poga CONSULTING ENGINEERS
STRUCTURAL & CIVIL

Engineering Planning Report

Residential Development at Tubber Lane, Phase 3, Adamstown, County Dublin.

Ref: 20065-EPR-R3

Date of Issue: December 2021

Revision: R3

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1.0 INTRODUCTION

POGA Consulting Engineers were engaged by Tierra Ltd and Hugh McGreevy & Sons to carry out an engineering design on a residential site located at Tubber Lane, Adamstown, County Dublin. The subject site is approximately 9.95 Ha in size and it is accessed off the Adamstown Drive (Shackleton Drive) access road. The site is bound by Tubber Lane to the North and the Celbridge Link Road that divides the site between 2/3 on the west and 1/3 east.

The site forms part of the Adamstown Strategic Development Zone (SDZ) and the proposed development will, if granted, deliver roads, streets, foul sewers, surface water drainage and watermains in accordance with the Adamstown Strategic Development Zone and the South Dublin County Council Development Plan (2016-2022).

The proposed Phase 3 development will comprise of 455 no. residential units (including a mixture of 2 and 3 storey semi-detached and terraced houses, and duplex units and apartments in 3 and 4 storey blocks), finishing works to the Celbridge Link Road, development of new internal roads and footpaths, site access, public open space, car parking, cycle stores, landscaping, bin stores, foul and surface water drainage, boundary walls and fences, ESB substations and all associated site development works. Private and semi-private open space to serve the proposed units will be provided in the form of balconies, terraces and gardens.

This report should be read in conjunction with POGA Consulting Engineers drawings and all other Consultants' reports and drawings. The engineering drainage design philosophy is outlined below and detailed calculations are contained in the Appendices of this report.

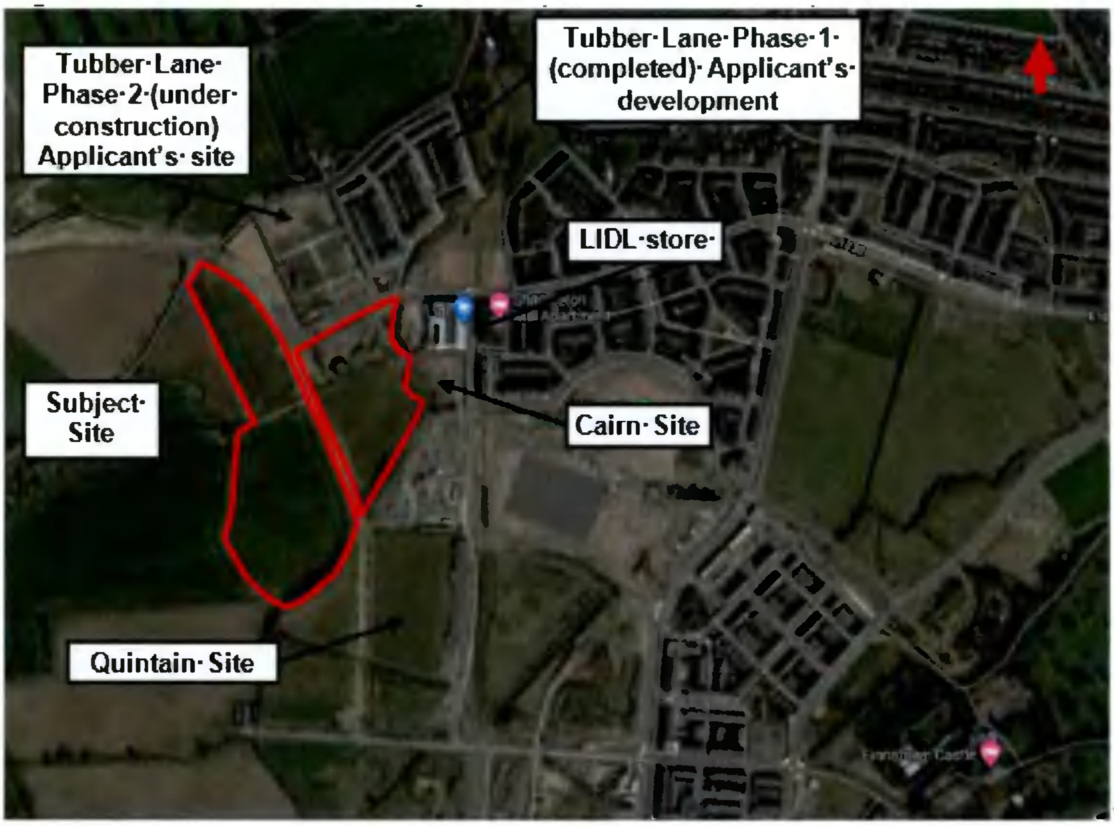


Fig 1 Extract from Google maps showing Arial view of site

2.0 EXISTING SERVICES

Surface Water

There is an ø600mm, 750mm and 900mm surface water pipe location in the Celbridge Link Road and Adamstown Drive respectively which was built by SDCC as part of the Celbridge Link Road construction. This pipe outfall to the trunk surface water pipe located in Tobermaclugg Valley. This was provided as part of the overall strategic SDZ.

Fig 2.1 Extract from SDZ showing proposed surface water infrastructure

Wastewater

There is an existing ø450mm foul pipe that runs under Adamstown Drive which connects into an ø750mm foul pipe that runs parallel with the Tobermaclugg Valley and outfalls to the Adamstown pumping station. This was provided as part of the overall strategic SDZ.

Furthermore, there is an ø225mm and 375mm wastewater network at Celbridge Link Road which is built by SDCC as part of the Celbridge Link Road construction.

Fig 2.2 Extract from SDZ showing proposed wastewater infrastructure

Water

An existing ø250mm HDPE watermain and an existing ø150mm HDPE watermain run under Celbridge Link Road and Adamstown Drive as part of the overall strategic SDZ. The existing infrastructure was provided in accordance with Adamstown masterplan.

In addition, there is an existing ø150mm HDPE watermain at the adjacent lands to the Eastern boundary which was constructed by our Client. This site is currently under construction, refer to Planning Application Reference Number SDZ17A/006.

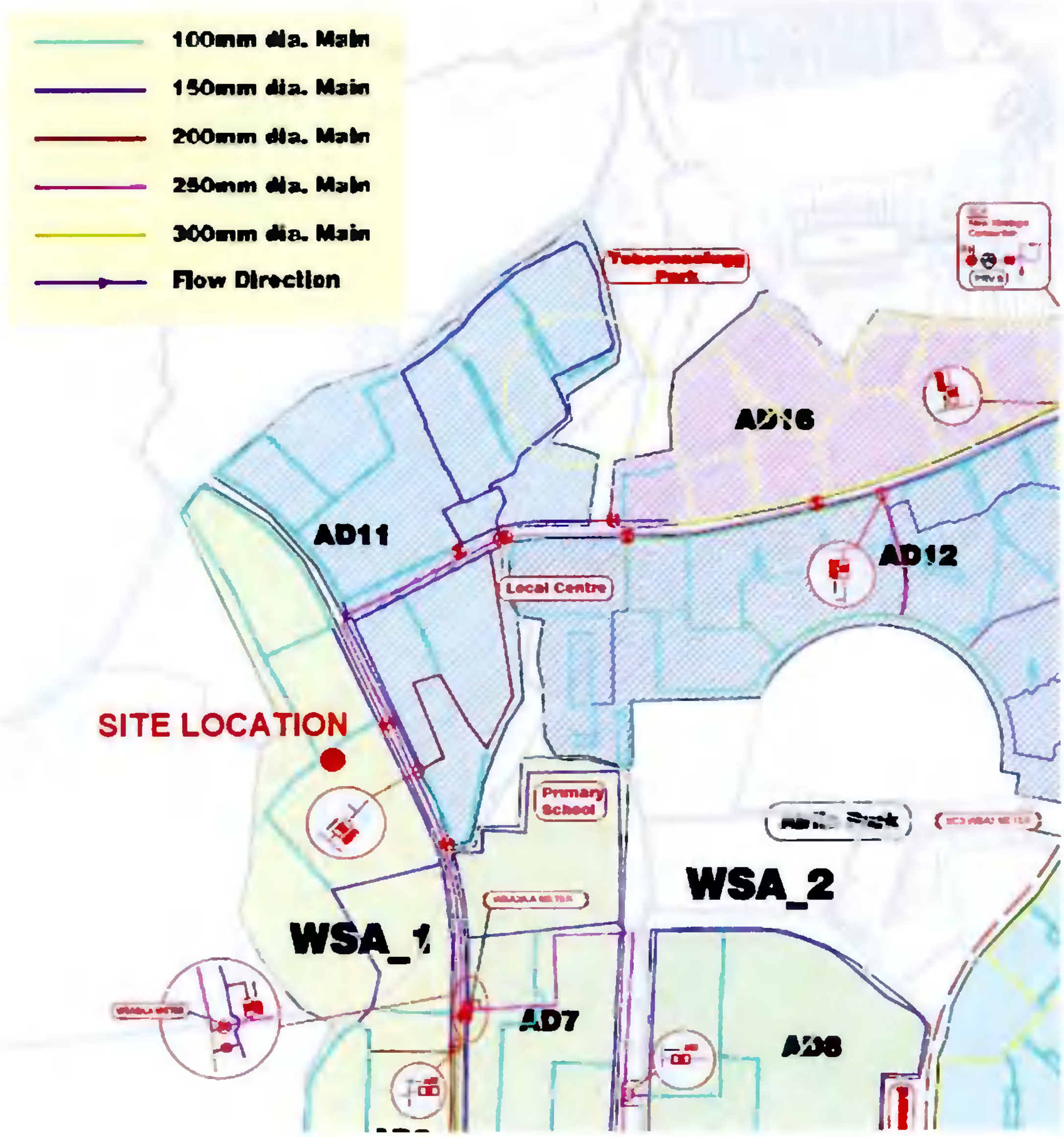


Fig 2.3 Extract from PH McCarthy Consulting Engineers drawing No. 821/06/001-REVE

3.0 FLOOD RISK ASSESSMENT

3.1 SCOPE OF ASSESSMENT

The flood risk for the Adamstown SDZ was assessed previously as part of the overall masterplan application. Appendix A.1 shows the predicted 1:100 year flood risk preliminary maps produced as part of the CFRAM program in 2011 by the Office of Public Works (OPW) and Appendix A.2 shows the final Fluvial Flood Extent mapping concluded in 2016. Appendix A.3 shows the Fluvial Flood Zone Mapping extracted from South Dublin County Council (SDCC) Strategic Flood Risk Assessment document as part of the 2016-2022 Development Plan.

3.2 FLUVIAL FLOODING

Fluvial or river flooding occurs when the capacity of a watercourse is exceeded or the channel is blocked or restricted, and excess water spills out from the channel onto adjacent low-lying area. On all of the mapping collected, the only source of flooding predicted in the vicinity of the site is fluvial flooding from the Tobermaclugg stream which runs to the East of the site. However, the closest point of site from the potential flood point is 80m distant and 1.5 m higher, therefore the risk is low.

3.3 PLUVIAL FLOODING

Pluvial flooding can be defined as flooding that results from rainfall-generated overland flow, before the runoff enters any watercourse or sewer. It is usually associated with high intensity 'extreme or monster' rainfall events (typically >30mm/h) resulting in overland flow and ponding in depressions in the topography. In urban situations underground sewerage/drainage systems and surface watercourses may be completely overwhelmed.

Floodinfo.ie shows past flood events. The website allows the user to view reports, photographs, newspaper articles, and other information about reported floods. From a search of this source, there is a record of several past flood events occurring around the Adamstown Tubber Lane area, however, no flood events have taken place within a radius of 1km around the subject development - refer to Figure 3 below. We would therefore classify the risk of Pluvial flooding as low.

Figure 3 Flood events around subject siteMaping from Floodinfo.ie

3.3 COASTAL FLOODING

The development is located approximately 10km away from a potential point of a Coastal flooding. Floodinfo.ie, OPW's website dedicated to providing information on flooding, provides flood maps for the whole of Ireland. The area within Adamstown area where the subject development is located, shows no risk of coastal flooding. Based on those information's, it is the opinion of POGA Consulting Engineers that the risk of coastal flooding is extremely low.

4.0 PROPOSED SURFACE WATER MANAGEMENT

The management of surface water for the proposed subject development has been designed to comply with the policies and guidelines of the Greater Dublin Strategic Drainage Study (GDSDS). The overall objective is to minimise stormwater runoff and to collect and treat this minimised amount of runoff as close to the source as possible.

In accordance with the SuDS philosophy, a Surface Water Treatment Train approach has been applied to the design of the surface water drainage on this site. The techniques that apply here suit the site topography, ground conditions and receiving environment. There are also four main criteria to be satisfied in new developments regarding stormwater management, these are described below.

- **Criteria 1:** River Water Quality Protection – interception and treatment volume.
- **Criteria 2:** River Regime Protection – limit of discharge to receiving water.
- **Criteria 3:** Level of Service (flooding) for the site – internal protection against flooding of propriety.
- **Criteria 4:** River Flood Protection – long-term flood storage.

4.1 Surface Water Drainage Design

The topography of the site falls gently from South-West to North-East with an approximate slope of 1 in 80. There are no significant surface features or outcrops. A preliminary site investigation was not carried out, but it is assumed soil conditions are similar to adjacent lands to the Eastern boundary which is also owned by Hugh McGreevy & Sons. The sequence of strata encountered on this adjacent site were generally comprised of Topsoil layer, Cohesive Deposits layer, Granular Deposits layer, Weathered Rock layer, down to presumed bedrock level.

It is proposed to build a new surface water network running towards the centre of the site. The proposed surface water connects into in 4 locations the drainage under the Celbridge Link Road Planning Application Reference SDZ17A/009, which then connects into the existing drainage under the Adamstown Drive. Please refer to Appendix B for Rainfall data.

4.2 SuDS Techniques

SuDS techniques comprise a flexible series of options, which allow the drainage designer to select those systems that best suit the circumstances of the site. The treatment train approach assures that both runoff quantity and quality are addressed, through the overall techniques of:

Pollution Prevention

Pollution prevention is essentially good housekeeping, since minimising or preventing pollution in the first place is more practical and cost effective than having to treat it afterwards. Thus, the best approach to urban runoff pollution is to prevent chemical and other pollutants from coming into contact with rainfall runoff through appropriate storage and management, and through education. In this respect, it is proposed that the developer will provide information to the operator on appropriate usage of the proposed drainage systems.

Source Control

The second element of the treatment train is to detain or infiltrate runoff as close as possible to the point of origin. The use of such source control devices reduces the peak runoff rate and attenuates flows, thus reducing stress on downstream facilities, allowing them to be smaller in capacity.

For the subject development, it is proposed to have six source control measures comprising: permeable paving, green-roof system, swales, filter drains, and rainwater harvesting butts retention system are proposed. These will minimise impermeable areas and encourage stormwater to soak into the ground/soil while filtering pollutants.

Permeable paving is a range of sustainable materials with a base and sub-base that allow the movement of stormwater through the surface. In addition to reducing runoff, this effectively traps suspended solids and filters pollutants from the water, and recharges the ground water. Refer to Figure 4.1 for a typical permeable paving and drawing 20065-101-P1, 20065-102-P1, 20065-103-P1 for locations where this is proposed. In accordance with the SuDS design philosophy we are proposing to drain the surface water run-off from the roof areas through the permeable paving areas to act as a form of treatment.

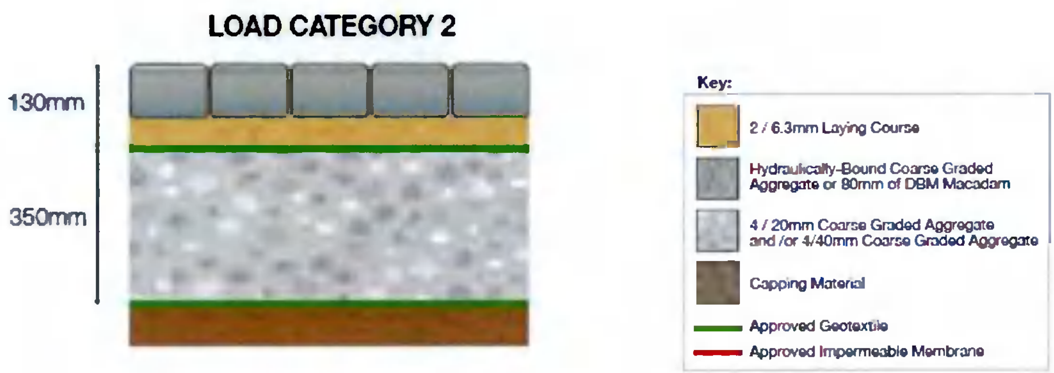


Figure 4.1 Typical Permeable Paving Build-up

It is proposed to drain the surface water run-off from a section of the roads into an infiltration trench and swale system located at the open space area, please refer to Drawing 20065-104-P1, 20065-105-P1, 20065-106-P1 for locations. The infiltration trench and swale treat the surface water run-off and act as a form of attenuation during storm events. It is also proposed to provide a 220L rainwater retention butt to each house in order to reuse the water for gardening purposes. No outside tap will be provided.

Tree pits are proposed at 17 locations at build-outs on the road. These road drainage will be diverted to theses tree pits. Approximately $4m^3$ of soil will be used at the tree base, providing $1.6m^3$ of storage per tree pit, any overflow of surface water will be directed towards the closed pipe system. The tree pits will have the added benefit of providing traffic calming on the roads.

The Green Roof Systems are located at roof level over each apartment block, the green roofs occupy 90% of the total roof area (allowing for lift and stare core overruns, drainage stone, and the inclusion of PV panels, etc.), please refer to Appendix C Paved Area factors. The system is designed to store part of the 1 in 100-year storm event plus 20% for climate change and will discharge the surface water at a Greenfield run-off rate. Refer to Figure 4.2 for indicative Green Roof Build up detail. The Green Roof System will include a 150mm deep biodiverse substratum.

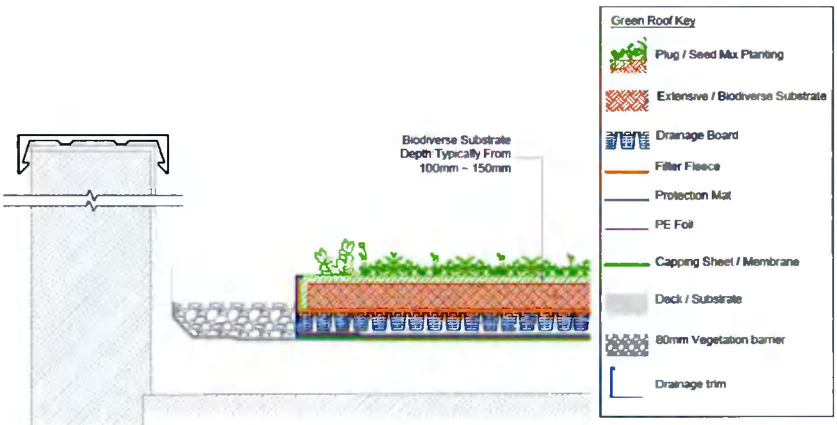


Figure 4.2 Typical Green Roof Detail

Site Control

Site control comprises runoff and treatment installations to serve individual developments or combinations of developments on adjacent sites. The SuDS treatment train approach for the subject development is satisfied by the sources that act as a form of attenuation, intercepting and treating the surface water before it runs into the drainage system. Please refer to drawing 20065-115-P0 for SuDS details.

The attenuation for this site has already been provided as part of the SDZ strategic infrastructure granted under Planning Reference SDZ06A/04. Please refer to enclosed report in Appendix G by Waterman Moylan (WM), "Adamstown Strategic Development Zone Surface Water Drainage Engineering Assessment Report". The WM report pulls together all the design reports, design tweaks and "look back" assessments of Adamstown Surface Water infrastructure and in particular the Tobermaclugg Catchment, which this site forms part of. This submission should be considered in the context of the WM report. This development forms part of the Tobermaclugg Catchment, refer to Figure D (page 13) and the attenuation strategy for this catchment has been provided as part of the Tobermaclugg Surface Water Drainage scheme constructed in 2008. This drainage strategy has been previously accepted and granted by the previous planning applications on neighbouring lands. This application attempts to remain consistent with what was already approved for the neighbouring developments and to be in accordance with the masterplan strategy for the Adamstown SDZ.

Regional Control

Regional control comprises of treatment facilities to reduce pollutants from contaminated runoff, with the potential to provide biological treatment on a catchment scale. They are often end-of-pipe facilities and are no provided on this scheme.

Pipe Design

All surface water pipes sizes and gradients are designed in accordance with the Department of Environment Recommendation for Site Development Works, Building Regulations and Irish Water Standards. Refer to Appendix D & Appendix E to Surface Water and Wastewater Pipe Design.

Please refer to drawings 20065-104-P1, 20065-105-P1, 20065-106-P1 for full drainage layout and details. Also refer to drawing 20065-113-P0 for manhole and typical drainage details.

poga Consulting Engineers					
			Project :	Adamstown Phase 3	
			POGA Ref:	20065	
			Title:	Treatment Train	
			Date:	15/11/2021	
Treatment Train Approach - Runoff quantity and quality					
Subject Site Information					**Units**
Total Area of Site				11.6	Ha
PIMP Factor				0.5	
Total Impermeable area				5.7	
Criteria 1 - River Quality Protection (Volumes required for Small Events)					
Interception volume (5mm of rainfall & 80% run-off from paved surfaces)				227.0	m³
Treatment volume (15mm of rainfall & 80% run-off from paved surfaces)				680.9	m³
Total Volume				**907.9**	m³
SUDS techniques and respective volumes provided					
Type	**Criteria 1**	**Criteria 2**	**Type**		
Source Control	Interception & Treatment	-	Permeable paving (350mm Storage Stone 40% voids)	625.8	m³
Source Control	Interception & Treatment	-	Green Roof 150mm soil, 80mm Drainage board, 60% retention)	580.5	m³
Source Control	Interception & Treatment	-	Filter Drains	41.8	m³
Source Control	Interception & Treatment	-	Swales	61.9	m³
Source Control	Interception	-	Rainwater Butt's (255l per house)	83.6	m³
Source Control	Interception	-	Tree pits (urban Soil, Vol 4m³ soil pre tree, 1.6m³ storage per tree 40& voids)	26.9	m³
Total Interception, Treatment Volume provided				**1420.5**	m³
Criteria 3 - Level of Service of the Site					
All mitigation measures recommended on the Site Specific Flood Risk Assessment were implemented.					
Criteria 4 - River Flood Protection					
No long term storage is provided.					

Table 4.1 Volume treated and required for the proposed development

5.0 WASTEWATER

All foul water pipes sizes and gradients are designed in accordance with the Department of Environment Recommendation for Site Development Works, Building Regulations and Irish Water Standards

It is proposed to provide separate surface water and wastewater networks running under the development's courtyard.

All connections to the public wastewater infrastructure will be made following a connection agreement with Irish Water and under their direction. Refer to drawings 20065-104-P1, 20065-105-P1, 20065-106-P1 for wastewater drainage layout.

6.0 WATER SUPPLY

The development will be supplied from a new ø100mm and 200mm HDPE watermain connected to the existing ø 150mm and 225mm HDPE watermain under the Celbridge Link Road and under the Adamstown Drive which was built by SDCC as part of the Celbridge Link Road construction.

A Bulk flow magnetic water meter will be proposed at the estate entrance. Boundary boxes capable of taking an individual meter will be fitter on all property connections. Both the bulk flow meter and the boundary boxes will be to Irish Water's Specification at the time of construction.

Refer to Appendix F for detailed design of water demand for the proposed development.

All connection to the public water infrastructure will be made following a connection agreement with Irish Water and under their direction. Refer to Drawings 20065-107-P1, 20065-108-P1, 20065-109-P1 for the watermain layout.

6.1 Water Conservation and Management

To conserve water the following is proposed;

1. All bathroom and staff facilities to be fitted with low flow fittings such as taps, shower head, etc.
2. All electrical appliances will be an energy rated.
3. All bathrooms will be fitted with dual flush toilet cisterns
4. All houses will be fitted with a rainwater butt for garden use.
5. All fittings will be installed by qualified personnel and the pumping arrangement for each unit type agreed with Irish Water prior to construction.

7.0 ROADS ACCESS AND EGRESS

It is proposed to access the subject development with new entrances from the Celbridge Link Road, which is currently under construction.

Main junction site distance on the Celbridge Link Road is provided in accordance with the Design Manual for Urban Roads and Streets (DMURS) for a 50kph main road speed limit. This equates to a "Y" distance of 49m and a 2.4m "X" set back distance. Internal junction are designed for a speed limit of 30kph, this equates to a "Y" distance of 24m and a 2.4m "X" set back distance. Junction raised tables and kerb built-outs (with Tree pits) are prudently placed to keep traffic speeds to a minimum. Please see drawing 20065-101-P1, 20065-102-P1, 20065-103-P1 for junction plans, site visibility splays raised table and kerb built-out locations.

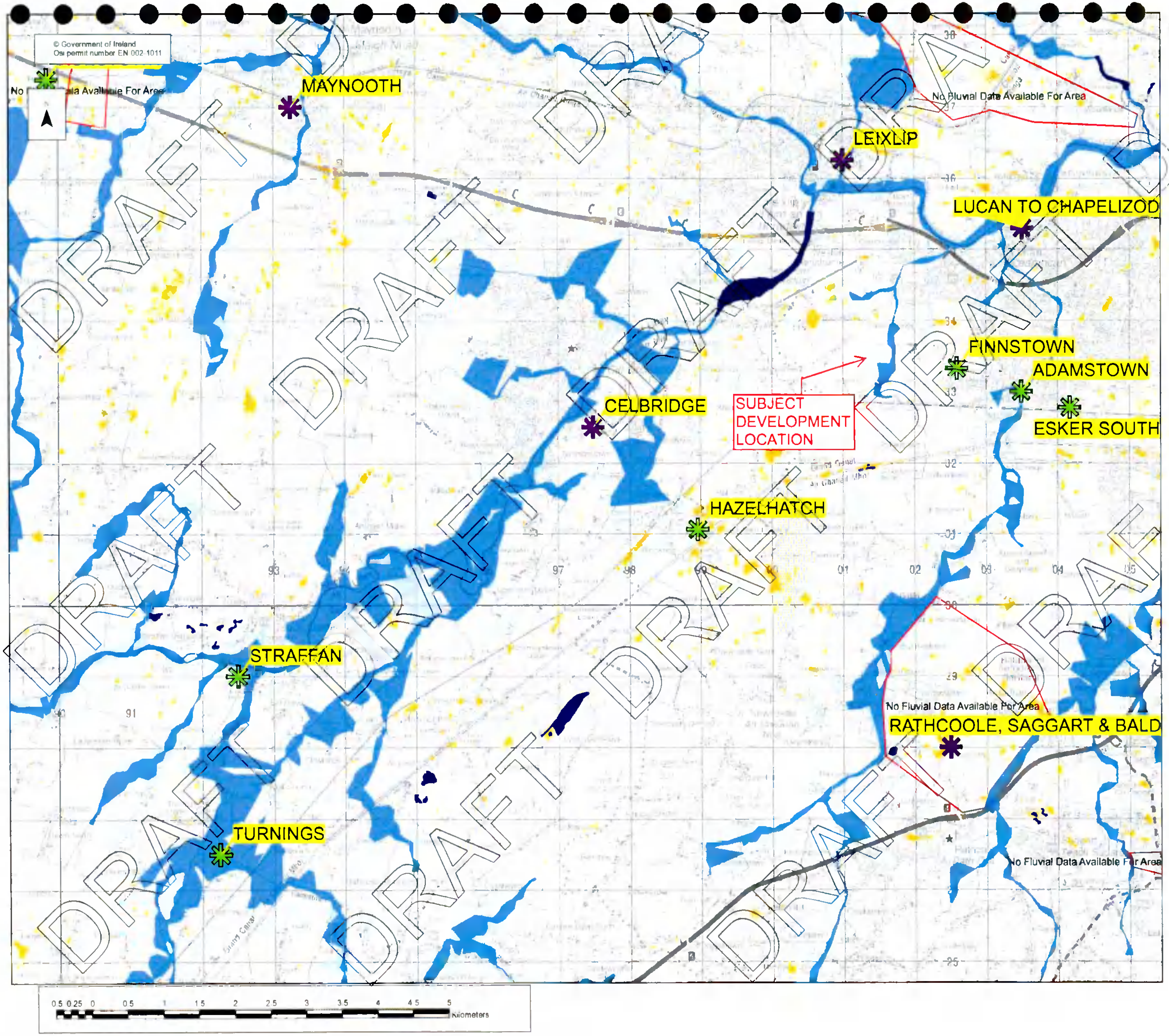
Please refer to drawings 20065-120, 121, 122, 123, 124 & 125 for swept path analysis completed as part of the planning application.

