ARUP

Dublin City Council

St. Anne's Court in Raheny, Dublin 5

Part 8 – Drainage and Watermain Report

Reference: SAC-ARUP-ZZ-XX-RP-C-0010

C03 | 21 December 2023

Job number 288354-00

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Document Verification

Project title	St. Anne's Court in Raheny, Dublin 5
Document title	Issued for Planning – Drainage and Watermain Report
Job number	288354-00
Document ref	SAC-ARUP-ZZ-XX-RP-C-0010
File reference	4-04-01

Revision	**Date**	**Filename**	C02		
C02	25 August 2023	**Description**	Approved for Section 179A of the Planning and Development Act Circulation – Status A2		
			Prepared by	**Checked by**	**Approved by**
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		Signature	[signature]	[signature]	[signature]
C03	21 Dec 2023	**Filename**	C03		
		Description	Issued for Planning (Status S4)		
			Prepared by	**Checked by**	**Approved by**
		Name	Shelly Bosman	Niamh McKevitt	Gregg Sim
		Signature	[signature]	[signature]	[signature]
		Filename			
		Description			
			Prepared by	**Checked by**	**Approved by**
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		Signature			

Issue Document Verification with Document ✓

Contents

Tables

Figures

Appendices

1. Introduction

This report outlines the civil engineering design (drainage and watermains) proposals for the redevelopment of St. Anne's Court, All Saint Drive, Dublin 5 to be included as part of the overall planning application package.

The Client has expressed their desire that a design embracing the principles of green infrastructure be implemented for the development. The scheme and proposed SuDS techniques were presented to DCC on 20th of June 2023, at a pre-application meeting under Section 247 of the Planning and Development Act 2000 as amended.

The purpose of this report is to explain the holistically integrated civil engineering solutions (primarily green infrastructure in the form of sustainable drainage systems, or SuDS) for the scheme and to describe the approaches taken in delivering the proposed solution.

In conjunction with other project planning information, this report should be used to describe the principles and details of the engineering design to support the planning submission.

2. Project Description

Dublin City Council intends to apply for planning permission of the "Older Persons Housing" project at St. Anne's Court in Raheny, Dublin 5. The proposed site is bound by All Saint's Park on the east, west and north. The proposal includes the demolition of all existing structures on site and the construction of new structures, as detailed below.

The project aims to replace the existing 61 bed-sit units on the site with 102 dwellings constructed to "Universal Design" and "Universal Design Plus" standards, as per the Dublin City Council Project Brief.

The project achieves the required 102nr - 1 bed 2-person Universal Design apartments, which include 96nr - 1 bed 2-person Universal Design apartments and 6nr 1 bed 2-person Universal Design Plus apartments. The overall massing is four stories on all elevations. The proposed development includes associated plant, landscaping and ancillary development and site works above and below ground.

Figure 1 Site Plan – © Google Maps

3. Reference Documents

The basis of the SuDS and drainage strategies outlined in this report are founded on the principles detailed in the below list of documents.

- Greater Dublin Strategic Drainage Study (GDSDS)
- Dublin City Council Sustainable Drainage Design and Evaluation Guide 2021
- Dublin City Council Green and Blue Roof Guide 2021
- CIRIA report C753 The SuDS Manual

4. Background Surveys

4.1 Topographical

A topographical survey of the existing site was carried out by Apex Surveys. The existing levels fall from 28.89m at the north-east of the site to 20.00m at the south-west of the site.

Refer to Appendix C.1 for the site topographical survey.

4.2 Utility

A utility survey of the existing site has been carried out by Apex Surveys. Refer to Appendix C.2 for the existing utility survey in the vicinity of the site.

5. Drawings

The following engineering drawings accompany this report:

Table 1 List of drawings

Drawing Number	Drawing Title
SAC-ARUP-ZZ-XX-DR-C-2100	Existing Topographical Survey
SAC-ARUP-ZZ-XX-DR-C-2101	Existing Site Services
SAC-ARUP-ZZ-XX-DR-C-2102	Proposed Project Zones
SAC-ARUP-ZZ-XX-DR-C-2103	Proposed SuDS Features and Catchment Boundaries Zone 1
SAC-ARUP-ZZ-XX-DR-C-2104	Proposed SuDS Features and Catchment Boundaries Zone 2
SAC-ARUP-ZZ-XX-DR-C-2105	Proposed Surface Water Network
SAC-ARUP-ZZ-XX-DR-C-2106	Proposed Foul and Watermain Networks
SAC-ARUP-ZZ-XX-DR-C-2107	Typical Details – Sheet 1 of 2
SAC-ARUP-ZZ-XX-DR-C-2108	Typical Details - Sheet 2 of 2

A copy of the engineering drawings is included in Appendix A.

6. Geotechnical Data

Preliminary design of the proposed development is informed by existing site investigation records, which are available from the construction of the existing buildings. A project specific site investigation has commenced on site and will include a number of soakaway tests to confirm the permeability of the in-situ soils, for final sizing and design of the SuDS features. The calculations in this report are based on a conservative view of the likely permeability given the high probability of typical Dublin boulder clays being present on site.

7. Existing Services

7.1 Existing Drainage

The existing drainage systems on the site are mainly combined with some separate foul and surface water drains connecting to the combined system. These drains discharge by gravity through 2 No. existing 225mm and 150mm diameter pipes, which outfall to the combined sewer on All Saints Park at the south-east corner of the site and the west of the site respectively.

7.1.1 Foul Water

There is a 225mm existing concrete foul sewer on All Saints Park on both the east and west sides of the proposed site. The existing 225mm foul sewers discharge to a 225mm foul sewer on Watermill Drive.

The current daily wastewater hydraulic loading is estimated to be 18.3 cubic metres per day.

The peak discharge is estimated to be 1.6 litres per second.

7.1.2 Surface Water

An existing 225mm diameter surface water sewer runs along the north and west (All Saints Park) of the development. A 300mm and 225mm surface water sewer on All Saints Park east and south of the site was identified on a utilities survey commissioned for the project and discharge in a southerly direction. From the utility survey it appears that the surface water sewer drains gullies from the public roadways and one of the existing buildings on the northeast side of the existing site.

See Appendix C for the Irish Water/DCC Drainage Division record drawing and underground utilities survey information carried out by Apex Surveys.

7.2 Existing Water

The site is bound by a 4-inch Irish Water watermain on the north and east sides of the site on All Saints Park. There is an existing 6-inch watermain on All Saints Park along the west side of the development. The water supply connection to the existing development appears to be from a valved arrangement off the existing 6-inch watermain to the west of the site and 4-inch internal ring main on the north of the site on All Saints Park.

There are two fire hydrants located in the public way on All Saints Park. We would recommend that flow tests be carried out on the existing mains/hydrants to confirm both the pressure and flow from the existing network to confirm adequacy of supply and compliance with the Local Fire Officer's requirements and Part B of the Building Regulations.

See Appendix C for the Irish Water/DCC Drainage Division record drawing and underground utilities survey information carried out by Apex Surveys.

8. Proposed Services

8.1 Proposed Surface Water

8.1.1 Design Criteria

It is proposed to discharge the surface water to an existing 225mm diameter surface water sewer at the south-west corner of the site on All Saints Park, which in turn discharges south into a 300mm surface water sewer.

Surface water will be managed in accordance with the CIRIA SuDS Manual and discharges from the proposed development will be restricted in accordance with the Greater Dublin Strategic Drainage Study (GDSDS). Surface water discharges will be retained within the various SuDS systems, sized to contain the 1 in 100-year event plus 20% for climate change.

Surface water from the proposed development will be intercepted and treated in a SuDS system comprising of blue roofs, green roofs, swales and porous paving.

The drainage systems will be designed in accordance with Part H of the Building Regulations, BS EN 752 Drain and Sewer Systems outside Buildings, the Greater Dublin Regional Code of Practice for Drainage Works and Irish Water requirements.

8.1.2 Design Rainfall

The Dublin rainfall depth for various return periods and storm duration are provided by Met Eireann as indicated in the following table:

Table 2 Site Specific Dublin rainfall data

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 321238, Northing: 237840,

	Interval		Years										
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	120,
5 mins	2.6,	3.6,	4.2,	5.1,	5.7,	6.2,	7.7,	9.4,	10.6,	12.2,	13.6,	14.8,	15.5,
10 mins	3.6,	5.1,	5.9,	7.1,	7.9,	8.6,	10.7,	13.1,	14.7,	17.0,	19.0,	20.6,	21.6,
15 mins	4.2,	6.0,	6.9,	8.4,	9.3,	10.1,	12.6,	15.4,	17.3,	20.0,	22.4,	24.2,	25.5,
30 mins	5.6,	7.8,	9.0,	10.8,	12.0,	12.9,	16.0,	19.4,	21.7,	24.9,	27.7,	29.9,	31.4,
1 hours	7.3,	10.2,	11.6,	13.9,	15.4,	16.5,	20.2,	24.4,	27.2,	31.0,	34.4,	37.0,	38.8,
2 hours	9.7,	13.2,	15.1,	17.8,	19.7,	21.1,	25.7,	30.7,	34.0,	38.6,	42.7,	45.8,	47.8,
3 hours	11.4,	15.5,	17.6,	20.7,	22.8,	24.4,	29.5,	35.1,	38.8,	43.9,	48.4,	51.8,	54.1,
4 hours	12.8,	17.3,	19.6,	23.0,	25.2,	27.0,	32.5,	38.6,	42.6,	48.1,	52.9,	56.6,	59.0,
6 hours	15.1,	20.2,	22.8,	26.6,	29.2,	31.1,	37.4,	44.2,	48.6,	54.7,	60.0,	64.1,	66.8,
9 hours	17.8,	23.6,	26.5,	30.9,	33.8,	35.9,	42.9,	50.5,	55.4,	62.2,	68.0,	72.5,	75.5,
12 hours	20.0,	26.3,	29.6,	34.3,	37.4,	39.8,	47.4,	55.6,	60.9,	68.1,	74.4,	79.2,	82.4,
18 hours	23.5,	30.7,	34.4,	39.8,	43.3,	45.9,	54.4,	63.6,	69.4,	77.4,	84.4,	89.7,	93.2,
24 hours	26.4,	34.3,	38.3,	44.2,	48.0,	50.9,	60.0,	69.9,	76.2,	84.8,	92.3,	97.9,	101.7,
2 days	32.4,	41.4,	45.8,	52.2,	56.4,	59.5,	69.4,	79.8,	86.5,	95.5,	103.2,	109.0,	112.8,
3 days	37.5,	47.3,	52.2,	59.1,	63.5,	66.9,	77.4,	88.5,	95.5,	104.9,	112.9,	119.0,	123.0,
4 days	42.1,	52.6,	57.8,	65.2,	69.9,	73.5,	84.6,	96.2,	103.6,	113.4,	121.8,	128.1,	132.2,
6 days	50.3,	62.1,	67.9,	76.1,	81.3,	85.3,	97.4,	110.1,	118.0,	128.6,	137.6,	144.3,	148.7,
8 days	57.7,	70.7,	77.0,	85.9,	91.5,	95.8,	108.9,	122.5,	130.9,	142.2,	151.7,	158.8,	163.5,
10 days	64.6,	78.6,	85.4,	94.9,	101.0,	105.5,	119.4,	133.9,	142.8,	154.7,	164.7,	172.2,	177.1,
12 days	71.1,	86.1,	93.3,	103.5,	109.9,	114.7,	129.4,	144.6,	153.9,	166.4,	176.9,	184.7,	189.9,
16 days	83.4,	100.1,	108.2,	119.4,	126.5,	131.8,	147.9,	164.5,	174.6,	188.2,	199.5,	207.9,	213.5,
20 days	95.0,	113.3,	122.1,	134.3,	142.0,	147.7,	165.1,	182.9,	193.8,	208.3,	220.4,	229.4,	235.3,
25 days	108.8,	129.0,	138.6,	151.9,	160.3,	166.5,	185.4,	204.6,	216.4,	231.9,	244.9,	254.5,	260.7,

NOTES:
These values are derived from a Depth Duration Frequency (DDF) Model update 2023
For details refer to:
'Mateus C., and Coonan, B. 2023. Estimation of point rainfall frequencies in Ireland. Technical Note No. 68. Met Eireann',
Available for download at:
http://hdl.handle.net/2262/102417

To calculate the critical storm duration for the St. Anne's Court site we performed an analysis in the Microdrainage software package. The critical storm was identified as the 1:100 year, 16-hour long winter storm, with a rainfall depth of 67mm, allowing for 20% climate change. Refer to Appendix B.1 for the Microdrainage critical storm calculation.

8.1.3 Run-off Coefficient

Selection of a run-off coefficient can be somewhat subjective and there is a vast amount of literature advising on appropriate factors for various ground types, slopes etc. The table below provides a comprehensive selection of potential run-off coefficients for different land uses, soil types and slopes:

Table 3 Runoff coefficient

Land use	Slope (%)	Sand	Loamy sand	Sandy loam	Loam	Silt loam	Silt	Sandy clay loam	Clay loam	Silty clay loam	Sandy clay	Silty Clay	Clay
Forest	<0,5	0.03	0.07	0.10	0.13	0.17	0.20	0.23	0.27	0.30	0.33	0.37	0.40
	0,5–5	0.07	0.11	0.14	0.17	0.21	0.24	0.27	0.31	0.34	0.37	0.41	0.44
	5–10	0.13	0.17	0.20	0.23	0.27	0.30	0.33	0.37	0.40	0.43	0.47	0.50
	>10	0.25	0.29	0.32	0.35	0.39	0.42	0.45	0.49	0.52	0.55	0.59	0.62
Grass	<0,5	0.13	0.17	0.20	0.23	0.27	0.30	0.33	0.37	0.40	0.43	0.47	0.50
	0,5–5	0.17	0.21	0.24	0.27	0.31	0.34	0.37	0.41	0.44	0.47	0.51	0.54
	5–10	0.23	0.27	0.30	0.33	0.37	0.40	0.43	0.47	0.50	0.53	0.57	0.60
	>10	0.35	0.39	0.42	0.45	0.49	0.52	0.55	0.59	0.62	0.65	0.69	0.72
Crop	<0,5	0.23	0.27	0.30	0.33	0.37	0.40	0.43	0.47	0.50	0.53	0.57	0.60
	0,5–5	0.27	0.31	0.34	0.37	0.41	0.44	0.47	0.51	0.54	0.57	0.61	0.64
	5–10	0.33	0.37	0.40	0.43	0.47	0.50	0.53	0.57	0.60	0.63	0.67	0.70
	>10	0.45	0.49	0.52	0.55	0.59	0.62	0.65	0.69	0.72	0.75	0.79	0.82
Bare	<0,5	0.33	0.37	0.40	0.43	0.47	0.50	0.53	0.57	0.60	0.63	0.67	0.70
soil	0,5–5	0.37	0.41	0.44	0.47	0.51	0.54	0.57	0.61	0.64	0.67	0.71	0.74
	5–10	0.43	0.47	0.50	0.53	0.57	0.60	0.63	0.67	0.70	0.73	0.77	0.80
	>10	0.55	0.59	0.62	0.65	0.69	0.72	0.75	0.79	0.82	0.85	0.89	0.92
IMP		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

For the purposes of the hydraulic calculations in this report we have adopted the following run-off factors:

Table 4 Adopted Runoff coefficients

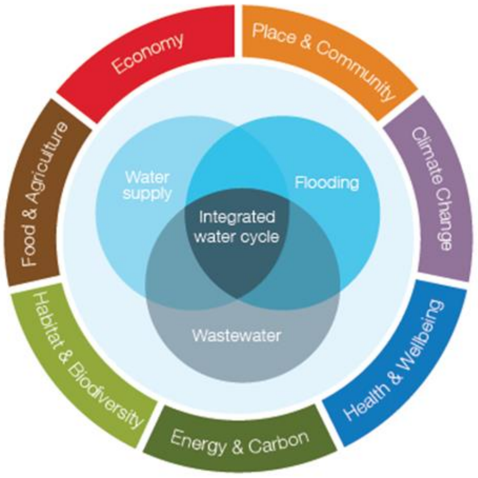
Land use	Run-off coefficient
Blue roofs	1.0 (throttled and attenuated in situ)
Hard paved areas	1.0
Permeable paving	0.7 (on the assumption there will be some infiltration capacity on site)
Green roof	0.7 (on the assumption circa 30% of rainfall gets intercepted)
Swale / Dry detention basin	1.0

8.1.4 Green Infrastructure

Green Infrastructure (GI) is a strategically planned and delivered network of natural and man-made green (land) and blue (water) spaces that sustain natural processes (CIRIA, 2014). GI delivers a wide variety of benefits for biodiversity, amenity, health and wellbeing and climate change adaptation. GI can be subdivided into assets and functions that may be a park, woodland, green roof or street tree (to name a few) and can range in terms of both size and scale. GI functions relate to the roles that the assets can play if planned and managed in a way that is sensitive to, and includes provision for, natural features and ecosystems services.

The Primary Objective of GI in the context of drainage is to improve the status quo (which typically has prioritised volumetric control of run-off over at-source volumetric control and water quality improvement) by bringing a new approach to creating sustainable development through Water Sensitive Urban Design.

Water Sensitive Urban Design is the process of integrating water cycle management with the built environment. It is about using the transition of water through communities to add value, to enhance the wellbeing of the people and their environment, both natural and man-made, in a way which is aesthetically pleasing and adds to our overall appreciation and enjoyment of the setting. For new developments, water and its management need to be central to the planning and urban design ethos.



Arup has identified the elements in the above graphic as core to successful and lasting Water Sensitive Urban Design strategies.

In a world of growing populations and changing climates, water management is of key importance for the health and wellbeing of our planet. Arup thinks and plans at catchment scale and fully integrates with the planning and management of urban systems to deliver Water Sensitive Urban Design.

We propose a concept for achieving water supply resilience through **blue** and **green** thinking.

Blue thinking

- Work with the **water cycle**
- Use **green** and **blue** space –create, expand, adapt
- Capture, store, re-use and release
- Design places using **water**
- Natural/semi-natural **puddles, pools, ponds, lakes, streams and rivers**
- Man-made: **Taps, toilets, reservoirs, canals, swales, fountains, ditches and drains**

Green thinking

- Use **green** and **blue** space –create, expand, adapt
- Capture, store and release and treat
- Design places using **vegetation**
- Natural/semi-natural: **bush, tree, wood, forest, meadow, wetland**
- Man-made: **green roof, planter, flowerbed, park, field, footpath, hedgerow**

8.1.5 SuDS

We propose to implement SuDS to the maximum extent possible across the full extent of the site, with the intention of filtering and storing rainfall at source and eliminating the need for conventional underground attenuation tank at the bottom end of the catchment. This will be achieved through a range of techniques and associated flow controls.

Sustainable drainage systems are designed to maximise the opportunities and benefits that can be secured from surface water management. SuDS can take many forms, both above and below ground, and they facilitate four main categories of benefits (water quantity, water quality, amenity, and biodiversity).

SuDS deliver high quality drainage while supporting urban areas to cope better with severe rainfall both now and in the future. SuDS also help counteract some of the impacts in the water cycle caused by increased urbanisation, such as reduced infiltration, which in turn can result in diminished groundwater supplies.

Arup has been delivering SuDS solutions worldwide in the last few years. The various available solutions for SuDS require a coordinated design between engineering, sustainability consultancy and landscape design.

There are several factors to be considered in advance of a system design including existing and proposed site topography, ground water levels, ground permeability, space availability, capital and ongoing maintenance costs etc.

A Management Train comprising of a series of features has been proposed to ensure that the series of features treat and attenuate the stormwater run-off to acceptable quality at greenfield rates of flow. Ideally systems should treat and control the run-off as close as possible to the source.

Several SuDS components in a Management Train facilitates the capture, conveyance and storage of surface water runoff while delivering interception and pollutant risk management. The suitability of different SuDS techniques in a Management Train is indicated in the following table:

Table 5 SuDS components within a management train

Indicative suitability of SuDS components within the Management Train				
SuDS component	**Interception**[1]	**Close to source/ primary treatment**	**Secondary treatment**	**Tertiary treatment**
Rainwater harvesting	Y			
Filter strip	Y	Y		
Swale	Y	Y	Y	
Filter drain	Y		Y	
Pervious pavements	Y	Y		
Bioretention	Y	Y	Y	
Green roof	Y	Y		
Detention basin	Y	Y	Y	
Pond	[3]	Y[2]	Y	Y
Wetland	[3]	Y[2]	Y	Y
Infiltration system (soakaways/ trenches/ blankets/basins)	Y	Y	Y	Y
Attenuation storage tanks	Y[4]			
Proprietary treatment systems		Y[5]	Y[5]	Y[5]

8.1.6 Proposed SuDS Techniques

We propose implementing a SuDS scheme at the St. Anne's Court site, compatible with the above philosophy. The site has been apportioned into two zones for the purpose of designing the SuDS scheme:

- Zone 1: Area comprising of the buildings and courtyard within
- Zone 2: Peripheral areas (ground floor between the outer building façade and redline boundary)

Refer to Drawing SAC-ARUP-ZZ-XX-DR-C-2102 in Appendix A for the extent of Zones 1 and 2.

The proposed SuDS scheme includes the following features:

Table 6 Zone 1 SuDS features

Area	SuDS techniques
Roof	Blue roof; Green roof
Courtyard	Permeable paving, Swales/Dry detention basins

Table 7 Zone 2 SuDS features

Area	SuDS techniques
Overall	Permeable paving Addition of gardens/green areas where feasible

The proposed SuDS techniques are indicated on Drawings SAC-ARUP-ZZ-XX-DR-C-2103 and SAC-ARUP-ZZ-XX-DR-C-2104 in Appendix A. Each technique is described in more detail below:

Blue Roofs

These are similar in principle to green roofs but with a variation in design that is explicitly intended to store water, typically via a reservoir zone beneath the finished surface.

