SANDYFORD CENTRAL STRATEGIC HOUSING DEVELOPMENT AT THE FORMER ALDI SITE, CARMANHALL ROAD, SANDYFORD BUSINESS DISTRICT, DUBLIN 18

Site Specific Flood Risk Assessment

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1 INTRODUCTION

RPS were commissioned by Sandyford GP Limited (acting in its capacity as general partner for the Sandyford Central Partnership), to undertake a site specific flood risk assessment (SSFRA) for a strategic housing development at a 1.54 ha site at the former Aldi Site, Carmanhall Road, Sandyford Business District, Dublin 18 (known as the Sandyford Central site). The purpose of the assessment is to ensure that the development takes cognisance of the existing flood risk and does not result in increased flood risk elsewhere. Sandyford GP Limited intend to apply to An Bord Pleanála for permission for a strategic housing development which will principally consist of the demolition of the existing structures on site and the provision of a Build-to-Rent residential development comprising 564 No. apartments in 6 No. blocks, a resident amenity spaces, crèche, café and basement/ground level parking. The nearest watercourse is the Carysfort Maretimo Stream which flows at a distance to the south of the site.

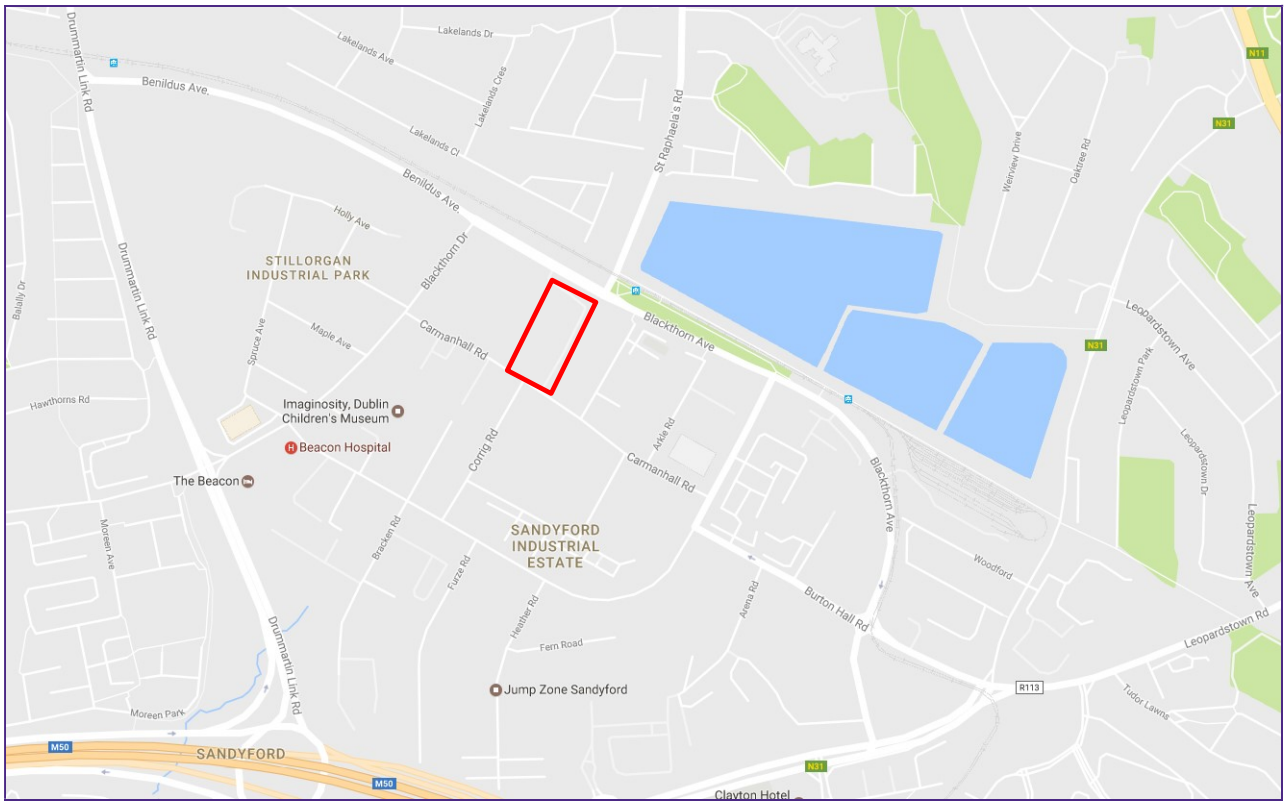


Figure 1.1 Site Location

1.1 Study objectives

The site is within the Sandyford Business Estate and has been zoned as 'Mixed Use Inner Core' (MIC) in the Dún Laoghaire-Rathdown County Development Plan 2016-2022. The Strategic Flood Risk Assessment accompanying the Development Plan noted that a Site Specific FRA appropriate to the nature and scale of the proposed development must be prepared for this site.

This report has been prepared in accordance with the requirements of 'The Planning System and Flood Risk Management' Guidelines (DEHLG 2009) as required under Policy FRA3 of the Development Plan.

A site specific flood risk assessment should provide the information detailed in Appendix A of the Guidelines but in general should include:

- Plans showing the site and development proposals and its relationship with watercourses and structures which may influence local hydraulics;
- Surveys of site levels and cross-sections relating relevant development levels to sources of flooding;
- Assessments of:
    - All potential sources of flooding;
    - Flood alleviation measures already in place;
    - The potential impact of flooding on the site;
    - How the layout and form of the development can reduce those impacts, including arrangements for safe access and egress;
    - Proposals for surface water management according to sustainable drainage principles;
    - The effectiveness and impacts of any mitigation measures;
    - The residual impacts to the site after the construction of any necessary measures and the means of managing those risks.

2 SITE DESCRIPTION

2.1 General

The site comprises 1.54 hectares in the Sandyford Business Estate, bounded to the north by Blackthorn Drive, to the south by Carmanhall Road, to the west by the Rockbrook development, and to the east by the rear of buildings fronting onto Ballymoss Road. The site is currently covered mostly in concrete slabs and a derelict industrial unit.

2.2 Existing Drainage Infrastructure

There are no open watercourses in the vicinity of the application site but the Carysfort Maretimo is culverted at a distance to the south of the site. There is also a storm water drainage network in the vicinity which is connected to the Carysfort Maretimo culvert. The flooding in this area of the city is very integrated and a combined assessment of the storm water drainage network and culverted watercourse is required to fully quantify the existing flood risk and establish the impact of the proposed development.

3 EXISTING FLOOD RISK

3.1 Historical Flooding

No historical flood events have been recorded on OPW's website FloodMaps.ie, however Dún Laoghaire-Rathdown County Council (DLRCC) indicated that there had been incidents of the drainage network surcharging in the vicinity of the proposed development site.

3.2 Eastern CFRAM Study

The National Catchment-based Flood Risk Assessment and Management (CFRAM) Programme was developed by the Office of Public Works (OPW) to meet national policy needs and the requirements of the EU Floods Directive. As part of the Eastern Catchment-based Flood Risk Assessment and Management (CFRAM) Study, the Carysfort Maretimo was identified as a High Priority Watercourse. This meant that was modelled and flood maps produced.

The Eastern CFRAMS maps shows that the site is estimated to be at risk of flooding from fluvial events in the Carysfort Maretimo with a frequency of 0.1% Annual Exceedance Probability (AEP) and greater. An extract from the CFRAM Study Flood Hazard Map is shown in Figure 3.1 with the site location marked on in red and the full map is shown in Appendix A. The maps are available to download from the Eastern CFRAM Study website.[1]

While the mapping provided as part of the CFRAM study incorporates the Carysfort Maretimo culvert it does not include the storm water drainage network and therefore is not as detailed as it could be for this area of the city. From previous knowledge of the area RPS recognise that in order to properly assess the risk to the existing site and proposed development a comprehensive integrated model is needed capturing the interaction between the storm water drainage network and the main Carysfort Maretimo Culvert. RPS have therefore undertaken further hydrological and hydraulic analyses as described in Sections 5, 6 and 7 of this report.

[1] Final Flood Hazard and Risk Maps available at http://maps.opw.ie/floodplans/uom/9/

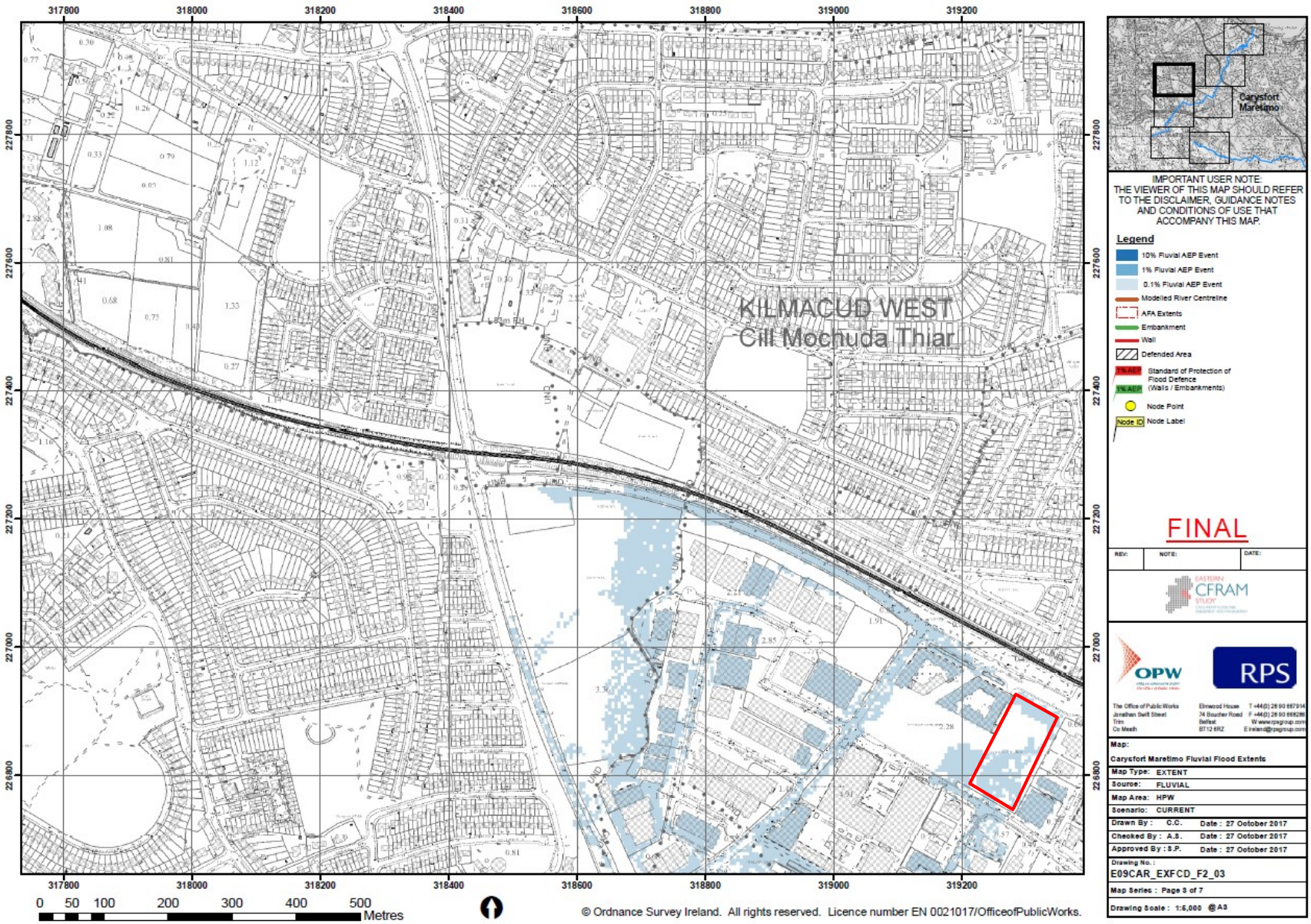


Figure 3.1 Eastern CFRAM Study Flood Extents

4 DATA COLLECTION

4.1 Methodology

In order to construct the hydraulic model and carry out the assessment of the subject site a number of datasets were reviewed and utilised. The data sets used during the study shown in Table 4.1.

Table 4.1 Data Collection

Use	Data Source
Identification of Topographical features	OSi LiDAR 2mx2m
	OSi 5k Raster Mapping
	OSi 1k Vector Mapping
	OSi Building Polygon Layer
	Detailed topographical survey of proposed sites and surrounding environs
Identification Existing Flood Risk	OSi LiDar 2mx2m
	FSU DDF Grid
	FSU Flow Analysis
	Discussion with DLRCC
	DLRCC Drainage Network Data
	GDSDS Drainage Network Data
Identification of Historical Flood Risk	Discussion with DLRCC
	OPW FloodMaps.ie
	OPW Draft CFRAMS Flood Hazard Mapping (CFRAM.ie)

4.2 Topographical Survey Data

RPS was supplied with a detailed topographical survey of the study site and the surrounding road networks allowing all topographical features which may affect flood flow paths to be identified. 2m x 2m LiDAR data was also purchased from OSi to provide a consistent topographical dataset from which to generate the initial two dimensional computational mesh.

4.3 Hydrological Data

The Carysfort Maretimo stream is an ungauged catchment, as such no specific flow information is available for the river.

5 HYDROLOGICAL ASSESSMENT

5.1 Methodology

The study site is situated in the Sandyford Industrial Estate which is entirely urbanised and the Carysfort Maretimo River has been culverted in a 1.2m diameter pipe to the south of the site. In order to take account of surcharging manholes and the storm water drainage network the portion of the model through the industrial estate will be modelled as an integrated catchment model with rainfall driven hydrology applied to subcatchments generating the inflows. The hydrology for the unmodelled portion of the catchment upstream of the Drummartin Link Road will be assessed using FSU methodologies and applied to the model as a point inflow at the upstream node.