Report by;
Carina Gato
BEng. MIEI

Checked By;
Paul Moran
Beng (Hons) Dip.Eng Eur.Ing CEng MIEI

8.0 APPENDICES

8.1 APPENDIX A - Flood Mapping



Location Plan :

Legend:

Flood Extents

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

PFRA Outcomes

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

Important User Note

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

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

Office of Public Works
Jonathon Swift Street
Trim
Co Meath
Ireland

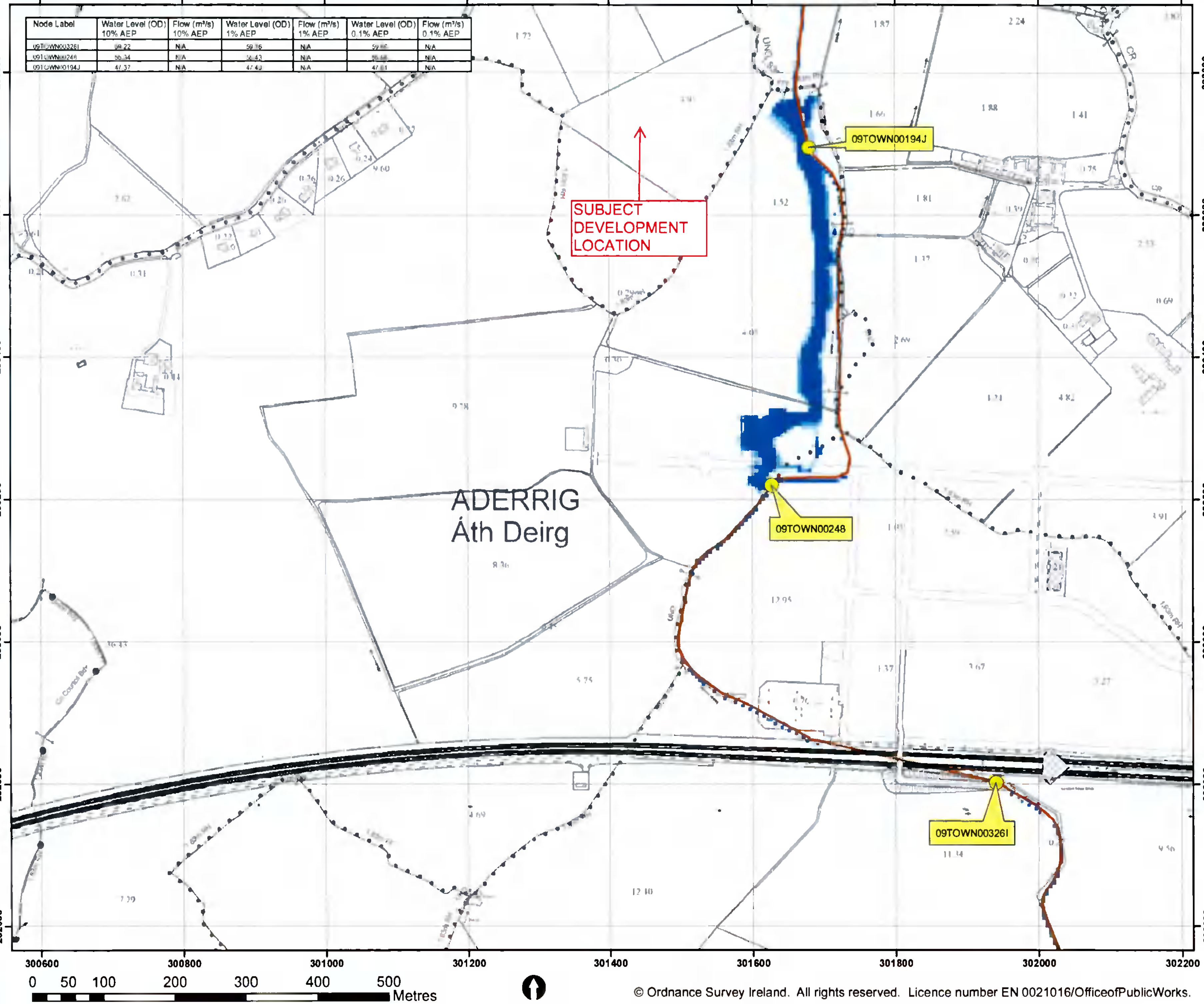
OPW

Project
PRELIMINARY FLOOD RISK ASSESMENT (PFRA)

Map
PFRA Indicative extents and outcomes
- Draft for Consultation

Figure By	PJW	Date	July2011
Checked By	MA	Date	July 2011
Figure No	2019 / MAP / 237 / A	Revision	0
Drawing Scale	1:50,000	Plot Scale	1:1 @ A3

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
09TOWN003261	59.22	N/A	59.16	N/A	59.[illegible]	N/A
09TOWN00248	56.34	N/A	[illegible].43	N/A	[illegible]	N/A
09TOWN00194J	47.37	N/A	47.40	N/A	47.[illegible]1	N/A



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
- Node Point
- Node ID Node Label

FINAL

REV	NOTE	DATE

CFRAM

OPW

RPS

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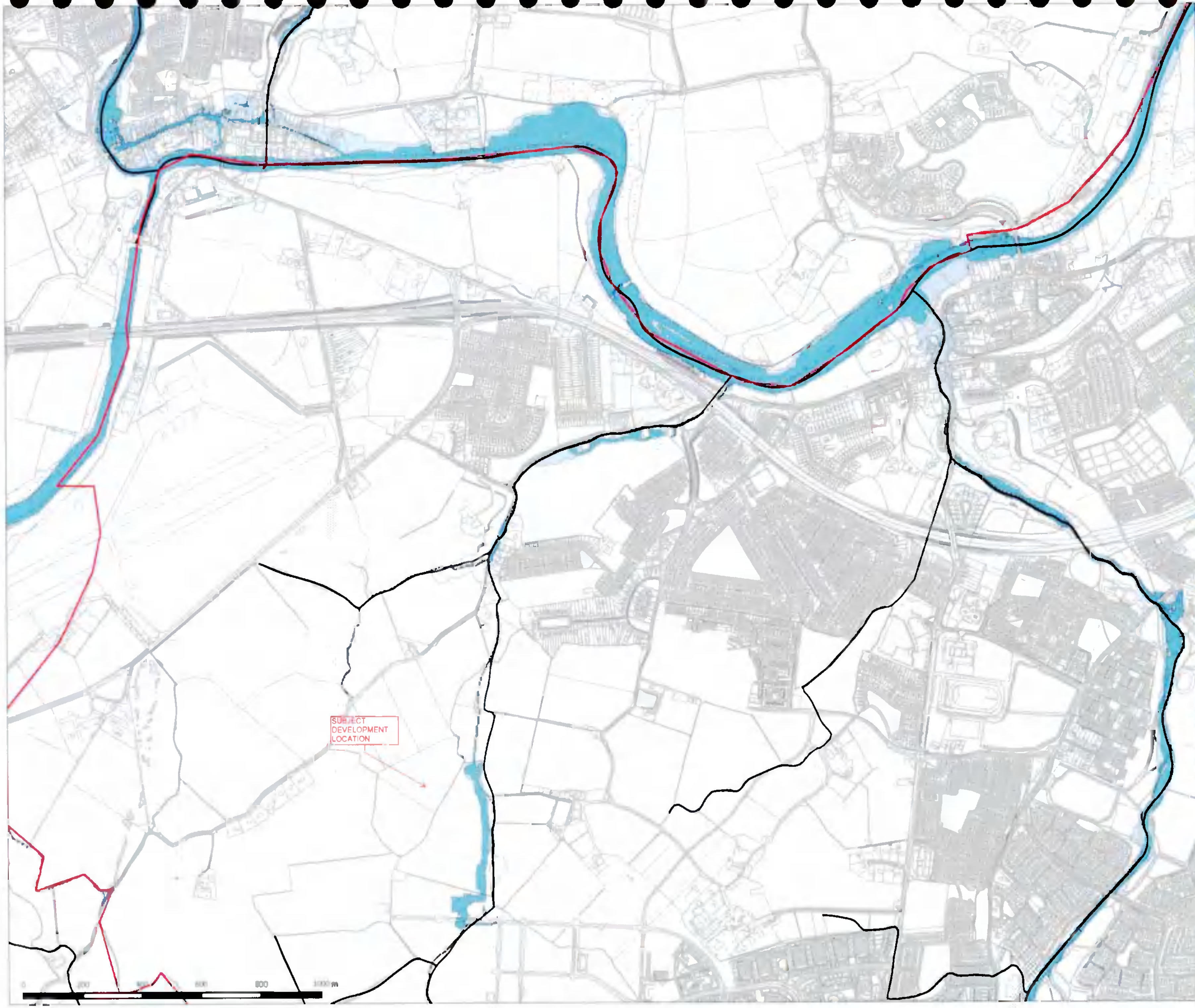
Map:
Lucan to Chapelizod Fluvial Flood Extents

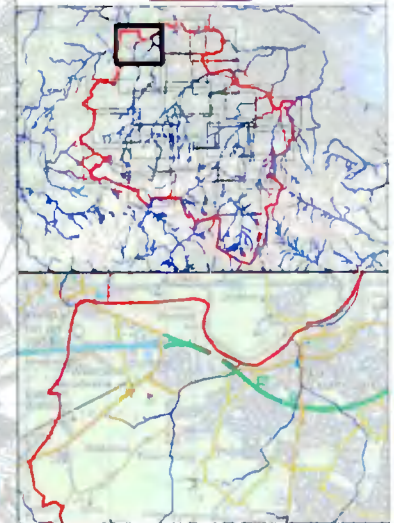
Map Type:	EXTENT
Source:	FLUVIAL
Map Area:	HPW
Scenario:	CURRENT
Drawn By: C.C.	Date: 27 uly 2016
Checked By: S.P.	Date: 27 uly 2016
Approved By: G.G.	Date: 27 uly 2016
Drawing No.:	E09LUC EXFCD F0 02
Map Series:	Page 2 of 12
Drawing Scale: 1:5,000	A3



Legend

- Flood Zone A - 1% AEP Flood Extent (1 in 100 chance in any given year)
- Flood Zone B - 1% AEP Flood Extent (1 in 1000 chance in any given year)
- Defended Area
- Watercourse Centreline
- Indicative Flood Extents
- County Boundary

DRAFT



South Dublin County Council

Project: Strategic Flood Risk Assessment

Title: Fluvial Flood Zone Mapping

Figure: MDW657_0001

RPS

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West Pier Business Campus
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Issue Details

Drawn:	BT	Project No.	[illegible]
Checked:	JH	File Ref	[illegible]
Approved:	JH		
Scale:	1:6000 @ A1	Drawing No.	Projection
Date:	14/01/2016	1 of 26	IG

Notes: 1. The viewer of this map should refer to the SFRA Report and Disclaimer

2. Ordnance Survey Ireland Licence No. EN 0005016 © Ordnance Survey Ireland/Government of Ireland

8.2 APPENDIX B - Rainfall Data

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 301472, Northing: 233784,

	Interval		Years													
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.3,	3.4,	4.0,	5.0,	5.7,	6.2,	7.9,	10.0,	11.4,	13.4,	15.2,	16.7,	18.9,	20.7,	22.2,	N/A ,
10 mins	3.2,	4.7,	5.6,	6.9,	7.9,	8.6,	11.1,	13.9,	15.9,	18.7,	21.2,	23.2,	26.4,	28.8,	30.9,	N/A ,
15 mins	3.7,	5.6,	6.6,	8.2,	9.3,	10.1,	13.0,	16.4,	18.7,	22.0,	25.0,	27.3,	31.0,	33.9,	36.4,	N/A ,
30 mins	4.9,	7.3,	8.6,	10.5,	11.9,	13.0,	16.5,	20.7,	23.4,	27.4,	31.0,	33.8,	38.2,	41.7,	44.6,	N/A ,
1 hours	6.5,	9.5,	11.1,	13.6,	15.2,	16.6,	20.9,	26.0,	29.4,	34.2,	38.5,	41.9,	47.1,	51.3,	54.7,	N/A ,
2 hours	8.6,	12.4,	14.4,	17.5,	19.5,	21.2,	26.6,	32.7,	36.8,	42.6,	47.8,	51.9,	58.1,	63.0,	67.1,	N/A ,
3 hours	10.2,	14.4,	16.8,	20.2,	22.6,	24.5,	30.5,	37.4,	42.0,	48.5,	54.3,	58.7,	65.7,	71.1,	75.6,	N/A ,
4 hours	11.4,	16.1,	18.7,	22.5,	25.1,	27.1,	33.7,	41.2,	46.1,	53.1,	59.3,	64.2,	71.6,	77.4,	82.2,	N/A ,
6 hours	13.4,	18.8,	21.7,	26.1,	29.0,	31.3,	38.7,	47.1,	52.6,	60.4,	67.4,	72.7,	81.0,	87.4,	92.7,	N/A ,
9 hours	15.8,	22.0,	25.3,	30.2,	33.5,	36.1,	44.5,	53.9,	60.1,	68.8,	76.4,	82.4,	91.5,	98.6,	104.4,	N/A ,
12 hours	17.7,	24.5,	28.2,	33.6,	37.2,	40.0,	49.1,	59.3,	66.0,	75.3,	83.6,	90.0,	99.8,	107.4,	113.6,	N/A ,
18 hours	20.9,	28.7,	32.8,	38.9,	43.0,	46.2,	56.4,	67.8,	75.3,	85.7,	94.9,	102.0,	112.8,	121.1,	128.0,	N/A ,
24 hours	23.4,	32.0,	36.5,	43.2,	47.7,	51.1,	62.3,	74.6,	82.7,	93.9,	103.8,	111.4,	123.0,	132.0,	139.3,	164.9,
2 days	29.4,	39.1,	44.1,	51.4,	56.2,	59.9,	71.6,	84.5,	92.8,	104.2,	114.1,	121.7,	133.2,	142.0,	149.2,	174.0,
3 days	34.2,	44.8,	50.2,	58.0,	63.1,	67.0,	79.3,	92.7,	101.2,	112.9,	123.0,	130.7,	142.3,	151.2,	158.4,	183.1,
4 days	38.5,	49.8,	55.5,	63.7,	69.1,	73.1,	86.0,	99.8,	108.6,	120.6,	130.9,	138.7,	150.5,	159.5,	166.8,	191.6,
6 days	46.0,	58.5,	64.7,	73.7,	79.5,	83.9,	97.6,	112.2,	121.4,	133.9,	144.7,	152.8,	164.9,	174.0,	181.5,	206.7,
8 days	52.6,	66.1,	72.9,	82.4,	88.6,	93.2,	107.7,	123.0,	132.6,	145.6,	156.7,	165.0,	177.5,	186.8,	194.4,	220.0,
10 days	58.7,	73.1,	80.3,	90.4,	96.8,	101.7,	116.9,	132.8,	142.7,	156.1,	167.5,	176.1,	188.8,	198.4,	206.1,	232.2,
12 days	64.4,	79.6,	87.2,	97.7,	104.5,	109.6,	125.3,	141.8,	152.1,	165.8,	177.5,	186.3,	199.3,	209.0,	216.9,	243.4,
16 days	75.0,	91.7,	99.8,	111.3,	118.5,	124.0,	140.8,	158.2,	169.0,	183.5,	195.7,	204.8,	218.3,	228.4,	236.5,	263.7,
20 days	84.8,	102.8,	111.5,	123.7,	131.4,	137.2,	154.8,	173.1,	184.4,	199.4,	212.1,	221.5,	235.5,	245.9,	254.2,	282.1,
25 days	96.3,	115.7,	125.1,	138.1,	146.3,	152.4,	171.0,	190.2,	202.1,	217.7,	230.9,	240.7,	255.1,	265.8,	274.5,	303.0,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

8.3 APPENDIX C - Paved Area Factors

PHASE 3
TUBBER LANE - ADAMSTOWN

DAVEY & SMITH ARCHITECTS

Date	By	Checked	Scale
SEPT 2021	CG	PM	1:2000

PAVED AREA FACTORS

PLANNING

Job No.	Drawing No.	Issue
20065	118	P2

poga CONSULTING ENGINEERS

poga Consulting Engineers	Project :	Adamstown Tubber Lane Phase 3
	POGA Ref:	20065
	Title:	Paved Area Factors
	Date:	Nov-21

Site Areas

Element		
Roofs (m^2)	20018	
Green Roofs (m^2)	4674	
Main Road (under construction)	6655	
Roads/Hardstanding (m^2)	36355	
Roads/Hardstanding draining to SuDS (m^2)	2681	
Green Area (m^2)	42841	
Permeable Paving (parking) (m^2)	4469	
Sub Total (m^2)	99500	

Paved Area Factors (PIMP Factors)

Roofs	0.95	
Green Roofs	0.40	
Roads/Hardstanding	0.85	
Roads/Hardstanding draining to SuDS	0.40	
Green Area	0.05	
Permeable Paving	0.05	(no run-off)

PIMP

Element	
Roofs	16.4%
Green Roofs	1.6%
Roads/Hardstanding	26.6%
Roads/Hardstanding SuDS	0.9%
Green Area	1.8%
Permeable Paving	0.2%
Average PIMP Factor Per site	47.6%

8.4 APPENDIX D - Surface Water Network Design

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	16.500	Add Flow / Climate Change (%)	20
Ratio R	0.280	Minimum Backdrop Height (m)	0.600
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.800
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)	0.75
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	200

Designed with Level Soffits

Time Area Diagram for Surface Network 1

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.638	4-8	0.555

Total Area Contributing (ha) = 1.193

Total Pipe Volume (m³) = 35.513

Network Design Table for Surface Network 1

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
1.000	51.940	0.810	64.1	0.168	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	89.007	0.610	145.9	0.230	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	38.322	1.175	32.6	0.087	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.003	55.341	0.780	71.0	0.171	0.00	0.0	0.600	o	300	Pipe/Conduit	
2.000	70.199	1.380	50.9	0.179	4.00	0.0	0.600	o	225	Pipe/Conduit	
2.001	49.524	0.891	55.6	0.103	0.00	0.0	0.600	o	225	Pipe/Conduit	
3.000	12.003	0.442	27.2	0.000	4.00	0.0	0.600	o	300	Pipe/Conduit	
2.002	50.197	1.673	30.0	0.087	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)
1.000	50.00	4.53	51.500	0.168	0.0	0.0	4.5	1.64	65.0	27.3
1.001	47.72	5.67	50.690	0.398	0.0	0.0	10.3	1.30	91.9	61.7
1.002	46.98	5.90	50.080	0.485	0.0	0.0	12.3	2.76	195.3	74.0
1.003	45.48	6.40	48.830	0.656	0.0	0.0	16.2	1.87	132.1	97.0
2.000	50.00	4.64	51.980	0.179	0.0	0.0	4.8	1.84	73.1	29.1
2.001	49.68	5.11	50.600	0.282	0.0	0.0	7.6	1.76	69.9	45.5
3.000	50.00	4.07	50.000	0.000	0.0	0.0	0.0	3.03	214.1	0.0
2.002	48.65	5.40	49.558	0.369	0.0	0.0	9.7	2.88	203.6	58.3

Network Design Table for Surface Network 1

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
1.004	86.312	1.290	66.9	0.165	0.00	0.0	0.600	o	375	Pipe/Conduit	●
4.000	26.858	0.091	294.9	0.000	4.00	0.0	0.600	o	150	Pipe/Conduit	●
1.005	8.621	0.046	187.4	0.003	0.00	0.0	0.600	o	450	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)
1.004	43.68	7.04	47.810	1.190	0.0	0.0	28.2	2.22	245.0	168.9
4.000	50.00	4.77	46.836	0.000	0.0	0.0	0.0	0.58	10.3	0.0
1.005	43.42	7.14	46.445	1.193	0.0	0.0	28.2	1.48	235.7	168.9

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 2

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	16.600	Add Flow / Climate Change (%)	20
Ratio R	0.280	Minimum Backdrop Height (m)	0.600
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.800
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)	0.75
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	200

Designed with Level Soffits

Time Area Diagram for Surface Network 2

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.638	4-8	0.555

Total Area Contributing (ha) = 1.193

Total Pipe Volume (m³) = 35.038

Network Design Table for Surface Network 2

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
1.000	51.940	0.810	64.1	0.168	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	89.007	0.610	145.9	0.230	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	38.322	1.175	32.6	0.087	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.003	55.341	0.780	71.0	0.171	0.00	0.0	0.600	o	300	Pipe/Conduit	
2.000	70.199	1.380	50.9	0.179	4.00	0.0	0.600	o	225	Pipe/Conduit	
2.001	49.524	0.891	55.6	0.103	0.00	0.0	0.600	o	225	Pipe/Conduit	
3.000	12.003	0.442	27.2	0.000	4.00	52.3	0.600	o	300	Pipe/Conduit	
2.002	50.197	1.673	30.0	0.087	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)
1.000	50.00	4.53	51.500	0.168	0.0	0.0	4.5	1.64	65.0	27.3
1.001	48.01	5.67	50.690	0.398	0.0	0.0	10.4	1.30	91.9	62.1
1.002	47.26	5.90	50.080	0.485	0.0	0.0	12.4	2.76	195.3	74.5
1.003	45.75	6.40	48.830	0.656	0.0	0.0	16.3	1.87	132.1	97.5
2.000	50.00	4.64	51.980	0.179	0.0	0.0	4.8	1.84	73.1	29.1
2.001	49.98	5.11	50.600	0.282	0.0	0.0	7.6	1.76	69.9	45.8
3.000	50.00	4.07	50.000	0.000	52.3	0.0	10.5	3.03	214.1	62.8
2.002	48.94	5.40	49.558	0.369	52.3	0.0	20.2	2.88	203.6	121.5

Network Design Table for Surface Network 2

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
1.004	86.312	1.290	66.9	0.165	0.00	0.0	0.600	o	375	Pipe/Conduit	●
1.005	8.621	0.046	187.4	0.003	0.00	0.0	0.600	o	450	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)
1.004	43.94	7.04	47.810	1.190	52.3	0.0	38.8	2.22	245.0	232.7
1.005	43.69	7.14	46.445	1.193	52.3	0.0	38.8	1.48	235.7	232.7

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 3

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	16.600	Add Flow / Climate Change (%)	20
Ratio R	0.280	Minimum Backdrop Height (m)	0.600
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.800
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)	0.75
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	200

Designed with Level Soffits

Time Area Diagram for Surface Network 3

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.585	4-8	0.544

Total Area Contributing (ha) = 1.129

Total Pipe Volume (m³) = 36.021

Network Design Table for Surface Network 3

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**
1.000	85.840	0.476	180.3	0.108	4.00	0.0	0.600	o	225	Pipe/Conduit	●
1.001	6.629	0.043	154.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	●
1.002	27.593	0.156	176.9	0.096	0.00	0.0	0.600	o	225	Pipe/Conduit	●
1.003	7.449	0.116	64.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	●
1.004	56.310	0.379	148.6	0.142	0.00	0.0	0.600	o	300	Pipe/Conduit	●
1.005	54.122	0.271	199.7	0.172	0.00	0.0	0.600	o	300	Pipe/Conduit	●
2.000	68.747	0.347	198.1	0.227	4.00	0.0	0.600	o	225	Pipe/Conduit	●
3.000	49.852	0.878	56.8	0.144	4.00	0.0	0.600	o	150	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)**
1.000	48.67	5.47	46.097	0.108	0.0	0.0	2.8	0.97	38.6	17.1
1.001	48.32	5.58	45.621	0.108	0.0	0.0	2.8	1.05	41.8	17.1
1.002	46.80	6.05	45.578	0.204	0.0	0.0	5.2	0.98	39.0	31.0
1.003	46.56	6.12	45.422	0.204	0.0	0.0	5.2	1.63	65.0	31.0
1.004	44.45	6.85	45.306	0.346	0.0	0.0	8.3	1.29	91.0	50.0
1.005	42.36	7.67	44.927	0.518	0.0	0.0	11.9	1.11	78.4	71.3
2.000	49.50	5.24	46.910	0.227	0.0	0.0	6.1	0.93	36.8	36.5
3.000	50.00	4.62	47.942	0.144	0.0	0.0	3.9	1.34	23.6	23.4

Network Design Table for Surface Network 3

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
2.001	75.018	0.840	89.3	0.104	0.00	0.0	0.600	o	300	Pipe/Conduit	●
4.000	12.526	0.164	76.4	0.000	4.00	41.6	0.600	o	450	Pipe/Conduit	●
2.002	53.888	0.311	173.3	0.062	0.00	0.0	0.600	o	450	Pipe/Conduit	●
1.006	16.930	0.106	159.7	0.074	0.00	0.0	0.600	o	525	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)
2.001	46.98	5.99	46.563	0.475	0.0	0.0	12.1	1.66	117.7	72.5
4.000	50.00	4.09	45.200	0.000	41.6	0.0	8.3	2.33	370.3	49.9
2.002	45.24	6.57	45.036	0.537	41.6	0.0	21.5	1.54	245.2	128.9
1.006	41.98	7.83	44.650	1.129	41.6	0.0	34.0	1.77	383.1	204.0

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 4

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	16.600	Add Flow / Climate Change (%)	20
Ratio R	0.280	Minimum Backdrop Height (m)	0.600
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.800
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)	0.75
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	200

Designed with Level Soffits

Time Area Diagram for Surface Network 4

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.082	4-8	0.026

Total Area Contributing (ha) = 0.108

Total Pipe Volume (m³) = 2.473

Network Design Table for Surface Network 4

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
1.000	29.752	0.187	159.1	0.108	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	20.006	0.156	128.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	12.438	0.081	153.5	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)
1.000	50.00	4.48	45.400	0.108	0.0	0.0	2.9	1.03	41.1	17.5
1.001	50.00	4.77	45.213	0.108	0.0	0.0	2.9	1.15	45.8	17.5
1.002	50.00	4.97	45.057	0.108	0.0	0.0	2.9	1.05	41.9	17.5

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 5

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	16.600	Add Flow / Climate Change (%)	20
Ratio R	0.280	Minimum Backdrop Height (m)	0.600
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.800
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)	0.75
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	200

