Kellystown
Local Area Plan

Adopted 11th January 2021

Appendix 2
Surface Water Management Plan Part 1: Strategic Flood Risk Assessment

Surface Water Management Plan Part 2: Sustainable Drainage Systems (SuDS) Strategy

Comhairle Contae Fhine Gall
Fingal County Council

Kellystown, Clonsilla, Dublin 15

Surface Water Management Plan (SWMP)

September 2020

www.fingal.ie

Comhairle Contae
Fhine Gall
Fingal County
Council

INTRODUCTION

This Surface Water Management Plan (SWMP) was commissioned by Fingal County Council and prepared by McCloy Consulting for lands at Kellystown, Clonsilla, Dublin 15. The purpose of the SWMP is to determine flood risk at lands at Kellystown and to develop a strategy for the sustainable management of surface water as part of an overall Local Area Plan.

The SWMP consists of two parts:

- Strategic Flood Risk Assessment (SFRA)
- Sustainable Drainage Strategy (SDS)

Strategic Flood Risk Assessment (SFRA)

The SFRA is intended to produce a Stage 1 to 3 Flood Risk Assessment (FRA) as defined by the OPW Planning System and Flood Risk Management Guidelines to refine the existing SFRA for the Fingal Development Plan 2017-2023 and ensure that all relevant issues related to flooding are addressed.

The assessment will determine potential sources of flooding at the Plan Area and their associated risk to life and new development. The SFRA will determine the suitability of lands for development and set standards for flood protection material to the Plan Area.

Sustainable Drainage Strategy (SDS)

The purpose of the SDS is to set out a framework for the delivery of a drainage system which will integrate multi-functional SuDS components within the Plan Area to manage water at or near the surface, providing high quality blue / green infrastructure which enhances and improves biodiversity and brings significant community benefits within developed areas.

The SDS seeks to demonstrate that the objectives set out in Fingal Development Plan 2017 – 2023 and requirements set out in GDSDS (Volume 3) SuDS Requirements can be satisfied.

Health and Safety

The appointed Project Supervisor Design Process (PSDP) consultant has completed the required Health and Safety assessment which is provided under separate cover.

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Strategic Flood Risk Assessment

Lands at Kellystown, Clonsilla, Dublin 15

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1 INTRODUCTION

1.1 Terms of Reference

This Strategic Flood Risk Assessment (SFRA) was commissioned by Fingal County Council (hereafter *Fingal CC*) to form a Surface Water Management Plan (SWMP) in conjunction with a Sustainable Drainage Strategy (SDS) for lands at Kellystown, Clonsilla, Dublin 15 (hereafter *Plan Area*).

1.2 Purpose

Flood risk management for development planning is guided by 'The Planning System and Flood Risk Management – Guidelines for Planning Authorities (Department of the Environment & Local Government, November 2009)' [hereafter *OPW Guidelines*].

This SFRA is intended to produce a Stage 1 to 3 Flood Risk Assessment (FRA) as defined by the OPW Guidelines to refine the existing SFRA for the Fingal Development Plan 2017-2023 (hereafter *Fingal SFRA*) and ensure that all relevant issues related to flooding are addressed.

The assessment will determine potential sources of flooding at the Plan Area and their associated risk to life and new development as well as determine the suitability of lands for development and set standards for flood protection.

This assessment is intended for 'plan making' and is not intended to assess the risk to development proposals. Risk to development would be assessed separately by Site-Specific Flood Risk Assessment(s) (SSFRA) submitted in support of planning application(s) and would be specific to development proposal(s). Any latter SSFRA may be informed by flood hazard information determined by this assessment.

1.3 Statement of Authority

This report and assessment has been prepared and reviewed by qualified professionals with appropriate experience in the fields of flood risk, drainage, wastewater, and hydraulic modelling studies. The key staff members involved in this project are as follows:

- Michael Rea *MEng (Hons)* – Project Engineer with experience in the fields of flood risk assessment, flood modelling, drainage and surface water management design.
- Paul Singleton *BEng (Hons) MSc CEng MIEI* – Chartered Civil / Environmental Engineer with particular experience in drainage, SuDS and flood risk assessment, and a recognised industry professional having given industry training in these fields in Ireland and the UK.
- Kyle Somerville *BEng (Hons) CEng MIEI* – Associate and Chartered Engineer specializing in the fields of flood risk assessment, flood modelling, drainage and surface water management design for public and private sectors.

2 PLAN AREA DETAILS

2.1 Plan Area Location

The Plan Area is located in Kellystown, Clonsilla, Dublin 15 and is bound by the Dublin-Sligo railway line and Royal Canal Way to the north, the Luttrellstown Road (L3032) to the south, the Porterstown Road / Diswellstown Road to the east and Clonsilla Road (R121) to the west.

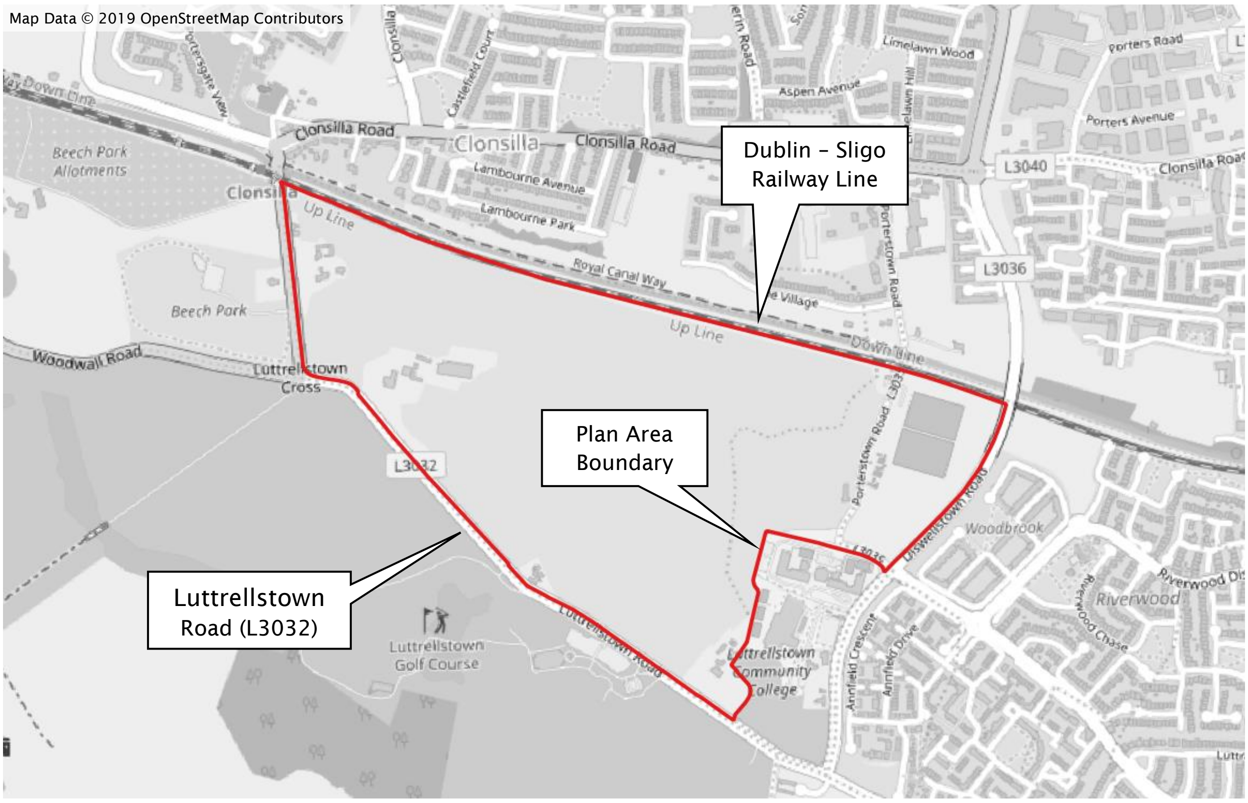

Figure 2-1 Plan Area Location

2.2 Plan Area Description

The Plan Area has an areal extent of 57 ha and currently comprises predominantly of agricultural land, with residential dwellings to the west and sports pitches to the east. Figure 2-2 illustrates the current land usage.

Land within the Plan Area generally falls from north east to south west with ground levels varying between 54 meters Ordnance Datum (m OD) to 64 m OD.

Existing levels used as the basis for this flood risk assessment are based on Ordnance Survey Ireland (OSI) 2 m LiDAR supplemented with ground based topographical survey, included in Appendix A. Photographs of the existing Plan Area and its surroundings taken as part of a walkover survey are included in Appendix B.

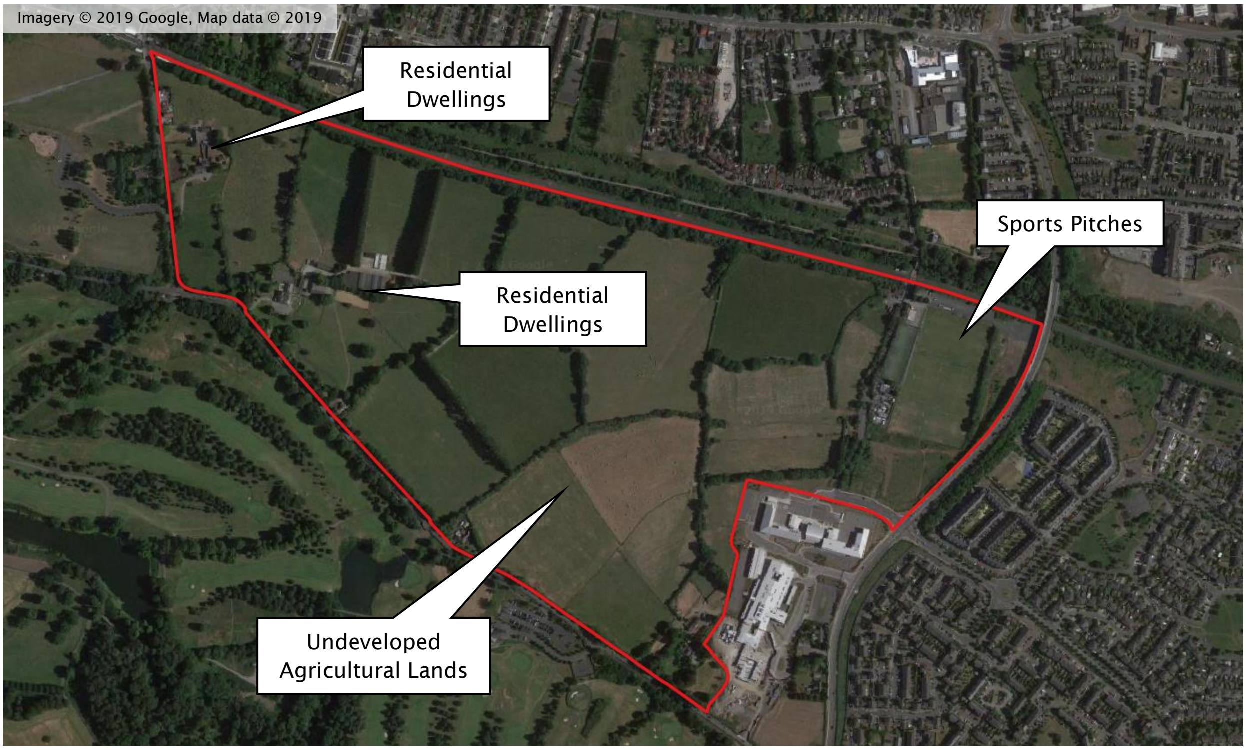

Figure 2-2 Existing Land Use

2.3 Existing Drainage

Analysis of Environmental Protection Agency (EPA) Water Framework Directive (WFD) datasets indicates that the entire Plan Area lies within the sub-catchment of a watercourse identified by EPA to be known as the Rusk Watercourse, located 0.4 km south west and part of the wider River Liffey catchment as shown in Figure 2-3. No watercourse known to EPA exists within the boundary of the plan area.

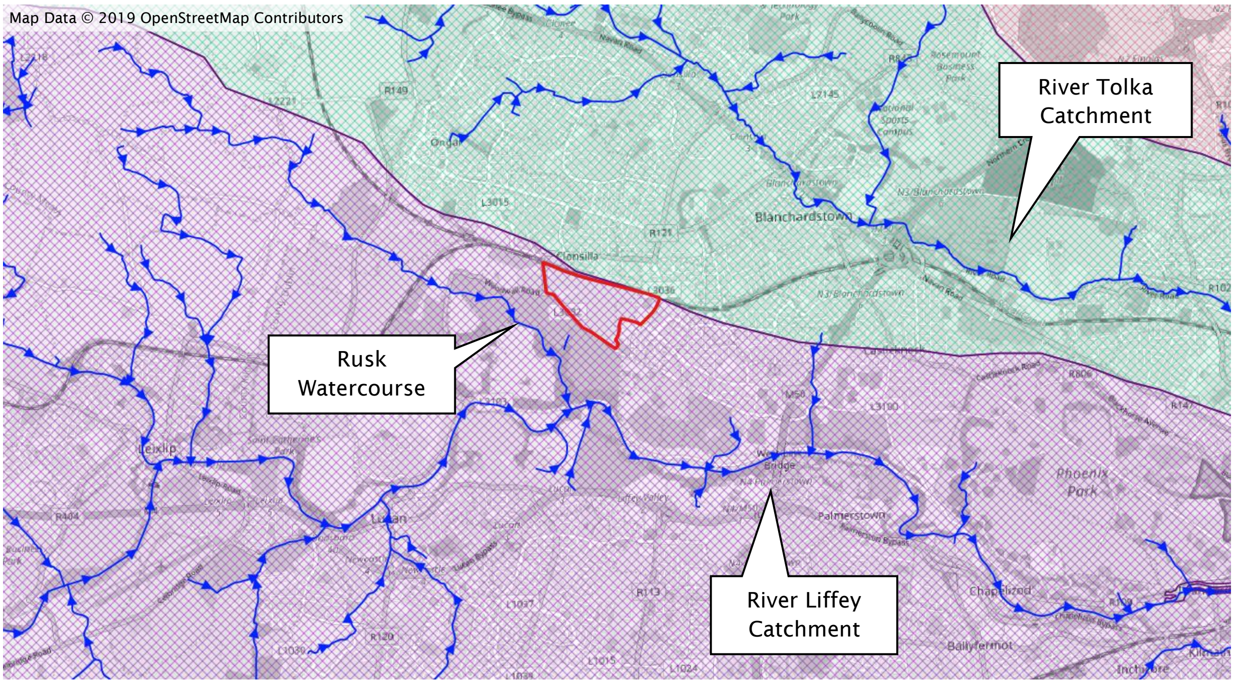

Figure 2-3 Wider Catchment Area

An open drain flows through the south east of the Plan Area and flows through the 480 mm x 770 mm concrete arch culvert under the Luttrellstown Road. The open drain discharges into a pond 50 m downstream within the grounds of Luttrellstown Castle Golf Course. The drain performs a local land / field drainage function, and therefore is not considered to be a watercourse with a fluvial function. Other smaller hydraulically unconnected land / field drains exist through the Plan Area, coinciding with field boundaries and perform a local drainage function for lands immediately adjacent.

The Royal Canal is situated c. 5 m below the Plan Area and causes a hydrological break along the northern boundary. Elevation difference negates potential for controlled or uncontrolled spills into the Plan Area.

A surface water feature, marked on historical mapping as a pond exists to the north east of the Plan Area, and is hydraulically unconnected to the field drain to the south east of the Plan Area or any other surface water feature.

A 1200 mm diameter storm sewer known as the 'Riverwood Storm Outfall' traverses the south eastern section of the Plan Area, generally following a similar alignment to that of the open drain. The sewer outlets to the open drain immediately downstream of the Luttrellstown Road and discharges to the Luttrellstown pond c. 50 m downstream. Surface water drainage asset information is described further in Section 4.5.1.

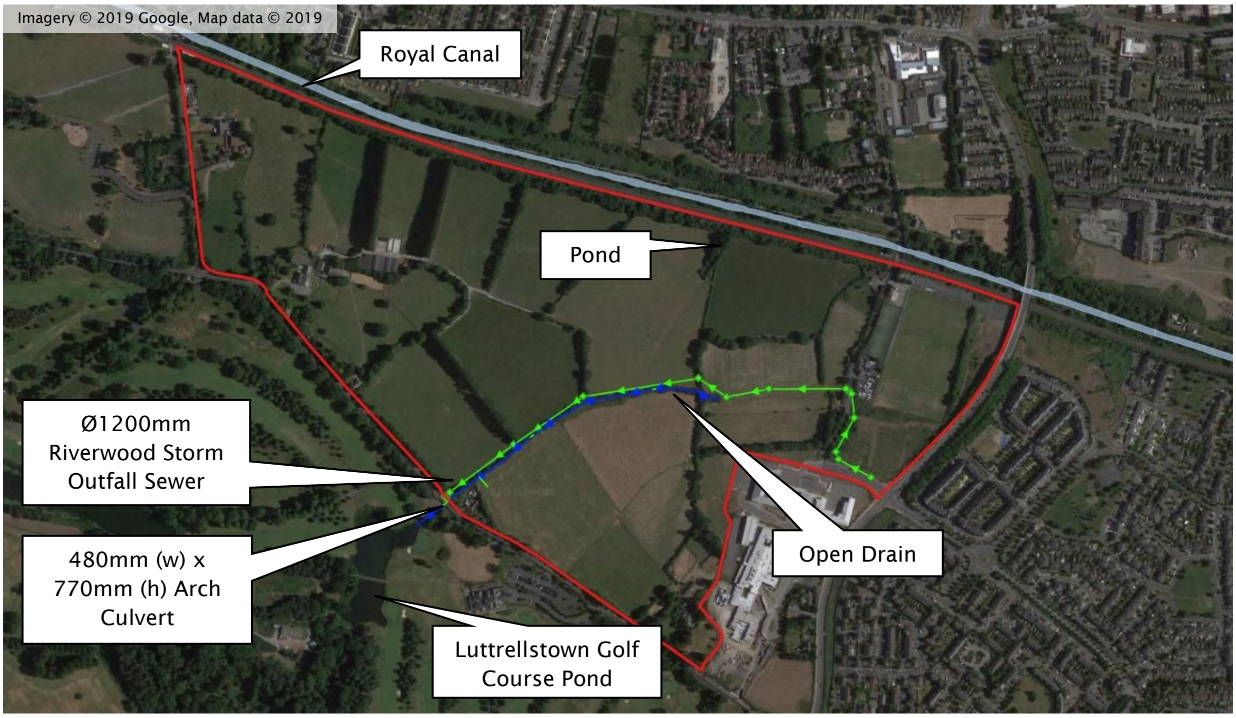

Figure 2-4 Drainage Features

2.4 Environment

While not material to the assessment of flood likelihood or flood risk, it is pertinent to determine water-environment linkages to sites of designated environmental importance, in order to inform the Strategic Environmental Assessment (SEA) for the Plan Area.

There are no Natura 2000 sites within the Plan Area. The South Dublin Bay and River Tolka Estuary SPA and South Dublin Bay SAC are located approximately 16 km east and are hydrologically linked (downstream of) the Plan Area.

Under Article 6 (3) of the EU Habitats Directive, an 'appropriate assessment' is required where any plan or project, either alone or in combination with other plans or projects, could have an adverse effect of the integrity of a Natura 2000 site.

Natural Heritage Areas (NHAs) are sites of national importance for nature conservation and are afforded protection under planning policy and the Wildlife Acts 1976-2012. Proposed NHAs (pNHAs) are published sites identified as of similar conservation interest but have not been statutorily proposed or designated.

The nearest NHA/pNHAs to the Plan Area are The Royal Canal and Rhy Water Valley / Carton pNHA are located 5 km to the south west of the Plan Area, neither of which are hydrologically linked to the Plan Area. For avoidance of doubt, the pNHA area for Royal Canal does not extend to the canal reach adjacent to the Plan Area.

2.5 Proposed Development

Notwithstanding particular objectives of the Plan Area that this assessment is intended to inform, Zoning objectives contained within the Fingal Development Plan 2017 – 2023 are shown in Figure 2-5 and summarised in Table 2.1.

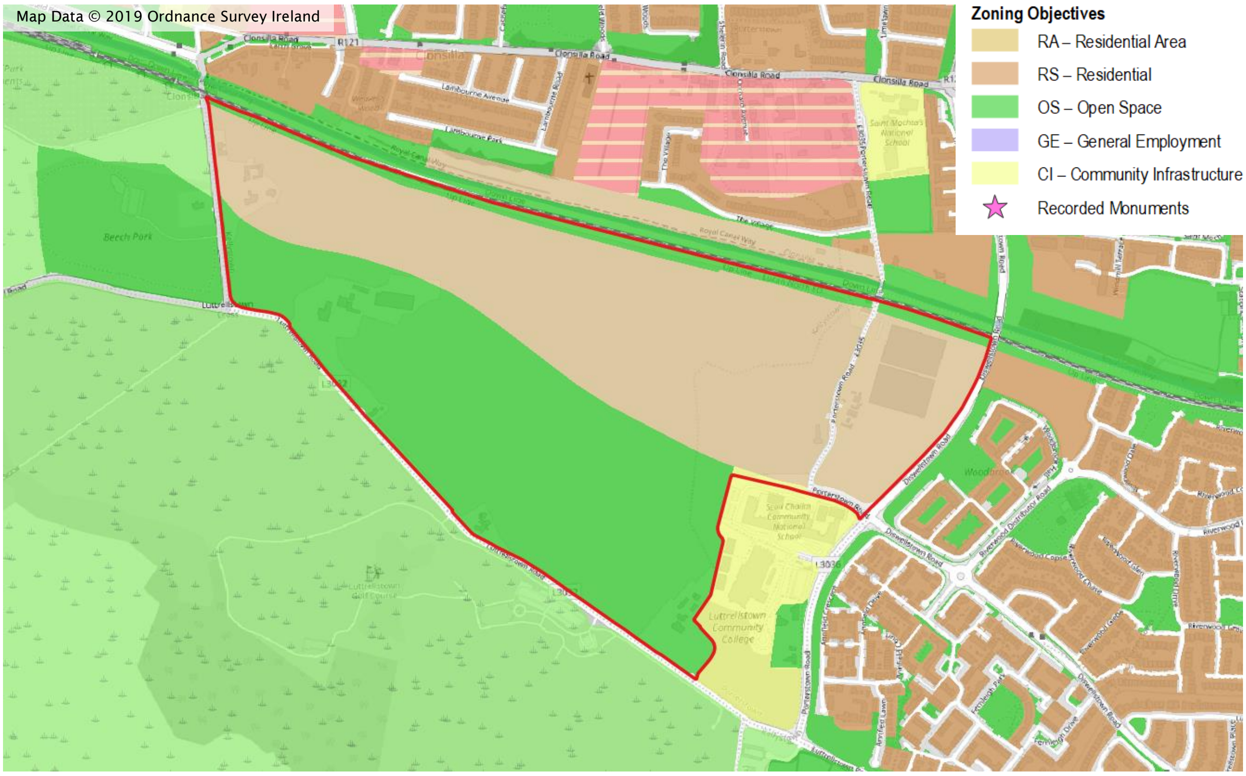

Figure 2-5 Fingal CC Zoning Objectives

Table 2.1 Fingal CC Zoning Objectives

Objective	Description
RA – Residential Area (R1)	Provide for new residential communities subject to the necessary social and physical infrastructure.
OS – Open Space	Preserve and provide for open space and recreational amenities.

3 APPROACH AND METHODOLOGY

3.1 Introduction

This Strategic Flood Risk Assessment report has been prepared in accordance with the OPW Guidelines. The OPW Guidelines have been implemented and embedded within the context of the Fingal Development Plan 2017 – 2023 through informing the approach adopted by the Fingal SFRA.

This SFRA further refines the general requirements of the OPW Guidelines and particular requirements of the Fingal SFRA.

3.2 Definition of Flood Risk

Flood risk is a combination of the likelihood of the occurrence of a flood event and the potential consequences arising from that flood evet, expressed as the following:

Flood Risk = Likelihood of Flooding x Consequences of Flooding

3.2.1 Likelihood of Flooding

The likelihood of flooding is defined in the OPW Guidelines as the percentage probability of a flood of a given magnitude or severity, occurring or being exceeded in any given year. It is generally expressed as a return period or annual exceedance probability (AEP). For example, a 1% AEP indicates the severity of a flood that has a 1 in 100 (1%) chance of occurring in any one year. Annual exceedance probability is the inverse of return period as shown in Table 3.1 below.

