MALONE O'REGAN
CONSULTING ENGINEERS

DUBLIN CITY COUNCIL

ENGINEERING REPORT

SOCIAL HOUSING BUNDLE 4,
DEVELOPMENT AT
CROKE VILLAS, SACKVILLE AVENUE.

Job: 23006

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1 INTRODUCTION

1.1 Introduction

This Engineering Planning Report has been prepared on behalf of the National Development Finance Agency (NDFA) and Dublin City Council, to accompany a Part 8 proposal for the development of 52no. residential units on a site of circa 0.88 hectares in area, located at Croke Villas, Sackville Avenue, Dublin 3. The full development description is as follows;

Notice is hereby given of the construction of 52 no. apartments at a site c.0.88 ha at Croke Villas, Sackville Avenue, bounded by Ballybough Road, Sackville Gardens, Sackville Avenue, Ardilaun Square, Ardilaun Road and GAA National Handball Centre, Dublin 3, which will consist of the following:

- Clearance works at the site will comprise the removal of walls and perimeter fencing and an allotment garden at the Croke Villas site bounded by Ballybough Road, Sackville Gardens, Sackville Avenue, Ardilaun Square, Ardilaun Road and GAA National Handball Centre. A wall along the boundary of the site and Irish Rail lands and railway line (to the south) will also be removed and replaced with a new boundary wall.
- Demolition of 1 no. remaining Croke Villas flat block will be demolished in accordance with PA. Reg. Ref. 2946/16
- Construction of two apartment blocks between 4 to 5 storeys, consisting of a total of 52 no. residential units:
  - Block A consists of 35 no. residential units (1 no. 1 bed and 34 no. 2 bed apartments); and
  - Block B consists of 17 no. residential units (4 no. 1 bed and 13 no. 2 bed apartments) and 152 sqm of internal community, arts and cultural space at ground floor.
- 4 no. car parking spaces and 129 no. cycle spaces.
- Sackville Gardens street will be extended to join with Ardilaun Square to form a new perimeter street to the southern edge of Block A, which will function as a new pedestrian and cycle link and also serve as an emergency vehicle access.
- Removal of undesignated car parking spaces along Sackville Avenue and construction of a new Boulevard on Sackville Avenue from the Ballybough Road junction to Ardilaun Road, which will also facilitate vehicular access.
- Provision of c. 961 sqm public open space, c.500 sqm communal open space, c.367 sqm private open space and 68 sqm of outdoor community, arts and cultural space (55 sqm facing Sackville Avenue and 13 sqm in internal courtyard).
- Boundary treatments, public lighting, site drainage works, road surfacing and footpaths, ESB substation, ESB meter rooms, plant rooms, stores, bin and bicycle storage, landscaping; and
- All ancillary site services and development works above and below ground.

This report has been compiled to address the engineering aspects related to the planning application. Engineering Drawings submitted with the application are listed in the appendices.

1.2 Site Description

The location of the proposed development is illustrated in Figure 1.1 below. The site is situated in the north area of Dublin city centre. There are existing two-storey houses with back gardens and the main GAA grounds Croke Park bordering the development on the north of the site. The site bounds the Croke Park Handball Alley on all sides. The west boundary runs along the Royal Canal and the railway tracks on the western line running into Connolly Station. This boundary runs on into two storey housing with back gardens on Sackville Gardens. The southern boundary of the site borders a row of existing two storey houses with back gardens on the Ballybough Road. Malone O'Regan have attempted to contact Irish Rail (Contact – Nick West) on several occasions to discuss boundary treatments along the railway line. Irish Rail have not engaged and we are awaiting a response.

The proximity of the site to natural watercourses is outlined in Figure 1.2 below.

Figure 1.1 – Site location

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Figure 1.2 – Surrounding Watercourse (Extract from the EPA Maps)

2 SURFACE WATER DRAINAGE DESIGN

2.1 Introduction

This chapter follows the guidelines set out in Greater Dublin Strategic Drainage Study (GDSDS) and the CIRIA 2015 SuDS Manual.

The aim of any SuDS strategy is to ensure that a new development does not negatively affect surrounding watercourse systems, existing surface water networks and groundwater systems. This SuDS strategy will achieve these aims by using a variety of SuDS measures within the site. These measures include water interception, treatment, infiltration and attenuation.

The SuDS strategy has been developed with the following steps:

1. The existing greenfield run-off of the development site is calculated and used as the minimum benchmark for the SuDS design. This run-off calculation is based on the drained area of the new development. The post development run-off will not exceed the greenfield run-off.
2. A set of SuDS measures is chosen based on their applicability and usage for the site.
3. A “FLOW” model was created to analyse the rainfall on the site and the effectiveness of the proposed SuDS measures.
4. These SuDS measures have been incorporated into the proposed design.

Table 2.1 outlines the parameters adopted in the design of the surface water drainage infrastructure.

Parameter Description	Assigned Value
Surface Water Drainage Pipework Design Return Period	2 years (Ref IS EN 752 Table 2 for 'Residential areas')
Attenuation Design Return Period	100 years
Allowance for climate change	20% (Ref. OPW Flood Risk Management Climate Change Sectoral Adaptation Plan, High-End Future Scenario)
M5-60	16.1mm (Met Eireann data)
M5-2D	58.1mm (Met Eireann data)
Ratio, r	0.28
Time of Entry	4 min
Pipe roughness, Ks	0.6mm (Ref. GDSDS Volume 2, Table 6.4)
Minimum velocity	1.0 m/s (Ref. GDSDS Volume 2, Table 6.4)

Table 2.1 Surface Water Design Parameters

2.2 Existing Services

An existing network of drainage runs around the perimeter of the site on two sides. These underground sewers carry surface water runoff towards existing catchment areas in the north Dublin area. Due to the relative levels of the existing drainage within the road and the proposed site levels, it is possible to achieve a gravity connection to the combined drainage pipework installed. There is a 990 x 730mm brick combined sewer running parallel to the Royal Canal on the western boundary. There is a 300mm concrete combined sewer on Sackville Avenue parallel to the eastern boundary.

2.3 Proposed Services

The proposed surface water drainage system is designed to comply with the 'Greater Dublin Strategic Drainage Study (GDSDS) Regional Drainage Policies Technical Document – Volume 2, New Developments, 2005' and the 'Greater Dublin Regional Code of Practice for Drainage Works, V6.0 2005'. CIRIA Design Manuals C753, C697 and C609 have also been used to design the surface water drainage system within the site.

The proposed surface water drainage layout for the development is indicated on Malone O'Regan drawings SHB4-CVD-DR-MOR-CS-P3-130, 150 and 151. Surface water runoff from new internal surfaces, footpaths, other areas of hardstanding and the roofs of buildings will be collected within a gravity drainage network and directed towards an attenuation storage system. The attenuation storage is sized to cater for a 1 in 100-year storm event.

The outfall from the attenuation tank will be restricted to a flowrate of 2.0 L/s as the discharge is to an existing combined sewer, using a Hydrobrake flow control device.

A number of sustainable drainage systems (SuDS) are proposed in order to minimise the volume and rate of runoff from the site. Further details on these SuDS measures are provided in Section 2.5.

All surface water drainage will be designed and installed in accordance with the Greater Dublin Regional Code of Practice for Drainage Works.

The runoff coefficients used in the calculations are as outlined in the Table 2.2 below.

Type of Areas	CV
Landscaping (Grass / Soft)	0.2
Extensive Green Roof	0.917
Permeable Paving	0.5
Impermeable Surface (Incl. tree pits & rain gardens)	0.9
Standard Roof (Impermeable)	0.95

Table 2.2: Runoff Coefficients

Calculations for the Surface Water Pipe Network are provided in Appendix C.

2.4 Permissible Runoff

The regression equation recommended for use by the Greater Dublin Strategic Drainage Study 2005 calculates a value, $QBAR_{rural}$, which is sourced from the Institute of Hydrology Report 124. This value is the mean annual flood flow from a rural catchment in m^3/s and is given by the equation,

$$QBAR_{rural} = 0.00108[Area^{0.89}] \times [SAAR^{1.17}] \times [Soil^{2.17}]$$

Where:

$QBAR_{rural}$	Mean annual flood flow from a rural catchment in m^3/s
Area	Area of the catchment in km^2
SAAR	Standard Average Annual Rainfall in mm.
Soil	Soil index

For catchments smaller than 50 hectares, $QBAR_{rural}$ is first calculated assuming an area of 50ha and then $QBAR_{rural}$ for the site area is calculated on a pro rata basis.

Standard Average Annual Rainfall for the site in Croke Villas was taken from the Flood Studies Report as 797mm.

The Soil Type was taken from the Flood Studies Report as Soil Type 2 which has a corresponding Standard Percentage Runoff (SPR) coefficient of 0.3. Soil Type 2 is typically described as very permeable soil such as sand or gravel with low runoff potential.

In January and February of 2024, IGSL completed a comprehensive programme of ground investigations for the site which indicates a significant level of variability in the soil throughout the site. The investigation generally showed a cover of placed Topsoil approximately 200mm deep, with Made Ground from 0.2 – 2m. The Made Ground consists primarily of dark brown and grey sandy slightly gravelly Clay with building rubble throughout. The Made Ground was found to be underlain by Gravels and Clays to approximately 4.5m. A very stiff Basal Till is present at depths greater than 4m. IGSL conclude that the occurrence of soft soil deposits is likely confined to the upper 2m.

Water ingress was noted in the majority of the boreholes with isolated seepages in the Made Ground. More charged water ingress was noted at approximately 2.5m deep with slow to moderate water entry and a modest rise. Blowing sands were observed in one borehole which indicates a localised area of confined groundwater under pressure.

The groundwater level recorded in the area for the underground attenuation tank is 1.57m O.D (refer to SHB4-CVD-RP-IGSL-CS-P3-0001 - Factual Ground Investigation Report).

Four soakaway tests were conducted as part of the investigation which varied significantly in their results. Infiltration rates were calculated ranging between 1.12×10^{-5} m/s and 4.58×10^{-5} m/s. IGSL note that the soil at the site is highly impermeable in nature which would account for the low infiltration rates observed. It is likely that such soils would not be suitable for conventional soakaways, with the soil offering only low natural infiltration.

The ground investigations reveal that the soils would be closer to Soil Type 3, with a corresponding SPR of 0.37, however runoff calculations have been based on the more conservative value of 0.3.

When this equation is applied to the proposed development, the following value for $QBAR_{rural}$ is obtained.

For 50ha area $QBAR_{rural}$ $= 0.00108\ [0.5]^{0.89} \times [916]^{1.17} \times [0.47]^{2.17}$

$= 0.281\ m^3/s$

$= 281.0$ l/s (for 50ha)

$QBAR_{rural}$ = 5.756l/s

For the purposes of surface water attenuation design, the site is dealt with as two catchments as shown in Figure 2.1 and is draining to an existing catchment/treatment system via existing public sewers. Table 2.3 below provides a breakdown of the impermeable areas contributing to surface water runoff for the overall site.

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Total Area sq.m	Type of Surface		Area sq.m	Run-off Coefficient	Equivalent Impermeable	Urban Creep Allowance	Overall Impermeable
8769	Roof - Apartments	Standard	946.0	0.95	898.7	988.6	7103.6
		Green Roof	595.0	0.92	547.4	602.1	
		Blue Roof	0.0	0.60	0.0	0.0	
	Permeable Paving inc. areas from hardstanding		918.0	0.50	459.0	504.9	
ha	Landscaped Areas inc. areas from hardstanding		1609.0	0.20	321.8	354.0	ha
0.88							0.7
	Hardstanding		4701.0	0.90	4230.9	4654.0	

Table 2.3 Breakdown of Impermeable Areas – Catchment 2

Catchment 1 is attenuated in the underground attenuation tank within the Communal Open Space, while Catchment 2 is attenuated and filtered within the tree pits and bioretention/rain gardens along the boulevard. The green roofs to the apartment blocks are also providing attenuation for the roof runoff.

A breakdown of the impermeable areas relevant for the sizing of the underground attenuation tank in Catchment 1 with applied runoff coefficients is provided in Table 2.4 below.

Total Area sq.m	Type of Surface		Area sq.m	Run-off Coefficient	Equivalent Impermeable	Urban Creep Allowance	Overall Impermeable
3552	Roof - Apartments	Standard	946.0	0.95	898.7	988.6	2287.2
		Green Roof	595.0	0.92	547.4	602.1	
		Blue Roof	0.0	0.60	0.0	0.0	
	Permeable Paving inc. areas from hardstanding		918.0	0.50	459.0	504.9	
ha	Landscaped Areas inc. areas from hardstanding		871.0	0.20	174.2	191.6	ha
0.36							0.2
	Hardstanding		0.0	0.90	0.0	0.0	

Table 2.4 Breakdown of Impermeable Areas – Catchment 1

Figure 2.1 – Surface Water Drainage Catchment Area

2.5 Sustainable Drainage Systems (SuDS)

The proposed development is designed in accordance with the principles of Sustainable Drainage Systems (SuDS) as embodied in the recommendations of the Greater Dublin Strategic Drainage Study (GDSDS) and will significantly reduce run-off rates and improve storm water quality discharging to the public storm water system. The GDSDS addresses the issue of sustainability by requiring designs to comply with a set of drainage criteria which aim to minimize the impact of urbanization by replicating the run-off characteristics of the greenfield site. The criteria provide a consistent approach to addressing the increase in both rate and volume of run-off, as well as ensuring the environment is protected from any pollution from roads and buildings. These drainage design criteria are as follows:

- Criterion 1 – River Water Quality Protection
- Criterion 2 – River Regime Protection
- Criterion 3 – Flood Risk Assessment
- Criterion 4 – River Flood Protection

The requirements of SuDS are typically addressed by provision of the following:

- Interception storage
- Treatment storage (commonly addressed in interception storage)
- Attenuation storage
- Long term storage (not applicable if growth factors are not applied to Qbar when designing attenuation storage)

2.5.1 Compliance with the principles of the CIRIA C753 SuDS Manual

The C753 SuDS Manual explains that the primary function of SuDS measures is to protect watercourses from any impact due to the new development. However, SuDS can also improve the quality of life in a new development and urban spaces by making them more vibrant, visually attractive, sustainable and more resilient to change. This document explains the wider social context of SuDS and how SuDS can deliver high quality drainage while supporting urban areas to cope better with severe rainfall both in present and future.

There are four main categories of benefits that can be achieved by SuDS:
1. Water Quantity (mitigate flood risk & protect natural water cycle)
2. Water Quality (manage the quality of the runoff to prevent pollution)
3. Amenity (create and sustain better places for people)
4. Biodiversity (create and sustain better places for nature)

Table 2.5 below includes a list of all current SuDS measures which would typically be considered when designing a new residential development such as that which is now proposed. This table also outlines the rationale behind the selection of SuDS measures and why other measures would not be appropriate.

The runoff generated from Catchment 1 will be attenuated in storage structures within and below ground as well as within the green roofs. The proposed attenuation systems are explained in section 2.5.