Designed with Level Soffits

Time Area Diagram for Surface Network 5

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.810	4-8	0.895

Total Area Contributing (ha) = 1.705

Total Pipe Volume (m³) = 44.602

Network Design Table for Surface Network 5

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
1.000	71.771	0.757	94.8	0.409	4.00	0.0	0.600	o	300	Pipe/Conduit	🔒
1.001	17.623	0.202	87.2	0.111	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
1.002	11.050	0.060	184.2	0.021	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
1.003	13.820	0.120	115.2	0.060	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
1.004	58.639	0.293	200.1	0.087	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
2.000	47.683	0.284	167.9	0.196	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
2.001	65.621	0.402	163.2	0.163	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
1.005	17.941	0.220	81.5	0.014	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
1.006	9.309	0.093	100.1	0.009	0.00	0.0	0.600	o	375	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)
1.000	50.00	4.74	47.264	0.409	0.0	0.0	11.1	1.62	114.2	66.5
1.001	50.00	4.92	46.432	0.520	0.0	0.0	14.1	1.68	119.1	84.5
1.002	50.00	5.05	46.230	0.541	0.0	0.0	14.7	1.33	147.1	87.9
1.003	49.67	5.19	46.170	0.601	0.0	0.0	16.2	1.69	186.4	97.0
1.004	47.09	5.96	46.050	0.688	0.0	0.0	17.5	1.28	141.1	105.3
2.000	50.00	4.79	46.577	0.196	0.0	0.0	5.3	1.01	40.0	31.8
2.001	47.98	5.68	46.293	0.359	0.0	0.0	9.3	1.23	86.8	56.0
1.005	46.63	6.10	45.741	1.061	0.0	0.0	26.8	2.01	221.8	160.8
1.006	46.37	6.19	45.521	1.070	0.0	0.0	26.9	1.81	200.0	161.2

Network Design Table for Surface Network 5

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
1.007	52.490	0.520	100.9	0.121	0.00	0.0	0.600	o	375	Pipe/Conduit	●
3.000	37.507	0.228	164.5	0.219	4.00	0.0	0.600	o	225	Pipe/Conduit	●
3.001	69.840	0.359	194.5	0.195	0.00	0.0	0.600	o	300	Pipe/Conduit	●
3.002	10.699	0.129	82.9	0.010	0.00	0.0	0.600	o	300	Pipe/Conduit	●
1.008	22.185	0.204	108.8	0.027	0.00	0.0	0.600	o	450	Pipe/Conduit	●
1.009	18.901	0.166	113.9	0.063	0.00	0.0	0.600	o	450	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)
1.007	44.95	6.67	45.428	1.191	0.0	0.0	29.0	1.80	199.2	174.0
3.000	50.00	4.61	45.695	0.219	0.0	0.0	5.9	1.02	40.4	35.6
3.001	48.08	5.65	45.467	0.414	0.0	0.0	10.8	1.12	79.4	64.7
3.002	47.74	5.75	45.108	0.424	0.0	0.0	11.0	1.73	122.1	65.8
1.008	44.42	6.86	44.908	1.642	0.0	0.0	39.5	1.95	310.0	237.1
1.009	43.98	7.03	44.704	1.705	0.0	0.0	40.6	1.90	302.9	243.7

8.5 APPENDIX E - Wastewater Network Design

FOUL SEWERAGE DESIGN

Design Criteria for Foul Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	0
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.200
Flow Per Person (l/per/day)	222.00	Maximum Backdrop Height (m)	1.500
Persons per House	3.00	Min Design Depth for Optimisation (m)	1.200
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	1.00
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	75.341	0.762	98.9	0.000	20	0.0	1.500	o	225	Pipe/Conduit	
2.000	32.212	0.261	123.4	0.000	4	0.0	1.500	o	150	Pipe/Conduit	
1.001	89.993	0.687	131.0	0.000	28	0.0	1.500	o	225	Pipe/Conduit	
1.002	18.155	0.200	90.8	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
1.003	14.560	0.132	110.3	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
1.004	64.121	0.537	119.4	0.000	9	0.0	1.500	o	225	Pipe/Conduit	
3.000	58.554	0.475	123.3	0.000	6	0.0	1.500	o	150	Pipe/Conduit	
3.001	88.501	0.744	119.0	0.000	24	0.0	1.500	o	225	Pipe/Conduit	
3.002	30.951	0.276	112.1	0.000	3	0.0	1.500	o	225	Pipe/Conduit	
1.005	19.771	0.220	89.9	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
1.006	30.907	0.161	192.0	0.000	5	0.0	1.500	o	225	Pipe/Conduit	
1.007	29.019	0.279	104.0	0.000	2	0.0	1.500	o	225	Pipe/Conduit	
4.000	12.908	0.173	74.6	0.000	9	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	48.300	0.000	0.0	20	0.0	22	0.45	1.15	45.9	0.9
2.000	46.992	0.000	0.0	4	0.0	12	0.26	0.79	13.9	0.2
1.001	46.656	0.000	0.0	52	0.0	38	0.55	1.00	39.9	2.4
1.002	45.969	0.000	0.0	52	0.0	34	0.62	1.21	47.9	2.4
1.003	45.769	0.000	0.0	52	0.0	36	0.58	1.09	43.4	2.4
1.004	45.637	0.000	0.0	61	0.0	40	0.60	1.05	41.8	2.8
3.000	46.180	0.000	0.0	6	0.0	15	0.30	0.79	13.9	0.3
3.001	45.630	0.000	0.0	30	0.0	28	0.48	1.05	41.8	1.4
3.002	44.886	0.000	0.0	33	0.0	29	0.50	1.08	43.1	1.5
1.005	44.610	0.000	0.0	94	0.0	46	0.75	1.21	48.2	4.3
1.006	44.390	0.000	0.0	99	0.0	57	0.58	0.83	32.9	4.6
1.007	44.229	0.000	0.0	101	0.0	49	0.73	1.13	44.7	4.7
4.000	45.887	0.000	0.0	9	0.0	16	0.41	1.01	17.9	0.4

Network Design Table for Foul Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
4.001	82.536	0.638	129.4	0.000	33	0.0	1.500	o	225	Pipe/Conduit	🔒
4.002	26.212	0.141	185.9	0.000	10	0.0	1.500	o	225	Pipe/Conduit	🔒
4.003	6.797	0.165	41.2	0.000	0	0.0	1.500	o	225	Pipe/Conduit	🔒
1.008	26.895	0.188	143.1	0.000	0	0.0	1.500	o	225	Pipe/Conduit	🔒
1.009	18.740	0.142	132.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	🔒

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
4.001	45.639	0.000	0.0	42	0.0	34	0.52	1.01	40.1	1.9
4.002	45.001	0.000	0.0	52	0.0	41	0.49	0.84	33.4	2.4
4.003	44.860	0.000	0.0	52	0.0	28	0.82	1.79	71.2	2.4
1.008	43.950	0.000	0.0	153	0.0	66	0.73	0.96	38.1	7.1
1.009	43.762	0.000	0.0	153	0.0	64	0.75	1.00	39.7	7.1

FOUL SEWERAGE DESIGN

Design Criteria for Foul Network 2

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	0
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.200
Flow Per Person (l/per/day)	222.00	Maximum Backdrop Height (m)	1.500
Persons per House	3.00	Min Design Depth for Optimisation (m)	1.200
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	1.00
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul Network 2

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	55.345	0.655	84.5	0.000	5	0.0	1.500	o	150	Pipe/Conduit	🔒
1.001	85.898	0.690	124.5	0.000	21	0.0	1.500	o	225	Pipe/Conduit	🔒
1.002	44.327	1.130	39.2	0.000	6	0.0	1.500	o	225	Pipe/Conduit	🔒
1.003	54.530	1.330	41.0	0.000	15	0.0	1.500	o	225	Pipe/Conduit	🔒
2.000	69.020	1.350	51.1	0.000	11	0.0	1.500	o	225	Pipe/Conduit	🔒
2.001	55.157	1.340	41.2	0.000	6	0.0	1.500	o	225	Pipe/Conduit	🔒
3.000	14.660	0.289	50.8	0.000	1040	0.0	1.500	o	225	Pipe/Conduit	🔒
2.002	51.353	1.710	30.0	0.000	12	0.0	1.500	o	225	Pipe/Conduit	🔒
1.004	83.730	0.940	89.1	0.000	11	0.0	1.500	o	300	Pipe/Conduit	🔒
4.000	30.164	0.760	39.7	0.000	3	0.0	1.500	o	150	Pipe/Conduit	🔒

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	51.470	0.000	0.0	5	0.0	13	0.32	0.95	16.8	0.2
1.001	50.740	0.000	0.0	26	0.0	27	0.45	1.03	40.9	1.2
1.002	50.050	0.000	0.0	32	0.0	22	0.72	1.84	73.0	1.5
1.003	48.920	0.000	0.0	47	0.0	27	0.80	1.80	71.4	2.2
2.000	51.990	0.000	0.0	11	0.0	15	0.47	1.61	63.9	0.5
2.001	50.640	0.000	0.0	17	0.0	17	0.58	1.79	71.3	0.8
3.000	49.600	0.000	0.0	1040	0.0	146	1.77	1.61	64.1	48.1
2.002	49.300	0.000	0.0	1069	0.0	125	2.19	2.10	83.5	49.4
1.004	47.590	0.000	0.0	1127	0.0	150	1.47	1.47	103.9	52.1
4.000	47.485	0.000	0.0	3	0.0	8	0.36	1.39	24.6	0.1

Network Design Table for Foul Network 2

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.005	11.760	0.078	150.8	0.000	0	0.0	1.500	o	300	Pipe/Conduit	●

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.005	46.650	0.000	0.0	1130	0.0	177	1.20	1.13	79.8	52.3

FOUL SEWERAGE DESIGN

Design Criteria for Foul Network 3

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	0
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.200
Flow Per Person (l/per/day)	222.00	Maximum Backdrop Height (m)	1.500
Persons per House	3.00	Min Design Depth for Optimisation (m)	1.200
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	1.00
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul Network 3

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	75.341	0.762	98.9	0.000	20	0.0	1.500	o	225	Pipe/Conduit	🔒
2.000	32.212	0.261	123.4	0.000	4	0.0	1.500	o	150	Pipe/Conduit	🔒
1.001	89.993	0.687	131.0	0.000	28	0.0	1.500	o	225	Pipe/Conduit	🔒
1.002	18.155	0.200	90.8	0.000	0	0.0	1.500	o	225	Pipe/Conduit	🔒
1.003	14.560	0.132	110.3	0.000	0	0.0	1.500	o	225	Pipe/Conduit	🔒
1.004	64.121	0.537	119.4	0.000	9	0.0	1.500	o	225	Pipe/Conduit	🔒
3.000	58.554	0.475	123.3	0.000	6	0.0	1.500	o	150	Pipe/Conduit	🔒
3.001	88.501	0.744	119.0	0.000	24	0.0	1.500	o	225	Pipe/Conduit	🔒
3.002	30.951	0.276	112.1	0.000	3	0.0	1.500	o	225	Pipe/Conduit	🔒
1.005	19.771	0.220	89.9	0.000	0	0.0	1.500	o	225	Pipe/Conduit	🔒
1.006	30.907	0.161	192.0	0.000	5	0.0	1.500	o	225	Pipe/Conduit	🔒
1.007	29.019	0.279	104.0	0.000	2	0.0	1.500	o	225	Pipe/Conduit	🔒

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	48.300	0.000	0.0	20	0.0	22	0.45	1.15	45.9	0.9
2.000	46.992	0.000	0.0	4	0.0	12	0.26	0.79	13.9	0.2
1.001	46.656	0.000	0.0	52	0.0	38	0.55	1.00	39.9	2.4
1.002	45.969	0.000	0.0	52	0.0	34	0.62	1.21	47.9	2.4
1.003	45.769	0.000	0.0	52	0.0	36	0.58	1.09	43.4	2.4
1.004	45.637	0.000	0.0	61	0.0	40	0.60	1.05	41.8	2.8
3.000	46.180	0.000	0.0	6	0.0	15	0.30	0.79	13.9	0.3
3.001	45.630	0.000	0.0	30	0.0	28	0.48	1.05	41.8	1.4
3.002	44.886	0.000	0.0	33	0.0	29	0.50	1.08	43.1	1.5
1.005	44.610	0.000	0.0	94	0.0	46	0.75	1.21	48.2	4.3
1.006	44.390	0.000	0.0	99	0.0	57	0.58	0.83	32.9	4.6
1.007	44.229	0.000	0.0	101	0.0	49	0.73	1.13	44.7	4.7

Network Design Table for Foul Network 3

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
4.000	11.620	0.173	67.2	0.000	9	0.0	1.500	o	150	Pipe/Conduit	●
4.001	82.536	0.638	129.4	0.000	33	0.0	1.500	o	225	Pipe/Conduit	●
4.002	26.212	0.141	185.9	0.000	10	0.0	1.500	o	225	Pipe/Conduit	●
4.003	6.797	0.165	41.2	0.000	0	0.0	1.500	o	225	Pipe/Conduit	●
1.008	26.895	0.188	143.1	0.000	0	0.0	1.500	o	225	Pipe/Conduit	●
1.009	18.740	0.142	132.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	●

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
4.000	45.887	0.000	0.0	9	0.0	16	0.42	1.07	18.9	0.4
4.001	45.639	0.000	0.0	42	0.0	34	0.52	1.01	40.1	1.9
4.002	45.001	0.000	0.0	52	0.0	41	0.49	0.84	33.4	2.4
4.003	44.860	0.000	0.0	52	0.0	28	0.82	1.79	71.2	2.4
1.008	43.950	0.000	0.0	153	0.0	66	0.73	0.96	38.1	7.1
1.009	43.762	0.000	0.0	153	0.0	64	0.75	1.00	39.7	7.1

FOUL SEWERAGE DESIGN

Design Criteria for Foul Network 4

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	0
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.200
Flow Per Person (l/per/day)	222.00	Maximum Backdrop Height (m)	1.500
Persons per House	3.00	Min Design Depth for Optimisation (m)	1.200
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	1.00
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul Network 4

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	48.007	0.337	142.5	0.000	4	0.0	1.500	o	150	Pipe/Conduit	
1.001	77.885	0.526	148.0	0.000	10	0.0	1.500	o	150	Pipe/Conduit	
2.000	54.978	0.932	59.0	0.000	9	0.0	1.500	o	225	Pipe/Conduit	
1.002	74.234	0.618	120.1	0.000	10	0.0	1.500	o	225	Pipe/Conduit	
3.000	49.009	0.471	104.1	0.000	5	0.0	1.500	o	150	Pipe/Conduit	
4.000	12.528	0.140	89.5	0.000	831	0.0	1.500	o	225	Pipe/Conduit	
1.003	49.284	1.305	37.8	0.000	3	0.0	1.500	o	225	Pipe/Conduit	
5.000	22.236	0.233	95.4	0.000	1	0.0	1.500	o	150	Pipe/Conduit	
5.001	6.756	0.048	140.4	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
5.002	27.183	0.229	118.7	0.000	6	0.0	1.500	o	150	Pipe/Conduit	
5.003	6.026	0.078	77.1	0.000	0	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	47.288	0.000	0.0	4	0.0	13	0.25	0.73	13.0	0.2
1.001	46.951	0.000	0.0	14	0.0	23	0.37	0.72	12.7	0.6
2.000	47.950	0.000	0.0	9	0.0	14	0.42	1.50	59.5	0.4
1.002	46.354	0.000	0.0	33	0.0	30	0.49	1.05	41.6	1.5
3.000	46.076	0.000	0.0	5	0.0	13	0.30	0.86	15.2	0.2
4.000	45.670	0.000	0.0	831	0.0	152	1.35	1.21	48.3	38.4
1.003	45.530	0.000	0.0	872	0.0	118	1.91	1.87	74.4	40.3
5.000	46.008	0.000	0.0	1	0.0	6	0.18	0.90	15.8	0.0
5.001	45.775	0.000	0.0	1	0.0	7	0.16	0.74	13.0	0.0
5.002	45.727	0.000	0.0	7	0.0	16	0.32	0.80	14.2	0.3
5.003	45.498	0.000	0.0	7	0.0	14	0.37	1.00	17.6	0.3

Network Design Table for Foul Network 4

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
6.000	19.407	0.194	100.0	0.000	8	0.0	1.500	o	150	Pipe/Conduit	●
6.001	8.085	0.054	150.0	0.000	0	0.0	1.500	o	150	Pipe/Conduit	●
5.004	53.078	0.298	178.1	0.000	19	0.0	1.500	o	225	Pipe/Conduit	●
5.005	50.909	0.897	56.8	0.000	19	0.0	1.500	o	225	Pipe/Conduit	●
1.004	25.857	0.150	172.4	0.000	1	0.0	1.500	o	300	Pipe/Conduit	●
7.000	45.075	0.571	78.9	0.000	5	0.0	1.500	o	150	Pipe/Conduit	●
7.001	9.186	0.367	25.0	0.000	0	0.0	1.500	o	150	Pipe/Conduit	●

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
6.000	45.900	0.000	0.0	8	0.0	16	0.36	0.88	15.5	0.4
6.001	45.706	0.000	0.0	8	0.0	18	0.31	0.71	12.6	0.4
5.004	45.420	0.000	0.0	34	0.0	33	0.43	0.86	34.1	1.6
5.005	45.122	0.000	0.0	53	0.0	31	0.74	1.53	60.7	2.5
1.004	44.150	0.000	0.0	926	0.0	163	1.09	1.06	74.6	42.8
7.000	46.437	0.000	0.0	5	0.0	12	0.33	0.99	17.4	0.2
7.001	45.866	0.000	0.0	5	0.0	10	0.49	1.76	31.0	0.2

FOUL SEWERAGE DESIGN

Design Criteria for Foul Network 5

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	0
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.200
Flow Per Person (l/per/day)	222.00	Maximum Backdrop Height (m)	1.500
Persons per House	3.00	Min Design Depth for Optimisation (m)	1.200
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	1.00
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul Network 5

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	29.767	0.192	155.0	0.000	6	0.0	1.500	o	225	Pipe/Conduit	🔒
1.001	8.633	0.089	97.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	🔒

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	45.410	0.000	0.0	6	0.0	14	0.26	0.92	36.6	0.3
1.001	45.218	0.000	0.0	6	0.0	13	0.31	1.17	46.3	0.3

8.6 APPENDIX F - Water & Wastewater Demand Calculations

poga Consulting Engineers

CALCULATIONS - PROPOSED DEVELOPMENT

Accommodation Schedule		Average Occupancy Rate	Population (P)	Daily Water Consumption per Capita (G)	Daily Water Consumption (L/s)
Existing Residential Units (unit)	0	2.7 people / unit	0	150 L/capita/day	0.000
Existing Commercial area (m2)	0	1 person / 25 m2	0	50 L/day/capita	0.000
Existing Light Industrial area (m2)	0	1 person / 33 m2	0	50 L/day/capita	0.000
Existing Retail area (m2)	0	1 person / 100 m2	0	30 L/day/capita	0.000
Proposed Residential Units (unit)	455	2.7 people / unit	1229	150 L/capita/day	0.711
Proposed Commercial area (m2)	0	1 person / 25 m2	0	50 L/day/capita	0.000
Proposed Light Industrial area (m2)	0	1 person / 33 m2	0	50 L/day/capita	0.000
Proposed Creche (m2)	0	1 person / 20 m2	0	40 L/day/capita	0.000
Proposed Retail area (m2)	0	1 person / 100 m2	0	30 L/day/capita	0.000

Coefficients for Subject Site

Infiltration rate for Existing properties (I)	=	20
Infiltration rate for New properties (I)	=	10
Commercial Peaking Factor (Pfdom,ind)	=	4.50 (up to 5.5Ha area)
Domestic Peaking Factor (Pfdom)	=	3.00 (up to 5000 people)
Trade Wastewater Flow Peaking Factor (Pftrade)	=	3.00
Site Area	=	11.60 ha
Paved Area Factor	=	0.40
C factor (Cv x Cr)	=	0.80
Rainfall intensity (i) for sub-catchment greater than 400m2 for 2 years Return Period	=	7.00 mm/hr
Storm Design event peak rate runoff (Q = 2.78 x C x I x A)	=	72.24 l/s
SW Allowance (1.5% of Gross Area)	=	1.08

Foul Wastewater Discharge

Domestic Dry Weather Flow (P x G + I)	=	0.78 l/s
Design Foul Flow (Domestic Dry Weather Flow x Pfdom + SW Allowance)	=	3.43 l/s
Commercial/Retail Dry Weather Flow (P x G + I)	=	0.00 l/s
Design Foul Flow (Eqn1)	=	0.00 l/s
Industrial Dry Weather Flow (P x G + I)	=	0.00 l/s
Design Foul Flow (Eqn1)	=	0.00 l/s
Total		**3.43 l/s**

Water Demand

Domestic	=	0.71 l/s
Commercial	=	0.00 l/s
Average Demand	=	0.71 l/s
Peak Demand (2.1 times average)	=	1.49 l/s
Normal Demand (Average demand over 8 hours)	=	**2.13 l/s**

8.7 APPENDIX G - Irish Water PCE Responce

UISCE
ÉIREANN : IRISH
WATER

Paul Moran

Unit C2
Nutgrove Office Park
Co. Dublin
D14CR20

Uisce Éireann
Bosca OP 448
Oifig Sheachadta na
Cathrach Theas
Cathair Chorcaí

Irish Water
PO Box 448,
South City
Delivery Office,
Cork City.

www.water.ie

20 May 2021

Re: CDS21001304 pre-connection enquiry - Subject to contract Contract denied

Connection for Housing Development of 420 unit(s) at Adamstown Tubberlane, Tobermaclugg, Co. Dublin

Dear Sir/Madam,

Irish Water has reviewed your pre-connection enquiry in relation to a Water & Wastewater connection at Adamstown Tubberlane, Tobermaclugg, Co. Dublin (the **Premises**). Based upon the details you have provided with your pre-connection enquiry and on our desk top analysis of the capacity currently available in the Irish Water network(s) as assessed by Irish Water, we wish to advise you that your proposed connection to the Irish Water network(s) can be facilitated at this moment in time.

SERVICE	**OUTCOME OF PRE-CONNECTION EN UIRY** **THIS IS NOT A CONNECTION OFFER. YOU MUST APPLY FOR A CONNECTION(S) TO THE IRISH WATER NETWORK(S) IF YOU WISH TO PROCEED.**
Water Connection	Feasible subject to upgrades
Wastewater Connection	Feasible without upgrades by Irish Water
SITE SPECIFIC COMMENTS	
Water Connection	In order to accommodate the proposed connection to Irish Water network at the Premises, upgrade works are required as follows: Connection main – Approx. 100m of new 200mm ID pipe main to be laid to connect the site development (see yellow section below) to the new 200mm ID main. As shown below (See green line in figure). DMA meter to be installed on the connection main and linked up with telemetry online. Upgrade main – approx. 650m of new 200mm ID pipe main to be laid to link the connection main and the existing 250mm Trunk main. (red dashed line in figure below). Can reduce to 150mm ID diameter if linked with existing 160mm pipe main which works together.
Wastewater Connection	The proposed wastewater connections for this to connect to the Irish Water network is via infrastructure that has not been taken in charge by Irish

8.8 APPENDIX H - Adamstown SDZ Surface Water Drainage Engineering Assessment Report

Waterman Moylan
Engineering Consultants

Adamstown Strategic Development Zone
Surface Water Drainage
Engineering Assessment Report

Consolidated Review of Strategic Surface Water Drainage via the Tobermaclugg Stream and Backstown Stream

December 2017

Waterman Moylan Consulting Engineers Limited
Block S, East Point Business Park,
Alfie Byrne Road, Dublin D03 H3F4
www.watermangroup.com

Waterman Moylan
Engineering Consultants

Client Name:
Document Reference: 17-113r.002
Project Number: 17-113

Quality Assurance Approval Status

This document has been prepared and checked in accordance with
Waterman Group s IMS (BS EN ISO 9001: 2008, BS EN ISO 14001: 2004 and BS OHSAS 18001:2007)

Issue	Date	Prepared by	Checked by	Approved by
No. 1	Oct 2017	I Swartz		
	Nov 2017	I Swartz	B Jackson	
	Dec 2017	I Swartz	B Jackson	
	Jan 2017	I Swartz	B Jackson	Joe Gibbons

Comments

Disclaimer

This report has been prepared by Waterman Moylan, with all reasonable skill, care and diligence within the terms of the Contract with the Client, incorporation of our General Terms and Condition of Business and taking account of the resources devoted to us by agreement with the Client.

We disclaim any responsibility to the Client and others in respect of any matters outside the scope of the above.

This report is confidential to the Client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at its own risk.

Content

A Overall SDZ Drainage Layout SK121

B Downstream Defenders

C Background Reports Summaries

1. Overview

This report has been prepared by **Waterman Moylan Engineering Consultants Limited** to consolidate all previous surface water reports (from 2005 - 2010) prepared by **PH McCarthy Consulting Engineers (Subsequently WYG)** for the Upgrading of **Tobermaclugg Stream** to drain the bulk (approximately 85%) of the **Adamstown Strategic Development Zone** (ASDZ) Surface Water Catchment (200 ha) and the subsequent remedial works. It also takes into account the updated **2014 SDCC Adamstown SDZ Planning Scheme** to ensure overall compliance regarding surface water going forward.

PH McCarthy Consulting Engineers (PHMcC) had been appointed to carry out an assessment of the proposed amelioration of the **Tobermaclugg Stream**, as an element of the development of the ASDZ Lands in South Lucan.

There were approximately 200 hectares of formerly agricultural lands set aside for development within the ASDZ, which will increase the volume and rate of surface water runoff incrementally until it is completely developed. The first phase of construction commenced in 2004 through Planning Permission **SDZ 04/001A**. Following a series of subsequent permissions, approximately 1395 units of the initial 10 000 units (subsequently revised down to 7 010 - 8 905 units see pg 10 ASDZ 2014 Planning Scheme), with the associated infrastructure, were completed and occupied in accordance with the ASDZ Planning Scheme, by means of a series of phased construction, up until around 2009. Due to the onset of the recession in late 2008 (in full swing by mid-2009), development within the ASDZ practically ground to a halt until around 2016.

The Adamstown SDZ area is naturally subdivided into three **Surface Water Drainage** sub-catchments as follows: -

i) **Tobermaclugg Stream** catchment, which covers most of the ASDZ, (65%) drains to the north.

ii) **North East** (Griffeen Tributary) catchment consists of approximately 20% of the ASDZ and will mostly be redirected to the surface water outfall via the Tobermaclugg by agreement with SDCC due to issues with the receiving system to the north east.

iii) **South East** (Griffeen Tributary) - This catchment consists of approximately 15% of the ASDZ.

Given the scale and significance of the ASDZ, the development and its surrounding surface water catchments have been fully analysed and a fully engineered system designed and constructed to manage and control the storm and development flows to reduce flood occurrences and protect against pollution of the bio-systems of the watercourses. The design and construction to date was developed through multiple reports (dating back to the inception of the SDZ), models and subsequently construction contracts during the period 2003 to 2010.