We propose blue roofs on all the proposed blocks, sized to collect and store up to the 1 in 100-year rainfall event for slow release to the public system.

We propose blue roofs with a coverage of 37% of the total roof area.

Refer to Drawing SAC-ARUP-ZZ-XX-DR-C-2107 in Appendix A for typical blue roof details.

Green Roofs

These are roofs that are adapted or designed to support plants. They are areas of living vegetation, installed on the top of buildings for a range of reasons including visual benefit, ecological value, enhanced building performance and the reduction of surface water run-off. Green roofs offer many benefits including:

- Supporting biodiversity
- Providing cooler buildings in summer
- Cleaning run-off
- Reducing run-off for day-to-day rain

- Green roofs can be installed on a variety of roof types, sizes and slopes. They principally come in two forms – extensive (low substrate depth) and intensive (deeper substrates). Both types are unlikely to increase the load on a roof by more than 20%.

The principal components of a green roof structure are:

- Waterproof membrane
- Root barrier
- Drainage layer
- Geotextile filter layer
- Soil or growing medium
- Vegetation

Green roofs absorb most of the rainfall during frequent events but have a similar hydraulic performance to standard roofs once saturated. They can be assumed to meet interception requirements in the summer months based on their minimum retention of 5 to 10mm of rainfall. They can reduce the peak flow and volume of run-off in warmer periods when the soil moisture deficit is high. They are unlikely to perform as well during the winter months when they are likely to be saturated for much of the time.

We propose green roofs with a coverage of 25% of the total roof area.

To mitigate against reduced performance in the winter months we propose connecting the rainwater downpipes to swales at ground level, which will be sized to collect and store up to the 1 in 100-year rainfall event.

Refer to drawing SAC-ARUP-ZZ-XX-DR-C-2107 for typical green roof details.

Porous/Permeable Paving

These are hard surfaces that can support vehicles or pedestrian loading, which also allow rainfall to soak into the ground or into underground storage to slow the release of runoff. Porous surfaces, together with their associated substructures, are an efficient means of managing surface water runoff close to its source – intercepting runoff, reducing the volume and frequency of runoff, and providing a treatment medium.

There are three principal systems of water management below the surface of porous paving:

- Total infiltration (typically flat areas with highly permeable subsoil conditions)
- Partial infiltration (flat or sloping sites with partially permeable subsoils)
- No infiltration (flat or sloping sites with impermeable subsoils)

Building Regulations Part H indicates that Soakaways should not be constructed within 5 m of a building, this ‘rule’ is usually applied where infiltration within the 5m offset from the foundation is not permitted. We propose a partial infiltration philosophy for the St. Anne’s Court project as some areas of the porous pavement is within 5m of the proposed building.

Porous pavements are not suitable in areas at high risk of silt loads. They generally require flow controls at the outlets to ensure effective use of the storage in the subbase. The design thickness will be the greater of:

- Required thickness for hydraulic storage
- Required thickness structurally

If the site is sloping (as is the case for the St. Anne's Court site), then check dams may be required at intervals to maximise the storage in the substructure.

We propose porous paving to the pedestrian pathways within the central courtyard of the development.

The porous paving will be sized to collect and store up to the 1 in 100-year rainfall event.

Refer to Drawing SAC-ARUP-ZZ-XX-DR-C-2103 in Appendix A for the extent of the proposed porous paving and Drawing SAC-ARUP-ZZ-XX-DR-C-2108 in Appendix A for typical porous paving details.

Swales/Dry detention basins

Swales are shallow, flat bottomed, vegetated open channels designed to convey, treat and often attenuate surface water runoff. They can enhance the natural landscape and provide aesthetic and biodiversity benefits. They are designed to slow the water thereby facilitating sedimentation, filtration through the root zone and soil matrix, evapotranspiration and infiltration into the underlying soil.

On sites with steeper gradients, swales can have berms or check dams across the flow path to temporarily pond runoff, reduce velocities and increase pollutant retention and infiltration.

Typical features of a swale include:

- Bottom width 0.5 – 2.0m
- Longitudinal gradient 0.5 – 6%
- Maximum side slope 3%
- Maximum depth typically 400 – 600mm

We propose a network of swales to take excess runoff from the green roofs, hard roof areas, ground level landscaped areas and footpaths on the periphery of the courtyard. The swales discharge to a collector filter drain running beneath the courtyard permeable paving pathways. The swales will be fitted with orifice plates to restrict the discharge rate, to encourage infiltration and to attenuate runoff.

Refer to drawing SAC-ARUP-ZZ-XX-DR-C-2105 in Appendix A for locations of the swales and drawing STAC-ARUP-ZZ-XX-DR-C-2108 for a typical swale detail.

The management train for the proposed SuDS scheme is:

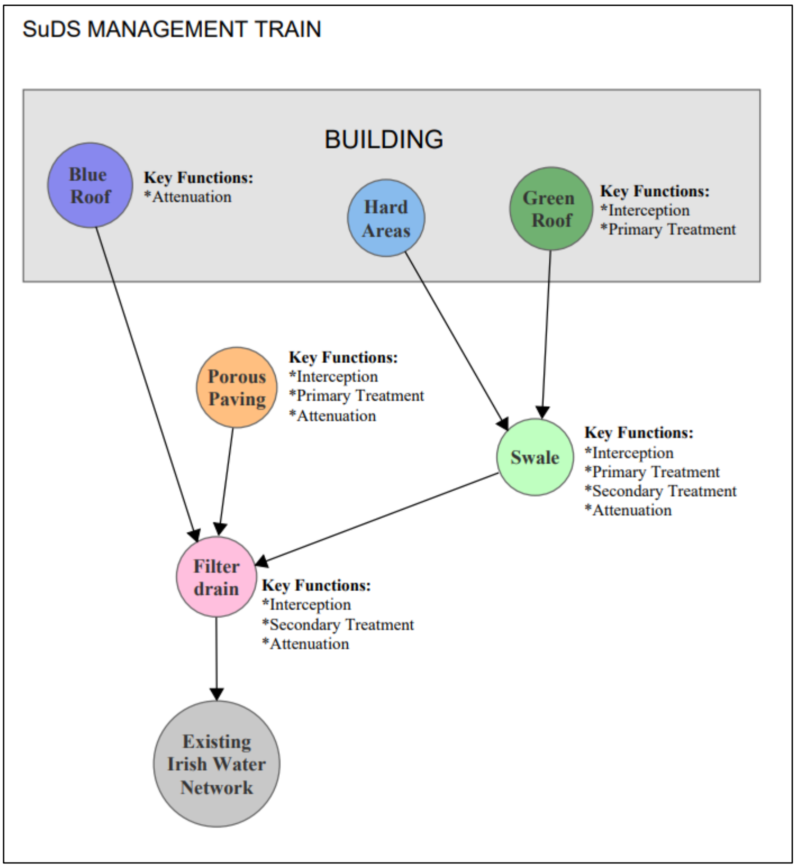


Figure 2 SuDS schematic and management train

A full schematic of the Zone 1 catchments and SuDS scheme is provided in Appendix B3.

8.1.7 Catchment Delineation

For the purpose of hydraulic calculations, the site has been divided into catchments based on SuDS technique/surface finish/topography. See Drawings SAC-ARUP-ZZ-XX-DR-C-2103 and SAC-ARUP-ZZ-XX-DR-C-2104 in Appendix A.

Zone 1 (Building and Courtyard):

The catchments for Zone 1 are summarised in the following table:

Table 8 Zone 1 catchments

Zone	Level	Catchment name	Details	Total area (m2)
1	Roof	BR.A1, BR.A2, BR.B, BR.C, BR.D1, BR.D2	Blue roof	1056
1	Roof	GR.A, GR.B, GR.C1, GR.C2, GR.D	Green roof	724
1	Roof	HL1.1, HL1.2, HL1.3, HL1.4, HL1.5, HL1.6, HL1.7, HL1.8, HL1.9, HL1.10, HL1.11	Hard standing	1076
1	GF	SW.A1, SW.A2, SW.B1, SW.B2, SW.C1, SW.D	Swale	336
1	GF	SL1.1, SL1.2, SL1.3, SL1.4, SL1.5, SL1.6, SL1.7, SL1.8, SL1.9, SL1.10, SL1.11, SL1.12, SL1.13	Soft Landscaping	1087
1	GF	PP1.1	Permeable Paving	419
				4,697

Zone 2 (Peripheral areas):

The catchments for Zone 2 are summarised in the following table:

Table 9 Zone 2 catchments

Zone	Catchment name	Details	Total area (m2)
2	SL2.1, SL2.2, SL2.3, SL2.4, SL2.5, SL2.6, SL2.7, SL2.8, SL2.9, SL2.10, SL2.11, SL2.12, SL2.13, SL2.14, SL2.15, SL2.16, SL2.17, SL2.18, SL2.19, SL2.20, SL2.21, SL2.22, SL2.23, SL2.24, SL2.25, SL2.26, SL2.27, SL2.28, SL2.29, SL2.30	Soft Landscaping	693
2	PP2.1, PP2.2, PP2.3	Permeable Paving	99
2	HL2.1, HL2.2, HL2.3, HL2.4, HL2.5, HL2.6, HL2.7, HL2.8	Hard Landscaping	765
			1557

8.1.8 QBAR Calculation

A QBAR calculation was carried out for the site within the redline boundary (0.6254 hectares) to determine the allowable run-off rate, as presented in Appendix B2.

The $QBAR_{rural}$ figure equates to 2.852 l/s. When including the multiplier of 2.6 for the 1:100 year event the QBAR = 7.42 l/s.

When looking at Zone 1, the allowable discharge for the area of 0.4701ha:

QBAR= 2.14 l/s. When including the multiplier of 2.6 for the 1:100 year event the QBAR for Zone 1 = 5.57 l/s.

The QBAR for Zone 2 would therefore equate to 1.85 l/s

All the QBAR figures above relate to greenfield sites. The St. Anne’s Court site is brownfield so our strategy is to limit the discharge in Zone 1 to the greenfield QBAR rate, where we can make the biggest impact in terms of reducing the peak discharge via implementation of a comprehensive

SuDS scheme. The Zone 1 SuDS scheme will have throttles on the blue roofs, swales (collecting runoff from the green roofs, hard roof areas and ground level soft landscaped areas) and the bottom end of the porous paving system (the final chamber will comprise an orifice plate restricting the Zone 1 discharge to less than the QBAR rate of 5.57 l/s).

We are not proposing any throttles or formal collection of surface water in Zone 2 as it would require an extensive network of linear drains e.g. aco channels to be installed along the redline boundary to intercept a relatively small amount of water that currently runs off directly into the public system.

As demonstrated in this report the proposed SuDS scheme will result in an overall significant reduction in the peak discharge when considering the overall site (Zone 1 plus Zone 2).

8.1.9 Throttles

Outlet structures are proposed to convey and control the flow out of the SuDS components. Their principal function is to throttle the discharge passed downstream in accordance with the GDSDS and thereby enable the attenuation volume to fill. Outlets can either be on the surface, piped systems or slow seepage systems. Outlets are usually built into the downstream side of SuDS components with easy access for maintenance.

The SuDS components at St. Anne's Court have been designed to maximise the volume of surface water stored locally (at source). The following throttles will help to achieve this goal:

Table 10 Proposed throttles

SuDS Technique	Throttle
Blue roof	Outlet Flow Restrictor (orifice)
Swale	Outlet Flow Restrictor (orifice)
Greenroof	Discharges to swale, which has a flow restrictor
Porous Paving	Final Outlet Flow Restrictor (orifice)

The orifice plate throttle is described in more detail below:

Orifice Plate

An orifice is a circular or rectangular opening of a prescribed shape and size that allows a controlled rate of outflow when the orifice is submerged. The flow rate depends on the height of water above the opening (hydraulic head) and the size and edge treatment of the orifice. When using a simple orifice plate, the flow rate passing through the control is directly proportional to the square root of the upstream head. We propose that orifice plates be installed in the wall of an outlet flow control chamber.

$$Q = C_d \, A_o \sqrt{2gh}$$

Where:

Q	=	orifice discharge rate (m^3/s)
C_d	=	coefficient of discharge (m) (0.6 if material is thinner than orifice diameter; 0.8 if material is thicker than orifice diameter, 0.92 if edges of orifice are rounded)
A_o	=	area of orifice (m^2)
h	=	hydraulic head (m)
g	=	9.81 m/s^2

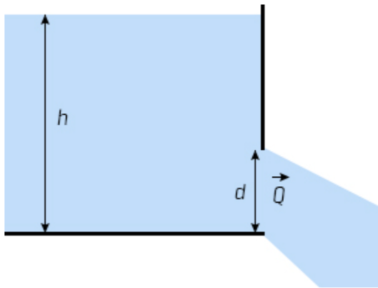


Figure 3 Orifice formula

We have considered 10mm, 20mm, 25mm and 50mm orifice plates. The following table indicates the discharge rate and velocity through the orifice for a range of heads up to 1m:

Table 11 Discharge through orifice

Head (m)	Hydraulics through Orifice							
	50mm		25mm		20mm		10mm	
	Q (l/s)	v (m/s)	Q (l/s)	v (m/s)	Q (l/s)	v (m/s)	Q (l/s)	v (m/s)
0.1	1.71	0.86	0.43	0.87	0.27	0.87	0.07	0.87
0.2	2.41	1.23	0.60	1.23	0.39	1.23	0.10	1.23
0.3	2.95	1.50	0.74	1.50	0.47	1.50	0.12	1.50
0.4	3.41	1.74	0.85	1.74	0.54	1.74	0.14	1.74
0.5	3.81	1.94	0.95	1.94	0.61	1.94	0.15	1.94
0.6	4.18	2.13	1.04	2.13	0.67	2.13	0.17	2.13
0.7	4.51	2.30	1.13	2.30	0.72	2.30	0.18	2.30
0.8	4.82	2.46	1.21	2.46	0.77	2.46	0.19	2.46
0.9	5.12	2.61	1.28	2.61	0.81	2.61	0.20	2.61
1.0	5.39	2.75	1.35	2.75	0.86	2.75	0.22	2.75

The maximum head of water on the final orifice plate in the catchpit SMH03 is circa 1m, resulting in a restricted flow rate through a 50mm orifice of 5.39 l/s at a velocity of 2.75 m/s, which is below the QBAR discharge rate for Zone 1 of 5.57 l/s.

8.1.10 Piped Networks

We propose constructing piped surface water networks as follows:

- Zone 1 – ground level filter drain network collecting discharges from the blue roofs (direct connection), green roofs and hard roof areas (routed via the swales), porous paving paths and ground level soft landscaped areas.

8.1.11 Hydraulic Calculations – Zone 1

Zone 1 volumetric calculations (m3)

The volumetric runoff for each catchment (see Drawings SAC-ARUP-ZZ-XX-DR-C-2103 and SAC-ARUP-ZZ-XX-DR-C-2104 in Appendix A) was calculated using a rainfall depth of 67mm (see section 8.1.2) and runoff factors as detailed in section 8.1.3.

The runoff volumes per catchment are presented in the table in Appendix B.4.

The various proposed SuDS techniques (see section 8.1.6) were then sized to store the calculated volume locally for rainfall events up to and including the 1:100-year event plus 20% for climate change, for slow release once the storm abates.

Storage is proposed in the following locations:

- Blue roof
- Green roof
- Permeable Paving
- Swales

The volume of rain falling on the footprint of Zone 1 has been calculated as 315 m^3, of which 74 m^3 is removed via interception and evapotranspiration and infiltration through soft landscaping, with the remaining 241 m^3 being stored/routed through the blue roof, swales and permeable paving subbase.

Table 12 Volume stored in SuDS techniques – Zone 1

SuDS Technique	Volume stored (m3)	Comments
Blue Roof	71	Discharges at 0.22 l/s per blue roof section (1.34 l/s total) to the DCC Surface Water Network
Greenroof	15	Removed through interception and evapotranspiration, excess rainfall discharges to swales
Porous Paving	10	Discharges to the DCC Surface Water Network
Swale	62	Discharges to the DCC Surface Water Network
Total	158	

The total volume of water leaving Zone 1 has been calculated at 241 m^3 compared to a rainfall volume of 315 m^3 i.e., a 23% reduction in volume.

The philosophy for each SuDS technique/drainage zone and hydraulic sizing is described below:

Blue Roofs

The blue roofs cover approximately 38% of the total roof area.

The entirety of the 1 in 100-year rainfall event can be stored within the build-up of the blue roof.

The discharge from the blue roofs will be controlled via a flow restrictor.

The total rate of water leaving the blue roof is circa 0.22 l/s per blue roof section i.e. cumulative discharge of 1.34 l/s.

Green Roofs

The green roofs cover approximately 25% of the total roof area. The first 10mm of rainfall on the existing buildings is intercepted by the green roof. All subsequent rainfall is brought to the swales within the central courtyard area.

The swales have been sized to store the entirety of the excess 1 in 100-year rainfall event.

The flow restricting orifice plate within the swale serves as the throttle, restricting the rate of flow to the piped network.

The cumulative rate of water leaving the swales to which the green roofs are connected is circa 2.64 l/s.

Swales / Detention Basins

Drawing SAC-ARUP-ZZ-XX-DR-C-2103 in Appendix A shows the catchment delineation, with corresponding hydraulic calculation tables in Appendix B6.

The green roof catchments and ground level soft landscaped areas are linked to a swale/detention basin with a flow restrictor installed at the outlet of the swales.

SW.A1, SW.A2, SW.B1, SWB2, SW.C1, SW.D connect to the piped network, with the flow restricted via an orifice plate in the last downstream manhole.

The total rate of water leaving the swales/dry detention basins is circa 2.64 l/s.

Porous Paving

The porous paving in the courtyard collects runoff from the path itself and some of the adjacent soft landscaped areas. It is underlain by a filter drain that has piped connections from the throttled blue roof and swale discharges. The filter drain network and stone base (30% void ratio) serve as the final attenuation system for Zone 1.

See catchment delineation drawing SAC-ARUP-ZZ-XX-DR-C-2103 in Appendix B6 and associated calculations in Appendix B4.

The stone base and filter drain have a capacity to store 65 m3 versus the required storage of 10 m3 (see calculation in Appendix B4) on the basis that 5.39 l/s exits the site from this system i.e. below the QBAR rate for Zone 1.

Zone 1 discharge calculations (l/s)

The estimated existing/pre-development runoff from the overall site is 72 l/s based on a rainfall intensity of 67 mm/hr for the 1:100-year rainfall event.

The estimated existing/pre-development runoff from Zone 1 is 58.9 l/s based on a rainfall intensity of 67 mm/hr for the 1:100-year rainfall event.

The post development discharge rate is:

- 1.34 l/s from the blue roofs at the uppermost level discharging to the filter collector drain in the porous paving.
- 2.64 l/s from the swales discharging to the filter collector drain in the porous paving.

The filter collector drain is part of the porous paving system in the courtyard that serves as the final SuDS attenuation system. The flow discharging from this system i.e. the total discharge leaving the site is 5.39 l/s (orifice plate installed in final manhole).

This represents a 90.8% reduction in peak discharge from Zone 1 post implementation of the SuDS measures.

8.1.12 Hydraulic Calculations – Zone 2

Zone 2 volumetric calculations (m3)

The runoff volumes per catchment, are presented in the table in Appendix B.5.

There is limited SuDS proposed in this area principally due to space constraints and the difficulty in collecting surface water from a narrow flat parcel of land. The cost of installing a linear drainage system along the perimeter of the site is cost prohibitive for what would be a marginal benefit in overall (Zone 1 plus 2) discharge rates.

There is a small section of porous paving and increased green areas to restrict the runoff rate and volume to figures we believe are feasible and reasonable.

The volume of rain falling on the footprint of Zone 2 has been calculated as 104 m3, of which 34.4 m3 is expected to be removed via infiltration, interception and evapotranspiration, with the remaining 69.6m3 discharging to the Irish Water network.

These figures are summarised in the following table:

Table 13 Volume stored in SuDS techniques – Zone 2

SuDS Technique	Volume stored (m3)	Comments
Porous paving	2	Removed through infiltration
Soft landscaping	32.5	Removed through interception and evapotranspiration
Total	34.5	

The total volume of water leaving Zone 2 has been calculated at 70 m3 versus a rainfall volume of 104 m3 i.e. 33% removed in the various SuDS techniques, compared to the current estimated 48 m3 runoff volume.

Zone 2 discharge calculations (l/s)

The estimated existing/pre-development runoff from the overall site is 72 l/s based on a rainfall intensity of 67 mm/hr for the 1:100-year rainfall event.

The estimated existing/pre-development runoff from Zone 2 is 13.3 l/s based on a rainfall intensity of 67 mm/hr for the 1:100-year rainfall event.

The post development discharge rate is 19.4 l/s, slightly higher than the pre-development rate, but we are not proposing any throttles or formal collection of surface water in Zone 2 as it would require an extensive network of linear drains e.g. aco channels to be installed along the redline boundary to intercept a relatively small amount of water that currently runs off directly into the public system. As demonstrated throughout this report the proposed SuDS scheme will result in an overall significant reduction in the peak discharge when considering the overall site (Zone 1 plus Zone 2).

8.1.13 Operation and Maintenance

The future operation and Maintenance of the SuDS components should be considered at all stages of the planning, design and construction process. At the planning stage it needs to be considered in terms of who will be doing it and whether they can do it. Design considerations include providing source control, ease of access, health and safety and potential cost of maintaining features. During and at the end of construction, inspection is necessary to ensure the system has been constructed correctly and will not require remedial works

Despite perceptions to the contrary, the maintenance requirements of well designed and constructed SuDS are quite simple, and it is easy to estimate the costs. Well designed and constructed SuDS that incorporate source control will be easy to maintain, regardless of whether they are landscape or hard engineered solutions. Poorly designed or constructed drainage systems without source control (e.g., end of pipe ponds, basins, wetlands and storage tanks) will be inherently more difficult and costly to maintain because of greater potential to silt.