Table 3.1 Return Periods and AEP

Return Period (Years)	Annual Exceedance Probability (%)
1	100
10	10
50	2
100	1
200	0.5
1000	0.1

3.2.2 Consequences of Flooding

The consequences of flooding are determined by the hazards associated with the flooding (e.g. depth of water, speed flow, rate of onset, duration, wave action, water quality), and the vulnerability of people, property and the environment potentially affected by a flood (e.g. age profile of the population, type of development, presence and reliability of mitigation measures).

3.3 Objectives and Principles of the OPW Guidelines

The Fingal SFRA recognises the core objectives of the OPW Guidelines which are designed to:

- Avoid inappropriate development in areas at risk of flooding.
- Avoid new developments increasing flood risk elsewhere, including that which may arise from surface water 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 OPW Guidelines recommend that Flood Risk Assessments be carried out to identify the risk of flooding to land, property and people.

3.4 Flood Risk Assessment

The Fingal SFRA, in line with the OPW Guidelines, advocates the use of the Source – Pathway – Receptor model in Flood Risk Assessments (FRA) to identify the sources of flooding (e.g. high sea levels, intense or prolonged rainfall leading to increased runoff and increased flow in rivers and sewers), the people and assets impacted by flooding (receptors) and the pathways by which the flood water reaches those receptors (e.g. overland flow, river and coastal floodplains, river channels and sewers). Figure 3-1 shows the source-pathway-receptor model from the Fingal SFRA.

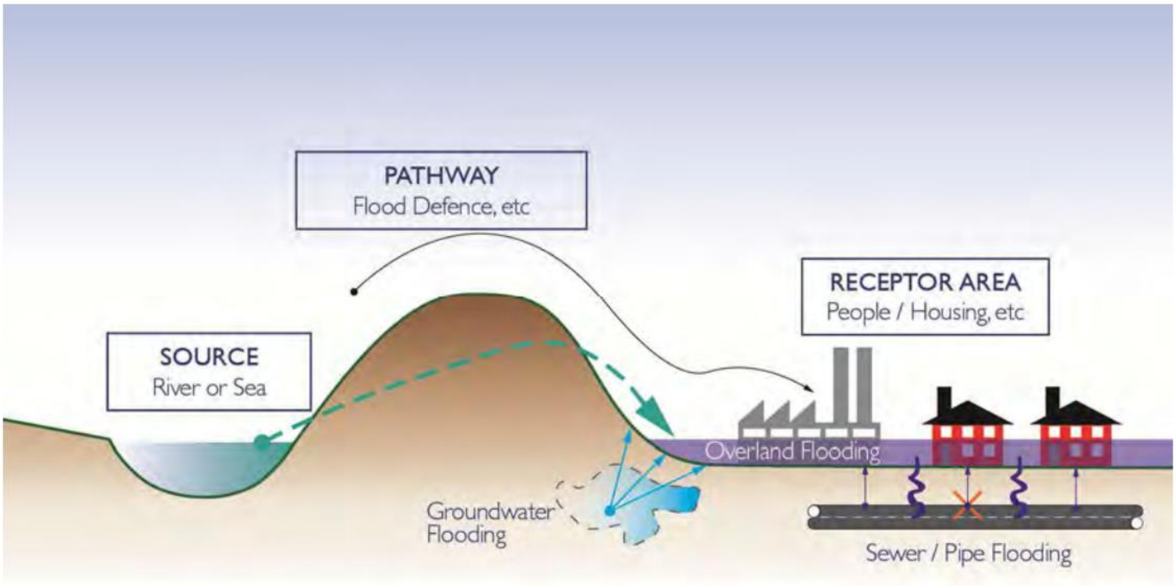

Figure 3-1 Sources, pathways and receptors of flooding from the Fingal SFRA

3.5 Flood Zones

Flood Zones are geographical areas within which the likelihood of flooding is in a particular range. The Fingal SFRA in conjunction with the OPW Guidelines defines three Flood Zones for **flooding from rivers and sea only** as indicated in Table 3.2.

Table 3.2 Flood Zones

Flood Zone	Description	Probability (Rivers)	Probability (Coastal)
A	Probability of flooding from rivers and sea is highest	Greater than 1% or 1 in 100	Greater than 0.5% or 1 in 200
B	Probability of flooding from rivers and sea is moderate	Between 0.1% or 1 in 1000 and 1% or 1 in 100	Between 0.1% or 1 in 1000 and 0.5% or 1 in 200
C	Probability of flooding from rivers and sea is low. Covers all Plan Areas which are not in zones A or B	Less than 0.1% or 1 in 1000	Less than 0.1% or 1 in 1000

Flood Zones are generated without the inclusion of climate change factors. When determining Flood Zones, the presence of flood protection structures should be ignored as areas protected by flood defences still carry a residual risk from overtopping or breach of defences.

Section 4.3 of the Fingal SFRA makes provision for consideration of residual risk factors such as culvert / bridge blockages and the effects of climate change which may expand the extents of Flood Zones A and B.

3.6 Climate Change

Climate change is expected to increase flood risk, in terms of more frequent flooding and increasing the depth and extent of flooding. Due to the uncertainty of the potential effects of climate change, the Fingal SFRA sets out recommendations in line with the precautionary approach adopted by the OPW Guidelines in managing the effects of climate change:

- Recognise that significant changes in the flood extent may result from an increase in rainfall or tide events and accordingly adopt a cautious approach to zoning land in transitional areas.
- Ensure that the levels of structures designed to protect against flooding, such as flood defences, land-raising or raised floor levels are sufficient to cope with the effects of climate change over the lifetime of the development.
- Ensure that structures to protect against flooding and the protected development are capable of adaptation to the effects of climate change when there is more certainty about the effects and still time for such adaptation to be effective.

3.7 The Sequential Approach and Justification Test

The Fingal SFRA, in line with the OPW Guidelines recommend a sequential approach to planning to ensure the core objectives outlined in section 3.3 are implemented. It is of particular importance at the plan making stage but is also applicable in the layout and design of development at the development management stage. The broad philosophy of the sequential approach in flood risk management from the Fingal SFRA / OPW Guidelines is shown in Figure 3-2.

In general, most types of development would be considered inappropriate in Flood Zone A. In Flood Zone B highly vulnerable development (e.g. hospitals, dwelling houses and primary infrastructure) would be considered inappropriate but less vulnerable development (e.g. retail, commercial and industrial uses) might be considered appropriate. Development within Flood Zone C is appropriate from a flood risk perspective.

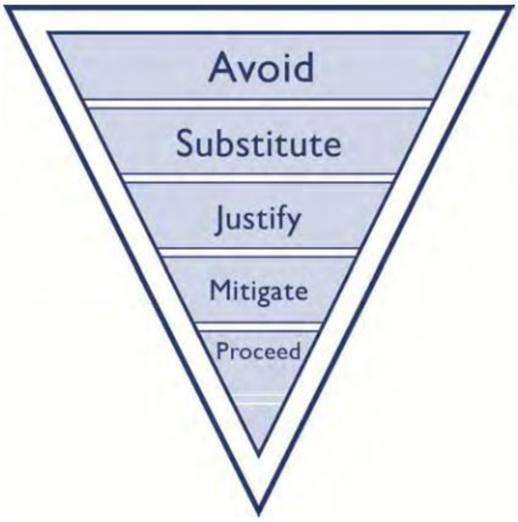

Figure 3-2 The Sequential Approach

The Justification Test has been designed to rigorously assess the appropriateness, or otherwise, of particular developments that, for the reasons outlined above, are being considered in areas of moderate or high flood risk. The test is comprised of two processes:

- **Plan Making Justification Test** – used at the plan preparation and adoption stage where it is intended to zone or otherwise designated land which is at moderate or high risk of flooding.
- **Development Management Justification Test** – used at the planning application state where it is intended to develop land at moderate or high risk of flooding for uses or development vulnerable to flooding that would generally be inappropriate for that land.

Table 3.3 below indicates the types of development that would be required to meet the Justification Test.

Table 3.3 Vulnerability and Flood Zone Matrix for Justification Test

Development Vulnerability[1]	Flood Zone A	Flood Zone B	Flood Zone C
Highly Vulnerable (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less Vulnerable	Justification Test	Appropriate	Appropriate
Water-compatible	Appropriate	Appropriate	Appropriate

[1] Full descriptions and examples of development vulnerability can be found in Section 3.6 of the Fingal SFRA

4 STAGE 1 – FLOOD RISK IDENTIFICATION

As part of the Stage 1 flood risk identification phase, several available sources of information generally as set out in the Fingal SFRA and OPW Guidelines were investigated in order to build an understanding of the potential risk of flooding to the Plan Area.

The following review highlights the key findings of the Stage 1 FRA to identify any flooding issues that may warrant further investigation.

Stage 1 data gathering informs the screening of potentially significant flood mechanisms (Stage 2 FRA) described in subsequent Section 5 of this assessment.

4.1 Information Sources Summary

The following table summarises the data sources consulted as part of the flood risk identification process. Pertinent data obtained from these sources is described and screened in the following sections.

Table 4.1 Flood Data Sources

Source	Relevant?	Described in Section
Topographic Data		
OSI Close-Scale Mapping	Close scale OSI mapping for the Plan Area has been reviewed was found not to accurately represent water features within the Plan Area per walkover survey and aerial photography. OSI datasets for flooding, marsh, and seasonal lakes indicate no features on and adjacent to the Plan Area.	N/A
OSI Historical Maps	OSI 6” and 25” mapping have been reviewed and do not indicate any additional information not included on current OSI mapping.	N/A
OSI Height Data	OSI 25 m DTM has been used to inform macro-level catchment assessments. 2 m Grid Urban LiDAR height data has been used to inform the Plan Area assessment.	4.2.1
Land Survey	Survey data instructed as part of this SFRA conducted by a 3rd party surveyor has been reviewed.	4.2.1
Flood Data (Predictive and Flood Records)		
OPW ‘Past Flood Events’	Review of flood records indicates one flood event within 1.6 km of the area of interest which occurred on the other side of the canal / railway.	N/A
OPW Preliminary Flood Risk Assessment Maps (PFRA)	Fluvial, pluvial, coastal and ground water flooding datasets have been reviewed.	4.3.1
Catchment Flood Risk Assessment and Management (CFRAM)	No CFRAM mapping is available for the Plan Area.	N/A
Dublin Pluvial Study	Pluvial flood mapping published as part of the study does not cover the Plan Area.	N/A
Greater Dublin Strategic Drainage Strategy (GDSDS)	Content relevant to the Plan Area has been reviewed.	4.3.2

Source	Relevant?	Described in Section
SFRA for Fingal Development Plan 2017-2013	Review of the Fingal SFRA in relation to predictive or historic flood data indicates no further information over and above that established from original sources already described.	N/A
Media Search	A media search has found evidence of flooding occurring within the general area on two occasions. No evidence of flooding within the Plan Area was found.	4.3.3
Plan Area Observations		
Walk Over Survey – July / August 2019	Ground truthing topographical information and drainage data.	4.4
Drainage Data		
Irish Water / Fingal CC Drainage Records	Sewerage records have been made available including as built information for the Riverwood Storm Outfall within the Plan Area.	4.5.1
EPA Datasets	No lakes, rivers, streams or canals mapped on EPA datasets were identified within 1 km of the Plan Area.	N/A
OPW Arterial Drainage Datasets	No drainage district, channel, embankment, or benefitting land affects the Plan Area.	N/A
Drainage Surveys	Additional survey was obtained for the culvert under the Luttrellstown Road and to verify the Riverwood Storm Outfall as built records.	4.5.2
Ground Conditions		
Geological Survey of Ireland (GSI) Maps	Bedrock and superficial geology datasets have been reviewed.	4.6

4.2 Topography

4.2.1 OSI Height Data

Review of OSI 2 m LiDAR datasets indicates that the natural hydrological catchment upstream north of the Plan Area has been broken by the lower lying royal canal. Lands to the east incorporating an area of c. 105 ha bounded by the Carpenterstown Road to the east and Luttrellstown Road to the south.

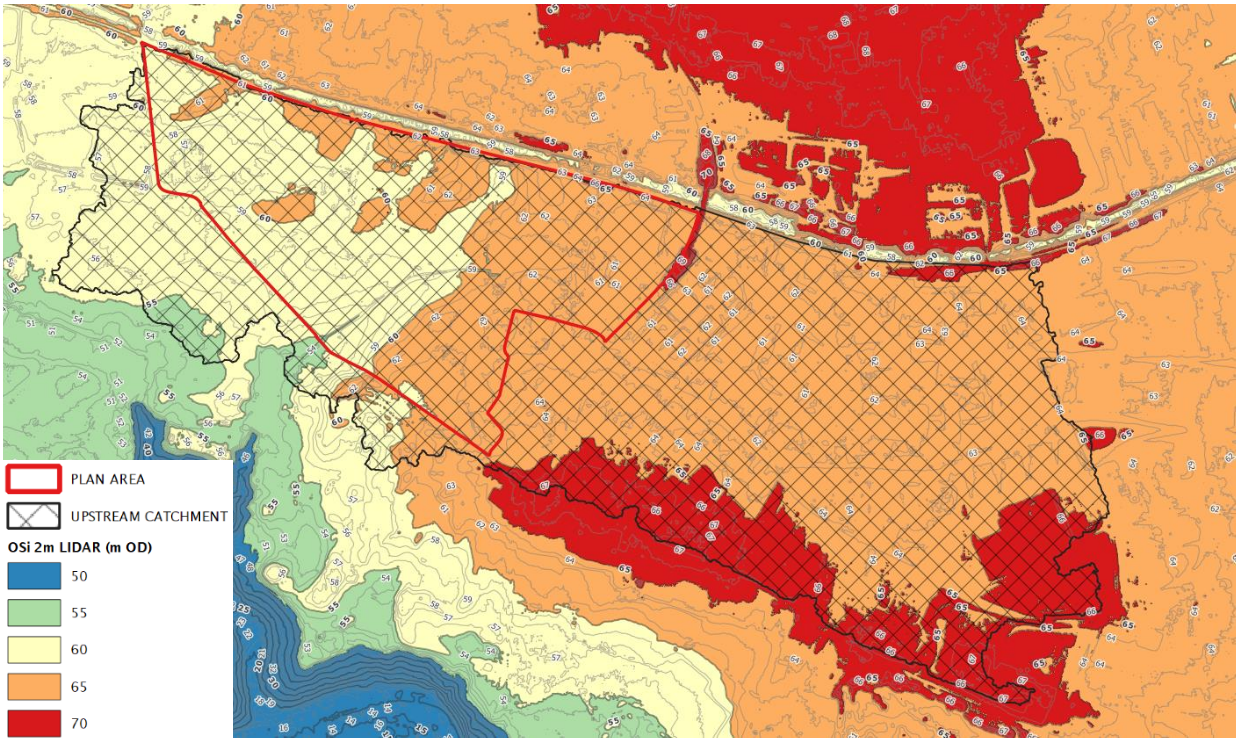

Figure 4-1 OSI Topographical Information

4.3 Flood Data

4.3.1 OPW Preliminary Flood Risk Assessment (PFRA) Maps

The Office of Public Works (OPW) has developed Preliminary Flood Maps as part of the Catchment Flood Risk Assessment and Management (CFRAM) Programme.

The first stage of the CFRAM process was to produce a Preliminary Flood Risk Assessment (PFRA) that included flood mapping for the entire country. The PFRA is a preliminary assessment only, based on available or readily-derivable information. The analysis was undertaken to identify areas prone to flooding but the analysis is purely indicative; mapping is considered to be coarse and is designed to inform further stages in the CFRAM process.

The PFRA flood mapping indicates that part of the Plan Area:

- is predicted to be partly affected by localised pluvial (surface water) flooding
- is not assessed as being at risk from fluvial or groundwater flooding.

An extract from the PFRA flood map, obtained via myplan.ie, is shown in Figure 4-2.

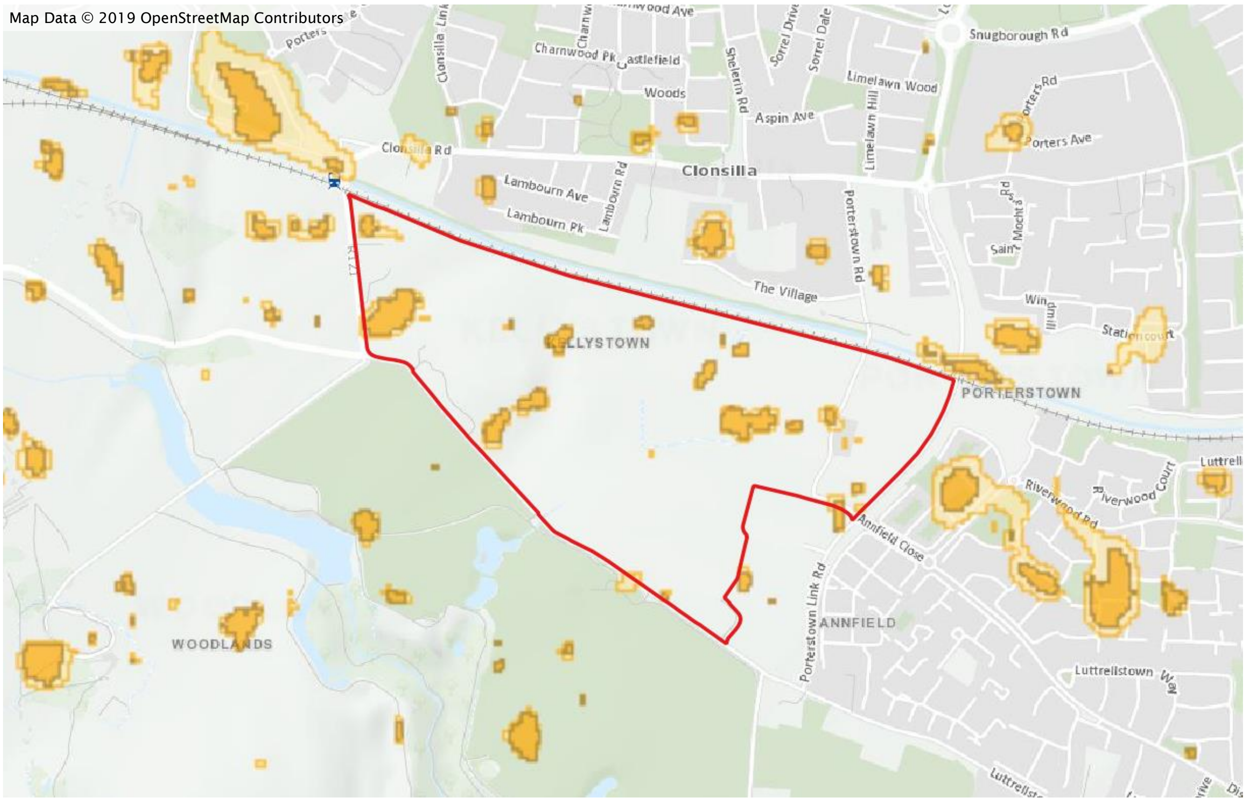

Figure 4-2 OPW PFRA Indicative Extents and Outcomes

4.3.2 Greater Dublin Strategic Drainage Study

The Greater Dublin Strategic Drainage Study (GDSDS) was commissioned in 2001 to carry out a strategic analysis of the existing foul and surface water systems in the local authority areas of Dublin (including Fingal CC) and adjacent catchments. The objectives of the Study were to identify policies, strategies and projects for the development of a sustainable drainage system for the Greater Dublin region.

The GDSDS report includes information relating to the areas surrounding the Plan Area:

- Developments to the south of Clonsilla are served by a storm water drain which discharges to a tributary of the River Liffey.

The location of the watercourse receiving storm discharge from the area is not stated and no further details relating to the Plan Area and its environs are covered.

4.3.3 Internet / Media / Background Search

A media search comprising internet media and archived newspaper articles found evidence of flooding occurring in the Clonsilla / Porterstown area in November 2014[2] and November 2002[3]. These events were caused by heavy rainfall and caused localised road flooding.

Reports include references to flooding along the Luttrellstown Road / Porterstown Road which was also reported by Fingal CC staff and local residents.

No evidence of flooding within the boundary of the Plan Area was found.

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[2] https://www.thejournal.ie/weather-flooding-dublin-area-1777455-Nov2014/ [accessed 21st October 2019]

[3] https://www.irishtimes.com/news/more-floods-feared-as-rain-set-to-continue-in-leinster-1.446825 [accessed 21st October 2019]

4.4 Walkover Survey

A walk over survey of the Plan Area and adjacent lands was conducted by McCloy Consulting Ltd. on 1st July 2019 and 8th August 2019 during which a photographic survey of the Plan Area and adjacent areas was undertaken; photos are included within Appendix B. The purpose of the inspections was to ground-truth desktop study outcomes and to verify data-gaps and identify the need for any further survey.

The Plan Area was noted to be generally undulating in topography comprising agricultural land with limited standalone residential development to the west. The majority of the Plan Area slopes towards an open land drain that runs from north to south through the eastern part of the Plan Area, as shown in Figure 4-3.

The open drain was observed to be dry during both visits, the second of which took place following periods of heavy rainfall. Local topography suggests the drain performs a local drainage function only and has a limited upstream catchment, therefore is not considered to be a watercourse. The open drain is culverted for agricultural access at the centre of the Plan Area and discharges through an arch culvert beneath of Luttrellstown Road.

A pond exists to the north east of the Plan Area that was noted as being lower than surrounding area, heavily overgrown with no evidence of inflow or outflow

Visual inspection of the open drain within the Plan Area was undertaken to identify outlets and connections. A Ø 500 mm culvert outlet is located on the eastern bank of the open drain at the south of the Plan Area, noted to be dry on all occasions of inspection, including after periods of heavy rainfall. No intermediate manholes upstream of the outlet were found in attempt to trace the culvert alignment.

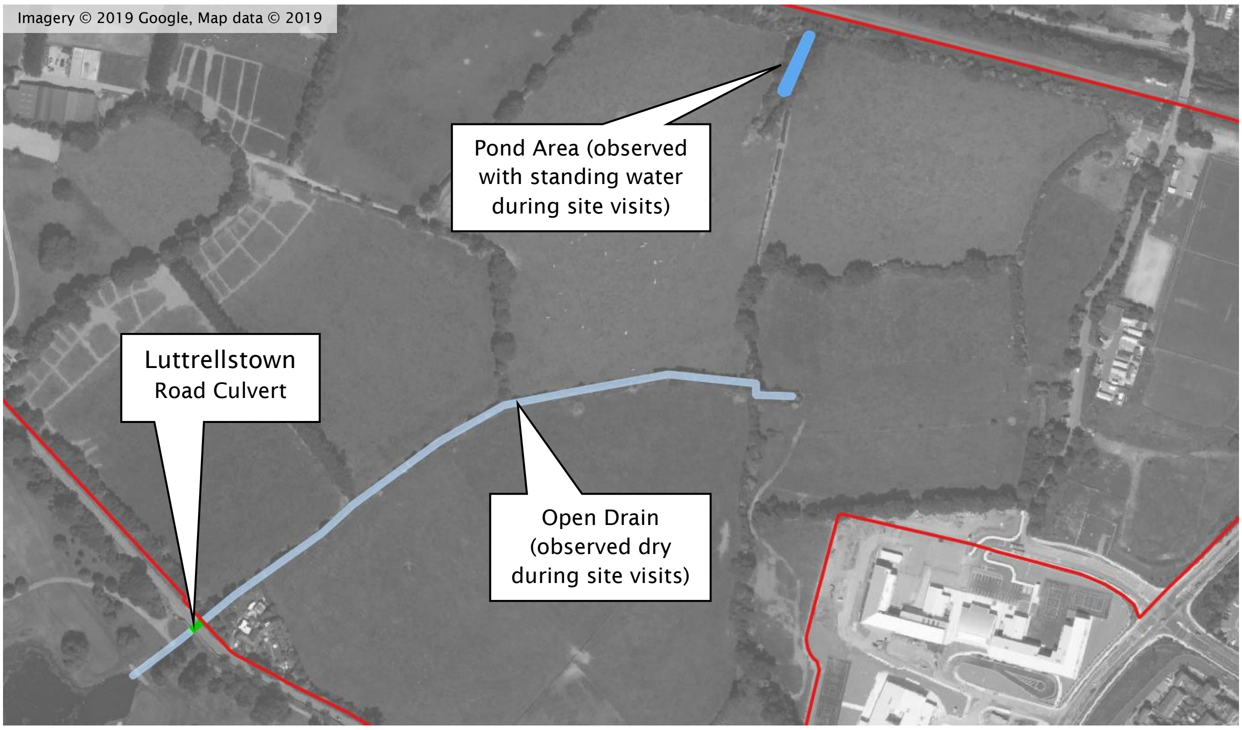


Figure 4-3: Identified Water Features

4.5 Drainage Data

4.5.1 Fingal CC – Water Services Drainage Records

Drainage records for the Plan Area and wider environs were gathered to identify potential linkages to or from open drains within the Plan Area. The surrounding area is served by a separated drainage system. Taking in charge (TIC) as built drawings were provided for the Annfield and Riverwood developments, including the Riverwood Storm Outfall that traverses the south east corner of the Plan Area, as shown in Figure 4-4.

