AECOM Imagine it. Delivered.

Carmanhall Road SHD at the Former Avid Technology International Site, Carmanhall Road, Sandyford Industrial Estate, Dublin 18

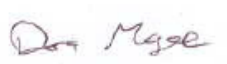
Stage 3: Planning Application to An Bord Pleanala
Flood Risk Assessment

Atlas GP Ltd.

Project reference: PR-461030

February 2021

Quality information

Prepared by	Checked by	Verified by	Approved by
			
Dara Magee Graduate Engineer	Clodagh Holmes Principal Engineer	Brendan Mitchell Associate Director	Clodagh Holmes Principal Engineer

Revision History

Revision	Revision date	Details	Authorized	Name	Position
0	22.06.2020	Pre-App Stage 2 Issue	MD	Michael Dunne	Regional Director
1	17.02.2021	Stage 3 Planning Issue	CH	Clodagh Holmes	Principal Engineer

Distribution List

# Hard Copies	PDF Required	Association / Company Name
10	Yes	Hughes Planning & Development Consultants

Prepared for:

Atlas GP Ltd.

Prepared by:

Dara Magee
Graduate Engineer
T: +353 (0)1 238 3100
M: +353 87 431 6228
E: Dara.Magee@aecom.com

AECOM Ireland Limited
4th Floor
Adelphi Plaza
Georges Street Upper
Dun Laoghaire
Co. Dublin A96 T927
Ireland

T: +353 1 238 3100
aecom.com

Table of Contents

Figures

Tables

1. Introduction

AECOM have been appointed by Atlas GP Ltd. to undertake a Stage 1 & 2 Flood Risk Assessment (FRA), in support of a proposed Strategic Housing Development (SHD) at the former Avid Technology International Site, Carmanhall Road, Sandyford Industrial Estate, Dublin 18.

This site-specific Flood Risk Assessment (FRA) has been prepared to accompany the planning application for the proposed development. This FRA has been prepared in line with the requirements of "*The Planning System and Flood Risk Management Guidelines for Planning Authorities*", (The 2009 Guidelines) as published in November 2009, and the particular requirements of a site-specific Flood Risk Assessment as outlined in Appendix A of the Technical Appendices to those Guidelines.

The site is located within the jurisdiction of Dún Laoghaire-Rathdown County Council (DLRCC). The current brownfield site was previously occupied by a commercial building which has now been demolished. The site is bounded to the east by Blackthorn Road, to the north by Carmanhall Road and to the south and west by existing commercial buildings. Refer to Figure 1.1 for the site location.

The Carysfort Maretimo Stream flows approximately 130 m to the south and approximately 200 m east of the site. The Stillorgan Reservoir is situated approximately 300 m to the north of the site. Existing ground levels on the proposed site range from 84.45 mOD to 86.41 mOD Malin Head. The proposed Finished Floor Level is 84.5 mOD.

Refer to BKD Architect's Drawing No. 6246-101 – 6246-119 for floor plan layouts. The proposed development comprises of a childcare facility, resident's amenities, community infrastructure and car parking at ground floor level. All residential units are proposed above ground floor level.

Hughes Planning & Development Consultants submitted a Section 247 planning pack to DLRCC, PAC Number PAC/SHD/91/20.

Permission was previously granted by An Bord Pleanála in April 2019, under a separate application, Reg. Ref. PL06D.303467, for the construction of student accommodation on the site. This was granted under the Strategic Housing Development (SHD) process.

The full development description is as follows;

(i) construction of a Build-To-Rent residential development within a new part six, part eight, part nine, part eleven storey rising to a landmark seventeen storey over basement level apartment building (40,814sq.m) comprising 428 no. apartments (41 no. studio, 285 no. one-bedroom, 94 no. two-bedroom & 8 no. three-bedroom units) of which 413 no. apartments have access to private amenity space, in the form of a balcony or lawn/terrace, and 15 no. apartments have access to a shared private roof terrace (142sq.m) at ninth floor level;

(ii) all apartments have access to 2,600sq.m of communal amenity space, spread over a courtyard at first floor level and roof terraces at sixth, eighth and ninth floor levels, a 142sq.m resident's childcare facility at ground floor level, 392sq.m of resident's amenities, including concierge/meeting rooms, office/co-working space at ground floor level and a meeting/games room at first floor level, and 696sq.m of resident's amenities/community infrastructure inclusive of cinema, gym, yoga studio, laundry and café/lounge at ground floor level. The café/lounge will primarily serve the residents of the development and will be open for community use on a weekly/sessional basis;

(iii) provision of 145 no. vehicular parking spaces (including 8 no. mobility parking spaces, 2 no. club-car spaces and 44 no. electric charging spaces), 5 no. motorcycle parking spaces, bin stores, plant rooms, switch room and 2 no. ESB sub-stations all at ground floor level; provision of bicycle parking (752 no. spaces), plant and storage at basement level; permission is also sought for the removal of the existing vehicular entrance and construction of a replacement vehicular entrance in the north-western corner of the site off Carmanhall Road;

(iv) provision of improvements to street frontages to adjoining public realm of Carmanhall Road & Blackthorn Road comprising an upgraded pedestrian footpath, new cycling infrastructure, an increased quantum of landscaping and street-planting, new street furniture inclusive of bins, benches and cycle parking facilities and the upgrading of the existing Carmanhall Road & Blackthorn Road junction through provision of a new uncontrolled pedestrian crossing; and,

(v) All ancillary works including provision of play equipment, boundary treatments, drainage works - including SuDS drainage, landscaping, lighting, rooftop telecommunications structure and all other associated site services, site infrastructure and site development works. The former Avid Technology International buildings were demolished on foot of Reg. Ref. D16A/0158 which also permitted a part-five rising to eight storey apartment building. The development approved under Reg. Ref. D16A/0158, and a subsequent part-seven rising to nine storey student accommodation development permitted under Reg. Ref. PL06D.303467, will be superseded by the proposed development.

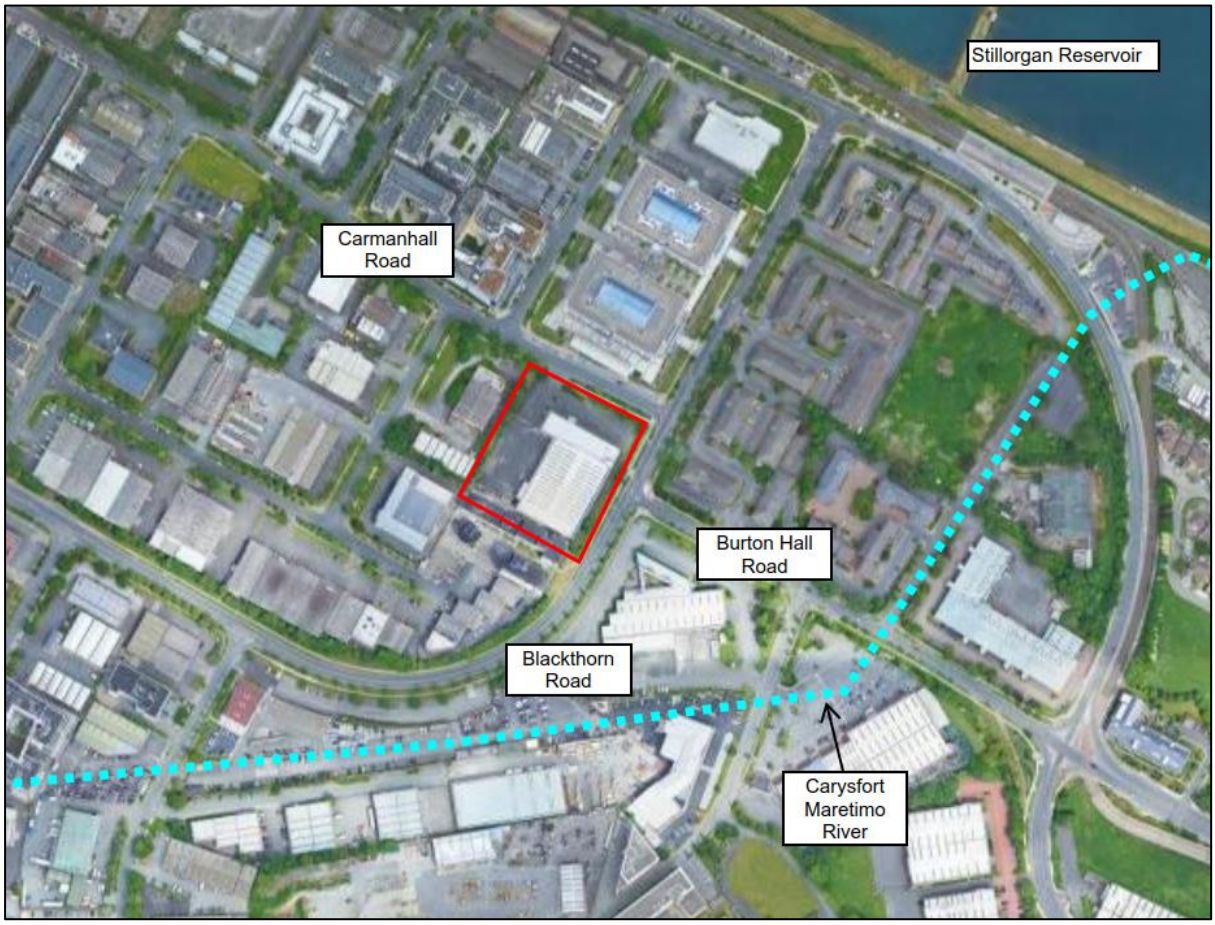


Figure 1.1: Site Location (Route informed by DLRCC Strategic Flood Risk Assessment)

2. The Planning System and Flood Risk Management Guidelines, 2009

In September 2008 “The Planning System and Flood Risk Management Guidelines for Planning Authorities” (The 2009 Guidelines) were published by the Department of Environment, Heritage and Local Government in Draft format. In November 2009, the adopted version of the document was published.

