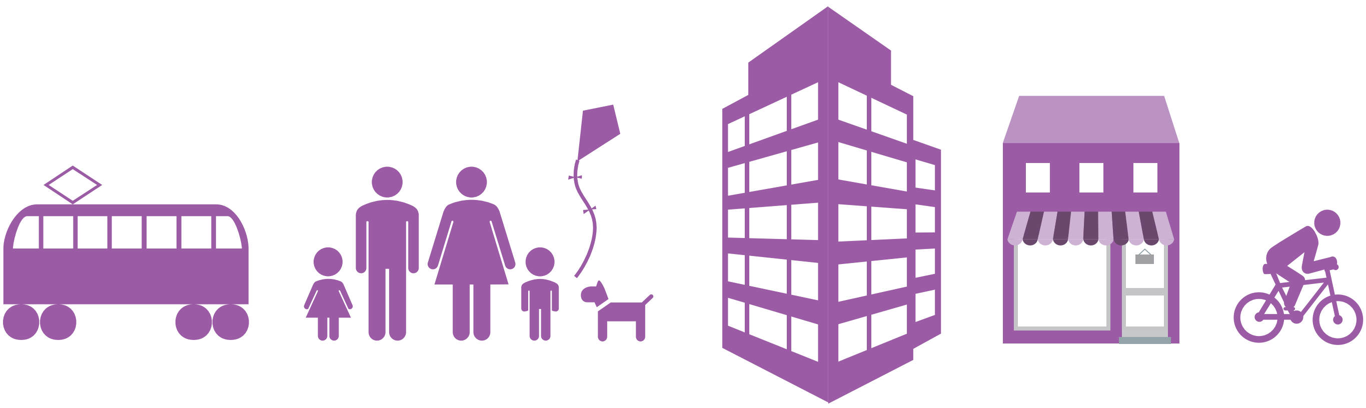
Appendix C

Fosterstown Masterplan

Surface Water Management Plan (SWMP)



May 2019

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25 BLIANA YEARS

Comhairle Contae Fhine Gall
Fingal County Council

Prepared by
Roughan & O'Donovan
Arena House, Arena Road, Sandyford, Dublin 18
Tel: +353 1 2940800 Fax: +353 1 2940820
Email: info@rod.ie www.rod.ie

Fingal County Council

Fosterstown Masterplan

Surface Water Management Plan
[FINAL – May 2019]

ROUGHAN & O'DONOVAN

Comhairle Contae Fhine Gall
Fingal County Council

INTRODUCTION

The following Surface Water Management Plan has been prepared by ROD to supplement the Fosterstown Masterplan for Fingal County Council. The Surface Water Management Plan comprises of two parts which should be read in conjunction with one another:

- Part 1 – Strategic Flood Risk Assessment
- Part 2 – Sustainable Drainage Systems (SuDS) Strategy

As part of the iterative assessment process ROD were a part of a team of consultants that fed into the process of preparing the final version of the Masterplan. The draft Masterplan was published for a period of public consultation from the 12th March to 3rd April 2019. Submissions received after this period of public consultation were taken into account during the subsequent stages in the preparation of the Final Surface Water Management Plan issued May 2019. The final report issued May 2019 is cognisant of the various stages in the preparation of the Masterplan.

Part 1 of the Surface Water Management Plan consists of a Stage I, II and III Flood Risk Assessment for the lands.

Part 2 of the Surface Water Management Plan outlines a Sustainable Drainage Systems (SuDS) Strategy for the lands which should be adapted for particular types of future development.

The full scope this Surface Water Management is as follows:

- Provide an assessment/identification of flood risk for the Masterplan lands in accordance with "The Planning System and Flood Risk Management – Guidelines for Planning Authorities" (The Guidelines), 2009, published by the Department for the Environment, Heritage and Local Government and the Office of Public Works (OPW).
- Undertake a Flood Risk Assessment Report assessing the hydrology and hydraulics and determining, modelling and mapping the cause, extents, depths and mechanisms of flooding in the Masterplan lands, taking into account anticipated future increases in rainfall, river flows and sea level rise as a result of climate change.
- Provide recommendations for future flood risk assessments for proposed developments and planning applications, in accordance with The Guidelines.
- Generate flood depth and extent maps for the 1% & 0.1% AEP fluvial flood events, the 0.5% & 0.1% AEP coastal flood events, (as applicable to the Masterplan lands), and the 1% & 0.1% pluvial flood events. The flood maps consider the Current Climate Scenario as well as the OPWs Mid-Range Future Scenario and the High-End Future climate change scenarios (Climate Change Sectoral Adaptation Plan Flood Risk Management 2015 - 2019).
- Review the existing drainage network servicing the lands and provide an assessment of the Masterplan lands in terms of sustainable drainage possibilities, in accordance with the requirements of the GDSDS, CIRIA SuDS Manual C753 and the current Fingal County Development Plan (2017 – 2023).
- Prepare a SuDS Strategy with recommendations regarding appropriate SuDS systems and devices for the implementation of the SuDS strategy for all proposed development within the Fosterstown masterplan boundary.

- Incorporate the effects of Climate Change, soil type and groundwater into the SuDS Strategy.
- Determine the effects on and of flooding, groundwater and surface water drainage system in the masterplan area due to the incorporation of the SuDS Strategy.
- Make recommendations on the discharge rate to be applied across the Masterplan lands and as to the future development and sustainable drainage of the Plan lands.
- Liaison with Consultants completing the Strategic Environmental Assessment (SEA), Appropriate Assessment and Fingal County Council as well as public consultation.

Prepared by
Roughan & O'Donovan
Arena House, Arena Road, Sandyford, Dublin 18
Tel: +353 1 2940800 Fax: +353 1 2940820
Email: info@rod.ie www.rod.ie

Fingal County Council

Fosterstown Masterplan

Surface Water Management Plan Part 1: Strategic Flood Risk Assessment

May 2019 (FINAL)

ROD
ROUGHAN & O'DONOVAN

Comhairle Contae Fhine Gall
Fingal County Council

Fosterstown Masterplan
Surface Water Management Plan
Part 1: Strategic Flood Risk Assessment

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1. INTRODUCTION

1.1 Commission

Roughan & O'Donovan Consulting Engineers (ROD) was commissioned by Fingal County Council (FCC) to prepare a Surface Water Management Plan to supplement the Fosterstown Masterplan in Swords, Co. Dublin. As part of this commission, the Stage I, II and III Flood Risk Assessment for the Masterplan lands was undertaken. The Masterplan will set out the local land use and planning policy for the Fosterstown site and provide a strategy for the future planning and sustainable development of the Area.

1.2 Scope

The scope of this report is as follows:

- Provide an assessment/identification of flood risk for the Masterplan lands in accordance with "*The Planning System and Flood Risk Management – Guidelines for Planning Authorities"* (The Guidelines), 2009, published by the Department for the Environment, Heritage and Local Government and the Office of Public Works (OPW).
- Undertake a Flood Risk Assessment Report assessing the hydrology and hydraulics and determining, modelling and mapping the cause, extents, depths and mechanisms of flooding in the Masterplan lands, taking into account anticipated future increases in rainfall, river flows and sea level rise as a result of climate change.
- Provide recommendations for future flood risk assessments for proposed developments and planning applications, in accordance with The Guidelines.
- Generate flood depth and extent maps for the 1% & 0.1% AEP fluvial flood events, the 0.5% & 0.1% AEP coastal flood events, (as applicable to the Masterplan lands), and the 1% & 0.1% pluvial flood events. The flood maps consider the Current Climate Scenario as well as the OPWs Mid-Range Future Scenario and the High-End Future climate change scenarios (Climate Change Sectoral Adaptation Plan Flood Risk Management 2015 - 2019).
- Liaison with Consultants completing the Strategic Environmental Assessment (SEA), Appropriate Assessment and Fingal County Council as well as public consultation.

1.3 Study Area

1.3.1 Overview

The subject area is located at Fosterstown, Swords, North County Dublin. The masterplan lands are located approximately 1.6km west of the M1 motorway, 4.3km north of the M50 motorway and 2.0km north of Dublin Airport. The masterplan site is located within an urban environment. The site is bounded by residential developments to the south-west and commercial / retail developments to the north-east. The R132 Dublin Road runs adjacent to the eastern boundary of the site, while Forest Road runs adjacent the western boundary of the site.

The Fosterstown Masterplan lands, total approximate area of 13.14ha, part of which is zoned RA – Residential Area (11.69ha), in which the objective is to "provide for new residential communities subject to the provision of the necessary social and physical infrastructure" and the remaining 1.45ha is zoned MC – Major Town Centre in which the objective is to "Protect, provide for and/or improve major town centre facilities." Refer to Figure 1.1 below.

Figure 1.1: Fosterstown Masterplan lands

The topography of the Fosterstown site generally falls from approximately 48mOD to 33mOD in a south-western to north-eastern direction.

1.3.2 Catchment Description

The masterplan lands appear to be within the catchments of the River Ward and the River Gaybrook. Both watercourses generally flow from west to east and ultimately discharge to the Malahide Estuary, approximately 4.5km north east of the masterplan lands. Refer to Figure 1.2.

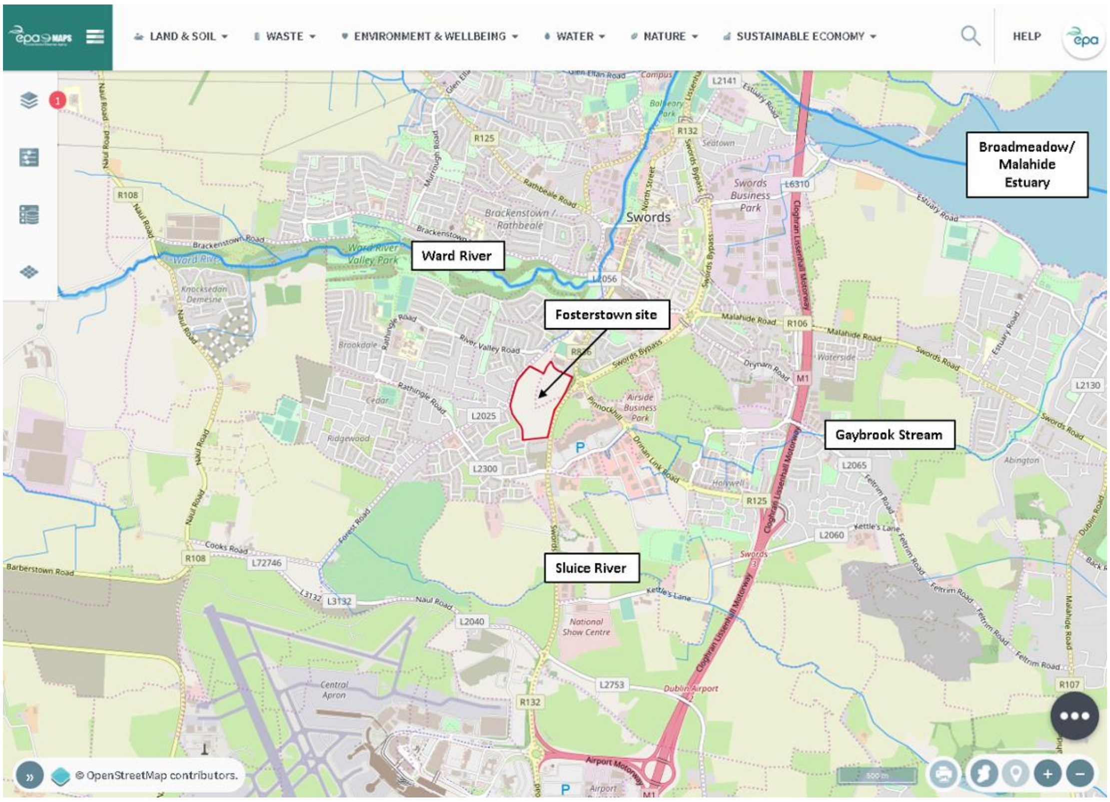


Figure 1.2: Watercourses around the Fosterstown site (EPA Catchments.ie)

Irish Water records indicate that there is existing surface water drainage infrastructure within the vicinity of the masterplan lands. There are also 2nr drainage channels within the site. The River Gaybrook crosses the centre of the site from west to east and appears to drain the southern extent of the site, while a second drainage ditch originates in the centre of the site and falls in a northernly direction. This ditch appears to drain the west and north eastern sides of the site, however this secondary ditch appears to be dry the majority of the time, with runoff infiltrating to ground.

1.3.3 Environment

There are no Natura 2000 sites located within the study area; however, the Natura 2000 sites Malahide Estuary (SPA and SAC) is located 3.0km north-east of the masterplan lands, Rogerstown Estuary (SPA and SAC) is located 7.7km north-east of the masterplan lands and Baldoyle Bay (SPA and SAC) is located 9.0km south-east of the masterplan lands.

Under Article 6(3) of the EU Habitats Directive, an “appropriate assessment” (AA) is required where any plan or project, either alone or ‘in combination’ with other plans or projects, could have an adverse effect on 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 study area are:

- Malahide Estuary (proposed NHA) ~ 3km north-east of the Fosterstown masterplan lands

- Rogertown Estuary (proposed NHA) ~ 7.7km north-east of the Fosterstown masterplan lands
- Baldoyle Bay (proposed NHA), ~9km south-east of the Fosterstown masterplan lands
- Sluice River Marsh (proposed NHA), ~ 6km south-east of the Fosterstown masterplan lands
- Feltrim Hill (proposed NHA), ~2.5km south-east of the Fosterstown masterplan lands
- Santry Demesne (proposed NHA), ~5.2km south of the Fosterstown masterplan lands

Therefore, the management of flood risk within the masterplan study area must have regard to potential negative impacts to this environment.

1.4 Proposed Development

The Fosterstown Masterplan lands comprise two zoning objectives in the Fingal Development Plan 2017 – 2023. The sites division of the two zoning objectives consists of 89% RA – Residential Area along with 11% MC – Major Town Centre which is shown in Table 1.1 below.

Table 1.1 Fosterstown Zoning Objectives

Objective	Description	Area
RA – Residential Area TC	Provide for new residential communities subject to the provision of the necessary social and physical infrastructure	West, south and eastern extents of lands
MC – Major Town Centre	Protect, provide and/or improve major town centre facilities	Northern extents of lands

The Fingal Development Plan for the Fosterstown zoning objectives are reproduced in Figure 1.3 below.

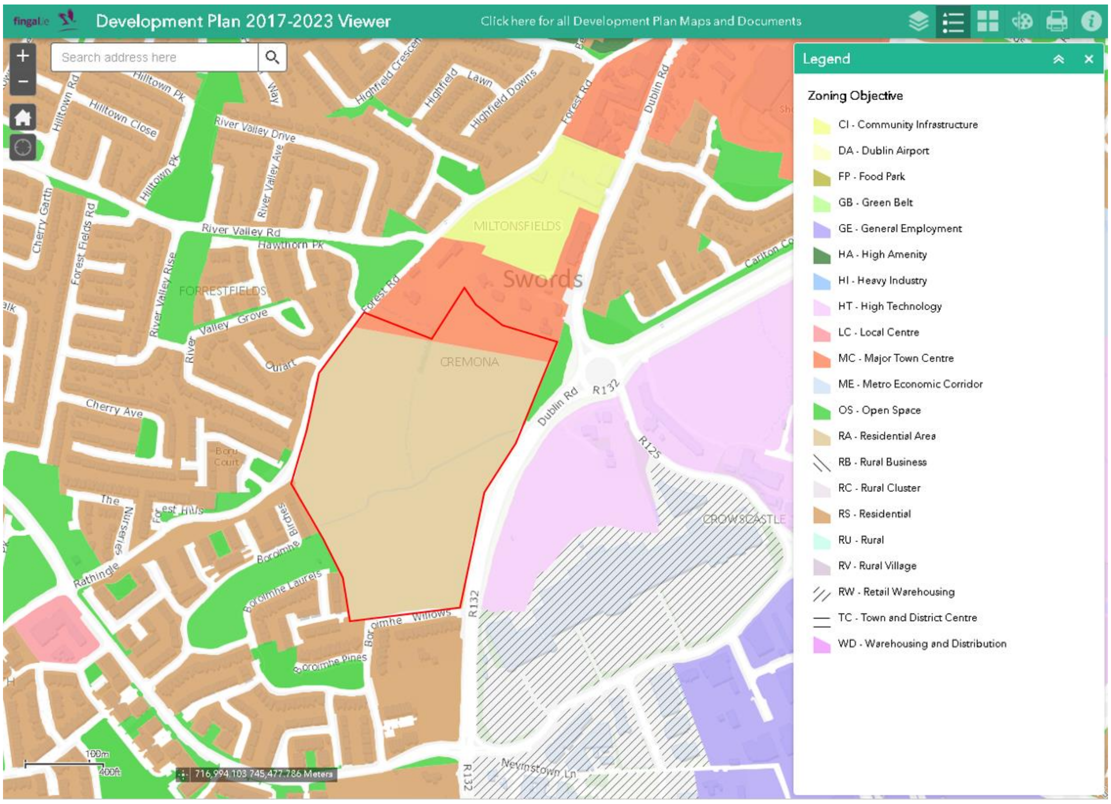


Figure 1.3: Fosterstown Zoning Objective (Fingal Co Co Development Plan 2017 – 2023)

2. METHODOLOGY

2.1 Introduction

This Flood Risk Assessment report has been prepared in accordance with 'The Planning System and Flood Risk Management Guidelines for Planning Authorities' herein referred to as 'The Guidelines' as published by the Office of Public Works (OPW) and Department of Environment, Heritage and Local Government (DoHLG) in 2009.

2.2 Definition of Flood Risk

Flood risk is a combination of the likelihood of a flood event occurring and the potential consequences arising from that flood event and is then normally expressed in terms of the following relationship:

Flood risk = Likelihood of flooding x Consequences of flooding.

To fully assess flood risk an understanding of where the water comes from (i.e. the source), how and where it flows (i.e. the pathways) and the people and assets affected by it (i.e. the receptors) is required. Figure 2.1 below shows a source-pathway-receptor model reproduced from 'The Guidelines'.

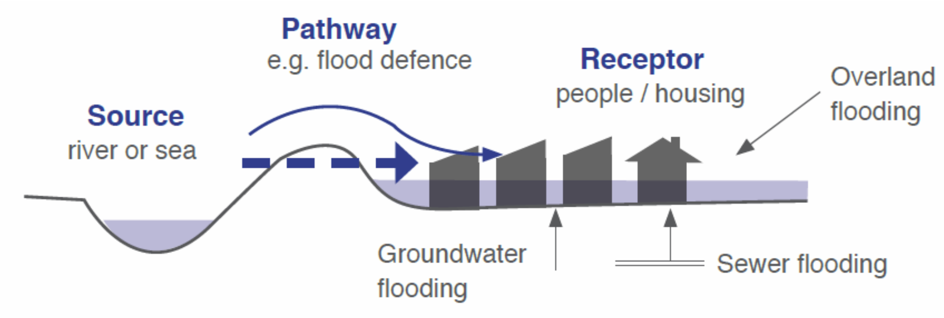


Figure 2.1 Source-Pathway-Receptor Model

The principal sources of flooding are rainfall or higher than normal sea levels. The principal pathways are rivers, drains, sewers, overland flow and river and coastal floodplains. The receptors can include people, their property and the environment. All three elements as well as the vulnerability and exposure of receptors must be examined to determine the potential consequences.

2.3 Likelihood of Flooding

The Guidelines define the likelihood of flooding 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). A 1% AEP flood indicates a flood event that will be equalled or exceeded on average once every hundred years and has a return period of 1 in 100 years. Annual Exceedance Probability is the inverse of return period as shown in Table 2.1 below.

Table 2.1 Correlation between return period and AEP

Return Period (years)	Annual Exceedance Probability (%)
1	100
10	10
50	2

Return Period (years)	Annual Exceedance Probability (%)
100	1
200	0.5
1000	0.1

2.4 Definition of Flood Zones

Flood zones are geographical areas within which the likelihood of flooding is in a particular range and are split into three categories in The Guidelines:

Flood Zone A

Flood Zone A where the probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding);

Flood Zone B

Flood Zone B where the probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 and 1% or 1 in 100 for river flooding and between 0.1% or 1 in 1000 and 0.5% or 1 in 200 for coastal flooding);

Flood Zone C

Flood Zone C where the probability of flooding from rivers and the sea is low (less than 0.1% or 1 in 1000 for both river and coastal flooding. Flood Zone C covers all plan areas which are not in zones A or B.

It is important to note that when determining flood zones the presence of flood protection structures should be ignored. This is because areas protected by flood defences still carry a residual risk from overtopping or breach of defences and the fact that there is no guarantee that the defences will be maintained in perpetuity.

2.5 Objectives and Principles of the Planning Guidelines

The principle actions when considering flood risk are set out in the planning guidelines and are summarised below:

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

- *Strategic environmental assessment (SEA) of regional planning guidelines, development plans and Masterplans should include flood risk as one of the key environmental criteria..."*

2.6 The Sequential Approach and Justification Test

The Guidelines outline the sequential approach that is to be applied to all levels of the planning process. This approach should also be used in the design and layout of a development and the broad philosophy is shown in Figure 2.2 below. In general, development in areas with a high risk of flooding should be avoided as per the sequential approach. However, this is not always possible as many town and city centres are within flood zones and are targeted for development.

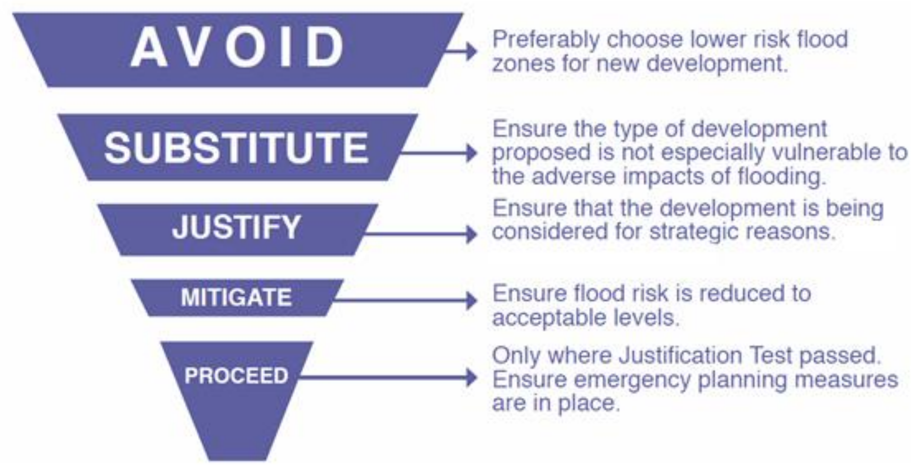


Figure 2.2 Sequential Approach (The Guidelines)

The Justification Test has been designed to rigorously assess the appropriateness, or otherwise, of developments that are being considered in areas of moderate or high flood risk. The test comprises the following two processes.

- The first is the Plan-making Justification Test and is used at the plan preparation and adoption stage where it is intended to zone or otherwise designate land which is at moderate or high risk of flooding.
- The second is the Development Management Justification Test and is used at the planning application stage 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 2.2 below illustrates the types of development that would be required to meet the Justification Test.

Table 2.2 Matrix of Vulnerability Versus Flood Zone to Illustrate Appropriate Development and that Required to Meet the Justification Test (The Guidelines)

Vulnerability Class (The Guidelines section 3.5)	**Flood Zone A**	**Flood Zone B**	**Flood Zone C**
Highly vulnerable development (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less vulnerable development	Justification Test	Appropriate	Appropriate
Water-compatible development	Appropriate	Appropriate	Appropriate

3. STAGE 1 - FLOOD RISK IDENTIFICATION

3.1 General

This Flood Risk Identification phase includes a review of the existing information and the identification of any flooding or surface water management issues in the vicinity of the Fosterstown Masterplan lands that may warrant further investigation.

3.2 Information Sources Consulted

The following information sources were consulted as part of the Flood Risk Identification:

Table 3.1 Information Sources Consulted

Source	Comments
OPW Preliminary Flood Risk Assessment (PFRA) maps	Fluvial, Pluvial, Coastal and Groundwater flooding examined;
OPW Benefitting Land Maps	Available at OPW Drainage District Viewer
OPW National Flood Hazard Mapping	www.floodmaps.ie
Geological Survey of Ireland (GSI) Maps	Utilised multiple data layers available at the GSI Groundwater Data viewer
OSI Historical Maps	OSI 6" and 25" mapping examined
Catchment Flood Risk Assessment and Management Study (CFRAM)	CFRAM mapping available at fem.cfram.com
Irish Coastal Protection Strategy Study (ICPSS)	No ICPSS maps are not available for Masterplan lands
Fingal Development Plan 2017-2023	Relevant sections of the Development Plan
Flood Risk Assessment and Management Studies	Fingal East Meath Flood Risk Assessment and Management Study (FEMFRAMS)
Irish Water / Fingal Co. Co. Drainage Records	Existing drainage records used in determining the drainage catchment

3.2.1 Predictive Flood Maps and Flood Hazard Records

(i) OPW Preliminary Flood Risk Assessment

The PFRA is a national screening exercise to identify the areas where there may be a significant risk associated with flooding (referred to as Areas for Further Assessment or AFA's). As part of the PFRA study, maps of the country were produced showing the indicative fluvial, coastal, pluvial and groundwater flood extents.

Fluvial flooding is indicated along the length of the Ward River. The PFRA mapping indicates no fluvial flooding within the Fosterstown site. There is also no indication of pluvial flooding or groundwater flooding on the site.

It is important to note that these maps have limitations as any local errors in the digital terrain model (DTM) were not filtered out, local in-channel works were not included, flood defences were excluded, and channel structures were not considered.

The *PFRA Maps for the area are reproduced in Appendix A.*

(ii) OPW Drainage Districts

Under the Arterial Drainage Act, 1945 the OPW undertook a number of arterial drainage schemes to improve land for agricultural production. The OPW has a statutory duty to maintain these schemes, which is delivered through their arterial drainage maintenance programme. The OPW does not have powers to undertake river or channel maintenance other than where these rivers form part of an arterial drainage scheme or flood relief schemes.

The OPW Drainage district maps do not show any “benefiting lands” within Fosterstown, i.e. lands that have benefited from flood alleviation works previously completed under the Arterial Drainage Act, 1945.

The OPW Drainage Districts are reproduced in Appendix B.

(iii) OPW National Flood Hazard Mapping

The OPW National Flood Hazard Mapping Web Site, www.floodmaps.ie, was examined to identify any recorded flood events within and in the vicinity of the Masterplan lands.
Recurring flood events have been recorded at Pinnock Hill, immediately east of the site.

The OPW Flood Hazard Mapping is reproduced in Appendix C.

(iv) Fingal East Meath Flood Risk Assessment and Management Study (FEM-FRAM Study)

The FEM-FRAM Study was undertaken by FCC in conjunction with project partners Meath County Council and the OPW and is a catchment based flood risk management study of nineteen rivers and streams and their catchments.

The flood extent mapping indicates that the Fosterstown site is not subject to fluvial or tidal flooding.

The FEM-FRAM Mapping is reproduced in Appendix D.

(i) Secondary Sources of Baseline data

Table 3.2 below lists secondary sources examined to identify areas that may be liable to flooding:

Table 3.2 Secondary Sources of Baseline Data

Source	Data Gathered
GSI Maps	GSI Teagasc subsoils map shows that the Fosterstown Masterplan lands are underlain by BminDW - Deep well drained mineral (Mainly basic), BminPD - Mineral poorly drained (Mainly basic), and AlluvMIN – Alluvium (mineral). Soil permeability is low throughout the Masterplan lands. The groundwater recharge rates for the Masterplan lands are indicated to be between 1-50 mm/yr. No evidence of Karst features have been identified within the Fosterstown Masterplan lands. Refer to Appendix E for GSI maps.
Historical Maps	No areas of the site are labelled as “liable to flooding” or have other indicators of historic flooding. Refer to Appendix F for Historical Maps.

4. FLOOD RISK IDENTIFICATION SUMMARY

In accordance with The Guidelines the sources of flooding within the Fosterstown Masterplan boundary have been identified. These are summarised in Table 4.1 below.

Table 4.1 Possible Sources of Flooding Associated within the Fosterstown Masterplan lands

Source	Pathway	Receptor	Likelihood	Consequence	Risk
Tidal	River Gaybrook / Ward River – overflow of culverts and out of bank	Fosterstown Masterplan Lands	Low Possibility	Medium – The masterplan lands are distant from the Ward River. The River Gaybrook flows through the masterplan lands	Low – There is no indication of tidal flooding on the site from the River Gaybrook or the Ward River. Ground level on the Masterplan lands are significantly above sea level.
Fluvial	River Gaybrook / Ward River - overflow of culverts and out of bank		Possible	Medium - The masterplan lands are distant from the Ward River. The River Gaybrook flows through the masterplan lands.	Low – There is no indication of fluvial flooding on the site from the River Gaybrook or the Ward River
Surface Water / Pluvial	Overland flow		Possible	Medium – No indication of pluvial flooding on the site.	Low - If appropriate drainage system incorporating SuDS are adopted in potential development areas and maintained appropriately
Ground Water	Rising levels		Low Possibility	Medium (No indications of previous groundwater flooding)	Low - Due to soil drainage characteristics including moderate soil permeability
The following potential flood sources were also scoped but no perceptible flood risk was identified: dam breach, flood defence failure, canal bank breach, snow melt, watermain burst.					

The findings of the Stage 1 assessment do not indicate that the masterplan lands are at risk of flooding. For the purpose of supplementing this masterplan, a Stage 2 flood risk assessment will be carried out in accordance with the Guidelines. This is outlined in Section 5 of this report.

5. STAGE 2 – INITIAL FLOOD RISK ASSESSMENT

5.1 General

A Stage 2 SFRA (initial flood risk assessment) was undertaken to:

- Appraise the adequacy of existing information as identified by the Stage 1 FRA.

5.2 Sources of Flooding

Flooding from Fluvial & Sea Level Rises / Coastal Flooding

The potential source of fluvial flooding is the River Gaybrook and the Ward River as identified in the Stage I FRA. The Fosterstown Masterplan lands are bisected by the River Gaybrook flowing from west to east. This section of the Gaybrook is fluvially dominated, as such; the most prevalent flood risk to the site is from extreme fluvial inundation events. A tributary of the Ward River is in an open channel approximately 250m north of the Fosterstown lands parallel to Forest Road. This is fed completely by urban runoff from the adjacent housing estates. The lowest site level is approximately 4m above the highest bank level of this stream. As such the Ward Tributary is not considered to be a viable source of flooding for the Fosterstown lands.

Tidal flooding does not affect the masterplan lands due to the site being a significant elevation above sea level. No areas of the Masterplan lands are indicated to be within flood zones A and B in the OPW FEM-FRAM Study and the OPW PFRA. Extreme flows within Gaybrook stream may be restricted from exiting the site due to the existing culvert downstream. The Fosterstown Masterplan lands are progressed to a stage 3 detailed flood risk assessment with respect to flooding derived from fluvial sources.

Surface Water Flooding

Surface water flooding occurs when a local drainage system cannot convey stormwater flows from extreme rainfall events. In such circumstances, rainwater does not drain away through the normal drainage pathways or infiltrate into the ground but instead ponds on or flows over the ground. Surface water flooding is unpredictable as it depends on several factors including ground levels, rainfall and the local drainage network. All future developments within the Fosterstown Masterplan lands shall incorporate SuDS as described in the Fosterstown Masterplan Surface Water Management Plan Part 2: Sustainable Drainage Systems (SuDS) Strategy for the purposes of managing flood risk, assisting in the attainment of obligations made under the Water Framework Directive (WFD). The Masterplan lands do not require a stage 3 detailed flood risk assessment with respect to surface water flooding.

Groundwater Flooding

Ground water flooding is a result of upwelling in occurrences where the water table or confined aquifers rises above the ground surface. This tends to occur after long periods of sustained rainfall and/or very high tides. High volumes of rainfall and subsequent infiltration to ground will result in a rising of the water table. Groundwater flooding tends to occur in low-lying areas, where with additional groundwater flowing towards these zones, the water table can rise to the surface causing groundwater flooding. The sources consulted such as the PFRA mapping show no indication that the lands within the Fosterstown Masterplan area are subject to groundwater derived flooding. Factors such as soil permeability and drainage characteristics indicates that the risk of groundwater flooding is low. GSI borehole records in adjacent lands indicate that the ground water table is greater than 2m below ground surface. Thus, a stage 3 detailed flood risk assessment with respect to groundwater flooding is not required.

Pluvial Flood Risk

Pluvial flooding results from heavy rainfall that exceeds ground infiltration capacity or more commonly in Ireland where the ground is already saturated from previous rainfall events. This causes ponding and flooding at localized depressions. Pluvial flooding is usually caused by changes to the natural flow regime such as the adverse effects of urbanisation. The sources consulted such as the PFRA mapping indicate that the Fosterstown Masterplan lands are subject to pluvial derived flooding at topographic low points. Pluvial flooding will be managed through the appropriate design and implementation of Sustainable Drainage Systems (SuDS) as part of all future planned development within Fosterstown Masterplan lands in line with the recommendations outlined in the Fosterstown Masterplan SuDS Strategy Report. Therefore, the Masterplan lands will require a stage 3 flood risk assessment with respect to flooding derived from pluvial sources.

6. STAGE 3 DETAILED FLOOD RISK ASSESSMENT

6.1 Introduction

Stages 1 and 2 of the flood risk assessment for the Fosterstown Masterplan do not indicate that the Masterplan lands are subject to flooding in medium and high probability exceedance events from fluvial, tidal and pluvial sources. However, as per The Guidelines precautionary principle a hydraulic model has been prepared to verify the effects of extreme pluvial and fluvial events.

This section outlines the hydrological analysis carried out for the River Gaybrook and the hydraulic modelling methodology.

6.2 Hydrological Analysis

6.2.1 Fluvial Flow Estimation

The River Gaybrook catchment upstream of Masterplan lands is shown in Figure 6.1 below.

Figure 6.1 River Gaybrook Catchment upstream of Masterplan Lands

The peak fluvial flows for the 1 in 100 year and 1 in 1000 year events were estimated for the Gaybrook catchment using a series industry standard flow estimation methods including:

- Flood Studies Report;
- Flood Studies Report 3 variable
- Flood Studies Supplementary Reports No. 16 and;
- Institute of Hydrology Report 124.

The results are stated below in Table 6.1 and compared against the FEM FRAMS flow input.

Table 6.1 Gaybrook Upstream Flow Estimation

Return Period Current Scenario (1:x year)	FSR	FSR - 3 Variable	FSSR No: 16	IH124 / ICP IH124	FEM FRAMs
100	1.92	1.96	1.70	1.93	0.21
1000	2.68	2.74	2.37	2.70	0.36

The estimation methods stated above are supportive of the IH124 / ICP IH124 generated flows. The IH124 methodology is generally regarded as the most appropriate methodology for flow estimation in small catchments (<25km^2). It is noted that the flows inputted as part of the FEM FRAMs study are significantly lower. The FEM FRAM study used the FSSR16 estimation methodology with site specific catchment parameters. An investigation of the FEM FRAM model parameters indicates that both the catchment size and urbanised percentage of the catchment are underestimated. The hydraulic modelling of the River Gaybrook was progressed using the IH124 figures.

In addition to the current climate scenario, flows were estimated for two climate change scenarios as stated in the OPWs Climate Change Sectoral Adaptation Plan - Flood Risk Management (2015 - 2019): the Mid-Range Future Scenario (MRFS) and High End Future Scenario (HEFS). Climate change. OPW climate change allowances are stated in Table 6.2 below.

Table 6.2 Allowances in Flood Parameters for Mid-Range and High-End Future Scenarios

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

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

Note 2: Reduction in the time to peak (Tp) to allow for potential accelerated runoff that may arise as a result of drainage of afforested land

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

The IH124 calculated flows plus climate change allowances are shown in Table 6.3 below.

Table 6.3 Summary of ROD Hydrological Assessment

Return Period (1:x year)	Peak flow Current Scenario (m^3/s)	Peak flow MRFS Scenario (m^3/s)	Peak flow HEFS Scenario (m^3/s)
100	1.93	2.32	2.51
1000	2.70	3.24	3.51

6.2.2 Tidal Level Estimation

An analysis of existing tidal levels on the Gaybrook was undertaken using available data from OPW FEM FRAMs and the Irish Coastal Protection Strategy Study. Tidal flooding is restricted to downstream of the M1 motorway east of Swords and does not affect the Fosterstown Masterplan lands.

6.2.3 Rainfall Estimation

Rainfall hyetographs were estimated for the 1 in 100 year and 1 in 1000 year rainfall events using the OPW Flood Studies Update Depth Duration Frequency Module. These were then compared with calculations undertaken using the Unit Hydrograph Method. The FSU rainfall hyetographs were seen to be more representative of the catchment characteristics. The effective rainfall levels were used as the model inputs.

6.3 Hydraulic Model

A 1D-2D hydraulic model of the River Gaybrook was developed using the Jacobs Flood Modeller software v4.4. The 1D river sections were created from a topographic survey, commissioned by ROD. An example of a typical cross section from the 1D model is included in Figure 6.2 below.

