport and a portion of the terminal buildings.

'Local' attenuation facilities (refer Figure 6-4) are provided along Apron 5G and the taxiways in advance of entering the global storage attenuation. Attenuation from Apron 5G provides onsite attenuation of 3,600m^3. Attenuation from the taxiways include individual storage facilities of 2,750m^3 and 1,500m^3 prior to the global attenuation facility.

De-icing of planes and taxi/runways occurs at Dublin Airport several times a year during cold weather. As a result, associated runoff will be polluted within the Cuckoo catchment when flows are drained into the stream when ice melts or from the first flush of the event. During these periods, the BOD_5 of the polluted water will spike and exceed the permissible BOD_5 discharge limit. To counter same, a flow diversion chamber and pollution control tank has been constructed at the Cuckoo stream adjacent to the underground attenuation facility. As water is conveyed along the channel BOD_5 monitors take readings of flow within the watercourse. If and when the BOD_5 levels exceed the allowable threshold, flow is diverted out of the channel and into the pollution tank. The polluted water is than pumped from the site to sewage treatment facility at Ringsend. The capacity of the existing pollution tank is known to be 30,000m^3.

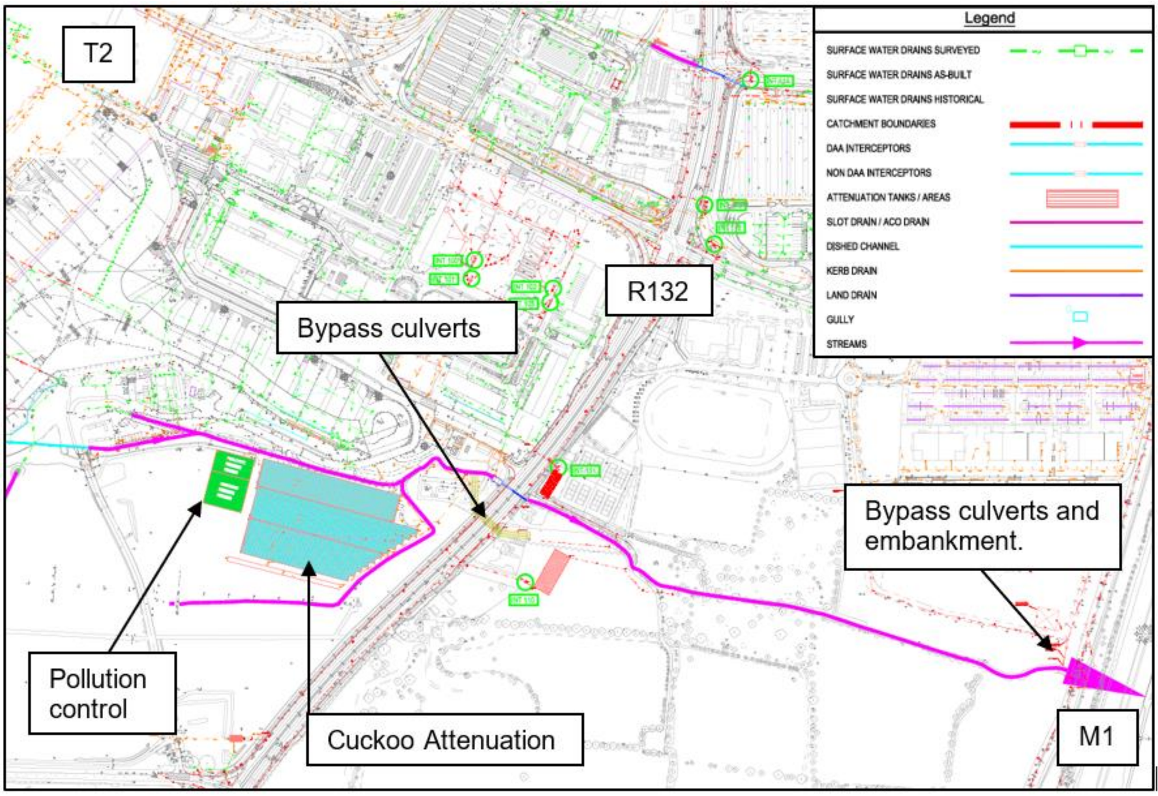


Figure 6-3: Cuckoo Attenuation and Pollution control (Source: G00-1012-002 daa surface water map)

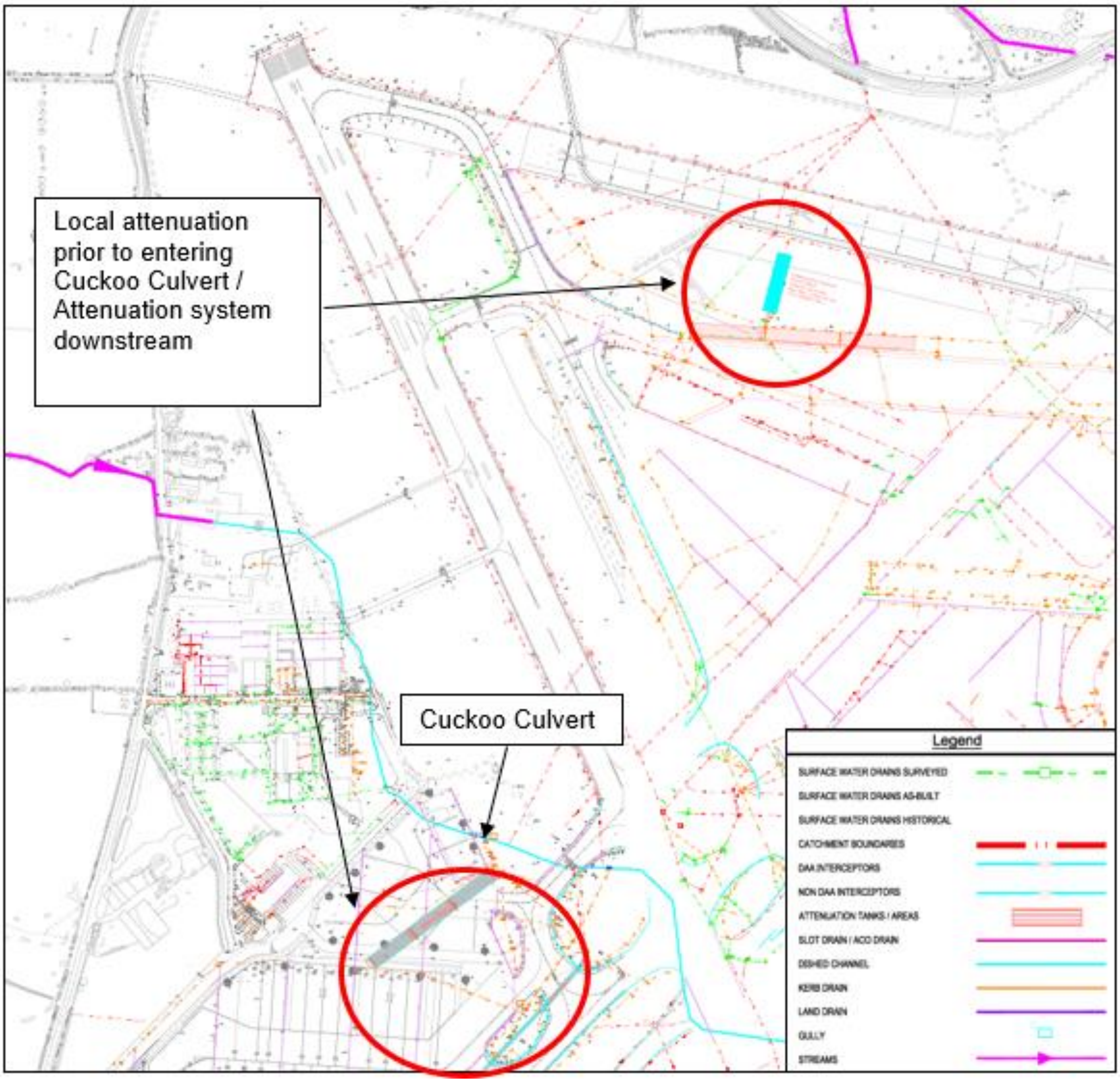


Figure 6-4: Local Attenuation within the Cuckoo catchment (Source: G00-1012-002 daa surface water map)

6.1.3 Forrest Little Catchment:

The Forrest little Stream primarily receives unattenuated flow from some paved areas and grasslands to the north of the main terminal buildings.

The proposed north runway when constructed is envisaged to discharge runoff from all paved areas to the Forrest Little Stream. The proposed runway is not designed to intercept any major watercourses but may intercept minor land drains across the site. These drains will be rerouted during construction and are subject to the Northern Runway Detailed FRA (see Section 4.2.4). Underground attenuation facilities should be designed to store the 1 in 100 year storm event with an existing greenfield runoff rate.

6.1.4 Mayne River and Santry River Catchments

The areas of the Mayne River Catchment and Santry River catchment within the Dublin Airport LAP are currently unattenuated, despite draining part of the main runway which impacts on the rate and quality of the surface water discharge to the receiving watercourse.

6.1.5 Ward Catchment

Agricultural lands to the north-west of the study area currently drain to the Barberstown & St. Margaret's stream which are tributaries of the Ward River located north of the LAP. These drains will be impacted during construction of the future runway and are subject to the Northern Runway Detailed FRA (see Section 4.2.4).

6.2 Assessment of Existing Stormwater Infrastructure

Attenuation has been provided at all key discharge points except on the River Mayne. Attenuation reduces the impacts of rapid runoff from paved areas, but does not address the increase in overall volume when an area is drained positively to a defined outfall. The current provisions do not address water quality aspects, that would be expected in all future developments. Also, large end of pipe attenuation storage has a finite ability to deal with multiple rain events as it cycles through the fill and empty sequence over a long period of time.

