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ENGINEERING SUBMISSION

PROJECT: COOKSTOWN CASTLE, COOKSTOWN INDUSTRIAL ESTATE

REPORT TITLE: ENGINEERING SERVICES REPORT

STATUS: PLANNING PERMISSION

CLIENT: JOSEPH COSTELLO, ABSOLUTE LIMOUSINES LTD AND BOHERKILL PROPERTY DEVELOPMENT 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 Please replace all superseded pages of this document with current version.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	
PP	19 Dec 2019	Pre-Planning Submission to ABP	PTC	GD		
PP1	14 Dec 2020	Planning Submission	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 lands west of Old Belgard Road and north, south and west of Cookstown Road, Cookstown Industrial Estate, Tallaght, Dublin 24. The development site is located at the intersection of Cookstown Road and First Avenue, extending to the intersection of Cookstown Road and the Old Belgard Road, Cookstown Industrial Estate, Dublin 24. The proposed development comprises 4 blocks, with Block A located immediately to the north of Cookstown Road and Blocks B, C and D located immediately to the south of Cookstown Road.

Block A, has an area of circa 0.81ha and **Blocks B, C & D** have a combined area of circa 4.98Ha. The development is located approximately 750m northeast of Tallaght Hospital.

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

Figure 1 – Site Location Map

Block A is relatively flat and is bounded to the south by Cookstown Road, and to the east, north and west by industrial units. The **Block B, C & D precinct** falls from west to east at a grade of 1:100. The proposed development 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 1104 multi-level apartment units with an undercroft 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 designed 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

For each of the blocks within the development, surface water attenuation system will be provided using an off-line a Stormtech SC740 attenuation system for Block A and MC3500 attenuation system for Blocks B, C & D. The attenuation facilities will be located within the courtyard/surface parking areas for Blocks B, C & D and within the undercroft footprint, below the parking area of the proposed development for Block A. For maintenance purposes, the attenuation tank will be accessed via lids to be located within the courtyard/surface parking and undercroft areas.

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

Block A Attenuation Volume = 439m^3
Block B Attenuation Volume = 743m^3
Block C Attenuation Volume = 562m^3
Block D Attenuation Volume = 540m^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 80% impermeable. Permeable paving areas are assumed to be 50% 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.

The individual catchment characteristics outlining Effective Contributing Impermeable Areas used in the attenuation calculations are as follows:

Block A - Catchment Characteristics			
Cookstown Phase - Block A	**Area (m^2)**	**Runoff Coeff.**	**Effective Area (m^2)**
Roofs - Type 1 (Draining to gullies)	2,240	1.00	2240.0
Roofs - Type 2 (Draining to SUDS features)	-	0.70	0.0
Roofs - Type 3 (Draining to Back Gardens)	-	0.00	0.0
Green Roofs	1,520	0.70	1064.0
Grass over Basements/Podiums	770	0.70	539.0
Roads and Footpaths - Type 1 (Draining to gullies)	1,905	0.80	1524.0
Roads and Footpaths - Type 2 (Draining to Suds features)	-	0.70	0.0
Permeable Paving	-	0.50	0.0
Gardens	-	0.15	0.0
Verges	2,450	0.15	367.5
Parks	-	0.15	0.0
Public Open Space	-	0.05	0.0

Impermeable Contributing Area **0.573** Hectares

Block B - Catchment Characteristics			
Cookstown Phase - Block B	**Area (m^2)**	**Runoff Coeff.**	**Effective Area (m^2)**
Roofs - Type 1 (Draining to gullies)	1,975	1.00	1975.0
Roofs - Type 2 (Draining to SUDS features)	-	0.70	0.0
Roofs - Type 3 (Draining to Back Gardens)	-	0.00	0.0
Green Roofs	3,525	0.70	2467.5
Grass over Basements/Podiums	750	0.70	525.0
Roads and Footpaths - Type 1 (Draining to gullies)	4,890	0.80	3912.0
Roads and Footpaths - Type 2 (Draining to Suds features)	-	0.70	0.0
Permeable Paving	-	0.50	0.0
Gardens	-	0.15	0.0
Verges	1,920	0.15	288.0
Parks	-	0.15	0.0
Public Open Space	-	0.05	0.0

Impermeable Contributing Area **0.917** Hectares

Block C - Catchment Characteristics			
Cookstown Phase - Block C	**Area (m^2)**	**Runoff Coeff.**	**Effective Area (m^2)**
Roofs - Type 1 (Draining to gullies)	2,990	1.00	2990.0
Roofs - Type 2 (Draining to SUDS features)	-	0.70	0.0
Roofs - Type 3 (Draining to Back Gardens)	-	0.00	0.0
Green Roofs	1,820	0.70	1274.0
Grass over Basements/Podiums	344	0.70	240.8
Roads and Footpaths - Type 1 (Draining to gullies)	2,636	0.80	2108.8
Roads and Footpaths - Type 2 (Draining to Suds features)	-	0.70	0.0
Permeable Paving	-	0.50	0.0
Gardens	-	0.15	0.0
Verges	2,410	0.15	361.5
Parks	-	0.15	0.0
Public Open Space	-	0.05	0.0

Impermeable Contributing Area **0.698** Hectares

Block D - Catchment Characteristics			
Cookstown Phase - Block D	**Area (m^2)**	**Runoff Coeff.**	**Effective Area (m^2)**
Roofs - Type 1 (Draining to gullies)	2,840	1.00	2840.0
Roofs - Type 2 (Draining to SUDS features)	-	0.70	0.0
Roofs - Type 3 (Draining to Back Gardens)	-	0.00	0.0
Green Roofs	1,840	0.70	1288.0
Grass over Basements/Podiums	350	0.70	245.0
Roads and Footpaths - Type 1 (Draining to gullies)	2,240	0.80	1792.0
Roads and Footpaths - Type 2 (Draining to Suds features)	-	0.70	0.0
Permeable Paving	1,230	0.50	615.0
Gardens	-	0.15	0.0
Verges		0.15	0.0
Parks	-	0.15	0.0
Public Open Space	-	0.05	0.0

Impermeable Contributing Area **0.678** Hectares

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).

The catchment areas and associated Qbar values are as follows, (see appendix for permissible discharge calculations):

Block A : Area = 0.81hectares, Qbar = 1.7l/s

Block B : Area = 1.31hectares, Qbar = 2.7l/s

Block C : Area = 0.82hectares, Qbar = 1.7l/s

Block D : Area = 1.09hectares, Qbar = 2.3l/s

It should be noted that the existing development is a brownfield site which currently does 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:

Interception storage required = 28657m^{2}x 0.8 x 0.005 = 115m^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%.

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:

Treatment storage required = 28657ha x 0.8 x 0.015 = 344m^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 treatment storage.

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.

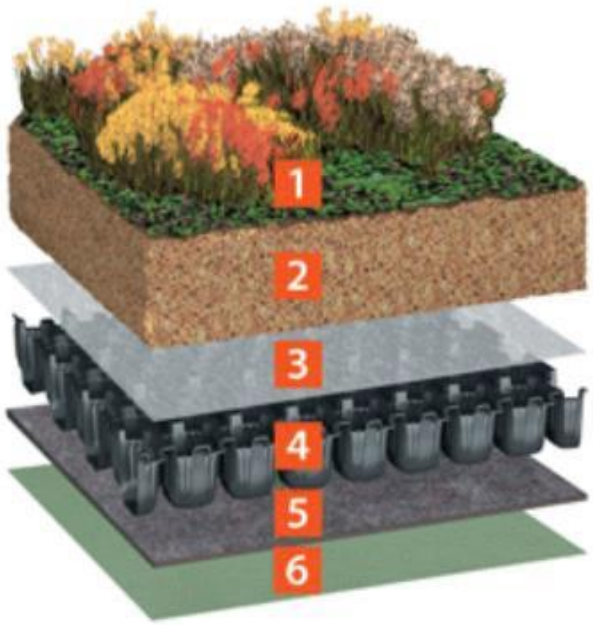


Figure 2 –Typical Extensive Green Roof

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 will be located within the courtyard/surface parking and undercroft areas of the individual catchments.

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 additional roof and podium slab gullies draining via downpipes and pipe slung to the underside of the ground floor slab before discharging into the attenuation facility allocated to each block.

Flows from the attenuation tanks will be throttled at greenfield runoff rates before discharging into the existing surface water network.

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

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 300mm diameter foul sewer in running in an easterly direction along the footpath for Cookstown Road. Block A foul drainage will discharge to this foul sewer.

There is an existing 450mm diameter foul sewer currently located within the existing access lane currently the south of the existing warehouse where proposed Blocks C & D will be located. Proposed flows for Blocks B, C and D will discharge to this sewer.

Where applicable, foul flows from the development would be slung under the podium slab and would connect to the proposed gravity sewers.

There is an existing 300mm diameter foul sewer in running in a southerly direction from Cookstown road to the existing 450mm diameter foul sewer located within the existing access lane south of the existing warehouse where proposed Blocks C & D will be located. It is proposed to relocate this foul sewer under the proposed located between proposed Blocks B and C.

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) and Irish Water requirements.

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 is estimated at 26.1l/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.

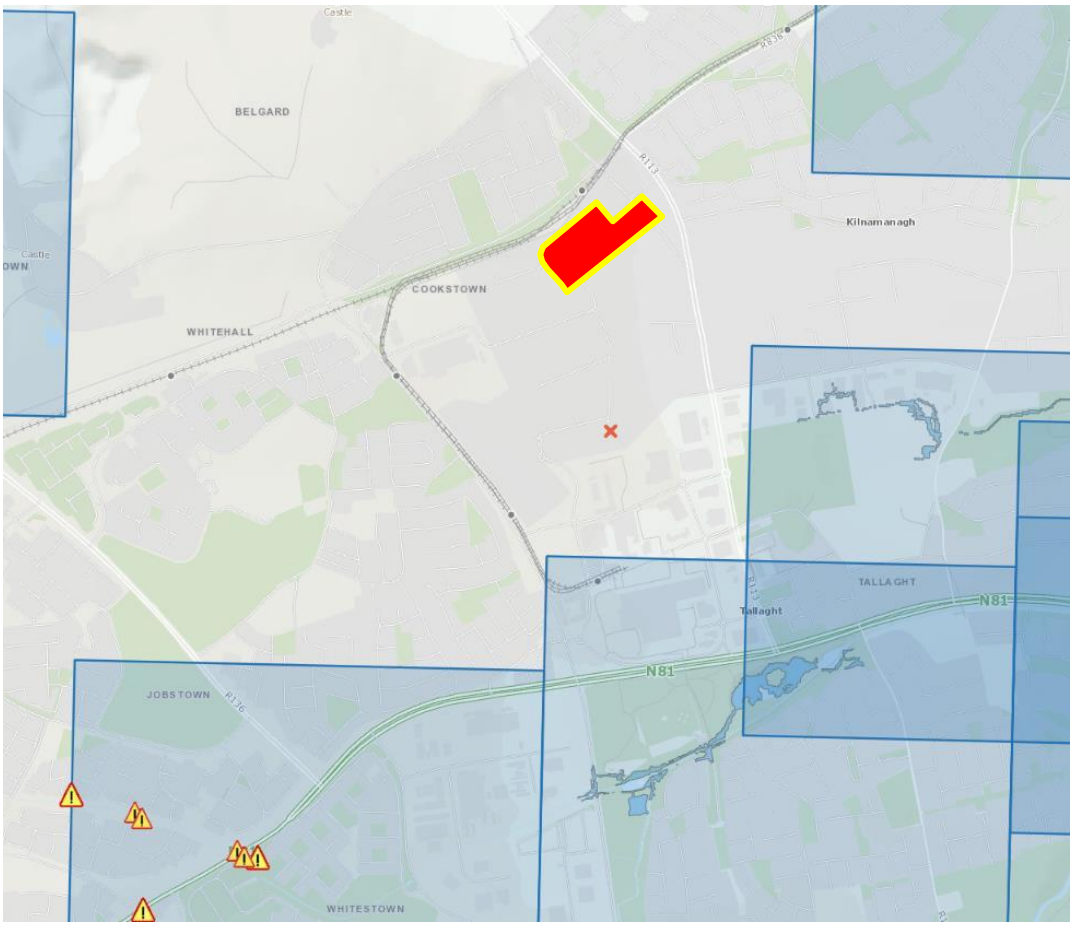
Sewers and drains shall be laid to comply with the requirements of the Building Regulations 1997 in accordance with the recommendations contained in the Technical Guidance Documents, Section H (revised 2005) and Irish Water.

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

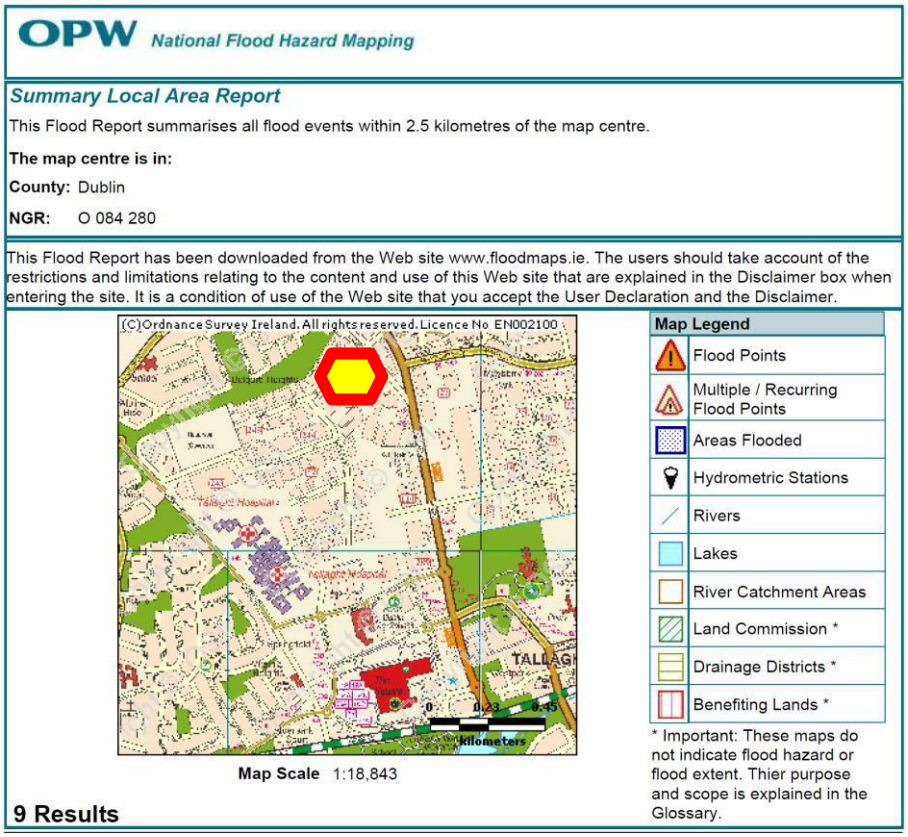
8.0 FLOOD RISK

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

Block A will be serviced by a proposed 150mm diameter watermain which connects to the existing 150mm diameter watermain located in the Cookstown Road footpath**.**

Blocks B, C and D will be serviced by a proposed 150mm diameter ring watermain with individual connections to the existing 150mm diameter watermain located in the Cookstown Estate Road footpath**,** to the west of Block B.

