P-1606	DOCUMENT LEAD SHEET	

ENGINEERING SERVICES REPORT

PROJECT: COOKSTOWN CROSS, FOURTH AVENUE, COOKSTOWN INDUSTRIAL ESTATE

TITLE: ENGINEERING SERVICES REPORT

STATUS: PLANNING PERMISSION

CLIENT: STEELWORKS PROPERTY DEVELOPMENTS LTD

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Where this document has been revised it is recorded as indicated below. Please replace all superseded pages of this document with current version.

Rev	Date	Description	By	Checked	Approvals	
P	10 Sep 18	Irish Water Submission	PTC	GD		
P1	20 Nov 18	Pre-Planning Submission (SDCC)	PTC	GD		
P2	29 Apr 19	Pre-Planning Meeting (ABP)	PTC	GD		
P3	21 Aug 19	Irish Water Submission (Revised Scheme)	PTC	GD		
P4	09 Oct 19	Planning (ABP)	PTC	GD		

☑ Entire Document Issued this Revision

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APPENDICES

1.0 INTRODUCTION

This report relates to the proposed mixed use retail and residential development at the intersection of Fourth Avenue and Cookstown Road, Cookstown Industrial Estate, Dublin 24. The proposed development comprises a site, located immediately to the east of the southern arm of the Cookstown Road/Fourth Avenue roundabout.

The site which is the subject of the current planning application submission, has an area of circa 0.7064ha and is located at the junction of Fourth Avenue and Cookstown Road, immediately east of Tallaght Hospital, approximately 220m east of the hospital.

Refer to **Figure 1** below for a site location map.

Figure 1 – Site Location Map

The site falls from north to south and is bounded to the north by Fourth Avenue, to the east by Cookstown Road, and to the south and west by industrial units. The site is situated within an industrial area and is immediately surrounded predominantly by warehouses and industrial units with both sites currently consisting of a warehouse with surface parking.

The proposed development consists of a mix of commercial units, a gym, with 275 multi-level apartment units with an underground basement for parking, surface water attenuation, water boosting and other plant and storage rooms.

The aim of this report is to provide information on the calculations, estimates and assumptions used to design the foul drains, surface water drains, SuDS systems, surface water attenuation and water supply for the proposed development.

Foul and surface water systems for the site will be separate and are designed in accordance with the requirements of South Dublin County Council, the recommendations of the Greater Dublin Strategic Drainage Study (GDSDS), the Building Regulations and the recommendations of the DOE Recommendations for Site development works for Housing areas. In addition, surface water has been design with reference to the 'The Planning System and Flood Risk Management Guidelines', the Greater Dublin Regional Code of Practice for drainage works and Irish Water Standards Details for water and wastewater.

2.0 SURFACE WATER ATTENUATION

Surface water attenuation system will be provided using an off-line Stormtech SC740 attenuation system. The attenuation facility will be located within the courtyard. For maintenance purposes, the attenuation tank will be accessed via lids to be located within the courtyard.

Surface water discharge from the site will be controlled using a hydrobrake at the outlet from the attenuation system. The total volume of the attenuation system is as follows:-

Site Details

Plan Area = 565m^2

150mm Stone Base

150mm Stone Capping

Stone Voids ratio = 40%

Stormtech and stone storage capacity = 388m^3

The hydraulic modelling software system 'WinDes' was used to calculate the attenuation volumes required. Maximum rainfall data from Extreme Rainfall Return Period values produced by Met Eireann (Rainfall Return Periods Table website) was used to input into WinDes to determine maximum flood volume. For Cookstown (708365, 728000 ITM):

SAAR = 782mm

Ratio M560/M52d = 0.27

M560 = 18.6mm

As per current practice, these values were increased by 10% within Windes to account for climate change.

Runoff from roofs areas was assumed to be 100% impermeable. Runoff from green roof and permeable pavement areas over slabs is assumed to be 70% as at least 30% of the rainfall during an extreme event would be stored in the green roof/permeable pavement and only 70% of total rainfall will discharge to the site attenuation system (in the basement) during the duration of an extreme rainfall event. All other areas are assumed to have a 100% runoff rate in this site.

Site Catchment

Site A catchment constituents are as follows:

- Roof area = 428m^2
- Paths/Roads Area = 1250m^2
- Permeable Paving = 1500m^2
- Green Roof Area = 3125m^2
- Remaining Area = 812m^2

Effective catchment area is = 5216m^2

The Greater Dublin Strategic drainage Study (GDSDS) recommends that surface water runoff from new developments is limited to 2l/s/ha or Qbar (calculated using the UK IH124 equation).

As the site area is approximately 0.71ha, this results in a Qbar value of 1.5l/s, see appendix for calculation.

It would not be practical to limit the allowable outflow to this value as the required hydrobrake orifice would be too small. Therefore, it is proposed to limit the allowable outflow to 1.7l/s using a hydrobrake orifice diameter of 50mm (lowest recommended by manufacturers) and the corresponding design head of 1.83m (maximum water depth).

It should be noted that the existing site is a brownfield site which currently do provide any attenuation, therefore this reduction in flow would result in a significant benefit to the downstream system capacity.

A calculation sheet has been appended to this report which shows how the attenuation volume and discharge rate were calculated.

3.0 INTERCEPTION STORAGE

It is current good practice in sustainable surface water drainage design that no run-off should directly pass to a receiving surface water system for rainfall depths of 5mm, therefore interception/infiltration storage should be provided at source where practicable. The volume of infiltration required is based on 5mm of rainfall depth from 80% of the runoff from impermeable areas and is calculated as follows:

Site Interception storage required = 0.71ha x 0.8 x 0.005 = 28m^3

Interception storage will be provided within the green roof and permeable paving areas located on the apartment building roofs and podium slab. The green roof and permeable pavement will have a substrate/subbase depth of 150mm with a void ratio of 40%.

Site Interception storage provided = 0.46ha x 0.15 x 0.4 = 276m^3

The benefit of providing interception storage is that it allows some form of storage for small rainfall events which results in water evaporation and adsorption in small quantities, therefore there will be less run-off from the system in small rainfall events thus mimicking the natural response for the catchment. Also, the permeable paving car-parking spaces will reduce the amount of run-off from the site as well as slowing down the rate of runoff.

4.0 TREATMENT VOLUME

It is also current good practice in sustainable surface water drainage design that a “treatment volume” is provided in order to prevent any pollutants or sediments discharging into river systems, additionally a ‘treatment train’ stormwater runoff management system should be applied. According to CIRIA document C697 the following treatment train approach is necessary:

Roofs – 1 Treatment method

Paved Areas excluding Roads - 1 Treatment method

Roads - 2 Treatment Methods

The volume of treatment required is based on 15mm of rainfall depth from 80% of the runoff from impermeable areas and is calculated as follows:

Site Treatment storage required = 0.71ha x 0.8 x 0.015 = 85m^3

As all runoff is routed through the petrol interceptor and silt trap manhole as part of the offline attenuation system this will provide treatment storage in the system. Furthermore, the green roofs and permeable pavements will provide a treatment storage volume of 276m^3 for the site.