In view of the current LAP proposals, there is an opportunity to reduce current discharge rates (if required) through the provision and/or retro-fitting of various SuDS measures, especially if managing the overall volume of discharge in the Cuckoo stream has the potential to create issues in tide locked areas downstream. A reliance on an arbitrary limiting discharge rate, for the scale of development envisaged needs to be fully supported by an evidence base.

Whereas, it is not part of the current brief, the daa should review the performance of all stormwater infrastructure, both within the subject study area and also the receiving watercourses downstream. JBA understands that there are ongoing surface water management studies being conducted by a third party consultant for the daa. The ongoing studies will include important information on the surface water management system and flood risk for daa lands. This information is currently not available and is unlikely to be available prior to the adoption of the Dublin Airport LAP. Any subsequent updated relevant information regarding drainage or flooding that becomes available post adoption of the LAP will be considered at that time. As there are areas of predicted flooding downstream of Dublin Airport (as referenced by the CFRAM flood mapping), there is an opportunity to potentially reduce both the rate and volume of stormwater from the Airport lands which would be advantageous for all concerned. This can be achieved by the introduction of various SuDS measures (including retro-fitting) to maximise infiltration and re-cycling which will reduce overall volumes of stormwater being discharged downstream. If the overall volume of stormwater is reduced, the discharge rate can be also reduced without necessarily increasing existing attenuation storage volumes. However, a detailed study would be required to assess the changes brought about by implementing SuDS measures so that a reduced discharge rate could be derived. Such a study is outside the scope of this report.

Volume reduction can easily be attained by the introduction of the SuDS Management Train, refer to Section 6.4.1 whereby the runoff is addressed for the most part at source (close to where the rainfall falls) by the introduction of green roofs, infiltration trenches, rainwater harvesting etc. The provision of infiltration type SuDS measures (trenches, drains, swales etc) are particularly beneficial in terms of both water treatment and volume reduction with the extent of volume reduction dependent on the infiltration characteristics of the underlying ground strata.

6.3 Legislation Requirements

The following legislative requirements guide the approach to sustainable drainage systems (SuDS) proposed for the Dublin Airport Local Area Plan.

6.3.1 Water Framework Directive (WFD) (2000/60/EC)

This is a European Parliament Directive and of the Council establishing a framework for community action in the field of water policy. This directive is concerned with the protection of the aquatic ecosystem by preventing any further deterioration in status of waters, groundwater and water dependent ecosystems and where necessary the restoration of the water body, to achieve a 'good' condition. The status is based on both ecological status as well as the natural chemical and physical condition. In addition to qualitive targets, the Directive also promotes the sustainable use of water resources and most notably, the elimination of the discharge of specific hazardous substances.

The legislation places onus upon stakeholders, including both the polluters and regulators to ensure all appropriate measures are taken to protect the environment at risk. In terms of surface water discharges, there will be an increasing emphasis on treatment volumes and processes within the developed lands as well as peak flow rates.

6.3.2 The Planning and Development Act 2000 (S.I 600,2001) and associated regulations

This gives local government power to sanction regarding acceptance, or otherwise, of developer proposals.

6.3.3 The Local Government (Water Pollution) Acts, 1977/1990 (Various S.I)

This sets out a general prohibition on the entry of polluting matters to open water bodies and gives the Local Authority the power to require measures to be taken to prevent such water pollution. The legislation also sets out the roles and responsibilities of the Local Authority with respect to monitoring of waterbodies and reposting of results to the Environmental Protection Agency (EPA).

6.3.4 Water Quality (Dangerous Substances) Regulations, 2001, S.I 12 of 2001

Guides the water quality monitoring programme in the region.

6.4 Surface Water Management Strategy

The focus of the strategy is to manage the surface water runoff in a more sustainable way, ensuring that future development works within the Dublin Airport LAP will:

- Adhere to the principles of the SuDS Management Train;
- Reduce the rate of discharge from the site(s);
- Reduce the overall volume of stormwater discharging downstream;
- Address water quality issues;
- Not increase the risk of a bird strike along flight paths.

Fingal Co Council / daa should also look to retro-fit SuDS where feasible to:

- Already developed areas without attenuation or treatment provision, for example, the existing runway within the Mayne and Santry catchments and existing paved areas within the Forrest Little catchment;
    - This should be possible without much disruption to airport operations
- Public realm areas, for example existing access roads;
    - It is accepted that the provision of SuDS measures to such areas would be problematic given the traffic volumes in the area but where the opportunity presents itself through road improvement works or otherwise, suitable SuDS measures like tree pits, infiltration trenches with an overflow to the main storm sewer network should be installed.

Water quality is particularly important and is a fundamental part of the strategy in terms of providing adequate levels of treatment prior to discharge. The initial runoff from a site or catchment is known as the 'first flush'. The first flush is generally the most polluted as the flows will contain a high level of contaminants such as dust, oil, litter, organic matter amongst others. Interception of flows is therefore important as a significant amount of pollution can be prevented from reaching downstream watercourses.

The Wad and Kealy's stream are tributaries to the Sluice River which discharges to the Irish Sea through the Portmarnock Estuary. The Cuckoo stream which drains the majority of the Airport lands is a tributary of the Mayne River which discharges to the sea through Baldoyle.

There should be adequate levels of treatment of the surface water prior to discharge from the subject lands as downstream estuaries are designated as Special Protection Area (SPA), Special Areas of Conservation (SAC) and proposed National Heritage Areas (pNHA). Such treatment can be achieved through a detailed surface water management strategy that incorporates new and existing drainage features to control and treat surface water runoff. The guiding principles for this strategy are shown in Table 6-1.

The following surface water management strategy provides a basis for sustainable development of the subject LAP lands in terms of the management and control of surface water discharge from the site. Future development works shall be carried out in accordance with the GDSDS and The SuDS Manual (CIRIA C753) with the exception of any specific design requirements and/or restrictions as set out in this strategy document.

Table 6-1: Surface Water Management Strategy Principles

	Principle	Purpose
1	Manage surface runoff at source	Prevention and / or reduction of surface water flows.
2	Manage water on the surface	The ability to intercept flows and direct them to areas designed to treat, store and discharge flows away from buildings, commercial areas and transportation networks where disruption and flooding can occur.
3	Integrate public space and drainage design	SuDS features can be incorporated into open public spaces. Communities can enjoy a variety of diverse features. The design of SuDS features within the open public spaces can be of high quality to achieve a multi-functional space for amenity, biodiversity and surface water management. In this context, design should have regard to The SuDS Manual (C753).
4	Effective operation and maintenance	A robust operation and maintenance schedule of SuDS measures should be produced and adhered to, to ensure SuDS measures are operating to their full capacity, and that life cycles can be extended as much as possible. SuDS designs and maintenance schedules should be agreed with those adopting them early in the planning process. It can be beneficial to make maintenance contracts mandatory in advance of SuDS construction. The lifespan of SuDS measure should also be considered in design.
5	Account for climate change and changes in impermeable area	20% allowance for climate change generally (office / commercial developments, car-parks etc) but increased to 30% for key infrastructure projects such as runways, aprons, terminal buildings and key road infrastructure works.

6.4.1 SuDS Management Train

Each site should adopt the SuDS Management Train approach, illustrated in Figure 6-5. Preventative, source, site and regional controls can be used to mimic the catchments natural processes as closely as possible. Whilst there are many different SuDS techniques that could be successfully implemented across the site, there is no one correct drainage solution for a site and in most cases a combination of techniques will be required, which could include:

- Prevention - good housekeeping and site design to prevent runoff and pollution i.e. rainwater reuse / harvesting / minimise extent of hardstanding areas;
- Source Control - control runoff as close to the source as possible through soakaways, infiltration trenches, green roofs, pervious pavements and rainwater gardens;
- Site Control - management of runoff in a local area or site by routing runoff to swales, detention basins, underground storage facilities, ponds or wetlands;
- Regional Control - management of runoff from site or several sites to a regional control facility. Whereas, a balancing pond or wetland is normally preferable for regional controls, same will not be permitted in this instance due to the risk of bird strike.

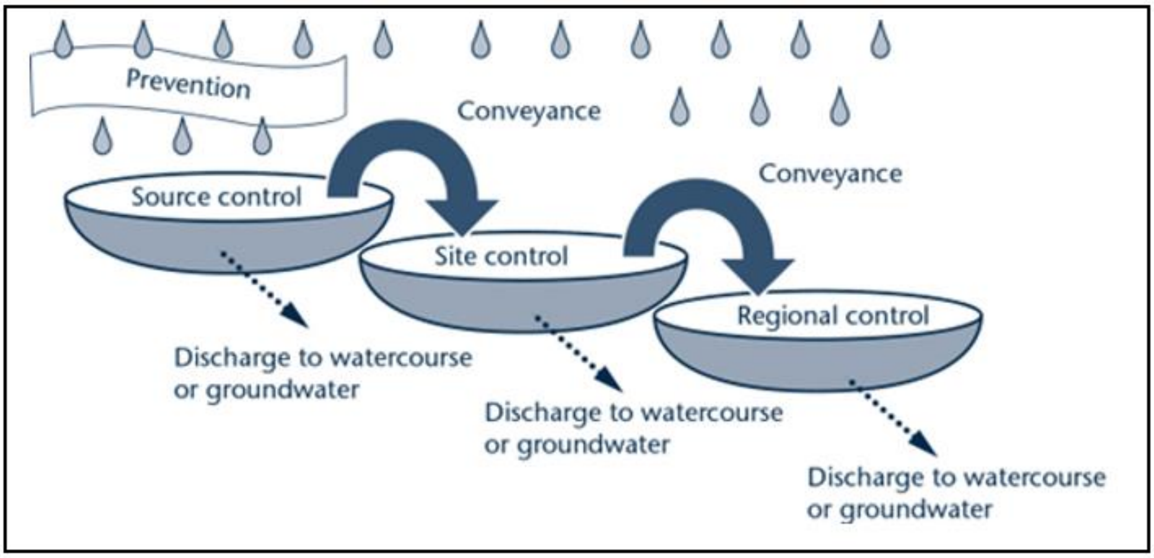


Figure 6-5: SuDS management train

6.4.1.1 Prevention

The first step in the surface water management train for each site should be the prevention or reduction of surface water flows and pollution during the first flush of rain generated runoff. The GDSDS states that there should be no discharge to a surface water body or sewer from the first 5mm of any rainfall event. This can be achieved using a combination of methods including:

- Good Housekeeping - regular and planned maintenance of all impermeable surfaces (e.g. road sweeping). Such activity will extend the design life of the SuDS systems;
- Minimise extent of impermeable surfaces - can impermeable surfaces be reduced and/or avoided;
- Rainwater Harvesting;
- Rainwater butts.