These proposed watermains in turn will connect to a water booster and balancing system to be located in the plant room located on the ground floor/undercroft area 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 fire main will be provided within the carparking area of the development, below 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.

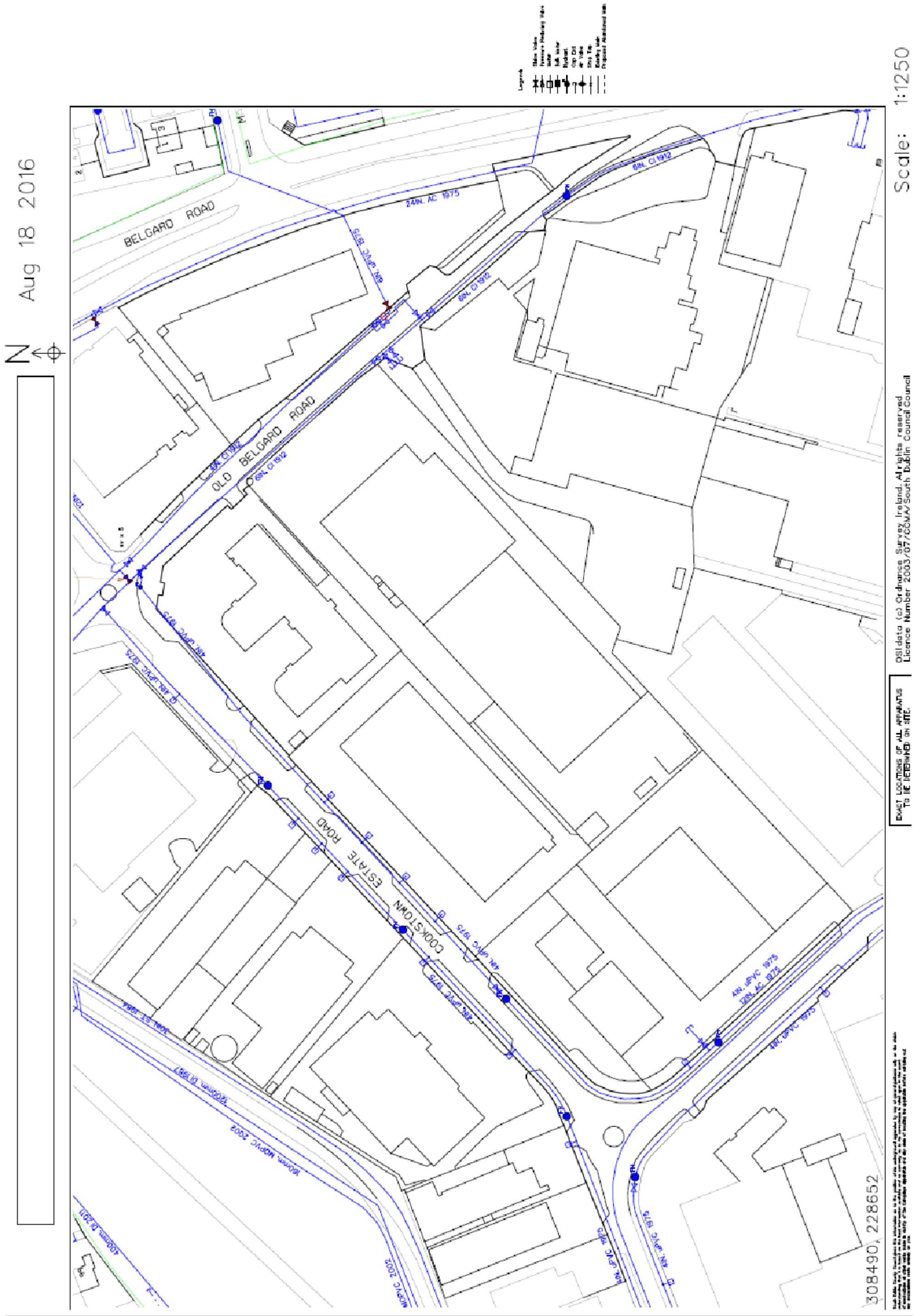
Bulk water meters will be provided at the connection to the site from the existing watermains. This electromagnetic flow meter will include a remote telemetry unit and associated mini kiosk, to the requirements of SDCC Water Management Section and Irish Water.

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 23.3l/s.

Refer to appendices for watermain and water supply calculations.

APPENDIX A

Water Services Records


Aug 18 2016
BELGARD ROAD
OLD BELGARD ROAD
COOKSTOWN ESTATE ROAD
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308490, 228652
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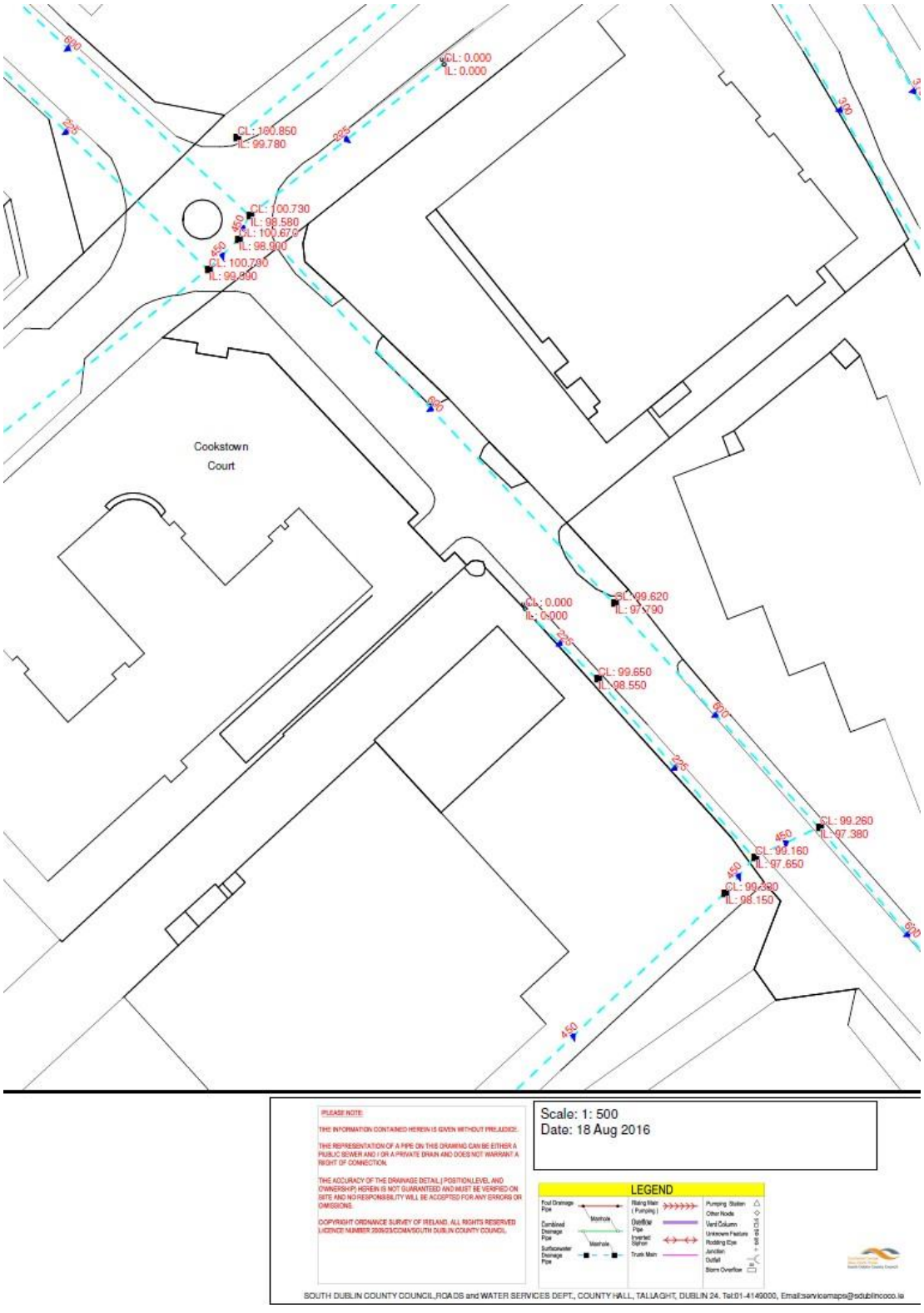
EXACT LOCATIONS OF ALL APPARATUS TO BE DETERMINED ON SITE.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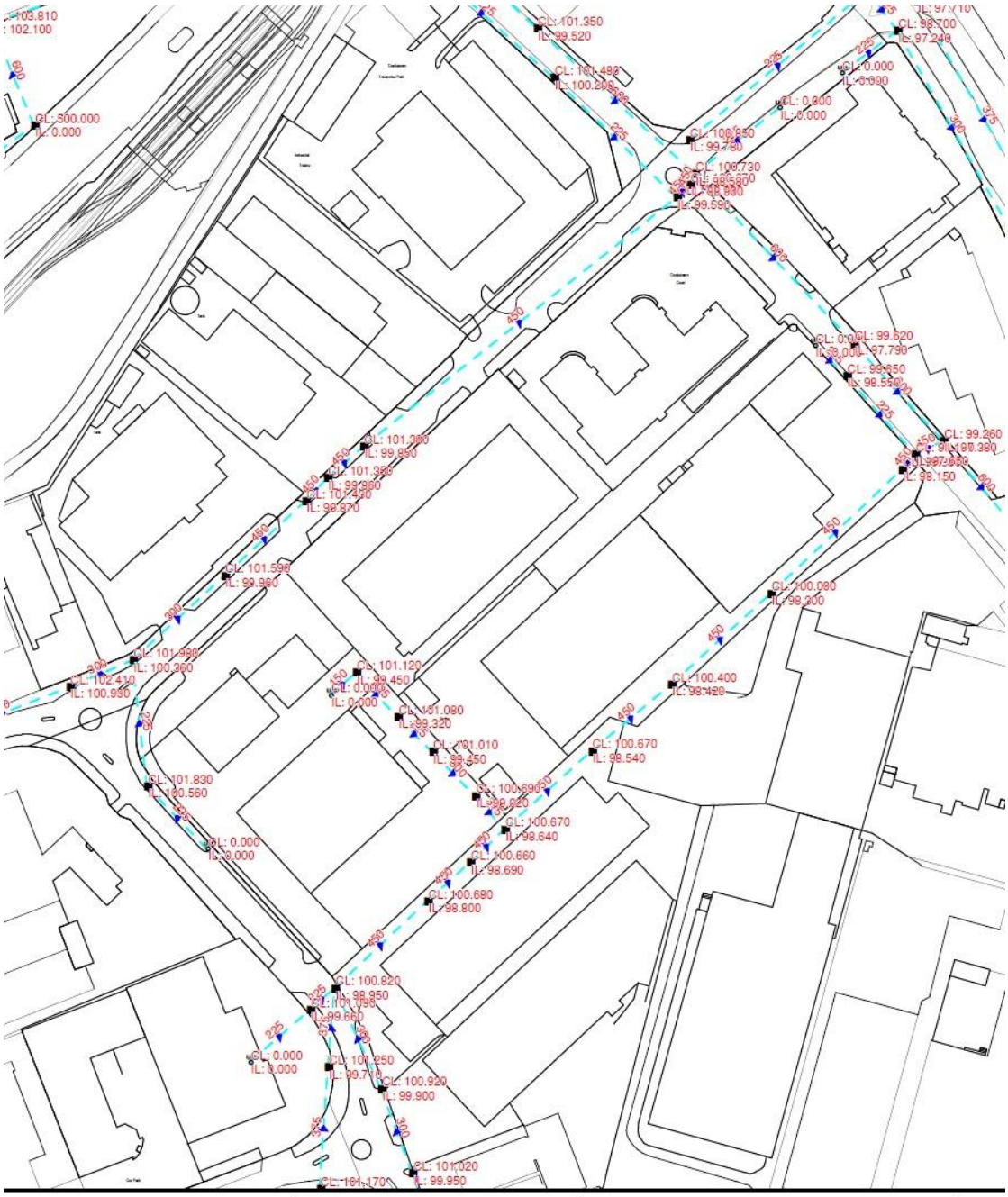
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LEGEND
Foul Drainage Pipe
Manhole
Combined Drainage Pipe
Manhole
Surfacewater Drainage Pipe
Rising Main (Pumping)
Overflow Pipe
Inverted Siphon
Trunk Main
Pumping Station
Other Node
Vent Column
Unknown Feature
Rodding Eye
Junction
Outfall
Storm Overflow
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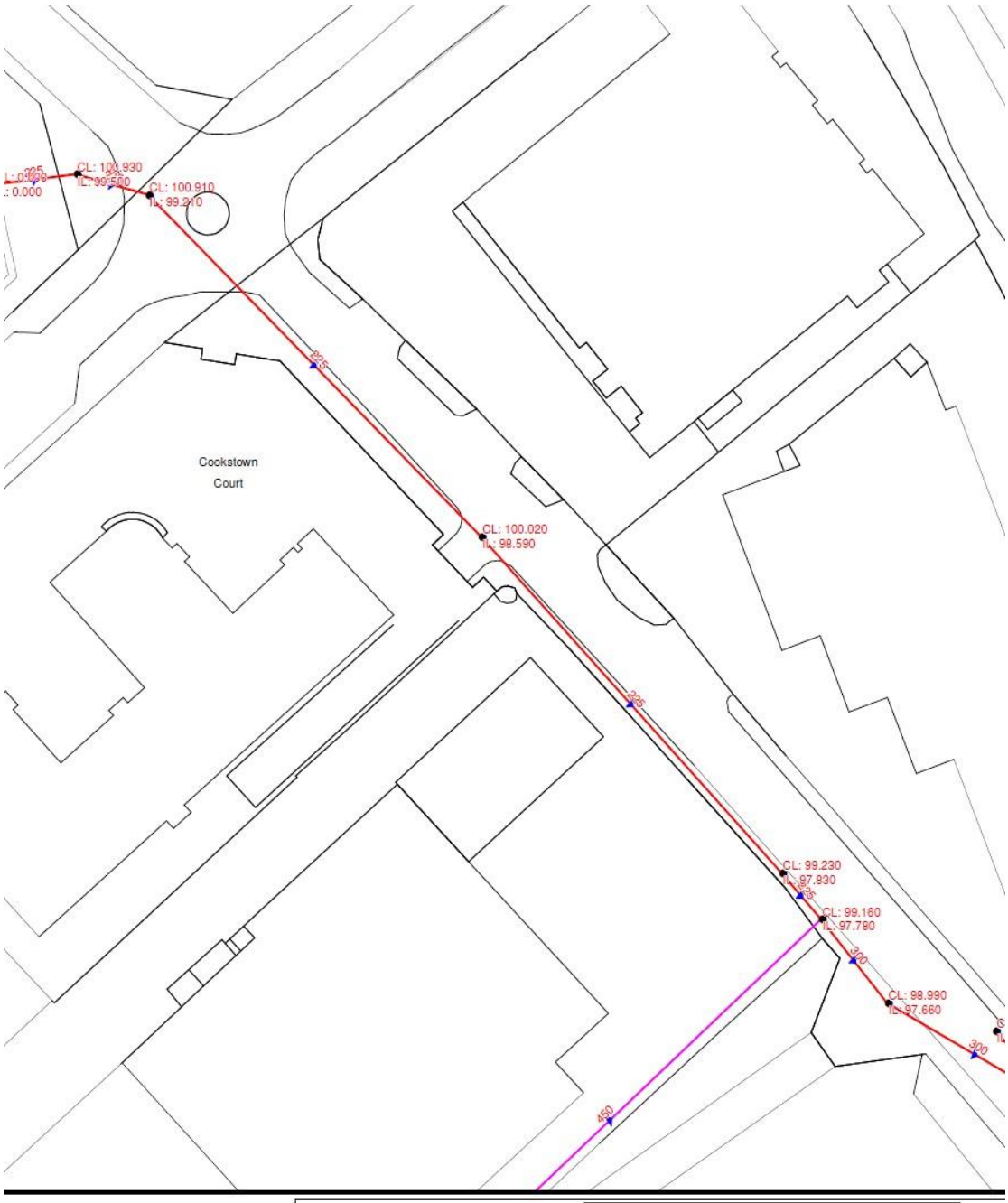