The runoff from Catchment 2 will be attenuated within the landscaping, rain gardens and tree pits along the boulevard prior to discharging to the network, reducing the runoff rate from the existing conditions along Ardilaun Road and Sackville Avenue.

A wide range of SuDS measures are proposed across the site to maximise interception and treatment.

SUDS Measure	Measure Adopted?	Rationale for Selecting / Not Selecting Measure
Bioretention Swales *Shallow landscaped depressions that serve to reduce runoff rates / volumes as well as providing interception storage, treatment of runoff and encouraging biodiversity*	No	Bioretention swales are not proposed due to the quantity of hard landscaping required within the site to accommodate the emergency egress requirements from Croke Park.
Tree pits *Attenuate surface water runoff by utilising voids within the root zone*	Yes	Tree pits have been specified in suitable areas beside the development roads and car parking. Attenuation tree pits will only be utilised in areas to be maintained by PPPco.
Green Roofs *Vegetated roofs used to reduce the rate and volume of runoff as well as encouraging biodiversity*	Yes	It is proposed to provide green roofs for low-pitch roofs on the apartment buildings.

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Blue Roofs *Provide attenuation storage, reducing requirement for storage elsewhere on site*	No	It is not proposed to provide blue roofs due to the pitch of the apartment roofs.
Green Living Walls *Planted walls which improve air quality and encourage biodiversity*	No	Green walls are not considered appropriate given the proposed residential building use.
Rain Gardens *Localised depressions in the ground that collect runoff from hard surfaces and allow infiltration and absorption*	Yes	Localised Rain Gardens are proposed along the road/plaza area where appropriate in combination with the Tree Pits.
Rainwater harvesting *Runoff captured from roofs is reused for non-potable purposes, thereby reducing overall runoff volume.*	No	In the case of the proposed residential development, rainwater harvesting is not proposed due to the limited space and the provision of green roofs.
Permeable paving *Allows runoff to percolate into the subsoil, reducing overall runoff volume*	Yes	A large area of permeable paving is proposed within the development, within the communal open space and around the apartment blocks
Porous asphalt *Allows runoff to percolate into the subsoil, reducing overall runoff volume*	No	Porous asphalt is not considered suitable for use in roads within the development as it does not comply with the Local Authority roads standards.
Integrated Constructed Wetlands (ICWs) *System of shallow ponds, planted to treat water, removing nutrients and harmful impurities*	No	ICWs are not considered appropriate due to the limited space available.

Table 2.5 Proposed SuDS Features

Further details of the principal SuDS features proposed for this development are provided in the following sections.

2.5.2 Tree Pit and Rain Gardens

It is proposed to provide a number of tree pits adjacent to the proposed boulevard at Sackville Avenue as indicated on drawing SHB4-CVD-DR-MOR-CS-P3-150. The proposal, where appropriate, is to combine individual tree pits into lowered rain gardens as indicated. Aco drains will be provided between the tree pits/rain gardens (within PPPco. areas) to maximise the available storage depth. Runoff from the roads and footpaths will be directed towards these SuDS areas. Refer to the details on drawings SHB4-CVD-DR-MOR-CS-P3-150 and 151. These features will provide a level of storage to attenuate the runoff flows. It is anticipated that runoff from minor rainfall events will be able to percolate directly into the soil and be utilised by the planting and vegetation. An overflow from the tree pits/rain gardens will be provided. During larger storm events, the water in the tree pits and bioretention areas will be able to overflow and discharge from the site.

The rain gardens will be planted in order to promote biodiversity, and have been coordinated with the landscape architect’s design. Runoff will also be treated through the adsorption of particles by vegetation or by soil, and by biological activity. Tree pits can reduce the runoff rates and volumes of surface water. Although the area contributing is small, they are effective in delivering interception and treatment storage. The proposed bioretention areas allow for a larger area to be drained. The levels have been developed to allow surface water to be directed towards the bioretention areas and tree pits.

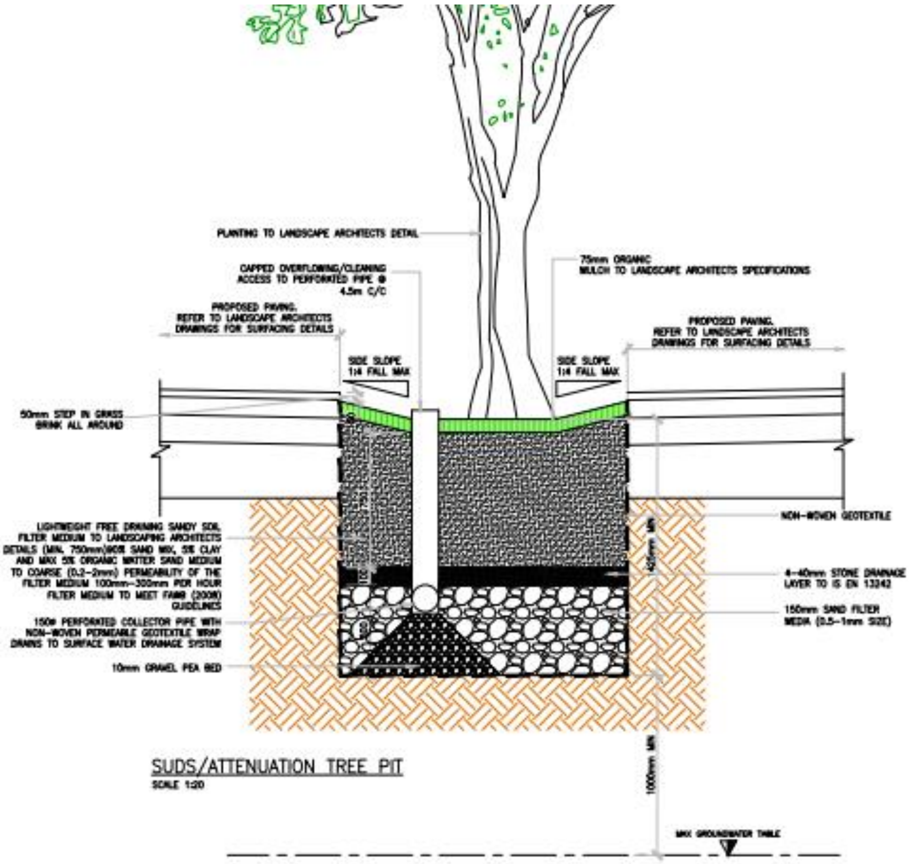


Figure 2.2 – Attenuation Tree Pit

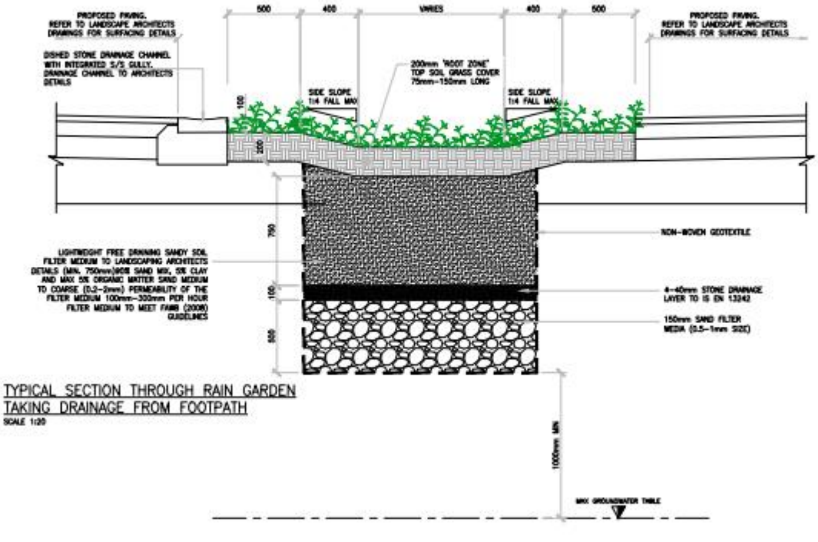


Figure 2.3 – Rain Garden

2.5.3 Green Roofs

Green roofs will be installed above the apartment flat roof buildings. These roofs will provide initial storage of rainwater, while also reducing the rate at which rainwater from heavier rainfall events discharges to the attenuation systems. They can also help to filter the run-off, removing pollutants and resulting in a higher quality of water discharging into the drainage system and receiving watercourse. Refer to the Malone O'Regan SuDS detail drawing no. SHB4-CVD-DR-MOR-CS-P3-150 for typical roof details.

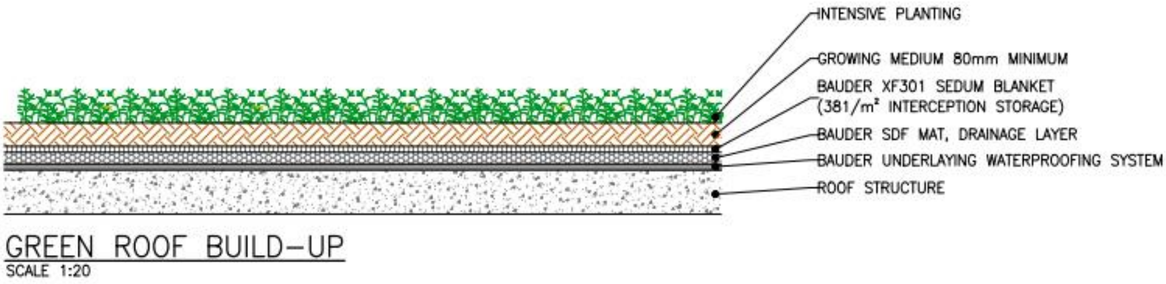


Figure 2.4 – Green Roof Typical Build-up

Extensive roofs have low substrate depths and therefore low loadings on the building structure, they are lightweight and have a low cost to maintain. These systems cover the entire roof area with hardy, slow growing, drought resistant, low maintenance plants and vegetation, such as sedums. The planting usually matures slowly, with the long-term biodiverse benefits being the sought-after results. These roofs are typically only accessed for maintenance and are usually comprised of between 80mm – 150mm overall total depth of growth medium.

A typical extensive green roof system can intercept and retain over 30 litres/m² (i.e., 30 mm) depending on the build-up. Since these roofs are exposed to the Irish climate, there is a high probability that the roof will not be completely dry, and the storage capacity will be compromised on any given rainfall event. Thus, the more conservative estimate of 12 litres/m² (12mm) interception storage will be assumed.

2.5.4 Permeable Paving

It is proposed to use permeable paving to surface the communal open space in the development, as well as an extensive area to the south, located between Block A and the railway line. It is anticipated that most of the rainwater will be able to percolate through the permeable paving and infiltrate into the underlying soils. However, it is proposed to provide a number of overflow outlets within the permeable paving build-up which will ensure the communal space is not flooded during severe rainfall events. The outlet from the permeable paving areas will be raised 100-150mm above formation level to provide interception storage within the stone sub-base; this gives 30mm interception storage @ 30% voids in the gravel.

These permeable surfaces, together with their associated substructures, are an efficient means of managing surface water runoff close to source – intercepting runoff, reducing the volume and frequency of runoff, and providing treatment medium. Refer to the Malone O'Regan SuDS detail drawing no. SHB4-CVD-DR-MOR-CS-P3-150 for typical permeable paving details.

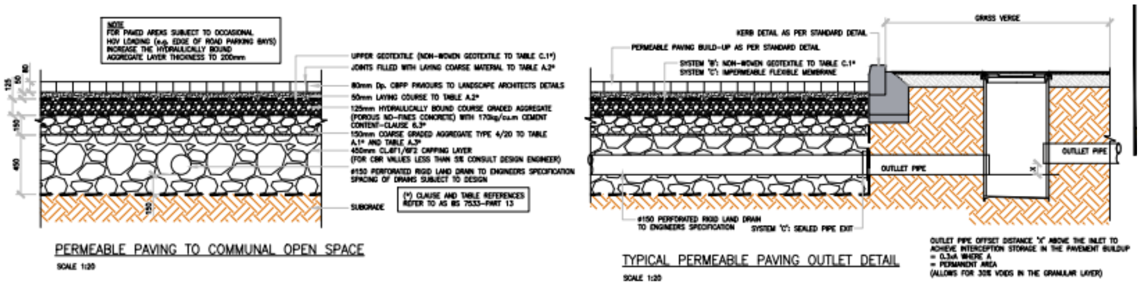


Figure 2.5 – Typical Section Through Permeable Paving

2.6 Interception Storage

To prevent pollutants or sediments discharging into watercourses the GDSDS requires "interception storage" to be incorporated into the drainage design for the development. The volume of interception required is based on 5-10mm of rainfall depth from 80% of the runoff from impermeable areas as defined in GDSDS. The interception volume attributable to each SuDS feature consists of the volume of water that can infiltrate to the ground, the quantity that evaporates into the atmosphere and the volume lost through transpiration in plants and vegetation. Additionally, there will be some loses of water due to absorption and wetting of stone and soil media.

2.6.1 Required Interception Storage

The total equivalent impermeable area is 7104m^2 including 10% allowance for urban creep (refer to Table 2.4)

Therefore, the total interception storage required = 7104 x 0.8 x 0.01 x 1.2 = **68.19m^3**.

2.6.2 Interception Storage Provided

Permeable Paving

Area = 918m^2

Stone layer 100mm deep below outlet;

Void Ratio = 30%

Storage Volume = 918 x 0.1 x 0.3 = 27.54m^3

Green Roofs

A "Bauder Sedum Blanket" or equivalent designed to retain 30 litres/m2 of rainwater will be used on roof level of both blocks where only maintenance access is provided.

Plan Area = 595m^2

Interception storage = 30 litres / m^2

Storage Volume = 595 x 0.03 = 17.85m^3

<u>Tree Pits / Bioretention Zones</u>

equivalent

Plan Area = 617m^2

150mm storage below the outlet level

Storage Volume = 617 x 0.15 = 92.55m^3

The total interception volume provided for the overall site is **137.94m^3** which exceeds the required volume calculated in Section 2.6.1.

2.7 Attenuation Design

Attenuation storage is provided on the site using an attenuation storage system. For the purposes of surface water attenuation design, the site is reviewed as two catchment areas as shown in Figure 2.1. Surface water arising from within catchment 1 will drain by gravity to the underground attenuation system. Attenuation for catchment 2 is provided within the bioretention areas and improves on the current drainage design, which provides no attenuation. The volume of surface water storage required has been calculated in accordance with the SuDS Manual Ciria C697, taking account of design invert levels, ground levels and allowable discharge rate. Calculations for the attenuation storage system is provided in Appendix B.

Surface water runoff from the site areas will drain by gravity to the attenuation system located in the central open space between the apartment blocks A and B. During a 1 in 100-year storm event, this storage system will store a maximum of 82m^3 of surface water runoff. This volume has been calculated allowing for a 20% increase in future rainfall intensities as a result of climate change.

The outflow from the attenuation tank is limited by a Hydrobrake flow control device which restricts the flow to 2.0 L/s.

