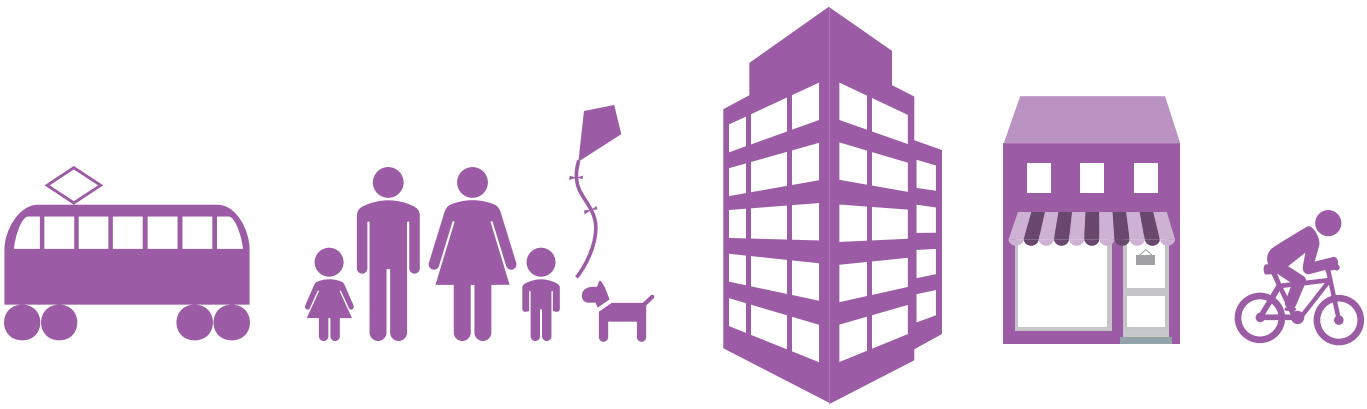
Appendix C

Barrysparks & Crowscastle Masterplan

Surface Water Management Plan (SWMP)



May 2019

www.fingal.ie

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

Barrysparks/Crowscastle Masterplan

Surface Water Management Plan [FINAL – May 2019]

ROD
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 Barrysparks / Crowscastle 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 Barrysparks / Crowscastle 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

Barrysparks / Crowscastle 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

Barrysparks/Crowscastle Masterplan
Surface Water Management Plan
Part 1: Strategic Flood Risk Assessment

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 Barrysparks/Crowscastle Masterplan in Swords. As part of this commission, the Stage I, II and III Flood Risk Assessment for the Masterplan and additional Airside lands was undertaken. The Masterplan will set out the local land use and planning policy for the subjected sites and provides 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 and additional Airside 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 and additional Airside 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 subjected lands are located within the vicinity of Airside Retail Park, Swords, North County Dublin. The masterplan and additional Airside lands are located approximately 1km west of the M1 motorway, 4.0km north of the M50 motorway and 2.4km north east of Dublin Airport. The subject lands are located within an urban environment consisting of predominantly commercial, retail, industrial and residential development. Refer to Figure 1.1 below.

Figure 1.1: Barrysparks/Crowscastle Masterplan and additional Airside lands

The topography data for the Barrysparks lands indicates that there is a high point of approximately 27mOD towards the centre of the site and generally falls from this point in all directions to approximately 24mOD.

The topography data for the Crowscastle lands indicate that the lands generally falls towards the existing watercourses that flows through the lands. The lands to the south of the River Gaybrook generally fall from approximately 37mOD to 25mOD, while the lands to the north generally fall from the centre of the site to the watercourse from a level of approximately 31mOD to 25mOD. The remaining land from the centre and northern extents of the site generally fall towards a second tributary of the Gaybrook that flows through the site. The lands to the south of this watercourse generally fall from the centre of the site to this watercourse from approximately 31mOD to 22mOD and the lands to the north of the watercourse fall from approximately 25mOD to 22mOD.

The topography data for the Airside Additional Lands 1 indicates that the lands generally fall from south west to north east from approximately 41mOD to 36mOD.

The topography data for Airside Additional Lands 2 indicates that the lands generally fall from west to east from approximately 48mOD to 41mOD.

The topography data for Airside Additional Lands 3 indicates that the lands generally fall from south to north from approximately 45mOD to 32mOD.

The topography data for Airside Additional Lands 4 indicates that the lands generally fall from south west to east from approximately 30mOD to 25mOD.

1.3.2 Catchment Description

The Masterplan and additional Airside lands are located within the catchment of the River Gaybrook and the Ward River. The Ward River is a tributary of the Broadmeadow River. Both watercourses ultimately discharge to the Malahide Estuary, approximately 4.6km north east of the study areas as outlined in Figure 1.2. There are a number of existing drainage ditches located within the Barrysparks/Crowscastle Masterplan lands.

The Ward River rises approximately 16.5km west of the study area at a location approximately 4.5km south of Ratoath. The river generally flows in an easterly direction towards Malahide Estuary.

The River Gaybrook rises within the vicinity of the study area on Airside Additional Lands 2. The river generally flows in a west to east direction towards Malahide Estuary.
A tributary of the River Gaybrook rises west of Fosterstown. The river generally also flows west to east through Airside Additional Lands 3, 4, and Barrysparks/Crowscastle before discharging to the River Gaybrook downstream of the M1 motorway.

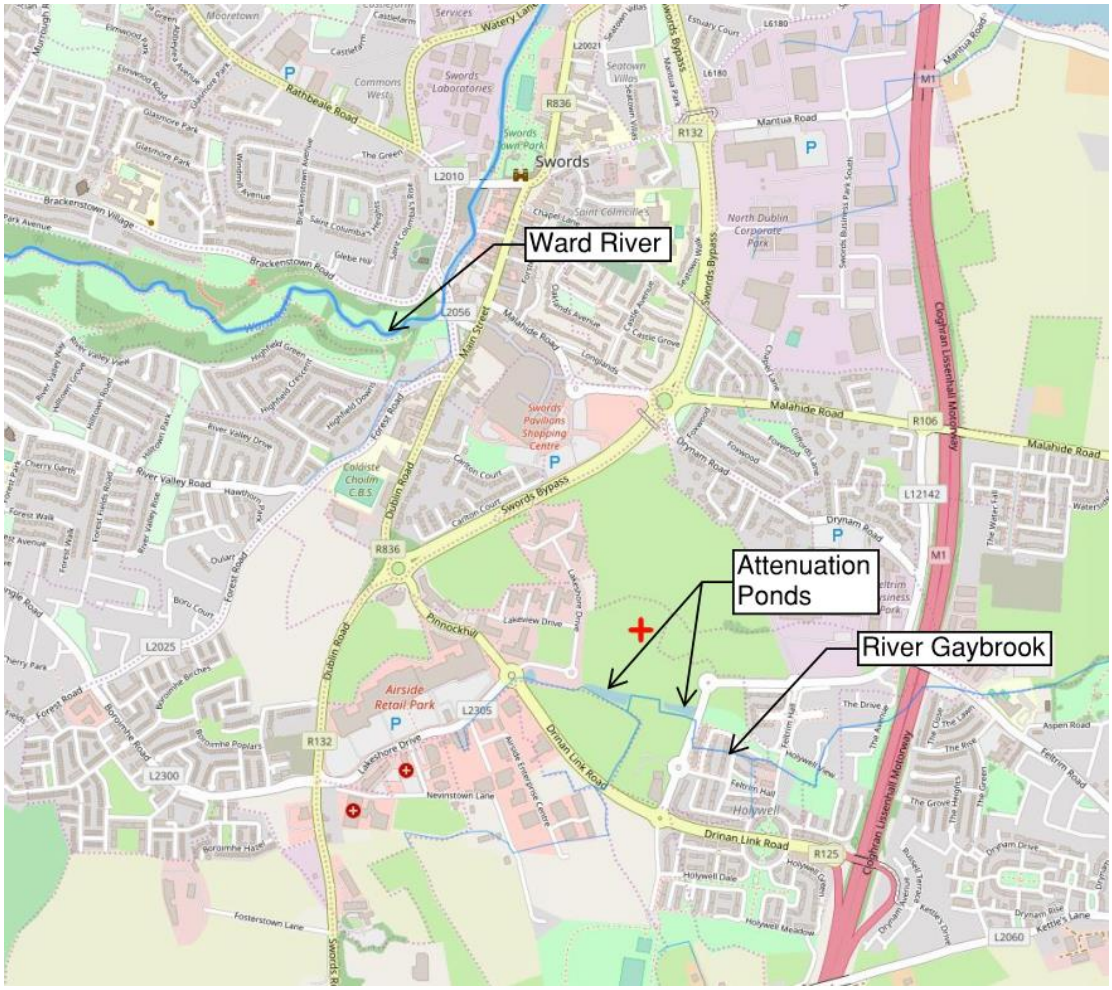


Figure 1.2: Watercourses around Barrysparks/Crowscastle (EPA Catchments.ie)

Irish Water records indicate that there is existing extensive surface water drainage infrastructure within the vicinity of the Masterplan and additional Airside lands. Upon carrying out a site visit, it was found that there are a number of drainage ditches that

are present within the Crowscastle/ Barrysparks lands, some of which appeared to be dry.

1.3.3 Environment

There are no Natura 2000 sites located within the study area; however, the Natura 2000 site Malahide Estuary (SPA and SAC) is located 2.5km north-east of the study area, Rogerstown Estuary (SPA and SAC) is located 6.4km north east of the study area and Baldoyle Bay (SPA and SAC) is located 7km south-east of the study area.

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) ~ 2.5km north-east of the study area,
- Rogerstown Estuary (proposed NHA) ~ 6.4km north-east of the study area,
- Baldoyle Bay (proposed NHA) ~7km south-east of the study area,
- Sluice River Marsh (proposed NHA) ~ 5.14km south-east of the study area,
- Feltrim Hill (proposed NHA), ~1.73km south-east of the study area,
- Santry Demesne (proposed NHA), ~5.2km south-west of the study area.

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

1.4 Proposed Development

The Masterplan Lands in combination with Airside additional lands comprise four different zoning objectives in the Fingal Development Plan 2017 – 2023 which are shown in *Table 1.1* below.

Table 1.1 Masterplan and additional Airside Lands Zoning Objectives

Objective	Description	Area
ME - Metro Economic Corridor	Facilitate opportunities for high density mixed use employment generating activity and commercial development, and support the provision of an appropriate quantum of residential development within the Metro Economic Corridor.	Barrysparks
HT – High Technology	Provide for office, research and development and high technology/high technology manufacturing type employment in a high quality built and landscaped environment.	Crowscastle, Airside Additional Lands 3 + 4
RW – Retail Warehousing	Provide for retail warehousing development	Airside Additional Lands 2
GE - General Employment	Provide opportunities for general enterprise and employment	Airside Additional Lands 1

The Fingal Development Plan for the Masterplan lands zoning objective is reproduced in Figure 1.3 below.

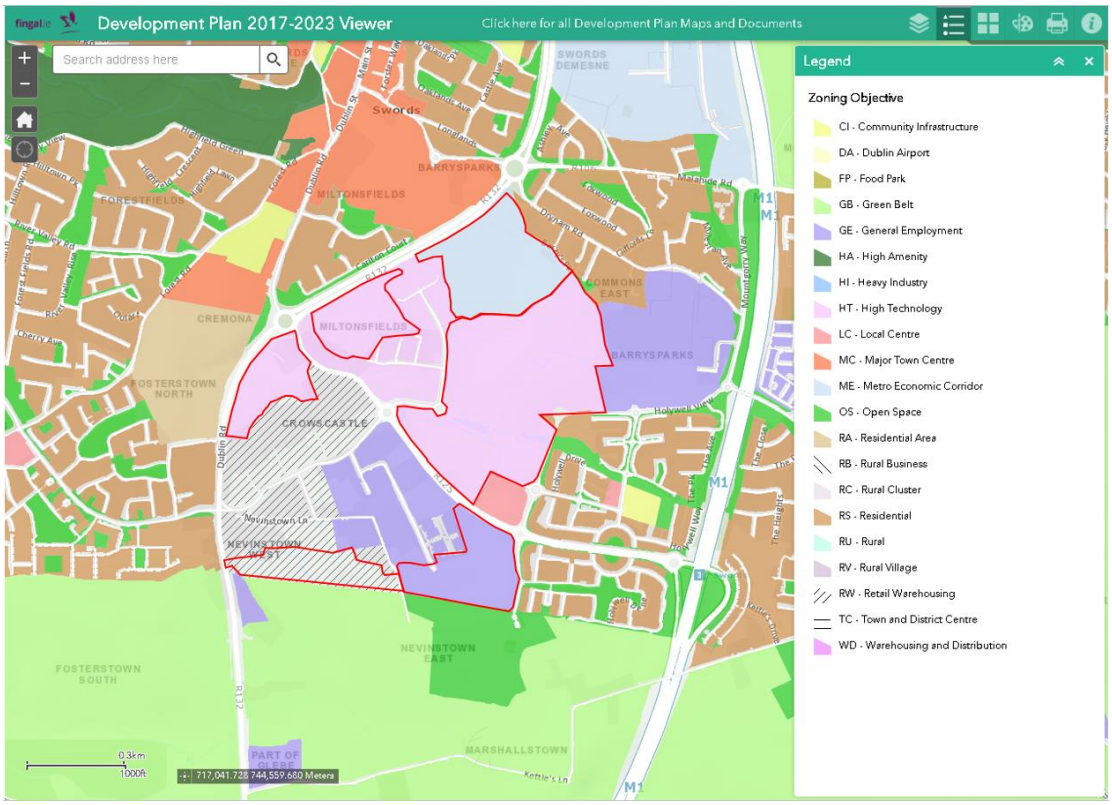


Figure 1.3: Masterplan and additional Airside lands Zoning Objectives (Fingal Co Co Development Plan 2017 – 2023)

2. METHODOLOGY

2.1 Introduction

This 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'.

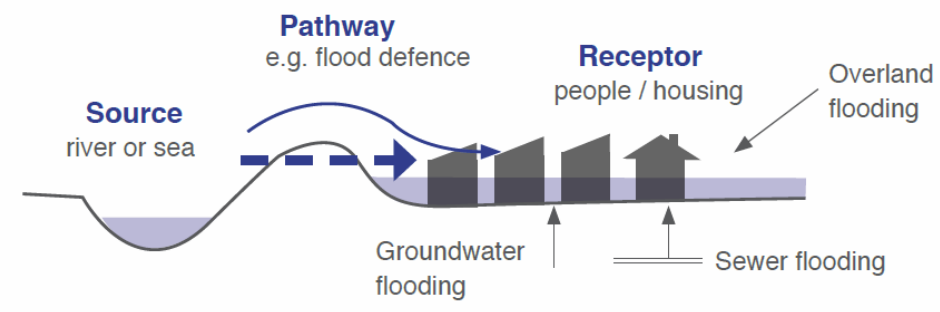


Figure 2.1 Source-Pathway-Receptor Model

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
100	1

Return Period (years)	Annual Exceedance Probability (%)
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.

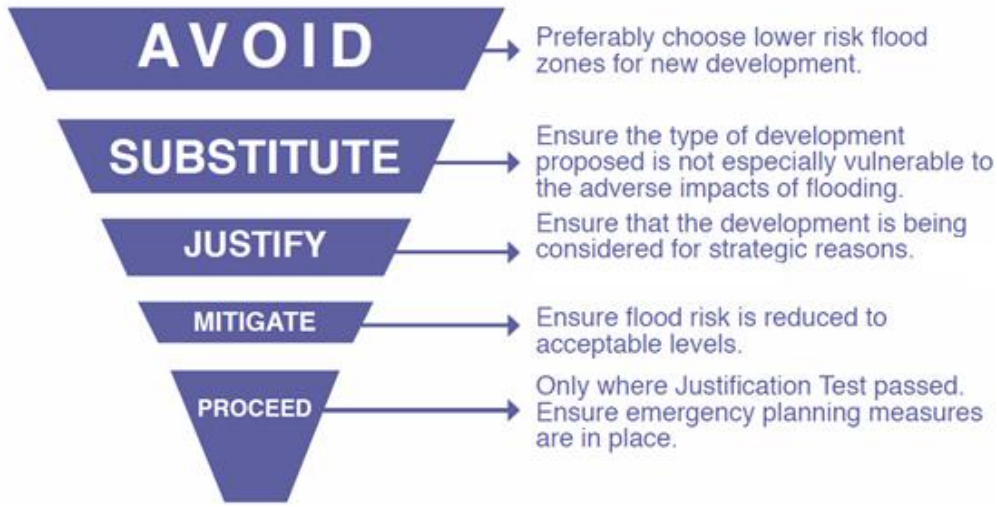


Figure 2.2 Sequential Approach (The Guidelines)

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 Masterplan and additional Airside 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 and additional Airside 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 River Gaybrook. The PFRA mapping indicates fluvial flooding for the Barrysparks/ Crowscastle 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 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 identify lands within the study area as "benefiting lands", 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, west of the study area.

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 areas within the study area are subject to flooding in the 1% and 0.1% AEP fluvial flood events.

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 the Masterplan and additional Airside lands are underlain by both BminDW - Deep well drained mineral (Mainly basic) and BminPD - Mineral poorly drained (Mainly basic). The groundwater recharge rates for the Masterplan and additional Airside lands are indicated to be between 1 and 50 mm/y. No evidence of Karst features has been identified within the Masterplan and additional Airside lands. However, a spring referred to as St. Werburghs Well is located adjacent to Lakeshore Drive. 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 Masterplan and additional Airside lands have been identified. These are summarised in Table 5.1 below.

Table 5.1 Possible Sources of Flooding Associated within the Barrysparks / Crowscastle Masterplan and additional Airside Lands

Source	Pathway	Receptor	Likelihood	Consequence	Risk
Tidal	River Gaybrook - out of bank	Barrysparks/ Crowscastle Masterplan and additional Airside lands	Low Possibility - No indication of direct tidal impacts	High – Large portions of the development land areas are in close proximity to the River Gaybrook and tributaries	Low – No sources indicate potential Tidal flooding from River Gaybrook
Fluvial	River Gaybrook - out of bank		Possible	High – Large portions of the development land areas are in close proximity to the River Gaybrook and tributaries	High - Multiple sources indicate potential fluvial flooding from River Gaybrook
Surface Water/ Pluvial	Overland flow		Possible	Medium – possible pluvial flooding within potential development land areas	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 indicate that the lands identified for development within the study area are at risk of flooding. Therefore, in accordance with The Guidelines, a Stage 2 flood risk assessment should be carried out. 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:

- Confirm the sources of flooding that may affect the masterplan and additional Airside lands;
- 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 main source of fluvial flooding is the River Gaybrook, as identified in the Stage I FRA and is discussed in more detail below.

The Masterplan and additional Airside lands are drained by the River Gaybrook and its tributaries flowing generally 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. Large portions of the lands are indicated to be within flood zones A and B as per the OPW FEM-FRAM Study and the OPW PFRA mapping. The Masterplan and additional Airside lands are therefore considered to require 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 Masterplan and additional Airside lands shall incorporate SuDS as described in the Barrysparks / Crowscastle 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 and additional Airside 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 study area are subject to groundwater derived flooding. However, a spring referred to as St. Werburghs Well is located adjacent to Lakeside Drive, this discharges directly to the River Gaybrook. Factors such as topography, soil permeability and drainage characteristics indicates that the risk of groundwater flooding is low for the majority of the study area. 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 Masterplan and additional Airside 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 Barrysparks/Crowscastle Masterplan lands. Therefore, the Masterplan and additional Airside 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 Barrysparks/Crowscastle Masterplan have indicated that the Masterplan and additional Airside lands are subject to flooding in medium and high probability exceedance events from fluvial and pluvial sources. A hydraulic model has been prepared to ascertain 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 and tributaries catchment is shown in Figure 6.1 below.

Figure 6.1 River Gaybrook and Tributaries Catchment

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.

Table 6.1 Gaybrook Upstream Flow Estimation

Return Period Current Scenario (1:x year)	FSR	FSR - 3 Variable	FSSR No: 16	IH124 / ICP IH124
100	2.67	2.10	2.12	2.06
1000	3.73	2.93	2.97	2.87

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 were significantly lower than the flows calculated using the standard flow estimation methods and as such have not been considered as part of this assessment. 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	2.06	2.47	2.68
1000	2.87	3.44	3.73

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. The downstream invert of the Gaybrook channel within the Barrysparks / Crowscastle masterplan lands is 20.8mOD and as such, the lands are not subjected to tidal flooding.

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.

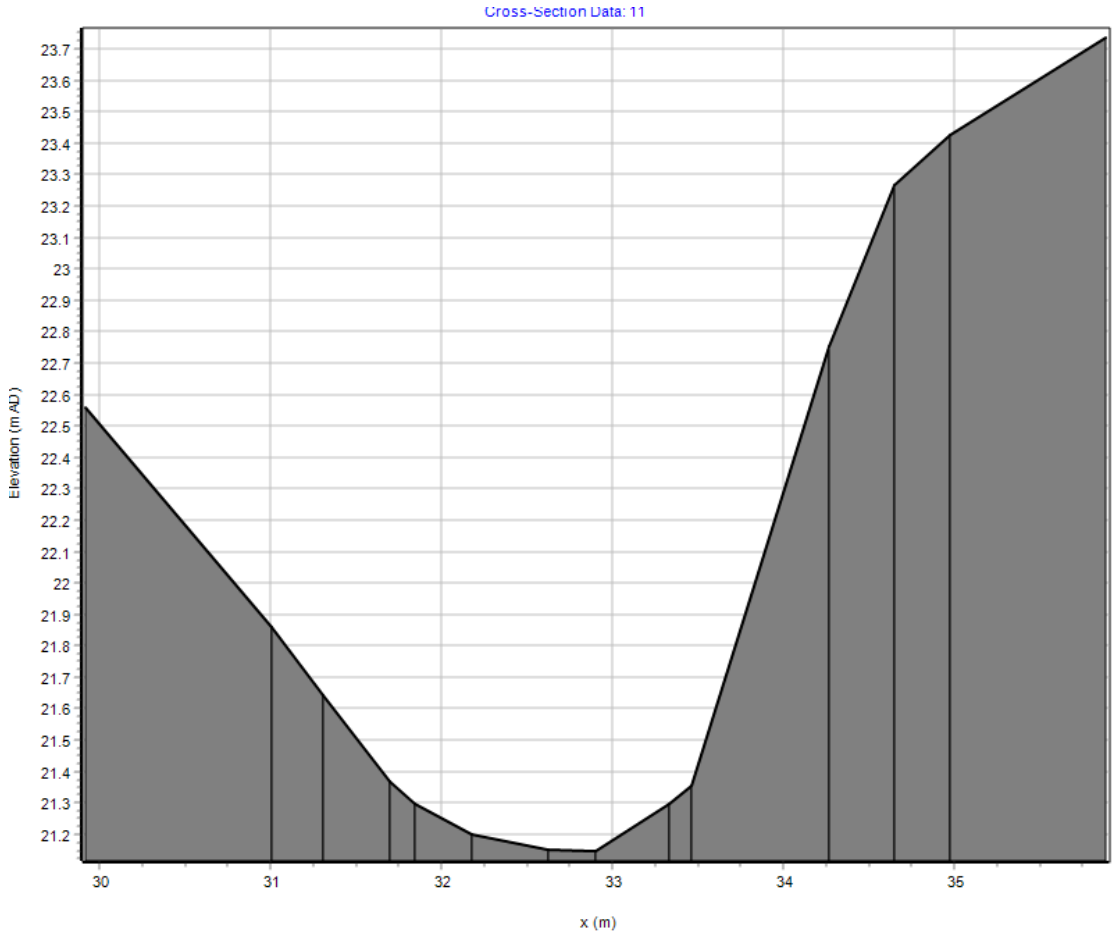


Figure 6.2 Typical 1D Channel Cross Section

A digital terrain model (DTM) of the Masterplan and additional Airside 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.