5.0 SUDS FEATURES

The surface water drainage system for the proposed development includes a number of SuDS features (Sustainable Urban Drainage Systems), in accordance with the recommendations of the 'Greater Dublin Strategic Drainage Study,' (GDSDS) and the SuDS Strategy adopted by South Dublin County Council. The implementation of SuDS features to manage surface water runoff from developments is also recommended in 'The Planning System and Flood Risk Management Guidelines'.

The SuDS strategy adopted by South Dublin County Council aims to provide an effective system to mitigate the adverse effects of urban stormwater runoff on the environment by reducing runoff rates, volumes and frequency, reducing pollutant concentrations in stormwater, contributing to amenity, aesthetics and biodiversity enhancement where possible. In addition, SuDS features aim to replicate the natural characteristics of rainfall runoff for any site by providing control of run-off at source.

Green Roof: Green roofs provide ecological, aesthetic and amenity benefits and intercept and retain rainfall, at source, reducing the volume of runoff and attenuating peak flows. Green

roofs absorb most of the rainfall that they receive during ordinary events although they will only contribute to attenuation of flows for larger events. Additionally, green roofs treat surface water through removal of atmospherically deposited urban pollutants.

Cellular Attenuation System (Stormtech): A proprietary modular block or arch structure with a maintenance/inspection tunnel for providing underground surface water attenuation storage and can infiltrate runoff to the ground where the subgrade is suitable. This is located in the courtyard area of the site.

Petrol Interceptor: A proprietary oil/water separator which prevents hazardous chemical and petroleum products from entering watercourses and public sewers. This is proposed at the outfall from the site.

6.0 SURFACE WATER DRAINAGE SYSTEM

Surface water throughout the site will collected by a green roof system with addition roof and podium slab gullies draining via downpipes and pipe slung to the underside of the ground floor slab.

For the site, surface water will be discharged from the site, following attenuation, to the existing 450mm diameter surface water sewer located to the north of the Fourth Avenue roundabout.

Surface water drains will also be located within the basement and will be for incidental spillages of water and for wheel wash only. The surface water will be collected in a pump sump chamber and will be pumped via a rising main to the gravity foul drainage system located outside the basement at ground floor level.

Surface water drains were designed using the Rational Method to size the pipes for a 1 year storm event. The following parameters applied:

Return period 1 year
Time of entry 4 minutes
Pipe Ks 0.6mm (concrete)
Minimum velocity 0.75 m/s
Maximum velocity 3.0 m/s

Roofs and podium slab areas are assumed to be 100% impermeable.

Surface water calculations are included in the appendices of this report which show the maximum size of slung drainage pipe required within the system.

7.0 FOUL DRAINAGE

Foul sewage within the site will be drained by a separate system via 150mm and 225mm diameter pipes.

There is an existing 225mm diameter foul sewer in running in an easterly direction along the footpath for Fourth Avenue. This sewer connects to a 225mm diameter foul sewer which runs in a northerly direction in the footpath along the eastern side of Cookstown Road. It is proposed to drain foul flows from the site to the 225mm diameter foul sewer along the northern boundary of the site. Foul flows from the development would be slung under the podium slab and would connect to a short section of gravity sewer at the northwest corner of the proposed development before discharging to the public sewer in the footpath.

There is an existing 225mm diameter foul sewer in running in a northerly direction along the eastern footpath for Cookstown Road. This sewer continues in a northerly direction under the footpath and collects flows from a 225mm diameter sewer from Fourth Avenue to the west.

Foul sewers have been designed in accordance with the Building Regulations and in accordance with the EPA Treatment Systems for Small Communities, Business, Leisure and Hotel, DOE *'Recommendations for Site Development Works'* and the recommendations of the 'Greater Dublin Strategic Drainage Study' (GDSDS).

The following design criteria have been applied in the design of foul sewers:

(i) Pipe Ks 0.6 mm (uPVC)
(ii) Minimum velocity 0.75 m/s (self-cleansing velocity)
(iii) Maximum velocity 3 m/s
(v) Minimum gradients:

No. of Connections	Minimum Pipe Gradient
1	100mm dia. @ 1:60 or self-cleansing gradient
2-8	150mm dia. @ 1:80 or self-cleansing gradient
>8	Min 150mm dia.; 1:DN or self-cleansing gradient

The peak flow from the proposed development of the site is estimated at 6.49l/s. The foul outfall pipe from the development would comprise a 225mm diameter pipe at a gradient of not flatter than 1 in 80. This pipe at full capacity of the sewer is estimated at 51.1l/s.

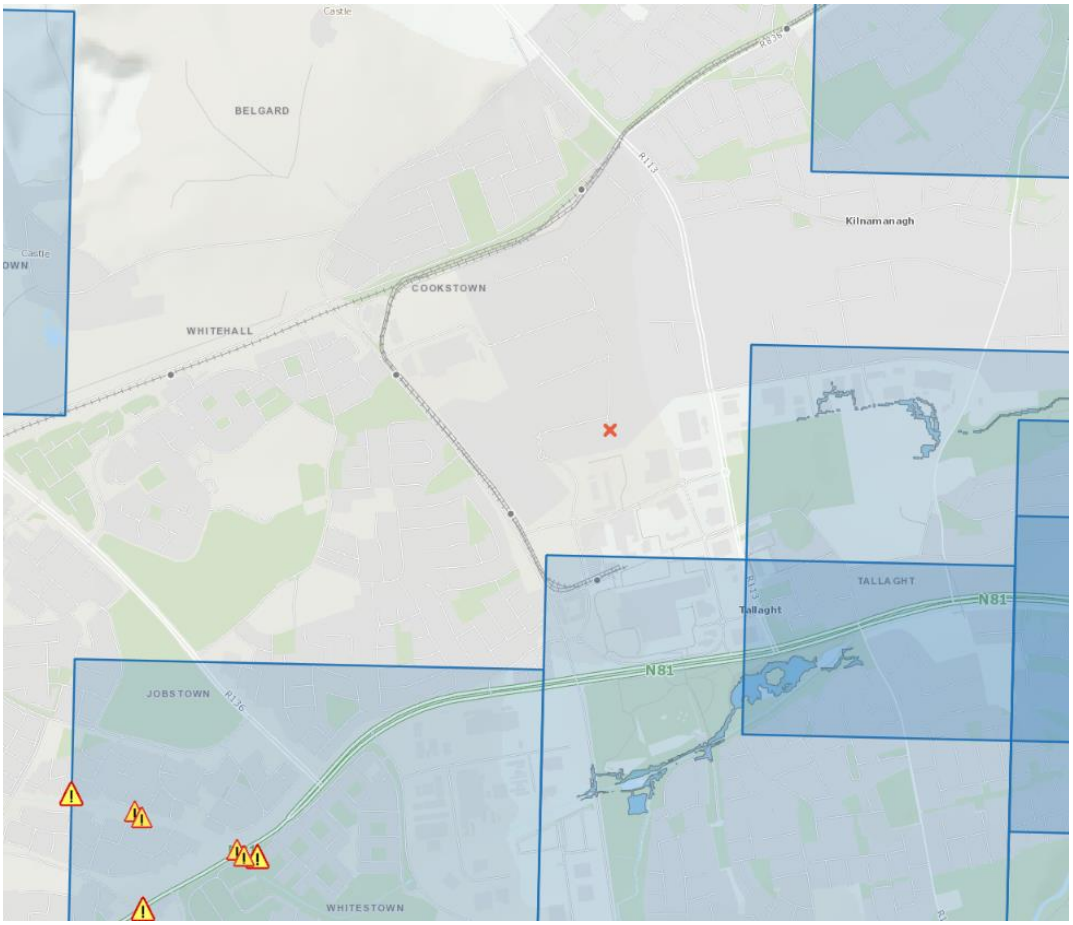
Sewers and drains shall be laid to comply with the requirements of the Building Regulations 1997 in accordance with the recommendations contained in the Technical Guidance Documents, Section H (revised 2005) and Irish Water.