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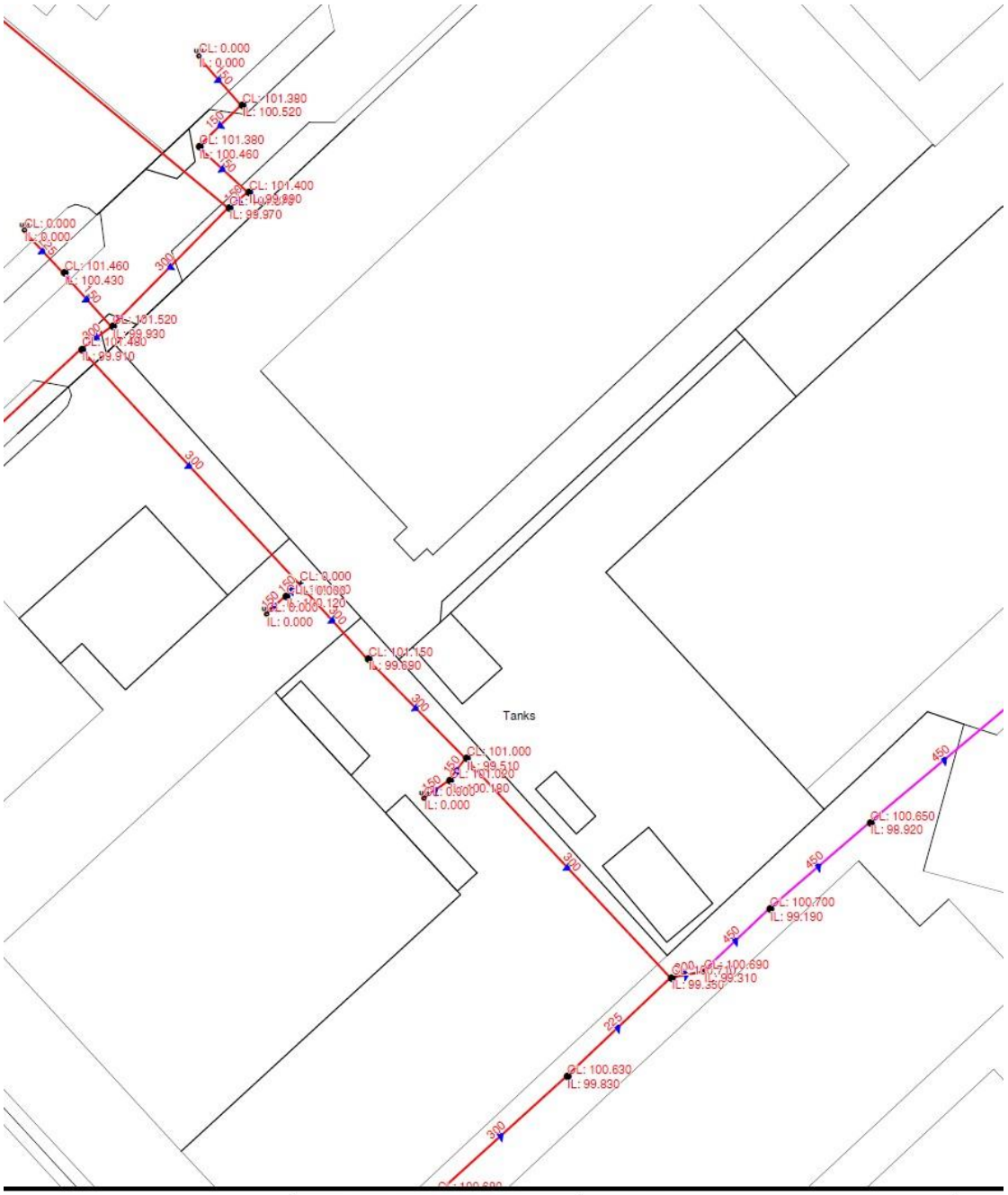

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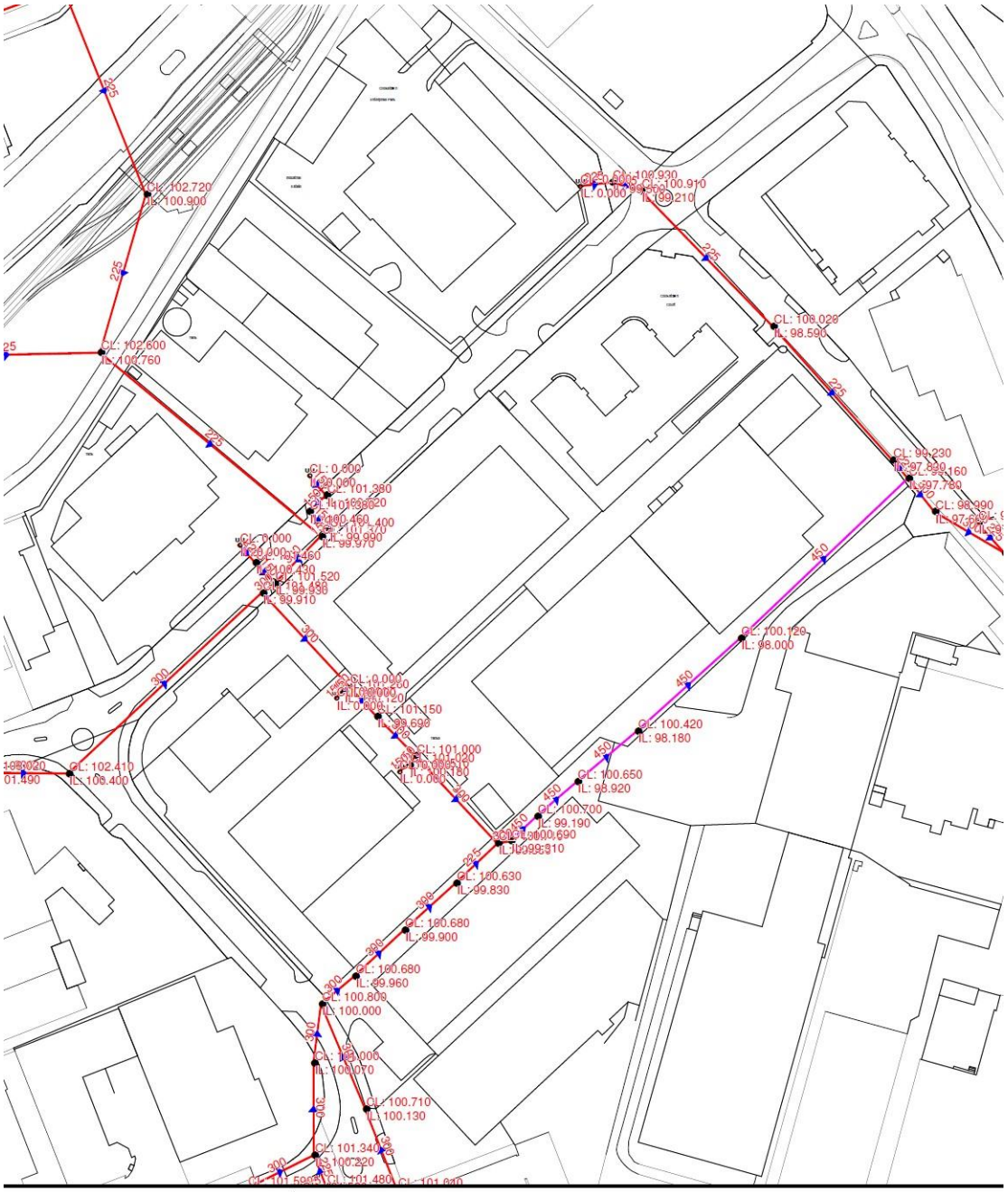

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Outfall
Storm Overflow

SOUTH DUBLIN COUNTY COUNCIL,ROADS and WATER SERVICES DEPT., COUNTY HALL, TALLAGHT, DUBLIN 24. Tel:01-4149000, Email:servicemaps@sdublincoco.ie

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

Qbar Calculation
Using IOH Report 124 for Sites < 25 km²

Catchment Name
Cookstown Phase - Block A

[1] $Q_{bar} = 0.00108 * (AREA)^{0.89} (SAAR)^{1.17} (SOIL)^{2.17}$ — **Estimation of QBAR from IOH Report 124 for catchments less than 25 km² using the 3 variable equation**

AREA =	0.89	Ha	Overall Catchment Area (Hectares) For catchments < 50 hectares in area, flow rates are linearly interpolated for smaller areas.
AREA =	0.009	km^2	Area of the Catchment (km^2)
SAAR =	782	mm	Standard Annual Average Rainfall (mm)
SOIL =	0.30		
$M5_{60}$	18.2	mm	
$M5_{2day}$	67.6	mm	
Ratio $M5_{60}/M5_{2d}$	0.269		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 .

Soil Type Expressed as a Percentage	Soil 1	Soil 2	Soil 3	Soil 4	Soil 5
	0	100	0	0	0
SOIL Value	0.15	0.30	0.40	0.45	0.50

Flood Return Event	[5] Growth Factor	Permitted Flow (l/s)
1	0.85	1.6
QBAR	1	1.8
10	1.67	3.1
30	2.1	3.9
50	2.33	4.3
100	2.6	4.8
200	2.85	5.3
1000	3.5	6.5

[4] QBar from Site with Factorial Error Allowance

r^2 =	0.847
n =	71
fse =	1.651

Q'_{bar} = 3.04 l/s
(With Allowance for the standard factorial error)

Pro-rata based on 50 Ha Site area to calculate Qbar

Q_{bar} =	0.00004	cumecs/Ha
Q_{bar} =	2.1	l/s/Ha

$Q_{bar[rural]}$ = 1.8 l/s

Block A - Catchment Characteristics

Cookstown Phase - Block A	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)	2,240	1.00	2240.0
Roofs - Type 2 (Draining to SUDS features)	-	0.70	0.0
Roofs - Type 3 (Draining to Back Gardens)	-	0.00	0.0
Green Roofs	1,520	0.70	1064.0
Grass over Basements/Podiums	770	0.70	539.0
Roads and Footpaths - Type 1 (Draining to gullies)	1,905	0.80	1524.0
Roads and Footpaths - Type 2 (Draining to Suds features)	-	0.70	0.0
Permeable Paving	-	0.50	0.0
Gardens	-	0.15	0.0
Verges	2,450	0.15	367.5
Parks	-	0.15	0.0
Public Open Space	-	0.05	0.0

Impermeable Contributing Area **0.573** Hectares

Effective Catchment Runoff Coefficient **0.65**

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Innovyze	Source Control 2018.1

