SOCIAL HOUSING BUNDLE 4

DEVELOPMENT AT WELLMOUNT ROAD, FINGLAS.

ENGINEERING REPORT

DUBLIN CITY COUNCIL

July 2024

Project No: 23006

Contents Amendment Record

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Title: SOCIAL HOUSING BUNDLE 4
DEVELOPMENT AT WELLMOUNT ROAD, FINGLAS.
Engineering Report / Dublin City Council

Job Number: 23006

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Revision Record

Issue No.	Date	Description	Remark	Prepared	Checked	Approved
0	21/09/2023	Information	P1	PB	ND	ND
1	19/10/2023	Information	P1	PB	ND	ND
2	27/10/2023	Information	P1	KA	ND	ND
3	15/04/2024	Information	P1	KA	ND	ND
4	18/04/2024	Information	P1	KA	ND	ND
5	02/07/2024	Planning	P3	MG	DW	DW

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1 INTRODUCTION

1.1 Introduction

This report is prepared on behalf of Dublin City Council to accompany a Part 8 proposal for the construction of 77 apartment dwelling units at a site c.1.3 ha bound by Cardiffsbridge Road, Wellmount Road and Wellmount Drive, Finglas, Dublin 11, which will consist of the following:

- One apartment block with primary frontage onto Cardiffsbridge Road, ranging in height from 4 to 6-storeys, comprising 77 residential units (38 no. 1 bed units, 25 no. 2 bed units and 14 no. 3 bed units);
- 28 no. car parking spaces, 2 no. motorcycle spaces and 1 no. loading bay;
- 175 no. bicycle parking spaces;
- 135 sqm of internal community, arts and cultural floor space;
- 0.56 ha of public open space and 0.11 ha communal open space;
- Two vehicular accesses are proposed, one from Cardiffsbridge Road and one from Wellmount Road;
- Boundary treatments, public lighting, site drainage works, internal roads and footpaths, ESB substation, stores, bin and bicycle storage, plant rooms, landscaping; and
- All ancillary site services and development works above and below ground.

The purpose of this document is to describe the engineering proposals associated with the new development. These proposals are indicated on the drawings prepared by Malone O'Regan which accompany the planning submission. Where reference is made to drawings and drawing numbers within this report these should be taken as meaning those drawings produced by Malone O'Regan unless specifically stated otherwise.

1.2 Site Description

The location of the proposed development is illustrated in Figure 1-1 below. The site is situated in the residential area of Finglas, approximately 5km from Dublin city centre. The lands to the northwest of the site are a carpark for a Dunnes Stores shopping centre. Existing two storey houses are opposite the development on the northeast of the site. To the west of the site the new development fronts Cardiffsbridge Road with existing housing running off this road onto Deanstown Avenue. The east side of the development is facing onto two storey houses either end on or face on with a junction with Dunsink Drive leading to more housing. The proximity of the site to natural watercourses is outlined in Figure 1-2 below.