A well-designed SuDS system will follow the management train principle and include source controls, followed by site and possibly regional features.

Maintenance operations can be divided into the following categories:

- **Regular -** this covers items that are carried out typically with a frequency from monthly to annually. It includes item such as inspection and monitoring, litter removal, grass cutting or other vegetation management, sweeping permeable pavements
- **Occasional -** this covers items that are required typically with a frequency from annually up to 25 years (or possibly greater).
- It includes items such as wetland vegetation management, silt removal from swales, ponds or wetlands, scarifying and spiking infiltration basins and gravel replacement to filter drains
- **Remedial -** this covers maintenance that is not usually required, but may be necessary because of vandalism, accidental damage, rainfall that exceeds the design capacity or similar events. Examples include repair of erosion in a swale or repair of permeable surfaces blocked for example by mixing concrete on them

Most manufacturers provide guidance on the maintenance requirements for the “harder” or engineered solutions. The recommendations can also be checked using knowledge of the estimated time for silt to build up in the system combined with judgement.

For soft SuDS the regular maintenance simply comprises litter removal, grass cutting and other vegetation management that landscape contractors are familiar with and will carry out for the rest of the open space. Additional items for the SuDS include inspection and clearing of flow control structures (inlets and outlets) and occasional removal of silt.

The recommended type and frequency of the operation and maintenance regime for the various SuDS techniques is provided in Table 32.1 of the CIRIA SuDS Manual 2015:

Table 14 SuDS maintenance

TABLE 32.1 Typical key SuDS components operation and maintenance activities (for full specifications, see Chapters 11–23)

Operation and maintenance activity	SuDS component												
	Pond	Wetland	Detention basin	Infiltration basin	Soakaway	Infiltration trench	Filter drain	Modular storage	Pervious pavement	Swale/bioretention/ trees	Filter strip	Green roofs	Proprietary treatment systems
Regular maintenance													
Inspection	■	■	■	■	■	■	■	■	■	■	■	■	■
Litter and debris removal	■	■	■	■	□	■	■	□	■	■	■		□
Grass cutting	■	■	■	■	□	■	■	□	□	■	■		
Weed and invasive plant control	□	□	□	□		□	□		□		□	■	
Shrub management (including pruning)	□	□	□	□					□	□	□		
Shoreline vegetation management	■	■	□										
Aquatic vegetation management	■	■	□										
Occasional maintenance													
Sediment management[1]	■	■	■	■	■	■	■	■	■	■	■		■
Vegetation replacement	□	□	□	□						□	□	■	
Vacuum sweeping and brushing									■				
Remedial maintenance													
Structure rehabilitation /repair	□	□	□	□	□	□	□	□	□	□	□	□	
Infiltration surface reconditioning				□	□	□	□		□	□	□		

Key

■ will be required

□ may be required

Notes

1 Sediment should be collected and managed in pre-treatment systems, upstream of the main device.

8.2 Proposed Foul

Foul drainage from the new development will be drained by a separate system to that of the surface water drainage system.

It is proposed to discharge the foul drainage from the new development to the existing foul sewer on All Saints Park via 2 No. connections to existing manholes.

See Arup Drawing SAC-ARUP-ZZ-XX-DR-C-2106 in Appendix A for proposed foul network.

The design team has liaised with Irish Water in relation to the Pre-connection Enquiry Application (PCE). A confirmation of feasibility has been received for the proposal with reference CDS23004655. All proposals are subject to agreement with Irish Water.

8.2.1 Design Criteria

The foul drainage system will be designed in accordance with Part H of the Building Regulations, BS EN 752 Drain and Sewer Systems outside Buildings, the Greater Dublin Regional Code of Practice for Drainage Works and Irish Water requirements.

8.2.2 Demand Estimation

The estimated foul discharge has been calculated based on "population" Method as per Irish Water Guidance:

Irish Water Code of Practice for Wastewater Infrastructure Water demands

Table 15 Foul demands (IW)

Occupants/Population	Flow	Flow	Flow	Peak factor	Total
	l/h/d	l/d	l/s		l/s
122	150	18,300	0.212	6	1.59

The proposed development will have 122 occupants based on occupancy rates for the 102 units.

The Irish Water Hydraulic Design Guidance advises a discharge of 150 litres per head per day for residential domestic.

The estimated daily wastewater hydraulic loading would be 18,3 cubic metres per day for the proposed development.

This figure equates to an average (DWF) of approximately 0.212 litres per second based on a 24-hour day.

Assuming a peaking factor of 6 times DWF for peak discharge. Peaking factor from Irish Water Wastewater Code of Practice.

Peak discharge would be 1.59 litres per second.

8.3 Proposed Water

The utility survey commissioned for the project indicates there is an existing 6 -inch diameter watermain running along All Saints Park on the west of the site.

The proposed connection to the existing 6-inch watermain is shown on Arup drawing SAC-ARUP-ZZ-XX-DR-C-2106 in Appendix A.

The design team has liaised with Irish Water in relation to the Pre-connection Enquiry Application (PCE). A confirmation of feasibility has been received for the proposal with reference CDS23004655. All proposals are subject to agreement with Irish Water.

The installation of low flow fittings for the development will reduce the demand on the existing water supply network.

8.3.1 Design Criteria

The new watermain network will be designed in accordance with the Irish Water “Code of Practice for Water Infrastructure” and detailed in accordance with the Irish Water “Water Infrastructure Standard Details” documents.

The proposed watermain system will be designed to supply water to the development with sluice valves and hydrants located in compliance with Part B of the Building Regulations and the local Fire Officers requirements. See Arup drawing SAC-ARUP-ZZ-XX-DR-C-2106 in Appendix A for layout of the watermain and connection to the public network.

8.3.2 Demand Estimation

The anticipated average water demand is 0.212 litres / second with a peak demand of 1.325 litres / second.

9. Summary

This report outlines the civil engineering design proposals for the proposed St. Anne's Court development. The proposals have been fully workshopped and aligned with the Architect and Landscape Architect.

A key area of focus is green infrastructure (GI). GI is a strategically planned and delivered network of natural and man-made green (land) and blue (water) spaces that sustain natural processes. GI delivers a wide variety of benefits for biodiversity, amenity, health and wellbeing and climate change adaptation. GI in the context of drainage translates into Sustainable Drainage Systems (SuDS). SuDS are designed to maximise the opportunities and benefits that can be secured from surface water management.

The site comprises the following zones:

- Zone 1: Building footprints and courtyard within
- Zone 2: Peripheral areas (ground floor between the building façade and redline boundary)

We propose implementing a range of SuDS techniques covering most of the site footprint. i.e., blue roof, green roof, porous paving and swale network.

The intention is to manage surface water runoff as close to source as possible. Where possible we have linked these SuDS features in a Management Train to facilitate the capture, conveyance and storage of surface water runoff as close to source as possible whilst delivering interception and pollutant risk management.

Most of these SuDS features can be designed to accommodate runoff up to and including the 1:100-year rainfall event. Where constraints such as sloping topography exist, interventions such as the installation of check dams and throttles can be made to maximise the storage of water at source e.g. on the porous paving system.

The volumetric runoff (pre and post development) and peak discharge (pre and post development) has been calculated for Zones 1 and 2, summarised as follows:

Table 16 Comparison of pre and post development volumetric runoff and peak discharge

Area	Volumetric runoff (m3)			Peak discharge (l/s)		
	Pre-development	Post-development	% increase	Pre-development	Post-development	% reduction
Zone 1	212	241	13.6%	59	5.39	91%
Zone 2	48	70	45.8%	13	19.4	49% increase
Overall site	260	311	19.6%	72	24.8	65%

If the full extent of the SuDS measures discussed in this report is implemented:

- The peak discharge from the site will be reduced by 47 l/s i.e., 65%, through installation of various throttles in strategic locations i.e., orifice plates from blue roof, porous paving and swales.

The discharge rate coming off Zone 1 has been restricted to 5.39l/s which is less than the calculated Q_{BAR} allowable discharge of 5.57l/s. Although the Zone 2 peak discharge rate has increased by 49%, the overall site has a reduction of 65%.

We do not consider it practical or cost effective to reduce this figure any further, as it would require an extensive network of linear drains e.g., aco channels to be installed along the redline boundary to intercept a small amount of water in Zone 2 and introduce the potential requirement for the addition of an attenuation tank. This would introduce additional capital, operating and maintenance costs that are disproportionately high when compared to the small reduction in flow that would be achieved by further interventions in Zone 2. It would further impact negatively on the carbon footprint of the project.

We are therefore hoping that Dublin City Council/Irish Water will accept the proposed discharge rates given the substantial SuDS solutions being proposed resulting in a significant reduction in peak discharge from the St. Anne’s Court site.

Appendix A (Drawings)

A.1 General Arrangements and Typical Details

A1

Legend

Redline Boundary

Rev	Date	By	Chkd	Appd
C02	20/12/23	DF	SB	GS
	Issued for Planning (Status S4)			
C01	21/08/23	DF	SB	GS
	Issued for Pre-Planning (Status A2)			

ARUP

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Tel +353(0)1 233 4455 Fax +353(0)1 668 3169

Client
Dublin City Council

Project Title
St. Anne's Court in Raheny
Dublin 5

Drawing Title
Existing Topographical Information

Scale at A1: 1:250

Role: Civil Infrastructure

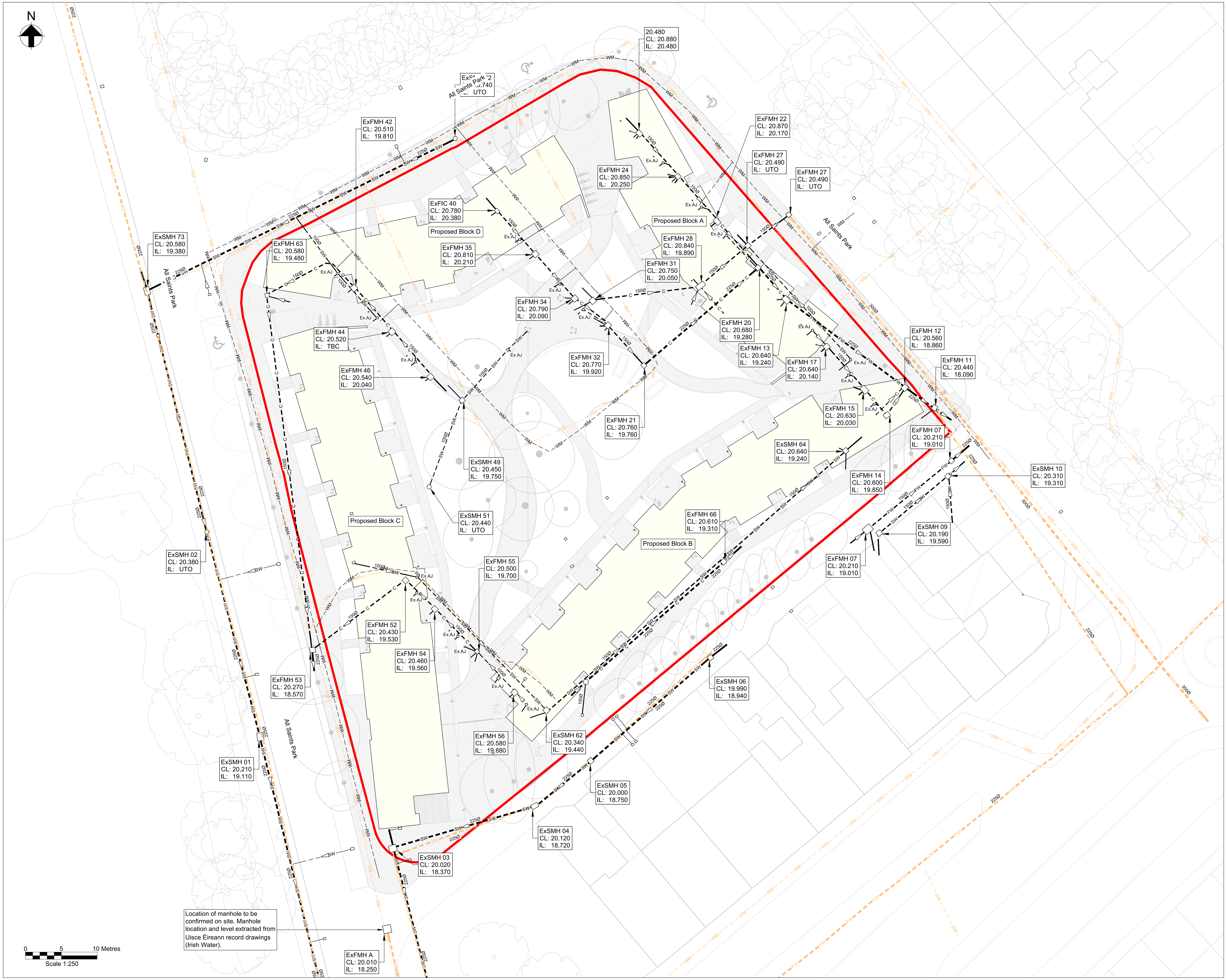
Suitability: S4 - Issued for Planning

Arup Job No: **288354-00**

Rev: **C02**

Name: **SAC-ARUP-ZZ-XX-DR-C-2100**

Do not scale



Legend:

Existing Surface Water Drain (GPR Survey)	SW
Existing Foul Drain (GPR Survey)	FW
Existing Watermain (GPR Survey)	WM
Existing Combined Drain (GPR Survey)	C
Existing Surface Water Drain (Records)	SW
Existing Foul Drain (Records)	FW
Existing Watermain (Records)	WM

UTO - Unable to Open
TBC - To be Confirmed
Ex.AJ - Existing Access Junction

Rev	Date	By	Chkd	Appd
C02	20/12/23	DF	SB	GS
	Issued for Planning (Status S4)			
C01	21/08/23	DF	SB	GS
	Issued for Pre-Planning (Status A2)			

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Client
Dublin City Council

Project Title
St. Anne's Court in Raheny
Dublin 5

Drawing Title
Existing Site Services

Scale at A1: 1:250

Role: Civil Infrastructure

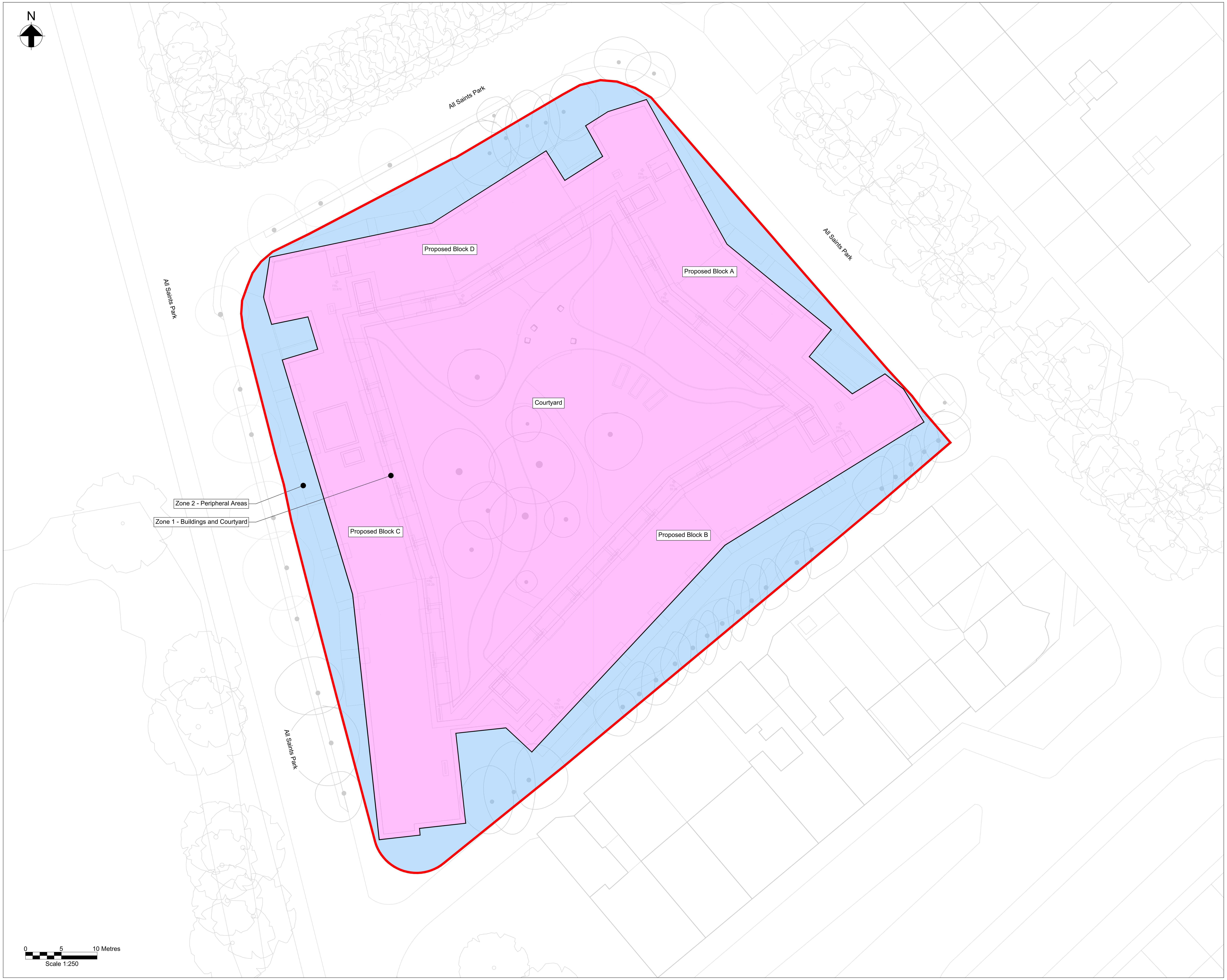
Suitability: S4 - Issued for Planning

Arup Job No: **288354-00**

Rev: **C02**

Name: **SAC-ARUP-ZZ-XX-DR-C-2101**

Do not scale



Legend

- Zone 1 - Buildings and Courtyard
- Zone 2 - Peripheral Areas
- Redline Boundary

Rev	Date	By	Chkd	Appd
C02	20/12/23	DF	SB	GS
	Issued for Planning (Status S4)			
C01	21/08/23	DF	SB	GS
	Issued for Pre-Planning (Status A2)			

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Client
Dublin City Council

Project Title
St. Anne's Court in Raheny
Dublin 5

Drawing Title
Proposed Project Zones

Scale at A1: 1:250

Role: Civil Infrastructure

Suitability: S4 - Issued for Planning

Arup Job No: **288354-00**

Rev: **C02**

Name: **SAC-ARUP-ZZ-XX-DR-C-2102**

Do not scale

Legend:

Green Roof	
Blue Roof	
Hard Landscaping	
Soft Landscaping	
Permeable Paving	
Zone 2	
Catchment Boundary	
Redline Boundary	

Refer to Arup drawing:
STAC-ARUP-ZZ-XX-DR-C-2104
For Zone 2 SuDS Features & Catchment Boundaries.

Rev	Date	By	Chkd	Appd
C02	20/12/23	DF	SB	GS
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Dublin 5

Drawing Title
Proposed SuDS Features & Catchment Boundaries
Zone 1

Scale at A1: 1:250

Role: Civil Infrastructure

Suitability: S4 - Issued for Planning

Arup Job No: 288354-00

Rev: C02

Name: SAC-ARUP-ZZ-XX-DR-C-2103

Do not scale

\\global\europe\dublin\jobs\288000\288354-00\4. Internal\4-02 Drawings\4-02-3 Civil Infrastructure\SAC-ARUP-ZZ-XX-DR-C-2103.dwg 20 Dec 2023 09:28:47

Legend:

Hard Landscaping	(orange fill)
Soft Landscaping	(green fill)
Permeable Paving	(blue hatched fill)
Zone 1	(grey fill)
Redline Boundary	(red line)

Refer to Arup drawing:
STAC-ARUP-ZZ-XX-DR-C-2103
For Zone 1 SuDS Features & Catchment Boundaries.