5.2 Upstream Fluvial Hydrology

The Carysfort Maretimo is a heavily urbanised catchment with its upstream reaches on the eastern side of Ticknock and discharging into Dublin Bay at Blackrock. The catchment for the Carysfort Maretimo is not defined in the FSU, and as such catchment descriptors have been derived/estimated based on nearby defined catchments, mapping, aerial photography. The catchment area of approximately 9.5km^2 is almost entirely urbanised with only a small upland catchment outside the urban fabric as shown in Figure 5.1.

The catchment is ungauged although there are a number of gauging stations on nearby watercourses. The Slang sub-catchment of the Dodder is located 3km to the west and also represents a catchment with very high urbanisation (68%). The application of this station as a pivotal site poses problems as the adjustment is done prior to the application of urbanisation and as such the catchment needs the effects of urbanisation on the observed Q_{med} removed before any like for like adjustment can be made. The adjustment factor following the removal of urbanisation, based on the inverse of the urban adjustment factor results in an adjustment factor that suggests lowering the Q_{med}. The most hydrologically similar site, albeit one that compares rural catchment descriptors is the Kinsaley Hall gauge to the north of Dublin. Use of this station as a pivotal site would result in an adjustment factor of 1.36. The Q_{med} values are therefore based on an FSU regression equation estimate based on the derived catchment descriptors and adjusted based on two pivotal sites. The flows produced by the FSU analysis were compared with those derived from the CFRAM flood risk mapping and adjusted to take account of constrictions and flood plain attenuation in the upstream portions of the catchment.

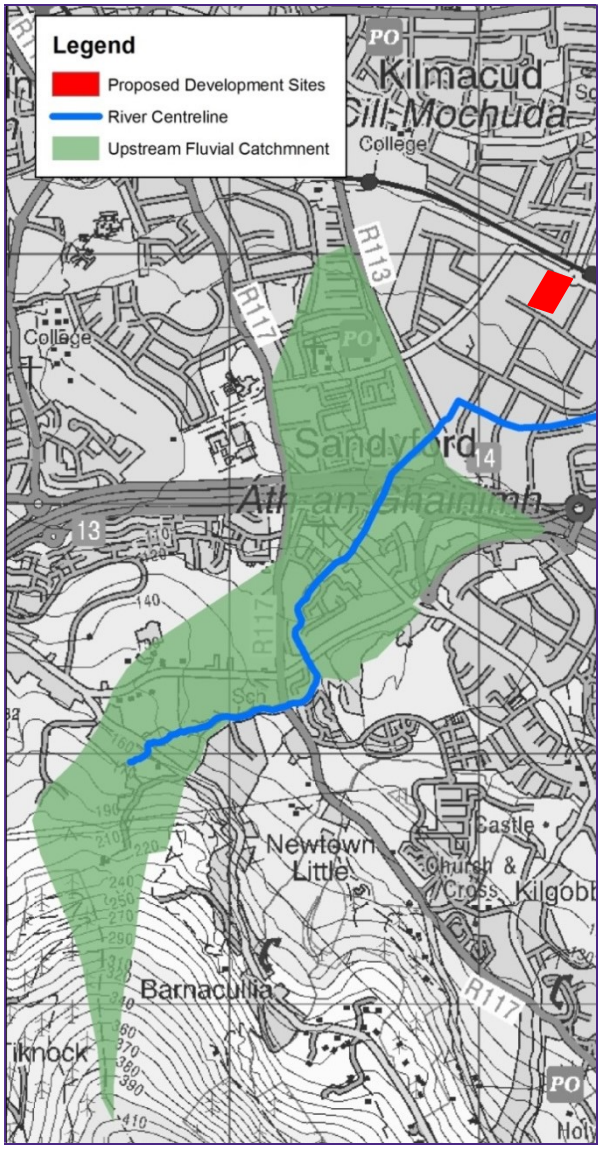


Figure 5.1 Carysfort Maretimo Upstream Catchment

5.3 Drainage Network Hydrology

In order to accurately capture the performance of the Carysfort Maretimo system during a flood event it is necessary to also consider the storm water drainage network and topography which drain to the watercourse through an integrated modelling approach. The modelled approach requires that rainfall events are applied directly to the model. The rainfall events have been derived from FSU Work Package 1.2 'Estimation of Point Rainfall Frequencies' and the accompanying Depth, Duration, Frequency (DDF) 2km x 2km gridded rainfall sum data for a range of return periods (or AEPs) and storm durations. The design rainfall sums which are to be applied within the integrated model are shown in Table 5.1.

Table 5.1: FSU DDF Derived Design Rainfall Sums

Storm Duration	Annual Exceedance Probability (AEP) %									
	50%	**20%**	**10%**	**5%**	**3.30%**	**2%**	**1%**	**0.67%**	**0.50%**	**0.10%**
	Rainfall Sums in mm									
15 mins	7.1	10.8	13.7	17.2	19.5	22.8	28.1	31.7	34.6	55.0
30 mins	9.2	13.8	17.4	21.6	24.4	28.4	34.8	39.2	42.6	67.0
1 hour	12	17.6	22.1	27.3	30.7	35.5	43.2	48.5	52.5	81.0
2 hour	15.5	22.6	28.1	34.4	38.5	44.4	53.6	59.9	64.7	98.0
3 hour	18.1	26.1	32.3	39.3	44	50.5	60.8	67.8	73.1	111.0
4 hour	20.2	28.9	35.7	43.3	48.3	55.4	66.5	74.0	79.8	120.3
6 hour	23.5	33.4	41.0	49.6	55.2	63.1	75.5	83.7	90.1	135
9 hour	27.3	38.6	47.2	56.8	63.1	71.9	85.6	94.8	101.9	151

Within the computational model, run-off surfaces or sub-catchments are set-up to calculate the volume and rate of run-off to the storm water drainage network during a storm event. In order for the model to calculate the change in run-off over time the design rainfall sums must be translated into a representative rainfall time series. For each AEP design event a range of storm durations are converted to rainfall hyetograph profiles using storm profiles developed through the FSR and subsequent Flood Studies Supplementary Report No. 16. The recommended profiles are the 50% summer, a more peaked shape representing the 50th percentile average of an analysed set of summer storm profiles, and the 75% winter, a less peaked shape representing the 75th percentile (in terms of peaked shape) of an analysed set of recorded winter storm profiles. Following initial calibration attempts whereby design rainfall sums were disaggregated into both profiles the FSR 50% summer profile was found to produce the most onerous flood flow conditions within the model and as such was used as the design storm profile to all design rainfall AEP events. Examples of the design rainfall sums disaggregated to the hyetograph profiles used in the computational model are shown Figure 5.2.

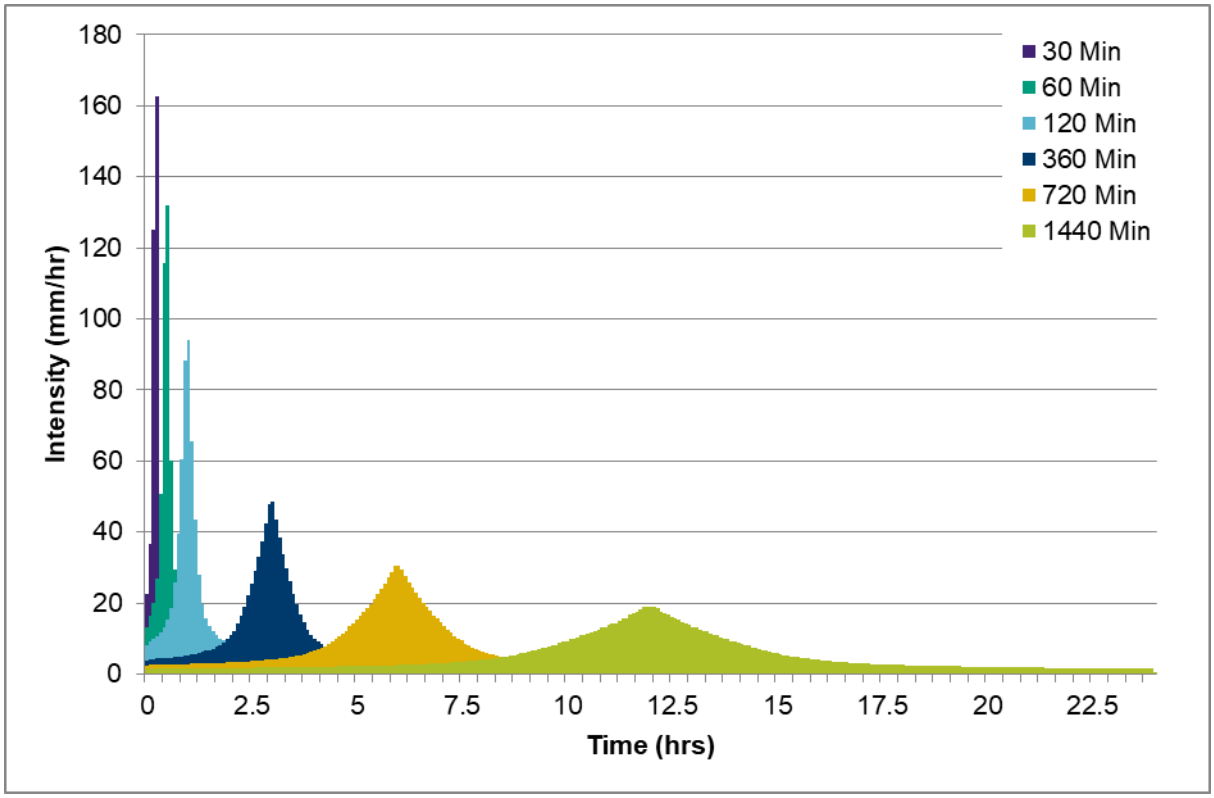


Figure 5.2 Hyetograph Profiles

5.4 Climate Change Projections

In line with the Guidelines, a precautionary approach should be taken to allow for uncertainties in data and risk assessment procedures and to enable adaptability to future changes in risk, including the effects of climate change.

A 10% climate change allowance has been used in the modelling. This is the current default amount outlined in the Greater Dublin Strategic Drainage Strategy (GDSDS) for drainage networks.

6 HYDRAULIC MODELLING AND MAPPING

6.1 Model Conceptualisation

For this project RPS used Infoworks ICM to undertake the numerical modelling of the Carysfort Maretimo Stream and the storm water drainage networks in the vicinity of the study site. Infoworks ICM is an integrated hydrological and hydraulic modelling package developed by Innovyze. InfoWorks ICM includes full solution modelling of both below and above ground watercourses, floodplains, embankments and hydraulic structures. Additionally, the 2-dimensional areas within Infoworks ICM are modelled through a triangular flexible mesh which allows for high levels of detail in specific areas (for example at river banks and around buildings) and a broader approach in other areas (for example open floodplains). This can give better results compared with a rectangular grid approach utilised in some other packages.

6.1.1 Survey Information

DLRCC supplied storm water drainage area network information for the entire study area. The data contained all relevant geometric information relating to the pipe network and associated manholes. LiDAR coverage of the entire modelled area was purchased from the OSi. The LiDAR information available was 2m x 2m which was deemed acceptable for use in this project. A detailed topographical survey of the study site and the surrounding road network which was used to augment the LiDAR and manhole cover level information.

The LiDAR was shown to have slight discrepancies when compared to the topographical survey. Following interrogation of the two data sets the LiDAR was found to be on average, excluding outliers, approximately 170mm higher than the topographical survey. The levels across the LiDAR were dropped by 170mm to reconcile the two data sets.

6.2 Model Construction

6.2.1 Hydraulic Model Construction

For 1D/2D modelling, RPS constructed a 1D storm water drainage network model combined with a 2D flood plain model which provides an accurate assessment of both the in pipe drainage flow regime and floodplain flow paths. For an accurate assessment of 2D flow paths the bare earth DTM data was used within the modelling package to generate the computational mesh, the mesh was then augmented to include buildings which will affect flow paths. Building footprints were defined by a GIS shape file which was then used to exclude the building footprints from the 2D mesh or designated as having zero porosity to force flow to pass around.

The extent of the integrated hydraulic model of the Carysfort Stream and relevant storm water drainage network developed by RPS is shown in Figure 6.1.

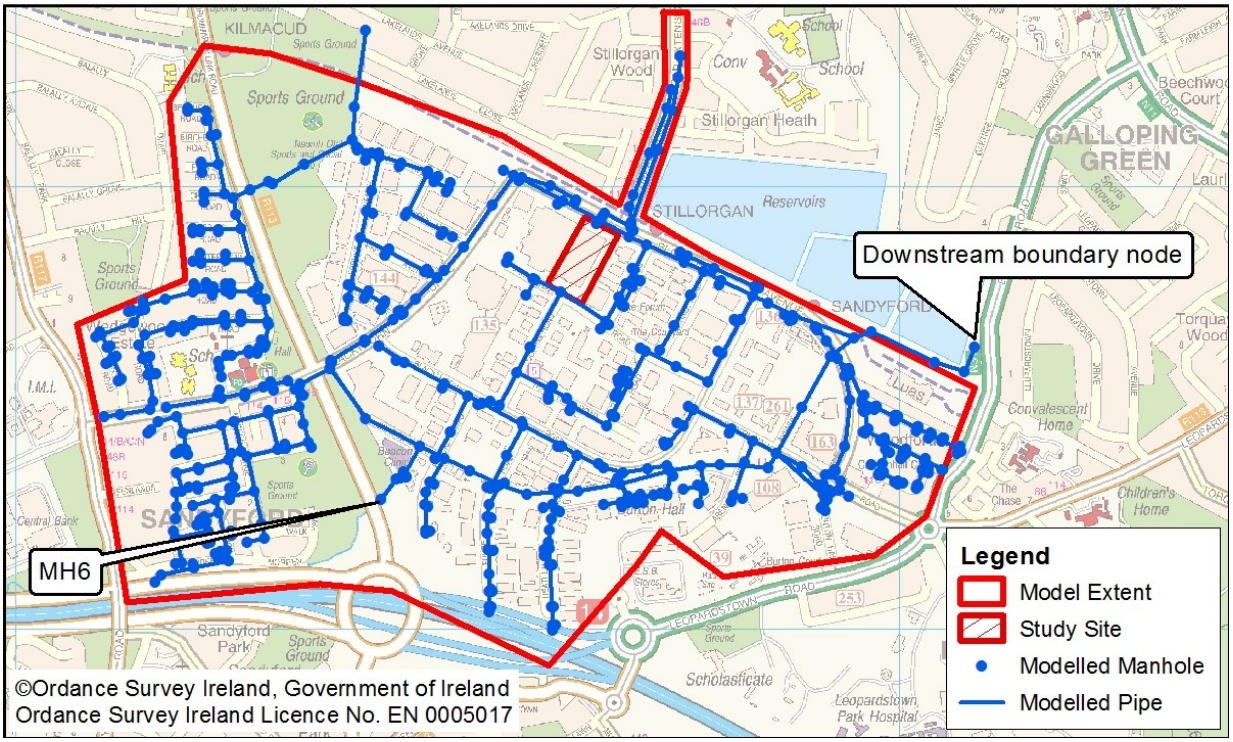


Figure 6.1 Modelled Area and Extent

This model includes a 2-dimensional hydrodynamic model of the floodplain with a 1-dimensional or integrated model of the culverted Carysfort Maretimo stream and its pipe network. The 1D pipe network model is connected to the 2D flood plain at manhole nodes. The manhole nodes spill water to the floodplain when they become sufficiently surcharged using a weir equation to calculate the flow onto the floodplain.