Figure 1-1– *Site location*

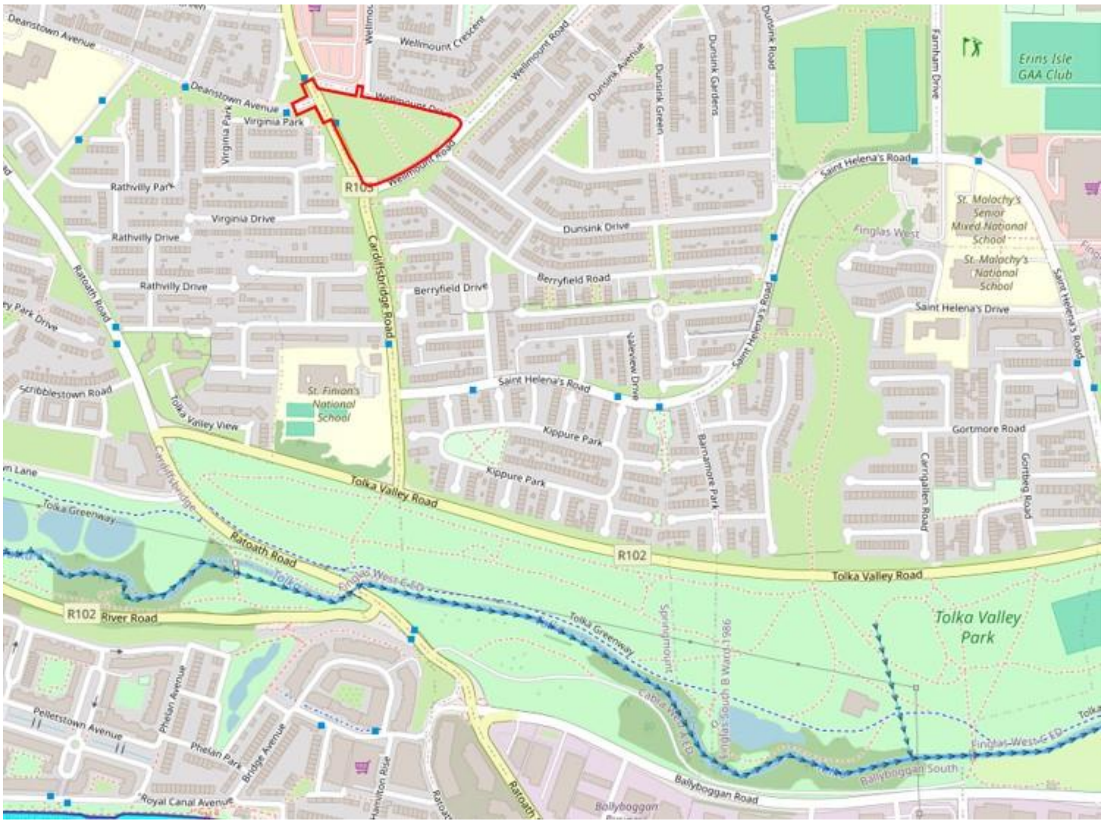

Figure 1-2– *Surrounding Watercourse (Extract from the EPA Maps)*

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 will be developed with the following steps:

1. The existing greenfield run-off of the development site will be 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 will be chosen based on their applicability and usage for the site.
3. A "FLOW" model will be created to analyse the rainfall on the site and the effectiveness of the proposed SuDS measures.
4. If effective, these SuDS measures will be incorporated into the proposed design.

Table 2-1 outlines the parameters adopted in the design of the surface water drainage

Parameter Description	Assigned Value
Surface Water Drainage Pipework Design Return Period	2 years (Ref IS EN 752 Table 2 for 'City centres / industrial / commercial areas')
Attenuation Design Return Period	100 years
Allowance for climate change	20% (Ref. OPW Flood Risk Management Climate Change Sectoral Adaptation Plan, Mid-Range Future Scenario)
M5-60	16.4mm (Met Eireann data)
M5-2D	59.3mm (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)

infrastructure.

Table 2-1 - *Surface Water Design Parameters*

2.2 Existing Services

An existing network of drainage runs around the perimeter of the site on three 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 surface water drainage pipework installed. There is a 225mm concrete sewer running parallel to the northern boundary, a 225mm concrete sewer increasing to a 300mm diameter running parallel to the western boundary, and separate runs of a 300mm concrete sewer and a 225mm concrete sewer running parallel to the eastern boundary of the site.

It is proposed to remove and relocate the existing surface water manhole, 5m distance, along the northern boundary of the site due to the proposed location of an ESB Substation. This is indicated on Malone O'Regan drawings SHB4-WRF-DR-MOR-CS-P3 130 and 150. The ground penetrating survey shows that the manhole is blocked and as such would be redundant.