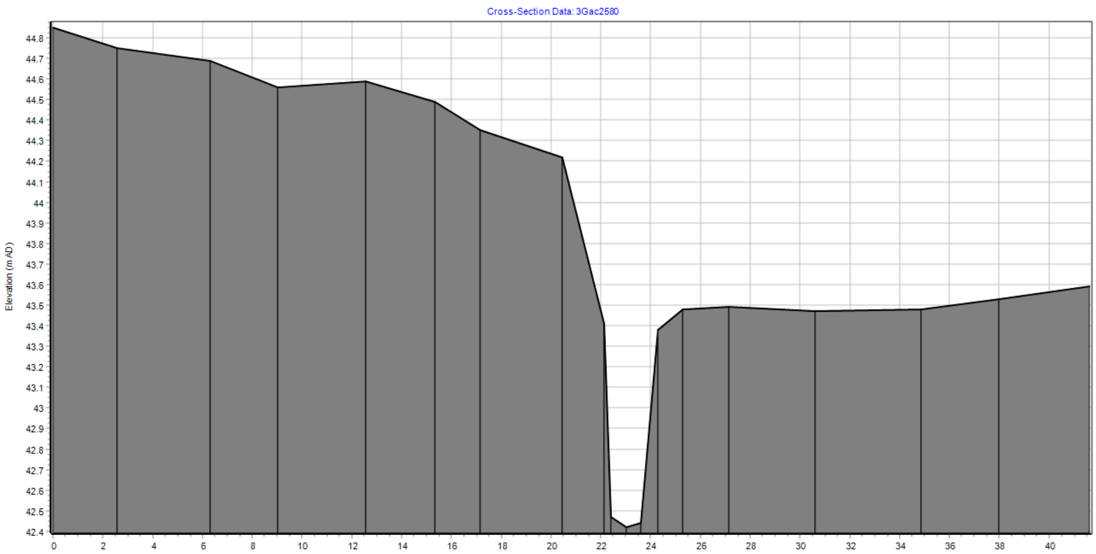


Figure 6.2 Typical 1D Channel Cross Section

A digital terrain models (DTM) of the Fosterstown Masterplan Lands was created using LiDAR data. The DTM was linked to the 1D model using a series of link lines that allow water to pass from the 1D domain to the 2D domain when the water level in the channel exceeds the bank levels. The DTM used in the hydraulic model is shown in Figure 6.3 below.

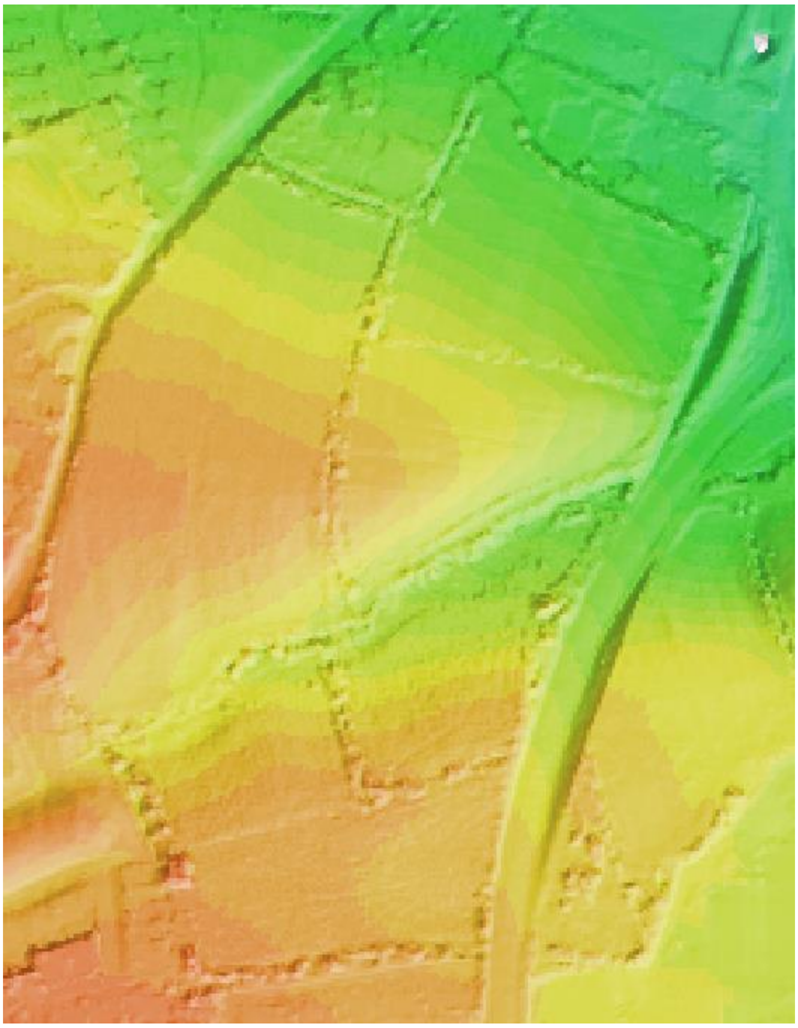


Figure 6.3 LiDAR Derived Digital Terrain Model

A site visit was conducted on the 21st November 2018. Significant features within the channel and in the floodplain were recorded. It was noted that the main channel was significantly overgrown with vegetation. The site visit aided in determining the manning's roughness values attributable to the reach. A roughness grid shapefile was used in the model to represent the effects of different surfaces on overland flow. Manning's N values ranged from 0.015 for pavement to 0.3 to simulate the permeability of flooded buildings.

6.3.1 Pluvial Flood Modelling

Pluvial flooding was assessed in a 2D model. This comprised topographic LiDAR data as used in the fluvial model as well as the roughness grid as discussed above. Return periods representing 1 in 100 year and 1 in 1000 year rainfall events for the current, MRFS and HEFS climate scenarios were used as inputs. Flooding less than 50mm in depth was removed from the model outputs which is in line with best practice for pluvial flood mapping.

6.4 Hydraulic Modelling Summary

The findings from the hydraulic model are that there is minimal flooding within the Fosterstown lands, however in extreme events the downstream culvert under the R132 Dublin Road has insufficient capacity and flood waters exit the site flowing onto the R132 Dublin Road. Flooding within the site is restricted to the immediate vicinity of the R132 Dublin Road culvert. Flood extent and flood depth mapping generated as part of this Hydraulic assessment are shown in the Fosterstown Masterplan - Surface Water Management Plan Part 1: Strategic Flood Risk Assessment Appendix G and Appendix H respectively.

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

Pluvial flooding should be managed through appropriate surface water management strategies incorporating Sustainable Drainage Systems (SuDS). Refer to *Fosterstown Masterplan Surface Water Management Plan: Part 2: Sustainable Drainage Systems (SuDS)* Strategy for detailed SuDS implementation protocol.

Although great care and modern widely-accepted methods have been used in the preparation and interpretation of the hydraulic model, there is inevitably a range of inherent uncertainties and assumptions made during the estimation of design flows and the construction of flood models. The inherent uncertainty necessitates a precautionary approach when interpreting the flood extent and flood depth mapping.

Flood risk is detailed for specific potential development areas within the Fosterstown Masterplan lands, which is described below.

6.5 Development Land Use Zoning Review

The zoning objectives within Fosterstown Masterplan are identified in Figure 6.4 below. This review will look at the development land use zoning for the areas within the Fosterstown Masterplan and comment on the flood risk in each area. The specific flood risk implications for each of these sites is described in Table 6.4 below.

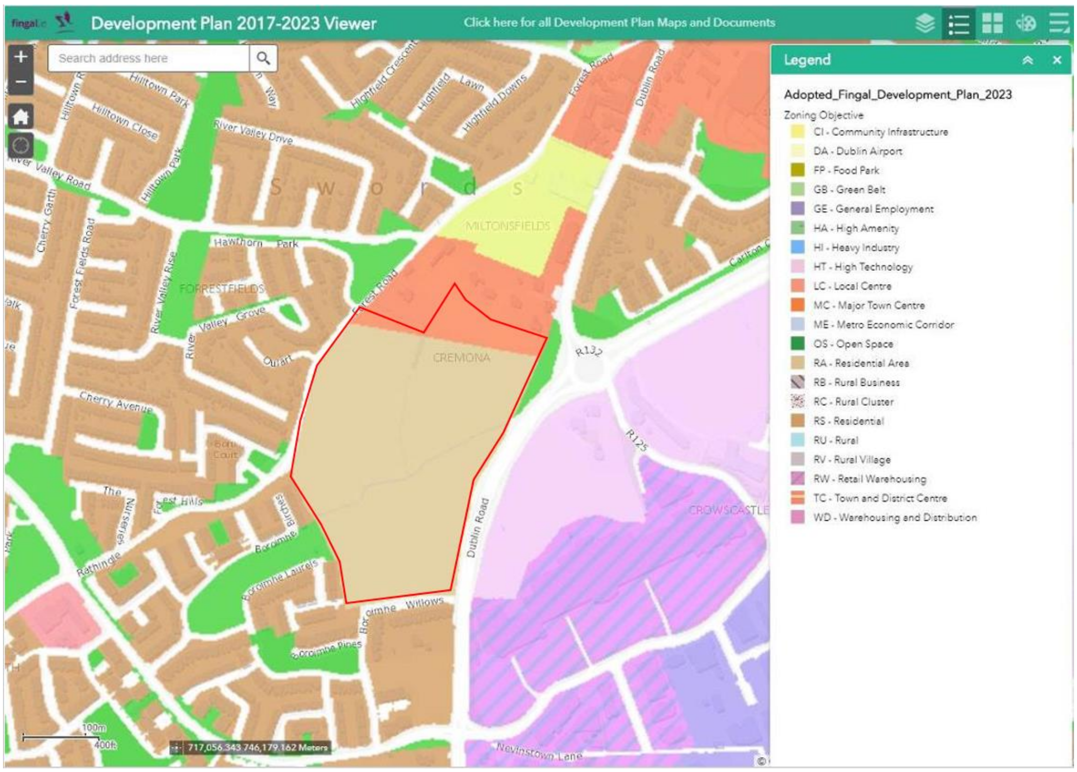


Figure 6.4 **Fosterstown Zoning Objectives (Fingal Co Co Development Plan 2017 – 2023)**

Table 6.4 **Potential Development Flood Risk**

Development Area Zoning	Likely Uses	Comment on Flood Risk	Justification Test for Development Management Required?*
RA – Residential Area	Provide for new residential communities subject to the provision of the necessary social and physical infrastructure	The majority of the Residential Area zoned lands are not affected by current and future estimated fluvial or tidal flood risk. However, the culvert under the Dublin Road appears to have insufficient capacity for extreme events. This causes flooding in a very small area on the eastern boundary of the Fosterstown Masterplan lands and on the Dublin Road. It is recommended that the lands subject to the 0.1% AEP (HEFS) fluvial flood extent shown in Appendix G Drawing 18.164-FT-107 be designated for appropriate uses such as amenity space. This will ensure that Natural Floodplain Management and floodplain protection & enhancement principles are implemented in accordance with the Fosterstown Masterplan Surface Water Management Plan Part 2: Sustainable Drainage Systems (SuDS) Strategy section 3.4 and FDP 2017-2023 chapter 7.2. Water Services & chapter 9.2 biodiversity. The masterplan lands are also susceptible to flooding from pluvial sources as seen in the pluvial flood mapping (Appendix G) at a series of localised topographic depressions. This risk should be managed through appropriate surface water management strategies incorporating Sustainable Drainage Systems (SuDS).	Yes
MC – Major Town Centre	Protect, provide for and/ or improve major town centre facilities	The Major Town Centre zoned area is not affected by current and future estimated fluvial or tidal flood risk. It is still susceptible to flooding from pluvial sources and this risk should be managed through appropriate surface water management strategies incorporating Sustainable Drainage Systems (SuDS).	Yes
*Refer to Section 5.15 of The Guidelines			

7. FLOOD RISK ASSESSMENT CONCLUSIONS

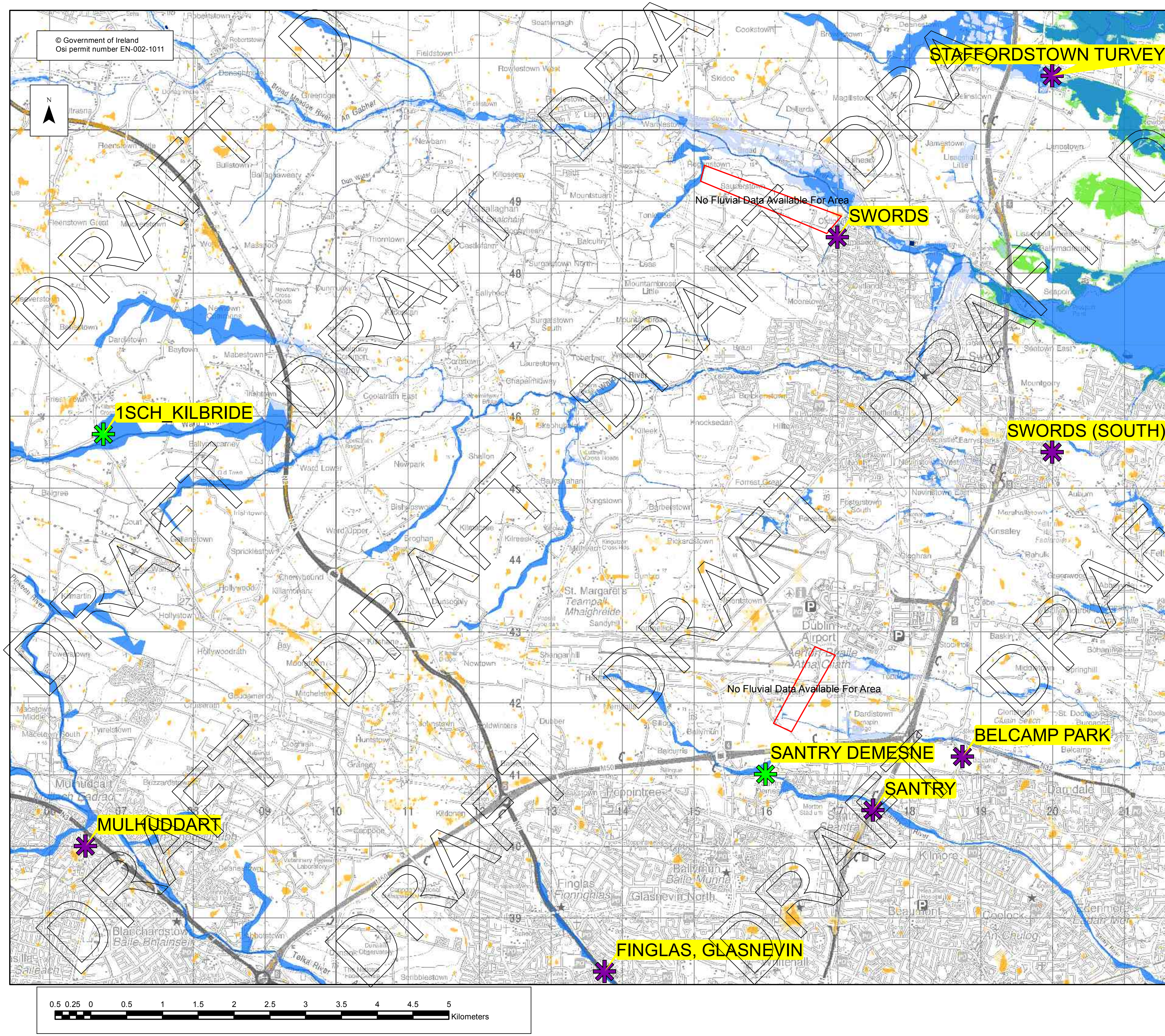
The SFRA for the Fosterstown Masterplan lands has been carried out in accordance with the requirements of the OPW "The Planning System and Flood Risk Management Guidelines for Planning Authorities", 2009. It was determined that the most significant source of flooding within the Masterplan area is from fluvial inundation from the Gaybrook Stream. There are several other minor areas of pluvial flooding within the Masterplan boundary.

The majority of the Masterplan area is within Flood Zone C where the probability of flooding from rivers and the sea is low (<1 in 1000 year) and is therefore appropriate for highly vulnerable developments. Section 6.2 details the specific flood risk associated with the two land use zoning areas within Fosterstown Masterplan.

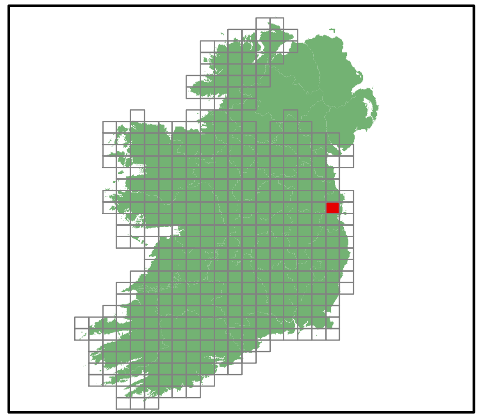
8. RECOMMENDATIONS

1) It is recommended that the drainage channels, watercourses and floodplains within the developed and undeveloped areas of the Masterplan boundary be maintained and protected.
2) Riparian corridors should be provided in accordance with the requirements of the Fingal Development Plan 2017-2023 to protect and enhance watercourses and their natural regimes including: ecological, biogeochemical and hydromorphological.
3) Sustainable Drainage Systems should be incorporated in all new developments and retro-fitting of SuDS should be encouraged within the Fosterstown Masterplan lands.
4) Future developments within Fosterstown Masterplan should be designed and constructed in accordance with the "Precautionary Principle" detailed in The Guidelines. It is recommended that the flood zoning within the Masterplan is based on the High-End Future Scenario (HEFS) for climate change, shown in Drawing 18.164-FT-107 Appendix G.
5) There is an increasing likelihood that Irelands climate will be similar to that depicted in the High-End Future climate change scenario by the year 2100. Therefore, it is prudent to consider the HEFS parameters when planning for vulnerable infrastructure and developments. No new development shall be constructed within the HEFS fluvial flood extents.
6) To address the risk of pluvial flooding in new developments in the Masterplan area, the Fosterstown Masterplan Surface Water Management Plan Part 2: Sustainable Drainage Systems (SuDS) Strategy should be adopted. This will ensure a consistent approach to the management of flood risk and water quality within Fosterstown Masterplan. Implementing these measures and complying with the GDSDS will ensure the risk of flooding downstream of any new developments is minimised.
7) Site specific flood risk assessments shall be undertaken for all new developments within Fosterstown Masterplan in accordance with The Planning System and Flood Risk Management – Guidelines for Planning Authorities (2009). Detailed topographical surveys and site development plans should be used to provide a more accurate estimation of the flood extents and aid in deciding the location of various development types.

APPENDIX A
PFRA MAPS



Location Plan :



Legend:

Flood Extents

- Fluvial - Indicative 1% AEP (100-yr) Event
- Fluvial - Extreme Event
- Coastal - Indicative 0.5% AEP (200-yr) Event
- Coastal - Extreme Event
- Pluvial - Indicative 1% AEP (100-yr) Event
- Pluvial - Extreme Event
- Groundwater Flood Extents
- Lakes / Turloughs

PFRA Outcomes

- Probable Area for Further Assesment
- Possible Area for Further Assesment

Important User Note:

The flood extents shown on these maps are based on broad-scale simple analysis and may not be accurate for a specific location. Information on the purpose, development and limitations of these maps is available in the relevant reports (see www.cfram.ie). Users should seek professional advice if they intend to rely on the maps in any way.

If you believe that the maps are inaccurate in some way please forward full details by contacting the OPW (refer to PFRA Information leaflets or 'Have Your Say' on www.cfram.ie).

Office of Public Works
Jonathon Swift Street
Trim
Co Meath
Ireland

Project :
PRELIMINARY FLOOD RISK ASSESMENT (PFRA)

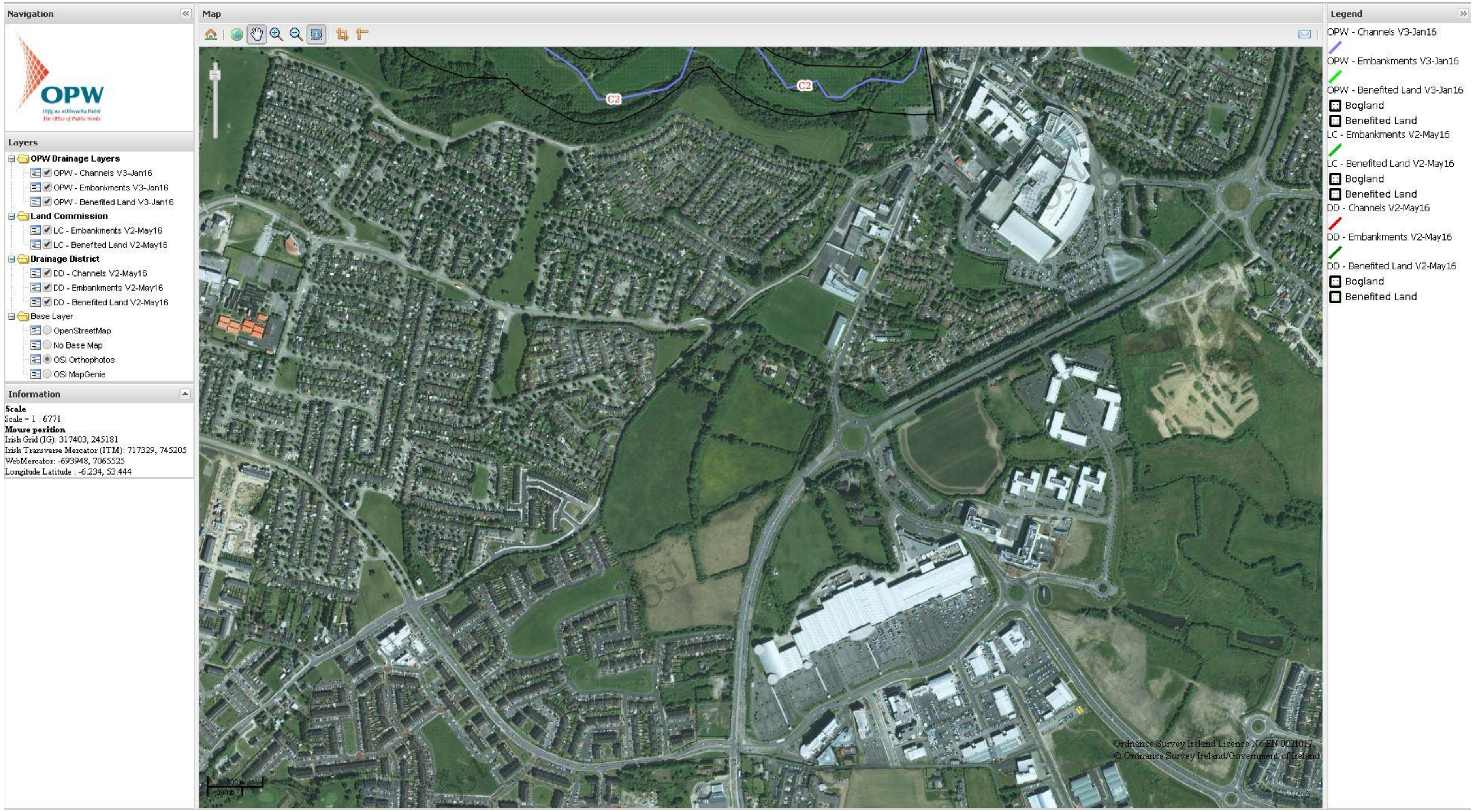
Map :
PFRA Indicative extents and outcomes
- Draft for Consultation

Figure By : PJW — Date : July2011
Checked By : MA — Date : July 2011

Figure No. : 2019 / MAP / 256 / A — Revision 0

Drawing Scale : 1:50,000 — Plot Scale : 1:1 @ A3

APPENDIX B
OPW BENEFITTING LAND MAPS


Navigation
Map
Legend
OPW
Oifig na nOibreacha Poiblí
The Office of Public Works
Layers
OPW Drainage Layers
OPW - Channels V3-Jan16
OPW - Embankments V3-Jan16
OPW - Benefited Land V3-Jan16
Land Commission
LC - Embankments V2-May16
LC - Benefited Land V2-May16
Drainage District
DD - Channels V2-May16
DD - Embankments V2-May16
DD - Benefited Land V2-May16
Base Layer
OpenStreetMap
No Base Map
OSi Orthophotos
OSi MapGenie
Information
Scale
Scale = 1 : 6771
Mouse position
Irish Grid (IG): 317403, 245181
Irish Transverse Mercator (ITM): 717329, 745205
WebMercator: -693948, 7065525
Longitude Latitude : -6.234, 53.444
C2
C2
Ordnance Survey Ireland Licence No EN 0021017
© Ordnance Survey Ireland/Government of Ireland
OPW - Channels V3-Jan16
OPW - Embankments V3-Jan16
OPW - Benefited Land V3-Jan16
Bogland
Benefited Land
LC - Embankments V2-May16
LC - Benefited Land V2-May16
Bogland
Benefited Land
DD - Channels V2-May16
DD - Embankments V2-May16
DD - Benefited Land V2-May16
Bogland
Benefited Land

APPENDIX C
OPW FLOOD RECORDS

OPW *National Flood Hazard Mapping*

Summary Local Area Report

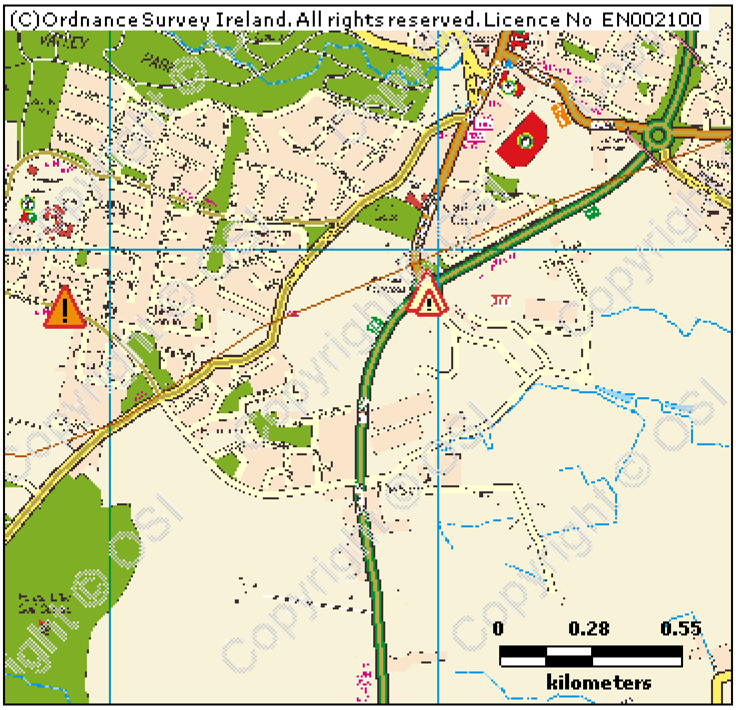
This Flood Report summarises all flood events within 2.5 kilometres of the map centre.

The map centre is in:

County: Dublin

NGR: O 177 456

This Flood Report has been downloaded from the Web site www.floodmaps.ie. The users should take account of the restrictions and limitations relating to the content and use of this Web site that are explained in the Disclaimer box when entering the site. It is a condition of use of the Web site that you accept the User Declaration and the Disclaimer.



Map Scale 1:22,981

Map Legend
Flood Points
Multiple / Recurring Flood Points
Areas Flooded
Hydrometric Stations
Rivers
Lakes
River Catchment Areas
Land Commission *
Drainage Districts *
Benefiting Lands *

* Important: These maps do not indicate flood hazard or flood extent. Thier purpose and scope is explained in the Glossary.

12 Results

1. Estuary Road Swords Feb 2002 — Start Date: 01/Feb/2002
County: Dublin — Flood Quality Code:3
Additional Information: Reports (1) More Mapped Information

2. Flooding at Kinsealy Court, Swords, Co. Dublin — Start Date: 24/Nov/2011
County: Dublin — Flood Quality Code:3
Additional Information: Reports (1) More Mapped Information

3. Pinnock Hill Nov 2002 — Start Date: 14/Nov/2002
County: Dublin — Flood Quality Code:3
Additional Information: Reports (1) More Mapped Information

4. Ward North Street Swords Nov 2002 — Start Date: 13/Nov/2002
County: Dublin — Flood Quality Code:3
Additional Information: Reports (3) Press Archive (3) More Mapped Information

5. N1 at Roundabout at Fingallions Nov 2002 — Start Date: 13/Nov/2002
County: Dublin — Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

---

6. Pinnock Hill October 2002
County: Dublin

Start Date: 20/Oct/2002
Flood Quality Code:3

Additional Information: Reports (3) More Mapped Information

---

7. Melrose Park Oct 2002
County: Dublin

Start Date: 20/Oct/2002
Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

---

8. Gartan Court Swords Feb 2002
County: Dublin

Start Date: 01/Feb/2002
Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

---

9. Pine Grove Park Swords Nov 1982
County: Dublin

Start Date: 05/Nov/1982
Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

---

10. Rathingle Swords Nov 1982
County: Dublin

Start Date: 05/Nov/1982
Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

---

11. Seatown Villas Swords Nov 1982
County: Dublin

Start Date: 05/Nov/1982
Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

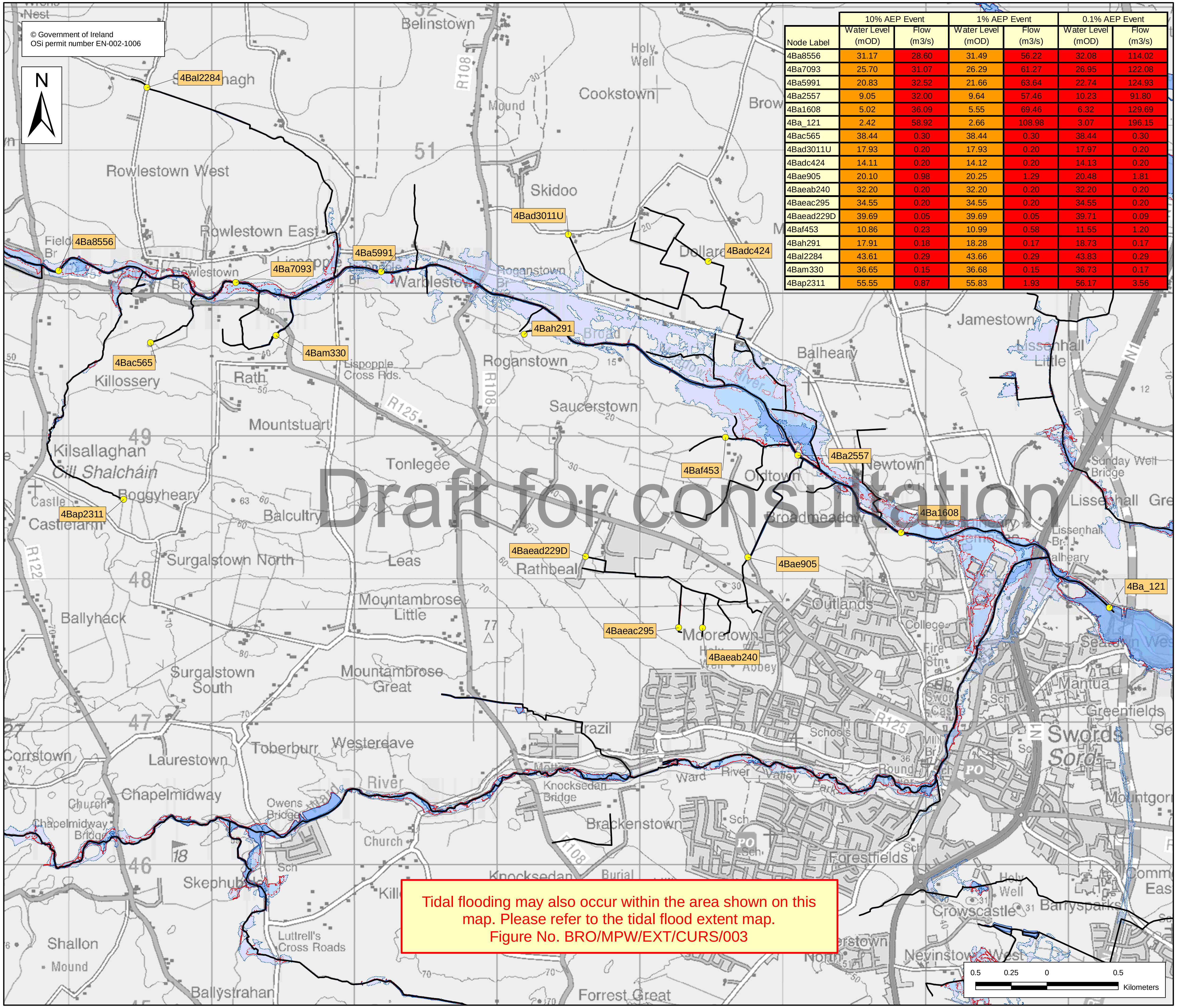
---

12. Pinnock Hill Swords Recurring
County: Dublin

Start Date:
Flood Quality Code:3

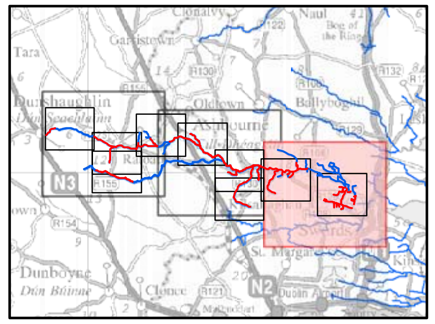
Additional Information: Reports (6) More Mapped Information

APPENDIX D
FINGAL AND EAST MEATH FLOOD RISK ASSSESMSNST AND MANAGAMENT STUDY – FLOOD MAPPING



Node Label	10% AEP Event Water Level (mOD)	10% AEP Event Flow (m3/s)	1% AEP Event Water Level (mOD)	1% AEP Event Flow (m3/s)	0.1% AEP Event Water Level (mOD)	0.1% AEP Event Flow (m3/s)
4Ba8556	31.17	28.60	31.49	56.22	32.08	114.02
4Ba7093	25.70	31.07	26.29	61.27	26.95	122.08
4Ba5991	20.83	32.52	21.66	63.64	22.74	124.93
4Ba2557	9.05	32.00	9.64	57.46	10.23	91.80
4Ba1608	5.02	36.09	5.55	69.46	6.32	129.69
4Ba_121	2.42	58.92	2.66	108.98	3.07	196.15
4Bac565	38.44	0.30	38.44	0.30	38.44	0.30
4Bad3011U	17.93	0.20	17.93	0.20	17.97	0.20
4Badc424	14.11	0.20	14.12	0.20	14.13	0.20
4Bae905	20.10	0.98	20.25	1.29	20.48	1.81
4Baeab240	32.20	0.20	32.20	0.20	32.20	0.20
4Baeac295	34.55	0.20	34.55	0.20	34.55	0.20
4Baead229D	39.69	0.05	39.69	0.05	39.71	0.09
4Baf453	10.86	0.23	10.99	0.58	11.55	1.20
4Bah291	17.91	0.18	18.28	0.17	18.73	0.17
4Bal2284	43.61	0.29	43.66	0.29	43.83	0.29
4Bam330	36.65	0.15	36.68	0.15	36.73	0.17
4Bap2311	55.55	0.87	55.83	1.93	56.17	3.56

Location Plan :



EXTENT MAP

Legend:

- 10 % AEP Flood Extent (1 in 10 chance in any given year)
- 1 % AEP Flood Extent (1 in 100 chance in any given year)
- 0.1 % AEP Flood Extent (1 in 1000 chance in any given year)
- Defended area
- High Confidence (<20m) (10% AEP)
- Medium Confidence (<40m) (10% AEP)
- Low Confidence (>40m) (10% and 0.1% AEP)
- High Confidence (<20m) (1% AEP)
- Medium Confidence (<40m) (1% AEP)
- Low Confidence (>40m) (1% AEP)
- Modelled River Centreline
- Node Point
- 21Ma237 Node label with level data (refer to table)
- 21Ma237 Node level with flow & level data (refer to table)

High confidence / Medium confidence / Low confidence — refer to table

USER NOTE :
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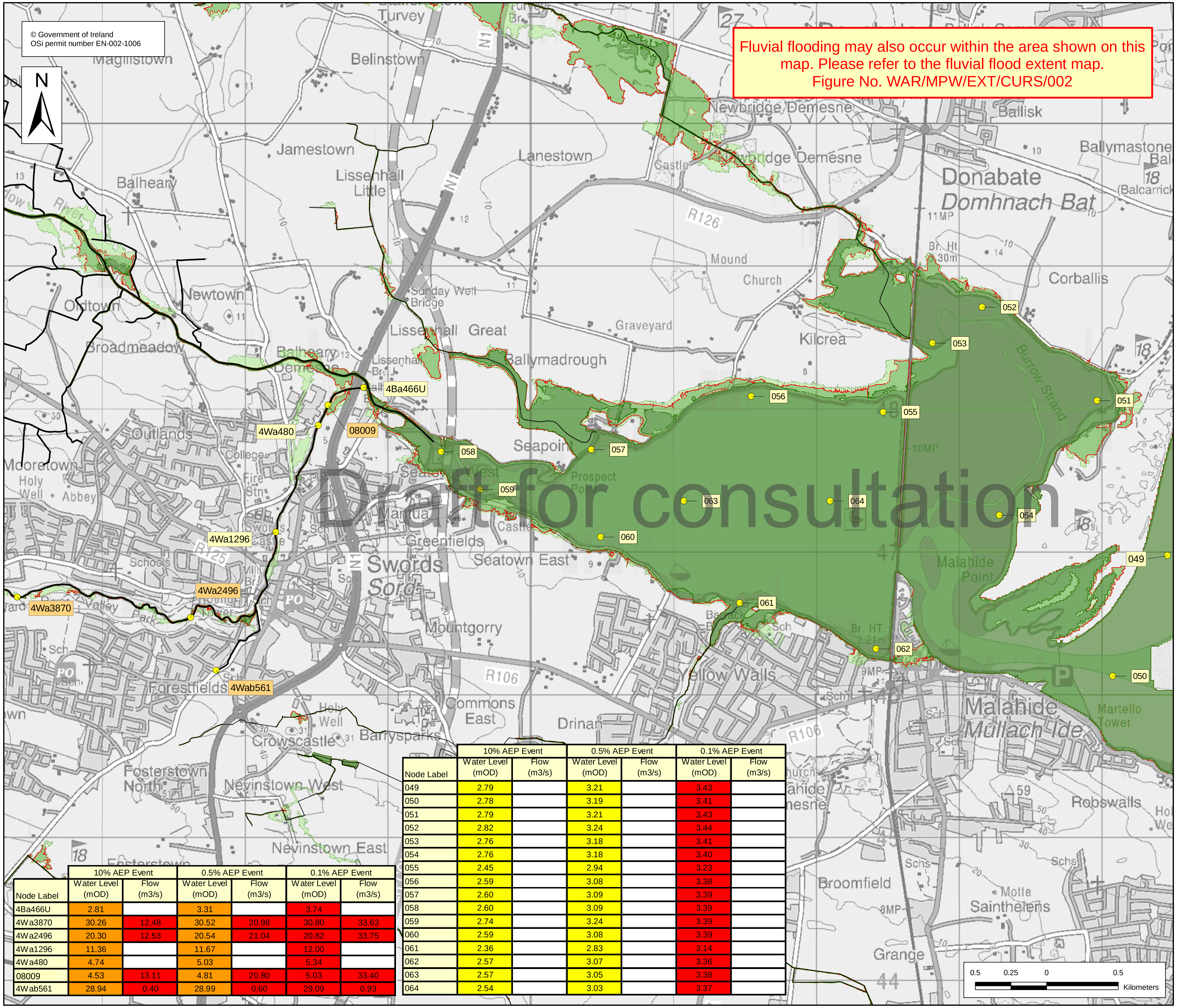
HalcrowBarry
Tramway House
32 Dartry Road
Dublin 6
Tel: +353-1-4975716