6.4.1.2 Source control using SuDS within Individual Sites

Where possible, the first two stages (where 2 stages are required) should be in-curtilage, i.e. privately owned systems that are maintained by the owner.

Roof water runoff should be captured and treated within the curtilage of each individual site. This could be typically achieved by using SuDS measures such as green roofs, rain water gardens, filter trenches or bio-retention units. All other areas such as car parking areas and access roads in commercial sites will typically require two stages of SuDS treatment. This could be typically achieved using SuDS measures such as improved swales, porous paving and bio-retention. Where two stages of SuDS treatment cannot be achieved at source, site control SuDS should be considered or addressed by reference to Chapter 26 (Water Quality Management) of The SuDS Manual (CIRIA C753).

6.4.1.3 Site Control using SuDS in Public Realm Areas

Where possible the first two stages of SuDS treatment from public realm areas, such as footpaths, roads and public open spaces should be achieved at source. It is accepted this may not be feasible in every case and can be addressed with alternative approaches demonstrated at detail design stage.

This could be typically achieved by using SuDS measures such as infiltration trenches; bio-retention units, or possibly porous paving.

These SuDS will generally be taken-in-charge / maintained by the local authority and constructed in easily maintained, open public spaces having the multi-functional use of surface water treatment, biodiversity habitats as well as being a focal point for amenity.

6.4.1.4 Regional Controls

Given the risk of bird strike, the provision of Integrated Constructed Wetlands (ICW's) or ponds will not be permitted as regional controls for the 1 in 100-year event plus climate change. As a result, the treatment benefits provided by such open ponds is removed which places further emphasis on enhanced water treatment measures upstream of regional controls, which for the most part will be underground facilities with little by way of associated water treatment.

6.4.2 Discharge Rate

It is probable that local soil infiltration rates coupled with the extent of hardstanding areas proposed will be such that the overall volume of surface water will increase because of various development(s) throughout the study area. Stormwater volume will also be dependent on the extent and type of SuDS measures that will be adopted at detailed design and planning stage.

To counter the potential increase in water volumes, the allowable discharge rate from all future developments and/or re-developments (individual plots) shall be in accordance with the GDSDS requirements. Where attenuation is retro-fitted to existing paved areas (for example the existing runway within the Forrest Little, Mayne and Santry catchments), the allowable discharge rate shall also be in accordance with the GDSDS.

By adopting a discharge rate in accordance with the GDSDS for future developments and/or re-developments, the pressure on existing attenuation facilities will be reduced, which in turn will provide for a greater level of service for exceedance rainfall events. It may also afford the opportunity to reduce the discharge rate from regional attenuation facilities should downstream flooding issues exist or arise in the future.

6.4.3 Reduction in Storm Volumes

At present, storm water is predominantly collected and drained directly to dedicated surface water sewers with little by way of infiltration and associated recharge of the groundwater. Such a drainage regime, especially if repeated on a catchment wide basis can be problematic as there will be little by way of a baseflow in the receiving watercourses once the storm event has passed which impacts on the local hydromorphology.

To assist with groundwater recharge a reduction in stormwater volumes, various SuDS measures can be incorporated into new developments which will address rainfall at source, namely:

- Infiltration Systems;
  - Soakaways;
  - Infiltration trenches;
- Swales;
- Filter strips;
- Filter drains;
- Bio-retention systems;
- Tree Pits (note that trees may increase risk of bird strike and should be avoided where possible or coppiced/pollarded regularly, see section 6.4.5);
- Pervious pavements.

It is acknowledged that such measures may not infiltrate all flows to the ground and may only result in partial infiltration pending the percolation characteristics of the underlying ground strata. However, the provision of the above SuDS measures will provide a level of infiltration whilst at the same time enhancing the quality of the stormwater prior to downstream discharge. Where full infiltration is not achievable, a perforated overflow pipe can be provided at a higher level to convey flows to the next stage of the SuDS Management Train.

6.4.4 Address water quality issues

Diffuse urban pollution arises from a multiple of sources and is a contributing factor in compromising both the groundwater and receiving water standards that are required under the EU Water Framework Directive. Potential impacts on receiving surface waters include the blanketing of river beds with sediment and the reduction of light penetration from suspended solids causing negative impacts on ecosystems.

The provision of SuDS measures is therefore an important means of reducing urban runoff and improving the water quality of any discharges from the site. Runoff from all development sites must adhere to the minimum number of treatment train components as outlined within the GDSDS or The Suds Manual (CIRIA C753) bearing in mind that the provision of an open pond will not be accommodated which would normally provide enhanced water treatment prior to discharge. Therefore, there will be more of a reliance on upstream SuDS measures to deliver the required quality standards.

6.4.5 Risk of a bird strike

As outlined in Section 6.4.1.4, the provision of open ponds and/or wetlands will not be considered as a SuDS measure given the risk of a bird strike. There are currently no open ponds/wetlands within the LAP and they should not be introduced.

Rooftops in themselves are attractive to birds and in relation to green roofs; which are permitted under this strategy, these shall be designed such that they are not attractive to gulls or wading birds such as oystercatchers, for nesting, loafing and roosting. Design may need to consider species planting and or active measures to achieve this.

Any requirement for a new regional control facility shall be by way of underground structure only.

Decision making has been supported by the CAA publication CAP772 Wildlife hazard management at aerodromes (CAA 2017). The report highlights that each aerodrome location presents a unique habitat that influences the type and population of bird species present. Bird strike risk management should focus on deterring birds from flying in the same airspace as aircraft and a principal measure to ensure this is aerodrome habitat management.

Dublin Airport currently has no open water, so the main attractant for high risk birds are the wide open grasslands surrounding runways. Putting in new open water/ponds/wetlands will significantly increase the attractiveness to birds (especially large flocking birds such as; ducks, geese, swans, grebes, waders, herons, coot, moorhen and cormorant) by adding a nesting habitat. With this additional habitat will come an increase in birds and therefore an unnecessary increase in severity and risk. This will introduce an increased requirement for active control procedures and an adjustment of the current wildlife management strategy. A continued policy of avoidance is therefore recommended under which it is considered to restrict the creation of any new open ponds/wetlands.

In general, when conducting any new development/redevelopment of the Airport LAP area then due consideration should be given to bird strike risk management with regard to wildlife attractant habitats created by water, open terrain and landscaping. SuDS measures that include vegetation and tree planting should adhere to the guidelines such as those discussed within CAP772, or as advised by daa.

6.4.6 Exceedance Flows

The increasing frequency and intensity of significant rainfall events will require that all developments allow for ‘exceedance’ in their internal surface water drainage design. In particular, the design of all drainage systems shall, if possible, allow for surface flood pathways, on-site low level storage in less vulnerable areas (car parks, planted areas etc), over and above the SuDS volumes required.

6.4.7 Eastlands Attenuation

Eastlands attenuation is located in an area of predicted pluvial flooding, refer Figure 5-1. Assuming the pluvial flooding originates within the catchment for which the underground storage is designed, an inlet from ground level into the attenuation tank system and upstream of any hydrobrake or flow control device can be provided which will minimise the duration of flooding on the surface.

Alternatively, the gully arrangement and collection system should be reviewed as to why such volume of water is conveyed by way of overland flow. Additional gully's and catchpits could be provided throughout the catchment in order to minimise the extent of overland flow conveyance.

Should the pluvial flooding local to the Eastlands attenuation be from outside the catchment for which the attenuation system is designed, the attenuation system should be either enlarged or the current pluvial flooding be assessed in terms of overall flood risk.

6.5 Benefits of holistic surface water management

Sustainable surface water management will:

- Reduce the volume of surface water by managing surface water runoff at source and reducing areas of impermeable surfaces;
- Manage or reduce surface water flooding by maximising the potential for flood storage through appropriately located storage facilities, infiltration trenches, tree pits, swales etc;
- Manage water on the surface during exceedance events by designing multi-functional open spaces to safely route and manage temporary surface water;
- Enhance local biodiversity and water quality by protecting, enhancing and providing high quality blue and green infrastructure;
- Improve local access to natural, shady outdoor spaces;
- Manage urban cooling;
- Protect or create carbon sinks and other climate change mitigation or adaptation benefits;
- Provide an attractive setting for development, with better public access;
- Achieve a number of strategic objectives and planning policies.

This high level strategy is required to achieve a coordinated and cohesive approach to surface water management and provide for the consistent designing of SuDS and traditional systems to achieve the benefits identified above. It is a requirement that a detailed surface water drainage system is designed at planning stage based on the strategy document.

6.6 Surface Water Drainage Design

6.6.1 Stormwater Management for Development

Urbanisation disturbs natural soil profiles, increases impervious surfaces and decreases vegetation cover. These disruptions increase surface water run off which can result in downstream flooding, impairment of groundwater recharge and degraded water quality.