A calculation sheet has been appended to this report which indicates the peak foul flows.

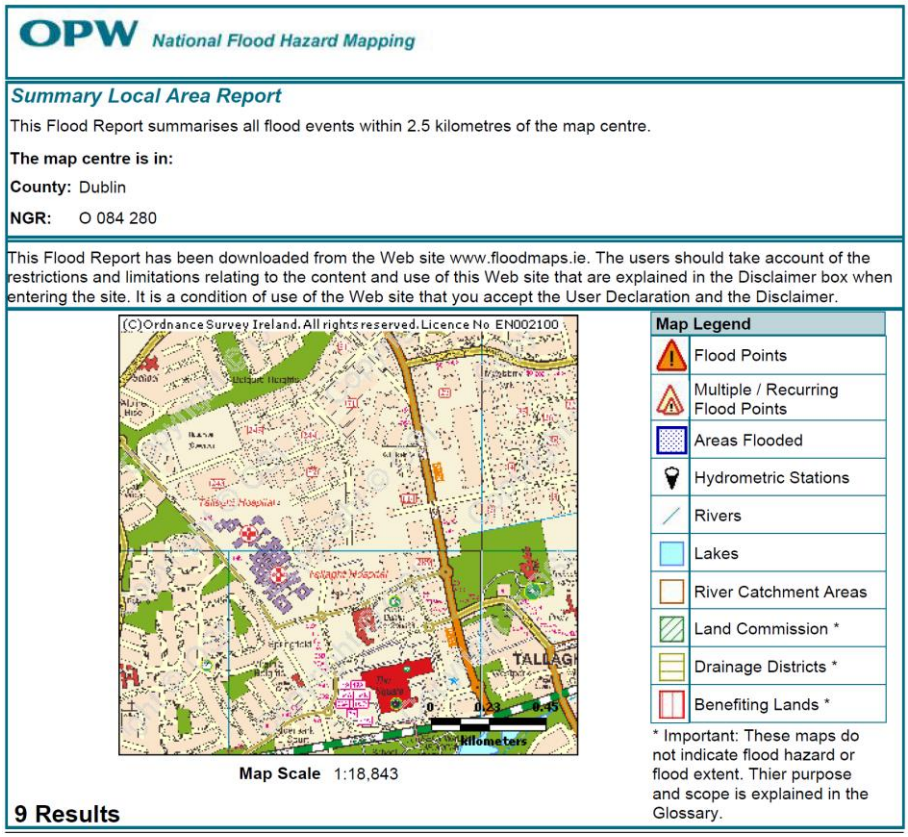
8.0 FLOOD RISK

The subject site is located more than 1.1km from the Whitestown Stream and therefore has not been included in the ECFRAMS study. The site is therefore deemed to be within **Flood Zone C**, i.e. outside the 1000 year flood events. Additionally, the site is also located more than 12km from the coast.

The sequential approach recommended by *"The Planning System and Flood Risk Management Guidelines for Planning Authorities"* has been complied with for the subject site as it is within Flood Zone C.



Floodinfo.ie showing OPW Flood Mapping



Floodmaps.ie showing no historical flooding event with 2.5km of site

9.0 WATER SUPPLY

For the site proposed 150mm diameter watermain will be connected to the existing 150mm diameter watermain located in the footpath along the northern boundary of the site.

These proposed watermains in turn will connect to a water booster and balancing system to be located in the two respective basements of the proposed development. This booster system will store and pump potable water to all apartments and commercial units within the development. In addition to the watermain, a new firemain will be provided within the courtyard of the development with fire hydrants on the podium slab. The external areas of the development will be served by existing fire hydrants together with additional hydrants to be located on the new 150mm diameter watermains.

For the site a bulk water meter will be provided at the connection to the site from the existing watermain. This electromagnetic flow meter will include a remote telemetry unit and associated mini kiosk, to the requirements of SDCC Water Management Section and Irish Water.

The supply arrangements will be carried out to the requirements of Irish Water. The Peak Hour Water demand for the proposed development is estimated at 6.2l/s for the site.

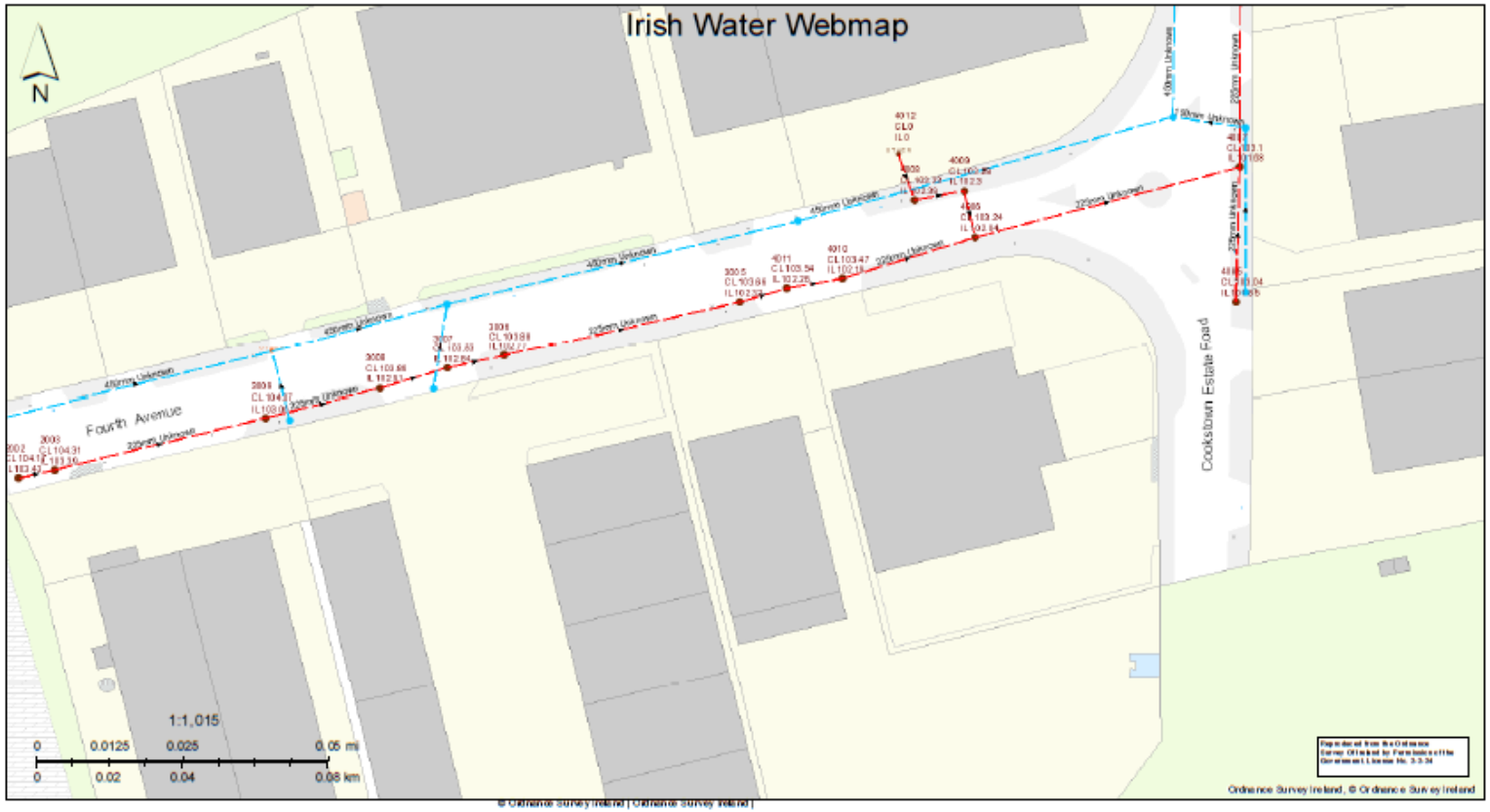
Refer to appendices for watermain and water supply calculations.