Clients :
Fingal County Council, Meath County Council, OPW

Project : FEM FRAMS

Map : BROAD MEADOW MODEL FLOOD EXTENT

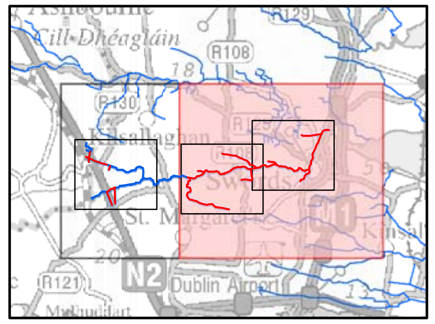
Map Type :	FLOOD EXTENT
Source :	FLUVIAL FLOODING
Map area :	MEDIUM PRIORITY WATERCOURSE
Scenario :	CURRENT
Figure By : Mara Ruiz	Date : 8 August 2010
Checked By : Sergio Herbón	Date : 8 August 2010
Approved By : Clare Dewar	Date : 8 August 2010
Figure No. : BRO/MPW/EXT/CURS/003	Revision 0
Drawing Scale : 1:25,000	Plot Scale : 1:1 @ A3



Node Label	10% AEP Event Water Level (mOD)	10% AEP Event Flow (m3/s)	0.5% AEP Event Water Level (mOD)	0.5% AEP Event Flow (m3/s)	0.1% AEP Event Water Level (mOD)	0.1% AEP Event Flow (m3/s)
4Ba466U	2.81		3.31		3.74	
4Wa3870	30.26	12.48	30.52	20.98	30.80	33.63
4Wa2496	20.30	12.53	20.54	21.04	20.82	33.75
4Wa1296	11.36		11.67		12.00	
4Wa480	4.74		5.03		5.34	
08009	4.53	13.11	4.81	20.80	5.03	33.40
4Wab561	28.94	0.40	28.99	0.60	29.09	0.93

Node Label	10% AEP Event Water Level (mOD)	10% AEP Event Flow (m3/s)	0.5% AEP Event Water Level (mOD)	0.5% AEP Event Flow (m3/s)	0.1% AEP Event Water Level (mOD)	0.1% AEP Event Flow (m3/s)
049	2.79		3.21		3.43	
050	2.78		3.19		3.41	
051	2.79		3.21		3.43	
052	2.82		3.24		3.44	
053	2.76		3.18		3.41	
054	2.76		3.18		3.40	
055	2.45		2.94		3.23	
056	2.59		3.08		3.38	
057	2.60		3.09		3.39	
058	2.60		3.09		3.39	
059	2.74		3.24		3.39	
060	2.59		3.08		3.39	
061	2.36		2.83		3.14	
062	2.57		3.07		3.36	
063	2.57		3.05		3.38	
064	2.54		3.03		3.37	

Location Plan :



EXTENT MAP

Legend:

- 10 % AEP Flood Extent (1 in 10 chance in any given year)
- 0.5 % AEP Flood Extent (1 in 200 chance in any given year)
- 0.1 % AEP Flood Extent (1 in 1000 chance in any given year)
- Defended area
- High Confidence (<20m) (10% AEP)
- Medium Confidence (<40m) (10% AEP)
- Low Confidence (> 40m) (10% and 0.1% AEP)
- High Confidence (<20m) (0.5% AEP)
- Medium Confidence (<40m) (0.5% AEP)
- Low Confidence (>40m) (0.5% AEP)
- Modelled River Centreline
- Node Point
- 21Ma237 Node label with level data (refer to table)
- 21Ma237 Node level with flow & level data (refer to table)
- High confidence / Medium confidence / Low confidence — refer to table

USER NOTE :

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HalcrowBarry
Tramway House
32 Dartry Road
Dublin 6
Tel: +353-1-4975716

Clients :

Project :
FEM FRAMS

Map :
WARD MODEL FLOOD EXTENT MAP

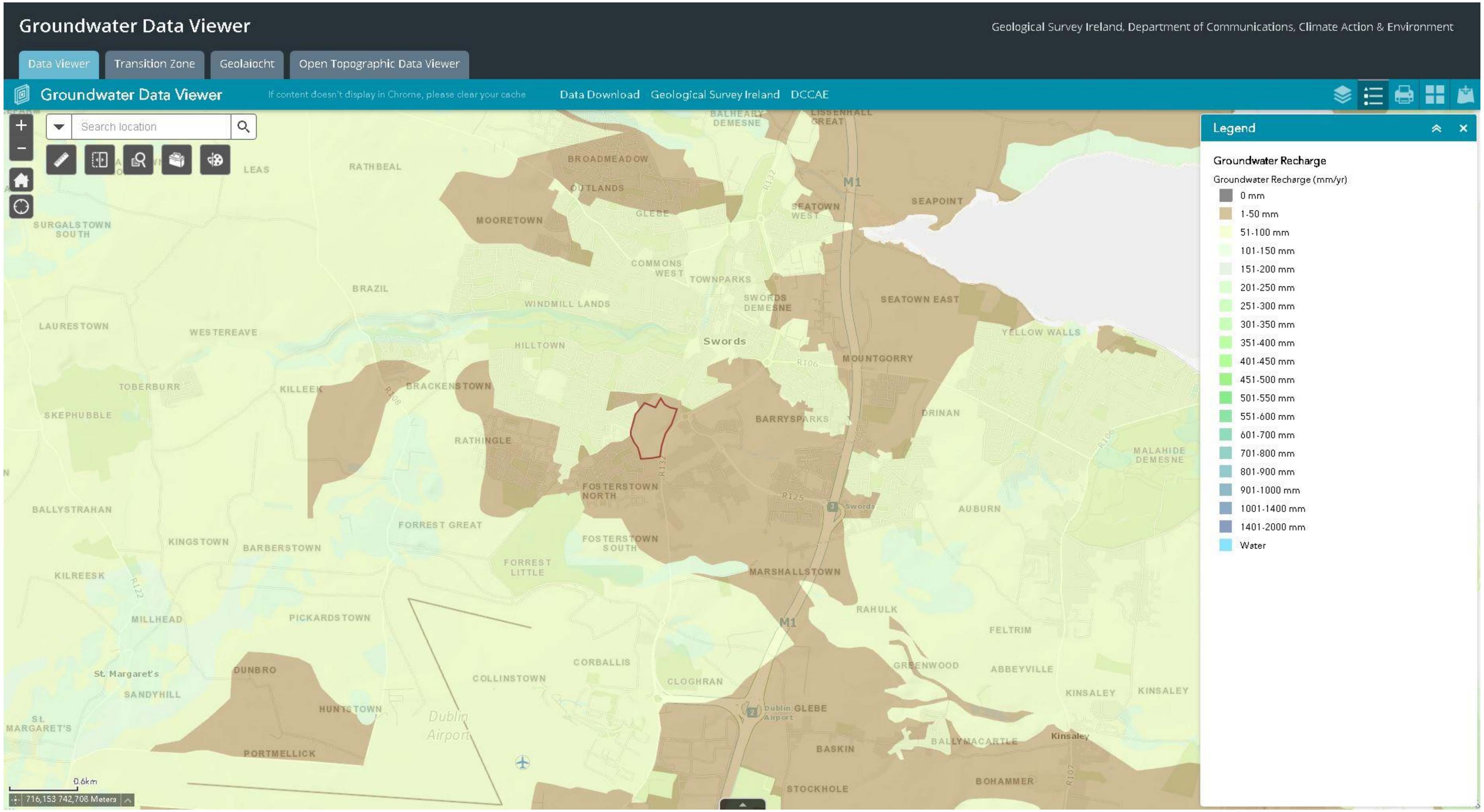
Map Type :	FLOOD EXTENT
Source :	TIDAL FLOODING
Map area :	MEDIUM PRIORITY WATERCOURSE
Scenario :	CURRENT

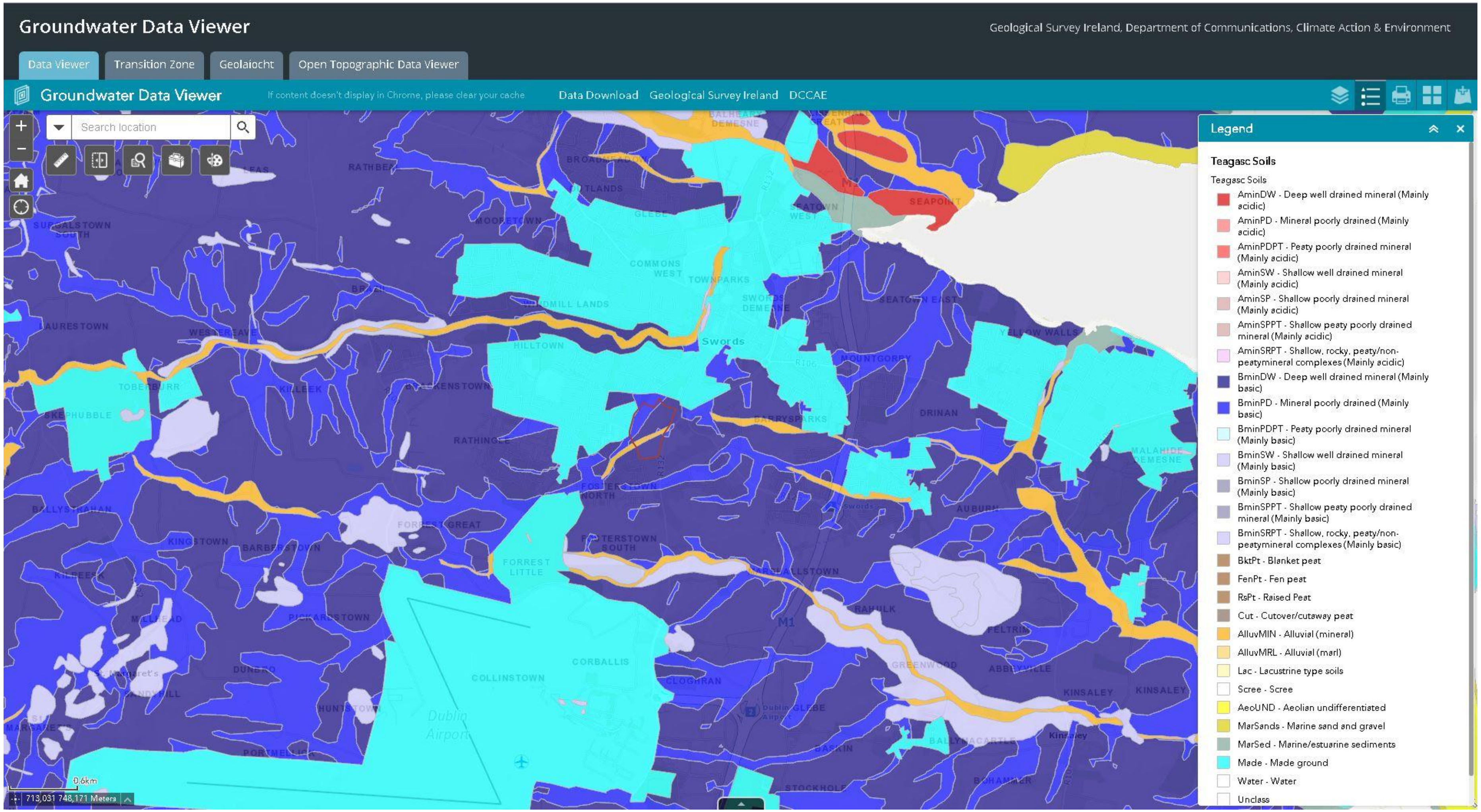
Figure By : Mara Ruiz	Date : 25 April 2012	
Checked By : Sergio Herbón	Date : 25 April 2012	
Approved By : Clare Dewar	Date : 25 April 2012	

Figure No. : WAR/MPW/EXT/CURS/T/002 — Revision 2

Drawing Scale : 1:25,000 — Plot Scale : 1:1 @ A3

APPENDIX E
GEOLOGICAL SURVEY OF IRELAND (GSI) MAPS


Groundwater Data Viewer
Geological Survey Ireland, Department of Communications, Climate Action & Environment
Data Viewer
Transition Zone
Geolaiocht
Open Topographic Data Viewer
Groundwater Data Viewer
If content doesn't display in Chrome, please clear your cache
Data Download
Geological Survey Ireland
DCCAE
Search location
Legend
Groundwater Recharge
Groundwater Recharge (mm/yr)
0 mm
1-50 mm
51-100 mm
101-150 mm
151-200 mm
201-250 mm
251-300 mm
301-350 mm
351-400 mm
401-450 mm
451-500 mm
501-550 mm
551-600 mm
601-700 mm
701-800 mm
801-900 mm
901-1000 mm
1001-1400 mm
1401-2000 mm
Water
BROADMEADOW
OUTLANDS
MOORETOWN
RATHBEAL
SEAPOINT
SEATOWN EAST
Swords
MOUNTGORRY
BARRYSPARKS
FOSTERSTOWN NORTH
FOSTERSTOWN SOUTH
RATHINGLE
BRACKENSTOWN
FORREST GREAT
FORREST LITTLE
MARSHALLSTOWN
Dublin Airport
CORBALLIS
COLLINSTOWN
CLOGHRAN
PORTMELLICK
HUNTSTOWN
DUNBRO
PICKARDSTOWN
KILREESK
MILLHEAD
BALLYSTRAHAN
KINGSTOWN
BARBERSTOWN
SKEPHUBBLE
TOBERBURR
LAURESTOWN
WESTEREAVE
KILLEEK
BRAZIL
WINDMILL LANDS
HILLTOWN
COMMONS WEST
TOWNPARKS
SWORDS DEMESNE
GLEBE
YELLOW WALLS
DRINAN
MALAHIDE DEMESNE
AUBURN
FELTRIM
RAHULK
GREENWOOD
ABBEYVILLE
KINSALEY
BALLYMACARTLE
BASKIN
STOCKHOLE
BOHAMMER
SURGALSTOWN SOUTH
St. Margaret's
SANDYHILL
ST. MARGARET'S
LEAS
M1
0.6km
716,153 742,708 Meters


Groundwater Data Viewer
Geological Survey Ireland, Department of Communications, Climate Action & Environment
Data Viewer
Transition Zone
Geolaíocht
Open Topographic Data Viewer
Groundwater Data Viewer
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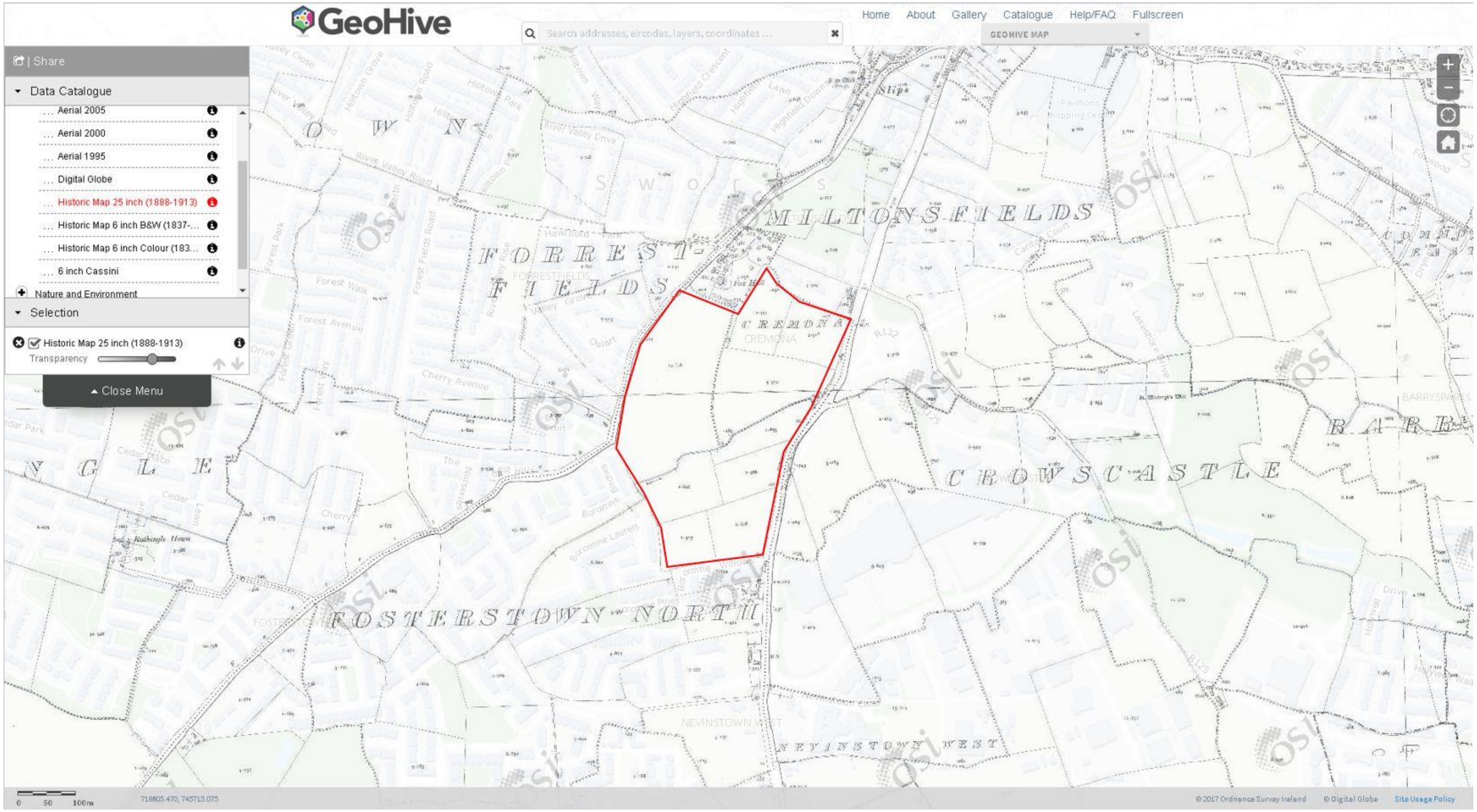
Data Download
Geological Survey Ireland
DCCAE
Search location
Legend
Teagasc Soils
Teagasc Soils
AminDW - Deep well drained mineral (Mainly acidic)
AminPD - Mineral poorly drained (Mainly acidic)
AminPDPT - Peaty poorly drained mineral (Mainly acidic)
AminSW - Shallow well drained mineral (Mainly acidic)
AminSP - Shallow poorly drained mineral (Mainly acidic)
AminSPPT - Shallow peaty poorly drained mineral (Mainly acidic)
AminSRPT - Shallow, rocky, peaty/non-peatymineral complexes (Mainly acidic)
BminDW - Deep well drained mineral (Mainly basic)
BminPD - Mineral poorly drained (Mainly basic)
BminPDPT - Peaty poorly drained mineral (Mainly basic)
BminSW - Shallow well drained mineral (Mainly basic)
BminSP - Shallow poorly drained mineral (Mainly basic)
BminSPPT - Shallow peaty poorly drained mineral (Mainly basic)
BminSRPT - Shallow, rocky, peaty/non-peatymineral complexes (Mainly basic)
BktPt - Blanket peat
FenPt - Fen peat
RsPt - Raised Peat
Cut - Cutover/cutaway peat
AlluvMIN - Alluvial (mineral)
AlluvMRL - Alluvial (marl)
Lac - Lacustrine type soils
Scree - Scree
AeoUND - Aeolian undifferentiated
MarSands - Marine sand and gravel
MarSed - Marine/estuarine sediments
Made - Made ground
Water - Water
Unclass
Swords
Dublin Airport
SEAPOINT
COMMONS WEST
HILLTOWN
RATHINGLE
FOSTERSTOWN NORTH
FOSTERSTOWN SOUTH
FORREST GREAT
FORREST LITTLE
CORBALLIS
COLLINSTOWN
CLOGHRAN
MOUNTGORRY
DRINAN
AUBURN
FELTRIM
RAHULK
GREENWOOD
ABBEYVILLE
KINSALEY
YELLOW WALLS
MALAHIDE DEMESNE
BALLYSTRAHAN
KINGSTOWN
BARBERSTOWN
PICKARDSTOWN
DUNBRO
HUNTSTOWN
PORTMELLICK
LAURESTOWN
TOBERBURR
SKEPHUBBLE
KILLEEK
KNOCKSEDAN
MOORETOWN
RATHBEAL
BROADMEADOW
GLEBE
TOWNPARKS
SWORDS DEMESNE
SEATOWN WEST
SEATOWN EAST
BARRYSPARKS
M1
0.6km
713,031 748,171 Meters

APPENDIX F
OSI HISTORICAL MAPS


GeoHive
Home
About
Gallery
Catalogue
Help/FAQ
Fullscreen
Share
Data Catalogue
Aerial 2005
Aerial 2000
Aerial 1995
Digital Globe
Historic Map 25 inch (1888-1913)
Historic Map 6 inch B&W (1837-...
Historic Map 6 inch Colour (183...
6 inch Cassini
Nature and Environment
Selection
Historic Map 25 inch (1888-1913)
Transparency
Close Menu
MILTONSFIELDS
FORREST-FIELDS
CREMONA
CROWSCASTLE
FOSTERSTOWN NORTH
NEVINSTOWN WEST
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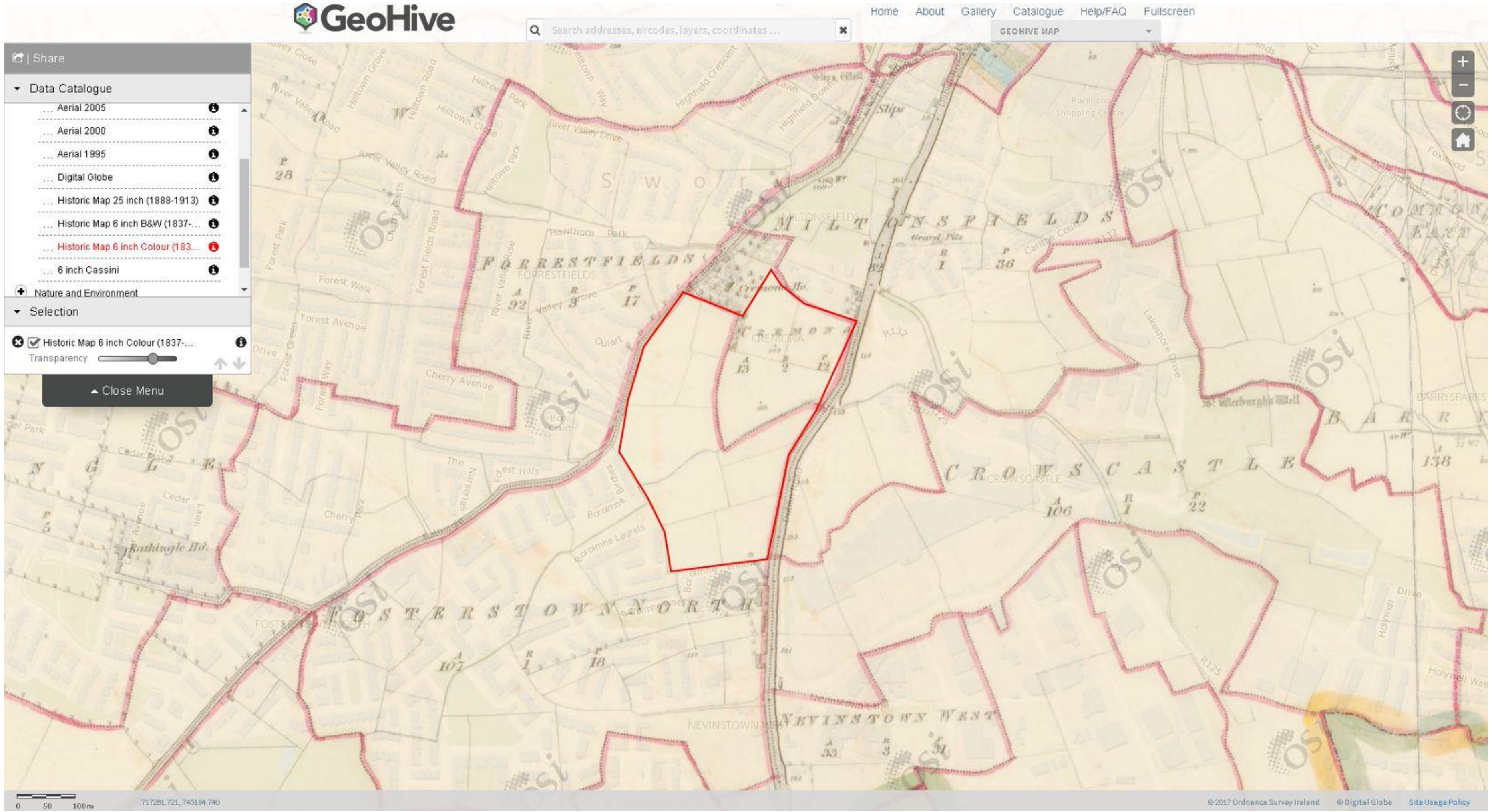
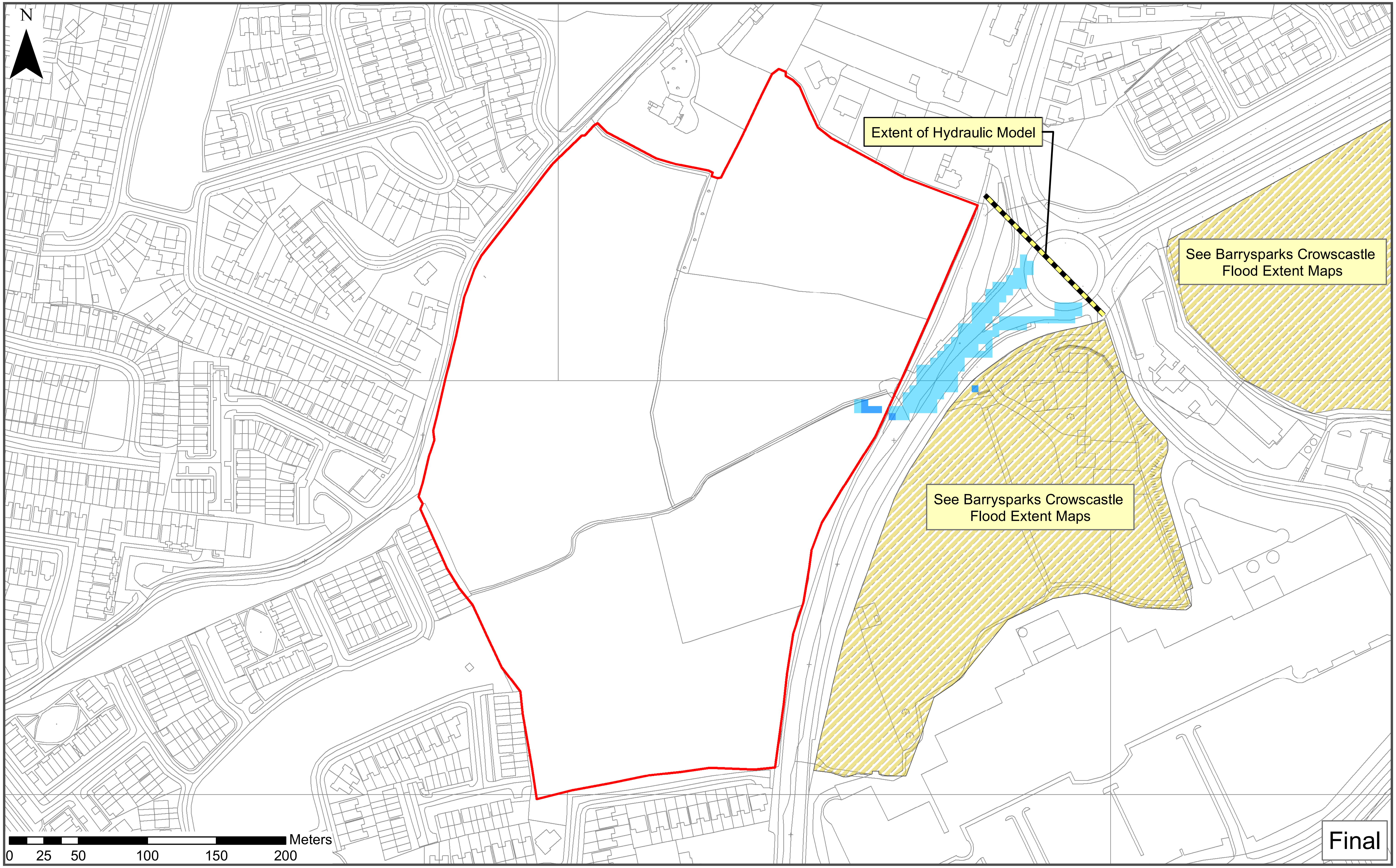


APPENDIX G
STRATEGIC FOOD RISK ASSESSMENT FLOOD EXTENT MAPPING



Legend

- Fosterstown Masterplan Lands
- Barrysparks Crowscastle Masterplan Lands
- Fosterstown - 1 in 100 Year Fluvial Event - Current Scenario
- Fosterstown - 1 in 1000 Year Fluvial Event - Current Scenario

No.	Revision	Date	By	Chk'd	App'd
F01	Final Flood Extents	09/05/2019	BP	WV	JPR
D02	Draft Flood Extents	25/02/2019	BP	WV	JPR
D01	Draft Flood Extents	24/01/2019	BP	WV	JPR

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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ROUGHAN & O'DONOVAN
Consulting Engineers
Civil - Structural - Transportation - Environmental

Arena House, Arena Road,
Sandyford, Dublin 18.
Tel : +353 1 294 0800
Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

Project Title: Fosterstown Surface Water Management Plan

Drawing Title: Fluvial Flood Extents (Current Scenario)

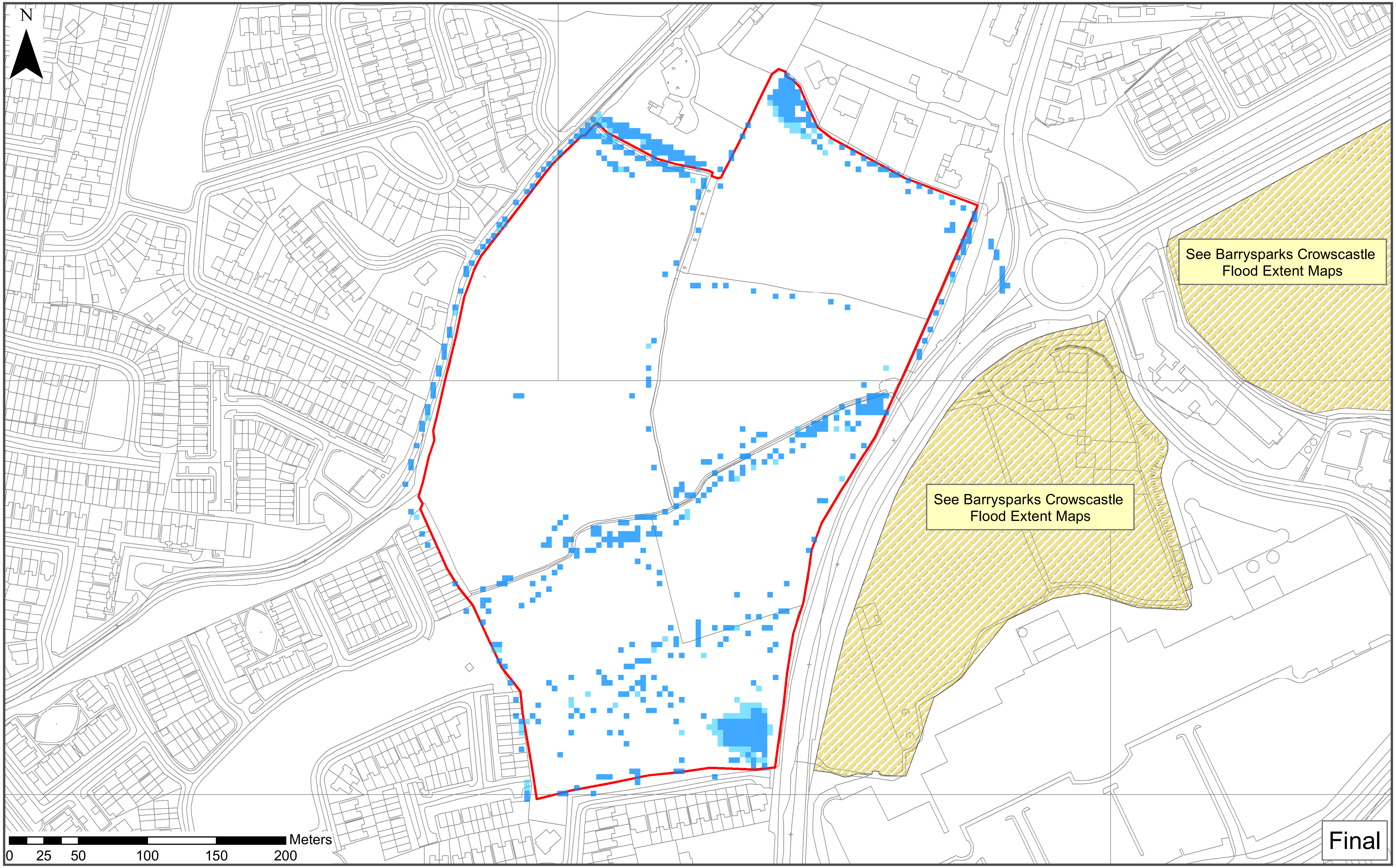
Designed: BP | Checked: WV | Approved: JPR | Status: FINAL

Drawn: BP | Job No: 18.164 | Drawing No: 18.164-FT-101 | Rev: F01

Scale: 1:2,500 (@ A3) | Date: 25/02/2019

09 May 2019 18:21:12 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Extents\Final\Fluvial\18.164-FT-101 Fluvial Flood Extents CS F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY



Legend

- Fosterstown Masterplan Lands
- Barrysparks Crowscastle Masterplan Lands
- Fosterstown - 1 in 100 Year Pluvial Event - Current Scenario
- Fosterstown - 1 in 1000 Year Pluvial Event - Current Scenario

Note:
Pluvial flooding in excess of 50mm depth.