The 2009 Guidelines provide guidance on flood risk and development. A precautionary approach is recommended when considering flood risk management in the planning system. The core principle of the guidelines is to adopt a risk based sequential approach to managing flood risk and to avoid development in areas that are at risk. The sequential approach is based on the identification of flood zones for river and coastal flooding.

The objective of a site-specific Flood Risk Assessment (FRA) is to assess all types of flood risk to a development. The assessment should investigate potential sources of flood risk and include for the effects of climate change. The assessment is required to examine the impact of the development and the effectiveness of flood mitigation and management procedures proposed. It should also present the residual risks that remain after those measures are put in place.

This approach is based on the identification of flood zones for river and coastal flooding. “Flood Zones” are geographical areas used to identify areas at various levels of flood risk. It should be noted that these do not consider the presence of flood defences, as the risks remain of overtopping and breach of the defences. There are three flood zones defined (refer to Figure 2.1):

Flood Zone A (high probability of flooding) is for lands where the probability of flooding is greatest (greater than 1% or 1 in 100 for river flooding and 0.5% or 1 in 200 for coastal flooding).

Flood Zone B (moderate probability of flooding) refers to lands where the probability of flooding is moderate (between 0.1% or 1 in 1,000 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 (low probability of flooding) refers to lands where the probability of flooding is low (less than 0.1% or 1 in 1000 for both river and coastal flooding).

Figure 2.1: Indicative Flood Zone Map (Extract from The 2009 Guidelines, Figure 2.3)

Once a flood zone has been identified, the guidelines set out the different types of development appropriate to each zone. Exceptions to the restriction of development due to potential flood risks are provided for through the use of the Justification Test, where the planning need and the sustainable management of flood risk to an acceptable level must be demonstrated. This recognises that there will be a need for future development in existing towns and urban centres that lie within flood risk zones, and that the avoidance of all future development in these areas would be unsustainable.

The current Dun Laoghaire-Rathdown Development Plan 2016-2022 was adopted following the publication of the 2009 Guidelines and includes a Strategic Flood Risk Assessment.

The 2009 Guidelines set out a stage approach to assessment. The stages of assessment are:

Flood Risk Identification (Stage 1) – Identification of any issues relating to the site that will require further investigation through a Flood Risk Assessment.

Initial Flood Risk Assessment (Stage 2) – Involves establishment of the sources of flooding, the extent of the flood risk, potential impacts of the development and possible mitigation measures.

Detailed Flood Risk Assessment (Stage 3) – Assess flood risk issues in sufficient detail to provide quantitative appraisal of potential flood risk to the development, impacts on flooding elsewhere and the effectiveness of any proposed mitigation measures.

This report addresses the requirements of a Stage 1 and 2 Site Specific Flood Risk Assessment.

The potential risk to the proposed development associated with each of the following sources of flooding is investigated in this report;

- Fluvial flooding,
- Pluvial flooding, and
- Groundwater Flooding.

3. Flood Risk Identification (Stage 1)

As part of Stage 1 of the FRA, a review of historical flooding records and predictive flood mapping was carried out to identify the potential sources of flooding to the development site.

3.1 History of Flooding - OPW Flood Hazard Mapping

The Office of Public Works (OPW) collates available reports of flooding from all sources (e.g. fluvial, pluvial, coastal, etc.) on a nationwide basis. The OPW's website (www.floodmaps.ie) was consulted to obtain reports of recorded flooding within and surrounding the site. Figure 3.1 is an extract from the mapping available on the OPW database website, which indicates there is no historic records of flooding in the immediate vicinity of the site. The subject site is marked with a red star. The summary report is included in Appendix A.

Figure 3.1: OPW Recorded Flood Events

To the north east of the site, a recurring flood event is noted on Brewery Road. The meeting minutes (2005) available on the database notes Brewery Road experienced flooding on a number of occasions due to the Carysfort Maritime Stream overflowing. It is noted that these floods are usually caused by screens blocked by storm debris. The Flood Points to the east, north and south west are related to sewer and drain issues in January 1980. These flood points are all located more than 700 m from the site.

3.2 CFRAM Predictive Flood Risk Mapping

The CFRAM (Catchment Flood Risk Assessment and Management) programme is a national programme which produced a series of Preliminary Flood Risk Assessment (PFRA) which cover the entire country. This assessment was carried out based on available and readily derivable information to identify areas where there may be a significant risk of flooding. The objective of the PFRA is to identify areas where the risks associated with flooding might be significant.

The PFRA was undertaken by:

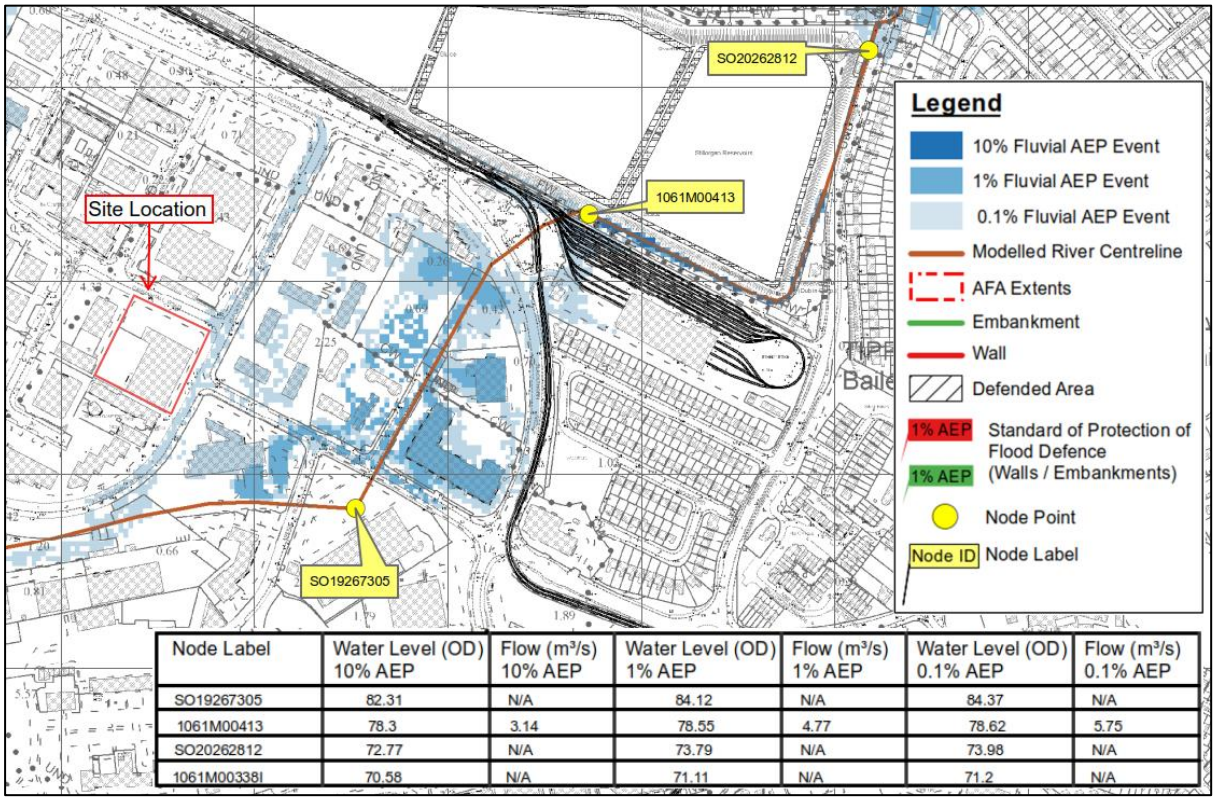
- Reviewing records of flood that have happened in the past;
- Undertaking analysis to determine which areas might flood in the future, and what the impacts might be; and

- Consulting with Local Authorities and other Government department and agencies.

The objective of the PFRA was to identify areas where the risk associated with flooding might be significant. These areas, which are referred to as 'Areas for Further Assessment' or AFAs, were selected for a more detailed assessment in order to accurately define the extent and degree of flood risk.