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-WRF-DR-MOR-CS-P3 130, 150 and 151. Surface water runoff from new internal road 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 detention basin will be restricted to the applicable 'greenfield' runoff rate 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)	0.20
Intensive/Extensive Green Roof	0.60
Blue Roof	0.60
Permeable Paving	0.50
Impermeable Surface (Incl. tree pits)	0.90
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 Wellmount Road was taken from the Flood Studies Report as 967mm.

An appropriate Soil Index value was determined following a review of published data and site-specific ground investigation works.

The 1975 Flood Studies Report included a Soil Index map, a digitised version of which available at www.uksuds.com. This map indicated that the site lies within an area of Soil Type 2. Soil Type 2 corresponds with a very permeable soil such as sand and gravel with low runoff potential.

However, Site Investigation works completed by Ground Investigations Ireland in March 2024 indicates that the subsoils are actually impermeable in nature with high runoff potential. These investigations showed that ground conditions varied across the site. Generally, topsoil/made ground in varying depths from 0.4-1.1m below finished ground level overlay cohesive deposits. The cohesive deposits were described as brown to grey, brown slightly sandy slightly gravelly

Clay with occasional cobbles and boulders. The strength of the cohesive deposits typically increased with depth and was firm or firm to stiff 1m below finished ground level. Granular deposits lay below the clay layer and was described as brown clayey angular sandy to subangular fine to coarse gravel with subangular cobbles or grey to dark grey slightly clayey very sandy subangular to rounded fine to coarse gravel with some subrounded cobbles. The gravel was typically medium dense in consistency.

2 no. infiltration tests were conducted across the site. The results of these tests did not yield an infiltration rate as the water level dropped too slowly to allow calculation of the soil infiltration rate in both locations. The report prepared by Ground Investigations Ireland concludes that the site is not suitable for soakaway design due to the impermeable nature of the subsoils.

Given the impermeable nature of the subsoils it is considered appropriate to adopt a Soil Index value of 3 which equates to very fine sands, silts and clays with moderate runoff potential. Soil Type 3 has a corresponding Standard Percentage Runoff (SPR) of 0.37.

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

For 50ha area $QBAR_{rural}$ $= 0.00108\ [0.5]^{0.89} \times [967]^{1.17} \times [0.37]^{2.17}$

$= 0.210\ m^3/s$

$= 210.0$ l/s (for 50ha)

$QBAR_{rural}$ **= 4.193 l/s/ha** > 2l/s/ha

$QBAR_{rural}$ for the subject site (overall catchment area) = 4.193 l/s/ha x 0.63ha

QBAR = 2.638 l/s

According to the GDSDS Chapter 6.3.14 if the separate long-term storage cannot be provided and temporary flood storage forms part of the single attenuation system, all the runoff from the site should be discharged at a rate of 2 l/s/ha or the average annual peak flow rate QBAR, whichever is greater. In this case QBAR is the higher value and has been adopted as the limiting discharge rate.

For the purposes of surface water attenuation design, the site is dealt with as one catchment as indicated by the red hatched area in Figure 2-1. The developed section of the site is less than 50% of the existing green open space. The undeveloped section of the site is to remain as green public open space as noted in the green zone in Figure 2-1. A breakdown of the impermeable areas contributing to the surface water drainage network in each catchment with applied runoff coefficients is provided in Table **2**-**3** and Table **2**-**4** below.

Figure 2-1 – *Surface Water Drainage Catchment Area (shown in Red hatch)*

Total Area sq.m	Type of Surface		Area sq.m	Run-off Coefficient	Equivalent Impermeable	Urban Creep Allowance	Overall Impermeable
6293	Roof	Standard roof - 30%	487.98	0.95	463.58	509.93	2367.24
		Blue/Green Roof - 70%					
	Permeable Paving inc. areas from hardstanding		1987.90	0.50	993.95	1093.35	
ha	Landscaped Areas inc. areas from hardstanding		2451.70	0.20	490.34	539.37	ha
0.63							0.24
	Hardstanding (not including strip of access road with area of 334m2)		226.86	0.90	204.17	224.59	