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

Half Drain Time : 1724 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	99.274	0.274	0.1	1.6	1.7	92.1	O K
30 min Summer	99.376	0.376	0.2	1.6	1.7	126.2	O K
60 min Summer	99.482	0.482	0.2	1.6	1.7	161.9	O K
120 min Summer	99.597	0.597	0.2	1.6	1.7	200.5	O K
180 min Summer	99.666	0.666	0.2	1.6	1.7	223.9	O K
240 min Summer	99.716	0.716	0.2	1.6	1.7	240.5	O K
360 min Summer	99.783	0.783	0.2	1.6	1.8	263.2	O K
480 min Summer	99.827	0.827	0.2	1.6	1.8	278.0	O K
600 min Summer	99.858	0.858	0.2	1.6	1.8	288.2	O K
720 min Summer	99.879	0.879	0.2	1.7	1.8	295.4	O K
960 min Summer	99.904	0.904	0.2	1.7	1.8	303.8	O K
1440 min Summer	99.915	0.915	0.2	1.7	1.9	307.5	O K
2160 min Summer	99.906	0.906	0.2	1.7	1.9	304.6	O K
2880 min Summer	99.893	0.893	0.2	1.7	1.8	300.2	O K
4320 min Summer	99.863	0.863	0.2	1.7	1.8	290.0	O K
5760 min Summer	99.827	0.827	0.2	1.6	1.8	277.9	O K
7200 min Summer	99.788	0.788	0.2	1.6	1.8	265.0	O K
8640 min Summer	99.748	0.748	0.2	1.6	1.7	251.5	O K
10080 min Summer	99.708	0.708	0.2	1.6	1.7	238.0	O K
15 min Winter	99.308	0.308	0.1	1.6	1.7	103.4	O K
30 min Winter	99.422	0.422	0.2	1.6	1.7	141.8	O K
60 min Winter	99.542	0.542	0.2	1.6	1.7	182.1	O K
120 min Winter	99.672	0.672	0.2	1.6	1.7	225.9	O K
180 min Winter	99.752	0.752	0.2	1.6	1.7	252.9	O K
240 min Winter	99.810	0.810	0.2	1.6	1.8	272.2	O K
360 min Winter	99.890	0.890	0.2	1.7	1.8	299.0	O K
480 min Winter	99.943	0.943	0.2	1.7	1.9	317.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	87.395	0.0	93.7	19
30 min Summer	60.231	0.0	129.3	34
60 min Summer	39.049	0.0	167.6	64
120 min Summer	24.673	0.0	211.9	124
180 min Summer	18.722	0.0	241.1	184
240 min Summer	15.356	0.0	263.8	242
360 min Summer	11.587	0.0	282.9	362
480 min Summer	9.477	0.0	283.8	482
600 min Summer	8.105	0.0	284.0	602
720 min Summer	7.131	0.0	284.2	722
960 min Summer	5.827	0.0	284.8	960
1440 min Summer	4.380	0.0	288.7	1342
2160 min Summer	3.287	0.0	508.4	1708
2880 min Summer	2.679	0.0	552.3	2104
4320 min Summer	2.005	0.0	524.1	2940
5760 min Summer	1.632	0.0	673.2	3752
7200 min Summer	1.391	0.0	717.2	4608
8640 min Summer	1.221	0.0	755.3	5448
10080 min Summer	1.093	0.0	789.1	6256
15 min Winter	87.395	0.0	105.0	19
30 min Winter	60.231	0.0	143.6	33
60 min Winter	39.049	0.0	187.8	64
120 min Winter	24.673	0.0	237.3	122
180 min Winter	18.722	0.0	270.2	180
240 min Winter	15.356	0.0	283.3	240
360 min Winter	11.587	0.0	285.4	356
480 min Winter	9.477	0.0	286.5	474

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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 Σ Outflow (l/s)	Max Volume (m³)	Status
600 min Winter	99.982	0.982	0.2	1.7	1.9	330.0	O K
720 min Winter	100.010	1.010	0.2	1.8	1.9	339.5	O K
960 min Winter	100.047	1.047	0.2	1.8	2.0	352.0	O K
1440 min Winter	100.076	1.076	0.2	1.8	2.0	361.7	O K
2160 min Winter	100.066	1.066	0.2	1.8	2.0	358.3	O K
2880 min Winter	100.048	1.048	0.2	1.8	2.0	352.2	O K
4320 min Winter	99.995	0.995	0.2	1.8	1.9	334.3	O K
5760 min Winter	99.935	0.935	0.2	1.7	1.9	314.1	O K
7200 min Winter	99.870	0.870	0.2	1.7	1.8	292.5	O K
8640 min Winter	99.805	0.805	0.2	1.6	1.8	270.5	O K
10080 min Winter	99.740	0.740	0.2	1.6	1.7	248.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
600 min Winter	8.105	0.0	287.9	590
720 min Winter	7.131	0.0	289.6	706
960 min Winter	5.827	0.0	294.4	932
1440 min Winter	4.380	0.0	302.0	1370
2160 min Winter	3.287	0.0	569.6	1796
2880 min Winter	2.679	0.0	577.5	2220
4320 min Winter	2.005	0.0	551.0	3156
5760 min Winter	1.632	0.0	753.6	4088
7200 min Winter	1.391	0.0	803.0	4976
8640 min Winter	1.221	0.0	845.6	5880
10080 min Winter	1.093	0.0	883.5	6752

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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)	18.200	Shortest Storm (mins)	15
Ratio R	0.269	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.573

Time (mins) From:	To:	Area (ha)
0	4	0.573

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Model Details

Storage is Offline Cover Level (m) 101.500 Dividing Weir Level (m) 99.000

Cellular Storage Structure

Invert Level (m) 99.000 Safety Factor 1.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.66
Infiltration Coefficient Side (m/hr) 0.00100

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	509.2	509.2	1.100	509.2	608.9	1.200	0.0	608.9

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0061-1800-1150-1800	Sump Available	Yes
Design Head (m)	1.150	Diameter (mm)	61
Design Flow (l/s)	1.8	Invert Level (m)	98.910
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	75
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.150	1.8	Kick-Flo®	0.550	1.3
Flush-Flo™	0.269	1.6	Mean Flow over Head Range	-	1.5

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)	Depth (m)	Flow (l/s)
0.100	1.4	0.800	1.5	2.000	2.3	4.000	3.2	7.000	4.1
0.200	1.6	1.000	1.7	2.200	2.4	4.500	3.4	7.500	4.3
0.300	1.6	1.200	1.8	2.400	2.5	5.000	3.5	8.000	4.4
0.400	1.5	1.400	2.0	2.600	2.6	5.500	3.7	8.500	4.5
0.500	1.4	1.600	2.1	3.000	2.8	6.000	3.9	9.000	4.7
0.600	1.3	1.800	2.2	3.500	3.0	6.500	4.0	9.500	4.8

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STORMTECH Stormwater Management System Design Tool

ver: Jun14

PROJECT REF:	Cookstown Phase 3
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	439	m^3
Stormtech chamber model	SC740	
Number of Isolator Rows for TSS Removal	1	

SITE PARAMETERS

Maximum Width at Excavation Base	19.24	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	13		ea
Number of units per Row	15		ea
Number of SC740 Chambers	195		ea
Number of SC740 Endcaps	26		ea
System Installed Storage Depth (effective storage depth)	1.060		m
Tank overall installed Width at base	19.24	19.24	m
Tank overall installed Length at Base	33.25	33.25	m
Total Effective System Storage	**438.9**	**438.9**	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	713	
Area of Dig at Base of System	640	m^2
Area of Dig at Top of System	705	m^2
Void Ratio	62%	
Stone Requirement - tonne	750	tonne

StormTech
Detention • Retention • Recharge
Subsurface Stormwater Management™

WARNING - Volume not enough, increase dig dimension or stone around chamber

Qbar Calculation
Using IOH Report 124 for Sites < 25 km²

Catchment Name
Cookstown Phase - Block B

$^1Q_{bar} = 0.00108 * (AREA)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$ — **Estimation of QBAR from IOH Report 124 for catchments less than 25 km² using the 3 variable equation**

AREA = 1.31 Ha — Overall Catchment Area (Hectares) For catchments < 50 hectares in area, flow rates are linearly interpolated for smaller areas.

AREA = 0.013 km^2 — Area of the Catchment (km^2)

SAAR = 782 mm — Standard Annual Average Rainfall (mm)

SOIL = 0.30

Soil Type Expressed as a Percentage	Soil 1	Soil 2	Soil 3	Soil 4	Soil 5
	0	100	0	0	0
SOIL Value	0.15	0.30	0.40	0.45	0.50

$M5_{60}$ = 18.2 mm

$M5_{2day}$ = 67.6 mm

Ratio $M5_{60}/M5_{2d}$ = 0.269

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 .

Flood Return Event	[5]Growth Factor	Permitted Flow (l/s)
1	0.85	2.3
QBAR	1	2.7
10	1.67	4.5
30	2.1	5.7
50	2.33	6.3
100	2.6	7.0
200	2.85	7.7
1000	3.5	9.5

[4]QBar from Site with Factorial Error Allowance

r^2 =	0.847
n =	71
fse =	1.651

Q'_{bar} = 4.47 l/s

(With Allowance for the standard factorial error)

Pro-rata based on 50 Ha Site area to calculate Qbar

Q_{bar} =	0.00004	cumecs/Ha

Q_{bar} =	2.1	l/s/Ha

$Q_{bar[rural]}$ = 2.7 l/s

Block B - Catchment Characteristics

Cookstown Phase - Block B	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)	1,975	1.00	1975.0
Roofs - Type 2 (Draining to SUDS features)	-	0.70	0.0
Roofs - Type 3 (Draining to Back Gardens)	-	0.00	0.0
Green Roofs	3,525	0.70	2467.5
Grass over Basements/Podiums	750	0.70	525.0
Roads and Footpaths - Type 1 (Draining to gullies)	4,890	0.80	3912.0
Roads and Footpaths - Type 2 (Draining to Suds features)	-	0.70	0.0
Permeable Paving	-	0.50	0.0
Gardens	-	0.15	0.0
Verges	1,920	0.15	288.0
Parks	-	0.15	0.0
Public Open Space	-	0.05	0.0

Impermeable Contributing Area: **0.917** Hectares

Effective Catchment Runoff Coefficient: **0.70**

Date 18/08/2020 09:20	Designed by
File Cookstown Phase 3	Checked by
Innovyze	Source Control 2018.1

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

Half Drain Time : 1867 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	99.245	0.245	0.1	2.7	2.8	148.1	O K
30 min Summer	99.336	0.336	0.1	2.7	2.8	203.0	O K
60 min Summer	99.431	0.431	0.1	2.7	2.8	260.5	O K
120 min Summer	99.534	0.534	0.1	2.7	2.8	323.2	O K
180 min Summer	99.599	0.599	0.1	2.7	2.8	362.3	O K
240 min Summer	99.646	0.646	0.1	2.7	2.8	390.9	O K
360 min Summer	99.713	0.713	0.1	2.7	2.8	431.4	O K
480 min Summer	99.758	0.758	0.1	2.7	2.8	458.7	O K
600 min Summer	99.791	0.791	0.1	2.7	2.8	478.3	O K
720 min Summer	99.815	0.815	0.1	2.7	2.8	493.0	O K
960 min Summer	99.847	0.847	0.1	2.7	2.8	512.5	O K
1440 min Summer	99.874	0.874	0.1	2.7	2.8	528.5	O K
2160 min Summer	99.877	0.877	0.1	2.7	2.8	530.7	O K
2880 min Summer	99.871	0.871	0.1	2.7	2.8	526.7	O K
4320 min Summer	99.846	0.846	0.1	2.7	2.8	511.4	O K
5760 min Summer	99.813	0.813	0.1	2.7	2.8	492.0	O K
7200 min Summer	99.778	0.778	0.1	2.7	2.8	470.5	O K
8640 min Summer	99.740	0.740	0.1	2.7	2.8	447.8	O K
10080 min Summer	99.700	0.700	0.1	2.7	2.8	423.6	O K
15 min Winter	99.275	0.275	0.1	2.7	2.8	166.1	O K
30 min Winter	99.377	0.377	0.1	2.7	2.8	227.8	O K
60 min Winter	99.484	0.484	0.1	2.7	2.8	292.5	O K
120 min Winter	99.602	0.602	0.1	2.7	2.8	364.1	O K
180 min Winter	99.676	0.676	0.1	2.7	2.8	409.2	O K
240 min Winter	99.731	0.731	0.1	2.7	2.8	441.9	O K
360 min Winter	99.807	0.807	0.1	2.7	2.8	488.1	O K
480 min Winter	99.860	0.860	0.1	2.7	2.8	519.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	87.395	0.0	148.1	19
30 min Summer	60.231	0.0	196.4	34
60 min Summer	39.049	0.0	268.3	64
120 min Summer	24.673	0.0	339.1	124
180 min Summer	18.722	0.0	383.7	184
240 min Summer	15.356	0.0	413.9	242
360 min Summer	11.587	0.0	443.0	362
480 min Summer	9.477	0.0	443.7	482
600 min Summer	8.105	0.0	439.5	602
720 min Summer	7.131	0.0	434.4	722
960 min Summer	5.827	0.0	424.9	962
1440 min Summer	4.380	0.0	409.9	1440
2160 min Summer	3.287	0.0	807.3	1812
2880 min Summer	2.679	0.0	834.8	2192
4320 min Summer	2.005	0.0	773.4	3024
5760 min Summer	1.632	0.0	1077.2	3864
7200 min Summer	1.391	0.0	1147.5	4688
8640 min Summer	1.221	0.0	1208.5	5536
10080 min Summer	1.093	0.0	1262.7	6360
15 min Winter	87.395	0.0	164.2	19
30 min Winter	60.231	0.0	214.0	33
60 min Winter	39.049	0.0	300.5	64
120 min Winter	24.673	0.0	378.3	122
180 min Winter	18.722	0.0	421.6	180
240 min Winter	15.356	0.0	443.2	240
360 min Winter	11.587	0.0	446.5	358
480 min Winter	9.477	0.0	441.6	474

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Innovyze	Source Control 2018.1

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 Σ Outflow (l/s)	Max Volume (m³)	Status
600 min Winter	99.899	0.899	0.1	2.7	2.8	543.5	O K
720 min Winter	99.928	0.928	0.1	2.7	2.8	561.6	O K
960 min Winter	99.970	0.970	0.1	2.7	2.8	586.8	O K
1440 min Winter	100.011	1.011	0.1	2.7	2.8	611.7	O K
2160 min Winter	100.020	1.020	0.1	2.7	2.8	616.8	O K
2880 min Winter	100.007	1.007	0.1	2.7	2.8	609.3	O K
4320 min Winter	99.969	0.969	0.1	2.7	2.8	586.4	O K
5760 min Winter	99.917	0.917	0.1	2.7	2.8	554.7	O K
7200 min Winter	99.859	0.859	0.1	2.7	2.8	519.5	O K
8640 min Winter	99.798	0.798	0.1	2.7	2.8	482.5	O K
10080 min Winter	99.733	0.733	0.1	2.7	2.8	443.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
600 min Winter	8.105	0.0	436.7	590
720 min Winter	7.131	0.0	432.5	708
960 min Winter	5.827	0.0	426.3	934
1440 min Winter	4.380	0.0	422.3	1384
2160 min Winter	3.287	0.0	871.0	2012
2880 min Winter	2.679	0.0	857.4	2304
4320 min Winter	2.005	0.0	802.5	3240
5760 min Winter	1.632	0.0	1206.4	4152
7200 min Winter	1.391	0.0	1285.2	5112
8640 min Winter	1.221	0.0	1353.6	5968
10080 min Winter	1.093	0.0	1410.1	6864