The following are key measures which can be used to assist in management of surface water run-off from existing and new developments within the study area at Dublin Airport:

Underground Modular Systems with a high void ratio (e.g. Stormtech system or similar) will be used subject to agreement with the Local Authority in any suitable locations of open spaces subject to level and ready access to provide below ground storage and infiltration.

Filter strips can be used as treatment for road and car park run off where space allows for them. The can reduce the need for kerbing and runoff collection systems

Infiltration trench: Linear soakaways. The advantages of trenches over soakaways is that they can often be kept shallower and in variable soils can help distribute the infiltration area so that the impact of less permeable areas of soil is less pronounced.

Tree Root Structural Cell Systems (e.g. Silva Cell) are subsurface tree and surface water systems that hold large soil volumes while supporting traffic loads beneath paving and hardscapes. Addition of trees should be considered in line with the airport habitat management policy in relation to bird strike risk (see Section 6.4.5).

Green Roofs can be designed to give a wide range of benefits. These include; reducing the amount of storm water running off the roof reducing the risk of flooding - it is suggested that they result in reduced annual run-off of at least 40% and more usually 60-70%, providing habitat, water quality improvement, keeping buildings cool, help reduce the amount of dust and pollutants in the air, creating new open space for relaxation and creating green useable spaces. Again, the implementation of green roofs should consider the risk of bird strike, as discussed in Section 6.4.5.

Pervious Paving, namely:

- Modular permeable paving;
- Porous asphalt;
- Grass reinforcement;
- Resin bound gravel;
- Porous Concrete;
- Macro pervious paving;
- Sports surfaces;
- Block porous paving.

Rainwater Harvesting - the collection of rainwater runoff for re-use**;**

- Rainwater tanks - can be gravity or pumped solution to residential, industrial or commercial developments for general use, thereby, reducing the demand for water from the public water supply;
- StormHarvester - enables attenuation structures to also be used for rainwater harvesting purposes. The smart technology continually monitors and optimises water levels within an attenuation system. By maximising available volumes of reusable water, StormHarvester ensures attenuation tanks contribute far more than just flood prevention within individual developments.

Swales - shallow, flat bottomed, vegetated open channels, designed to convey, treat and attenuate surface water flows.

Detention basins, Infiltration basins, ponds and/or wetlands will not be accepted due to the risk of bird strike (as discussed in Section 6.4.5). Whereas, conveyance of flows will be considered on the surface, the retention and storage of stormwater will be underground.

Petrol inceptors, SurfSeps, Downstream Defenders or other such proprietary devices are not considered primary SuDS measures and shall not be provided in lieu of acceptable SuDS measures as outlined above.

6.6.2 Drain Down Times

Based on the volumes of attenuation and associated discharge rates, drain down times are envisaged to be prolonged, refer Section 6.1.1 where the drain down time for attenuation within the Kealy's Catchment is estimated to be c.18 hours. The probability of subsequent storms, whereby, the storage facilities will not have emptied completely prior to the onset of further rainfall should be considered for existing facilities and any new storage facilities that will be required going forward. The design of these critical regional ponds should be tested using time series rainfall to assess their effectiveness in long duration multiple peaked events.

The primary requirements for attenuation volumes within the regional controls is a function of the total area of roads and public open spaces contributing surface water run-off. In reality, it is expected that the provision of SuDS devices at source, (i.e. via infiltration trenches and other SuDS devices flanking the roads) will reduce the attenuation volumes at the regional controls. SuDS measures must be incorporated along roadways and greenways, to reduce the demand on regional ponds. Proper design and implementation of SuDS measures at source will further improve the hydraulic resilience within the regional ponds.

This coupled with the potential volume reduction due to infiltration is likely to reduce the drain down times to acceptable limits.

6.7 Summary

The key recommendations in terms of the SWMP are as follows:

- daa to consider downstream flooding issues (if any) on all relevant watercourses and following extensive redevelopment and installation of associated SuDS measures, review if reduced discharge rates from individual regional control facilities can be implemented. Such a review will require a detailed assessment including flow measurement to quantify any reduction;
- Review all regional control facilities to ensure adequate storage provision is available for long duration multiple peaked events, and including for climate change;
- Review of the drain down times of all regional control facilities and consider impact of subsequent storm events;
- Introduction of SuDS to new and re-development sites by adoption of the SuDS Management Train approach;
- Discharge rate from new developments and / or re-development sites to be in accordance with the GDSDS;
- Reduction in storm volumes by the use of SuDS measures;
    - Rainwater harvesting and potentially in combination with a shared storage facility, i.e. StormHarvester, given the proximity of the Airport to a local weather station;
    - Green Roof (minimise extent of impermeable surface);
    - Infiltration systems.
- Review where SuDS measures can be retro-fitted throughout the study area, public realm areas, existing access roads etc and provide suitable SuDS measures where the opportunity arises by way of planned road works or other to provide interception of storm flows from highly contaminated surfaces given the traffic volumes in the Airport environs.

7 Flood Risk Management

The Planning Guidelines recommend a sequential approach to spatial planning, promoting avoidance rather than justification and subsequent mitigation of risk. Key objectives for flood risk management for all LAPs within County Fingal, is principally informed by the Fingal Development Plan. However, the formal management plan is achieved through the application of the specific objectives identified in the hierarchy of plans that impact the LAP.

The hierarchy of plans is as follows;

- The Fingal Development Plan (2017-23), this in turn informs;
- The Dublin Airport LAP (2006);
- The Dublin Airport Central Masterplan (drafted during the draft phase of the 2017 Development Plan), a development framework for High Technology lands adjacent to the Airport.

7.1 Planning Policy

7.1.1 Fingal County Council Development Plan

The current plan covers the period from 2017 to 2023. The plan sets out compliance with the National Spatial Strategy and the Greater Dublin Area Regional Planning Guidelines.

The flood management and climate change objectives as laid out in the development plan are as follows:

Objective SW01	Protect and enhance the County's floodplains, wetlands and coastal areas subject to flooding as vital green infrastructure which provides space for storage and conveyance of floodwater, enabling flood risk to be more effectively managed and reducing the need to provide flood defences in the future and ensure that development does not impact on important wetland sites within river/stream catchments.
Objective SW02	Allow no new development within floodplains other than development which satisfies the justification test, as outlined in the Planning system and Flood Risk Management Guidelines 2009 for Planning Authorities.
Objective SW03	Identify existing surface water drainage systems vulnerable to flooding and develop proposals to alleviate flooding in the areas served by these systems.
Objective SW04	Require the use of sustainable drainage systems (SuDS) to minimise and limit the extent of hard surfacing and paving and require the use of sustainable drainage techniques where appropriate, for new development or for extensions to existing developments, in order to reduce the potential impact of existing and predicted flooding risks.
Objective SW05	Discourage the use of hard non-porous surfacing and pavements within the boundaries of rural housing sites.
Objective SW06	Encourage the use of Green Roofs particularly on apartment, commercial, leisure and educational buildings.
Objective SW07	Implement the Planning System and Flood Risk Management-Guidelines for Planning Authorities (DoEHLG/OPW 2009) or any updated version of these guidelines. A site-specific Flood Risk Assessment to an appropriate level of detail, addressing all potential sources of flood risk, is required for lands identified in the SFRA, located in the following areas: Courtlough; Ballymadun; Rowlestown; Ballyboghil; Coolatrath; Milverton, Skerries; Channell Road, Rush; Blakescross; Lanestown/Turvey; Lissenhall, Swords; Balheary, Swords; Village/Marina Area, Malahide; Streamstown, Malahide; Balgriffin; Damastown, Macetown and Clonee, Blanchardstown; Mulhuddart, Blanchardstown; Portrane; Sutton; and Howth, demonstrating compliance with the aforementioned Guidelines or any updated version of these guidelines, paying particular attention to residual flood risks and any proposed site specific flood management measures.

Objective SW08	Implement the recommendations of the Fingal East Meath Flood Risk Assessment and Management Study (FEMFRAMS).
Objective SW09	Assess and implement the recommendations of the Eastern CFRAMS when complete.
Objective SW10	Require the provision of regional stormwater control facilities for all Local Area Plan lands and Strategic Development Zones with a view to also incorporating these control facilities in currently developed catchments prone to flooding.
Objective SW11	Ensure that where flood protection or alleviation works take place that the natural and cultural heritage of rivers, streams and watercourses are protected and enhanced to the greatest extent possible.
Objective SW12	Require an environmental assessment of all proposed flood protection or alleviation works.
Objective SW13	Provide for the schemes listed in Table SW01: TABLE SW01: 1. Implementation of Fingal East Flood Risk Assessment and Management Study, measures - Flood mitigation 2. Implementation of CFRAMs: Eastern CFRAM measures 3. Early Flood Warning System 4. Donabate & Garristown Surface Water Systems
Objective CC01	Comply with the recommendations of the GDSDS Climate Change Policy with regard to the provision and management of drainage services in the County and recognise that climate mitigation and adaption measures are evolving and comply with new national measures as presented in National Plans and Frameworks.
Objective CC02	Implement the specific recommendations of Table CC1 of the GDSDS Regional Policy Volume 5 Climate Change Policy for all housing, commercial and industrial developments within the County.
Objective CC03	Continue to reduce energy and chemical consumption within the Council's treatment plants and pumping stations.
Objective CC04	Mitigate the causes of climate change as per COP21 also known as the 2015 Paris Climate Conference.

7.1.2 Dublin Airport Central Masterplan, March 2016

The Dublin Airport Central Masterplan applies only to the High Technology lands as zoned under the Fingal Development Plan 2017-23. The Masterplan is a framework for the future development of lands strategically located adjacent to Dublin Airport.