The CFRAM predictive flood risk mapping was based on the output of hydraulic modelling carried out as part of the study. The hydraulic model predicts the water levels for three fluvial flood events at given nodes. Based on the predicted water levels at these nodes, fluvial flood extents associated with the 10% AEP event, 1% AEP event (Flood Zone A), and the 0.1% AEP event (Flood Zone B) are mapped.

The PFRA mapping is available on myplan.ie and shows the same predicted flood extents as that on the CFRAM mapping available on floodinfo.ie, see Figure 3.2 which shows the flood extent for different fluvial events of the Carysfort Maretimo Stream. The proposed site is situated in Flood Zone C, as it is outside the 0.1% fluvial AEP (Annual Exceedance Probability) event. However, Blackthorn Road is shown to be affected by the 0.1% fluvial AEP event and is therefore classified as Flood Zone B.



Node Label	Water Level (OD) 10% AEP	Flow (m³/s) 10% AEP	Water Level (OD) 1% AEP	Flow (m³/s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m³/s) 0.1% AEP
SO19267305	82.31	N/A	84.12	N/A	84.37	N/A
1061M00413	78.3	3.14	78.55	4.77	78.62	5.75
SO20262812	72.77	N/A	73.79	N/A	73.98	N/A
1061M00338I	70.58	N/A	71.11	N/A	71.2	N/A

Figure 3.2: CFRAM Fluvial Flood Risk Map Extract (Full Map in Appendix B)

Node SO19267395 is situated approximately 180 m to the south east of the site boundary. The predicted 1 in 1000 year fluvial flood water level is 84.37 mOD, which is below the lowest existing ground level within the site boundary, existing levels range from 84.45 mOD to 86.41 mOD Malin Head. However, the flood extent shown which is based on topography, indicates that other low lying areas between the node and the site will store the flood water, i.e., the flood water is prevented from reaching the site due to the topography of the area. Flood water on Blackthorn Road will flow north, as the existing topography of the road falls in that direction.

As the proposed site is over 3.5 km from the coast and the levels on site range from 84.45 mOD to 86.41 mOD Malin Head it is reasonable to assume no tidal flood risk is associated with the site.

4. Initial Flood Risk Assessment (Stage 2)

4.1 Potential Sources of Flooding

Based on the review of the historical data and existing flood studies, the potential sources of flooding at the proposed development site are the following;

- Fluvial;
- Pluvial/Surface Water; and
- Groundwater.

4.1.1 Fluvial Flooding

Fluvial flooding is the result of a river exceeding its capacity and excess water spilling out on to the adjacent floodplain. Mapping published as part of the OPW CFRAM Study is used to evaluate the fluvial flood risk to the proposed development. From a review of this mapping it is concluded that Blackthorn Road will likely flood during a 1 in 1000 year fluvial flood event. However, the site is concluded to be within Flood Zone C. See Figure 3.2: CFRAM Fluvial Flood Risk Map Extract (Full Map in Appendix B).

4.1.2 Pluvial Flooding

Pluvial flooding is the result of rainfall-generated overland flows which arise before run-off can enter any watercourse or sewer. It is usually associated with high intensity rainfall. Flood risk from pluvial sources exists in all areas.

The proposed development includes a separate surface water drainage network to collect run-off generated within the site. This system will collect rainfall generated run-off within the site and convey flows through the proposed network. The layout of the proposed surface water drainage network is illustrated in AECOM Drawing No. PR461030-ACM-XX-00-DR-CE-10-0502.

It is proposed to restrict surface water run-off from the development to a maximum of 4.9 l/s, by providing a Hydrobrake flow control system (or similar approved). It is proposed to attenuate run-off in excess of greenfield run-off rates by providing attenuation within the proposed drainage network. The proposed attenuation storage has been designed using a 1 in 100-year return period rainfall event, with a 20% increase in rainfall depths to allow for the impact of climate change on rainfall, in accordance with the Greater Dublin Strategic Drainage Study. Refer to Section 5 for an assessment of the proposed drainage network and associated water levels within the network for the critical rainfall events.

The 100% impermeable brownfield site does not currently restrict runoff. Therefore, by restricting the rate of run-off from the development site to greenfield run-off rates, there will be a significant decrease in the flow discharged from the site following its development for large rainfall events. Therefore, the proposed drainage system would result in a decrease in potential pluvial flood risk on the site.

Given it is proposed to discharge surface water to the 450 mm dedicated surface water sewer in Carmnhall Road, which has a steep gradient, it is considered there is low risk of flooding at this point.

4.1.3 Groundwater Flooding

Site Investigation has revealed a high water table is present at the site. The highest groundwater table was recorded as 1.63 – 2.5 m bgl (below ground level), in June 2020, four months after installation of the standpipes. It is proposed to collect groundwater in filter trenches adjacent to the proposed basement and retaining structures, before pumping to the surface water network.

Mitigation measures, as described in the accompanying Infrastructure Report, are proposed to prevent uplift of the attenuation tanks and other drainage elements.

4.2 Climate Change

The CFRAM map outputs, discussed in Section 3.2, are a 'present day scenario' as allowances for climate change are not included.

Advice on the expected impacts of climate change and the allowances to provide for future flood risk management in Ireland is given in the "OPW Assessment of Potential Future Scenarios, Flood Risk Management Draft Guidance", 2009. Two climate change scenarios are considered, the Mid-Range Future Scenario (MRFS) and the High-End Future Scenario (HEFS).

The MRFS is intended to represent a 'likely' future scenario based on the wide range of future predictions available. The HEFS represents a more 'conservative' future scenario at the upper boundaries of future projections. Based on these two scenarios, the OPW recommended allowances for climate change are given in Table 1.

Table 1: Recommended allowances for climate change

Parameter	MRFS	HEFS
Flood Flows	+20%	+30%
Mean Sea Level Rise	+500 mm	+1000 mm
Land Movement	-0.5 mm/year *	-0.5 mm/year *
Forestation	-1/6 Tp**	-1/3 Tp** +10% SPR ***

Notes:

* Applicable to the southern part of the country (Dublin – Galway and south of this).

** Reduce the time to peak (Tp) by a third; this allows for potential accelerated run-off that may arise as a result of drainage of afforested land.

*** Add 10% to the Standard Percentage Run-off (SPR) rate; this allows for increased run-off rates that may arise following felling of forestry.

The modelled future scenarios (MRFS & HEFS) of the 1:1000 year fluvial flood event, available on floodinfo.ie, do not predict a further increase in the 'present day' 1 :1000 year flood extent area on Blackthorn Road. Refer to Figure 4.1. Therefore, it is concluded that increased flow in the Carysfort Maretimo Stream, due to climate change, does not pose foreseeable additional fluvial flood risk to the site, based on the modelled scenarios on floodinfo.ie.

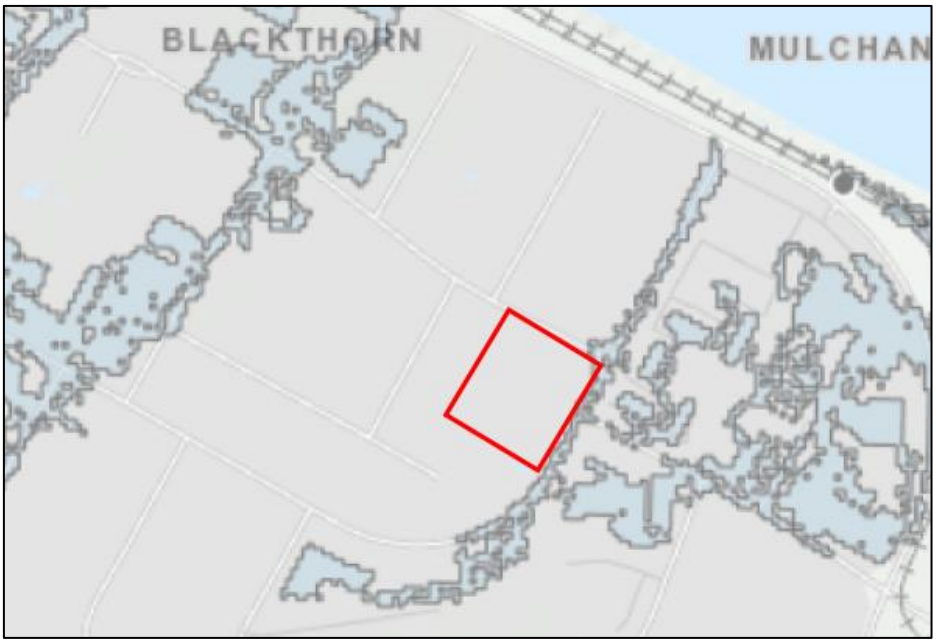


Figure 4.1: Present Day Scenario, MRFS & HEFS 1:1000 year Fluvial Flood Event – all predict the same flood extent (available on floodinfo.ie)

5. Drainage Impact Assessment

The Strategic Flood Risk Assessment (SFRA), Appendix 13 of the DLRCC Development Plan, outlines a requirement for all proposed developments, including those in Flood Zone C, must undertake a drainage impact assessment.