Rev	Date	By	Chkd	Appd
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Dublin 5

Drawing Title
Proposed SuDS Features & Catchment Boundaries
Zone 2

Scale at A1: 1:250

Role: Civil Infrastructure

Suitability: S4 - Issued for Planning

Arup Job No: 288354-00

Rev: C02

Name: SAC-ARUP-ZZ-XX-DR-C-2104

Do not scale

Legend:

- Proposed Surface Water Drain
- Proposed Perforated Drain
- Proposed Gravel Strip
- Proposed Swale
- Green Roof
- Blue Roof
- Proposed Perforated Riser Pipe Incorporating Orifice Plate Flow Control Device
- Outlet Connection
- Existing Surface Water Drain
- Redline Boundary

SMH - Surface Water Manhole
SWCP - Surface Water Catch Pit
SWIC - Surface Water Inspection Chamber

Rev	Date	By	Chkd	Appd
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	Issued for Planning (Status S4)			
C01	21/08/23	DF	SB	GS
	Issued for Pre-Planning (Status A2)			

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Project Title
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Dublin 5

Drawing Title
Proposed Surface Water Network

Scale at A1: 1:250

Role: Civil Infrastructure

Suitability: S4 - Issued for Planning

Arup Job No: 288354-00

Rev: C02

Name: SAC-ARUP-ZZ-XX-DR-C-2105

Do not scale

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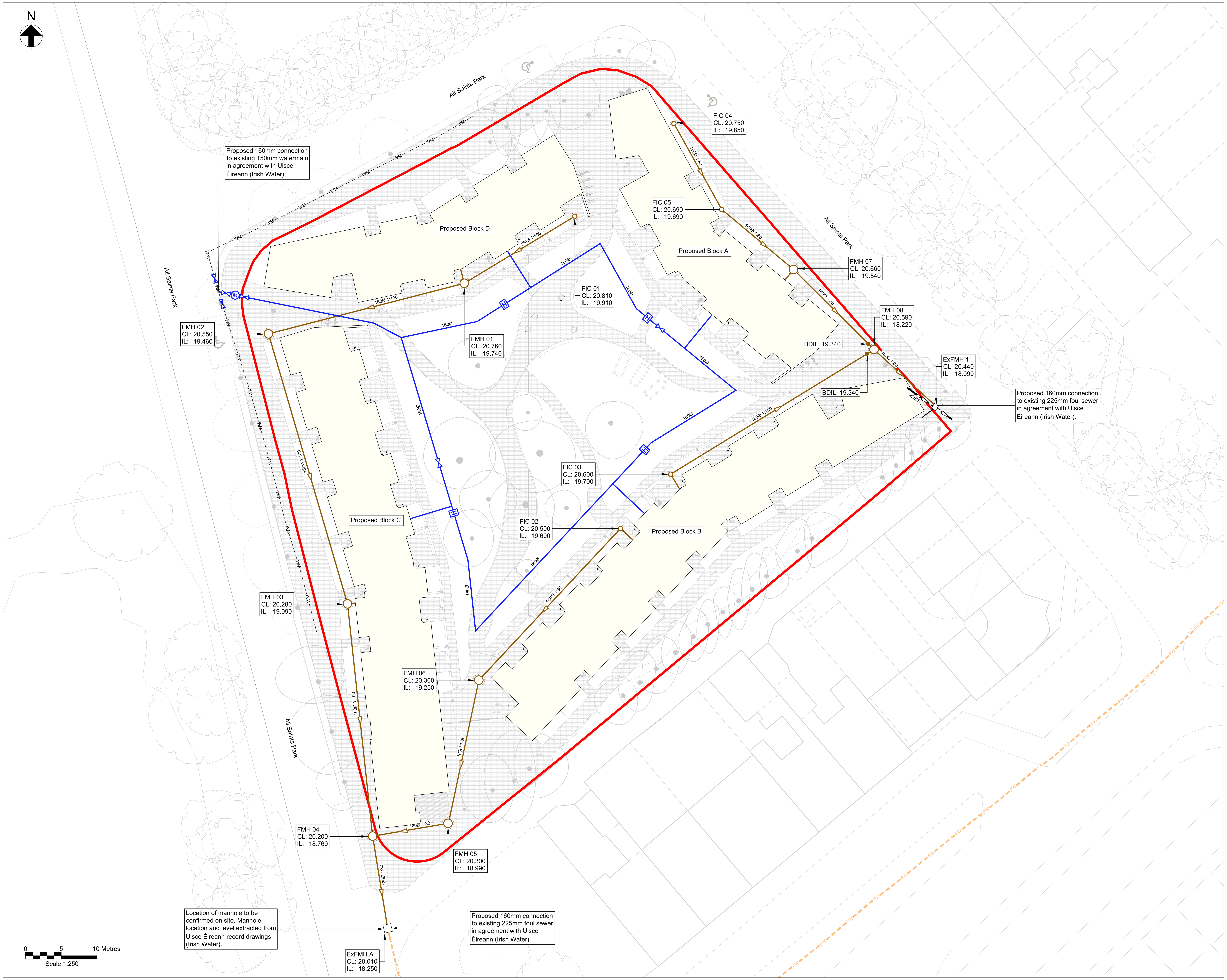

Legend:

- Proposed Foul Drain
- Proposed Back Drop
- Proposed Watermain
- Proposed Sluice Valve
- Proposed Water Meter
- Proposed Hydrant
- Existing Watermain
- Existing Combined Drain
- Existing Foul Drain (Records)
- Redline Boundary

Rev	Date	By	Chkd	Appd
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	Issued for Pre-Planning (Status A2)			

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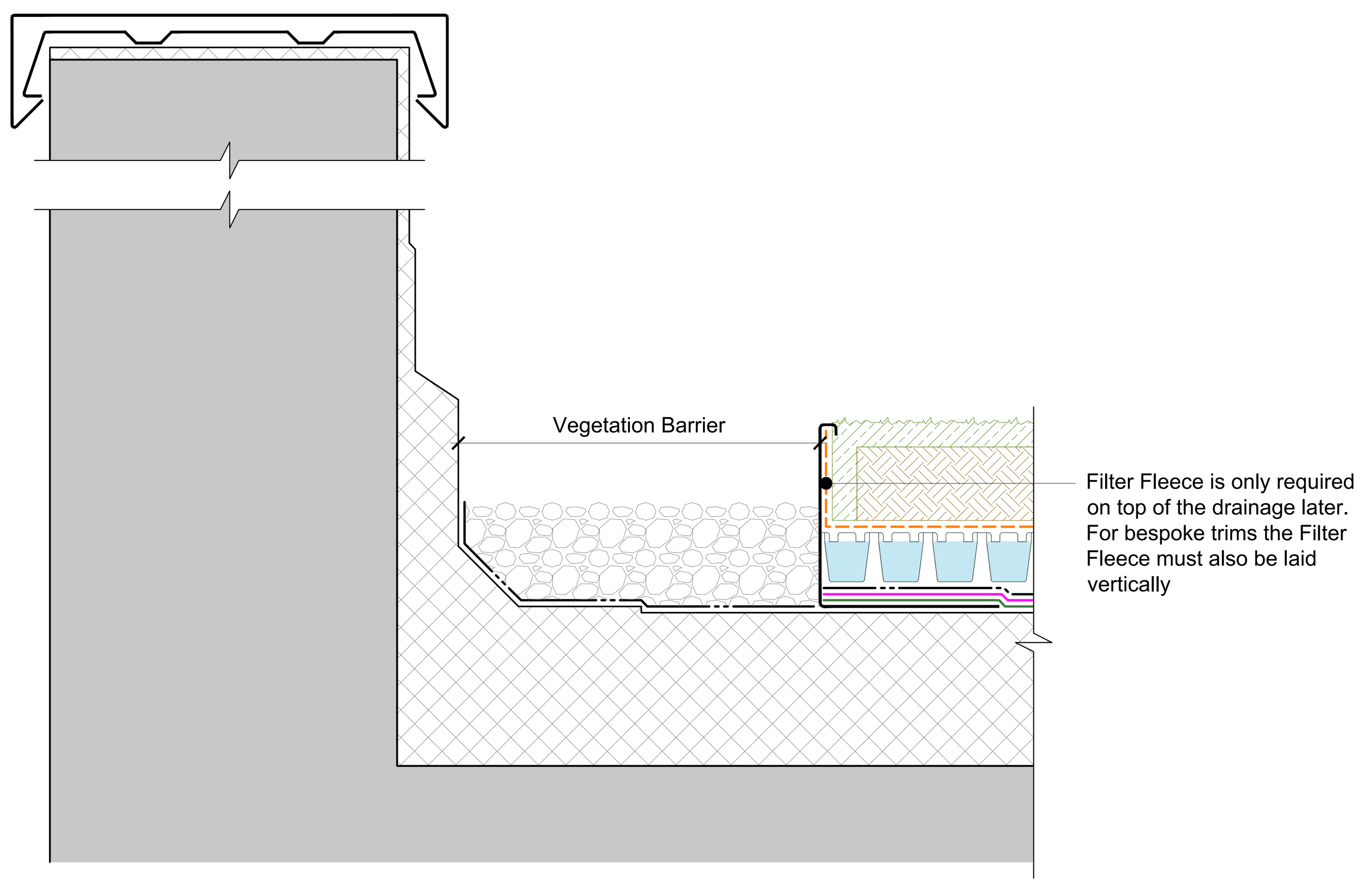
Dublin 5

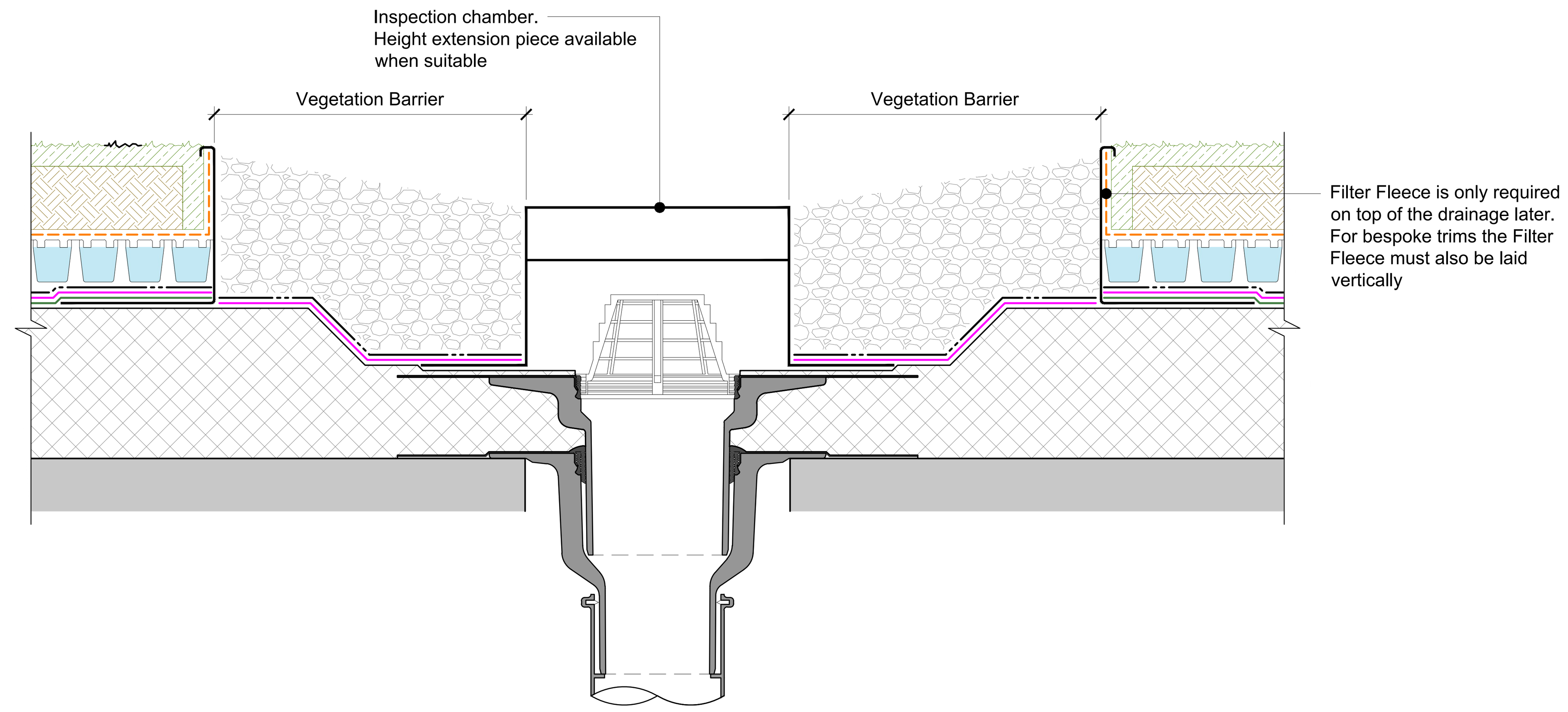
Drawing Title
Proposed Foul & Watermain Network

Scale at A1: 1:250
Role: Civil Infrastructure
Suitability: S4 - Issued for Planning
Arup Job No: 288354-00
Rev: C02
Name: SAC-ARUP-ZZ-XX-DR-C-2106

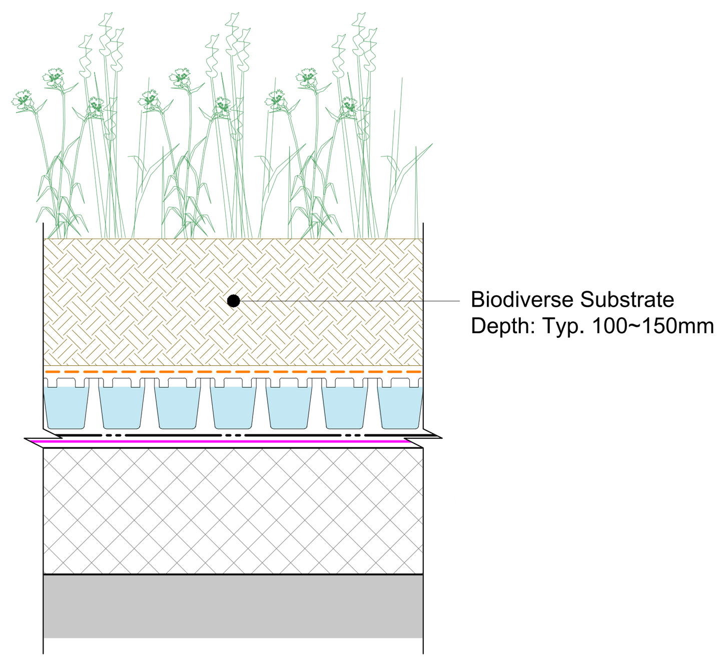
Do not scale



Green Roof - Upstand to Parapet
Scale: 1:5

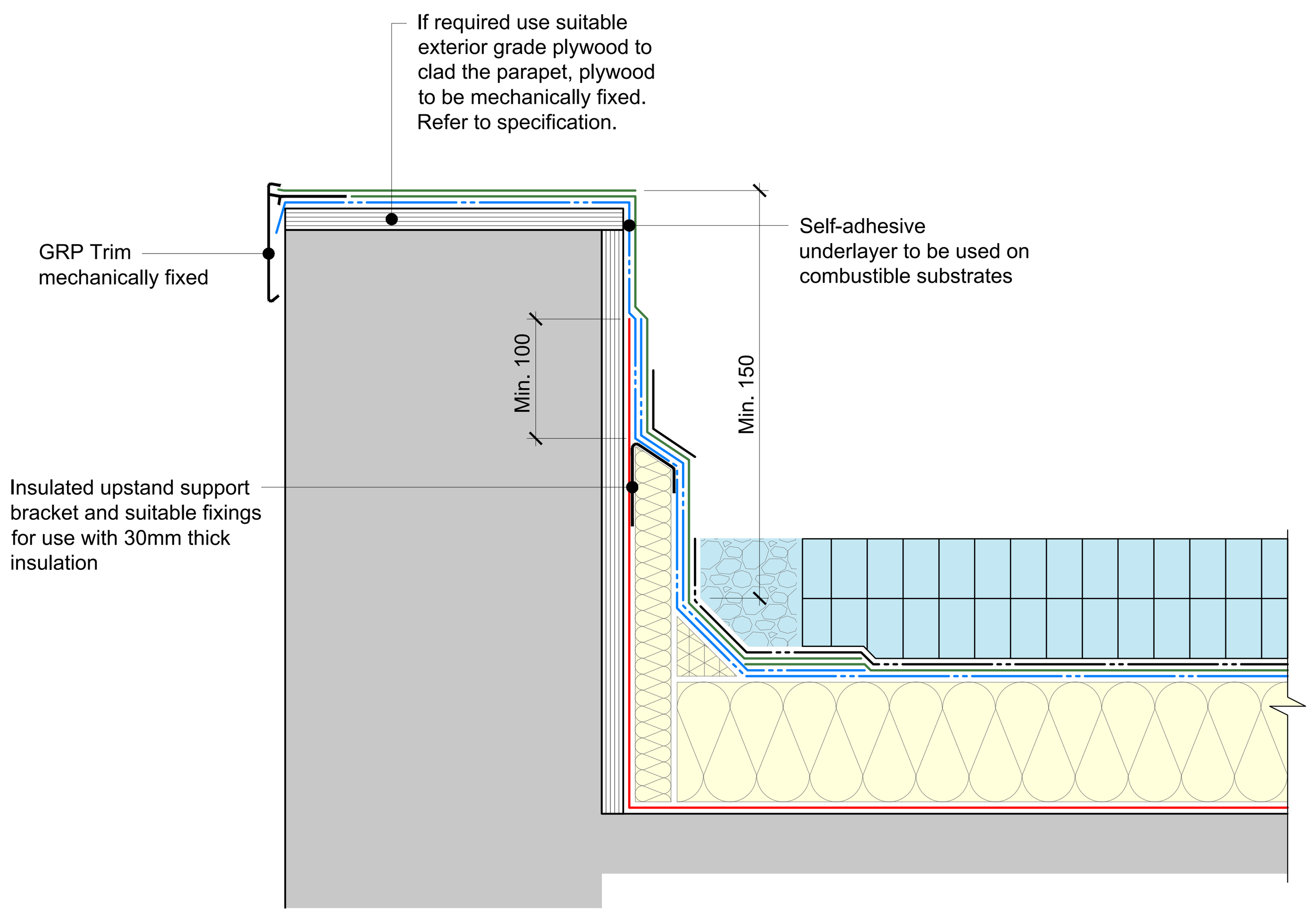


Green Roof - Outlet
Scale: 1:5

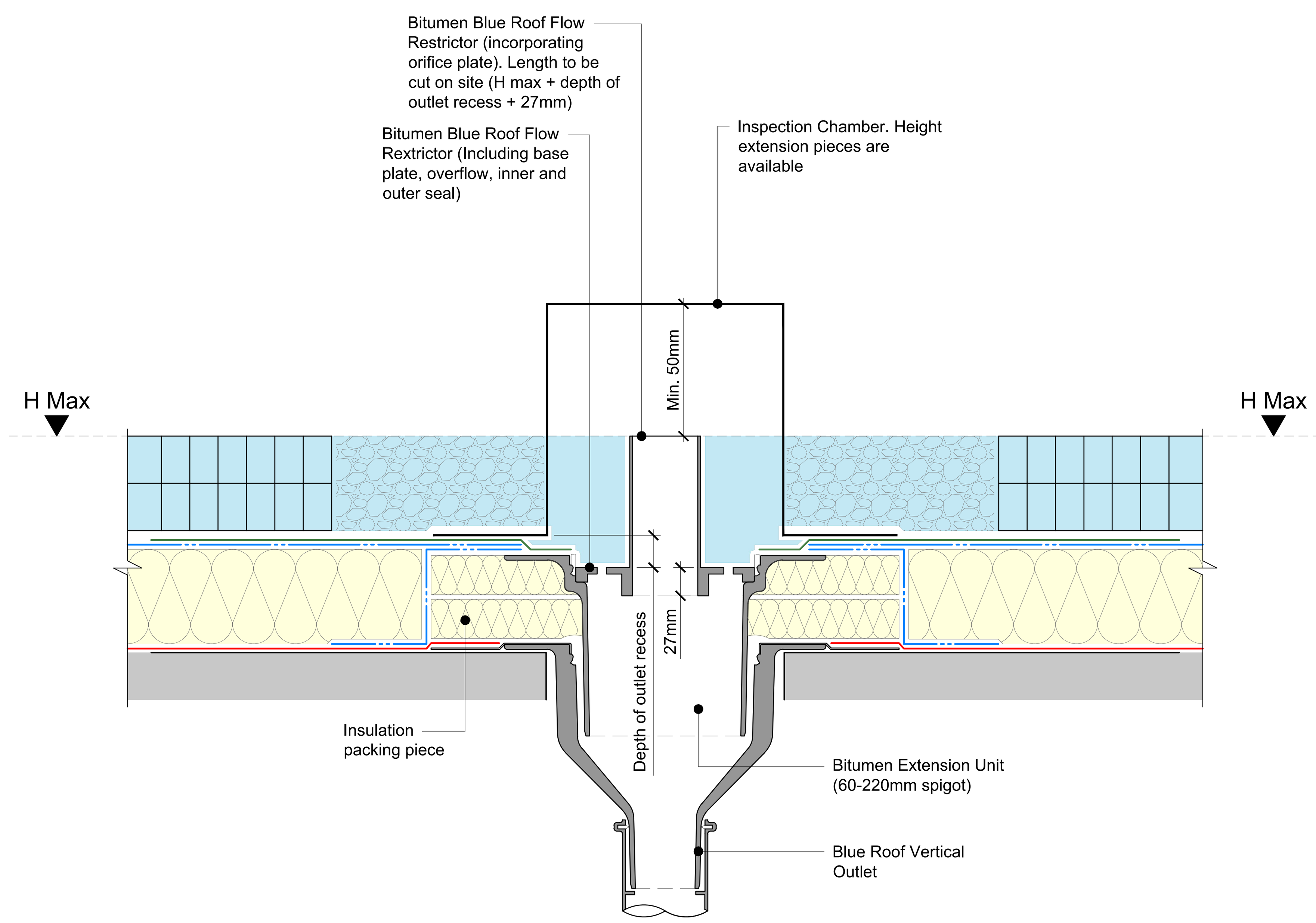


Build-up Depth (from): 145mm
Saturated Weight (from) 140kg/m²
(Excluding waterproofing system & planting)