Table 2-3 - *Breakdown of Impermeable Areas for Proposed Development*

Total Area sq.m	Type of Surface		Area sq.m	Run-off Coefficient	Equivalent Impermeable	Urban Creep Allowance	Overall Impermeable
6293	Roof	Standard roof - 30%					751.48
		Blue/Green Roof - 70%	1138.61	0.60	683.17	751.48	
	Permeable Paving inc. areas from hardstanding						
ha	Landscaped Areas inc. areas from hardstanding						ha
0.63							0.08
	Hardstanding (not including strip of access road with area of 334m2)						

Table 2-4 - *Breakdown of Impermeable Areas for Proposed Development – Blue Green Roof*

2.5 Sustainable Drainage Systems (SuDS)

The proposed development will be 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 sever 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 the catchment will be attenuated in storage structures within and below ground and in the blue roof attenuation systems. The proposed attenuation systems are explained in section 2.5. 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 in areas beside roads and green spaces within the site due to lack of space.
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.
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 flat roofs above apartment buildings.
Blue Roofs *Provide attenuation storage, reducing requirement for storage elsewhere on site*	Yes	It is proposed to provide blue roofs in areas directly below the green roof. Refer to 'Green Roofs' above.
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 roofs/roads and allow infiltration and absorption*	Yes	Rain Gardens are proposed in the back garden of the apartments and green spaces.
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, it is not considered viable to gather the water for grey water usage in the maintenance aspect of the building.
Permeable paving *Allows runoff to percolate into the subsoil, reducing overall runoff volume*	Yes	Permeable paving is proposed within the development in footpaths, private curtilage areas and car parking spaces.
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.
Dry Ponds *Depressed area of site for water infiltration, planted to treat water, removing harmful impurities and provide attenuation*	Yes	Detention Basins are considered appropriate in the communal open 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 Pits

It is proposed to provide a number of tree pits adjacent to car parking and footpaths where feasible within the development. Runoff from the roads and footpaths will be directed towards these tree pits. Refer to the details on drawings SHB4-WRF-DR-MOR-CS-P3-150 for locations of tree pits on plan. Refer to landscape architect drawing for tree pit detail.

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. An overflow from the tree pits will be provided. During larger storm events, the water in the bioretention areas will be able to overflow and drain towards the attenuation system.

The bioretention areas will be planted in order to promote biodiversity. 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.