As mentioned in Section 4.1.2, the proposed restricted discharge rate from the site (maximum 4.9 l/s) is an improvement, as the 100% impermeable brownfield does not restrict generated runoff. Therefore, it is considered that the proposed development will have a positive impact on the existing drainage network. The proposed drainage network also includes a 20% allowance for an increase in rainfall depths due to climate change.

The proposed SuDS measures, as shown in PR461030-ACM-XX-00-DR-CE-10-0501 (refer to AECOM's accompanying Infrastructure Report for further detail), will help to reduce the rate of runoff from the site by allowing longer retention times on site and reducing the amount of runoff overall by providing interception through evapotranspiration from the green roofs, biorientation and swales. The proposed SuDS measures also provide a better water quality discharging from the site as the proposed SuDS measures remove pollutants and suspended solids at source.

The Finished Floor Level of 84.5 mOD. is proposed in order to suit the existing ground levels surrounding the site. Due to the gradient of Blackthorn Road, any flood water will flow north the road levels naturally fall from south to north by approximately 2.5 m along the eastern boundary of the site. The proposed ground floor use is classified as 'less vulnerable' as it is not residential. This is explained further in Section 6.2.

At the request of DLRCC Drainage Department, a surcharge analysis has been carried out for the critical storm and corresponding maximum water levels. A similar analysis was undertaken for the event of a 50% blockage at the Hydrobrake, i.e., the outflow has been reduced from 4.6 l/s, to 2.4 l/s. The results of these analyses are available in Appendix C.

In summary, the maximum water level in the proposed drainage network (without any blockage at the Hydrobrake) is 83.832 m. This is more than 650 mm below the Finished Ground Floor Level of the proposed building.

For the case of a 50% Hydrobrake blockage, 101 m^3 is predicted to flood from the drainage network, for the 2160 minute, 100 year Winter event (including 20% climate change allowance). Please refer to the summary table below. The highest water level predicted is 84.346 m at the head of the network. The lowest gullies and manholes, which are upstream of the Hydrobrake, will allow the excess water from the network onto the surface. The lowest gullies on the site are at the Hydrobrake manhole, S16, at a ground level of 84.280 m. The topography of the site falls towards the north and therefore, any flood water as a result of a Hydrobrake blockage will flow away from the building and onto Carmanhall Road. Please refer to the flood exceedance route shown on drawing no. PR461030-ACM-XX-00-DR-CE-10-0601.

Table 2: Maximum Water Levels (50% Hydrobrake blockage)

Pipe Number	US/MH Name	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)
S1.000	**S1**	84.36	84.346	1.936	0
S1.008	**S15**	84.30	84.336	2.534	35.9
S1.009	**S16**	84.27	84.335	2.710	65.0

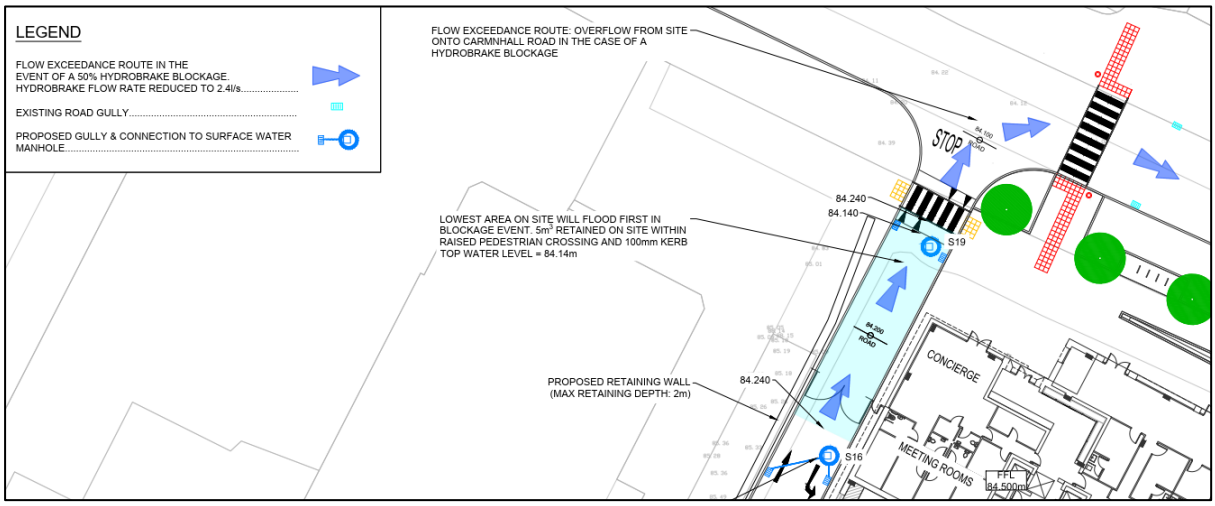


Figure 5.1: Flow Exceedance Route (See Drawing No. PR461030-ACM-XX-00-DR-CE-10-0601)

6. Flood Risk Management

Chapter 3 of the Planning System and Flood Risk Management Guidelines (DEHLG/ OPW, 2009) describes the key principles of a risk based sequential approach to managing flood risk. The sequential approach is aimed at directing development toward land that is at low risk of flooding. Figure 6.1 is extracted from the 2009 Guidelines and illustrates the sequence in which a site must be assessed from a flood risk standpoint. Specifically, the order in which the planning authority must be satisfied from a flood risk perspective is to *Avoid* (locate in an area that is not prone to flooding), then *Substitute* (if in a flood risk zone, then substitute the type of development), *Justify* (if substitution does not reduce flood risk sufficiently, then perform Justification Test) and *Mitigate*. This section discusses the sequential approach recommended in the 2009 Guidelines with regard to the proposed development.

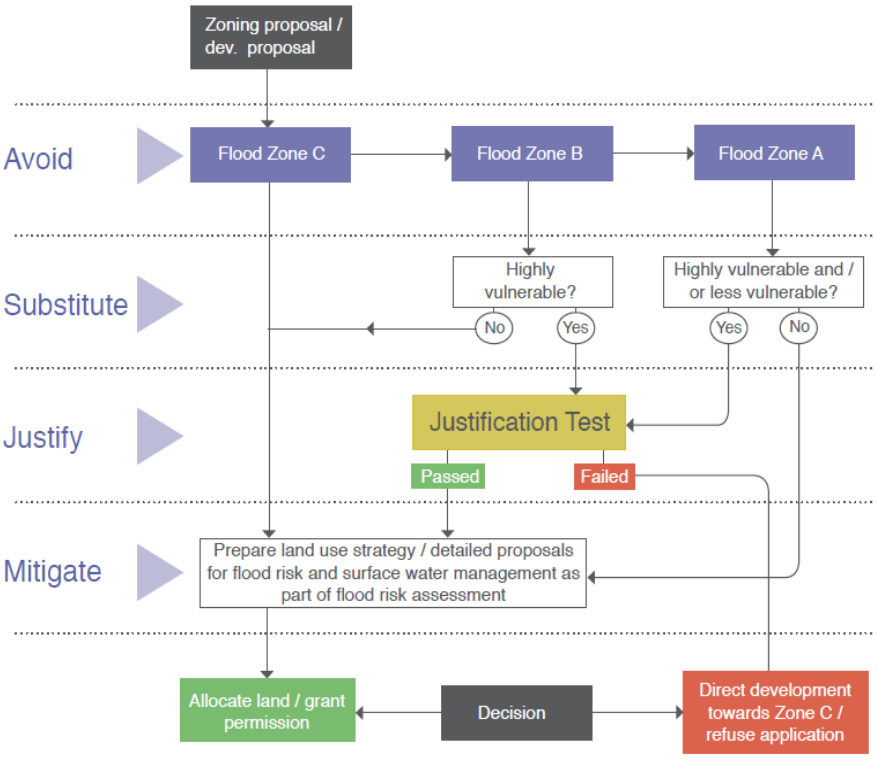


Figure 6.1: Sequential Approach Mechanism in the Planning Process

6.1 Sequential Approach

The first stage of the sequential approach is to avoid development in areas at risk of flooding. Flood Zones associated with river and coastal flooding are identified as Flood Zones A, B and C (refer to Section 2 for definitions). The planning implications for each of the flood zones include:

Flood Zone A – High probability of flooding: most types of development would be considered inappropriate in this zone. Development in this zone should be avoided or only considered in exceptional circumstances, such as in city and town centres where the Justification Test has been applied. Water compatible development such as docks or marinas, dockside activities that require a waterside location, amenity open space, outdoor sports and recreation would be considered appropriate in this zone.

Flood Zone B – Moderate probability of flooding: highly vulnerable development would generally be considered inappropriate in this zone, unless the requirements of the Justification Test can be met. Less vulnerable development and water compatible development would be considered appropriate in this zone. In general, less vulnerable development should only be considered in this zone if adequate lands or sites are not available within Flood Zone C and subject to a flood risk assessment to the appropriate level of detail to demonstrate that flood risk to and from the development can or will be adequately managed.

Flood Zone C – Low probability of flooding: Development in this zone is considered appropriate from a flood risk perspective (subject to assessment of flood hazard from sources other than rivers and the coast) but would need to meet the normal range of other proper planning and sustainable development considerations.