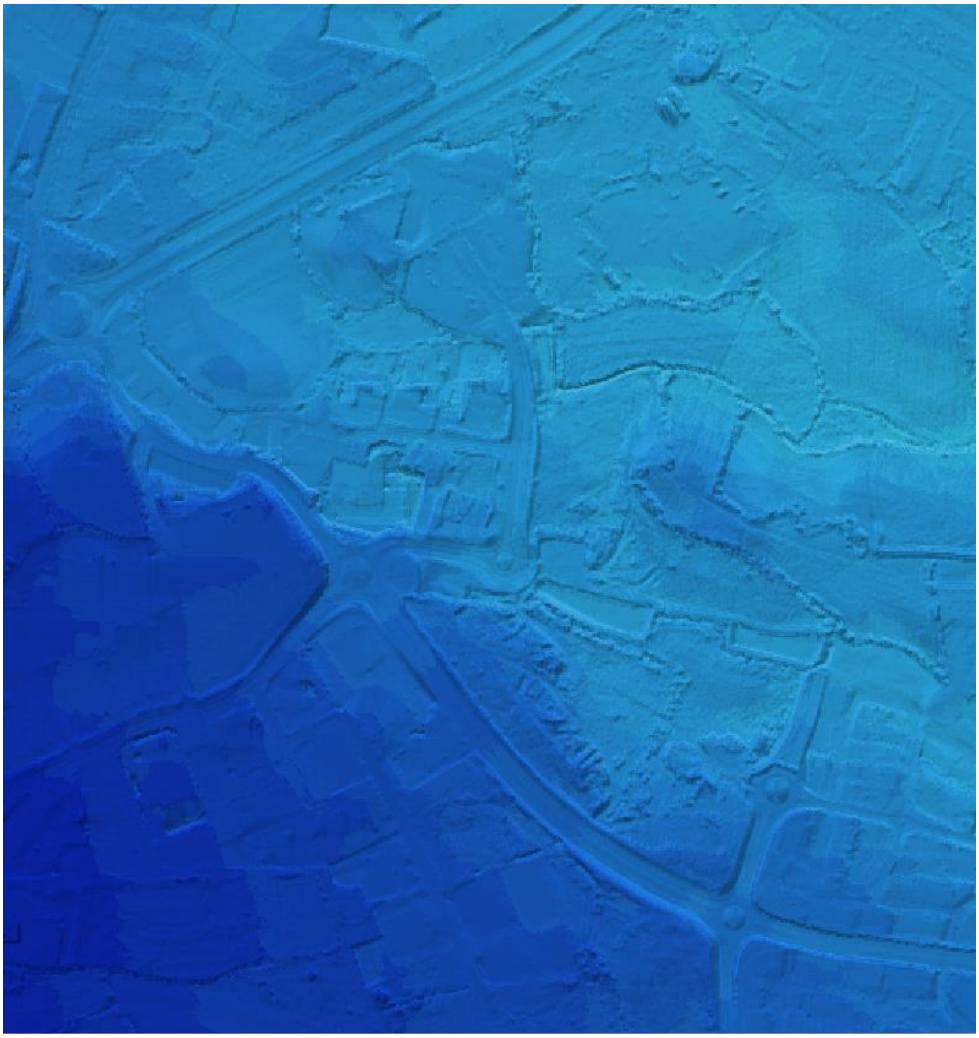


Figure 6.3 LiDAR Derived Digital Terrain Model

A site visit was conducted on the 21st November 2018. Significant features within the channels and in the floodplains were recorded. It was noted that the channels through the masterplan lands were significantly overgrown with vegetation in places. 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 are significant areas of flooding in areas directly adjacent the River Gaybrook. Out of bank flooding appears to occur as a result of insufficient capacity in multiple existing culverts. Flood extent and flood depth mapping generated as part of this Hydraulic assessment are shown in the

Barrysparks/Crowscastle Masterplan - Storm 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 HEF 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 Barrysparks/Crowscastle 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 Masterplan and additional Airside lands, which is described below.

6.5 Development Land Use Zoning Review

The zoning objectives within the Masterplan and additional Airside lands are identified in Figure 6.4 below. This review will look at the development land use zoning for the areas within the Masterplan and the additional Airside lands 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.

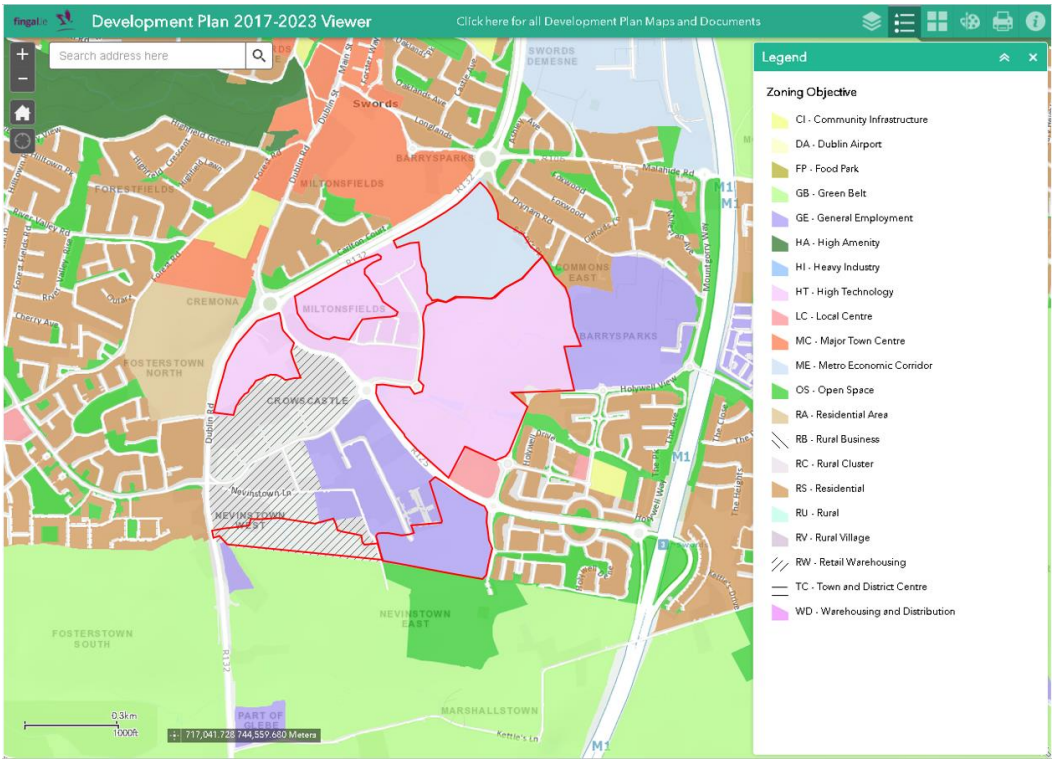


Figure 6.4 Masterplan and additional Airside lands Zoning Objectives (Fingal Co Co Development Plan 2017 – 2023)

Table 6.4 Potential Development Flood Risk

Development Area Zoning	Likely Uses	Comment on Flood Risk	Justification Test for Development Management Required?*
ME - Metro Economic Corridor (Barrysparks)	Facilitate opportunities for high density mixed use employment generating activity and commercial development, and support the provision of an appropriate quantum of residential development within the Metro Economic Corridor.	The majority of the ME zoned lands are not affected by current and future estimated fluvial flood risk. However, the southern and western boundary of the Barrysparks lands are formed by tributaries of the River Gaybrook. Localised flooding is contained within channel at these locations. It is recommended that the lands subject to the 0.1% AEP (HEFS) fluvial flood extent shown in Appendix G Drawing 18.164-BC-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 Barrysparks/Crowscastle 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 and this risk should be managed through appropriate surface water management strategies incorporating Sustainable Drainage Systems (SuDS).	Yes

Development Area Zoning	Likely Uses	Comment on Flood Risk	Justification Test for Development Management Required?*
HT - High Technology (Crowscastle, Airside Additional Lands 3 & 4)	Provide for office, research and development and high technology / high technology manufacturing type employment in a high quality built and landscaped environment.	The HT zoned areas are subject to significant flooding caused by insufficient capacity in existing culverts. Flooding occurs at the eastern boundary of the Crowscastle site where the River Gaybrook tributary enters a 1200mm diameter culvert. Flooding also occurs within the Airside Additional Lands 3&4 at the inlets to culverts under the R125 and Lakeshore Drive. Floodwaters flow from Airside Additional Lands 3 over the R125 and pond within Airside Additional Lands 4. Flooding within Airside Additional Lands 4 is also caused by insufficient capacity in the culverts under Lakeshore Drive. It is recommended that the lands subject to the 0.1% AEP (HEFS) fluvial flood extent shown in Appendix G Drawing 18.164-BC-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 Barrysparks/Crowscastle 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 and additional Airside lands are also susceptible to flooding from pluvial sources and this risk should be managed through appropriate surface water management strategies incorporating Sustainable Drainage Systems (SuDS).	Yes
GE – General Employment (Airside Additional Lands 1)	Provide opportunities for general enterprise and employment	Flooding occurs within the Airside Additional Lands 1 where the Gaybrook is culverted through Airside retail Park. Flooding occurs where stream is in open channel and within the culverted network. Floodwaters flow both north towards the Crowscastle lands and south where a series of overland flow paths convey floodwaters to the River Sluice catchment. It is recommended that the lands subject to the 0.1% AEP (HEFS) fluvial flood extent shown in Appendix G Drawing 18.164-BC-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 Barrysparks/Crowscastle 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 additional Airside lands are also susceptible to flooding from pluvial sources and this risk should be managed through appropriate surface water management strategies incorporating Sustainable Drainage Systems (SuDS).	Yes

Development Area Zoning	Likely Uses	Comment on Flood Risk	Justification Test for Development Management Required?*
RW – Retail Warehousing (Airside Additional Lands 2)	Provide for retail warehousing development	Flooding also occurs within the Airside additional lands 2 where the Gaybrook is culverted through Airside Retail Park. Flooding occurs where the stream is in open channel along the northern periphery of Airside Additional lands 2. Floodwaters flow south where a series of overland flow paths convey floodwaters to the River Sluice catchment. It is recommended that the lands subject to the 0.1% AEP (HEFS) fluvial flood extent shown in Appendix G Drawing 18.164-BC-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 Barrysparks / Crowscastle 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 additional Airside lands are also 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 Barrysparks/Crowscastle Masterplan and additional Airside 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 study area is from fluvial inundation from the River Gaybrook caused by insufficient capacity in the existing culvert network. There are several other minor areas of pluvial flooding within the Masterplan and additional Airside lands boundary.

The majority of the study 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 four land use zoning areas within the Barrysparks/Crowscastle Masterplan and the additional Airside lands.

8. RECOMMENDATIONS

1) It is recommended that the drainage channels, watercourses and floodplains within the developed and undeveloped areas of the Masterplan and additional Airside lands 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 Barrysparks/Crowscastle Masterplan and additional Airside lands.
4) Future developments within Barrysparks/Crowscastle Masterplan and additional Airside lands 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 and additional Airside lands is based on the High-End Future Scenario (HEFS) for climate change, shown in Drawing 18.164-BC-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 study area, the Barrysparks/Crowscastle 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 Barrysparks/Crowscastle Masterplan and additional Airside lands. 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 Barrysparks/Crowscastle Masterplan and additional Airside lands 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

STAFFORDSTOWN TURVEY

No Fluvial Data Available For Area

SWORDS

SWORDS (SOUTH)

1SCH_KILBRIDE

No Fluvial Data Available For Area

BELCAMP PARK

SANTRY DEMESNE

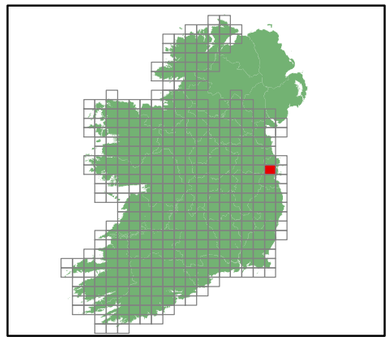
SANTRY

MULHUDDART

FINGLAS, GLASNEVIN

0.5 0.25 0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 Kilometers

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
OPW
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 : 14K
Mouse position
Irish Grid (IG): 317292, 244529
Irish Transverse Mercator (ITM): 717218, 744553
WebMercator: -694161, 7064435
Longitude Latitude : -6.236, 53.438
Map
Swords
Malahide Road
Swords Bypass
Dublin Road
Drinan Link Road
Clonshaugh Lissenhall Motorway
Airside Retail Park
Swords Pavilions Shopping Centre
Feltrim Business Park
Swords Enterprise Park
Holywell
Data CC-By-SA by OpenStreetMap
Legend
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

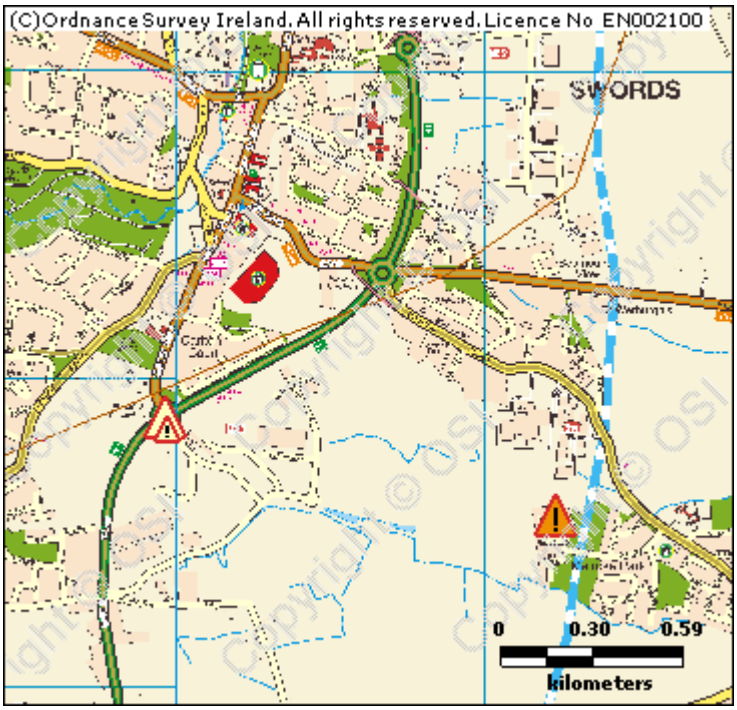
Summary Local Area Report

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

The map centre is in:

County: Dublin

NGR: O 186 460



Map Scale 1:24,513

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.

13 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. Ward Swords Co.Dublin August 2008
Start Date: 09/Aug/2008
County: Dublin
Flood Quality Code:3
Additional Information: Reports (1) More Mapped Information

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

5. 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

---

6. 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

7. Pinnock Hill October 2002

Start Date: 20/Oct/2002

County: Dublin

Flood Quality Code:3

Additional Information: Reports (3) More Mapped Information

8. Melrose Park Oct 2002

Start Date: 20/Oct/2002

County: Dublin

Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

9. Gartan Court Swords Feb 2002

Start Date: 01/Feb/2002

County: Dublin

Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

10. Pine Grove Park Swords Nov 1982

Start Date: 05/Nov/1982

County: Dublin

Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

11. Rathingle Swords Nov 1982

Start Date: 05/Nov/1982

County: Dublin

Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

12. Seatown Villas Swords Nov 1982

Start Date: 05/Nov/1982

County: Dublin

Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

13. Pinnock Hill Swords Recurring

Start Date:

County: Dublin

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	Water Level (mOD) 10% AEP	Flow (m3/s) 10% AEP	Water Level (mOD) 1% AEP	Flow (m3/s) 1% AEP	Water Level (mOD) 0.1% AEP	Flow (m3/s) 0.1% AEP
2Saaa1428	22.4	0.27	23.15	0.46	23.22	0.8
01STRE00970	15.51	0.28	15.66	0.41	15.79	0.48
3Ga5126	41.87	0.14	42.13	0.14	42.37	0.14
3Ga3779	23.83	0.05	24.08	0.11	25.57	0.21
3Ga2074	14.89	2.72	15.03	4.4	15.11	6.12
3Ga1525	10.71	3.48	10.9	6.03	11.02	8.63
3Gab213	28	0.2	28	0.2	28.07	0.2
4Wab561	0	0	0	0	0	0

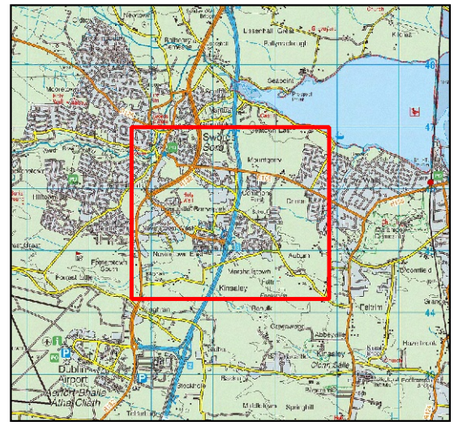
318000 318500 319000 319500 320000 320500

246500 246000 245500 245000 244500

SWORDS GLEBE
Gleib Shoird
TOWN
Páirc
SWORDS DEMESNE
Dímeín Shoird
MOUN
Cnocá
MOUNTGORRY
Cnocán Ghofraidh
MILTONSFIEL
Páirceanna Bl
YELLOW WALL
Na Ballaí Bui
4Wab561
COMMONS E
An Coimín Th
CREMONA
Cremona
CROWSCASTLE
Caisleán na bPréachán
3Gab213
3Ga3779
DRINAN
Draighnean
3Ga2074
NEVINST
Baile Nao
3Ga5126
NEVINSTOWN EAST
Baile Naoimhín Thoir
TH
n Theas
DRINAN
Draighnean
AUBURN
Auburn
3Ga1525
MARSHALLSTOWN
Baile an Mharascalaigh
2Saaa1428
01STRE00970
FELTRIM
Faoldroim

250 0 250 500 750 1000 Meters

Location Plan:



LEGEND

- AFA Boundary
- Defended Area
- Modelled River Centreline
- Node Point
- 10% AEP Fluvial Extent (High Risk)
- 1% AEP Fluvial Extent (Medium Risk)
- 0.1% AEP Fluvial Extent (Low Risk)
- Flood Defence - Embankment
- Flood Defence - Wall
- Gate
- NODE123 — Node Label
- x.x% AEP — Standard of Protection of Flood Defence

IMPORTANT USER NOTE:
THE VIEWER OF THIS MAP SHOULD REFER TO THE DISCLAIMER, GUIDANCE NOTES AND CONDITIONS OF USE THAT ACCOMPANY THIS MAP.

OPW
Oifig na nOibreacha Poiblí
The Office of Public Works

The Office of Public Works
Jonathan Swift Street
Trim
Co. Meath

Project:
FINGAL EAST MEATH FRAM STUDY

Map: **SWORDS FLUVIAL EXTENT MAP**

Map Type:	EXTENT		
Source:	FLUVIAL		
Map Area:	HPW		
Scenario:	CURRENT		
Drawn by:	IH	Date:	Mar - 2019
Checked by:	TC	Date:	Mar - 2019
Approved by:	GP	Date:	Mar - 2019

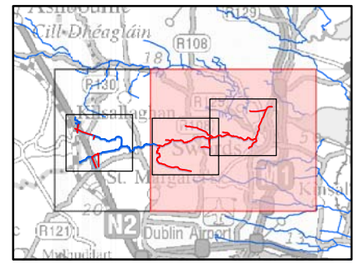
Map No.: E08SWO_EXFCD_F1_34
Revision: F1
Map Scale: 1:10000 Plot Scale: 1:1 @ A3

Fluvial flooding may also occur within the area shown on this map. Please refer to the fluvial flood extent map. Figure No. WAR/MPW/EXT/CURS/002

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 :

USERS OF THESE MAPS SHOULD REFER TO THE DETAILED DESCRIPTION OF THEIR DERIVATION, LIMITATIONS IN ACCURACY AND GUIDANCE AND CONDITIONS OF USE PROVIDED AT THE FRONT OF THIS BOUND VOLUME. IF THIS MAP DOES NOT FORM PART OF A BOUND VOLUME, IT SHOULD NOT BE USED FOR ANY PURPOSE.