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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)	18.200	Shortest Storm (mins)	15
Ratio R	0.269	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.917

Time (mins) From:	To:	Area (ha)
0	4	0.917

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Innovyze	Source Control 2018.1

Model Details

Storage is Offline Cover Level (m) 100.700 Dividing Weir Level (m) 99.000

Cellular Storage Structure

Invert Level (m) 99.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.65
Infiltration Coefficient Side (m/hr) 0.00100

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	930.6	930.6	1.100	930.6	1080.9	1.200	0.0	1080.9

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0077-2700-1080-2700	Sump Available	Yes
Design Head (m)	1.080	Diameter (mm)	77
Design Flow (l/s)	2.7	Invert Level (m)	98.980
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	100
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.080	2.7	Kick-Flo®	0.672	2.2
Flush-Flo™	0.330	2.7	Mean Flow over Head Range	-	2.4

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)	Depth (m)	Flow (l/s)
0.100	2.2	0.800	2.4	2.000	3.6	4.000	5.0	7.000	6.4
0.200	2.6	1.000	2.6	2.200	3.7	4.500	5.2	7.500	6.7
0.300	2.7	1.200	2.8	2.400	3.9	5.000	5.5	8.000	6.9
0.400	2.7	1.400	3.0	2.600	4.0	5.500	5.8	8.500	7.1
0.500	2.6	1.600	3.2	3.000	4.3	6.000	6.0	9.000	7.3
0.600	2.4	1.800	3.4	3.500	4.7	6.500	6.2	9.500	7.4

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STORMTECH Stormwater Management System Design Tool

ver: Jun14

PROJECT REF:	Cookstown Phase 3
LOCATION:	Site B
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	692	m^3
Stormtech chamber model	MC3500	
Number of Isolator Rows for TSS Removal	1	

SITE PARAMETERS

Maximum Width at Excavation Base	28.78	m	
Stone Porosity	40%		
Excavation Batter Angle (degrees)	60	°	*Minimum Requirement*
Stone Below Chambers	0.23	m	*0.23*
Stone Above Chambers	0.3	m	*0.30*
Additional Storage. E.g manholes, pipe	0	m^3	

CALCULATED CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows	13		ea
Number of units per Row	10		ea
Number of MC3500 Chambers	130		ea
Number of MC3500 Endcaps	26		ea
System Installed Storage Depth (effective storage depth)	1.675		m
Tank overall installed Width at base	28.78	28.78	m
Tank overall installed Length at Base	23.54	23.54	m
Total Effective System Storage	**742.4**	**742.5**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC3500	
Unit Width	1.955	m
Unit Length	2.18	m
Unit Height	1.145	m
Min Cover Over System	0.3	m
Max Cover Over Chamber	2.4	m
Internal Storage Vol. (Chamber only)	3.11	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	1223	
Area of Dig at Base of System	677	m^2
Area of Dig at Top of System	782	m^2
Void Ratio	61%	
Stone Requirement - tonne	1321	tonne

StormTech®
Detension • Retention • Recharge
Subsurface Stormwater Management™

Qbar Calculation
Using IOH Report 124 for Sites < 25 km²

Catchment Name
Cookstown Phase - Block C

$^1Q_{bar} = 0.00108 * (AREA)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$ — **Estimation of QBAR from IOH Report 124 for catchments less than 25 km² using the 3 variable equation**

AREA =	1.02	Ha	Overall Catchment Area (Hectares) For catchments < 50 hectares in area, flow rates are linearly interpolated for smaller areas.
AREA =	0.010	km^2	Area of the Catchment (km^2)
SAAR =	782	mm	Standard Annual Average Rainfall (mm)
SOIL =	0.30		
$M5_{60}$	18.2	mm	
$M5_{2day}$	67.6	mm	
Ratio $M5_{60}/M5_{2d}$	0.269		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 .

Soil Type Expressed as a Percentage	Soil 1	Soil 2	Soil 3	Soil 4	Soil 5
	0	100	0	0	0
SOIL Value	0.15	0.30	0.40	0.45	0.50

Flood Return Event	^{5}Growth Factor	Permitted Flow (l/s)
1	0.85	1.8
QBAR	1	2.1
10	1.67	3.5
30	2.1	4.4
50	2.33	4.9
100	2.6	5.5
200	2.85	6.0
1000	3.5	7.4

^{4}QBar from Site with Factorial Error Allowance

r^2 =	0.847
n =	71
fse =	1.651

Q'_{bar} = 3.49 l/s
(With Allowance for the standard factorial error)

Pro-rata based on 50 Ha Site area to calculate Qbar

Q_{bar} =	0.00004	cumecs/Ha

Q_{bar} =	2.1	l/s/Ha

$Q_{bar[rural]}$ = 2.1 l/s

Block C - Catchment Characteristics

Cookstown Phase - Block C	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)	2,990	1.00	2990.0
Roofs - Type 2 (Draining to SUDS features)	-	0.70	0.0
Roofs - Type 3 (Draining to Back Gardens)	-	0.00	0.0
Green Roofs	1,820	0.70	1274.0
Grass over Basements/Podiums	344	0.70	240.8
Roads and Footpaths - Type 1 (Draining to gullies)	2,636	0.80	2108.8
Roads and Footpaths - Type 2 (Draining to Suds features)	-	0.70	0.0
Permeable Paving	-	0.50	0.0
Gardens	-	0.15	0.0
Verges	2,410	0.15	361.5
Parks	-	0.15	0.0
Public Open Space	-	0.05	0.0

Impermeable Contributing Area **0.698** Hectares

Effective Catchment Runoff Coefficient **0.68**

Date 18/08/2020 09:30	Designed by
File Cookstown Phase 3	Checked by
Innovyze	Source Control 2018.1

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

Half Drain Time : 1546 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	99.225	0.425	0.1	1.9	2.0	112.3	O K
30 min Summer	99.383	0.583	0.1	1.9	2.0	154.0	O K
60 min Summer	99.547	0.747	0.1	1.9	2.0	197.4	O K
120 min Summer	99.723	0.923	0.1	2.0	2.1	244.0	O K
180 min Summer	99.830	1.030	0.1	2.1	2.2	272.2	O K
240 min Summer	99.906	1.106	0.1	2.1	2.3	292.2	O K
360 min Summer	100.008	1.208	0.1	2.2	2.3	319.2	O K
480 min Summer	100.074	1.274	0.1	2.3	2.4	336.7	O K
600 min Summer	100.118	1.318	0.1	2.3	2.4	348.5	O K
720 min Summer	100.149	1.349	0.1	2.3	2.5	356.5	O K
960 min Summer	100.183	1.383	0.1	2.3	2.5	365.4	O K
1440 min Summer	100.196	1.396	0.1	2.4	2.5	369.1	O K
2160 min Summer	100.185	1.385	0.1	2.3	2.5	366.0	O K
2880 min Summer	100.165	1.365	0.1	2.3	2.5	360.8	O K
4320 min Summer	100.117	1.317	0.1	2.3	2.4	348.0	O K
5760 min Summer	100.061	1.261	0.1	2.3	2.4	333.4	O K
7200 min Summer	100.002	1.202	0.1	2.2	2.3	317.7	O K
8640 min Summer	99.942	1.142	0.1	2.2	2.3	301.7	O K
10080 min Summer	99.882	1.082	0.1	2.1	2.2	286.0	O K
15 min Winter	99.277	0.477	0.1	1.9	2.0	126.1	O K
30 min Winter	99.454	0.654	0.1	1.9	2.0	172.9	O K
60 min Winter	99.639	0.839	0.1	1.9	2.0	221.8	O K
120 min Winter	99.840	1.040	0.1	2.1	2.2	275.0	O K
180 min Winter	99.964	1.164	0.1	2.2	2.3	307.5	O K
240 min Winter	100.051	1.251	0.1	2.2	2.4	330.7	O K
360 min Winter	100.173	1.373	0.1	2.3	2.5	362.8	O K
480 min Winter	100.254	1.454	0.1	2.4	2.5	384.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	87.395	0.0	114.3	19
30 min Summer	60.231	0.0	157.6	34
60 min Summer	39.049	0.0	204.3	64
120 min Summer	24.673	0.0	258.2	124
180 min Summer	18.722	0.0	293.9	182
240 min Summer	15.356	0.0	321.5	242
360 min Summer	11.587	0.0	344.2	362
480 min Summer	9.477	0.0	348.3	482
600 min Summer	8.105	0.0	351.5	602
720 min Summer	7.131	0.0	354.5	722
960 min Summer	5.827	0.0	361.3	960
1440 min Summer	4.380	0.0	372.2	1242
2160 min Summer	3.287	0.0	619.5	1640
2880 min Summer	2.679	0.0	673.2	2044
4320 min Summer	2.005	0.0	656.8	2892
5760 min Summer	1.632	0.0	820.5	3696
7200 min Summer	1.391	0.0	873.8	4544
8640 min Summer	1.221	0.0	920.0	5360
10080 min Summer	1.093	0.0	961.4	6152
15 min Winter	87.395	0.0	128.0	19
30 min Winter	60.231	0.0	162.6	33
60 min Winter	39.049	0.0	228.7	64
120 min Winter	24.673	0.0	289.3	122
180 min Winter	18.722	0.0	329.3	180
240 min Winter	15.356	0.0	345.2	240
360 min Winter	11.587	0.0	352.4	356
480 min Winter	9.477	0.0	358.1	472

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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 Σ Outflow (l/s)	Max Volume (m³)	Status
600 min Winter	100.311	1.511	0.1	2.4	2.6	399.3	O K
720 min Winter	100.352	1.552	0.1	2.5	2.6	410.2	O K
960 min Winter	100.404	1.604	0.1	2.5	2.6	424.1	O K
1440 min Winter	100.440	1.640	0.1	2.5	2.7	433.4	O K
2160 min Winter	100.426	1.626	0.1	2.5	2.7	429.7	O K
2880 min Winter	100.396	1.596	0.1	2.5	2.6	421.8	O K
4320 min Winter	100.309	1.509	0.1	2.4	2.6	398.9	O K
5760 min Winter	100.215	1.415	0.1	2.4	2.5	374.1	O K
7200 min Winter	100.117	1.317	0.1	2.3	2.4	348.2	O K
8640 min Winter	100.020	1.220	0.1	2.2	2.4	322.5	O K
10080 min Winter	99.927	1.127	0.1	2.2	2.3	297.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
600 min Winter	8.105	0.0	363.9	588
720 min Winter	7.131	0.0	370.6	702
960 min Winter	5.827	0.0	381.8	926
1440 min Winter	4.380	0.0	391.5	1356
2160 min Winter	3.287	0.0	693.9	1708
2880 min Winter	2.679	0.0	723.1	2188
4320 min Winter	2.005	0.0	701.2	3112
5760 min Winter	1.632	0.0	918.2	4032
7200 min Winter	1.391	0.0	978.8	4896
8640 min Winter	1.221	0.0	1030.3	5784
10080 min Winter	1.093	0.0	1076.6	6648

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Innovyze	Source Control 2018.1

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)	18.200	Shortest Storm (mins)	15
Ratio R	0.269	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.698

Time (mins) From:	To:	Area (ha)
0	4	0.698

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Innovyze	Source Control 2018.1

Model Details

Storage is Offline Cover Level (m) 101.450 Dividing Weir Level (m) 98.800

Cellular Storage Structure

Invert Level (m) 98.800 Safety Factor 1.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.69
Infiltration Coefficient Side (m/hr) 0.00100

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	383.1	383.1	1.700	383.1	516.7	1.800	0.0	516.7

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0066-2100-1160-2100	Sump Available	Yes
Design Head (m)	1.160	Diameter (mm)	66
Design Flow (l/s)	2.1	Invert Level (m)	98.700
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	100
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.160	2.1	Kick-Flo®	0.593	1.5
Flush-Flo™	0.294	1.9	Mean Flow over Head Range	-	1.7

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)	Depth (m)	Flow (l/s)
0.100	1.6	0.800	1.8	2.000	2.7	4.000	3.7	7.000	4.8
0.200	1.9	1.000	2.0	2.200	2.8	4.500	3.9	7.500	5.0
0.300	1.9	1.200	2.1	2.400	2.9	5.000	4.1	8.000	5.1
0.400	1.9	1.400	2.3	2.600	3.0	5.500	4.3	8.500	5.3
0.500	1.8	1.600	2.4	3.000	3.2	6.000	4.5	9.000	5.4
0.600	1.6	1.800	2.6	3.500	3.5	6.500	4.7	9.500	5.6

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STORMTECH Stormwater Management System Design Tool

ver: Jun14

PROJECT REF:	Cookstown Phase 3
LOCATION:	Site C
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	520	m^3
Stormtech chamber model	MC3500	
Number of Isolator Rows for TSS Removal	1	

SITE PARAMETERS

Maximum Width at Excavation Base	26.59	m	
Stone Porosity	40%		
Excavation Batter Angle (degrees)	60	°	*Minimum Requirement*
Stone Below Chambers	0.23	m	*0.23*
Stone Above Chambers	0.3	m	*0.30*
Additional Storage. E.g manholes, pipe	0	m^3	

CALCULATED CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows	12		ea
Number of units per Row	8		ea
Number of MC3500 Chambers	96		ea
Number of MC3500 Endcaps	24		ea
System Installed Storage Depth (effective storage depth)	1.675		m
Tank overall installed Width at base	26.59	26.59	m
Tank overall installed Length at Base	19.18	19.18	m
Total Effective System Storage	**561.7**	**561.7**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC3500	
Unit Width	1.955	m
Unit Length	2.18	m
Unit Height	1.145	m
Min Cover Over System	0.3	m
Max Cover Over Chamber	2.4	m
Internal Storage Vol. (Chamber only)	3.11	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	932	
Area of Dig at Base of System	510	m^2
Area of Dig at Top of System	602	m^2
Void Ratio	60%	
Stone Requirement - tonne	1018	tonne

StormTech®
Detention • Retention • Recharge
Subsurface Stormwater Management™

Qbar Calculation
Using IOH Report 124 for Sites < 25 km²

Catchment Name
Cookstown Phase - Block D

$^1Q_{bar} = 0.00108 * (AREA)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$ — **Estimation of QBAR from IOH Report 124 for catchments less than 25 km² using the 3 variable equation**

AREA = 0.85 Ha — Overall Catchment Area (Hectares) For catchments < 50 hectares in area, flow rates are linearly interpolated for smaller areas.