2.8 GDSDS Criterion Compliance

2.8.1 Criterion 1 River Water Quality Protection

Run-off from natural greenfield areas contributes very little pollution and sediment to rivers and for most rainfall events direct run-off from greenfield sites to rivers does not take place as rainfall percolates into the ground. By contrast, urban run-off, when drained by pipe systems, results in run-off from virtually every rainfall event with high levels of pollution, particularly in the first phase of run-off, with little rainfall percolating to the ground. To prevent this happening, Criterion 1 requires that interception storage and/or treatment storage is provided, thereby replicating the run-off characteristics of the pre-development greenfield site.

2.8.2 Criterion 3 Site Flooding

The GDSDS requires that no flooding should occur on site for storms up to and including the 1 in 30-year event. The pipe network and the attenuation storage volumes should,

therefore, be checked for such storms to ensure that no site flooding occurs although partial surcharging of the system is allowed if it does not threaten to flood.
For the 1 in 100-year event, the pipe network can fully surcharge and cause site flooding, but the top water level due to any such flooding must be at least 500mm below any vulnerable internal floor levels, and the flood waters should be contained within the site. In addition, the top water level in any attenuation device during the 100-year storm must be at least 500mm below any vulnerable internal floor levels.

Surface water drains have been sized to ensure the following:

- The system does not surcharge for the 1-year event.
- The system surcharges but does not flood for the 30-year event.
- The system surcharges but does not flood for the 100-year event.

Detailed modelling of the surface water sewer network has been carried out using Causeway Flow software to confirm the above criteria is adequately met. The outputs are appended to this report.

2.8.3 Criterion 2 & 4 River Regime & Flood Protection

Regardless of the rainfall event, unchecked run-off from the developed site through traditional pipe networks will discharge into receiving waters at rates that are an order of magnitude greater than that prior to development. This can cause flash flow in the outfall river / stream that can cause scour, erosion & downstream flooding. Attenuation storage is provided to prevent this occurring by limiting the rate of run-off to that which took place from the pre-development greenfield site. In practice, the rate of run-off needs to be appropriately low for most rainfall events, and attenuation storage volumes should be provided for the 1 and 100-year storm event + 20% for climate change. The rate of outflow from such storage should be controlled so that it does not exceed the greenfield run-off rate of QBAR, which can be factored upwards by factors appropriate to the various return periods (given in the Flood Studies Report) if long term storage is provided. Notwithstanding that significant long-term storage will be provided in the form of interception storage, this does not equate to full long-term storage volume provision and so growth factors will not be applied to QBAR when calculating the attenuation storage volume required.

Qbar for the site has been calculated in accordance with the IH124 method as 5.756 l/s, based on the drained areas of the site. As the surface runoff flow rate discharged from the site does not exceed Qbar, there is a requirement for long-term storage to limit the impact on the receiving watercourse. Please refer to section 2.3.2 of this report for the Qbar calculation.

Criterion 4 is intended to prevent flooding of the receiving system / watercourse by either.

- Limiting the volume of run-off to the pre-development greenfield volume using ‘long-term storage’ (Option 1) or by

- Limiting the rate of run-off for the 1 in 100-year storm to QBAR without applying growth factors using 'extended attenuation storage' (Option 2).

Significant long-term storage will be provided in the form of interception storage. This does not, however, equate to full long term storage volumes and it is not feasible to provide additional storage areas elsewhere on site to achieve the required volume, due to the constrained nature of this brownfield urban regeneration site.

Option (2) has therefore been used to comply with Criterion 4 and an attenuation volume will be provided in the proposed attenuation storage system in the central POS area of the site to limit the rate of discharge in the 1 in 100-year storm +20% event to QBAR without growth factors applied.
Refer to Appendix B for surface water network design calculations.

2.9 Enhanced Biodiversity

The encouragement of biodiverse environments within urban environments is incredibly important and will be included as part of the proposed development. Biodiversity has been carefully considered when determining both the location and the detailed design of these elements. The proposed rain gardens offer the opportunity to create a planted vegetation zone for plants and animals which will encourage biodiversity on the site. The SuDS measures must not only replicate the pre-development surface water runoff systems and treatment for rainfall, but they should also aim to replicate the existing habitats from the pre- development stage. By incorporating large landscaped areas, green roofs throughout the site and the bio- retention areas, biodiversity on site is promoted.

2.10 SuDS CIRIA Pillars of Design

2.10.1 Water Quantity

The "Water Quantity" design objective is to ensure that the surface water runoff from a developed site does not have a detrimental impact on people, property, or the environment, it is important to control:

- How fast the runoff is discharged from the site (i.e., the peak runoff rate) and
- How much runoff is discharged from the site (i.e., the runoff volume)

2.10.2 Water Quality

The "Water Quality" design objective seeks to ensure the surface water runoff from the site does not compromise the groundwater or surrounding water courses relating to the site.

2.10.3 Amenity

The "Amenity" design objective aims to deliver attractive, pleasant, useful and above all liveable urban environments. SuDS measures should be designed to replicate the existing natural environment and blend in with the urban development.

MOR have worked closely with the landscaping architect throughout the SuDS strategy design process to ensure that the measures which have been suggested and incorporated have a high sense of public use. Throughout the site, there are green roofs, bio-retention areas and tree pits.

2.10.4 SuDS Conclusion

This section of the report has comprehensively discussed the various SuDS measures which can be applied to the site and then selected the applicable systems, based on the site layout. A wide range of measures have been employed.
The chosen SuDS measures have been analysed for various rainfall scenarios to ensure that all the SuDS design principles are met. A diverse range of SuDS measures are proposed with extensive coverage of the developed area of the site. These measures will be effective in treating rainfall on the site to meet GDSDS and CIRIA.

2.11 Assessment for Flood Risk due to Potential Blockage of the Surface Water Drainage System on Site

A secondary check has been carried out to assess for flood risk arising from potential blockages in the proposed surface water network. This analysis was carried out using Causeway Flow by modelling the Hydrobrake at half of the Qbar for 50% blockage of the system. The results are appended in Appendix C of the report and indicate the flood volumes. Refer to the flood risk assessment report for further information.

2.12 Maintenance and Management Plan

Refer to Appendix E for details of maintenance requirements for individual SuDS drainage measures on the site.

2.13 Potential Future Expansion

No future expansion has been considered for the proposed drainage networks for the development.

3 FOUL WATER DRAINAGE DESIGN

3.1 General

The foul water drainage infrastructure has been designed in accordance with Irish Water Technical Standard for Wastewater Gravity Sewers (Document Number: IW-TEC-800-01) and the Irish Water Code of Practice for Wastewater Infrastructure (Document Number: IW-CDS-5030-03).

A Pre-Connection Enquiry Form was submitted to Irish Water in respect of this development. Irish Water provided a Confirmation of Feasibility letter which confirms that, subject to a valid connection agreement being put in place, the proposed connection to the public sewer network can be facilitated. The letter further notes that Irish Water have reviewed the wastewater characteristics and hydraulic discharge load and determined that no upgrades are required to the Irish Water network or municipal wastewater treatment plant. There are existing sewers in the site and it is proposed to carry out diversion works to ensure the development requirements can be achieved, while having no impact on Irish Water assets.

A Copy of the Irish Water Confirmation of Feasibility Letter is provided in Appendix A.

Table 3.1 outlines the parameters adopted in the design of the foul water drainage infrastructure.

Parameter Description	Assigned Value
Hydraulic Loading (Foul associated with domestic)	150 litres / person / day
Pipe Friction	1.5 mm
Minimum Velocity	0.75 m/s
Maximum Velocity	3.0 m/s
Peaking Factor (for domestic foul flows only)	6.0

Table 3.1 Foul Water Design Parameters

Hydraulic loading for the foul drainage i.e. domestic foul flows from toilets, sinks etc. have been calculated in accordance with the Irish Water Code of Practice for Wastewater Infrastructure which gives a flow rate of 150 litres per person per day for domestic dwellings.

Calculations for the foul water pipe network are provided in Appendix D.

3.2 Existing Services

An existing network of drainage runs around the perimeter of the site on two sides. These underground drains carry foul water towards existing treatment areas in the north Dublin area. Due to the relative levels of the existing drainage within the road and the proposed site levels, it is possible to achieve a gravity connection to the foul water drainage pipework installed. There is a 990X730mm brick combined sewer running parallel to the Royal Canal on the western boundary. There is a 300mm concrete combined sewer on Sackville Avenue parallel to the eastern boundary.

3.3 Proposed Services

The proposed foul water drainage system is designed to comply with the ‘Greater Dublin Strategic Drainage Study (GDSDS) Regional Drainage Policies Technical Document – Volume 2, New Developments, 2005’ and the ‘Greater Dublin Regional Code of Practice for Drainage Works, V6.0 2005’.

The proposed foul water drainage layout for the development is indicated on Malone O’Regan drawing SHB4-CVD-DR-MOR-CS-P3-130. Foul water from new housing units will be collected within a gravity drainage network and directed towards the existing public sewer system.

3.4 Potential Future Expansion

No future expansion has been considered for the proposed drainage networks for the development.

4 WATER SUPPLY

4.1 General

The Proposed Development will use public mains water. The proposed water supply infrastructure has been designed in accordance with the Irish Water Code of Practice for Water Infrastructure (Document Number: IW-CDS-5020-03).

A Pre-Connection Enquiry Form was submitted to Irish Water in respect of this development. Irish Water provided a Confirmation of Feasibility (CoF) letter which confirms that, subject to a valid connection agreement being put in place, the proposed connection to the public water supply network can be facilitated.

A Copy of the Irish Water Confirmation of Feasibility Letter is provided in Appendix A.

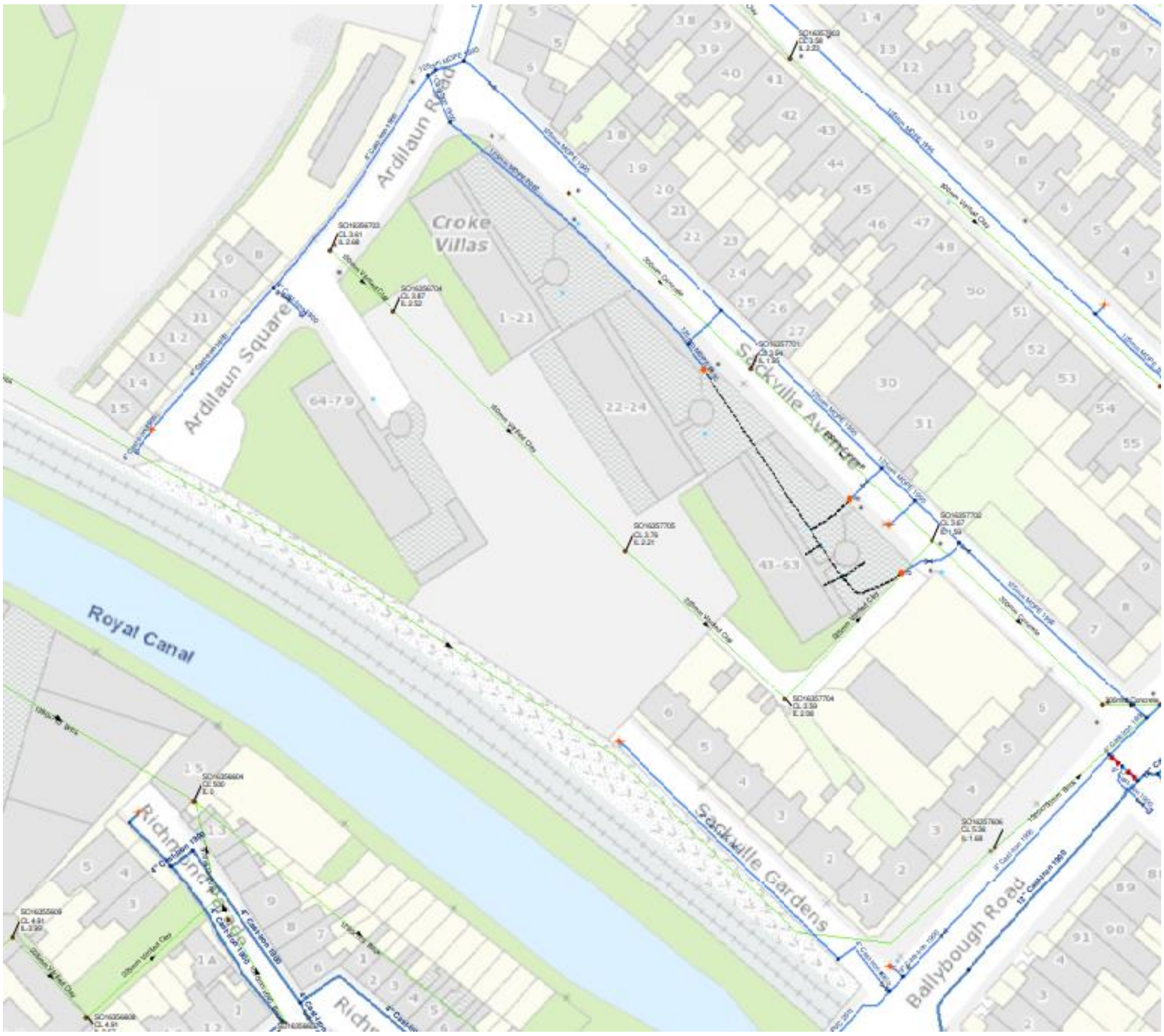


Figure 4.1 – Extract from Irish Water maps

4.2 Existing & Proposed Services

There is a 125mm watermain located in Sackville Avenue which connects to a 9” Cast-Iron watermain in the R803 Ballybough Road. There is a 100mm watermain terminating in the southwest corner of the site on Sackville Gardens. There is also a 100mm watermain located in Ardilaun Square.

The proposed watermain layout is indicated on drawing SHB4-CVD-DR-MOR-CS-P3-140 which accompanies this planning application.

4.3 Water Demand Calculations

Average and peak water demand rates have been calculated as follows, in accordance with the Irish Water Code of Practice for Water Infrastructure:

Domestic Water Demand

Total no. residents = 201

Irish Water Code of Practice for Water Infrastructure gives flow rate for Domestic Dwellings' as 150 litres per person per day.

Total Daily Water Demand = 201 people x 150 litres per day per person
= 30,150 litres/day

Average Hour Demand = 30,150 litres/day / (24hr x 60min x 60sec)
= 0.349 litres/sec

The average day, peak week demand is taken as 1.25 times the average daily domestic demand.

Average Day / Peak Week Demand = 0.349 litres/sec x 1.25
= 0.436 litres/sec

The above figures were provided to Irish Water within the Pre-Connection Enquiry Form dated *13th December 2023*. Irish Water’s response to the Pre-Connection Enquiry, outlined in their Confirmation of Feasibility Letter, is therefore based on these figures.

5 DMURS COMPLIANCE

This section describes the various measures implemented during the design process to ensure that compliance with the Design Manual for Urban Roads and Streets (DMURS) has been achieved.
The scheme proposals are the outcome of an integrated design approach that seeks to implement a sustainable community connected by well-designed streets which deliver safe, convenient and attractive networks in addition to promoting a real and viable alternative to car-based journeys.