No.	Revision	Date	By	Chk'd	App'd
F01	Final Flood Extents	10/05/2019	BP	WV	JPR
D02	Draft Flood Extents	25/02/2019	BP	WV	JPR
D01	Draft Flood Extents	24/01/2019	BP	WV	JPR

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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Sandyford, Dublin 18.
Tel : +353 1 294 0800
Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

Project Title: Fosterstown Surface Water Management Plan

Drawing Title: Pluvial Flood Extents (Current Scenario)

Designed: BP	Checked: WV	Approved: JPR	Status: FINAL
Drawn: BP	Job No: 18.164	Drawing No: 18.164-FT-103	Rev: F01
Scale: 1:2,500 (@ A3)	Date: 25/02/2019		

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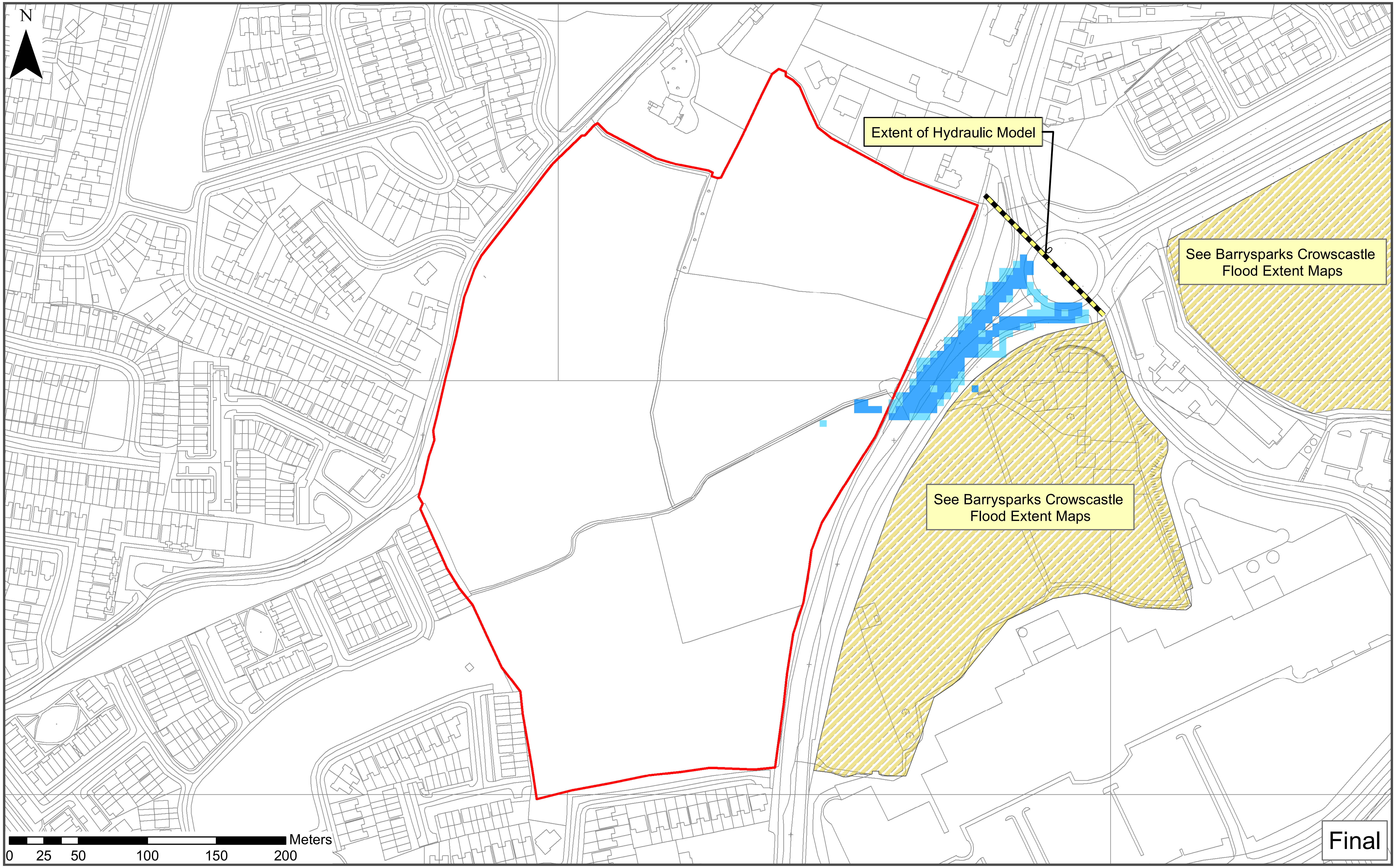
DO NOT SCALE USE FIGURED DIMENSIONS ONLY



Legend

- Fosterstown Masterplan Lands
- Barrysparks Crowscastle Masterplan Lands
- Fosterstown - 1 in 100 Year Fluvial Event - Mid Range Future Scenario
- Fosterstown - 1 in 1000 Year Fluvial Event - Mid Range Future Scenario

No.	Revision	Date	By	Chk'd	App'd
F01	Final Flood Extents	09/05/2019	BP	WV	JPR
D02	Draft Flood Extents	25/02/2019	BP	WV	JPR
D01	Draft Flood Extents	24/01/2019	BP	WV	JPR

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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Sandyford, Dublin 18.
Tel : +353 1 294 0800
Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

Project Title: Fosterstown Surface Water Management Plan

Drawing Title: Fluvial Flood Extents (Mid Range Future Scenario)

Designed: BP	Checked: WV	Approved: JPR	Status: FINAL

Drawn: BP	Job No: 18.164	Drawing No: 18.164-FT-104	Rev: F01
Scale: 1:2,500 (@ A3)	Date: 25/02/2019		

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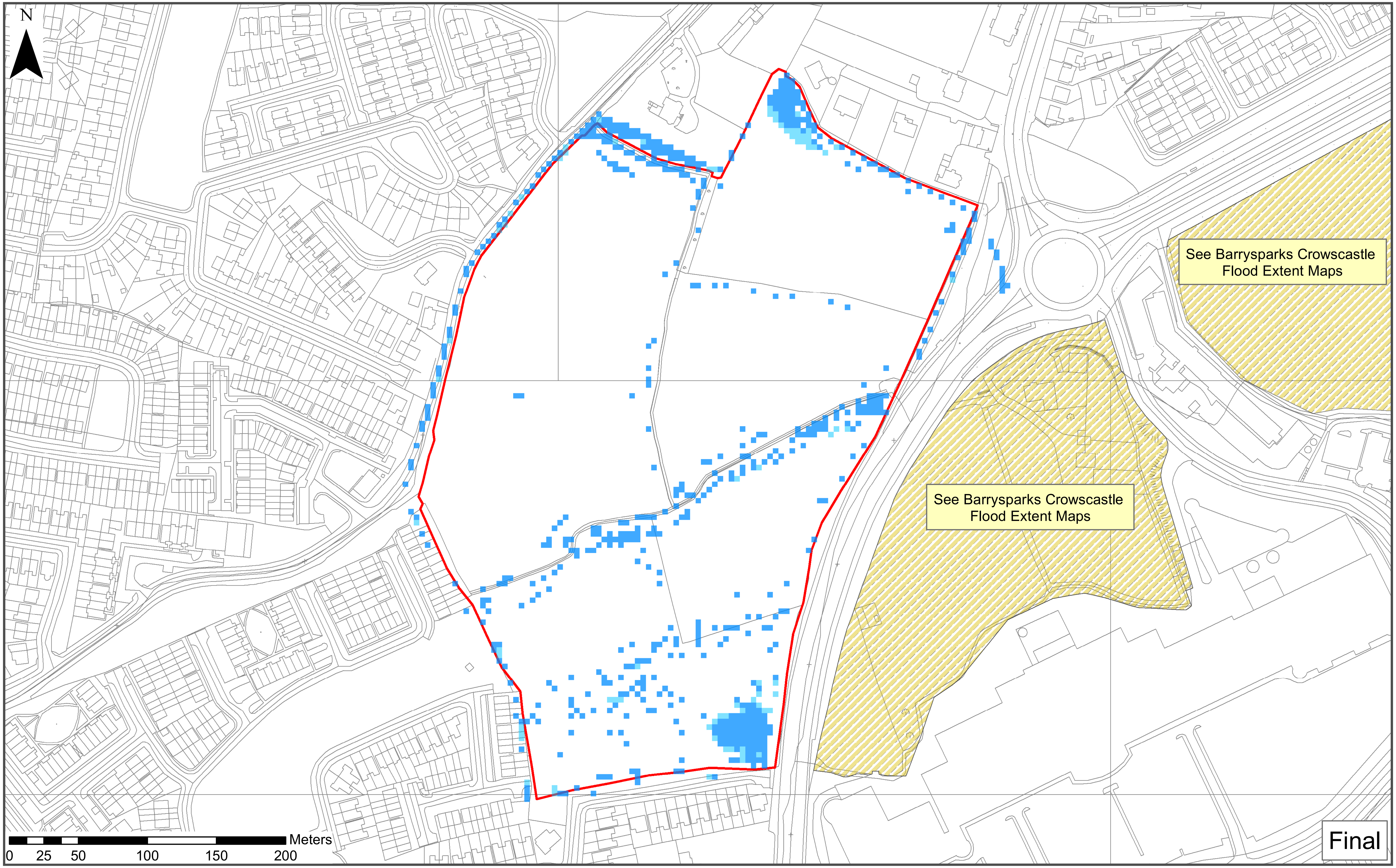
DO NOT SCALE USE FIGURED DIMENSIONS ONLY



Legend

- Fosterstown Masterplan Lands
- Barrysparks Crowscastle Masterplan Lands
- Fosterstown - 1 in 100 Year Pluvial Event -Mid Range Future Scenario
- Fosterstown - 1 in 1000 Year Pluvial Event - Mid Range Future Scenario

Note:
Pluvial flooding in excess of 50mm depth.

No.	Revision	Date	By	Chk'd	App'd
F01	Final Flood Extents	10/05/2019	BP	WV	JPR
D02	Draft Flood Extents	25/02/2019	BP	WV	JPR
D01	Draft Flood Extents	24/01/2019	BP	WV	JPR

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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Sandyford, Dublin 18.
Tel : +353 1 294 0800
Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

Project Title: Fosterstown Surface Water Management Plan

Drawing Title: Pluvial Flood Extents (Mid Range Future Scenario)

Designed: BP	Checked: WV	Approved: JPR	Status: FINAL

Drawn: BP	Job No: 18.164	Drawing No: 18.164-FT-106	Rev: F01
Scale: 1:2,500 (@ A3)	Date: 25/02/2019		

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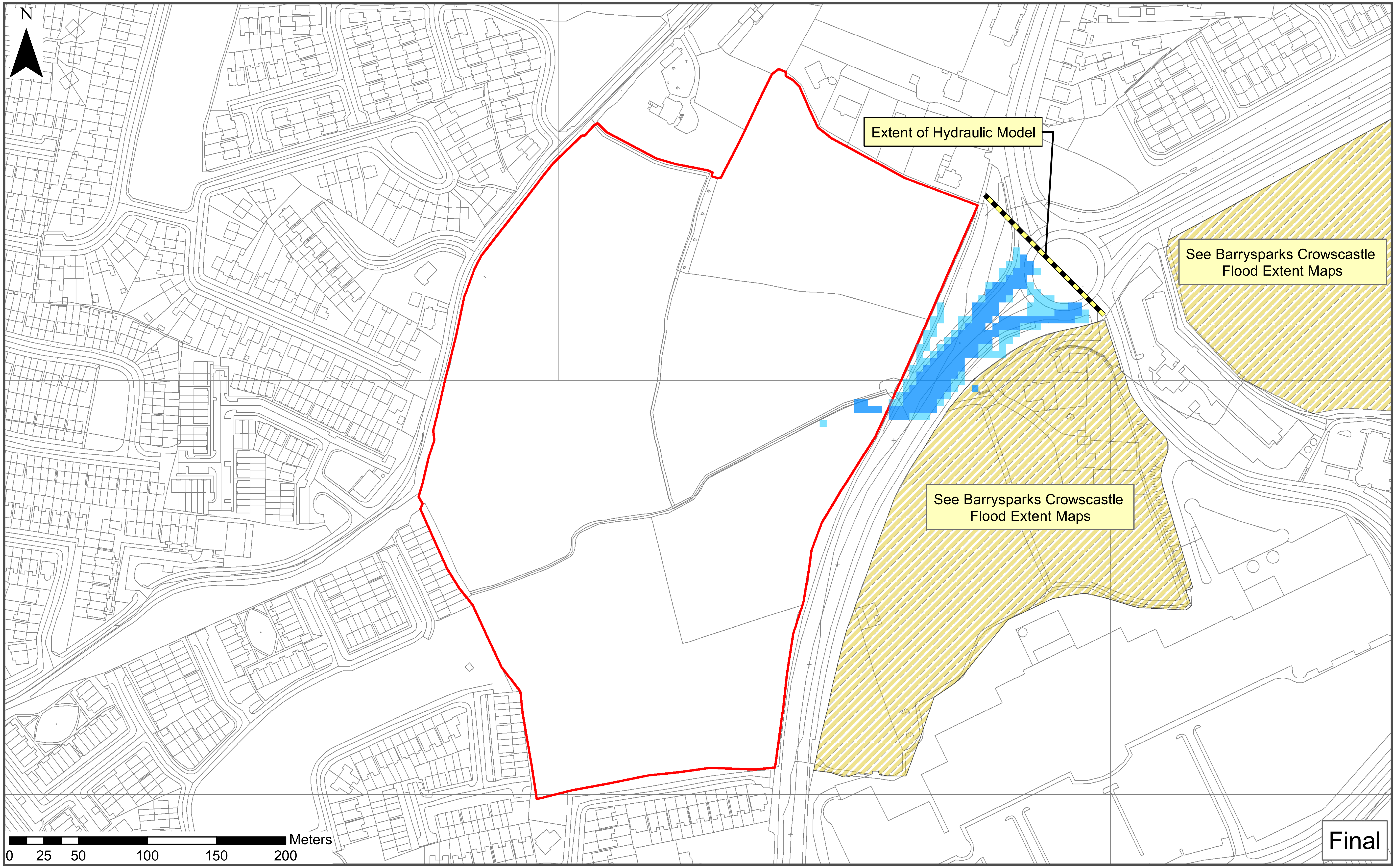
DO NOT SCALE USE FIGURED DIMENSIONS ONLY



Legend

- Fosterstown Masterplan Lands
- Barrysparks Crowscastle Masterplan Lands
- Fosterstown - 1 in 100 Year Fluvial Event - High End Future Scenario
- Fosterstown - 1 in 1000 Year Fluvial Event - High End Future Scenario

No.	Revision	Date	By	Chk'd	App'd
F01	Final Flood Extents	09/05/2019	BP	WV	JPR
D02	Draft Flood Extents	25/02/2019	BP	WV	JPR
D01	Draft Flood Extents	25/01/2019	BP	WV	JPR

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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Website : www.rod.ie

Designed: BP | Checked: WV | Approved: JPR | Status: FINAL

Project Title: Fosterstown Surface Water Management Plan

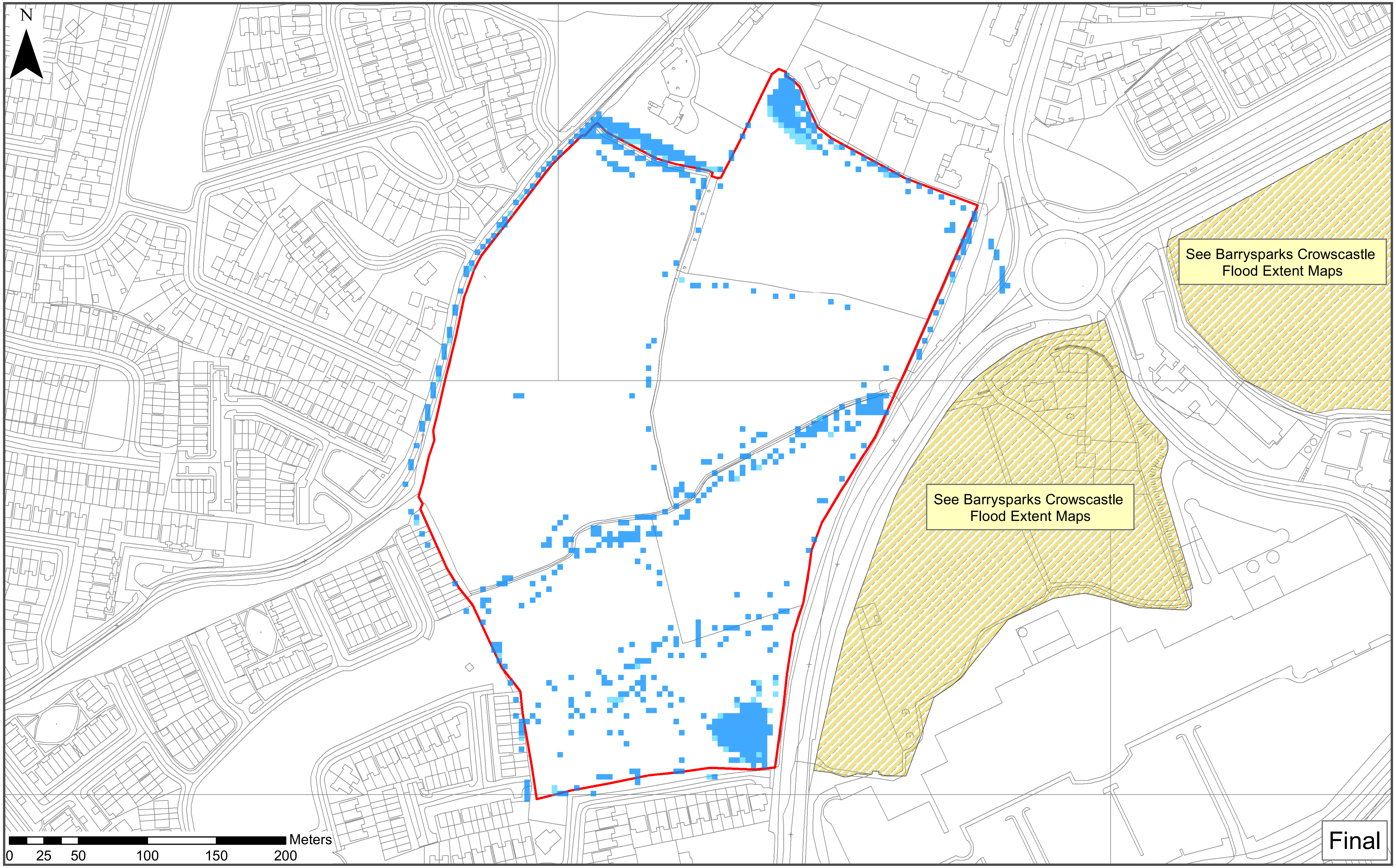
Drawing Title: Fluvial Flood Extents (High End Future Scenario)

Drawn: BP | Job No: 18.164 | Drawing No: 18.164-FT-107 | Rev: F01

Scale: 1:2,500 (@ A3) | Date: 25/02/2019

09 May 2019 18:23:40 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Extents\Final\Fluvial\18.164-FT-107 Fluvial Flood Extents HEFS F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY



Legend

- Fosterstown Masterplan Lands
- Barrysparks Crowscastle Masterplan Lands
- Fosterstown - 1 in 100 Year Pluvial Event - High End Future Scenario
- Fosterstown - 1 in 1000 Year Pluvial Event - High End Future Scenario

Note:
Pluvial flooding in excess of 50mm depth.

No.	Revision	Date	By	Chk'd	App'd
F01	Final Flood Extents	10/05/2019	BP	WV	JPR
D02	Draft Flood Extents	25/02/2019	BP	WV	JPR
D01	Draft Flood Extents	24/01/2019	BP	WV	JPR

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
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Sandyford, Dublin 18.
Tel : +353 1 294 0800
Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

Project Title: Fosterstown Surface Water Management Plan

Drawing Title: Pluvial Flood Extents (High End Future Scenario)

Designed: BP	Checked: WV	Approved: JPR	Status: FINAL

Drawn: BP	Job No: 18.164	Drawing No: 18.164-FT-109	Rev: F01
Scale: 1:2,500 (@ A3)	Date: 25/02/2019		

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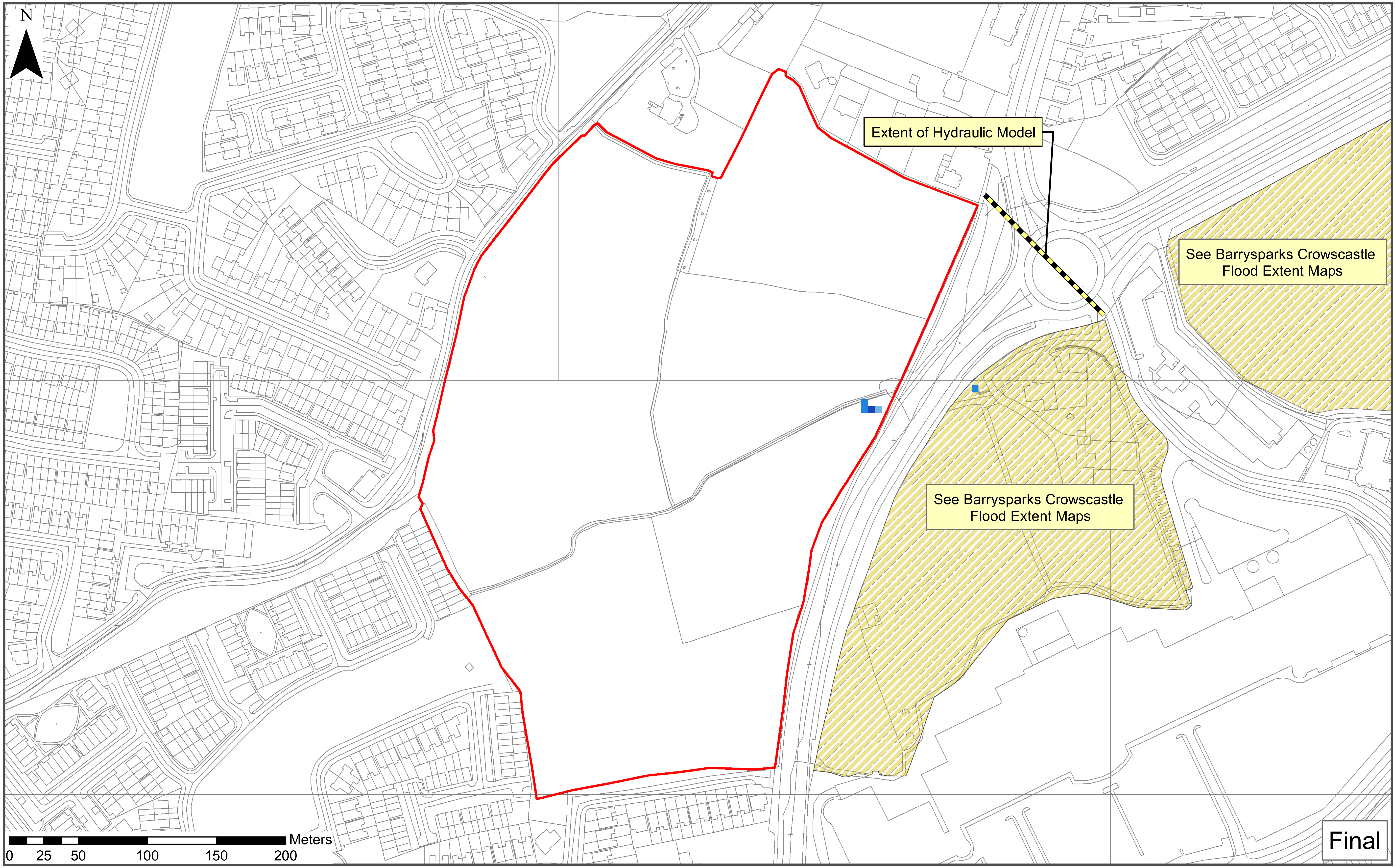
DO NOT SCALE USE FIGURED DIMENSIONS ONLY

APPENDIX H
STRATEGIC FOOD RISK ASSESSMENT FLOOD DEPTH MAPPING



Legend

Depth (m)

- 0 - 0.1m
- 0.1 - 0.2m
- 0.2 - 0.3m
- 0.3 - 0.4m
- 0.4 - 0.5m
- Fosterstown Masterplan Lands
- Barrysparks Crowscastle Masterplan Lands

No.	Revision	Date	By	Chk'd	App'd
F01	Final Flood Depths	09/05/2019	BP	WV	JPR
D02	Draft Flood Depths	25/02/2019	BP	WV	JPR
D01	Draft Flood Depths	30/01/2019	BP	WV	JPR

Stage	Date	App'd
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Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

Project Title: Fosterstown Surface Water Management Plan

Drawing Title: Fluvial 1 in 100 Year Flood Depths (Current Scenario)

Designed: BP | Checked: WV | Approved: JPR | Status: FINAL

Drawn: BP | Job No: 18.164 | Drawing No: 18.164-FT-201 | Rev: F01

Scale: 1:2,500 (@ A3) | Date: 25/02/2019

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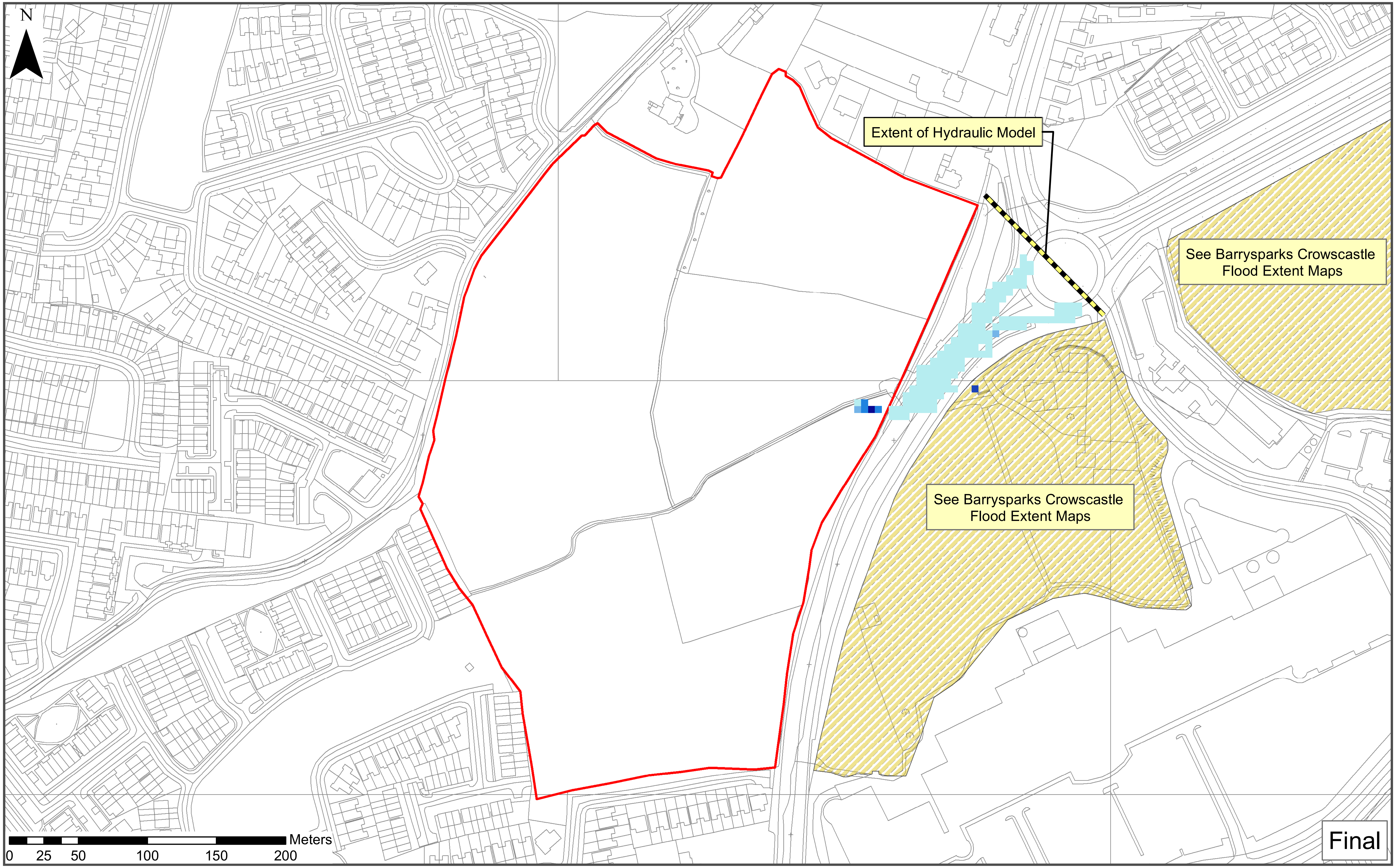
DO NOT SCALE USE FIGURED DIMENSIONS ONLY



Legend

Depth (m)

- 0 - 0.1m
- 0.1 - 0.2m
- 0.2 - 0.3m
- 0.3 - 0.4m
- 0.4 - 0.5m
- Fosterstown Masterplan Lands
- Barrysparks Crowscastle Masterplan Lands

No.	Revision	Date	By	Chk'd	App'd
F01	Final Flood Depths	09/05/2019	BP	WV	JPR
D02	Draft Flood Depths	25/02/2019	BP	WV	JPR
D01	Draft Flood Depths	30/01/2019	BP	WV	JPR

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
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CONSTRUCTION		

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Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

Designed: BP	Checked: WV	Approved: JPR	Status: FINAL

Project Title: Fosterstown Surface Water Management Plan

Drawing Title: Fluvial 1 in 1000 Year Flood Depths (Current Scenario)

Drawn: BP	Job No: 18.164	Drawing No: 18.164-FT-202	Rev: F01
Scale: 1:2,500 (@ A3)	Date: 25/02/2019		

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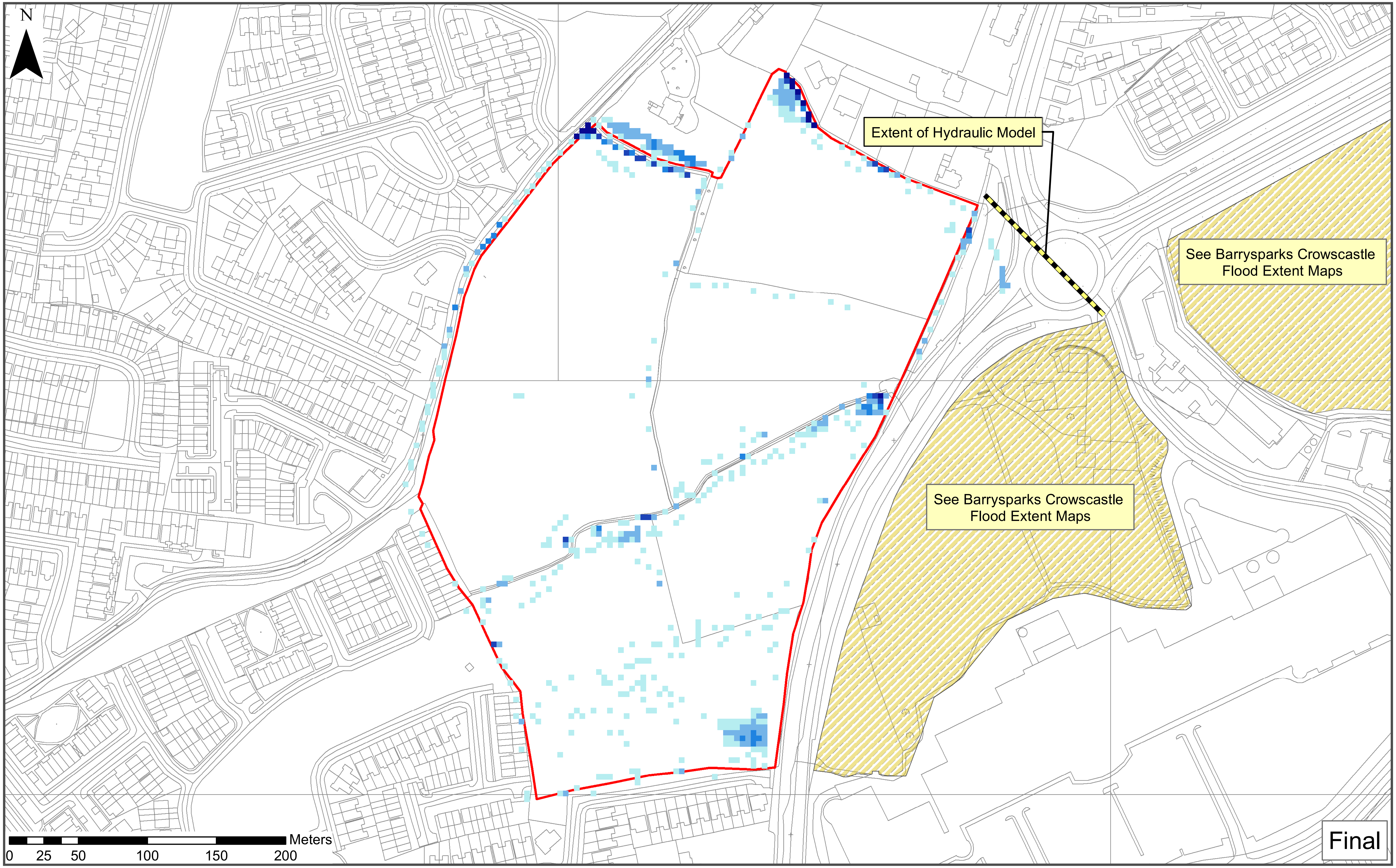
DO NOT SCALE USE FIGURED DIMENSIONS ONLY



Legend

Depth (m)

- 0.05- 0.2m
- 0.2 - 0.4m
- 0.4 - 0.6m
- 0.6 - 1m
- 1 - 2m
- Fosterstown Masterplan Lands
- Barrysparks Crowscastle Masterplan Lands

No.	Revision	Date	By	Chk'd	App'd
F01	Final Flood Depths	09/05/2019	BP	WV	JPR
D02	Draft Flood Depths	25/02/2019	BP	WV	JPR
D01	Draft Flood Depths	30/01/2019	BP	WV	JPR

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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Consulting Engineers
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Sandyford, Dublin 18.
Tel : +353 1 294 0800
Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

Project Title: Fosterstown Surface Water Management Plan

Drawing Title: Pluvial 1 in 100 Year Flood Depths (Current Scenario)

Designed: BP | Checked: WV | Approved: JPR | Status: FINAL

Drawn: BP | Job No: 18.164 | Drawing No: 18.164-FT-205 | Rev: F01

Scale: 1:2,500 (@ A3) | Date: 25/02/2019

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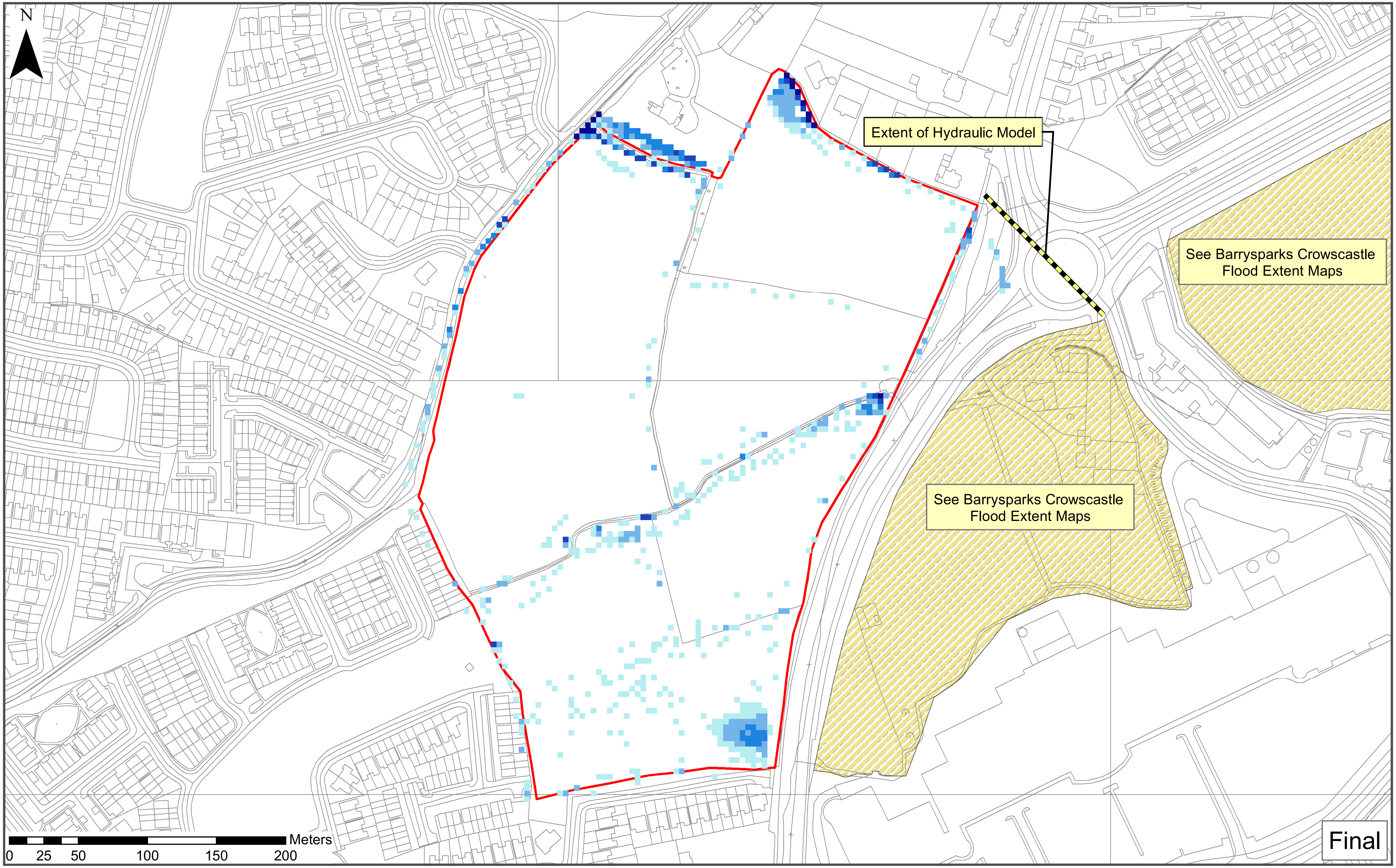
DO NOT SCALE USE FIGURED DIMENSIONS ONLY



Legend

Depth (m)

- 0.05- 0.2m
- 0.2 - 0.4m
- 0.4 - 0.6m
- 0.6 - 1m
- 1 - 2m
- Fosterstown Masterplan Lands
- Barrysparks Crowscastle Masterplan Lands

No.	Revision	Date	By	Chk'd	App'd
F01	Final Flood Depths	09/05/2019	BP	WV	JPR
D02	Draft Flood Depths	25/02/2019	BP	WV	JPR
D01	Draft Flood Depths	30/01/2019	BP	WV	JPR

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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Arena House, Arena Road,
Sandyford, Dublin 18.
Tel : +353 1 294 0800
Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

Project Title: Fosterstown Surface Water Management Plan

Drawing Title: Pluvial 1 in 1000 Year Flood Depths (Current Scenario)