Green Roof - Extensive Soft Landscaping
Scale: 1:5



Blue Roof - Parapet Upstand
Scale: 1:5



Blue Roof - Controlled Outlet
Scale: 1:5

0 0.05 0.1 0.15 0.2 0.25 Metres
Scale 1:5

Issue	Date	By	Chkd	Appd
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Project Title
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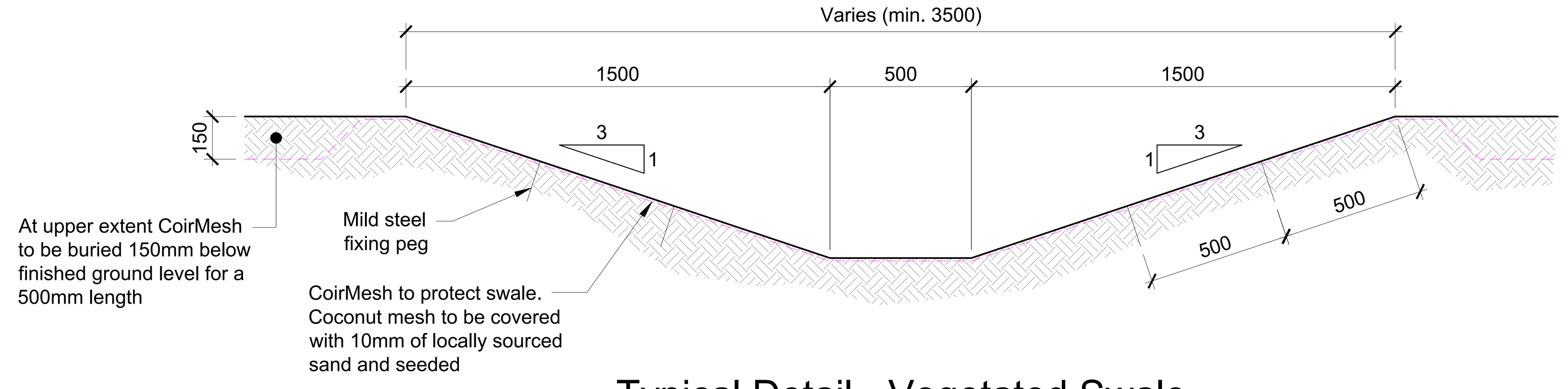
Dublin 5

Drawing Title
Typical Details
Sheet 1 of 2

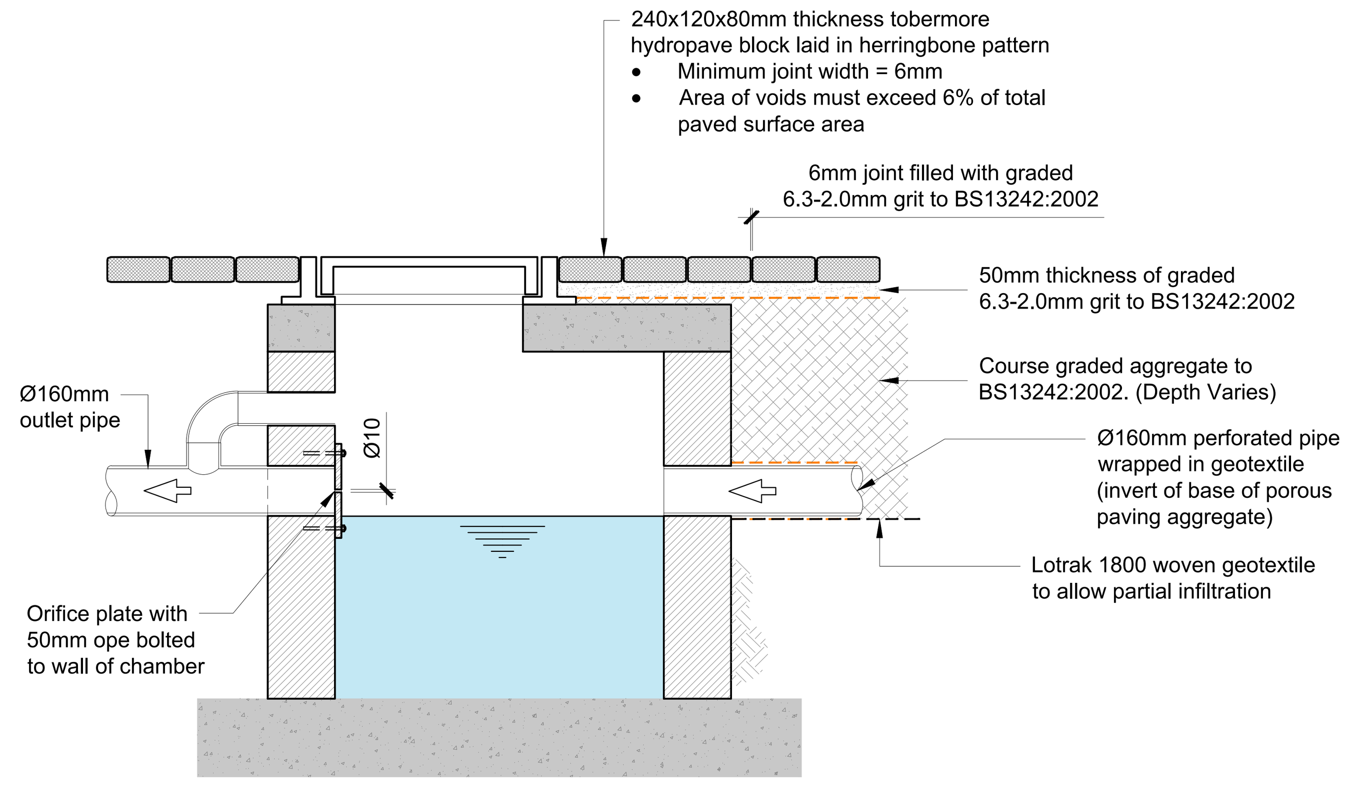
Scale at A1: 1:5
Role: Civil Infrastructure
Suitability: S4 - Issued for Planning
Arup Job No: 288354-00
Rev: C02
Name: SAC-ARUP-ZZ-XX-DR-C-2107

Do not scale



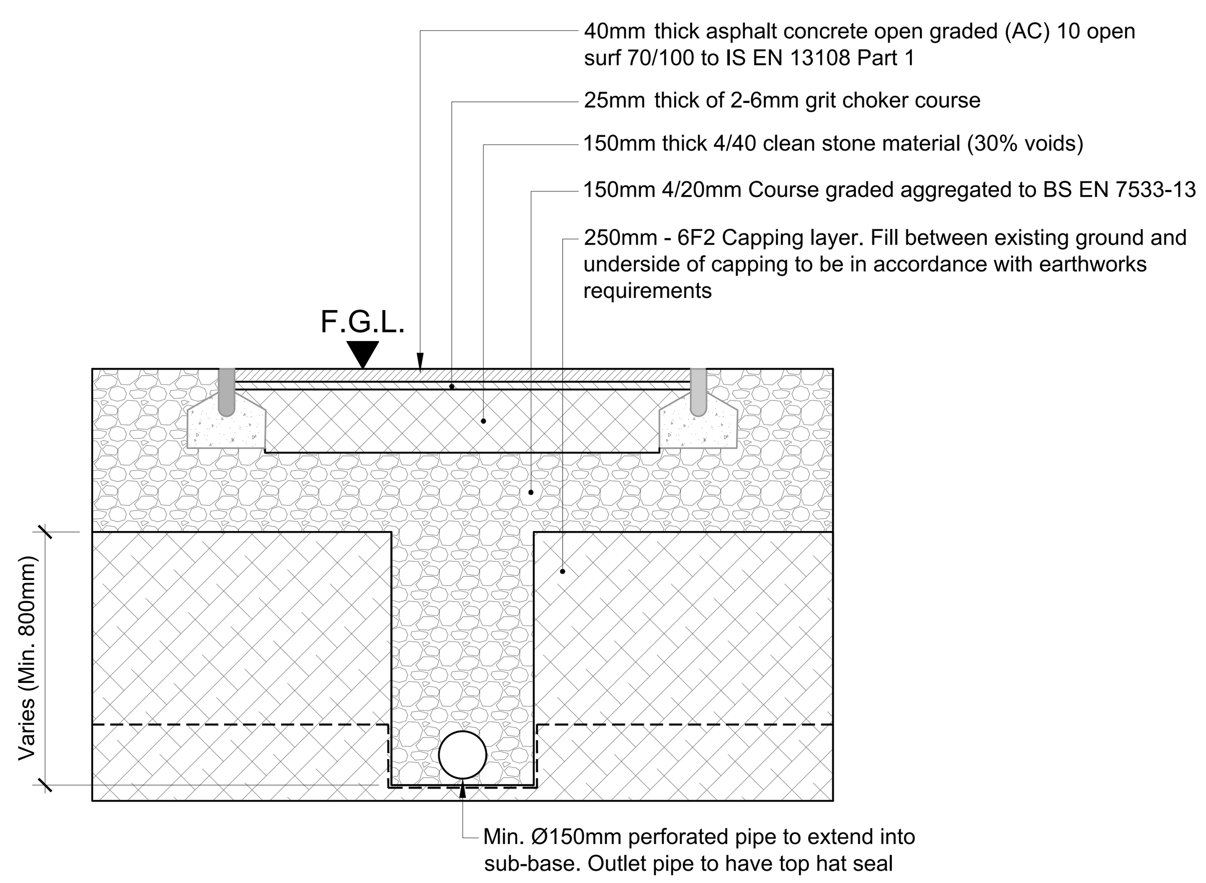
Typical Detail - Vegetated Swale

Scale 1:20



SMH 03 - Flow Control Chamber

Scale 1:20



Porous Asphalt Walkway Detail
Infiltration Trench
Section A-A

Scale: 1:20

C02	20/12/23	DF	SB	GS
	Issued for Planning (Status S4)			
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Rev	Date	By	Chkd	Appd

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Project Title
St. Anne's Court in Raheny
Dublin 5

Drawing Title
Typical Details
Sheet 2 of 2

Scale at A1 1:20

Role Civil Infrastructure

Suitability S4 - Issued for Planning

Arup Job No **288354-00**

Rev **C02**

Name **SAC-ARUP-ZZ-XX-DR-C-2108**

0 0.1 0.2 0.3 0.4 0.5 1.0 Metres
Scale 1:20

Do not scale

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Appendix B (Calculations)

B.1 Critical Storm Calculation

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	19.485	0.335	2.7	97.0	O K
30 min Summer	19.610	0.460	2.7	133.5	O K
60 min Summer	19.740	0.590	2.7	171.1	O K
120 min Summer	19.879	0.729	2.7	211.3	O K
180 min Summer	19.959	0.809	2.7	234.7	O K
240 min Summer	20.015	0.865	2.7	250.9	O K
360 min Summer	20.087	0.937	2.7	271.7	O K
480 min Summer	20.130	0.980	2.7	284.1	O K
600 min Summer	20.156	1.006	2.7	291.7	O K
720 min Summer	20.171	1.021	2.7	296.0	O K
960 min Summer	20.181	1.031	2.7	299.0	O K
1440 min Summer	20.183	1.033	2.7	299.5	O K
2160 min Summer	20.165	1.015	2.7	294.3	O K
2880 min Summer	20.137	0.987	2.7	286.1	O K
4320 min Summer	20.069	0.919	2.7	266.5	O K
5760 min Summer	19.996	0.846	2.7	245.3	O K
7200 min Summer	19.918	0.768	2.7	222.9	O K
8640 min Summer	19.829	0.679	2.7	196.9	O K
10080 min Summer	19.729	0.579	2.7	168.1	O K
15 min Winter	19.526	0.376	2.7	108.9	O K
30 min Winter	19.667	0.517	2.7	150.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	86.789	0.0	96.8	26
30 min Summer	59.964	0.0	133.9	41
60 min Summer	38.900	0.0	177.3	70
120 min Summer	24.535	0.0	223.7	130
180 min Summer	18.574	0.0	254.0	188
240 min Summer	15.221	0.0	277.4	248
360 min Summer	11.461	0.0	312.9	366
480 min Summer	9.359	0.0	339.9	484
600 min Summer	7.993	0.0	361.8	602
720 min Summer	7.024	0.0	379.7	722
960 min Summer	5.727	0.0	402.6	898
1440 min Summer	4.293	0.0	396.0	1140
2160 min Summer	3.217	0.0	531.0	1536
2880 min Summer	2.618	0.0	575.9	1960
4320 min Summer	1.957	0.0	642.7	2808
5760 min Summer	1.590	0.0	701.2	3632
7200 min Summer	1.353	0.0	745.9	4464
8640 min Summer	1.186	0.0	784.2	5280
10080 min Summer	1.061	0.0	817.6	5952
15 min Winter	86.789	0.0	108.5	26
30 min Winter	59.964	0.0	149.7	40

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	19.814	0.664	2.7	192.6	O K
120 min Winter	19.971	0.821	2.7	238.1	O K
180 min Winter	20.063	0.913	2.7	264.9	O K
240 min Winter	20.129	0.979	2.7	283.8	O K
360 min Winter	20.214	1.064	2.7	308.6	O K
480 min Winter	20.267	1.117	2.7	324.0	O K
600 min Winter	20.302	1.152	2.7	334.0	O K
720 min Winter	20.324	1.174	2.8	340.5	O K
960 min Winter	20.345	1.195	2.8	346.7	O K
1440 min Winter	20.341	1.191	2.8	345.5	O K
2160 min Winter	20.316	1.166	2.8	338.1	O K
2880 min Winter	20.270	1.120	2.7	324.9	O K
4320 min Winter	20.159	1.009	2.7	292.7	O K
5760 min Winter	20.040	0.890	2.7	258.1	O K
7200 min Winter	19.913	0.763	2.7	221.3	O K
8640 min Winter	19.746	0.596	2.7	172.7	O K
10080 min Winter	19.614	0.464	2.7	134.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	38.900	0.0	198.7	70
120 min Winter	24.535	0.0	250.5	128
180 min Winter	18.574	0.0	284.3	186
240 min Winter	15.221	0.0	310.4	242
360 min Winter	11.461	0.0	349.6	358
480 min Winter	9.359	0.0	378.9	474
600 min Winter	7.993	0.0	401.0	588
720 min Winter	7.024	0.0	414.7	700
960 min Winter	5.727	0.0	417.4	918
1440 min Winter	4.293	0.0	405.8	1190
2160 min Winter	3.217	0.0	594.6	1644
2880 min Winter	2.618	0.0	644.8	2108
4320 min Winter	1.957	0.0	715.4	3028
5760 min Winter	1.590	0.0	785.4	3920
7200 min Winter	1.353	0.0	835.4	4824
8640 min Winter	1.186	0.0	878.4	5536
10080 min Winter	1.061	0.0	916.0	6152

Rainfall depth:
Discharge volume / Site Area
=417.4m3 / 6254m2
= 67mm

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 321238, Northing: 237840,

	Interval		Years										
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	120,
5 mins	2.6,	3.6,	4.2,	5.1,	5.7,	6.2,	7.7,	9.4,	10.6,	12.2,	13.6,	14.8,	15.5,
10 mins	3.6,	5.1,	5.9,	7.1,	7.9,	8.6,	10.7,	13.1,	14.7,	17.0,	19.0,	20.6,	21.6,
15 mins	4.2,	6.0,	6.9,	8.4,	9.3,	10.1,	12.6,	15.4,	17.3,	20.0,	22.4,	24.2,	25.5,
30 mins	5.6,	7.8,	9.0,	10.8,	12.0,	12.9,	16.0,	19.4,	21.7,	24.9,	27.7,	29.9,	31.4,
1 hours	7.3,	10.2,	11.6,	13.9,	15.4,	16.5,	20.2,	24.4,	27.2,	31.0,	34.4,	37.0,	38.8,
2 hours	9.7,	13.2,	15.1,	17.8,	19.7,	21.1,	25.7,	30.7,	34.0,	38.6,	42.7,	45.8,	47.8,
3 hours	11.4,	15.5,	17.6,	20.7,	22.8,	24.4,	29.5,	35.1,	38.8,	43.9,	48.4,	51.8,	54.1,
4 hours	12.8,	17.3,	19.6,	23.0,	25.2,	27.0,	32.5,	38.6,	42.6,	48.1,	52.9,	56.6,	59.0,
6 hours	15.1,	20.2,	22.8,	26.6,	29.2,	31.1,	37.4,	44.2,	48.6,	54.7,	60.0,	64.1,	66.8,
9 hours	17.8,	23.6,	26.5,	30.9,	33.8,	35.9,	42.9,	50.5,	55.4,	62.2,	68.0,	72.5,	75.5,
12 hours	20.0,	26.3,	29.6,	34.3,	37.4,	39.8,	47.4,	55.6,	60.9,	68.1,	74.4,	79.2,	82.4,
18 hours	23.5,	30.7,	34.4,	39.8,	43.3,	45.9,	54.4,	63.6,	69.4,	77.4,	84.4,	89.7,	93.2,
24 hours	26.4,	34.3,	38.3,	44.2,	48.0,	50.9,	60.0,	69.9,	76.2,	84.8,	92.3,	97.9,	101.7,
2 days	32.4,	41.4,	45.8,	52.2,	56.4,	59.5,	69.4,	79.8,	86.5,	95.5,	103.2,	109.0,	112.8,
3 days	37.5,	47.3,	52.2,	59.1,	63.5,	66.9,	77.4,	88.5,	95.5,	104.9,	112.9,	119.0,	123.0,
4 days	42.1,	52.6,	57.8,	65.2,	69.9,	73.5,	84.6,	96.2,	103.6,	113.4,	121.8,	128.1,	132.2,
6 days	50.3,	62.1,	67.9,	76.1,	81.3,	85.3,	97.4,	110.1,	118.0,	128.6,	137.6,	144.3,	148.7,
8 days	57.7,	70.7,	77.0,	85.9,	91.5,	95.8,	108.9,	122.5,	130.9,	142.2,	151.7,	158.8,	163.5,
10 days	64.6,	78.6,	85.4,	94.9,	101.0,	105.5,	119.4,	133.9,	142.8,	154.7,	164.7,	172.2,	177.1,
12 days	71.1,	86.1,	93.3,	103.5,	109.9,	114.7,	129.4,	144.6,	153.9,	166.4,	176.9,	184.7,	189.9,
16 days	83.4,	100.1,	108.2,	119.4,	126.5,	131.8,	147.9,	164.5,	174.6,	188.2,	199.5,	207.9,	213.5,
20 days	95.0,	113.3,	122.1,	134.3,	142.0,	147.7,	165.1,	182.9,	193.8,	208.3,	220.4,	229.4,	235.3,
25 days	108.8,	129.0,	138.6,	151.9,	160.3,	166.5,	185.4,	204.6,	216.4,	231.9,	244.9,	254.5,	260.7,

NOTES:
These values are derived from a Depth Duration Frequency (DDF) Model update 2023
For details refer to:
'Mateus C., and Coonan, B. 2023. Estimation of point rainfall frequencies in Ireland. Technical Note No. 68. Met Eireann',
Available for download at:
http://hdl.handle.net/2262/102417

B.2 Qbar calculation

Calculation Sheet

ARUP

Job title	SCA Zone 1 works Q_{BAR}	Job number	Sheet number	Revision
		288254-00	1	01
Calc title	Greenfield Runoff Rate Analysis	Member/Location	ZZ	
		Drg. Ref.		
		Made by SB	Date 03/08/2023	Chd. GS

Greenfield Runoff Rate Analysis

Catchment Characteristics:
Total Site Area: 0.6254ha
SAAR: 723mm
SOIL: 4
SOIL Value: 0.45 (Taken from reference table below, *Table D1 Different Classes of Soil, GDSDS, Volume 2, Appendix D)*

SOIL	WRAP	Runoff	SOIL Value	Soil Characteristics
1	Very high	Very low	0.15	Sandy, well drained
2	High	Low	0.30	Intermediate soils (sandy)
3	Moderate	Moderate	0.40	Intermediate soils (silty)
4	Low	High	0.45	Clayey, poorly drained
5	Very low	Very high	0.50	Steep, rocky areas

Table D1 Different Classes of Soil

Extract from the Greater Dublin Strategic Drainage Strategy

The formula from report IoH 124:

$$\mathbf{QBAR_{rural} = 0.00108AREA^{0.89}SAAR^{1.17}SOIL^{2.17}}$$

As the site is less than 50ha, the formula is applied with an area of 50ha.