In terms of DMURS, the R803 Ballybough Road is considered a Link Street. Sackville Avenue, Ardilaun Road and Ardilaun Square are considered Local Streets.

5.1 Linkages and Permeability

As part of the development design, integrated bicycle and pedestrian routes have been provided with a high level of connectivity to the surrounding network. Bicycle storage areas will be provided within the proposed apartment buildings and externally, with a total of 129no. spaces being provided.

5.2 Design Parameters

The adopted design approach successfully achieves the appropriate balance between the functional requirements of different network users whilst enhancing the sense of place. The implementation of self-regulating streets actively manages movement by offering real modal and route choices in a low speed / high quality residential environment. Specific attributes of the schemes design which contribute to achieving this DMURS objective include:

I. The proposed design approach provides connectivity and pedestrian routes with priority of movement given to the pedestrian and cyclist. Crossing points for cyclists and pedestrians are provided at each of the roads and safely connect to the surrounding networks.

II. The proposed design has sought to specify minimal signage and line marking in the development, with such measures utilised predominantly at transition areas between the internal roads.

III. Road geometry such as corner radii, visibility splays, alignment and deflections have been designed according to DMURS to naturally promote lower vehicle speeds and prioritise pedestrian and cyclist safety.

IV. The proposed paving finishes for the carriageway and pedestrian paths, along with the landscaping proposals promote a strong sense of place while encouraging a low-speed shared environment for all road users.

The table in the following Section *'DMURS Design Attributes'* describes the various elements of guidance contained within the DMURS document. It also identifies the design measures which have been implemented to ensure compliance.

5.3 DMURS Design Attributes

Design Element	DMURS Guidance	Proposed Development Adopted Design Approach
Movement Function	DMURS encourages designers to consider the movement function of a street/street network and develop a street hierarchy reflective of the levels of connectivity required and volumes of traffic	The development is set in an existing street hierarchy. The development will be set on a **Local Street** with connections to the **Link Street** the R803 Ballybough Road. Safe pedestrian and cycle access is provided directly to the R803.
Place Context	The *'Place Context'* defines the characteristics of the area and sets the requirement of the design solutions within each of the different contexts, defined as; • Centre • Neighbourhood • Suburbs • Industrial • Rural	In the context of DMURS the proposed development can be defined as a neighbourhood, located in close proximity to the City Centre. The design approach utilises urban centre strategies to account for the continued and future expansion of the urban core, and to promote sustainable modes of travel to the nearby City Centre. The apartment blocks have been designed with a scale and form appropriate to the location of the development.
Street Layout	DMURS looks to encourage street layouts where *"all streets lead to other streets, limiting the number of cul-de-sacs that provide no through access"* and maximise the number of walkable/cyclable routes between destinations	Footpath and bicycle routes are catered for at both main access points to the development. The links provide a convenient and attractive route for pedestrians and cyclists from the site to a Link Street with high connectivity to the City Centre and greater Dublin area. The proposed design approach provides connectivity and permeability within the scheme with priority of movement given to the pedestrian and cyclists.

Traffic Congestion	DMURS states that adopting sustainable modes of transport such as walking and cycling leads to a far more efficient manner of catering for high volumes of movement.	The proposed layout has considered sustainable modes of transport and a connected network has been provided to the development with facilities for bicycles and bicycle parking within the apartment buildings. The traffic-calmed street environment has been promoted by a paving surface with embedded kerbs to prioritise pedestrians and cyclists. Local bus routes are located on the surrounding roads.
Approach to Speed	DMURS states that designers should balance speed management, the values of place and reasonable expectations of appropriate speed according to Context and Function. Where vehicle movement priorities are low, such as on Local Streets, lower speeds limits should be applied (30km/h)	A speed limit of 30km/h is applied to Sackville Avenue as recommended for Local Streets. Sackville Avenue is raised at the junctions with the surrounding network to provide a vertical deflection and reinforce the low-speed environment. This in combination with the paved surface is an effective approach to reducing speed and prioritising pedestrians. Uncontrolled pedestrian crossing points are also included. The geometry of the roads and junctions promotes the natural reduction of vehicle speeds.
Street Trees	DMURS states planting of trees as an integral part of street design and should proportionally relates the width of the street reserve and species' canopies.	Planting, trees and soft landscaping are proposed within the integrated design strategy for the boulevard and within the apartment development. The street trees have been designed in the context of the GAA to create a sense of character for the area close to Croke Park. Refer to the landscape architecture documents for full details.
Active Street Edges	Designers should aim for active street edges which provide passive surveillance and promote pedestrian activity	The streets and communal open spaces are overlooked by the apartment buildings and houses, providing passive surveillance to the streets and parking areas.

Signage and Line Marking	According to DMURS, the implementation of self-regulating streets means that the reliance on signage to instruct people is significantly reduced, and drivers must navigate with full regard to their own behaviour. The TSM warns against 'over providing' signage as it detracts from the effectiveness.	Line marking and signage has been kept to the minimum required in regard to the proposed development. A stop sign and line marking are located at the junction with the R803, with yield signs and marking at the other minor junctions.
Carriageway Surfaces	DMURS states that "The use of paving, imprinted or looser materials (combined with no kerbing, see Section 4.4.8 Kerbs) is one of the clearest ways of reinforcing a low-speed environment and of signalling to all users that the main carriageway is to be shared (see Figure 4.56). The use of such surfaces also adds value to place, particularly in historic settings.	The proposed surface materials are in line with the requirements of DMURS. Contrasting paving with embedded kerbing and coloured tactile paving is provided to the boulevard. Permeable paving is provided to the communal areas.
Carriageway Widths	The standard carriageway width on Local Streets should be between 5-5.5m.	The carriageway for Sackville Avenue is designed at 5.5m wide in accordance with DMURS.
Visibility Splays	DMURS states that for Urban areas; Vehicles require 23m clear visibility splays from 2.4m setback	The proposed design allows for the required visibility splays at all junctions as indicated on the submitted engineering drawings. Additionally, pedestrian visibility splays have been provided at 23m from a 0.7m setback from the road edge. These measures are further evaluated in the accompanying Road Safety Audit.

Corner Radii	Reducing corner radii improves pedestrian and cyclist safety at junctions by lowering vehicles speeds and increasing inter-visibility between users. Where design speeds are low and movements by larger vehicles are infrequent, such as on Local streets, a maximum corner radii of 1-3m should be applied. Where turning movements occur from an Arterial or Link street into a Local street corner radii may be reduced to 4.5m. Designers may have concerns regarding larger vehicles crossing the centre line of the intersecting street or road. Such manoeuvres are acceptable when turning into/or between Local or lightly trafficked Link streets as keeping vehicle speeds low is of higher priority.	Complying with requirements of DMURS, junctions and corner radii are proposed as following: Junctions from the Link Road to Sackville Avenue – 4.5m. Junctions between Local Streets – 3m. The vehicle access track drawings provided with the application show refuse and fire tender vehicles crossing the centre line of the Local Street. This is acceptable within DMURS and is encouraged rather than increasing corner radii.

Appendix A

Uisce Eireann Confirmation of Feasibility

CONFIRMATION OF FEASIBILITY

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

Uisce Éireann
PO Box 448
South City
Delivery Office
Cork City

www.water.ie

Ray O'Connor

Malone O'Regan
2B Richview Office Park
Clonskeagh
Dublin 14
Dublin
D14 XT57

22 January 2024

Our Ref: CDS23009359 Pre-Connection Enquiry
Apartments at Croke Village, Sackville Avenue, Dublin

Dear Applicant/Agent,

We have completed the review of the Pre-Connection Enquiry.

Uisce Éireann has reviewed the pre-connection enquiry in relation to a Water & Wastewater connection for a Housing Development of 67 unit(s) at Apartments at Croke Village, Sackville Avenue, Dublin (the **Development)**.

Based upon the details provided we can advise the following regarding connecting to the networks;

- **Water Connection** - Feasible without infrastructure upgrade by Irish Water

- The proposed Development indicates that Uisce Éireann assets are present on the site. The Developer has to demonstrate that proposed structures and works will not inhibit access for maintenance or endanger structural or functional integrity of the assets during and after the works. For design submissions and queries related to diversion/build near or over, please contact UÉ Diversion Team via email address diversions@water.ie

- **Wastewater Connection** - Feasible without infrastructure upgrade by Irish Water

- The proposed Development indicates that Uisce Éireann assets are present on the site. The Developer has to demonstrate that proposed structures and works will not inhibit access for maintenance or endanger structural or functional integrity of the assets during and after the works. For design submissions and queries related to diversion/build near or over, please contact UÉ Diversion Team via email address diversions@water.ie

- The Development has to incorporate Sustainable Drainage Systems/ Attenuation in the management of storm water and to reduce surface water inflow into the receiving combined sewer. Full details of these have to be agreed with the LA Drainage Division.

This letter does not constitute an offer, in whole or in part, to provide a connection to any Uisce Éireann infrastructure. Before the Development can be connected to our network(s) you must submit a connection application and be granted and sign a connection agreement with Uisce Éireann.

As the network capacity changes constantly, this review is only valid at the time of its completion. As soon as planning permission has been granted for the Development, a completed connection application should be submitted. The connection application is available at www.water.ie/connections/get-connected/

Where can you find more information?

- **Section A -** What is important to know?
- **Section B -** Details of Uisce Éireann's Network(s)

This letter is issued to provide information about the current feasibility of the proposed connection(s) to Uisce Éireann's network(s). This is not a connection offer and capacity in Uisce Éireann's network(s) may only be secured by entering into a connection agreement with Uisce Éireann.

For any further information, visit **www.water.ie/connections**, **email newconnections@water.ie** or contact 1800 278 278**.**

Yours sincerely,

Dermot Phelan
Connections Delivery Manager

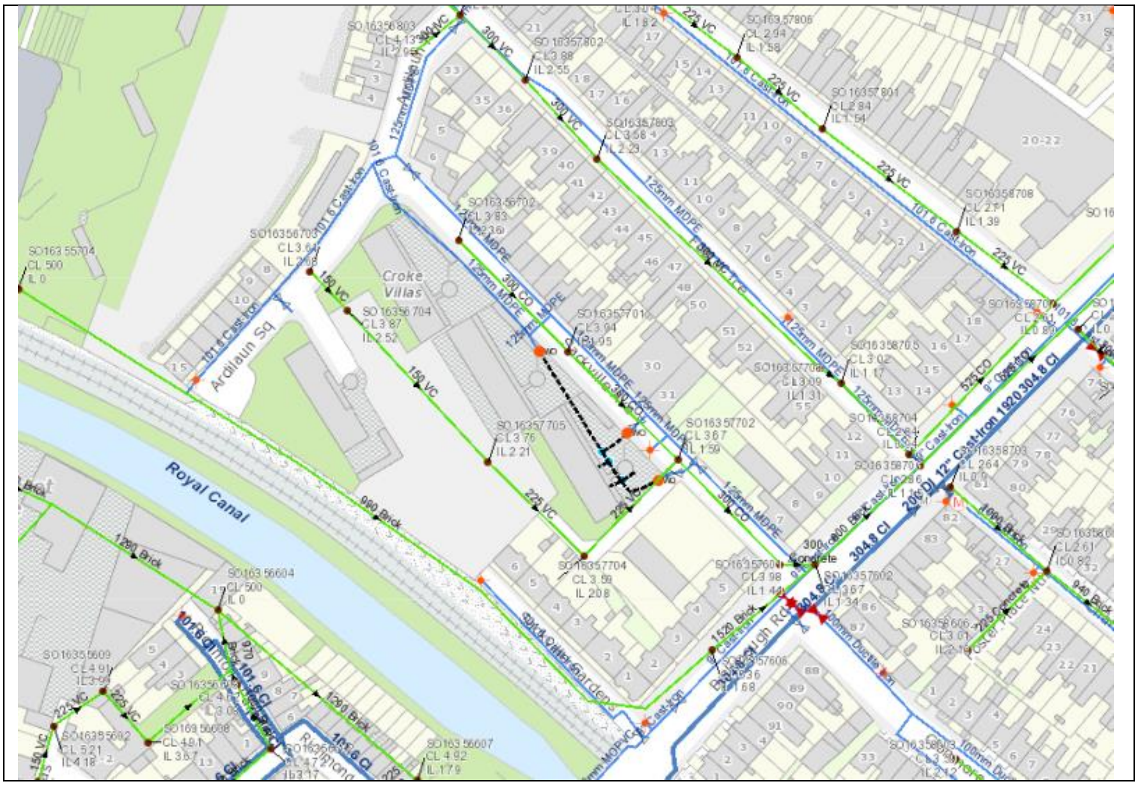
Section A - What is important to know?

What is important to know?	Why is this important?
Do you need a contract to connect?	• Yes, a contract is required to connect. This letter does not constitute a contract or an offer in whole or in part to provide a connection to Uisce Éireann's network(s). • Before the Development can connect to Uisce Éireann's network(s), you must submit a connection application and be granted and sign a connection agreement with Uisce Éireann.
When should I submit a Connection Application?	• A connection application should only be submitted after planning permission has been granted.
Where can I find information on connection charges?	• Uisce Éireann connection charges can be found at: https://www.water.ie/connections/information/charges/
Who will carry out the connection work?	• All works to Uisce Éireann's network(s), including works in the public space, must be carried out by Uisce Éireann*. *Where a Developer has been granted specific permission and has been issued a connection offer for Self-Lay in the Public Road/Area, they may complete the relevant connection works
Fire flow Requirements	• The Confirmation of Feasibility does not extend to fire flow requirements for the Development. Fire flow requirements are a matter for the Developer to determine. • **What to do?** - Contact the relevant Local Fire Authority
Plan for disposal of storm water	• The Confirmation of Feasibility does not extend to the management or disposal of storm water or ground waters. • **What to do?** - Contact the relevant Local Authority to discuss the management or disposal of proposed storm water or ground water discharges.
Where do I find details of Uisce Éireann's network(s)?	• Requests for maps showing Uisce Éireann's network(s) can be submitted to: datarequests@water.ie

What are the design requirements for the connection(s)?	• The design and construction of the Water & Wastewater pipes and related infrastructure to be installed in this Development shall comply with ***the Uisce Éireann Connections and Developer Services Standard Details and Codes of Practice,*** available at www.water.ie/connections
Trade Effluent Licensing	• Any person discharging trade effluent** to a sewer, must have a Trade Effluent Licence issued pursuant to section 16 of the Local Government (Water Pollution) Act, 1977 (as amended). • More information and an application form for a Trade Effluent License can be found at the following link: https://www.water.ie/business/trade-effluent/about/ **trade effluent is defined in the Local Government (Water Pollution) Act, 1977 (as amended)

Section B – Details of Uisce Éireann's Network(s)

The map included below outlines the current Uisce Éireann infrastructure adjacent the Development: To access Uisce Éireann Maps email datarequests@water.ie



Note: The information provided on the included maps as to the position of Uisce Éireann's underground network(s) is provided as a general guide only. The information is based on the best available information provided by each Local Authority in Ireland to Uisce Éireann.