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

Clients :

Project :
FEM FRAMS

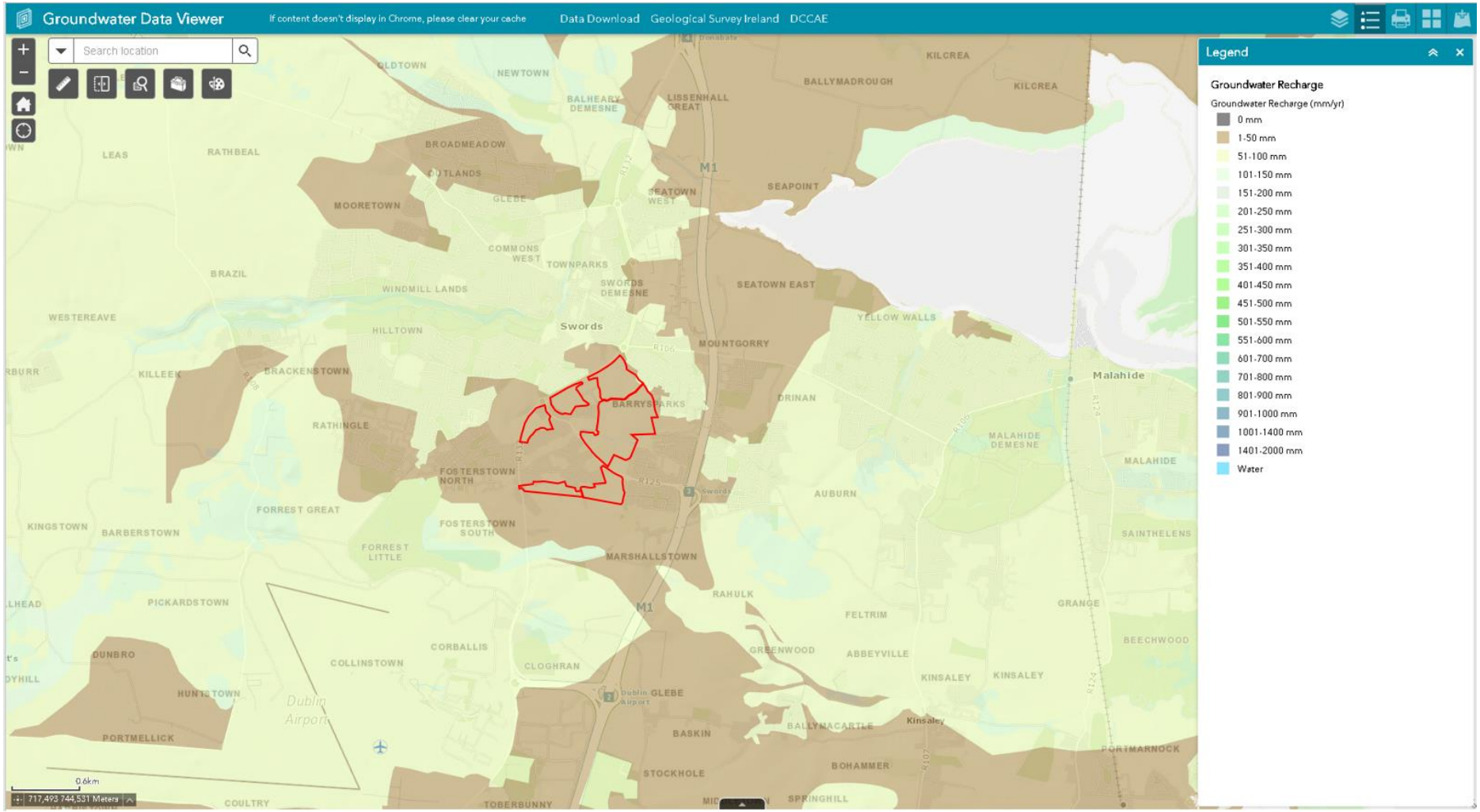
Map :
WARD MODEL FLOOD EXTENT MAP

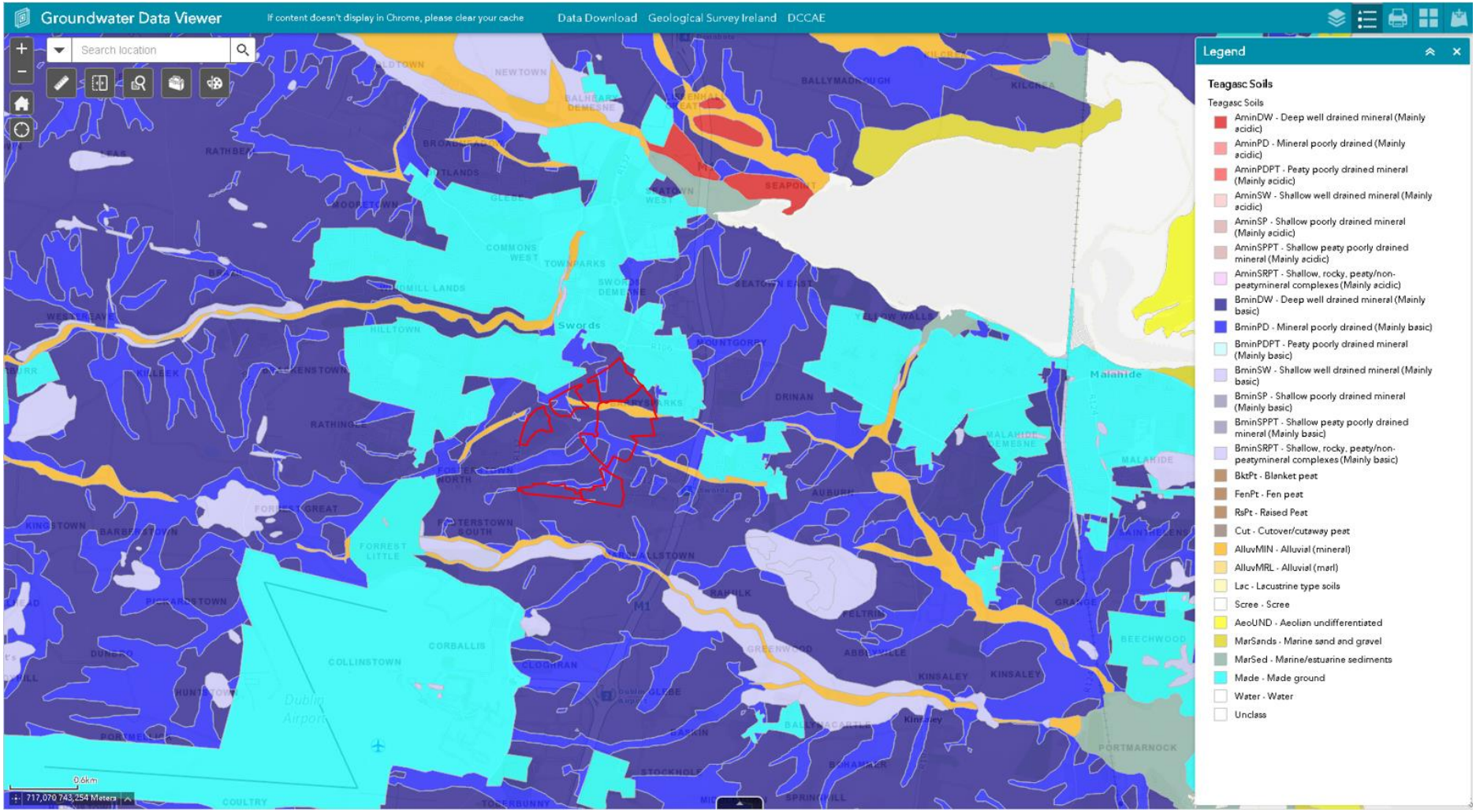
Map Type :	FLOOD EXTENT	
Source :	TIDAL FLOODING	
Map area :	MEDIUM PRIORITY WATERCOURSE	
Scenario :	CURRENT	
Figure By :	Mara Ruiz	Date : 25 April 2012
Checked By :	Sergio Herbón	Date : 25 April 2012
Approved By :	Clare Dewar	Date : 25 April 2012

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

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

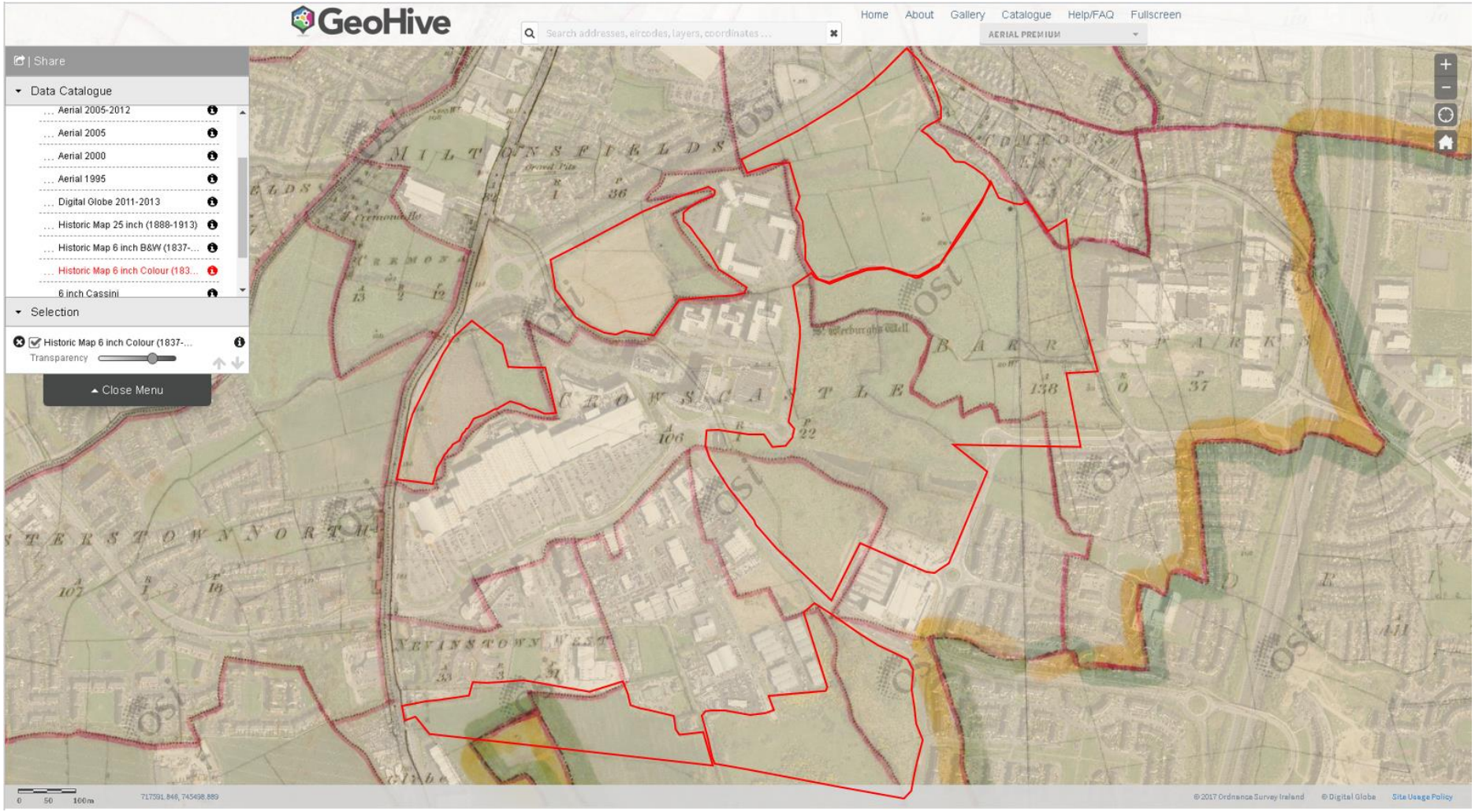
APPENDIX E
GEOLOGICAL SURVEY OF IRELAND (GSI) MAPS


Groundwater Data Viewer
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
Swords
Malahide
BARRYSPARKS
M1
0.6km
717,493 744,531 Meters


Groundwater Data Viewer
If content doesn't display in Chrome, please clear your cache
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
Malahide
Dublin Airport
0.6km
717,070 743,254 Meters

APPENDIX F
OSI HISTORICAL MAPS


GeoHive
Home
About
Gallery
Catalogue
Help/FAQ
Fullscreen
Search addresses, eircodes, layers, coordinates ...
AERIAL PREMIUM
Share
Data Catalogue
Aerial 2005-2012
Aerial 2005
Aerial 2000
Aerial 1995
Digital Globe 2011-2013
Historic Map 25 inch (1888-1913)
Historic Map 6 inch B&W (1837-...
Historic Map 6 inch Colour (183...
6 inch Cassini
Selection
Historic Map 25 inch (1888-1913)
Transparency
Close Menu
MILTONSFIELDS
CREMONA
BARRYSPARKS
CROWSCASTLE
STERSTOWN NORTH
NEVINSTOWN WEST
0 50 100m
717889.659, 745161.545
© 2017 Ordnance Survey Ireland
© Digital Globe
Site Usage Policy


GeoHive
Home
About
Gallery
Catalogue
Help/FAQ
Fullscreen
Search addresses, eircodes, layers, coordinates ...
AERIAL PREMIUM
Share
Data Catalogue
Aerial 2005-2012
Aerial 2005
Aerial 2000
Aerial 1995
Digital Globe 2011-2013
Historic Map 25 inch (1888-1913)
Historic Map 6 inch B&W (1837-...
Historic Map 6 inch Colour (183...
6 inch Cassini
Selection
Historic Map 6 inch Colour (1837-...
Transparency
Close Menu
MILTONSFIELDS
CROWSCASTLE
BARRYSPARKS
NEVINSTOWN WEST
0 50 100m
717591.848, 745498.889
© 2017 Ordnance Survey Ireland
© Digital Globe
Site Usage Policy

APPENDIX G
STRATEGIC FOOD RISK ASSESSMENT FLOOD EXTENT MAPPING

N

0 50 100 200 300 400 Meters

Final

Legend

- Barrysparks Crowscastle Masterplan Lands
- Barrysparks Crowscastle - 1 in 100 Year Fluvial Event - Current Scenario
- Barrysparks Crowscastle - 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	22/02/2019	BP	WV	JPR
D01	Draft Flood Extents	14/02/2019	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

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

Project Title: Barrysparks Crowscastle Surface Water Management Plan

Drawing Title: Fluvial Flood Extents (Current Scenario)

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

Scale: 1:6,000 (@ A3) | Date: 22/02/2019

09 May 2019 18:06:50 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Extents\Final\Fluvial\18.164-BC-101 Fluvial Flood Extents CS F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

Meters
0 50 100 200 300 400

Final

Legend

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

Note:
Pluvial flooding in excess of 50mm depth.

No.	Revision	Date	By	Chk'd	App'd
	Stage		Date		App'd
F01	Final Flood Extents	10/05/2019	BP	WV	JPR
D02	Draft Flood Extents	28/02/2019	BP	WV	JPR
D01	Draft Flood Extents	13/02/2019	BP	WV	JPR
	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: Barrysparks Crowscastle Surface Water Management Plan

Drawing Title: Pluvial Flood Extents (Current Scenario)

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-103	F01

Scale: 1:6,000 (@ A3) Date: 28/02/2019

10 May 2019 09:00:09 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Extents\Final\Pluvial\18.164-BC-103 Pluvial Flood Extents CS F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

Meters
0 50 100 200 300 400

Final

Legend

- Barrysparks Crowscastle Masterplan Lands
- Barrysparks Crowscastle - 1 in 100 Year Fluvial Event - Mid Range Future Scenario
- Barrysparks Crowscastle - 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	22/02/2019	BP	WV	JPR
D01	Draft Flood Extents	14/02/2019	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: Barrysparks Crowscastle Surface Water Management Plan

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

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-104	F01

Scale: 1:6,000 (@ A3) Date: 22/02/2019

09 May 2019 18:08:37 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Extents\Final\Fluvial\18.164-BC-104 Fluvial Flood Extents MRFS F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

Meters
0 50 100 200 300 400

Final

Legend

- Barrysparks Crowscastle Masterplan Lands
- Barrysparks Crowscastle - 1 in 100 Year Pluvial Event - Mid Range Future Scenario
- Barrysparks Crowscastle - 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
	Stage		Date		App'd
F01	Final Flood Extents	10/05/2019	BP	WV	JPR
D02	Draft Flood Extents	28/02/2019	BP	WV	JPR
D01	Draft Flood Extents	13/02/2019	BP	WV	JPR
	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: Barrysparks Crowscastle Surface Water Management Plan

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

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-106	F01

Scale: 1:6,000 (@ A3) Date: 28/02/2019

10 May 2019 09:01:56 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Extents\Final\Pluvial\18.164-BC-106 Pluvial Flood Extents MRFS F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

0 50 100 200 300 400 Meters

Final

Legend

- Barrysparks Crowscastle Masterplan Lands
- Barrysparks Crowscastle - 1 in 100 Year Fluvial Event - High End Future Scenario
- Barrysparks Crowscastle - 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
D03	Draft Flood Extents	22/02/2019	BP	WV	JPR
D02	Draft Flood Extents	14/02/2019	BP	WV	JPR
D01	Draft Flood Extents	25/01/2019	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: Barrysparks Crowscastle Surface Water Management Plan

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

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-107	F01

Scale: 1:6,000 (@ A3) Date: 22/02/2019

09 May 2019 18:10:07 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Extents\Final\Fluvial\18.164-BC-107 Fluvial Flood Extents HEFS F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

0 50 100 200 300 400 Meters

Final

Legend

- Barrysparks Crowscastle Masterplan Lands
- Barrysparks Crowscastle - 1 in 100 Year Pluvial Event - High End Future Scenario
- Barrysparks Crowscastle - 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
	Stage		Date		App'd
F01	Final Flood Extents	10/05/2019	BP	WV	JPR
D02	Draft Flood Extents	28/02/2019	BP	WV	JPR
D01	Draft Flood Extents	13/02/2019	BP	WV	JPR
	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: Barrysparks Crowscastle Surface Water Management Plan

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

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-109	F01

Scale: 1:6,000 (@ A3) Date: 28/02/2019

10 May 2019 10:01:30 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Extents\Final\Pluvial\18.164-BC-109 Pluvial Flood Extents HEFS F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

APPENDIX H
STRATEGIC FOOD RISK ASSESSMENT FLOOD DEPTH MAPPING

N

Meters
0 50 100 200 300 400

Final

Legend

Depth (m)

- 0.05 - 0.2m
- 0.2 - 0.5m
- 0.5 - 1m
- 1 - 1.5m
- 1.5 - 3m

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	22/02/2019	BP	WV	JPR
D01	Draft Flood Depths	14/02/2019	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: Barrysparks Crowscastle Surface Water Management Plan

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

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-201	F01

Scale: 1:6,000 (@ A3) Date: 22/02/2019

09 May 2019 16:52:38 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Depths\Final\Fluvial\18.164-BC-201 Fluvial Flood Depth CS Q100 F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

Meters
0 50 100 200 300 400

Final

Legend

Depth (m)

- 0.05 - 0.2m
- 0.2 - 0.5m
- 0.5 - 1m
- 1 - 1.5m
- 1.5 - 3m

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	22/02/2019	BP	WV	JPR
D01	Draft Flood Depths	14/02/2019	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: Barrysparks Crowscastle Surface Water Management Plan

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

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-202	F01

Scale: 1:6,000 (@ A3) Date: 22/02/2019

09 May 2019 16:52:12 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Depths\Final\Fluvial\18.164-BC-202 Fluvial Flood Depth CS Q1000 F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

Meters
0 50 100 200 300 400

Final

Legend

Depth (m)

- 0.05 - 0.2m
- 0.2 - 0.5m
- 0.5 - 1m
- 1 - 1.5m
- 1.5 - 3m

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	28/02/2019	BP	WV	JPR
D01	Draft Flood Extents	13/02/2019	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

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

Project Title: Barrysparks Crowscastle Surface Water Management Plan

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

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

Scale: 1:6,000 (@ A3) | Date: 28/02/2019

09 May 2019 17:11:40 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Depths\Final\Pluvial\18.164-BC-205 Pluvial Flood Depth CS Q100 F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

0 50 100 200 300 400 Meters

Final

Legend

Depth (m)

- 0.05 - 0.2m
- 0.2 - 0.5m
- 0.5 - 1m
- 1 - 1.5m
- 1.5 - 3m

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	28/02/2019	BP	WV	JPR
D01	Draft Flood Extents	13/02/2019	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: Barrysparks Crowscastle Surface Water Management Plan

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

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-206	F01

Scale: 1:6,000 (@ A3) Date: 28/02/2019

09 May 2019 17:13:18 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Depths\Final\Pluvial\18.164-BC-206 Pluvial Flood Depth CS Q1000 F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

Meters
0 50 100 200 300 400

Final

Legend

Depth (m)

- 0.05 - 0.2m
- 0.2 - 0.5m
- 0.5 - 1m
- 1 - 1.5m
- 1.5 - 3m

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	22/02/2019	BP	WV	JPR
D01	Draft Flood Depths	14/02/2019	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: Barrysparks Crowscastle Surface Water Management Plan

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

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-207	F01

Scale: 1:6,000 (@ A3) Date: 22/02/2019

09 May 2019 16:51:57 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Depths\Final\Fluvial\18.164-BC-207 Fluvial Flood Depth MRFS Q100 F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

Meters
0 50 100 200 300 400

Final

Legend

Depth (m)

- 0.05 - 0.2m
- 0.2 - 0.5m
- 0.5 - 1m
- 1 - 1.5m
- 1.5 - 3m

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	22/02/2019	BP	WV	JPR
D01	Draft Flood Depths	14/02/2019	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: Barrysparks Crowscastle Surface Water Management Plan

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

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	Final	BP	18.164	18.164-BC-208	F01

Scale: 1:6,000 (@ A3) Date: 22/02/2019

09 May 2019 16:54:11 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Depths\Final\Fluvial\18.164-BC-208 Fluvial Flood Depth MRFS Q1000 F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

Meters
0 50 100 200 300 400

Final

Legend

Depth (m)

- 0.05 - 0.2m
- 0.2 - 0.5m
- 0.5 - 1m
- 1 - 1.5m
- 1.5 - 3m

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	28/02/2019	BP	WV	JPR
D01	Draft Flood Extents	13/02/2019	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: Barrysparks Crowscastle Surface Water Management Plan

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

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-211	F01

Scale: 1:6,000 (@ A3) Date: 28/02/2019

09 May 2019 17:14:21 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Depths\Final\Pluvial\18.164-BC-211 Pluvial Flood Depth MRFS Q100 F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

Meters
0 50 100 200 300 400

Final

Legend

Depth (m)

- 0.05 - 0.2m
- 0.2 - 0.5m
- 0.5 - 1m
- 1 - 1.5m
- 1.5 - 3m

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	28/02/2019	BP	WV	JPR
D01	Draft Flood Extents	13/02/2019	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: Barrysparks Crowscastle Surface Water Management Plan

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

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-212	F01

Scale: 1:6,000 (@ A3) Date: 28/02/2019

09 May 2019 17:15:22 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Depths\Final\Pluvial\18.164-BC-212 Pluvial Flood Depth MRFS Q1000 F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

Meters
0 50 100 200 300 400

Final

Legend

Depth (m)

- 0.05 - 0.2m
- 0.2 - 0.5m
- 0.5 - 1m
- 1 - 1.5m
- 1.5 - 3m

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	22/02/2019	BP	WV	JPR
D01	Draft Flood Depths	14/02/2019	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: Barrysparks Crowscastle Surface Water Management Plan

Drawing Title: Fluvial 1 in 100 Year Flood Depths (High End Future Scenario)

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-213	F01

Scale: 1:6,000 (@ A3) Date: 22/02/2019

09 May 2019 16:55:33 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Depths\Final\Fluvial\18.164-BC-213 Fluvial Flood Depth HEFS Q100 F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

Meters
0 50 100 200 300 400

Final

Legend

Depth (m)

- 0.05 - 0.2m
- 0.2 - 0.5m
- 0.5 - 1m
- 1 - 1.5m
- 1.5 - 3m

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	22/02/2019	BP	WV	JPR
D01	Draft Flood Depths	14/02/2019	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: Barrysparks Crowscastle Surface Water Management Plan

Drawing Title: Fluvial 1 in 1000 Year Flood Depths (High End Future Scenario)

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-214	F01

Scale: 1:6,000 (@ A3) Date: 22/02/2019

09 May 2019 16:56:36 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Depths\Final\Fluvial\18.164-BC-214 Fluvial Flood Depth HEFS Q1000 F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

Meters
0 50 100 200 300 400

Final

Legend

Depth (m)

- 0.05 - 0.2m
- 0.2 - 0.5m
- 0.5 - 1m
- 1 - 1.5m
- 1.5 - 3m

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	28/02/2019	BP	WV	JPR
D01	Draft Flood Extents	13/02/2019	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: Barrysparks Crowscastle Surface Water Management Plan

Drawing Title: Pluvial 1 in 100 Year Flood Depths (High End Future Scenario)

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-217	F01

Scale: 1:6,000 (@ A3) Date: 28/02/2019

09 May 2019 17:18:07 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Depths\Final\Pluvial\18.164-BC-217 Pluvial Flood Depth HEFS Q100 F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

Meters
0 50 100 200 300 400

Final

Legend

Depth (m)

- 0.05 - 0.2m
- 0.2 - 0.5m
- 0.5 - 1m
- 1 - 1.5m
- 1.5 - 3m
- 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	28/02/2019	BP	WV	JPR
D01	Draft Flood Extents	13/02/2019	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: Barrysparks Crowscastle Surface Water Management Plan

Drawing Title: Pluvial 1 in 1000 Year Flood Depths (High End Future Scenario)

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-BC-218	F01

Scale: 1:6,000 (@ A3) Date: 28/02/2019

09 May 2019 17:19:13 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Flood Depths\Final\Pluvial\18.164-BC-218 Pluvial Flood Depth HEFS Q1000 F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

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

Barrysparks / Crowscastle Masterplan

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

May 2019 (FINAL)

ROD
ROUGHAN & O'DONOVAN

Comhairle Contae
Fhine Gall
Fingal County
Council

Barrysparks/Crowscastle 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 Barrysparks/Crowscastle Masterplan. As part of this commission, a Sustainable Drainage Systems (SuDS) Strategy for the masterplan lands and the Airside additional lands 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 and additional Airside 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 Barrysparks/Crowscastle 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 study area due to the incorporation of the SuDS Strategy.
- Make recommendations on the discharge rate to be applied across the Masterplan and additional Airside 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 subjected lands are located within the vicinity of Airside Retail Park, Swords, North County Dublin. The Masterplan and Airside additional lands are located approximately 1km west of the M1 motorway, 4.0km north of the M50 motorway and 2.4km north east of Dublin Airport. The subject lands are located within an urban environment consisting of predominantly commercial, retail, industrial and residential development. Refer to Figure 1 below.