The second stage of the sequential approach is to substitute the type of development to one less vulnerable to flooding.

6.2 Vulnerability

Table 3.1 of The Planning System and Flood Risk Management Guidelines for Planning Authorities, 2009, provides a classification of vulnerability of different types of development. Figure 6.2 is taken from the 2009 Guidelines (Table 3.1) and sets out the Vulnerability Classifications of different types of land uses. Figure 6.3 (Table 3.2 of the 2009 Guidelines) describes the vulnerability of developments relative to the identified Flood Zone and when the requirements of the Justification Test must be satisfied.

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 6.2: Classification of Vulnerability (Table 3.1 taken from the 2009 Guidelines)

	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 6.3: Matrix of Vulnerability (Table 3.2 taken from the 2009 Guidelines)

The proposed land use for the proposed development is predominantly residential which falls within the 'Highly Vulnerable Development' classification, as shown in Figure 6.2. Based on the review carried out of the predicted flood water levels and the topographical survey, the proposed residential units have been located outside Flood Zones A and B and within Flood Zone C (Low probability of flooding). As shown in Figure 6.3, Flood Zone C is a suitable land use for Highly Vulnerable Developments.

The site is currently located in Flood Zone C and although the predicted future scenarios which include climate change shown in Figure 4.1 do not predict the site to be impacted by the 1:1000 year event, the proposed ground floor use is deemed acceptable even if the a portion of the site was to be reassessed as Flood Zone B.

7. Conclusion

This site-specific Flood Risk Assessment has been carried out to accompany the planning application for a Strategic Housing Development at Carmanhall Road, Sandyford, Dublin 18. This report was written with "The Planning System and Flood Risk Management Guidelines for Planning Authorities, 2009" in mind and follows the requirements of a Stage 1 and 2 Flood Risk Assessment. The proposed development comprises a childcare facility, resident's amenities, community infrastructure and car parking at ground floor level with residential units proposed above ground floor level.

All existing information has been reviewed regarding the flood risk in the area, there is no recorded history of flood events at the site. The CFRAM fluvial flood risk mapping is considered to have the most up to date and reliable estimates of extreme water levels. This mapping provides estimated water levels associated with a 1:10 year event (Flood Zone A), 1:100 year event (also Flood Zone A) and 1:1000 year event (Flood Zone B). This mapping confirms that the site is not currently at risk of fluvial flooding but the bordering road (Blackthorn Road) is predicted to flood during a 1:1000 year flood event.

Available future scenario models including climate change allowances, do not predict an increase in flood extent onto the site, i.e., the site remains in Flood Zone C which is most preferable for residential developments. From a review of the topography of Blackthorn Road, the gradient slopes away from the site, reducing the potential impact to the site from the 1:1000 year fluvial flood event.

The proposed surface water drainage network which restricts runoff rates to that of a greenfield site in the area would produce, reduces the risk of pluvial flooding on the site and surrounding area, as the brownfield site is 100% impermeable and does not restrict runoff.

The proposed attenuation storage has been designed using a 1 in 100-year return period rainfall event, with a 20% increase in rainfall depth to allow for the impact of climate change. The proposed SuDS measures and restriction of run-off to greenfield run-off rates means there will not be an increase in flood risk as a result of the proposed development. In the event of a blockage at the flow control within the stormwater drainage network, flood water will flow away from the building, towards Carmanhall Road.

Appendix A – OPW Flood Records Summary

OPW National Flood Hazard Mapping

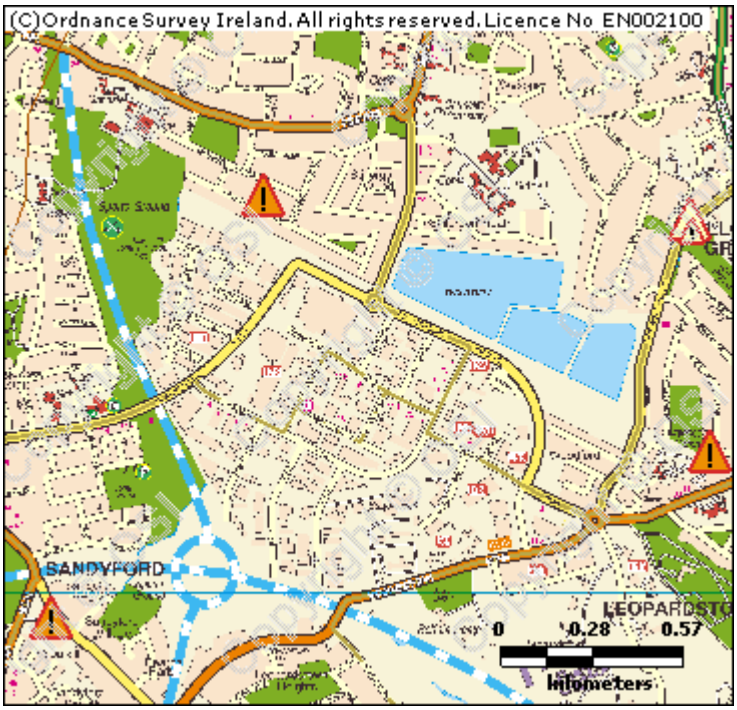
Summary Local Area Report

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

The map centre is in:

County: Dublin

NGR: O 193 267



Map Scale 1:23,495

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.

26 Results

1. Flooding at Avoca Park, Blackrock, Co. Dublin on 24th Oct 2011
County: Dublin
Start Date: 24/Oct/2011
Flood Quality Code:2
Additional Information: Reports (1) More Mapped Information

2. Flooding at Dundrum Shopping Centre and Taney Cross, Co. Dublin on 24th Oct 2011
County: Dublin
Start Date: 24/Oct/2011
Flood Quality Code:2
Additional Information: Reports (1) More Mapped Information

3. Flooding at Riverdale, Dundrum, Dublin 14 on 24th Oct 2011
County: Dublin
Start Date: 24/Oct/2011
Flood Quality Code:2
Additional Information: Reports (1) More Mapped Information

4. Flooding at Orpen Dale, Stillorgan, Co. Dublin on 24th Oct 2011
County: Dublin
Start Date: 24/Oct/2011
Flood Quality Code:2
Additional Information: Reports (1) More Mapped Information

5. Flooding at Willow Bank Apartments, Sandyford Rd, Dublin 14 on 24th Oct 2011
County: Dublin
Start Date: 24/Oct/2011
Flood Quality Code:2

Additional Information: Reports (1) More Mapped Information

6. Flooding at Dale Drive, Stillorgan, Co. Dublin on 24th Oct 2011
Start Date: 24/Oct/2011
County: Dublin
Flood Quality Code:3

Additional Information: Reports (2) More Mapped Information

7. Stillorgan Hill Nov 2002
Start Date: 10/Nov/2002
County: Dublin
Flood Quality Code:4

Additional Information: Reports (4) More Mapped Information

8. Ashlawn Ballinteer Road June 1993
Start Date: 11/Jun/1993
County: Dublin
Flood Quality Code:4

Additional Information: Reports (1) More Mapped Information

9. Ramore Leopardstown Road May and June 1993
Start Date: 01/May/1993
County: Dublin
Flood Quality Code:3

Additional Information: Reports (2) More Mapped Information

10. School House Lane Sandyford Nov 1982
Start Date: 26/Nov/1982
County: Dublin
Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

11. Torquay Road Foxrock Nov 1982
Start Date: 05/Nov/1982
County: Dublin
Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

12. Sandyford Church Jan 1980
Start Date: 21/Jan/1980
County: Dublin
Flood Quality Code:4

Additional Information: Reports (1) More Mapped Information

13. Lakelands Close Stillorgan Jan 1980
Start Date: 21/Jan/1980
County: Dublin
Flood Quality Code:4

Additional Information: Reports (1) More Mapped Information

14. Brighton Terrace Jan 1980
Start Date: 01/Jan/1980
County: Dublin
Flood Quality Code:3

Additional Information: Reports (1) More Mapped Information

15. Leopardstown Road Dec 1979
Start Date: 14/Dec/1979
County: Dublin
Flood Quality Code:4

Additional Information: Reports (1) More Mapped Information

16. Brighton Cottages Dec 1978
Start Date: 26/Dec/1978
County: Dublin
Flood Quality Code:3

Additional Information: Reports (2) More Mapped Information

17. Slang Old Ballinteer Road Recurring
Start Date:
County: Dublin
Flood Quality Code:3

Additional Information: Reports (3) More Mapped Information

18. Brighton Cottages Foxrock Recurring
Start Date:
County: Dublin
Flood Quality Code:3

Additional Information: Reports (7) More Mapped Information

---

19. Carysfort MaretimoStillorgan Gr Orpen Gr Recurring
Start Date:
County: Dublin
Flood Quality Code:3
Additional Information: Reports (1) More Mapped Information

20. Torquay Road Recurring
Start Date:
County: Dublin
Flood Quality Code:3
Additional Information: Reports (4) More Mapped Information