Additional indicative data was provided for the remainder of the catchments to the east of the Plan Area indicating the Annfield, Riverwood and Fernleigh developments drain to the Riverwood Storm Outfall that and eventually discharges to an open drain immediately downstream of the Plan Area. The remainder of the sewer infrastructure within the eastern hydrological catchment is shown to drain easterly outside of the hydrological catchment by indicative asset data.

Direct flood risk from the Riverwood Storm Outfall is perceived as unlikely as the sewer is designed to serve a recently developed upstream storm network draining to it by smaller pipes which are more critical in terms of capacity. Therefore, any out of sewer flooding from developed lands east of the Plan area would be realised further up the network and may tend to flow overland onto the Plan Area.

No asset information relating to the Ø 500 mm culvert outlet found within the Plan Area was established within the records. It is presumed, in the absence of other information and given the absence of any flow from the outlet at the time of inspection, that the outlet is likely either redundant or associated with local field drainage or land drainage that would be rendered redundant by development of the lands.

Figure 4-4 indicates the surface water sewer network within the upstream catchment of the Plan Area.

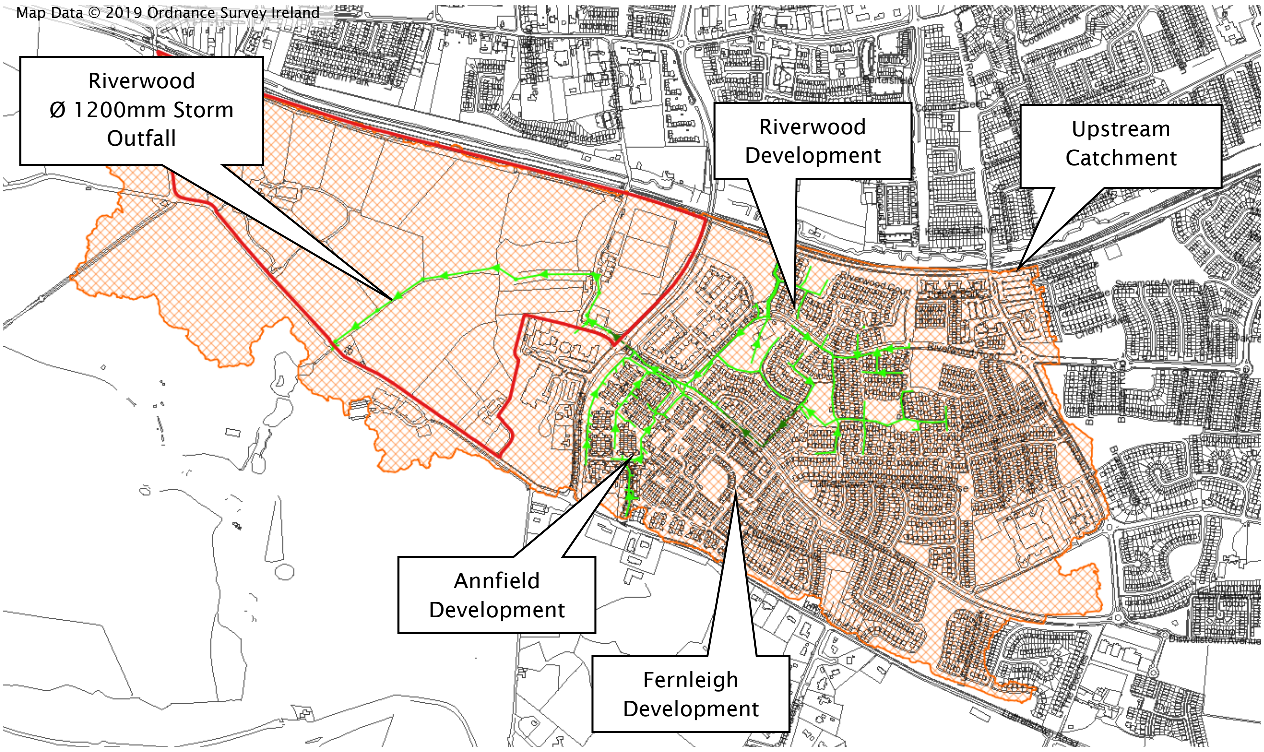


Figure 4-4 Surface Water Sewer Network

4.5.2 Surveyed Drainage Assets

Survey was undertaken for drainage assets within the Plan Area pertinent to the open drain to account for any constriction in flows and outlets to the open drain. In addition, manholes and pipe sizes for the Riverwood Storm Outfall were surveyed along a portion of the alignment to verify the TIC as built records, including the sewer outfall to the open drain downstream of the Plan Area.

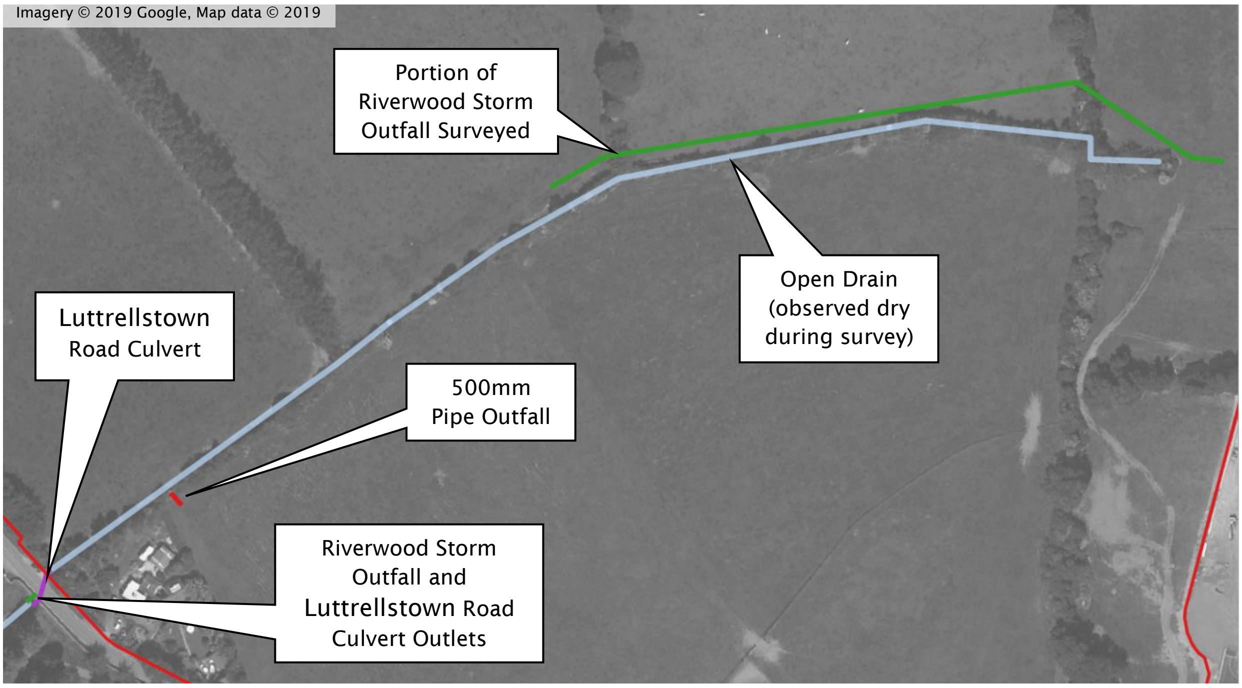


Figure 4-5 Surveyed Drainage Assets

4.6 Ground Conditions

Geological Survey of Ireland mapping were analysed to determine ground conditions within the Plan Area. No site investigation or infiltration testing was conducted within the Plan Area.

Geological mapping indicates that the Plan Area is predominantly underlain by a bedrock of limestone and shale with superficial deposits of till derived from limestone.

5 STAGE 2 – INITIAL FLOOD RISK ASSESSMENT

5.1 Preamble

Further to the Stage 1 assessment, the following Stage 2 assessment summarises the potential sources of flood risk that have a potential pathway to affect the Plan Area and identifies those sources of flooding that require further detailed analysis as part of a Stage 3 assessment.

5.2 Initial Assessment

The following is a record of the screening assessment of the Plan Area for potential flooding mechanisms requiring subsequent detailed assessment, based on the information obtained from the background information review and consultations.

Table 5.1 Possible Flooding Mechanisms

Source/Pathway		Significant / Assess Further?	Reason
Fluvial Flooding	Floodplain	No	There are no water features in the Plan Area perceived as watercourses with any fluvial function. OPW flood mapping indicates that there is no fluvial flooding at or on lands proximal to the Plan Area.
Fluvial Flooding	Flood Defence / Failure	No	The Plan Area is undefended.
Coastal Flooding		No	The Plan Area lies at sufficient elevation relative to coastal flooding that it can be discounted.
Surface Water Flooding	Surface Water Flooding	Yes	Dublin Pluvial Study and OPW PFRA mapping indicates areas of potential surface water flooding on and adjacent to the Plan Area. An open drain that would convey surface water flows southerly westerly at the south east of the Plan Area.
Surface Water Flooding	Culvert Blockage	Yes	An open drain is culverted at its downstream extent within the Plan Area.
Urban Drainage		Possible	The Plan Area is predominantly undeveloped. Developed lands to the east / upslope of the Plan Area are served by separated urban drainage. Surface water drainage from these areas discharges to a 1200 mm pipe that runs through the Plan Area.
Groundwater		No	Superficial geology within the Plan Area established from GSI tends to indicate that land cover is till derived from limestone. Groundwater subsoil permeability maps indicates low to very low permeability of soils within the Plan Area Topography on the Plan Area and wider environs is not characteristic of a relatively depressed ‘bowl’ where clear groundwater flooding would feasibly be experienced.

Source/Pathway	Significant / Assess Further?	Reason
Reservoirs / Canals / Artificial Sources	No	A screening assessment based on OSI and EPA mapping relative to the topographic catchment draining toward the area confirms that there are no lakes, reservoirs, or other impoundments with potential to affect the Plan Area. The Royal Canal along the northern boundary is c. 5 m lower than the Plan Area and does not represent a risk of breached impoundment or overtopping.

Those flood mechanisms screened as being potentially significant and requiring Stage 3 assessment have been assessed in further detail, the findings of which are detailed in the following sections.

6 STAGE 3 – DETAILED FLOOD RISK ASSESSMENT

6.1 Preamble

The Stage 2 assessment has determined that surface water flooding and culvert blockage have potential to be significant at the Plan Area.

No existing modelled or other predictive data is available to inform the assessment. In order to provide a more accurate and up-to-date (present day) assessment of flood risk in the vicinity of the area of interest, a location-specific detailed 1D-2D surface water model has been developed for the Plan Area using InfoWorks ICM software (version 9.5).

ICM solves full two-dimensional depth averaged shallow water equations to produce a virtual representation of flow paths, velocities, volumes and depths.

The following sections provide detail on the modelling methodology and the hydrological assessment.

6.2 Model Coverage

The area of assessment for the model has been determined using Geographical Information Systems (GIS) analysis of a LiDAR based terrain model, utilising the software to determine flow direction and accumulation for each cell to delineate the natural topographic catchment.

The outlet point for the model has been located sufficiently downstream from the Plan Area to ensure predicted water levels in the area of interest are not susceptible to any backwater effect as a result of the boundary condition, and to ensure that the backwater effect of the flow controls are included as they may have potential to influence flood levels at the Plan Area.

The hydrological catchment on and upgradient of the Plan Area is broadly limited to the south of the Royal Canal and extends east incorporating an area of c. 105 ha bounded by the Carpenterstown Road to the east and Luttrellstown Road to the south.

The topographic hydrological catchment was assessed in conjunction with the catchment of the surface water sewer network draining lands adjacent to and downstream of the Plan Area, to ensure that sewer flows (and any out of sewer flooding) is collected and represented within the model.

The surface water catchment was buffered by minimum 40 m and up to 400 m downslope of the Plan Area to enclose the entire contributing catchment and to ensure the model boundary was sited sufficiently downstream. The hydraulic model extent is displayed on the following Figure 6-1.

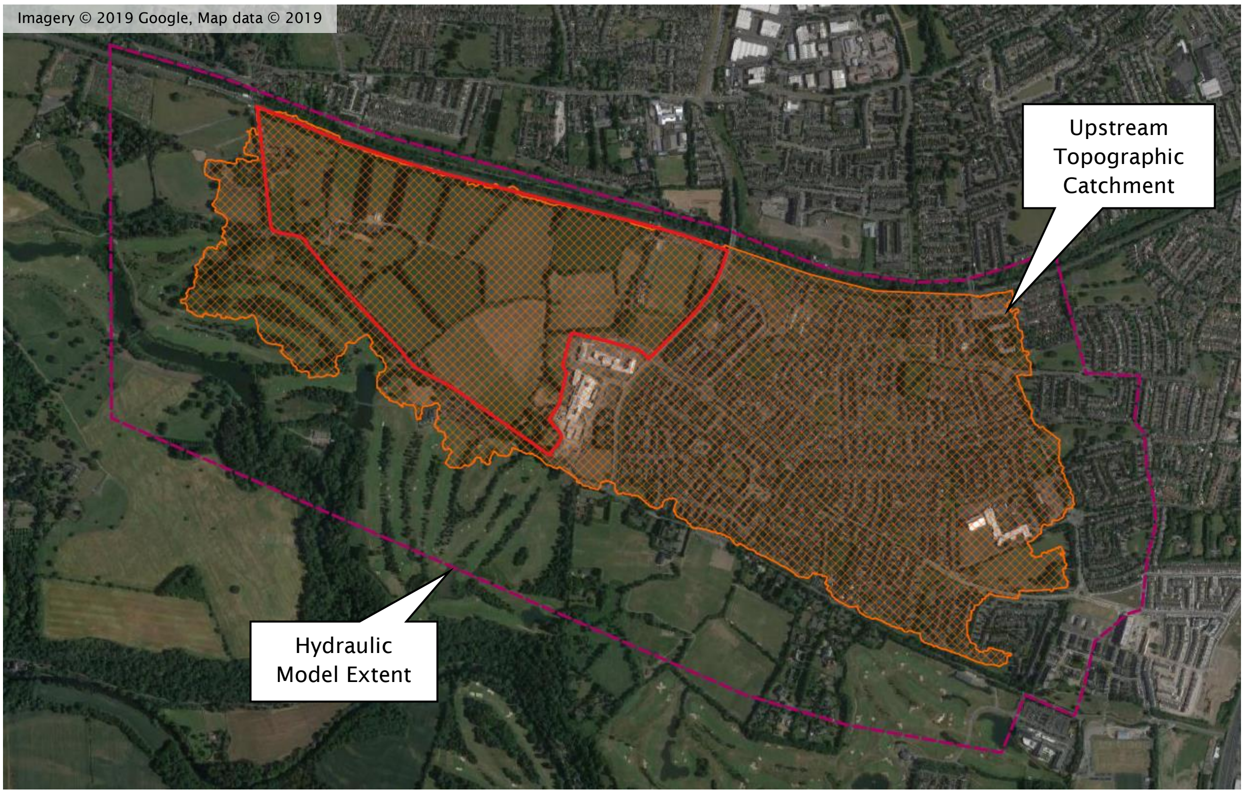


Figure 6-1 Model Extent

6.3 Model Hydrology (Rainfall Analysis)

Model hydrology is via the application of rainfall direct to the 2D surface. Rainfall has been derived from the OPW Flood Studies Update (FSU) Rainfall Depth Duration Frequency (DDF) module. Due to the small (<5km^2) and ungauged nature of the catchment, the rainfall DDF module uses the nearest 2 km grid point for analysis. Rainfall is therefore calculated at Clonsilla Road / Luttrellstown Road junction approximately 300 m north of the Plan Area.

Rainfall profiles for the 1/3/6-hour storm durations for the 1% event have been calculated from the FSU Rainfall DDF module and converted from rainfall depth to intensity for use in the ICM model for the summer and winter rainfall profiles.

The catchment is approximately 50% urban, therefore in order to determine the most critical rainfall profile the 1% AEP return period was simulated for both the winter and summer profiles for all durations. Measurements of flood levels at key flow paths throughout the Plan Area indicate the summer profile results in higher flood depths and therefore is the most critical. The summer rainfall profile is more peaked than the winter profile and representative of the prevalence of intense convective storms during summer which is more critical for surface water flooding in this area.

The FSU methodology does not extend to allow estimation of 0.1% AEP rainfall directly. Rainfall for the 1/3/6-hour storm durations for the 0.1% AEP event were therefore estimated by plotting a range of total rainfall depths against the associated return periods up to the 0.4% AEP (250 year) event. The rainfall curves were plotted on a logarithmic scale and the 0.1% AEP total rainfall estimated from the trendline equation. Rainfall profiles for each storm duration were derived through scaling the total rainfall depth to the 1% AEP hyetograph.

6.3.1 Critical Duration Analysis

The critical duration rainfall was determined for each storm event probability from the analysis of model simulation results by measurement of flood levels at key flow paths / accumulations of flood waters throughout the Plan Area.

Additional analysis was conducted by measurement of total area inundated above 0.02 m within the model. As shown in following table, the critical duration for the model was assessed to be 1 hour for the 1% and 0.1% AEP storms.

Table 6.1 Critical Duration Analysis

Rainfall Probability	Inundation Extents (m^2) for Storm Duration		
	1hr	3hr	6hr
1% AEP	889560	835770	794270
0.1% AEP	1195150	1080260	779560

The respective critical storm duration for each return period is used as a basis for all subsequent analysis and shown in Figure 6-2 below.

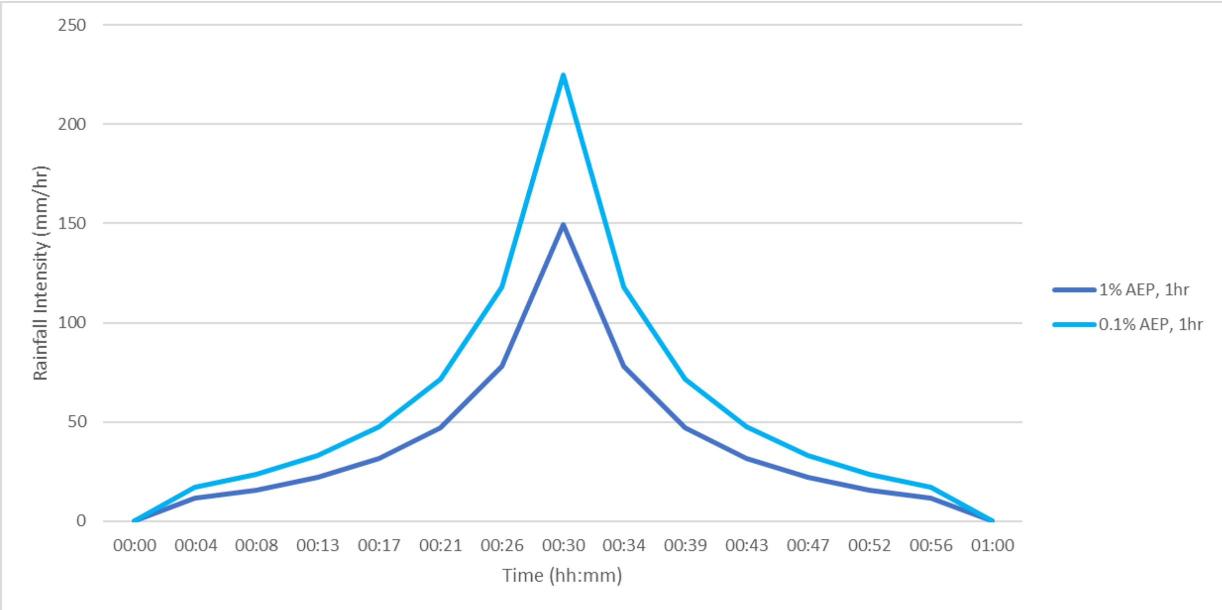


Figure 6-2 Critical Storm Durations for 1% and 0.1% AEP Storm Events

6.3.2 Climate Change

The effect of climate change has been applied to the critical duration storms for the 1% and 0.1% AEP events for both the Mid Range (+20%) and High End (+30%) future scenarios as set out in the OPW's Climate Change Sectoral Adaptation Plan – Flood Risk Management (2015-2019). The resulting hyetographs are shown in Figure 6-3 and Figure 6-4.

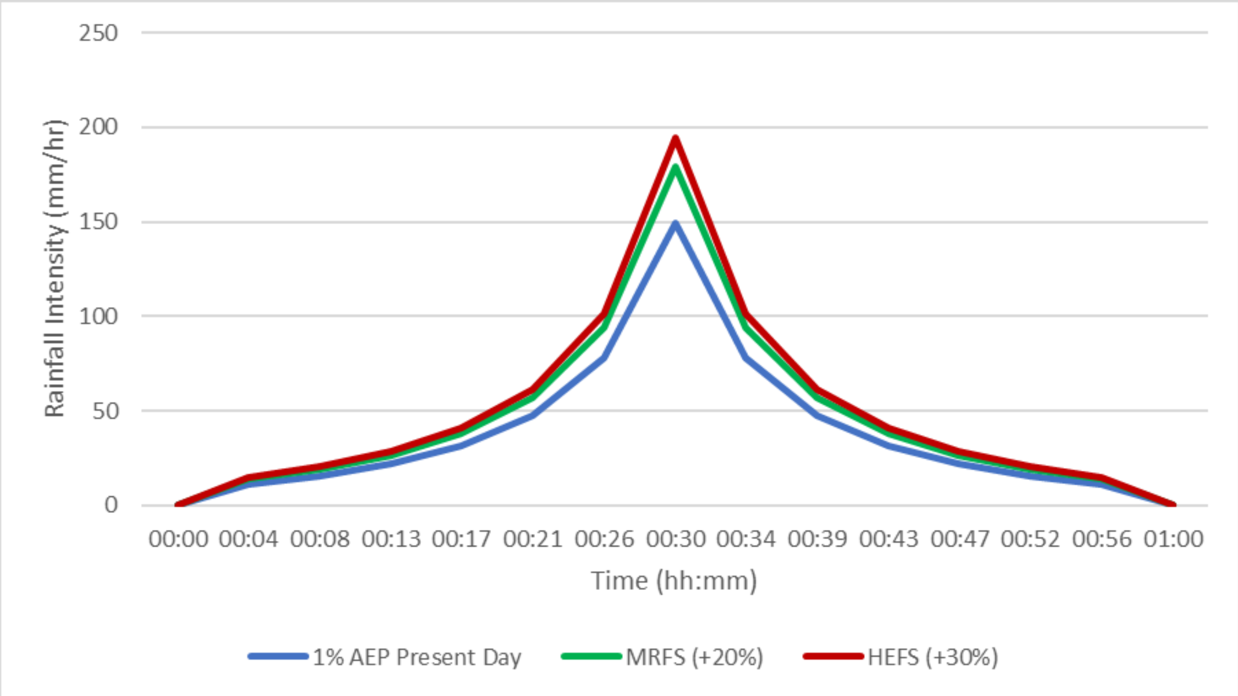


Figure 6-3 Present Day and Climate Change Rainfall – 1% AEP, 1 hour

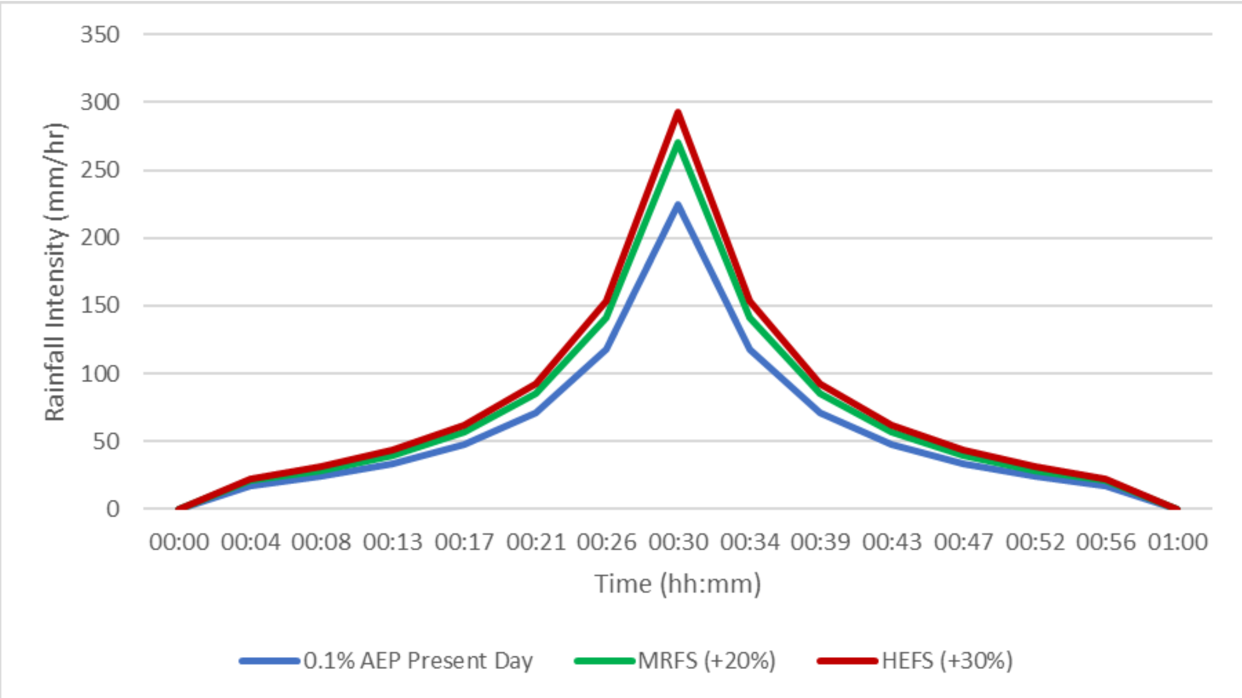


Figure 6-4 Present Day and Climate Change Rainfall – 0.1% AEP, 1 hour

6.4 Plan Area Specific Model Data

6.4.1 1-Dimensional Model Data

The drainage channels in the model area are not included as 1D elements and are included in the 2D model surface discussed subsequently.