Figure 1.1 Masterplan and additional Airside Study Areas

The topography data for the Barrysparks lands indicates that there is a high point of approximately 27mOD towards the centre of the site and generally falls from this point in all directions to approximately 24mOD.

The topography data for the Crowscastle lands indicate that the lands generally falls towards the existing watercourses that flows through the lands. The lands to the south of the River Gaybrook generally fall from approximately 37mOD to 25mOD, while the lands to the north generally fall from the centre of the site to the watercourse from a level of approximately 31mOD to 25mOD. The remaining land from the centre and northern extents of the site generally fall towards a second watercourse (un-named) that flows through the site. The lands to the south of this watercourse generally fall from the centre of the site to this watercourse from approximately 31mOD to 22mOD and the lands to the north of the watercourse fall from approximately 25mOD to 22mOD.

The topography data for the Airside Additional Lands 1 indicates that the lands generally fall from south west to north east from approximately 41mOD to 36mOD.

The topography data for Airside Additional Lands 2 indicates that the lands generally fall from west to east from approximately 48mOD to 41mOD.

The topography data for Airside Additional Lands 3 indicates that the lands generally fall from south to north from approximately 45mOD to 32mOD.

The topography data for Airside Additional Lands 4 indicates that the lands generally fall from south west to east from approximately 30mOD to 25mOD.

1.3.2 Catchment Description

The Masterplan and Airside additional lands are located within the catchment of the River Gaybrook and the Ward River. The Ward River is a tributary of the Broadmeadow River. Both watercourses ultimately discharge to the Malahide Estuary, approximately 4.6km north east of the study areas as outlined in Figure 1.2. There are a number of existing drainage ditches located within the Barrysparks/Crowscastle Masterplan lands.

The Ward River rises approximately 16.5km west of the study area at a location approximately 4.5km south of Ratoath. The river generally flows in an easterly direction towards Malahide Estuary.

The River Gaybrook rises within the vicinity of the study area on Airside Additional Lands 2. The river generally flows in a west to east direction towards Malahide Estuary.

A tributary of the River Gaybrook rises west of Fosterstown. The river generally also flows west to east through Airside Additional Lands 3, 4, and Barrysparks / Crowscastle before discharging to the River Gaybrook downstream of the M1 motorway.

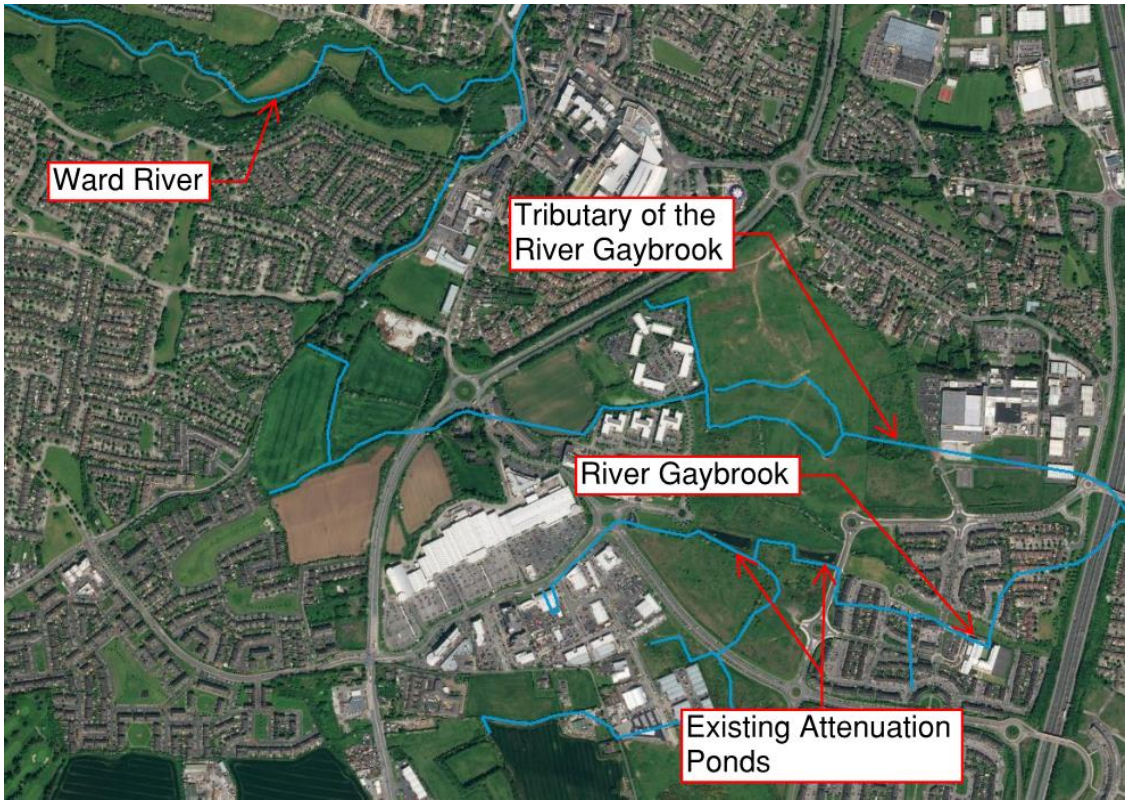


Figure 1.2: Watercourses around Barrysparks/Crowscastle (EPA Envision)

Irish Water records indicate that there is existing extensive surface water drainage infrastructure within the vicinity of the subject lands. Upon carrying out a site visit, it was found that there are a number of drainage ditches that are present within the Crowscastle/ Barrysparks lands, some of which appeared to be dry.

1.3.3 Environment

There are no Natura 2000 sites located within the study area; however, the Natura 2000 site Malahide Estuary (SPA and SAC) is located 2.5km north-east of the study area, Rogerstown Estuary (SPA and SAC) is located 6.4km north east of the study area and Baldoyle Bay (SPA and SAC) is located 7km south-east of the study area.

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) ~ 2.5km north-east of the study area,
- Rogertown Estuary (proposed NHA) ~ 6.4km north-east of the study area,
- Baldoyle Bay (proposed NHA) ~7km south-east of the study area,
- Sluice River Marsh (proposed NHA) ~ 5.14km south-east of the study area,
- Feltrim Hill (proposed NHA), ~1.73km south-east of the study area,
- Santry Demesne (proposed NHA), ~5.2km south-west of the study area.

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

1.4 Proposed Development

The Masterplan lands in combination with Airside additional lands comprises of four main zoning objectives in the Fingal Development Plan 2017 – 2023 as outlined in Figure 1.3 and Table 1.1 below.

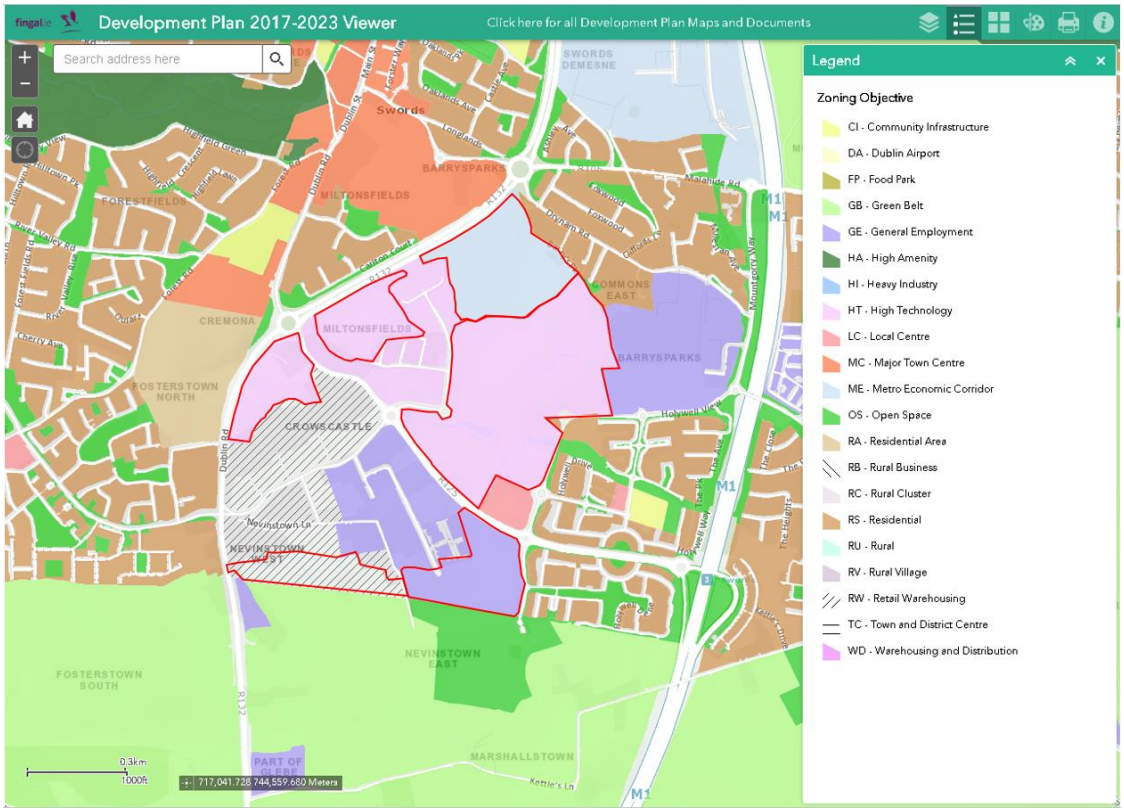


Figure 1.3 **Masterplan and additional Airside lands Zoning Objectives (Fingal Co Co Development Plan 2017 – 2023)**

Table 1.1 **Masterplan and additional Airside lands Current Zoning Objectives**

Objective	Description	Area
ME - Metro Economic Corridor	Facilitate opportunities for high density mixed use employment generating activity and commercial development, and support the provision of an appropriate quantum of residential development within the Metro Economic Corridor.	Barrysparks
HT - High Technology	Provide for office, research and development and high technology/high technology manufacturing type employment in a high quality built and landscaped environment.	Crowscastle, Airside Additional Lands 3, Airside Additional Lands 4
GE – General Employment	Provide opportunities for general enterprise and employment	Airside Additional Lands 1
RW – Retail Warehousing	Provide for retail warehousing development	Airside Additional Lands 2

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 both wet and dry conditions 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. The 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, 1km north of the study area. The EPA Envision website indicates that the last recorded Q-Value at this location was in 1991, where a value of 3 was recorded. There is another monitoring point located approximately 950m downstream of this monitoring point with more recent monitoring information. The last recorded Q-Value at this point was in 2014, where a value of 3 was recorded. There are no Q-Value monitoring points located along the River Gaybrook. 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 as being currently "poor" status and "at risk" of failing to meet the directives environmental objectives. The River Gaybrook currently has no status or risk rating assigned to it.

Groundwater status within the study area 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 and additional Airside lands should ensure that the quality and quantity of discharge from future development to surrounding watercourses will not negatively impact the existing condition of the watercourses, moreover, the adoption of SuDS systems in all new developments, the retrofitting of SuDS 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

This section outlines the various SuDS techniques, existing and proposed in either live planning applications or development proposals, within close proximity to study areas. Information has been gathered from a review of planning applications in Swords, Fingal Development Plan 2017-2023, and a site visit undertaken on the 31st August 2018.

Development within the vicinity of the study areas is predominantly commercial, retail, industrial and residential development. Implementation of SuDS techniques by Local Authorities typically began following the publication of the Greater Dublin Strategic Drainage Strategy (GDSDS) in 2005.

4.1 Current Scenario

Table 4.1 Impact of Existing SuDS Techniques on Existing Drainage Network

Development	SuDS Techniques	Comment	Impact on Existing Network
Tesco Holywell Centre, Swords, Co. Dublin	Underground attenuation tank	Underground attenuation system located on site.	Prevents increase in peak flow rate in drainage network as a result of development
	Permeable Paving	Permeable paving on driveways allows partial infiltration of surface water to subsoil	Reduces potential runoff to existing network. Removal of potential urban pollutants
	Rainwater Harvesting Tank	Stores rainwater for re-use within the development	Reduces water demand on surrounding public infrastructure

There are two pond structures located within the Crowscastle masterplan land extents. These ponds appear to be taking flows from developments within the Airside retail / business park areas.

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

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

Barrysparks:

- Provide for high-density high-quality mixed-use development, which ensures connectivity between Major Town Centre lands east and west of the R132 and facilitates a multi-modal interchange at Swords Metro Stop providing for pedestrian and cycle links.
- Establish strong links between Barrysparks and Holywell.

- A new road shall be constructed through the western section of the subject lands which shall in time connect the R132 to the proposed Airside – Drinan Link Road to the south.
- A new road shall be constructed through the eastern section of the subject lands which shall in time connect the R132 via the Drynam Road to the proposed Airside – Drinan Link Road to the south.

Crowscastle:

- Develop a detailed road design for Airside – Feltrim Link Road within the corridor and ensure delivery of this road in tandem with/prior to development of adjoining RS, RA and HT lands.
- A new road shall be constructed through the western section of the subject lands which shall in time connect the R132 to the proposed Airside – Drinan Link Road to the south.
- A new road shall be constructed through the eastern section of the subject lands which shall in time connect the R132 via the Drynam Road to the proposed Airside – Drinan Link Road to the south.
- Provide for pedestrian and cycle routes within the Masterplan lands
- Establish strong links between Barrysparks and Holywell.
- Provide for a linear park incorporating a Strategic SuDS and Flood Risk Management corridor across the northern part of these lands.
- Provide for a linear park incorporating a Strategic SuDS and Flood Risk Management corridor across these lands, immediately to the south of the Airside – Drinan Link Road and linking into the existing public open space at Holywell.

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. There are no site specific plans outlined for the Airside Additional Lands, however any future development of these lands can incorporate the developed SuDS protocol.

4.3 Sustainable Water Management

It is a specific objective of the current Fingal County Development Plan to require all Local Area Plans 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 open watercourses, free from development will be provided along the length of the existing watercourses that flow through the Masterplan and additional Airside 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 Barrysparks/Crowscastle 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 and additional Airside lands are outlined in Figure 4.1.

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 and additional Airside lands. 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 and additional Airside lands will ultimately drain to the surround public surface water network and the River Gaybrook. If the new surface water drainage network for the lands is to connect to the existing surface water network in places, the capacity of the existing network will need to be established at these locations and discharge from the development 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 Barrysparks lands are zoned Objective ME – "*Facilitate opportunities for high density mixed use employment generating activity and commercial development, and support the provision of an appropriate quantum of residential development within the Metro Economic Corridor".* The Crowscastle, Airside Additional Lands 3 and Airside Additional Lands 4 lands are zoned Objective HT – "*Provide for office, research and development and high technology/high technology manufacturing type employment in a high quality built and landscaped environment* ". The Airside Additional Lands 1 lands are zoned Objective GE – *"Provide opportunities for general enterprise and employment"*. The Airside Additional Lands 2 are zoned Objective RW – "Provide for retail warehousing development". The extent of land zoned under each of the different zoning types is outlined in Table 5.1 below.

Table 5.1 Masterplan and additional Airside lands Zoning Objectives

Zoning Ref	Description	Approximate size (ha)
ME	*Facilitate opportunities for high density mixed use employment generating activity and commercial development, and support the provision of an appropriate quantum of residential development within the Metro Economic Corridor*	9.85
HT	*Provide for office, research and development and high technology/high technology manufacturing type employment in a high quality built and landscaped environment*	33.35
GE	*Provide opportunities for general enterprise and employment*	6.50
RW	*Provide for retail warehousing development*	4.64

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 study area generally consist of Limestone Till (Carboniferous) with some alluvium in the floodplains of the existing watercourses that flow through the Crowscastle lands.

No site specific ground investigations are available for the lands. Ground investigations were previously undertaken adjacent to the western boundary of the Crowscastle lands as part of the Airside Business Park Extension Scheme. The boreholes undertaken generally consisted of topsoil underlain by clay with made ground in some locations. Bedrock was not identified.

Ground investigations were previously undertaken adjacent to the northern boundary of the Barrysparks lands as part of the Swords By-pass Bridges Scheme. The boreholes undertaken generally consisted of topsoil, fill made ground and clay. Bedrock was not identified.

As part of the Swords Development, N1 Scheme, ground investigations were undertaken on lands immediately west of Airside Additional Lands 3. Boreholes and trial pits undertaken 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 and additional Airside lands. GSI Ground water vulnerability mapping indicates that ground water vulnerability within the study area is low. *Refer to Appendix B.*

5.2.2 Area Draining to SuDS Component

The Masterplan and additional Airside lands comprise approximately 54.34ha 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 study areas is diverse but generally slopes towards the existing watercourses within the vicinity of the lands. The majority of the lands have a gentle slope 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 land within the study areas, 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 Masterplan and additional Airside lands are underlain by Locally Important Aquifer (LI) – Bedrock which is Moderately Productive only in Local Zones. This suggests a reasonable depth to groundwater. There are no GSI or EPA Source Protection Zones in the vicinity of the lands. The GSI groundwater viewer indicates an existing holy well within the Crowscastle lands, to the west of the site. Multiple groundwater springs/supplies were identified to the north of the masterplan study area, close to Swords town centre. A groundwater well used for agricultural and domestic purposes is also located within the vicinity of the lands. *Refer to Appendix B*.

5.3.2 Surface Waters used for Public Supply

The watercourses within the vicinity of the Masterplan and additional Airside 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 masterplans surface water drainage system to protect and enhance the receiving coastal / 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 Masterplan lands), 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 the Masterplan and the additional Airside lands have been identified:

- Malahide Beach located approximately 5.0km east of the study area;
- Donabate Beach located approximately 5.4km north east of the study area;
- Portmarnock Beach located approximately 6.6km south east of the study area;
- Tower Bay Beach located approximately 8.1km north east of the study area.

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 office, commercial, industrial, retail or warehousing 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 and additional Airside lands, 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 predominately be the River Gaybrook and the surrounding public surface water drainage network prior to discharging to the Malahide Estuary, and through the protection and enhancement of existing floodplains from the watercourses within the Masterplan and additional Airside 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 Barrysparks/Crowscastle 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 Masterplan and additional Airside 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.

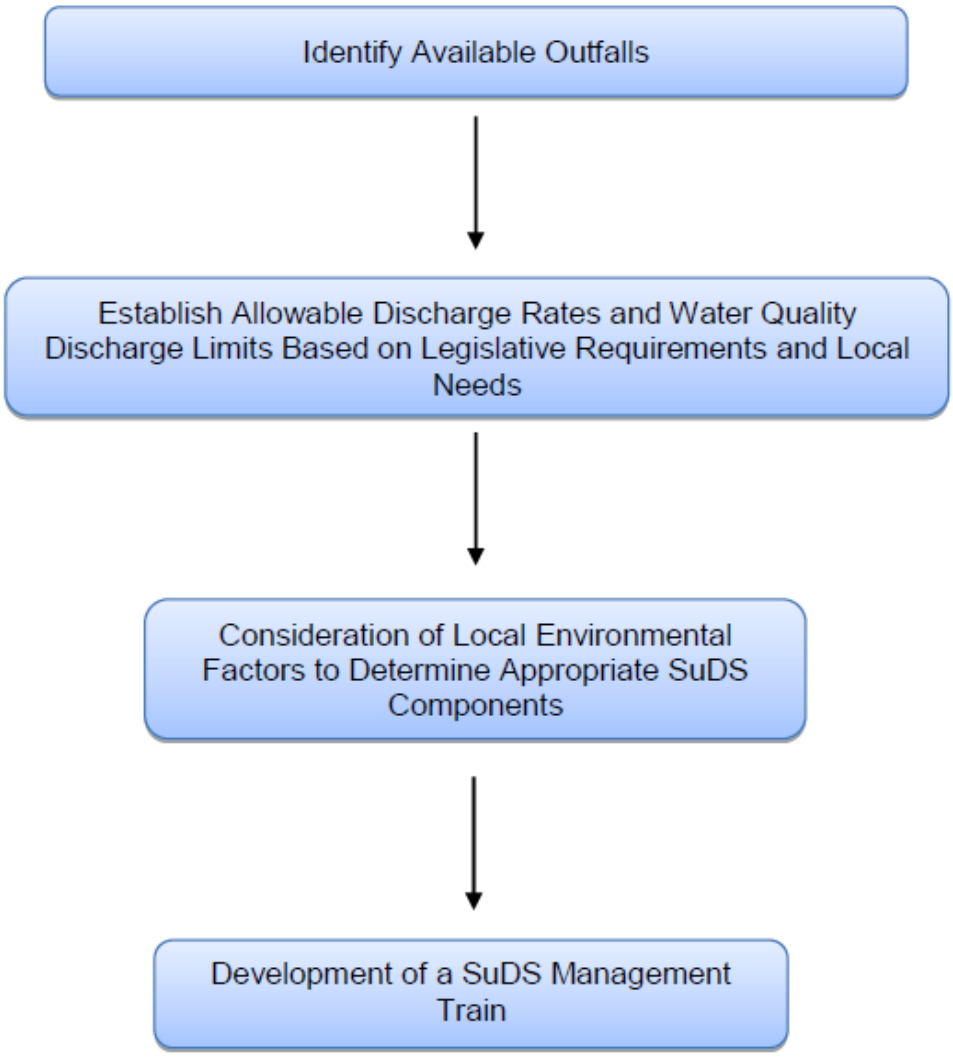


Figure 6.1 Recommended SuDS Protocol to Be Adapted

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 within the Masterplan and additional Airside lands are described below. Given the extent of potential development land 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