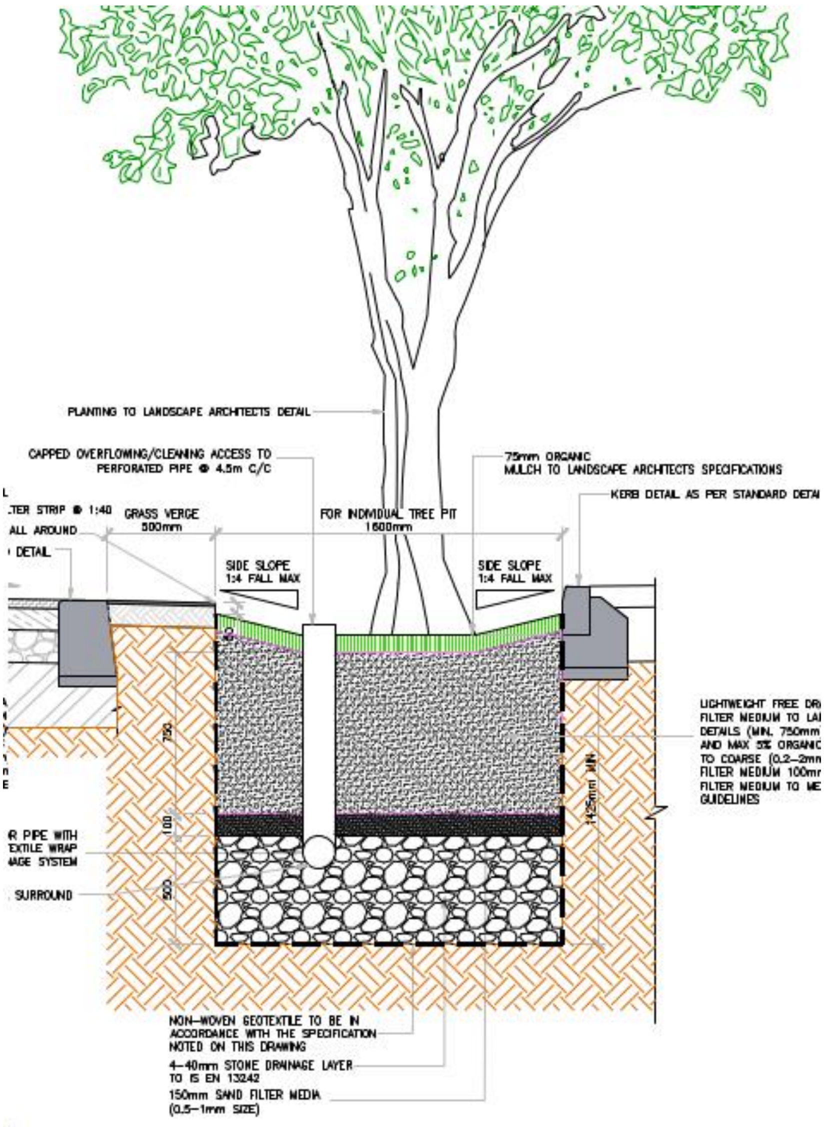

Figure 2-2 – *Tree Pit*

2.5.3 Intensive Green/ Blue Roofs

As part of the proposed development, it is intended to provide intensive green / blue roofs to appropriate areas of the building. Green roofs provide ecological, aesthetic and amenity benefits and intercept and retain rainfall, at source, reducing the volume of runoff and attenuating peak flows. Details from the suppliers of green roof systems indicate that they will typically provide interception storage of 38 litres per square metre of roof covering.

Green roofs absorb most of the rainfall that they receive during normal rainfall events and treat surface water through removal of atmospherically deposited urban pollutants. They also reduce building heating requirements (by adding mass and thermal resistance value) and cooling requirements (by evaporative cooling). Intensive green roofs typically have a growing medium of 200mm allowing for a wider array of planting possibilities than extensive (sedum) green roof coverings.

The green roofs will be underlaid by a storage medium so that they also perform as blue roofs, capable of attenuating rainwater. The proposed green / blue roofs will provide initial storage of rainwater, while also reducing the rate at which rainwater from heavier rainfall events discharges to the attenuation systems.

Flow restrictor outlets will be provided to control the rate of runoff from the roof. Since the green / blue roofs provide their own attenuation with flow restrictor outlet on the roof, these areas will not drain towards the main attenuation system on site. Runoff from the green / blue roofs will connect to the surface water drainage pipework downstream of the main attenuation system and associated Hydrobrake.

It is proposed to provide intensive green / blue roofs over at least 70% of the total roof area, which exceeds the minimum coverage requirement of 50% as outlined in the Dublin City Council Green & Blue Roof Guidelines 2021. Refer to Figure 2.4 below for Green/ Blue Roof location.

Roof structures will be designed to cater for the additional loads associated with the blue roof storage layer and the overlying green roof build-up. Details of the proposed green / blue roof build-up are provided on Malone O'Regan drawing no. SHB4-WRF-DR-MOR-CS-P3-150 and 151 an extract from which is provided below.