This Report will demonstrate that the designed and implemented system meets the requirements of the Adamstown SDZ Planning Schemes and Greater Dublin Drainage Strategies to convey surface water, prevent flooding and protect the environment, in accordance with the following criteria:-

- **No surcharge in 2 years Average Recurrence Interval (ARI) rainfall event**
- **No flooding in a 30-year ARI rainfall event within the ASDZ**
- **Only localised ponding of the Lucan Golf Course would occur under 1 : 100 year ARI return storms and above. However, this will occur for a short duration only and the golf course is unlikely to be open under such extreme events**
- **No flooding of Tubber Lane Road in a 100 year ARI rainfall event**
- **No flooding of the proposed Tobermaclugg Pumping Station in a 1 000 year rainfall event**
- **A basic continuous flow of 100ℓ/s in the Tobermaclugg Stream through the ASDZ and downstream of the old confluence point**
- **Continuous flow in the salmonid Tobermaclugg/Backstown Stream in the Golf Course**
- **The stormwater culvert through the Lucan Golf Course serves as the emergency outfall for the Tobermaclugg Foul Pumping Station**
- **To protect the streams from the risk of pollution from run-off of paved areas, (by the initial rainfall in any storm washing oils, grease, grits and organics into the system) it was agreed that Downstream Defenders, located at strategic locations within the SDZ be installed to remove suspended solids, whilst performing as a Class 2 hydrocarbon separator.**
- **Secondary treatment has been provided by means of a reed planted 5000m^3 attenuation pond next to the Millstream Road**

Therefore in summary the following has been implemented as at 2010 for the Tobermaclugg Stream (See overall ASDZ Surface Water Drawing SK121):-

Reach	**Culvert Size Installed as at 2010**	
	Length (m)	Description
Reach 1 (Through ASDZ)	181	1 ! 1500 mm ø.
	657	Temporary open channel/overflow
	33	1 ! 1500 mm ø.
	301	1 ! 1200 mm ø
	388	1 ! 1500 mm ø
	495	1 ! 2100mm ø
	2055	
Reach 2 (Lucan GC)	878	1 ! 2400 mm ø
	44	Open channel through Pond
	29	Twin 2.1m box culverts
	76	2.9m x 1.7m rect. open channel
	31	3.6m x 1.2m rect. open channel
	1058	

Culvert size Summary Installed as at 2010

Therefore it can be noted that the external Surface Water Drainage, into which the ASDZ drains, has been completed in accordance with the SDCC s Planning Scheme and GDSDS, which includes the secondary treatment with the provision of a 5000m^3 reed planted attenuation point next to the Millstream Road.

2.1/2.4m ø pipes have been installed (through Tobermaclugg Park) passed the Tobermaclugg Foul PS and through the Lucan Golf course to cater for the surface water discharge requirements of the ASDZ Tobermaclugg and North East catchments along with a series of surface water pipes within the SDZ to accommodate the surface water for the fully post development ASDZ. All that remains is for the remaining undeveloped areas within the SDZ to be progressed based on the agreed surface water design strategy and to complete the detail design to connect into the existing installed surface water pipes.

2. Adamstown SDZ – Extracts from SDCC 2014 Planning Scheme

At the onset of the preplanning and development of the Adamstown Strategic Development Zone (**ASDZ**), numerous meetings took place between the engineers, planners, designers and the engineering and planning departments within South Dublin County Council prior to the approval of the first draft of the Planning SDZ document. From these meetings and throughout the development of the preliminary assessments, and then subsequent designs, the Planning Documents and Guidelines were updated to reflect the strategy in dealing with the surface water and the **Tobermaclugg Stream,** as well as other engineering considerations for the ASDZ.

As can be seen in previous SDCC documents, the area was zoned To provide for new residential communities in accordance with approved Action Area Plans when SDCC adopted the South Dublin County Development Plan in 1998.

In summary, the following process took place to arrive at the current 2014 ASDZ Planning Scheme: -

i) *In December 2002, a Draft Planning Scheme was prepared and submitted to the Elected Members of South Dublin County Council. An Bord Pleanála held an oral hearing in respect of the Draft Planning Scheme during July 2003. The Board approved the Planning Scheme, subject to 26 further modifications, on 25 September 2003.*

ii) *In October 2013 South Dublin County Council, being the specified Development Agency for the Adamstown SDZ and the relevant Planning Authority, submitted 49 proposed amendments to the Adamstown SDZ Planning Scheme, 2003 (as amended) to the Elected Members of South Dublin County Council. An Environmental Report, under the provisions of the SEA regulations, was prepared in respect of the Scheme. Following a screening exercise, the Planning Authority determined that an Appropriate Assessment was not required in respect of the Adamstown SDZ Planning Scheme 2003 and the proposed amendments.*

iii) *On 10th February 2014, South Dublin County Council decided by resolution, to amend the Adamstown Strategic Development Zone (ASDZ) Planning Scheme, 2003, subject to variations and modifications as detailed in the addendum document. A* *motion to amend a phasing requirement was also proposed and passed by the Elected Members.*

Following an Oral Hearing, An Bord Pleanála approved the amendments to the Planning Scheme, subject to 11 further modifications on the 2nd December 2014. The Adamstown Strategic Development Zone Planning Scheme Document (Dated Dec 2014) compromises of the consolidated Planning Scheme and incorporates all changes, variations and modifications to date.

Below are extracts from the current Dec 2014 ASDZ Planning documents in relation to the Tobermaclugg Stream, for ease of reference. One particular aspect, as reflected in *2.5.7"* below, is the agreement with SDCC to divert the flow from the North East Griffeen Catchment to the Tobermaclugg catchment in the North West of the site, due to challenges and constraints faced through the existing development to the north east of the ASDZ.

2.1 EXTRACT FROM ADAMSTOWN STRATEGIC DEVELOPMENT ZONE SOUTH DUBLIN COUNTY COUNCIL DECEMBER 2014 DEVELOPMENT PLANNING GUIDELINES

Adamstown is subdivided into three surface water drainage sub-catchment as follows:-

Tobermaclugg

2.5.5 Most of the SDZ (65%) is drained to a large surface water outfall and attenuation pond at Tobermaclugg Stream. The Tobermaclugg Stream is joined by the Backstown Stream on leaving the SDZ and continues along Tubber Lane and under the N4 via a culvert before discharging to the River Liffey in the vicinity of Lucan Village.

2.5.6 In order to cater for up to a 100-year storm, the stream capacity of Tobermaclugg was supplemented by the construction of a 2400mm diameter surface water pipeline and attenuation pond. Dry weather and normal flows will continue to discharge into Tobermaclugg Stream.

North East Griffeen Tributary

2.5.7 This catchment consists of approximately 20% of the SDZ and is drained to the surface water outfall and attenuation pond at Tobermaclugg.

2.5.8 Attenuation has been achieved by using underground storage in the form of a combination of precast concrete tanks and oversized pipes in conjunction with flow control devices.

South East Griffeen Tributary

2.5.9 This catchment consists of approximately 15% of the SDZ. A section of this area drains to the Griffeen River via oversized pipes into precast attenuation tanks. On leaving Adamstown, it drains to an existing 450mm diameter pipe under the Newcastle Road before continuing eastwards and discharging to the main channel of the Griffeen River.

2.5.10 The remainder of the South-East Catchment compromises of a gravity-fed system via oversized pipes and precast concrete attenuation tanks with flow control devices, discharging to the Griffeen River.

Below is a map extracted from the current Dec 2014 ASDZ Planning documents in relation to the following:-

i) the three Surface Water Catchment Areas and

ii) the Tobermaclugg Stream and its planned route through the ASDZ.

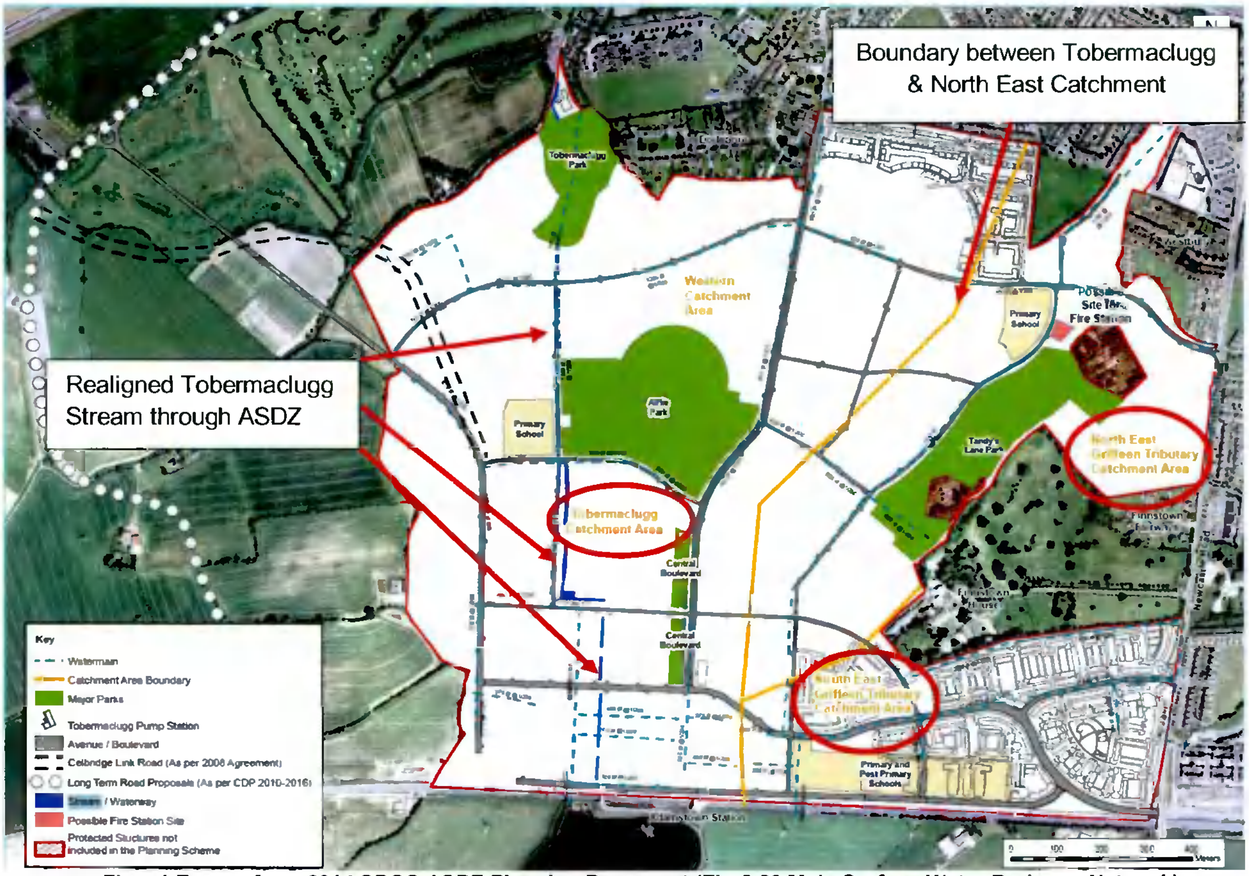


Fig x.1 Extract from 2014 SDCC ASDZ Planning Document (Fig 2.26 Main Surface Water Drainage Network)

2.2 EXTRACT FROM - 2014 ADAMSTOWN SDZ PLANNING DOCUMENT – REGARDING PHASE 3

With reference to the SDCC planning documents, the following paragraph has been extracted from the table reflecting the various aspects of the infrastructure that must be completed relating to Phase 3 of the development of the ASDZ.

"Works to upgrade Tobermaclugg Stream between the SDZ lands and the N4 to include upgrading the Tubber Lane (Road) surface water drain, regrading sections of the channel and enhancing the capacity of the N4 culvert (not illustrated). ***(Complete)"***

3. Environmental Issues

3.1 POLLUTION CONTROL

There is a risk of pollution from run-off of paved areas. This is caused primarily by the initial rainfall in any storm washing oils, grease, grits and organics into the system.

To protect the watercourses in the area, appropriately sized Storm King type Downstream Defenders will be installed at strategic locations on the stormwater sewers within the ASDZ.

i) These units will ensure the water quality being discharged into the pipe network leading to the Stream and protect against the first flush occurrence of a rainfall event. The Downstream Defender is an advanced hydrodynamic separator designed to remove sediment, floatables & associated pollutants from storm water.

ii) This device meets the separation requirements for a class 2 oil interceptor, without the alarms, and also removes material suspended within the water column that will settle out. The device is constructed into a concrete manhole and is made from co-polymer polypropylene, which will not corrode and has no moving parts. The Downstream Defender is positioned to allow for easy access and is maintained using a simple gully sucker to remove the oils and sediments by means of the access points provided.

Further secondary protection is provided by the 5000m^3 attenuation pond constructed downstream of the Lucan Golf Course planted with reeds, as specified by **Vesi Environmental Consultant**. This will protect both the lower reaches off Tobermaclugg / Backstown Stream and the River Liffey.

3.2 FISHERIES

The Tobermaclugg / Backstown Stream, downstream of the confluence, is designated salmonoid.

The Millstream Road and Tubber Lane box culverts have been modelled and installed to include partial burying to 300mm below the existing stream bed and reinstatement of the bed to the requirements of the Eastern Regional Fisheries Board (ERFB).

3.3 ARTERIAL DRAINAGE ACT 1945 (SECTION 50)

Under the Arterial Drainage Act of 1945 (Section 50), works altering any bridge or culvert affecting the hydraulics of a watercourse received approval from the Office of Public Works (OPW) prior to commencement.

3.4 VEGETATION

The channel and surrounding banks upstream of the Millstream culvert are vegetated with medium dense brush and small trees that border the streambed. Vegetation sporadically overtops the channel and can create resistance to the flow of water in times of high water. The Lucan Golf Course maintains the channel edges through the golf course.

Over grown vegetation was found between Millstream culvert and the N4 culvert prior to the upgrade works and was cut back under the supervision of SDCC. This growth was limited to the banks of the stream but overhangs the main channel and would create a high resistance to flow in times of high water. This would be under the control of SDCC in relation to maintenance and can be assumed that periodical maintenance works has been and will be carried out to clear the upstream entrance to the N4 culvert to clear debris.

This area was walked with a representative from SDCC Parks Division and agreement was reached in relation to the development for the 5000m³ attenuation pond with its suitable landscaping plan, which was incorporated as part of the scheme. An ecological survey of this area was undertaken in advance of the Part 8 Planning Process.

4. Adamstown SDZ – Hydraulic Model Methodology & Analysis

4.1 STUDY AREA DESCRIPTION

The Adamstown Strategic Development Zone (**ASDZ**) lands, approximately 200 ha in area, are located 13km west of Dublin and 1.5 km south of Lucan Village. The ASDZ is bounded by the Dublin - Kildare railway line to the south, the **R120** (Newcastle/Lock Rd or more recently renamed Adamstown Road) to the east, the existing development of Dodsbourough and the N4 to the north and agricultural lands to the west. (See Figure A7 below)

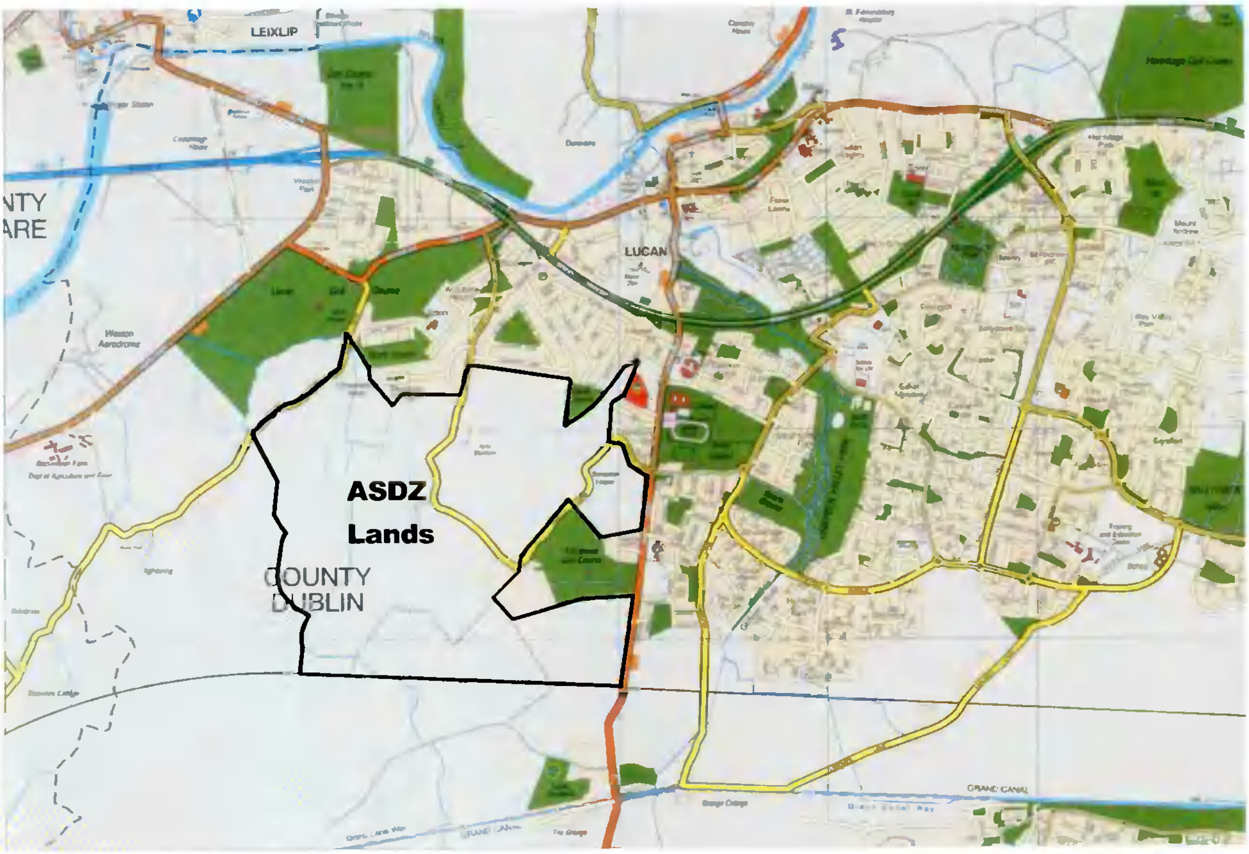


Fig A7 ASDZ Location Map

4.2 ASDZ SURFACE WATER CATCHMENTS

The ASDZ is split into three surface water sub catchments, namely

i) the Tobermaclugg Catchment,

ii) the North-East Catchment and

iii) the South-East Catchment

Of the 200 hectares of ASDZ lands, approximately 140 ha naturally drained to the **Tobermaclugg Stream Catchment**. (See in Fig B below). The remaining 60 ha comprises of two portions that naturally drained to the **South-East** & **North-East Catchments,** initially via the existing ditches and then surface water sewer network, and ultimately to the Griffeen River. The **Backstown Catchment** is outside of the ASDZ and located to the west & north west of the ASDZ as can be seen below, but was included in the study area due to its influence on the flows, as it converges with the Tobermaclugg Stream prior to its combined flow discharge to the River Liffey.

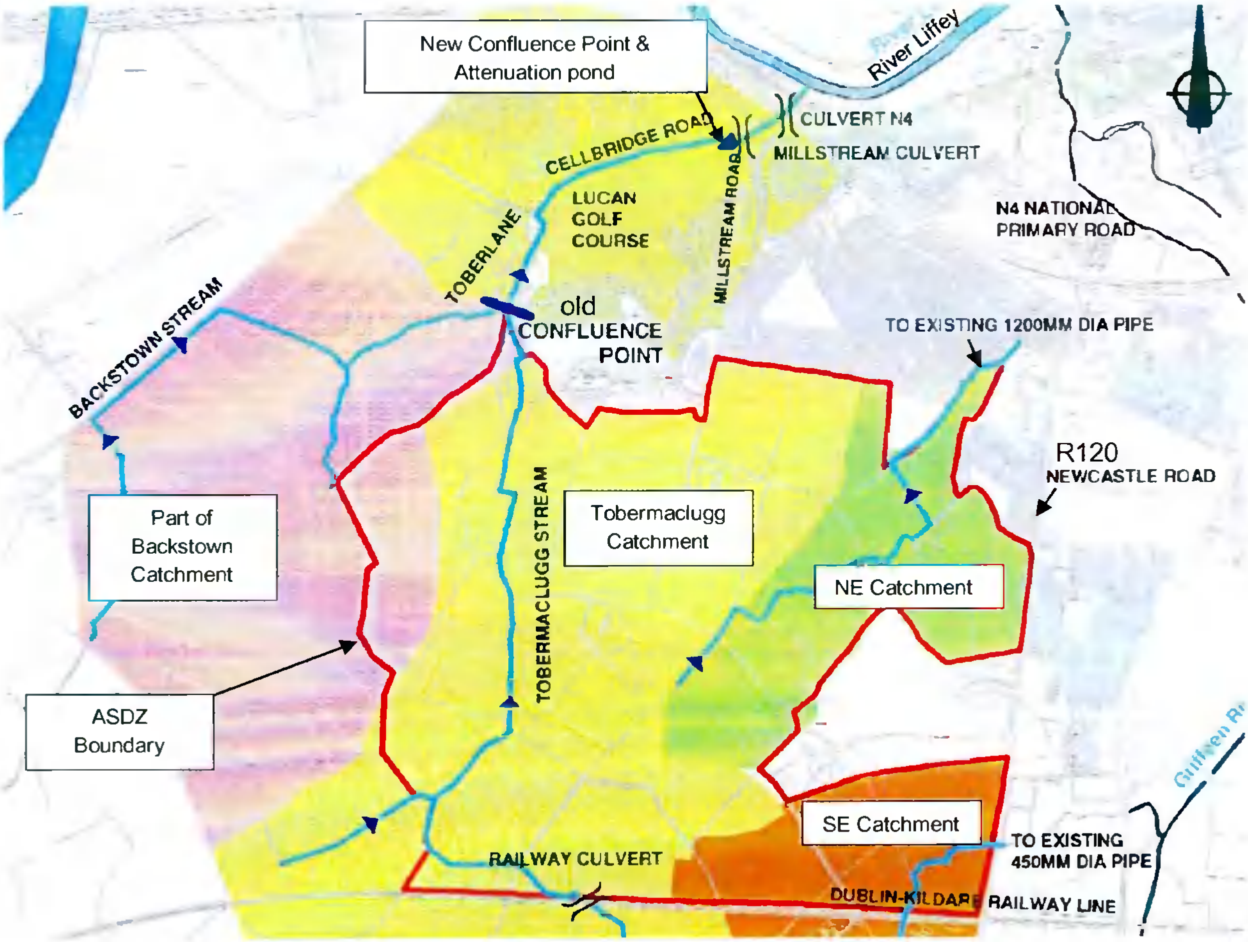


Fig B. Extract from PHMcC May 2005 Report (reduced Backstown Catchment)

The catchments are described further below in **Sections 4.2.1 – 4.2.3**. The main focus of this report is the **Tobermaclugg/Backstown Catchments** since it addresses 85% of the ASDZ. But it is worth noting that the **South East Catchment** (the remaining 15%) has almost been completely developed except for its western most portion that forms the earmarked **Leisure Centre** and a small proportion that extends into the proposed **Town Centre** (See Fig C below). In this catchment attenuation tanks, hydro brakes and Downstream Defenders have been provided at the agreed discharge rate. The attenuation constructed under the All-Weather pitch provides the capacity for the remaining area still to be developed.

4.2.1 Tobermaclugg Catchment

The Tobermaclugg Stream catchment consisted of the land to the west of the South-East and North-East Catchment and to the East of the Backstown Catchment, which drains to the River Liffey in a northerly direction. It has a total catchment area of approximately 486 hectares, which extends south of the railway line as can be seen in **Figure 1.0 below.**

The Backstown Stream converges with the Tobermaclugg Stream at Tubber Lane Road to the north of the ASDZ, before its combined flow discharges to the River Liffey in the north.

4.2.2 South-East Catchment

The South-East catchment consisted of the lands south of Finnstown House Hotel. It is bounded to the south by the Grand Canal, to the east by the R120 Adamstown Road (formally referred to as the Newcastle/Lock Road) and to the west by the Western Sub-catchment and has an approximate area of 66 hectares.

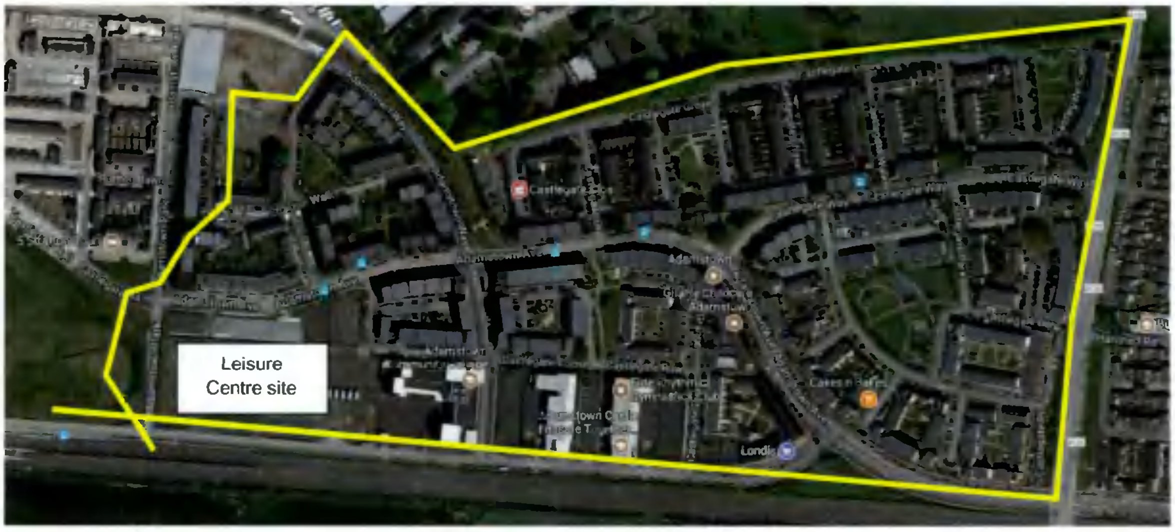


Fig C. ASDZ South East Catchment (as at Google Image 2017)

At the time of pre-commencement of the ASDZ there was no storm water (piped) drainage system. This catchment drained into an existing stream (ditch system) within the catchment, which ultimately discharged to the Griffeen river, through an existing 450mm ø pipe under the R120 (Newcastle/Lock Road) See Fig B above. This catchment includes about 30 hectares of ASDZ lands to be developed. As of 2017, the full extent of this catchment has been developed and occupied, bar south western corner. See Fig C above.

4.2.3 North-East Catchment

The North-East sub-catchment consists of the lands immediately west and north of the Finnstown House Hotel and has an approximate area of 53 hectares. It is bounded to the east by the R120 (Newcastle/Lock Road), to the north by existing development and to the west by the Tobermaclugg-(and Backstown) Stream sub-catchment.