The maximum mesh size used in the vicinity of the study sites was 1m^2 which ensured that all topographical features were picked up accurately and all flood flow paths were identified and developed accurately by the model.

6.2.2 Model Boundaries

Upstream boundary conditions and input hydrographs for the model were provided from the Hydrological Assessment and have been introduced directly to the 1D domain as a point inflow. An input hydrograph was applied as a point flow at the upstream boundary of the culverted Carysfort Maretimo stream at node MH6 by the Drummartin Link Road. The rainfall is applied throughout the catchment area using rainfall boundaries applied to sub-catchment polygons.

Downstream boundary condition for the culverted Carysfort Maretimo stream is defined by a normal depth boundary outfall node downstream of the Luas depot to the open section of the Carysfort Maretimo stream.

6.2.3 Model Roughness

A global roughness of 0.05 was applied across the 2D model domain which gives a good representation for streets and roads in the urban environment. This figure takes account of hedges and fences in gardens, street furniture and other obstacles in the urban area.

Within the 1D drainage network the Colebrook-White roughness is 0.6mm.

6.3 Model Calibration and Verification

The Carysfort Maretimo stream is an ungauged catchment; as such there is no specific flow information available against which model flows/levels can be calibrated.

No historical flood events have been recorded on OPW's website FloodMaps.ie. Dún Laoghaire-Rathdown County Council indicated that there had been incidents of the drainage network surcharging in the vicinity of the proposed development sites, however there is no recorded information that the model can be compared to.

6.4 Model Results

6.4.1 Existing Present Day Scenario - 1% AEP

The model was used to simulate the present day scenario for the existing site for a 1% AEP event. The model showed no flooding from the culverted Carysfort Maretimo stream or storm water drainage network during a 1% AEP event in or around the site.

The flow in the culverted Carysfort Maretimo stream downstream of Blackthorn Avenue is 7.12m^3/s.

6.4.2 Existing Climate Change Scenario - 1% AEP

The model was used to simulate the climate change scenario for the existing site. An increase of 10% in the upstream fluvial hydrology and the applied rainfall was used to simulate the climate change scenario. This is the current default amount outlined in the GDSDS for drainage networks. The model showed no flooding from the culverted Carysfort Maretimo stream or drainage network occurs during a 1% AEP event plus climate change in or around the site.

The flow in the culverted Carysfort Maretimo stream downstream of Blackthorn Avenue is 7.26m^3/s.

6.4.3 Existing Present Day Scenario – 0.1% AEP

The model was used to simulate the present day scenario for the existing site during a 0.1% AEP event. During this event and scenario there are manholes surcharging on Carmanhall Road and Corrig Road, causing flooding within the site as well as numerous buildings and roads in the surrounding area. The flood extent from this model is shown in Figure 6.2.

Manholes on Corrig Road surcharge (shown in red in Figure 5.2) causing out of pipe flooding which leads to an overland flowpath along Corrig Road, onto Carmanhall Road and into the Sandyford Central site. A small portion of the flood waters then flow from the Sandyford Central site into the Rockbrook site. A manhole on Carmanhall Road (shown in red in Figure 5.2) also surcharges causing out of pipe flooding on Carmanhall Road and an overland flowpath into the Rockbrook site.

The flow in the culverted Carysfort Maretimo stream downstream of Blackthorn Avenue is 7.81m^3/s.

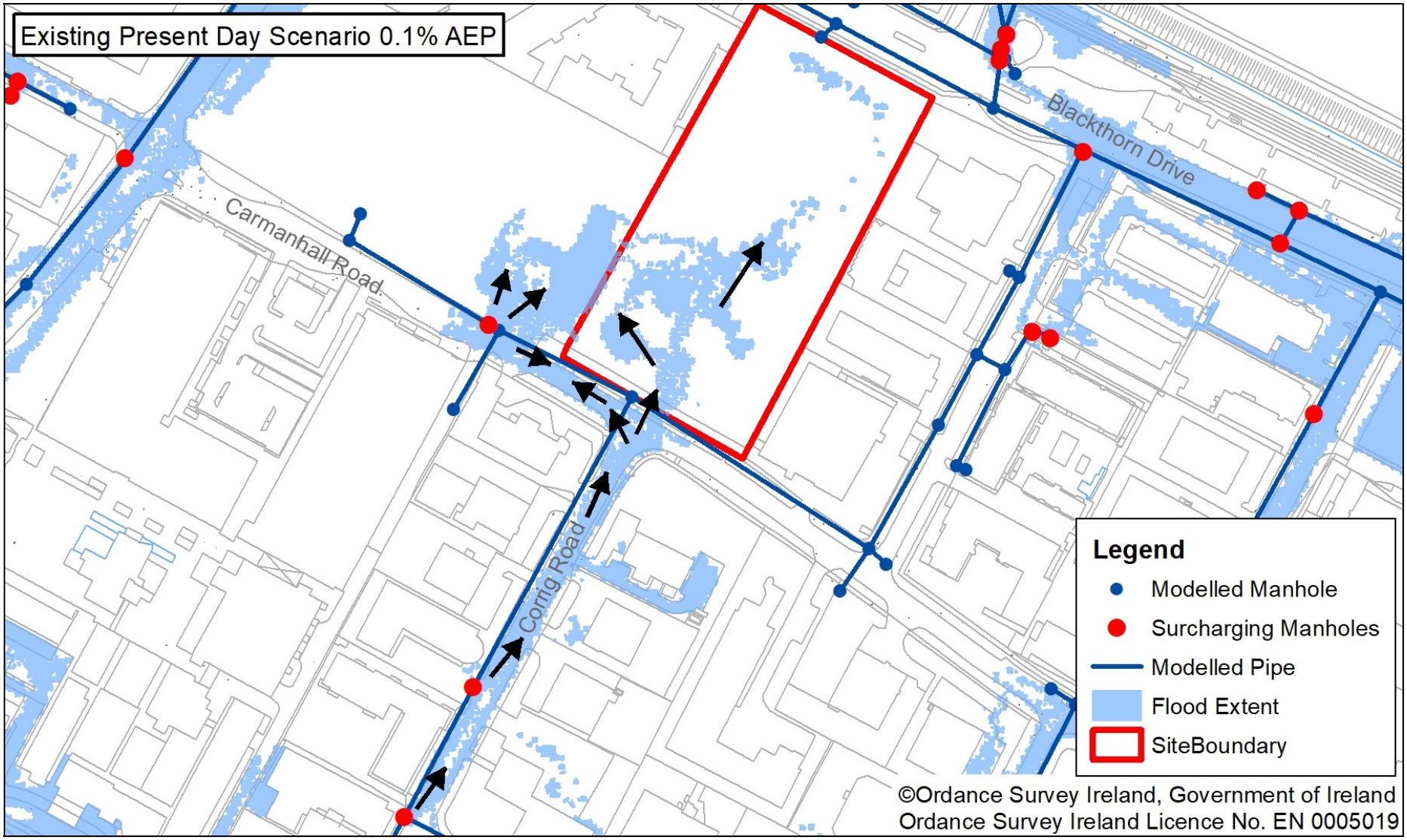


Figure 6.2 Existing Present Day Scenario 0.1% AEP Extents

6.5 Comparison with Eastern CFRAM Study Maps

The upstream fluvial hydrology methodologies used in both the Eastern CFRAM Study and this Sandyford Central SSFRA are similar and comparable. However the methodologies used across the urban Sandyford area differ. The Eastern CFRAM Study represented the Sandyford area using lateral flows. These were calculated over the entire reach and while it has taken into account the urban area, it would also include the rural area upstream. In contrast the approach for the Sandyford Central site used rainfall applied directly onto the drainage network across the Sandyford area. This is considered a more representative approach as the inflows from the lateral catchment are directly modelled through the drainage network rather than being estimated based on catchment hydrology approaches which are inherently uncertain in relation to urban catchments.

The results of the Sandyford Central model generally correlate well with the Eastern CFRAM Study. However, the Sandyford Central model includes more detail than the Eastern CFRAM Study, i.e. the Sandyford Central model includes the local storm water drainage network whereas the Eastern CFRAM Study does not. Therefore there are areas of flooding which can be seen in the Sandyford Central model that are not in the ECFRAM Study. This is due to storm water drainage manholes surcharging in the Sandyford Central model which are not represented in ECFRAM Study. One such area is at Ballymoss Road/ Blackthorn Drive.

Flooding in the 0.1%AEP event on the Ballymoss Road/ Blackthorn Drive occurs during both the Present Day Scenario and Post Development Scenario as shown in drawing IBE1639/001 in Appendix B. Once the Sandyford Central development is built into the model the flooding in the area is shown to be slightly reduced due to the attenuation incorporated within the Sandyford Central development. The Beacon South Quarter site is not adversely impacted as seen in drawing IBE1639/001 in Appendix B. Therefore the development of the Sandyford Central site has a slightly positive impact on the flood risk in this area.

6.6 Flood Zones

Flood Zones are classified under the Planning System and Flood Risk Management Guidelines (2009) as follows:

- **Flood Zone A**: areas where the probability of flooding is highest (1%);
- **Flood Zone B:** areas where the probability of flooding is moderate (between 0.1% and 1%);
- **Flood Zone C**: Areas where the probability of flooding is low (less than 0.1%).

Figure 6.3 shows that none of the site is considered to be in Flood Zone A however a portion of the site can be considered to be in Flood Zone B. This means that a Justification Test will be required for all types of development apart from those considered to be 'Water-compatible'. As the proposed development is for residential apartments a full Justification Test will be required. This is considered in Section 9.

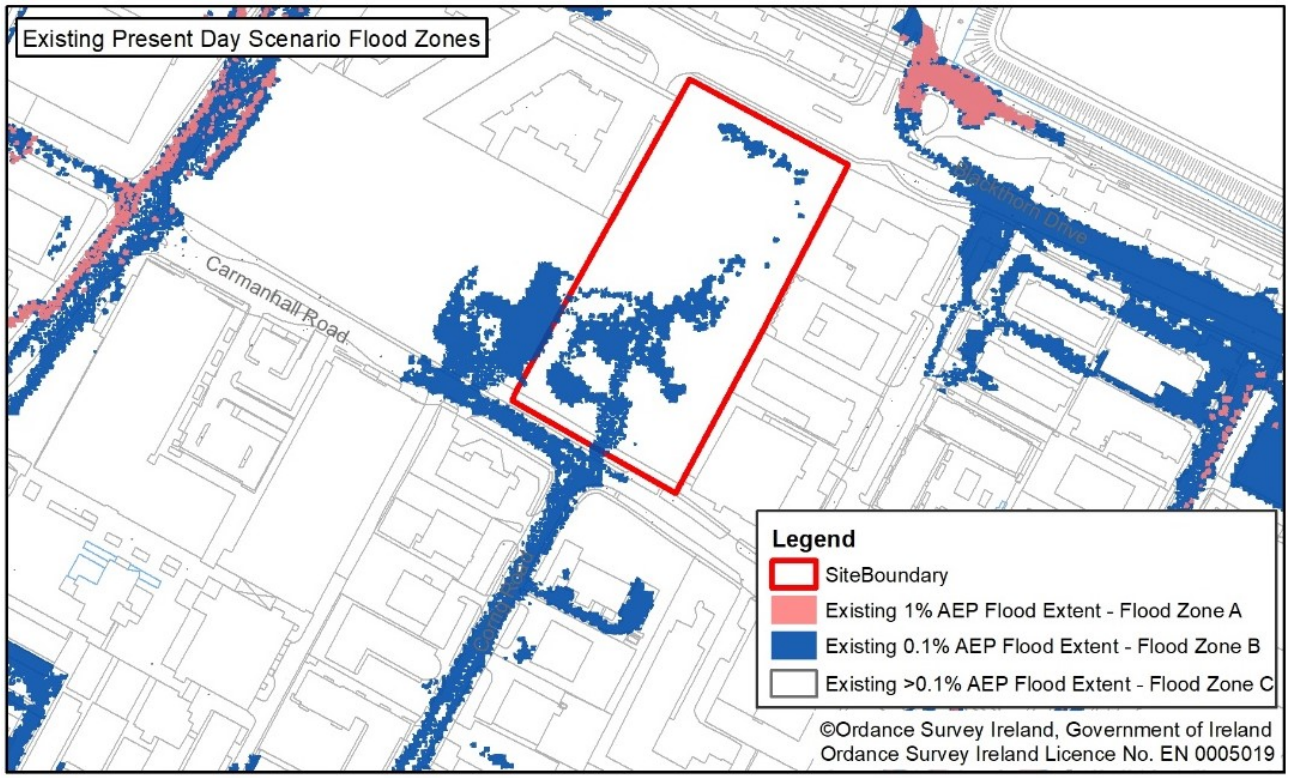


Figure 6.3 Flood Zones at Sandyford Central

7 FLOOD MITIGATION AND ANALYSIS

7.1 Development Proposal

It is proposed to demolish the existing structures on the site and to construct a strategic housing development. There will be six blocks with parking at basement level and ground level. The development will have a proposed ground level / finished floor level of approximately 85.30mOD across the majority of the site. Access to the basement is from the Carmanhall Road with a level of 84.30mOD.