21. Carysfort Maretimo Stream StillorganPark Recurring
Start Date:
County: Dublin
Flood Quality Code:3
Additional Information: Reports (1) More Mapped Information

22. Slang Pyelands Dundrum recurring1
Start Date:
County: Dublin
Flood Quality Code:3
Additional Information: Reports (1) More Mapped Information

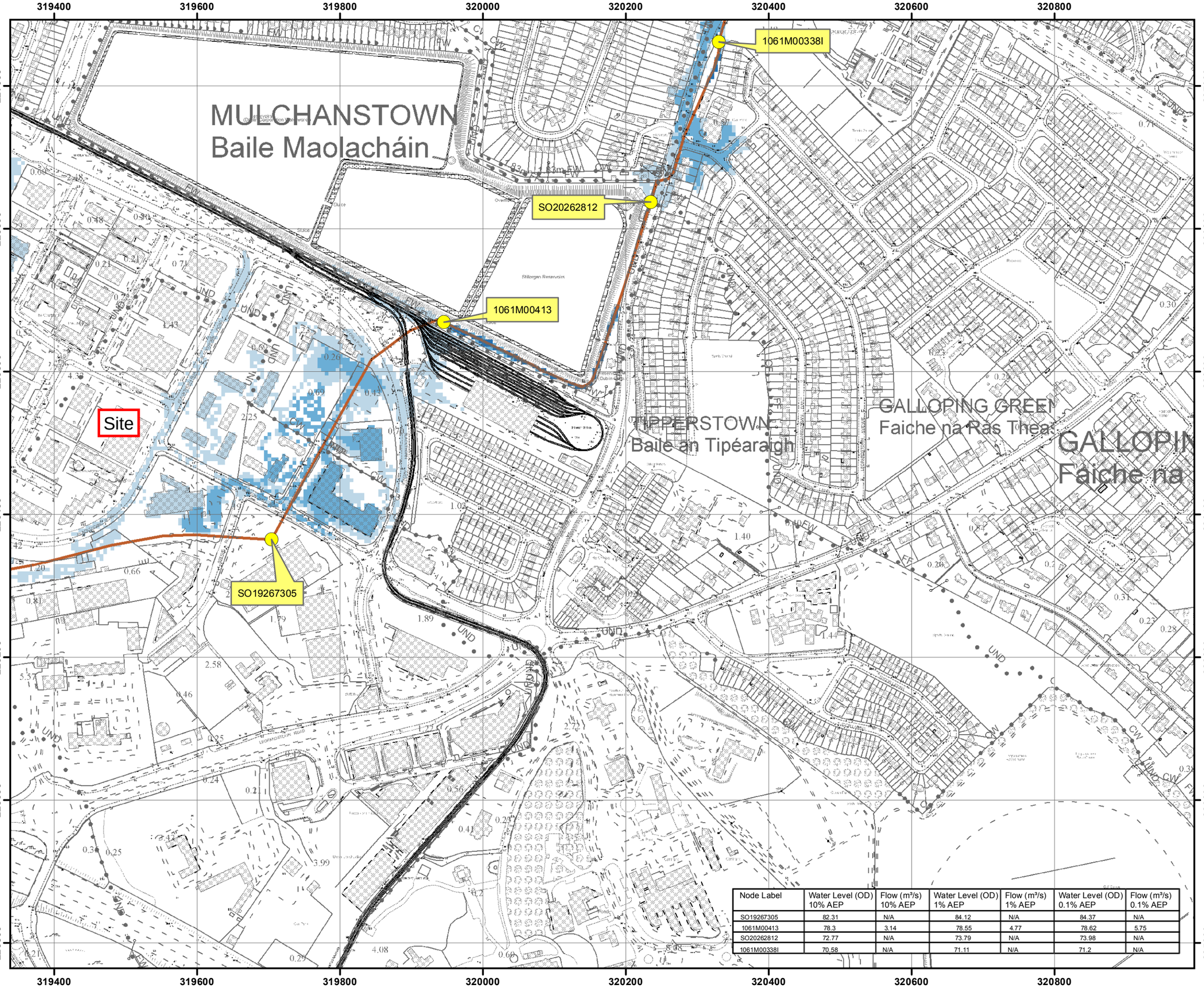
23. Brewery Road Recurring
Start Date:
County: Dublin
Flood Quality Code:4
Additional Information: Reports (3) More Mapped Information

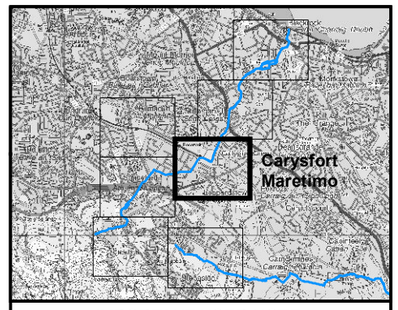
24. Ballyogan Stream Lambs Cross Recurring
Start Date:
County: Dublin
Flood Quality Code:4
Additional Information: Reports (1) More Mapped Information

25. Carrickmines River Sandyford Hall Recurring
Start Date:
County: Dublin
Flood Quality Code:4
Additional Information: Reports (1) More Mapped Information

26. Kilgobbin Road Recurring
Start Date:
County: Dublin
Flood Quality Code:4
Additional Information: Reports (2) More Mapped Information

Appendix B – CFRAM Fluvial Flood Risk Map





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 / 1% AEP — Standard of Protection of Flood Defence (Walls / Embankments)
- Node Point
- Node ID — Node Label

Node Label	Water Level (OD) 10% AEP	Flow (m³/s) 10% AEP	Water Level (OD) 1% AEP	Flow (m³/s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m³/s) 0.1% AEP
SO19267305	82.31	N/A	84.12	N/A	84.37	N/A
1061M00413	78.3	3.14	78.55	4.77	78.62	5.75
SO20262812	72.77	N/A	73.79	N/A	73.98	N/A
1061M00338I	70.58	N/A	71.11	N/A	71.2	N/A

FINAL

REV:	NOTE:	DATE:

EASTERN CFRAM STUDY
CATCHMENT FLOOD RISK ASSESSMENT AND MANAGEMENT

OPW
Oifig na nOibreacha Poiblí
The Office of Public Works

RPS

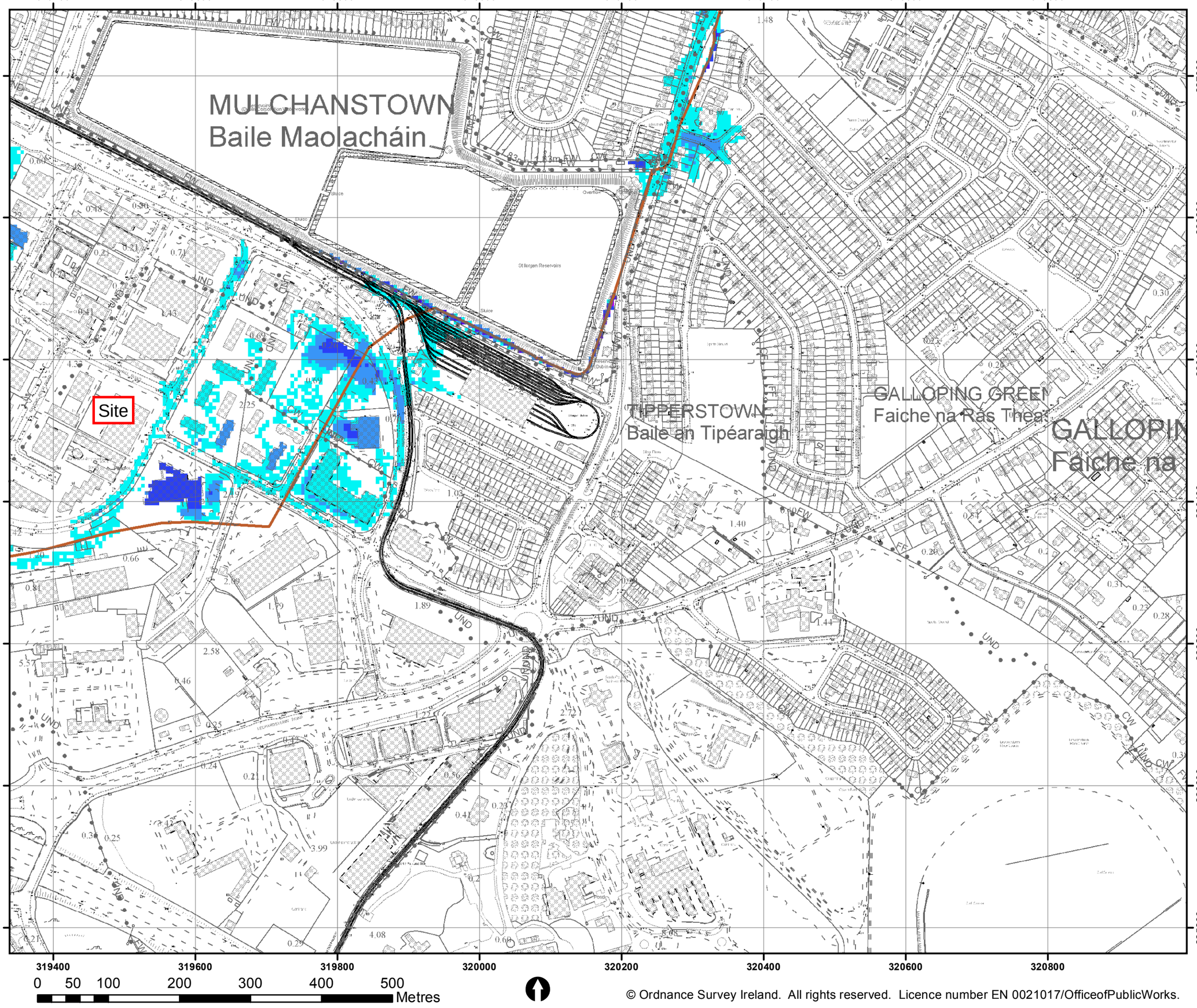
The Office of Public Works
Jonathan Swift Street
Trim
Co Meath