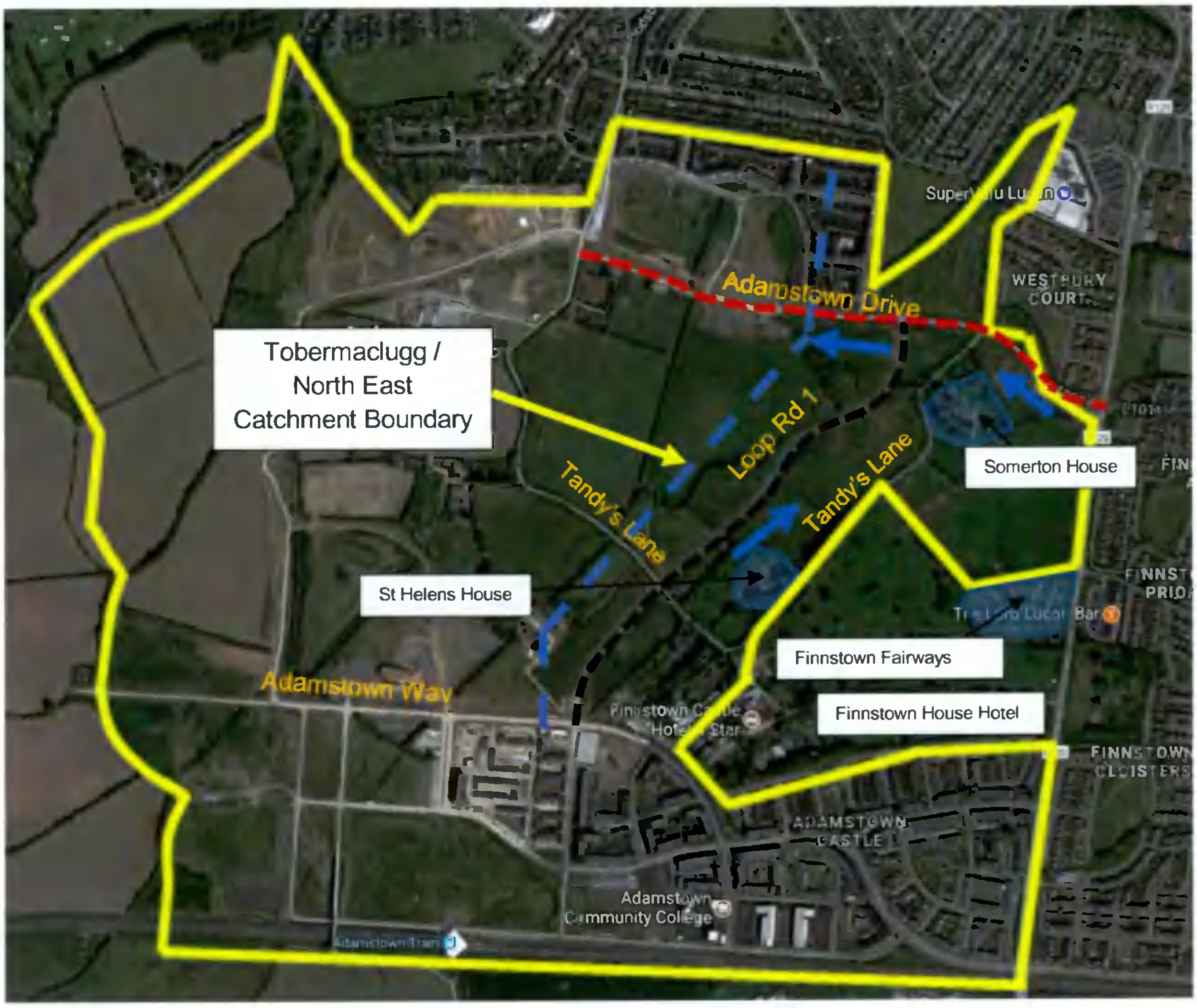


Fig D. Diversion of North East Catchment to Tobermaclugg Catchment

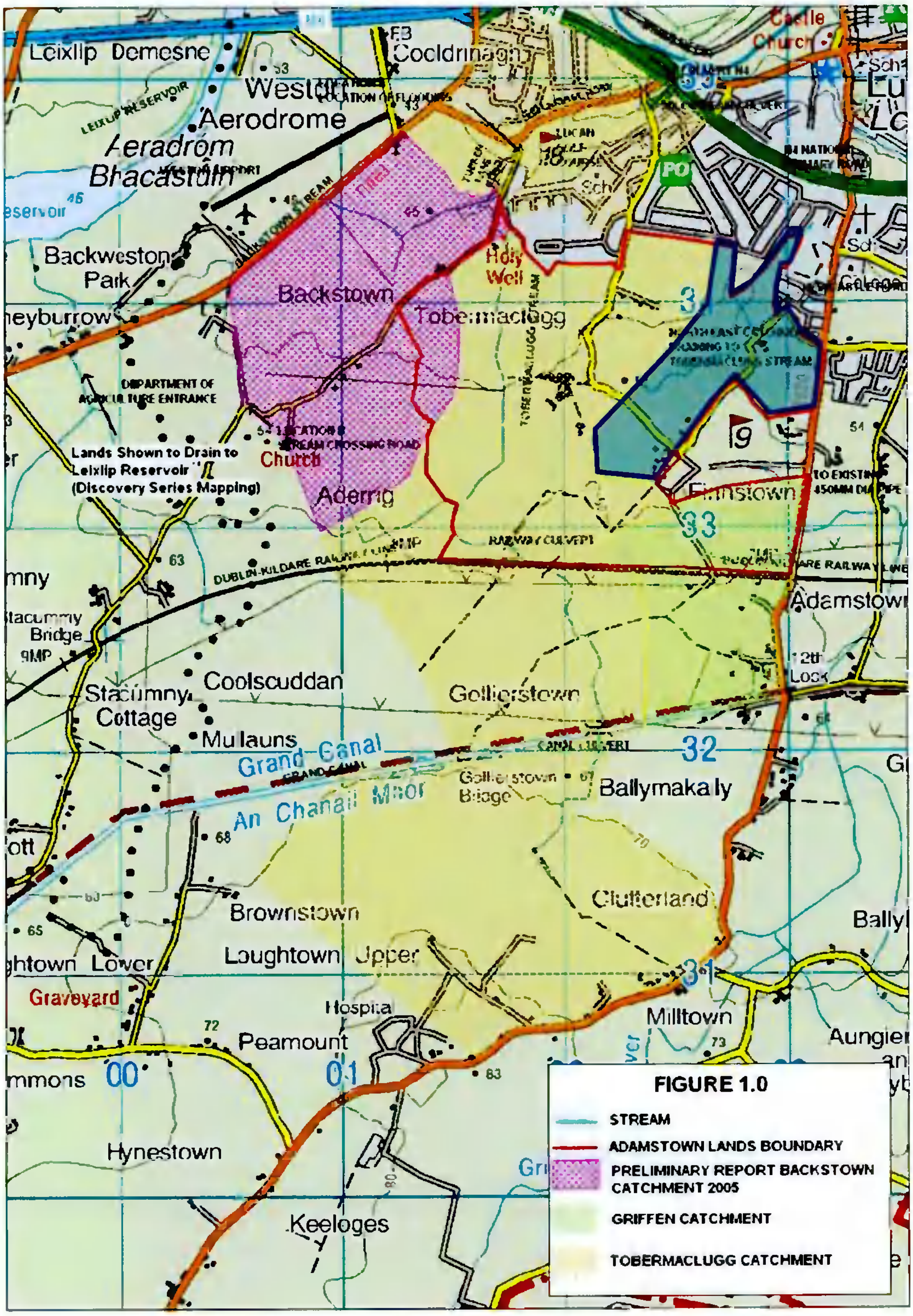
At the time of pre-commencement of the ASDZ there was no storm water piped drainage system within the lands. The North-East sub-catchment discharged into an existing stream (ditch network) within the catchment. This area originally discharged to an existing 1200mm ø surface water pipe located to the rear (west) of the Supevalu (former Superquinn) shopping centre to the north. (See Fig B above and Fig D below) Some 29 hectares of the 53 hectares are within the ASDZ lands. However it was confirmed by SDCC that the surface water 1200ø sewer in question has still not been taken in charge.

During 2006/7 Loop Road 1 (Adamstown Park) and Adamstown Drive were constructed along with the associated surface water drainage (Following the approval of the SDZ 05A/2 for the Paddocks, SDZ 06A/5 for the Strategic Roads and SDZ 07A/0012 for part of the Somerton Development Area), which intercepted some of the flows and diverted them to the Tobermaclugg outfall surface water system, as reflected above. The remaining network of ditches still services the surface water run-off from Finnstown House Hotel, Finnstown Fairways (residential estate) and Somerton & St Helens houses.

4.3 INITIAL 2005 CATCHMENT MODEL (TOBERMACLUGG/BACKSTOWN)

An ***Infoworks CS*** strategic hydraulic model of the Tobermaclugg/Backstown catchments was first developed in 2005 in accordance with WaPUG code of practice , **Greater Dublin Strategic Drainage Study** (GDSDS) & best international practice. Prior to that, assessments were carried out to give guidance in the preparation of the areas 2003 SDZ Planning Scheme documents. Pre & post developed scenarios up to 2031 were initially simulated to estimate the design storm **(30yr ARI & 100 yr ARI)** and associated runoff. The catchment extents were based on contours, OS mapping & aerial photography. The extent of the **initial** catchments (Tobermaclugg Stream-Backstown Stream) modelled, and the location of flooding, are shown in **Figure 1.0** below along with the North East Catchment.

- Greater Dublin Strategic Study (GDSDS) Regional Drainage Policies require a 10% increase in rainfall intensity for climate change.
- Office of Public Works (OPW) Climate Change Requirements +20% when sizing the culverts under Millstream Road and Tubber Lane Road (See Section 50 Reports)



4.3.1 Pre-Development of ASDZ Model Construction

The initial hydraulic model in accordance with the **WaPUG Code of Practice** comprised of the following:

i) the full extent of the Tobermaclugg Stream catchment

ii) the full extent of the Backstown Stream Catchment (However this was subsequently determined to have been under calculated, in error). *The correct figures were included in the 2009 reassessment.*

iii) The housing developments draining into the stream at the time, based upon sewer records prepared by South Dublin County Council.

iv) relevant information gleaned from the available contour plans, OS mapping and aerial photography.

Refer to the **May 2005 Report** for network schematics of the *InfoWorks* CS model. This model was updated and assessed when adjustments were made in **2006/7** and again in **2008** before the construction of the culverts to the north of the ASDZ and extents of **Reach 2** from just north of the ASDZ to the River Liffey.

A topographical survey was carried out on the streams and hydraulic structures, taking cross-sections at various locations on both the Tobermaclugg & Backstown Streams and the tributary to the Griffeen River, assessing details on the existing pipes, culverts, bridges, road crossings etc.

Four major culverts were noted along the Tobermaclugg/Backstown Streams until the discharge point into the River Liffey, some of which have been upgraded since the initial assessment. (The location of these **four major culverts** are noted on Fig 2.0 below)

i) The first culvert crossing under the Grand Canal. Assumptions were made regarding the details of this culvert, due to lack of information available from the OPW and difficulties occurring accessing the culvert. It was then assumed, for the purpose of the study, that the flow through the culvert under the Grand Canal discharges freely.

ii) The arched culvert under the railway line with dimensions of 0.75m x 0.90m. (Upgraded by CIE)

iii) The arch culvert under the Millstream Road with dimensions of 2.86m x 1.64m (Upgraded to twin 2.1m box culverts, partly buried to approx. 300mm in 2008/9).

iv) The culvert under the N4 - approximately rectangular in shape with upstream dimension of 1.7m x 2.0m traversing 78m with an approximate 30° bend left after approximately 58m from the inlet. The culvert then widens to accommodate the original stone arch structure 4m wide x 2m high, approximately 15m long. The Stone arch flows to a 3.6m wide x 2m high concrete box culvert approximately 15m long with a faced on the downstream culvert outlet replicating the stone arch structure.

4.3.2 System Analysis

As can be seen in the 2005/2008 Reports (aspects extracted below), the simulation model was run with a number of storms of various durations (30, 60, 90, 120, 240, 360, 480, 540, 720, 1440, 2160 and 2880 min) and return periods (1, 2, 5, 10, 30, 50, 100 and 200 years) to determine the critical duration storm. In line with the Greater Dublin Strategic Drainage Study (GDSDS), an allowance for the effect off climate change over the next 30 to 50 years was also included, which equates to **10% extra rainfall** on the catchment.

The **540 minutes duration** with a **winter profile storm** was established as the critical storm for the Tobermaclugg catchment. For the purpose of this study the critical storm is defined as the storm which results in the highest predicted peak flow **at the confluence point** of the Tobermaclugg and Backstown streams.

Table 4.1 below shows the predicted peak flows at confluence point of the Tobermaclugg and Backstown streams for various duration & return periods, including the **540 min critical duration**.

!	Rainfall Duration (min)	Predicted Peak flow (m^3/s)							
		1yr	**2yr**	**5yr**	**10yr**	**30yr**	**50yr**	**100yr**	**200yr**
1	30	0.341	0.454	0.596	0.716	0.954	1.102	1.317	1.550
2	60	0.471	0.616	0.812	1.002	1.348	1.526	1.803	2.135
3	90	0.559	0.737	0.981	1.194	1.574	1.786	2.121	2.510
4	120	0.625	0.811	1.103	1.330	1.747	1.987	2.357	2.788
5	240	0.774	1.004	1.320	1.578	2.090	2.369	2.792	3.252
6	360	0.821	1.069	1.392	1.662	2.196	2.196	2.885	3.356
7	480	0.829	1.076	1.402	1.677	2.216	2.505	2.891	3.360
8	**540**	**0.831**	**1.087**	**1.417**	**1.696**	**2.241**	**2.529**	**2.911**	**3.385**
9	720	0.820	1.058	1.386	1.663	2.206	2.489	2.852	3.308
10	1440	0.714	0.906	1.191	1.452	1.963	2.239	2.565	2.935
11	2160	0.618	0.778	1.016	1.241	1.699	1.957	2.321	2.621
12	2880	0.550	0.687	0.893	1.086	1.488	1.721	2.081	2.400

Table 4.1 Predicted peak flows (as extracted from the 2005 Report)

The model predicted flooding at various locations

i) within the predeveloped ASDZ catchment,
ii) in the Lucan Golf Course,
iii) the **old** confluence point of the Tobermaclugg & Backstown streams and
iv) at the railway culvert.

Flooding was known to occur at the above locations on a regular basis prior to the simulation assessment.

Table 4.2 below summarises the peak flow at four identified locations for the 30 year ARI and 100 year ARI storm events, which includes the Free Discharge point assumed at the Grand Canal.

Location	30 Year ARI Peak Flow (m^3 / s)	100 Year ARI Peak Flow (m^3 / s)
Flow from South of Grand Canal (Free Discharge)	1.76	2.62
Culvert Under Railway	1.28	1.28
Culvert Under Millstream	2.53	2.94
Culvert Under N4	2.63	3.07

Table 4.2 Predicted peak flows at Culvert

Figures 4.1 & 4.2 within the 2005/2008 Reports demonstrate the predicted hydrographs for the existing Tobermaclugg-Backstown catchment for the 30 year and 100 year ARI storms at three identified locations. The flat peak of the graph for Railway culvert represents the capacity constraint of this culvert.

Due to lack of information available on the Grand Canal culvert at the time in 2005, it has been assumed that flow through this culvert discharges freely.

Based on the surveyed data the estimated pipe full capacities of three identified culverts are as follows:

Location	Capacity
Culvert Under Railway Line	0.34 m^3 / s
Culvert Under Millstream Road	11.00 m^3 / s (increased to 18.38m^3/s with Twin 2.1 Culverts)
Culvert Under N4 National Primary Road	26.88 m^3 / s upstream and 42.61 m^3 / s downstream

Table 4.3 Full Capacity of **Existing** Culverts (as extracted from 2005/2008 Reports)

The hydraulic analysis results showed that: -

i) the railway culvert is submerged upstream for both 30 and 100 year ARI storms.

ii) the upstream end of the culvert flows are sub-critical with flows at downstream end super-critical.

iii) The upstream end of the railway culvert is submerged for the large events and there is a free discharge at the downstream end of the culvert.

The system had also been analysed with the railway culvert silted to a depth of 700mm to check the sensitivity of the analysis. This obviously resulted in a reduction in the culvert capacity and the flow regime was predicted to change with sub-critical flows along the length of the culvert.

The report recommended that a cleaning programme of the railway culvert be carried out to avoid the loss of capacity through this culvert.

Table 4.4 shows the siltation results and reduced flows through the railway culvert.

Location	30 Year ARI Peak Flow (m^3 / s)	100 Year ARI Peak Flow (m^3 / s)
Flow from South of Grand Canal (Free Discharge)	1.76	2.62
Culvert Under Railway	0.126	0.126
Culvert Under Millstream	2.53	2.94
Culvert Under N4	2.63	3.07

Table 4.4 Predicted peak flow at various culverts with silt in Railway Culvert (as extracted from 2005 & 2008 Reports) (pre Development)

Based on the analysis of the models comparing the behaviour of the system, both with and without silt at the railway culvert, the models predict that the siltation causes more flooding of the channel upstream of the railways culvert and results in less flooding at the downstream locations of Tubber Lane Road and Lucan Golf Course. However further downstream i.e. at the Millstream culvert and the N4 culvert, there is no change of the flooding regime due to the presence/absence of the silt in the railway culvert.

The model results indicated the following return periods at which the identified culverts were flowing at full capacity: -

a) The 200-year ARI was the largest return period storm.

b) The 10-year ARI (240-minute duration) storm was the event at which the railway culvert was at full capacity.

c) The small culverts along Tubber Lane Road flooded at various return periods (5, 10 or 50-year ARI) for the 30-minute event.

d) The culverts under Millstream/Dodsbourgh Road and the N4 have sufficient capacity to convey even up to the 200-year ARI storm scenario.

4.3.3 The River Liffey in Flood

In order to simulate extreme conditions, the model was also run to simulate discharge to the River Liffey with the river in flood. The 1954 flood is one of the largest floods on record in recent times and has been estimated previously as 200 to 250 years, however it is not clear whether this would be the return period for the River Liffey at Lucan.

The model showed that the N4 culvert does surcharge due to high water levels in the River Liffey, but that these high-water levels do not cause any surcharge or flooding further upstream in the Tobermaclugg-Backstown catchments. (due to the level difference between the River Liffey, Tubber Lane Road and the ASDZ

It is important to note that for any notable rainfall event, the times to peak for the Liffey catchment and the Tobermaclugg-Backstown catchment are significantly different. The rate of response of a catchment is based on a number of factors including:

- Catchment area;
- Length of the watercourse;
- Rate of runoff for the catchment; and
- Slope/grade of the channel.

Due to the relative size, length and the predominantly rural nature off the River Liffey catchment the time of concentration of the catchment is considerably greater than the Tobermaclugg/Backstown Streams.

Furthermore, the River Liffey is impounded at Poulaphaca, Golden Falls and Leixlip, managed and controlled by ESB.

Therefore, in a rainfall event occurring over both the Liffey and Tobermaclugg/Backstown catchments, it is extremely unlikely that the peak off the two floods will ever coincide at Lucan. Peak flows from the existing Tobermaclugg/Backstown catchment will have dissipated well in advance of peak flows from the River Liffey.

4.4 POST-DEVELOPMENT MODEL SCENARIO

As can be seen in the reports generated prior to 2009, the initial *InfoWorks* models of the proposed developments of the ASDZ lands had been constructed for the two separate scenarios, of which **Scenario 2 B** was agreed with SDCC and adopted (Refer to the 2008 Report):

Scenario 2 Tobermaclugg-Backstown catchments and the North-East sub-catchment draining to the Tobermaclugg Stream

and the South-East sub-catchment draining to the existing 450mm ø sewer.

Using the 2002 report ***Interim Design Report on Roads and Services*** , a master plan for the storm water drainage was established and formed the basis for the study. The design criteria used to check the preliminary sizing of the sewers was as follows:

- **No surcharge in 2 years Average Recurrence Interval (ARI) rainfall event, and**
- **No flooding in a 30-year ARI rainfall event within the ASDZ.**

In the 2006 report the following additional criteria were added:-

- **No flooding of the Lucan Golf Course in a 100 year ARI rainfall event**
- **No flooding of Tubber Lane Road in a 100 year ARI rainfall event**
- **No flooding of the proposed Tobermaclugg Pumping Station in a 1 000 year rainfall event**
- **A basic continuous flow in the Tobermaclugg Stream downstream of the old confluence point**
- **Use of 1954 flood level of River Liffey at discharge point of the Tobermaclugg Stream**
- **Continuous flow in the salmonid Tobermaclugg/Backstown Stream in the Golf Course**

- **The stormwater culvert through the Lucan Golf Course will serve as the emergency outfall for the Tobermaclugg Foul Pumping Station**

For the proposed development the trunk sewers were modelled, as was the culverting of the Tobermaclugg Stream, with circular sewer from the railway culvert to the end of Lucan Golf Course.

Downstream of the Lucan Golf Course to the discharge point to River Liffey open rectangular channels are proposed. (*Refer to Appendix 1 in 2005 Report to see the Network schematic of the InfoWorks model of Scenarios 1 & 2.*)

Various durations and return periods were simulated to establish the critical duration storm for the post development scenario, in line with the GDSDS, while making allowance for climate change by also including a 10% additional rainfall for each storm event and a 4% reduction in rainfall for the size of the catchment area (2006 report pg 4). For the **post development scenarios in 2005**, a **540 min (winter profile) duration storm** was established as the **critical storm**. However in the **2006 Report** taking into account the adjustments to the model, **the 30 min winter profile for the 100 year ARI duration** was established as the critical storm for the culverts **downstream** (**Reach 2**) of the **Tobermaclugg Pump Station.** The **May 2006** report then assesses the options of the culvert system for **Reach 2**, to be the most cost effective with the least amount of disruption to local traffic.

The addendum report of **Oct 2006** made the following further adjustments and then minor tweaks in **April 2007** when the box culvert for the upper portion of Reach 2 was converted into a pipe culvert equivalent through the Lucan Golf Course: -

i) Revision of the stream vegetation coefficients between the golf course & N4 culvert

ii) Dimensions of the composite N4 culvert

iii) The flow path & drainage mechanism for the Lucan Golf Course (This was the constructed 2.1m/2.4m ø culverts past the Tobermaclugg PS through the Lucan

Golf Course and upgrading the arrangement of surface water pipes (900/750/600/300 ø) at Backstown Stream crossing of Tubber Lane Road to a 2.4 x 0.8 box culvert in late 2009/10).

In addition, two alternatives were also analysed as follows for both Scenarios 1 & 2:

Alternative A With the existing railway culvert in place.

Alternative B With an increase in the size off the railway culvert to remove the existing throttling effect at this culvert.

The models of the proposed alternatives to the system were run for a number of rainfall events up to the 100 years ARI storm.

For the purpose of the analysis of the system, the length of the stream has been divided into **two reaches.** These are indicated on Figure 3.3 and described below:

Reach 1 Stream from railway culvert at southern end of ASDZ to the confluence point of Tobermaclugg & Backstown streams; and

Reach 2 From the confluence point of the streams to the outfall point at the River Liffey.

4.4.1 Scenario 2 B

As can be seen in the **2005 Report**, the **Scenario 2 B** model was simulated for both 30 year and 100-year ARI events. Peak flows at various sections were predicted with the use of the model, ***which had an increase in the size of the railway culvert to remove the existing throttling effect***. Figure 4.5 below represents the catchment delineation for Scenario 2 B.

Alternative 2B (With Upsized Railway Culvert):

Table 4.5 below summarises results from the modeling of Scenario 2B.

Location	30 Year ARI Peak Flow (m^3 / s)	100 Year ARI Peak Flow (m^3 / s)
Flow from South of Grand Canal (Free Discharge)	1.76	**2.62**
Culvert Under Railway	2.54	**3.85**
Culvert Under Millstream	7.36	**10.31**
Culvert Under N4	7.44	**10.84**

Table 4.5 Scenario 2B (2005 Report) simulation Results

The results for Scenario 2B show:

a) an increase in flows through the railway culverts and downstream of it, due to the additional capacity provided.

b) The flows downstream increase by some $0.2m^3/s$ at peak for the 30-year ARI.

c) The peak flow increases for the 100-year ARI by some $0.53m^3/s$ and $0.87m^3/s$ for the Millstream culvert and the N4 culvert respectively.

The arch shape culvert under the railway is 900 mm x 750 mm.

a) For the 100-year ARI, the culvert would need to be augmented with two 1050 mm ø pipe culverts.

b) For the 30-year ARI, the culvert would need to be augmented with one 900 mm ø pipe culvert. (These upgrades are the same as those identified for Scenario 1B.)

The **2005 Report** compared the results for **Scenarios 1A & 2B** which showed that cumulative effect of

i) upsizing the railway culvert, along with

ii) discharging the **North-East catchment** to the **Tobermaclugg-Backstown catchment,** would increase the peak flow for 100-year ARI storm by approximately: -

- 1.83m^3/s at the **Millstream culvert** and
- 2.24m^3/s at the **N4 culvert**.

The **2005 Report's** predicted hydrographs (Fig 3.13 and 3.14) reflects the Tobermaclugg-Backstown catchments for the 30 year and 100-year ARI storms at three identified locations respectively.

The initially proposed culvert sizes for **Scenarios 2B** are summarised in Table 4.6 below, where **Reach 1** (Approx 2087m) based on the original stream route through the ASDZ until the old confluence point and **Reach 2** is from the old confluence point to the discharge into the River Liffey. (See Fig E below which shows the respective reaches)

Reach	**Culvert Size for 30 Year ARI**		**Culvert Size for 100 Year ARI**	
	Length (m)	Description	Length (m)	Description
Reach 1	591	1 ! 1350 mm ø.	591	1 ! 1500 mm ø.
	1295	1 ! 1350 mm ø	1295	1 ! 1500 mm ø
	201	1 ! 1350mm & 1 ! 1500mm ø	201	1 ! 1500mm & 1 ! 1800mm ø
	2087	**Total length of Original Stream Route**	**2087**	
Reach 2	836	1 ! 1350mm & 1 ! 1500mm ø	274	1 ! 1500mm & 1 ! 1800mm ø
	69	1 ! 1350mm & 1 ! 1800mm ø	631	2 ! 1800 mm ø
	76	2.9m x 1.7m rect. open channel	76	2.9m x 1.7m rect. open channel
	31	3.6m x 1.2mm rect. open channel	31	3.6m x 1.2m rect. open channel
	1012		**1012**	

Table 4.6 Proposed culvert size for Scenario 2B for 30 & 100 Year ARI (2005 Report).