Designed: BP | Checked: WV | Approved: JPR | Status: FINAL

Drawn: BP | Job No: 18.164 | Drawing No: 18.164-FT-206 | Rev: F01

Scale: 1:2,500 (@ A3) | Date: 25/02/2019

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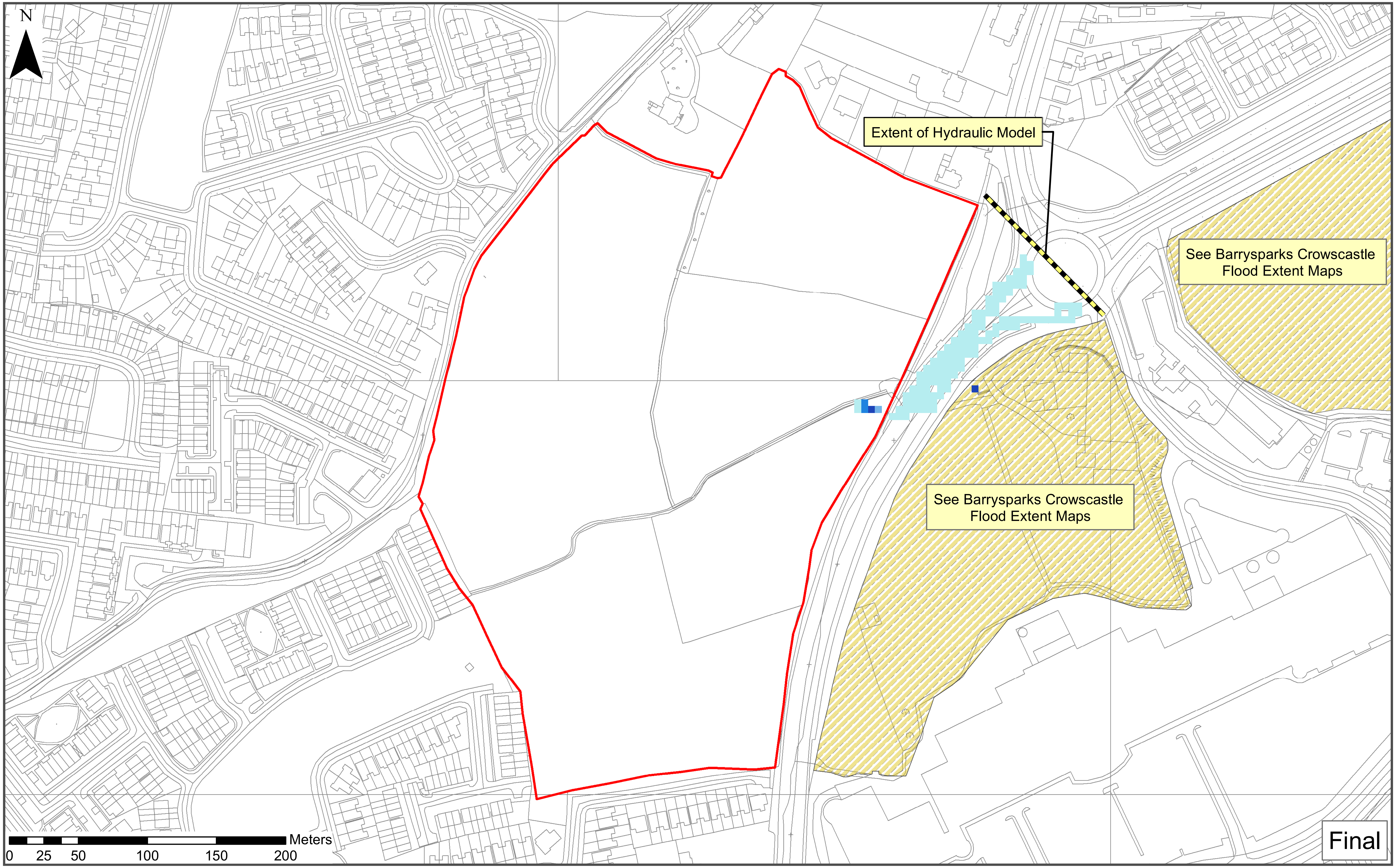
DO NOT SCALE USE FIGURED DIMENSIONS ONLY



Legend

Depth (m)

- 0 - 0.1m
- 0.1 - 0.2m
- 0.2 - 0.3m
- 0.3 - 0.4m
- 0.4 - 0.5m
- Fosterstown Masterplan Lands
- Barrysparks Crowscastle Masterplan Lands

No.	Revision	Date	By	Chk'd	App'd
F01	Final Flood Depths	09/05/2019	BP	WV	JPR
D02	Draft Flood Depths	25/02/2019	BP	WV	JPR
D01	Draft Flood Depths	30/01/2019	BP	WV	JPR

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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Civil - Structural - Transportation - Environmental

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Sandyford, Dublin 18.
Tel : +353 1 294 0800
Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

Designed: BP | Checked: WV | Approved: JPR | Status: FINAL

Project Title: Fosterstown Surface Water Management Plan

Drawing Title: Fluvial 1 in 100 Year Flood Depths (Mid Range Future Scenario)

Drawn: BP | Job No: 18.164 | Drawing No: 18.164-FT-207 | Rev: F01

Scale: 1:2,500 (@ A3) | Date: 25/02/2019

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

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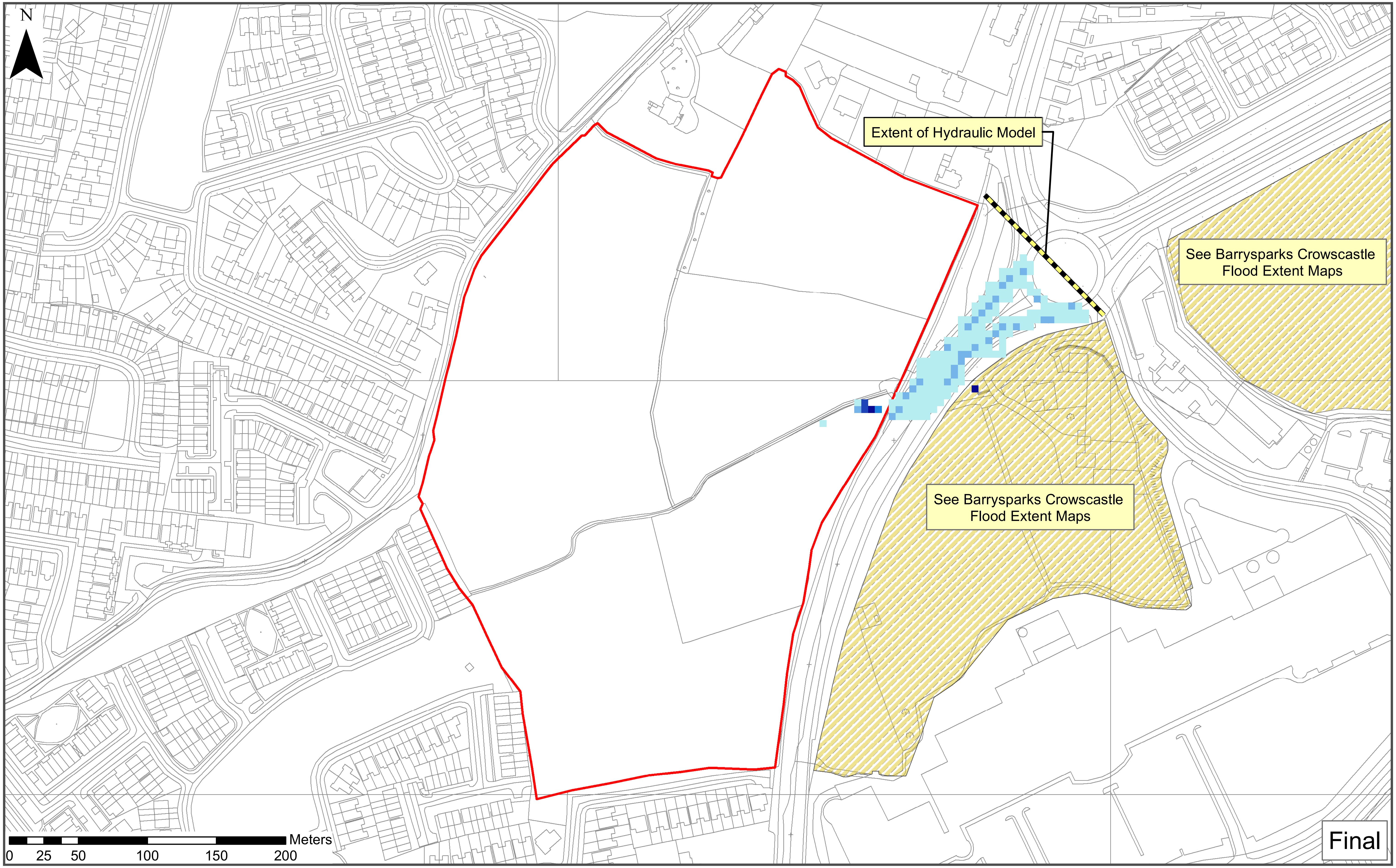

Legend

Depth (m)

- 0 - 0.1m
- 0.1 - 0.2m
- 0.2 - 0.3m
- 0.3 - 0.4m
- 0.4 - 0.5m
- Fosterstown Masterplan Lands
- Barrysparks Crowscastle Masterplan Lands

No.	Revision	Date	By	Chk'd	App'd
F01	Final Flood Depths	09/05/2019	BP	WV	JPR
D02	Draft Flood Depths	25/02/2019	BP	WV	JPR
D01	Draft Flood Depths	30/01/2019	BP	WV	JPR

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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Arena House, Arena Road,
Sandyford, Dublin 18.
Tel : +353 1 294 0800
Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

Project Title: Fosterstown Surface Water Management Plan

Drawing Title: Fluvial 1 in 1000 Year Flood Depths (Mid Range Future Scenario)

Designed: BP	Checked: WV	Approved: JPR	Status: FINAL

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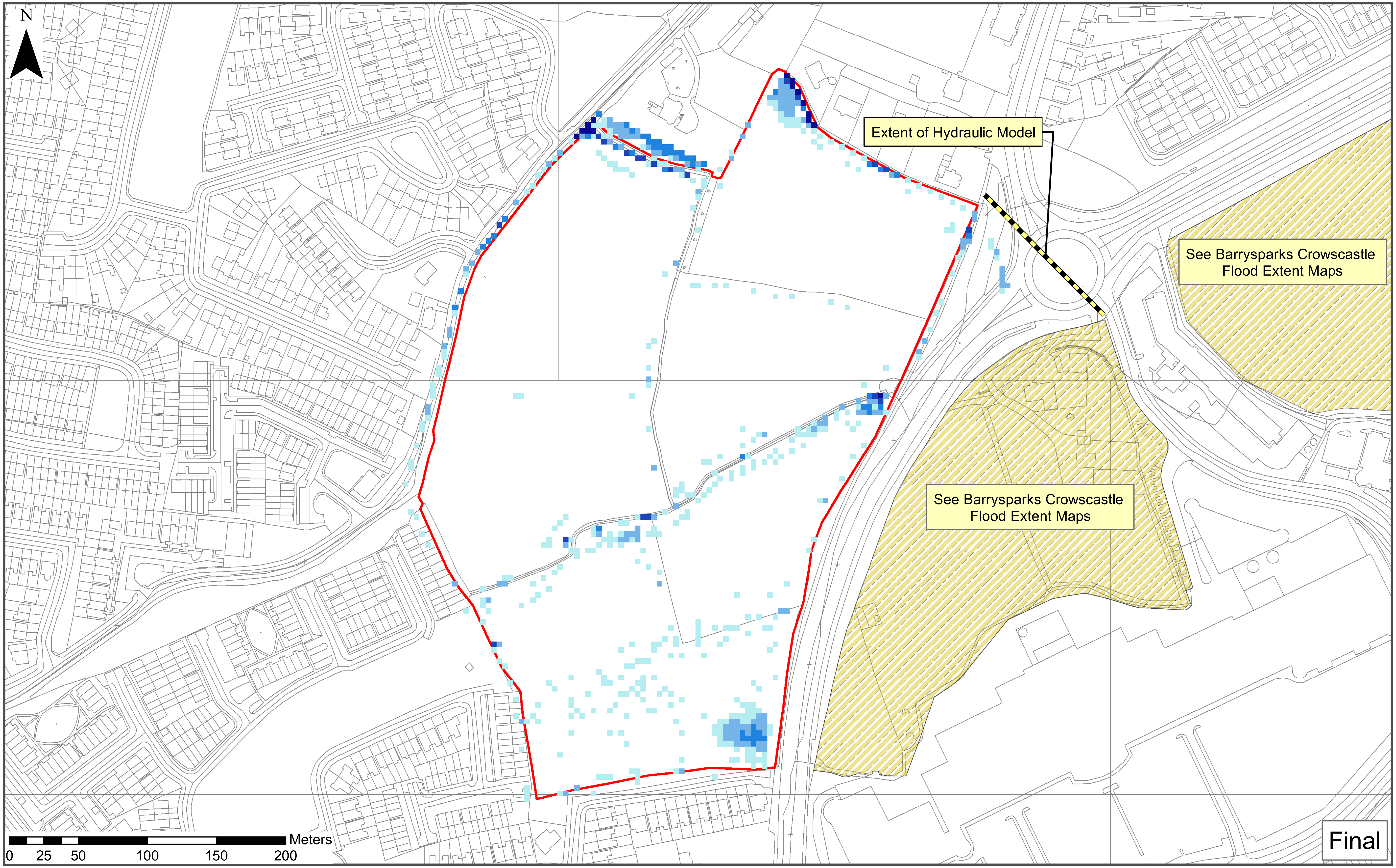

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- 0.4 - 0.6m
- 0.6 - 1m
- 1 - 2m
- Fosterstown Masterplan Lands
- Barrysparks Crowscastle Masterplan Lands

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D01	Draft Flood Depths	30/01/2019	BP	WV	JPR

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ROD
ROUGHAN & O'DONOVAN
Consulting Engineers
Civil - Structural - Transportation - Environmental

Arena House, Arena Road,
Sandyford, Dublin 18.
Tel : +353 1 294 0800
Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

Project Title: Fosterstown Surface Water Management Plan

Drawing Title: Pluvial 1 in 100 Year Flood Depths (Mid Range Future Scenario)

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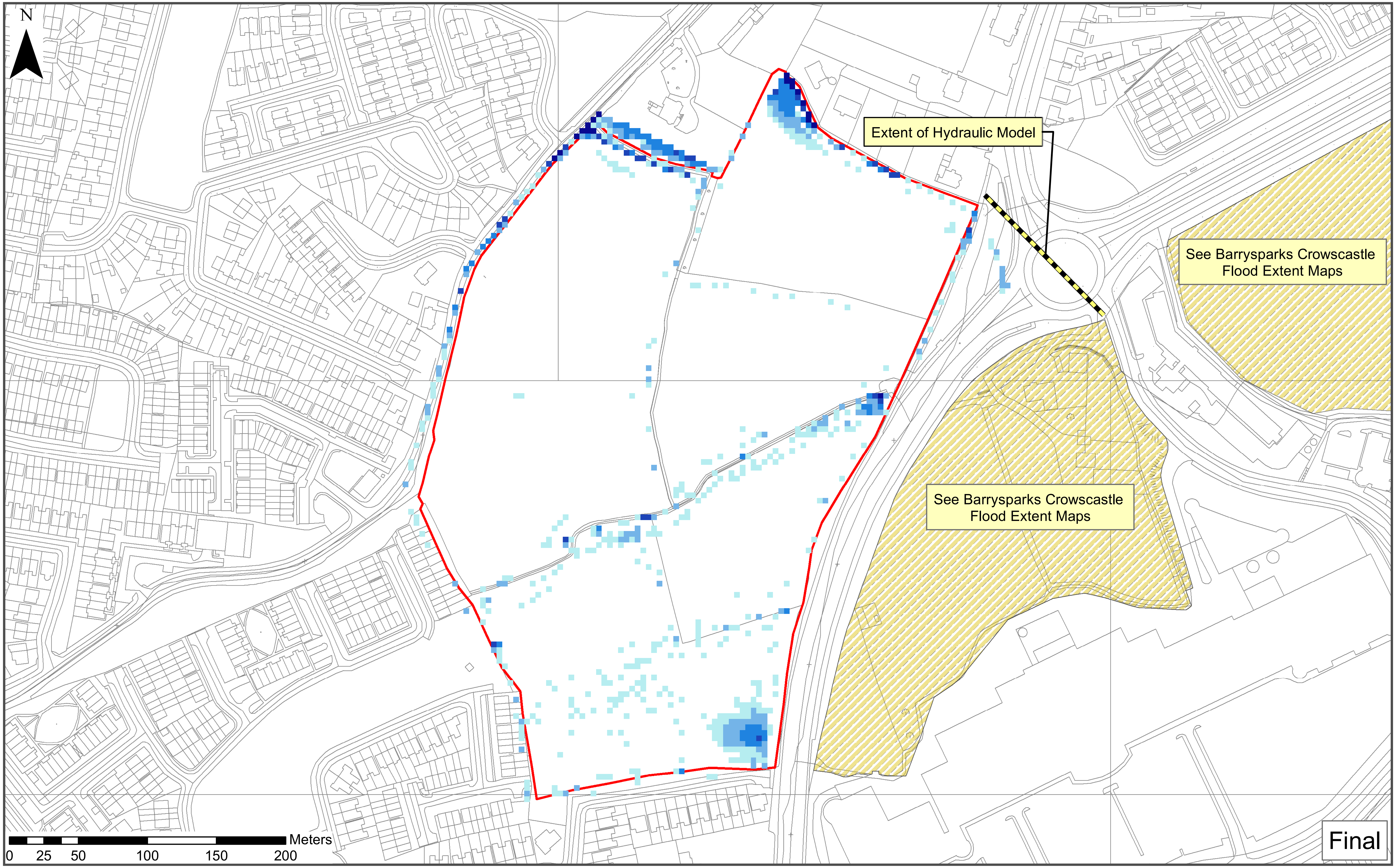

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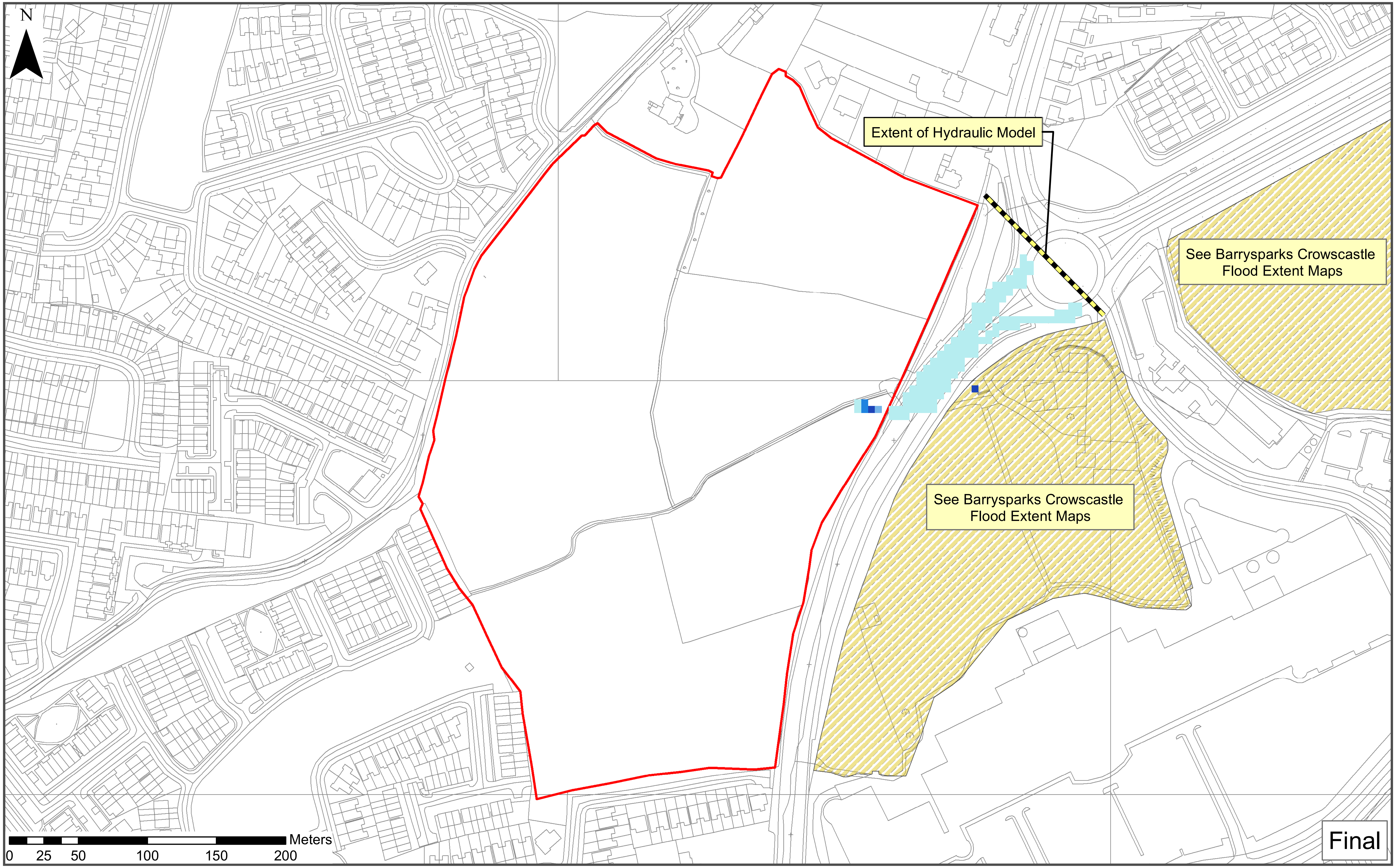

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Sandyford, Dublin 18.
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Fax : +353 1 294 0820
e-mail : info@rod.ie
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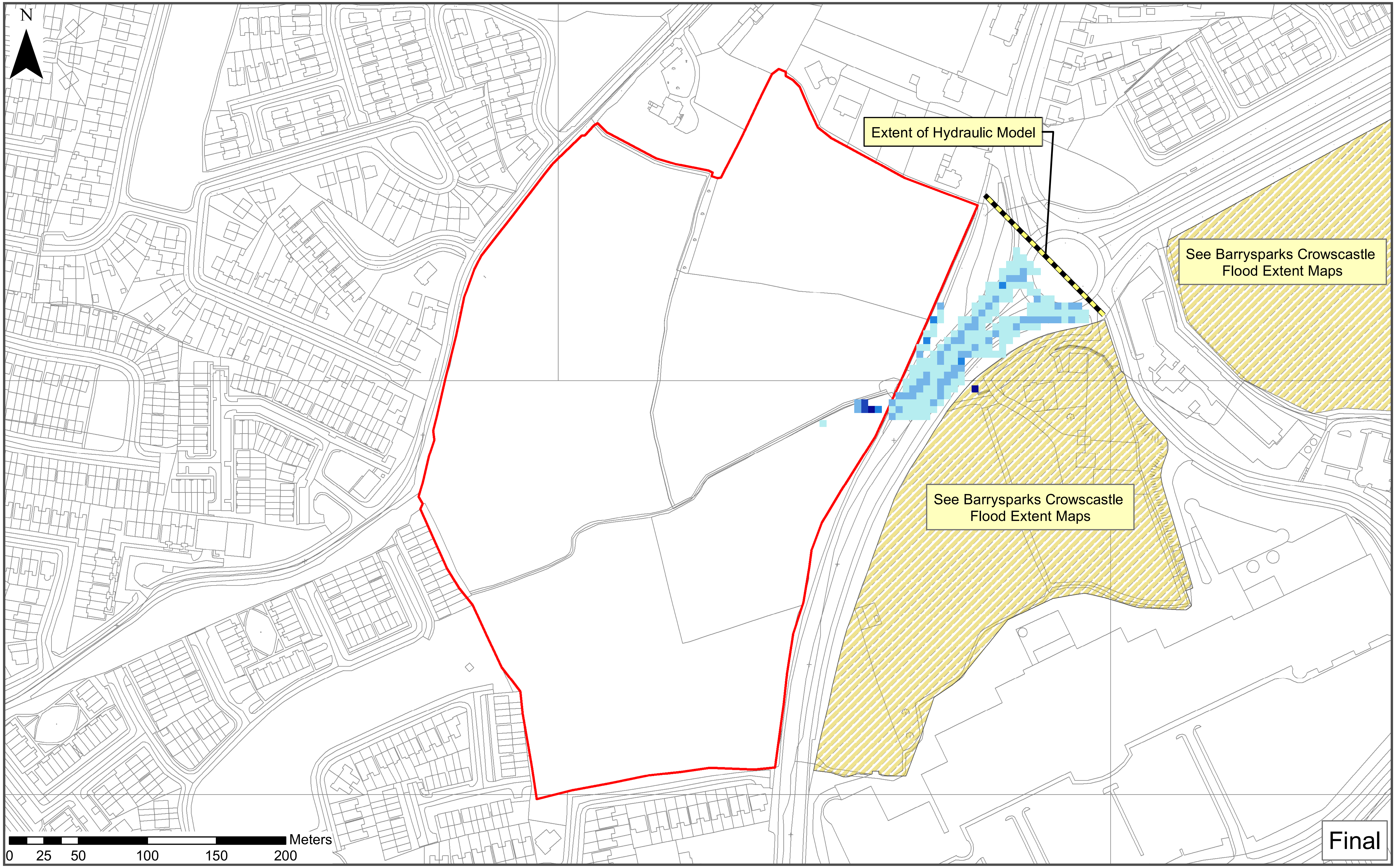

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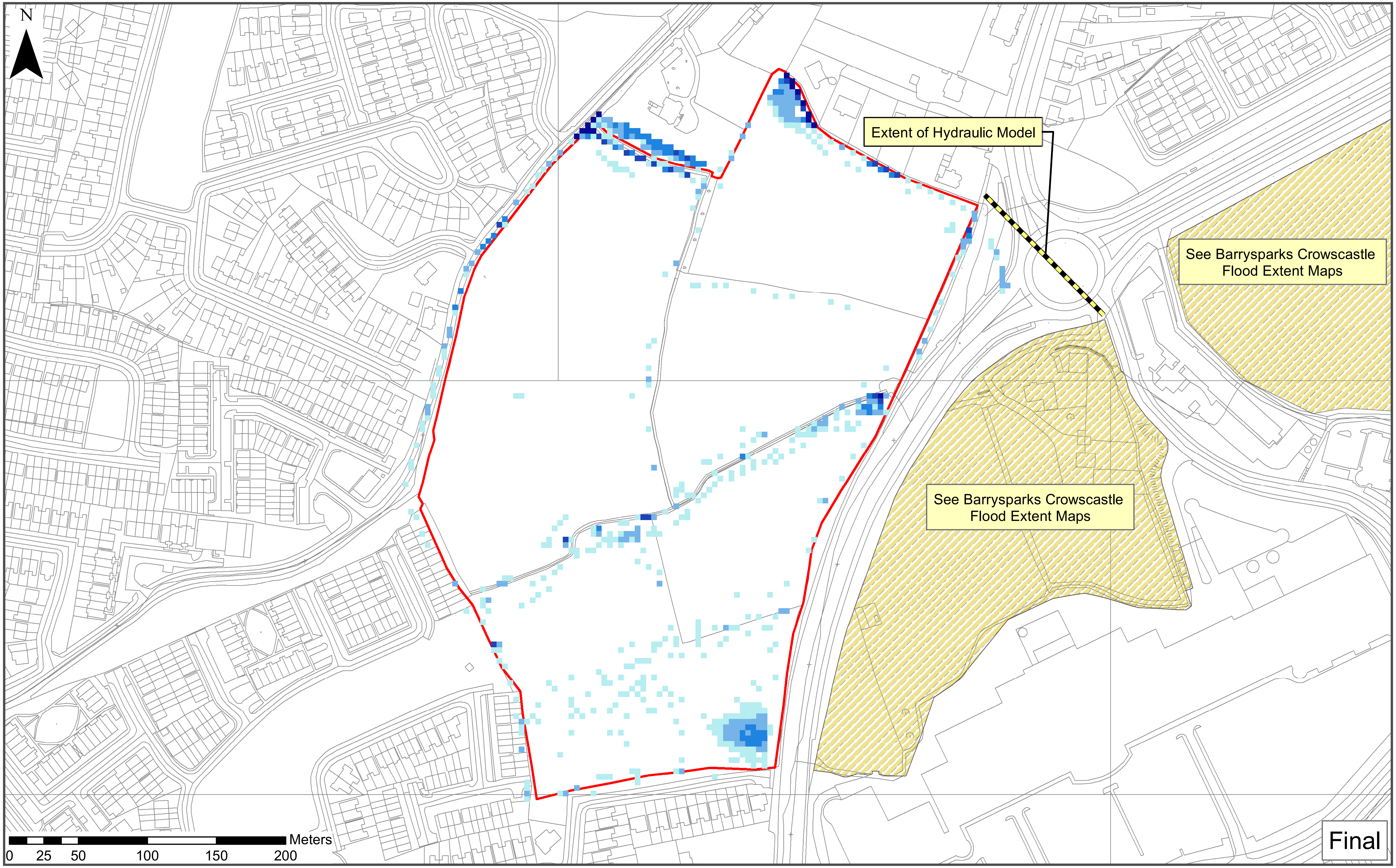

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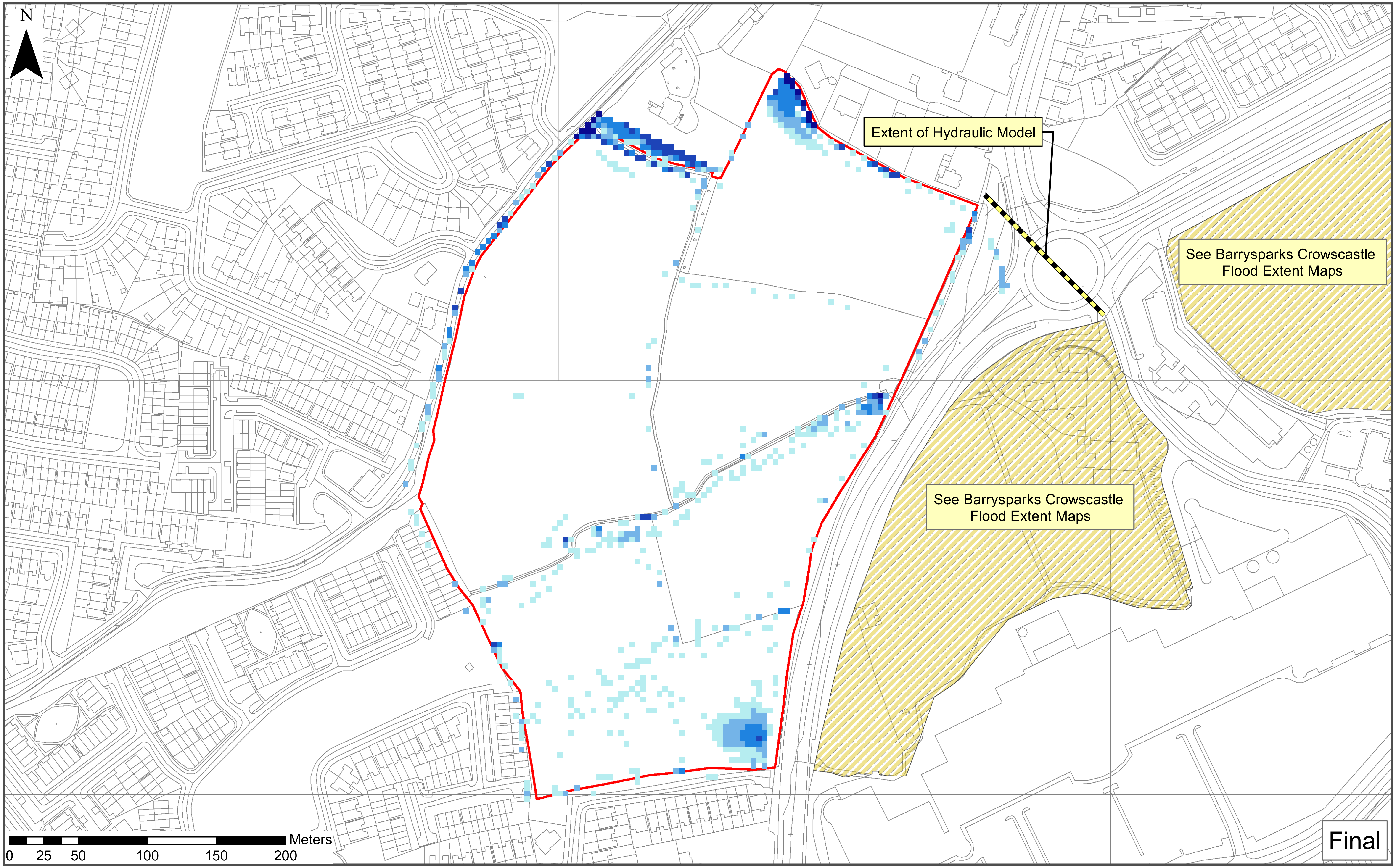

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Consulting Engineers
Civil - Structural - Transportation - Environmental

Arena House, Arena Road,
Sandyford, Dublin 18.
Tel : +353 1 294 0800
Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

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Prepared by
Roughan & O'Donovan
Arena House, Arena Road, Sandyford, Dublin 18
Tel: +353 1 2940800 Fax: +353 1 2940820
Email: info@rod.ie www.rod.ie

Fingal County Council

Fosterstown Masterplan

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

May 2019 (FINAL)

Comhairle Contae Fhine Gall
Fingal County Council

Fosterstown Masterplan in Swords Co. Dublin
Surface Water Management Plan:
Part 2: Sustainable Drainage Systems (SuDS) Strategy

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Commission

Roughan & O'Donovan Consulting Engineers (ROD) was commissioned by Fingal County Council (FCC) to prepare a Surface Water Management Plan to supplement the Fosterstown Masterplan. As part of this commission, a Sustainable Drainage Systems (SuDS) Strategy for the masterplan has been developed. The masterplan will set out the local land use and planning policy and provide a strategy for the future planning and sustainable development of the area.

1.2 Scope

The scope of this report is as follows:

- Review the existing drainage network servicing the lands and provide an assessment of the Masterplan lands in terms of sustainable drainage possibilities, in accordance with the requirements of the GDSDS, CIRIA SuDS Manual C753 and the current Fingal County Development Plan (2017 – 2023).
- Prepare a SuDS Strategy with recommendations regarding appropriate SuDS systems and devices for the implementation of the SuDS strategy for all proposed development within the Fosterstown masterplan boundary.
- Incorporate the effects of Climate Change, soil type and groundwater into the SuDS Strategy.
- Determine the effects on and of flooding, groundwater and surface water drainage system in the masterplan area due to the incorporation of the SuDS Strategy.
- Make recommendations on the discharge rate to be applied across the Masterplan lands and as to the future development and sustainable drainage of the Plan lands.
- Liaison with Consultants completing the Strategic Environmental Assessment (SEA), Appropriate Assessment and Fingal County Council.

1.3 Study Area

1.3.1 Overview

The subject area is located at Fosterstown, Swords, North County Dublin. The Masterplan lands are located approximately 1.6km west of the M1 motorway, 4.3km north of the M50 motorway and 2.0km north of Dublin Airport. The masterplan site is located within an urban environment. The site is bounded by residential developments to the west and south and commercial / retail developments to the north and east. The R132 Dublin Road runs adjacent to the eastern boundary of the site, while Forest Road runs adjacent the western boundary of the site. Refer to Figure 1.1 below.

Figure 1.1 Fosterstown Masterplan

The topography of the Masterplan lands generally falls from south west to north east from a level of approximately 48mOD to 33mOD.

1.3.2 Catchment Description

The Masterplan lands appear to be within the catchments of the Ward River and the River Gaybrook. Both watercourses generally flow from west to east and ultimately discharge to the Malahide Estuary, approximately 4.5km north east of the Masterplan lands.

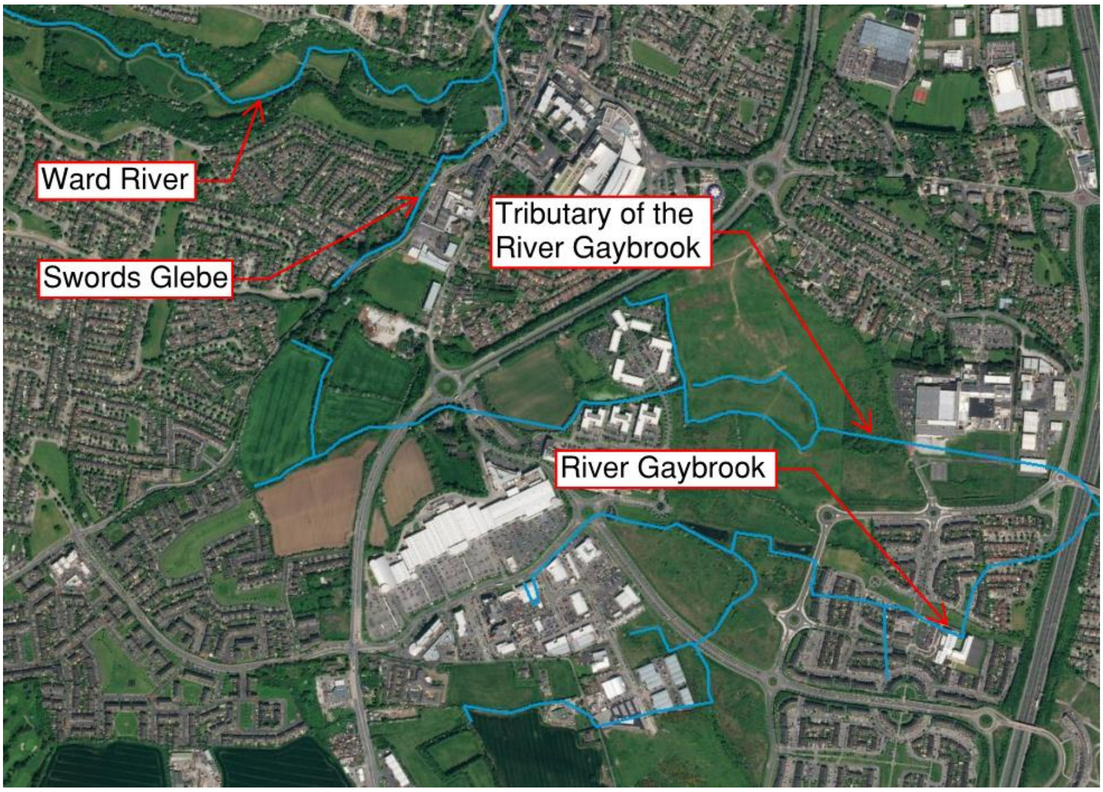


Figure 1.2 Watercourses around the Fosterstown masterplan area (EPA Envision)

Irish Water records indicate that there is existing surface water drainage infrastructure within the vicinity of the Masterplan lands. There are also 2nr drainage channels within the site. The River Gaybrook crosses the centre of the site from west to east and appears to drain the southern extent of the site, while a second drainage ditch originates in the centre of the site and falls in a northernly direction. This ditch appears to drain the west and north eastern sides of the site. This secondary ditch appears to be dry the majority of the time.

1.3.3 Environment

There are no Natura 2000 sites located within the study area; however, the Natura 2000 sites Malahide Estuary (SPA and SAC) is located 3.0km north-east of the Masterplan lands, Rogerstown Estuary (SPA and SAC) is located 7.7km north-east of the Masterplan lands and Baldoyle Bay (SPA and SAC) is located 9.0km south-east of the Masterplan lands.

Under Article 6(3) of the EU Habitats Directive, an “appropriate assessment” (AA) is required where any plan or project, either alone or ‘in combination’ with other plans or projects, could have an adverse effect on 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 study area are:

- Malahide Estuary (proposed NHA) ~ 3km north-east of the Fosterstown Masterplan lands
- Rogertown Estuary (proposed NHA) ~ 7.7km north-east of the Fosterstown Masterplan lands

- Baldoyle Bay (proposed NHA), ~9km south-east of the Fosterstown Masterplan lands
- Sluice River Marsh (proposed NHA), ~ 6km south-east of the Fosterstown Masterplan lands
- Feltrim Hill (proposed NHA), ~2.5km south-east of the Fosterstown Masterplan lands
- Santry Demesne (proposed NHA), ~5.2km south of the Fosterstown Masterplan lands

Therefore, the management of flood risk within the masterplan study area must have regard to potential negative impacts to this environment.