Two conduits (with inlets and outlets linked to the 2D surface) were included within the model, as shown in the following Figure 6-5 and detailed in Table 6.2. Conduit details have been taken from the Plan Area specific survey and as built drawing information, verified by survey data.

6.4.1.1 Luttrellstown Road Culvert

Flows from the open drain leave the Plan Area via a 480 mm high x 770 mm wide arched culvert under the Luttrellstown Road. The inclusion of the culvert permits water accumulated in the open drain discharge downstream from the Plan Area.

6.4.1.2 Riverwood Storm Outfall

The Ø 1200 mm sewer approximately follows that of the south eastern open drain within the Plan Area. As discussed in Section 4.5.1, out of sewer flooding would be realised further up the network from the Riverwood Storm Outfall and flow overland onto the Plan Area. In addition, several data gaps remain in the upstream network. Therefore, the upstream contributing network has been rationalised to a portion of the sewer downstream at the Luttrellstown Road to its outlet in the open drain downstream from the Plan Area to represent flows discharging from the sewer to the receiving open drain downstream of the Plan Area that may influence flood levels at the Plan Area.

The peak flow in the sewer has been rationalised to a maximum discharge rate of full-bore capacity estimated by Colebrooke-White and applied as a continuous hydrograph upstream of the Luttrellstown Road.

The rationalisation ensured a precautionary approach, a sensibility check was undertaken to ensure the sewer discharge volume and loses within the upstream sewered area cumulatively do not exceed the volume of rainfall applied to those areas.

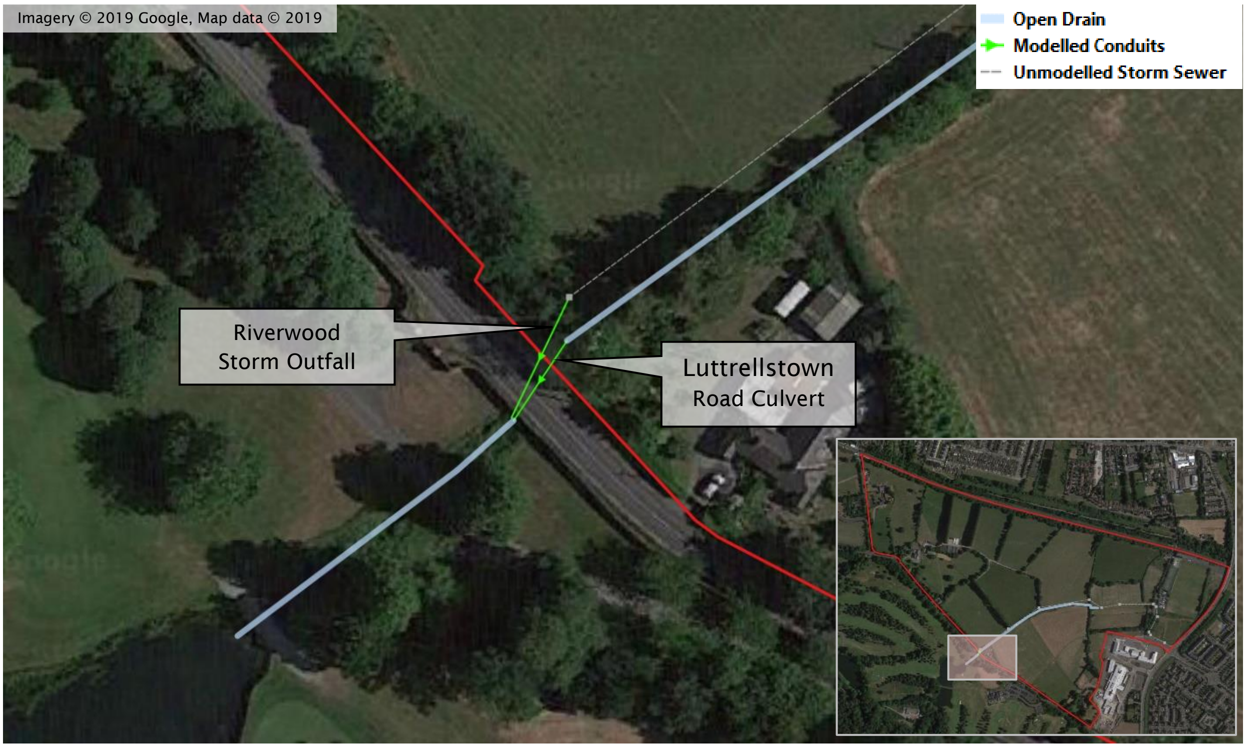


Figure 6-5 Modelled Conduits

Table 6.2 Conduit Register

Conduit	Shape	Material	Size (mm)	Upstream Invert Level (mOD)	Downstream Invert Level (mOD)	Manning's 'n' Roughness Value (Top / Bottom)
Luttrellstown Road Culvert	Arch	Concrete	480 x 770	53.44	53.21	0.013 / 0.020
Riverwood Storm Outfall	Circular	Concrete	1200	53.32	53.23	0.013 / 0.013

6.4.2 2-Dimensional Model Data

6.4.2.1 Topography

Topographic survey of the Plan Area has been made available from a 3rd party surveyor in addition to Ordnance Survey Ireland (OSI) 2 m LiDAR provided by FCC. A terrain model was generated to represent the topography of the area using a combination of the two data sources. The LiDAR has been augmented by topographic survey in the area of the main open drain at the south east of the Plan Area to ensure this key flow route is adequately represented.

6.4.2.2 Open Drains

The Plan Area has potential to be affected by flooding from the main open drain that serves lands within the immediate vicinity within the south eastern portion of the Plan Area and conveys flows out of the Plan Area via the Luttrellstown Road culvert. The main open drain was represented in the 2D domain.

A topographical and bathymetric survey was undertaken by a specialist survey contractor that included the south eastern open drain due to the importance of this key flow route for pluvial flows. The survey included discrete cross sections at a 60 m spacing that included top and bottom bank lines and channel inverts giving an accurate depiction of the entire drain.

Other minor hydraulically unconnected drains largely corresponding with field boundaries exist within the Plan Area were defined by the OSI 2 m LiDAR.

6.4.2.3 Roads

OSI Prime 2 mapping was provided by Fingal CC and used to delineate roads for representation in the model.

Roads were loaded as mesh zones and lowered by 0.125 m per best industry practice to delineate these important flow paths. Additionally, roads were loaded in as roughness zones

6.4.2.4 Buildings

OSI Prime 2 mapping has been provided by Fingal CC and used to delineate existing buildings for representation within the model.

While not intended to assess flood risk to buildings, it was pertinent to ensure that buildings are included in the model to ensure that the effect of obstructions to overland flooding and routing of surface water is assessed. In the absence of surveyed floor levels, building footprints have been raised 0.3 m per best industry practice.

Buildings have been assigned a porosity of 0.1 to allow water to flow through them.

6.4.2.5 Surface Roughness

Figure 6-6 summarises the Manning's N values applied to the model that includes both green areas and urban fabric.

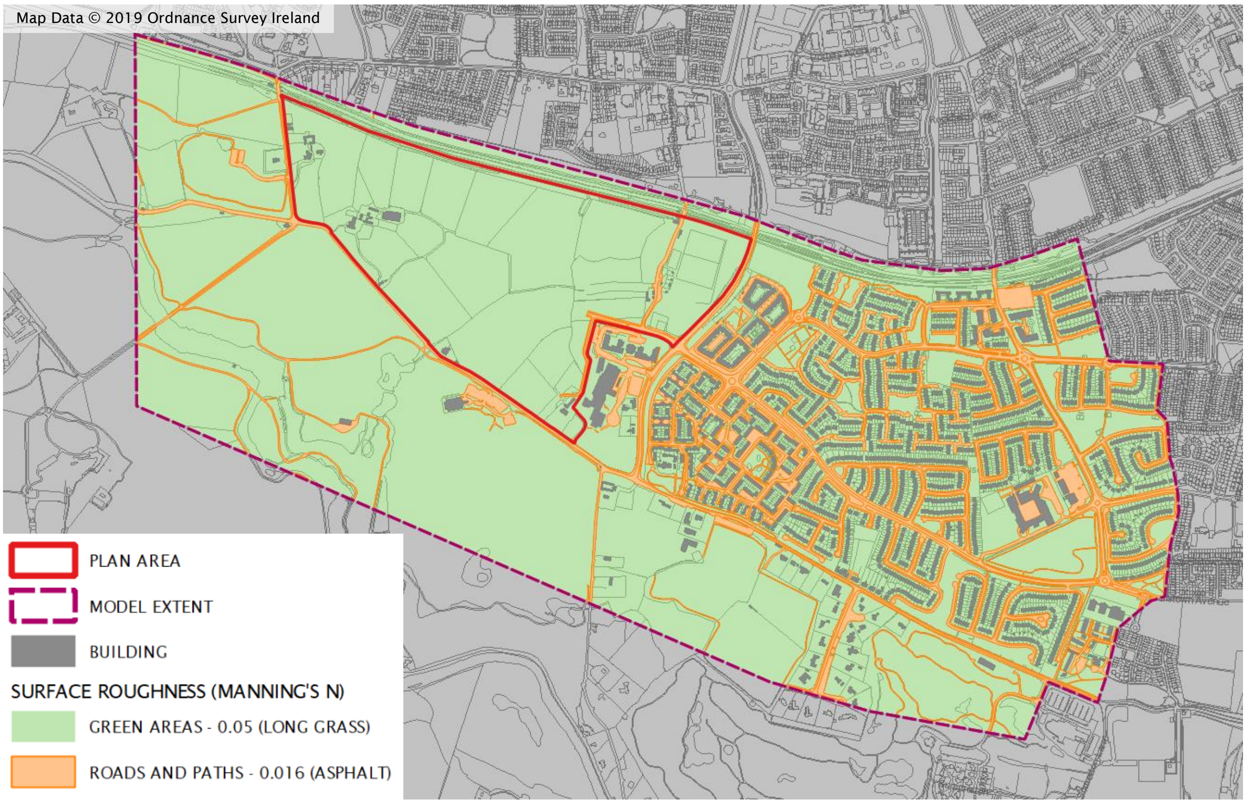


Figure 6-6 Surface Roughness

6.4.2.6 *Surface Infiltration*

Infiltration was applied to the model instead of using effective rainfall due to the varying surface types within the Plan Area and wider catchment which is the adopted methodology in the production of (England and Wales) Environment Agency surface water mapping, adopted as best practice in the absence of particular guidance for Ireland.

Permeable Areas

No site investigation was conducted for the Plan Area. GSI mapping indicated the Plan Area is underlain by Till derived from Limestone, indicating poorly drained soils.

Losses have been applied to permeable areas based upon the 2D Horton Infiltration model included within the InfoWorks ICM software. This model converts the direct rainfall applied to the mesh into a runoff volume which is determined by the parameters set for the surface. The Horton infiltration model was selected as appropriate as it continues to simulate infiltration in the absence of rainfall, i.e. after the event.

Horton infiltration parameters reflective of the underlying soil conditions applied to the model across the wider catchment are detailed in Table 6.3.

Table 6.3 Horton Parameters

Horton Initial (mm/hr)	Horton Limiting (mm/hr)	Horton Decay (1/hour)	Description
25.4	0.64	2	Dry clay soils with little vegetation

Impermeable Areas

A Constant Infiltration model where the maximum theoretical infiltration is given by the function of the infiltration loss coefficient was applied to roads, railway tracks, paths, other hardstanding areas and building surfaces where the surface water sewerage network is not represented. The effective infiltration is determined by the available water volume in the surface.

A runoff coefficient of 95% was adopted for all roads and paths, 80% for railway tracks and 85% for buildings.

As no surface water sewerage is represented throughout the model a typical drainage removal rate of 12 mm/hr has been applied to roads, railways and buildings in line with (England and Wales) Environment Agency Flood Maps for Surface Water updated guidance[4] adopted as best practice in the absence of particular guidance for Ireland, to account for losses to urban drainage systems.

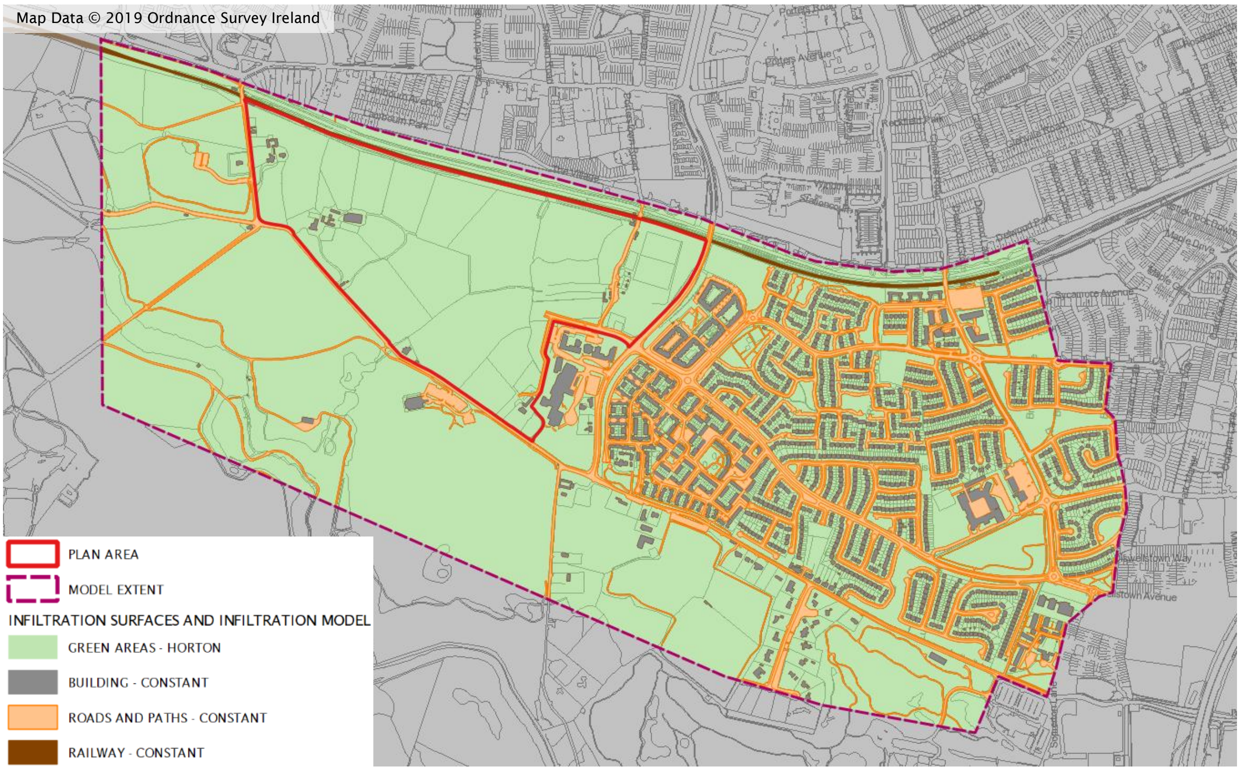


Figure 6-7 Surface Infiltration

6.5 Model Stability

A number of parameters were checked to assess the model stability:

i. The mass balance is considered to give an indicator of model stability and relates to the flow entering and leaving the model. The mass balance values for the 1% and 0.1% AEP events are below 0.005%, which is well within acceptable tolerances.

ii. A review of stage hydrographs was undertaken across the model to locate any significant spikes in graphs that would suggest issues with model stability. A review of graphs indicated that the model exhibited no abnormal stage variations that would tend to indicate a model instability.

A review of the above parameters indicates that the model is stable, allowing substantial confidence in model outputs.

6.6 Model Sensitivity

Model sensitivity analysis was carried out to assess the sensitivity of the simulation to changes in base parameters. The sensitivity testing makes comparisons to the base model and was carried out for the 1% AEP flood event.

[4] Environment Agency (2013) What is the updated Flood Map for Surface Water? Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/297432/LIT_8988_0bf634.pdf Accessed on 25/10/2019.

6.6.1 Sensitivity to Roughness

The sensitivity of the modelled water levels to conduits and overland roughness was assessed by varying the standard values of Manning's n for the base model.

Increasing the roughness value of the 1D conduits by 20% causes no measurable increase in flood levels at the Plan Area. Increasing the roughness value of the 2D Zone by 20% causes an increase in flood level of 0.02 m. Results for the sensitivity testing show no significant differences within the model output – flow paths and flood extents remain largely the same.

The increase in water levels within the 2D zone are generally within acceptable limits. The model therefore does not exhibit a significant sensitivity to roughness variation and would not cause the ultimate finding of the model to be unreliable. Careful consideration has been given to conservatively specifying Manning's n values and there is therefore reasonable confidence in model results.

6.6.2 Sensitivity to 1D Loss Model

The infiltration / loss model to represent surface water sewer losses where no surface water drainage network is represented directly within the model is per normal industry practice by an approved EA methodology (in the absence of an Irish equivalent).

Water levels within the 2D Zone were analysed for sensitivity to the loss model to represent the 1D network. A 2 mm/hr decrease in rates to 10 mm/hr results in an increase of up to 0.007 m within the Plan Area. Subsequently, a 2 mm/hr increase in rates to 14 mm/hr results in a 0.006 m within the Plan Area.

The 1D loss model is per normal industry best practice. There is a limited amount of drained areas within the Plan Area to be represented by the loss model, therefore the is confidence that there model is suitably representative.

6.6.3 Sensitivity to Infiltration

The sensitivity of the model to infiltration elsewhere has been assessed by varying the infiltration parameters on surfaces where parameters have been estimated based on GSI mapping. Horton initial and Horton limiting parameters were varied by +/-20%.

Water levels within the 2D zone were analysed for sensitivity to infiltration. A 20% decrease in Horton infiltration parameters results in an increase of up to 0.02 m in water levels within the Plan Area. Subsequently, a 20% increase in Horton infiltration parameters results in a decrease of up to -0.02 m in water levels.

Horton values have been carefully specified to ensure representative values for the underlying ground conditions are adopted, and there is confidence that the model infiltration is suitably representative. Increases in flood levels due to changes in infiltration parameters are within acceptable limits.

6.6.4 Sensitivity to Rainfall

The design rainfall events were derived using best industry techniques and the most conservative storm durations were selected and there is therefore reasonable confidence in the results. In order to determine the effect of underestimation of rainfall on the model and what could be expected if an extreme event were to occur, the flows in the model have been increased by 30% in line with the OPWs Climate Change Sectoral Adaptation Plan – Flood Risk Management (2015-2019) High End Future Scenario. The hydrograph length / shape is unchanged and there is therefore an overall increase of mass within the model.

Increasing the design rainfall by 30% results in an increase in flood level within the Plan Area 2D Zone of up to 0.19 m. The highest increase in depths within the 2D zone correlate with the pond adjacent to the northern boundary of the Plan Area and the downstream portion of the open drain due to restrictions the ability of rainfall to flow away from these areas.

The model indicates a moderate sensitivity within the 2D zone to increases in rainfall which would not be unexpected with increases to rainfall.

6.6.5 Sensitivity to Downstream Boundary Condition

The downstream boundary of the 2D component of the model is sufficiently located downstream that there is up to a 24 m height difference to the south and 5 m height difference to the south west in favour of the Plan Area preventing any artificial influence on water levels at the Plan Area due to any uncertainty in the 2D downstream boundary condition.

The 2D downstream boundary is therefore considered sufficiently robust against any uncertainty in downstream boundary condition.

6.6.6 Sensitivity to Culvert Blockage

The effect of blockage in the downstream 480 mm x 770 mm arched culvert under the Luttrellstown Road on flood levels in the Plan Area was assessed by blocking the culvert by 50% of its capacity for the 1% AEP rainfall event.

Results indicated no significant increase in in-channel flood levels (<0.02 m) or on lands adjacent to the culvert inlet. The insignificant additional depth over base-conditions is as a result of the blockage backwater effect being limited by the Luttrellstown Road level. In the event of culvert blockage, floodwater would tend to overtop / weir over the road and flow towards Luttrellstown Castle Golf Course. The remainder of the Plan Area is unaffected by the effects of culvert blockage.

Figure 6-8 demonstrates no significant change in flood levels within the Plan Area as a result of culvert blockage.

Figure 6-8 1% AEP + 50% Culvert Blockage Surface Water Change in Depth

6.6.7 Sensitivity Analysis Summary

The results of the sensitivity analysis are generally within acceptable limits and where the model has shown a sensitivity to downstream boundary condition, a conservative approach has been taken.

The sensitivity analysis has demonstrated that the model can be deemed reliable.

6.7 Assumptions and Limitations of Modelling

The representation of any complex system by a model requires a number of assumptions to be made. In the case of the hydraulic model developed for the purposes of the study it is assumed that:

- The terrain model (based on LiDAR and topographical survey information) accurately represents the surface topography and associated flow paths.
- The design rainfall is an accurate representation of rainfall of a given return period.
- Inflows from the Ø500 mm culvert outlet to the open drain are excluded; that culvert is assumed to be redundant or have a limited local drainage function and so flows that may be carried in this drain are instead carried by overland flood routing, and as such the analysis is precautionary.
- Roughness does not vary with time.

The primary limitations of the study are noted as follows:

- The upstream contributing catchment to the Riverwood Storm Outfall has not been calculated in detail due to data gaps in the 1D network. A conservative approach to rationalise the maximum discharge rate estimated based on a full-bore capacity. A sensitivity check was undertaken to ensure that the sewer discharge volume and volume of losses within the upstream sewered area cumulatively do not exceed the volume of rainfall applied to those areas. Where the conservative approach is disproven then predicted water levels on the Plan Area, immediately upstream of the culvert may be unnecessarily conservative, but not to an extent that it materially changes the findings of this assessment.
- The model does not represent any additional out of catchment inflows to the open drain.
- The model does not represent any topographic features smaller than the minimum resolution of the underlying terrain model derived for the area.

6.8 Discussion of Results

6.8.1 Results Processing

Flooding less than 20 mm in depth was removed from model outputs in line with best practice for pluvial flood mapping. The results were processed using a similar methodology to the (England and Wales) Environment Agency Flood Maps for Surface Water updated guidance[5], in the absence of a similar guidance document for such work in Ireland. The following filters were used on model outputs:

- Removed flood areas with a very low hazard rating below 0.575
- Removed areas of flooding with a total area of less than 100 m^2
- Filled in isolated dry areas (within a larger flooded area) of less than 50 m^2

6.8.2 Present Day Results

The modelling undertaken shows the Plan Area is affected by pluvial/overland flooding. The primary flood mechanism is direct rainfall falling onto the surface and routing towards / gathering in relative depressions.