$QBAR_{rural} = 0.00108 \times 0.5^{0.89} \times 723^{1.17} \times 0.45^{2.17}$

$QBAR_{rural} = 0.00108 \times 0.5396 \times 2214 \times 0.1768$

$QBAR_{rural} = 0.2281\ m^3/s$

$QBAR_{rural} = 228$ l/s

$QBAR_{rural} = 4.56$ l/s/ha

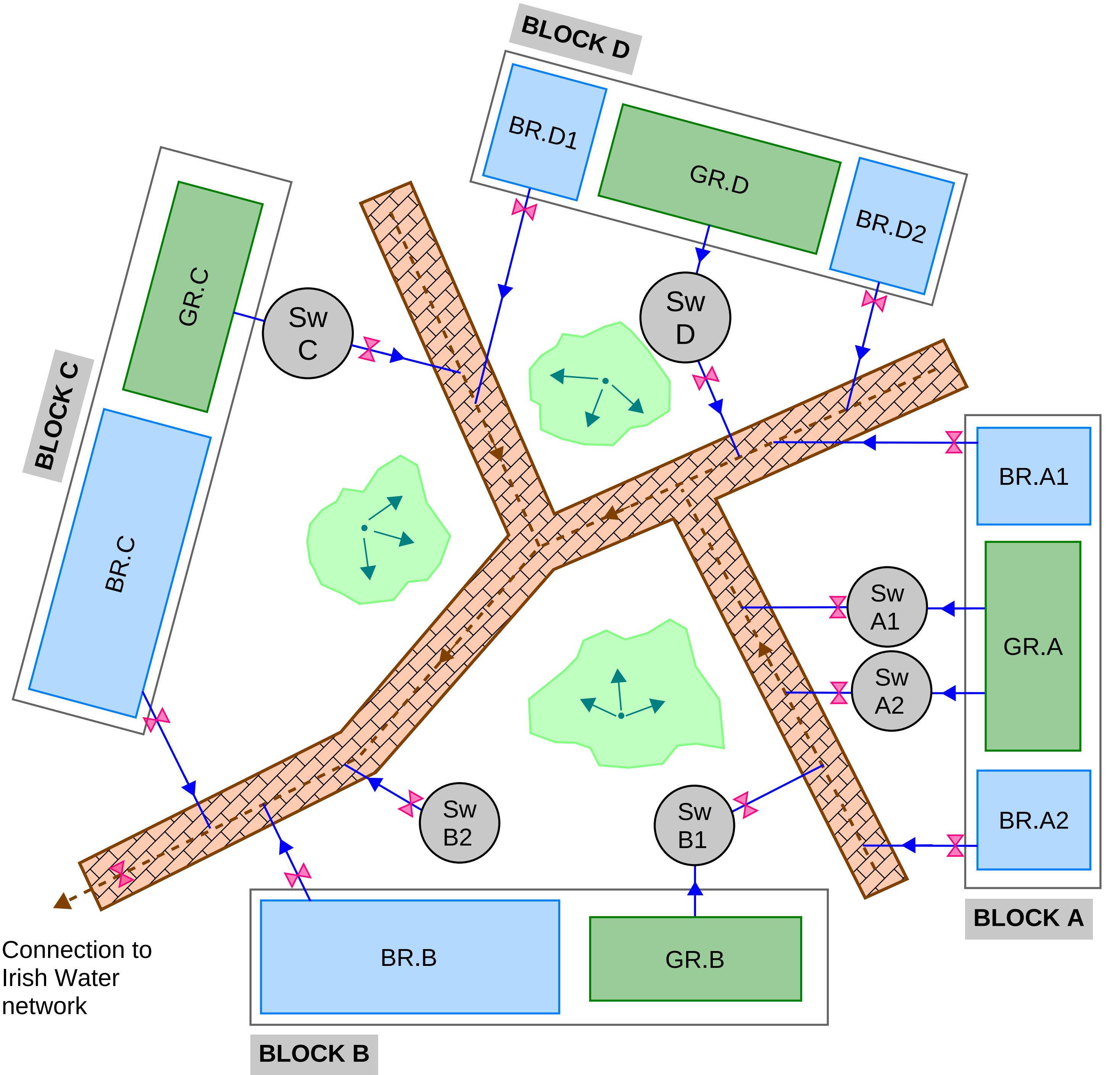
The allowable discharge for zone 1 is calculated for an area of 0.4701ha
∴ QBARZ1 = 2.14 l/s

With the multiplier of 2.6 for a 1:100 year event, the allowable runoff for Zone 1 = 5.57 l/s

The allowable discharge for proposed site is calculated for an area of 0.6254 ha
∴ QBAR = 2.852 l/s

B.3 Zone 1 SuDS Schematic

ST ANNES COURT
Zone 1 SuDS SCHEMATIC



LEGEND

- Blue roof
- Green roof
- Sx.x Swale
- Porous paving
- Gravel strip (extension of porous paving base) collecting runoff from mounded courtyard areas
- Surface water pipe
- Filter drain
- Orifice plate
- Mounded courtyard areas draining towards gravel strip / filter drain

B.4 Zone 1 Runoff Calculations

Predevelopement Zone 1

Catchment	Details	Rainfall depth	Area	Rainfall volume	Runoff factor	Runoff volume	Peak Discharge
		mm	m2	m3	C Coeff	m3	l/s
Zone 1	Hard Landscaping	67	2503	167.70	1.00	167.70	46.62
Zone 1	Soft Landscaping	67	2198	147.27	0.30	44.18	12.28
			4701	**314.97**		**211.88**	**58.90**

Post developement discharge, volume and rate
Zone 1

Zone	Level	Catchment	Details	Rainfall depth	Area	Rainfall volume	Runoff factor	Runoff volume
				mm	m2	m3	C Coeff	m3
1	Roof	BR.A1	Blue roof	67	96	6.4	1	6.4
1	Roof	GR.A	Green roof	67	64	4.3	0.7	3.0
1	Roof	BR.A2	Blue roof	67	158	10.6	1	10.6
1	Roof	GR.B	Green roof	67	160	10.7	0.7	7.5
1	Roof	BR.B	Blue roof	67	278	18.6	1	18.6
1	Roof	BR.C	Blue roof	67	332	22.2	1	22.2
1	Roof	GR.C1	Green roof	67	164	11.0	0.7	7.7
1	Roof	GR.C2	Green roof	67	178	11.9	0.7	8.3
1	Roof	BR.D1	Blue roof	67	97	6.5	1	6.5
1	Roof	GR.D	Green roof	67	158	10.6	0.7	7.4
1	Roof	BR.D2	Blue roof	67	95	6.4	1	6.4
1	Roof	HL1.1	Hard Landscaping	67	76	5.1	1	5.1
1	Roof	HL1.2	Hard Landscaping	67	43	2.9	1	2.9
1	Roof	HL1.3	Hard Landscaping	67	121	8.1	1	8.1
1	Roof	HL1.4	Hard Landscaping	67	74	4.9	1	4.9
1	Roof	HL1.5	Hard Landscaping	67	142	9.5	1	9.5
1	Roof	HL1.6	Hard Landscaping	67	188	12.6	1	12.6
1	Roof	HL1.7	Hard Landscaping	67	89	6.0	1	6.0
1	Roof	HL1.8	Hard Landscaping	67	126	8.5	1	8.5
1	Roof	HL1.9	Hard Landscaping	67	81	5.4	1	5.4
1	Roof	HL1.10	Hard Landscaping	67	81	5.4	1	5.4
1	Roof	HL1.11	Hard Landscaping	67	55	3.7	1	3.7
1	GF	SW.A1	Swale	67	49	3.3	1	3.3
1	GF	SW.A2	Swale	67	29	1.9	1	1.9
1	GF	SW.B1	Swale	67	88	5.9	1	5.9
1	GF	SW.B2	Swale	67	56	3.8	1	3.8
1	GF	SW.C1	Swale	67	48	3.2	1	3.2
1	GF	SW.D	Swale	67	66	4.4	1	4.4
1	GF	SL1.1	Soft Landscaping	67	6	0.4	0.3	0.1
1	GF	SL1.2	Soft Landscaping	67	55	3.7	0.3	1.1
1	GF	SL1.3	Soft Landscaping	67	62	4.2	0.3	1.2
1	GF	SL1.4	Soft Landscaping	67	161	10.8	0.3	3.2
1	GF	SL1.5	Soft Landscaping	67	120	8	0.3	2
1	GF	SL1.6	Soft Landscaping	67	41	2.7	0.3	0.8
1	GF	SL1.7	Soft Landscaping	67	103	6.9	0.3	2.1
1	GF	SL1.8	Soft Landscaping	67	45	3.0	0.3	0.9
1	GF	SL1.9	Soft Landscaping	67	223	14.9	0.3	4.5
1	GF	SL1.10	Soft Landscaping	67	112	7.5	0.3	2.3
1	GF	SL1.11	Soft Landscaping	67	101	7	0.3	2.0
1	GF	SL1.12	Soft Landscaping	67	16	1	0.3	0.3
1	GF	SL1.13	Soft Landscaping	67	42	3	0.3	0.8
1	GF	PP1.1	Permeable Paving	67	419	28.1	0.7	19.7
					4,697	**315**		**241**

B.5 Zone 2 Runoff Calculations

Predevelopement Zone 2

Catchment	Details	Rainfall depth	Area	Rainfall volume	Runoff factor	Runoff volume	Peak Discharge
		mm	m2	m3	C Coeff	m3	l/s
Zone 2	Hard Landscaping	67	356.14	23.86	1.00	23.86	6.63
Zone 2	Soft Landscaping	67	1196.86	80.19	0.30	24.06	6.69
			1553	**104.05**		**47.92**	**13.32**

Post developement discharge, volume and rate
Zone 2

Zone	Catchment	Details	Rainfall depth	Area	Rainfall volume	Runoff factor	Runoff volume
			mm	m2	m3	C Coeff	m3
2	SL2.1	Soft Landscaping	67	268	17.9	0.3	5.4
2	SL2.2	Soft Landscaping	67	9	0.6	0.3	0.2
2	SL2.3	Soft Landscaping	67	19	1.3	0.3	0.4
2	SL2.4	Soft Landscaping	67	18	1.2	0.3	0.4
2	SL2.5	Soft Landscaping	67	40	2.6	0.3	0.8
2	SL2.6	Soft Landscaping	67	19	1.3	0.3	0.4
2	SL2.7	Soft Landscaping	67	10	0.6	0.3	0.2
2	SL2.8	Soft Landscaping	67	14	1.0	0.3	0.3
2	SL2.9	Soft Landscaping	67	15	1.0	0.3	0.3
2	SL2.10	Soft Landscaping	67	12	0.8	0.3	0.2
2	SL2.11	Soft Landscaping	67	3	0.2	0.3	0.1
2	SL2.12	Soft Landscaping	67	9	0.6	0.3	0.2
2	SL2.13	Soft Landscaping	67	9	0.6	0.3	0.2
2	SL2.14	Soft Landscaping	67	8	0.5	0.3	0.2
2	SL2.15	Soft Landscaping	67	10	0.6	0.3	0.2
2	SL2.16	Soft Landscaping	67	10	0.6	0.3	0.2
2	SL2.17	Soft Landscaping	67	10	0.7	0.3	0.2
2	SL2.18	Soft Landscaping	67	14	1.0	0.3	0.3
2	SL2.19	Soft Landscaping	67	16	1.1	0.3	0.3
2	SL2.20	Soft Landscaping	67	13	0.9	0.3	0.3
2	SL2.21	Soft Landscaping	67	16	1.1	0.3	0.3
2	SL2.22	Soft Landscaping	67	16	1.1	0.3	0.3
2	SL2.23	Soft Landscaping	67	16	1.1	0.3	0.3
2	SL2.24	Soft Landscaping	67	16	1.1	0.3	0.3
2	SL2.25	Soft Landscaping	67	14	0.9	0.3	0.3
2	SL2.26	Soft Landscaping	67	34	2.3	0.3	0.7
2	SL2.27	Soft Landscaping	67	12	0.8	0.3	0.2
2	SL2.28	Soft Landscaping	67	15	1.0	0.3	0.3
2	SL2.29	Soft Landscaping	67	16	1.1	0.3	0.3
2	SL2.30	Soft Landscaping	67	14	0.9	0.3	0.3
2	PP2.1	Permable Paving	67	44	2.9	0.7	2.1
2	PP2.2	Permable Paving	67	25	1.7	0.7	1.2
2	PP2.3	Permeable Paving	67	30	2.0	0.7	1.4
2	HL2.1	Hard Landscaping	67	75	5.0	1	5.0
2	HL2.2	Hard Landscaping	67	16	1.1	1	1.1
2	HL2.3	Hard Landscaping	67	342	22.9	1	22.9
2	HL2.4	Hard Landscaping	67	218	14.6	1	14.6
2	HL2.5	Hard Landscaping	67	56	3.7	1	3.7
2	HL2.6	Hard Landscaping	67	12	0.8	1	0.8
2	HL2.7	Hard Landscaping	67	3	0.2	1	0.2
2	HL2.8	Hard Landscaping	67	44	2.9	1	2.9
				1557	**104**		**70**

B.6 Swale attenuation volumes

Contract		Job ref.	
St Anne's Court		288354	
Part of Structure		**Calc. Sheet No.**	
Swale A1			
Drawing ref.	**Calculations by**	**Checked by**	**Date**
	GS	SB	Aug 2023

RCD.		**ISSUE.**		**REV.**	A

				Runoff factor
Storm Return Period =	100	Years		
Total Site Area =	0.034	Hectares (ha)		
Existing Open Space =	0.034	ha		
Proposed development mix				
Roof Area =	0.005	ha	............@	0.30
Hard Standing /Road Area =	0.016	ha	............@	0.70
Vegetation =	0.013	ha	............@	1.00
Allowable Outflow =	13.10	Litres/sec/ha		

0.44 l/s discharge through a 20mm orifice with 400mm head

Duration (min)	**Rainfall** (mm)	**Intensity** (mm/hr)	**Rainfall** (m^3/ha)	**Runoff** (m^3)	**Allowable Outflow** (m^3)	**Storage Req'd** (m^3)
1						
2		0.00	0	0	0	0
5		0.00	0	0	0	0
10		0.00	0	0	0	0
15	**29.0**	116.16	290	7	0	7
30	**35.9**	71.76	359	9	1	8
60	**44.4**	44.40	444	11	2	10
120	**55.0**	27.48	550	14	3	11
240	**67.9**	16.98	679	17	6	11
360	**76.9**	12.82	769	19	10	10
720	**95.0**	7.92	950	24	19	5
1440	**117.5**	4.90	1175	30	38	-8
2880	**130.8**	2.73	1308	33	76	-43

base case 20% climate change

24.2	29.0
29.9	35.9
37.0	44.4
45.8	55.0
56.6	67.9
64.1	76.9
79.2	95.0
97.9	117.5
109.0	130.8

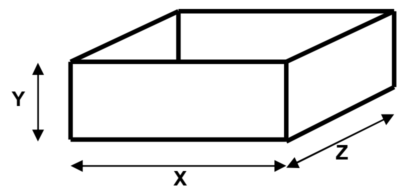
Minimum value of storage required = **11** m^3

Oversized Pipe Requirements

Pipe dia. (mm)	**Length** (m)
600	38
900	17
1050	13
1200	10
1500	6

Tank Requirements

X =	**3**	**m**
Y =	**1.0**	**m**
Z =	**3**	**m**



Contract		**Job ref.**	
St Anne's Court		288354	
Part of Structure		**Calc. Sheet No.**	
Swale A2			
Drawing ref.	**Calculations by**	**Checked by**	**Date**
	GS	SB	Aug 2023

RCD.		**ISSUE.**		**REV.**	**A**

Storm Return Period =	100	Years		
Total Site Area =	0.019	Hectares (ha)		
Existing Open Space =	0.019	ha		
Proposed development mix				Runoff factor
Roof Area =	0.006	ha	............@	0.30
Hard Standing /Road Area =	0.006	ha	............@	0.70
Vegetation =	0.007	ha	............@	1.00
Allowable Outflow =	22.80	Litres/sec/ha		
	0.44	l/s	discharge through a 20mm orifice with 400mm head	

Duration (min)	**Rainfall** (mm)	**Intensity** (mm/hr)	**Rainfall** (m^3/ha)	**Runoff** (m^3)	**Allowable Outflow** (m^3)	**Storage Req'd** (m^3)
1						
2		0.00	0	0	0	0
5		0.00	0	0	0	0
10		0.00	0	0	0	0
15	**24.2**	96.80	242	3	0	3
30	**29.9**	59.80	299	4	1	3
60	**37.0**	37.00	370	5	2	3
120	**45.8**	22.90	458	6	3	3
240	**56.6**	14.15	566	8	6	1
360	**64.1**	10.68	641	9	10	-1
720	**79.2**	6.60	792	11	19	-8
1440	**97.9**	4.08	979	13	38	-25
2880	**109.0**	2.27	1090	15	76	-62

base case 20% climate change

base case	20% climate change
24.2	29.0
29.9	35.9
37.0	44.4
45.8	55.0
56.6	67.9
64.1	76.9
79.2	95.0
97.9	117.5
109.0	130.8

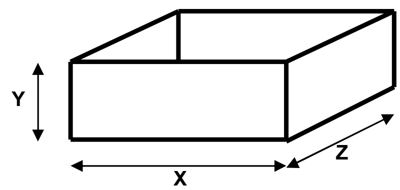
Minimum value of storage required = **3** m^3

Oversized Pipe Requirements

Pipe dia. (mm)	**Length** (m)
600	12
900	5
1050	4
1200	3
1500	2

Tank Requirements

X =	**2**	**m**
Y =	**1.0**	**m**
Z =	**2**	**m**



Contract		Job ref.	
St Anne's Court		288354	
Part of Structure		**Calc. Sheet No.**	
Swale B1			
Drawing ref.	**Calculations by**	**Checked by**	**Date**
	GS	SB	Aug 2023

RCD.		ISSUE.		REV.	A

Storm Return Period =	100	Years		
Total Site Area =	0.049	Hectares (ha)		
Existing Open Space =	0.049	ha		
Proposed development mix				Runoff factor
Roof Area =	0.017	ha	............@	0.30
Hard Standing /Road Area =	0.016	ha	............@	0.70
Vegetation =	0.016	ha	............@	1.00
Allowable Outflow =	9.07	Litres/sec/ha		
	0.44	l/s	discharge through a 20mm orifice with 400mm head	

Duration (min)	Rainfall (mm)	Intensity (mm/hr)	Rainfall (m^3/ha)	Runoff (m^3)	Allowable Outflow (m^3)	Storage Req'd (m^3)		base case	20% climate change
1									
2		0.00	0	0	0	0			
5		0.00	0	0	0	0			
10		0.00	0	0	0	0			
15	**29.0**	116.16	290	9	0	9		**24.2**	29.0
30	**35.9**	71.76	359	12	1	11		**29.9**	35.9
60	**44.4**	44.40	444	14	2	13		**37.0**	44.4
120	**55.0**	27.48	550	18	3	15		**45.8**	55.0
240	**67.9**	16.98	679	22	6	16		**56.6**	67.9
360	**76.9**	12.82	769	25	10	15		**64.1**	76.9
720	**95.0**	7.92	950	31	19	12		**79.2**	95.0
1440	**117.5**	4.90	1175	38	38	0		**97.9**	117.5
2880	**130.8**	2.73	1308	42	76	-34		**109.0**	130.8

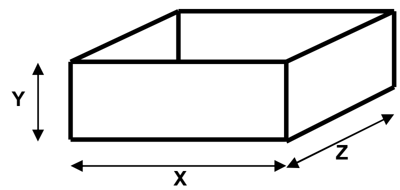
Minimum value of storage required = **16** m^3

Oversized Pipe Requirements

Pipe dia. (mm)	Length (m)
600	55
900	24
1050	18
1200	14
1500	9

Tank Requirements

X =	4	m
Y =	1.0	m
Z =	4	m



Contract		Job ref.	
St Anne's Court		288354	
Part of Structure		**Calc. Sheet No.**	
Swale B2			
Drawing ref.	**Calculations by**	**Checked by**	**Date**
	GS	SB	Aug 2023

RCD.		ISSUE.		REV.	A

Storm Return Period =	100	Years		
Total Site Area =	0.015	Hectares (ha)		
Existing Open Space =	0.015	ha		
Proposed development mix				Runoff factor
Roof Area =	0.010	ha	............@	0.30
Hard Standing /Road Area =	0.000	ha	............@	0.70
Vegetation =	0.006	ha	............@	1.00
Allowable Outflow =	28.95	Litres/sec/ha		
	0.44	l/s	discharge through a 20mm orifice with 400mm head	

Duration (min)	Rainfall (mm)	Intensity (mm/hr)	Rainfall (m^3/ha)	Runoff (m^3)	Allowable Outflow (m^3)	Storage Req'd (m^3)
1						
2		0.00	0	0	0	0
5		0.00	0	0	0	0
10		0.00	0	0	0	0
15	**29.0**	116.16	290	2	0	2
30	**35.9**	71.76	359	3	1	2
60	**44.4**	44.40	444	4	2	2
120	**55.0**	27.48	550	5	3	1
240	**67.9**	16.98	679	6	6	-1
360	**76.9**	12.82	769	7	10	-3
720	**95.0**	7.92	950	8	19	-11
1440	**117.5**	4.90	1175	10	38	-28
2880	**130.8**	2.73	1308	11	76	-65

base case	20% climate change
24.2	29.0
29.9	35.9
37.0	44.4
45.8	55.0
56.6	67.9
64.1	76.9
79.2	95.0
97.9	117.5
109.0	130.8

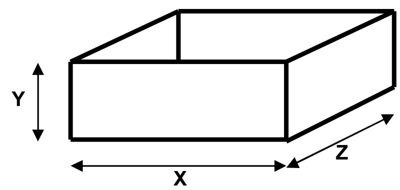
Minimum value of storage required = 2 m^3

Oversized Pipe Requirements

Pipe dia. (mm)	Length (m)
600	8
900	4
1050	3
1200	2
1500	1

Tank Requirements

X =	2	m
Y =	1.0	m
Z =	2	m



Contract		Job ref.	
St Anne's Court		288354	
Part of Structure		**Calc. Sheet No.**	
Swale C			
Drawing ref.	**Calculations by**	**Checked by**	**Date**
	GS	SB	Aug 2023

RCD.		ISSUE.		REV.	A

				Runoff factor
Storm Return Period =	100	Years		
Total Site Area =	0.040	Hectares (ha)		
Existing Open Space =	0.040	ha		
Proposed development mix				
Roof Area =	0.009	ha	............@	0.30
Hard Standing /Road Area =	0.017	ha	............@	0.70
Vegetation =	0.014	ha	............@	1.00
Allowable Outflow =	11.08	Litres/sec/ha		
	0.44	l/s	discharge through a 20mm orifice with 400mm head	

Duration (min)	Rainfall (mm)	Intensity (mm/hr)	Rainfall (m^3/ha)	Runoff (m^3)	Allowable Outflow (m^3)	Storage Req'd (m^3)
1						
2		0.00	0	0	0	0
5		0.00	0	0	0	0
10		0.00	0	0	0	0
15	**29.0**	116.16	290	8	0	8
30	**35.9**	71.76	359	10	1	9
60	**44.4**	44.40	444	13	2	11
120	**55.0**	27.48	550	16	3	12
240	**67.9**	16.98	679	19	6	13
360	**76.9**	12.82	769	22	10	12
720	**95.0**	7.92	950	27	19	8
1440	**117.5**	4.90	1175	33	38	-5
2880	**130.8**	2.73	1308	37	76	-39

base case	20% climate change
24.2	29.0
29.9	35.9
37.0	44.4
45.8	55.0
56.6	67.9
64.1	76.9
79.2	95.0
97.9	117.5
109.0	130.8