1.4 Proposed Development

The Fosterstown Masterplan lands comprises two main zoning objectives in the Fingal Development Plan 2017 – 2023. The zoning objectives are split as follows:

- 89% RA – Residential Area and;
- 11% MC – Major Town Centre.

The zoning objectives for the subject lands are outlined in Figure 1.3 and Table 1.1 below.

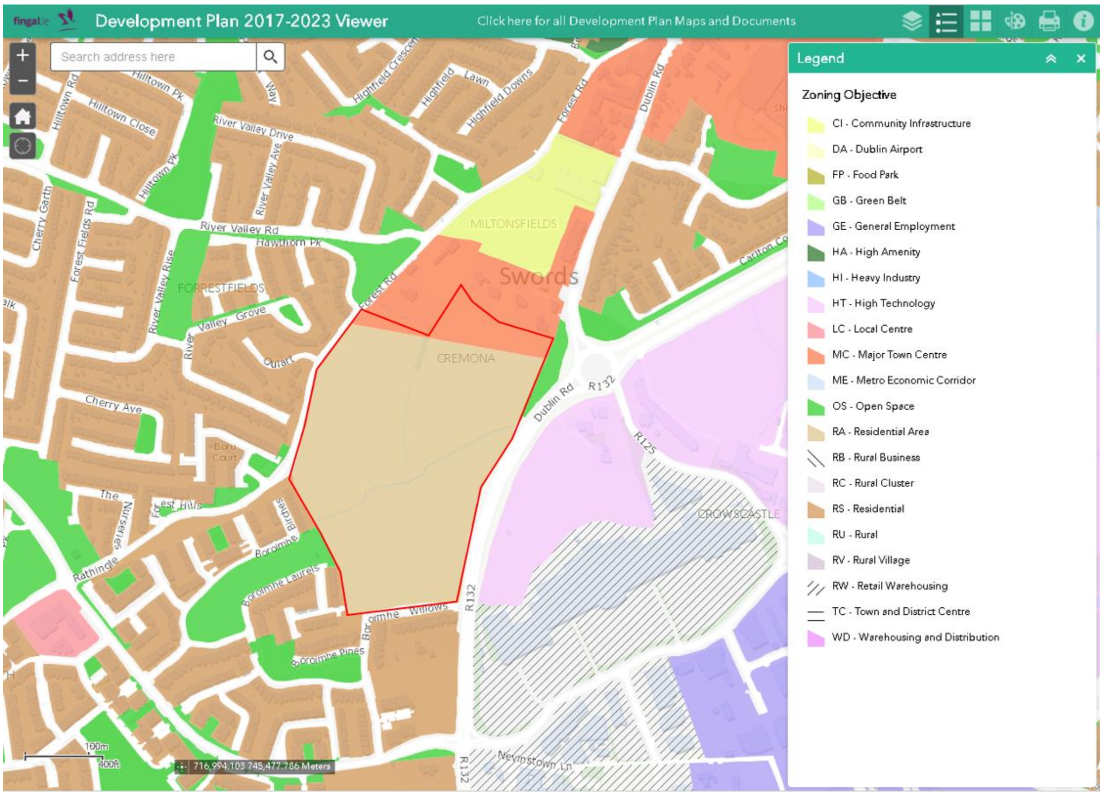


Figure 1.3 **Fosterstown Zoning Objectives (Fingal Co Co Development Plan 2017 – 2023)**

Table 1.1 ***Fosterstown Masterplan lands Current Zoning Objectives***

Objective	Description	Area
RA - Residential Area	Provide for new residential communities subject to the provision of the necessary social and physical infrastructure	West, south and eastern extents of lands
MC – Major Town Centre	Protect, provide for and/ or improve major town centre facilities	Northern extents of lands

2. SUDS OVERVIEW

2.1 Introduction

The SuDS philosophy is to mimic the natural hydrological cycle by promoting; infiltration, evaporation, evapotranspiration, the harvesting of rainwater at source and the temporary storage of water (ponding), through the construction of a combination or series of components to form a 'management train'. Whilst there is no internationally agreed definition for SuDS – as the understanding of the SuDS philosophy correlates to the extent to which it is embedded in policy and practice over time, the three 'pillars' of sustainable stormwater management practice are generally accepted as;

(i) Reducing the rate and quantity of stormwater discharge,

(ii) Improve the quality of stormwater discharges and receiving water bodies and

(iii) Provide amenity and biodiversity value.

Consideration of the sensitivity of the surrounding environment and downstream water quality is fundamental to the successful implementation of SUDS systems, particularly as we face into the uncertainties of a changing climate.

2.2 Benefits of SuDS

Traditional surface water drainage design is relatively simple, using the Rational method to size pipes to ensure that surface water is removed as quickly as possible to ensure flooding does not take place on the road itself. Unfortunately, this philosophy is flawed as, in more rapidly transferring the surface water downstream, it provides the potential for flooding of other areas. This accelerated run-off gives rise to higher flood levels and the corresponding loss of groundwater recharge results in reduced low flows in rivers thus increasing environmental vulnerability. In addition, the pollution in the run-off is conveyed into the natural environment.

SuDS offer multiple benefits over traditional drainage practices managing discharge rates, volumes and diffuse pollution as well as providing the flexibility for adaption to future drainage needs through a modular implementation. Climate change predictions suggest that some types of extreme events will become more frequent, such as heat waves, flooding caused by extreme rainfall and drought. The SuDS approach is more robust and adaptable than the traditional approach of underground piped drainage systems. In shallow surface-based systems, such as swales, water levels rise gradually and visibly. When the capacity of the SuDS feature is exceeded, the excess water can be directed to safe storage zones. This allows the general public, and road owners and operators to prepare for flood events more effectively. Conversely, flooding from underground piped drainage systems can occur suddenly and rapidly when the design capacity is exceeded. Furthermore, shallow, visible surface-based systems can be designed to offer greater flexibility to adapt to Climate

Change. SuDS systems can enhance more readily and cheaply, compared to underground drainage systems. Lower River flows; caused by drought, result in reduced dilution of pollutants following rainfall events. The treatment of surface water runoff, through SuDS, helps to protect and enhance the quality of receiving watercourses.

2.3 Factors Influencing the Design of SuDS

There is no unique solution and each situation has to be evaluated on its own merits and suitable SuDS solutions applied, although the means to achieving these objectives are many and varied. Factors such as site suitability, available space, cost, maintenance regimes and community acceptance must be considered to ensure successful implementation. The various SuDS features can generally be categorised as ‘hard’ SuDS and ‘soft’ SuDS. Soft SuDS resemble natural features and include techniques such as swales, ponds and wetlands. Hard SuDS are more similar to traditional drainage methods but incorporate SUDS principles. Examples of these are permeable pavements and proprietary SUDS features such as filtration systems and vortex separators.

2.4 The Management Train

The individual components described above do not constitute SuDS, if applied in isolation. The SuDS philosophy, and effective stormwater management in general, requires a series of SuDS features, linked together, to form a stormwater management system to treat and attenuate surface water runoff as close to the source of runoff as possible, before being conveyed downstream for further treatment and storage.

3. OPPORTUNITIES FOR SUDS SYSTEMS IN A CHANGING CLIMATE

The principal treatment processes in a SuDS system are Sedimentation and Biodegradation.

3.1 Sedimentation

Sedimentation is one of the primary removal mechanisms in SuDS. Most pollution in stormwater runoff is attached to sediment particles and therefore the removal of sediment will achieve a significant reduction in pollution loading to receiving water bodies. Sedimentation is achieved through the reduction in flow velocities to a level at which the sediment particles fall out of suspension.

3.2 Biodegradation

Biodegradation is a natural biological treatment process that is a feature of several SuDS systems - systems that are subject to both wet and dry conditions. In addition to the physical and chemical processes of SuDS systems, biological treatment may also occur. Microbial communities may be established in the ground using the oxygen within the free-draining materials and the nutrients supplied with the inflows, to degrade pollutants such as hydrocarbons and grease.

The level of bioremediation activity will be affected by environmental conditions such as temperature and the supply of oxygen and nutrients. It also depends on the physical conditions within the ground such as the suitability of the materials for colonisation.

'Wet and Dry' SuDS Systems Perform Best

The presence of vegetation adds a physical filtration aspect to SuDS systems in the case of filter strips leading to swale/basins, the majority of hydrocarbons are removed by the first stage. If vegetation has been affected by drought, this element of the treatment train will be absent (in a worst-case scenario or significantly diminished at best). Maintenance of filter strips, swales and detention basins typically involve grass cutting. It is worth noting that hydrocarbons are also broken down by UV light in a process called photolysis, but where increasing levels of contaminants are building up in the soil (in the swale, basin, pond or wetland) the affected soil is likely to require removal and will more than likely be classified as contaminated waste.

The most recent published literature suggests that ponds and wetlands do not seem to benefit from the enhanced biological treatment of hydrocarbons found in the oxygen-rich conditions of the swales and basins (which are not designed to hold a permanent volume of water). Nonetheless, ponds and wetlands have been utilised extensively as the default treatment system serving roads and motorways in Ireland and UK, with little supporting literature to justify such initiatives.

In the selection of the most resilient and enduring suds systems, this fact is important:

Only the suds features that experience <u>both wet and dry conditions</u> benefit from this added biological treatment - ponds and wetlands are proposed as polishing stage options as part of a treatment train.

The temperature dependence of these aerobic microbes (responsible for this additional layer of treatment) means that the chemical and biological treatment mechanisms found in SuDS systems are enhanced with increasing temperature.

3.2.1 The Benefits of Vegetative Systems

The successful implementation of bioremediation systems requires the establishment of appropriate plants and /or microorganisms at the containment site. Factors to be considered include: (i) selection of appropriate plant species, (ii) the influence of contaminants on seed germination, (iii) the use of native versus non-native plants and (iv) the effectiveness of inoculating contaminated soils with microorganisms. Furthermore, the plant species must be well adapted to the soil and climate of the region, making soil characteristics, length of growing season, average temperature and annual rainfall important considerations in plant-assisted bioremediation / biodegradation planning. T he rate of microbial degradation generally doubles for every 10-degree centigrade increase in temperature.

Indirect benefits include enhanced soil quality through improvements in soil structure, increased porosity and therefore water infiltration, providing nutrients, accelerating nutrient cycling and increasing soil organic carbon. The use of plants also stabilises the soil thus preventing erosion and direct human exposure.

3.3 SuDS Objectives

3.3.1 Quantity Control Processes

Several techniques can be implemented to control the quantity of runoff from a development. Each technique presents different opportunities for stormwater control, flood risk management, water conservation and groundwater recharge.

a) Infiltration

- Soaking of water into the ground

- Most desirable solution to runoff management as it restores the natural hydrologic process
- Impacted by groundwater vulnerability and infiltration ability of subsoil

b) Detention / Attenuation

- Slows down surface water flows before their transfer downstream
- Usually achieved through use of a storage volume and constrained outlet
- Should be above ground
- Reduces peak flow rate but total volume of runoff remains the same

c) Conveyance

- Transfer of surface runoff from one place to another
- Through grassed channels/trenches and pipes
- Transfer essential for managing flows and linking SuDS components
- Uncontrolled conveyance to a point of discharge in the environment not considered sustainable

d) Water Harvesting

- Direct capture and use of runoff on site for domestic or irrigation, overflowing/discharging to adjoining SuDS component(s)
- Contributes to Flood Risk Management

3.3.2 Quality Control Processes

A number of natural water quality treatment processes can be exploited within SuDS design. Different processes will predominate for each SuDS technique and will be present at different stages in the treatment train (*Refer to Section 3.5*).

a) Sedimentation – reducing flow velocities to a level at which the sediment particles fall out of suspension;

b) Filtration & Biofiltration – trapping pollutants within the soil or aggregate matrix, on plants or on geotextile layers;

c) Adsorption – pollutants attach or bind to the surface of soil or aggregate particles;

d) Biodegradation – Microbial communities in the ground degrade organic pollutants such as oils and grease;

e) Volatilisation – transfer of a compound from solution in water to the soil atmosphere and then to the general atmosphere;

f) Precipitation – transform dissolved constituents to form a suspension of particles of insoluble precipitates;

g) Plant Uptake – removal of nutrients from water by plants in ponds and wetland;

h) Nitrification – Ammonia and ammonium ions can be oxidised by bacteria in the ground to form nitrate which readily used as a nutrient by plants;

i) Photolysis – The breakdown of organic pollutants by exposure to ultraviolet light.

3.3.3 Amenity & Biodiversity Processes

SuDS provides opportunities to create attractive landscaping features which offer a variety of amenity/biodiversity. The following are the main SuDS components offering aesthetic, amenity and ecological benefits *(Refer to Section 6 for details on each technique)*

Primary Processes:

a) Blue/Green Roofs

b) Grassed channels/Swales

c) Filter strips

d) Bioretention Areas

e) Vegetated swales and detention basins

f) Infiltration Basins

Benefits subject to design:

a) Ponds

b) Wetlands

3.3.4 Water Quality

There is an existing Q Value monitoring point located on the Ward River, approximately 840m north of the Masterplan lands. The EPA Envision website indicates that the last recorded Q Value at this location was in 1991, where a Q Value of 3 was recorded. There is a second monitoring point located further downstream, approximately 1.8km north of the site. This monitoring point has more recent monitoring information available. The last recorded Q Value at this location was in 2014 where a Q Value of 3 was also recorded. Table 3.1 details the biotic indices (Q Values) ranges as per the EPA's website, indicating that a river with a Q value of 3 is considered moderately polluted.

The Water Framework Directive Monitoring Programme became operational in 2006. The most recent monitoring period (2010 – 2015) identifies the Ward River and Swords Glebe watercourse as being currently "Poor" status and "at risk" of failing to meet the directives environmental objectives. Groundwater status for the 2010 – 2015 monitoring period identifies as being "good" status. Table 3.1 correlates the Water Framework Directive Status to Q Value readings.

Table 3.1 Surface Water Quality Ranges

Q Value*	WFD Status	Pollution Status	Condition*
Q5, Q4-5	High	Unpolluted	Satisfactory
Q4	Good	Unpolluted	Satisfactory
Q3-4	Moderate	Slightly polluted	Unsatisfactory
Q3, Q2-3	Poor	Moderately polluted	Unsatisfactory
Q2, Q1-2, Q1	Bad	Seriously polluted	Unsatisfactory

Note:

* "Condition" refers to the likelihood of interference with beneficial or potential beneficial uses.

The implementation of SuDS as part of future development within the masterplan area should ensure that the quality and quantity of discharge from future development to the surrounding watercourses will not negatively impact the existing condition of the watercourses, moreover, the adoption of SuDS systems in all new developments and the protection of existing floodplains shall assist in the attainment of our objectives under the Water Framework Directive.

3.4 Effects of Climate Change

The effects of climate change need to be considered when designing and preparing maintenance regimes for SuDS features. Sedimentation is one of the primary removal mechanisms in SuDS. As discussed above in Section 3.1, this is achieved through the reduction in flow velocities to a level at which particles fall out of suspension. However, care must be taken through design and appropriate maintenance regimes to ensure the risk of re-suspension is minimised during extreme rainfall events.

The level of biodegradation activity that occurs within SuDS features will be affected by environmental conditions such as temperature and the supply of oxygen and nutrients. It is also depending on the physical conditions within the ground such as the suitability of the materials for colonisation.

3.5 SuDS Techniques

In addition to the objectives above, in order to replicate the natural drainage system, a 'Management Train' is required. The Management Train sets a hierarchy of SuDS techniques which should be implemented in series as follows:

(iv) Prevention – prevent runoff and pollution

(v) Source Control – control runoff at or close to the source

(vi) Site Control – management of surface water in the site/local area

(vii) Regional Control – management of surface water from a number of sites together

Various SuDS components have different capabilities regarding the objectives outlined above and are more suited to certain stages of the Management Train. The principle of the Management Train is that wherever possible, surface water should be managed locally in small, sub-catchments rather than being conveyed to and managed in large systems further down the catchment. Table 3.1 below contains examples of SuDS techniques for Source, Site and Regional controls. *(Refer to Section 6 for details on each technique).*

Table 3.1 SuDS Techniques for Source, Site & Regional Control

Source Control	Site Control	Regional Control
Rainwater Harvesting	Permeable Paving	Detention Ponds/Basins
Green Roofs	Bioretention Strips	Retention Ponds/Basins
Permeable Paving	Infiltration Trenches	Wetlands
Bioretention Strips	Filter Drains	Infiltration Basins
Filter Drains	Filter Strips	Detention Basins
Infiltration Trenches	Swales	Petrol Interceptors*
Filter Strips	Sand Filters	
Soakaways	Infiltration Basins	
Blue Roofs	Detention Basins	
Swales	Petrol Interceptors*	

*Use of Petrol Interceptors should be avoided except where the potential for hydrocarbons entering the surface water drainage network is particularly high. Treatment of surface water runoff should be provided through the use other SuDS techniques.

3.6 Modular SuDS Components

Management trains for new and existing developments should facilitate the construction of future SuDS components and/or provide for future enhancements to existing SuDS components – to mitigate the risk of flooding caused by more extreme rainfall events and risk of pollution due to lower baseflow in receiving waters.

Modular components can include:

- Additional physical SuDS features e.g. swales, basins and ponds and/or;
- Enhancements to existing SuDS features by upsizing and/or;
- Introducing vegetation and/or;
- Management actions e.g. changing the maintenance regime in response to findings of a monitoring regime.

Subject to the findings of a monitoring regime, it may be found that more frequent maintenance of the SuDS components (e.g. grass cutting, disposal of contaminated soil and planting) may negate the requirement for additional SuDS components.

4. REVIEW OF EXISTING DRAINAGE NETWORK IN RESPECT OF SUDS

A review was undertaken of the various SuDS techniques, existing and proposed in either live planning applications or development proposals, within close proximity to the Fosterstown Masterplan lands. Information has been gathered from a review of planning applications in Swords, Fingal Development Plan 2017-2023, and site visits undertaken on the 31st August 2018 and the 21st November 2018.

Development within the vicinity of the Masterplan lands is predominantly residential to the north, south and west of the lands, with retail and commercial development to the east. Implementation of SuDS techniques by Local Authorities typically began following the publication of the Greater Dublin Strategic Drainage Strategy (GDSDS) in 2005. Given that the majority of development within the vicinity of the Masterplan lands is dated pre 2005, SuDS techniques generally have not been adapted in the areas within the vicinity of the Masterplan lands. There are currently no live planning applications within the vicinity of the Masterplan lands for proposed developments that will implement SuDS techniques.

4.1 Future Scenario – Proposed Development and Infrastructure as per Fingal Development Plan 2017-2023 if built

Proposals for the Fosterstown Masterplan lands, as identified in the Fingal Development Plan 2017 – 2023 include the following:

- Provide for required road improvements including: the construction of the Fosterstown Link Road; realignment and improvements to the Forrest Road and improvements to the R132 (including Pinnock Hill) as part of the phased development of the Masterplan lands.
- Provide for a vehicular connection to the adjoining MC zoned lands to the north.
- In order to protect existing residential amenities, where development immediately adjoins existing residential development, the heights of such development shall be restricted to 2-3 storeys.

- Future development shall provide a strong urban edge with attractive elevations which satisfactorily address, overlook and provide a high degree of informal supervision of the R132, the Forrest Road and the Fosterstown Link Road.
- Consider the provision of a hotel at a suitable location at Cremona within the Fosterstown Masterplan lands.
- Facilitate the indicative route for MetroLink and an appropriate relationship with the indicative route for MetroLink at this location.
- The existing stream which crosses the lands shall be maintained within a riparian corridor. The majority of the public open space shall be provided along the stream and it shall link into the existing public open space at Boroimhe.

As part of these future proposals, various SuDS techniques can be implemented and a SuDS protocols developed, which will be discussed further in Section 6.

4.2 Sustainable Water Management

It is a specific objective of the current Fingal County Development Plan to require all Masterplans to protect, enhance, provide and manage green infrastructure in an integrated and coherent manner, which includes sustainable water management. This can be achieved through the implementation of the SuDS Protocol, (which will be discussed further in Section 6) along with natural floodplain management. It is a specific objective to establish riparian corridors free from new development along significant watercourses. In line with the current County Development Plan, a 15m wide riparian corridor, measured from the top of the bank to either side of the watercourses, free from development will be provided along the length of the existing minor watercourses that flow through the Masterplan lands, rather than culverting these watercourses beneath ground. The provision of such buffer strips will:

- Preserve water quality by filtering sediment from runoff before it enters the river;
- Protect the river bank from erosion;
- Provide an undeveloped flood plain to accommodate flood waters during extreme flooding events (Refer to Fosterstown Strategic Flood Risk Assessment Flood Maps);
- Provide food and habitat for fish and wildlife;
- Preserve open space and aesthetic surroundings.

The proposed riparian corridors through the masterplan lands are outlined in Figure 4.1 below.

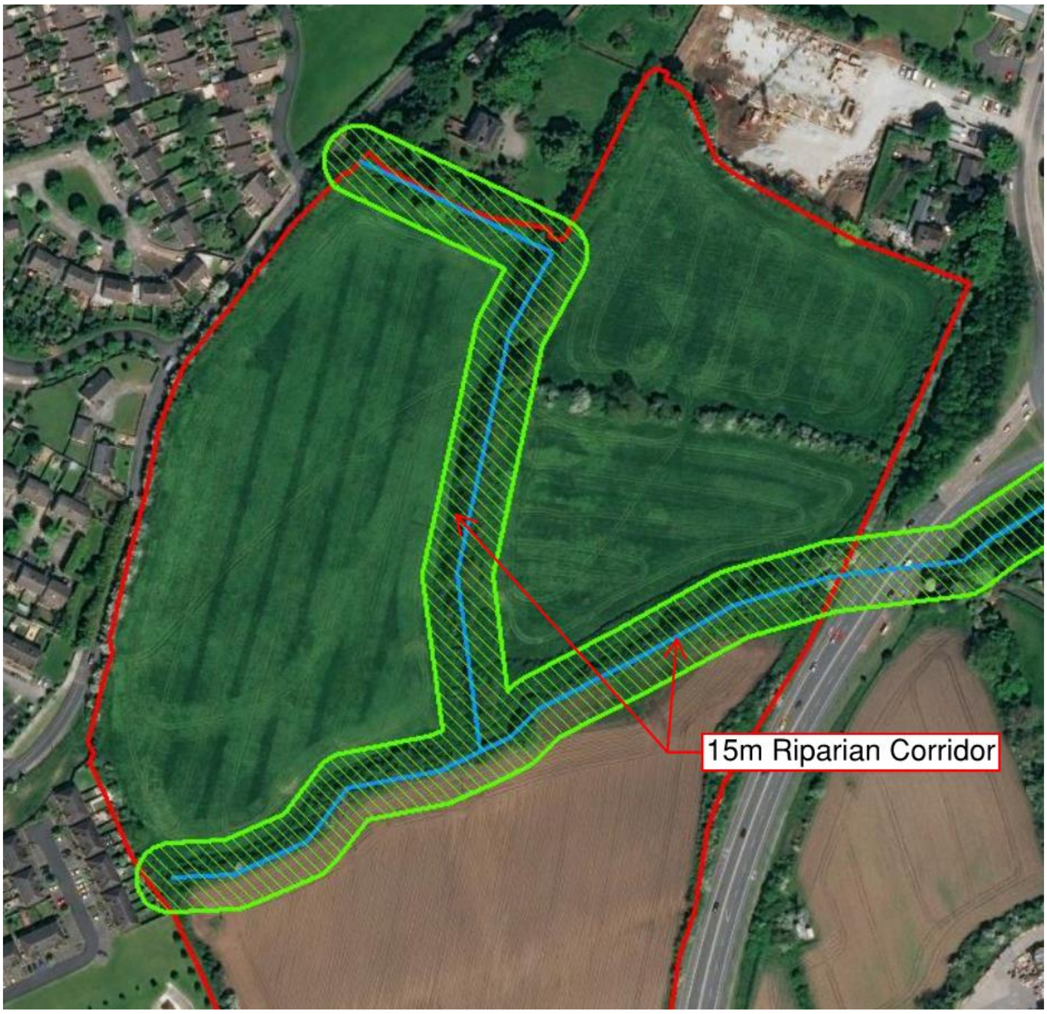


Figure 4.1 Proposed Riparian Corridors

The primary impact on the existing surface water drainage network will be as a result of new development within the masterplan boundary. Integration of SuDS techniques within these new developments will be required to ensure that the capacity of the existing network is not exceeded, and the quality of surface water runoff is not negatively impacted by the development. As discussed further in Section 6, it is recommended that runoff from private developments be managed at source, by limiting discharge to 2l/sec/ha and by providing attenuation for the 1 in 100-year rainfall event, including an allowance for climate change of 20%, in line with regional drainage policy, within the curtilage of all proposed development plots. Runoff from public infrastructure such as roads and landscaped areas should be managed within the public realm, by also limiting discharge to 2l/sec/ha and by providing attenuation for the 1 in 100-year rainfall event, including an allowance for climate change of 20%. These SuDS features should also convey the attenuated flows from individual private plot. As discussed later in Section 6, runoff from roads and parking bays in public areas should be treated by a minimum of two SuDS components prior to discharge to receiving watercourses / sewers.

Based on the existing surface water drainage network and topographic levels obtained from contour mapping provided by FCC, it is likely that the Masterplan lands will outfall to the existing watercourses that cross the lands and to the existing surface water drainage network on the R132 immediately east of the lands. Where the new surface water drainage network for the Masterplan lands is connecting to the existing surface water network, the capacity of the existing network will need to be established at these locations and discharge from the developments limited to acceptable flow rates. The quality of any runoff from any new development will need to be such that the existing water quality and flow regime is not negatively affected.

5. SUDS SELECTION

5.1 Land use

Under the current Fingal County Development Plan (2017 – 2023), the Fosterstown Masterplan lands are zoned Objective RA – "*Provide for new residential communities subject to the provision of the necessary social and physical infrastructure*" and Objective MC – "*Protect, provide for and/or improve major town centre facilities*". The extent of land zoned under each of the different zoning types is outlined in Table 5.1 below and Appendix A.

Table 5.1 Fosterstown Masterplan lands Zoned Objectives RA & MC

Zoning Ref	Description	Approximate size (ha)
RA	Provide for new residential communities subject to the provision of the necessary social and physical infrastructure	11.48
MC	Protect, provide for and/or improve major town centre facilities	1.42

5.2 Site Characteristics

The various site characteristics which influence SuDS techniques are outlined below. The site characteristics have been obtained from a desktop study of LiDAR and Contour maps, Ordnance Survey maps and Geological Survey of Ireland (GSI) maps. *Refer to Appendix B for relevant maps.*

5.2.1 Soils

The soil at the Fosterstown lands generally consist of Limestone Till (Carboniferous) with some alluvium in the floodplain of the existing watercourse that flows through the Masterplan lands.

Ground investigations were undertaken within the Fostertown Masterplan lands as part of the Swords development, N1, south of Swords Co. Dublin. Boreholes and trial pits undertaken at the southern end of the Masterplan lands generally consisted of topsoil underlain by sandy-gravel clay. Bedrock was not identified. Localised ground investigation will need to be undertaken to determine the depth to bedrock within the Masterplan lands. GSI ground water vulnerability mapping indicates that the Masterplan lands have low groundwater vulnerability. *Refer to Appendix B.*

5.2.2 Area Draining to SuDS Component

The Fosterstown Masterplan lands comprise approximately of 13.14ha in total, with varying; ecological characteristics, topography, subsoil permeability, and with some areas at risk of flooding, therefore, a carefully selected Management Train of various SuDS components will be required to effectively manage surface water runoff.

5.2.3 Minimum Depth to Water Table

Typically, some SuDS techniques require a minimum 1m depth of soil between the maximum water Table level and the base of the device (e.g. Soakaways). Localised ground investigation will need to be undertaken to determine the depth to groundwater at each development area.

5.2.4 Site Slope

The slope of the lands within the Masterplan Area is diverse but generally slopes towards the existing watercourses within the lands and towards the existing public drainage infrastructure located on the R132 to the north eastern corner of the lands. The majority of the Masterplan lands have a gentle slopes of approximately 5%.

In steeper sections, swales can be routed along contours or fitted with cascades to reduce the effective gradient. Ponds and basins are not usually located in areas with slopes >5%, although tiered systems can be effective in treating runoff but need to be carefully designed.

5.2.5 Available Head

Based on existing levels in the proposed development areas, available head is unlikely to be an issue for any SuDS solutions.

5.2.6 Available Space

Given the extent of undeveloped lands within the masterplan area, there should be significant available space to incorporate SuDS features as part of any future development.

5.3 Catchment Characteristics

5.3.1 Aquifers used for Public Water supply

The Fosterstown site is underlain by Locally Important Aquifer (LI) – Bedrock which is Moderately Productive only in Local Zones. This suggests a reasonable depth to groundwater. This is expected based on the coastal location of the area. There are no GSI or EPA Source Protection Zones in the vicinity of the masterplan area. The GSI groundwater viewer indicates multiple groundwater springs/supplies identified north and south-east of Forsterstown lands. *Refer to Appendix B*.

5.3.2 Surface Waters used for Public Supply

The watercourses within the vicinity of the Masterplan lands do not appear to be used for surface water abstraction.

5.3.3 Coastal / Estuarial Waters

According to the SuDS Manual (2015) and Greater Dublin Strategic Drainage Study (GDSDS), discharge to coastal waters do not typically require attenuation as there will be no deterioration in flood risk as a result of an increase in runoff. However, it will be necessary to provide a combination of source controls, site controls and regional controls as part of the Fosterstown surface water drainage system to protect and enhance the receiving costal / estuarine waterbodies. This will help achieve our obligations under the Water Framework Directive.

It will be necessary to provide a combination of SuDS systems within the curtilage of all new individual development plots and proposed public areas (to be taken-in-charge) as part of all new developments. This approach should be adopted in tandem with Fingal County Council Policy, to protect and enhance floodplains (as identified in the Strategic Flood Risk Assessment for the Fosterstown Masterplan), to ensure high water quality from runoff into these downstream areas.

5.3.4 Receiving Waters that act as Formal Recreational / Amenity Facilities

The following recreational / amenity facilities in receiving waters from Fosterstown been identified:

- Malahide Beach located approximately 6.0m east of Fosterstown;
- Donabate Beach located approximately 6.3km north east of Fosterstown;
- Portmarnock Beach located approximately 8.0km south east of Fosterstown;
- Tower Bay Beach located approximately 8.60km north east of Fosterstown.

5.3.5 Requirements for Sustainable Water Management / Water Conservation Measures

The provision of rainwater harvesting for landscaping purposes should be provided in all residential developments. Any commercial, retail, educational or institutional buildings should provide rainwater harvesting for non-consumption purposes (eg. flushing toilets).

5.3.6 Habitat – Dependent Flow Regime

As part of any future development within the masterplan boundary, discharging to the existing surface water network shall not exceed 2l/sec/ha. This shall be implemented via SuDS measures and on-site attenuation, ensuring that there is no significant impact on the existing flow regime of the receiving waters which will penultimately be the River Gaybrook and Ward River prior to discharging to the Malahide Estuary, and through the protection and enhancement of existing floodplains from the watercourses within the Masterplan lands.

5.3.7 Flood Risk

Proposed surface water drainage networks should be designed such that runoff is limited to 2l/sec/ha. *Refer to Fosterstown masterplan Flood Risk Assessment*.

5.4 Quantity and Quality Performance

In selecting suitable SuDS components for a SuDS management train, the quantity of runoff and quality performance for various SuDs techniques should be assessed:

- Source Control techniques are most effective in reducing run off volume
- Open Channels and Detention Basins provide the best hydraulic control for large flows (1% AEP), and water quality benefits.
- Permeable paving, Infiltration and Filtration techniques (filter strips, swales, grassed channels) are most effective for water quality treatment
- Subsurface storage systems offer limited potential for water treatment.

5.5 Community, Environmental and Amenity Performance

Community and environmental factors for various SuDS techniques include Maintenance Regime, Community Acceptability, Construction and Maintenance Costs and Habitat Creation Potential.

Detention Basins and Swales (particularly Conveyance Swales) typically provide the most cost-effective SuDS solution while also incorporating the potential for habitat creation.

The implementation of wetlands will typically promote habitat creation and are generally accepted by communities as they provide valuable open space for visual and recreational enjoyment, however capital and maintenance costs can be relatively high.

There may be some public safety concerns associated with SuDS techniques involving open water, however good design and education can help minimise these concerns. This can be achieved through ‘demonstration projects’ and initiatives to educate local residents of the benefits of SuDS systems and natural floodplain management approaches as a means to tackle flood risk, particularly in response to climate change and the adverse environmental effects of uncontrolled contaminated stormwater runoff from urban developments. The SuDS approach also offers benefits to the health and wellbeing of citizens.

6. SUDS STRATEGY

6.1 SuDS Protocol for New Development

As part of any future development within the Fosterstown Masterplan lands, the developing authority should adapt the following protocol. This protocol will provide guidance for assessing the resilience of SuDS to climate change during periods of drought, flash flooding, temperature extremes and periods of persistent rainfall and to propose appropriate resilient SuDS strategies to manage stormwater runoff arising from severe rainfall events now and into the future. An overview of this protocol is outlined in Figure 6.1 below.

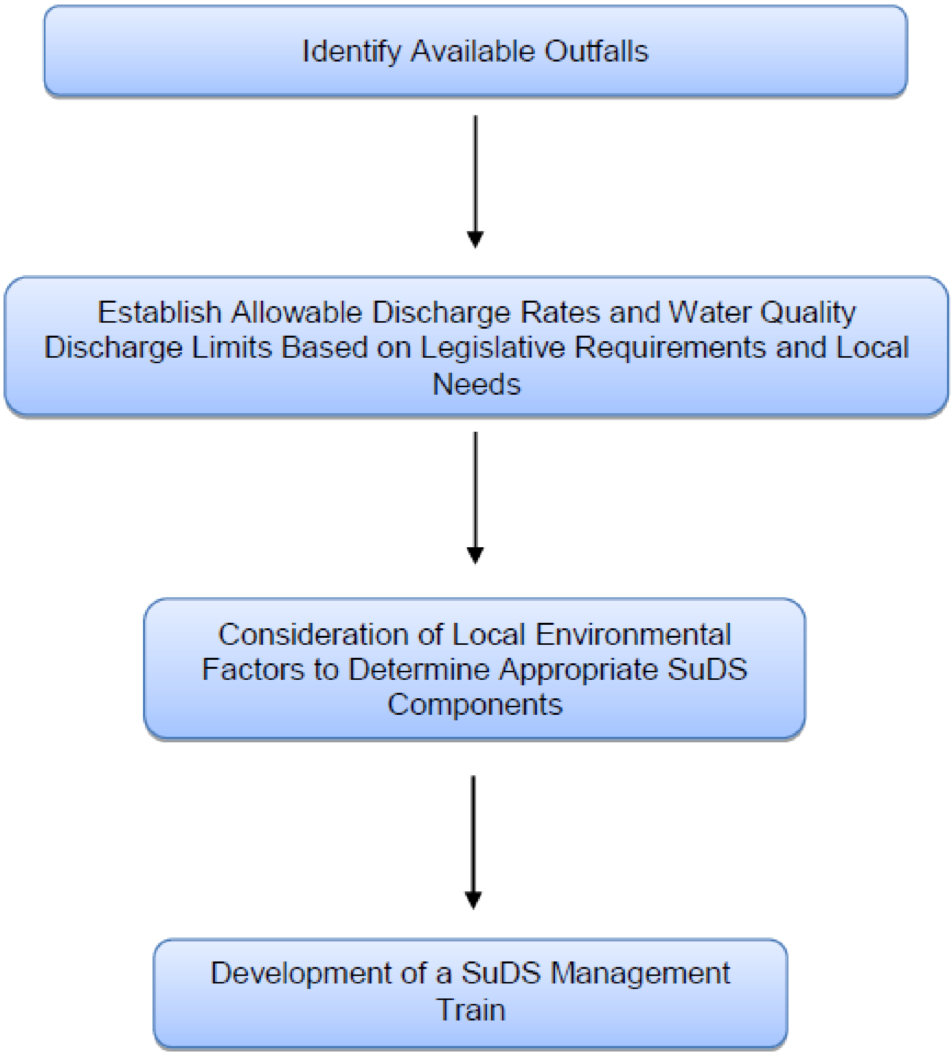


Figure 6.1 Recommended SuDS Protocol to Be Adapted

6.2 Management Train

A Management Train is usually required when developing a SuDS strategy. A Management Train sets a hierarchy of SuDS techniques which are subsequently linked together. Each technique employed contributes in different ways and degrees to the overall drainage network. The scale and number of components required will depend on the respective catchment characteristics and likely concentration of pollutants in the inflow. Considering the scale of proposed developments, a combination of carefully designed and appropriately maintained source controls, site controls and possibly regional controls are required as part of the surface water drainage system to ensure high water quality from runoff into these areas.

Following a review of all the information presented in previous sections, a selection of some SuDS techniques suitable for inclusion in the Fosterstown masterplan are described below. Given the extent of potential development land within the masterplan and that source and site control devices should be utilised on these lands, regional control measures may not be required.

6.3 Source Controls

6.3.1 Water Butts

Water Butts are small, offline storage devices designed to collect runoff from roofs. They are the most common means of harvesting rainwater for garden use and have a typical capacity of less than $0.5m^3$. Two-stage devices can provide some storage volume for attenuation using a throttled overflow, however poor maintenance can lead to blockages.

Table 6.1 Advantages of Water Butts

Advantages
Ease of installation (new and retrofit)
Inexpensive
Provides water for non-potable means – typically garden use
Suitable for all developments

Figure 6.2 Domestic Water Butt (Susdrain.org)

Water Butts are recommended for all residential properties.