Whilst every care has been taken in respect of the information on Uisce Éireann's network(s), Uisce Éireann assumes no responsibility for and gives no guarantees, undertakings or warranties concerning the accuracy, completeness or up to date nature of the information provided, nor does it accept any liability whatsoever arising from or out of any errors or omissions. This information should not be solely relied upon in the event of excavations or any other works being carried out in the vicinity of Uisce Éireann's underground network(s). The onus is on the parties carrying out excavations or any other works to ensure the exact location of Uisce Éireann's underground network(s) is identified prior to excavations or any other works being carried out. Service connection pipes are not generally shown but their presence should be anticipated.

Appendix B

Attenuation Calculations

Job Title	B4 05 Croke Villas	Job no.	23006
By:	Caolan Carty	Checked by:	
Date	Mar-24	Rev number	4

Part 1 **Permissible Runoff**

The regression equation recommended for use by the Greater Dublin Strategic Drainage Study 2005 calculates a value, QBARural, which is sourced from the Institute of Hydrology Report 124. This value is the mean annual flood flow from a rural catchment in m³/s and is given by the equation:

QBARrural = 0.00108[Area^0.89] x [SAAR^1.17] x [Soil^2.17]

Rainfall Data	
M5-60 (1 hour - 5 years) mm	16.1
M5-2D (2 days - 5 years) mm	58.1
Ratio "r" (M5-60/ M5-2D)	0.28
SAAR mm	797
Soil/ SPR mm	0.47

For 50 Ha Area ~ QBARrural =	0.281	m³/s
For 0.35 Ha Area ~ QBARrural =	1.996	l/s
Allowable outflow from the site (Council recommendation)	2	l/s

*Note: (1) The attenuation tank is only for the apartment block. The boulevard is seperated from the attenuation tank and is put through the tree pits to delay and cleanse. (2) Blue/Green Roof is providing its own attenuation. See calcs for attenuation volume.

Part 2 **Impermeable Area**

Breakdown of the impermeable areas contributing to the surface water drainage network in each catchment with applied runoff coefficients is provided in the table below

Total Area sq.m	Type of Surface		Area sq.m	Run-off Coefficient	Equivalent Impermeable	Urban Creep Allowance	Overall Impermeable
3552	Roof - Apartments	Standard	946.0	0.95	898.7	988.6	2287.2
		Green Roof	595.0	0.92	547.4	602.1	
		Blue Roof	0.0	0.60	0.0	0.0	
	Permeable Paving inc. areas from hardstanding		918.0	0.50	459.0	504.9	
ha	Landscaped Areas inc. areas from hardstanding		871.0	0.20	174.2	191.6	ha
0.36							0.2
	Hardstanding		0.0	0.90	0.0	0.0	

Part 3 **Attenuation Volume Required**

1 in 10 Years								
Time	%	M5	Growth	Area	MT	Inflow	Outflow	Capacity Required
			Factor (10 Years)	Factor	Factor	"I"	"O"	"I"-"O" ="S"
note	1	2	3	4	5	6	7	8
1 min	3.3	1.9	1.15	1	2.205	5.043	0.12	4.923
2min	5.7	3.3	1.16	1	3.842	8.787	0.24	8.547
5 min	10.3	6.0	1.18	1	7.061	16.151	0.6	15.551
10 min	14.8	8.6	1.18	1	10.147	23.208	1.2	22.008
15 min	17.7	10.3	1.18	1	12.135	27.755	1.8	25.955
30 min	23.3	13.5	1.18	1	15.974	36.536	3.6	32.936
60 min	30	17.4	1.17	1	20.393	46.644	7.2	39.444
2 hour	38	22.1	1.16	1	25.610	58.577	14.4	44.177
4 hour	48	27.9	1.15	1	32.071	73.354	28.8	44.554
6 hour	55	32.0	1.14	1	36.429	83.321	43.2	40.121
12 hour	68	39.5	1.14	1	45.039	103.015	86.4	16.615
24 hour	85	49.4	1.13	1	55.805	127.639	172.8	-45.161
48 hour	106	61.6	1.12	1	68.976	157.765	345.6	-187.835
Size of Attenuation for 1 in 10 year flood event m³								**44.554**

1 in 30 Years								
Time	%	M5	Growth	Area	MT	Inflow	Outflow	Capacity Required
			Factor (30 Years)	Factor	Factor	"I"	"O"	"I"-"O" ="S"
note	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1 min	3.3	1.9	1.39	1	2.665	6.096	0.12	5.976
2min	5.7	3.3	1.41	1	4.669	10.680	0.24	10.440
5 min	10.3	6.0	1.44	1	8.617	19.710	0.6	19.110
10 min	14.8	8.6	1.46	1	12.554	28.714	1.2	27.514
15 min	17.7	10.3	1.48	1	15.220	34.811	1.8	33.011
30 min	23.3	13.5	1.49	1	20.171	46.135	3.6	42.535
60 min	30	17.4	1.48	1	25.796	59.002	7.2	51.802
2 hour	38	22.1	1.47	1	32.455	74.231	14.4	59.831
4 hour	48	27.9	1.45	1	40.438	92.490	28.8	63.690
6 hour	55	32.0	1.44	1	46.015	105.247	43.2	62.047
12 hour	68	39.5	1.42	1	56.101	128.317	86.4	41.917
24 hour	85	49.4	1.38	1	68.151	155.878	172.8	-16.922
48 hour	106	61.6	1.34	1	82.525	188.754	345.6	-156.846
Size of Attenuation for 1 in 30 year flood event m³								**63.690**

1 in 100 Years								
Time	%	M5	Growth	Area	MT	Inflow	Outflow	Capacity Required
			Factor (30 Years)	Factor	Factor	"I"	"O"	"I"-"O" ="S"
note	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1 min	3.3	1.9	1.87	1	3.585	8.201	0.12	8.081
2min	5.7	3.3	1.88	1	6.226	14.240	0.24	14.000
5 min	10.3	6.0	1.97	1	11.789	26.964	0.6	26.364
10 min	14.8	8.6	1.98	1	17.026	38.942	1.2	37.742
15 min	17.7	10.3	1.95	1	20.053	45.866	1.8	44.066
30 min	23.3	13.5	1.91	1	25.856	59.139	3.6	55.539
60 min	30	17.4	1.85	1	32.246	73.753	7.2	66.553
2 hour	38	22.1	1.78	1	39.299	89.885	14.4	75.485
4 hour	48	27.9	1.73	1	48.246	110.350	28.8	81.550
6 hour	55	32.0	1.71	1	54.643	124.981	43.2	81.781
12 hour	68	39.5	1.62	1	64.003	146.389	86.4	59.989
24 hour	85	49.4	1.58	1	78.028	178.469	172.8	5.669
48 hour	106	61.6	1.53	1	94.227	215.518	345.6	-130.082
Size of Attenuation for 1 in 100 year flood event m³								**81.781**

Part 4 **Interception Storage**

To prevent pollitant or sediments discharging into water courses the GDSDS required "interception storage" to be incorporated into the drainage design for the development. The volume of interception required is based on the 5-10mm of rainfall depth from 80% of the runoff from impermeable areas. The interception volume attributable to each of the SuDS features consists of the volyme of water that can infiltrate to the ground, the quanity that evaporates into the atmosphere and the volyme lost through transpiration in plants and vegitation. Additionally, there will be some loses of water due to absorption and westting of stone and soil media.

Required Interception Storage

Overall Impermeable area is 7104.0 m² including 10% for urban creep

Therefore, the total interception storage required is 'overall impermeable area x 80% x 0.005 x 1.2 for climate change' 68.20 m³

Interception Storage Provided *Only fill in SuDS on your site

Permeable Paving	Area	918.0	m²
	Stone Layer 100mm deep	0.1	m
	Void Ratio	30%	
	Storage Volume	27.54	m³

*Storage depth will depend on your site

Swale	Area	0.0	m²
	*75mm	0.075	m
	Storage Volume	0	m³

Bio-Retention Area/ Raingarden inc. bio-retentiona areas from private house gardens	Area	617.0	m²
	Depth of Subgrade	0.15	m
	Storage Volume	92.55	m³

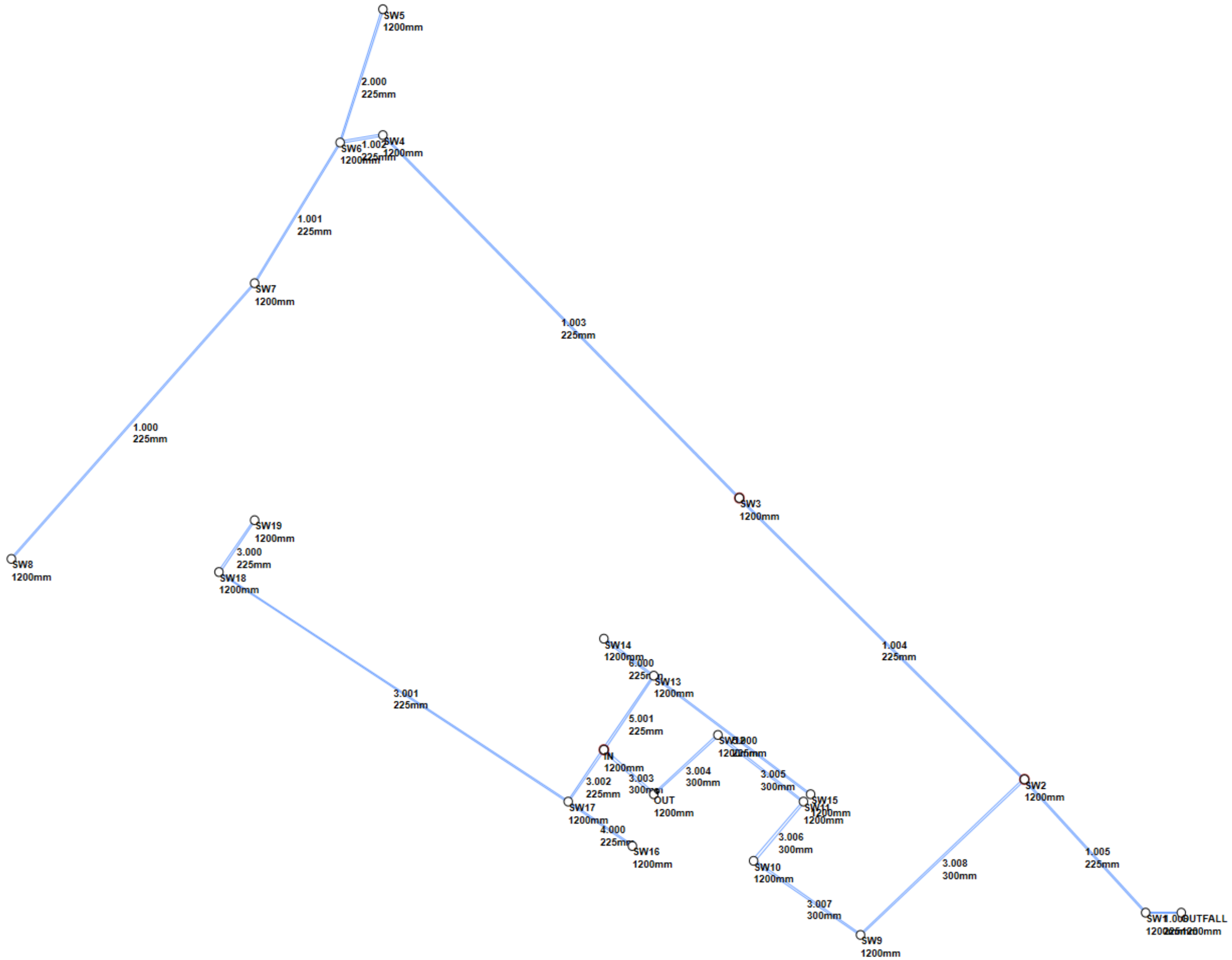
Green Roof A 'Bauder Sedume' or equivalent design to retain 30 l/m² of rainwater will be used on roof level	Area	595.0	m²
	Interception Store 30 l/m²	0.03	l/m²
	Storage Volume	17.85	m³

Total interception volume provided for the overall site 137.94 m³

which exceeds the required volume calculated of 68.20 m³

Appendix C

Surface Water Network Calculations



SW5
1200mm
2.000
225mm
SW6
1200mm
SW4
1200mm
1.001
225mm
SW7
1200mm
1.003
225mm
1.000
225mm
SW3
1200mm
SW19
1200mm
3.000
225mm
SW8
1200mm
SW18
1200mm
SW14
1200mm
6.000
SW13
1200mm
1.004
225mm
3.001
225mm
5.001
225mm
IN
1200mm
3.002
225mm
3.003
3.004
300mm
OUT
1200mm
3.005
300mm
SW15
1200mm
SW2
1200mm
SW17
1200mm
4.000
SW16
1200mm
3.006
300mm
SW10
1200mm
3.008
300mm
1.005
225mm
3.007
300mm
SW9
1200mm
OUTFALL

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	2	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	0.70
FSR Region	Scotland and Ireland	Connection Type	Level Inverts
M5-60 (mm)	16.100	Minimum Backdrop Height (m)	0.500
Ratio-R	0.277	Preferred Cover Depth (m)	1.000
CV	0.750	Include Intermediate Ground	x
Time of Entry (mins)	4.00	Enforce best practice design rules	x

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
SW8	0.023	4.00	3.710	1200	716545.879	735772.771	1.245
SW7	0.060	4.00	3.680	1200	716580.000	735810.000	1.423
SW6	0.030	4.00	3.990	1200	716592.000	735829.000	1.824
SW5	0.023	4.00	4.080	1200	716598.000	735847.000	1.425
SW4			3.990	1200	716598.000	735830.000	1.847
SW3	0.180	4.00	4.010	1200	716648.000	735781.000	2.147
SW2	0.080	4.00	3.800	1200	716688.000	735743.000	2.145
SW1	0.040	4.00	3.930	1200	716705.000	735725.000	2.390
SW9	0.000	4.00	3.440	1200	716665.000	735722.000	1.050
SW10	0.000	4.00	3.610	1200	716650.000	735732.000	1.150
SW11			3.800	1200	716657.000	735740.000	1.305
SW12			3.800	1200	716645.000	735749.000	1.245
OUT	0.000	4.00	4.500	1200	716636.000	735741.000	1.900
IN	0.000	4.00	4.500	1200	716629.000	735747.000	1.895
SW13	0.030	4.00	3.800	1200	716636.000	735757.000	1.155
SW14	0.023	4.00	3.800	1200	716629.000	735762.000	1.110
SW15	0.040	4.00	3.800	1200	716658.000	735741.000	1.015
SW16	0.010	4.00	5.520	1200	716633.000	735734.000	1.195
SW17	0.070	4.00	5.520	1200	716624.000	735740.000	2.885
SW18	0.010	4.00	4.125	1200	716575.000	735771.000	1.225
SW19	0.010	4.00	3.625	1200	716580.000	735778.000	0.625
OUTFALL	0.000		4.000	1200	716710.000	735725.000	2.480