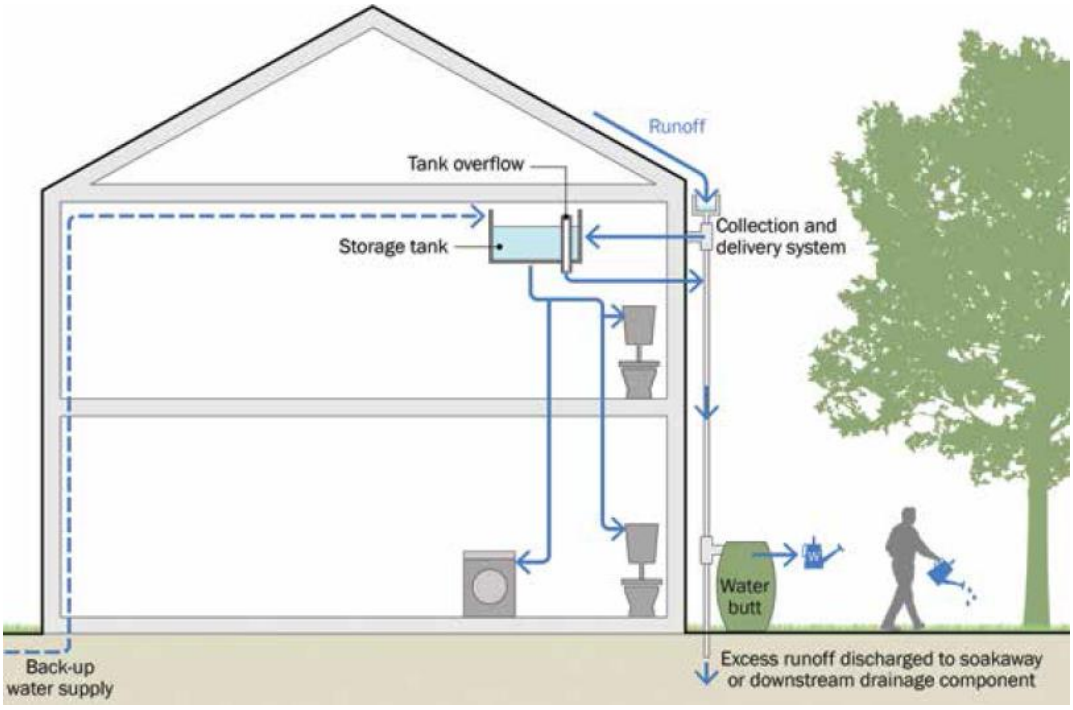


Figure 6.3 Rainwater Harvesting Schematic (CIRIA 753)

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
Low maintenance costs
Good community acceptability

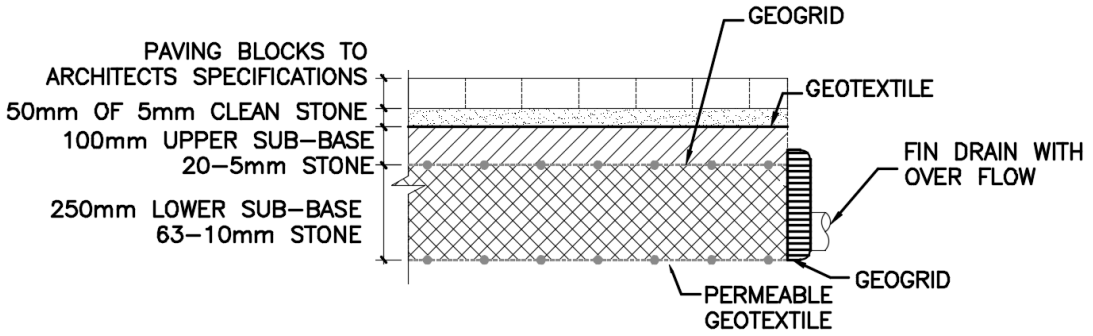


Figure 6.4 Typical Permeable Paving Detail

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

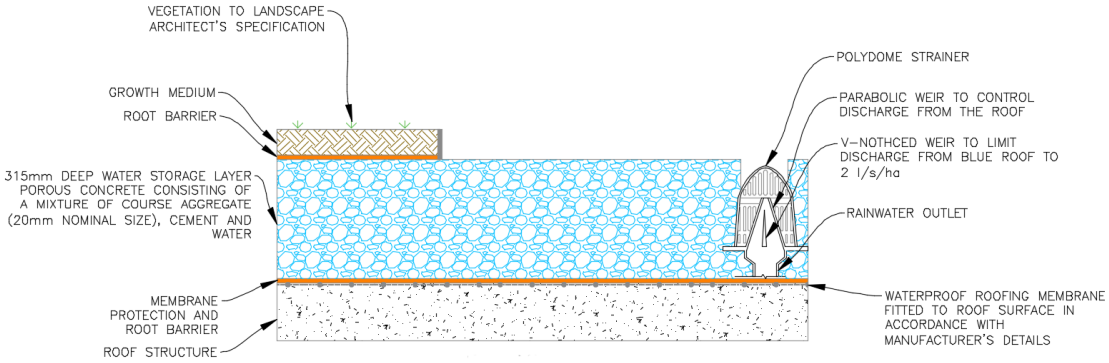


Figure 6.5 Typical Green / Blue Roof Schematic

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

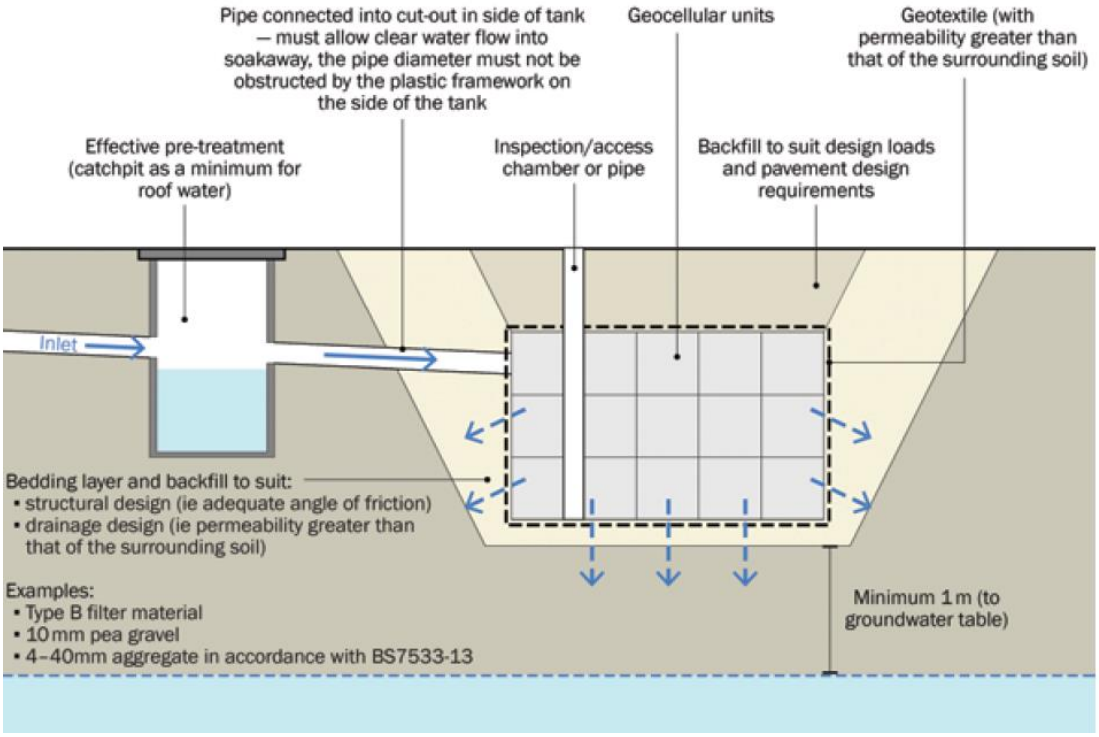


Figure 6.8 Typical Schematic of a Soakaway (SuDS Manual, 2015)

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)

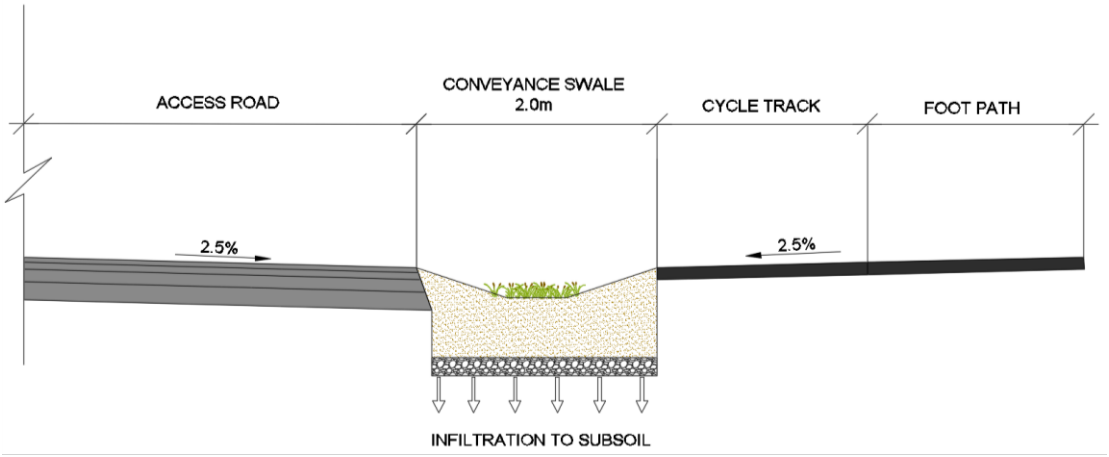


Figure 6.9 Typical Swale Schematic

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

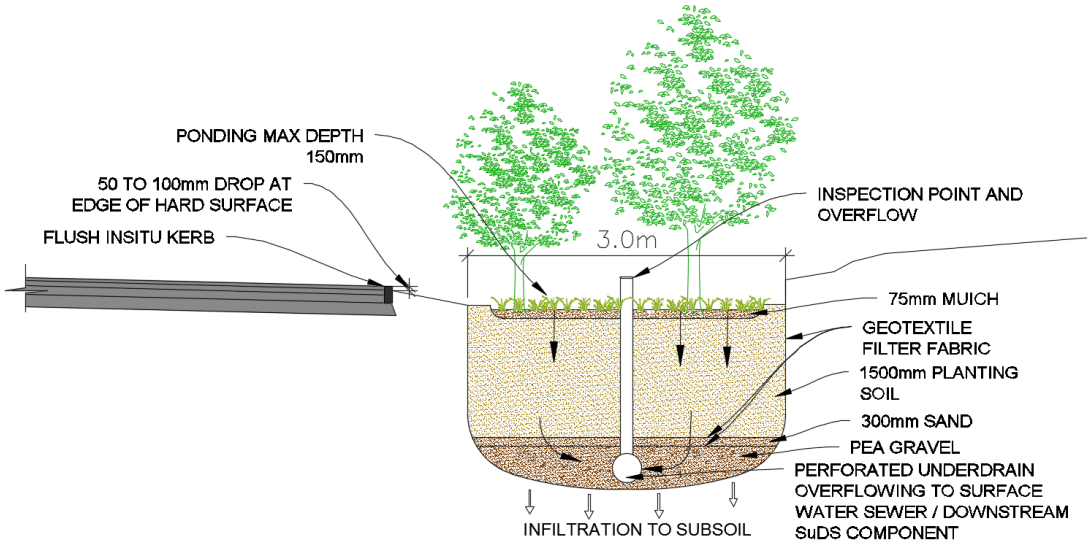


Figure 6.12 Bioretention Area Schematic

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 the Masterplan and additional Airside lands

Recommended SuDS features that should be utilised as part of a management train for undeveloped areas for any office, commercial, industrial, residential, retail or warehousing developments 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 existing 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.

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

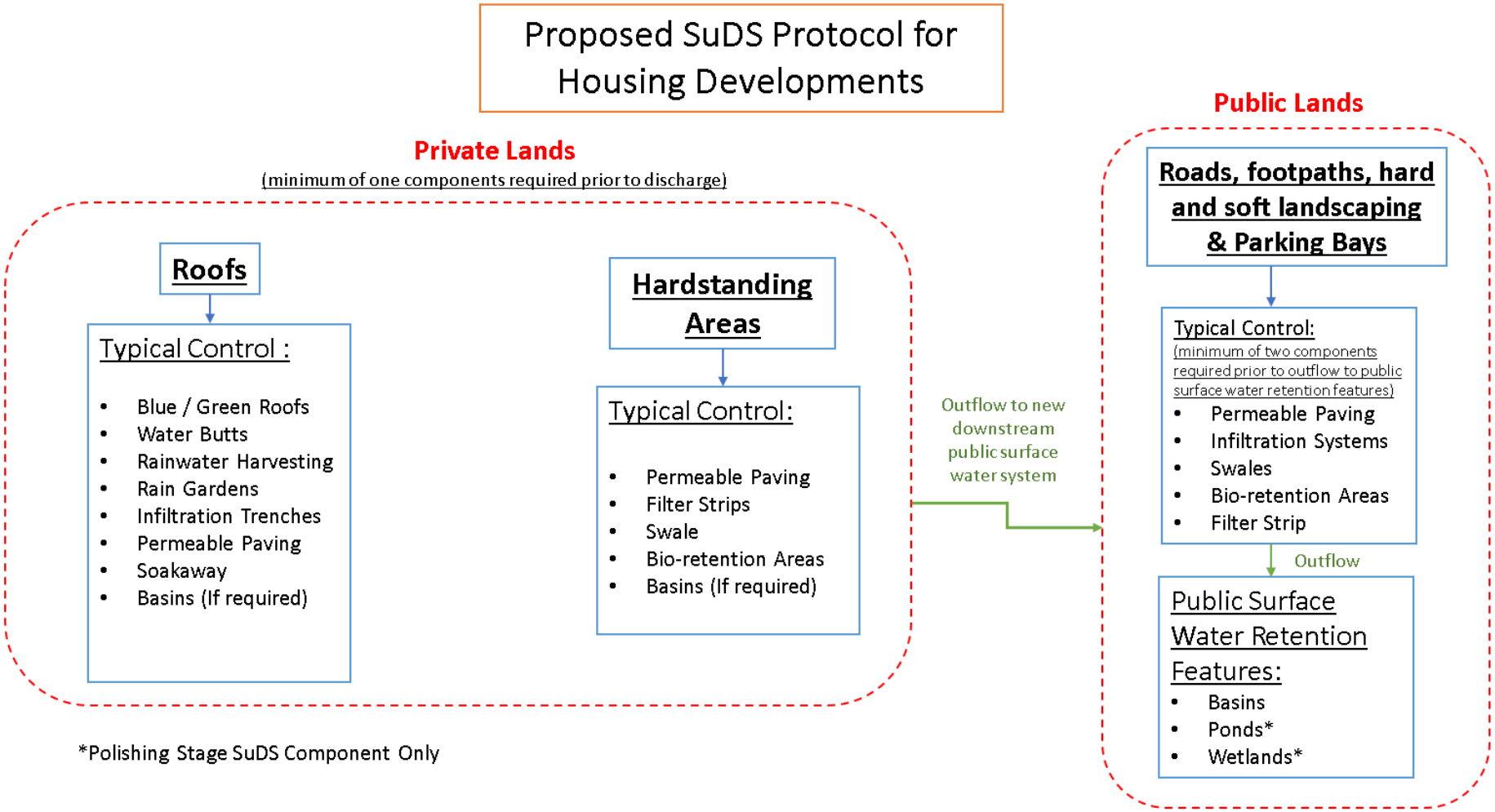


Figure 6.17 Proposed SuDS Features to Be Utilised for Residential Development Management Train

Office, Commercial, Industrial, Retail, Warehousing and Apartment Developments:

For all future office, commercial, industrial, retail, warehousing 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 watercourses present on the Masterplan and additional Airside lands.

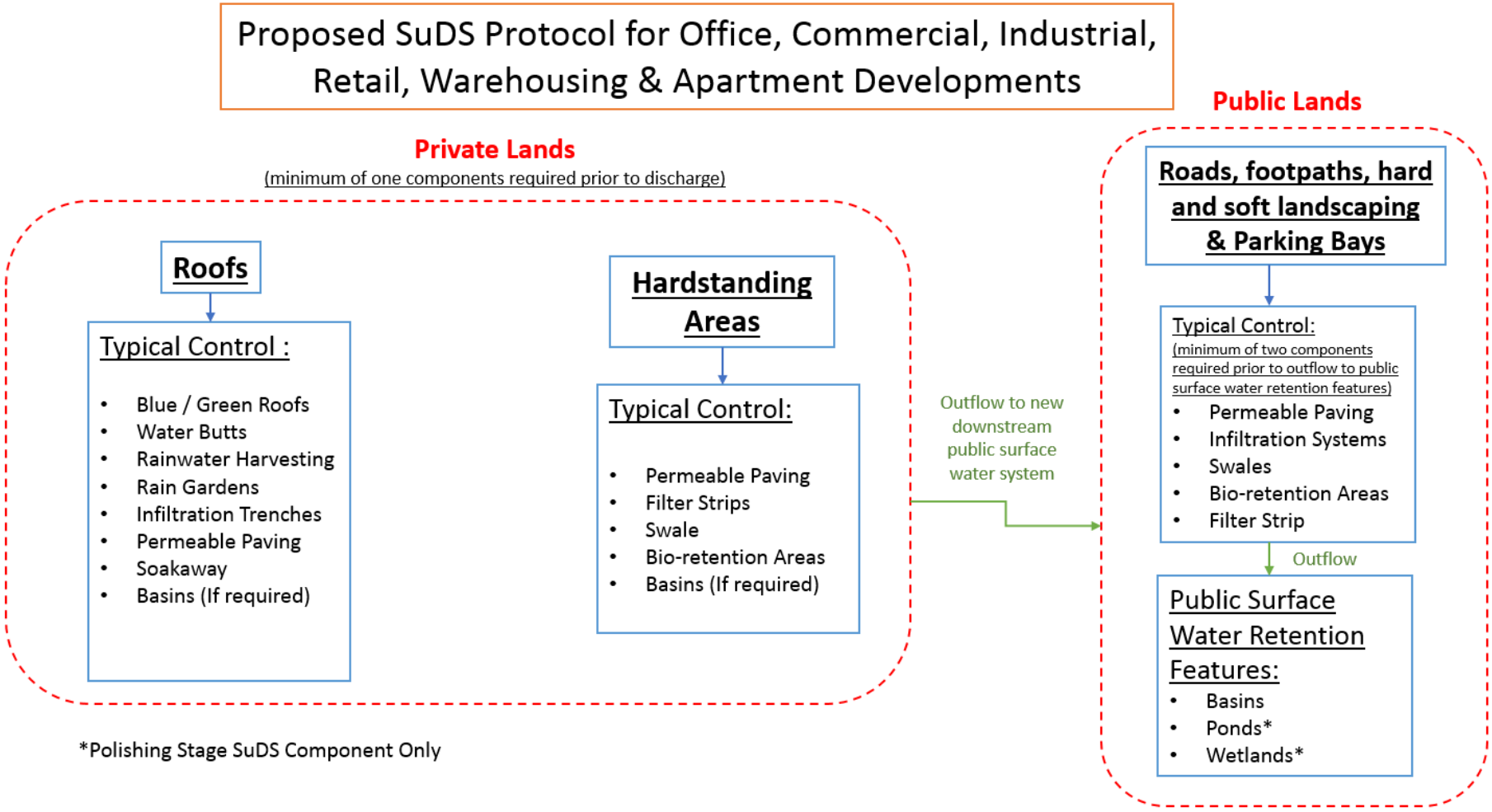


Figure 6.18 **Proposed SuDS Features to Be Utilised Commercial, Industrial, Retail, Warehousing and Apartment Development Management Train**

There are two existing attenuation pond structures located within the Crowscastle Masterplan lands, as outlined in figure 6.19 below. These ponds appear to be receiving runoff from a number of developments within the Airside retail area. As part of any new development within the subject area, no new development shall discharge to these existing ponds.

Figure 6.19 Existing Attenuation Ponds on Crowscastle Site

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 and additional Airside 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 Barrysparks / Crowscastle Masterplan Strategic Flood Risk Assessment*.

7.5 Groundwater

It is expected that the infiltration capacity of the soil within the Masterplan and additional Airside lands will be generally good as the lands 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 and additional Airside 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 lands 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 the downstream watercourses.

8. CONCLUSIONS

- As part of new development in the Masterplan and additional Airside lands, new surface water drainage networks will be required.
- SuDS measures will be required as part of these new 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 an undeveloped floodplain to accommodate flood waters during extreme flooding events through the provision of a riparian corridors – refer to the Strategic Flood Risk Assessment for the Barrysparks/Crowscastle 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 River Gaybrook watercourse or local surface water sewers. 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 Office, Commercial, Industrial, Retail, Warehousing 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 residential developments.

7) Any Office, Industrial, Commercial, Retail 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 Barrysparks/ Crowscastle 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 Barrysparks/Crowscastle Masterplan Flood Risk Assessment for flood extent mapping.