6.3.2 Rainwater Harvesting

Rainwater harvesting involves collection of rainwater from roofs and hard surfaces, similar in principle to Water Butts but generally on a much larger scale. Collected water is typically used for non-potable purposes such as irrigation, flushing toilets and washing machines. The size of the harvesting tank depends on catchment area, seasonal rainfall pattern, demand pattern and retention time. Stormwater attenuation can also be provided by additional storage capacity in the tank.

Table 6.2 Advantages of Rainwater Harvesting

Advantages
Reduced demand of mains water
Can provide source control of stormwater runoff

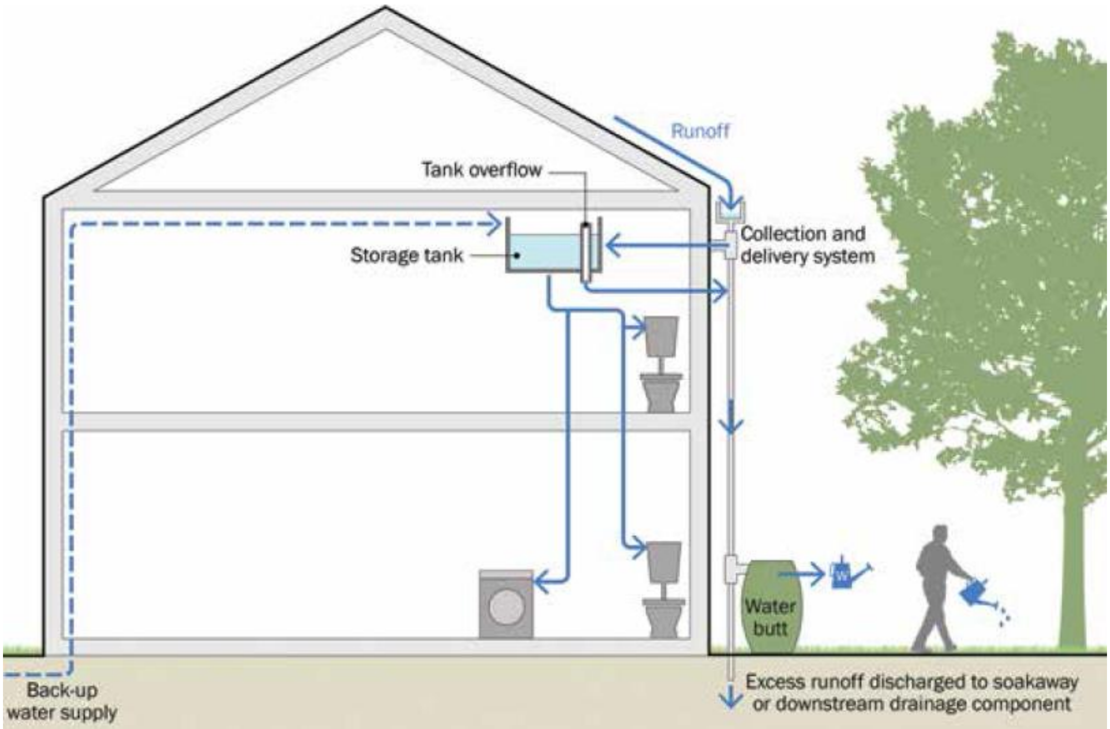


Figure 6.3 Rainwater Harvesting Schematic (CIRIA 753)

Rainwater Harvesting is recommended for use in commercial, retail, industrial and educational buildings.

6.3.3 Permeable Pavements

Permeable pavements provide a pavement suitable for pedestrian and/or vehicular traffic, while allowing rainwater infiltrate through the surface and into the underlying layers where it is subsequently infiltrates to the ground and/or is collected and conveyed to the drainage network. Permeable pavements are most suitable for areas with light traffic loads and volume. The pavement generally caters for rainwater which lands directly on its surface but in certain cases, can accept runoff from other impermeable areas, such as Water Butts, Modified Planters or directly from rainwater goods and paved areas.

Table 6.3 Advantages of Permeable Paving

Advantages
Peak flow reduction
Runoff volume reduction
Effective in removing urban runoff pollutants
No additional land space requirements

Advantages
Low maintenance costs
Good community acceptability

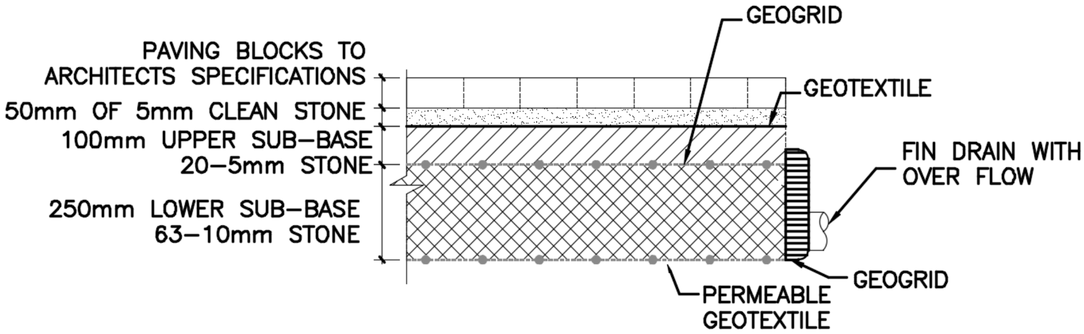


Figure 6.4 Typical Permeable Paving Detail

Permeable paving is recommended for all residential, commercial and retail parking spaces. Lightly trafficked roads should be considered for permeable block paving. Detailed site investigation will be required to determine if total, partial or no infiltration to groundwater is possible.

6.3.4 Green / Blue Roofs

Green Roofs comprise a multi-layered system which covers the roof of a building with vegetation and landscaping over a drainage layer. Blue Roofs comprise a porous surface that is explicitly designed to store water. Both systems are designed to intercept and retain precipitation which reduces the volume and rate of surface water runoff. Both systems can be integrated on a variety of roof types and sizes, although larger roof areas are typically more cost effective. They are particularly suited to flat / gently sloping roofs on commercial buildings, sports centres, schools, apartment blocks and other similar buildings.

Table 6.4 Advantages of Green / Blue Roofs

Advantages
No additional land take
Ecological, aesthetic and amenity benefits
Good removal of atmospherically deposited pollutants
Provides further insulation to buildings
Runoff storage provided at source

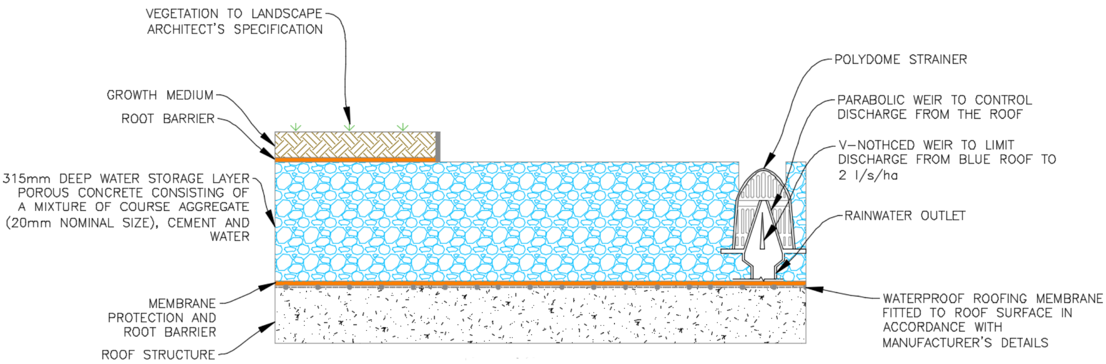


Figure 6.5 Typical Green / Blue Roof Schematic

6.3.5 Green Walls

Green Walls are walls that have plants growing on, or integrated within them, providing a living and self-regenerating cladding system. Green walls can comprise climbing plants supported by the wall, hanging plants which hang from suspended planters or plants growing within them.

Table 6.5 Advantages of Green Walls

Advantages
Can occupy much greater surface area than green roofs
High amenity & biodiversity benefits
Improves thermal efficiency of building
Good removal of atmospherically deposited pollutants

Figure 6.6 Green Wall (CIRIA C644, 2007)

6.3.6 Filter Drains

Filter drains are shallow excavations backfilled with granular material that create temporary subsurface storage for either filtration or infiltration of stormwater runoff. Filter drains can contain a perforated pipe at the base to convey runoff to further SuDS components in the Management Train.

Table 6.6 Advantages of Filter Drains

Advantages
Can reduce runoff rates and volumes
Significant reduction in pollutant load
Easily incorporated into site landscaping

Figure 6.7 Example Filter Drain

Subject to appropriate ground conditions, filter drains are recommended for draining residential back gardens and other small grassed areas where subsoil permeability is low. Filter drains can also be used to drain carriageways. The base of the filter drain should be a minimum 500mm above highest expected groundwater table level.

6.3.7 Soakaways

Soakaways are excavations that are filled with a void-forming material that allows the temporary storage of water before it soaks into the ground. They are generally suited for small catchments, such as within the curtilage of a dwelling. Many soakaways are now constructed with geocellular units, as these units provide good overall storage capacity.

Table 6.7 Advantages of Soakaways

Advantages
Minimal net land take
Provides groundwater recharge
Good volume reduction and peak flow attenuation
Easy to construct and operate

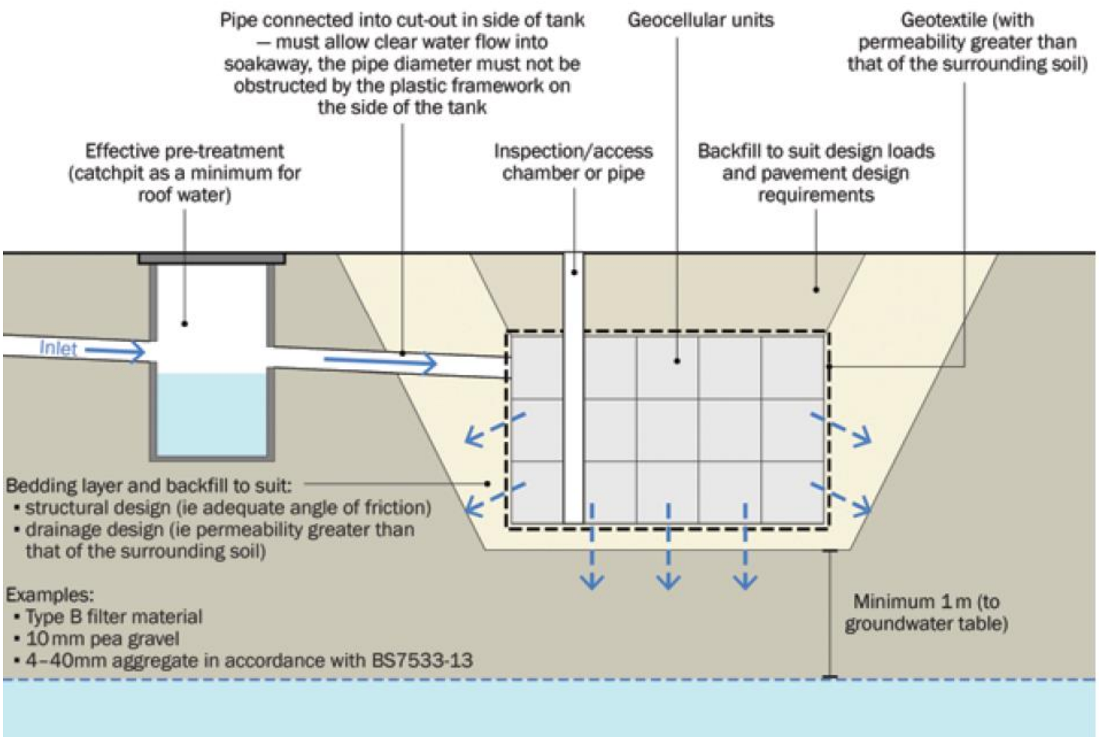


Figure 6.8 Typical Schematic of a Soakaway (SuDS Manual, 2015)

Subject to appropriate ground conditions, soakaways are recommended for draining residential gardens and other small grassed areas where subsoil permeability is low.

6.4 Site Controls

6.4.1 Swales

Swales are broad, shallow, vegetated drainage channels which can be used to convey or store surface water. Swales are generally suited for small catchments with impermeable areas. They are typically provided along roads in grass verges. Swales can be designed for infiltration to subsoil or detention and conveyance to another stage in the management train. Conveyance can be in the open channel or in a perforated pipe within a filter bed below the base of the channel.

Table 6.8 Advantages of Swales

Advantages
Good removal of pollutants
Easy to incorporate into landscaping
Peak flow reduction
Runoff volume reduction (depending on design)

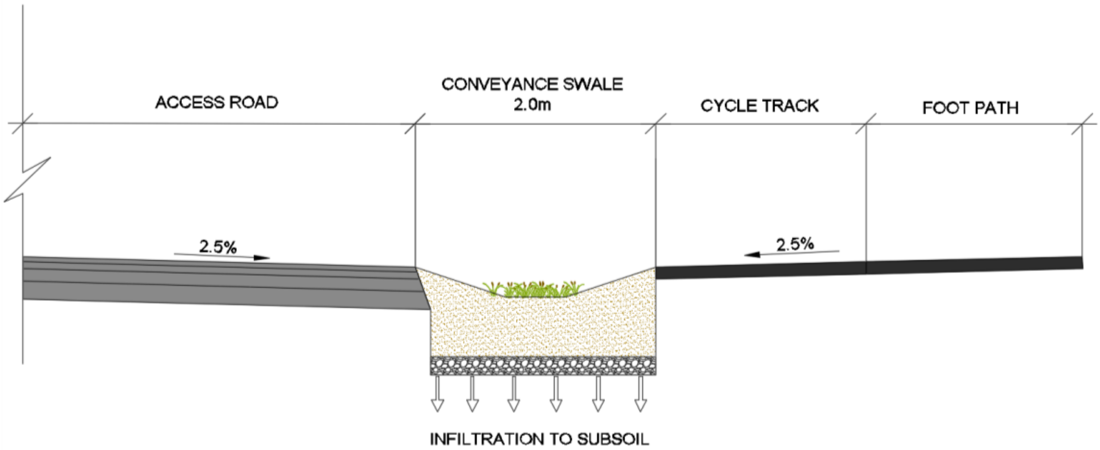


Figure 6.9 Typical Swale Schematic

Figure 6.10 Example Roadside Swale

Swales are recommended to cater for runoff from access roads, providing water treatment and reduction in peak flow. Depending on local subsoil conditions, dry swales are recommended which provide infiltration and further reduce runoff volume. Where vehicle and pedestrian access is required across a swale, a causeway can be provided. The levels at the outer swale banks will be higher than at the centre of the crossing point. This drop-in level acts as an exceedance route for runoff from the swale during extreme rainfall events.

Figure 6.11 Example Causeway for Access Across Swale (Robert Bray Associates)

6.4.2 Bioretention Areas / Modified Planters

Bioretention areas are stormwater controls that collect and treat stormwater runoff. The runoff is treated using soils and vegetation in shallow landscaped basins to remove pollutants. Treated runoff can be collected and conveyed further downstream and/or allowed infiltrate into the subsoil. Part of the runoff volume will be removed by evaporation and plant transpiration.

Table 6.9 Advantages of Bioretention Areas / Modified Planters

Advantages
Very good removal of pollutants
Runoff volume and peak flow reduction
Flexible layouts possible
Can be aesthetic landscaping features

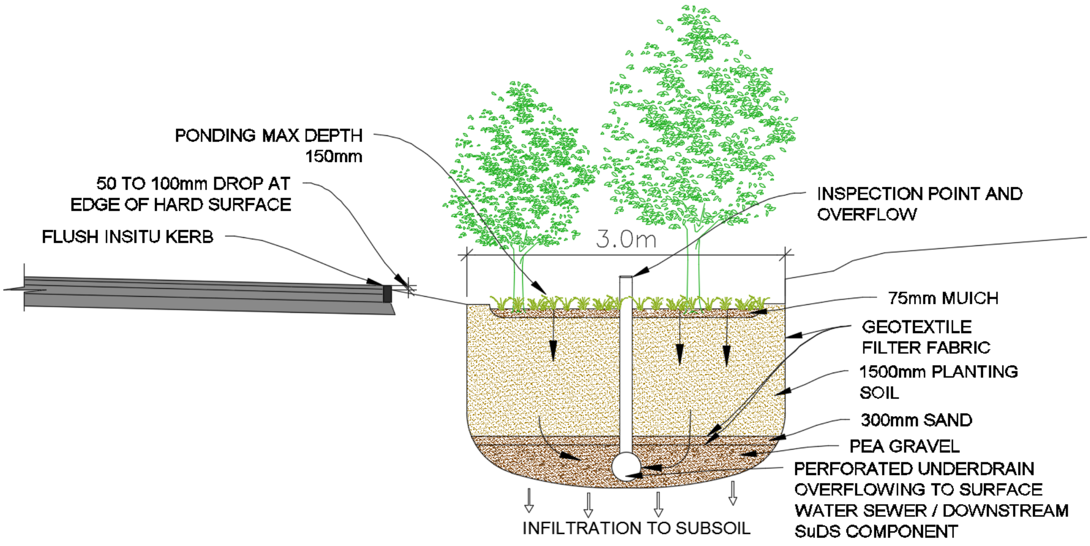


Figure 6.12 Bioretention Area Schematic

Figure 6.13 Example Roadside Bioretention Area (Portlandoregon.gov)

Bioretention areas are recommended to cater for runoff from residential neighbourhoods and car parks.

6.4.3 Detention Basins

Detention Basins are dry basins that attenuate stormwater runoff by providing temporary storage with flow control of the attenuated runoff. Detention basins are generally applicable to most types of developments. In residential areas they are normally dry and often function as a recreational facility, e.g. sports fields or play grounds. They may be constructed such that surface runoff is routed through them during storm events with an outflow restriction (online), or such that runoff typically bypasses the detention basin until a design storm event occurs when runoff is received by a flow diverter or overflow and temporarily stored until the inflow recedes below a design level (offline). Small permanent pools at the outlet can enhance water treatment quality.

Table 6.10 Advantages of Detention Basins

Advantages
Can cater for wide range of rainfall events
Simple to design and construct
Potential for dual use
Easy to maintain

Figure 6.14 Example Detention Basin (SuDS Manual, 2015)

6.5 Regional Controls

6.5.1 Ponds

Ponds are basins which have a permanent depth of water. They can be constructed in an existing depression, by excavating a new depression or by constructing embankments. Runoff which enters the pond is detained and treated by settlement and often biological uptake before out falling. Ponds should contain the following features:

- Sediment Forebay – This may not be required if previous SuDS techniques are implemented upstream
- Permanent pool – This minimum volume of water (excluding losses due to infiltration and evaporation) will remain throughout the year. The main treatment associated with the pond occurs in this pool.
- Temporary Storage Volume – An additional storage volume within the pond to provide flood attenuation for design events.
- Aquatic Bench – A shallow zone around the perimeter of the pool to support wetland planting which provides biological treatment, ecology, amenity and safety benefits.

Table 6.11 Advantages of Ponds

Advantages
Good removal of pollutants
High potential ecological, aesthetic and amenity benefits

Figure 6.15 Example Landscaped Pond

Ponds are recommended at the end of proposed surface water drainage networks following previous SuDS techniques in the Management Train. Outflow from any proposed ponds may be restricted at times due to high tide levels and as such may require additional attenuation volume. Inclusion of several independent cells is encouraged which will enhance biodiversity, improve water quality levels and provide a more environmentally effective management programme.

6.5.2 Constructed Wetlands

Constructed Wetlands comprise of shallow ponds and marshy areas which are designed primarily for stormwater treatment but can also provide some attenuation above the permanent water level. Well designed and maintained wetlands can offer significant aesthetic, amenity and biodiversity opportunities. Constructed wetlands require a continuous baseflow to support a plant-rich community. Wetlands should contain the following features:

- Shallow, vegetated areas of varying depths
- Permanent pools or micropools
- Small depth range overlying permanent pool in which runoff control volumes are stored
- Sediment forebay
- Emergency spillway
- Maintenance access
- Safety bench

Table 6.12 Advantages of Constructed Wetlands

Constructed Wetlands
Good removal of pollutants
High potential ecological, aesthetic and amenity benefits

Figure 6.16 Example Constructed Wetland

Constructed Wetlands are recommended at the end of proposed surface water drainage networks following previous SuDS techniques in the Management Train. Their primary objective should be treatment, not attenuation. Outflow from any proposed ponds may be restricted at times due to high tide levels and as such may require additional attenuation volume. Inclusion of several independent cells is encouraged which will enhance biodiversity, improve water quality levels and provide a more environmentally effective management programme. Permanent pond volume should be provided in accordance with CIRIA C753 'The SuDS Manual'.

6.6 Recommended Management Train for Fosterstown Masterplan lands

Recommended SuDS features that should be utilised as part of a management train for undeveloped areas for residential, commercial, retail, educational and recreational uses are outlined below:

SuDS Protocol for Housing Developments:

For all future residential developments:

- Runoff within the curtilage of the property boundary shall pass through at least one SuDS component prior to discharging to downstream SuDS components within the public realm.
- Storage for the 100-year event (as a minimum) including a 20% increase in rainfall intensity for climate change shall be provided within the curtilage of the property boundary, with a maximum discharge rate of 2l/s/ha.
- Runoff from public areas (such as roads, parking bays, hard and soft landscaped areas and footpaths) shall pass through at least two SuDS components prior to discharging to the final downstream detention/retention/polishing SuDS components within the public realm.
- The Final SuDS Components located in the public realm shall comprise basins/ponds/wetlands (as appropriate), prior to discharge to the Swords Glebe and River Gaybrook watercourses or local surface water sewer. The provision of ponds and wetlands should only be for polishing purposes prior to discharging to receiving watercourses. The location of such basins, ponds and wetlands shall be outside the

high-end future scenario fluvial flood extents.

- Storage for the 100-year event (as a minimum) including a 20% increase in rainfall intensity for climate change shall be provided for runoff from the public realm, with a maximum discharge rate of 2l/s/ha.

In addition, a 15m wide riparian buffer strip shall be provided from top of bank to either side of the minor watercourses present on the Masterplan lands.

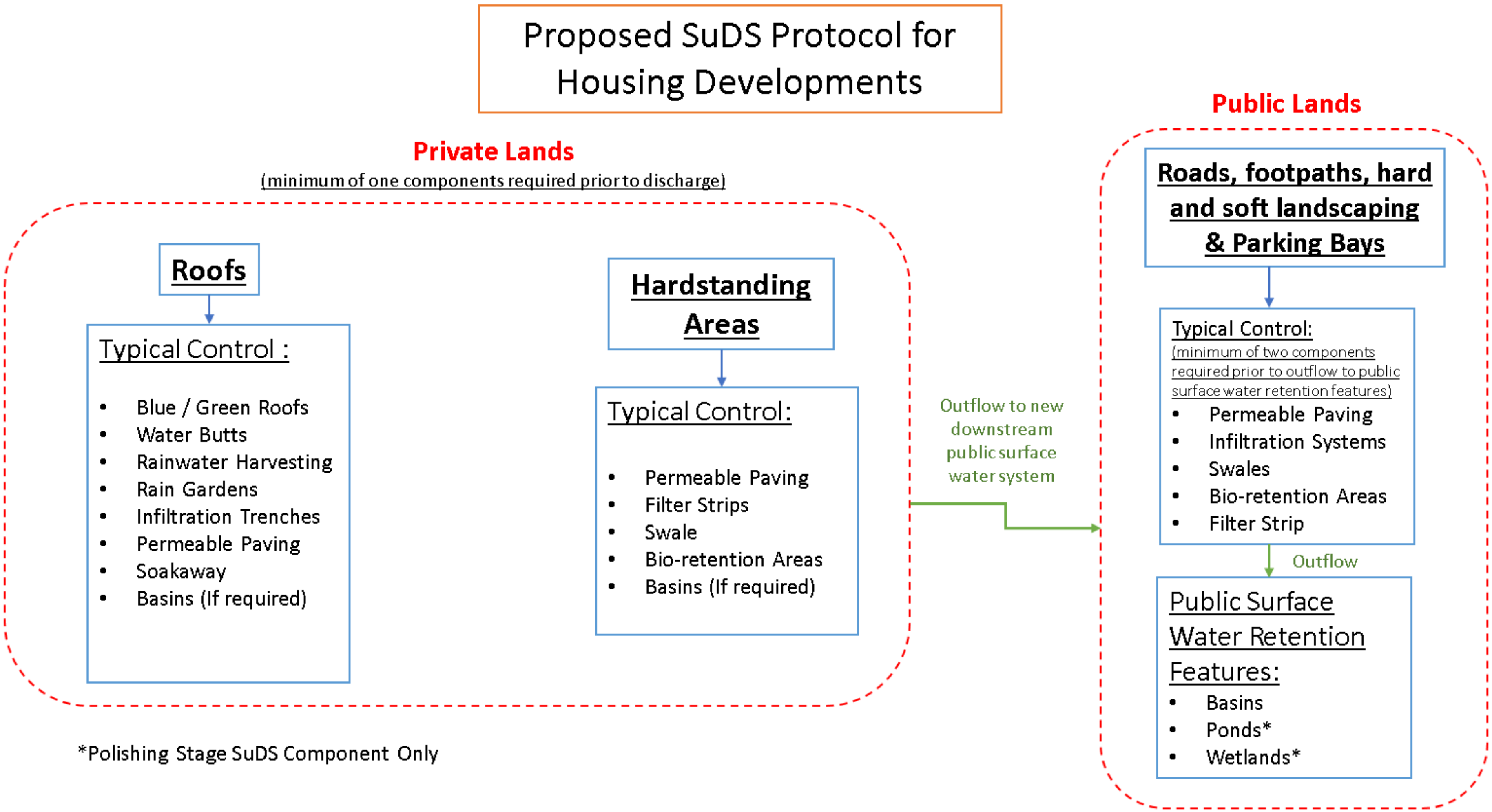


Figure 6.17 Proposed SuDS Features to Be Utilised for Housing Development Management Train

Commercial, Retail, Recreational, Educational and Apartment Developments:

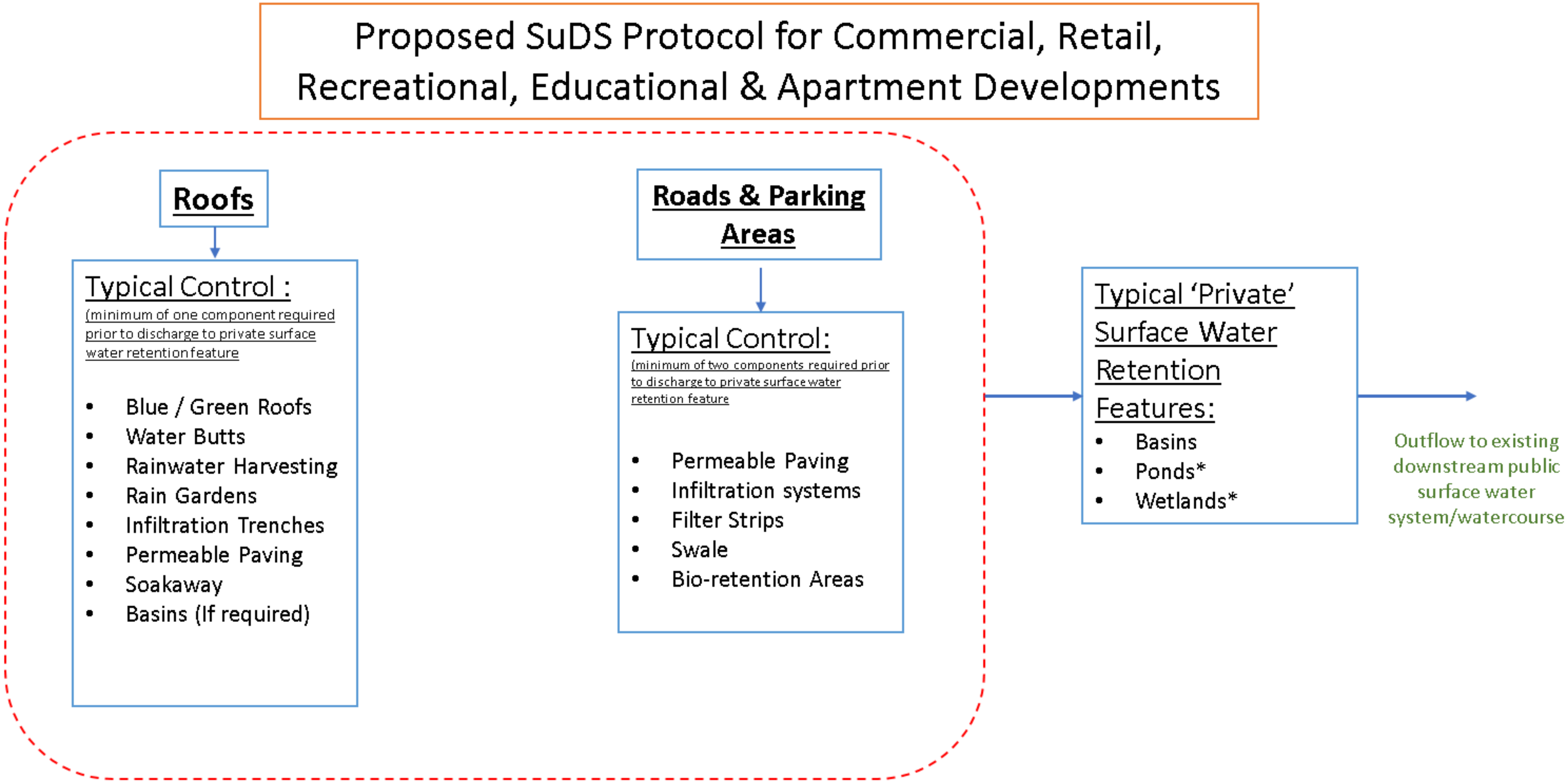
For all future commercial, retail, recreational, educational and apartment developments:

- Runoff from roofs shall pass through at least one SuDS feature prior to discharge to on-site surface water retention features.
- Blue/green roofs shall be provided to store the 100-year event with an allowance for Climate Change.
- Runoff from roads and parking areas shall past through at least two SuDS features prior to discharge to the final on-site surface water retention features.

The final ‘Private’ surface water retention features shall comprise basins/ponds/wetlands (as appropriate), prior to discharge to the local surface water sewers/watercourses. The location of such basins, ponds and wetlands shall be outside the high-end future scenario fluvial flood extents.

Storage for the 100-year event (as a minimum) including a 20% increase in rainfall intensity for climate change shall be provided for runoff from the developments, with a maximum discharge rate of 2l/s/ha.

In addition, a 15m wide riparian buffer strip shall be provided from top of bank to either side of the minor watercourses present on the Masterplan lands.



*Polishing Stage SuDS Component Only
All new industrial/commercial and apartment developments shall incorporate blue / green roofs to attenuate the 1 in 100 year (incl. climate change) rainfall event.

Figure 6.18 Proposed SuDS Features to Be Utilised for Commercial, Retail, Recreational, Educational & Apartments Development Management Train

If the proposed Fosterstown Link Road is to progress (as outlined in the current Fingal County Development Plan 2017 – 2023), it is recommended that filter strips, swales and detention basins (as a minimum) be utilised to cater for runoff from the proposed road, providing water treatment and reduction in peak flow.

7. IMPACT OF SUDS STRATEGY

7.1 Runoff Quantity

Increase in the area of hardstanding within the development areas will result in an increase in the total runoff quantity due to reduced infiltration of surface water to ground. This increase will be minimised through the use of rainwater harvesting and evaporation and transpiration from open channels / ponds and vegetation respectively.

7.2 Runoff Quality

Management of runoff quality is important in order to protect existing water quality in receiving waters. The proposed SuDS Strategy implements a Management Train whereby runoff will pass through a series of SuDS techniques prior to outfall. Each technique will provide different treatment processes – settlement, filtration, removal of nutrients, removal of heavy metals and biological treatment through vegetation.

7.3 Amenity and Biodiversity

The Masterplan lands available for new development are currently greenfield plots. The proposed SuDS Strategy will introduce a variety of features to promote and enhance amenity and biodiversity in the area. Tree plantings will be incorporated within Bioretention Areas. Ponds/Wetlands should be designed with an emphasis on ecology. Ponds should contain multiple pools fed by cleaner surface water runoff from surrounding grassland or scrub. This will allow a wider range of plants and animals to exploit the overall pond development. A variety of local (c.30km) pond plants should be included to maximise habitat structural diversity. A mix of open, lightly shaded and densely shaded areas will also add to the diversity of habitats available.

7.4 Flooding

Implementation of the SuDS Strategy will reduce peak flow runoff of the proposed development and minimise the risk of flooding. Ponds located in low lying areas will need to be designed to provide additional attenuation volume as it may not be possible to outfall during periods of extreme tidal events. *Refer to Fosterstown Masterplan Strategic Flood Risk Assessment*.

7.5 Groundwater

It is expected that the infiltration capacity of the soil within the Masterplan lands will be generally good as the masterplan land are within Soil Class 2, as identified in the Flood Studies Report. Infiltration SuDS techniques may be favourable as part of this SuDS Strategy. As a result of the proposed development, there will be a significant increase in the area of hardstanding within the Masterplan lands, resulting in a loss of surface water infiltration to the underlying subsoil. Where possible, infiltration SuDS techniques should be implemented to minimise the effect of the development and replicate the natural hydrological process. Site specific ground investigations should be undertaken when determining the infiltration capacity for future development sites.

7.6 Surface Water Drainage Network

The majority of land zoned for new development will require construction of new surface water drainage networks. It is recommended that the SuDS Protocol described above is adapted for all sites and that a SuDS Management Train is developed for all future development sites, prior to discharging from the lands to downstream watercourses.

8. CONCLUSIONS

- As part of new development in the Masterplan lands, new surface water drainage networks will be required.
- SuDS measures will be required as part of this developments to ensure the quantity, quality and ecological/biodiversity value of downstream water bodies are protected and enhanced, to assist in achieving our obligations under the WFD.
- The protocols outlined in this report for the various land uses should be adopted as a minimum, in accordance with Fingal County Council policy, and overarching national and EU legislation.

9. RECOMMENDATIONS

1) New surface water drainage networks will be required as part of the land available for development. These networks should be designed in accordance with this SuDS Strategy, CIRIA C753 'The SuDS Manual' and the Greater Dublin Strategic Drainage Systems (GDSDS).

2) Provide undeveloped flood-plains along the existing watercourses that flow through the lands to accommodate flood waters during extreme flooding events through the provision of riparian corridors – refer to the Strategic Flood Risk Assessment for the Fosterstown masterplan.

3) For all future housing developments:
    - Runoff within the curtilage of the property boundary shall pass through at least one SuDS component prior to discharging to downstream SuDS components within the public realm.
    - Storage for the 100-year event (as a minimum) including a 20% increase in rainfall intensity for climate change shall be provided within the curtilage of the property boundary, with a maximum discharge rate of 2l/s/ha.
    - Runoff from public areas (such as roads, parking bays, hard and soft landscaped areas and footpaths) shall pass through at least two SuDS components prior to discharging to the final downstream detention/retention/polishing SuDS components within the public realm.
    - The Final SuDS Components located in the public realm shall comprise basins/ponds/wetlands (as appropriate), prior to discharge to the Swords Glebe and River Gaybrook watercourses or local surface water sewer. The location of such basins, ponds and wetlands shall be outside the high-end future scenario fluvial flood extents.

- Storage for the 100-year event (as a minimum) including a 20% increase in rainfall intensity for climate change shall be provided for runoff from the public realm, with a maximum discharge rate of 2l/s/ha.

4) For all future commercial, retail, recreational, educational and apartment developments:
   - Runoff from roofs shall pass through at least one SuDS feature prior to discharge to on-site surface water retention features.
   - Blue/green roofs shall be provided to store the 100-year event with an allowance for Climate Change.
   - Runoff from roads and parking areas shall past through at least two SuDS features prior to discharge to the final on-site surface water retention features.
   - The final 'Private' surface water retention features shall comprise basins/ponds/wetlands (as appropriate), prior to discharge to the local surface water sewers/watercourses. The location of such basins, ponds and wetlands shall be outside the high-end future scenario fluvial flood extents.
   - Storage for the 100-year event (as a minimum) including a 20% increase in rainfall intensity for climate change shall be provided for runoff from the developments, with a maximum discharge rate of 2l/s/ha.

5) A Management Train should be incorporated during the design stage whereby surface water should be managed locally in small sub-catchments rather than being conveyed to and managed in large systems further down the catchment.

6) Water Butts, Rainwater Harvesting, Rain Gardens and Permeable Paving are recommended for use in all housing developments.

7) Any Commercial, Retail, Educational, Recreational developments and Apartment blocks should incorporate rainwater harvesting for re-use and should incorporate blue / green roof structures.

8) Subject to subsoil permeability, filter drains may be required to drain residential gardens and other small green areas within future developments. Runoff from green areas should, where possible, infiltrate directly to groundwater.