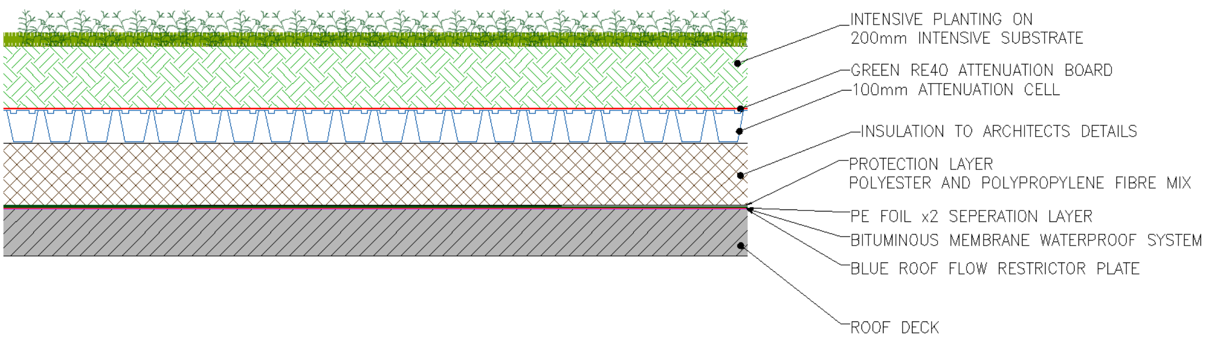

Figure 2-3 – *Typical Intensive Green/ Blue Roof Landscaping*

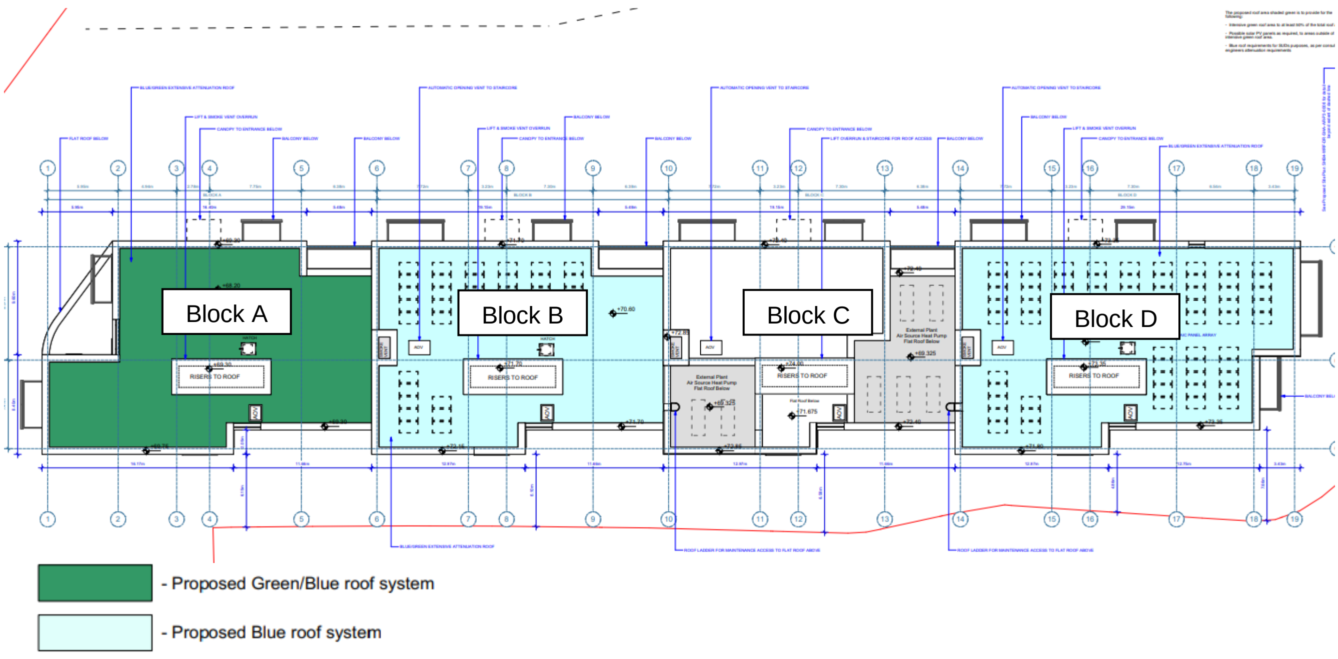

Figure 2-4 – *Proposed Green/ Blue and Blue Roof on Plan (Extract from Architects Drawing – Proposed Roof Level Plan)*