10.0 ACCESS

For site access to the basement car park would be via a ramp from Fourth Avenue, at the northwest corner of the site.

APPENDIX A

Water Services Records



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June 28, 2016

Legend

- Surface
- Surface
- Surface
- Surface
- Cascade
- Catchpit
- Hatchbox

Irish Water gives this information as to the position of its underground network as a general guide only on the strict understanding that it is based on the best available information provided by each Local Authority in Ireland. It should not be relied upon in the event of excavations or other works being carried out in the vicinity of the network. The onus is on the parties carrying out the works to ensure the exact location of the network is identified prior to mechanical works being carried out. Service pipes are not generally shown but their presence should be anticipated. © Irish Water

UISCE ÉIREANN : IRISH WATER

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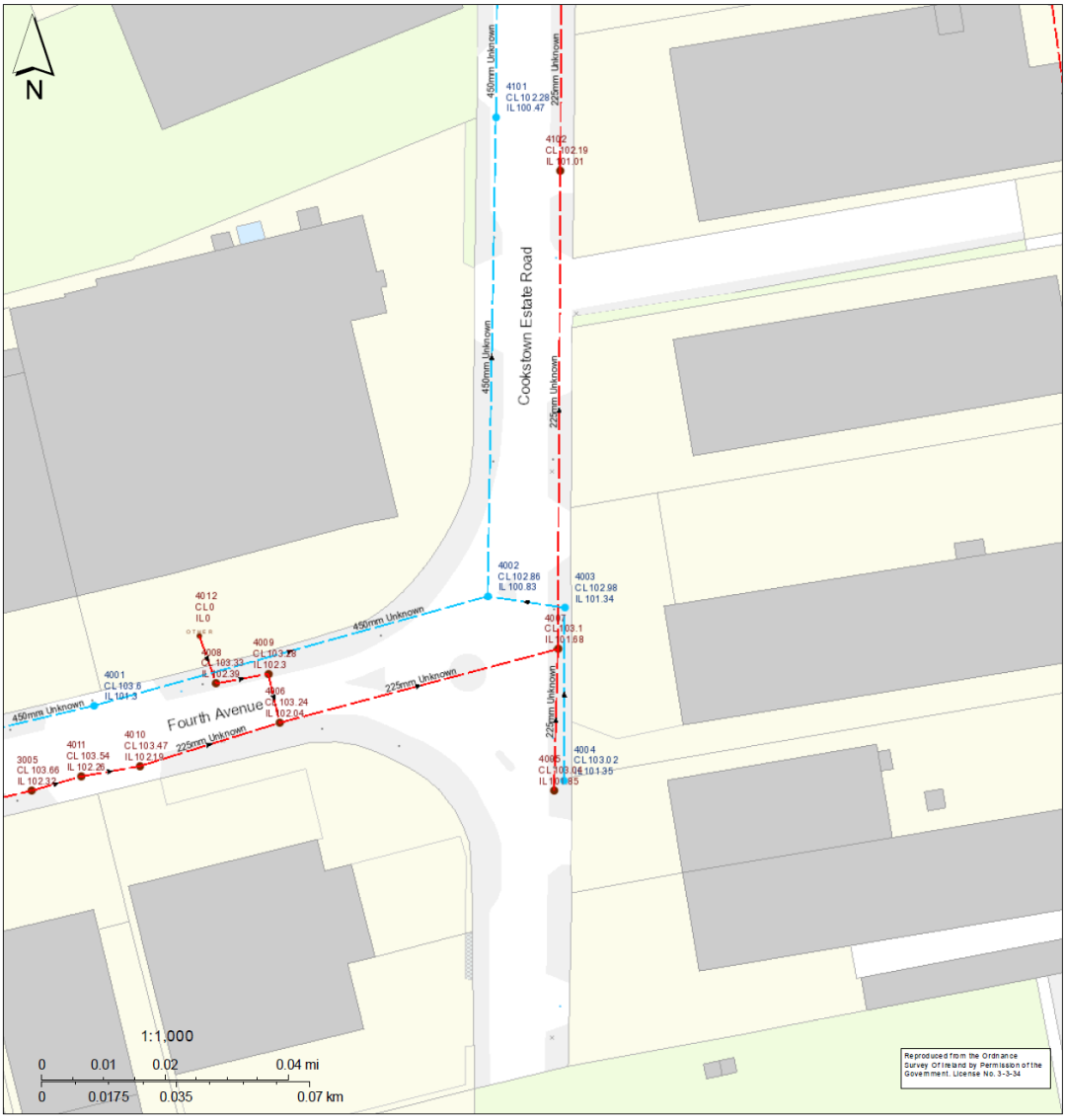
Irish Water Webmap



July 6, 2016

.egend

- Surface
- Surface
- Surface
- Surface
- Cascade
- Catchpit
- Hatchbox
- Lamphole
- Standard
- Other; Unknown
- Gully
- Standard