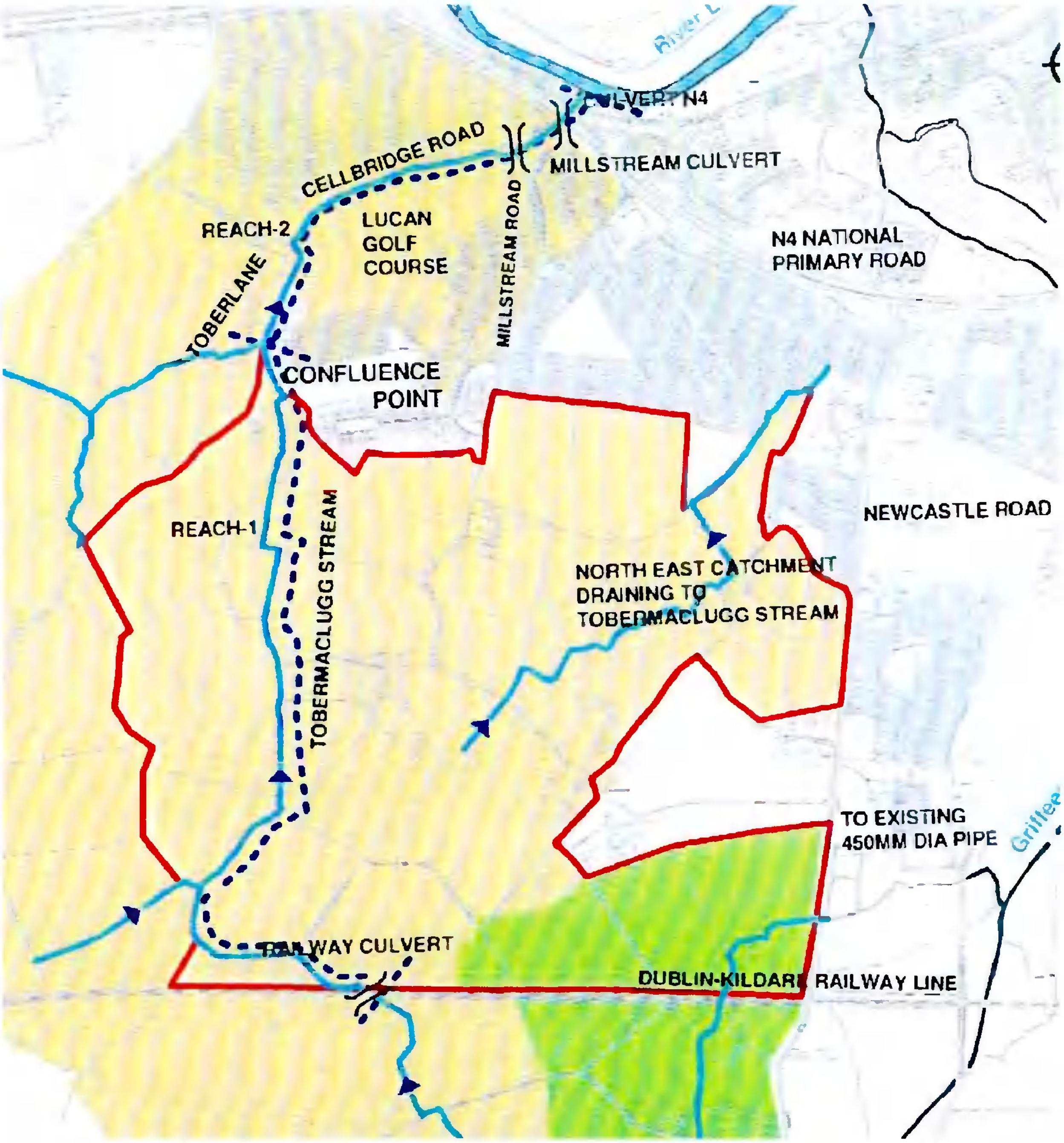


Figure E - Reflecting the Reach 1 & 2

4.4.2 The River Liffey in Flood

i) The preliminary sizing of the surface water system (for both the proposed sewers and the proposed Tobermaclugg culvert) was based on free discharge from the drainage system to the River Liffey.

ii) To test the system for an extreme event, the model was simulated with boundary conditions at its outlet, setting the 1954 flood level in the River Liffey as a boundary condition.

iii) The 1954 event was an extreme event as it is the only historic flood level available at the location of interest in the River Liffey.

iv) The model showed that the culvert would be submerged downstream of the N4 throughout the event, but it would not cause any flooding upstream of the catchment due to the significantly higher invert levels of the sewers upstream of the N4 culvert.

The **2005 Report's** *InfoWorks* Hydrograph s (Figure 3.15) reflected the predicted flows for the discharge point of Tobermaclugg/Backstown Stream to the River Liffey under free discharge for the various scenarios for the 100-year ARI storm. For comparison, the corresponding hydrographs for the existing (undeveloped) situations are also included in the figure.

Flow estimates for two extreme historical events are available for the River Liffey, upstream of Lucan.

i) The December 1954 was estimated to be some 175m³/s and

ii) the November 2000 flows estimated to be some 190m³/s.

For comparison, the predicted flows for the 100-year ARI for the various scenarios, demonstrates that the flows for the Tobermaclugg/Backstown catchment, even in extreme events, are small in comparison to the flows in the River Liffey.

2005 Report's *InfoWorks* Hydrographs (Figure 3.16) exhibit the estimated flows in the River Liffey for two extreme historical rainfall events: December 1954 and November 2000.

4.4.3 Selection of the Post- ASDZ development Scenario

Based on discussions with SDCC and the design engineers at the time regarding the possibility of the railway culvert being upgraded to accommodate flows for the 100-year ARI event, it was agreed that **Alternative B** be adopted, whether it is for Scenario 1 or Scenario 2. The requirements of Scenarios 1B & 2B in terms of the culvert size, based on Table 3.7 and 3.11 can be summarised as follows:

- In **Reach 1** the first 1,886 metres of culvert is to be a 1500 ø culvert for both scenarios; (A 1500ø pipe has been installed from the entry point into the ASDZ until the temporary Park & Ride)
- Immediately downstream of the above within **Reach 1** the following 201 metres is sized for **Scenario 2B requiring 1 no. 1500 mm ø and 1 no. 1800 mm ø culvert**; (in the detailed design process a 2.1m ø pipe installed for approx. 490m this equates to 21 800 l/s at a grade of 1 :70 Ks = 0.6)
- The upstream end of **Reach 2** has been sized for **Scenario 2B** is sized as 274 metres of 1 no. 1500 mm ø and 1 no. 1800 mm ø culvert followed by 631 metres of twin 1800 mm ø culverts. (During detailed design and consultation with SDCC, 2.4mø was installed for 846m has a capacity of 24 500 l/s at grade 1 :111 Ks = 0.6)
- The 107 metres of open channel through Lucan Golf Course for both scenarios, comprises of 76 metres of 2900 x 1700 mm, followed by 3600 mm x 1200 mm open channel.

Following the amendments to the model in the Oct 2006 report to take into account the adjusted vegetation co-efficient, the actual N4 culvert dimensions and the drainage mechanism through the golf course, the following amendments were incorporated into the design and subsequently constructed:-

a) Replacement of the Millstream culvert with twin 2.1m box culverts (partly buried to 300mm below the existing stream bed to preserve existing salmonoid habitat
b) Excavation of proposed attenuation pond (to maximum possible storage volume with property boundaries, maintain a min of 300mm depth in the existing channel) immediately upstream of the Millstream culvert
c) Construction of a bund max 1m along the left overbank of the Stream along Celbridge Road between the Millstream culvert and the N4 culvert to 26.0 m OD (assuming ½ m freeboard).

d) Preservation of the natural state of Stream between the Millstream culvert and the N4 culvert

e) Removal of the 750mmø pipe channelling flows form the Lucan Golf Course with flows to fall directly into the proposed Millstream attenuation pond.

4.4.4 Adjustments to Model between Tobermaclugg PS and the River Liffey

Adjustments were continually made to the model using the latest information to analyse the stormwater flows between the Tobermaclugg PS and the River Liffey and were taken into account when developing the construction options as reflected in the 2008 Report.

It was noted that there is close interaction between the Tobermaclugg Foul Water Pump Station and the design of the Surfaced Water outfall past the PS, so changes to the design of either one of these elements impacts on others and the way they function. During the design process, the following were proposed:-

a) To culvert all the stormwater flows from the ASDZ within 2.4m ø culverts in **Reach 2** from the Tobermaclugg PS to the north eastern end of the Lucan Golf Course.

b) To contain a continuous flow of 100 !/s in the Tobermaclugg Stream upstream of the old confluence point with the Backstown Stream in order to maintain an environmentally sustainable watercourse through the ASDZ.

c) To leave the existing Tobermaclugg and Backstown Stream, downstream from the point where they meet on Tubber Lane Road, unchanged (Except for the increase in culvert size for the Tubber Lane Road crossing see e) below). However it was recommended that this section be cleaned to restore its original condition.

d) To retain the old confluence point between the Tobermaclugg and Backstown Stream in order to maintain the 100 !/s in the Tobermaclugg Stream

e) To upgrade the existing 900/750/600/300ø pipe configuration crossing of the Backstown Stream of Tubber Lane Road, (the entrance grating which was completely blocked during the 2009 flood event and was the primary cause of the flooding), was upsized to a 2.4 x 0.8 box culvert when the full extent of the Backstown Stream catchment was confirmed.

f) The removal of the Lucan Golf course flows to the water feature (pond) on the eastern boundary of the golf course, closest to the Millstream culvert

g) The stream was widened and bunded between the Millstream culvert and the N4 Culvert. The rest of the route to the discharge point to the River Liffey remained unchanged.

h) It also mentioned limiting the flow at the PS to 12m³/s to prevent flooding of the Lucan Golf Couse

i) The incorporation of a 5000m³ attenuation pond based on the results of the model.

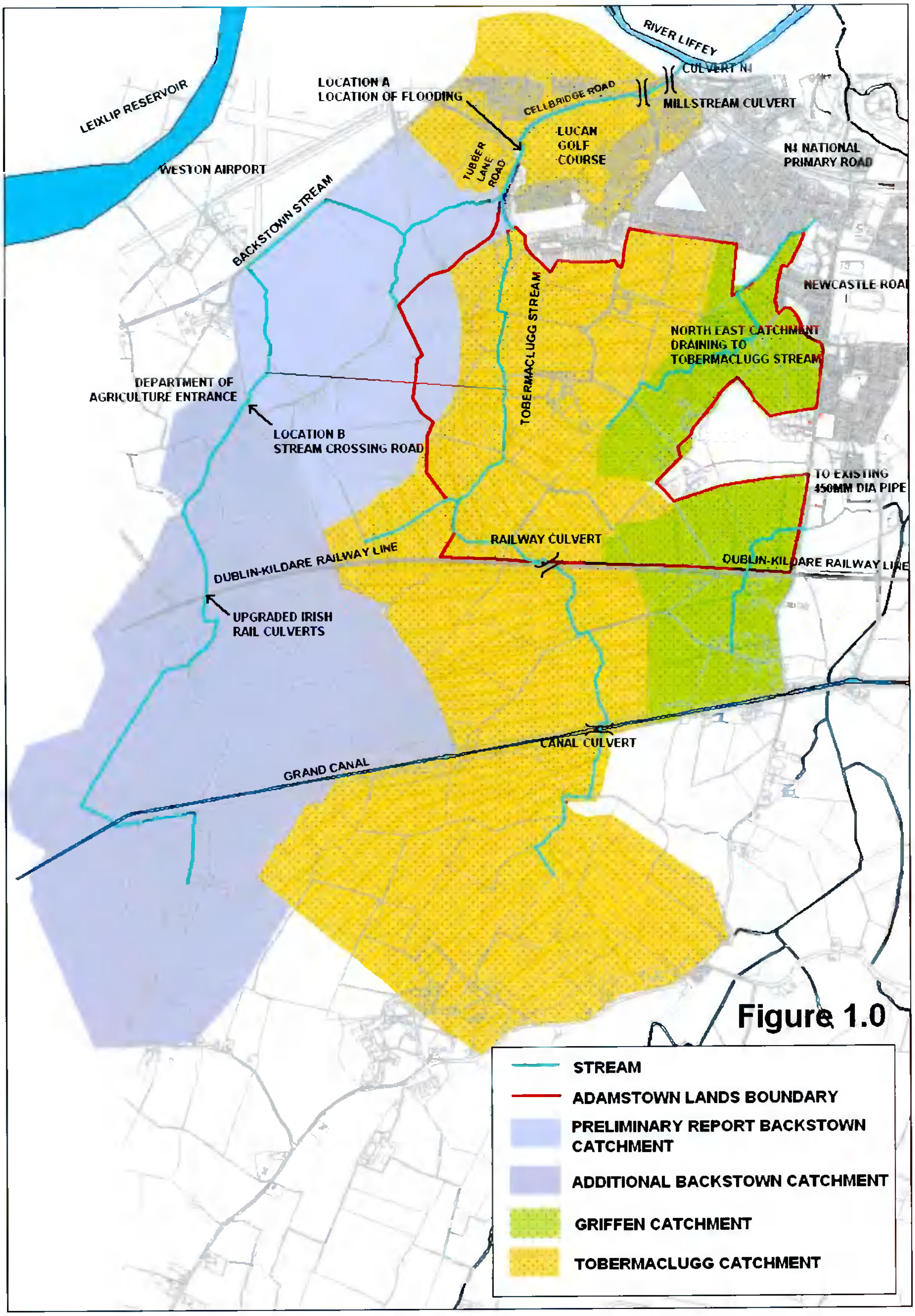
4.5 UPDATED 2010 CATCHMENT MODEL

The survey data recorded in January 2010 was collated and input to the existing *Infoworks* model to assess the existing pipe network and attenuation pond, and to examine the potential impacts on flooding on Tubber Lane Road. The revised model was developed with the existing enlarged catchment area and existing structures information from the survey.

4.5.1 Design Storm Updated for Backstown Stream Adjusted Catchment

The revised model estimates a flow of 4m³/s in the Backstown Stream in the 100-year ARI event at Tubber Lane Road. This volume is generated because of the following:

- Catchment Area Revision
- Upstream Structure Construction at the railway crossings
- Channel Cleaning
- Office of Public Works (OPW) Climate Change Requirements +20%. (Greater Dublin Strategic Study (GDSDS) Regional Drainage Policies Require only a 10% increase in rainfall intensity for climate change.)



LEIXLIP RESERVOIR
WESTON AIRPORT
RIVER LIFFEY
CULVERT N4
CELLBRIDGE ROAD
MILLSTREAM CULVERT
LOCATION A
LOCATION OF FLOODING
TUBBER LANE ROAD
LUCAN GOLF COURSE
N4 NATIONAL PRIMARY ROAD
BACKSTOWN STREAM
TOBERMACLUGG STREAM
NEWCASTLE ROAD
NORTH EAST CATCHMENT DRAINING TO TOBERMACLUGG STREAM
DEPARTMENT OF AGRICULTURE ENTRANCE
LOCATION B
STREAM CROSSING ROAD
TO EXISTING 450MM DIA PIPE
RAILWAY CULVERT
DUBLIN-KILDARE RAILWAY LINE
UPGRADED IRISH RAIL CULVERTS
CANAL CULVERT
GRAND CANAL
STREAM
ADAMSTOWN LANDS BOUNDARY
PRELIMINARY REPORT BACKSTOWN CATCHMENT
ADDITIONAL BACKSTOWN CATCHMENT
GRIFFEN CATCHMENT
TOBERMACLUGG CATCHMENT

Figure 1.0

4.5.2 Reassessment of Attenuation Pond North of Lucan Golf Club

Following the reassessment after 2009, the model indicated that the Backstown and Tobermaclugg Streams have different response times to storm events. **The critical storm duration** for the **Tobermaclugg and Backstown Stream** catchments are the **60 min** and **1220 min** storm respectively. The Tobermaclugg Stream catchment dictates the attenuation pond s capacity due to the volume of runoff estimated and the faster response of the catchment, the 60min storm is shown graphically in Figure 5.5 below. Because of the varying critical storm durations the increased Backstown Catchment area does not increase the attenuation volume requirement.

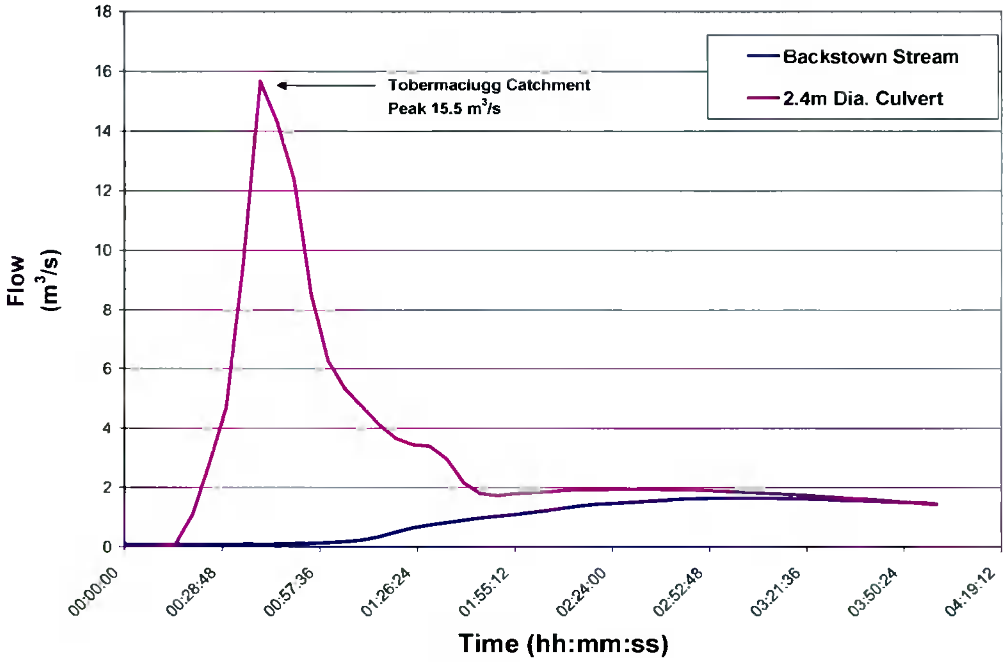


Figure 5.5 Catchment Storm Profiles

When examining the attenuation pond, it should be noted that a new 750m ø pipe has been constructed as part of the N4 road upgrade which now discharges to the N4 culvert. The impact of this pipe will depend on its contributing catchment and its response to storm events. Tobermaclugg Stream

The Tobermaclugg Stream catchment consists of 486 ha, which represents 54% of the revised current model of Backstown Tobermaclugg catchment (902 ha) and includes the ASDZ lands.

The stream is conveyed to the River Liffey via the new 1.5m, 2.1m / 2.4m ø culvert system constructed as part of the Tobermaclugg Surface Water Drainage Scheme.

A reduced maximum flow of circa 100 !/s is permitted in the existing stream channel, which passes through the Tobermaclugg Foul Water pumping station site. The flow in the stream is prioritised for environmental requirements.

The diversion of the Tobermaclugg Stream into the 2.1m / 2.4m ø culvert is constructed within the Adamstown SDZ and then runs through Lucan Golf Course and is vital to reduce downstream flooding in Tubber Lane Road. All but 100!/s has been removed from the old confluence point. The rest of the flows only re-joins the stream at Millstream road where the 2.4m ø culvert discharges into the attenuation pond.

4.6 BACKSTOWN STREAM

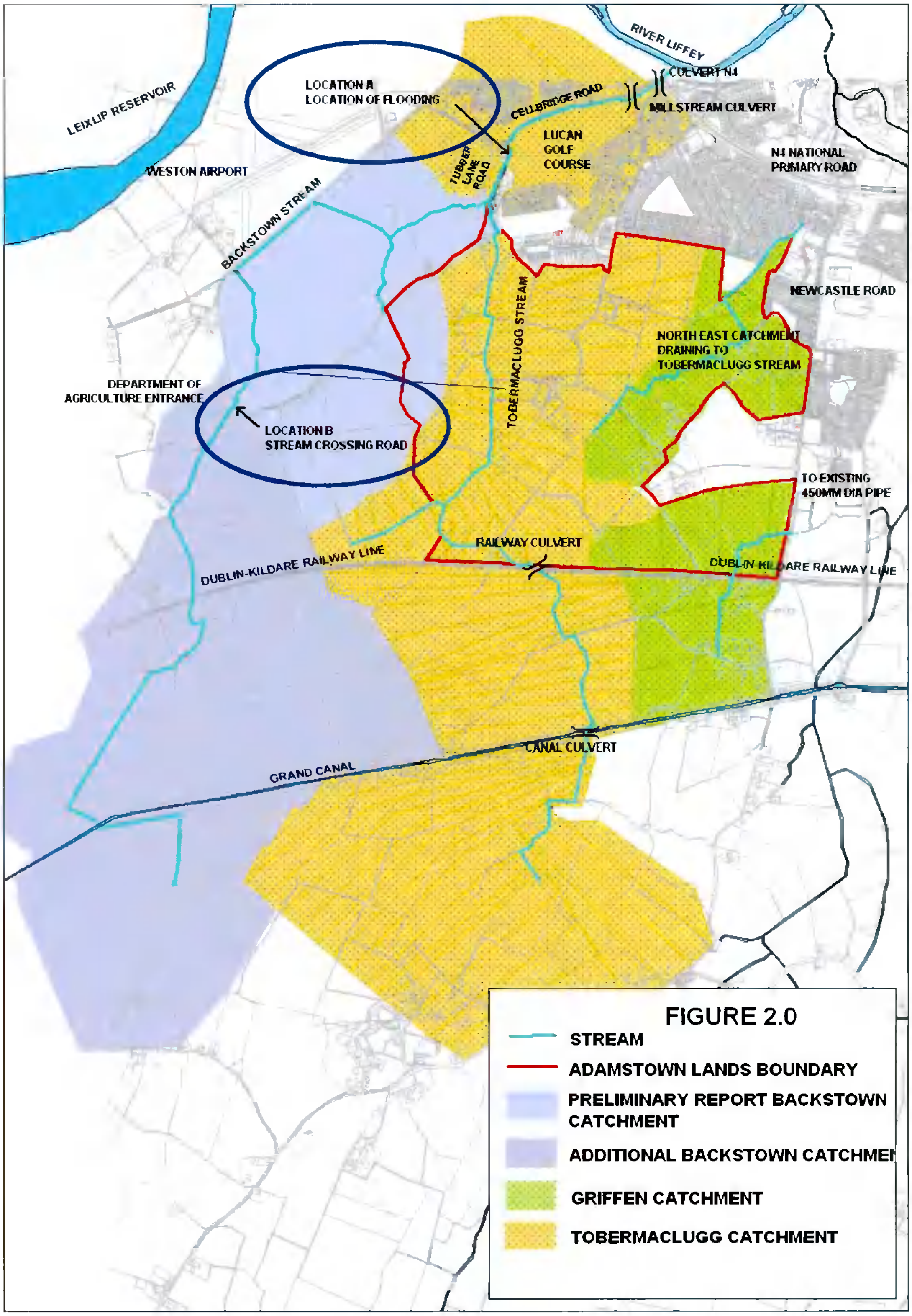
The Backstown Stream consists of a 416 ha catchment or approximately 46% of the contributing catchment area. The earlier reports and simulation model erroneously reflected a catchment area of only 126 ha. (There is no obvious reason for this error and it would appear to have been an oversight when determining the extent of the Backstown Stream Catchment). Downstream of the old confluence point of Backstown Stream and the Tobermaclugg Stream, the stream ditch was culverted, initially through a series of 225mm and 300mm ø pipes, at various locations where it crossed driveways and accesses to the private properties flanking Tubber Lane Road. The development areas at the time, included Airlie Heights, Woodview Heights, Kew Park Crescent and Western Meadow, which discharge storm water into Tobermaclugg Stream at various locations en route.

In 2007/8 surface water pipe culverts (2.4m ø) were installed through the Lucan Golf Course into which the bulk of the Tobermaclugg Stream (except for 100 !/s) was diverted upstream from the original confluence point on Tubber Lane Road, to now join the Backstown Stream to the North of the Lucan Golf Course, south of the Millstream Road.

Observations during storm events in November and December 2009 led to a re-examination of the above-mentioned catchment areas to determine the cause of the flooding. Significant flows causing flooding of the Tubber Lane Road were noted where the stream crosses Tubber Lane Road at **Location B**, as well as at **Location A** (Figure 2.0 below), where the stream passes through Lucan Golf Club. The stream s source is adjacent to the Grand Canal and it was noted that this contributes an additional area of 290 ha to the Backstown catchment as shown in Figure

2.0. below As stated in the report, **Location A** was addressed by increasing the Culvert size to a 2.4 x 0.8 box culvert in 2010 as the primary cause of the flooding was the blockage of the existing stream and entrance into the 900mm pipe. A new 900mm ø concrete culvert was installed after 2008 at **Location B** at the entrance to the Department of Agriculture Lands

The combined Tobermaclugg Backstown stream catchment actually equates to a total of 902 ha (i.e 486 ha + 416 ha = 902 ha) as can be seen below.



5. Review of Engineering Reports and findings

In 2005 PHMcC completed a report titled **"Assessment of the Tobermaclugg Stream Upgrade to the River Liffey"**. The report s main focus was: -

a) to examine options for the **Tobermaclugg Stream upgrade** as part of the **ASDZ**.
b) to develop proposals as set out in the 2002 PHMcC report entitled **Interim Design Report on Roads and Services** .
c) to alleviate the existing flooding issues on Tubber Lane Road.

The **Backstown Stream**, which converged with the Tobermaclugg Stream on **Tubber Lane Road**, was also included in the study although no development was planned for its catchments at the time, as the combined flow traversed the downstream 1110 m to its discharge point at the River Liffey.

The **May 2006 PHMcC Report** progressed on the initial 2005 Report, as detailed design and discussions with SDCC progressed to accommodate the surface water run-off of the ASDZ lands and to alleviate the localised flooding on Tubber Lane Road.

a) It further developed the proposed surface water drainage upgrade

b) focused on the proposals for the Tobermaclugg Steam downstream of the old confluence point with the Backstown Stream on Tubber Lane Road, resulting in the incorporation of **a 5,000m^3 attenuation pond** at Millstream Road below the Lucan Golf Course,

c) The strategic *Infoworks* CS stormwater simulation model developed at the time for the contributing catchments, was based on available contour plans, OS mapping and aerial photography.

d) A separate report **"Tobermaclugg Pump Station Preliminary Report – May 2006"** has been prepared and should be read in conjunction with this report.

Following an **Addendum Report in Oct 2006,** further design enhancements were considered after receiving queries relating to :-

i) the drainage mechanism within the golf course,

ii) the actual composition of the N4 culvert and

iii) requirements by SDCC **not to discharge stormwater to the storage tanks at the Tobermaclugg Foul Water Pumping Station** (PS). (See below a map reflecting the location of the attenuation pond and the old confluence point of the Tobermaclugg Stream with the Backstown Stream relative to the Lucan Golf Course.)

A further Report (titled **Tobermaclugg Stream Upgrade Preliminary Report Addendum**) was prepared in **April 2007,** which indicated :-

i) the final route selection

ii) the conversion of initial box culverts design to equivalent pipe sizes of 2.1m/2.4m for part of the **Reach 2** alignment of the Tobermaclugg Stream through the Lucan Golf Course, along with

iii) the upsizing of the Millstream Culvert to Twin 2.1m box culverts.