As part of the proposed development an underground tank in the northeast corner of the site will provide storage to attenuate the runoff generated within the site. This will discharge to the existing 900mm diameter public surface water sewer in Blackthorn Drive. This sewer in turn discharges to the culverted Carysfort Maretimo stream approximately 635m downstream on Blackthorn Drive. The discharge from the site will be limited to a discharge rate of 0.0081m^3/s thus providing attenuation over and above the existing situation. All proposed flood mitigation measures are within the red line boundary of the site.

Figure 7.1 shows the proposed development including the proposed Finished Floor Levels of the buildings.

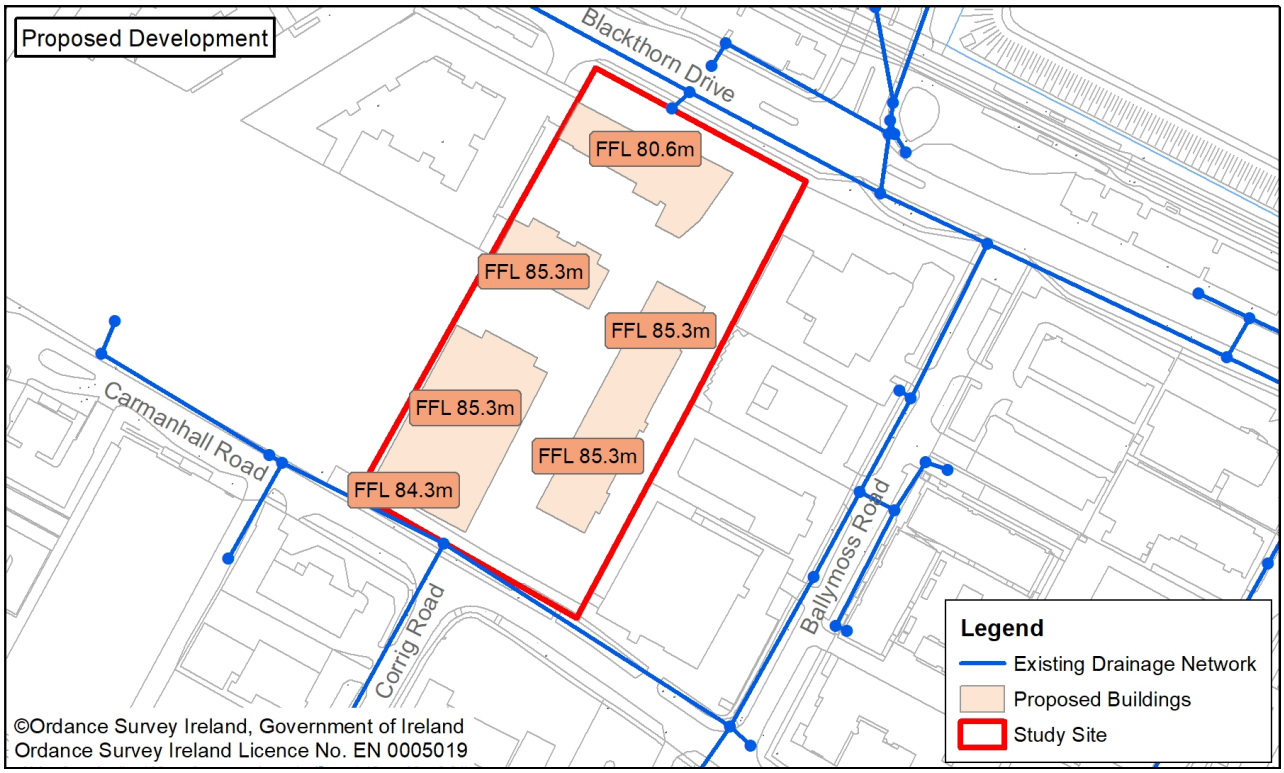


Figure 7.1 Proposed Development

7.2 Modelling of Proposed Development

The proposed site levels were built into the 2D mesh of the model to simulate the impact it will have on flooding in the area. The effect of attenuation and the subsequent reduction in flow leaving the proposed

development site has also been incorporated within the model by adjusting the flow from the contributing sub-catchment to a rate of 0.0081m^3/s.

The site is unaffected by the 1% AEP or 1% AEP plus Climate Change scenarios. There is no flooding on the site during these events, there is also a proposed reduction in the rate of run off to the storm drainage network. Therefore it can be concluded that for these two events the construction of the proposed development will not increase the risk of flooding elsewhere. RPS have still considered the 1% AEP and 1% AEP plus Climate Change flood levels, albeit contained within the storm water drainage network, and compared these to the proposed finished floor level of 85.30mOD to ensure there is adequate freeboard above events of this magnitude. As a further analysis to demonstrate the robustness of the proposed development in mitigating flood risk, the 0.1% AEP event has also been considered.

7.2.1 Post Development Scenario - 1% AEP

The model showed no flooding from the culverted Carysfort Maretimo stream or storm water drainage network occurs during a 1% AEP event in or around the site.

A predicted 1% AEP water level of 81.60mOD was taken within the existing manhole outside the site on the Carmanhall Road. The finished floor level of the proposed buildings on the Carmanhall Road is set at 85.30mOD and the entrance to the basement is at 84.30mOD providing confidence that adequate freeboard has been provided.

The flow in the culverted Carysfort Maretimo stream downstream of Blackthorn Avenue is 7.06m^3/s which is a marginal decrease compared to the existing scenario of 7.12m^3/s at this return period. This can be attributed to the runoff from the site being attenuated before entering the Carysfort Maretimo.

7.2.2 Post Development Climate Change Scenario - 1% AEP

The 1% AEP event plus climate change event was run to ensure that the flood levels are within the freeboard provided and did not reach the finished floor level of the proposed building.

The model showed no flooding from the culverted Carysfort Maretimo stream or storm water drainage network occurs during a 1% AEP climate change event in or around the site.

A predicted water level of 81.93mOD was taken within the existing manhole outside the site on the Carmanhall Road. The finished floor level of the proposed building is set at 85.30mOD and the entrance to the basement is at 84.30mOD providing confidence that the site is not sensitive to the predicted effects of climate change.

The flow in the culverted Carysfort Maretimo stream downstream of Blackthorn Avenue is 7.21m^3/s which is a slight decrease compared to the existing scenario of 7.26m^3/s at this return period.

7.2.3 Post Development Scenario - 0.1% AEP

The 0.1% AEP event was run to ensure that the flood levels are within the freeboard provided and did not reach the finished floor level of the proposed buildings or enter the basement. This model simulation included raising the existing ground levels across the site to the proposed levels.

During the existing 0.1% AEP event manholes on the Carmanhall Road and Corrig Road surcharge, causing out of pipe flooding. In the post development scenario the same flowpaths occur, with the exception that the overland flow does not enter the Sandyford Central site. The flood extent from this model is shown in Figure 7.2.

During this simulation a manhole on Carmanhall Road surcharges (shown in red in Figure 7.2) causing flooding on Carmanhall Road and an overland flowpath into the Rockbrook site. Two manholes on Corrig Road (shown in red in Figure 7.2) also surcharge causing an overland flowpath along Corrig Road, onto Carmanhall Road. As the proposed ground levels within the developed site are raised the overland flow cannot enter the site and remains on the Carmanhall Road. Some of this overland flow makes its way back into the drainage network on Carmanhall Road. As the runoff from the Sandyford Central site is attenuated there is more capacity in the drainage system, and this results in a marginally different flood extent on Carmanhall Road. This is further discussed below.

The predicted 0.1% AEP maximum water level adjacent to the site is 84.20mOD. The proposed finished floor level is 85.30mOD and the entrance to the basement is 84.30mOD providing confidence that adequate mitigation has been provided.

The flow in the culverted Carysfort Maretimo stream downstream of Blackthorn Avenue is 7.79m^3/s, which is a slight decrease compared to the existing scenario of 7.81m^3/s at this return period. This can be attributed to the runoff from the site being attenuated before entering the culverted Carysfort Maretimo stream.

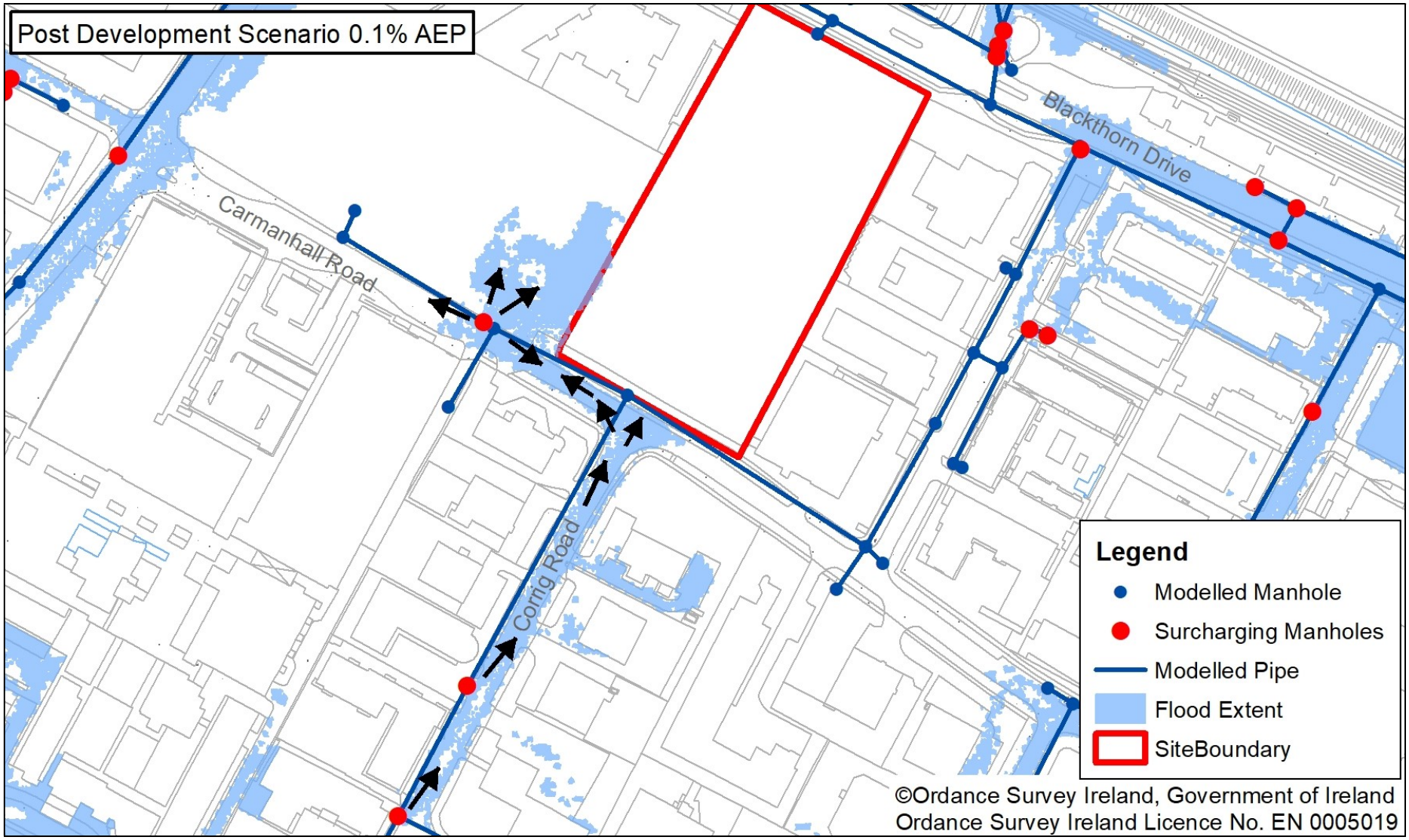


Figure 7.2 Post Development Scenario 0.1% AEP Extents

The extent and depth of flooding outside of the site were compared to the existing present day scenario 0.1% AEP event. The model shows that there would be no additional properties at risk of flooding and there would be no increase in flood risk to properties in the surrounding area due to the proposed development. A comparison of the present day and post development scenario extents can be seen in Figure 7.3 and at a larger scale in Appendix B.

Figure 7.3 contains three flood outlines as described below:

- Red – Those areas which flooded in the existing scenario but will no longer flood post development in the 0.1% AEP event.
- Blue – Those areas which did not flood in the existing scenario but will flood post development in the 0.1% AEP event.
- Purple – Those areas which flooded pre and post development i.e. no change.

It can be seen that flooding within the existing site will be removed by the development of the Sandyford Central site. Outside the site there are slight differences in the extents between the pre and post development scenarios (red and blue areas). A key aspect is that no new flood mechanisms have developed and no additional properties (including the Rochebois building in Beacon South Quarter and GC Technologies on Carmanhall Road) are shown to be at risk in the post development model simulation. However DLRCC have requested additional investigation on the risk to the Rochebois building on the eastern corner of the Beacon South Quarter site.