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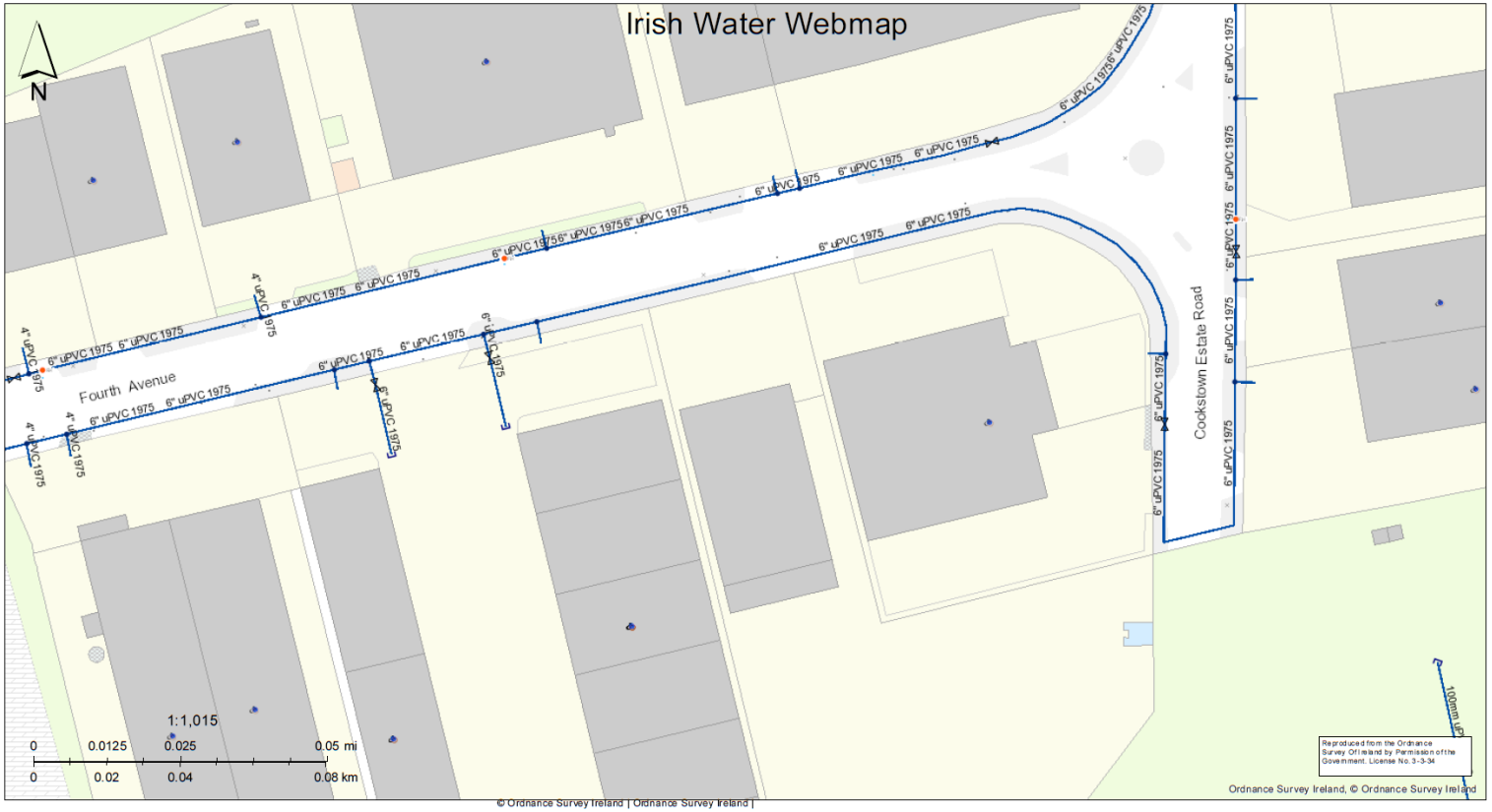

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une 28, 2016

egend

- Non-return
- Hydro
- Orifice Plate
- PRV
- PSV
- Other
- Open

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APPENDIX B

Surface Water Attenuation Calculations

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 308460, Northing: 228650,

	Interval		Years											
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.5,	3.8,	4.4,	5.5,	6.2,	6.7,	8.6,	10.8,	12.3,	14.4,	16.3,	17.8,	20.2,	22.0,	23.6,	N/A ,
10 mins	3.5,	5.2,	6.2,	7.6,	8.6,	9.4,	12.0,	15.1,	17.1,	20.1,	22.7,	24.8,	28.1,	30.7,	32.8,	N/A ,
15 mins	4.2,	6.2,	7.3,	9.0,	10.1,	11.1,	14.1,	17.7,	20.2,	23.6,	26.8,	29.2,	33.1,	36.1,	38.6,	N/A ,
30 mins	5.5,	8.0,	9.4,	11.6,	13.0,	14.2,	18.0,	22.5,	25.5,	29.8,	33.6,	36.7,	41.4,	45.0,	48.1,	N/A ,
1 hours	7.2,	10.5,	12.2,	14.9,	16.8,	18.2,	23.0,	28.6,	32.3,	37.5,	42.3,	46.0,	51.7,	56.2,	60.0,	N/A ,
2 hours	9.5,	13.6,	15.9,	19.3,	21.6,	23.4,	29.4,	36.3,	40.8,	47.3,	53.1,	57.7,	64.7,	70.2,	74.7,	N/A ,
3 hours	11.1,	15.9,	18.5,	22.4,	25.0,	27.1,	33.9,	41.7,	46.9,	54.2,	60.8,	65.9,	73.7,	79.9,	85.0,	N/A ,
4 hours	12.5,	17.7,	20.6,	24.9,	27.8,	30.1,	37.5,	46.0,	51.7,	59.7,	66.8,	72.3,	80.9,	87.6,	93.1,	N/A ,
6 hours	14.6,	20.7,	23.9,	28.9,	32.2,	34.8,	43.3,	52.9,	59.3,	68.3,	76.4,	82.6,	92.2,	99.7,	105.9,	N/A ,
9 hours	17.1,	24.1,	27.9,	33.5,	37.3,	40.3,	49.9,	60.9,	68.1,	78.3,	87.3,	94.3,	105.1,	113.5,	120.5,	N/A ,
12 hours	19.2,	26.9,	31.1,	37.2,	41.4,	44.7,	55.3,	67.2,	75.1,	86.2,	96.0,	103.6,	115.3,	124.4,	132.0,	N/A ,
18 hours	22.5,	31.4,	36.2,	43.2,	48.0,	51.7,	63.7,	77.3,	86.2,	98.7,	109.7,	118.3,	131.5,	141.7,	150.1,	N/A ,
24 hours	25.2,	35.1,	40.3,	48.1,	53.3,	57.4,	70.5,	85.3,	95.0,	108.6,	120.7,	130.0,	144.3,	155.3,	164.4,	196.3,
2 days	31.8,	43.0,	48.8,	57.4,	63.2,	67.6,	81.7,	97.3,	107.4,	121.5,	133.8,	143.2,	157.6,	168.7,	177.8,	209.2,
3 days	37.1,	49.4,	55.7,	65.0,	71.1,	75.8,	90.7,	107.1,	117.7,	132.2,	144.9,	154.5,	169.2,	180.4,	189.6,	221.3,
4 days	41.7,	54.9,	61.7,	71.5,	78.0,	82.9,	98.6,	115.6,	126.6,	141.6,	154.6,	164.5,	179.5,	190.9,	200.3,	232.3,
6 days	49.9,	64.6,	72.1,	82.9,	90.0,	95.3,	112.2,	130.4,	142.0,	157.8,	171.5,	181.8,	197.4,	209.2,	218.9,	251.7,
8 days	57.1,	73.2,	81.3,	92.9,	100.4,	106.1,	124.1,	143.3,	155.4,	171.9,	186.1,	196.9,	213.0,	225.2,	235.1,	268.8,
10 days	63.7,	80.9,	89.6,	101.9,	109.9,	115.9,	134.7,	154.8,	167.5,	184.6,	199.3,	210.4,	227.0,	239.6,	249.8,	284.2,
12 days	69.9,	88.2,	97.3,	110.3,	118.6,	124.9,	144.6,	165.5,	178.6,	196.3,	211.5,	222.9,	240.0,	252.8,	263.3,	298.4,
16 days	81.4,	101.6,	111.5,	125.6,	134.7,	141.5,	162.6,	184.9,	198.9,	217.6,	233.6,	245.6,	263.4,	276.8,	287.7,	324.2,
20 days	92.0,	113.9,	124.6,	139.7,	149.3,	156.6,	179.0,	202.5,	217.2,	236.8,	253.5,	266.0,	284.6,	298.5,	309.7,	347.4,
25 days	104.5,	128.2,	139.8,	156.0,	166.3,	174.1,	197.9,	222.8,	238.2,	258.9,	276.3,	289.4,	308.7,	323.2,	334.9,	373.9,