Surface water objectives are as follows:

Objective UT9	To require that development within the Masterplan lands incorporate SUDS (Sustainable Drainage Systems) in the surface water design in line with the GDSDS (Greater Dublin Strategic Drainage Study) Regional Drainage Policies, 2005, Volume 2 New Development and Volume 3 Environmental Management.
Objective UT10	To facilitate ongoing monitoring/ maintenance of existing and proposed drainage systems associated with developments within the Masterplan area.
Objective UT11	To require the provision of additional SuDS devices to cater for the development of the Masterplan lands in line with previous agreements in relation to run-off rates for new and redeveloped sites.
Objective UT12	Ensure a Construction Management Plan (CMP) is produced as part of any planning application detailing how surface water run-off, especially in relation to release of silt and other pollutants, will be controlled during construction.

7.1.3 Dublin Airport LAP

The proposed objectives for flood risk management are as follows:

Objective FRM01	Have regard to The Planning System and Flood Risk Management, Guidelines for Planning Authorities (DoEHLG/OPW 2009) and Circular PL2/2014, through the use of the sequential approach and application of the Justification Tests for Development Plans and Development Management
Objective FRM02	Protect existing flood risk management infrastructure and safeguard planned future infrastructure.
Objective FRM03	Implement and comply fully with the recommendations of the Dublin Airport Local Area Plan Strategic Flood Risk Assessment and Surface Water Management Plan.
Objective FRM04	Ensure that a Flood Risk Assessment is carried out for any development proposal, in accordance with the The Planning System and Flood Risk Management, Guidelines for Planning Authorities (DoEHLG/OPW 2009) and the recommendations of the Dublin Airport Local Area Plan Strategic Flood Risk Assessment and Surface Water Management Plan. This assessment should be appropriate to the scale and nature of risk to the potential development.

The proposed objectives for surface water management are as follows:

Objective SW01	Require all applications for development at Dublin Airport to demonstrate compliance with the Dublin Airport Local Area Plan Strategic Flood Risk Assessment and Surface Water Management Plan.
Objective SW02	Introduce SuDS to new greenfield and brownfield development sites by adoption of the SUDS Management train approach.
Objective SW03	That Dublin Airport examine the feasibility of incorporating SUDS features into existing areas for the flooding and water quality benefits of same.
Objective SW04	Recharge the ground and reduce storm volumes by the use of suitable SUDS measures.
Objective SW05	Alleviate local flooding issues within the plan area by providing positive drainage to affected areas. Proposals should take into account FRM04 and that a Flood Risk Assessment is also conducted to ensure no increase in risk to third parties.
Objective SW06	Reduce risk of bird strike when developing new sites and implementing SUDS measures.
Objective SW07	Establish riparian corridors free from new development along all significant watercourses and streams. Ensure a riparian buffer strip either side of all watercourses within the LAP lands.
Objective SW08	Develop a robust surface water management system in compliance with the recommendations of the Dublin Airport Local Area Plan Strategic Flood Risk Assessment and Surface Water Management Plan associated with this LAP, to meet future development needs and providing resilience to the effects of climate change. The implementation of these plans and policy documents shall have regard to the outcomes of drainage studies undertaken for Dublin Airport, and any site specific, or industry specific information and requirements that may occur including consideration of upstream or downstream impacts.
Objective SW09	Develop a policy on sustainable drainage systems in proximity to the Airport, to ensure aircraft safety.

7.2 Development Management and Flood Risk

To guide stakeholders and Local Authority staff through the process of planning for and mitigating flood risk, the key features of a range of development scenarios (relating to flood zone and development vulnerability) are discussed in this section. For each scenario, a number of considerations relating to the suitability of the development are summarised.

It should be noted that this section of the SFRA begins from the point that all land zoned for development has passed a justification test for development plans and therefore passes part 1 of the Justification Test. Site specific recommendations are highlighted in Section 8.

In order to determine the appropriate design standards for a development, it may be necessary to undertake a site specific flood risk assessment. This will typically rely on the predictive flood mapping presented within this report but should include a quantitative appraisal of the risk from the drainage design. Further details of requirements of an FRA/Drainage Assessment are provided in the following sections.

7.2.1 Requirements for a Flood Risk Assessment

It is recommended that an assessment of flood risk is required in support of any planning application where flood risk may be an issue and this must include sites within Flood Zone C where field drains or small streams exist nearby. The level of detail required will vary depending on the risks which have been identified and the proposed land use. As a minimum, all proposed development, including that in Flood Zone C, must consider the impact of surface water flooding on drainage design, as outlined in Section 7.2.4. Flood risk from sources other than fluvial should also be reviewed.

Any proposal that is considered acceptable in principle shall demonstrate the use of the sequential approach in terms of the site layout and design and, in satisfying the Justification Test (where required), the proposal will demonstrate that appropriate mitigation and management measures are put in place.

7.2.1.1 Development Proposals in Flood Zone A and B

Development of highly or less highly vulnerable uses within Flood Zones A and B will be predominantly limited to existing sites, i.e.: change of use, extensions and re-development works to a very limited area impacted by flooding from the Cuckoo Stream.

Undefended Areas

It is not appropriate for new, highly/less vulnerable development to be located in Flood Zone A, particularly where there are no flood defences, and such proposals will not pass the Justification Test. Instead, a water compatible use should be considered.

The application of the sequential approach ensures that zones areas for vulnerable use are kept to a minimum by further analysis and avoidance. This allows for the continued application of the sequential approach and appropriate site specific FRAs.

Defended Areas

A raised embankment runs along the eastern boundary of the site perpendicular to the Cuckoo stream where flow is conveyed under the M1 Motorway via existing culvert. This embankment was designed to contain flows inside the Airport lands within the floodplain south of the cuckoo stream to avoid overflow onto the M1 motorway. This defends an existing car hire compound as well as the Dardistown Road and M1. Similarly, a raised embankment was added across the Cuckoo stream further upstream along the Swords Road (R132) to avoid flooding across the roadway. There are no other known defences within the Dublin Airport LAP.

Careful consideration must be given to the position and design of any re-development within the existing developed lands. The only development under consideration should be carparking or access roads - as per the current use which is understood to be enforced due to the position under/adjacent to the flight path. As such no large scale new development will take place and no further restrictions for Detailed FRA need be applied.

Note on Minor Developments

Section 5.28 of the Planning Guidelines on Flood Risk Management identifies certain types of development as being 'minor works' and therefore exempt from the Justification Test. Such development relates to works associated with existing developments, such as extensions, renovations and rebuilding of the existing development, small scale infill and changes of use.

Despite the 'Sequential Approach' and 'Justification Test' not applying, as they relate to existing buildings, an assessment of the risks of flooding should accompany such applications. This must demonstrate that the development would not increase flood risks, by introducing significant numbers of additional people into the area and or putting additional pressure on emergency services or existing flood management infrastructure. The development must not have adverse impacts or impede access to a watercourse, flood plain or flood protection and management facilities. Where possible, the design of built elements in these applications should demonstrate principles of flood resilient design (See 'The Planning System and Flood Risk Management Guidelines for Planning Authorities Technical Appendices, 2009, Section 4 - Designing for Residual Flood Risk).

7.2.1.2 Development Proposals in Flood Zone C

Where a site is within Flood Zone C, but adjoining or in close proximity to Flood Zone A or B there could be a risk of flooding associated with factors such as future scenarios (climate change) or in the event of failure of a defence (if applicable), blocking of a bridge or culvert. The general principles outlined under Section 7.2.1.1 therefore apply and FFL/mitigation must be carefully designed.

Risk from pluvial/surface water must also be addressed for all development in Flood Zone C and this should provide details of how surface water will be manged in line with the recommendations in Section 6 and all sites will require a Drainage Impact Assessment as outlined in Section 7.2.4.

7.2.2 Flood Mitigation Measures at Site Design

For any development proposal within Flood Zone A and B that is considered acceptable in principle, it must be demonstrated that appropriate mitigation measures can be put in place and that residual risks can be managed to acceptable levels.

Various mitigation measures are outlined in the following sections and further detail on flood resilience and flood resistance are included in the Technical Appendices of the Planning Guidelines, The Planning System and Flood Risk Management.

7.2.2.1 Site Layout and Design

To address flood risk in the design of new development, a risk based approach should be adopted to locate more vulnerable land use to higher ground while water compatible development i.e. recreational space can be located in higher flood risk areas. Whilst some car parking is located in the defended area adjacent to the Dardistown Road (upstream of M1), new areas of car parking in Flood Zone A should not be permitted. The sequential approach - principal avoidance of risk and substitution of water compatible land use, should be the approach in all areas within Flood Zone A/B.

7.2.3 Incorporating Climate Change into Development Design

The Flood Zones are determined based on readily available information and their purpose is to be used as a tool to avoid inappropriate development in areas of flood risk. Where development is proposed within an area of potential flood risk (Flood Zone A or B), a flood risk assessment of appropriate scale will be required and this assessment must take into account climate change and associated impacts.

Consideration of climate change is particularly important where flood alleviation measures are proposed as the design standard of the proposal may reduce significantly in future years due to increased rainfall and river flows. As recommended by the planning guidelines, a precautionary approach should be adopted.

Climate change may result in increased flood extents and therefore caution should be taken when zoning lands in transitional areas. In general, Flood Zone B, which represents the 0.1% AEP extent, can be taken as an indication of the extent of the 1% AEP flood event with climate change. In steep valleys (such as the smaller tributary streams) an increase in water level will relate to a very small increase in extent, however in flatter low-lying basins a small increase in water level can result in a significant increase in flood extent.

For most developments, the mid-range future scenario (20% increase in flows) is an appropriate consideration. This should be applied in all areas that are at risk of flooding (i.e. within Flood Zone A and B) and should be considered for sites which are in Flood Zone C, but are adjacent to Flood Zone A or B. This is because land which is currently not at risk may become vulnerable to flooding when climate change is taken into account. The high-end future scenario (30%) increase is reserved for critical airport infrastructure as explained in Table 6-1.