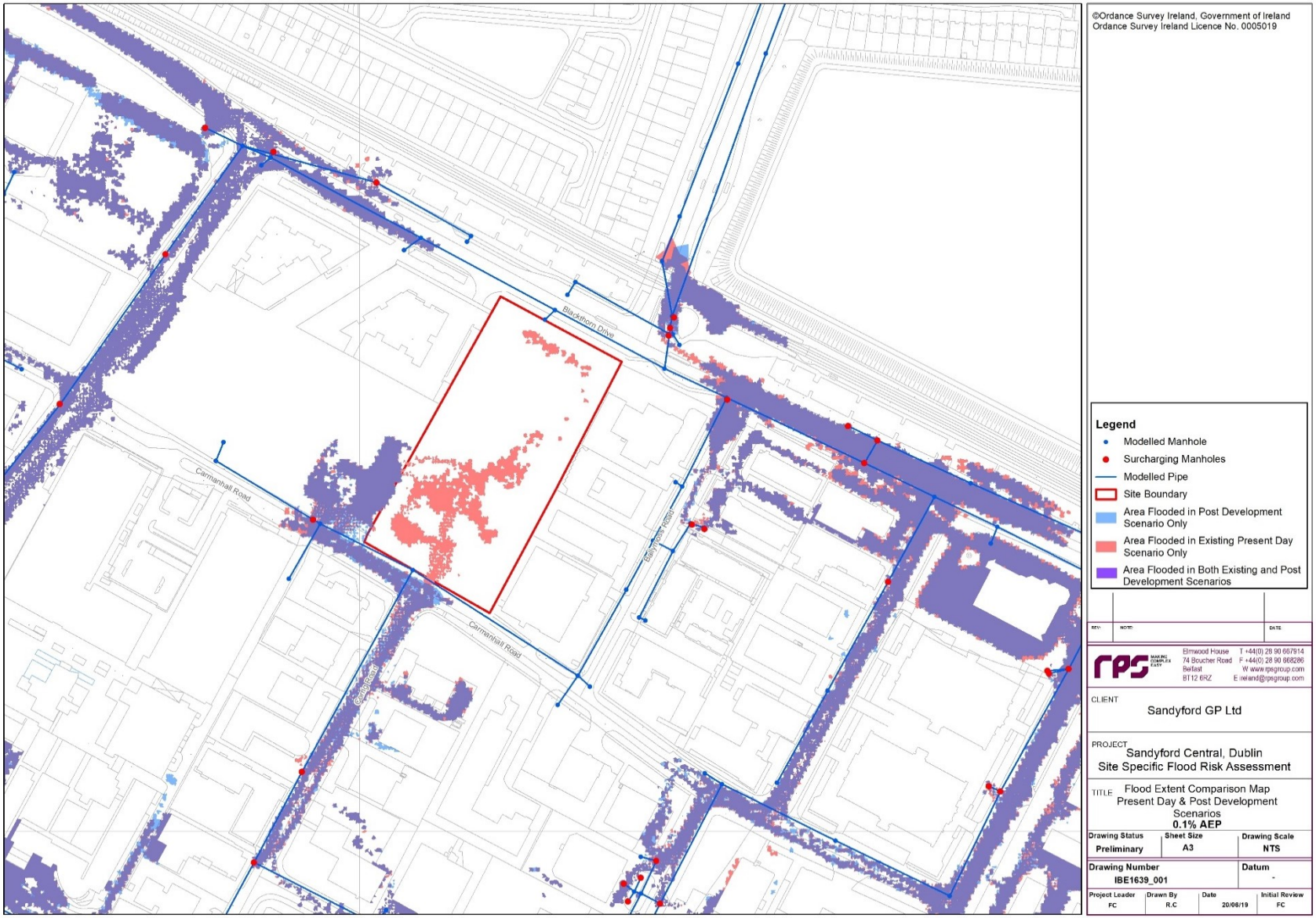


Figure 7.3 Comparison of Pre and Post Development Scenarios 0.1% AEP Extents

7.2.3.1 Beacon South Quarter – Fire doors at Rochebois

The Beacon South Quarter Buildings are across Carmanhall Road from the Rockbrook site. While the main access points are at first floor level there are two fire doors at the road level on the eastern corner with a finished floor level of 83.95mOD.

During the 0.1% AEP event for both the existing present day and post development scenarios the flood waters do not reach this building. The flood waters closest to the fire doors are on the Carmanhall Road. The flood water at this location is at a level of 83.91mOD during the existing present day scenario. During the existing present day scenario there is approximately 40mm freeboard provided to the fire doors on the eastern corner of the Beacon South Quarter Building.

During the post development scenario the flood water is at a level of 83.90mOD on the Carmanhall Road closest point to the fire doors. During the post development scenario there is approximately 50mm freeboard provided to the fire doors on the eastern corner of the Beacon South Quarter Building.

While these are very small margins of freeboard it must be considered that this is for the 0.1% AEP event and it still shows that the proposed development on the Sandyford Central site does not increase the risk to the Beacon South Quarter. The simulated levels can be seen in Figure 7.4 below and at a larger scale in drawing IBE1639/011 in Appendix C.

Figure 7.4 Comparison of Levels Pre and Post Development Scenarios 0.1% AEP

7.3 Modelling of Proposed Development plus Rockbrook Site Developed

The site adjacent to the Sandyford Central site on the northwest boundary is called the Rockbrook site. Currently this site is partially developed with the southern corner undeveloped. Both the existing present day and post Sandyford Central development scenarios in the previous chapters above have been modelled with the Rockbrook site in its current, partially developed condition. An additional scenario has been considered with both the proposed Sandyford Central site developed and the Rockbrook site fully developed.

An additional model was constructed to represent this scenario with the Sandyford Central site developed and the remaining portion of the Rockbrook site developed. This was done using the post Sandyford Central development model, as detailed in Section 6.2, and modifying it to include the elements of the proposed Rockbrook site. The Rockbrook site in the model was created based on the current Rockbrook planning application with details being taken from the SSFRA produced by Punch Consulting Engineers dated April 2019. The undeveloped southern portion of the Rockbrook site was set at a level of 85.05mOD with the runoff from the area attenuated to 0.010m^3/s. The proposed footway levels along the Carmanhall Road, access to the basement and the proposed wall at the Beacon South Quarter fire doors were also included in the model. The Rockbrook planning application also includes a proposed wall along the front of the Sandyford Central site. Currently within the Sandyford Central site the ground levels are lower than the Carmanhall Road levels and the purpose of this wall is to prevent displaced flood water entering into the Sandyford Central site. However, the proposed levels within the Sandyford Central site are higher than the wall. Therefore if both sites were developed as proposed, this wall would not be required. As such this wall has not been included in the model.

A 0.1% AEP event was simulated and compared to the existing present day scenario. During this event, in both scenarios, manholes on the Carmanhall Road and Corrig Road surcharge. The same flow paths occur in both scenarios, however in the post development scenario the overland flow from Carmanhall Road and Corrig Road does not enter either the Sandyford Central or Rockbrook sites.

The flood extent and levels from this model are shown in Figure 7.5, Figure 7.6 and at a larger scale in drawings IBE1639/003 and IBE1639/013 in Appendix D and E. Note that this scenario has different extents/depths from those with only the Sandyford Central site developed (Drawings 001 and 011). During this simulation manholes on Corrig Road surcharge causing an overland flowpath along Corrig Road, onto Carmanhall Road. A manhole on Carmanhall Road also surcharges causing flooding on Carmanhall Road. As the proposed ground levels of both the Rockbrook and Sandyford Central sites are raised the overland flow from Carmanhall Road cannot enter either site and remains on the road. The runoff from the developed site is attenuated to 0.010m^3/s which creates more capacity in the storm water drainage network allowing some flooding on Carmanhall Road to return to the drainage network. This results in only a slight increase in the flooding on Carmanhall Road as seen in Figure 7.5 (in blue) and at a larger scale in drawing IBE1639/003 in Appendix D. There is no adverse impact on the Beacon South Quarter building or other buildings in the surrounding area.

7.3.1 Rockbrook Site SSFRA

The modelling approach taken by Punch Consulting Engineers for the Rockbrook SSFRA differs to that undertaken for this SSFRA for the Sandyford Central site. The Rockbrook model uses a 1D-2D linked model and has not included the drainage network. It has also adjusted the existing ground model so that the baseline model does not include an existing basement structure in the unfinished Rockbrook site. While the Sandyford Central model includes the drainage network and is fully integrated across the 1D-2D. Therefore the results from the models also differ from each other, with those from the Rockbrook model being more conservative.

The Rockbrook model has predicted a flood level of 84.19mOD along Carmanhall Road during the 0.1%AEP event. The proposed finished floor levels in the Sandyford Central site are set at 85.30mOD.

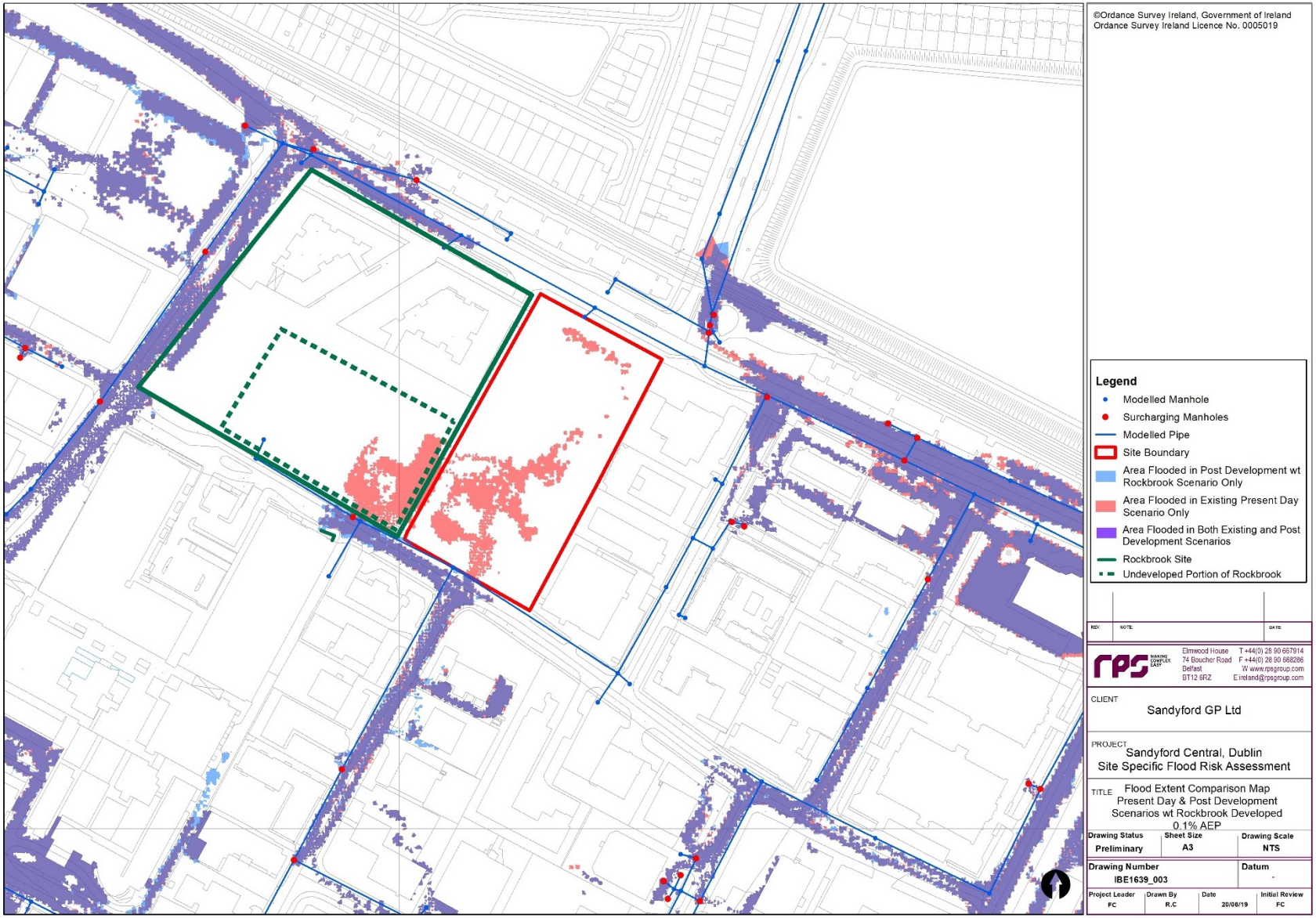


Figure 7.5 Comparison of Pre and Post Development Scenarios 0.1% AEP Extents (with Rockbrook site developed)