12) Management trains for new and existing 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

N

Barrysparks

Airside Additional Lands 4

Crowscastle

0 20 40 80 120 160 Meters

Masterplan lands

No.	Revision	Date	By	Chk'd	App'd
F01	Site Layout - Final	10/05/2019	BP	WV	JPR
D02	Site Layout - Draft	22/02/2019	BP	WV	JPR
D01	Site Layout - Draft	14/02/2019	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

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

Project Title: Swords Surface Water Management Plan

Drawing Title: Barrysparks / Crowscastle Masterplan Lands Site Layout - Sheet 1

Drawn: BP | Job No: 18.164 | Drawing No: 18.164-001-01 | Rev: F01

Scale: 1:2,500 (@ A3) | Date: 22/02/2019

10 May 2019 09:34:34 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Final\18.164-001-01 Swords Masterplan Barryspark with additional lands F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

N

Barrysparks

Airside Additional Lands 4

Crowscastle

Airside Additional Lands 3

Airside Additional Lands 1

Meters

0 25 50 100 150 200

Masterplan Lands

No.	Revision	Date	By	Chk'd	App'd
	Stage		Date		App'd
F01	Site Layout - Final	10/05/2019	BP	WV	JPR
D02	Site Layout - Draft	22/02/2019	BP	WV	JPR
D01	Site Layout - Draft	14/02/2019	BP	WV	JPR
	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

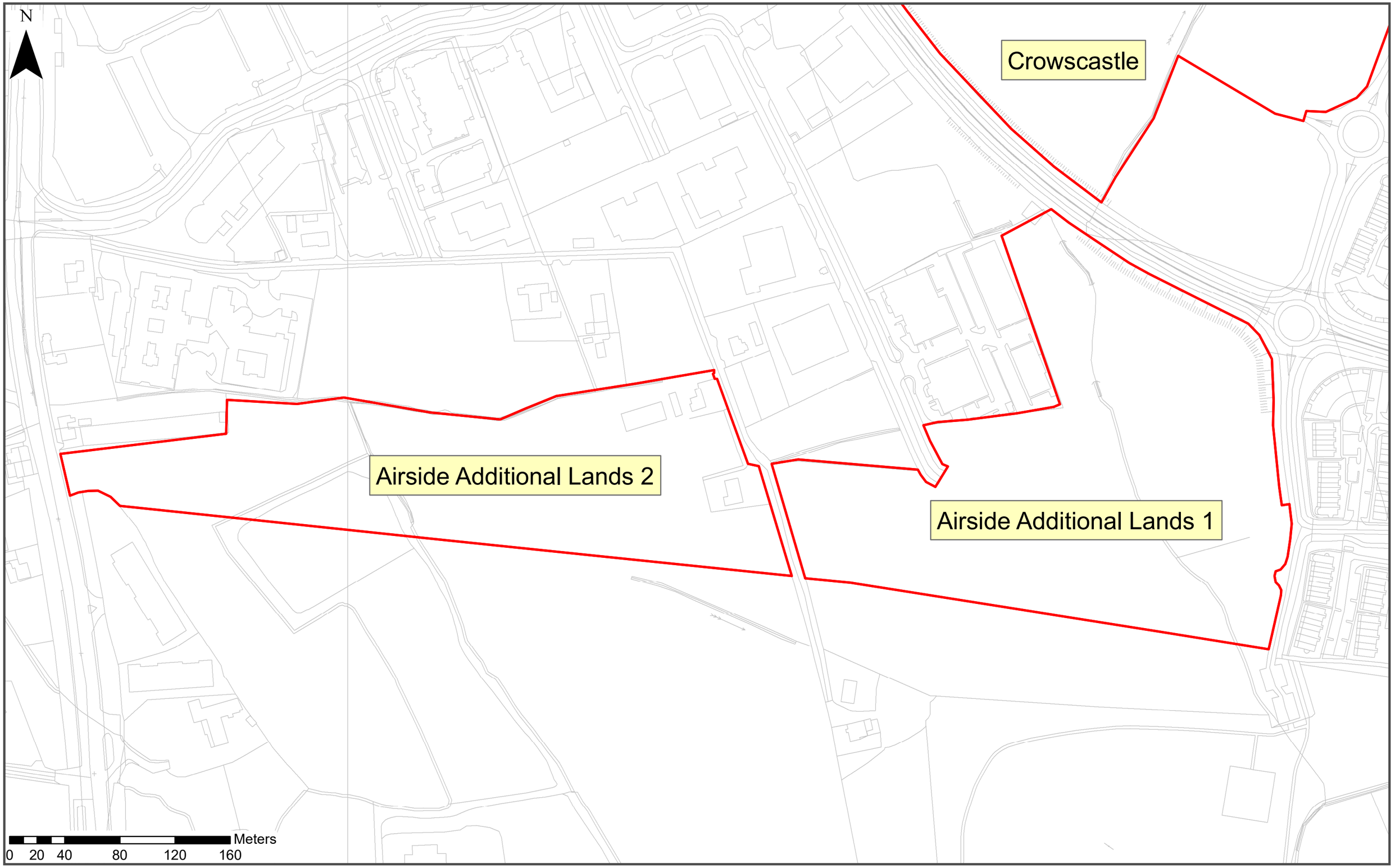
Drawing Title: Barrysparks / Crowscastle Masterplan Lands Site Layout - Sheet 2

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
BP	WV	JPR	FINAL	BP	18.164	18.164-001-02	F01

Scale: 1:3,000 (@ A3) Date: 22/02/2019

10 May 2019 09:36:49 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Final\18.164-001-02 Swords Masterplan Crowscastle with additional lands F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY



Masterplan Lands

No.	Revision	Date	By	Chk'd	App'd
F01	Site Layout - Final	10/05/2019	BP	WV	JPR
D02	Site Layout - Draft	22/02/2019	BP	WV	JPR
D01	Site Layout - Draft	14/02/2019	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

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

Project Title: Swords Surface Water Management Plan

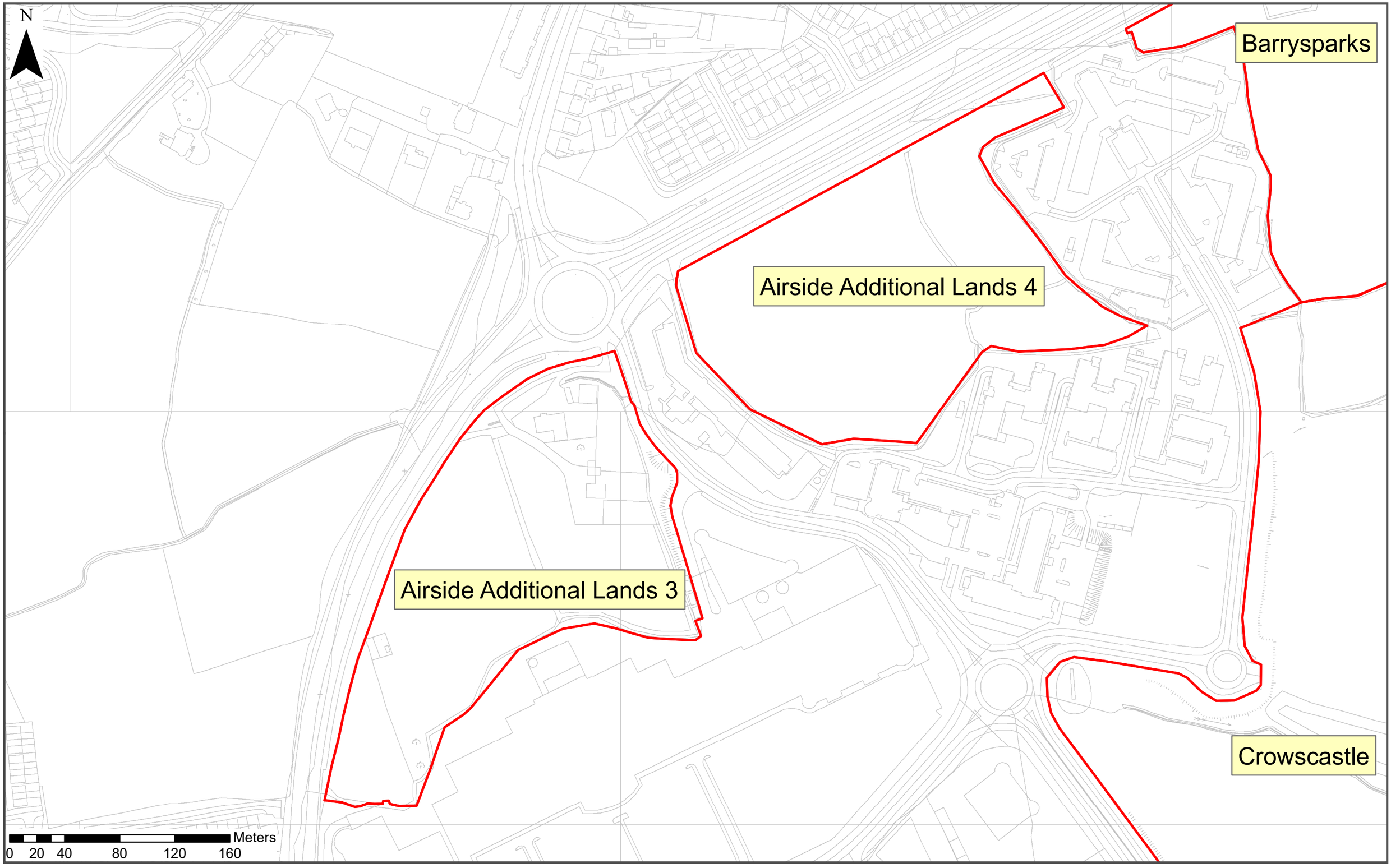
Drawing Title: Barrysparks / Crowscastle Masterplan Lands Site Layout - Sheet 3

Drawn: BP | Job No: 18.164 | Drawing No: 18.164-001-03 | Rev: F01

Scale: 1:2,500 (@ A3) | Date: 22/02/2019

10 May 2019 09:37:52 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Final\18.164-001-03 Swords Masterplan Additional Lands 1 and 2 F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY



Masterplan Lands

No.	Revision	Date	By	Chk'd	App'd
F01	Site Layout - Final	10/05/2019	BP	WV	JPR
D02	Site Layout - Draft	22/02/2019	BP	WV	JPR
D01	Site Layout - Draft	14/02/2019	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

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

Project Title: Swords Surface Water Management Plan

Drawing Title: Barrysparks / Crowscastle Masterplan Lands Site Layout - Sheet 4

Drawn: BP | Job No: 18.164 | Drawing No: 18.164-001-04 | Rev: F01

Scale: 1:2,500 (@ A3) | Date: 22/02/2019

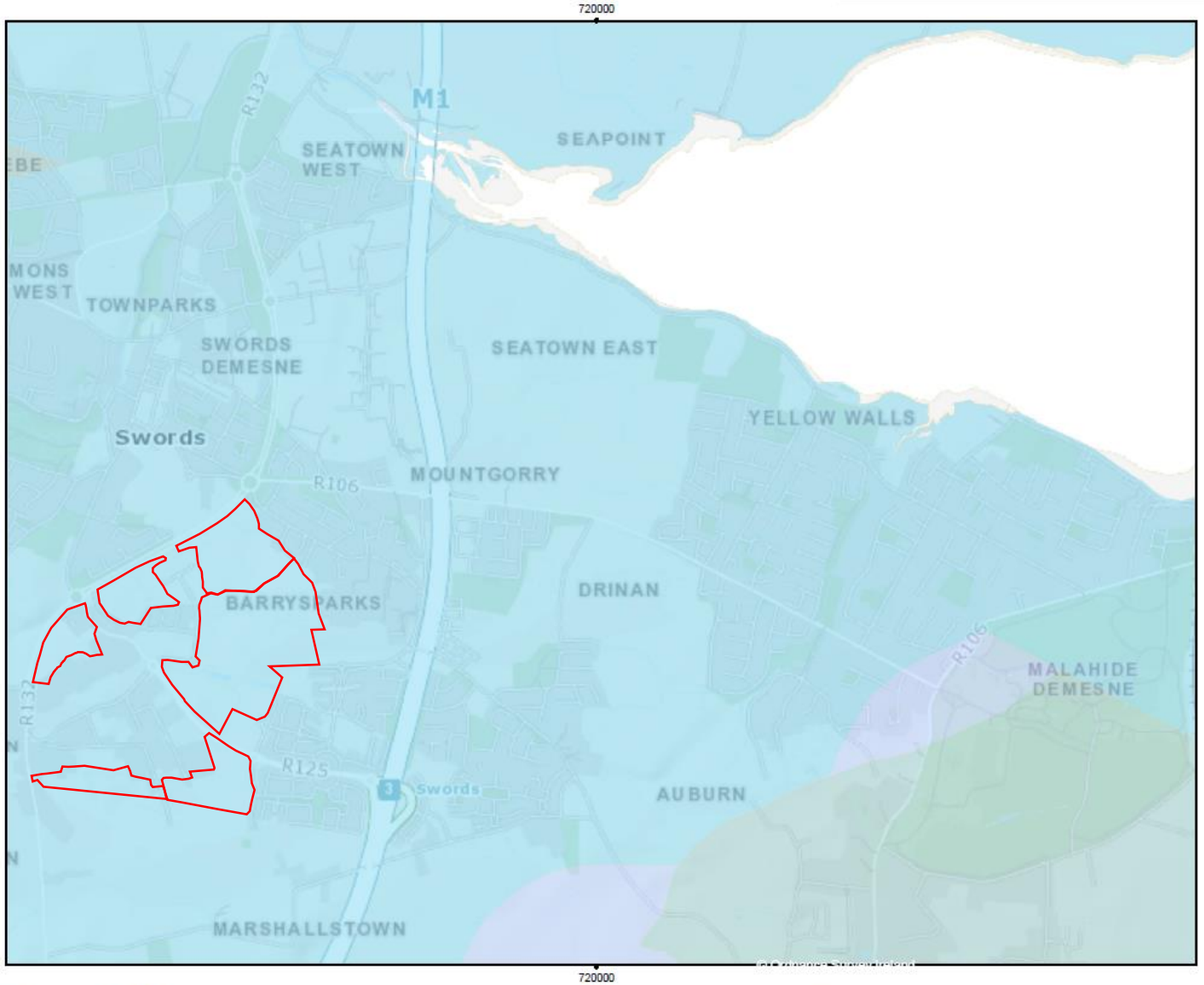
10 May 2019 09:47:52 Drawing Location: J:\2018\18164\18164-02_WIP\08 MODELS\05 GIS\01 MXD\Final\18.164-001-04 Swords Masterplan Additional Lands 3 and 4 F01.mxd

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

APPENDIX B
GSI MAPS

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Groundwater Data



Legend

Bedrock Rock Units

- Malahide Formation
- Tober Colleen Formation
- Waulsortian Limestones

Scale: 1:25,000

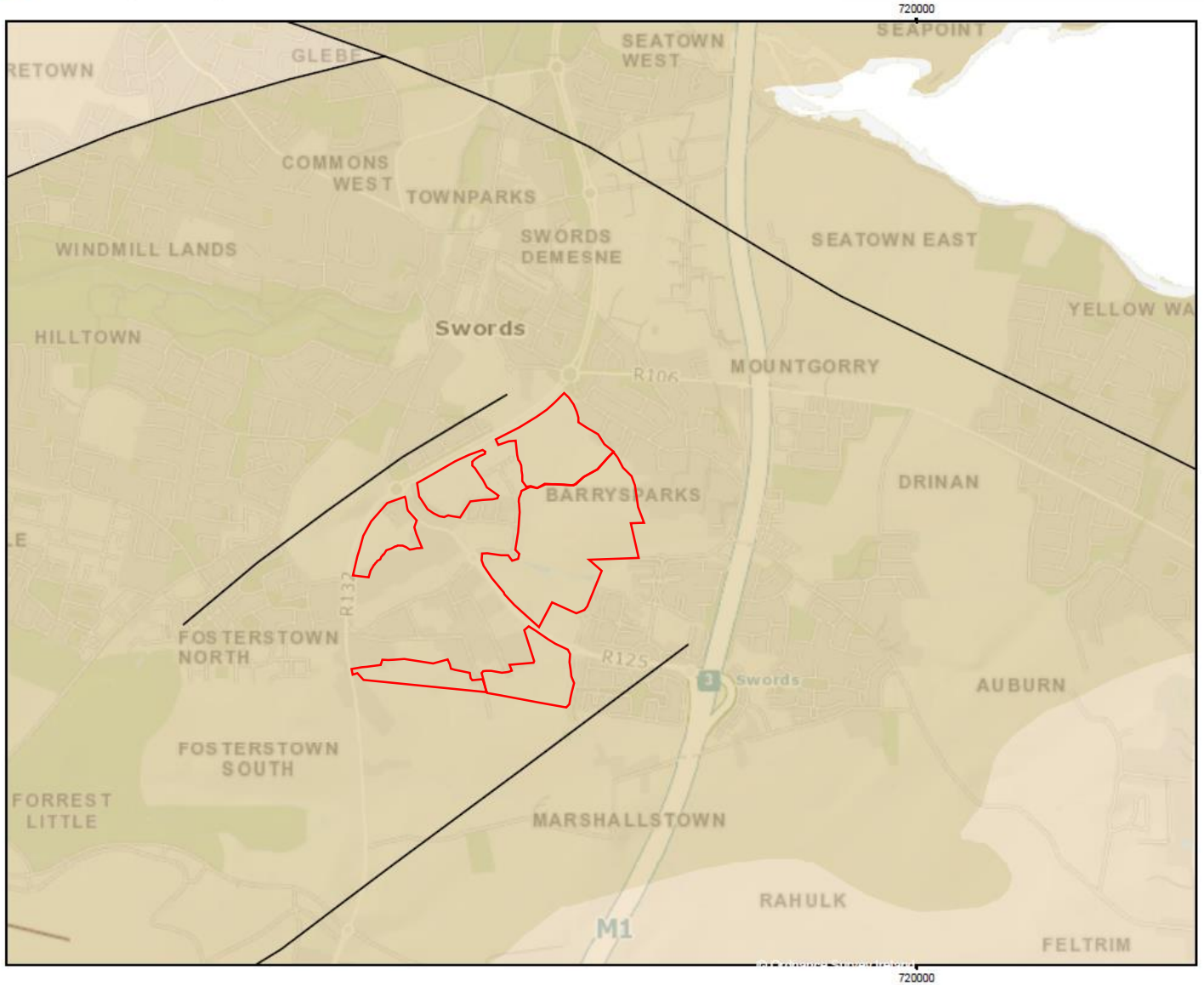
Geological Survey Ireland

N W E S

0 0.175 0.35 0.7 mi
0 0.275 0.55 1.1 km

Map Centre Coordinates (ITM) 720,020 746,321
10/26/2018, 9:20:52 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) 718,725 745,882

10/26/2018, 11:11:22 AM

Legend

Bedrock Aquifer Faults

— Bedrock Aquifer Faults

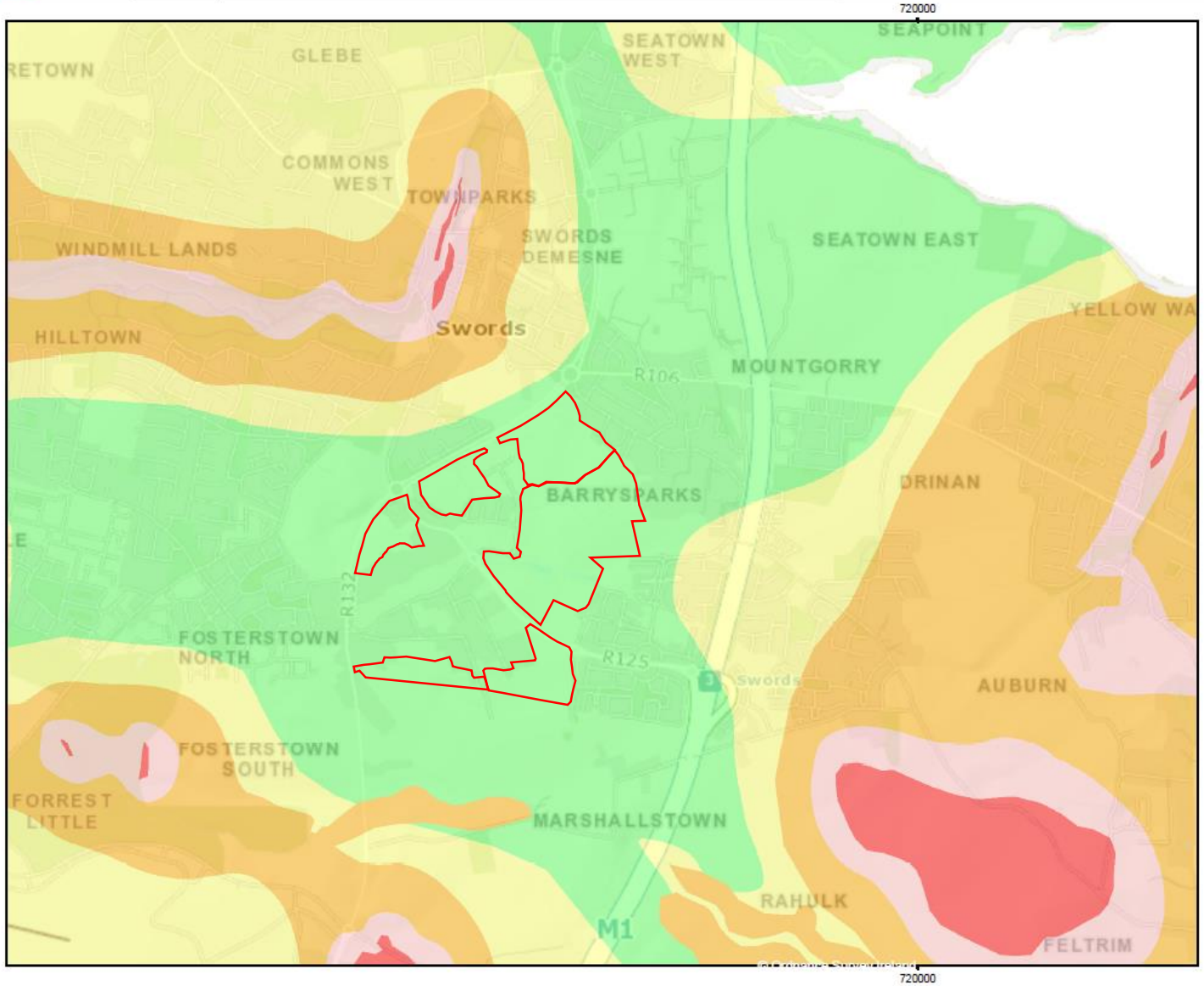
Bedrock Aquifer

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

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

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

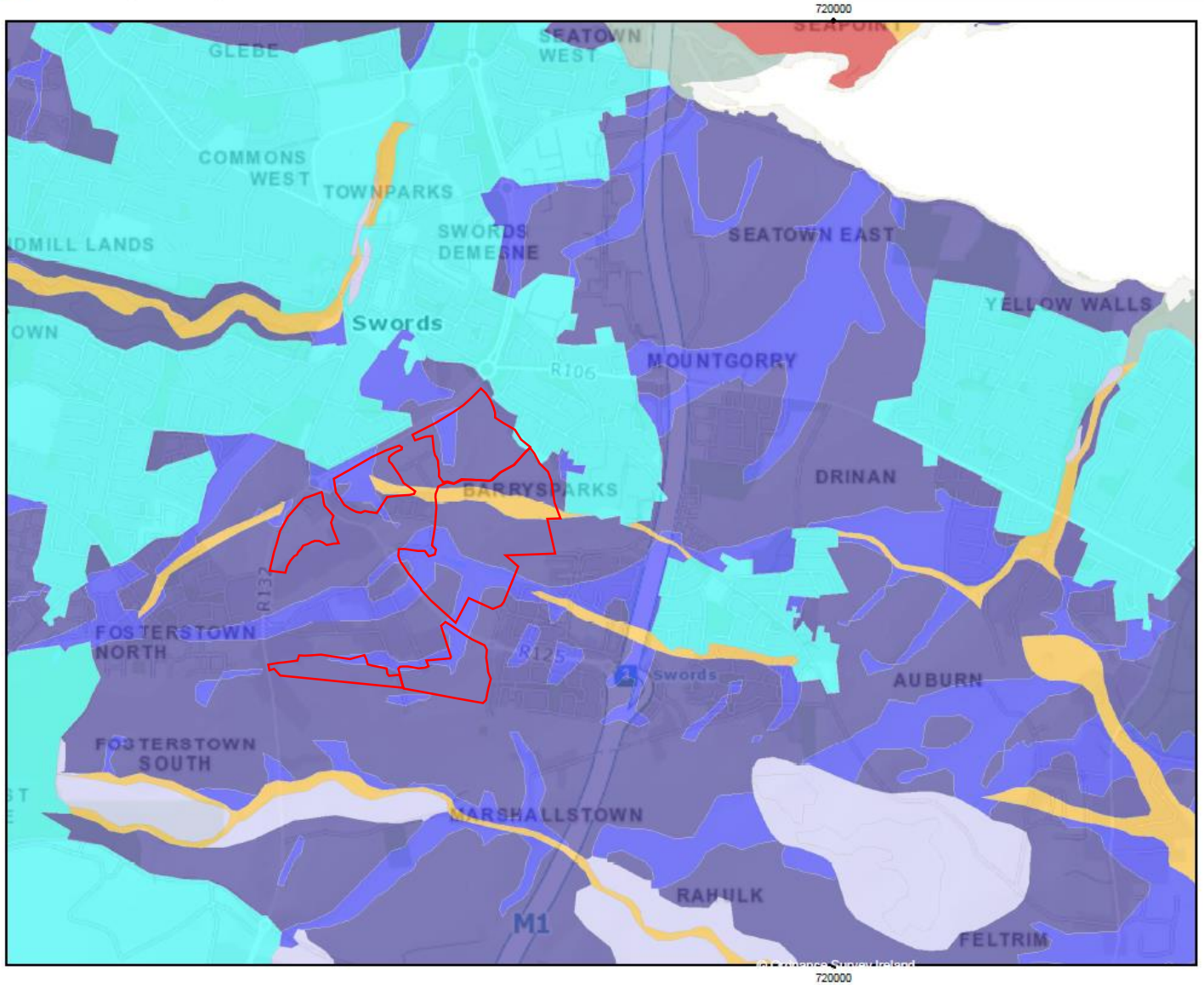
Map Centre Coordinates (ITM) 718,725 745,882
10/26/2018, 11:04:57 AM