Further consideration to the potential future impacts of climate change will be given for each settlement within Section 8.

7.2.4 Drainage Impact Assessment

It is recommended that all proposed development, whether in Flood Zones A, B or C, must consider the impact of surface water flood risks post development for both within the subject site and the downstream drainage infrastructure. A suitable standard for this is specified by the surface water management policies from the LAP and implementation of the advice and recommendations in Section 6.

Areas vulnerable to pluvial flooding are indicated in the pluvial mapping reproduced in Figure 5-1. Particular attention should be given to low lying areas which can act as ponds for collection of run-off, such as indicated in Table 5-1.

In line with the recommendations of Section 6, the drainage design should ensure there is no increase in flood risk to the site, or the downstream catchments. Where possible, and particularly in areas of new development, floor levels should at a minimum be 500mm above the top water level of any flood storage units to reduce the consequences of any localised flooding (as per GDSDS). Where this is not possible, an alternative design appropriate to the location may be prepared.

8 LAP Zoning Review

The purpose of land use zoning objectives is to indicate to the types of development the Planning Authority considers most appropriate in each land use category. Zoning is designed to reduce conflicting uses within areas, to protect resources and, in association with phasing, to ensure that land suitable for development is appropriately used.

This section of the SFRA will:

- Consider the land use zoning objectives utilised within the LAP boundary and assess their potential vulnerability to flooding.
- Based on the associated vulnerability of the particular use, a clarification on the requirement of the application of the Justification Test is provided.
- The consideration of the specific land use zoning objectives and flood risk will be presented for key areas within the LAP boundary. Comment will be provided on the use of the sequential approach and justification test. Conclusions will be drawn on how flood risk is proposed to be managed.

8.1 Land Use Zoning Objectives

8.1.1 Context

There is a hierarchy of plans that describe the land use zoning objectives within the Airport LAP boundary. The Fingal Development Plan 2017 - 2023 sets the zoning types for the LAP lands and this SFRA sets out the site specific recommendations for development.

Within the Fingal County Development Plan 2017 - 2023 there are two zonings applied within the LAP boundary; DA - Dublin Airport and HT - High Technology. The HT zoning applies to a relatively small area known as Dublin Airport Central. The DA objective is to ensure the operation/development of the airport in accordance with the LAP, it is an objective of the development plan (ED97 & DA01) to prepare the Dublin Airport LAP.

Fingal County Council in consultation with the Dublin Airport Authority (daa) have prepared a Masterplan (2016) for the development of Dublin Airport Central (HT zoning). This informs the framework for development within this discrete area of the Core Aviation Development Zone.

The following sections that review the zoning objectives DA and HT as stipulated in the Fingal Development Plan 2017 - 2023.

8.1.2 Zoning, Vulnerability and Risk

The zoning objectives can be related to the vulnerability classifications in the 'Planning System and Flood Risk Management'; highly vulnerable, less vulnerable and water compatible. As discussed in Section 2, the preference for the allocation of zoning objectives within areas at potential risk of flooding is that of avoidance (the sequential approach). Where avoidance or substitution of land use is not possible the specific vulnerability of the land use, coupled with the Flood Zone in which it lies, guides the need for application of the Justification Test.

A summary of flood risks associated with each of the zoning objectives has been provided in Table 8-1 below. Note that the zonings have been split into a number of permitted in principle uses to comment further on specific vulnerability and the requirement for the application of the Justification Test.

Table 8-1: Zoning Objectives

Zoning Objective	Indicative Primary Vulnerability	Flood Risk Commentary
DA (Dublin Airport) - Aerodrome/Airfield, General Aviation, Utility Installations, Air Navigation Installations, Cargo Yards, Telecommunications Structures, Air Transport Infrastructure, Fuel Depot/Storage	High vulnerability - use is critical to airport operation and safety.	Justification Test needs to be passed to allow highly vulnerable development in Flood Zone A/B.
DA (Dublin Airport) - Childcare facilities, Hotel	High vulnerability - used by highly vulnerable persons or for overnight accommodation.	Justification Test needs to be passed to allow highly vulnerable development in Flood Zone A/B.
DA (Dublin Airport) - Car Hire, Office, Place of Worship, Restaurant/Café, Taxi Office, Food Preparation, Public House, Retail, Warehousing, Carpark, Logistics, Petrol Station, Public Transport Station, Training Centre	Less vulnerable.	Justification Test needs to be passed to allow less vulnerable development Flood Zone A.
DA (Dublin Airport) - Open Space	Water compatible. Recommended to protect floodplain areas.	Zoning is appropriate in all Flood Zones; Justification Test does not apply.
HT (High Technology) - Hospital, Telecommunications Structures	High vulnerability - used by highly vulnerable persons/overnight accommodation or critical to airport operation and safety.	Justification Test needs to be passed to allow highly vulnerable development in Flood Zone A/B.
HT (High Technology) - Enterprise Centre, Light Industry, Office, R&D, Sustainable Energy Installation, Utility Installations, HT Manufacturing, Office, Restaurant, Retail, Training Centre.	Less vulnerable.	Justification Test needs to be passed to allow less vulnerable development in Flood Zone A.
HT (High Technology) - Open Space	Water compatible. Recommended to protect floodplain areas.	Zoning is appropriate in all Flood Zones; Justification Test does not apply.
* Land Use Vulnerability is expressed in relation to Table 3.1 (p25) of the Planning System and Flood Risk Management Guidelines for Planning Authorities. Some Zoning Objectives include a mix of different vulnerabilities of land use and are therefore presented as such in the table above.		

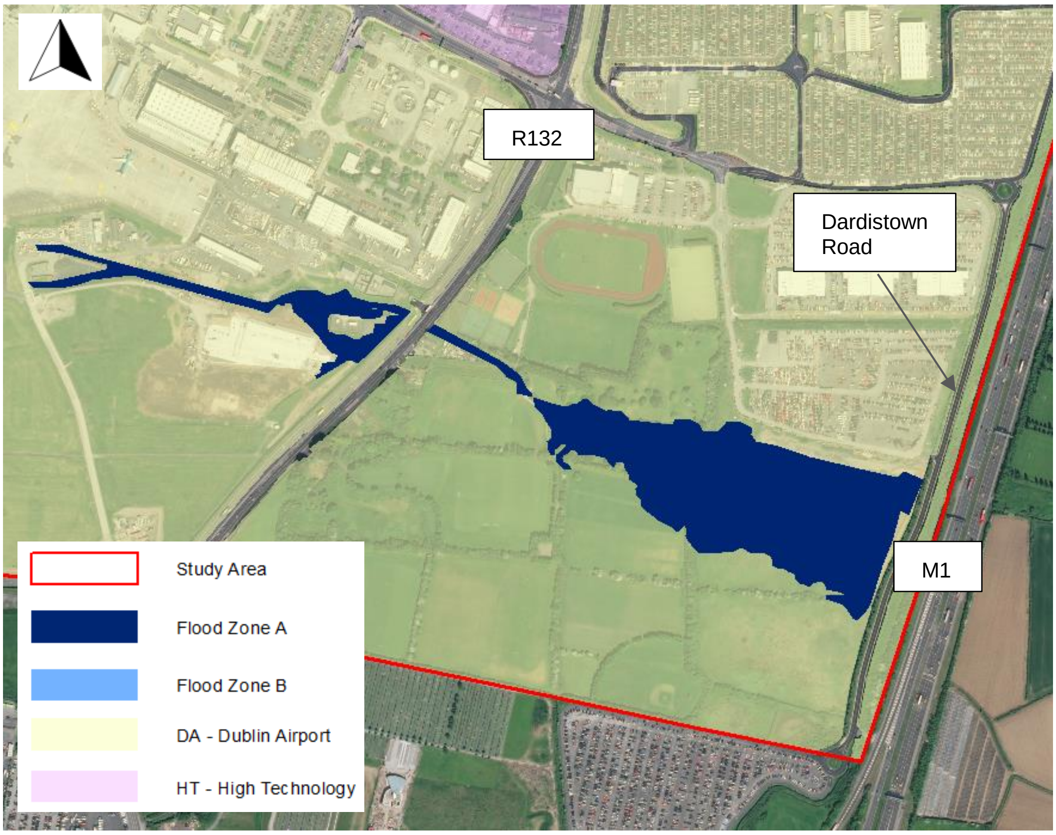
8.2 Zoning Review

In the following sections, a review of the flood risk to key sites has been provided, along with recommendations for the development of these sites.

For each site consideration of flood risk will be required at the development management stage of the planning process. This ranges from an assessment of surface water drainage from sites within Flood Zone C, to more considered FRAs for sites in Flood Zone A and B. The construction of any significant new development in close proximity to or within Flood Zone A or B will necessitate that a detailed flood risk assessment will be required to define residual flood risk and lead mitigation design. In other areas it is possible to understand risks through an initial FRA without incurring the cost and time input required for a detailed FRA.

In all cases, the advice on flood mitigation for site design contained within Section 7 should be followed along with any site specific recommendations detailed in the following sections.

8.2.1 Cuckoo Stream



Flood Zone Data	RPS R132 Upgrade FRA flood modelling (1% AEP + climate change proposed solution taken as being representative of Flood Zone A). OPW FEMFRAM mapping is used to the east of the settlement boundary. FEMFRAM mapping does not represent the current R132 upgrade works and has been superseded.
Flood Risk Overview	Potential flood risk from Cuckoo Stream to current greenfield sites to the south of the river bank. Bypass culverts are in place under the R132 and Dardistown Road. Embankment in place along Dardistown Road boundary and parallel to north bank of the Cuckoo Stream.
Sensitivity to Climate Change	High
Historical	Yes - downstream of M1 and Dardistown Road & M1 (mitigated).