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

TITLE		Job Reference	
Cookstown Cross			
SUBJECT		**Calc. Sheet No.**	
QBAR Calculation using IOH Report 124 for Sites < 25 km²		1	
DRAWING NUMBER	**Calculations by**	**Checked by**	**Date**
1606-C-100	PTC	GD	May 2018

Estimation of QBAR from IOH Report 124 for catchments less than 25 km² using the 3 variable equation

$$^{1}Q_{bar} = 0.00108 * (AREA)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$$

^{2}Site Area = 0.71 Ha

Site area is less than 50 Ha, calculate Qbar for a 50 Ha Site then pro-rata

AREA = 0.007 km²

SAAR = 782 mm

^{3}SOIL = 0.30

Q_{bar} = 0.00004 cumecs/Ha

Q_{bar} = 2.1 l/s/Ha

$Q_{bar\ [rural]}$ = 1.5 l/s

Note to Institute of Hydrology Report No. 124 Eqn

Q_{bar}	The Mean Annual Flood (cumecs)
AREA	Area of the Catchment (km²)
SAAR	Standard Annual Average Rainfall (mm) *NERC Flood Studies Report, 1975*
SOIL	Soil Index Values of Catchment *Winter Rain Acceptance Potential, (Supplementary Report No. 7)*

Soil Classification for Runoff Potential FSR Maps

			SOIL Value
Soil 1	0	%	0.15
Soil 2	100	%	0.30
Soil 3	0	%	0.40
Soil 4	0	%	0.45
Soil 5	0	%	0.50

^{4}QBar from Site with Factorial Error Allowance

r =	0.847
n =	71
fse =	1.651

Q'_{bar} = 2.44 l/s

(With Allowance for the standard factorial error)

Permissible Outflow from Site using Growth Factor

Qbar growth for permitted outlows from site for given return period (assuming long term storage). (No allowance for standard factorial error)

Flood Return Event	^{5}Growth Factor	Permitted Flow (l/s)
1	0.85	1.3
QBAR	1	1.5
10	1.67	2.5
30	2.1	3.1
50	2.33	3.4
100	2.6	3.8
200	2.85	4.2
1000	3.5	5.2

Is longterm storage provided? No

Storm Return Period to be provided for =	100	Years *
QBAR (Growth) =	3.8	Litres/sec
^{6}Permissible Outflow from site =	1.5	Litres/sec
^{7}Maximum Allowable Outflow from site =	2.0	Litres/sec

(* 30, 50 or 100)

Catchment 1	Area (m²)	Runoff Coeff.	Effective Area (m²)
Roofs - Type 1 (Draining to gullies)	428	1.00	428.0
Roofs - Type 2 (Draining to SUDS Soakaway features)	-	0.00	0.0
Green Roofs	3,125	0.70	2187.5
Roads and Footpaths - Type 1 (Draining to gullies)	1,250	1.00	1250.0
Roads and Footpaths - Type 2 (Draining to Suds features)	-	0.70	0.0
Paved Areas	-	0.80	0.0
Green Roof/Permeable Paving on Podium Slab	1,500	0.90	1350.0
Grass over Basement	-	0.70	0.0
Grassed Areas	-	0.00	0.0
Green Areas	812	0.00	0.0

Include Public Open Space in Effective Catchment Area? no

Assumed open space area does not drain to surface water network

Effective Catchment Area 5215.5 m²

Effective Catchment Runoff Coefficient 0.73

Long-Term Storage

Impermeable Area =	0.52	Hectares (ha)
^{8}Rainfall Depth for M100-6hr =	58.7	mm
Percentage Impermeable Area (PIMP) =	73.3%	%
Percentage Paved Area Draining to System (α) =	100	%
Percentage Pervious Area Draining to System (β) =	0	%
^{9}Long-Term Storage Volume =	N/A	m³

Interception Volume (Post-Development)

Impermeable Area =	0.47	Hectares (ha)
Rainfall depth =	5	mm
^{10}Minimum Volume =	18.9	m³

Treatment Volume (Post-Development)

Impermeable Area =	0.47	Hectares (ha)
Rainfall depth =	15	mm
^{10}Minimum Volume =	70.9	m³

1 hectare = 10,000m² 1km² - 100 hectares

Notes

1. Based on the Institute of Hydrology Report 124 for small catchments less than 25km².
2. For catchments smaller than 50 hectares in area, flow rates are linearly interpolated for smaller areas.
3. Soil index value (SPR) calculated from Flood Studies Report Vol V Fig I 4.18(1) - The Classification of Soils from Winter Rainfall Acceptance Rate .
4. Fse is the standard factoial error
5. QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year, 2.3 for 50 and 2.6 for 100 year return period events, from GDSDS Figure C2.
6. Total Permissible Outflow - QBAR $_{(RURAL)}$ calculated in accordance with GDSDS - Regional Drainage Policies (Volume 2 - Chapter 6), i.e. $QBAR(m3/s)=0.00108x(Area)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$
7. Where Total Permissible Outflow is less than 2.0l/s and not achievable, use 2.0l/s.
8. Rainfall depth for 100 year return period, 6 hour duration with additional 10% for climate change. (Value from Dublin Airport)
9. Long-term storage Vol_{ls} (m³) = Rainfall.Area.10.[(PIMP/100)(0.8.α)+(1-PIMP/100)(β.SPR)-SPR]. (GDSDS Section 6.7.3).
   Where long-term storage cannot be provided on-site due to ground conditions, Total Permissible Outflow is to be kept to QBAR $_{(RURAL)}$.
10. Interception Volume Vt (m3) = Impermeable Area (ha) x 10mm x 10 (GDSDS, Vol 2, Section 6.3.1.2.1).