The main surface water flow path is from lands within the north east of the Plan Area that tend in a southerly direction towards the open drain and a low point in the south-east corner adjacent to the Luttrellstown Road. In the west of the Plan Area water tends to gather in a localised depression bounded by the relatively raised Luttrellstown Road to the south and Clonsilla Road to the west.

The following Figure 6-9 provides an indication of the flood routing through the Plan Area to the open drain and south west corner.

[5] Environment Agency (2013) What is the updated Flood Map for Surface Water? Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/297432/LIT_8988_0bf634.pdf Accessed on 24/10/2019.

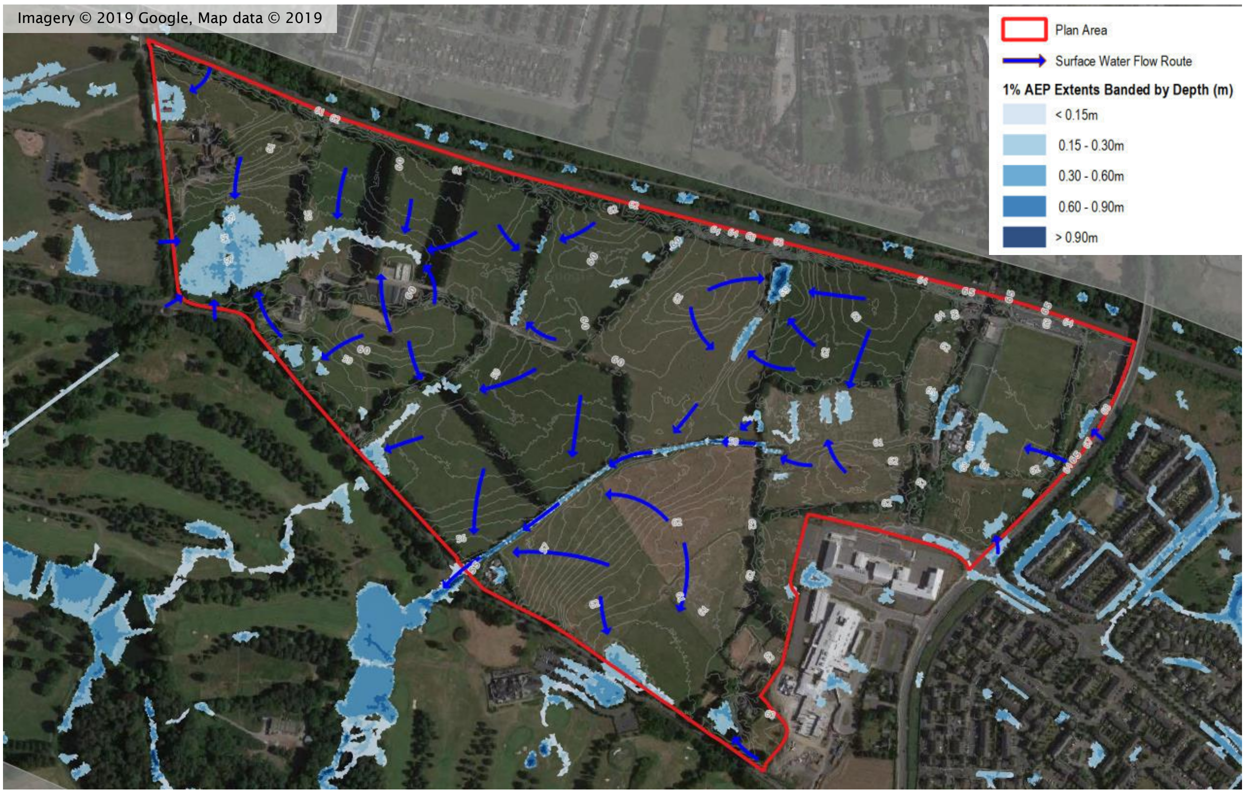


Figure 6-9 1% AEP Event Flood Routing

Detailed flood mapping for the Plan Area in Appendix C provide overland surface water flood levels for the 1% and 0.1% AEP events pertinent to design considerations within the Plan Area.

6.8.3 Climate Change

As outlined previously, the hydraulic model has been simulated with and uplift in rainfall of 20% and 30% in line with the OPW's Mid Range and High End future climate change scenarios, respectively, to ascertain existing climate change flood levels and extents.

The effect of climate change results in further intensification of the flow paths. Flood maps for each return period including allowance for climate change showing the full extent of flooding and flood levels within the Plan Area and surrounding lands are included in Appendix C.

7 SUMMARY OF FINDINGS AND RECOMMENDATIONS

7.1 Summary of Model Findings

The detailed flood risk assessment has determined that surface water (pluvial) flooding in combination with the effect of existing adjacent urban drainage infrastructure has potential to affect the Plan Area for floods of magnitude (probability) relevant to flood protection standards set out in the OPW Guidelines and Fingal SFRA.

The most significant source of flooding to the Plan Area is that of pluvial flooding from direct rainfall onto the ground surface. The Plan Area is affected by surface water flooding during the 1% and 0.1% AEP rainfall events for the present day scenario. The effect of climate change would be anticipated to cause flood levels at and adjacent to the Plan Area to rise.

Predicted surface water flood levels are summarised as follows:

Table 7.1 Flood Level Summary

Event Probability	Open Drain Flood Levels (m OD)	Wider Plan Area Flood Levels (m OD)
1% AEP Present Day	59.90 - 54.97	61.92 – 54.97
1% AEP – MRFS (+20%)	59.94 - 55.03	61.94 – 55.03
1% AEP – HEFS (+30%)	59.95 - 55.05	61.94 – 55.05
0.1% AEP Present Day	59.98 - 55.09	61.96 – 55.09
0.1% AEP – MRFS (+20%)	60.02 - 55.14	61.99 – 55.14
0.1% AEP – HEFS (+30%)	60.05 - 55.16	62.00 – 55.16

No other significant flood mechanism exists at the Plan Area.

7.2 Development Land Use Zoning Compatibility

The land zoning objectives within the Fingal Development Plan for the Plan Area have been identified in section 2.5 as RA – Residential Area and OS – Open Space.

As the flooding mechanism within the Plan Area is pluvial / urban drainage, then no flood zones as defined by the OPW Guidelines or Fingal SFRA applies. Therefore, no plan-making justification test is required to establish the principle of suitability of the lands for development.

7.3 Recommendations

While no restriction to land use is directed by the OPW Guidelines or Fingal SFRA, there remains an onus on any planned development to:

- Ensure that the proposal is flood resilient.
- Ensure that the proposal causes no increased flood risk that would cause an adverse effect elsewhere.

Management of internal surface water runoff within the Plan Area (i.e. surface water from development) shall be managed in accordance with the Sustainable Drainage Strategy (SDS) component of the Surface Water Management Plan (SWMP), the outcomes of which are informed by this SFRA.

Measures designed to manage flood risk connected to existing pluvial flooding are set out within the following sections. Recommendations are intended to inform plan-making for the lands, and / or any subsequent Site-Specific Flood Risk Assessment (SSFRA) for a planning application.

Figure 7-1 indicates the areas of surface water runoff that are to be managed by the Sustainable Drainage Strategy of the SWMP and the areas of surface water flood risk that are to be managed by recommendations set out in this SFRA.

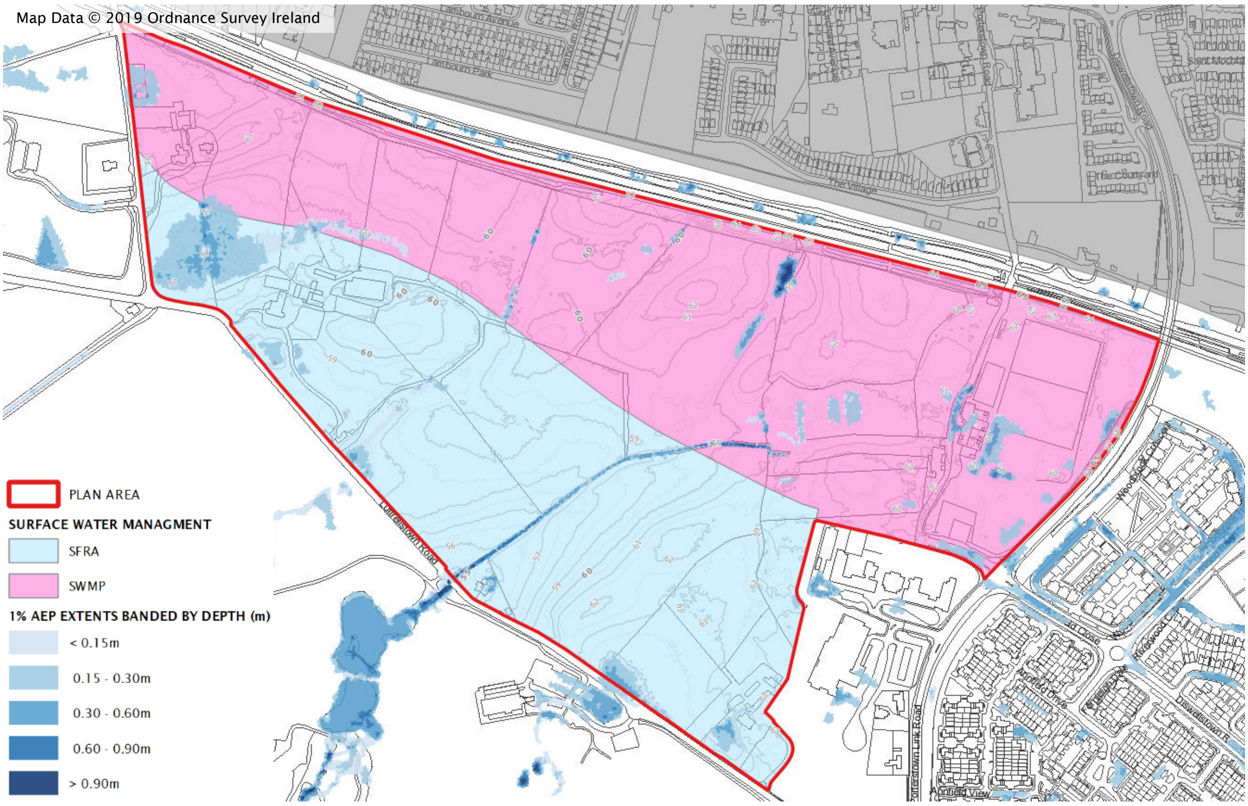


Figure 7-1 Surface Water Management

7.3.1 Design Levels

Guidance from the Fingal SFRA relevant to specifying of design levels is designed as follows:

- The minimum finished floor level (FFL) for highly vulnerable development should be above the 0.1% AEP event level plus suitable freeboard, whereby the recommended level of freeboard is 500 mm over and above the adjacent 0.1% AEP [*fluvial*] flood level.
- The minimum FFL for less vulnerable development should be above the 1% AEP event level plus suitable freeboard whereby the recommended level of freeboard is 500 mm over and above the adjacent 1% AEP [*fluvial*] flood level.

While the guidance states that it is to be applied to fluvial flood levels, it is considered appropriate and prudent to apply the freeboard requirements to the relevant return periods for pluvial flood levels.

Lands within the Plan Area are subject to a R1 (residential) zoning objective under the Fingal Development Plan which is classified as ‘highly vulnerable’. Therefore, all residential dwellings and associated essential infrastructure shall be sited with a 500 mm freeboard relative to the adjacent 0.1% AEP surface water flood level as shown on flood mapping (Ref.: M02127-02_FL02) or as may be changed where development proposals include works to the drains that affects predicted flood levels.

Any ‘less vulnerable’ development, such as commercial development or local transport infrastructure, shall be sited with a 500 mm freeboard relative to the adjacent 1% AEP surface water flood level as shown on flood mapping (Ref.: M02127-02_FL01) or as may be changed where development proposals include works to the drains that affects predicted flood levels.

While no flood zoning applies to the Plan Area, it is recommended that water compatible development such as open, amenity space is considered for areas affected by surface water flooding.

The Fingal SFRA also states the following:

- A precautionary approach to climate change includes recommendations to ensure that levels of structures designed to protect against flooding (such as flood defences or raised floor levels) are sufficient to cope with the effects of climate change over the lifetime of the development.

Therefore, proposals for the Plan Area should be tested against future climate change as well as culvert blockage scenarios at the Development Management stage to ensure that finished floor levels of structures are able to withstand their effects over the design life of the proposed development.

As well as the above, any SSFRA should consider the potential impact of development on lands elsewhere, particularly where any development within the existing pluvial flood extents is proposed.

It is recommended that additional scenarios and impact of the development are based on detailed hydraulic modelling as part of a SSFRA.

7.3.2 Protection and Maintenance of Drain

It is recommended that the open drain (as mapped on Figure 4-3) within the Plan Area should be maintained and protected as an open channel on its present alignment or alternative diverted form as it serves as a drainage function to a wider area extending beyond the Plan Area. It is recommended that:

- A minimum 10 m wide riparian buffer strip each side of the channel should be provided to allow access for maintenance and encourage biodiversity.
- Ownership and maintenance obligations are established, and provision should be made by the relevant party for preventative inspection and maintenance of the channel and culverted sections.

Any proposal to realign, divert, increase the dimension of, or otherwise alter the drain or culvert should be subject to robust hydraulic modelling and a flood risk assessment to assess the effect of such a proposal on flood risk at the Plan Area and elsewhere.

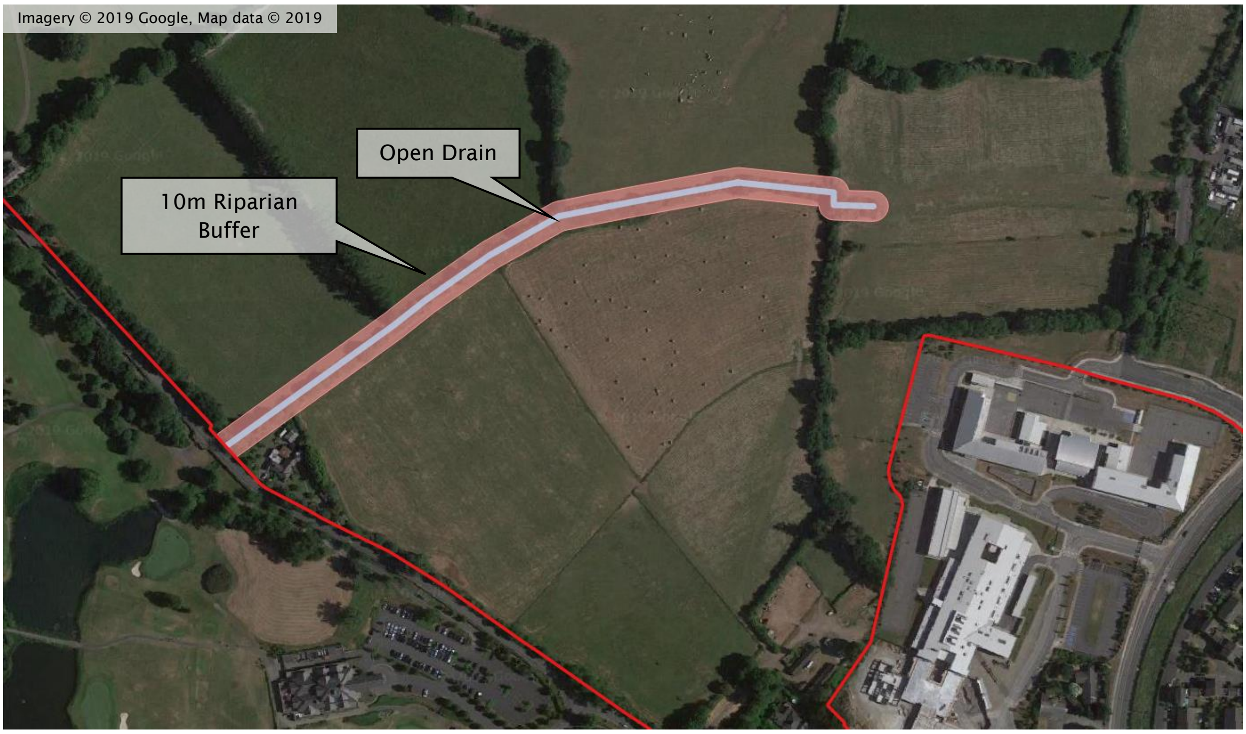
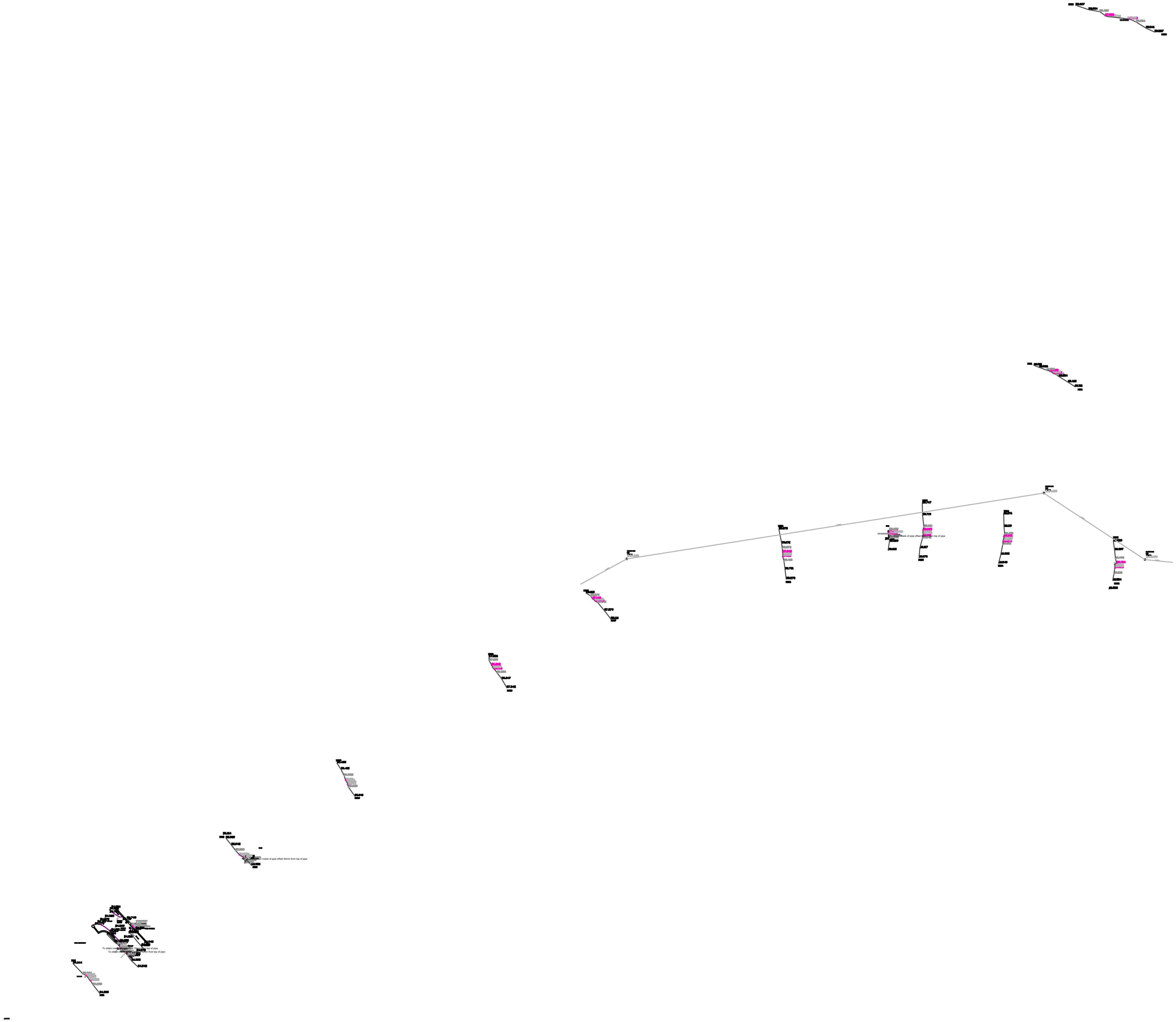


Figure 7-2: Open Drain Riparian Buffer

Appendix A

Topographical Survey


To obtain inside of pipe offset 40mm from top of pipe

Appendix B

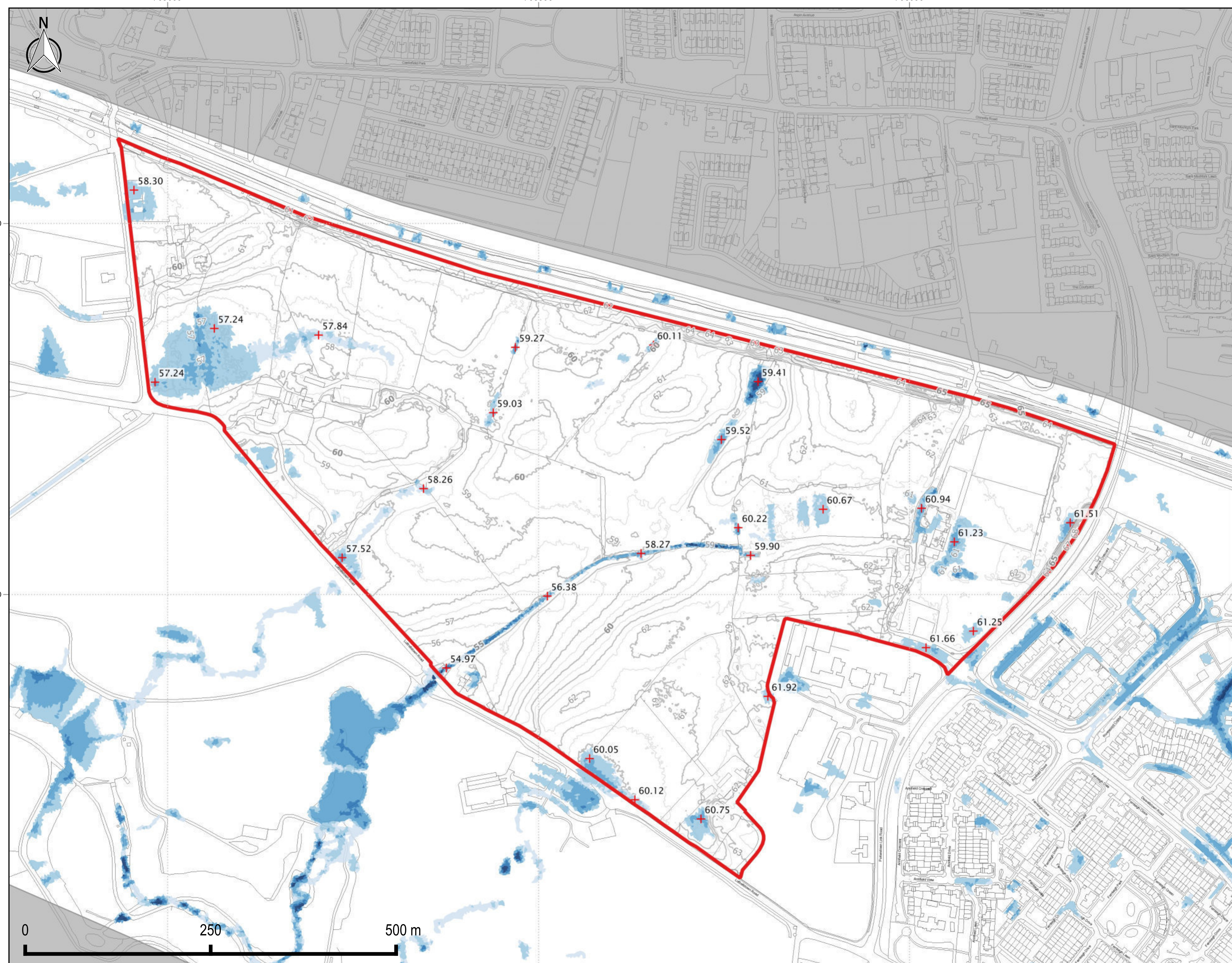
Plan Area Photographs

Photo Location 1: View of Plan Area from Eastern Boundary	Photo Location 2: View of Plan Area from Southern Boundary
	
Photo Location 3: View of Plan Area from Northern Boundary	**Photo Location 4:** View of Plan Area from Western Boundary
	
Photo Location 5: View of 'Pond' locaton along Northern Boundary of the Plan Area	**Photo Location 6:** View of Royal Canal along Northern Boundary of the Plan Area
	

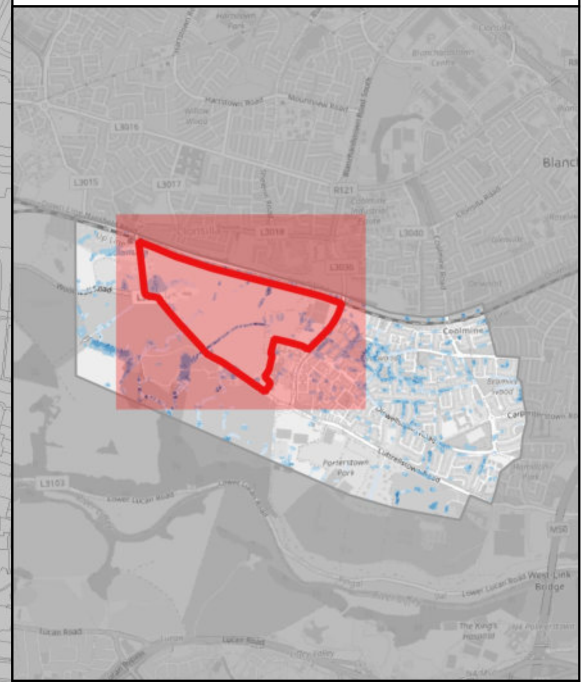
Photo Location 7: View of Open Drain in Northern part of the Plan Area	Photo Location 8: View of Open Drain in Southern part of the Plan Area
	
Photo Location 9: **View of 500 mm 'dry pipe' at Open Drain along Southern Boundary of the Plan Area**	**Photo Location 10:** **View of Open Drain crossing beneath Luttrellstown Road**
	
Photo Location 11: **View of Pipe beneath Luttrellstown Road within Luttrellstown Castle Golf Course**	**Photo Location 12:** **View of Pond / Lake within Luttrellstown Castle Golf Course**
	

Appendix C

Flood Maps



MODEL OVERVIEW



LEGEND

SFRA SITE AREA

FLOOD LEVELS (m OD)

FLOOD EXTENTS BANDED BY DEPTH (m)

- < 0.15m
- 0.15 - 0.30m
- 0.30 - 0.60m
- 0.60 - 0.90m
- > 0.90m

NOTES
1. ALL LEVELS INDICATED ARE TO ORDNANCE DATUM MALIN.