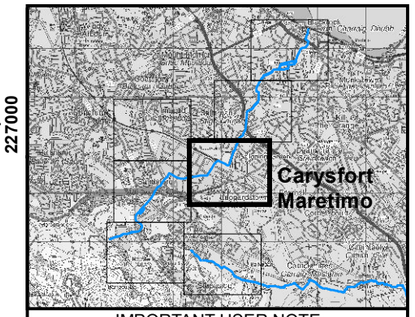
Elmwood House
74 Boucher Road
Belfast
BT12 6RZ

T +44(0) 28 90 667914
F +44(0) 28 90 668286
W www.rpsgroup.com
E ireland@rpsgroup.com

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_05
Map Series : Page 5 of 7
Drawing Scale : 1:5,000 @ A3





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

Legend

0.1% Fluvial AEP Flood Depth

- 0 - 0.25m
- 0.25 - 0.5m
- 0.5 - 1m
- 1.0 - 1.5m
- 1.5 - 2m
- >2m
- Modelled River Centreline
- AFA Extents

FINAL

REV:	NOTE:	DATE:
01	Amendment to Label.	08/12/16

EASTERN CFRAM STUDY
CATCHMENT FLOOD RISK ASSESSMENT AND MANAGEMENT

OPW
Oifig na nOibreacha Poiblí
The Office of Public Works

RPS

The Office of Public Works
Jonathan Swift Street
Trim
Co Meath

Elmwood House
74 Boucher Road
Belfast
BT12 6RZ

T +44(0) 28 90 667914
F +44(0) 28 90 668286
W www.rpsgroup.com
E ireland@rpsgroup.com

Map:
Carysfort Maretimo Fluvial Flood Depths

Map Type:	**DEPTH**	
Source:	**FLUVIAL**	
Map Area:	**HPW**	
Scenario:	**CURRENT**	
Drawn By :	**C.McG.**	**Date : 27 October 2017**
Checked By :	**A.S.**	**Date : 27 October 2017**
Approved By :	**G.G**	**Date : 27 October 2017**

Drawing No. :
E09CAR_DPFCD001_F2_05

Map Series : Page 5 of 7

Drawing Scale : 1:5,000 @A3

Appendix C – Surcharge Analysis

Surcharge Analysis – Without Blockage

Pipe Number	US/MH Name	Event	First (X) Surcharge	First (Y) Flood	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Maximum Vol (m³)	Discharge Vol (m³)	Status
S1.000	**S1**	600 minute 100 year Winter I+20%	30/15 Summer		84.360	83.832	1.422	0.0	1.857	16.023	SURCHARGED
S1.001	**S2**	600 minute 100 year Winter I+20%	30/15 Summer		84.410	83.832	1.460	0.0	2.151	16.023	SURCHARGED
S1.002	**S3**	600 minute 100 year Winter I+20%	1/240 Winter		84.440	83.832	1.520	0.0	2.395	15.992	SURCHARGED
S2.000	**S4**	600 minute 100 year Winter I+20%	1/180 Winter		84.400	83.832	1.549	0.0	2.000	-0.047	SURCHARGED
S1.003	**S5**	600 minute 100 year Winter I+20%	1/120 Winter		84.400	83.832	1.641	0.0	3.704	162.927	SURCHARGED
S3.000	**S6**	600 minute 100 year Winter I+20%	1/120 Summer		84.400	83.831	1.669	0.0	2.137	142.803	SURCHARGED
S1.004	**S7**	600 minute 100 year Winter I+20%	1/30 Winter		84.400	83.828	1.767	0.0	4.064	303.866	SURCHARGED
ATT. TANK 1		600 minute 100 year Winter I+20%	1/30 Summer		84.400	83.826	1.826	0.0	144.625	281.119	SURCHARGED
S4.000	**S9**	600 minute 100 year Winter I+20%	1/60 Summer		84.450	83.829	1.754	0.0	2.232	-0.275	SURCHARGED
S4.001	**S10**	600 minute 100 year Winter I+20%	1/30 Winter		84.500	83.828	1.798	0.0	2.592	-0.907	SURCHARGED
S4.002	**S11**	600 minute 100 year Winter I+20%	1/30 Summer		84.470	83.829	1.842	0.0	2.630	76.320	SURCHARGED
ATT. TANK 2		600 minute 100 year Winter I+20%	1/15 Summer		84.450	83.827	1.887	0.0	146.622	330.242	SURCHARGED
S1.007	**S13**	600 minute 100 year Winter I+20%	1/15 Summer		84.450	83.829	1.967	0.0	4.536	409.948	SURCHARGED
S5.000	**S14**	600 minute 100 year Winter I+20%	1/15 Summer		84.350	83.829	1.970	0.0	2.477	5.154	SURCHARGED
S1.008	**S15**	600 minute 100 year Winter I+20%	1/15 Summer		84.300	83.828	2.026	0.0	5.673	426.019	SURCHARGED
S1.009	**S16**	600 minute 100 year Winter I+20%	1/15 Summer		84.270	83.827	2.201	0.0	4.193	424.202	SURCHARGED
S6.000	**S17**	15 minute 1 year Summer I+20%			86.500	85.000	-0.225	0.0	0.000	0.000	OK
S6.001	**S18**	15 minute 1 year Summer I+20%			84.950	83.500	-0.225	0.0	0.000	0.000	OK
S1.010	**S19**	600 minute 100 year Winter I+20%			84.150	81.359	-0.163	0.0	0.155	424.051	OK
S1.011	**S20**	600 minute 100 year Winter I+20%			84.120	81.317	-0.167	0.0	0.102	423.916	OK

Surcharge Analysis – 50% Hydrobrake Blockage

Pipe Number	US/MH Name	Event	First (X) Surcharge	First (Y) Flood	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Maximum Vol (m³)	Discharge Vol (m³)	Status
S1.000	S1	2160 minute 100 year Winter I+20%	1/240 Winter		84.360	84.346	1.936	0.000	2.439	23.263	FLOOD RISK
S1.001	S2	2160 minute 100 year Winter I+20%	1/180 Winter		84.410	84.346	1.974	0.000	2.732	23.263	FLOOD RISK
S1.002	S3	2160 minute 100 year Winter I+20%	1/120 Winter		84.440	84.346	2.034	0.000	2.976	23.271	FLOOD RISK
S2.000	S4	2160 minute 100 year Winter I+20%	1/120 Winter		84.400	84.346	2.063	0.000	2.582	0.007	FLOOD RISK
S1.003	S5	2160 minute 100 year Winter I+20%	1/60 Winter		84.400	84.346	2.155	0.000	4.285	238.089	FLOOD RISK
S3.000	S6	2160 minute 100 year Winter I+20%	1/60 Winter		84.400	84.345	2.183	0.000	2.718	208.071	FLOOD RISK
S1.004	S7	2160 minute 100 year Winter I+20%	1/30 Winter		84.400	84.343	2.281	0.000	4.646	445.737	FLOOD RISK
ATT. TANK 1		1440 minute 100 year Winter I+20%	1/30 Summer		84.400	84.341	2.342	0.000	146.771	364.780	FLOOD RISK
S4.000	S9	1440 minute 100 year Winter I+20%	1/30 Winter		84.450	84.340	2.265	0.000	2.811	-0.352	FLOOD RISK
S4.001	S10	1440 minute 100 year Winter I+20%	1/30 Summer		84.500	84.340	2.310	0.000	3.172	-1.065	FLOOD RISK
S4.002	S11	1440 minute 100 year Winter I+20%	1/15 Winter		84.470	84.340	2.354	0.000	3.208	98.845	FLOOD RISK
ATT. TANK 2		1440 minute 100 year Winter I+20%	1/30 Summer		84.400	84.341	2.342	0.000	146.771	364.780	FLOOD RISK
S1.007	S13	1440 minute 100 year Winter I+20%	1/15 Summer		84.450	84.337	2.476	0.000	5.264	535.476	FLOOD RISK
S5.000	S14	2160 minute 100 year Winter I+20%	1/15 Summer		84.350	84.336	2.477	0.000	3.050	7.977	FLOOD RISK
S1.008	S15	2160 minute 100 year Winter I+20%	1/15 Summer	100/480 Winter	84.300	84.336	2.534	35.869	42.217	677.823	FLOOD
S1.009	S16	2160 minute 100 year Winter I+20%	1/15 Summer	100/360 Winter	84.270	84.335	2.710	65.015	69.843	676.332	FLOOD
S6.000	S17	15 minute 1 year Summer I+20%			86.500	85.000	-0.225	0.000	0.000	0.000	OK
S6.001	S18	15 minute 1 year Summer I+20%			84.950	83.500	-0.225	0.000	0.000	0.000	OK
S1.010	S19	5760 minute 100 year Summer I+20%			84.150	81.342	-0.180	0.000	0.109	834.072	OK
S1.011	S20	5760 minute 100 year Summer I+20%			84.120	81.301	-0.183	0.000	0.071	834.072	OK