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Innovyze	Source Control 2018.1

Summary of Results for 100 year Return Period (+10%)

Half Drain Time : 2796 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	102.334	0.234	0.0	1.1	1.1	86.3	O K
30 min Summer	102.420	0.320	0.0	1.1	1.1	118.1	O K
60 min Summer	102.512	0.412	0.0	1.1	1.1	151.9	O K
120 min Summer	102.614	0.514	0.0	1.1	1.1	189.3	O K
180 min Summer	102.677	0.577	0.0	1.1	1.1	212.8	O K
240 min Summer	102.724	0.624	0.0	1.1	1.1	229.9	O K
360 min Summer	102.791	0.691	0.0	1.1	1.1	254.5	O K
480 min Summer	102.838	0.738	0.0	1.1	1.1	271.9	O K
600 min Summer	102.873	0.773	0.0	1.2	1.2	285.0	O K
720 min Summer	102.901	0.801	0.0	1.2	1.2	295.2	O K
960 min Summer	102.941	0.841	0.0	1.2	1.2	309.9	O K
1440 min Summer	102.984	0.884	0.0	1.2	1.2	325.8	O K
2160 min Summer	103.002	0.902	0.0	1.3	1.3	332.3	O K
2880 min Summer	103.003	0.903	0.0	1.3	1.3	332.9	O K
4320 min Summer	102.993	0.893	0.0	1.2	1.2	329.0	O K
5760 min Summer	102.975	0.875	0.0	1.2	1.2	322.6	O K
7200 min Summer	102.955	0.855	0.0	1.2	1.2	315.3	O K
8640 min Summer	102.934	0.834	0.0	1.2	1.2	307.3	O K
10080 min Summer	102.911	0.811	0.0	1.2	1.2	299.1	O K
15 min Winter	102.363	0.263	0.0	1.1	1.1	96.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	89.558	0.0	84.7	19
30 min Summer	61.519	0.0	95.1	34
60 min Summer	39.838	0.0	155.2	64
120 min Summer	25.136	0.0	180.9	124
180 min Summer	19.065	0.0	180.6	184
240 min Summer	15.631	0.0	179.2	244
360 min Summer	11.789	0.0	177.8	362
480 min Summer	9.639	0.0	177.7	482
600 min Summer	8.242	0.0	178.7	602
720 min Summer	7.251	0.0	180.7	722
960 min Summer	5.923	0.0	185.6	962
1440 min Summer	4.451	0.0	190.1	1440
2160 min Summer	3.338	0.0	370.0	2052
2880 min Summer	2.719	0.0	367.1	2392
4320 min Summer	2.035	0.0	361.8	3156
5760 min Summer	1.655	0.0	619.6	3984
7200 min Summer	1.411	0.0	659.9	4832
8640 min Summer	1.238	0.0	659.9	5704
10080 min Summer	1.108	0.0	627.2	6464
15 min Winter	89.558	0.0	90.2	19

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Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	102.460	0.360	0.0	1.1	1.1	132.5	O K
60 min Winter	102.563	0.463	0.0	1.1	1.1	170.6	O K
120 min Winter	102.677	0.577	0.0	1.1	1.1	212.7	O K
180 min Winter	102.750	0.650	0.0	1.1	1.1	239.4	O K
240 min Winter	102.803	0.703	0.0	1.1	1.1	259.0	O K
360 min Winter	102.880	0.780	0.0	1.2	1.2	287.4	O K
480 min Winter	102.935	0.835	0.0	1.2	1.2	307.6	O K
600 min Winter	102.977	0.877	0.0	1.2	1.2	323.1	O K
720 min Winter	103.010	0.910	0.0	1.3	1.3	335.4	O K
960 min Winter	103.060	0.960	0.0	1.3	1.3	353.6	O K
1440 min Winter	103.118	1.018	0.0	1.3	1.3	375.1	O K
2160 min Winter	103.151	1.051	0.0	1.3	1.3	387.4	O K
2880 min Winter	103.154	1.054	0.0	1.3	1.3	388.4	O K
4320 min Winter	103.138	1.038	0.0	1.3	1.3	382.5	O K
5760 min Winter	103.111	1.011	0.0	1.3	1.3	372.6	O K
7200 min Winter	103.077	0.977	0.0	1.3	1.3	360.3	O K
8640 min Winter	103.041	0.941	0.0	1.3	1.3	346.9	O K
10080 min Winter	103.004	0.904	0.0	1.3	1.3	333.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	61.519	0.0	95.7	34
60 min Winter	39.838	0.0	172.8	64
120 min Winter	25.136	0.0	181.1	122
180 min Winter	19.065	0.0	179.5	182
240 min Winter	15.631	0.0	178.7	240
360 min Winter	11.789	0.0	179.5	358
480 min Winter	9.639	0.0	182.4	476
600 min Winter	8.242	0.0	186.8	594
720 min Winter	7.251	0.0	190.4	710
960 min Winter	5.923	0.0	195.3	942
1440 min Winter	4.451	0.0	199.2	1398
2160 min Winter	3.338	0.0	382.6	2056
2880 min Winter	2.719	0.0	387.2	2680
4320 min Winter	2.035	0.0	382.8	3332
5760 min Winter	1.655	0.0	693.9	4272
7200 min Winter	1.411	0.0	717.7	5192
8640 min Winter	1.238	0.0	693.9	6136
10080 min Winter	1.108	0.0	666.9	7056

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	18.600	Shortest Storm (mins)	15
Ratio R	0.270	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.520

Time (mins) From:	To:	Area (ha)
0	4	0.520

1	
Date 31/05/2018 18:44	Designed by
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Model Details

Storage is Offline Dividing Weir Level (m) 102.100
Cover Level (m) 104.250

Cellular Storage Structure

Invert Level (m) 102.100 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.65
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	567.0	567.0	1.200	0.0	689.1
1.100	567.0	689.1			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0053-1700-1830-1700
Design Head (m)	1.830
Design Flow (l/s)	1.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	53
Invert Level (m)	102.070
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.830	1.7	Kick-Flo®	0.475	0.9
Flush-Flo™	0.235	1.1	Mean Flow over Head Range	-	1.3

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.0	1.200	1.4	3.000	2.1	7.000	3.2
0.200	1.1	1.400	1.5	3.500	2.3	7.500	3.3
0.300	1.1	1.600	1.6	4.000	2.4	8.000	3.4
0.400	1.1	1.800	1.7	4.500	2.6	8.500	3.5
0.500	0.9	2.000	1.8	5.000	2.7	9.000	3.5
0.600	1.0	2.200	1.8	5.500	2.8	9.500	3.6
0.800	1.2	2.400	1.9	6.000	2.9		
1.000	1.3	2.600	2.0	6.500	3.0		

STORMTECH Stormwater Management System Design Tool

ver: Jun 14

PROJECT REF:	Cookstown Phase 2
LOCATION:	Site A
DATE:	12/02/2018
CREATED BY:	Peter Clarke

Instructions:
- Fill in blue highlighted cells
- Set width to maximum allowance
- Adjust site parameters and system dimension until volume achieved
- For Rectangular systems only, for irregular shape dig contact Microstrain

SYSTEM PARAMETERS

Required Total Storage	388	m^3
Stormtech chamber model	SC740	
Number of Isolator Rows for TSS Removal	1	

SITE PARAMETERS

Maximum Width at Excavation Base	13.5	m	
Stone Porosity	40%		
Excavation Batter Angle (degrees)	60	°	*Minimum Requirement*
Stone Below Chambers	0.15	m	*0.15*
Stone Above Chambers	0.15	m	*0.15*
Additional Storage. E.g manholes, pipe	0	m^3	