2. ALL GRID COORDINATE INFORMATION IS TO IRISH GRID.

3. FLOOD EXTENTS HAVE BEEN PROCESSED IN LINE WITH SURFACE WATER FLOOD MAPPING BEST PRATICE.

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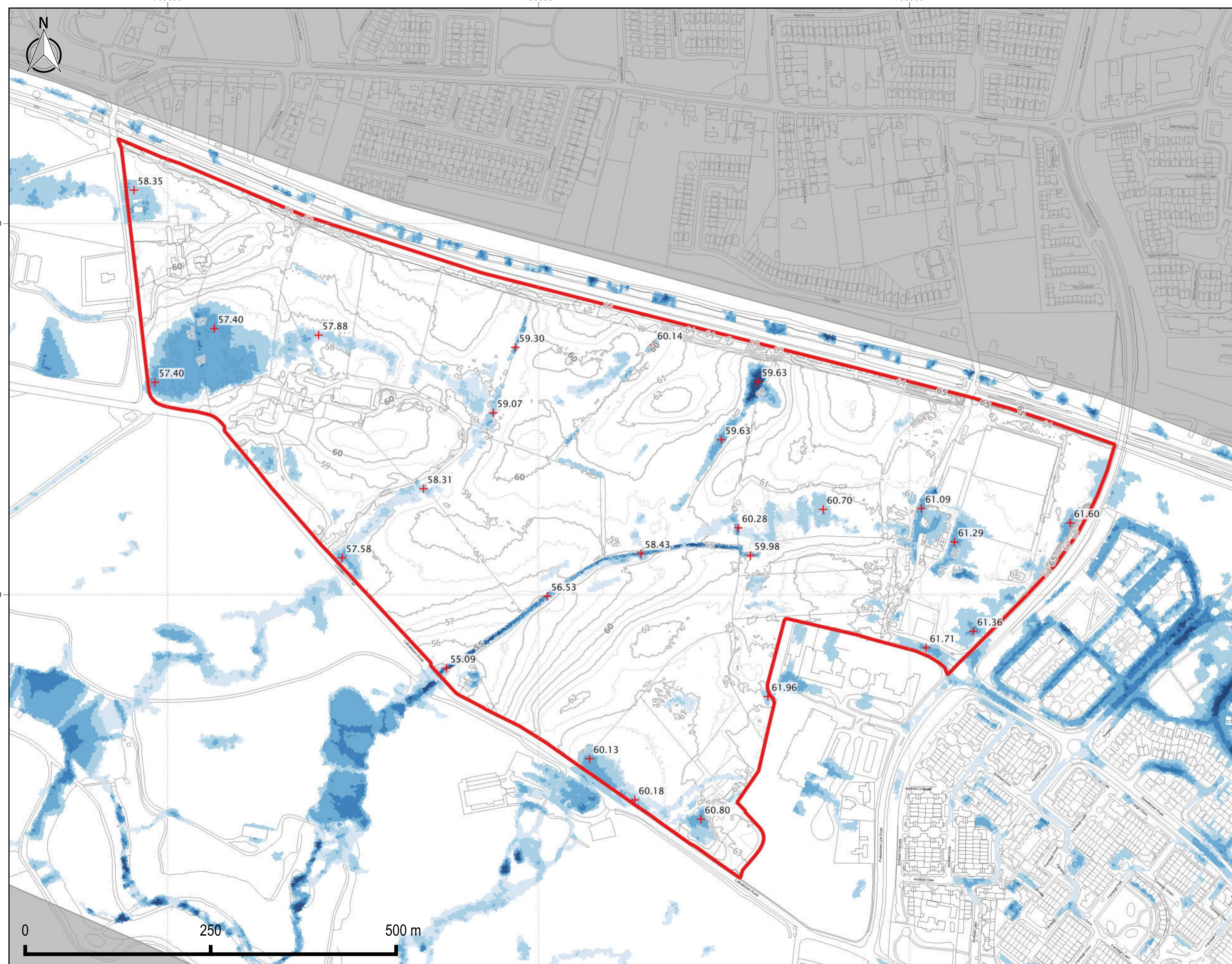
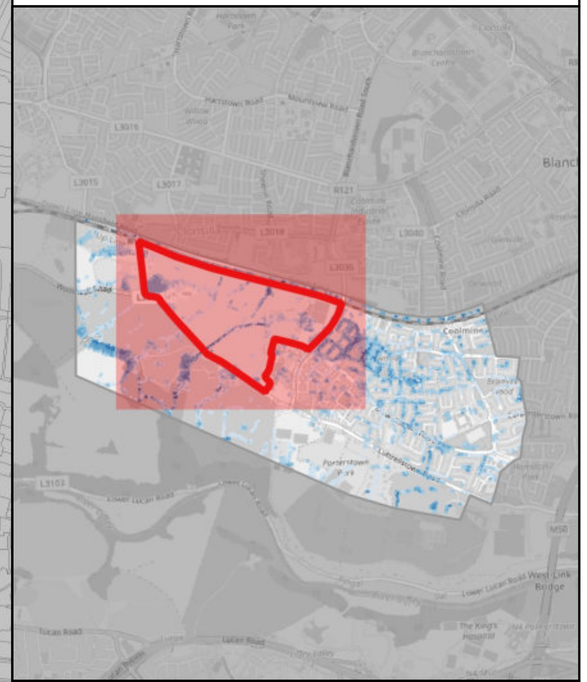
PROJECT		HYDROLOGY SCENARIO	SCALE	ORIGINAL SIZE
KELLYSTOWN, CLONSILLA, DUBLIN 15		PRESENT DAY	1:5000	A3
MAP TYPE		GEOMETRY SCENARIO	DRAWN BY	APPROVED
FLOOD EXTENT / DEPTH MAPPING		PRESENT DAY / UNDEFENDED	MR	DKS
SOURCE	FLOOD EVENT	FIGURE NUMBER	REVISION	DATE
PLUVIAL	1% AEP	M02127-02_FIG_FL01	2	14/08/2020



MODEL OVERVIEW



LEGEND

- SFRA SITE AREA
- + FLOOD LEVELS (m OD)

FLOOD EXTENTS BANDED BY DEPTH (m)

- < 0.15m
- 0.15 - 0.30m
- 0.30 - 0.60m
- 0.60 - 0.90m
- > 0.90m

NOTES

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3. FLOOD EXTENTS HAVE BEEN PROCESSED IN LINE WITH SURFACE WATER FLOOD MAPPING BEST PRATICE.

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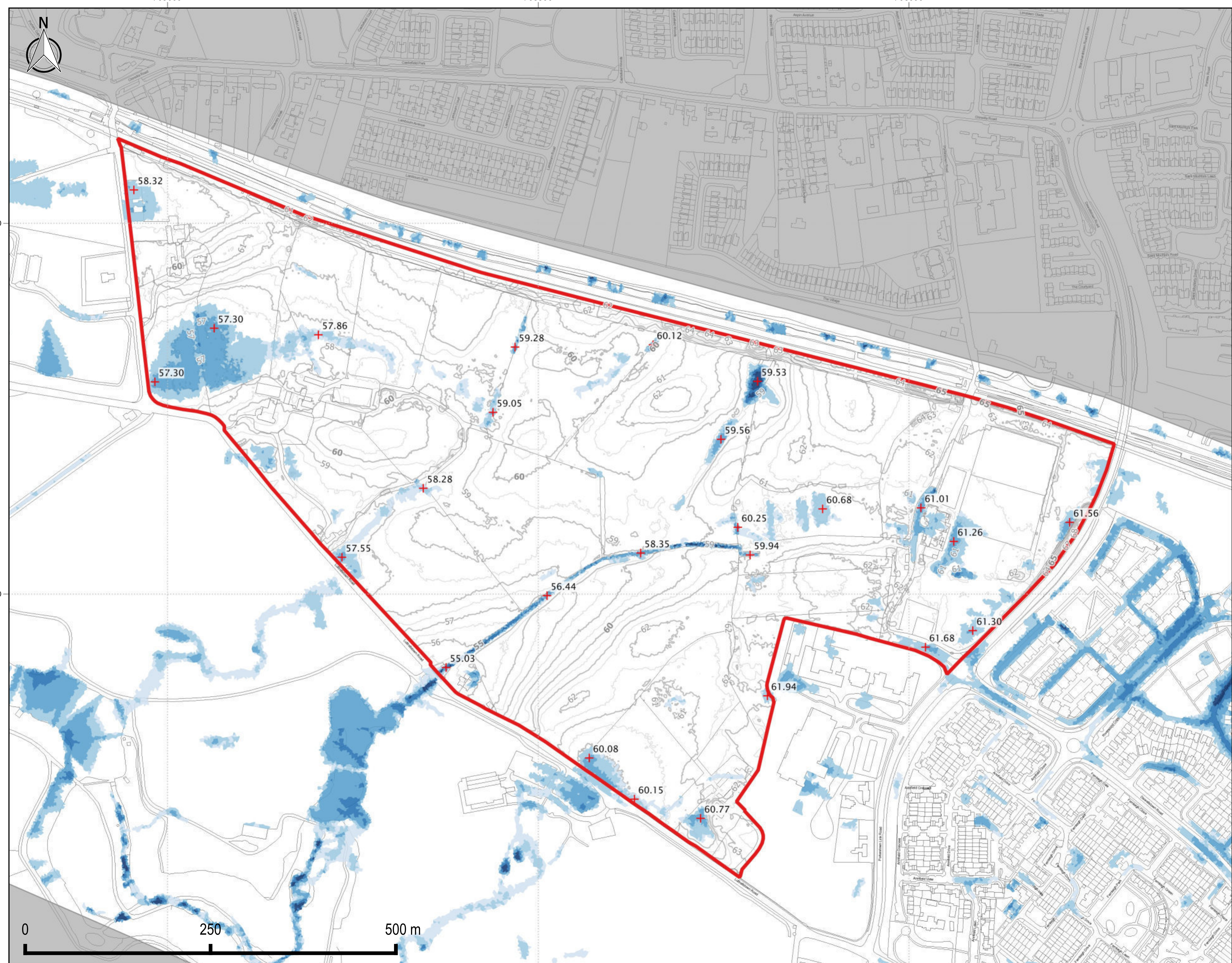
PROJECT KELLYSTOWN, CLONSILLA, DUBLIN 15		**HYDROLOGY SCENARIO** PRESENT DAY	**SCALE** 1:5000	**ORIGINAL SIZE** A3
MAP TYPE FLOOD EXTENT / DEPTH MAPPING		**GEOMETRY SCENARIO** PRESENT DAY / UNDEFENDED	**DRAWN BY** MR	**APPROVED** DKS
SOURCE PLUVIAL	**FLOOD EVENT** 0.1% AEP	**FIGURE NUMBER** M02127-02_FIG_FL02	**REVISION** 2	**DATE** 14/08/2020



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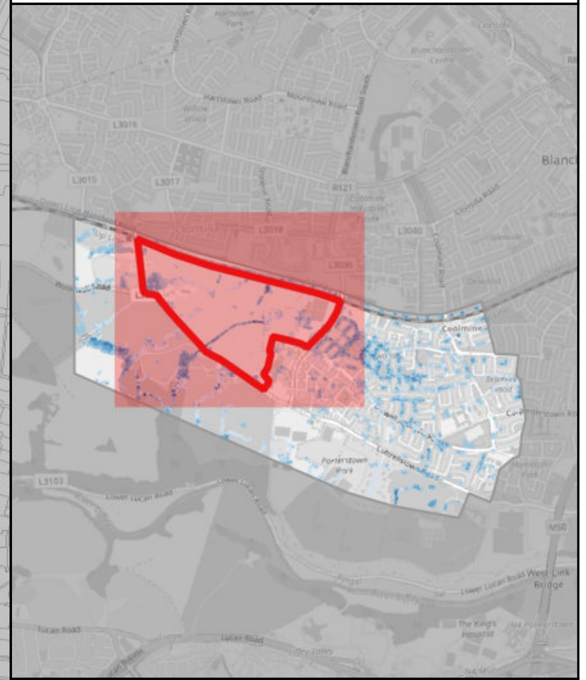

LEGEND

- SFRA SITE AREA
- + FLOOD LEVELS (m OD)

FLOOD EXTENTS BANDED BY DEPTH (m)

- < 0.15m
- 0.15 - 0.30m
- 0.30 - 0.60m
- 0.60 - 0.90m
- > 0.90m

NOTES
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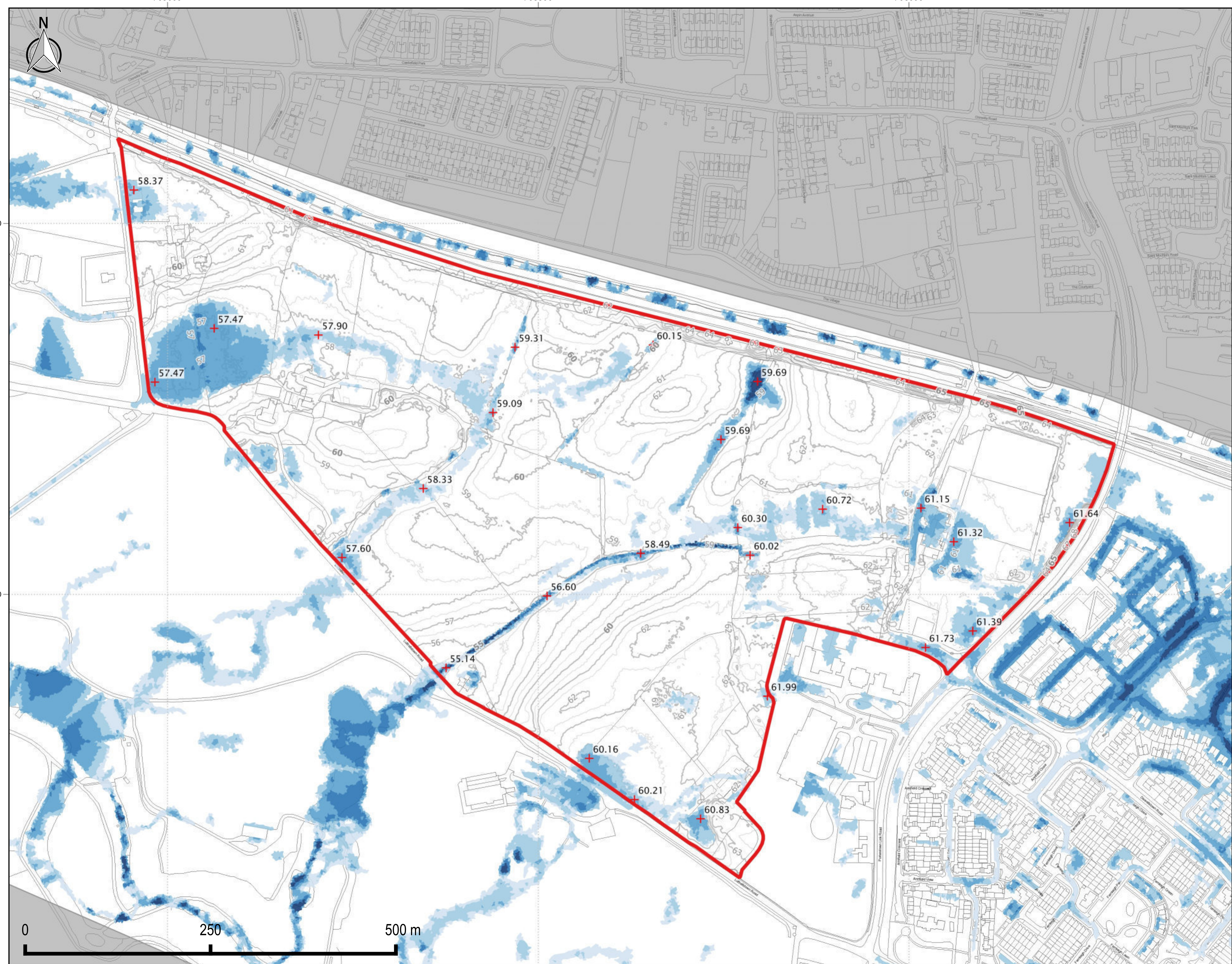
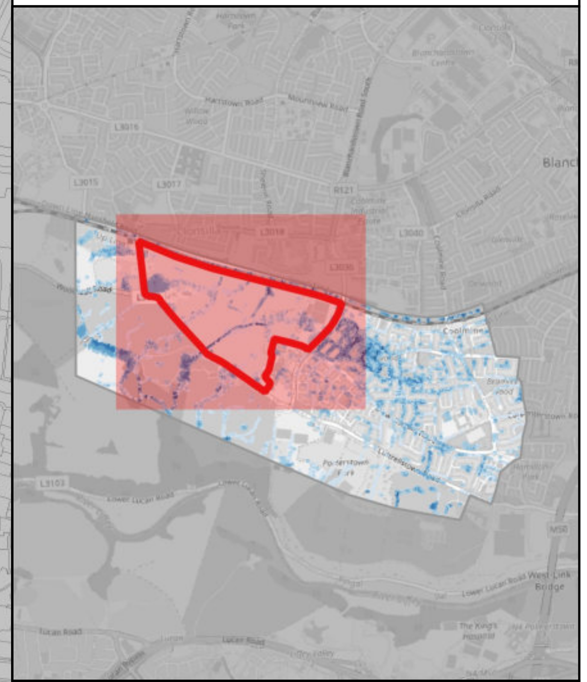
PROJECT		HYDROLOGY SCENARIO	SCALE	ORIGINAL SIZE
KELLYSTOWN, CLONSILLA, DUBLIN 15		MID RANGE FUTURE SCENARIO (+20%)	1:5000	A3
MAP TYPE		**GEOMETRY SCENARIO**	**DRAWN BY**	**APPROVED**
FLOOD EXTENT / DEPTH MAPPING		PRESENT DAY / UNDEFENDED	MR	DKS
SOURCE	**FLOOD EVENT**	**FIGURE NUMBER**	**REVISION**	**DATE**
PLUVIAL	1% AEP + 20%CC	M02127-02_FIG_FL03	2	14/08/2020



MODEL OVERVIEW



LEGEND

- SFRA SITE AREA
- + FLOOD LEVELS (m OD)

FLOOD EXTENTS BANDED BY DEPTH (m)

- < 0.15m
- 0.15 - 0.30m
- 0.30 - 0.60m
- 0.60 - 0.90m
- > 0.90m

NOTES
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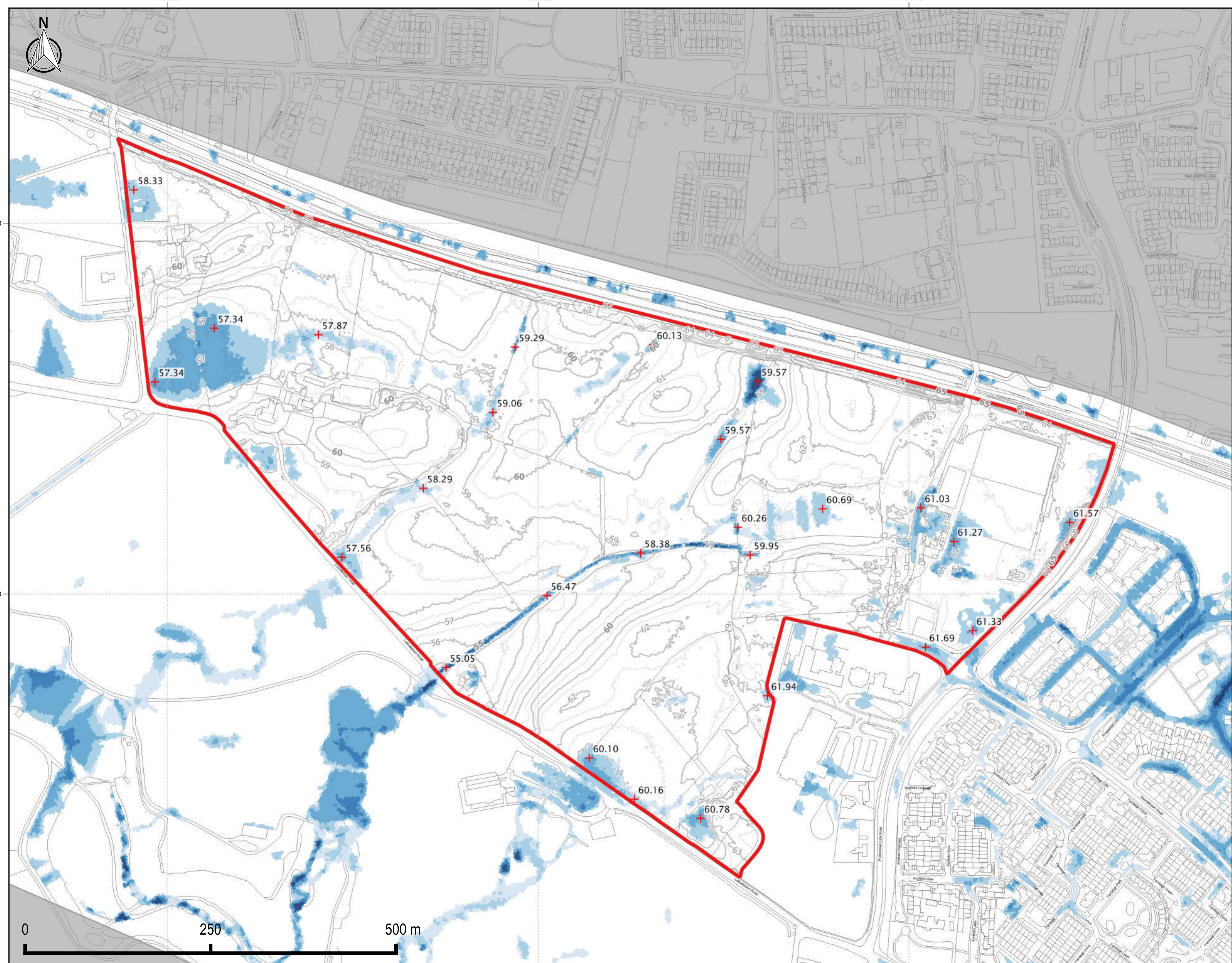
PROJECT KELLYSTOWN, CLONSILLA, DUBLIN 15	HYDROLOGY SCENARIO MID RANGE FUTURE SCENARIO (+20%)	SCALE 1:5000	ORIGINAL SIZE A3
MAP TYPE FLOOD EXTENT / DEPTH MAPPING	GEOMETRY SCENARIO PRESENT DAY / UNDEFENDED	DRAWN BY MR	APPROVED DKS
SOURCE PLUVIAL — FLOOD EVENT 0.1% AEP + 20%CC	FIGURE NUMBER M02127-02_FIG_FL04	REVISION 2	DATE 14/08/2020