AREA = 0.009 km^2 — Area of the Catchment (km^2)

SAAR = 782 mm — Standard Annual Average Rainfall (mm)

SOIL = 0.30

Soil Type Expressed as a Percentage	Soil 1	Soil 2	Soil 3	Soil 4	Soil 5
	0	100	0	0	0
SOIL Value	0.15	0.30	0.40	0.45	0.50

$M5_{60}$ = 18.2 mm

$M5_{2day}$ = 67.6 mm

Ratio $M5_{60}/M5_{2d}$ = **0.269**

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 .

Flood Return Event	^{5}Growth Factor	Permitted Flow (l/s)
1	0.85	1.5
QBAR	1	1.8
10	1.67	2.9
30	2.1	3.7
50	2.33	4.1
100	2.6	4.6
200	2.85	5.0
1000	3.5	6.2

^{4}QBar from Site with Factorial Error Allowance

r^2 =	0.847
n =	71
fse =	1.651

Q'_{bar} = 2.91 l/s
(With Allowance for the standard factorial error)

Pro-rata based on 50 Ha Site area to calculate Qbar

Q_{bar} =	0.00004	cumecs/Ha

Q_{bar} =	2.1	l/s/Ha

$Q_{bar[rural]}$ = 1.8 l/s

Block D - Catchment Characteristics

Cookstown Phase - Block D	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)	2,840	1.00	2840.0
Roofs - Type 2 (Draining to SUDS features)	-	0.70	0.0
Roofs - Type 3 (Draining to Back Gardens)	-	0.00	0.0
Green Roofs	1,840	0.70	1288.0
Grass over Basements/Podiums	350	0.70	245.0
Roads and Footpaths - Type 1 (Draining to gullies)	2,240	0.80	1792.0
Roads and Footpaths - Type 2 (Draining to Suds features)	-	0.70	0.0
Permeable Paving	1,230	0.50	615.0
Gardens	-	0.15	0.0
Verges		0.15	0.0
Parks	-	0.15	0.0
Public Open Space	-	0.05	0.0

Impermeable Contributing Area **0.678** Hectares

Effective Catchment Runoff Coefficient **0.80**

Date 18/08/2020 09:38	Designed by
File Cookstown Phase 3	Checked by
Innovyze	Source Control 2018.1

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

Half Drain Time : 2153 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	98.048	0.248	0.2	1.6	1.8	109.3	O K
30 min Summer	98.140	0.340	0.2	1.6	1.8	149.8	O K
60 min Summer	98.237	0.437	0.2	1.6	1.8	192.5	O K
120 min Summer	98.343	0.543	0.2	1.6	1.8	239.2	O K
180 min Summer	98.408	0.608	0.2	1.6	1.8	267.9	O K
240 min Summer	98.455	0.655	0.2	1.6	1.8	288.6	O K
360 min Summer	98.521	0.721	0.2	1.6	1.8	317.5	O K
480 min Summer	98.565	0.765	0.2	1.6	1.8	337.2	O K
600 min Summer	98.598	0.798	0.2	1.6	1.8	351.4	O K
720 min Summer	98.622	0.822	0.2	1.6	1.8	362.0	O K
960 min Summer	98.653	0.853	0.2	1.6	1.9	375.9	O K
1440 min Summer	98.679	0.879	0.2	1.7	1.9	387.1	O K
2160 min Summer	98.678	0.878	0.2	1.7	1.9	386.7	O K
2880 min Summer	98.668	0.868	0.2	1.7	1.9	382.3	O K
4320 min Summer	98.645	0.845	0.2	1.6	1.8	372.5	O K
5760 min Summer	98.619	0.819	0.2	1.6	1.8	361.0	O K
7200 min Summer	98.591	0.791	0.2	1.6	1.8	348.3	O K
8640 min Summer	98.561	0.761	0.2	1.6	1.8	335.1	O K
10080 min Summer	98.530	0.730	0.2	1.6	1.8	321.4	O K
15 min Winter	98.078	0.278	0.2	1.6	1.8	122.6	O K
30 min Winter	98.182	0.382	0.2	1.6	1.8	168.2	O K
60 min Winter	98.291	0.491	0.2	1.6	1.8	216.4	O K
120 min Winter	98.411	0.611	0.2	1.6	1.8	269.2	O K
180 min Winter	98.486	0.686	0.2	1.6	1.8	302.1	O K
240 min Winter	98.540	0.740	0.2	1.6	1.8	326.0	O K
360 min Winter	98.617	0.817	0.2	1.6	1.8	359.9	O K
480 min Winter	98.670	0.870	0.2	1.7	1.9	383.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	87.395	0.0	110.9	19
30 min Summer	60.231	0.0	148.8	34
60 min Summer	39.049	0.0	198.3	64
120 min Summer	24.673	0.0	250.6	124
180 min Summer	18.722	0.0	285.3	184
240 min Summer	15.356	0.0	288.1	244
360 min Summer	11.587	0.0	287.4	362
480 min Summer	9.477	0.0	286.8	482
600 min Summer	8.105	0.0	286.7	602
720 min Summer	7.131	0.0	287.2	722
960 min Summer	5.827	0.0	289.5	962
1440 min Summer	4.380	0.0	296.5	1440
2160 min Summer	3.287	0.0	585.5	1840
2880 min Summer	2.679	0.0	577.3	2224
4320 min Summer	2.005	0.0	547.7	3028
5760 min Summer	1.632	0.0	796.3	3864
7200 min Summer	1.391	0.0	848.6	4688
8640 min Summer	1.221	0.0	893.2	5536
10080 min Summer	1.093	0.0	933.6	6360
15 min Winter	87.395	0.0	124.2	19
30 min Winter	60.231	0.0	150.6	33
60 min Winter	39.049	0.0	222.2	64
120 min Winter	24.673	0.0	280.8	122
180 min Winter	18.722	0.0	288.4	180
240 min Winter	15.356	0.0	288.1	240
360 min Winter	11.587	0.0	288.0	358
480 min Winter	9.477	0.0	289.1	474

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File Cookstown Phase 3	Checked by
Innovyze	Source Control 2018.1

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 Σ Outflow (l/s)	Max Volume (m³)	Status
600 min Winter	98.710	0.910	0.2	1.7	1.9	400.8	O K
720 min Winter	98.740	0.940	0.2	1.7	1.9	414.1	O K
960 min Winter	98.782	0.982	0.2	1.7	2.0	432.8	O K
1440 min Winter	98.825	1.025	0.2	1.8	2.0	451.6	O K
2160 min Winter	98.835	1.035	0.2	1.8	2.0	456.0	O K
2880 min Winter	98.821	1.021	0.2	1.8	2.0	449.7	O K
4320 min Winter	98.785	0.985	0.2	1.7	2.0	433.8	O K
5760 min Winter	98.740	0.940	0.2	1.7	1.9	414.3	O K
7200 min Winter	98.693	0.893	0.2	1.7	1.9	393.3	O K
8640 min Winter	98.642	0.842	0.2	1.6	1.8	371.0	O K
10080 min Winter	98.591	0.791	0.2	1.6	1.8	348.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
600 min Winter	8.105	0.0	291.2	590
720 min Winter	7.131	0.0	294.4	708
960 min Winter	5.827	0.0	301.8	936
1440 min Winter	4.380	0.0	308.8	1386
2160 min Winter	3.287	0.0	597.7	2032
2880 min Winter	2.679	0.0	591.6	2332
4320 min Winter	2.005	0.0	579.9	3244
5760 min Winter	1.632	0.0	891.9	4200
7200 min Winter	1.391	0.0	950.4	5112
8640 min Winter	1.221	0.0	1000.5	5976
10080 min Winter	1.093	0.0	1003.3	6864

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Date 18/08/2020 09:38	Designed by
File Cookstown Phase 3	Checked by
Innovyze	Source Control 2018.1

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)	18.200	Shortest Storm (mins)	15
Ratio R	0.269	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.678

Time (mins) From:	To:	Area (ha)
0	4	0.678

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Date 18/08/2020 09:38	Designed by
File Cookstown Phase 3	Checked by
Innovyze	Source Control 2018.1

Model Details

Storage is Offline Cover Level (m) 99.800 Dividing Weir Level (m) 97.800

Cellular Storage Structure

Invert Level (m) 97.800 Safety Factor 1.0
Infiltration Coefficient Base (m/hr) 0.00100 Porosity 0.66
Infiltration Coefficient Side (m/hr) 0.00100

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	667.5	667.5	1.100	667.5	781.2	1.200	0.0	781.2

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0061-1800-1150-1800	Sump Available	Yes
Design Head (m)	1.150	Diameter (mm)	61
Design Flow (l/s)	1.8	Invert Level (m)	97.710
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	75
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.150	1.8	Kick-Flo®	0.550	1.3
Flush-Flo™	0.269	1.6	Mean Flow over Head Range	-	1.5

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)	Depth (m)	Flow (l/s)
0.100	1.4	0.800	1.5	2.000	2.3	4.000	3.2	7.000	4.1
0.200	1.6	1.000	1.7	2.200	2.4	4.500	3.4	7.500	4.3
0.300	1.6	1.200	1.8	2.400	2.5	5.000	3.5	8.000	4.4
0.400	1.5	1.400	2.0	2.600	2.6	5.500	3.7	8.500	4.5
0.500	1.4	1.600	2.1	3.000	2.8	6.000	3.9	9.000	4.7
0.600	1.3	1.800	2.2	3.500	3.0	6.500	4.0	9.500	4.8

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STORMTECH Stormwater Management System Design Tool

ver: Jun14

PROJECT REF:	Cookstown Phase 3
LOCATION:	Site C
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	540	m^3
Stormtech chamber model	MC3500	
Number of Isolator Rows for TSS Removal	1	

SITE PARAMETERS

Maximum Width at Excavation Base	17.85	m	
Stone Porosity	40%		
Excavation Batter Angle (degrees)	60	°	*Minimum Requirement*
Stone Below Chambers	0.23	m	*0.23*
Stone Above Chambers	0.3	m	*0.30*
Additional Storage. E.g manholes, pipe	0	m^3	

CALCULATED CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows	8		ea
Number of units per Row	12		ea
Number of MC3500 Chambers	96		ea
Number of MC3500 Endcaps	16		ea
System Installed Storage Depth (effective storage depth)	1.675		m
Tank overall installed Width at base	17.85	17.85	m
Tank overall installed Length at Base	27.9	27.9	m
Total Effective System Storage	**550.1**	**550.1**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC3500	
Unit Width	1.955	m
Unit Length	2.18	m
Unit Height	1.145	m
Min Cover Over System	0.3	m
Max Cover Over Chamber	2.4	m
Internal Storage Vol. (Chamber only)	3.11	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	911	
Area of Dig at Base of System	498	m^2
Area of Dig at Top of System	590	m^2
Void Ratio	60%	
Stone Requirement - tonne	991	tonne

StormTech®
Detention • Retention • Recharge
Subsurface Stormwater Management™

APPENDIX C

Surface Water Network Calculations

TITLE			Job Reference	Calculations by	Drawing No.			
Cookstown Phase 3				PTC		Ks	0.60	mm
Co. Dublin						Time of entry	4	mins
SUBJECT				Checked by	Date	Storm Frequency	5	year
Surface Water Drainage				GD	10/10/20	Climate Change	10	%

Pipe Section S	to	S	U/S IL (m)	D/S IL (m)	Length L_{pipe} (m)	Gradient 1 in	Pipe Dia. D (mm)	Pipe Cap. (l/s)	Velocity V_{pipe} (m/s)	T_{pipe} (mins)	T_c (mins)	Rainfall I (mm/hr)	Imp. Area A (Ha)	Cumulative Imp. Area (Ha)	Flow $Q_{existing}$ (l/s)	Flow Q=2.78CiA (l/s)	Flow Clim Chg (l/s)	Adequate / Fail ?
S8	to	S7	99.220	98.930	51.920	179	225	38.67	0.97	0.89	4.89	71.22	0.177	0.177	0.00	34.11	37.53	✓
S6-2	to	S6-1	99.340	99.200	25.960	185	225	37.99	0.96	0.45	4.45	73.11	0.088	0.088	0.00	17.51	19.26	✓
S6-1-1	to	S6-1	99.900	99.200	70.000	100	225	51.93	1.31	0.89	4.89	71.21	0.238	0.238	0.00	45.98	50.58	✓
S6-1	to	S6	99.200	98.710	83.000	169	375	153.28	1.39	1.00	5.00	70.81	0.283	0.609	0.00	116.91	128.60	✓
S7	to	S6	98.930	98.710	38.500	175	450	243.71	1.53	0.42	4.42	73.27	0.131	0.917	0.00	182.09	200.30	✓
								FLOW RESTRICTED TO		2.70	l/sec							
S4-3	to	S4-2	98.900	98.740	28.140	176	225	39.02	0.98	0.48	4.48	72.99	0.126	0.126	0.00	24.89	27.38	✓
S4-2-1	to	S4-2	99.340	98.740	60.000	100	300	111.04	1.57	0.64	4.64	72.27	0.268	0.268	0.00	52.54	57.80	✓
S4-2	to	S4-1	98.740	98.560	33.150	184	375	146.94	1.33	0.42	4.42	73.29	0.148	0.542	0.00	107.71	118.48	✓
S4-1-1	to	S4-1	98.750	98.560	34.820	183	450	238.10	1.50	0.39	4.39	73.42	0.156	0.698	0.00	138.89	152.78	✓
								FLOW RESTRICTED TO		2.10	l/sec							
S6	to	S5	98.710	98.500	38.810	185	300	81.41	1.15	0.56	4.56	72.61	0.088	0.088	2.70	19.99	21.72	✓
S5	to	S4	98.500	98.240	48.900	188	300	80.69	1.14	0.71	4.71	71.94	0.111	0.199	2.70	41.41	45.29	✓
S4-1	to	S4	98.560	98.240	55.740	174	225	39.21	0.99	0.94	4.94	71.02	0.126	0.126	2.10	26.39	28.82	✓
S4	to	S3	98.240	98.140	17.390	174	375	151.26	1.37	0.21	4.21	74.32	0.039	0.364	4.80	78.14	85.47	✓
S3	to	S2	98.140	97.960	32.340	180	375	148.78	1.35	0.40	4.40	73.36	0.073	0.437	4.80	91.75	100.45	✓
S2-2	to	S2-1	98.840	98.460	22.450	59	225	67.73	1.70	0.22	4.22	74.28	0.051	0.051	0.00	10.23	11.25	✓
S2-1	to	S2	98.460	97.960	29.157	58	225	68.18	1.71	0.28	4.28	73.95	0.066	0.117	0.00	23.41	25.75	✓
S2	to	S1	97.960	97.710	54.680	219	450	217.76	1.37	0.67	4.67	72.15	0.124	0.678	4.80	137.36	150.62	✓
								FLOW RESTRICTED TO		1.80	l/sec							
S1	to	ExSMH	97.710	97.680	4.500	150	225	42.30	1.06	0.07	4.07	75.09	0.000	0.000	1.80	1.80	1.80	✓