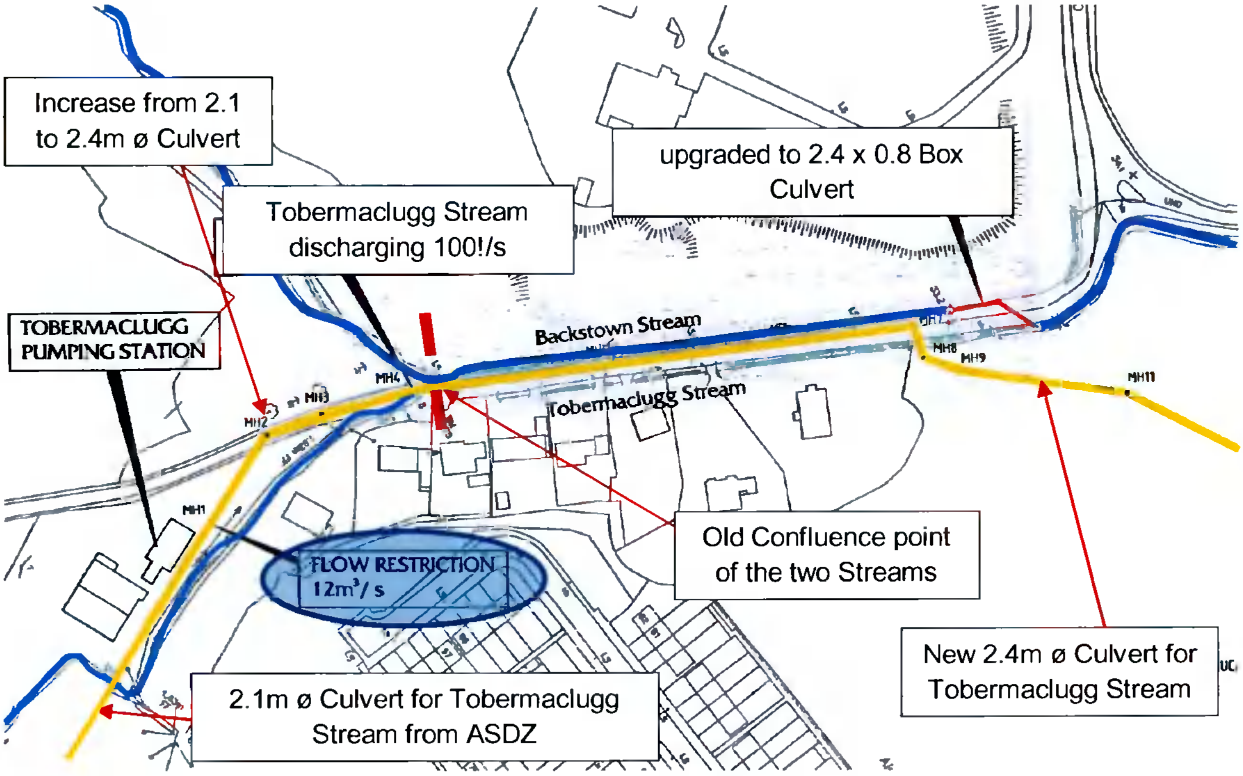
The culvert system constructed for the **Tobermaclugg Surface Water Drainage Scheme** conveys the bulk of the Tobermaclugg Stream flows away from Tubber Lane Road and has been designed to convey surface water runoff from the developed ASDZ lands. As part of the ASDZ design Strategy, it was agreed to maintain flow (approx. 100 l/s) in the Tobermaclugg Stream, where possible in the design of the various ASDZ development tiles/areas (See **Figure X.1** in **Section 4.1** above, showing the proposed route via which the final stream alignment will pass through the **Adamstown Boulevard**, **Aderrig**, **Tobermaclugg Village**, **Tobermaclugg Park** and **Airlie Park** SDZ Development Tiles). By diverting the bulk of the Tobermaclugg Stream and surface water flows into a new piped system, the volume of surface water on Tubber Lane Road had been reduced substantially as the Backstown Stream is now the main watercourse contributing to the stream at the Old confluence point on Tubber Lane Road. The two streams now primarily converge at the attenuation point south west of the Millstream Road (bar the agreed 100 ℓ/s) and the combined flow then traverses through the attenuation pond and existing ditch / culvert system for now only the final 230m of the original route, prior to the upgrade works carried out to date.

The plan below shows **Tubber Lane Road** through the Lucan Golf Course relative to the ASDZ Tobermaclugg Foul Water Pumping Station. Note the following:-

a) the location of the old confluence point,

b) the route of the 2.1 m /2.4m culvert into which all but 100 ℓ/s of the Tobermaclugg Stream (85% of the ASDZ contributing area) flows, and

c) the location of the new 2.4m x 0.8m culvert Tubber Lane Road crossing for the Backstown Stream (upgraded in 2010).



Plan A1 – Location of Backstown Stream and old Confluence Point with Tobermaclugg Stream

Fig A2 – Location of Backstown Stream and old Confluence Point with Tobermaclugg Stream

In **Early 2008** a further report was issued titled ***Tobermaclugg Stream Upgrade Preliminary Report (revised)*** . In this report :-

i) the proposal of the Tobermaclugg Stream upgrade and future drainage of these developed lands downstream from the Tobermaclugg Pumping Station are identified and on this basis, the design was agreed with SDCC Drainage Department, Part 8 Planning consent obtained and the scheme implemented/constructed in 2008/9 under supervision of SDCC Drainage Department.

ii) One of the two simulated models relates to the post-development scenario and its effects on the Tobermaclugg Stream from the Tobermaclugg Foul pumping station to its discharge point at the River Liffey (See above in Fig A2).

iii) six possible scenarios and alternatives had been considered to date (and taking into account all the design enhancements between 2005 and 2008), **Scenario 2 B** was adopted as the most critical and likely to occur.

Scenario 2 Tobermaclugg-Backstown catchments and the (ASDZ) North-East sub-catchment draining to the Tobermaclugg Stream

and the (ASDZ) South-East sub-catchment draining to the existing 450mm ø sewer (mostly developed except for the western end at the time of this report).

Alternative B With an increase in size of the railway culvert to remove the existing throttling effect at this culvert.

The Tobermaclugg Stream upstream, from its entry into the ASDZ on its southern boundary until its discharge at the old confluence point with the Backstown Stream, would be fed with a continuous flow of 100 !/s to maintain this stream as an environmentally sustainable watercourse. This would be achieved by diverting only 100 !/s into the realigned Tobermaclugg Stream through the ASDZ in accordance with the SDCC Planning scheme. The rest of the flows would be diverted into the underground pipe network (installed under mainly the following planning permissions: SDZ05A/2, SDZ 06A/4, SDZ06A/5 & SDZ 06A/11) and with future planning applications.

a) This would result in the removal of the bulk of the flow at the old confluence point on Tubber Lane Road bar the 100!/s.

b) The existing Tubber Lane Road crossing of the Backstown Stream was upgraded from a 900/750/600/300 ø pipe configuration to a 2.4m x 0.8m culvert in 2009/10 (following the finding of the increased Backstown Stream Catchment area) in addition to the 2.1/2.4m ø pipes installed past the newly constructed ASDZ Tobermaclugg Foul Pump Station through the Lucan Golf Club as part of a Part 8 Planning Consent with SDCC.

c) A 60-minute 100-year (winter profile) ARI duration storm was established as the most critical for the culvert downstream of the Tobermaclugg Foul Water Pump Station

d) Environmental risks were also identified in relation to the pollutants from run-off paved areas caused by storm washing oils, grease, grit and organics, it was indicated that appropriate sized *"Storm King* type ***"Downstream Defenders"*** be installed at strategic locations on the stormwater sewers within the ASDZ. Some of these Defenders have already been installed in the South East and Tobermaclugg Catchments. (See **Appendix B**)

In **November and December of 2009** certain elements of the historical flooding problem recurred on the public road (Tubber Lane Road), which passes through Lucan Golf Course, and as a result, further investigations were carried out.

A **Report in 2010** was prepared by **WYG** (formerly PH McCarthy Consulting Engineers) following a thorough reassessment of the whole surface water system and it was determined that the following factors combined to contribute to this particular flooding: -

ii) following intensive site investigations to determine the cause of the recent flooding in 2009 on Tubber Lane Road, it was noted that a reduced catchment area was used in error at the onset to determine the extent of the Backstown Stream Catchment Area,

iii) additional new, larger culverts had been installed under the railway lines to the south of the ASDZ, which had reduced the attenuation effect/time of concentration of the previous smaller culverts. (This did not have any direct impact on the flooding that occurred on Tubber Lane Road as the Tobermaclugg Stream is now piped passed the area of flooding and away from the old confluence point. From the assessment, It was confirmed that no additional flow from the Tobermaclugg Stream contributed to the flood waters as the diverted system was intact.)

iv) reduced openings along the base of the re-erected stone wall along the eastern side of Tubber Lane Road had restricted run off from the road and ditch on the western side of the road and into the stream to the east of the reconstructed wall. These were addressed by reconstructing larger openings in the base of the wall in 2010 See Fig A5 below.

Figure A3 Before Works 2005

Figure A4 After Wall Reinstatement 2008

Figure A5 New Opes After Wall Reinstatement 2010

v) pipe restrictions in the form of significant amounts of debris, hedge clippings and plywood, were removed from the surface water system by Chartridge Developments and SDCC in December 2009,

vi) cleaning of the screen installed on the inlet of 900mm ø culvert at the Tubber Lane Road (This culvert was upgraded to a 2.4 x 0.8 box culvert in 2010)

vii) the construction of an Arched Bridge over the stream within the Golf Course, (It would seem that no thought was given to the potential restriction this structure would have when the shape or size was designed and constructed. However, it would seem that this is not a critical factor but a possible contributory factor to the flooding that occurred in 2009.)

Figure A6 Arch Bridge

viii) it is worth noting that a temporary overflow constructed within the ASDZ lands near Adamstown Way to divert the stream into the pipe network upstream from the 2.1m / 2.4m ø pipe culvert, was breached during the flooding event of 29th November 2009 and resulted in greater than anticipated downstream flow.

a. Despite this breach, the Tobermaclugg Stream did not flood south of the old confluence point with the Backstown Stream as had regularly occurred prior to the construction of the piped Tobermaclugg Surface Water Drainage scheme in 2008.

b. As a precaution, and to reduce downstream flows, an emergency bund was constructed on the 29th Nov 09 and this rectified the breach by redirecting flows into the 2.1m / 2.4m ø culvert system. (This bund continues to control the stream flow well, as was demonstrated in the heavy rainfall events of the 29th/30th Dec 09.) (However this bund will be removed when the area in question is subsequently enveloped by development in accordance with the SDZ Planning Scheme.)

ix) Therefore it can be noted that the 2009 flooding that did occur seemed to be primarily related to:-

a. The increased area to the Backstown Catchment (however this area is in theory the same as it was prior to any development in ASDZ. It is not as if any physical adjustments were made to increase the contributing area, just an oversight to the extent of the actual catchment.) However, the 900ø pipe crossing Tubber Lane Road was increased to a 2.4 x 0.8 box culvert to increase the capacity of the road crossing)

b. Debris blocking the stream and a combination of lack of general maintenance was the primary causes of the flooding of Tubber Lane Road as the waters were simply blocked/contained due to the debris. (The new box culvert installed was oversized to minimise the occurrence of blockages which had occurred on the 900mm pipe.)

c. A programmed maintenance assessment strategy needs to be considered and implemented by SDCC.

d. In accordance with the findings, maintenance actions need to be set out and carried out to ensure that there are no restrictions to the system.

PHMcC had **prepared drawing SK121 (Overall Storm Sewer System)** which reflected a schematic of all the surface water sewers installed under the respective ASDZ planning permissions. **Waterman Moylan Engineering Consultants Limited** have taken this drawing and updated it to reflect the surface water sewer network installed to date as at November 2017. **(See Appendix A)**

6. CONCLUSIONS & RECOMMENDATIONS

1) This report provides an overview of a number of alternative design scenarios considered from 2005 - 2009 for the storm water system of the ASDZ lands to the River Liffey via Tubber Lane Road/Lucan Golf Club following extensive consultative process with the engineers at PHMcC and SDCC before works were carried out.

2) Hydraulic models were constructed and analysed using *InfoWorks CS*, in line with the methodologies used in the Greater Dublin Strategic Drainage Study (GDSDS) and then updated periodically, following amendments, whilst designing the Tobermaclugg Foul PS to service the ASDZ and construction details for the culverted system.

3) A series of reports and models of the existing Tobermaclugg-Backstown catchment were produced with the use of a topographical survey, the existing drainage records and conclude as follows:

   i) The total catchment is 902 hectares
   ii) The simulation model was run with a number of storms with various durations (30, 60, 90, 120, 240, 360, 480, 540, 720, 1440, 2160 and 2880 min) and return periods (1, 2, 5, 10, 30, 50, 100 and 200 years) for the assessment of the critical duration storm.
   iii) The 30 minute 100 year ARI duration (Winter profile) was the critical storm for the design of the culverts downstream of the Tobermaclugg PS (portion of Reach 2) based on the Tobermaclugg Catchment Area.
   iv) The 1200 minute 100 year ARI duration (Winter profile) was the critical storm for the Backstown Catchment when sizing the Tubber Lane Road Culvert. In the analysis it was noted that the critical storms are not the same and do not coincide, therefore the attenuation and capacity of the culverts downstream of the new confluence point where the combined Tobermaclugg and Backstown Catchments discharge has sufficient capacity.
   v) No information was available on the Grand Canal culvert and it is assumed to have adequate capacity to pass forward all flows. The railway culvert is a significant throttle on the system and furthermore can result in flooding of lands upstream of the culvert. The remaining significant culverts are of sufficient capacity up to the 100 year ARI.

vi) Sensitivity analysis of the railway culvert situation demonstrates that siltation does significantly reduce flows through the culvert and causes further flooding of lands upstream of the culvert. It is recommended that a regular programme of maintaining full flow in this culvert is carried out i.e. removal of silt, vegetation etc.

vii) The analysis takes into account Climate Change, allowing an additional 20% increase in rainfall intensity for the design of both the Millstream Road and Tubber Lane Culverts as per the OPW Section 50 requirements.

viii) The analysis for the ASDZ takes into account an additional 10% increase in rainfall intensity for climate Change as reflected in Greater Dublin Strategic Study (GDSDS) Regional Drainage Policies.

ix) The impact of the River Liffey has also been examined for all the alternative design scenarios. Whilst in extreme flood the river does surcharge the N4 culvert, it does not impact on the catchment further upstream due to the hydraulic grade line and the level difference.

x) The runoff from the development lands in time of extreme rainfall is found to be insignificant in comparison to flows in the River Liffey. Furthermore any peak response in the Tobermaclugg-Backstown catchment will have reached the River Liffey much earlier than the peak response of the river to the same event.

xi) By implementing the improvements and works below, it is predicted that flooding of Tubber Lane Road will not occur in storm events up to a 100 year ARI and that the Tobermaclugg PS will be protected against flooding for a 1000 year storm event.

xii) Pollution Control Consideration has been given to address the risk of pollution from run-off of paved areas. This is primarily caused by the initial rainfall in any storm washing oils, grease, grits and organics into the system. To protect the watercourses in the area, appropriately sized Storm King type downstream defenders are to be installed at strategic locations on the stormwater sewers within the ASDZ.

xiii) Provide a 5000m³ attenuation and reed planted as secondary treatment pond

4) Following extensive consultation with SDCC, including the Part 8 Planning Tobermaclugg Surface Water Scheme Upgrade, and based on all reports and models to date, the following works have been designed and constructed (and supervised by SDCC representative):

i) The culverting and upgrading of the Tobermaclugg Stream from the Railway to the N4 culvert was designed and constructed to replace all existing small culverts and open channels which were prone to flooding.

ii) The culverts have been designed and constructed so as not to cause flooding along Tubber Lane Road as they removed all but 100!/s from the Tobermaclugg Stream upstream of the Backstown confluence point.

iii) The Tobermaclugg Stream culverts have been designed to accommodate flows for the 100 year ARI with the railway culvert upgraded to accommodate the 100 year ARI.
iv) An emergency foul water overflow from the Tobermaclugg Pumping Station into the 2.1m ø surface water pipe with a 450ø pipe dry weather discharge point immediately upstream of the discharge point of the 2.4m pipe at the attenuation pond to prevent pollution of the pond and stream between the Golf Course and the Liffey in case of a discharge of foul water from the Tobermaclugg PS.
v) A bund wall of 1m has been constructed along the left overbank of the Stream along Celbridge Road between the Millstream culvert and the N4 culvert to 26.0 m OD (assumes ½ m freeboard).
vi) Debris and material has been excavated along the left bank between the Millstream culvert and the N4 culvert to increase capacity
vii) The Millstream Culvert has been upgraded to two 2.1m box culverts.
viii) A 2.4m ø pipe has been installed through the Lucan Golf Course to its discharge point at the Millstream Culvert
ix) A 2.1m ø pipe has been installed from through the Tobermaclugg Park pas the Tobermaclugg Pumping station to Lucan Golf Course
x) A series of 1.2m, 1.5m & 2.1m ø pipes have been installed from the Railway Culvert to Tobermaclugg Pumping station.
xi) The combined Tobermaclugg/Backstown Stream crossing of Tubber Lane Road has been upgraded from a blocked 900ø pipe to a 2.4 x 0.8 box culvert
xii) Low flow channels (100 !/s) at ground level and above the culverted of the Tobermaclugg stream have been provided and incorporated into the design. These channels have and can be constructed to convey base flows through the development lands where required. The underground culverts convey the additional storm and development flows.
xiii) A 5000m³ attenuation and reed planted secondary treatment pond has been constructed at the northern end of the Lucan Golf Course.
xiv) Downstream defenders have been, and will be installed at strategic locations as the primary protection against pollution.

Given the scale and significance of the Adamstown Strategic Development Zone, the development and its surrounding surface water catchments have been fully analysed and a fully engineered system designed and constructed to manage and control the storm and development flows in order to reduce flood occurrences and protect against pollution of the bio-systems of the watercourses.

Significant investment has been made in the system and it meets the requirements of the Adamstown SDZ Planning Schemes and Greater Dublin Drainage Strategies to prevent flooding and protect the environment. Further attenuation and Downstream Defender units are required and are being installed in the North east and South east catchment areas. The largest western SDZ catchment does not require any further attenuation to prevent flooding above the regional attenuation and secondary treatment installed. However, it does require additional primary pollution protection in the form of additional Downstream Defenders as the development progresses.

Appendices

A. Overall SDZ Drainage Layout SK121

B. Downstream Defenders

Design Data

Downstream Defender®

Advanced Hydrodynamic Vortex Separator

The Downstream Defender® is an advanced hydrodynamic vortex separator for the effective and reliable removal of fine particles, oils and other floatable debris from surface water runoff.

Its innovative design delivers high efficiency across a wide range of flows in a much smaller footprint than conventional or other swirl-type devices and it is the perfect choice for any catchment likely to convey high quantities of contamination.

1. Access for removal of floatables and sediments.
2. Inlet pipe.
3. Inlet chute.
4. Centre shaft.
5. Dip plate.
6. Centre cone.
7. Benching skirt.
8. Floatables and oil storage.
9. Isolated sediment storage zone.
10. Outlet pipe.

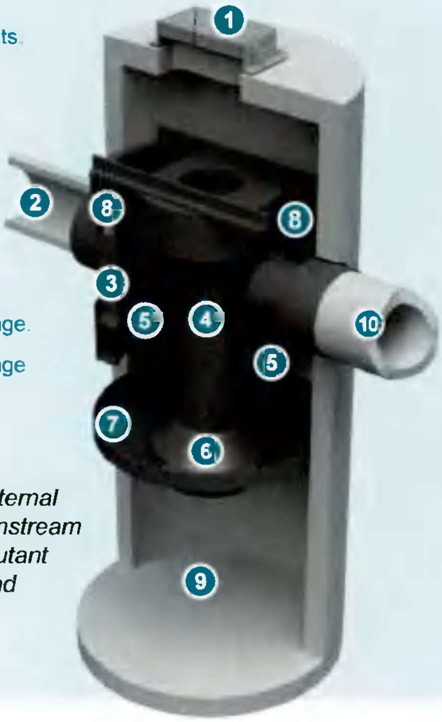


Figure 1 - The unique internal components of the Downstream Defender® enhance pollutant removal performance and prevent wash out.

Unique Flow Modifying Components

The Downstream Defender® consists of a structural concrete chamber with unique flow modifying internal components. It is these internal components that differentiate the Downstream Defender® from catchpits, sedimentation basins or sedimentation sumps. They facilitate advanced hydrodynamic vortex separation by reducing turbulence, lengthening the flow path to increase chamber residence time and introducing shear planes.

The internal components also ensure that the pollutant storage zones are isolated and protected from high flows that could cause pollutant re-entrainment or wash out.

Compared to devices that have poorly designed internal components, the Downstream Defender® captures and retains more of the annual pollutant load.

Watch a short video showing the Downstream Defender® components and operation at:

http://www.hydro-int.com/en-gb/products/down-stream-defender-0

Repeatable, Reliable Performance

The Downstream Defender® delivers high removal of pollutants through advanced, hydrodynamic separation across a wide range of flows. The device has a proven track record of tackling an assortment of pollutants including:

Fine particles

Greater than 80% removal of fine sand particles.

Gross Pollutants

100% of floatable debris, such as food wrappers, Styrofoam cups and drinks cartons removed in independent site trials.

Liquid and Sediment Bound Hydrocarbons

Greater than 50% removal of various forms of hydrocarbons, including free floating oils and polycyclic aromatic hydrocarbons (PAHs).

Sediment Bound Heavy Metals and Nutrients

Heavy Metals

Nutrients

As an efficient device for removal of fine sediment, the Downstream Defender® is also effective for removal of sediment bound pollutants.

Design Data
Downstream Defender®
Advanced Hydrodynamic Vortex Separator

No Risk of Pollutant Wash Out

The Downstream Defender® has been specially designed to isolate the pollutant storage zones and is proven to prevent pollutant wash out. See Technical Abstract: The Importance of Pollutant Wash Out Protection.

Sizing

The Downstream Defender® can be sized for different treatment goals and objectives.

For design purposes, the selected model's Treatment Flow Rate should be greater than or equal to the site's Water Quality Flow Rate.

The hydraulic capacity of the selected model should be considered with respect to the peak discharge flow rate from the site.

Model Diameter (m)	Treatment Flow Rate (l/s) a)	Hydraulic Capacity (l/s) b)	Oil Storage Capacity (l)	Sediment Storage Capacity (m^3)
1.2	42	120	270	0.7
1.8	96	270	1350	1.7
2.55	192	542	2500	3.8
3.0	265	750	4650	4.4

Notes:
a) Treatment flow rates based on >80% removal of US Silica Sand OK110 with no flow bypass. Sizing based on removal of finer or coarser sediment ranges or for free oil removal can be provided if required.
b) Maximum flow rate that can pass through the chamber without surcharge to the upstream network.

Head loss at the treatment flow rate is typically less than 500 mm.

Table 1 - Downstream Defender® design information.

Expert Design Service

Hydro's professional engineers are on hand to provide free support with the correct sizing and selection of the Downstream Defender® within each drainage design.

We can also provide estimated maintenance intervals, whole life cost estimates and predicted pollutant removal performance.

Call the StormTrain® Hotline on: 01275 337955 or email stormtrain@hydro-int.com

Setting Out

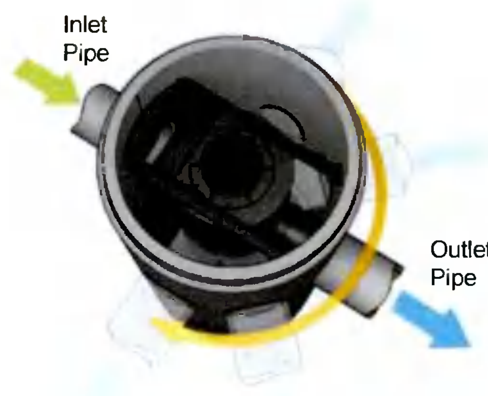
The Downstream Defender® can accommodate a change in pipe direction to suit site specific requirements. Combined with the high rate internal bypass, this helps to avoid the need for additional manholes on site. Head loss across the chamber is kept to a minimum (see Table 1).

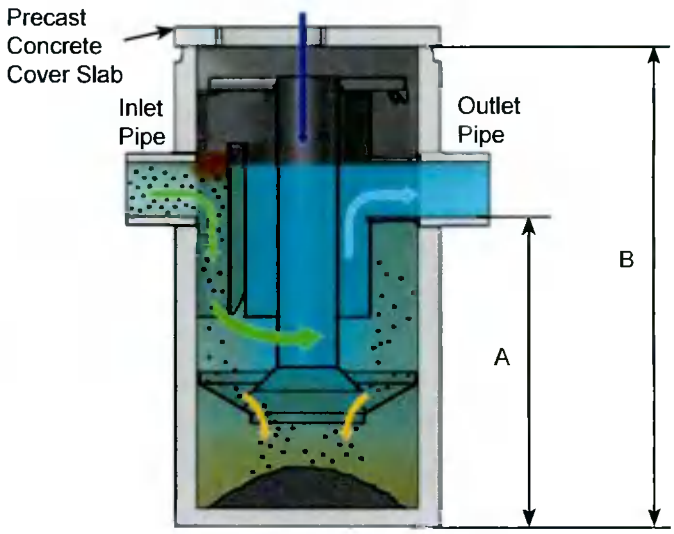
The inlet and outlet pipes should be sized in accordance with Table 2 (opposite), and a minimum of 90 degrees between inlet and outlet is required.

Inlet and outlet pipe connections are at the same invert level.

Additional manhole sections can be provided to extend the chamber to meet site cover and invert levels or provide additional pollutant storage where required.

Design Data
Downstream Defender®
Advanced Hydrodynamic Vortex Separator





Dimensions and Weights

General arrangement drawings of all units are available for download from:
http://www.hydro-int.com/en-gb/products/downstream-defender-0

Unit	External Diameter of Unit (mm)	Inlet & Outlet Pipe Diameter (mm)	Depth (m)			Lift Weight (t)
			A	B	Component Depth a)	
1.2 m Sealed Manhole System with HD Cover Slab	1460	300	1.910	2.600	2.830	
HD Cover Slab b)					0.230	0.6
Base Section					0.825	1.5
Top Section					1.765	2.5
1.8 m Sealed Manhole System with HD Cover Slab	2160	450	2.510	3.800	4.050	
HD Cover Slab b)					0.290	1.4
Base Section					1.235	5.0
Top Section					2.485	8.0
2.55 m System with HD Cover Slab	2850	600	2.950	4.750	4.950	
HD Cover Slab b)					0.200	2.8
Base Section					1.750	8.0
Top Section					3.000	10.0
3.0 m System with HD Cover Slab	3350	750	3 125	5.000	5.200	
HD Cover Slab b)					0.200	4.6
Base Section					2.000	12.5
Top Section					3.000	14.0

Notes:
a) Base and Top Section component depths are shown as the total height during transportation / before assembly on site. The total depth is the depth of the assembled unit.
b) Cover slabs are heavy duty, suited for highways loading and are supplied with one or two access openings for maintenance.
c) Inlets and outlets are supplied with cast-in holes only. No stub pipes are provided.

Dimensional Tolerances: Height ± 25 mm; Diameter ± 12 mm; Wall Thickness ± 10 mm

Table 2 - Downstream Defender® dimensions and weights.

Design Data
Downstream Defender®
Advanced Hydrodynamic Vortex Separator

Easy to Install

The Downstream Defender® is typically delivered to site as a precast concrete manhole with internal components already installed. Installation is therefore similar to any other manhole installation on site. Full installation guidelines are available.

Lightweight High Density Polyethylene (HDPE) chambers can be provided where installation of a concrete manhole is not practical.

Easy to Maintain

Maintenance of the Downstream Defender® is simple, safe and cost-effective. Maintenance is carried out from the surface, using a standard vacuum tanker and personnel are not required to enter the device.

With a large capacity to store sediments and oils (see Table 1), and with a proven ability to prevent wash out, maintenance intervals can be years rather than months - depending on site conditions.

Additional pollutant storage can be built into the chamber to extend maintenance intervals if required.