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	17.800	Add Flow / Climate Change (%)	0
Ratio R	0.275	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	0.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	7.508	0.038	197.6	0.022	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	11.942	0.060	199.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	24.199	0.121	200.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	18.420	0.092	200.2	0.000	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.003	25.924	0.130	200.0	0.205	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.000	20.028	0.100	200.3	0.199	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.004	12.362	0.062	200.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.005	11.747	0.059	200.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.14	82.185	0.022	0.0	0.0	0.0	0.93	36.8	3.0
S1.001	50.00	5.35	82.147	0.022	0.0	0.0	0.0	0.92	36.7	3.0
S1.002	50.00	5.79	82.087	0.022	0.0	0.0	0.0	0.92	36.6	3.0
S2.000	50.00	5.33	82.058	0.000	0.0	0.0	0.0	0.92	36.6	0.0
S1.003	50.00	6.26	81.966	0.228	0.0	0.0	0.0	0.92	36.6	30.8
S3.000	50.00	5.36	81.937	0.199	0.0	0.0	0.0	0.92	36.6	26.9
S1.004	50.00	6.44	81.761	0.426	0.0	0.0	0.0	1.11	78.3	57.7
S1.005	50.00	6.62	81.700	0.426	0.0	0.0	0.0	1.11	78.3	57.7

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S4.000	8.993	0.045	199.8	0.000	5.00	0.0	0.600	o	225	Pipe/Conduit	
S4.001	8.681	0.043	200.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S4.002	11.488	0.046	250.0	0.109	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.006	18.117	0.079	230.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.007	18.015	0.060	300.3	0.114	0.00	0.0	0.600	o	375	Pipe/Conduit	
S5.000	11.386	0.057	199.8	0.008	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.008	7.936	0.026	300.0	0.020	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.009	20.647	0.103	200.5	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S6.000	85.740	1.500	57.2	0.000	5.00	0.0	0.600	o	225	Pipe/Conduit	
S6.001	79.572	2.203	36.1	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.010	7.611	0.038	200.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.011	16.271	0.081	200.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S4.000	50.00	5.16	81.850	0.000	0.0	0.0	0.0	0.92	36.6	0.0
S4.001	50.00	5.32	81.805	0.000	0.0	0.0	0.0	0.92	36.6	0.0
S4.002	50.00	5.55	81.762	0.109	0.0	0.0	0.0	0.82	32.7	14.7
S1.006	50.00	6.91	81.641	0.535	0.0	0.0	0.0	1.03	73.0	72.4
S1.007	50.00	7.20	81.487	0.649	0.0	0.0	0.0	1.04	114.9	87.9
S5.000	50.00	5.21	81.634	0.008	0.0	0.0	0.0	0.92	36.6	1.1
S1.008	50.00	7.33	81.427	0.677	0.0	0.0	0.0	1.04	115.0	91.7
S1.009	50.00	5.37	81.400	0.000	4.9	0.0	0.0	0.92	36.6	4.9
S6.000	50.00	5.82	85.000	0.000	0.0	0.0	0.0	1.73	68.9	0.0
S6.001	50.00	6.43	83.500	0.000	0.0	0.0	0.0	2.18	86.8	0.0
S1.010	50.00	6.57	81.297	0.000	4.9	0.0	0.0	0.92	36.6	4.9
S1.011	50.00	6.86	81.259	0.000	4.9	0.0	0.0	0.92	36.6	4.9

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.011	S	83.980	81.178	81.175	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	17.800	Storm Duration (mins)	30
Ratio R	0.275		

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S16, DS/PN: S1.009, Volume (m³): 4.8

Unit Reference	MD-SHE-0060-2400-2355-2400
Design Head (m)	2.355
Design Flow (l/s)	2.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	60
Invert Level (m)	81.400
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.355	2.4	Kick-Flo®	0.538	1.2
Flush-Flo™	0.262	1.5	Mean Flow over Head Range	-	1.8

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.3	1.200	1.8	3.000	2.7	7.000	4.0
0.200	1.5	1.400	1.9	3.500	2.9	7.500	4.1
0.300	1.5	1.600	2.0	4.000	3.1	8.000	4.2
0.400	1.5	1.800	2.1	4.500	3.2	8.500	4.4
0.500	1.3	2.000	2.2	5.000	3.4	9.000	4.5
0.600	1.3	2.200	2.3	5.500	3.6	9.500	4.6
0.800	1.5	2.400	2.4	6.000	3.7		
1.000	1.6	2.600	2.5	6.500	3.8		

Storage Structures for Storm

Cellular Storage Manhole: S8, DS/PN: S1.005

Invert Level (m) 81.793 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.55
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	126.5	0.0	2.056	0.0	0.0
2.055	126.5	0.0			

Cellular Storage Manhole: S12, DS/PN: S1.006

Invert Level (m) 81.734 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.55
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	126.5	0.0	2.056	0.0	0.0
2.055	126.5	0.0			

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.275
Region	Scotland and Ireland	Cv (Summer)	0.750
M5-60 (mm)	17.800	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	S1	2160 Winter	100	+20%	1/240 Winter			
S1.001	S2	2160 Winter	100	+20%	1/180 Winter			
S1.002	S3	2160 Winter	100	+20%	1/120 Winter			
S2.000	S4	2160 Winter	100	+20%	1/120 Winter			
S1.003	S5	2160 Winter	100	+20%	1/60 Winter			
S3.000	S6	2160 Winter	100	+20%	1/60 Winter			
S1.004	S7	2160 Winter	100	+20%	1/30 Winter			
S1.005	S8	1440 Winter	100	+20%	1/30 Summer			
S4.000	S9	1440 Winter	100	+20%	1/30 Winter			
S4.001	S10	1440 Winter	100	+20%	1/30 Summer			
S4.002	S11	1440 Winter	100	+20%	1/15 Winter			
S1.006	S12	1440 Winter	100	+20%	1/15 Summer			
S1.007	S13	1440 Winter	100	+20%	1/15 Summer			
S5.000	S14	2160 Winter	100	+20%	1/15 Summer			
S1.008	S15	2160 Winter	100	+20%	1/15 Summer	100/480 Winter		
S1.009	S16	2160 Winter	100	+20%	1/15 Summer	100/360 Winter		
S6.000	S17	15 Summer	1	+20%				

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	84.346	1.936	0.000	0.01			0.4	FLOOD RISK	
S1.001	S2	84.346	1.974	0.000	0.01			0.4	FLOOD RISK	
S1.002	S3	84.346	2.034	0.000	0.01			0.4	FLOOD RISK	
S2.000	S4	84.346	2.063	0.000	0.01			0.2	FLOOD RISK	
S1.003	S5	84.346	2.155	0.000	0.12			4.1	FLOOD RISK	
S3.000	S6	84.345	2.183	0.000	0.12			3.8	FLOOD RISK	
S1.004	S7	84.343	2.281	0.000	0.13			7.8	FLOOD RISK	
S1.005	S8	84.341	2.342	0.000	0.14		2092	8.6	FLOOD RISK	
S4.000	S9	84.340	2.265	0.000	0.01			0.3	FLOOD RISK	
S4.001	S10	84.340	2.310	0.000	0.02			0.6	FLOOD RISK	
S4.002	S11	84.340	2.354	0.000	0.09			2.5	FLOOD RISK	
S1.006	S12	84.340	2.399	0.000	0.17		2166	10.8	FLOOD RISK	
S1.007	S13	84.337	2.476	0.000	0.14			13.1	FLOOD RISK	
S5.000	S14	84.336	2.477	0.000	0.02			0.5	FLOOD RISK	
S1.008	S15	84.336	2.534	35.869	0.14			11.1	FLOOD	11
S1.009	S16	84.335	2.710	65.015	0.08			2.6	FLOOD	19
S6.000	S17	85.000	-0.225	0.000	0.00			0.0	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S6.001	S18	15 Summer	1	+20%					83.500
S1.010	S19	5760 Summer	100	+20%					81.342
S1.011	S20	5760 Summer	100	+20%					81.301

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S6.001	S18	-0.225	0.000	0.00			0.0	OK	
S1.010	S19	-0.180	0.000	0.09			2.6	OK	
S1.011	S20	-0.183	0.000	0.08			2.6	OK	