APPENDIX D

Foul Sewer Loading Calculations

PROJECT TITLE: Cookstown Castle **JOB REFERENCE:** 1607

SUBJECT
Wastewater Load for Irish Water

DRAWING NO. 1607-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	3 Bed	2 Bed (4p)	2 Bed (3p)	1 Bed	Studio
Average Occupancy(persons)	4	3	4	3	1	1
Number of Units	0	45	106	346	475	132
Average Occupancy[5] (PE)	0	135	424	1038	475	132

Residential Dry Weather Flow(DWF) Volume[5] **363,660** litres

Commercial Unit Type	Commercial	Office	Pub/ Restaurant	Leisure/ Gym	Medical/ Care Home	Creche
Average Occupancy (per m2)	18	25	5	5	20	20
Area(m2)	762	1500	0	0	0	1531
Average Occupancy[5] (PE)	42	60	0	0	0	77
Average Usage(litres per person/day)[9]	25	100	60	50	350	60
Daily Usage(/)	1058	6000	0	0	0	4593

Commercial Dry Weather Flow(DWF) Volume[5] **12,111** litres

WASTEWATER LOADING SUMMARY

	Residential	Commercial	Total
Average Daily Discharge	4.21 l/s	0.14 l/s	4.35 l/s
Peak Discharge[6]	25.25 l/s	0.84 l/s	26.10 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	61.09	153.46	2.03	5.11	63.13	158.58
SS (mg/l)		SS (kg/day)		SS (kg/day)		SS (kg/day)	
163.0	435.0	59.28	158.19	1.97	5.27	61.25	163.46
N (mg/l)		N (kg/day)		N (kg/day)		N (kg/day)	
40.6	78.6	14.76	28.58	0.49	0.95	15.26	29.54
P (mg/l)		P (kg/day)		P (kg/day)		P (kg/day)	
7.1	15.5	2.58	5.64	0.09	0.19	2.67	5.82

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 E

Water Demand Calculations

PROJECT TITLE: Cookstown Castle **JOB REFERENCE:** 1607

SUBJECT
Water Demand for Irish Water

DRAWING NO. 1607-C-100 **CALCULATIONS BY** **CHECKED BY** **DATE**

gdcl CONSULTING ENGINEERS

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	3 Bed	2 Bed (4p)	2 Bed (3p)	1 Bed	Studio
Average Occupancy(persons)	4	3	4	3	1	1
Number of Units	0	45	106	346	475	132
Average Occupancy[5] (PE)	0	135	424	1038	475	132

Average Residential Demand[6] 310,350 l/day

Commercial Unit Type	Commercial	Office	Pub/ Restaurant	Leisure/ Gym	Medical/ Care Home	Creche
Average Occupancy (per m2)	18	25	5	5	20	20
Area(m2)	762	1500	0	0	0	1531
Average Occupancy[5] (PE)	42	60	0	0	0	77
Average Usage(litres per person/day)	25	100	60	50	350	60
Daily Usage(l)	1058	6000	0	0	0	4593

Average Commercial Demand[6] 11,651 l/day

Average Day/Week Demand Factor[3] 1.25

Peak Demand Factor[4] 5

WATER DEMAND SUMMARY

	Residential	Commercial	Total
Average Daily Demand	3.59 l/s	0.13 l/s	3.73 l/s
Average Day/Peak Week Demand[7]	4.49 l/s	0.17 l/s	4.66 l/s
Peak Hour Water Demand[8]	22.450 l/s	0.843 l/s	23.293 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

APPENDIX F

Irish Water - Confirmation of Feasibility

Uisce Éireann
Bosca OP 6000
Baile Átha Cliath 1
Éire

Irish Water
PO Box 6000
Dublin 1
Ireland

T: +353 1 89 25000
F: +353 1 89 25001
www.water.ie

Greg Daly
Scope House, Whitehall Road West
Perrystown, Dublin 12
Dublin

28 May 2019

Dear Greg Daly,

Re: Connection Reference No CDS19002183 pre-connection enquiry - Subject to contract | Contract denied

Connection for Housing Development of 1,389 units at Cookstown Estate Road, And Old Belgard Road, Cookstown Industrial Estate, Dublin.

Irish Water has reviewed your pre-connection enquiry in relation to a water connection at Cookstown Estate Road, And Old Belgard Road, Cookstown Industrial Estate, Dublin.
Based upon the details that you have provided with your pre-connection enquiry and on the capacity currently available in the network(s), as assessed by Irish Water, we wish to advise you that, subject to a valid connection agreement being put in place, your proposed connection to the Irish Water network(s) can be facilitated.

Water:
The Development should be supplied directly from the 12'' ID Asbestos trunk main in Cookstown Estate Road. Installation of an offtake with a PRV controller and a bulk meter with associated telemetry system will be required for the connection. Existing connection to the site from 4'' uPVC main should be closed and used only in emergences.
It will be necessary to carry out further detailed investigations, pressure tests and hydraulic model analysis to identify pulse-type demand within the DMA and to determine the full extent of any upgrades which may be required to be completed to Irish Water Infrastructure, prior to agreeing to the proposed connection.

Wastewater:
There are capacity issues downstream of sewers adjacent to the site. Therefore the Development should be connected into 600 mm ID concrete sewer in Airton Road. In order to complete the proposed connection, the sewer has to be extended for approximately 800 m. Irish Water currently does not have any plans to extend or commence upgrade works to its network in this area. Should you wish to progress with the connection, the extension works will be calculated in a connection offer for the Development.

There are existing Irish Water watermains and sewers within and in close proximity of the site boundaries (please see attached IW GIS record). The Developer will be required to survey the site to determine the exact location of the infrastructure. Any trial investigations should be carried out with the agreement and in the presence of LA Inspector.
You are advised that structures or works over or in close proximity to IW infrastructure that will inhibit access for maintenance or endanger structural or functional integrity of the infrastructure are not allowed.

Stiúrthóirí / Directors: Mike Quinn (Chairman), Eamon Gallen, Cathal Marley, Brendan Murphy, Michael G. O'Sullivan
Oifig Chláraithe / Registered Office: Teach Colvil, 24-26 Sráid Thalbóid, Baile Átha Cliath 1, D01 NP86 / Colvil House, 24-26 Talbot Street, Dublin 1, D01 NP86
Is cuideachta ghníomhaíochta ainmnithe atá faoi theorainn scaireanna é Uisce Éireann / Irish Water is a designated activity company, limited by shares.
Uimhir Chláraithe in Éirinn / Registered in Ireland No.: 530363

REV007

Diversion of the infrastructure may be required subject to layout proposal of the development and separation distances. The diversion will be subject to customer entering diversion agreement with Irish Water. For design submissions and queries related to diversion please contact IW Diversion Team via email address diversions@water.ie. For further information related to diversion please visit www.water.ie/connections/developer-services/diversions.

Strategic Housing Development
Irish Water notes that the scale of this development dictates that it is subject to the Strategic Housing Development planning process. Therefore:
A. In advance of submitting your full application to An Bord Pleanala for assessment, you must have reviewed this development with Irish Water and received a Statement of Design Acceptance in relation to the layout of water and wastewater services.
B. You are advised that this correspondence does not constitute an offer in whole or in part to provide a connection to any Irish Water infrastructure and is provided subject to a connection agreement being signed and appropriate connection fee paid at a later date.
C. In advance of submitting this development to An Bord Pleanala for full assessment, the Developer is required to have entered into a Project Works Services Agreement to deliver studies and investigations to confirm the available capacity and to determine the full extent of any upgrades which may be required to be completed to Irish Water infrastructure.
D. In advance of submitting this development to An Bord Pleanala for full assessment, the Developer is required to have entered into a Project Works Services Agreement to deliver infrastructure upgrades to facilitate the connection of the development to Irish Water infrastructure.

All infrastructure should be designed and installed in accordance with the Irish Water Codes of Practice and Standard Details.

You are advised that this correspondence does not constitute an offer in whole or in part to provide a connection to any Irish Water infrastructure and is provided subject to a connection agreement being signed at a later date.

A connection agreement can be applied for by completing the connection application form available at **www.water.ie/connections**. Irish Water's current charges for water and wastewater connections are set out in the Water Charges Plan as approved by the Commission for Regulation of Utilities.

If you have any further questions, please contact Marina Zivanovic Byrne from the design team on 01 89 25991 or email mzbyrne@water.ie. For further information, visit www.water.ie/connections.

Yours sincerely,

Maria O'Dwyer

Connections and Developer Services

Stiúrthóirí / Directors: Mike Quinn (Chairman), Eamon Gallen, Cathal Marley, Brendan Murphy, Michael G. O'Sullivan
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REV007

Confirmation of Feasibility (Diversion)

Joseph Costello
25 Cold Water Lakes
Saggart,
Co. Dublin
D24FH60

26 June 2020

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

Dear Joseph,

Re: Diversion Reference DIV20115 – Cookstown Estate Road & Old Belgard Road, Cookstown Industrial Estate, Dublin - Diversion enquiry.

Irish Water has reviewed your enquiry in relation to the proposed Development at (Cookstown Estate Road & Old Belgard Road, Cookstown Industrial Estate, Dublin) as indicated on drawing no. P-1607-C-103 rev.IW.& P-1607-C-112 rev.PP1.

Based upon the details you have provided with your enquiry and as assessed by Irish Water, we wish to advise you that, in this instance, Irish Water will accept the proposed diversion of the existing 300mm unknown sewer main to accommodate the new industrial development, with the condition that the construction of the new diverted 300mm uPVC sewer main is constructed in strict accordance with drawings no P-1607-C-103 rev.IW.& P-1607-C-112 rev.PP1.

If you have any further questions, please contact Juan Antonio Gragera Rubio from the diversions team on email diversions@water.ie. For further information, visit www.water.ie/connections.

Yours sincerely,

Maria O'Dwyer

Connections and Developer Services

Stiúrthóirí / Directors: Cathal Marley (Chairman), Niall Gleeson, Eamon Galler, Brendan Murphy, Michael G. O'Sullivan
Oifig Chláraithe / Registered Office: Teach Colvill, 24-26 Sráid Thalbóid, Baile Átha Cliath 1, D01 NP86 / Colvil House, 24-26 Talbot Street, Dublin 1, D01 NP86
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Statement of Design Acceptance

Greg Daly
Scope House, Whitehall Road West
Perrystown, Dublin 12
Dublin

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

27 July 2020

Re: Design Submission for Cookstown Estate Road, And Old Belgard Road, Cookstown Industrial Estate, Dublin (the "Development")
(the "Design Submission") / Connection Reference No: CDS19002183

Dear Greg Daly,

Many thanks for your recent Design Submission.

We have reviewed your proposal for the connection(s) at the Development. Based on the information provided, which included the documents outlined in Appendix A to this letter, Irish Water has no objection to your proposals.

This letter does not constitute an offer, in whole or in part, to provide a connection to any Irish Water infrastructure. Before you can connect to our network you must sign a connection agreement with Irish Water. This can be applied for by completing the connection application form at www.water.ie/connections. Irish Water's current charges for water and wastewater connections are set out in the Water Charges Plan as approved by the Commission for Regulation of Utilities (CRU)(https://www.cru.ie/document_group/irish-waters-water-charges-plan-2018/).

You the Customer (including any designers/contractors or other related parties appointed by you) is entirely responsible for the design and construction of all water and/or wastewater infrastructure within the Development which is necessary to facilitate connection(s) from the boundary of the Development to Irish Water's network(s) (the "**Self-Lay Works**"), as reflected in your Design Submission. Acceptance of the Design Submission by Irish Water does not, in any way, render Irish Water liable for any elements of the design and/or construction of the Self-Lay Works.

If you have any further questions, please contact your Irish Water representative:
Name: Alvaro Garcia
Email: agarcia@water.ie

Yours sincerely,

Maria O'Dwyer
Connections and Developer Services

Stiúrthóirí / Directors: Cathal Marley (Chairman), Niall Gleeson, Eamon Gallen, Yvonne Harris, Brendan Murphy, Maria O'Dwyer
Oifig Chláraithe / Registered Office: Teach Colvill, 24-26 Sráid Thalbóid, Baile Átha Cliath 1, D01 NP86 / Colvill House, 24-26 Talbot Street, Dublin 1, D01 NP86
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REV012