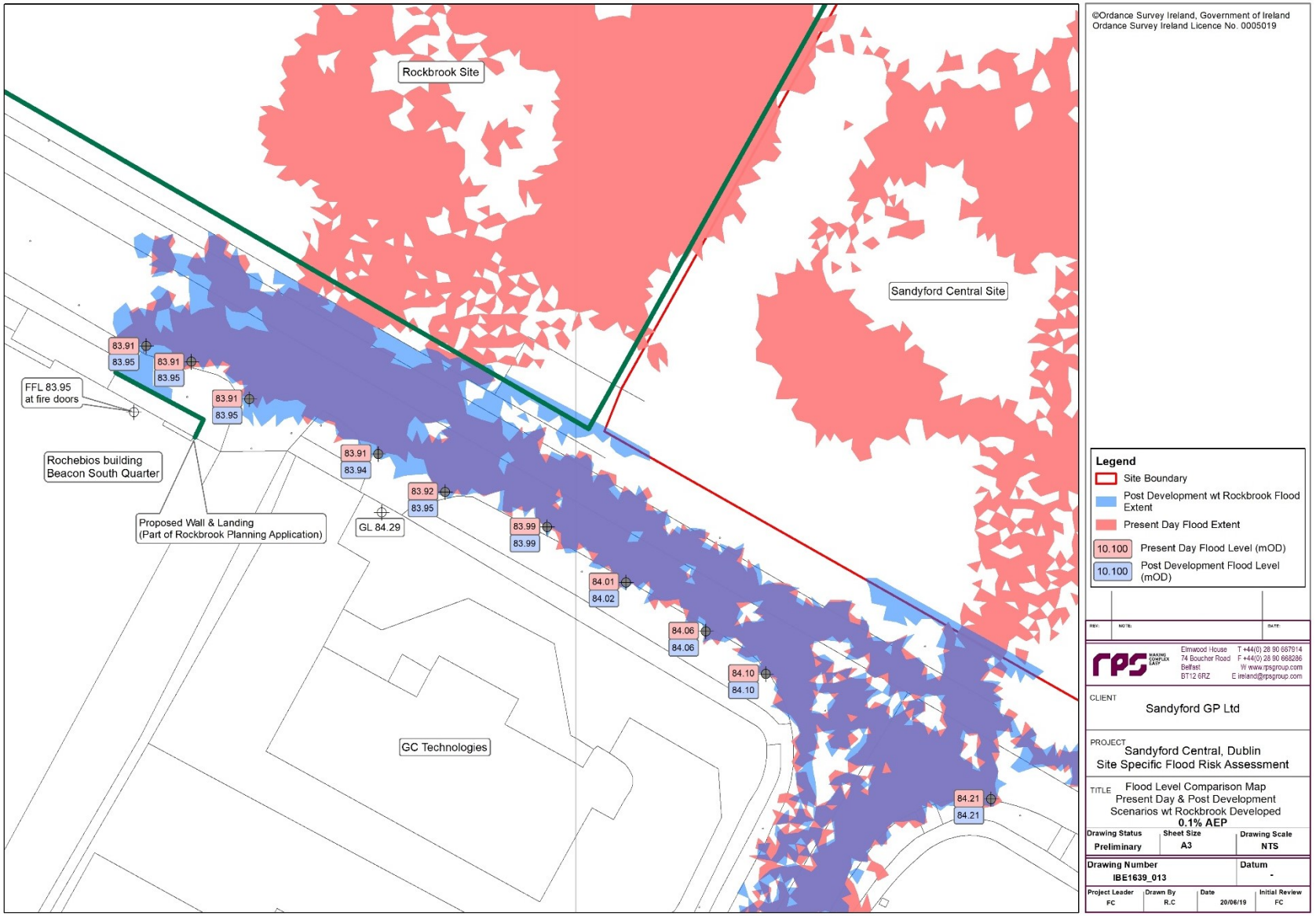


Figure 7.6 Comparison of Levels Pre and Post Development Scenarios 0.1% AEP (with Rockbrook site developed)

7.4 Emergency Plan and Access/Egress

The development itself is not at risk of flooding during the 1% AEP event as such no emergency plan is proposed. The roads surrounding the site are also shown not to be at risk during the 1% AEP event which highlights that safe access and egress to the site from either Carmanhall Road or Blackthorn Drive can still be maintained in the event of a 1% AEP flood.

7.5 Surface Water Drainage

The proposals for surface water management have been prepared by O'Connor Sutton Cronin and are shown in drawing SFC-OCSC-00-01-DR-C-0500 in Appendix F.

7.6 Residual Risk

Any site adjacent to an area prone to flooding can never have absolute protection as unforeseen circumstances, such as blockages, can occur which can cause elevated flood levels above those predicted in this report. Furthermore even the 0.1% AEP event analysed in this report can be exceeded and inundation of the proposed development could occur as a result. However the proposed development and finished floor levels incorporated within the design of the development have been demonstrated to be resilient to the effects of climate change and also extreme events up to the 0.1% AEP event. In risk terms the proposed development can therefore be considered to have a low residual risk.

Any buildings in the surrounding area that are at risk of flooding in the present day scenario remain at risk in the post development scenario. However the proposed Sandyford Central development will not increase this risk. There is therefore a residual flood risk to these properties, albeit the same as at present.

8 CLASSIFICATION UNDER PLANNING SYSTEM AND FLOOD RISK MANAGEMENT GUIDELINES

The 'Planning System and Flood Risk Management Guidelines' classify different types of development in terms of their vulnerability class (Table 3.1 of the Guidelines). This table has been reproduced as Figure 8.1.

Vulnerability class	Land uses and types of development which include*:
Highly vulnerable development (including essential infrastructure)	Garda, ambulance and fire stations and command centres required to be operational during flooding; Hospitals; Emergency access and egress points; Schools; Dwelling houses, student halls of residence and hostels; Residential institutions such as residential care homes, children's homes and social services homes; Caravans and mobile home parks; Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility; and Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.) in the event of flooding.
Less vulnerable development	Buildings used for: retail, leisure, warehousing, commercial, industrial and non-residential institutions; Land and buildings used for holiday or short-let caravans and camping, subject to specific warning and evacuation plans; Land and buildings used for agriculture and forestry; Waste treatment (except landfill and hazardous waste); Mineral working and processing; and Local transport infrastructure.
Water-compatible development	Flood control infrastructure; Docks, marinas and wharves; Navigation facilities; Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location; Water-based recreation and tourism (excluding sleeping accommodation); Lifeguard and coastguard stations; Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific warning and evacuation plan).
*Uses not listed here should be considered on their own merits	

Table 3.1 Classification of vulnerability of different types of development

Figure 8.1 Extract from Planning Guidelines - Classification of vulnerability of development

Table 3.2 of the Guidelines identifies the type of development that would be appropriate to each flood zone and those that would need the Justification Test. This table has been reproduced as Figure 8.2.

	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

Table 3.2: Matrix of vulnerability versus flood zone to illustrate appropriate development and that required to meet the Justification Test.

Figure 8.2 Extract from Planning Guidelines - Vulnerability versus flood zones

The type of development proposed for the site is mainly residential and will incorporate the following:

- Apartments - classified as 'highly vulnerable development'. This type of development requires a Justification Test in Flood Zones A and B (Table 3.2 of the guidelines);
- A crèche and café - classified as 'less vulnerable development'. This type of development is appropriate in Flood Zone B but requires a Justification Test in Flood Zone A (Table 3.2 of the guidelines).

9 JUSTIFICATION TEST

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

- The **Development Plan Justification Test** described in Chapter 4 of the Guidelines 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 **Development Management Justification Test** described in Chapter 5 of the Guidelines 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.

9.1 Development Plan Justification Test

The Justification Test for Development Plans (outlined in Box 4.1 of the guidelines) was applied in the making of the Dún Laoghaire-Rathdown County Development Plan 2016 – 2022 Strategic Flood Risk Assessment (SFRA) so it is not required to be completed as part of this Site Specific FRA. In the SFRA, the Justification Test was carried out for each land parcel where the encroachment of Flood Zones A and B is significant, as for this site. In regard to this site the SFRA recommends that the flood risk is managed through a site specific FRA.

9.2 Development Management Justification Test

Where a planning authority is considering proposals for new development in areas at a high or moderate risk of flooding that includes types of development that are vulnerable to flooding and that would generally be inappropriate as set out in Table 3.2 of the Guidelines, the planning authority must be satisfied that the development satisfies all of the criteria of the Development Management Justification Test outlined in Box 5.1 of the guidelines and reproduced as Figure 9.1.

Box 5.1 Justification Test for development management (to be submitted by the applicant)

When considering proposals for development, which may be vulnerable to flooding, and that would generally be inappropriate as set out in Table 3.2, the following criteria must be satisfied:

1. The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines.
2. The proposal has been subject to an appropriate flood risk assessment that demonstrates:
   - (i) The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;
   - (ii) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;
   - (iii) The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access; and
   - (iv) The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.

The acceptability or otherwise of levels of residual risk should be made with consideration of the type and foreseen use of the development and the local development context.

Note: See section 5.27 in relation to major development on zoned lands where sequential approach has not been applied in the operative development plan.

Refer to section 5.28 in relation to minor and infill developments.

Figure 9.1 Extract from Planning Guidelines - Justification Test for Development Management

Table 9.1 sets out the response to each of criteria in Box 5.1 that must be satisfied. Each of the criteria have been shown to be satisfied and therefore it is concluded that the proposed development complies with the requirements of the Development Plan Justification Test.

Table 9.1 Response to Justification Test for Development Management for proposed development

Criteria		Response
1.	The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development	The subject site is zoned 'MIC' in the Dún Laoghaire-Rathdown County Development Plan 2016-2022, where the stated objective is 'to consolidate and complete the development of the mixed-use inner core to enhance and reinforce sustainable development'. The proposed development which comprises 564 No. residential

	plan, which takes account of these Guidelines	units with ancillary residential amenities, crèche and café are permitted in principle at the subject lands. Please refer to the Planning Report and Statement of Consistency prepared by Thornton O'Connor Town Planning.
2.	The proposal has been subject to an appropriate flood risk assessment that demonstrates:	
(i)	The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk	This has been addressed in Section 7. The modelling shows that there is no increased flood risk to any neighbouring properties or lands. In order to discharge storm water flows to the existing storm network flows from the site will be attenuated. Therefore there will be no increased risk elsewhere from surface water or drainage from the proposed development.
(ii)	The development proposal includes mitigation measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible	There is no flooding in or adjacent to the site during the predicted 1% AEP event including a 10% climate change factor (as per the GDSDS). Access and egress routes to the site are maintained. Therefore, the risk of flooding to people, property and the environment is very low. This level of protection will ensure that there will be no impact on the economy, i.e. there will not be an unacceptable level of flood risk which might subsequently require government capital expenditure to alleviate the problem. In order to discharge storm water flows to the existing storm network, flows from the site will be attenuated and discharge will be restricted by a flow control device. In addition, minimum FFLs for the proposed site are above the predicted 0.1% AEP event flood levels. This provides adequate protection to the proposed development.
(iii)	The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures	The residual risk to the proposed development is low, as the development is protected up to a 0.1% AEP event. This gives added assurance that the proposed mitigation measures are more than adequate to deal with any future flood risk. The access to the site, car park and open space areas are above the 1% AEP flood level including climate change. This will ensure emergency access at all times. No specific risks have been identified that would necessitate a flood evacuation plan for the site.

	and provisions for emergency services access	
(iv)	The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of god urban design and vibrant and active streetscapes	The high quality residential development will have a positive contribution to the surrounding area of Carmanhall Road and Blackthorn Drive as discussed in detail in the accompanying Planning Report prepared by Thornton O'Connor Town Planning. The proposed layout which has been designed with regard to flood mitigation will create a vibrant and welcoming streetscape with the proposed resident amenities, creche and café providing an active frontage. In addition, the 6 No. Blocks will provide active surveillance of the streetscape and internal open spaces.

10 CONCLUSION

RPS were commissioned by Sandyford GP Limited (acting in its capacity as general partner for the Sandyford Central Partnership) to investigate the flood risk posed to a development site off Carmanhall Road in the Sandyford Business Estate. Flood risk in the study area originates from two main sources; the fluvial source is the Carysfort Maretimo Stream which is located to the south of the site as a culverted watercourse (1.2m diameter pipe), and pluvial source caused by the drainage network being overwhelmed by intense rainfall surcharging onto the road network causing overland flow into the study site.

In order to assess the existing flood risk to the site and determine the impact of the proposed development, RPS constructed a detailed site specific model. This consisted of a 1D drainage network model combined with a 2D flood plain model which provides an accurate assessment of both the in pipe drainage flow regime and floodplain flow paths.

The model has shown that the proposed development and mitigation measures will ensure that the risk of flooding to the proposed development is minimised. For all three events assessed neither the proposed buildings nor the basement are impacted by flood waters with adequate freeboard provided.

The model has also demonstrated that the proposed development causes no additional properties to flood and no increase in flood risk in the surrounding area during the 1% AEP, 1% AEP plus climate change or the 0.1% AEP events.

Following the development of the site the flow in the culverted Carysfort Maretimo stream downstream of the site will be reduced due to the attenuation of the runoff from the site.

Furthermore RPS assessed the scenario in which, in addition to the Sandyford Central site, the adjacent Rockbrook site is also developed. In this scenario the model demonstrated that with both developments in place there is no increase in flood risk to the properties in the surrounding area.

The ‘Planning System and Flood Risk Management Guidelines’ has been applied. It classifies different types of development in terms of their vulnerability. The proposed development will consist of residential apartment blocks incorporating a crèche and café which under the guidelines is classed as ‘highly vulnerable’. The modelling results show that the site is considered to be in Flood Zone B and due to the high vulnerability usage a Justification Test has been applied.

Each of criteria in the Development Management Justification Test was shown to be satisfied for the proposed development. Therefore it was concluded that the proposed development complies with the requirements of the Development Plan Justification Test.

The proposed development will not be at risk of flooding and will not give rise to an increase in flood risk elsewhere. The proposed development has therefore been shown to be compliant with the ‘Planning System and Flood Risk Management Guidelines’.