2.5.4 Blue Roofs

Blue roofs are proposed for Blocks B and Block D, refer to Figure 2.4 for location of Blue Roofs. Similar to the intensive green/ blue roof described above. 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. Flow restrictor outlets are critical to the good working of the roof system. Maintenance requirements are higher for blue roofs to ensure all outlets remain free from debris, silt, leaves etc.

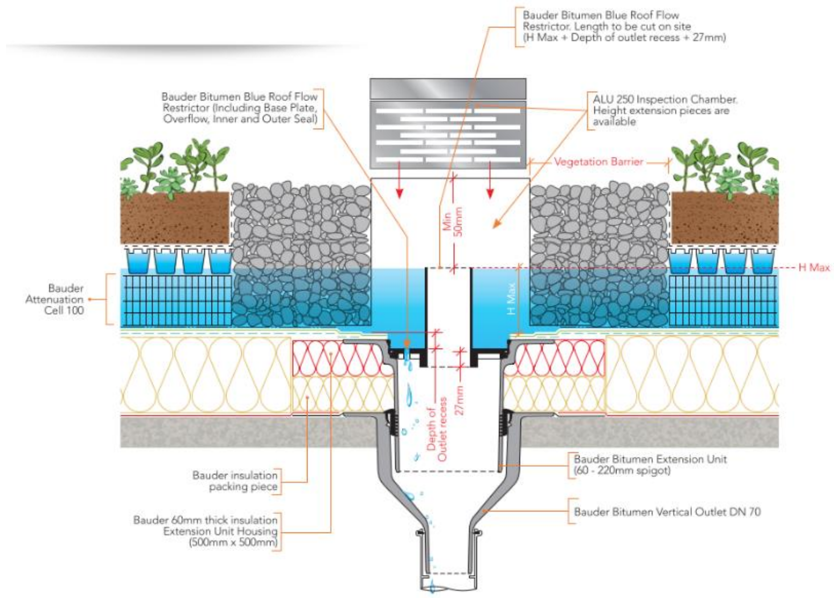

Figure 2-5 – *Typical Blue Roof Section*

2.5.5 Rain Gardens / Bioretention Area

It is proposed to provide a number of discrete, shallow landscaped areas in communal areas of the development. Runoff from the hard surfaced areas will be directed towards these bioretention gardens. Refer to the details on drawing no. SHB4-WRF-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. An overflow from the rain gardens will be provided. During larger storm events, the water in the bioretention areas will be able to overflow and drain towards the attenuation system.

The bioretention areas will be planted in order to promote biodiversity. Runoff will also be treated through the adsorption of particles by vegetation or by soil, and by biological activity. Rain gardens can reduce the runoff rates and volumes of surface water. They are very effective in delivering interception and treatment storage.