Flooding	

Comment:

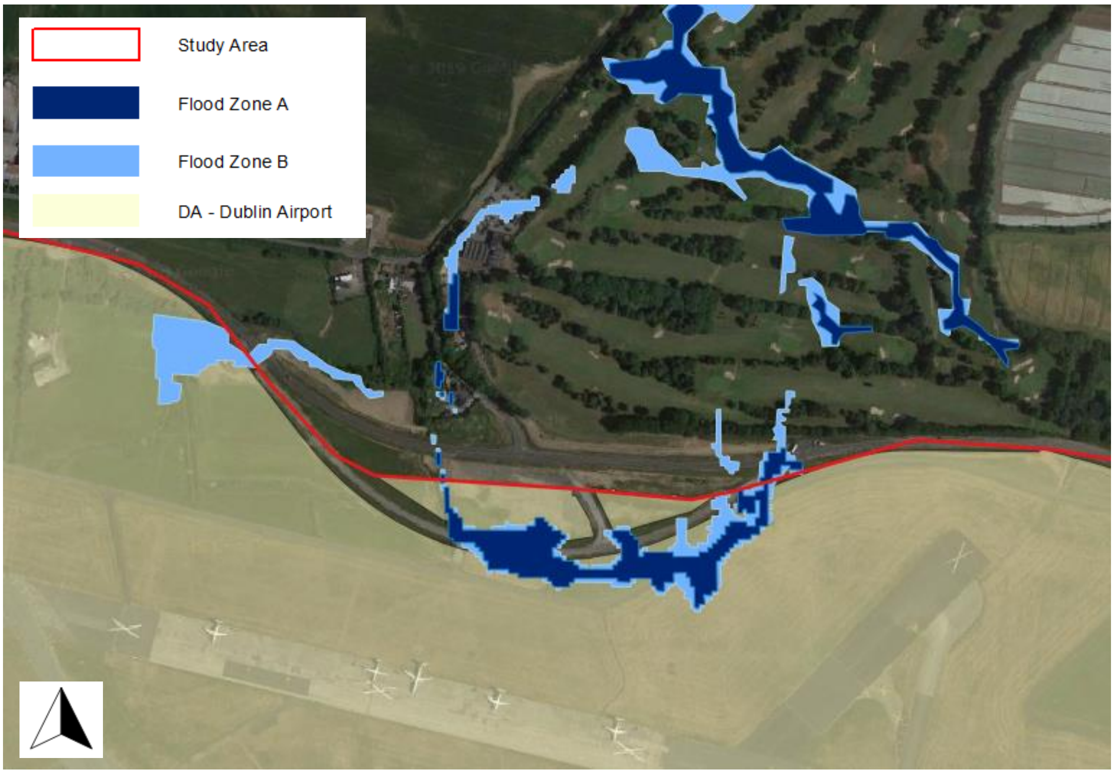
The existing greenfield sites along the Cuckoo Stream south of the core Airport Landside developments is at risk of flooding and forms an important flood storage area upstream of the Dardistown Road and LAP boundary. The FEMFRAM flood extents detailed the potential for out of bank flows to continue downstream of the airport lands effecting a portion of the M1 Motorway. The FEM FRAM studies have not represented the R132 upgrade works which contain the out of bank flows within greenfield areas. There are also bypass culverts beneath both the R132 and the Dardistown Road to improve conveyance and reduce flood risk to these roads.

Flood Zone A currently overlaps with the DA (Dublin Airport) land use zoning objective, this zone can facilitate a host of highly and less vulnerable uses and it is recommended that the use within Flood Zone A is restricted to open space/water compatible development only.

It is essential that the flood storage area is maintained and ground levels are not raised.

Future applications for any development in close proximity to (but not within) these flood extents will require an appropriately detailed FRA at the development management stage. This will ensure that FFLs and ground levels are set appropriately, and the surface water design is managed. The FRA should be in accordance with the objectives and requirements of Section 7 of this SFRA.

8.2.2 Forrest Little Stream



Flood Zone Data	RPS Northern Runway FRA. FEM FRAM mapping has been superseded.
Flood Risk Overview	Potential flood risk from the Forrest Little Stream overlapping within the proposed area for the Northern Runway and have been subject to an appropriately detailed FRA.
Sensitivity to Climate Change	Moderate
Historical Flooding	None recorded

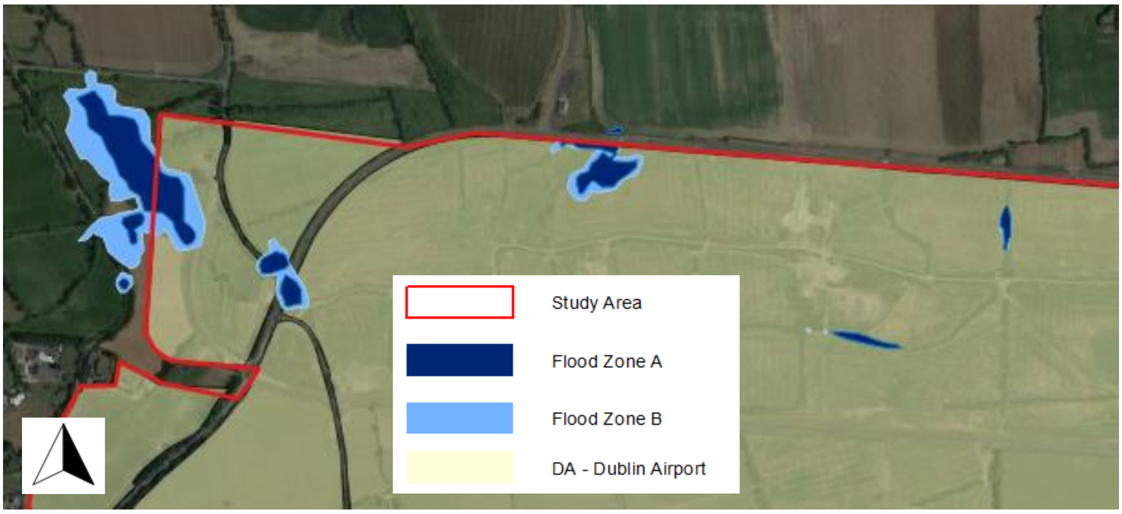
Comment:

Existing greenfield lands to the north boundary of the LAP are at risk of flooding from the Forrest Little stream and tributaries. Although there is no development within the impacted land currently, the proposed Northern Runway will redevelop this land with run-off discharged to the Forrest Little Stream at appropriate runoff rates via an attenuation tank.

The Northern Runway has undergone a detailed FRA and the existing scenario model results have been used to define Flood Zone A and B. The Flood Zone mapping indicates an overlap with the highly vulnerable Runway/Taxiway zoning and the Justification Test has been applied and passed (see Appendix A). The FRA provides details of post-development mitigation works to manage risk from the Forrest Little Stream and is fit for purpose.

Future applications for any development in close proximity of these flood extents will require an appropriately detailed FRA at the development management stage. This will ensure that development is managed appropriately. The FRA should be in accordance with the objectives and requirements of Section 7 of this SFRA.

8.2.3 St Margaret's Stream & Barberstown Stream



Flood Zone Data	RPS Northern Runway FRA.
Flood Risk Overview	Potential flood risk from the Forrest Little Stream overlapping with the Runway/Taxiway highly vulnerable zoning. The lands are within the proposed area for the Northern Runway and have been subject to an appropriately detailed FRA.
Sensitivity to Climate Change	Moderate
Historical Flooding	None recorded

Comment:

Existing greenfield lands to the north western boundary of the LAP are at risk of flooding from St Margaret's Stream and Barberstown Stream. Although there is no development in the area currently, the proposed Northern Runway will redevelop this land with run-off discharged at appropriate runoff rates via an attenuation tank - to the Forrest Little Catchment and will actually reduce direct runoff to St Margaret's Stream and Barberstown Stream.

The Northern Runway has undergone a detailed FRA and the existing scenario model results have been used to define Flood Zone A and B. The Flood Zone mapping indicates an overlap with the highly vulnerable use and the Justification Test has been applied and passed (see Appendix A).

The Northern Runway FRA provides details of post-development mitigation works to manage risk from St Margaret's Stream and Barberstown Stream and is fit for purpose.

Future applications for any development in close proximity of these flood extents will require an appropriately detailed FRA at the development management stage. This will ensure that development is managed appropriately. The FRA should be in accordance with the objectives and requirements of Section 7 of this SFRA.

8.3 SFRA & SWMP Review and Monitoring

An update to the SFRA/SWMP will be triggered by the six-year review cycle that applies to Local Authority development plans.

There are a number of key outputs from possible future studies and datasets, which should be incorporated into any update of the SFRA as availability allows. Not all future sources of information should trigger an immediate full update of the SFRA; however, new information should be collected and kept alongside the SFRA until it is updated.

Dublin Airport has been subject to a detailed flood risk mapping and management study under the Eastern CFRAM Study & FEM FRAM. Final flood maps were issued during 2017, As of March 2018 the Final Flood Risk Management Plan is yet to be published. The Eastern CFRAM (incorporating FEM FRAM) will be reviewed on a six year cycle. Any updates to the flood mapping during subsequent updates may trigger a review of the LAP.