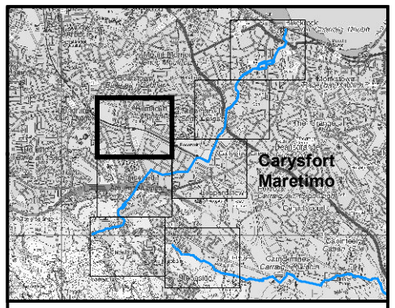
Appendix A

EASTERN CFRAM STUDY MAP E09_CAR_EXFCD_F2_03

317800 318000 318200 318400 318600 318800 319000 319200

227800 227600 227400 227200 227000 226800

KILMACUD WEST
Cill Mochuda Thiar



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

Legend

- 10% Fluvial AEP Event
- 1% Fluvial AEP Event
- 0.1% Fluvial AEP Event
- Modelled River Centreline
- AFA Extents
- Embankment
- Wall
- Defended Area
- 1% AEP Standard of Protection of Flood Defence (Walls / Embankments)
- Node Point
- Node ID Node Label

FINAL

REV:	NOTE:	DATE:

EASTERN CFRAM STUDY
CATCHMENT FLOOD RISK ASSESSMENT AND MANAGEMENT

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RPS

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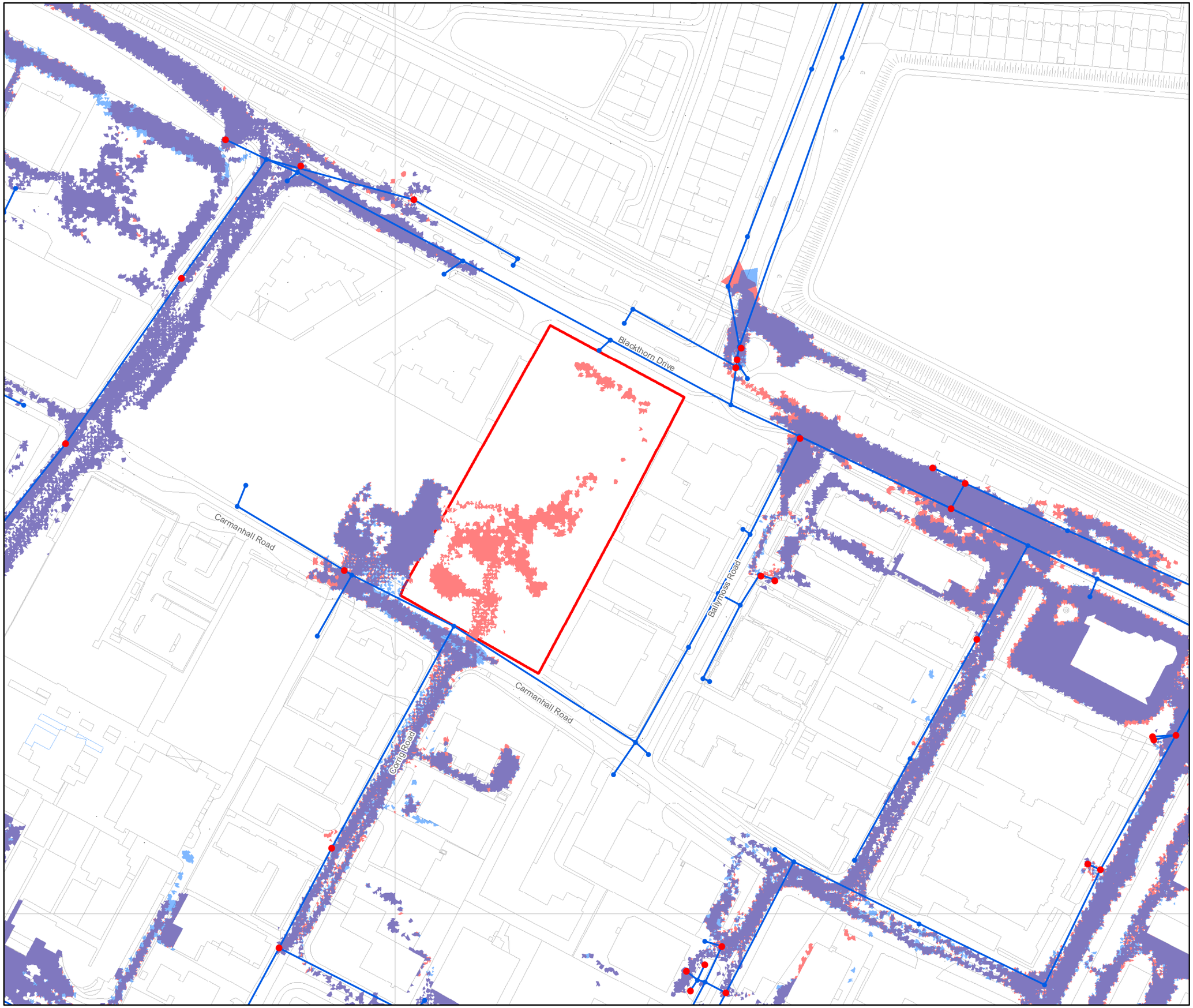
Map:	Carysfort Maretimo Fluvial Flood Extents
Map Type:	EXTENT
Source:	FLUVIAL
Map Area:	HPW
Scenario:	CURRENT
Drawn By : C.C.	Date : 27 October 2017
Checked By : A.S.	Date : 27 October 2017
Approved By : S.P.	Date : 27 October 2017
Drawing No. :	E09CAR_EXFCD_F2_03
Map Series :	Page 3 of 7
Drawing Scale :	1:5,000 @ A3

0 50 100 200 300 400 500 Metres

Appendix B

FLOOD EXTENT COMPARISON MAP PRESENT DAY & POST DEVELOPMENT SCENARIOS 0.1% AEP (DRAWING IBE1639/001)



Legend

- Modelled Manhole
- Surcharging Manholes
- Modelled Pipe
- Site Boundary
- Area Flooded in Post Development Scenario Only
- Area Flooded in Existing Present Day Scenario Only
- Area Flooded in Both Existing and Post Development Scenarios

REV:	NOTE:	DATE:

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CLIENT
Sandyford GP Ltd

PROJECT
Sandyford Central, Dublin
Site Specific Flood Risk Assessment

TITLE
Flood Extent Comparison Map
Present Day & Post Development Scenarios
0.1% AEP

Drawing Status	Sheet Size	Drawing Scale
Final	A3	NTS

Drawing Number	Datum
IBE1639_001	-

Project Leader	Drawn By	Date	Initial Review
FC	R.C	04/11/19	FC

Appendix C

FLOOD LEVEL COMPARISON MAP PRESENT DAY & POST DEVELOPMENT SCENARIOS 0.1% AEP (DRAWING IBE1639/011)

Legend

- Site Boundary
- Post Development Flood Extent
- Present Day Flood Extent
- 10.100 Present Day Flood Level (mOD)
- 10.100 Post Development Flood Level (mOD)

REV:	NOTE:	DATE:

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PROJECT
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Site Specific Flood Risk Assessment

TITLE
Flood Level Comparison Map
Present Day & Post Development Scenarios
0.1% AEP

Drawing Status	Sheet Size	Drawing Scale
Final	A3	NTS

Drawing Number	Datum
IBE1639_011	-

Project Leader	Drawn By	Date	Initial Review
FC	R.C	04/11/19	FC

Appendix D

FLOOD EXTENT COMPARISON MAP PRESENT DAY & POST DEVELOPMENT SCENARIOS 0.1% AEP WITH ROCKBROOK SITE DEVELOPED (DRAWING IBE1639/003)

Legend

- Modelled Manhole
- Surcharging Manholes
- Modelled Pipe
- Site Boundary
- Area Flooded in Post Development wt Rockbrook Scenario Only
- Area Flooded in Existing Present Day Scenario Only
- Area Flooded in Both Existing and Post Development Scenarios
- Rockbrook Site
- Undeveloped Portion of Rockbrook

REV:	NOTE:	DATE:

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Site Specific Flood Risk Assessment

TITLE
Flood Extent Comparison Map
Present Day & Post Development
Scenarios wt Rockbrook Developed
0.1% AEP

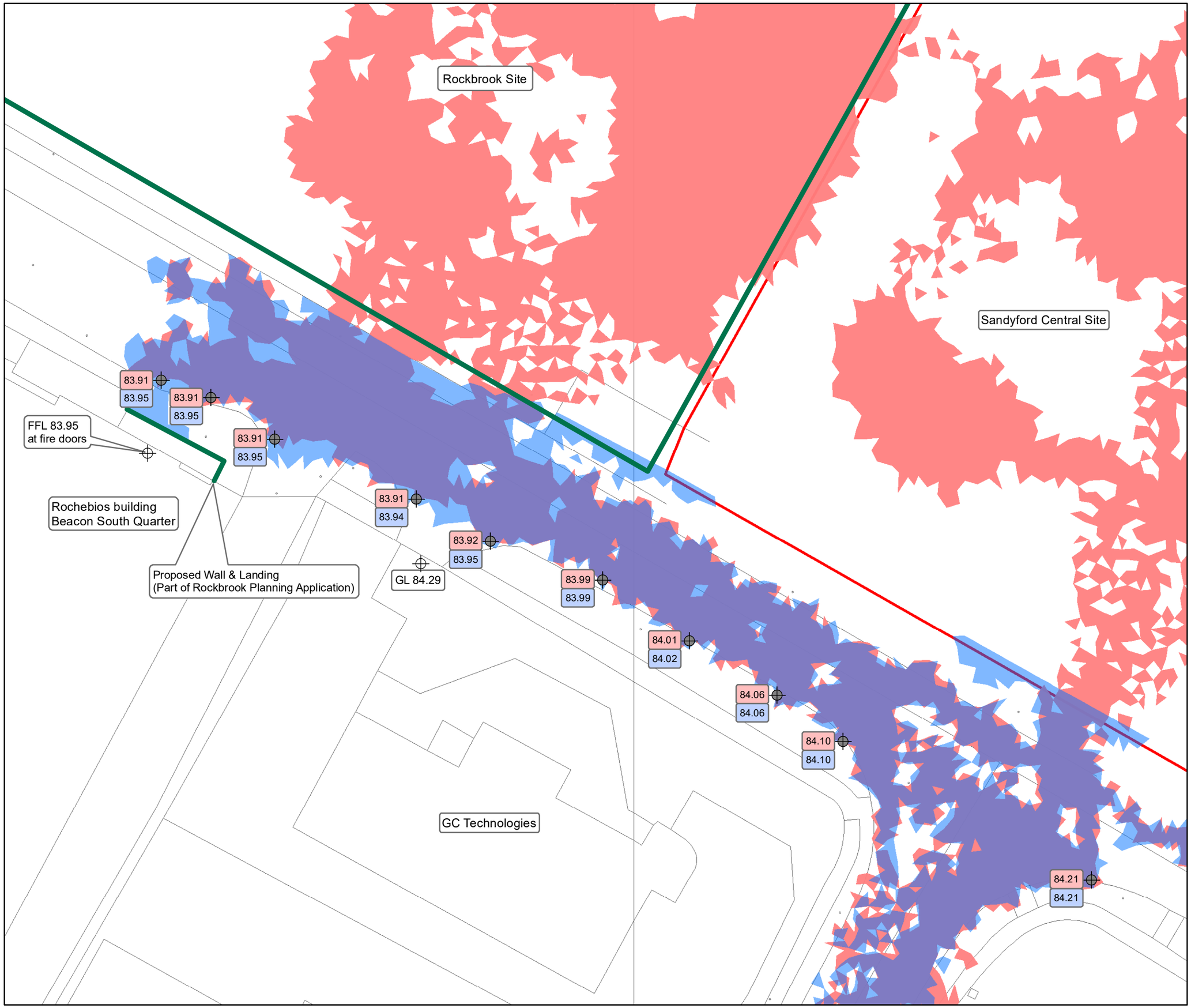
Drawing Status	Sheet Size	Drawing Scale
Final	A3	NTS

Drawing Number	Datum
IBE1639_003	-

Project Leader	Drawn By	Date	Initial Review
FC	R.C	04/11/19	FC

Appendix E

FLOOD LEVEL COMPARISON MAP PRESENT DAY & POST DEVELOPMENT SCENARIOS 0.1% AEP WITH ROCKBROOK SITE DEVELOPED (DRAWING IBE1639/013)



Legend

- Site Boundary
- Post Development wt Rockbrook Flood Extent
- Present Day Flood Extent
- 10.100 Present Day Flood Level (mOD)
- 10.100 Post Development Flood Level (mOD)

REV:	NOTE:	DATE:

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CLIENT
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PROJECT
Sandyford Central, Dublin
Site Specific Flood Risk Assessment

TITLE
Flood Level Comparison Map
Present Day & Post Development
Scenarios wt Rockbrook Developed
0.1% AEP

Drawing Status	Sheet Size	Drawing Scale
Final	A3	NTS

Drawing Number	Datum
IBE1639_013	-

Project Leader	Drawn By	Date	Initial Review
FC	R.C	04/11/19	FC

Appendix F

PROPOSED DRAINAGE LAYOUT – SURFACE WATER (DRAWING SFC-OCSC-00-04-DR-C-0500)

EXISTING SURFACE WATER

PROPOSED SURFACE WATER

PROPOSED FLOW CONTROL

BELOW FINISH SUDS FLOW PATHS

INDICATES 1:80 PAVEMENT FALLS

PROPOSED FILTER DRAIN

PROPOSED GREEN ROOF

AREA TO BE TAKEN IN CHARGE

PROPOSED OGCR/PERMEABLE PAVING ON PODIUM

PROPOSED BIORETENTION

PROPOSED RAINGARDENS /DEPRESSION STORAGE

PROPOSED TREE PIT

PROPOSED 300Dp. STORAGE (150Dp. PERMAVOID WITH 150Dp. OGCR ABOVE)

TOTAL SITE AREA = 1.54ha
SITE Qmax: 8.1 l/s (Q1) SOIL TYPE 4

TOTAL SITE IMPERMEABLE RUNOFF = 1.429ha

5mm INTERCEPTION
3,650m² GREEN ROOFS & 2,780m²BIO RETENTION / PLANTER ON PODIUM (6,430m² @ 5mm) = 32.0m³
510m² OGCR BELOW PERMEABLE PAVING (300mm Dp. @ 30% VOIDS) = 46m³

ATTENUATION
6,442m² CELLULAR STORAGE SUB BASE (150mm Dp. @ 95% VOIDS) = 918m³
6,089m² OGCR ABOVE CELLULAR STORAGE SUB BASE (150mm Dp. @ 30% VOIDS) = 317m³
510m² OGCR BELOW PERMEABLE PAVING (300mm Dp. @ 30% VOIDS) = 46m³
170m FILTER DRAINS (600mm² @ 30% VOIDS) = 18m³

TREATMENT
3,650m² GREEN ROOFS & 2,780m² BIO RETENTION / PLANTER ON PODIUM (200mm + 150mm Dp. @ 30% VOIDS) = 219m³ + 125.1m³ = 344m³
510m² OGCR BELOW PERMEABLE PAVING (300mm Dp. @ 30% VOIDS) = 46.0m³
710m² RAINGARDEN / SHALLOW DEPRESSION STORAGE @ 50mm = 35.5m³
170m FILTER DRAINS (600mm² @ 30% VOIDS) = 18.0m³

TOTAL STORAGE PROVIDED (EXCLUDING INTERCEPTION & TREATMENT STORAGE) & VERIFIED BY MODEL = 1,299m³

NOTE: PRELIMINARY DESIGN - SUBJECT TO DETAIL DESIGN FOR CONSTRUCTION, FINAL COORDINATION WITH LANDSCAPE ARCHITECT, ARBORIST AND M&E.