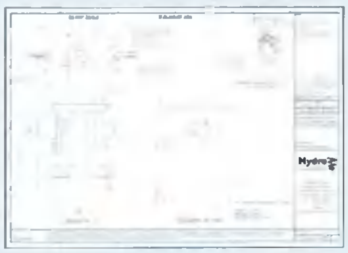
Watch a short video showing the Downstream Defender® maintenance at:

http://www.hydro-int.com/en-gb/products/downstream-defender-0

Downstream Defender® Technical Guidance

Case Studies

Installation and Maintenance Guidelines



General Arrangement Drawings

The Hydro StormTrain® Series of Surface Water Treatment Devices

The Downstream Defender® is one of the Hydro StormTrain® Series of surface water treatment devices. Each device delivers proven, measurable and repeatable surface water treatment performance. Each can be used independently to meet the specific needs of a site or combined to form a management train. They can be used alongside natural SuDS features to protect, enable or enhance them.

First Defense®
Vortex Separator

Downstream Defender®
Advanced Hydrodynamic Vortex Separator

Up-Flo™ Filter
Fluidised Bed Up Flow Filtration System

Hydro Biofilter™
Biofiltration System

The Hydro StormTrain® Series
StormTrain® Hotline: 01275 337955
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Hydro International
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Technical Abstract: Downstream Defender® & First Defense® EN858-1 Oil Removal Performance

27/10/2017

Introduction

Oil or fuel leaks and spills from trafficked areas, such as alongside highways, at commercial or industrial carparks, or residential homes, pose significant hazards to the environment. The capability to contain these spills is an important performance criterion for stormwater treatment devices, preventing toxic substances and high levels of COD and TOC entering the environment.

To verify the capability of the Downstream Defender® and First Defense® to protect water bodies from hazardous spills, Hydro International have used the BS EN858-1:2002 (Separator systems for light liquids) test protocol to provide appropriate sizing criteria.

Downstream Defender® & First Defense®

The Downstream Defender and First Defense are advanced vortex separators designed to utilize the principles of swirl-enhanced separation to remove TSS, trash and hydrocarbons from stormwater runoff. Flow modifying internal components enhance separation and provide distinct pollutant capture and storage zones.

Laboratory Testing Procedure

First Defense and Downstream Defender units were tested according to BS EN 858-1:2002 to assess their ability to capture oil for spill containment scenarios. The EN858-1 test procedure requires that diesel oil be dosed at a rate of 0.005 litres per litre of water to assess system capture performance. Separators are categorised into two classes, Classes I and II, depending on the average outlet oil concentration. The passing requirements for Class I and II are shown in the following table:

Table 1: EN858-1:2002 discharge limits

Class	Maximum permissible content of residual oil[a] mg/l
I	5,0
II	100

In addition to the average outlet concentration limits, a maximum is also imposed, where “no individual sample shall have a higher value than 10mg/l for class I or 120mg/l for class II.

Class I separators are usually applied to treat discharges to surface water bodies or drainage and Class II separators for discharges to foul water sewers.

Removal Performance and Unit Sizing

Testing of the separators according to the EN 858-1 protocol indicated it was possible for both the First Defense and Downstream Defender units to meet Class I and Class II effluent requirements. Small-scale 600mm diameter units were tested to limit environmental hazards associated with the test procedure. Scaling was performed according to Froude’s law to predict the maximum flow-rates at which 1.2, 1.8, 2.55 and 3.0m diameter units would meet the Class I or Class II removal criteria. Test results for the Downstream Defender are shown in Figure 1. The flow-rates satisfying the Class I/II removal criteria for both the Downstream Defender and First Defense are listed in Table 2.

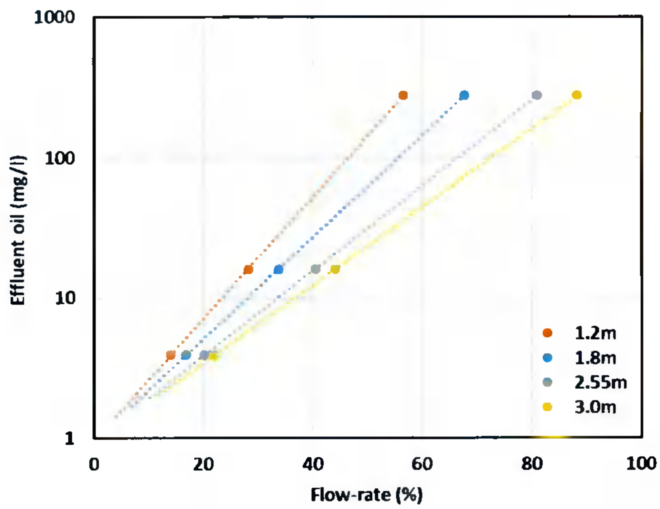


Figure 1: Effluent oil concentration from Downstream Defender separators in accordance to EN858-1:2002.

Table 2: Flow-rates meeting Class I/II removal criteria

Unit Size (m)	Downstream Defender®			First Defense®		
	Treatment Flow-rate (l/s)	EN858-1 Class I Flow-rate (l/s)	EN858-1 Class II Flow-rate (l/s)	Treatment Flow-rate (l/s)	EN858-1 Class I Flow-rate (l/s)	EN858-1 Class II Flow-rate (l/s)
1.2	30	5	14	29	4	TBC
1.8	69	14	38	65	12	TBC
2.55	138	33	92	-	-	-
3.0	190	49	138	-	-	-

Usage

Separators may be sized in two ways, full-retention or bypass. Full retention devices must be able to treat the peak flow-rate predicted for the unit. A bypass device may be sized to only treat a proportion of the predicted peak flow-rate, the remainder being bypassed. Bypass units are typically used where when it is considered an acceptable risk not to provide full treatment for high flows, e.g. where only small spillages can occur, and the risk of spillage is small. It is normally acceptable to consider bypass sizing protocols for SUDS scenarios, where 10% of the peak flow is an acceptable treatment target.

The First Defense and Downstream Defender are effective oil spill containment devices and meet BS EN 858-1:2002 Class I and II removal targets at the specified flow-rates. It should be noted these systems are not considered oil separators according to BS/DIN EN 858-1 and must NOT be used in applications where full certification is required.

Maintenance

In brief, where oil discharge is a potential hazard, EN858-1 recommends each separator should be inspected at least every six months to determine to levels of oil and sediment. A log of these inspections should be kept. If emptying is necessary, this should be carried out by a responsible contractor using the required EA certificates (notifiable waste) where required.

C. Background Reports Summary

The following sections give an overview of each report undertaken relating to the **Upgrade of the Tobermaclugg Stream** and the ASDZ from 2005 to 2010.

C.1 Summary of 2005 Report

The initial **Report of 2005 "***Assessment of the Tobermaclugg Stream Upgrade to the River Liffey* .

- The report s main focus was to examine options for the **Tobermaclugg Stream** as part of the ASDZ, since this passes through the ASDZ.

- The **Backstown Stream**, which converges with the Tobermaclugg Stream on Tubber Lane Road, was also included in the study although no development was planned for its catchments. (However, it was subsequently noted that only part of the catchment was included due to an initial oversight.)

- The report determined

  i. the proposed future drainage of the ASDZ lands and

  ii. the need to alleviate previous flooding issues on Tubber Lane Road.

  The strategic surface water model developed for the contributing catchments was based on available contour plans, OS mapping and aerial photography.

- The culvert constructed for the **Tobermaclugg Surface Water Drainage Scheme** conveys the **Tobermaclugg Stream** flows away from Tubber Lane Road within the north-western boundary of the ASDZ and is designed to convey surface water runoff from the developed ASDZ lands via a 2.1 / 2,4m ø pipe system down Tubber Lane Road and then through Lucan Golf Course, where the flows re-join the Backstown Stream below the Golf Course at Millstream Road. By diverting the Tobermaclugg Stream and surface water run off flows, the volume of surface water into the old ditch/stream onto Tubber Lane Road has been reduced considerably as the Backstown Stream is now the only watercourse contributing to the stream flow at the old confluence point.

1. This report provides a detailed analysis of a number of alternative design scenarios for the future storm water system of the ASDZ lands.
2. The analysis was carried out with the use of hydraulic models constructed using *InfoWorks CS*, in line with the methodologies used in the Greater Dublin Strategic Drainage Study (GDSDS).
3. A model of the existing Tobermaclugg-Backstown catchment was constructed with the use of a topographical survey, the existing drainage records etc. The total catchment is 612 hectares in area. A critical duration of 540 minutes for the catchment was identified. The systems were analysed for the 30 year and 100-year ARI events.
4. A number of culverts have been identified, viz: the culvert under the Grand Canal, culvert under railway immediately upstream of ASDZ lands, culvert at Millstream Road and a culvert under the N4.
5. No information was available on the Grand Canal culvert and it is assumed to have adequate capacity to pass forward all flows. The railway culvert is a significant throttle on the system and furthermore can result in flooding of lands upstream of the culvert. The remaining significant culverts are of sufficient capacity up to the 100 year ARI.
6. Sensitivity analysis off the situation of the railway culvert demonstrates that the siltation does significantly reduce flows through the culvert and causes further flooding of lands upstream of the culvert. It is recommended that a regular programme of maintaining full flow in this culvert is carried out i.e. removal of silt, vegetation etc.
7. The analysis takes into account climate change, allowing an additional 10% (20% mentioned as OPW requirement for Major Culverts) increase in rainfall intensity.
8. The impact of the River Liffey has also been examined for all the alternative design scenarios. Whilst in extreme flood the river does surcharge the N4 culvert it does not impact on the catchment further upstream.
9. The runoff from the development lands in time of extreme rainfall is found to be insignificant in comparison to flows in the River Liffey. Furthermore any peak response in the Tobermaclugg-Backstown catchment will have reached the River Liffey much earlier than the peak response of the river to the same event.
10. The model of the existing system predicts flooding at a number of locations throughout the catchment including upstream of the railway culvert and Tober Lane and the Golf Course Lands. This coincides with known instances of flooding.
11. Four design scenarios have been developed, viz:

Scenario 1A: Culverting of Tobermaclugg-Backstown catchment to Golf Course and stream improvement works from Golf Course to River Liffey.

Scenario 1B: Per Scenario 1A with upgrading of the railway culvert.

Scenario 2A: Per 1A with the northeast catchment draining into the Tobermaclugg-Backstown catchment.

Scenario 2B: Per Scenario 2A, with the upgrading of the railway culvert.

12. For Scenario 1A, the stream is culverted downstream of the railway culvert into a circular shaped culvert, to an open channel through the Golf Course lands. These culverts and channels have been sized for both the 30 year and 100-year ARI events.
13. Scenario 1B for the 30-year design requires an additional 900 diameter culvert under the railway. For the 100-year design 2 No. 1050 diameter culverts are required in addition to the existing culvert. Scenario 1B requires larger diameter culverts of the Tobermaclugg Stream in comparison to Scenario 1A. The dimensions of the proposed open channel are the same for both scenarios.
14. For Scenario 2A culverting of the stream is generally per Scenario 1A with some upsizing off the circular shaped culvert required to take account of additional flows from the North-East catchment.
15. For Scenario 2B the additional culverting under the railway culvert is per Scenario 1B viz: 30-year design of 1 no. 900 diameter culvert; 100-year design of 2 no. 1050 diameter culvert in addition to the existing arch culvert.
16. The difference between Scenario 2A and 2B is the upsizing of the circular shaped culverts generally by one size, with no difference in the dimensions of the proposed open channel cross section.
17. The culverting along Tubber Lane Road is designed to replace all existing small culverts and open channels which are prone to flooding. The proposed culvert along Tubber Lane Road is designed not to cause flooding along Tubber Lane Road.
18. Comparing Scenario 1 & 2 shows little difference in a 30-year design, with the only difference being the upgrade of the diameter of the circular shaped culvert downstream of the discharge point of the North-East catchment into the Tobermaclugg-Backstown catchment.
    For the 100 year design the difference between Scenarios 1 and 2 is again only in the sizing of the circular shaped culverts, with Scenario 2 requiring slightly larger circular shaped culverts.
19. There is an option to provide a low flow channel at ground level and above the proposed culverting of the Tobermaclugg-Backstown stream. These channels would be designed to

convey base flows through the development lands. The underground culverts would convey the additional storm flows.

20. The existing railway culvert, at the upstream end of the ASDZ lands has been identified as a significant throttle on flows to the downstream catchment. There is the possibility that in the future this culvert could be upgraded and in all likelihood this upgrade would be to the 100-year ARI design.

    It is therefore recommended that the proposed Tobermaclugg Stream culvert be designed to accommodate flows for the 100-year ARI with the railway culvert upgraded to accommodate the 100-year ARI. Therefore, Alternative B should be adopted, whether it is Scenario 1 or Scenario 2.
    Scenario 1 B has been designed to convey flows from the Tobermaclugg-Backstown catchment, with **Scenario 2B designed to accommodate flows from the Tobermaclugg-Backstown catchment and the North-East catchment**.

C.2 Summary of May 2006 Report

The **Addendum Report of May 2006** *Tobermaclugg Stream Upgrade* progressed matters with the proposed addition of a 5,000 m^3 attenuation pond at Millstream Road. This was included, following a design criteria change which restricted any storm flows being allowed to spill onto the old stream ditch or Tubber Lane Road at the Tobermaclugg Foul Pumping Station.

- The hydraulic results of the various critical storm durations were assessed for the various return periods in line with the GDSDS, whilst making allowance for climate change (10%) for each storm event and a 4% reduction in rainfall for the size of the catchment area. A 30-minute 100-year ARI duration storm with a winter profile was determined as critical for the system downstream of the Tobermaclugg Pumping Station. Therefore the following was implemented: -

    i. Limit the flow in the culvert to $12m^3/s$ at the Pump Station

    ii. Channel the existing Tobermaclugg Stream at the Pump Station with a 1m x 1.5m concrete channel & screen.

    iii. Construct an emergency overflow from the Tobermaclugg Stream into the stormwater culvert at the end of the concrete channel

iv. Pipe the Tobermaclugg Stream from the end of the channel to the existing Tobermaclugg Stream along Tubber Lane Road

v. Construct a 2.25m wide x 1.5m high stormwater culvert between the Pumping Station and Tubber Lane Road

vi. Construct a 2.6m wide x 1.5m high stormwater culvert between the Tubber Lane Road and its discharge point just before the Mill Stream Culvert

vii. Upgrade the Backstown Stream crossing of Tubber Lane Road to a 900mm ø pipe

viii. Remove the existing southern connection between the Tobermaclugg Stream and the Backstown Stream

ix. Restore the original profiles of the Backstown Stream and Tobermaclugg Stream

x. Create a 5 000m³ attenuation pond between the Golf Course and the Millstream Road culvert

xi. Construct a 450mm ø pipe from the discharge point of the stormwater culvert into the Liffey to prevent pollution of the Tobermaclugg Stream in case of discharge of foul water from the Tobermaclugg Pumping Station

C.3 Summary of October 2006 Report

In **October 2006** a further **Addendum Report** was issued following: -

- checks of the drainage mechanism within the Lucan Golf Course,
- check of the Composition/Dimensions of the N4 Culvert and
- the requirements from SDCC not to discharge stormwater to the storage tanks at the Tobermaclugg Pumping Station.

This led to a re-examination of the hydraulics of the Tobermaclugg Stream.

At the time of the original survey, the Tobermaclugg Stream had a low flow, and access to survey all relevant components was easily achieved. An assessment in September 2006 initiated alterations to the model, making the following adjustments to the in-situ components:

i. Revision of the vegetation coefficients of the stream between the Golf Course and the N4 Culvert

ii. Dimensions of the composite N4 Culvert The shape was initially assumed as being uniform, based on the entrance and exit opes, but was in fact as follows: -

   1. 1.7m (h) x 2.0m (w) for 78m with an approximate 30° bend left after approximately 58m from the inlet

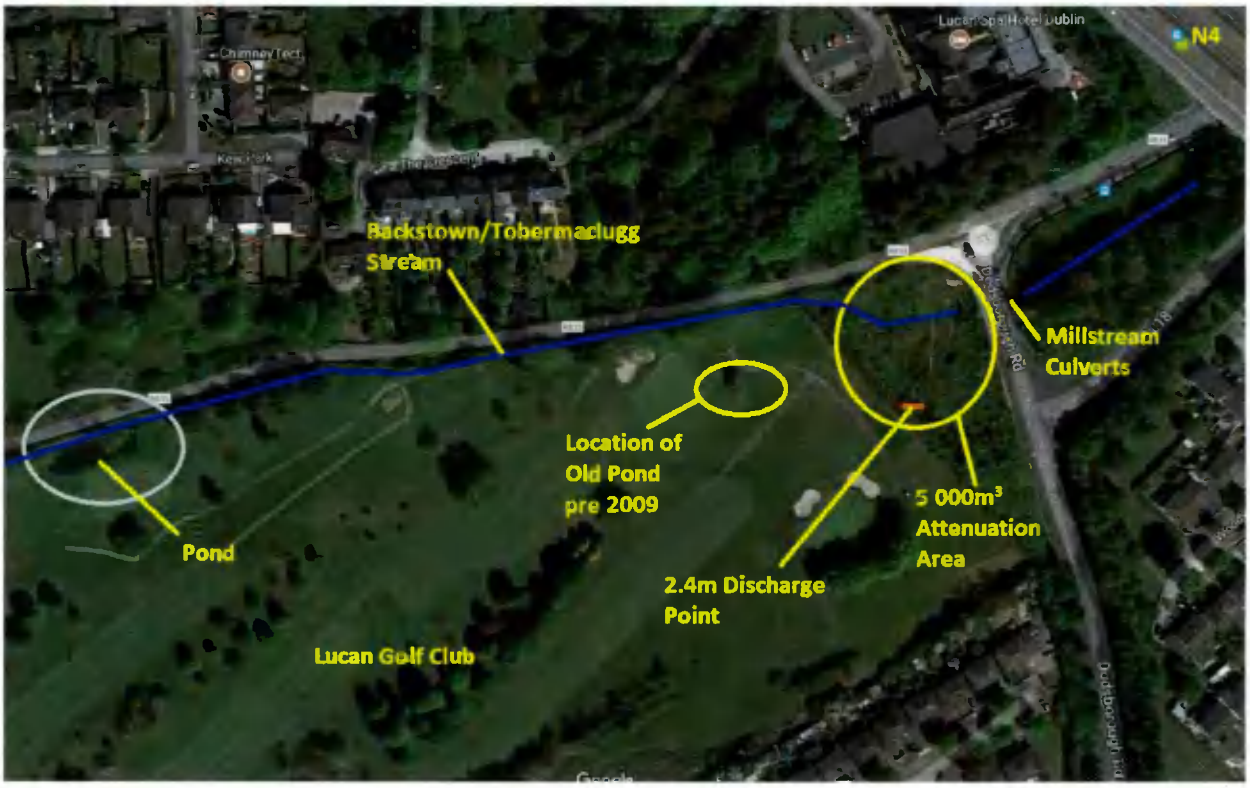
   2. The culvert then widens to accommodate the original stone arch structure 4.0m (w) x 2.0m (h) and approximately 15m long

   3. The Stone arch flows to 3.6m (w) x 2.0m (h) concrete box culvert for approximate 15m with the façade on the downstream culvert outlet replicating the stone arch structure.

iii. The flow path and drainage mechanism for the Lucan Golf Course.

   1. The flow through the golf course passes through a water feature (pond) on the eastern boundary closest to the Millstream culvert. The pond s water level is controlled by a buried 150m ø pipe, which then discharges to a ditch over the boundary of the golf course and flowing to the Tobermaclugg Stream via a 750mm ø pipe. During storm conditions the 150ø has insufficient capacity to carry the flows and the pond is overtopped. Water flows overland to the 750ø pipe. The capacity of the 750ø pipe exceeds the predicted flow

from the golf course and assuming no influence from the Tobermaclugg Stream, this level dictates the localised flooding of the golf course. (This pond has since been removed however there is a second pond approximately 240m upstream of the 5 000 m^3 attenuation pond. See below current 2017 layout of northern portion of the Lucan Golf Course.)



iv. Therefore, the following additional works were undertaken:

1. Replacing of the existing Millstream Road Culvert with twin 2.1m box culverts, partially buried 300mm below the existing streambed to preserve existing salmonoid habitat

2. Excavation of an attenuation pond (to maximise possible storage volume within the property boundaries) immediately upstream of the Millstream Road Culvert

3. Construction of a bund along the left overbank of the Tobermaclugg Stream along the Celbridge Road between the Millstream culvert and the N4 culvert assuming a 500mm freeboard.

4. Removal of the 750mm ø pipe channelling flows from the Lucan Golf Course, with flows to fall directly into the proposed Millstream Road attenuation pond. (This pond has since been removed.)

v. The results of the adjustments to the model indicate that the critical duration storm is now a 45min winter storm with the source of the primary peak determined as the proposed urban development. A secondary peak from the slow release vegetated regions upstream, is estimated to have a critical storm duration of approximately 720min. The secondary peak is not responsible for the flood water maxima at the junction of the proposed Lucan Golf Course Culvert and the Tobermaclugg Stream, but was used for runoff analysis from the undeveloped areas within the catchment. The failure mechanism at the junction of the proposed Lucan Golf Course culvert and the Tobermaclugg Stream is the short flash storm event whereby runoff from the proposed development upstream builds up behind the existing Millstream and N4 culverts. Analysis has included options of storage (Option 1) and construction of new culverts (Option 2) to allow passage of flow directly to the Liffey River as discussed in the respective sections in the report.

vi. Under the upgrade works undertaken, it was predicted that localised flooding would occur on the golf course under 1 : 30 year ARI return storms and above. However, this will occur for a short duration only and the golf course is unlikely to be open under such extreme events. Negotiations took place with the Lucan Golf Course and SDCC prior to undertaking the recommended upgrades.

C.4 Summary of October 2008 Report

This report dealt with the final detail of Tobermaclugg Stream Upgrade, whilst considering the requirements of the surface water runoff from ASDZ, and examined key issues, such as the Design Criteria and Proposed Scheme for implementation. The final route for the 2.4m ø storm sewer was developed in consultation with the Lucan Golf Club.

The project constructed later in 2008 comprised of the following:

i) Abandoning of the existing cross connection between Backstown Stream and Tobermaclugg Stream on the southern end of Tubber Lane Road.

ii) Installation of a 885m long 2.4 ø concrete pipe from Tobermaclugg Pumping Station, through Lucan Golf Course and to the Mill Stream culvert attenuation pond.

iii) Control of maximum flows in the Tobermaclugg Stream.

iv) Upgrading of Mill Stream culvert to twin box sections 2m x 2m. (Actual installed 2.1m)

v) Installation of 320m of 450mm ø emergency overflow sewer from termination of stormwater culvert to River Liffey. (This would operate in the unlikely event of a mechanical failure at the Tobermaclugg Pumping Station).

vi) Constructing a bund wall to the attenuation area between Celbridge Road and Old Millstream Road on existing South Dublin County Council lands.

vii) Constructing a 5000m^3 attenuation pond between Lucan Golf Course and Millstream Road and culvert and the fencing/landscaping to attenuation areas.

The works were implemented via Part 8 Planning through Chartridge Development .

C.5 Summary of March 2010 Report

In **March 2010** a further report titled **"Review of Flooding Events on Tubber Lane Road"** was prepared by WYG following flooding in November and December of 2009 of the public road (Tubber Lane Road), which passes through Lucan Golf Course.

a) The factors, which combined to contribute to this flooding and a proposed solution, were the subject of this report.

   i) A full reassessment of the contributing areas was undertaken during this process it was noted that the **Backstown Stream** consists of a 316 ha catchment or approximately 46% of the contributing catchment area.

   ii) This catchment was initially modelled strategically based on an area of 126 ha. (There is no clear reason why the catchment area was restricted to only 126 ha) Observations during storm events in November and December 2009 lead to a re-examination of this catchment. Significant flows, causing flooding of the road, were noted where the stream crosses Tubber Lane Road at Location B, as well as at Location A (Figure 1.0), where the stream passes through Lucan Golf Club. The stream emanates adjacent to the Grand Canal and contributes an additional area of approximately 290 ha to the catchment as shown in Figure 2.0.

- The combined Tobermaclugg Backstown Stream catchment equates to a total of 902 ha (i.e 486 ha + 416 ha = 902 ha).

Design Review – 2010

The following sub-sections give an overview of the components that were reassessed following the flooding of Tubber Lane Road in November/December 2009.

A Catchment Survey

Following recent observations of the catchment as described in the report, and to confirm its potentially greater extent, a surveyor was procured to resurvey the Backstown Stream and its catchment. The stream profile was surveyed at regular intervals along its length together with all structures encountered. The survey included 11 ! sections through the stream channel and 11 ! . hydraulic structures.

Ordnance Survey Ireland (OSI) LiDAR data, which provides topographical information, was also sourced to review the catchments extent.

B Tubber Lane Road Pipes

The Backstown Stream is conveyed via a ditch system before it merges with the old Tobermaclugg Stream ditch/pipe crossing at Tubber Lane Road. The stream then flows along the western edge along Tubber Lane Road via an open ditch for approximately 190m. According to records, it then enters a 900mm ø concrete culvert. This then bifurcates into 600mm ø and 750mm ø culverts, with the latter crossing the public road into the Golf course ditch. The 600mm ø culvert further bifurcates into twin 300mm ø and simple 300mm ø pipes which cross the Tubber Lane Road and join with the flows from the 750mm ø culvert in an open channel. Accordingly, the combined free flowing capacity of the network is 810 l/s, which is equivalent to a notional 900mm culvert.

The layout of the existing pipelines crossing the road is shown on drawing 880/02/123 (Appendix B).

C Other key culverts and recent works

In addition to those highlighted by the survey, a number of other significant structures were recorded throughout the Backstown catchment during a site visit on 3rd December 2009. Structures of note include recently constructed Irish Rail culverts beneath new rail lines, which include a combination of a 1,000mm x 2,000mm and 1,400mm ø concrete structures.

A new 900mm ø concrete culvert has been recently installed at Location B at the entrance to the Department of Agriculture Lands.

The open channels either side of Tubber Lane Road at Location A (Figure 1.0) have been cleared and pipes crossing the road have been unblocked.

These works alter the behaviour of the catchment during storm events by reducing upstream attenuation.

South Dublin County Council cleared the channels and pipes that traverse the entrances to the dwellings on the southern side of Tubber Lane Road. The Tobermaclugg Stream will travel through these channels and pipes and will join with the Backstown Stream north of Tubber Lane. As described in this report, Tobermaclugg Stream flows over approximately 100 l/s are diverted into the 2.1m-2.4m ø culvert upstream. A flow is maintained in the stream for environmental reasons. Therefore, although this measure will reduce flows crossing the road at Location A by circa 100 l/s, its impact on storm flow hydraulics and culvert sizing will not be significant.

Storm Events of November / December 2009

Weather stations throughout the country had record falls of rain for the month of November 2009. At Casement Aerodrome 225% of the normal monthly rainfall occurred. The rainfall event which occurred on the 29th November 2009 produced 36mm of rain over a 20-hr period and was categorised as a 2 year ARI event. It should be noted that the 2-year ARI event represents approximately 34% of the 100year ARI or 32% of the 200 year ARI event rainfall.

The occurrence of several major rainfall events in succession during the antecedent period in November contributed to high stream levels and saturation of the surrounding catchment. Met Eireann reported that rain or showers were recorded almost every day in November. The time of concentration of the catchment was significantly reduced and therefore the shorter duration events had a major impact on stream flows. The storm event of 29th November and the Met Eireann monthly report are included in Appendix A.

On 29th December 2009 a further flooding incident occurred during which Met Eireann recorded over 40mm of rain at Casement Airport.

UK and Ireland Office Locations