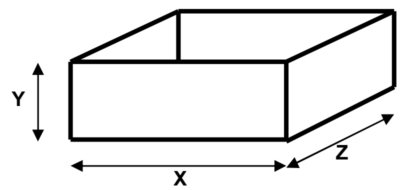
Minimum value of storage required = **13** m^3

Oversized Pipe Requirements

Pipe dia. (mm)	Length (m)
600	45
900	20
1050	15
1200	11
1500	7

Tank Requirements

X =	4	m
Y =	1.0	m
Z =	4	m



Contract		Job ref.	
St Anne's Court		288354	
Part of Structure		**Calc. Sheet No.**	
Swale D			
Drawing ref.	**Calculations by**	**Checked by**	**Date**
	GS	SB	Aug 2023

RCD.		ISSUE.		REV.	A

				Runoff factor
Storm Return Period =	100	Years		
Total Site Area =	0.045	Hectares (ha)		
Existing Open Space =	0.045	ha		
Proposed development mix				
Roof Area =	0.009	ha	............@	0.30
Hard Standing /Road Area =	0.017	ha	............@	0.70
Vegetation =	0.019	ha	............@	1.00
Allowable Outflow =	9.73	Litres/sec/ha		
	0.44	l/s	discharge through a 20mm orifice with 400mm head	

Duration (min)	Rainfall (mm)	Intensity (mm/hr)	Rainfall (m^3/ha)	Runoff (m^3)	Allowable Outflow (m^3)	Storage Req'd (m^3)
1						
2		0.00	0	0	0	0
5		0.00	0	0	0	0
10		0.00	0	0	0	0
15	**29.0**	116.16	290	10	0	9
30	**35.9**	71.76	359	12	1	11
60	**44.4**	44.40	444	15	2	13
120	**55.0**	27.48	550	19	3	15
240	**67.9**	16.98	679	23	6	17
360	**76.9**	12.82	769	26	10	16
720	**95.0**	7.92	950	32	19	13
1440	**117.5**	4.90	1175	40	38	2
2880	**130.8**	2.73	1308	44	76	-32

base case	20% climate change
24.2	29.0
29.9	35.9
37.0	44.4
45.8	55.0
56.6	67.9
64.1	76.9
79.2	95.0
97.9	117.5
109.0	130.8

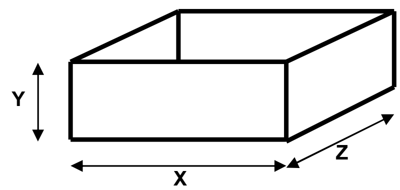
Minimum value of storage required = **17** m^3

Oversized Pipe Requirements

Pipe dia. (mm)	Length (m)
600	59
900	26
1050	19
1200	15
1500	9

Tank Requirements

X =	4	m
Y =	1.0	m
Z =	4	m



B.7 Courtyard porous paving attenuation volume

Contract		**Job ref.**	
St Anne's Court		288354	
Part of Structure		**Calc. Sheet No.**	
Courtyard Porous Paving system			
Drawing ref.	**Calculations by**	**Checked by**	**Date**
	GS	SB	Aug 2023

RCD.		**ISSUE.**		**REV.**	**A**

Storm Return Period =	100	Years		
Total Site Area =	0.096	Hectares (ha)		
Existing Open Space =	0.096	ha		
Proposed development mix				Runoff factor
Roof Area =	0.052	ha	............@	0.30
Hard Standing /Road Area =	0.044	ha	............@	0.80
Vegetation =	0.000	ha	............@	1.00
Allowable Outflow =	56.25	Litres/sec/ha		
	5.40	l/s		

discharge through a 50mm orifice with 1000mm head
[approx. Qbar discharge rate for Zone 1]

Duration (min)	**Rainfall** (mm)	**Intensity** (mm/hr)	**Rainfall** (m^3/ha)	**Runoff** (m^3)	**Allowable Outflow** (m^3)	**Storage Req'd** (m^3)
1						
2		0.00	0	0	1	-1
5		0.00	0	0	2	-2
10		0.00	0	0	3	-3
15	**29.0**	116.16	290	15	5	10
30	**35.9**	71.76	359	18	10	9
60	**44.4**	44.40	444	23	19	3
120	**55.0**	27.48	550	28	39	-11
240	**67.9**	16.98	679	34	78	-43
360	**76.9**	12.82	769	39	117	-78
720	**95.0**	7.92	950	48	233	-185
1440	**117.5**	4.90	1175	60	467	-407
2880	**130.8**	2.73	1308	66	933	-867

base case	20% climate change
24.2	29.0
29.9	35.9
37.0	44.4
45.8	55.0
56.6	67.9
64.1	76.9
79.2	95.0
97.9	117.5
109.0	130.8

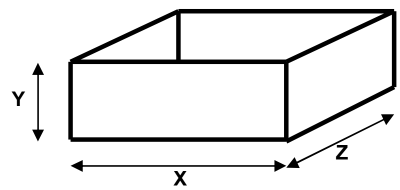
Minimum value of storage required = **10** m^3

Oversized Pipe Requirements

Pipe dia. (mm)	**Length** (m)
600	35
900	16
1050	11
1200	9
1500	6

Tank Requirements

X =	**3**	**m**
Y =	**1.0**	**m**
Z =	**3**	**m**



Appendix C (Background information)

C.1 Topographical Survey

APEX SURVEYS
www.apexsurveys.ie
info@apexsurveys.ie
00353 1 691 0156

RURAL/NATURAL FEATURES :

BUSH	
SAPLING	
TREE	
HEDGE	
TROUGH	TR
CATTLE GRID	GRID

LINEWORK:

EMBANKEMENT TOP	101.50
DRAIN	101.50
BREAKLINE	101.50
BUILDING	101.50
KERB BOTTOM	101.50
WALL	101.50
PATH/CHANGE SURFACE	101.50
O/HEAD ELECTRICITY	OE
O/HEAD TELECOM	OT

STREET FURNITURE :

BOLLARDS	BD
BORE HOLE	BH+
BUS STOP	BS
CRASH BARRIER	CB
ELECTRICITY POLE	EP
EARTHING ROD	ER+
GATE	
GROUND LIGHT	LT
ILLUMINATED BOLLARD	BOL
LAMP POST	LP
MARKER POST	MKR+
POST	POST
POST BOX	POST BOX+
ROADSIGN	RS RS
SIGN POST	SIGN
TELEPHONE BOX	TB
TELEPHONE POLE	TP
TRAFFIC LIGHT	TL
TRIAL PIT	TPIT+

SERVICES :

AIR VALVE	AV+
ARMSTRONG JUNCTION	AJ
CABLE TV IC	CATV
COVER LEVEL	CL
EIRCOM COVER	EIRCOM
EIRCOM JUNCTION BOX	EIRCOM BOX
ELECTRICAL CABLE PIT	ECP
ESAT COVER	ESAT
ESB COVER	ESB
ESB JUNCTION BOX	ESB BOX
FIRE HYDRANT	FH
GAS VALVE	GV
GULLY	G
INSPECTION COVER	IC
MANHOLE	MH
SEPTIC TANK	SEPTIC
SLUICE VALVE	SV
STOPCOCK	ST

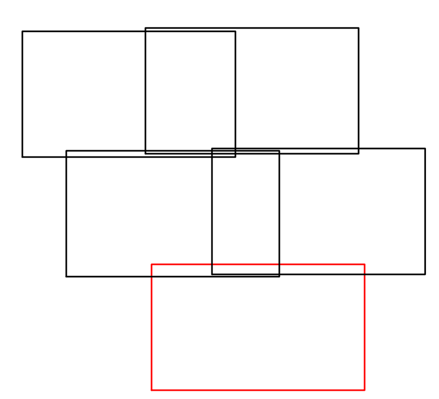
SERVICES :

SERVICE BOX (UNKNOWN)	BOX
TRAFFIC COVER	TLIC
VENT	VENT
WATER METER	WM+
UNABLE TO LIFT	UTO

LEVELS :

BED LEVEL	+BED101.50
EAVE LEVEL	+E101.50
FLOOR LEVEL	+FL101.50
INVERT LEVEL	+IL101.50
ROAD LEVEL	+101.50
RIDGE LEVEL	+R101.50
SOFFIT LEVEL	+SL101.50
SPOT LEVEL	+101.50
TOP OF FENCE LEVEL	+TOF101.50
TOP OF WALL LEVEL	+TOW101.50
WATER LEVEL	+WL101.50
SURVEY CONTROL STATION	

SHEET LAYOUT :



PLAN PRODUCED BY:

APEX SURVEYS

CONTACT INFORMATION:

Apex Surveys
Unit 78 Dunboyne Business Park
Dunboyne, Co. Meath, Ireland
www.apexsurveys.ie
info@apexsurveys.ie
00353 1 691 0156

CLIENT:

Dublin City Council

GRID SYSTEM: Irish Transverse Mercator
DATUM: Malin Head (OSGM15)
NOTES: Drawing Contains Scale Factor

REVISIONS:

No.	Date	Description
001	24/01/23	Original Drawing
002	09/02/23	Additional Trees Added
003	28/02/23	Additional Tree and Ridge Added

PROJECT:

St Anne's Court
Raheny, Dublin 5

SCALE : 1/200 A1

DATE : 24/01/2023

DRG No: 5474

DESCRIPTION : 2D Topographical

SURVEYED BY : Tetiana Slipchenko

PROCESSED BY : T.G.

SHEET: 1 of 5

CHECKED BY : Alan Brady

APEX SURVEYS

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RURAL/NATURAL FEATURES :

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SAPLING	
TREE	
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LINEWORK:

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DRAIN	101.50
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KERB BOTTOM	101.50
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O/HEAD TELECOM	OT

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BORE HOLE	BH
BUS STOP	BS
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ELECTRICITY POLE	EP
EARTHING ROD	ER
GATE	
GROUND LIGHT	LT
ILLUMINATED BOLLARD	BOL
LAMP POST	LP
MARKER POST	MKR
POST	POST
POST BOX	POST BOX
ROADSIGN	RS RS
SIGN POST	SIGN
TELEPHONE BOX	TB
TELEPHONE POLE	TP
TRAFFIC LIGHT	TL
TRIAL PIT	TPIT

SERVICES :

AIR VALVE	AV
ARMSTRONG JUNCTION	AJ
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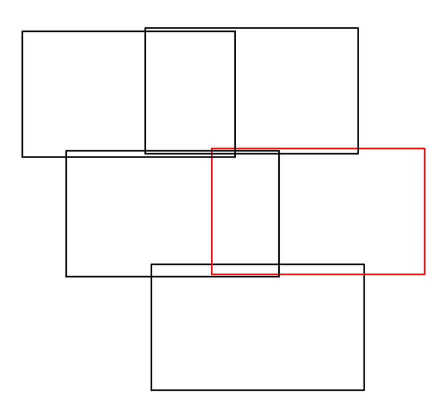
WATER LEVEL	WL101.50
SURVEY CONTROL STATION	

SHEET LAYOUT :



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Dunboyne, Co. Meath, Ireland
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00353 1 691 0156

CLIENT:

Dublin City Council

PROJECT:

St Anne's Court
Raheny, Dublin 5

GRID SYSTEM: Irish Transverse Mercator
DATUM: Malin Head (OSGM15)
NOTES: Drawing Contains Scale Factor

REVISIONS:

No.	Date	Description
001	24/01/23	Original Drawing
002	09/02/23	Additional Trees Added
003	28/02/23	Additional Tree and Ridge Added

SCALE : 1/200 A1
DATE : 24/01/2023
DRG No: 5474
SHEET: 2 of 5

DESCRIPTION : 2D Topographical
SURVEYED BY : Tetiana Slipchenko
PROCESSED BY : T.G.
CHECKED BY : Alan Brady

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PATH/CHANGE SURFACE	101.50
O/HEAD ELECTRICITY	OE
O/HEAD TELECOM	OT

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BOLLARDS	BD
BORE HOLE	BH+
BUS STOP	BS
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POST BOX	POST BOX+
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WATER LEVEL	+WL101.50
SURVEY CONTROL STATION	

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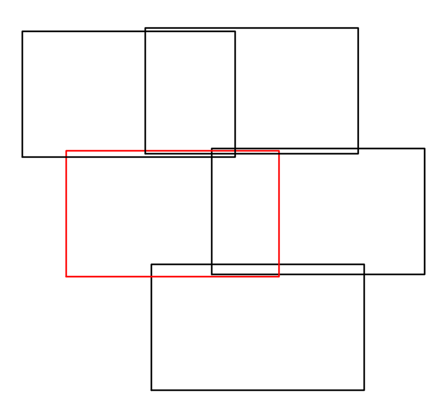

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CLIENT:

Dublin City Council

PROJECT:

St Anne's Court Raheny, Dublin 5

GRID SYSTEM: Irish Transverse Mercator
DATUM: Malin Head (OSGM15)
NOTES: Drawing Contains Scale Factor

REVISIONS:

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003	28/02/23	Additional Tree and Ridge Added

SCALE : 1/200 A1

DATE : 24/01/2023

DRG No: 5474

SHEET: 3 of 5

DESCRIPTION : 2D Topographical
SURVEYED BY : Tetiana Slipchenko
PROCESSED BY : T.G.
CHECKED BY : Alan Brady

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CATTLE GRID — GRID

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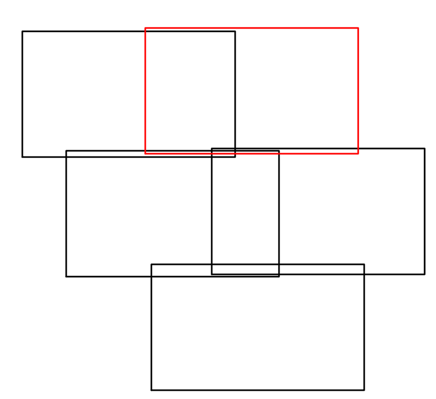
WATER LEVEL	WL101.50
SURVEY CONTROL STATION	

SHEET LAYOUT :



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CLIENT:

Dublin City Council

GRID SYSTEM: Irish Transverse Mercator
DATUM: Malin Head (OSGM15)
NOTES: Drawing Contains Scale Factor

REVISIONS:

No.	Date	Description
001	24/01/23	Original Drawing
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003	28/02/23	Additional Tree and Ridge Added

PROJECT:

St Anne's Court
Raheny, Dublin 5

SCALE : 1/200 A1
DATE : 24/01/2023
DRG No: 5474
DESCRIPTION : 2D Topographical
SURVEYED BY : Tetiana Slipchenko
PROCESSED BY : T.G.
SHEET: 4 of 5
CHECKED BY : Alan Brady

APEX SURVEYS

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RURAL/NATURAL FEATURES :

BUSH	
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TREE	
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TROUGH	TR
CATTLE GRID	GRID

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O/HEAD ELECTRICITY	OE
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EARTHING ROD	ER
GATE	
GROUND LIGHT	LT
ILLUMINATED BOLLARD	BOL
LAMP POST	LP
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POST	POST
POST BOX	POST BOX
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SERVICES :

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SLUICE VALVE	SV
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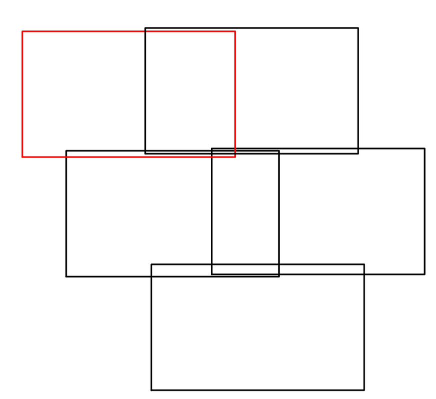
TOP OF WALL LEVEL	TOW101.50
WATER LEVEL	WL101.50
SURVEY CONTROL STATION	

SHEET LAYOUT :



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PROJECT:

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Raheny, Dublin 5

SCALE : 1/200 A1

DATE : 24/01/2023

DRG No: 5474

DESCRIPTION : 2D Topographical

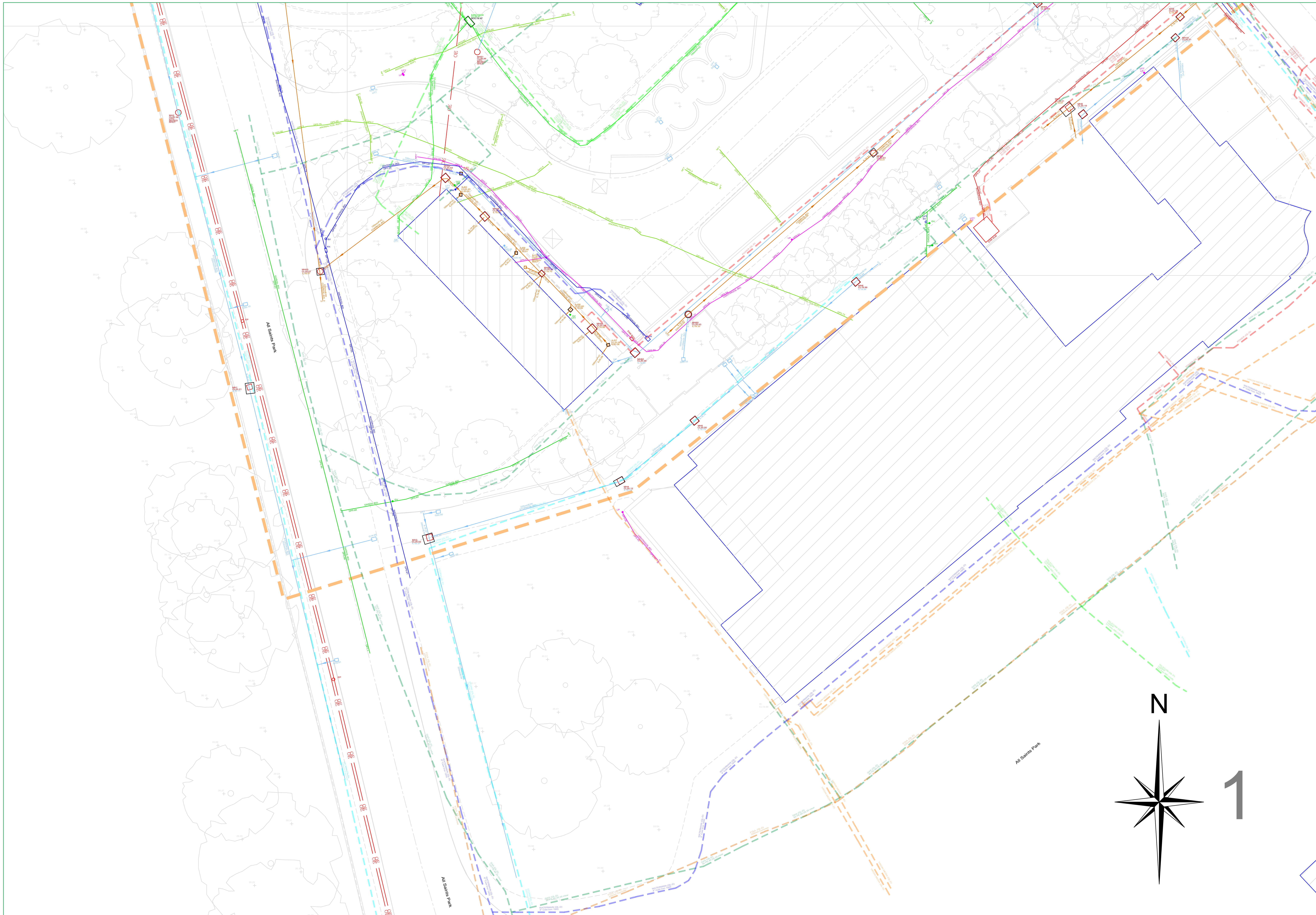
SURVEYED BY : Tetiana Slipchenko

PROCESSED BY : T.G.

SHEET: 5 of 5

CHECKED BY : Alan Brady

C.2 Utility Survey



PAS 128: 2014 (Quality of Survey Level Outputs):

DESKTOP UTILITY RECORDS SEARCH

QL-D	Drafted from utility records

SITE RECONNAISSANCE

QL-C	Location Demonstrated by visual reference to street furniture or evidence of previous streetworks, ie - reinstatement scars

DETECTION

QL-B4	A segment of utility suspected to exist but has not been detected by a geophysical technique
QL-B3	Horizontal location only of the utility detected by one of the geophysical techniques used
QL-B2	Horizontal and vertical location of the utility detected by one of the geophysical techniques used
QL-B1	Horizontal and vertical location of the utility detected by multiple geophysical techniques

VERIFICATION

QL-A	Horizontal and vertical location of the top and/or bottom of the utility

Apex Surveys Ltd. Disclaimer - Utility Survey

The interpretative nature and the non-intrusive, indirect and non-destructive survey methods must be taken into account when considering the results of the surveys. Therefore Apex Surveys, while using appropriate practice to execute, interpret and present the data, gives no guarantees that all underground utilities and underground structures will be located and mapped. Furthermore, Apex Surveys cannot guarantee the accuracy of the utility depths annotated on the survey drawings.
Apex Survey shall not be liable for any omissions or inaccuracies in the survey which arise due to the limitations of the service. No liability shall attach to Apex Surveys, in any circumstances, howsoever arising, in respect of any consequential loss or damages suffered by the Client.

The following is a non-exhaustive list of the limitations of utility surveys:

The Survey aims to map existing utilities subsurface utilities and provide information with respect to pipe size, material type and drainage connectivity. However utility surveying is limited by the following guidelines and it may not be possible to accurately survey, define and locate all services and sub-surface features.