FOOTPATHS FOR TAKING IN CHARGE AREAS TO DRAIN TO KERB & PUBLIC ROAD GULLIES & SW NETWORK

INDICATES PROPOSED SLOT DRAIN TO DELINEATE THE SITE AND PREVENT RUN OFF TO PROPOSED TAKING IN CHARGE AREA

REFER TO DETAIL DRG. No. 0510 FOR SLOT DRAIN CONNECTION TO FILTER DRAIN

CHAMBER OUTLET PIPE FITTED WITH FILTER & FLOW DIFFUSER TO DISTRIBUTE ROOF RUNOFF INTO SUDs COMPONENTS

ALL BRANCH PIPES TO BE 150mm uPVC AT 1:150 UNLESS OTHERWISE NOTED

INDICATES FLOW PATHS THROUGH OPEN GRADED CRUSHED ROCK (OGCR) BELOW PAVERS / LANDSCAPING AND ABOVE PODIUM. TYPICALLY 150mm DEPTH STONE LAYER WITH 40% POROSITY. WIDTH REQUIRED TO BE CONFIRMED WITH HYDRAULIC DESIGN CALCULATIONS

OPEN JOINT/PERMEABLE PAVING OR INLET LOCATIONS OGCR BELOW TO TO BE CONFIRMED AND AGREED WITH LANDSCAPE ARCHITECT

DOWNPIPE TO DISCHARGE TO PERMEABLE PAVING SUB BASE VIA GEOCELLUAR BOX / PERMAVOID OR EQUAL WRAPPED IN GEOTEXTILE TO FORM DIFFUSER

GREEN ROOF OUTLET FLOW CONTROL RESTRICTED TO 1.0l/s (41mm ORIFICE) WITH OVERFLOWS AT TOP OF SEDUM. DOWNPIPE LOCATED TO BE CONFIRMED BY ARCHITECT

ROOF DRAINAGE DOWNPIPES ADJACENT PLANTERS TO DISCHARGE AT PLANTER SURFACE LEVEL TO INFILTRATE AS PER DETAIL

PROPOSED GREEN ROOFS WITH 200mm MIN. Dp STORAGE @ 32% POROSITY

PROPOSED LIFT SHAFTS OVERRUN TO DISCHARGE VIA DOWNPIPES ONTO GREEN ROOF SURFACE

ALL OTHER FLOW CONTROLS @ 3.0l/s UNLESS OTHERWISE NOTED

ALL BLUE ROOF FLOW CONTROLS @ 1.0l/s PER OUTFALL UNLESS OTHERWISE NOTED

SURFACE WATER TO FLOW TO OGCR DRAINAGE PATHS VIA CELLULAR STORAGE DISTRIBUTION BOX WRAPPED IN GEOTEXTILE AS SHOWN ON DETAIL DRG. No. 0510

LINEAR DRAIN - SLOT DRAIN OR SIMILAR TO DELINEATE SITE BOUNDARY & PREVENT RUN OFF FROM PRIVATE SURFACES TO PUBLIC

EXISTING 300mm SURFACE WATER CONNECTION TO BE REUSED

TAKEN IN CHARGE AREA TO DRAIN TO ROAD & TREE PITS OUTSIDE OF SITE

LAST PRIVATE MANHOLE. WITH LIMITED SITE DISCHARGE

FLOW CONTROL WITH HYDROBRAKE CHAMBER LIMITED TO 8.1/s

PROPOSED CELLULAR STORAGE TANK LOCATION

PROPOSED OVERFLOW TO RAINGARDENS DURING EXCEEDANCE EVENTS WITH A STORAGE DESIGN DEPTH +0.150m WITH 150mm FREEBOARD

PROPOSED SWALE OUTFALL DEATIL WITH CONTROLLED DISCHARGE

CONTROFLOW 600 SERIES LEVEL INVERT OR EQUAL APPROVED FLOW CONTROL CHAMBER WITH ORIFICE LIMITED AS NOTED

PROPOSED600x600xmmFILTER DRAIN BELOW RAINGARDEN / SHALLOW DEPRESSION STORAGE

CHAMBER OUTLET PIPEFITTED WITH FILTER &FLOW DIFFUSER TODISTRIBUTE ROOF RUNOFFINTO SUDs COMPONENTS

PROPOSED SHALLOW 150mm DEPRESSION STORAGE INTEGRATED INTO LANDSCAPING FOR EXCEEDANCE EVENTS

PROPOSED 300 Dp. SWALE LOCATION WITH 150 Dp. STORAGE DESIGN DEPTH +0.150m WITH 150mm FREEBOARD. ROUTE INDICATIVE

PIPE BURIED UNDER CARPARK LEVEL 0

TAKEN IN CHARGE AREA TO DRAIN TO ROAD & TREE PITS OUTSIDE OF SITE

GR	- GREEN ROOF
BR	- BLUE ROOF / BIO RETENTION
DP	- DOWN PIPE
BP	- BRANCH PIPE CONNECTION
FD	- 300Ø FILTER DRAIN
AJ	- 350Ø ARMSTRONG JUNCTION < 600mm
IC	- 450Ø INSPECTION CHAMBER 600 - 1200mm
MH	- 1200Ø MANHOLE 1200 - 1500mm
HB	- 1200Ø HYDROBRAKE CHAMBER
FC	- 500Ø FLOW CONTROL CHAMBER

FOR THE SUB CATCHMENT AREA OVERVIEW, REFER TO Drg. SFC-OCSC-XX-XX-DR-C-0508

REFER TO ENGINEERS SERVICE REPORT FOR PIPE DESIGN CALCULATION AND DRAINAGE LONGSECTIONS

REFER TO Drg. SFC-OCSC-XX-XX-DR-C-0510 FOR SuDs DRAINAGE DETAILS AND Drg. SFC-OCSC-XX-XX-DR-C-0515 FOR TYPICAL DRAINAGE DETAILS

NOTES:
1. ALL PIPES TO BE SIZED AND LAID AS NOTED;
2. ALL POP-UP LOCATIONS AND SIZES TO BE CONFIRMED WITH ARCHITECTS & M&E DRAWINGS;
3. ALL FOUL AND SURFACE WATER PIPES >150mmØ TO BE CONCRETE OR SIMILAR APPROVED;
4. ALL INTERNAL DRAINAGE IN ACCORDANCE TO THE BUILDING REGULATIONS PART H;
5. ALL 100mmØ SURFACE PIPES TO BE uPVC LAID @ 1:100 GRADIENT UNLESS OTHERWISE NOTED;
6. ALL 150mmØ FOUL PIPES TO BE uPVC LAID @ 1:100 GRADIENT UNLESS OTHERWISE NOTED;
7. NON RETURN VALVES TO BE TIDEFLEX IN LINE CHECK VALVE OR SIMILAR APPROVED AT PIPE OUTLETS;
8. ALL CHAMBER COVERS TO BE D400 RATED;
9. ALL FOUL CHAMBERS TO HAVE DOUBLE-SEALED COVERS;
10. SADDLE CONNECTIONS TO BE PROVIDED AT ALL BRANCH CONNECTIONS TO MAIN DRAINAGE NETWORKS, UNLESS AT MANHOLE;
11. ALL NOTED PIPE DIAMETERS ARE INTERNAL.

INFORMATION ONLY

THIS DRAWING HAS BEEN ISSUED FOR INFORMATION PURPOSES ONLY AND MUST NOT BE USED FOR CONSTRUCTION UNDER ANY CIRCUMSTANCES

- FOR SETTING OUT REFER TO ARCHITECT'S DRAWINGS.
- THIS DRAWING TO BE READ IN CONJUNCTION WITH ALL OTHER ARCHITECTURAL AND ENGINEERING DRAWINGS AND ALL OTHER RELEVANT DRAWINGS AND SPECIFICATIONS.
- DO NOT SCALE DRAWING. USE FIGURED DIMENSIONS ONLY.
-

Rev No.	Date	Revision Note	Drn by	Chkd by
P01	14.06.19	SUITABLE FOR INFORMATION	JB	AH
P02	28.02.19	ISSUED FOR INORMATION	JB	AH
P03	14.06.19	ISSUED FOR INFORMATION	JB	PR
P04	17.06.19	ISSUED FOR INFORMATION	JB	PR
P05	17.07.19	ISSUED FOR INFORMATION	JS	JB
P06	24.09.19	ISSUED FOR INFORMATION	JB	AH
P07	03.10.19	ISSUED FOR INFORMATION	JB	AH
P08	04.11.19	ISSUED FOR INFORMATION	SVM	PR

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O'CONNOR | SUTTON | CRONIN
Multidisciplinary Consulting Engineers

Dublin | London | Belfast | Galway | Cork

Client: Sandyford GP Limited.
Project: Sandyford Central

Title: Proposed Drainage Layout - Surface Water

Code	Originator	Zone	Level	Type	Role	Number	Status	Revision
SFC	OCSC	00	01	DR	C	0500	S2	P08

Date: 21.02.19 Scale:1:350 @ A1 Drn by:JB Chkd by:AH Aprvd by:MOR

Appendix G

SITE SURVEY (DRAWING D15272-F2D)

N

E 719200

N 727000

80.53 Concrete Path Kerb 80.61 80.69

80.37 Tarmac G Kerb 80.49 80.52

80.44

80.56 80.6

80.65

80.65 80.72 80.76 MH cl:80.70

80.53 80.66

80.52 80.56

80.44

N 727000

E 719200

80.34 80.38 G 80.39 80.46 Low Kerb 80.49 G 80.43 LP

80.41 80.51 80.62 80.61 80.69

80.53 Line of Trees 80.51 Grass

80.48 Wall

Bollards Tarmac 80.66 80.01 80.13

80.57 80.67 80.18 80.11 Hyd

Grass 80.54 80.52 G

80.37 Bollards 80.54 RS 80.06

80.30 Strip Gully 80.59 80.55 80.52 80.59 MH cl:80.54 il:80.06 ø150

Bollards LP 80.55 Gravel Ramp Up

Paving Kerb 80.43

Bollards 80.48 80.47 80.43 79.89

Parapet:102.36 Soffit:85.64 Overhead Canopy 79.93 79.95 79.93 79.96

Strip Gully 80.25 79.21

80.47 80.45 80.49 80.40 79.99

D D Entrance

N 726950

N 726950

N 726950

E 719200

78.95 79.01 80.03 80.04

Bank Btm Bank Top

80.37 Bank Btm 80.30 80.10 80.08

79.06 80.23

Sheet 1 of 4

LAND SURVEYS
22 Mellifont Avenue, Dun Laoghaire, Co. Dublin.
Ph: 2805212 Fax: 2302535 info@landsurveys.ie

Site at: Tivway Site, Carmanhall Rd, Sandyford Industrial Estate

Client: Henry J. Lyons Architects

Scale:	1:250 (A3)
Contour:	Spot Levels
Datum:	OS Malin Head
Issued:	12.09.2016
Ref:	D15272-F2D

LAND SURVEYS
22 Mellifont Avenue, Dun Laoghaire, Co. Dublin.
Ph: 2805212 Fax: 2302535 info@landsurveys.ie
Site at: Tivway Site, Carmanhall Rd, Sandyford Industrial Estate
Client: Henry J. Lyons Architects
Scale: 1:250 (A1)
Contour: Spot Levels
Datum: OS Malin Head
Issued: 12.09.2016
Ref: D15272-F2D
Sheet 2 of 4
Blackthorn Drive
Rockbrook Building
Building
Container
Concrete
Luas Track
Concrete Path
Concrete Footpath
Tarmac Road
Tarmac Cyclepath
Timber Sheet Hoarding 4.0 High
Retaining Wall
Post & Wire Mesh Fence
Post & Wire Mesh Fence 2.8 high
Top of Bank
Bottom of Bank
Edge of Concrete
Gravel Ramp
Overhead Canopy
Entrance
N 727000
N 726950
N 726900
N 726850
E 719200
E 719250
E 719300
E 719350

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Sheet 3 of 4

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N 726950
E 719050
E 719100
E 719150
N 726900
N 726850
E 719000
N 726800
E 719050
E 719100
E 719150
N 726800

Inaccessible
Extent of Lower Basement
Lower Basement Level
Ceiling:77.76
Floor Slab:74.80
Columns
Hoarding
Retaining Wall
Bank Btm
Bank Top
Gravel Ramp Up
Building Under Construction
Edge of Upper/Lower Slab
Edge of Lower Slab
Upper Slab:78.11
Soffit:77.76
Lower Slab:74.80
Gravel
Plinth
Rubble/Overgrown
Inspection Cover On Biscuit cl:75.30
TOW:82.15
TOW:83.78
TOW:82.97
TOW:83.71
TOW:86.85
TOW:86.65
TOR:85.61
Building
Ridge:94.32
Eaves:92.31
Hoarding
Concrete Path
Kerb
Line of Bollards
Line of Pines
Grass
Tarmac
Tarmac Road
Concrete Path Wall & Railing
Carmanhall Road
Sheet 4 of 4

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