Legend

Groundwater Vulnerability

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

Groundwater Data



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

Scale: 1:25,000

Geological Survey Ireland

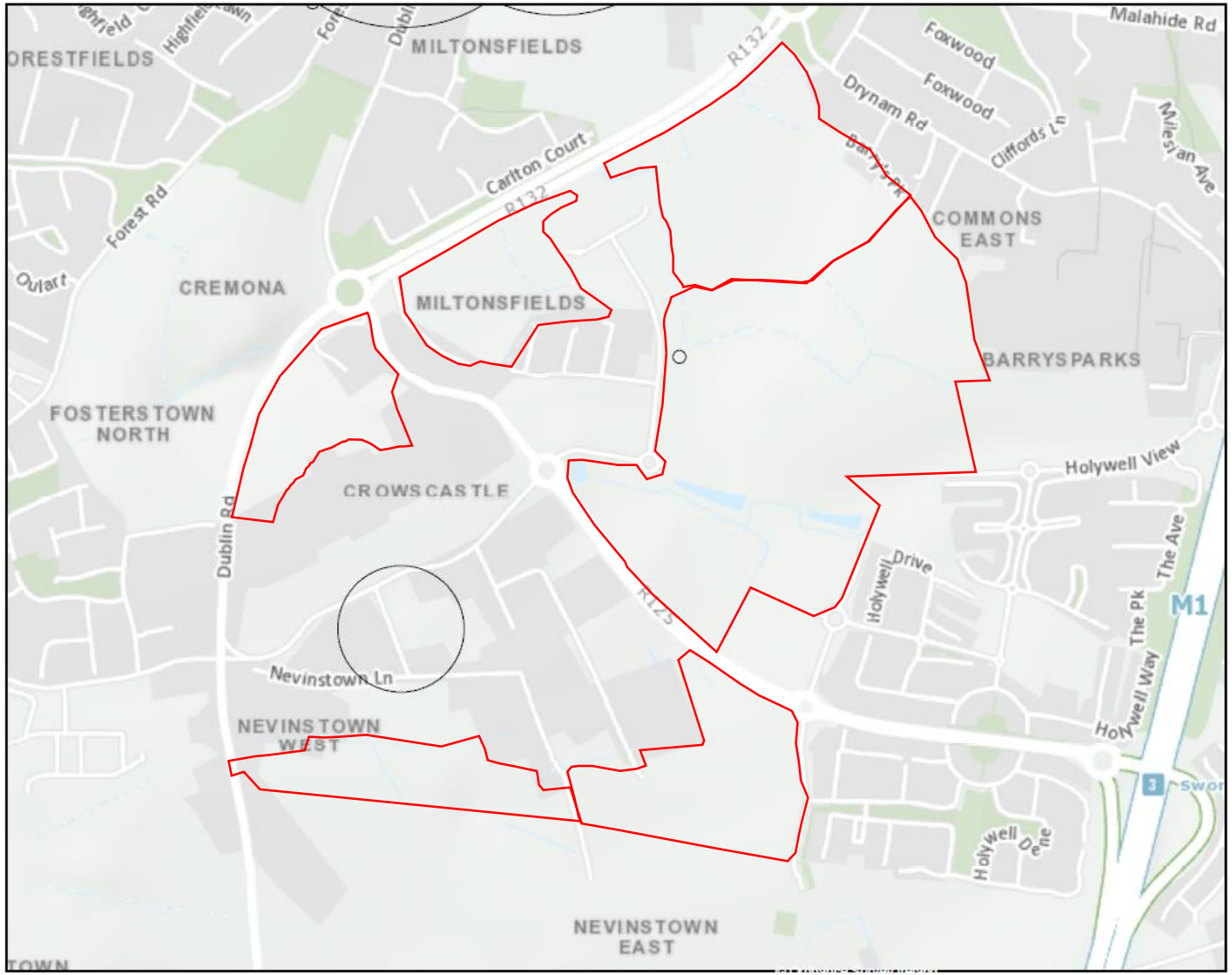
0 0.175 0.35 0.7 mi

0 0.275 0.55 1.1 km

Map Centre Coordinates (ITM) 719,061 745,862

10/26/2018, 8:54:17 AM

Groundwater Data



Scale: 1:10,000

Geological Survey Ireland

0 0.05 0.1 0.2 mi

0 0.1 0.2 0.4 km

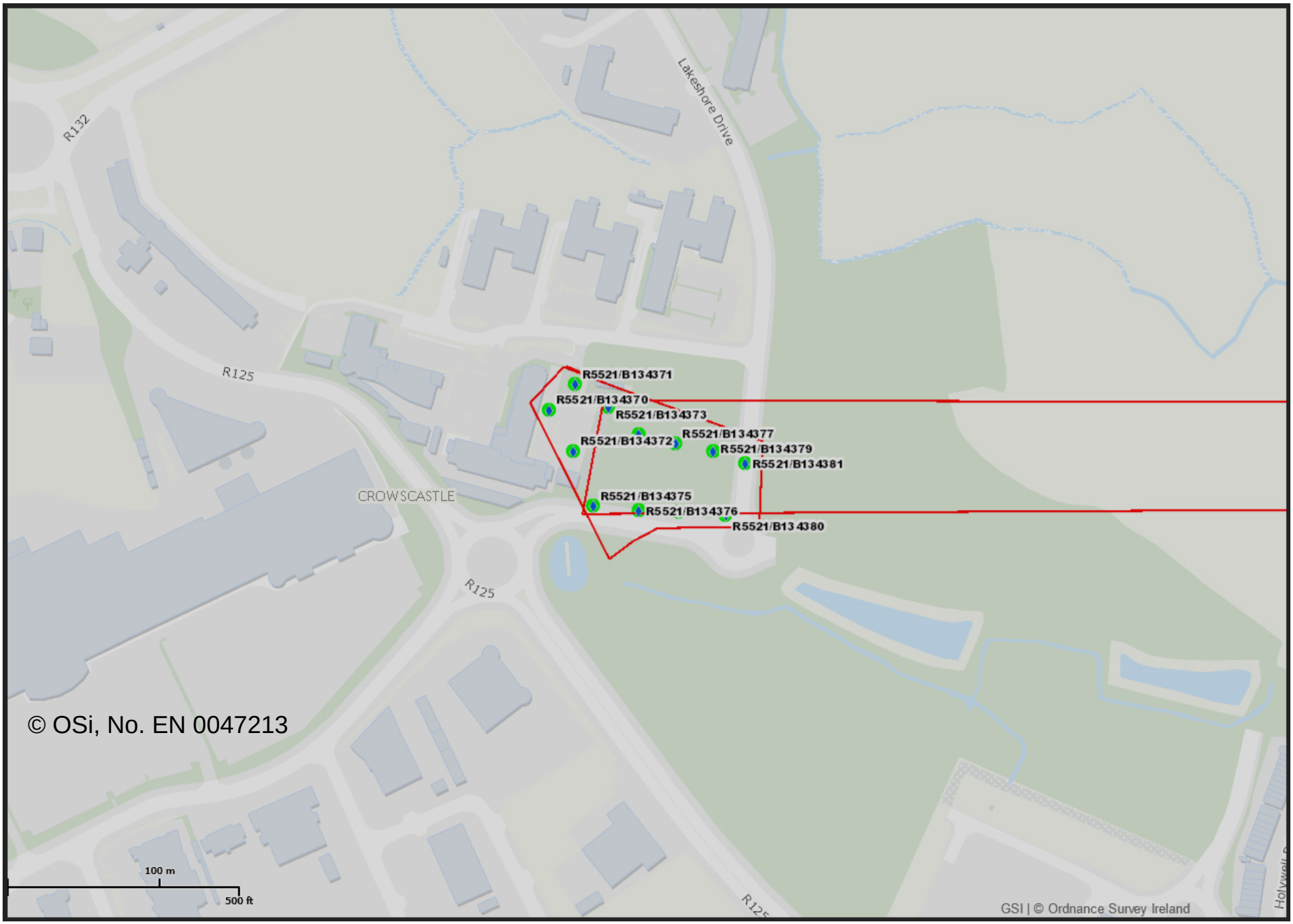
Map Centre Coordinates (ITM) 718,315 745,596

2/21/2019, 11:16:44 AM

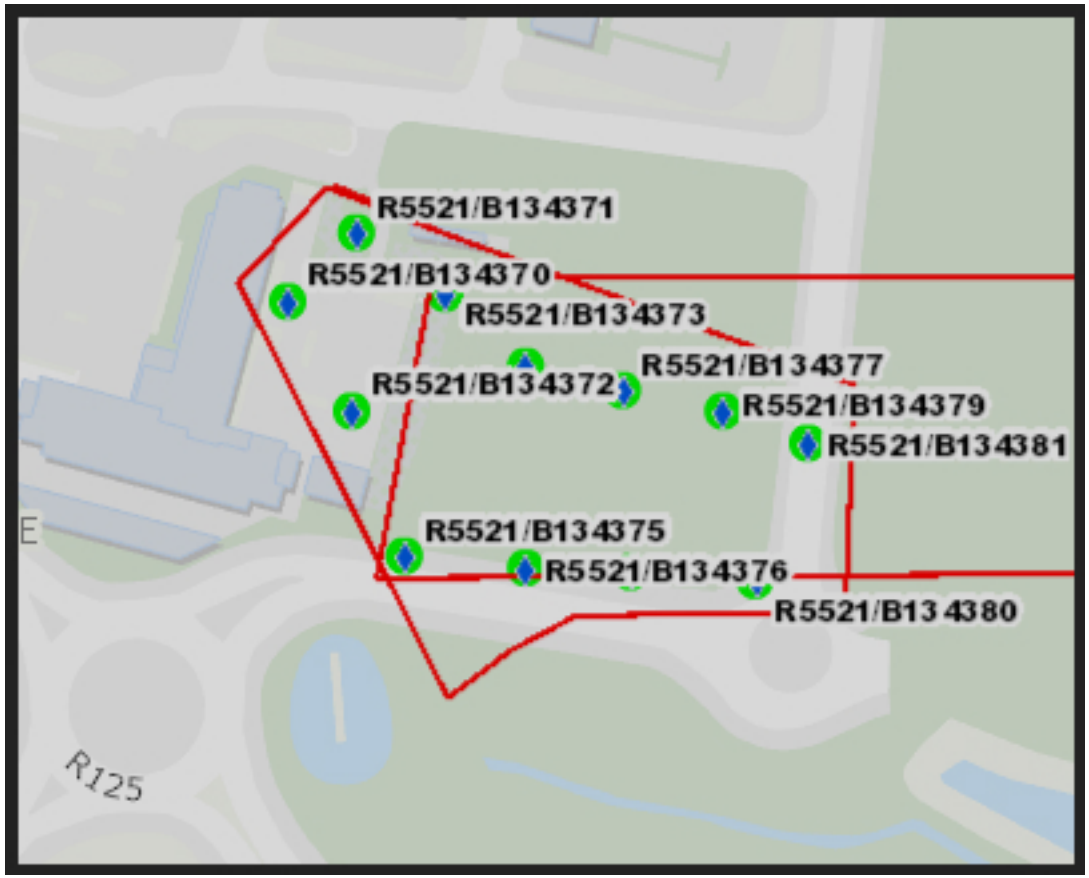
Legend

Groundwater Wells and Springs

Groundwater Wells and Springs



Overview Map for GSI Report 5521: Airside Business Park Extension
Swords, Co. Dublin
Points Observed: 12



GSI REPORT 5521

Airside Business Park Extension

Swords, Co. Dublin

Borehole List:

Borehole	Name	Depth	DTB	ODMALIN	Easting	Northing	Description
134370	BH1	6.7		30	318317	245699	Cable Percussion (Shell and Auger)
134371	BH2	7.2		30	318334	245716	Cable Percussion (Shell and Auger)
134372	BH3	6.7		30	318333	245672	Cable Percussion (Shell and Auger)
134373	BH4	7.3		30	318356	245701	Cable Percussion (Shell and Auger)
134374	BH5	7		30	318376	245683	Cable Percussion (Shell and Auger)
134375	BH6	8.5		30	318346	245636	Cable Percussion (Shell and Auger)
134376	BH7	8		30	318376	245633	Cable Percussion (Shell and Auger)
134377	BH8	6.8		30	318400	245677	Cable Percussion (Shell and Auger)
134378	BH9	9		30	318402	245632	Cable Percussion (Shell and Auger)
134379	BH10	6.8		30	318425	245672	Cable Percussion (Shell and Auger)
134380	Bh11	7.1		30	318433	245630	Cable Percussion (Shell and Auger)
134381	BH12	6.6		30	318446	245664	Cable Percussion (Shell and Auger)

GSI REPORT 5521

Airside Business Park Extension

LAYERS FOR BOREHOLE 134370 (Company Name: BH1)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
13437001	0	.3				Top Soil	Top Soil
13437002	.3	1.5	Firm	Brown	Sandy	Clay	Clay
13437003	1.5	3.4	Firm	Grey Brown		Clay	Clay
13437004	3.4	6.7	Very Stiff	Black	Slightly Sandy Gravelly	Clay	Clay

GSI REPORT 5521

Airside Business Park Extension

LAYERS FOR BOREHOLE 134371 (Company Name: BH2)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
13437101	0	.2				Top Soil	Top Soil
13437102	.2	1.6	Firm to Stiff	Brown	Sandy	Clay	Clay
13437103	1.6	2.4	Firm to Stiff	Grey Brown	Gravelly	Clay	Clay
13437104	2.4	3.5	Firm	Brown	Sandy	Silt And Clay	Silt And Clay
13437105	3.5	7.2	Very Stiff	Black	Slightly Sandy Gravelly	Clay	Clay

GSI REPORT 5521

Airside Business Park Extension

LAYERS FOR BOREHOLE 134372 (Company Name: BH3)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
13437201	0	.2				Top Soil	Top Soil
13437202	.2	2.6				Fill - Made Ground	Fill - Made Ground
13437203	2.6	5.1	Firm to Stiff	Grey Black	Sandy Gravelly	Clay	Clay
13437204	5.1	6.7	Hard	Black	Slightly Sandy Gravelly	Clay	Clay

GSI REPORT 5521

Airside Business Park Extension

LAYERS FOR BOREHOLE 134373 (Company Name: BH4)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
13437301	0	.35				Top Soil	Top Soil
13437302	.35	1.65	Firm to Stiff	Brown	Sandy	Clay	Clay
13437303	1.65	2.3	Firm to Stiff	Grey Brown	Gravelly	Clay	Clay
13437304	2.3	7.3	Very Stiff	Black	Slightly Sandy Gravelly	Clay	Clay

GSI REPORT 5521

Airside Business Park Extension

LAYERS FOR BOREHOLE 134374 (Company Name: BH5)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
13437401	0	.35				Top Soil	Top Soil
13437402	.35	3.2	Firm to Stiff	Brown	Gravelly	Clay	Clay
13437403	3.2	5.9	Medium Dense	Grey Black	Sandy	Gravel	Gravel
13437404	5.9	7	Hard	Black	Slightly Sandy Gravelly	Clay	Clay

GSI REPORT 5521

Airside Business Park Extension

LAYERS FOR BOREHOLE 134375 (Company Name: BH6)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
13437501	0	.2				Top Soil	Top Soil
13437502	.2	.9				Fill - Made Ground	Fill - Made Ground
13437503	.9	3.9	Firm	Brown		Clay	Clay
13437504	3.9	5	Stiff	Brown Grey	Gravelly	Clay	Clay
13437505	5	8.5	Hard	Black	Slightly Sandy Gravelly	Clay	Clay

GSI REPORT 5521

Airside Business Park Extension

LAYERS FOR BOREHOLE 134376 (Company Name: BH7)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
13437601	0	.2				Top Soil	Top Soil
13437602	.2	1.5				Fill - Made Ground	Fill - Made Ground
13437603	1.5	2.2	Very Stiff	Dark Brown	Gravelly	Clay	Clay
13437604	2.2	3.9	Stiff to very Stiff	Grey Black	Gravelly	Clay	Clay
13437605	3.9	5.5	Stiff	Grey Black	Gravelly	Clay	Clay
13437606	5.5	8	Hard	Black	Slightly Sandy Gravelly	Clay	Clay

GSI REPORT 5521

Airside Business Park Extension

LAYERS FOR BOREHOLE 134377 (Company Name: BH8)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
13437701	0	.2				Top Soil	Top Soil
13437702	.2	.9				Fill - Made Ground	Fill - Made Ground
13437703	.9	3.1	Very Stiff	Brown	Gravelly	Clay	Clay
13437704	3.1	6.8	Hard	Black	Slightly Sandy Gravelly	Clay	Clay

GSI REPORT 5521

Airside Business Park Extension

LAYERS FOR BOREHOLE 134378 (Company Name: BH9)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
13437801	0	.2				Top Soil	Top Soil
13437802	.2	1.4				Fill - Made Ground	Fill - Made Ground
13437803	1.4	6	Stiff to very Stiff	Grey Black	Gravelly	Clay	Clay
13437804	6	9	Very Stiff	Black	Sandy Gravelly	Clay	Clay

GSI REPORT 5521

Airside Business Park Extension

LAYERS FOR BOREHOLE 134379 (Company Name: BH10)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
13437901	0	.2				Top Soil	Top Soil
13437902	.2	1				Fill - Made Ground	Fill - Made Ground
13437903	1	3.1	Very Stiff	Brown	Gravelly	Clay	Clay
13437904	3.1	6.8	Hard	Black	Slightly Sandy Gravelly	Clay	Clay

GSI REPORT 5521

Airside Business Park Extension

LAYERS FOR BOREHOLE 134380 (Company Name: Bh11)

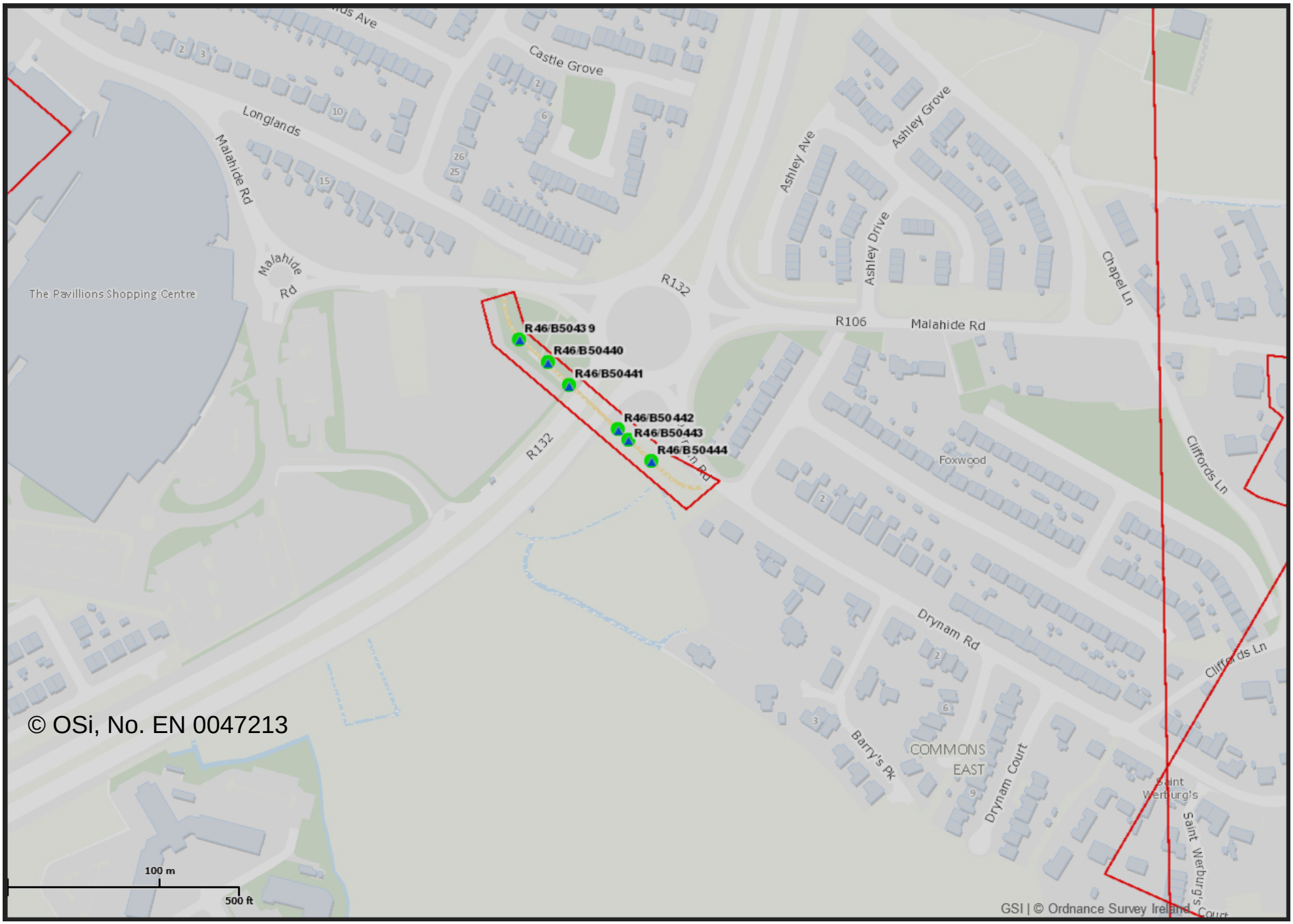
LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
13438001	0	.2				Top Soil	Top Soil
13438002	.2	3				Fill - Made Ground	Fill - Made Ground
13438003	3	3.9	Firm	Brown	Gravelly Sandy	Clay	Clay
13438004	3.9	7.1	Hard	Black	Slightly Sandy Gravelly	Clay	Clay