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	SW8	SW7	50.500	0.600	2.465	2.257	0.208	242.8	225	5.01	48.6
1.001	SW7	SW6	22.472	0.600	2.257	2.166	0.091	246.9	225	5.46	47.0
1.002	SW6	SW4	6.083	0.600	2.166	2.143	0.023	264.5	225	5.59	46.6
2.000	SW5	SW6	18.974	0.600	2.655	2.559	0.096	197.6	225	4.34	50.0
1.003	SW4	SW3	70.007	0.600	2.143	1.863	0.280	250.0	225	7.01	42.5
1.004	SW3	SW2	55.172	0.600	1.863	1.655	0.208	265.3	225	8.16	39.8
1.005	SW2	SW1	24.759	0.600	1.655	1.540	0.115	215.3	225	8.63	38.8
6.000	SW14	SW13	8.602	0.600	2.690	2.645	0.045	191.2	225	4.15	50.0
5.000	SW15	SW13	27.203	0.600	2.785	2.645	0.140	194.3	225	4.49	50.0
5.001	SW13	IN	12.207	0.600	2.645	2.605	0.040	305.2	225	4.76	49.5
3.003	IN	OUT	9.220	0.600	2.605	2.600	0.005	1843.9	300	5.82	45.9
3.004	OUT	SW12	12.042	0.600	2.600	2.555	0.045	267.6	300	6.03	45.2
3.005	SW12	SW11	15.000	0.600	2.555	2.495	0.060	250.0	300	6.28	44.5
3.006	SW11	SW10	10.630	0.600	2.495	2.460	0.035	303.7	300	6.48	43.9
3.007	SW10	SW9	18.028	0.600	2.460	2.390	0.070	257.5	300	6.79	43.1
3.008	SW9	SW2	31.145	0.600	2.390	2.270	0.120	259.5	300	7.32	41.7
3.000	SW19	SW18	8.602	0.600	3.000	2.900	0.100	86.0	225	4.10	50.0
3.001	SW18	SW17	57.983	0.600	2.900	2.635	0.265	218.8	225	5.20	47.9
4.000	SW16	SW17	10.817	0.600	4.325	4.048	0.277	39.0	225	4.09	50.0
3.002	SW17	IN	8.602	0.600	2.635	2.605	0.030	286.7	225	5.39	47.2

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	0.834	33.2	3.0	1.020	1.198	0.023	0.0	46	0.524
1.001	0.827	32.9	10.6	1.198	1.599	0.083	0.0	87	0.738
1.002	0.799	31.8	17.2	1.599	1.622	0.136	0.0	118	0.815
2.000	0.926	36.8	3.1	1.200	1.206	0.023	0.0	44	0.569
1.003	0.822	32.7	15.7	1.622	1.922	0.136	0.0	109	0.813
1.004	0.798	31.7	34.1	1.922	1.920	0.316	0.0	225	0.813
1.005	0.887	35.3	62.0	1.920	2.165	0.589	0.0	225	0.903
6.000	0.942	37.5	3.1	0.885	0.930	0.023	0.0	44	0.572
5.000	0.934	37.1	5.4	0.790	0.930	0.040	0.0	58	0.668
5.001	0.743	29.5	12.5	0.930	1.670	0.093	0.0	102	0.711
3.003	0.357	25.2	24.0	1.595	1.600	0.193	0.0	234	0.405
3.004	0.956	67.6	23.7	1.600	0.945	0.193	0.0	122	0.873
3.005	0.990	70.0	23.3	0.945	1.005	0.193	0.0	119	0.893
3.006	0.897	63.4	23.0	1.005	0.850	0.193	0.0	125	0.828
3.007	0.975	68.9	22.6	0.850	0.750	0.193	0.0	118	0.876
3.008	0.971	68.6	21.9	0.750	1.230	0.193	0.0	116	0.866
3.000	1.410	56.1	1.4	0.400	1.000	0.010	0.0	24	0.596
3.001	0.880	35.0	2.6	1.000	2.660	0.020	0.0	42	0.521
4.000	2.099	83.5	1.4	0.970	1.247	0.010	0.0	20	0.782
3.002	0.767	30.5	12.8	2.660	1.670	0.100	0.0	102	0.734

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.006	SW1	OUTFALL	5.000	0.600	1.555	1.520	0.035	142.9	225	8.70	38.6

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.006	1.092	43.4	65.9	2.150	2.255	0.629	0.0	225	1.112

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	50.500	242.8	225	Circular	3.710	2.465	1.020	3.680	2.257	1.198
1.001	22.472	246.9	225	Circular	3.680	2.257	1.198	3.990	2.166	1.599
1.002	6.083	264.5	225	Circular	3.990	2.166	1.599	3.990	2.143	1.622
2.000	18.974	197.6	225	Circular	4.080	2.655	1.200	3.990	2.559	1.206
1.003	70.007	250.0	225	Circular	3.990	2.143	1.622	4.010	1.863	1.922
1.004	55.172	265.3	225	Circular	4.010	1.863	1.922	3.800	1.655	1.920
1.005	24.759	215.3	225	Circular	3.800	1.655	1.920	3.930	1.540	2.165
6.000	8.602	191.2	225	Circular	3.800	2.690	0.885	3.800	2.645	0.930
5.000	27.203	194.3	225	Circular	3.800	2.785	0.790	3.800	2.645	0.930
5.001	12.207	305.2	225	Circular	3.800	2.645	0.930	4.500	2.605	1.670
3.003	9.220	1843.9	300	Circular	4.500	2.605	1.595	4.500	2.600	1.600
3.004	12.042	267.6	300	Circular	4.500	2.600	1.600	3.800	2.555	0.945
3.005	15.000	250.0	300	Circular	3.800	2.555	0.945	3.800	2.495	1.005
3.006	10.630	303.7	300	Circular	3.800	2.495	1.005	3.610	2.460	0.850
3.007	18.028	257.5	300	Circular	3.610	2.460	0.850	3.440	2.390	0.750

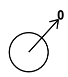
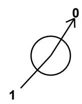
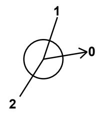
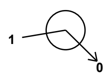
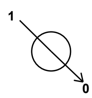
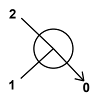
Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	SW8	1200	Manhole	Adoptable	SW7	1200	Manhole	Adoptable
1.001	SW7	1200	Manhole	Adoptable	SW6	1200	Manhole	Adoptable
1.002	SW6	1200	Manhole	Adoptable	SW4	1200	Manhole	Adoptable
2.000	SW5	1200	Manhole	Adoptable	SW6	1200	Manhole	Adoptable
1.003	SW4	1200	Manhole	Adoptable	SW3	1200	Manhole	Adoptable
1.004	SW3	1200	Manhole	Adoptable	SW2	1200	Manhole	Adoptable
1.005	SW2	1200	Manhole	Adoptable	SW1	1200	Manhole	Adoptable
6.000	SW14	1200	Manhole	Adoptable	SW13	1200	Manhole	Adoptable
5.000	SW15	1200	Manhole	Adoptable	SW13	1200	Manhole	Adoptable
5.001	SW13	1200	Manhole	Adoptable	IN	1200	Manhole	Adoptable
3.003	IN	1200	Manhole	Adoptable	OUT	1200	Manhole	Adoptable
3.004	OUT	1200	Manhole	Adoptable	SW12	1200	Manhole	Adoptable
3.005	SW12	1200	Manhole	Adoptable	SW11	1200	Manhole	Adoptable
3.006	SW11	1200	Manhole	Adoptable	SW10	1200	Manhole	Adoptable
3.007	SW10	1200	Manhole	Adoptable	SW9	1200	Manhole	Adoptable

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
3.008	31.145	259.5	300	Circular	3.440	2.390	0.750	3.800	2.270	1.230
3.000	8.602	86.0	225	Circular	3.625	3.000	0.400	4.125	2.900	1.000
3.001	57.983	218.8	225	Circular	4.125	2.900	1.000	5.520	2.635	2.660
4.000	10.817	39.0	225	Circular	5.520	4.325	0.970	5.520	4.048	1.247
3.002	8.602	286.7	225	Circular	5.520	2.635	2.660	4.500	2.605	1.670
1.006	5.000	142.9	225	Circular	3.930	1.555	2.150	4.000	1.520	2.255

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
3.008	SW9	1200	Manhole	Adoptable	SW2	1200	Manhole	Adoptable
3.000	SW19	1200	Manhole	Adoptable	SW18	1200	Manhole	Adoptable
3.001	SW18	1200	Manhole	Adoptable	SW17	1200	Manhole	Adoptable
4.000	SW16	1200	Manhole	Adoptable	SW17	1200	Manhole	Adoptable
3.002	SW17	1200	Manhole	Adoptable	IN	1200	Manhole	Adoptable
1.006	SW1	1200	Manhole	Adoptable	OUTFALL	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
SW8	716545.879	735772.771	3.710	1.245	1200		0	1.000	2.465	225
SW7	716580.000	735810.000	3.680	1.423	1200		1	1.000	2.257	225
							0	1.001	2.257	225
SW6	716592.000	735829.000	3.990	1.824	1200		1	2.000	2.559	225
							2	1.001	2.166	225
							0	1.002	2.166	225
SW5	716598.000	735847.000	4.080	1.425	1200		0	2.000	2.655	225
SW4	716598.000	735830.000	3.990	1.847	1200		1	1.002	2.143	225
							0	1.003	2.143	225
SW3	716648.000	735781.000	4.010	2.147	1200		1	1.003	1.863	225
							0	1.004	1.863	225
SW2	716688.000	735743.000	3.800	2.145	1200		1	3.008	2.270	300
							2	1.004	1.655	225
							0	1.005	1.655	225

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
SW1	716705.000	735725.000	3.930	2.390	1200	1	1.005	1.540	225
						0	1.006	1.555	225
SW9	716665.000	735722.000	3.440	1.050	1200	1	3.007	2.390	300
						0	3.008	2.390	300
SW10	716650.000	735732.000	3.610	1.150	1200	1	3.006	2.460	300
						0	3.007	2.460	300
SW11	716657.000	735740.000	3.800	1.305	1200	1	3.005	2.495	300
						0	3.006	2.495	300
SW12	716645.000	735749.000	3.800	1.245	1200	1	3.004	2.555	300
						0	3.005	2.555	300
OUT	716636.000	735741.000	4.500	1.900	1200	1	3.003	2.600	300
						0	3.004	2.600	300
IN	716629.000	735747.000	4.500	1.895	1200	1	5.001	2.605	225
						2	3.002	2.605	225
						0	3.003	2.605	300
SW13	716636.000	735757.000	3.800	1.155	1200	1	6.000	2.645	225
						2	5.000	2.645	225
						0	5.001	2.645	225
SW14	716629.000	735762.000	3.800	1.110	1200	0	6.000	2.690	225
SW15	716658.000	735741.000	3.800	1.015	1200	0	5.000	2.785	225
SW16	716633.000	735734.000	5.520	1.195	1200	0	4.000	4.325	225
SW17	716624.000	735740.000	5.520	2.885	1200	1	4.000	4.048	225
						2	3.001	2.635	225
						0	3.002	2.635	225
SW18	716575.000	735771.000	4.125	1.225	1200	1	3.000	2.900	225
						0	3.001	2.900	225

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
SW19	716580.000	735778.000	3.625	0.625	1200	0	3.000	3.000	225
OUTFALL	716710.000	735725.000	4.000	2.480	1200	1	1.006	1.520	225

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal
FSR Region	Scotland and Ireland	Skip Steady State	x
M5-60 (mm)	16.100	Drain Down Time (mins)	240
Ratio-R	0.280	Additional Storage (m³/ha)	20.0
Summer CV	0.750	Check Discharge Rate(s)	x
Winter CV	0.840	Check Discharge Volume	x

Storm Durations

15	30	60	120	180	240	360

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	20	0	0
30	20	0	0
100	20	0	0

Node OUT Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	2.600	Product Number	CTL-SHE-0067-2000-1000-2000
Design Depth (m)	1.000	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node IN Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	2.605
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	83.0	0.0	1.000	83.0	0.0	1.001	0.0	0.0

Node SW3 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	1.863
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	52

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	400.0	0.0	0.150	400.0	0.0	0.151	0.0	0.0

Node SW2 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	1.655
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	90

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	217.0	0.0	0.150	217.0	0.0	0.151	0.0	0.0

Results for 2 year +20% CC Critical Storm Duration. Lowest mass balance: 99.79%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SW8	10	2.516	0.051	3.9	0.0763	0.0000	OK
15 minute winter	SW7	10	2.356	0.099	14.1	0.1963	0.0000	OK
15 minute winter	SW6	11	2.328	0.162	22.4	0.2359	0.0000	OK
15 minute winter	SW5	10	2.705	0.050	3.9	0.0730	0.0000	OK
15 minute winter	SW4	11	2.299	0.156	21.6	0.1761	0.0000	OK
120 minute winter	SW3	84	1.945	0.082	19.2	33.0002	0.0000	OK
240 minute winter	SW2	164	1.744	0.089	12.6	19.4201	0.0000	OK
240 minute winter	SW1	160	1.645	0.105	12.2	0.1539	0.0000	OK
240 minute winter	SW9	184	2.425	0.035	1.9	0.0399	0.0000	OK
240 minute winter	SW10	180	2.495	0.035	1.9	0.0395	0.0000	OK
240 minute winter	SW11	180	2.532	0.037	1.9	0.0419	0.0000	OK
240 minute winter	SW12	180	2.589	0.034	1.9	0.0389	0.0000	OK
240 minute winter	OUT	180	2.860	0.260	2.0	0.2949	0.0000	OK
240 minute winter	IN	180	2.860	0.255	6.6	21.4449	0.0000	OK
240 minute winter	SW13	180	2.860	0.215	3.6	0.3546	0.0000	OK
240 minute winter	SW14	180	2.860	0.170	0.9	0.2625	0.0000	OK
240 minute winter	SW15	184	2.860	0.075	1.6	0.1437	0.0000	OK
15 minute winter	SW16	10	4.348	0.023	1.7	0.0294	0.0000	OK
240 minute winter	SW17	180	2.860	0.225	3.9	0.3635	0.0000	OK
15 minute winter	SW18	11	2.946	0.046	3.4	0.0590	0.0000	OK
15 minute winter	SW19	10	3.027	0.027	1.7	0.0389	0.0000	OK