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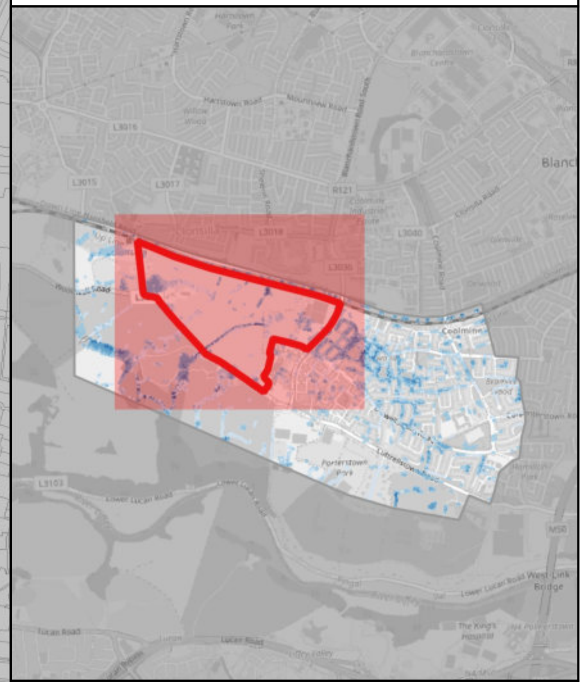

LEGEND

SFRA SITE AREA

FLOOD LEVELS (m OD)

FLOOD EXTENTS BANDED BY DEPTH (m)

- < 0.15m
- 0.15 - 0.30m
- 0.30 - 0.60m
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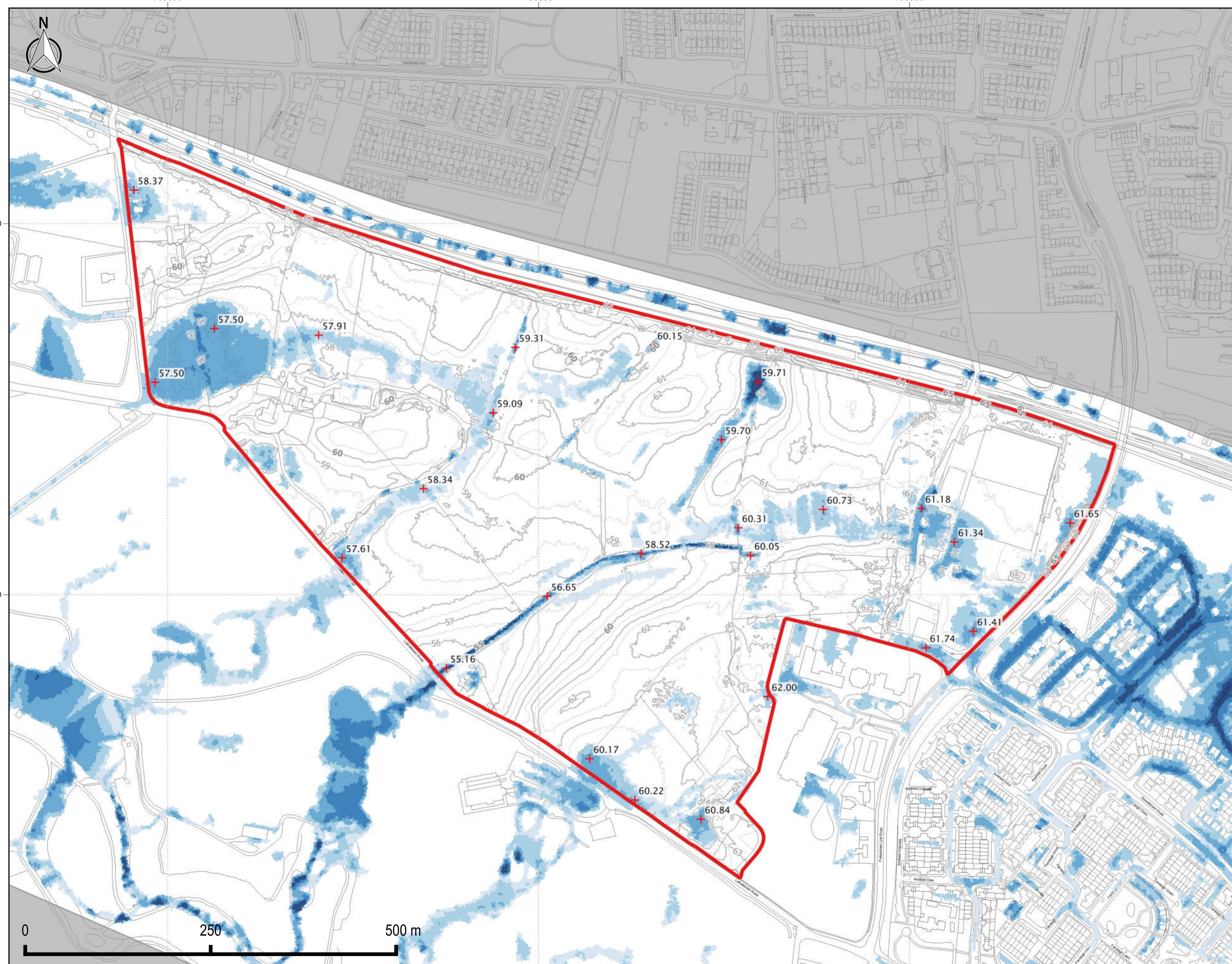
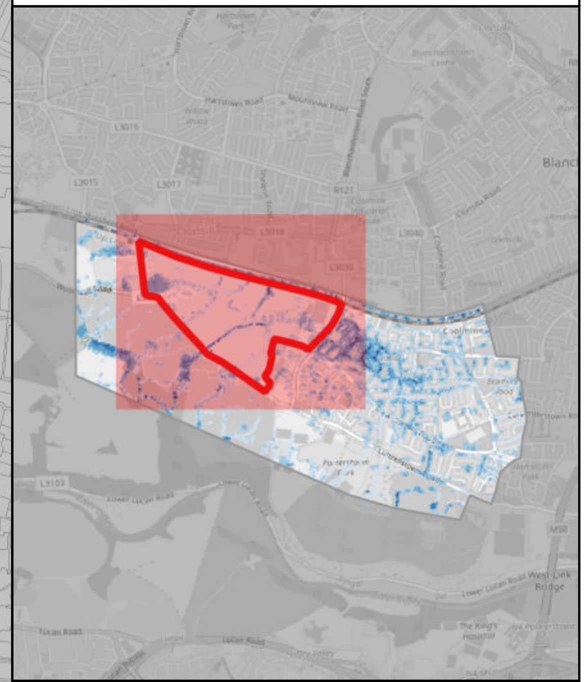
PROJECT		HYDROLOGY SCENARIO	SCALE	ORIGINAL SIZE
KELLYSTOWN, CLONSILLA, DUBLIN 15		HIGH END FUTURE SCENARIO (+30%)	1:5000	A3
MAP TYPE		**GEOMETRY SCENARIO**	**DRAWN BY**	**APPROVED**
FLOOD EXTENT / DEPTH MAPPING		PRESENT DAY / UNDEFENDED	MR	DKS
SOURCE	**FLOOD EVENT**	**FIGURE NUMBER**	**REVISION**	**DATE**
PLUVIAL	1% AEP + 30%CC	M02127-02_FIG_FL05	2	14/08/2020



MODEL OVERVIEW



LEGEND

- SFRA SITE AREA
- + FLOOD LEVELS (m OD)

FLOOD EXTENTS BANDED BY DEPTH (m)

- < 0.15m
- 0.15 - 0.30m
- 0.30 - 0.60m
- 0.60 - 0.90m
- > 0.90m

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PROJECT		HYDROLOGY SCENARIO	SCALE	ORIGINAL SIZE
KELLYSTOWN, CLONSILLA, DUBLIN 15		HIGH END FUTURE SCENARIO (+30%)	1:5000	A3
MAP TYPE		**GEOMETRY SCENARIO**	**DRAWN BY**	**APPROVED**
FLOOD EXTENT / DEPTH MAPPING		PRESENT DAY / UNDEFENDED	MR	DKS
SOURCE	**FLOOD EVENT**	**FIGURE NUMBER**	**REVISION**	**DATE**
PLUVIAL	0.1% AEP + 30%CC	M02127-02_FIG_FL06	2	14/08/2020

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Sustainable Drainage Strategy

Lands at Kellystown, Clonsilla, Dublin 15

M02127-02_DG02 | September 2020

WATER & ENVIRONMENTAL CONSULTANTS

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CLIENT CONTACT	Daragh Sheedy
PROJECT MANAGER	Anthony McCloy
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3	01/09/2020	PS	AMC	AMC	Minor Amendments per Fingal CC Comments	Draft for Consultation

DISTRIBUTION

Recipient	Revision					
	1	2	3	4	5	6
FILE	✓	✓	✓			
Fingal County Council	✓	✓	✓			

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LIST OF FIGURES

APPENDICES

1 INTRODUCTION

1.1 Terms of Reference

This Sustainable Drainage Strategy (SDS) was commissioned by Fingal County Council (hereafter *Fingal CC*) to form a Surface Water Management Plan (SWMP) in conjunction with a Strategic Flood Risk Assessment (SFRA) for lands at Lands at Kellystown, Clonsilla, Dublin 15 (hereafter *Plan Area*).

1.2 Introduction

Sustainable Drainage Systems or SuDS is a way of managing rainfall that minimises the negative impacts on the quantity and quality of runoff whilst maximising the benefits of amenity and biodiversity for people and the environment as defined in The SuDS Manual C753 (2015)[1] published by CIRIA.

SuDS, if designed correctly, has the ability to deliver multiple benefits. The layout of SuDS should consider the inter-relationships with the following aspects of the Plan Area (all of which have delivery objectives which are compatible with delivery of wider planning objectives including:

- Biodiversity
- Parks, Open Space and Recreation
- Sustainable Water Management
- Archaeological and Architectural Heritage
- Landscape

The SDS outlines the preferred approach for the management of rainfall runoff within the development to ensure no increase in flood risk to any development at the Plan Area or elsewhere with delivery of wider water quality, amenity and biodiversity benefits.

1.3 Sustainable Drainage Strategy Objectives

The purpose of the SDS is to set out a framework for the delivery of a drainage system which will integrate multi-functional SuDS components within the Plan Area to manage water at or near the surface, providing high quality blue / green infrastructure which enhances and improves biodiversity and brings significant community benefits within developed areas.

The layouts and components as depicted within the SDS are not fixed and there is flexibility as to how the final layout will be defined. The proposed development should carefully consider the findings and recommendations of the SDS when developing outline and detailed layouts.

The SDS seeks to demonstrate that the objectives set out in Fingal Development Plan (2017 – 2023) and requirements set out in GDSDS (Volume 3) SuDS Requirements can be satisfied.

The Fingal Development Plan 2017-2013 sets out the following objectives which relate directly to the delivery of SuDS or where delivery of the objective can be (in part) facilitated through the provision of suitably designed and constructed SuDS.

- SW01, SW04, SW06, SW10
- CC01
- NH32, NH34, NH36,
- GI11, GI02, GI03, GI04, GI07, GI08

The SDS is in line with the requirements and criteria set out in the Greater Dublin Strategic Drainage Study (GDSDS) (2005) and the Greater Dublin Regional Code of Practice for Drainage Works (2012) and ensures that drainage from the Plan Area is managed sustainably.

[1] CIRIA (2015). The SuDS Manual C753. [online] Available at: https://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx [Accessed 20 May 2019]

As well as establishing water quantity and quality criteria, discussed later in this report, the GDSDS provides the following definitions:

- *SuDS involve a change in our way of managing urban run-off from solely looking at volume control to an integrated multi-disciplinary approach which addresses water quality, water quantity, amenity and habitat (Vol 3 p.132)*
- *SuDS minimise the impacts of urban runoff by capturing runoff as close to source as possible and then releasing it slowly (Vol 3 p.133)*

In addition, the SDS is prepared generally in accordance with industry guidance - The SuDS Manual C753 (published by CIRIA 2015) and the SuDS Design and Evaluation Guide (produced by McCloy Consulting and Robert Bray Associates 2017).

Requirements for climate change allowances are as per OPW 'General Map User Guidance Notes'[2].

[2] OPW (2019) General Map User Guidance Notes (2019) Available at: https://www.floodinfo.ie/map/general_map_user_guidance_notes/ [Accessed 18 June 2019]

2 PLAN AREA DETAILS

2.1 Plan Area Location

Refer to Section 2.1 of the SFRA.

2.2 Plan Area Description

Refer to Section 2.2 of the SFRA.

2.3 Proposed Development

Notwithstanding particular objectives of the Local Area Plan that this assessment is intended to inform, Zoning objectives contained within the Fingal Development Plan 2017 – 2023 are shown in Section 2.5 in the SFRA.

In line with zoning objectives, development proposals for the Plan Area will include the construction of residential properties, commercial areas, open space and associated infrastructure. The proposed development will lead to an increase to the extent of impermeable areas within the Plan Area, resulting in an increased rate and volume of runoff when compared to the existing scenario.

2.4 Geology and Hydrogeology

Geological Survey of Ireland mapping has been reviewed and the following noted:

- Geological mapping indicates that the Plan Area is predominantly underlain by a bedrock of limestone and shale with superficial deposits of till derived from limestone.
- A borehole is located approximately 450 m to the north of the Plan Area.
- The Plan Area is noted as having a high vulnerability for groundwater to be contaminated by human activities.
- Areas within the northern and southern extent of the Plan Area are situated within a locally important aquifer area where bedrock is moderately productive only in local zones. The central extent is situated within a poor aquifer area where bedrock is generally unproductive except for local zones.
- The Plan Area is situated within the Liffey and Dublin Bay WFD catchment.

No Site Investigation (SI) or infiltration testing has been conducted within the Plan Area.

2.5 Water Environment

Refer to Section 2.3 of the SFRA.

2.6 Drainage Infrastructure

Refer to Section 4.5.1 of the SFRA.

2.7 Existing Utilities

With exception of surface water sewers (discussed subsequently), no other utility records have been provided for the purposes of undertaking the SDS. Whilst the Plan Area is currently undeveloped, there is potential for presence of further utilities (including additional surface water) within the Plan Area.

For the purposes of the SDS, the conceptual layout does not give material consideration to exact location of existing utilities. Any existing utilities which cannot be relocated or abandoned will have to be considered prior to progressing outline / detailed design (including SuDS design) for the Plan Area.

2.8 Plan Area Constraints

Table 2-1 summarises the constraints / parameters which will inform the development of the SDS.

Table 2-1 Plan Area Constraints / Parameters

Attribute	Comments	Confidence in Info (L/M/H)	Comment / Influence on SuDS design
Flooding	Flood risk at the Plan Area is assessed in the SFRA.	H	Hydraulic model results, presented in the SFRA, have determined existing flow routes, informed modified flow routes and pluvial flow routes and extents should be considered at all stage of design.
Existing Drainage Infrastructure	A 1200 mm diameter surface water sewer known as the 'Riverwood Storm Outfall' traverses the south eastern section of the Plan Area. An open drain runs from north to south through the eastern part of the Plan Area The open drain is culverted for agricultural access at the centre of the Plan Area and discharges through an arch culvert beneath of Luttrellstown Road.	M	A detailed drainage strategy will be required to ensure that any 'off-site' drainage function served by existing assets within the Plan Area is preserved. A recommendation of the SFRA is to maintain and protect the open drain as an open channel on its present alignment or alternative diverted form as it serves as a drainage function to a wider area extending beyond the Plan Area.
Utilities	Other utilities may be present –location unknown.	L	CAT scan / trial pits required – extent dependent on options taken to detailed design.
Topography	Based on topographical survey and LiDAR data, overall levels vary between 54 metres Ordnance Datum (m OD) to 64 m OD generally falling from north east to south west.	H	The topography will influence the existing and modified flow routes / management train.
Land use existing and proposed	Used predominantly as agricultural land with residential dwellings to the west and sports pitches to the east. Proposals include the development of residential area, commercial units, open space and associated infrastructure	H	SuDS components / design should be compatible with residential and commercial development design and landscape character.
Size of Plan Area	Plan Area is approximately 57 ha.	H	

Attribute	Comments	Confidence in Info (L/M/H)	Comment / Influence on SuDS design
Ground Contamination	No Site Investigation (SI) has been conducted within the Plan Area.	L	Ground Contamination issues are unknown. SI required – extent dependent on options taken to detailed design.
Infiltration potential	No Site Investigation (SI) or infiltration testing has been conducted within the Plan Area.	L	SI required – extent dependent on options taken to detailed design. Observations indicate that lands within the Plan Area are likely be suitable for infiltration.
Archaeological and Architectural Heritage	Ring Barrows[3] (circular enclosure) is located within the Plan Area which is designated as a recorded monument.	H	Will impact on implementation of SuDS features within a 20 m radius of the protected structure/recorded monument.
Local Authority requirements	Fingal CC has identified that it does not currently take in charge permeable pavement. Fingal CC Parks Department has indicated that SuDS should not take up greater than 10% of amenity space (to ensure that the space is useable for other purposes)	H	Where SuDS infrastructure is not taken in charge, these assets (if provided) would have to be managed by a maintenance company. Where SuDS requirement exceeds 10% of the amenity provision, the design is to consider that all lands in excess of 10% of the amenity space is only used for storage of excess runoff during extreme rainfall events. At all other times this space would serve the primary amenity function (therefore being multi-functional).

[3] Fingal County Council. (2016). Appendix 2: Record of protected structures | Fingal County Council Online Consultation Portal. [online] Available at: https://consult.fingal.ie/en/consultation/draft-fingal-development-plan-2017-%E2%80%93-2023-stage-2/chapter/appendix-2-record-protected [Accessed 18 Nov 2019].

3 SuDS STRATEGY

The SDS outlines the preferred approach for the management of rainfall runoff within the development to ensure no increase in flood risk to any development within the Plan Area or elsewhere with delivery of wider water quality, amenity and biodiversity benefits.

The approach to the SDS is as per the guidance from the CIRIA SuDS Manual which is summarised as follows:

- Identify existing and modified flow routes.
- Identify suitable mechanism of surface water discharge for Plan Area drainage.
- Allocate a management train and appropriate number of subcatchments to provide the collection, treatment, storage, conveyance of runoff across the Plan Area.
- Identify a range of SuDS components which are in keeping with the proposed landscape character and other objectives for the Plan Area. At this stage, any definition of SuDS features for specific areas of the Plan Area should not be treated as 'fixed' aspects of the design.

3.1 Flow Route Analysis

3.1.1 Existing Flow Route Analysis

The natural hydrology and existing characteristics have been assessed through flow route analysis to determine how the Plan Area behaves naturally before development and are illustrated in Figure 3-1. There are a number of existing flow routes identified which enter / exit the Plan Area. The detailed SuDS design will have to consider how flows along these flow paths will be managed.

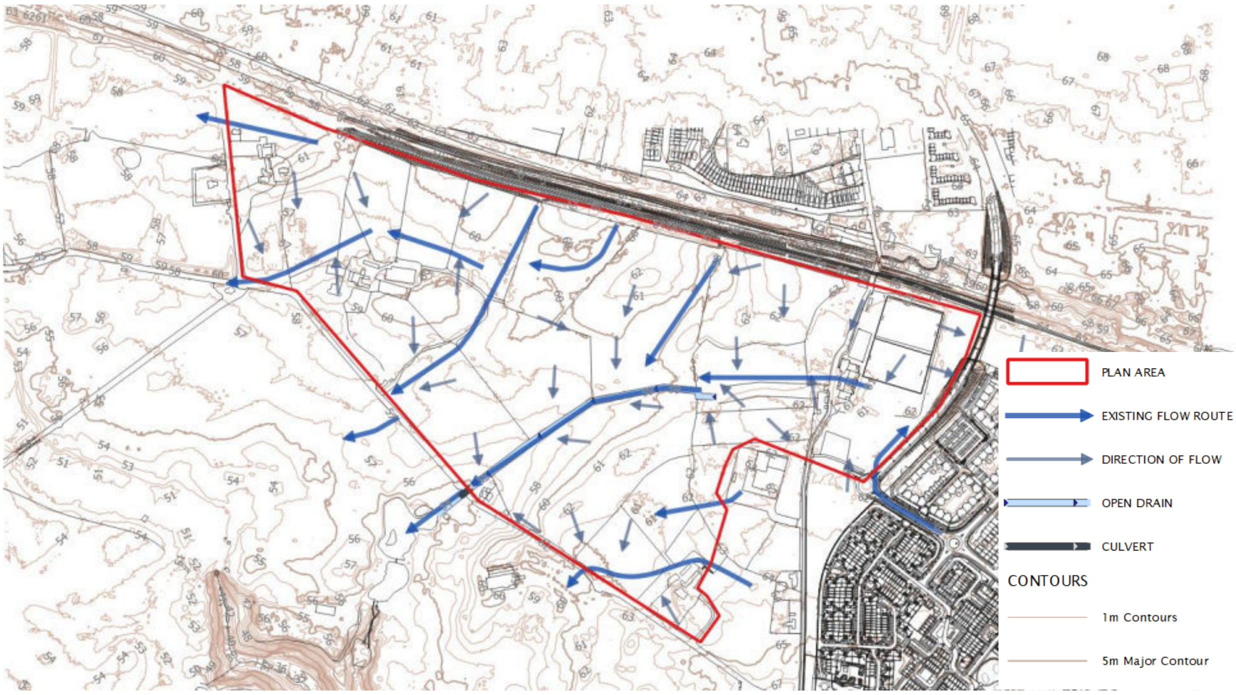


Figure 3-1 Existing Flow Route Analysis

3.1.2 Modified Flow Route Analysis

The modified flow route analysis is the basis for low flow conveyance, overflow arrangements and exceedance routes when design criteria are exceeded. The modified flow routes have been assessed in conjunction with the preliminary Plan Area layout and inform the concept SuDS design by suggesting a preferential flow path through the Plan Area.

As discussed elsewhere in this report, there is likely to be good infiltration potential at the Plan Area but no SI data is available at the time of writing. Therefore, two modified flow routes drawings are presented; Figure 3-2 based on infiltration and Figure 3-3 based on attenuation. Exceedance flow paths are also shown.