GSI REPORT 5521

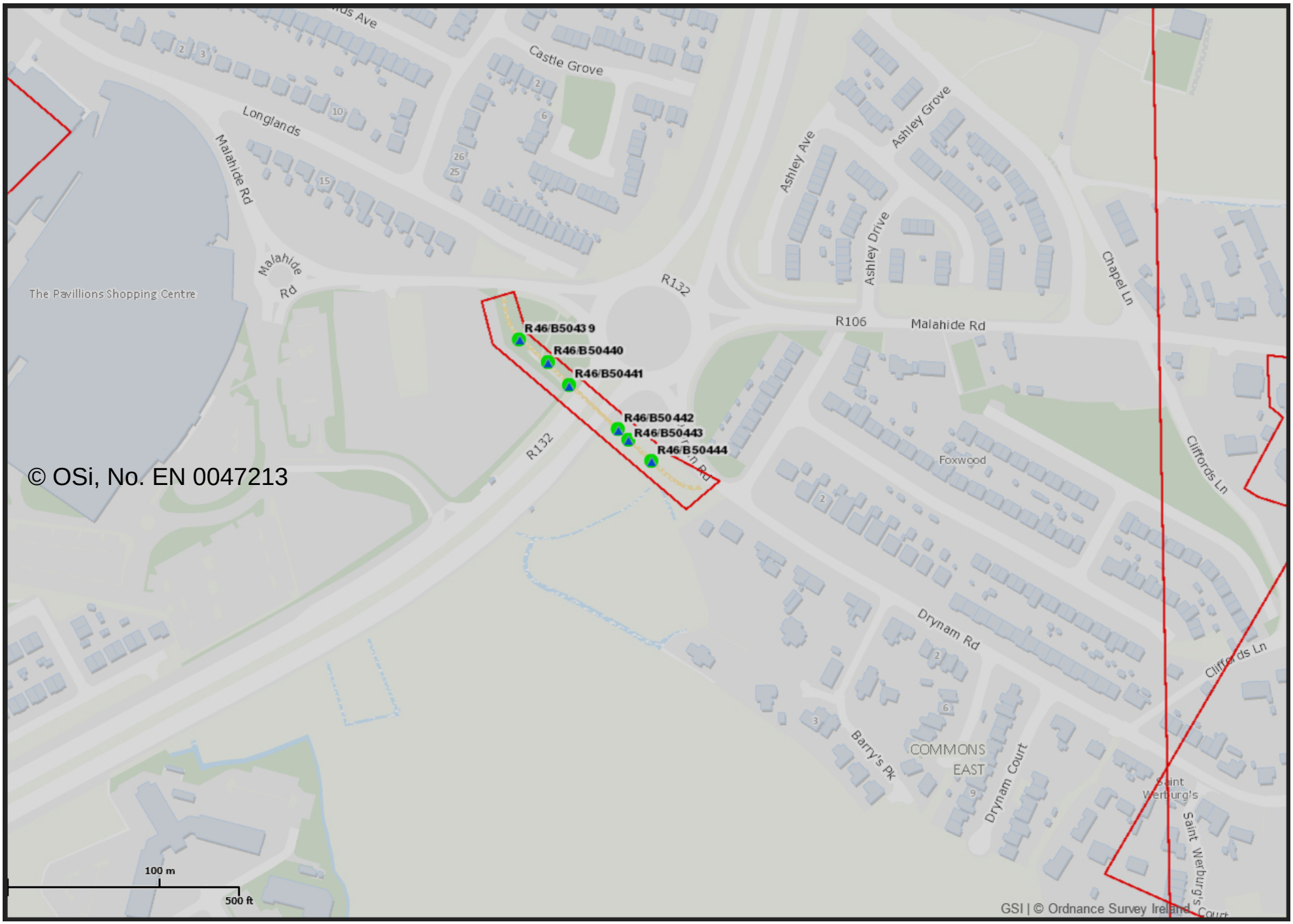
Airside Business Park Extension

LAYERS FOR BOREHOLE 134381 (Company Name: BH12)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
13438101	0	.2				Top Soil	Top Soil
13438102	.2	1.1				Fill - Made Ground	Fill - Made Ground
13438103	1.1	2.5	Stiff	Brown	Gravelly	Clay	Clay
13438104	2.5	5	Stiff to very Stiff	Dark Brown	Gravelly	Clay	Clay
13438105	5	6.6	Hard	Black	Slightly Sandy Gravelly	Clay	Clay



Overview Map for GSI Report 46: Swords By-Pass Bridges
Swords, Co. Dublin
Points Observed: 14


R46/B50439
R46/B50440
R46/B50441
R46/B50442
R46/B50443
R46/B50444
R132
R106
Malahide Rd
Castle Grove
Longlands
Ashley Ave
Ashley Grove
Ashley Drive
Chapel Ln
Foxwood
Cliffords Ln
Drynam Rd
COMMONS EAST
Barry's Pk
Drynam Court
Saint Werburg's
Saint Werburg's Court
The Pavillions Shopping Centre
© OSi, No. EN 0047213
100 m
500 ft
GSI | © Ordnance Survey Ireland

GSI REPORT 46

Swords By-Pass Bridges

Swords, Co. Dublin

Borehole List:

Borehole	Name	Depth	DTB	ODMALIN	Easting	Northing	Description
50439	1	5		25	318585	246338	Cable Percussion (Shell and Auger)
50440	2	4.5		25	318604	246323	Cable Percussion (Shell and Auger)
50441	3	4		25	318618	246308	Cable Percussion (Shell and Auger)
50442	4	5		25	318650	246279	Cable Percussion (Shell and Auger)
50443	5	4.5		25	318657	246272	Cable Percussion (Shell and Auger)
50444	6	4.5		25	318672	246258	Cable Percussion (Shell and Auger)
50445	7	4		25	318692	247086	Cable Percussion (Shell and Auger)
50446	8	5		25	318702	247103	Cable Percussion (Shell and Auger)
50447	9	5		25	318710	247117	Cable Percussion (Shell and Auger)
50448	10	4.5		25	318725	247120	Cable Percussion (Shell and Auger)
50449	11	5.2		25	318759	247127	Cable Percussion (Shell and Auger)
50450	12	5.5		25	318773	247131	Cable Percussion (Shell and Auger)
50451	13	5		25	318788	247128	Cable Percussion (Shell and Auger)
50452	14	5.5		25	318786	247116	Cable Percussion (Shell and Auger)

GSI REPORT 46

Swords By-Pass Bridges

LAYERS FOR BOREHOLE 50439 (Company Name: 1)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5043901	0	.6	Firm	Grey Brown	Sandy	Clay	Clay
5043902	.6	2.8	Stiff	Brown	Silty Stony	Clay	Clay
5043903	2.8	5	Stiff	Grey Black	Silty Stony	Clay	Clay

GSI REPORT 46

Swords By-Pass Bridges

LAYERS FOR BOREHOLE 50440 (Company Name: 2)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5044001	0	2.8	Firm to Stiff	Brown	Sandy Stony	Clay	Clay
5044002	2.8	4.5	Stiff		Silty, Very Stony	Clay	Clay

GSI REPORT 46

Swords By-Pass Bridges

LAYERS FOR BOREHOLE 50441 (Company Name: 3)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5044101	0	1.65	Stiff	Brown	Sandy Stony	Clay	Clay
5044102	1.65	4	Hard	Grey Black	Silty, Very Stony	Clay	Clay

GSI REPORT 46

Swords By-Pass Bridges

LAYERS FOR BOREHOLE 50442 (Company Name: 4)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5044201	0	3	Stiff	Brown	Sandy Stony	Clay	Clay
5044202	3	5	Hard	Grey Black	Silty, Very Stony	Clay	Clay

GSI REPORT 46

Swords By-Pass Bridges

LAYERS FOR BOREHOLE 50443 (Company Name: 5)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5044301	0	.3				Fill - Made Ground	Fill - Made Ground
5044302	.3	2.6	Stiff	Brown	Silty Stony	Clay	Clay
5044303	2.6	4.5	Hard		Silty Stony	Clay	Clay

GSI REPORT 46

Swords By-Pass Bridges

LAYERS FOR BOREHOLE 50444 (Company Name: 6)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5044401	0	.3				Fill - Made Ground	Fill - Made Ground
5044402	.3	2.5	Stiff	Brown	Sandy, Very Stony	Clay	Clay
5044403	2.5	4.5	Hard	Grey Black	Silty, Very Stony	Clay	Clay

GSI REPORT 46

Swords By-Pass Bridges

LAYERS FOR BOREHOLE 50445 (Company Name: 7)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5044501	0	1.6	Firm	Grey Brown	Silty	Clay	Clay
5044502	1.6	4	Stiff to Hard	Brown	Silty, Very Stony	Clay	Clay

GSI REPORT 46

Swords By-Pass Bridges

LAYERS FOR BOREHOLE 50446 (Company Name: 8)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5044601	0	1.9	Firm	Grey Brown	Silty	Clay	Clay
5044602	1.9	4	Stiff to Hard	Brown	Sandy, Very Stony	Clay	Clay
5044603	4	5	Hard	Black Blue	Silty Stony	Clay	Clay

GSI REPORT 46

Swords By-Pass Bridges

LAYERS FOR BOREHOLE 50447 (Company Name: 9)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5044701	0	.4				Top Soil	Top Soil
5044702	.4	1.7	Firm	Grey	Silty	Clay	Clay
5044703	1.7	4	Stiff	Brown	Sandy, Very Stony	Clay	Clay
5044704	4	5	Hard		Silty, Very Stony	Clay	Clay

GSI REPORT 46

Swords By-Pass Bridges

LAYERS FOR BOREHOLE 50448 (Company Name: 10)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5044801	0	.5	Firm	Dark Brown	Silty	Clay	Clay
5044802	.5	1.5	Stiff	Light Brown	Silty Stony	Clay	Clay
5044803	1.5	3.4	Firm	Brown	Sandy	Clay	Clay
5044804	3.4	4.5	Stiff to Hard	Grey Black	Silty, Very Stony	Clay	Clay

GSI REPORT 46

Swords By-Pass Bridges

LAYERS FOR BOREHOLE 50449 (Company Name: 11)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5044901	0	3.9	Firm	Grey Brown	Silty	Clay	Clay
5044902	3.9	4.1	Firm		Silty Stony	Clay	Clay
5044903	4.1	5.2	Hard		Silty, Very Stony	Clay	Clay

GSI REPORT 46

Swords By-Pass Bridges

LAYERS FOR BOREHOLE 50450 (Company Name: 12)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5045001	0	2.6	Firm	Grey Brown	Silty	Clay	Clay
5045002	2.6	3.8	Stiff	Brown	Silty, Very Stony	Clay	Clay
5045003	3.8	4.3	Firm		Silty	Clay	Clay
5045004	4.3	5.5	Very Hard	Grey Black	Silty Stony	Clay	Clay

GSI REPORT 46

Swords By-Pass Bridges

LAYERS FOR BOREHOLE 50451 (Company Name: 13)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5045101	0	2	Firm	Grey Brown	Silty	Clay	Clay
5045102	2	3.6	Stiff	Brown	Sandy Stony	Clay	Clay
5045103	3.6	5	Hard	Grey Black	Silty, Very Stony	Clay	Clay

GSI REPORT 46

Swords By-Pass Bridges

LAYERS FOR BOREHOLE 50452 (Company Name: 14)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5045201	0	1.5	Firm	Grey Brown	Silty Stony	Clay	Clay
5045202	1.5	3.9	Stiff	Brown	Silty Stony	Clay	Clay
5045203	3.9	4.2	Firm		Silty Stony	Clay	Clay
5045204	4.2	5.5	Hard	Grey Black	Silty	Clay	Clay

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5043902 IN BOREHOLE 50439 (Company Name: 1)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
1	1.5	FIELD	Standard Penetration Test	66	NBLOW
3	1.5	LABSOIL	Liquid Limit	36	%
4	1.5	LABSOIL	Plastic Limit	18	%
5	1.5	LABSOIL	Plasticity Index	18	%
6	1.5	LABSOIL	Moisture Content	13.4	%

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5043903 IN BOREHOLE 50439 (Company Name: 1)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
2	3.3	FIELD	Standard Penetration Test	65	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044001 IN BOREHOLE 50440 (Company Name: 2)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
1	1.5	FIELD	Standard Penetration Test	43	NBLOW
3	1.5	LABSOIL	Liquid Limit	30	%
4	1.5	LABSOIL	Plastic Limit	20	%
5	1.5	LABSOIL	Plasticity Index	10	%
6	1.5	LABSOIL	Moisture Content	17.2	%
7	1.5	LABSOIL	Unconfined Compressive Strength	7.6	

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044002 IN BOREHOLE 50440 (Company Name: 2)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
2	3	FIELD	Standard Penetration Test	83	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044101 IN BOREHOLE 50441 (Company Name: 3)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
1	1.5	FIELD	Standard Penetration Test	51	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044102 IN BOREHOLE 50441 (Company Name: 3)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
2	3	FIELD	Standard Penetration Test	77	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044201 IN BOREHOLE 50442 (Company Name: 4)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
1	1.5	FIELD	Standard Penetration Test	50	NBLOW
4	1.5	LABSOIL	Liquid Limit	36	%
5	1.5	LABSOIL	Plastic Limit	26	%
6	1.5	LABSOIL	Plasticity Index	10	%
7	1.5	LABSOIL	Moisture Content	15.5	%

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044202 IN BOREHOLE 50442 (Company Name: 4)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
3	3.5	FIELD	Standard Penetration Test	0	

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044302 IN BOREHOLE 50443 (Company Name: 5)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
1	1.5	FIELD	Standard Penetration Test	41	NBLOW
4	1.5	LABSOIL	Liquid Limit	28	%
5	1.5	LABSOIL	Plastic Limit	13	%
6	1.5	LABSOIL	Plasticity Index	15	%
7	1.5	LABSOIL	Moisture Content	13.7	%
8	1.5	LABSOIL	pH value	7.6	
8	1.5	LABSOIL	pH value	7.6	

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044303 IN BOREHOLE 50443 (Company Name: 5)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
2	3	FIELD	Standard Penetration Test	65	NBLOW
3	3.5	FIELD	Standard Penetration Test	0	

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044402 IN BOREHOLE 50444 (Company Name: 6)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
1	1.5	FIELD	Standard Penetration Test	35	NBLOW
3	1.5	LABSOIL	Liquid Limit	31	%
4	1.5	LABSOIL	Plastic Limit	18	%
5	1.5	LABSOIL	Plasticity Index	13	%
6	1.5	LABSOIL	Moisture Content	11.7	%

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044403 IN BOREHOLE 50444 (Company Name: 6)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
2	3	FIELD	Standard Penetration Test	64	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044501 IN BOREHOLE 50445 (Company Name: 7)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
1	1.5	FIELD	Standard Penetration Test	23	NBLOW
3	1	LABSOIL	Liquid Limit	25	%
4	1	LABSOIL	Plastic Limit	13	%
5	1	LABSOIL	Plasticity Index	12	%
6	1	LABSOIL	Moisture Content	11.8	%

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044502 IN BOREHOLE 50445 (Company Name: 7)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
2	2.5	FIELD	Standard Penetration Test	46	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044601 IN BOREHOLE 50446 (Company Name: 8)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
1	1.5	FIELD	Standard Penetration Test	12	NBLOW
4	1	LABSOIL	Liquid Limit	36	%
5	1	LABSOIL	Plastic Limit	19	%
6	1	LABSOIL	Plasticity Index	17	%
7	1	LABSOIL	Moisture Content	10.7	%
12	1	LABSOIL	pH value	7.5	
12	1	LABSOIL	pH value	7.5	

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044602 IN BOREHOLE 50446 (Company Name: 8)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
2	3	FIELD	Standard Penetration Test	59	NBLOW
8	2.5	LABSOIL	Liquid Limit	40	%
9	2.5	LABSOIL	Plastic Limit	22	%
10	2.5	LABSOIL	Plasticity Index	18	%
11	2.5	LABSOIL	Moisture Content	19.3	%

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044603 IN BOREHOLE 50446 (Company Name: 8)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
3	4.5	FIELD	Standard Penetration Test	97	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044702 IN BOREHOLE 50447 (Company Name: 9)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
1	1.5	FIELD	Standard Penetration Test	12	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044703 IN BOREHOLE 50447 (Company Name: 9)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
2	3	FIELD	Standard Penetration Test	17	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044704 IN BOREHOLE 50447 (Company Name: 9)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
3	4.5	FIELD	Standard Penetration Test	103	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044802 IN BOREHOLE 50448 (Company Name: 10)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
4	1	LABSOIL	Liquid Limit	37	%
5	1	LABSOIL	Plastic Limit	19	%
6	1	LABSOIL	Plasticity Index	18	%
7	1	LABSOIL	Moisture Content	17.4	%

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044803 IN BOREHOLE 50448 (Company Name: 10)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
2	3	FIELD	Standard Penetration Test	12	NBLOW
8	2	LABSOIL	Liquid Limit	25	%
9	2	LABSOIL	Plastic Limit	13	%
10	2	LABSOIL	Plasticity Index	12	%
11	2	LABSOIL	Moisture Content	13.3	%

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044804 IN BOREHOLE 50448 (Company Name: 10)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
3	4.5	FIELD	Standard Penetration Test	96	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044901 IN BOREHOLE 50449 (Company Name: 11)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
1	1.5	FIELD	Standard Penetration Test	12	
2	3	FIELD	Standard Penetration Test	13	NBLOW
4	2.5	LABSOIL	Liquid Limit	28	%
5	2.5	LABSOIL	Plastic Limit	14	%
6	2.5	LABSOIL	Plasticity Index	14	%
7	2.5	LABSOIL	Moisture Content	12.9	%

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5044903 IN BOREHOLE 50449 (Company Name: 11)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
3	4.5	FIELD	Standard Penetration Test	53	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5045001 IN BOREHOLE 50450 (Company Name: 12)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
1	1.5	FIELD	Standard Penetration Test	12	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5045002 IN BOREHOLE 50450 (Company Name: 12)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
2	3	FIELD	Standard Penetration Test	22	NBLOW
4	3	LABSOIL	Liquid Limit	33	%
5	3	LABSOIL	Plastic Limit	16	%
6	3	LABSOIL	Plasticity Index	17	%
7	3	LABSOIL	Moisture Content	16.4	%

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5045004 IN BOREHOLE 50450 (Company Name: 12)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
3	4.5	FIELD	Standard Penetration Test	94	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5045101 IN BOREHOLE 50451 (Company Name: 13)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
1	1.5	FIELD	Standard Penetration Test	12	NBLOW
4	1	LABSOIL	pH value	7.6	
4	1	LABSOIL	pH value	7.6	

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5045102 IN BOREHOLE 50451 (Company Name: 13)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
2	3	FIELD	Standard Penetration Test	45	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5045103 IN BOREHOLE 50451 (Company Name: 13)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
3	4.5	FIELD	Standard Penetration Test	91	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5045201 IN BOREHOLE 50452 (Company Name: 14)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
4	1	LABSOIL	Liquid Limit	25	%
5	1	LABSOIL	Plastic Limit	13	%
6	1	LABSOIL	Plasticity Index	12	%
7	1	LABSOIL	Moisture Content	22.4	%

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5045202 IN BOREHOLE 50452 (Company Name: 14)

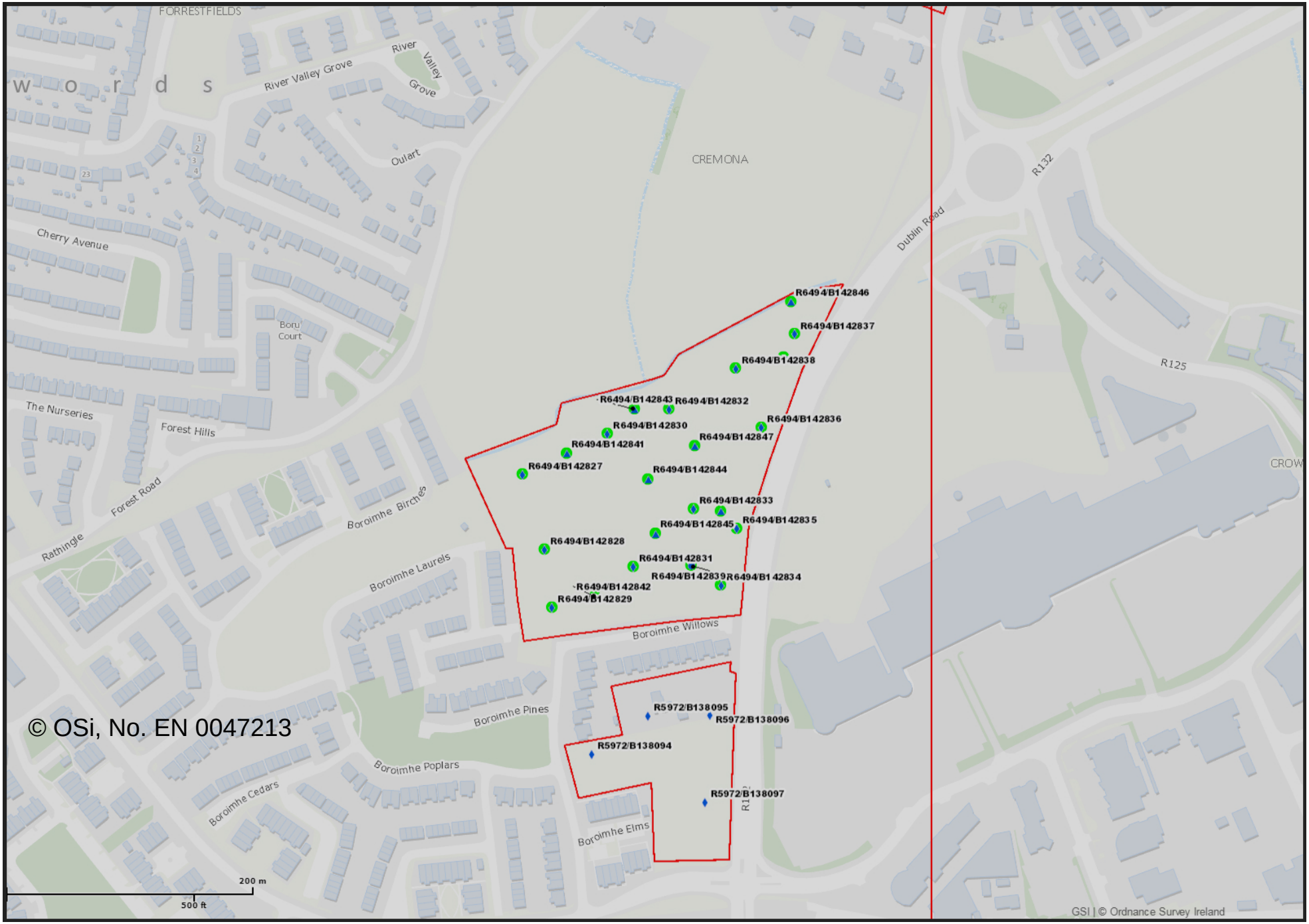
TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
2	3	FIELD	Standard Penetration Test	24	NBLOW

GSI REPORT 46

Swords By-Pass Bridges

TESTS FOR LAYER 5045204 IN BOREHOLE 50452 (Company Name: 14)

TEST	TOP	CLASS	DESCRIPTION	RESULT	UNITS
3	4.5	FIELD	Standard Penetration Test	88	NBLOW



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

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
14284001	0	.2				Top Soil	Top Soil
14284002	.2	2.5		Brown	Sandy Gravelly	Clay	Clay
14284003	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

GSI REPORT 6494

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

GSI REPORT 6494

Swords Development

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

GSI REPORT 6494

Swords Development

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

GSI REPORT 6494

Swords Development

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