Link Event (Velocity)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SW8	1.000	SW7	3.7	0.326	0.113	0.5906	
15 minute summer	SW7	1.001	SW6	13.3	0.573	0.404	0.5241	
15 minute summer	SW6	1.002	SW4	21.2	0.746	0.668	0.1807	
15 minute winter	SW5	2.000	SW6	3.9	0.599	0.105	0.1226	
15 minute summer	SW4	1.003	SW3	21.5	1.404	0.656	1.1267	
60 minute winter	SW3	1.004	SW2	7.7	0.741	0.241	0.6232	
180 minute winter	SW2	1.005	SW1	11.4	0.701	0.322	0.4015	
240 minute winter	SW1	1.006	OUTFALL	12.2	0.884	0.281	0.0691	126.0
240 minute winter	SW9	3.008	SW2	1.9	0.450	0.028	0.1351	
15 minute summer	SW10	3.007	SW9	1.7	0.544	0.025	0.0763	
15 minute winter	SW11	3.006	SW10	1.8	0.472	0.028	0.0476	
15 minute winter	SW12	3.005	SW11	1.8	0.480	0.026	0.0663	
240 minute winter	OUT	Hydro-Brake®	SW12	1.9				
15 minute summer	IN	3.003	OUT	2.4	0.285	0.094	0.2505	
15 minute summer	SW13	5.001	IN	15.7	1.242	0.530	0.2094	
30 minute summer	SW14	6.000	SW13	3.3	0.275	0.088	0.1332	
15 minute winter	SW15	5.000	SW13	6.9	0.478	0.185	0.3943	
15 minute winter	SW16	4.000	SW17	1.7	0.831	0.020	0.0221	
15 minute summer	SW17	3.002	IN	16.5	1.325	0.542	0.1569	
15 minute winter	SW18	3.001	SW17	3.2	0.263	0.092	0.7318	
15 minute summer	SW19	3.000	SW18	1.7	0.442	0.030	0.0355	

Results for 2 year +20% CC Critical Storm Duration. Lowest mass balance: 99.79%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	OUTFALL	160	1.601	0.081	12.2	0.0000	0.0000	OK

Link Event (Velocity)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)

Results for 30 year +20% CC Critical Storm Duration. Lowest mass balance: 99.79%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SW8	10	2.535	0.070	7.2	0.1048	0.0000	OK
15 minute winter	SW7	11	2.493	0.236	25.9	0.4666	0.0000	SURCHARGED
15 minute winter	SW6	11	2.447	0.281	36.5	0.4106	0.0000	SURCHARGED
15 minute winter	SW5	10	2.724	0.069	7.2	0.1007	0.0000	OK
15 minute winter	SW4	12	2.401	0.258	35.6	0.2920	0.0000	SURCHARGED
120 minute winter	SW3	80	1.990	0.127	34.3	51.3210	0.0000	OK
120 minute winter	SW2	92	1.789	0.134	26.1	29.2982	0.0000	OK
180 minute winter	SW1	120	1.687	0.147	23.3	0.2152	0.0000	OK
30 minute summer	SW9	38	2.425	0.035	2.0	0.0400	0.0000	OK
15 minute winter	SW10	14	2.495	0.035	1.9	0.0396	0.0000	OK
360 minute winter	SW11	568	2.532	0.037	2.0	0.0419	0.0000	OK
60 minute winter	SW12	37	2.589	0.034	2.0	0.0390	0.0000	OK
360 minute winter	OUT	336	3.144	0.544	2.1	0.6170	0.0000	SURCHARGED
360 minute winter	IN	336	3.144	0.539	8.9	45.3172	0.0000	SURCHARGED
360 minute winter	SW13	328	3.144	0.499	4.4	0.8228	0.0000	SURCHARGED
360 minute winter	SW14	328	3.144	0.454	1.2	0.7010	0.0000	SURCHARGED
360 minute winter	SW15	328	3.144	0.359	2.1	0.6884	0.0000	SURCHARGED
15 minute summer	SW16	10	4.355	0.030	3.1	0.0394	0.0000	OK
360 minute winter	SW17	336	3.144	0.509	5.1	0.8220	0.0000	SURCHARGED
360 minute winter	SW18	336	3.144	0.244	1.0	0.3154	0.0000	SURCHARGED
360 minute winter	SW19	336	3.144	0.144	0.5	0.2085	0.0000	OK

Link Event (Velocity)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SW8	1.000	SW7	7.0	0.352	0.212	1.2456	
15 minute summer	SW7	1.001	SW6	20.5	0.589	0.622	0.8897	
15 minute winter	SW6	1.002	SW4	35.6	0.896	1.122	0.2419	
15 minute winter	SW5	2.000	SW6	7.2	0.711	0.195	0.1917	
15 minute winter	SW4	1.003	SW3	34.0	1.403	1.041	1.8109	
30 minute winter	SW3	1.004	SW2	15.5	0.941	0.490	0.9793	
120 minute winter	SW2	1.005	SW1	21.8	0.842	0.617	0.6405	
180 minute winter	SW1	1.006	OUTFALL	23.3	1.039	0.536	0.1120	181.9
30 minute summer	SW9	3.008	SW2	2.0	0.450	0.028	0.1354	
15 minute winter	SW10	3.007	SW9	1.9	0.560	0.028	0.0827	
15 minute summer	SW11	3.006	SW10	1.9	0.493	0.030	0.0503	
15 minute winter	SW12	3.005	SW11	1.9	0.499	0.028	0.0706	
360 minute winter	OUT	Hydro-Brake®	SW12	2.0				
15 minute winter	IN	3.003	OUT	3.1	0.331	0.124	0.5677	
15 minute winter	SW13	5.001	IN	26.9	1.316	0.911	0.4723	
15 minute summer	SW14	6.000	SW13	6.9	0.284	0.185	0.2479	
15 minute summer	SW15	5.000	SW13	12.6	0.571	0.338	0.6049	
15 minute winter	SW16	4.000	SW17	3.1	0.992	0.037	0.0338	
15 minute summer	SW17	3.002	IN	29.4	1.400	0.965	0.3205	
15 minute summer	SW18	3.001	SW17	5.9	0.304	0.168	1.1673	
15 minute summer	SW19	3.000	SW18	3.1	0.513	0.055	0.0555	

Results for 30 year +20% CC Critical Storm Duration. Lowest mass balance: 99.79%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute winter	OUTFALL	120	1.636	0.116	23.3	0.0000	0.0000	OK

Link Event (Velocity)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.79%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SW8	12	2.667	0.202	9.4	0.3032	0.0000	OK
15 minute winter	SW7	12	2.654	0.397	33.0	0.7832	0.0000	SURCHARGED
15 minute winter	SW6	12	2.595	0.429	44.4	0.6270	0.0000	SURCHARGED
15 minute winter	SW5	10	2.735	0.080	9.4	0.1163	0.0000	OK
15 minute winter	SW4	12	2.536	0.393	42.7	0.4445	0.0000	SURCHARGED
60 minute winter	SW3	42	2.111	0.248	68.5	60.8966	0.0000	SURCHARGED
120 minute winter	SW2	78	1.903	0.248	41.5	33.1237	0.0000	SURCHARGED
120 minute winter	SW1	78	1.757	0.217	40.3	0.3183	0.0000	OK
15 minute winter	SW9	39	2.425	0.035	2.0	0.0400	0.0000	OK
15 minute winter	SW10	12	2.495	0.035	2.0	0.0400	0.0000	OK
15 minute winter	SW11	33	2.532	0.037	2.0	0.0419	0.0000	OK
15 minute winter	SW12	13	2.589	0.034	2.0	0.0390	0.0000	OK
360 minute winter	OUT	344	3.366	0.766	2.1	0.8697	0.0000	SURCHARGED
360 minute winter	IN	344	3.366	0.761	10.9	64.0483	0.0000	SURCHARGED
360 minute winter	SW13	344	3.366	0.721	5.7	1.1902	0.0000	SURCHARGED
360 minute winter	SW14	344	3.366	0.676	1.5	1.0449	0.0000	SURCHARGED
360 minute winter	SW15	344	3.366	0.581	2.6	1.1156	0.0000	SURCHARGED
15 minute summer	SW16	10	4.360	0.035	4.1	0.0453	0.0000	OK
360 minute winter	SW17	344	3.366	0.731	6.0	1.1818	0.0000	SURCHARGED
360 minute winter	SW18	344	3.366	0.466	1.4	0.6034	0.0000	SURCHARGED
360 minute winter	SW19	344	3.366	0.366	0.7	0.5315	0.0000	FLOOD RISK

Link Event (Velocity)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SW8	1.000	SW7	10.0	0.362	0.301	1.8027	
15 minute winter	SW7	1.001	SW6	24.3	0.611	0.738	0.8937	
15 minute summer	SW6	1.002	SW4	42.9	1.080	1.352	0.2419	
15 minute winter	SW5	2.000	SW6	9.4	0.764	0.255	0.2332	
15 minute winter	SW4	1.003	SW3	39.6	1.394	1.212	2.0619	
60 minute winter	SW3	1.004	SW2	36.2	1.043	1.140	1.8056	
120 minute winter	SW2	1.005	SW1	36.9	0.927	1.045	0.9790	
120 minute winter	SW1	1.006	OUTFALL	40.4	1.154	0.930	0.1738	193.8
15 minute winter	SW9	3.008	SW2	2.0	0.450	0.028	0.1354	
15 minute summer	SW10	3.007	SW9	2.0	0.563	0.028	0.0830	
15 minute winter	SW11	3.006	SW10	2.0	0.498	0.031	0.0510	
15 minute winter	SW12	3.005	SW11	2.0	0.501	0.028	0.0709	
360 minute winter	OUT	Hydro-Brake®	SW12	2.0				
15 minute summer	IN	3.003	OUT	3.7	0.315	0.147	0.6364	
15 minute winter	SW13	5.001	IN	33.7	1.373	1.142	0.4855	
15 minute winter	SW14	6.000	SW13	8.3	0.293	0.223	0.3421	
15 minute summer	SW15	5.000	SW13	16.3	0.612	0.438	0.7852	
15 minute winter	SW16	4.000	SW17	4.1	1.075	0.049	0.0413	
15 minute winter	SW17	3.002	IN	35.8	1.461	1.174	0.3421	
15 minute summer	SW18	3.001	SW17	7.9	0.320	0.225	1.4463	
15 minute summer	SW19	3.000	SW18	4.1	0.552	0.073	0.0681	

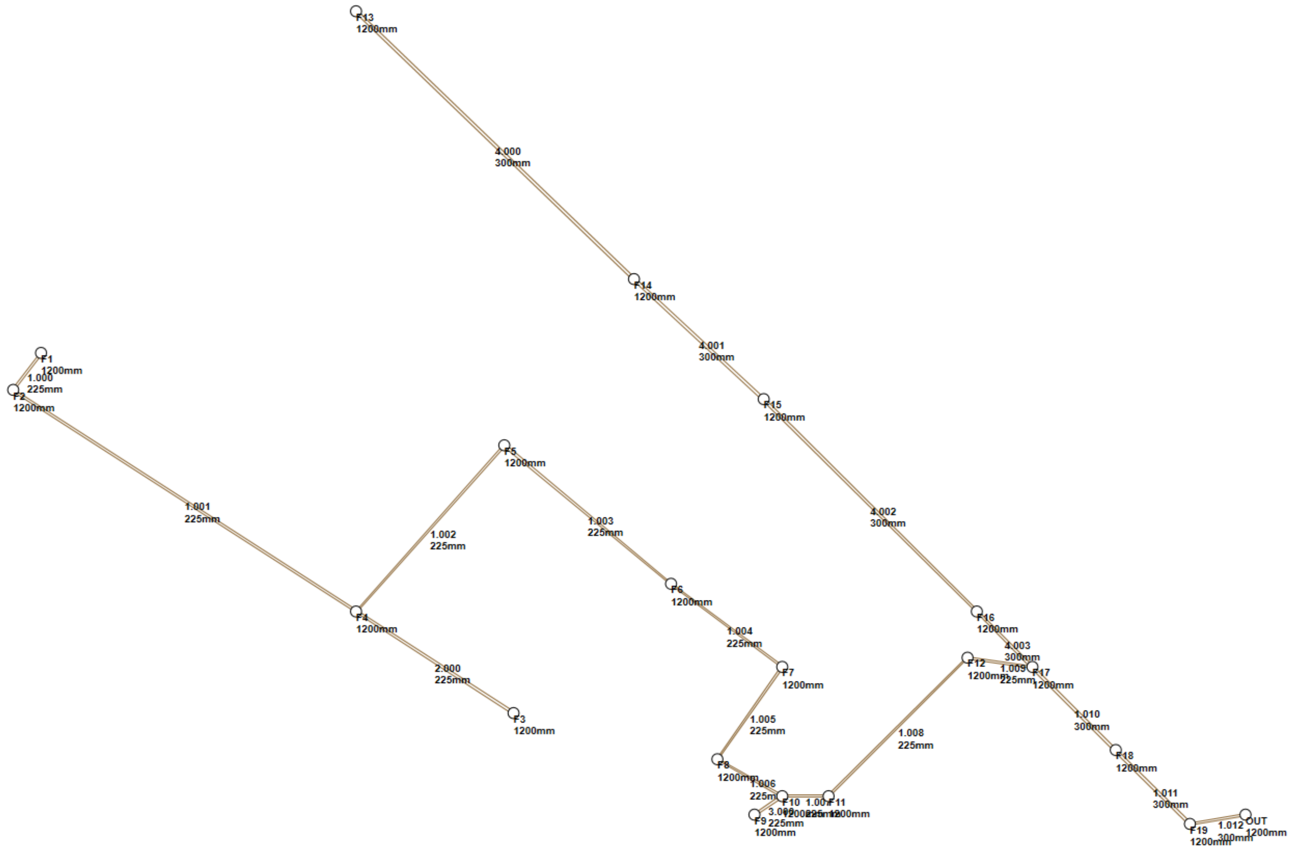
Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.79%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute winter	OUTFALL	78	1.689	0.169	40.4	0.0000	0.0000	OK

Link Event (Velocity)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)

Appendix D

Foul Water Network Calculations


F13
1200mm
4.000
300mm
F14
1200mm
4.001
300mm
F15
1200mm
4.002
300mm
F16
1200mm
4.003
300mm
F1
1200mm
1.000
225mm
F2
1200mm
1.001
225mm
F4
1200mm
1.002
225mm
F5
1200mm
1.003
225mm
F6
1200mm
1.004
225mm
F7
1200mm
1.005
225mm
F8
1200mm
1.006
F10
F9
1200mm
F11
1.008
225mm
F12
1200mm
1.009
225mm
F17
1200mm
1.010
300mm
F18
1200mm
1.011
300mm
F19
1200mm
1.012
300mm
OUT
1200mm
2.000
225mm
F3
1200mm

Design Settings

Frequency of use (kDU)	0.50	Minimum Velocity (m/s)	0.75
Flow per dwelling per day (l/day)	405	Connection Type	Level Soffits
Domestic Flow (l/s/ha)	1.0	Minimum Backdrop Height (m)	0.200
Industrial Flow (l/s/ha)	0.0	Preferred Cover Depth (m)	1.200
Additional Flow (%)	25	Include Intermediate Ground	✓