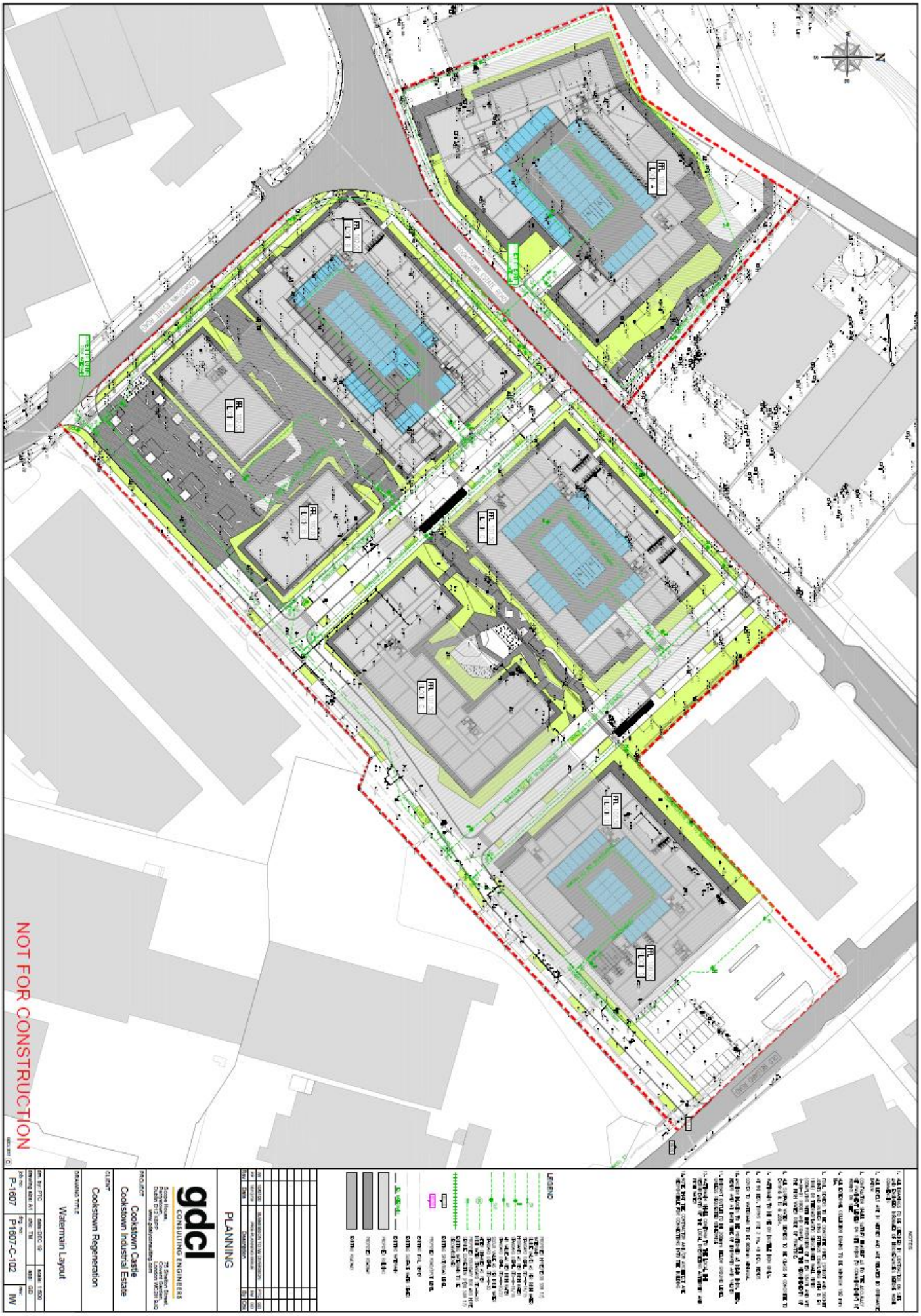
Appendix A

Document Title & Revision

- Foul sewer and surface water layout (Drawing no. P1607-C-103)
- General arrangement (Drawing no. P1607-C-110)
- Longitudinal sections (Drawing no. P1607-C-111)
- Watermain layout (Drawing no. P1607-C-102)

For further information, visit www.water.ie/connections

Notwithstanding any matters listed above, the Customer (including any appointed designers/contractors, etc.) is entirely responsible for the design and construction of the Self-Lay Works. Acceptance of the Design Submission by Irish Water will not, in any way, render Irish Water liable for any elements of the design and/or construction of the Self-Lay Works.


NOT FOR CONSTRUCTION
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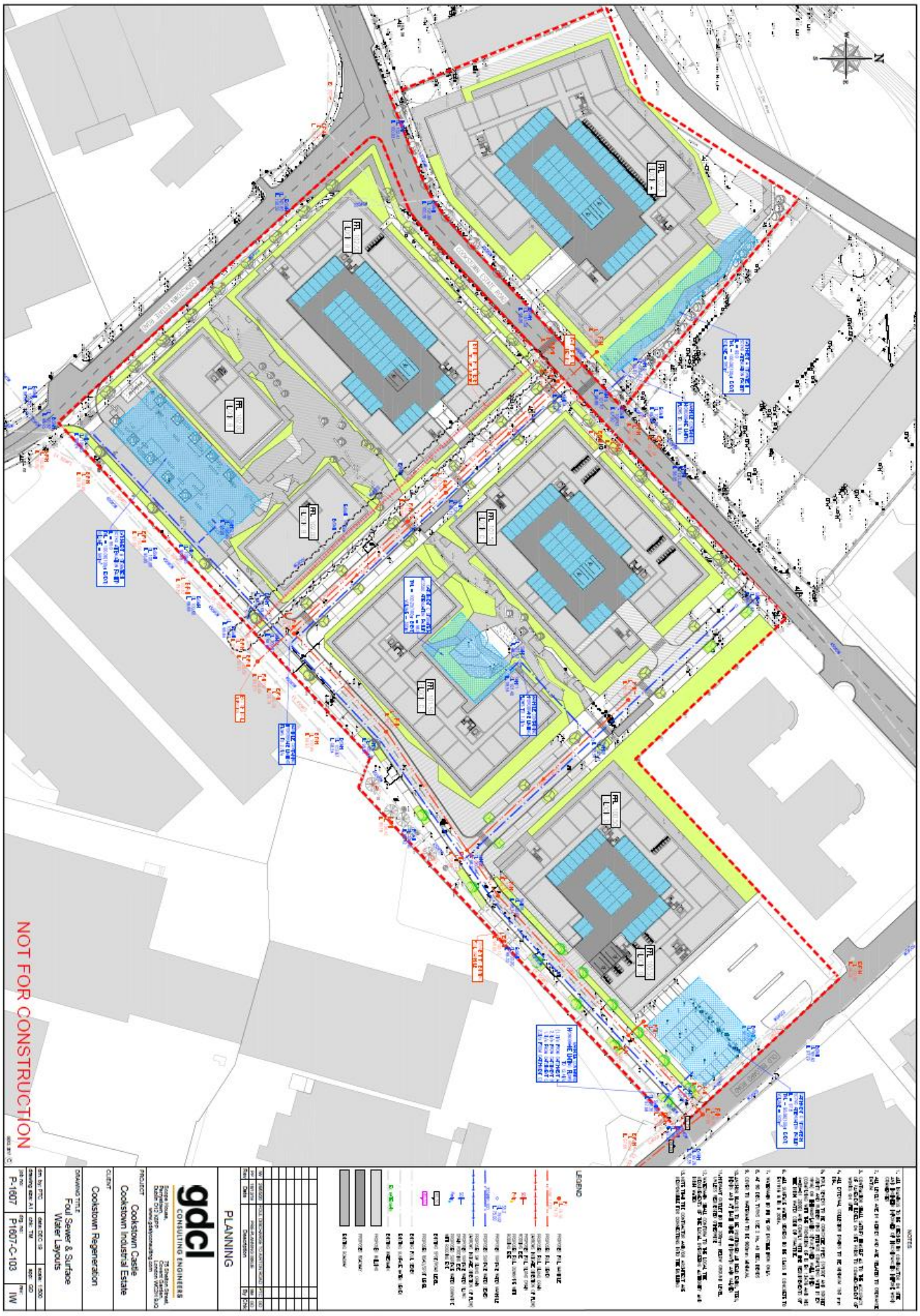
PLANNING
Cookstown Regeneration
Cookstown Castle
Cookstown Industrial Estate
Watermain Layout
P1607-C-102
P-1607
IW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P1607-C-103
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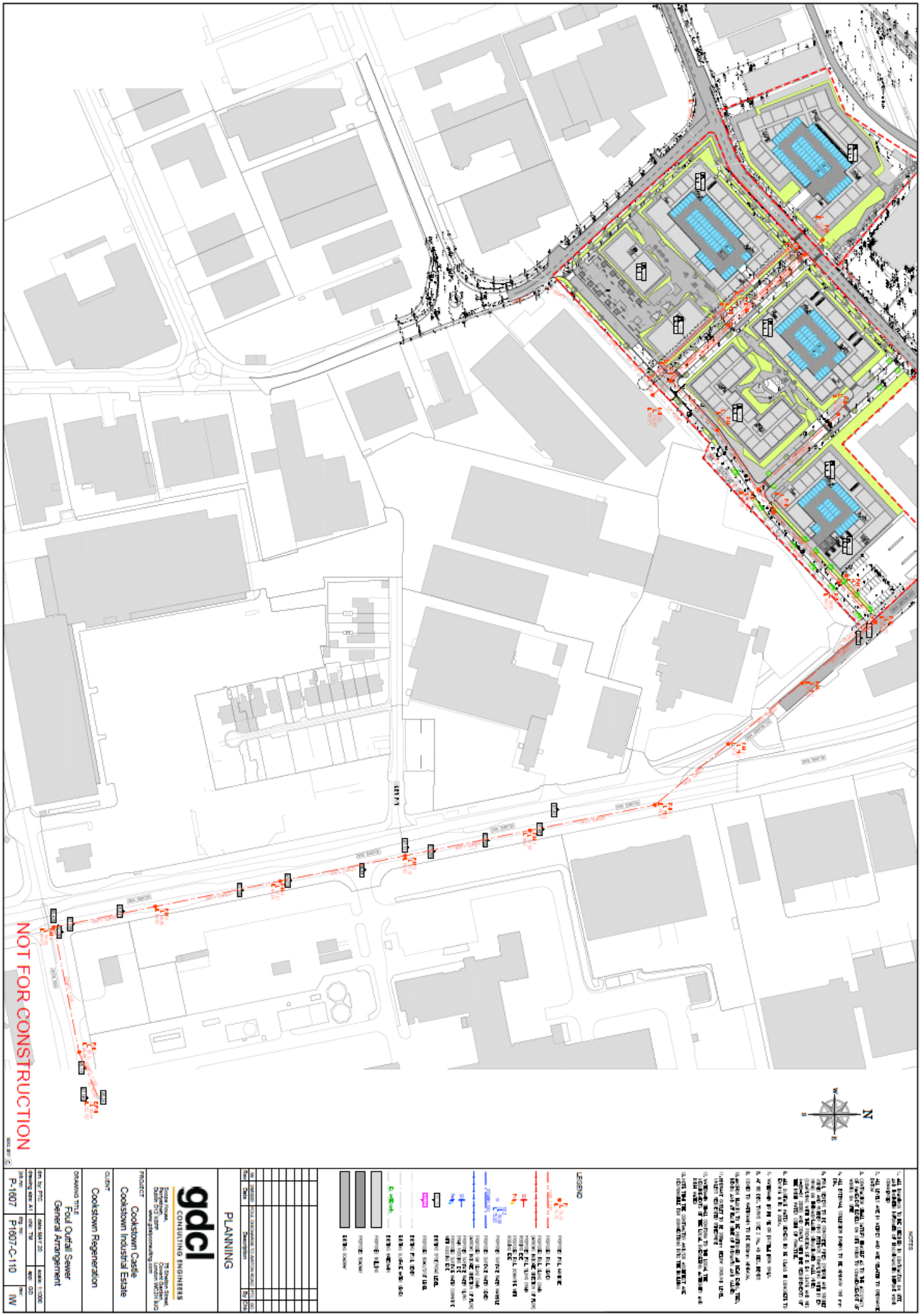
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Cookstown Castle
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Cookstown Regeneration
Foul Outfall Sewer
General Arrangement
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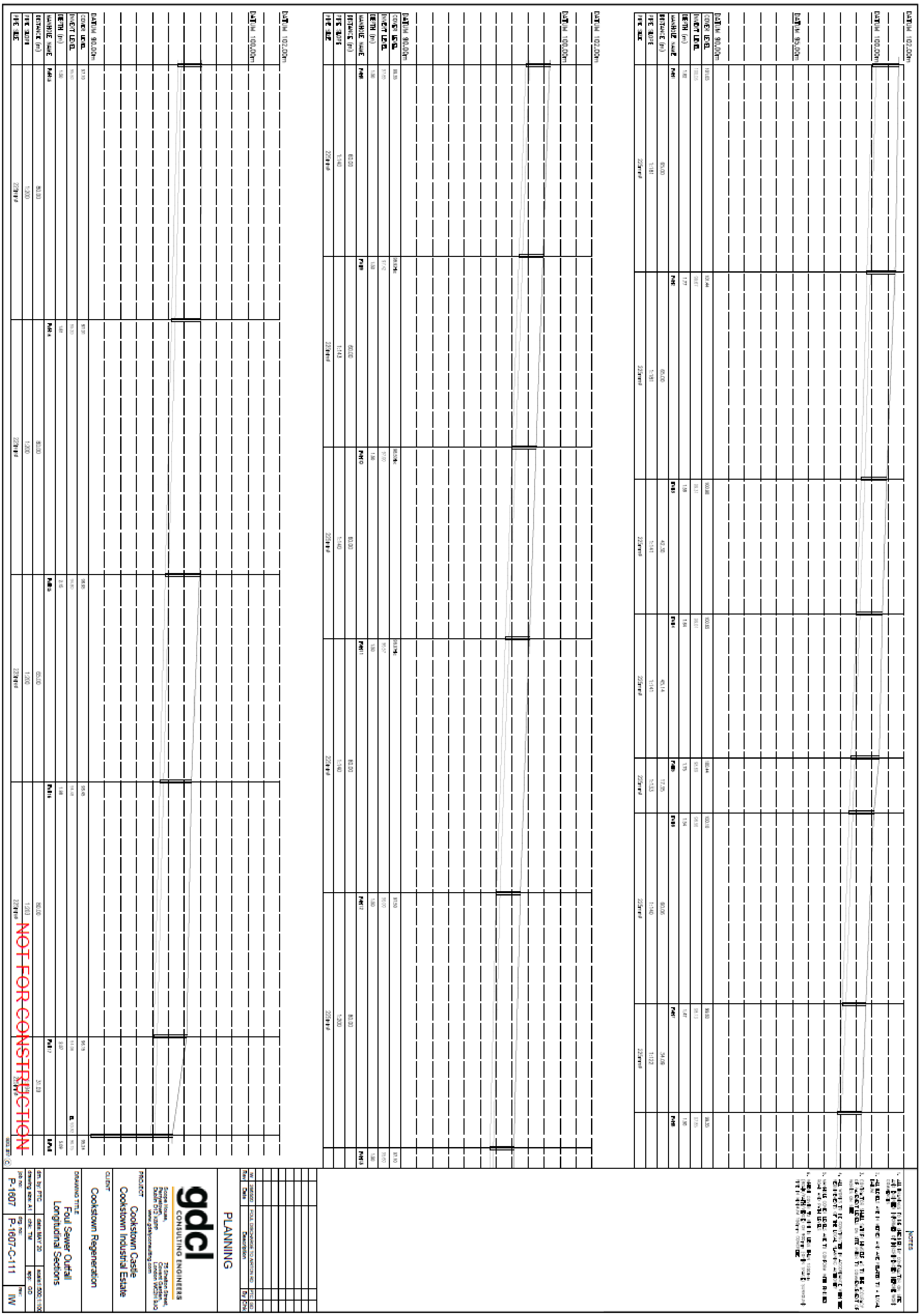
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