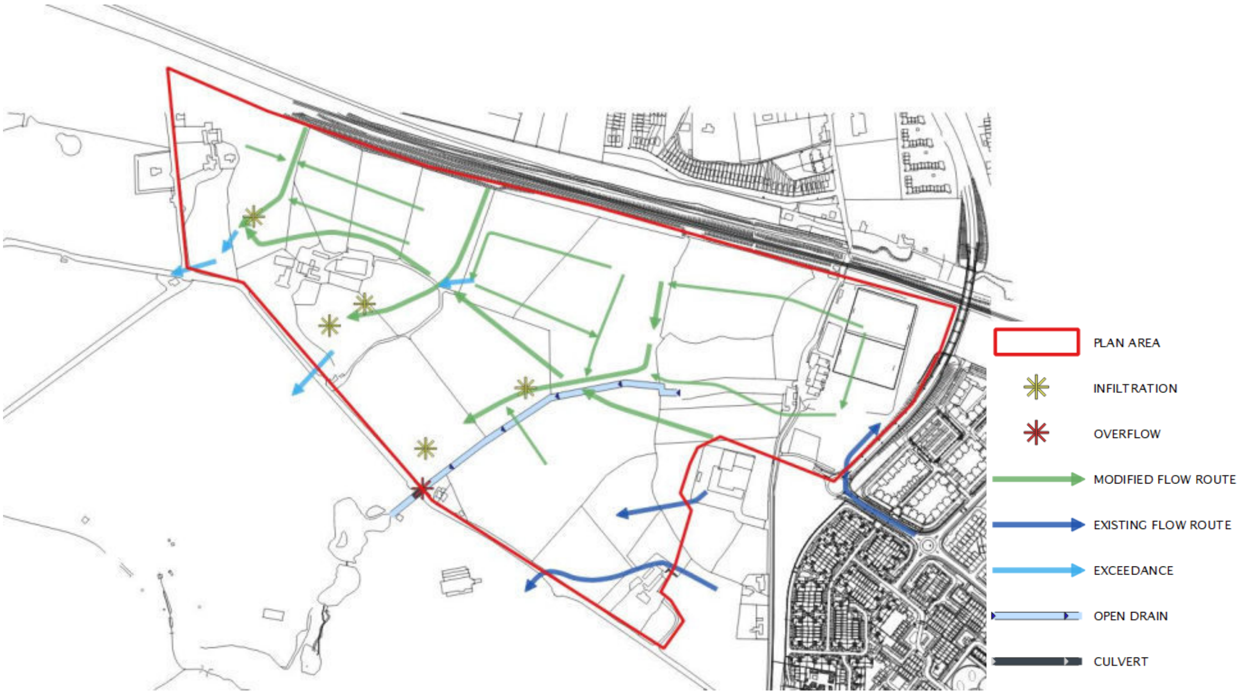


Figure 3-2 Modified Flow Route Analysis for Infiltration

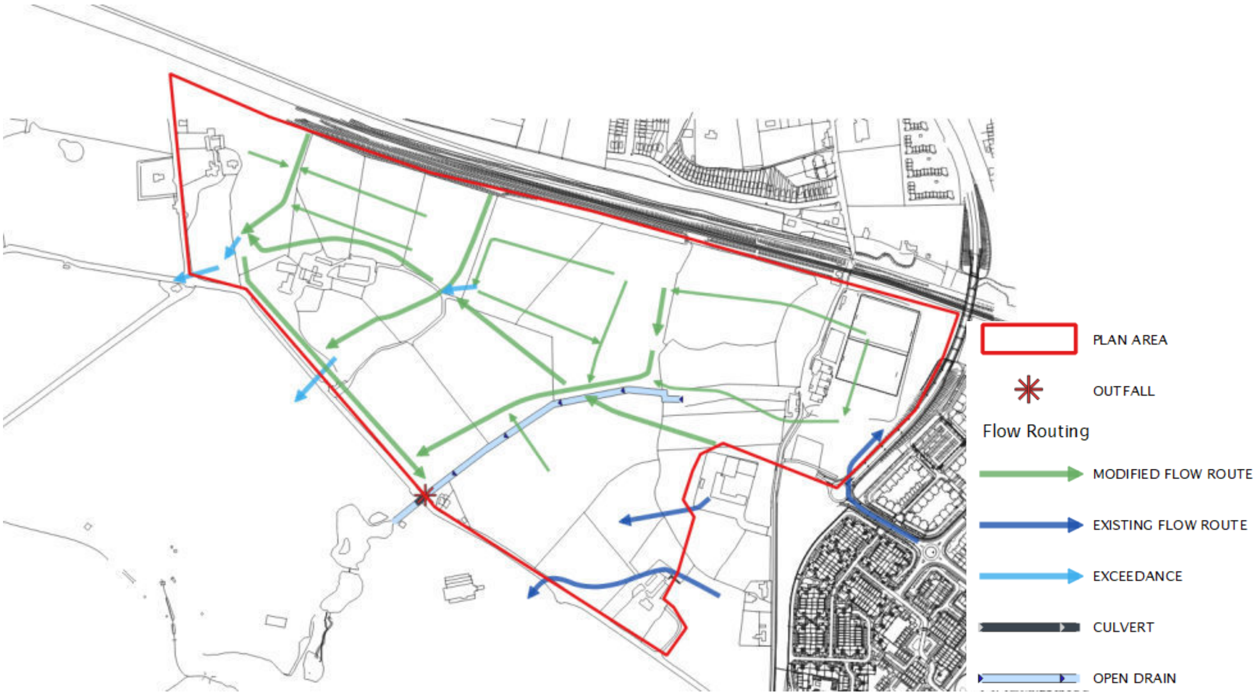


Figure 3-3 Modified Flow Route Analysis for Attenuation

3.2 Subcatchments

Figure 3-4 demonstrates how runoff from the Plan Area will be managed in subcatchments using natural overland conveyance. Flows will be conveyed from one subcatchment to the next along one or more management trains, following the modified flow routes.

Figure 3-4 Subcatchments

3.3 Drainage Hierarchy

The way that runoff is disposed from the Plan Area should adhere to the following hierarchy of discharge:

i. Re-Use – Where opportunities arise for rainfall harvesting within proposed development plans, these should be maximised.
ii. Infiltration – Infiltration could be utilised subject to outcome of SI.
iii. Watercourse – There are no natural watercourses in the vicinity of the Plan Area. Existing open drains collect and convey flows and could be suitable for receiving runoff discharge.
iv. Surface Water Sewer – A surface water sewer exists within the Plan Area.
v. Combined Sewer – Not applicable.

Given that the viability of infiltration will be pending outcome of SI, the preferred discharge route from the Plan Area will be via infiltration with discharge to an open drain and / or surface water sewer only if ground conditions are not suitable.

3.4 Water Quantity

Sufficient attenuation is to be provided to ensure that there is no unpredictable flooding within the Plan Area, future buildings are protected and no increase in flood risk elsewhere. Flows can be temporarily stored at points of collection (source control), along the conveyance route and at the points of proposed storage.

The SDS identifies the potential for infiltration. Where infiltration is deemed suitable through SI, then sufficient storage will be provided to accommodate up to the 1% AEP rainfall runoff with allowance for climate change. In this scenario, discharge from Plan Area would only occur in the event of design horizon being exceeded.

Where infiltration is assessed through SI as not feasible then flows will be attenuated throughout the Plan Area and final flows attenuated to the rates prescribed in Table 3-1.

3.4.1 Climate Change

The future impacts of climate change on rainfall should be accounted for within the design of the drainage scheme.

Requirements for climate change allowances are as per OPW 'General Map User Guidance Notes' found through floodinfo.ie[4] which recommended a 20% uplift in extreme rainfall depths for the Mid-Range Future Scenario (MRFS) and 30% for the High-End Future Scenario (HEFS).

In line with the current industry standard, the MRFS is applied for the climate change calculation in this report.

3.4.2 Controlled Flow Rates

The flow rates in the following table are based on the requirements of GDSDS and FCC for restriction of post-development runoff to greenfield rates. They provide guidance on the extent to which flows will be controlled from any proposed development within the Plan Area if infiltration is deemed not feasible / possible. The flow rates are calculated using Flood Studies Supplementary Report (FSSR) methodologies based on catchment specific characteristics; Soil WRAP Class 2 and SAAR of 765 mm.

Table 3-1 Attenuation Flow Rates

Return period	Attenuation Rate (l/s/ha) Greenfield Rate*	Attenuation Rate (l/s/ha) Qbar or 2 l/s/ha**
100% AEP (1 in 1 year)	1.76	2.06 (Qbar)
3.33% AEP (1 in 30 year)	3.40	2.06 (Qbar)
1% AEP (1 in 100 year)	4.05	2.06 (Qbar)
1% AEP (1 in 100 year) + 20% CC	4.86	2.06 (Qbar)
1% AEP (1 in 100 year) + 30% CC	5.27	2.06 (Qbar)

*Where volume is controlled to Greenfield volumes – flows attenuated to respective GF rate

**Volume not controlled – all return periods attenuated to Qbar or 2 l/s/ha whichever is the greater.

3.4.3 Storage of Runoff & Discharge Location

Runoff will be attenuated throughout the Plan Area within respective subcatchments. SuDS components for collection, storage and conveyance of flow will be selected on the basis of suitability for the development design and in consideration of relevant constraints.

Attenuation storage will be sized for the 1% AEP (with allowance for climate change) critical rainfall event. It is noted that while the Plan Area is likely to facilitate infiltration, due to a lack of SI data, indicative attenuation storage volumes in in Table 3-2 do not include an allowance for infiltration.

[4] OPW (2019) General Map User Guidance Notes (2019) Available at: https://www.floodinfo.ie/map/general_map_user_guidance_notes/ [Accessed 18 June 2019]

Table 3-2 Indicative Attenuation Storage Volumes

Return period	Indicative Attenuation Volume* (m^3 storage / m^2 development)
100% AEP (1 in 1 year)	0.02
3.33% AEP (1 in 30 year)	0.05
1% AEP (1 in 100 year) + CC	0.09

* Attenuated to Qbar or 2 l/s/ha whichever is the greater – no allowance made for infiltration

On the basis of a positive discharge system, the final discharge from the proposed development will likely be to the open drain which flows through and discharges to the south of the Plan Area.

Where discharge is via infiltration flows will be discharged to ground at the respective infiltration locations. The storage volumes for infiltration features are likely to result in different storage volumes to those provided for guidance above.

3.4.4 Designing for Exceedance

Plan Area levels and landscaping should be designed to route exceedance flows away from buildings. Overland flow routes should be managed in a safe manner by utilising the drainage systems, roads and public spaces to convey and control floodwater during extreme events. Exceedance outflows from the Plan Area will be designed to mimic the existing flow patterns and ensure that there is no increased risk to others outside the Plan Area.

3.5 Water Quality

3.5.1 Water Quality Requirements

Proposals for the Plan Area are likely to comprise mixed use development and therefore considered to be low risk. Treatment requirements are summarised as follows:

- Roof only runoff – removal of solids
- Roads used for vehicular movement – 1-2 stages of treatment dependant on SuDS component selected
- Commercial / delivery areas – 2-3 stages of treatment dependant on SuDS component selected

Design of individual SuDS features for water quality treatment should comply criteria set out in the CIRIA SuDS Manual (respective chapter on SuDS component).

Where outcome from SI infiltration testing deem the existing ground conditions to have sufficient capacity for infiltration, groundwater risk screening as set out by the SuDS Manual (Chapter 26 Table 26.5, 26.6) should be undertaken to demonstrate manageable risk. If infiltration is deemed suitable or attenuation is proposed with positive discharge point from Plan Area, the ‘simple index approach’ is to be used to validate design for water quality treatment (as set out in Chapter 26). Application of treatment indices applied in the simple index approach will depend on whether the proposed system is attenuation or infiltration (using SuDS Manual 26.3 and 26.4 respectively).

Sufficient treatment is to be provided prior to flows being attenuated in any SuDS areas being promoted for biodiversity / amenity function.

3.5.2 Construction Management

A Management Plan will be required to outline how surface water runoff will be managed during construction and ensure appropriate mitigation is in place to minimise risk of flooding and pollution during construction.

3.6 Amenity

Amenity focuses on the usefulness and aesthetic elements of SuDS design associated with features 'at or near the surface' and considers both multi-functionality and visual quality.

The following are highlighted for consideration as part of the development of the SuDS design:

- SuDS should be 'legible', i.e. understandable in terms of their operation to people using the area as well as maintenance personnel.
- The visual character of the SuDS will enhance the development.
- Spaces and connecting routes are multi-functional and can be used when not providing a SuDS function for surface water management.
- The design shall ensure the proposed development is generally accessible to meet FCC objective GI03 and be safe 'by design'.
- Consideration should be given to information boarding to inform Plan Area users of the benefits of the SuDS scheme and also give guidance to the potential of temporary / permanent presence of surface water storage.

3.7 Biodiversity

Biodiversity must be considered in the design at catchment scale to create sympathetic blue / green infrastructure and at local scale to provide habitat and connectivity linkages within and around the proposed development.

The following are highlighted for consideration as part of the development of the SuDS design:

- Ensure water quality within the water environment by following the steps of the simple index approach as per CIRIA SuDS Manual guidance (Chapter 26, Box 26.2).
- Demonstrate ecological design and the creation of habitats within the SuDS corridor to meet objectives NH02, GI03 and GI25.
- Keep water at or near the surface as it flows through the SuDS management train towards to wider landscape to ensure habitat connectivity.
- Confirm management practices to enhance habitat development during maintenance.

3.8 SuDS Components

Table 3-3 summarises a comprehensive review of potential SuDS components relative to Plan Area characteristics. It is noted that at initial / concept stage, this is not an exhaustive list and further information relating to the area is likely to lead to refinement of the audit.

It is noted that the Plan Area is likely to be reasonably free draining therefore any SuDS components selected which incorporate permanent water (such as ponds and wetlands) may need to be lined to ensure that they appear and function as intended.

Table 3-3 SuDS Component Audit

SuDS Component	Description	Suitable?	Rationale
Green Roofs	Green roofs are areas of living vegetation, installed on the top of buildings.	Possible	Proposed roofs have potential for green / blue roof solutions. There is potential to integrate into roof structures as part of design to promote biodiversity as well as reducing runoff and attenuating peak flows. This would meet Objective SW06 and GI33 in the Fingal Development Plan 2017-2023 which encourages the use of Green Roofs on apartments and provides benefits for biodiversity. Use of green roofs may be influenced by required landscape character for the Plan Area, e.g. if apartments are proposed.
Infiltration systems	Infiltration systems allow surface water runoff to infiltrate and filter through to the sublayer layer before returning to the water table.	Possible	Based on the Soil WRAP class and Plan Area observations, discharge via infiltration could be suitable subject to SI infiltration testing. Due to lack of SI data, infiltration features have not been included in the concept drainage strategy but, in line with the drainage hierarchy, should be prioritised over discharge to surface water bodies / sewers where possible.
Filter strips	The hard edge from a pavement to a filter strip is generally defined by a kerb.	Yes	There is potential to incorporate filter strips into the development to collect and provide treatment surface water runoff.
Filter drains	Filter drains, also known as a French drain, is an open stone filled trench.	Possible	Final appearance (at surface) is unlikely to be in keeping with the proposed landscape character of the Plan Area.
Swales	Swales are shallow, flat bottomed vegetated channels which can collect, treat, convey and store runoff.	Yes	Swales could be suitable to convey flows between other SuDS features and connect green-space areas. This would meet Objective GI03, GI11, GI21, GI25 and NH02 in the Fingal Development Plan 2017-2023.
Bioretention systems / rain planters	Bioretention systems are shallow landscaped depressions used to reduce runoff rates, volumes and treat pollution through the use of engineered soils and vegetation.	Yes	There is potential to incorporate bioretention systems into the development to collect roof and road runoff to attenuate and treat the water as well as providing amenity / biodiversity benefits.

SuDS Component	Description	Suitable?	Rationale
Tree pits	Trees pits attenuate surface water runoff underneath by utilising the void within each tree's rooting zone.	Yes	Trees will form part of the proposed Plan Area layout; therefore, there is potential to incorporate tree pits within the SuDS design.
Permeable pavements	Permeable pavements allow rainwater to infiltrate through the surface and into the underlying structural layers where it is temporarily stored before infiltrating or discharged downstream.	Possible	New Roads and hardstanding areas will be provided as part of the development therefore there is scope to include permeable paving within the development which would support Objective SW04 in the Fingal Development Plan 2017-2013. County Council do not currently take in charge permeable paving. This requires consideration in terms of future ongoing maintenance consideration.
Rain harvesting	Rainwater harvesting (RWH) involves the collection of rainwater runoff for reuse.	Possible	Rainwater reuse could be utilised to reduce surface water runoff and reduce demand on potable water supply. It is unlikely to yield sufficient decreases in flow rates to satisfy the requirements of the drainage strategy but may be considered at the discretion of the client / developer but will not form part of the primary drainage strategy.
Attenuation storage tanks	Attenuation tanks are used to create below ground storage before infiltrating or controlled release or use.	Possible	The relatively high discharge level will limit the potential for storage tanks (generally they require sufficient cover to facilitate structural loading). Removal of silt ingress to tanks is likely to pose a significant maintenance risk due to lack of direct accessibility. Objective DMS74 of the Fingal Development Plan 2017-2023 states that "underground tanks and storage systems will not be accepted under public open space, as part of a SuDS solution". In addition, preference should be given to above ground attenuation features to maximise benefits for water quality, amenity and biodiversity to support the Objectives outlined within the Development Plan. Below ground storage / tanks should only be used as a last resort where it has been demonstrated that other Green Infrastructure measures are not feasible. This assessment has found no reason why above ground surface water features would not be feasible.

SuDS Component	Description	Suitable?	Rationale
Detention basins	Detention basins are landscaped depressions that are normally dry except during and immediately after rainfall events.	Yes	Detention basins could be utilised to attenuate flows, improve water quality, and reduce runoff rates prior to discharge. They can be used for recreation and public open space which would support Objectives GI03, GI11, GI21, GI25 and NH02 in the Fingal Development Plan 2017-2023 which encourages the provision of accessible parks, open spaces and recreational facilities alongside the sustainably managing water within the Plan Area.
Ponds & wetlands	Ponds and wetlands are features with a permanent pool of water that provide attenuation and treatment of surface water runoff.	Yes	There is potential to utilise ponds and wetlands within the development which would specifically support Objectives SW01, NH02, GI21, GI25, GI31 and GI32 in the Fingal Development Plan 2017-2023 and form part of a park landscape. Ponds with a permanent water level are proposed for amenity / biodiversity reasons within the open green space / park areas and can be designed to also provide a water storage / treatment benefit.

4 SUMMARY AND RECOMMENDATIONS

4.1 Summary

This Sustainable Drainage Strategy outlines the approach and criteria that should be followed when developing a SuDS design as part of any future proposals for the Plan Area. The report includes design considerations for managing quantity, quality, amenity and biodiversity as well as demonstrating flow routes and sub-catchments.

A concept SuDS layout, based on the sub-catchments, modified flow routes and SuDS component audit, has been incorporated in the overall proposed layout for the Plan Area. Surface water drainage proposals that were appropriate with and complemented the overall Plan Area layout and character were developed and agreed during a number of design team meetings hosted by Fingal CC.

The Plan Area proposed layout is included in Appendix A. The conceptual layout, including SuDS, will be developed through outline and detailed design in parallel with development and finalisation of the proposed development layouts.

In addition to general design criteria outlined in the SDS, the following Plan Area specific recommendations are made to guide and improve sustainable surface water drainage management.

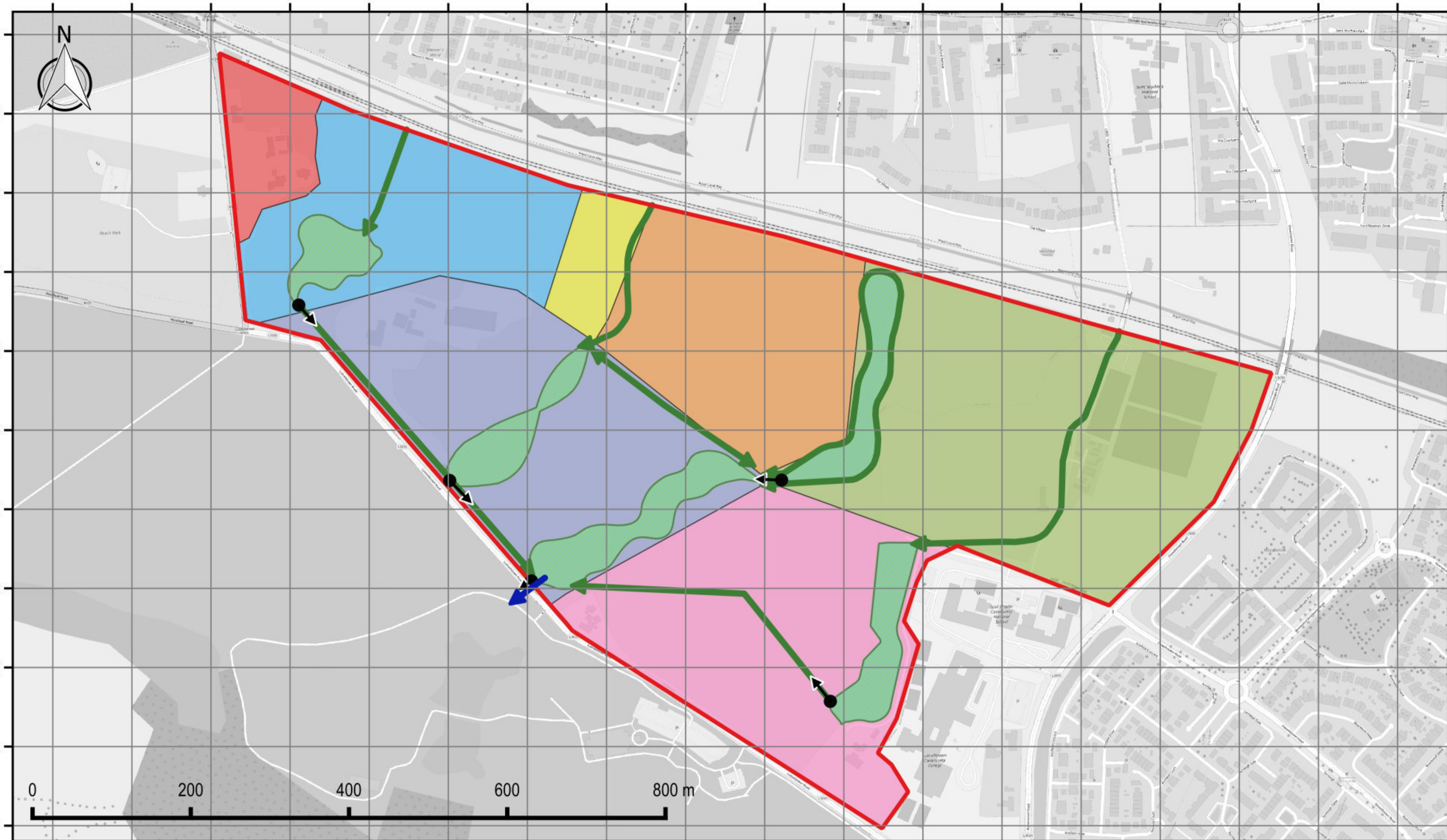
4.2 Recommendations

The following recommendations are made for the development of the SuDS / Sustainable Drainage Strategy for the Plan Area.

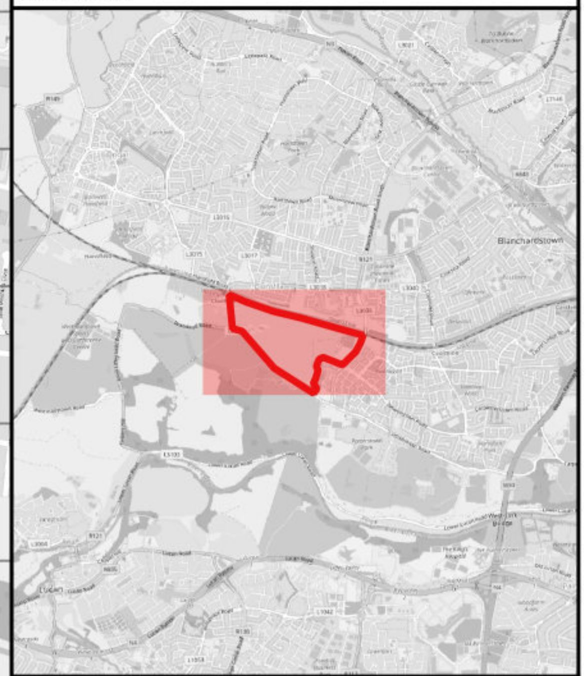
- The Plan Area has been identified as having potential for infiltration. Consideration has been given to the use of infiltration throughout the SDS. Where infiltration is not feasible, provision of attenuation storage with positive discharge outlet will be required.
- Fingal CC will be required to be satisfied through demonstration (SI and risk screening / assessment) that there is sufficient capacity within the Plan Area geology to infiltrate and that the risk to receiving groundwater can be suitably managed.
- Future proposed development layout designs to consider the existing flow route analysis and be undertaken in conjunction with the SuDS design to facilitate consideration of updated / amended modified flow routes.
- The SuDS / Sustainable Drainage Strategy will provide a management train through definition of subcatchments to maximise treatment and storage capacity.
- No SuDS features are to be located within 20 m of the protected structure / recorded monument.
- Application of greenfield runoff rate, dependent on adequate provision of 'long term storage / losses' to be agreed with Fingal CC.
- Final route of discharge from the proposed development to be proven and agreed as part of outline / detailed design process. The developed SuDS design should demonstrate that there is no increased flood risk to others, including residual risk from exceedance flow paths.
- Ownership and maintenance obligations for surface water drainage features should be established, and provision should be made by the relevant party for preventative inspection and maintenance.
- A construction management plan will be required to ensure appropriate mitigation is in place to minimise risk of flooding and pollution during construction.

Appendix A

Plan Area / SuDS Concept Masterplan



OVERVIEW



LEGEND

- PLAN AREA
- SUDS COMPONENTS
- CONTROL
- MODIFIED FLOW ROUTE
- EXCEEDANCE FLOW ROUTE

SUB-CATCHMENT

- A
- B
- C
- D
- E
- F
- G

Images show sample SuDS schemes using permeable surfaces, swales, tree pits, filter strips and basins to demonstrate potential landscape design and character of the Plan Area. SuDS components appropriate for proposed development to be decided at outline / detailed design stage.

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Comhairle Contae Fhine Gall
Fingal County Council