CALCULATED CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows	9		ea
Number of units per Row	19		ea
Number of SC740 Chambers	171		ea
Number of SC740 Endcaps	18		ea
System Installed Storage Depth (effective storage depth)	1.060		m
Tank overall installed Width at base	13.46	13.46	m
Tank overall installed Length at Base	41.93	42	m
Total Effective System Storage	**388.4**	**388.9**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	SC740	
Unit Width	1.295	m
Unit Length	2.17	m
Unit Height	0.76	m
Min Cover Over System	0.3	m
Max Cover Over Chamber	2.4	m
Internal Storage Vol. (Chamber only)	1.3	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	636	
Area of Dig at Base of System	565	m^2
Area of Dig at Top of System	635	m^2
Void Ratio	61%	
Stone Requirement - tonne	676	tonne

StormTech
Detension • Retention • Recharge
Subsurface Stormwater Management™

APPENDIX C

Foul Sewer Loading Calculations

PROJECT TITLE: Cookstown Cross **JOB REFERENCE:** 1606

SUBJECT
Wastewater Load for Irish Water

DRAWING NO. 1605-C-100 **CALCULATIONS BY** **CHECKED BY** **DATE**

gdcl CONSULTING ENGINEERS

POST DEVELOPMENT DEMAND

Wastewater flow per head[1]	150	litres	Unit Consumption Allowance[3]	10	%
Average Occupancy Ratio[2]	2.7	person/3 bed unit	DWF Peak Factor[4]	6	

Residential Unit Type	4 Bed	2 Bed (4p)	2 Bed (3p)	1 Bed	Studio
Average Occupancy(persons)	5	4	3	1	1
Number of Units	0	0	135	62	78
Average Occupancy[5] (PE)	0	0	405	62	78

Residential Dry Weather Flow(DWF) Volume[5] **89,925** litres

Commercial Unit Type	Shopping	Commercial	Pub/ Restaurant	Leisure/ Gym	Medical/ Care Home	Creche
Average Occupancy (per m2)	18	25	5	5	20	20
Area(m2)	0	255	0	255	0	0
Average Occupancy[5] (PE)	0	10	0	51	0	0
Average Usage(litres per person/day)[9]	25	100	60	50	350	60
Daily Usage(l)	0	1020	0	2550	0	0

Commercial Dry Weather Flow(DWF) Volume[5] **3,570** litres

WASTEWATER LOADING SUMMARY

	Residential	Commercial	Total
Average Daily Discharge	1.04 l/s	0.04 l/s	1.08 l/s
Peak Discharge[6]	6.24 l/s	0.25 l/s	6.49 l/s

ORGANIC LOADING

EPA Wastewater Parameters Loading Concentrations		Residential Organic Loading		Commercial Organic Loading		Total Organic Loading	
Average Concentration[7]	Max Concentration[8]	Average Conc[7]	Max Conc[8]	Average Conc[7]	Max Conc[8]	Average Conc[7]	Max Conc[8]
BOD(mg/l)		BOD(kg/day)		BOD(kg/day)		BOD(kg/day)	
168.0	422.0	15.11	37.95	0.60	1.51	15.71	39.45
SS (mg/l)		SS (kg/day)		SS (kg/day)		SS (kg/day)	
163.0	435.0	14.66	39.12	0.58	1.55	15.24	40.67
N (mg/l)		N (kg/day)		N (kg/day)		N (kg/day)	
40.6	78.6	3.65	7.07	0.14	0.28	3.80	7.35
P (mg/l)		P (kg/day)		P (kg/day)		P (kg/day)	
7.1	15.5	0.64	1.39	0.03	0.06	0.66	1.45

Notes:

1. Waste Water flow - 150 l/head as per Irish Water Code of Practice - (3.6)
2. Average Occupancy ratio of 2.7 persons per dwelling from Irish Water Code of Practice - (3.6)
3. 10% Unit Consumption Allowance as per Irish Water Code of Practice - (3.6.3)
4. DWF Peak Factor is 6 as per Irish Water Code of Practice - (3.6)
5. Dry Weather Flow = No. of Residential Units X Average Occupancy Ratio X Waste Water Flow X UCA[3]
6. Peak Discharge = Average Daily Discharge X DWF Peak Factor
7. The average concentrations of wastewater parameters taken from EPA "Wastewater Treatment Manuals, Treatment Systems for Small Communities, Business, Leisure Centres and Hotels".
8. Assumed Maximum concentration is equal to the average concentration plus 2 times the standard deviation (for the 95%ile) taken from EPA "Wastewater Treatment Manuals, Treatment Systems for Small Communities, Business, Leisure Centres and Hotels".

APPENDIX D

Water Demand Calculations

PROJECT TITLE: Cookstown Cross JOB REFERENCE: 1606

SUBJECT
Water Demand for Irish Water

gdcl CONSULTING ENGINEERS

DRAWING NO. CALCULATIONS BY CHECKED BY DATE
1606-C-100

POST DEVELOPMENT DEMAND

Per-Capita Consumption[1] 150 litres/person/day

Average Occupancy Ratio[2] 2.7 person/3 bed unit

Residential Unit Type	4 Bed	2 Bed (4p)	2 Bed (3p)	1 Bed	Studio
Average Occupancy(persons)	5	4	3	1	1
Number of Units	0	0	135	62	78
Average Occupancy[5] (PE)	0	0	405	62	78

Average Residential Demand[6] 81,750 l/day

Commercial Unit Type	Shopping	Commercial	Pub/ Restaurant	Leisure/ Gym	Medical/ Care Home	Creche
Average Occupancy (per m2)	18	25	5	5	20	20
Area(m2)	0	255	0	255	0	0
Average Occupancy[6] (PE)	0	10	0	51	0	0
Average Usage(litres per person/day)	25	100	60	50	350	60
Daily Usage(/)	0	1020	0	2550	0	0

Average Commercial Demand[6] 3,570 l/day

Average Day/Week Demand Factor[3] 1.25

Peak Demand Factor[4] 5

WATER DEMAND SUMMARY

	Residential	Commercial	Total
Average Daily Demand	0.95 l/s	0.04 l/s	0.99 l/s
Average Day/Peak Week Demand[7]	1.18 l/s	0.05 l/s	1.23 l/s
Peak Hour Water Demand[8]	5.914 l/s	0.258 l/s	6.172 l/s

Notes:

1. Per-Capita Consumption 150l/person/day as per Irish Water Code of Practice - (3.7.2)
2. Average Occupancy ratio of 2.7 persons per dwelling from Irish Water Code of Practice - (3.7.2)
3. Average Day/Week Demand Factor is 1.25 as per Irish Water Code of Practice - (3.7.2)
4. Peak Demand Factor is 5 as per Irish Water Code of Practice - (3.7.2)
5. Average Occupancy(or PE-Population Equivalent) = No. of Residential Units X Average Occupancy Ratio
6. Average Domestic Demand = Average Occupancy X Per-Capita Consumption
7. Average Day/Peak Week Demand = Average Daily Domestic Demand X Average Day/Week Demand Factor
8. Peak Hour Water Demand = Average Occupancy X Per-Capita Consumption X Average Day/Week Demand Factor X Peak Demand Factor