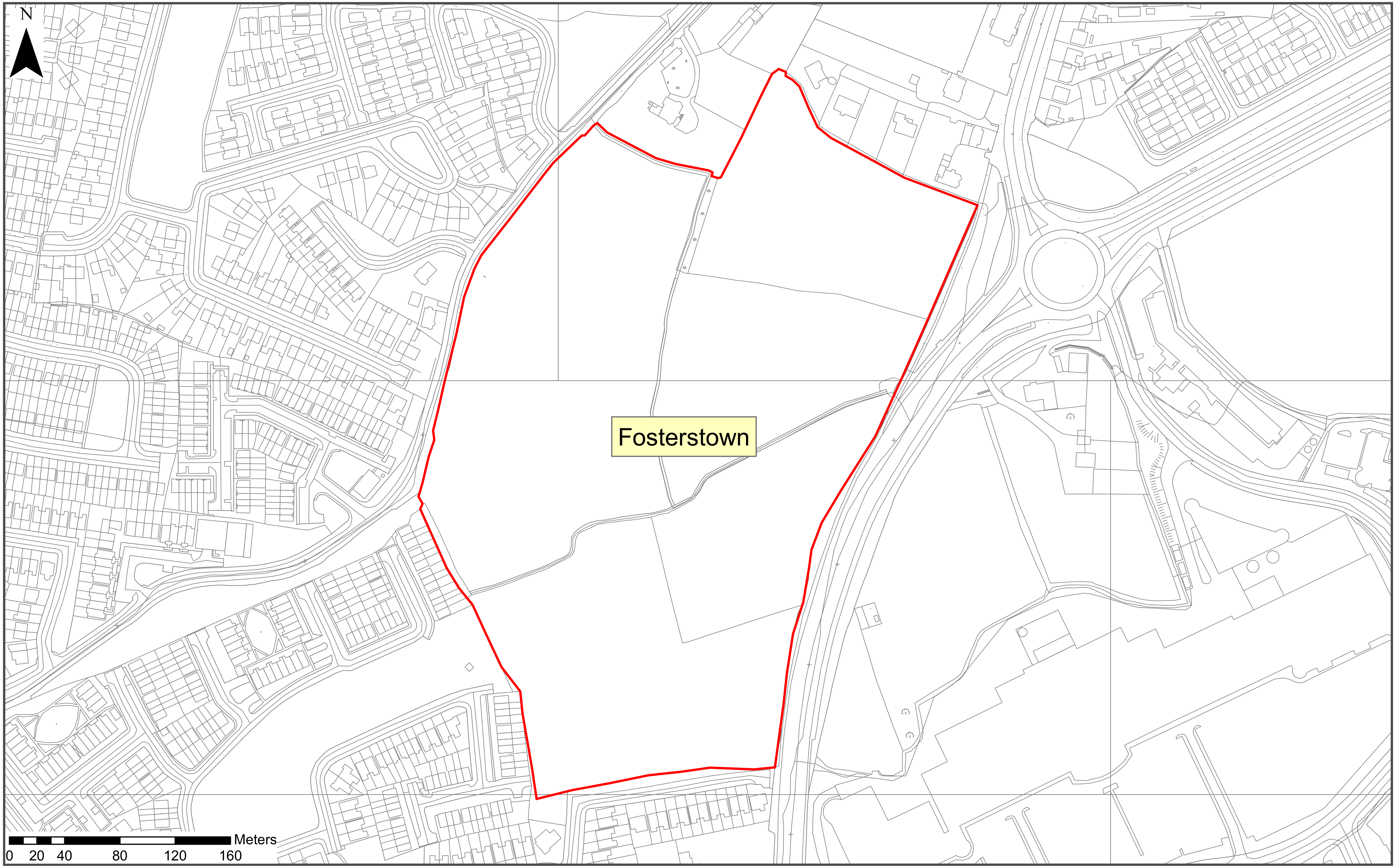
9) Runoff from development lands should be limited to 2l/sec/ha. Attenuation should be provided for the 1% AEP rainfall event plus an allowance for Climate Change in accordance with regional drainage policy. The siting of all future SuDS components shall be outside the high-end future scenario fluvial flood extents. Refer to the Fosterstown Masterplan Flood Risk Assessment for flood extent mapping.

10) The relevant authorities should promote the benefits of SuDS retrofitting to the general public.

11) No development shall occur within the 0.1% AEP Fluvial or Tidal Flood Extent, including defended areas. Refer to Fosterstown Masterplan Flood Risk Assessment for flood extent mapping.

12) Management trains for new developments should facilitate the construction of future SuDS components – to mitigate the risk of flooding caused by more extreme rainfall events and risk of pollution due to lower baseflow in receiving waters.

APPENDIX A
SITE LOCATION MAP



Masterplan lands

No.	Revision	Date	By	Chk'd	App'd
F01	Site Layout - Final	10/05/2019	BP	WV	JPR

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

ROD ROUGHAN & O'DONOVAN
Consulting Engineers
Civil - Structural - Transportation - Environmental

Arena House, Arena Road,
Sandyford, Dublin 18.
Tel : +353 1 294 0800
Fax : +353 1 294 0820
e-mail : info@rod.ie
Website : www.rod.ie

Project Title: Swords Surface Water Management Plan

Drawing Title: Fosterstown Site Layout

Designed: BP	Checked: WV	Approved: JPR	Status: FINAL

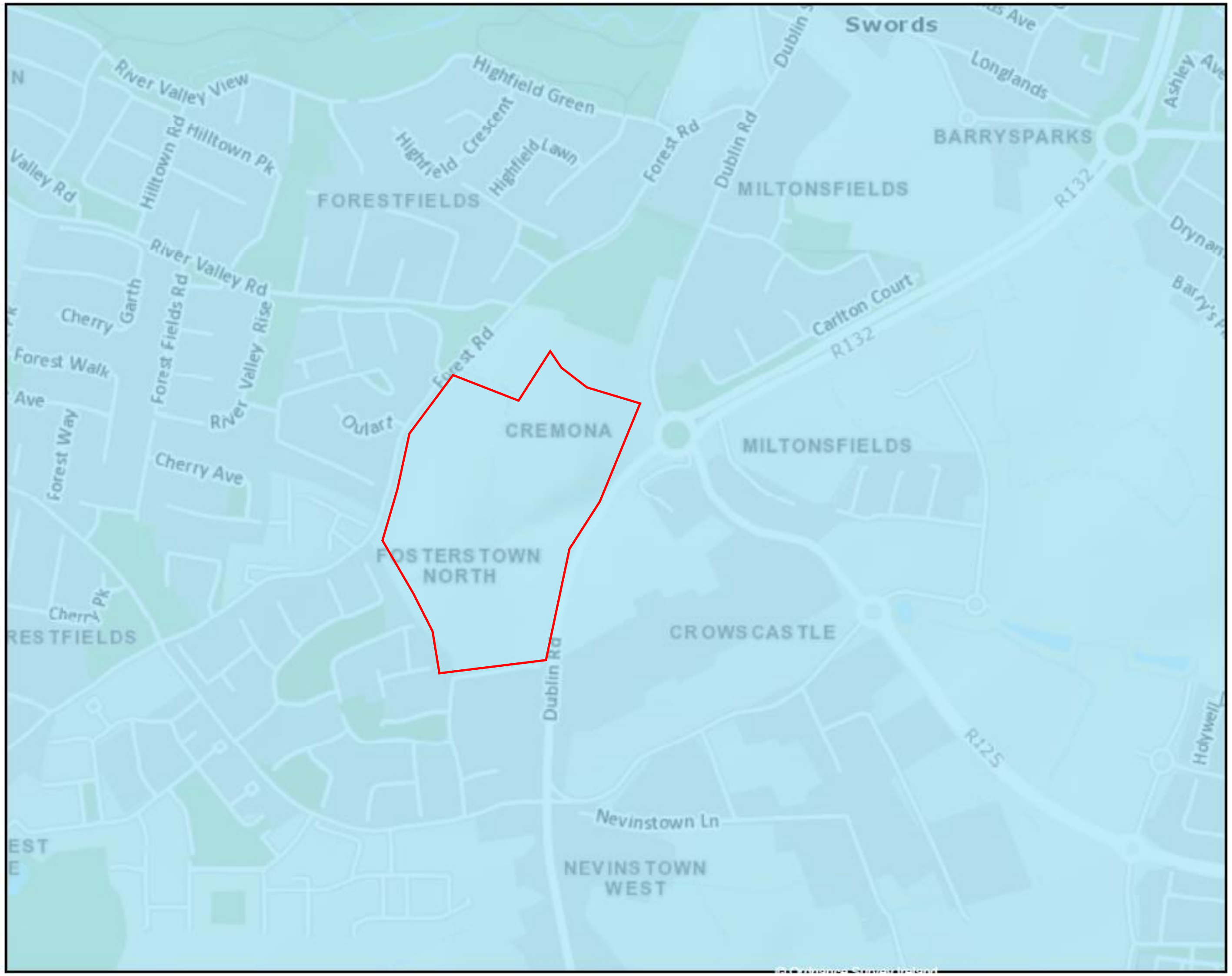
Drawn: BP	Job No: 18.164	Drawing No: 18.164-002	Rev: F01
Scale: 1:2,500 (@ A3)	Date: 29/11/2018		

10 May 2019 09:45:37 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Final\18.164-002 Swords Masterplan Fosterstown F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

APPENDIX B
GSI MAPS

Groundwater Data



Legend

Bedrock Rock Units

Malahide Formation

Scale: 1:10,000

Geological Survey Ireland

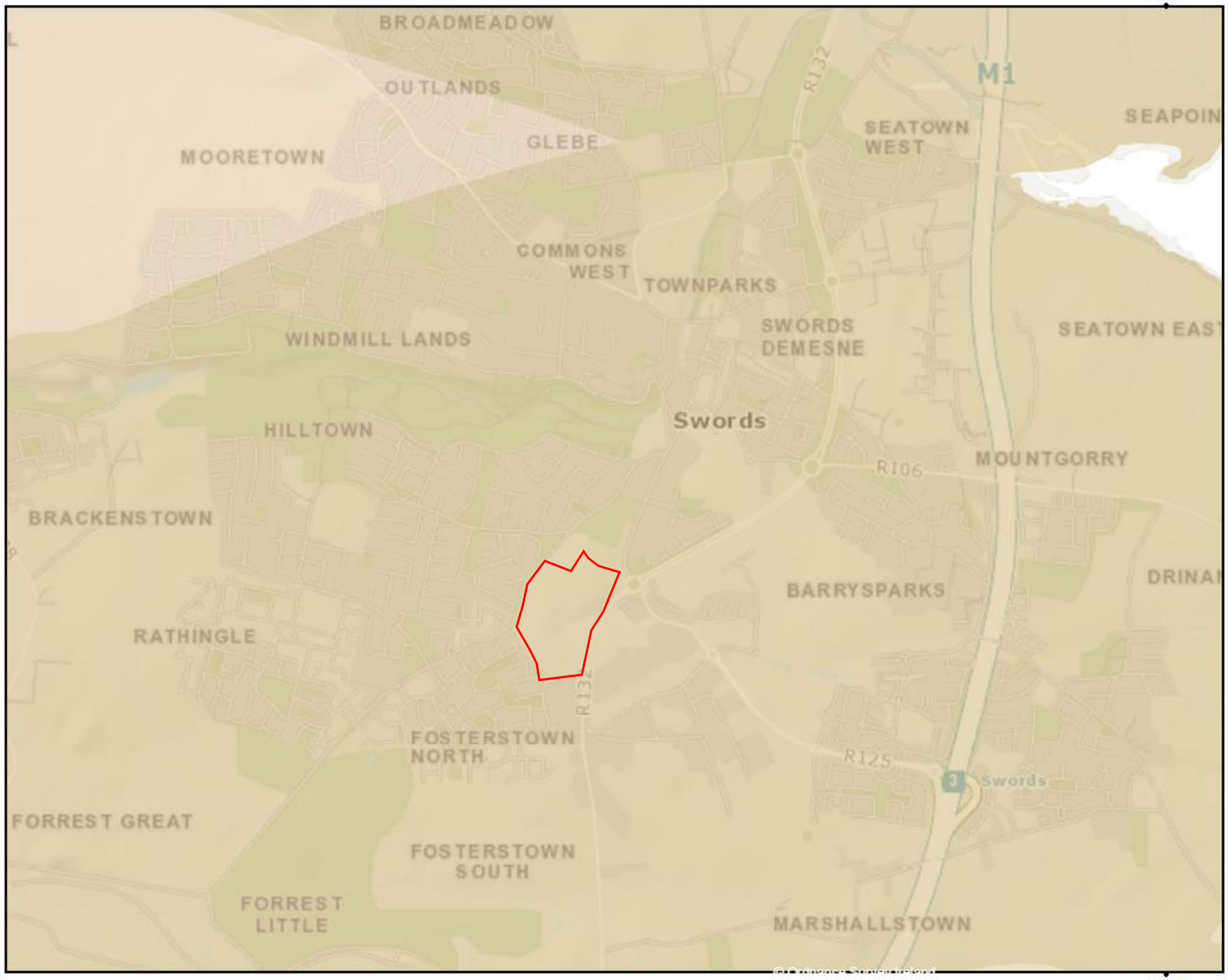
0 0.05 0.1 0.2 mi

0 0.1 0.2 0.4 km

Map Centre Coordinates (ITM) 717,799 745,820

11/2/2018, 3:09:55 PM

Groundwater Data



Legend

Bedrock Aquifer

- LI - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- PI - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones

Scale: 1:25,000

Geological Survey Ireland

0 0.175 0.35 0.7 mi
0 0.275 0.55 1.1 km

Map Centre Coordinates (ITM) 717,818 746,276
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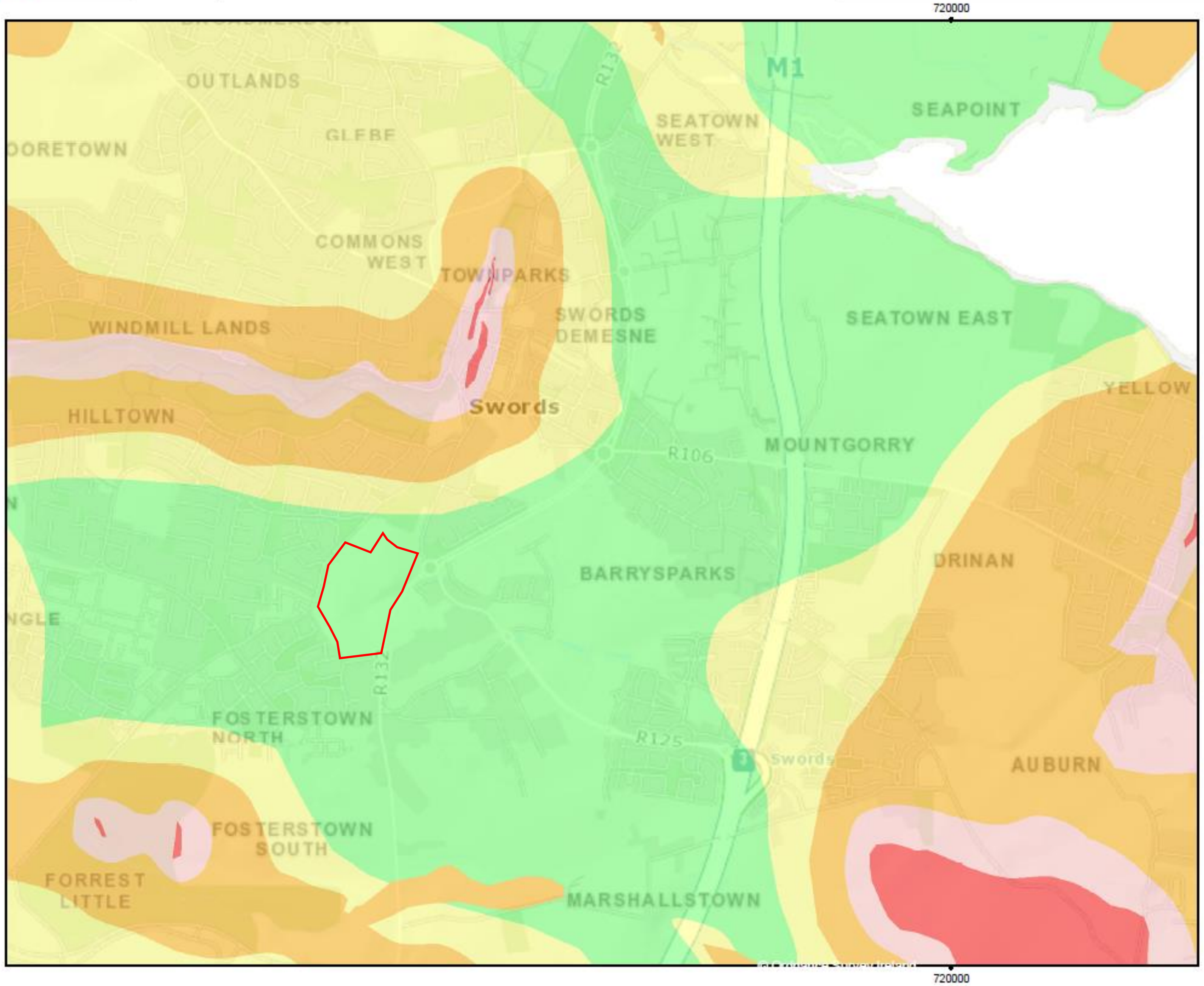
Groundwater Data



Legend

Groundwater Vulnerability

- X - Rock at or near surface or Karst
- E - Extreme
- H - High
- M - Moderate
- L - Low

Scale: 1:25,000

Geological Survey Ireland

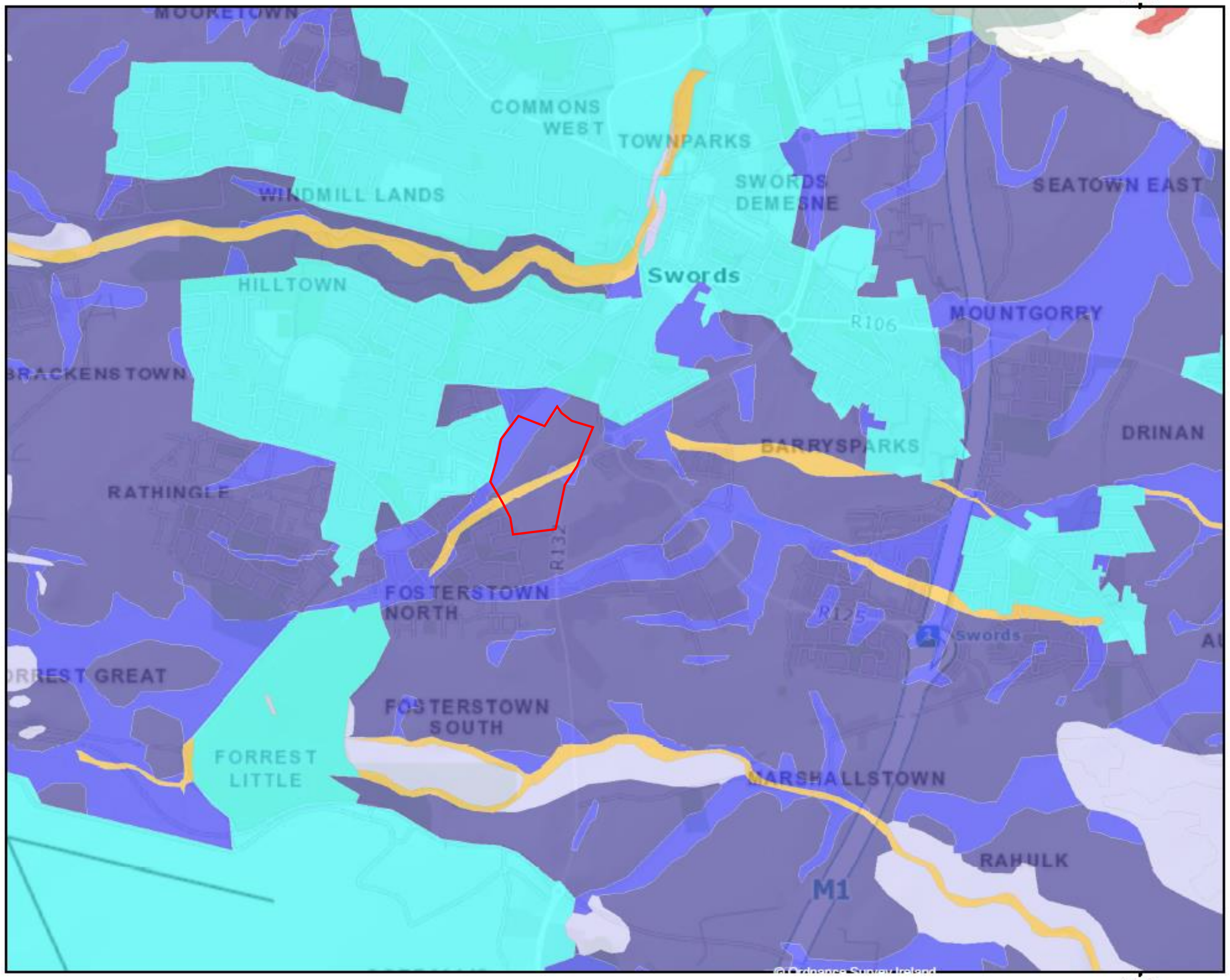
0 0.175 0.35 0.7 mi

0 0.275 0.55 1.1 km

Map Centre Coordinates (ITM) 718,589 746,202

11/2/2018, 11:42:16 AM

Groundwater Data



Scale: 1:25,000

Geological Survey Ireland

0 0.175 0.35 0.7 mi

0 0.275 0.55 1.1 km

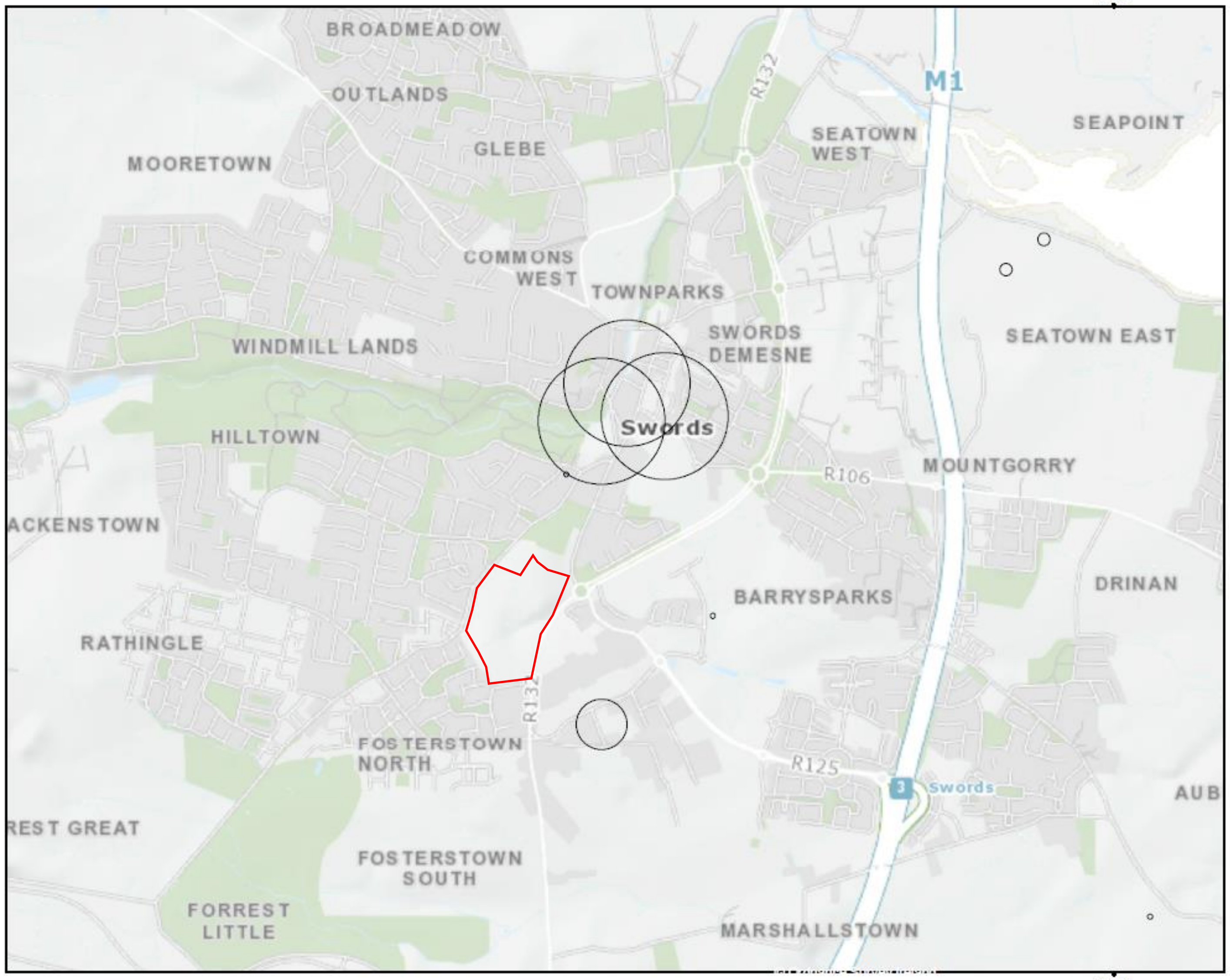
Map Centre Coordinates (ITM) 717,922 745,704

11/2/2018, 11:32:26 AM

Legend

- AminDW - Deep well drained mineral (Mainly acidic)
- BminDW - Deep well drained mineral (Mainly basic)
- BminPD - Mineral poorly drained (Mainly basic)
- BminSW - Shallow well drained mineral (Mainly basic)
- BminSRPT - Shallow, rocky, peaty/non-peatymineral complexes (Mainly basic)
- AlluvMIN - Alluvial (mineral)
- MarSed - Marine/estuarine sediments
- Made - Made ground

Groundwater Data



Scale: 1:25,000

Geological Survey Ireland

0 0.175 0.35 0.7 mi

0 0.275 0.55 1.1 km

Map Centre Coordinates (ITM) 718,029 746,303

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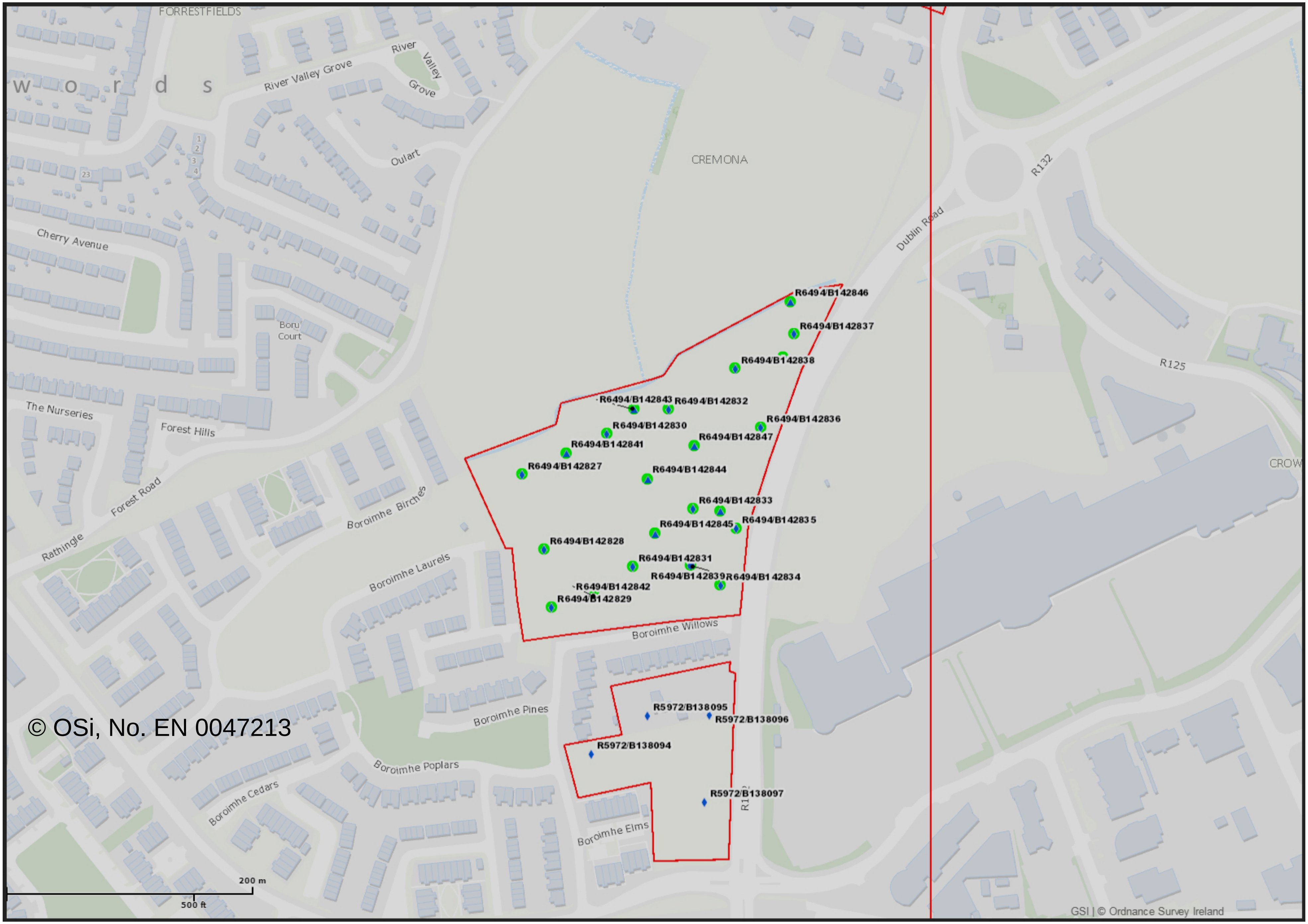
Legend

Groundwater Wells and Springs

Groundwater Wells and Springs



Overview Map for GSI Report 6494: Swords Development
N1, south of Swords, Co. Dublin
Points Observed: 22


R6494/B142846
R6494/B142837
R6494/B142838
R6494/B142843
R6494/B142832
R6494/B142836
R6494/B142830
R6494/B142847
R6494/B142841
R6494/B142827
R6494/B142844
R6494/B142833
R6494/B142845
R6494/B142835
R6494/B142828
R6494/B142831
R6494/B142839
R6494/B142834
R6494/B142842
R6494/B142829
Boroimhe Willows

GSI REPORT 6494

Swords Development

N1, south of Swords, Co. Dublin

Borehole List:

Borehole	Name	Depth	DTB	ODMALIN	Easting	Northing	Description
142827	BH1	7.5		43	317583	245633	Cable Percussion (Shell and Auger)
142828	BH2	7.5		43	317601	245572	Cable Percussion (Shell and Auger)
142829	BH3	8		42	317607	245525	Cable Percussion (Shell and Auger)
142830	BH4	7		42	317652	245666	Cable Percussion (Shell and Auger)
142831	BH5	8		42	317673	245558	Cable Percussion (Shell and Auger)
142832	BH6	8.1		42	317702	245686	Cable Percussion (Shell and Auger)
142833	BH7	10		42	317722	245605	Cable Percussion (Shell and Auger)
142834	BH8	5.4		42	317744	245543	Cable Percussion (Shell and Auger)
142835	BH9	7.5		42	317757	245589	Cable Percussion (Shell and Auger)
142836	BH10	9.2		42	317777	245671	Cable Percussion (Shell and Auger)
142837	BH11	8.5		42	317804	245747	Cable Percussion (Shell and Auger)
142838	BH12	8		42	317756	245719	Cable Percussion (Shell and Auger)
142839	RC2	15		42	317720	245559	Rotary Core Drilling
142840	RC4	15		42	317795	245728	Rotary Core Drilling
142841	TP1	3.5		42	317619	245650	Trial (or Observation) Pit
142842	TP2	3.2		42	317642	245534	Trial (or Observation) Pit
142843	TP3	3.6		42	317674	245686	Trial (or Observation) Pit
142844	TP4	3.4		42	317685	245629	Trial (or Observation) Pit
142845	TP5	3.4		42	317691	245585	Trial (or Observation) Pit
142846	TP6	3.5		42	317801	245773	Trial (or Observation) Pit
142847	TP7	3.4		42	317723	245656	Trial (or Observation) Pit
142848	TP8	3.3		42	317744	245603	Trial (or Observation) Pit

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142827 (Company Name: BH1)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14282701	0	.5				Top Soil	Top Soil
14282702	.5	2.9	Firm	Brown	Sandy Gravelly	Clay	Clay
14282703	2.9	3.5			Sandy Gravelly	Clay	Clay
14282704	3.5	7.5		Black	Sandy Gravelly	Clay	Clay

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142828 (Company Name: BH2)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14282801	0	.3				Top Soil	Top Soil
14282802	.3	2.5				Clay	Clay
14282803	2.5	7.5	Very Stiff to Hard	Black	Sandy Gravelly	Clay	Clay

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142829 (Company Name: BH3)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14282901	0	.3				Top Soil	Top Soil
14282902	.3	2.1	Firm to Stiff	Brown	Sandy Gravelly	Boulders	Boulders
14282903	2.1	7.95			Sandy Gravelly	Clay	Clay
14282904	7.95	8					

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142830 (Company Name: BH4)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14283001	0	.5				Top Soil	Top Soil
14283002	.5	2.8			Sandy Gravelly	Clay	Clay
14283003	2.8	7			Sandy Gravelly	Clay	Clay

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142831 (Company Name: BH5)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14283101	0	.2				Top Soil	Top Soil
14283102	.2	1.2	Soft	Brown	Sandy	Clay	Clay
14283103	1.2	2.3	Stiff	Brown	Sandy Gravelly	Clay	Clay
14283104	2.3	7.95	Very Stiff to Hard		Sandy Gravelly	Clay	Clay
14283105	7.95	8					

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142832 (Company Name: BH6)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14283201	0	.3				Top Soil	Top Soil
14283202	.3	3	Firm to Stiff	Brown	Sandy Gravelly	Clay	Clay
14283203	3	7.95	Very Stiff to Hard	Black	Sandy Gravelly	Clay	Clay
14283204	7.95	8.1					

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142833 (Company Name: BH7)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14283301	0	1.4				Fill - Made Ground	Fill - Made Ground
14283302	1.4	2.2	Firm	Brown	Sandy Gravelly	Clay	Clay
14283303	2.2	10	Very Stiff to Hard	Black	Sandy Gravelly	Clay	Clay

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142834 (Company Name: BH8)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14283401	0	.3				Top Soil	Top Soil
14283402	.3	2.2	Very Soft to Soft	Brown	Sandy Gravelly	Clay	Clay
14283403	2.2	5.1	Stiff to very Stiff	Black	Sandy Gravelly	Clay	Clay
14283404	5.1	5.4					

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142835 (Company Name: BH9)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14283501	0	.4				Top Soil	Top Soil
14283502	.4	2.1	Firm to Stiff	Brown	Sandy Gravelly	Clay	Clay
14283503	2.1	7.45	Very Stiff to Hard	Black	Sandy Gravelly	Clay	Clay
14283504	7.45	7.5					

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142836 (Company Name: BH10)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14283601	0	.3				Top Soil	Top Soil
14283602	.3	2.3	Firm	Brown	Sandy Gravelly	Clay	Clay
14283603	2.3	3.5	Stiff	Black	Sandy Gravelly	Boulders	Boulders
14283604	3.5	9.15	Very Stiff to Hard	Black	Sandy Gravelly	Clay	Clay

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142837 (Company Name: BH11)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142838 (Company Name: BH12)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14283801	0	.3				Top Soil	Top Soil
14283802	.3	1.4	Soft	Brown	Sandy Gravelly	Clay	Clay
14283803	1.4	3.2	Firm	Brown	Gravelly	Clay	Clay
14283804	3.2	8	Very Stiff	Black	Sandy Gravelly	Clay	Clay

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142839 (Company Name: RC2)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14283901	0	.2				Top Soil	Top Soil
14283902	.2	2.7		Brown	Sandy Gravelly	Clay	Clay
14283903	2.7	15		Black	Sandy Gravelly	Clay	Clay

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142840 (Company Name: RC4)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
1428400 1	0	.2				Top Soil	Top Soil
1428400 2	.2	2.5		Brown	Sandy Gravelly	Clay	Clay
1428400 3	2.5	15		Black	Sandy Gravelly	Clay	Clay

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142841 (Company Name: TP1)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14284101	0	.3				Top Soil	Top Soil
14284102	.3	1.2	Firm to Stiff	Light Brown	Sandy Gravelly	Clay	Clay
14284103	1.2	2.9	Firm to Stiff	Dark Brown	Sandy Gravelly	Clay	Clay
14284104	2.9	3.5	Very Stiff to Hard	Black	Sandy Gravelly	Clay	Clay

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142842 (Company Name: TP2)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14284201	0	.3				Top Soil	Top Soil
14284202	.3	1.8	Firm	Brown	Sandy Gravelly	Clay	Clay
14284203	1.8	3.2	Very Stiff	Black	Sandy Gravelly	Clay	Clay

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142843 (Company Name: TP3)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14284301	0	.4				Top Soil	Top Soil
14284302	.4	.9	Firm	Light Brown	Sandy	Clay	Clay
14284303	.9	3.1	Stiff	Brown	Sandy Gravelly	Clay	Clay
14284304	3.1	3.6	Very Stiff to Hard		Sandy Gravelly	Clay	Clay

GSI REPORT 6494

Swords Development

LAYERS FOR BOREHOLE 142844 (Company Name: TP4)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14284401	0	.3				Top Soil	Top Soil
14284402	.3	2	Firm to Stiff	Brown	Sandy Gravelly	Clay	Clay
14284403	2	3.4	Very Stiff to Hard	Black	Sandy Gravelly	Clay	Clay

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Swords Development

LAYERS FOR BOREHOLE 142845 (Company Name: TP5)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14284501	0	.4				Top Soil	Top Soil
14284502	.4	2	Firm to Stiff	Brown	Sandy Gravelly	Clay	Clay
14284503	2	3.4	Very Stiff to Hard	Black	Sandy Gravelly	Clay	Clay

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LAYERS FOR BOREHOLE 142846 (Company Name: TP6)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14284601	0	.4				Top Soil	Top Soil
14284602	.4	.8	Firm	Light Brown	Sandy Gravelly	Clay	Clay
14284603	.8	3.1	Firm	Brown	Sandy Gravelly	Clay	Clay
14284604	3.1	3.5	Very Stiff to Hard	Black	Sandy Gravelly	Clay	Clay

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LAYERS FOR BOREHOLE 142847 (Company Name: TP7)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14284701	0	.3				Top Soil	Top Soil
14284702	.3	2.2	Firm to Stiff	Brown	Sandy Gravelly	Clay	Clay
14284703	2.2	3.4	Very Stiff to Hard	Black	Sandy Gravelly	Clay	Clay

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LAYERS FOR BOREHOLE 142848 (Company Name: TP8)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
14284801	0	.3				Top Soil	Top Soil
14284802	.3	1.8	Firm	Brown	Sandy Gravelly	Clay	Clay
14284803	1.8	3.3	Very Stiff to Hard		Sandy Gravelly	Clay	Clay