- Depth of Utility: The depth and size of a utility affect the signal response and the degree with which a utility can be located.
  Due to attenuation of the radar signal with depth, resolution is restricted, hence making identification of utilities more difficult with increasing depth.
- Size of Utility: The smaller the diameter of a utility the more difficult it is to locate. This difficulty increases with depth.
- Ground Conditions: The depth penetration and quality of the data depends on the ground conditions of the site. GPR Surveying works best within high resistivity material. Clay overburden can impair GPR Surveying. Poor data may be a result of areas with high conductivity.
- Utility Congestion: Where different utilities converge together into a service corridor or cross paths it becomes difficult to isolate a specific utility and to map its route. The reflected signal will display a single response to multiple utilities. Therefore multiple utilities may appear to be a single utility. Where similar services run on close proximity, separation may be impossible.
- Signal Jumping: Signal from surrounding services may 'jump' to a highly conductive line masking its true identity.
- Shadowing: (of deeper utilities by shallower objects) Shallow utilities will mask the existence of deeper utilities where they are in close proximity. Also, high reflective materials close to the surface i.e rebar may hide deeper anomalies.
- Surface Obstructions: The GPR system relies on a relatively flat and even surface on which to perform radar passes. If ground obstructions such as vehicles, organic material (long grass, scrub) or undulating ground surface are present then the acquired data will be of lower resolution and in some cases not viable.
- Loss of signal: It is not always possible to trace the entire length of each underground service.
- Connections between manholes: Connections between manhole chambers are assumed to be straight.
- Non-metallic objects: Nonmetallic objects are amongst the most difficult to trace therefore successful tracing of non-metallic pipes/ utilities may be limited.
- Fiber Optic Cables: Fiber optic cables may not be possible to locate except where laid with a built in tracer wire or similar conductor system.
- Defective / flooded manholes or pipework: It may not be possible to establish connections between flooded or defective manholes or pipework.
- Acute bends in pipework: It may not be possible to trace a pipe past an acute bend.

Accuracy estimates:

- Locational accuracy is determined by referring to the manufacturers guidelines for the detector used.
- In ideal conditions the spatial accuracies for the underground utilities may be +/- 5% for Radiodetection and +/- 10% of depth for the GPR to 2.5m deep. However variations within the subsurface, depth below the ground, close proximity of other services and local magnetic, atmospheric or ground conditions, bends, lateral service connections and any of the other limitations listed in this disclaimer may alter this estimated accuracy.
- Plan accuracies of + or - 150mm may be achieved but this figure will depend on the depth of service below ground level. However variations within the subsurface subsurface, depth below the ground, close proximity of other services and local magnetic, atmospheric or ground conditions, bends, lateral service connections and any of the other limitations listed in this disclaimer may alter this estimated accuracy.
- DP represents distance from the surface level to the top of the service/ target
- Where technically possible, depth indications will be given. These along with plan positions should be used for guidance only and wherever critical accuracy is required these should be confirmed by the client by undertaking trial excavations or similar.

Record Drawing Information

- Services which have been untraceable are shown from records where possible or available. These lines are annotated as "Taken From Records" or "From Records".
- Existing record information showing underground services is often incomplete and with unknown accuracies therefore it should be regarded as indicative only.
- Where Apex Surveys issue a utility drawing, this should be read in conjunction with all available public or private utility records.
- Apex Surveys endeavor to add relevant Public Utility record information onto the final drawing. However, we would recommend that direct contact is made with the asset owner or statutory undertaker.
- We shall not be held responsible for the accuracy, or otherwise, of the location of a service, as issued by the utility provider and therefore shown as "Taken for Records" on the drawing.

The following have been excluded from the survey:

- Location of individual service feeds to properties or buildings as access would be required into each property to apply direct connections to inlet points and this would significantly increase the scope of works, survey cost and also cause possible disruption to occupants.
- Pot ended or disconnected cables or terminated short lengths of pipe.
- Internal building services.
- Small diameter cables less than 20mm diameter or pipes less than 40mm diameter.
- Above ground services unless specifically requested.
- Lifting manholes which require longer than 10 minutes effort using standard heavy duty apparatus.

All works carried out be Apex Surveys conforms to the guidelines set out by The Survey Association (TSA) and PAS:128 Standard for utility mapping

APEX SURVEYS

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STREET FURNITURE :

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GATE	
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TELEPHONE BOX	TB
POST	POST
POST BOX	POST BOX
ROADSIGN	RS · RS
BORE HOLE	BH +
TRIAL PIT	TPIT +

SERVICES :

AIR VALVE	AV
ARMSTRONG JUNCTION	AJ
CABLE TV IC	CATV
COVER LEVEL	CL
EIRCOM COVER	EIRCOM
EIRCOM JUNCTION BOX	EIRCOM BOX
ELECTRICAL CABLE PIT	ECP
ESAT COVER	ESAT
ESB COVER	ESB
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GAS VALVE	GV
GULLY	G
INSPECTION COVER	IC
MANHOLE	MH
SEPTIC TANK	SEPTIC
SLUICE VALVE	SV
STOPCOCK	ST
SERVICE BOX (UNKNOWN)	BOX
TRAFFIC COVER	TLIC
VENT	VENT
WATER METER	WM +

LEVELS :

BED LEVEL	+ BED101.50
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INVERT LEVEL	+ IL101.50
ROAD LEVEL	+ 101.50
SOFFIT LEVEL	+ SL101.50
SPOT LEVEL	+ 101.50
TOP OF WALL LEVEL	+ TOW101.50
WATER LEVEL	+ WL101.50
SURVEY CONTROL STATION	

BOTTOM OF CHAMBER	BOC
CAST-IRON	C/I
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DIAMETER	DIA
DOWNPIPE	DP
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NO FURTHER TRACE	NFT
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EIRCOM	EIRCOM
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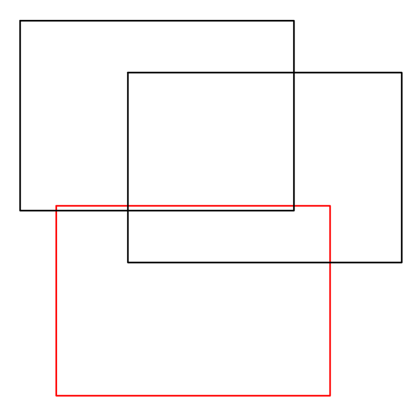
SHEET LAYOUT :



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CLIENT:

Dublin City Council

GRID SYSTEM:	Irish Transverse Mercator
DATUM:	Malin Head (OSGM15)
NOTES:	Drawing Contains Scale Factor

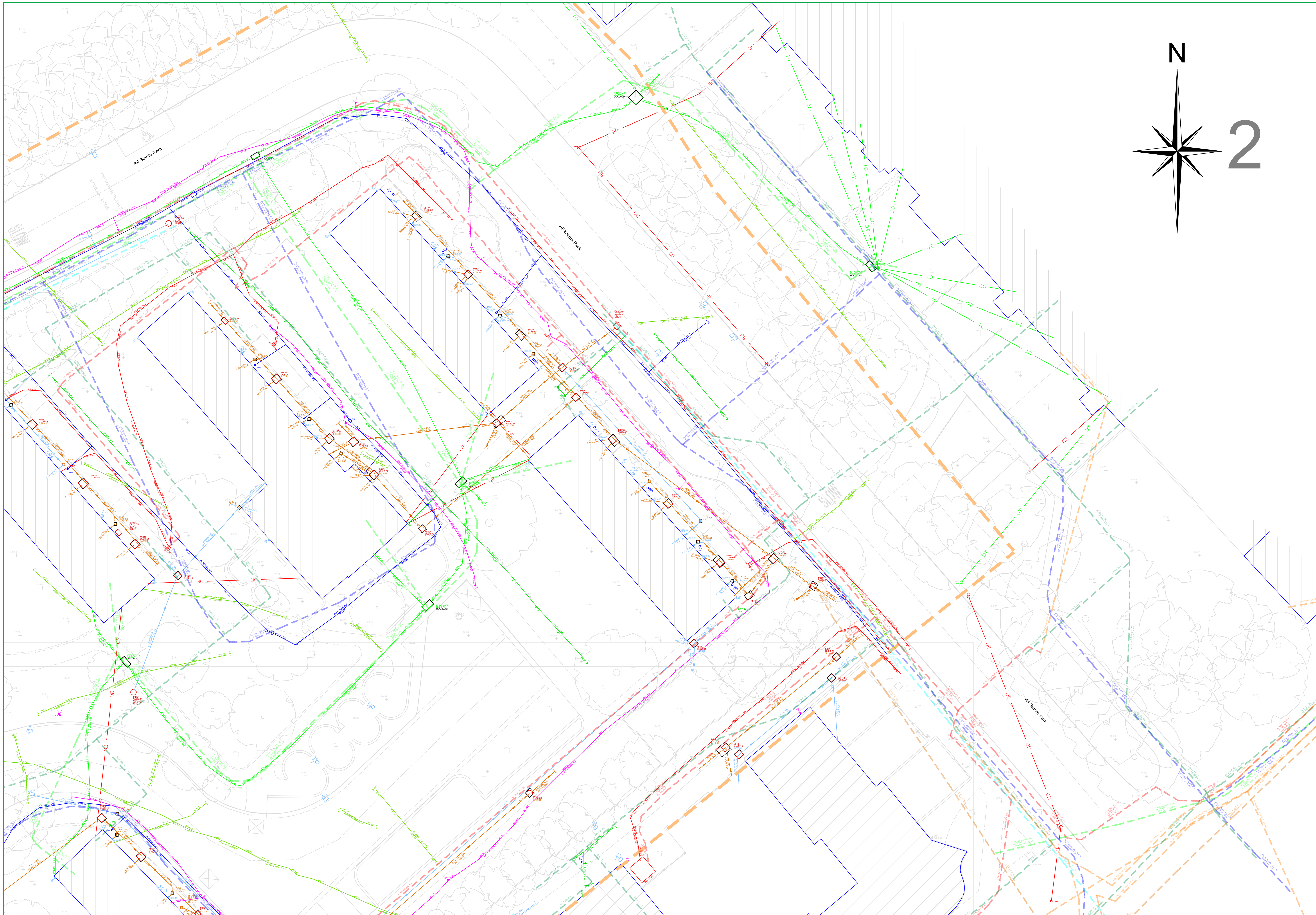
REVISIONS:

No.	Date	Description
001	N/A	Original Drawing

PROJECT:

St Anne's Court, Raheny, Dublin 5

SCALE :	1/200 A1	DATE :	03/02/2023
DRG No:	5474	DESCRIPTION :	2D Utilities
		SURVEYED BY :	Kresimir Kalafatic
SHEET:	1 of 3	PROCESSED BY :	T.G.
		CHECKED BY :	Alan Brady



PAS 128: 2014 (Quality of Survey Level Outputs):

DESKTOP UTILITY RECORDS SEARCH	
QL-D	Drafted from utility records
SITE RECONNAISSANCE	
QL-C	Location Demonstrated by visual reference to street furniture or evidence of previous streetworks, ie - reinstatement scars
DETECTION	
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QL-B1	Horizontal and vertical location of the utility detected by multiple geophysical techniques
VERIFICATION	
QL-A	Horizontal and vertical location of the top and/or bottom of the utility

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The Survey aims to map existing utilities subsurface utilities and provide information with respect to pipe size, material type and drainage connectivity. However utility surveying is limited by the following guidelines and it may not be possible to accurately survey, define and locate all services and sub-surface features.

- Depth of Utility: The depth and size of a utility affect the signal response and the degree with which a utility can be located.
  Due to attenuation of the radar signal with depth, resolution is restricted, hence making identification of utilities more difficult with increasing depth.
- Size of Utility: The smaller the diameter of a utility the more difficult it is to locate. This difficulty increases with depth.
- Ground Conditions: The depth penetration and quality of the data depends on the ground conditions of the site. GPR Surveying works best within high resistivity material. Clay overburden can impair GPR Surveying. Poor data may be a result of areas with high conductivity.
- Utility Congestion: Where different utilities converge together into a service corridor or cross paths it becomes difficult to isolate a specific utility and to map its route. The reflected signal will display a single response to multiple utilities. Therefore multiple utilities may appear to be a single utility. Where similar services run on close proximity, separation may be impossible.
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STREET FURNITURE :

BOLLARDS	BD
BUS STOP	BS
CRASH BARRIER	CB
GATE	
ELECTRICITY POLE	EP
TELEPHONE POLE	TP
EARTHING ROD	ER +
LAMP POST	LP
MARKER POST	MKR +
SIGN POST	SIGN
TRAFFIC LIGHT	TL
TELEPHONE BOX	TB
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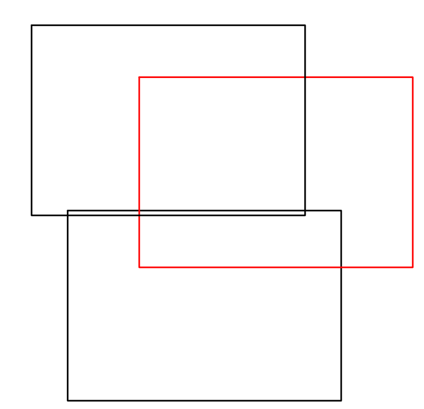

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NOTES: Drawing Contains Scale Factor

REVISIONS:

No.	Date	Description
001	N/A	Original Drawing

PROJECT:

St Anne's Court, Raheny, Dublin 5

SCALE : 1/200 A1

DATE : 03/02/2023

DRG No: 5474

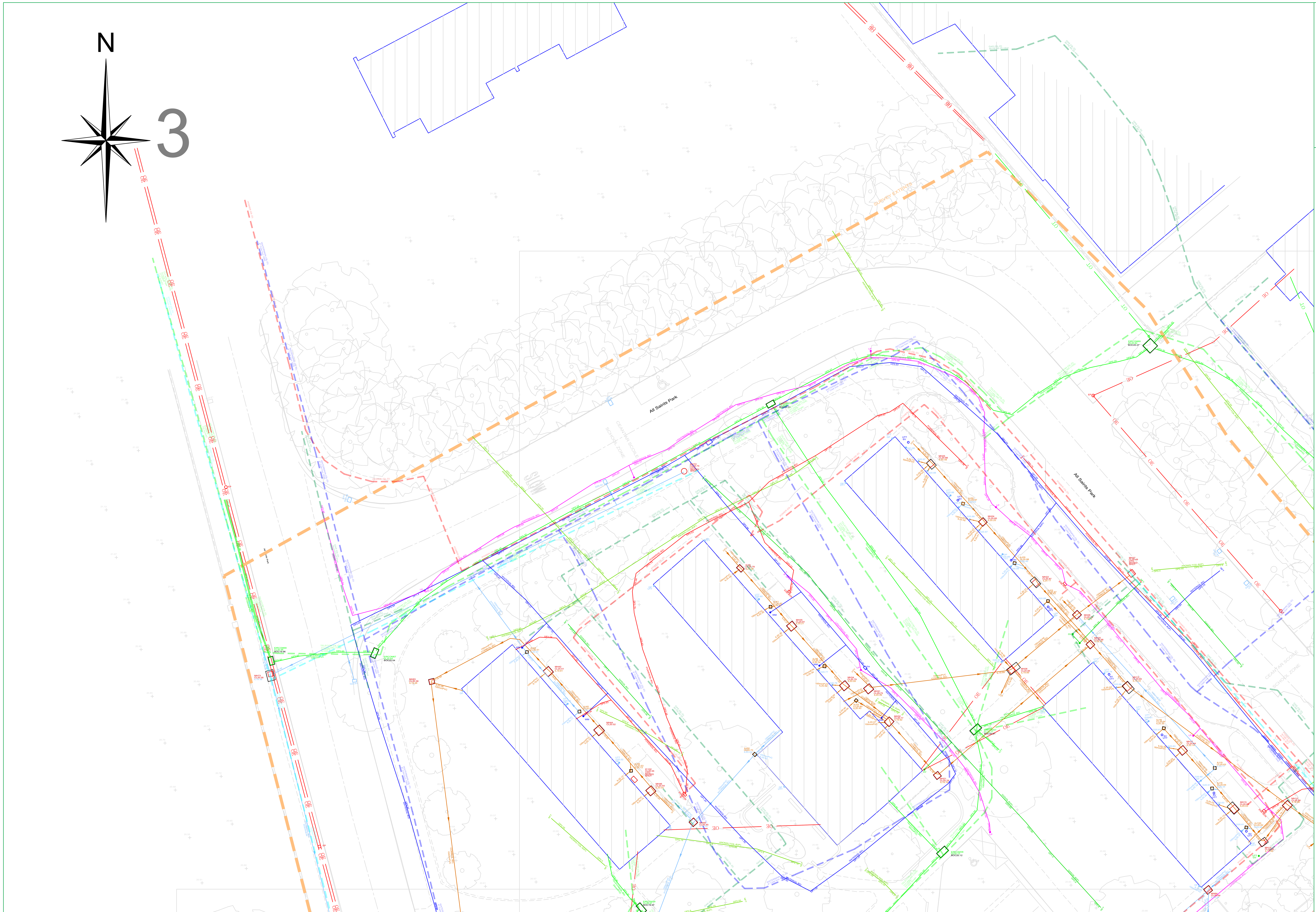
DESCRIPTION : 2D Utilities

SURVEYED BY : Kresimir Kalafatic

SHEET: 2 of 3

PROCESSED BY : T.G.

CHECKED BY : Alan Brady



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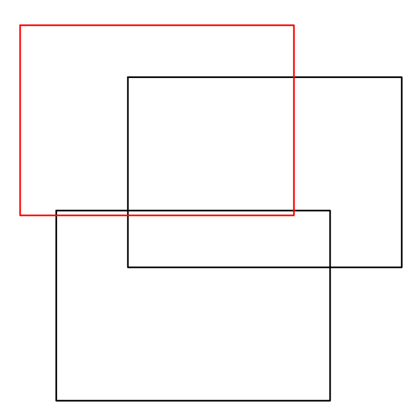

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No.	Date	Description
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		SURVEYED BY :	Kresimir Kalafatic
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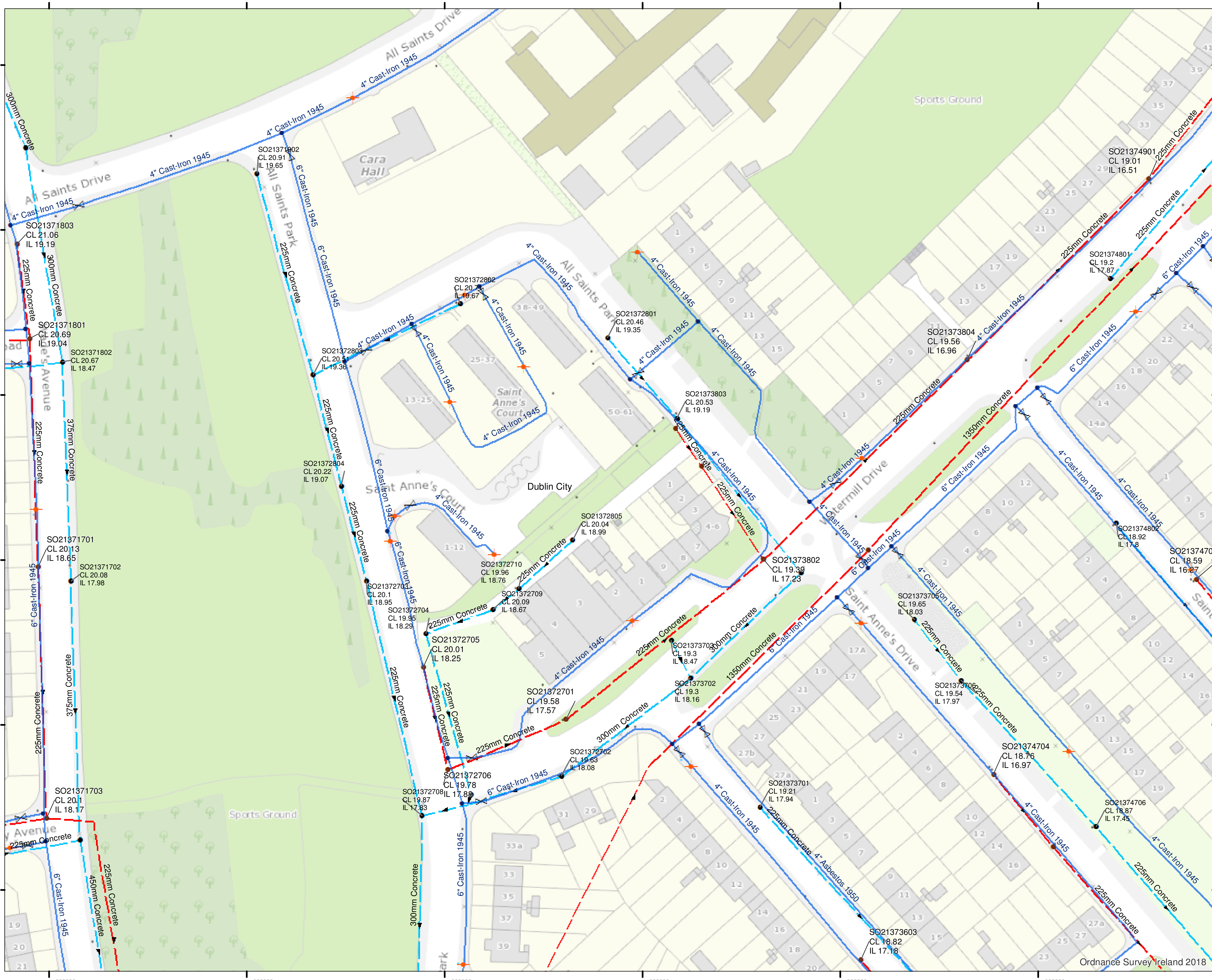
C.3 Irish Water Record Drawings

UISCE ÉIREANN : IRISH WATER



Print Date: 01/08/2023