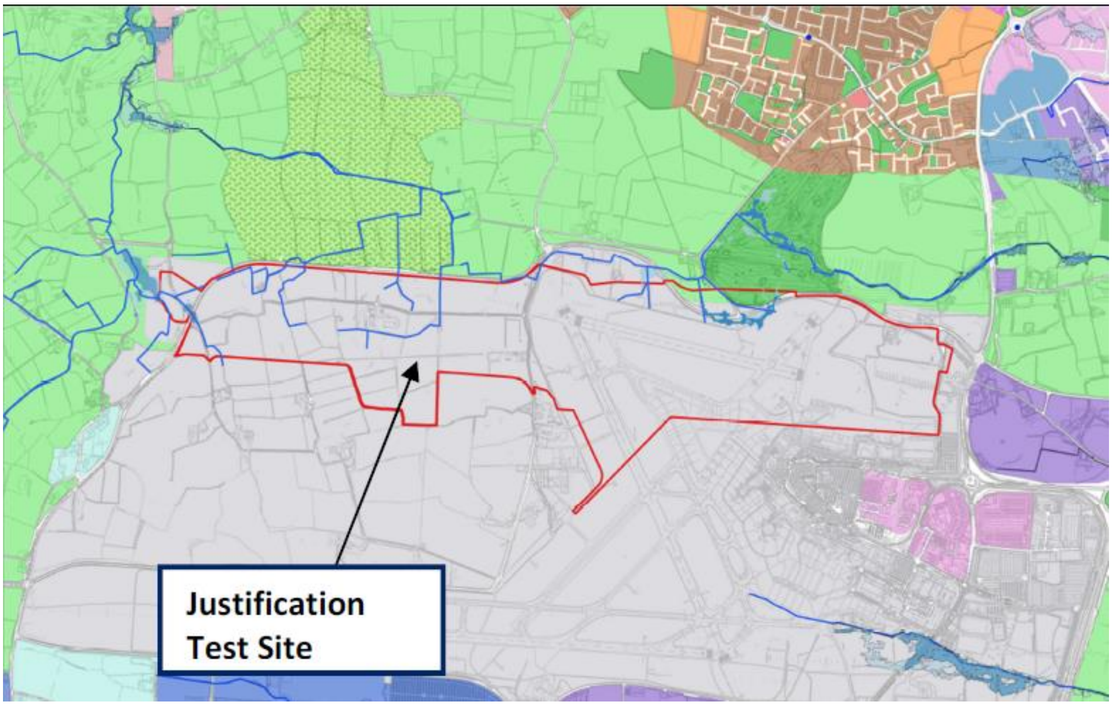
Detailed, site specific FRAs and stormwater drainage strategies may be submitted to support planning applications. Whilst these reports will not trigger a review of the Flood Zone maps or SFRA, they should be retained and reviewed as part of the next cycle of the Development Plan. The largest planned development that will impact the Flood Zones is the construction of the Northern Runway, once this is complete the Flood Zone maps can be updated with the post-development scenario from the Northern Runway FRA.

Appendices

A Justification Test - Northern Runway

The Dublin Airport North Runway - Flood Risk Assessment clarifies the application of both the Development Plan and Development Management Justification Tests. These have been reproduced below, both tests have been passed.

A.1 Development Plan Justification Test



1	The urban settlement is targeted for growth under the National Spatial Strategy, regional planning guidelines, and statutory plans as defined above or under the Planning Guidelines or Planning Directives provisions of the Planning and Development Act, 2000, as amended.	The economic importance and continued growth of Dublin Airport is recognised within the national, regional and local policy levels. The National Spatial Strategy (NSS) 2002-2020 guides that expanding the level of services available from Dublin Airport to an increasingly wider range of destinations is essential in the interests of underpinning Ireland's future international competitiveness. The new runway is acknowledged in the Regional Planning Guidelines for the Greater Dublin Area 2010-2022 which also identifies that "this investment is necessary to meet the rapid and continuing growth in the Irish economy experienced over the last decade". The subject lands are zoned Objective "DA" in the Fingal Development Plan 2011 – 2017 which seeks to ensure the efficient and effective operation and development of the airport in accordance with the adopted Dublin Airport Local Area Plan.
2	The zoning or designation of the lands for the particular use or development type is required to achieve the proper planning and sustainable development of the urban settlement and in particular:	The zoning of the land facilitates air transport infrastructure and airport related activity/uses (i.e. those uses that need to be located at or near the airport) including runways and taxiways; and the development of the new North Runway has been granted planning consent at this location. The development is therefore consistent with the proper planning and sustainable development of the airport.
	(i) Is essential to facilitate regeneration and / or expansion of the centre of the urban settlement;	The site is the location of the permitted North Runway which is consistent with Objective South Fingal Fringe 4: "to realise the optimal use of lands around the airport" and Objective EE48 "to facilitate the development of a second major east-west runway at Dublin Airport and the extension of the existing east-west runway 10/28". The site is therefore essential to the expansion of the airport.
	(ii) Comprises significant previously developed and / or underutilized lands;	The lands comprise previously developed taxiways of the airport and also undeveloped agricultural land immediately adjoining the airport all of which is zoned for the efficient and effective operation and development of the airport.

	(iii) Is within or adjoining the core of an established or designated urban settlement;	The lands immediately adjoin the existing airport and are zoned for the efficient and effective operation and development of the airport.
	(iv) Will be essential in achieving compact and sustainable urban growth; and	The permitted North Runway development is a use that needs to be located at the airport and its location on the subject site will achieve the compact and sustainable urban growth of the airport.
	(v) There are no suitable alternative lands for the particular use or development type, in areas at lower risk of flooding within or adjoining the core of the urban settlement.	There are no other suitable lands for the proposed runway within the daa lands or in the adjoining areas.
3	A flood risk assessment to an appropriate level of detail has been carried out as part of the Strategic Environmental Assessment as part of the development plan preparation process, which demonstrates that flood risk to the development can be adequately managed and the use or development of the lands will not cause unacceptable adverse impacts elsewhere. N.B. The acceptability or otherwise of levels of any residual risk should be made with consideration for the proposed development and the local context and should be described in the relevant flood risk assessment	Development proposals for the sites lands shall be the subject of a site-specific Flood Risk Assessment appropriate to the type and scale of the development being proposed: Site Specific FRAs should address the following: The sequential approach should be applied through site planning and should avoid encroachment onto, or loss of, the flood plain. Finished runway levels should be above the 0.1% AEP level. Proposals should not impede existing flow paths or cause flood risk impacts to the surrounding area. Compensatory storage should be provided for areas of lost floodplain provided there is no increased flood risk elsewhere. Existing watercourses and drainage ditches should be maintained by culverting, stream diversions or interceptor ditches.

A.2 Development Management Justification Test

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.	Zoning Objective “DA” - Dublin Airport ensures the efficient and effective operation and development of the airport in accordance with the adopted Dublin Airport Local Area Plan 2006. It facilitates air transport infrastructure and airport related activity/uses only (i.e. those uses that need to be located at or near the airport). Therefore, the proposed development is in compliance with the Fingal County Development Plan 2017 - 2023, which has adopted a Strategic Flood Risk Assessment in accordance with the Planning System and Flood Risk Management Planning Guidelines 2009.
2	(i) - The Development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;	The proposed scenario also shows reduced flooding outside of the daa lands downstream on each of the watercourses which can be attributed to reduced discharges from the airport. The St. Margaret’s Stream is not affected by discharges from the airport and hence flows have not changed. A comparison of flood levels in the proposed scenario show a reduction in flood levels along the Barberstown and Forest Little Streams. It shows a negligible increase in flood levels (+1mm) within the St Margaret’s Stream.
	(ii) the Development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible.	To alleviate flooding along the watercourses, culvert upgrades, stream diversions and an attenuation system will be constructed as part of the works. The proposed culverts have been designed to convey the 1% AEP flow with a minimum of 300mm freeboard as required by section 50 of the Arterial Drainage Act, 1945. The proposed stream diversions have been designed to convey the 1% AEP event without any out of bank flooding and a minimum of 300mm freeboard. There will also be interceptor drains along the route of the new proposed roads to convey any overland flows away from the proposed roads. In line with the requirements of Dublin City Council’s “Stormwater Management Policy for Developers” and the “Greater Dublin Strategic Drainage Study – Regional Policies – Volume 2 – New Development, July 2004, the surface water will be attenuated to ensure greenfield flow rates are maintained at

		all times. In recognition of the fact that a portion of the development that would have originally drained to the Ward River catchment and will be directed to the Forest Little Catchment, the maximum allowable discharge rates will be based on greenfield runoff calculations for the portion of the runway that falls into the Forest Little catchment only. Additional compensatory storage has been added to the attenuation system and interceptor ditches to accommodate for areas of lost floodplain that are traversed by the Runway hardstanding areas and its associated internal roadways.
	(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.	The residual risk to the runway and downstream areas is considered to be low. The final attenuation design will be in line with the requirements of Dublin City Council's "Stormwater Management Policy for Developers" and the "Greater Dublin Strategic Drainage Study – Regional Policies – Volume 2 – New Development, July 2004, the surface water will be attenuated to ensure greenfield flow rates are maintained at all times. Regular maintenance of the flow control devices and the attenuation system will be added to the Dublin Airport Drainage and Pollution Control Strategy. This strategy is included in the maintenance programme by the Airport Operations departments. The attenuation system is also integrated into the proposed pollution monitoring system. This will be operated by a fully automated Programme Logic Controller (PLC) and Supervisory Control and Data Acquisition (SCADA) programme. Flows will be controlled for the pollution monitoring system at a flow diversion chamber (FDC) on the north side of the runway. The FDC will split contaminated and clean water so as not to pollute the Forest Little Stream. This will also act as monitoring system for the attenuation as if there are any faults downstream of the FDC automated alarms will notify daa personnel to investigate such faults.
	(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 subject development is compatible with the achievement of wider planning objectives in relation to the efficient and effective operation and development of the airport. In this regard, it has been designed having regard to the policy requirements of the Fingal County Development Plan and the Dublin Airport LAP [2006] which inter alia promoted quality of design as a core principle (see Section 9 of the Dublin Area LAP [2006], in particular). It was also subject to thorough assessment by An Bord Pleanála and has been determined to be in accordance with the proper planning and sustainable development of the area.

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