Nodes

Name	Dwellings	Cover Level (m)	Manhole Type	Easting (m)	Northing (m)	Depth (m)
F1	5	3.625	Adoptable	716580.000	735775.000	1.155
F2	7	4.125	Adoptable	716577.000	735771.000	1.678
F4	10	5.160	Adoptable	716614.000	735747.000	2.935
F3	7	5.520	Adoptable	716631.000	735736.000	3.195
F5	7	3.800	Adoptable	716630.000	735765.000	1.695
F6	7	3.800	Adoptable	716648.000	735750.000	1.815
F7	10	3.800	Adoptable	716660.000	735741.000	1.890
F8		3.610	Adoptable	716653.000	735731.000	1.745
F9	10	3.790	Adoptable	716657.000	735725.000	1.935
F10		3.700	Adoptable	716660.000	735727.000	1.870
F11		3.440	Adoptable	716665.000	735727.000	1.640
F12		3.700	Adoptable	716680.000	735742.000	2.015
F13	25	3.930	Adoptable	716614.000	735812.000	1.300
F14		4.025	Adoptable	716644.000	735783.000	1.580
F15	10	3.855	Adoptable	716658.000	735770.000	1.505
F16		3.750	Adoptable	716681.000	735747.000	2.065
F17		3.800	Adoptable	716687.000	735741.000	2.145
F18	5	3.855	Adoptable	716696.000	735732.000	2.255
F19		3.910	Adoptable	716704.000	735724.000	2.355
OUT		3.940	Adoptable	716710.000	735725.000	2.420

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)
1.000	F1	F2	5.000	1.500	2.470	2.447	0.023	217.4	225
1.001	F2	F4	44.102	1.500	2.447	2.225	0.222	198.7	225
2.000	F3	F4	20.248	1.500	2.325	2.225	0.100	202.5	225
1.002	F4	F5	24.083	1.500	2.225	2.105	0.120	200.7	225
1.003	F5	F6	23.431	1.500	2.105	1.985	0.120	195.3	225
1.004	F6	F7	15.000	1.500	1.985	1.910	0.075	200.0	225

Name	Pro Vel @ 1/3 Q (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Dwellings (ha)	Σ Units (ha)	Σ Add Inflow (ha)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	0.082	0.777	30.9	0.0	0.930	1.453	0.000	5	0.0	0.0	6	0.111
1.001	0.101	0.813	32.3	0.1	1.453	2.710	0.000	12	0.0	0.0	8	0.156
2.000	0.085	0.805	32.0	0.0	2.970	2.710	0.000	7	0.0	0.0	7	0.129
1.002	0.142	0.809	32.2	0.2	2.710	1.470	0.000	29	0.0	0.0	12	0.202
1.003	0.157	0.820	32.6	0.2	1.470	1.590	0.000	36	0.0	0.0	14	0.226
1.004	0.168	0.810	32.2	0.3	1.590	1.665	0.000	43	0.0	0.0	15	0.233

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)
1.005	F7	F8	12.207	1.500	1.910	1.865	0.045	271.3	225
1.006	F8	F10	8.062	1.500	1.865	1.830	0.035	230.4	225
3.000	F9	F10	3.606	1.500	1.855	1.830	0.025	144.2	225
1.007	F10	F11	5.000	1.500	1.830	1.800	0.030	166.7	225
1.008	F11	F12	21.213	1.500	1.800	1.685	0.115	184.5	225
1.009	F12	F17	7.071	1.500	1.685	1.655	0.030	235.7	225
4.000	F13	F14	41.725	1.500	2.630	2.445	0.185	225.5	300
4.001	F14	F15	19.105	1.500	2.445	2.350	0.095	201.1	300
4.002	F15	F16	32.527	1.500	2.350	2.200	0.150	216.8	300
4.003	F16	F17	8.485	1.500	1.685	1.655	0.030	282.8	300
1.010	F17	F18	12.728	1.500	1.655	1.600	0.055	231.4	300
1.011	F18	F19	11.314	1.500	1.600	1.555	0.045	251.4	300
1.012	F19	OUT	6.083	1.500	1.555	1.520	0.035	173.8	300

Name	Pro Vel @ 1/3 Q (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Dwellings (ha)	Σ Units (ha)	Σ Add Inflow (ha)	Pro Depth (mm)	Pro Velocity (m/s)
1.005	0.153	0.695	27.6	0.3	1.665	1.520	0.000	53	0.0	0.0	17	0.225
1.006	0.167	0.754	30.0	0.3	1.520	1.645	0.000	53	0.0	0.0	16	0.235
3.000	0.101	0.955	38.0	0.1	1.710	1.645	0.000	10	0.0	0.0	7	0.153
1.007	0.197	0.888	35.3	0.4	1.645	1.415	0.000	63	0.0	0.0	16	0.278
1.008	0.187	0.844	33.5	0.4	1.415	1.790	0.000	63	0.0	0.0	17	0.274
1.009	0.175	0.746	29.7	0.4	1.790	1.920	0.000	63	0.0	0.0	18	0.250
4.000	0.124	0.922	65.1	0.1	1.000	1.280	0.000	25	0.0	0.0	11	0.178
4.001	0.132	0.976	69.0	0.1	1.280	1.205	0.000	25	0.0	0.0	11	0.189
4.002	0.143	0.940	66.4	0.2	1.205	1.250	0.000	35	0.0	0.0	13	0.203
4.003	0.125	0.822	58.1	0.2	1.765	1.845	0.000	35	0.0	0.0	13	0.183
1.010	0.197	0.910	64.3	0.6	1.845	1.955	0.000	98	0.0	0.0	20	0.275
1.011	0.189	0.873	61.7	0.6	1.955	2.055	0.000	103	0.0	0.0	21	0.275
1.012	0.220	1.051	74.3	0.6	2.055	2.120	0.000	103	0.0	0.0	20	0.312

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	5.000	217.4	225	Circular	3.625	2.470	0.930	4.125	2.447	1.453
1.001	44.102	198.7	225	Circular	4.125	2.447	1.453	5.160	2.225	2.710
2.000	20.248	202.5	225	Circular	5.520	2.325	2.970	5.160	2.225	2.710

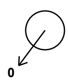
Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	F1	1200	Manhole	Adoptable	F2	1200	Manhole	Adoptable
1.001	F2	1200	Manhole	Adoptable	F4	1200	Manhole	Adoptable
2.000	F3	1200	Manhole	Adoptable	F4	1200	Manhole	Adoptable

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.002	24.083	200.7	225	Circular	5.160	2.225	2.710	3.800	2.105	1.470
1.003	23.431	195.3	225	Circular	3.800	2.105	1.470	3.800	1.985	1.590
1.004	15.000	200.0	225	Circular	3.800	1.985	1.590	3.800	1.910	1.665
1.005	12.207	271.3	225	Circular	3.800	1.910	1.665	3.610	1.865	1.520
1.006	8.062	230.4	225	Circular	3.610	1.865	1.520	3.700	1.830	1.645
3.000	3.606	144.2	225	Circular	3.790	1.855	1.710	3.700	1.830	1.645
1.007	5.000	166.7	225	Circular	3.700	1.830	1.645	3.440	1.800	1.415
1.008	21.213	184.5	225	Circular	3.440	1.800	1.415	3.700	1.685	1.790
1.009	7.071	235.7	225	Circular	3.700	1.685	1.790	3.800	1.655	1.920
4.000	41.725	225.5	300	Circular	3.930	2.630	1.000	4.025	2.445	1.280
4.001	19.105	201.1	300	Circular	4.025	2.445	1.280	3.855	2.350	1.205
4.002	32.527	216.8	300	Circular	3.855	2.350	1.205	3.750	2.200	1.250
4.003	8.485	282.8	300	Circular	3.750	1.685	1.765	3.800	1.655	1.845
1.010	12.728	231.4	300	Circular	3.800	1.655	1.845	3.855	1.600	1.955
1.011	11.314	251.4	300	Circular	3.855	1.600	1.955	3.910	1.555	2.055
1.012	6.083	173.8	300	Circular	3.910	1.555	2.055	3.940	1.520	2.120

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.002	F4	1200	Manhole	Adoptable	F5	1200	Manhole	Adoptable
1.003	F5	1200	Manhole	Adoptable	F6	1200	Manhole	Adoptable
1.004	F6	1200	Manhole	Adoptable	F7	1200	Manhole	Adoptable
1.005	F7	1200	Manhole	Adoptable	F8	1200	Manhole	Adoptable
1.006	F8	1200	Manhole	Adoptable	F10	1200	Manhole	Adoptable
3.000	F9	1200	Manhole	Adoptable	F10	1200	Manhole	Adoptable
1.007	F10	1200	Manhole	Adoptable	F11	1200	Manhole	Adoptable
1.008	F11	1200	Manhole	Adoptable	F12	1200	Manhole	Adoptable
1.009	F12	1200	Manhole	Adoptable	F17	1200	Manhole	Adoptable
4.000	F13	1200	Manhole	Adoptable	F14	1200	Manhole	Adoptable
4.001	F14	1200	Manhole	Adoptable	F15	1200	Manhole	Adoptable
4.002	F15	1200	Manhole	Adoptable	F16	1200	Manhole	Adoptable
4.003	F16	1200	Manhole	Adoptable	F17	1200	Manhole	Adoptable
1.010	F17	1200	Manhole	Adoptable	F18	1200	Manhole	Adoptable
1.011	F18	1200	Manhole	Adoptable	F19	1200	Manhole	Adoptable
1.012	F19	1200	Manhole	Adoptable	OUT	1200	Manhole	Adoptable

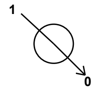
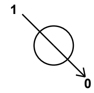
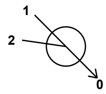
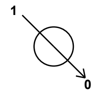
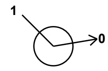
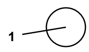
Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
F1	716580.000	735775.000	3.625	1.155	1200	 0	1.000	2.470	225

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
F2	716577.000	735771.000	4.125	1.678	1200	1	1.000	2.447	225
						0	1.001	2.447	225
F4	716614.000	735747.000	5.160	2.935	1200	1	2.000	2.225	225
						2	1.001	2.225	225
						0	1.002	2.225	225
F3	716631.000	735736.000	5.520	3.195	1200	0	2.000	2.325	225
F5	716630.000	735765.000	3.800	1.695	1200	1	1.002	2.105	225
						0	1.003	2.105	225
F6	716648.000	735750.000	3.800	1.815	1200	1	1.003	1.985	225
						0	1.004	1.985	225
F7	716660.000	735741.000	3.800	1.890	1200	1	1.004	1.910	225
						0	1.005	1.910	225
F8	716653.000	735731.000	3.610	1.745	1200	1	1.005	1.865	225
						0	1.006	1.865	225
F9	716657.000	735725.000	3.790	1.935	1200	0	3.000	1.855	225
F10	716660.000	735727.000	3.700	1.870	1200	1	3.000	1.830	225
						2	1.006	1.830	225
						0	1.007	1.830	225
F11	716665.000	735727.000	3.440	1.640	1200	1	1.007	1.800	225
						0	1.008	1.800	225
F12	716680.000	735742.000	3.700	2.015	1200	1	1.008	1.685	225
						0	1.009	1.685	225
F13	716614.000	735812.000	3.930	1.300	1200	0	4.000	2.630	300
F14	716644.000	735783.000	4.025	1.580	1200	1	4.000	2.445	300
						0	4.001	2.445	300

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
F15	716658.000	735770.000	3.855	1.505	1200		1	4.001	2.350	300
							0	4.002	2.350	300
F16	716681.000	735747.000	3.750	2.065	1200		1	4.002	2.200	300
							0	4.003	1.685	300
F17	716687.000	735741.000	3.800	2.145	1200		1	4.003	1.655	300
							2	1.009	1.655	225
							0	1.010	1.655	300
F18	716696.000	735732.000	3.855	2.255	1200		1	1.010	1.600	300
							0	1.011	1.600	300
F19	716704.000	735724.000	3.910	2.355	1200		1	1.011	1.555	300
							0	1.012	1.555	300
OUT	716710.000	735725.000	3.940	2.420	1200		1	1.012	1.520	300

Appendix E

Surface Water Maintenance and Management Plan

MALONE O'REGAN
CONSULTING ENGINEERS

Maintenance and Management Plan

Project	NDFA Social Housing Bundles 4 & 5	Analysed by	Kezia Adanza
Job no.	23006	Date	September 2023

SuDS Component	Maintenance Responsibility	Maintenance Schedule	Required Action	Typical Frequency
Permeable Paving	PPP management company for 25 years then Dublin City Council for public realm areas	Regular Maintenance	Brushing (Standard cosmetic sweep over whole surface)	Once a year or reduced frequency as required
		Occasional Maintenance	Removal of weeds or management using glyphosate or other suitable weed killer.	As required – once a year on less frequently used pavements
		Remedial Action	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing materials.	As required
			Remediate any landscaping which has been raised within the level of the paving.	As required
			Rehabilitation of surface and upper sub-structure by remedial sweeping.	Every 10 to 15 years or as required (if performance is reduced due to significant flooding)
		Monitoring	Initial Inspection	Monthly for three months after installation
			Inspect for evidence of poor operation and/ or weed growth – if required, take remedial action,	Every 3 months, 48 hours after large storms in first six months
			Inspect slit accumulation rates and establish appropriate brushing frequencies.	Annually
			Monitor inspection chambers	Annually

Maintenance and Management Plan			
Project	NDFA Social Housing Bundles 4 & 5	Analysed by	Kezia Adanza
Job no.	23006	Date	September 2023

SuDS Component	Maintenance Responsibility	Maintenance Schedule	Required Action	Typical Frequency
Bioretention Areas - tree pits	PPP management company for 25 years then Dublin City Council	Regular Inspections	Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility and assess standing water levels in underdrain to determine if maintenance is necessary.	Quarterly
			Check operation of underdrains by inspection of flows after rain.	Annually
			Assess plants for disease infection, poor growth, invasive species etc. and replace as necessary.	Quarterly
			Inspect inlets and outlets for blockage.	Quarterly
		Regular Maintenance	Remove litter, surface debris and weeds.	Quarterly (or more frequently for tidiness or aesthetic reasons)
			Replace any plants to maintain plant density.	Quarterly to bi-annually
			Remove sediment, litter and debris build-up from around inlets.	As required
		Occasional Maintenance	Infill any holes or scour in the filter medium, improve erosion protection if required.	As required
			Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch.	As required
		Remedial Actions	Remove and replace filter medium and vegetation.	As required but likely to be > 20 years

Maintenance and Management Plan			
Project	NDFA Social Housing Bundles 4 & 5	Analysed by	Kezia Adanza
Job no.	23006	Date	September 2023

SuDS Component	**Maintenance Responsibility**	**Maintenance Schedule**	**Required Action**	**Typical Frequency**
Attenuation Storage	PPP management company for 25 years then Dublin City Council	Regular Inspections	Inspect infiltration surfaces for silting, record de-watering time of the facility and assess standing water levels in underdrain to determine if maintenance is necessary.	Quarterly
			Check operation of underdrains by inspection of flows after rain.	Annually
			Inspect inlets and outlets for blockage.	Quarterly
		Regular Maintenance	Remove sediment, litter and debris build-up from around inlets.	As required