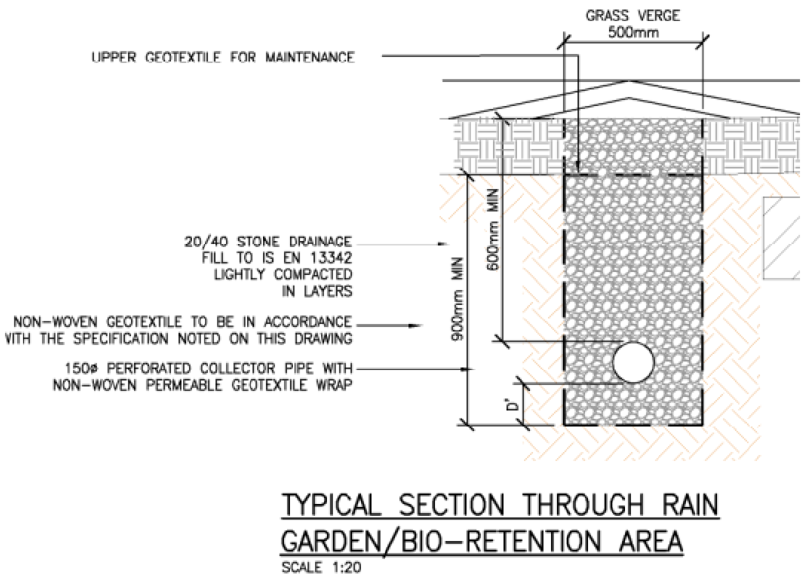

Figure 2-6 – *Rain Garden*

2.5.6 Permeable Paving

It is proposed to use permeable paving to surface the private curtilage areas, parking spaces and footpaths in the development. 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 parking area 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-WRF-DR-MOR-CS-P3- 151 for typical permeable paving details.

Permeable paving will be provided with a perforated underdrain pipe. The pipe shall be raised above the base of the stone sub-base so that minor accumulations of runoff water can percolate through the stone sub-base. During significant rainfall events, excess water will disperse through the perforated underdrain preventing flooding at surface level. The underdrain will connect to inspection manholes which will facilitate maintenance of the drainage pipework.

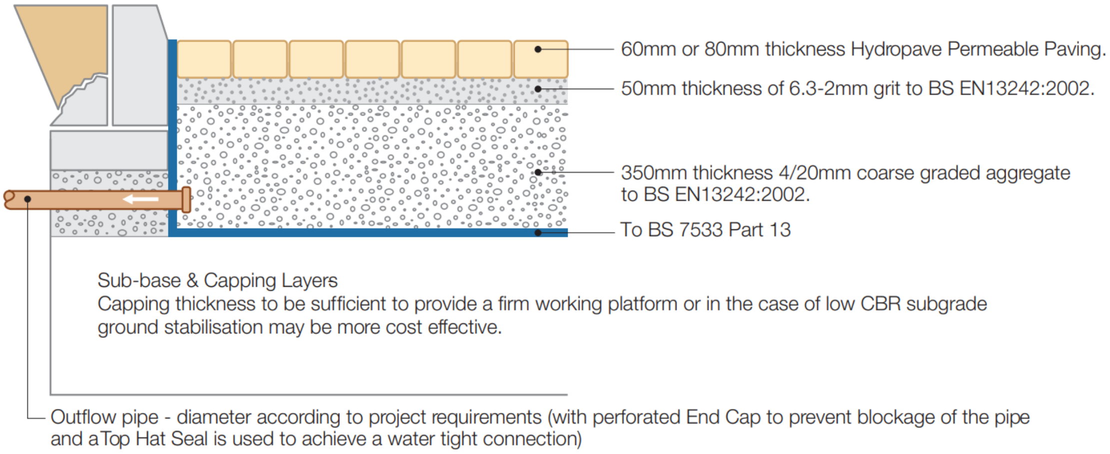

Figure 2-7 – Typical Section Through Permeable Paving in Parking Spaces

2.6 Dry Pond

It is proposed to provide a dry pond within the communal open space on the southeastern section of the site. This system may also be referred to as a detention basin. Runoff from the roofs, footpaths and roads will be directed towards this basin via other SuDS drainage methods in the surface water drainage scheme.

Refer to the details on drawing no. SHB4-WRF-DR-MOR-CS-P3-130, 150 and 151. These features will provide a level of storage to attenuate the runoff flows and also permit settlement of coarse silts.

As described in Section 2.4 above, the results of the infiltrations tests did not yield an infiltration rate as the water level dropped too slowly to allow calculation of the soil infiltration rate in both locations. The report prepared by Ground Investigations Ireland concludes that the site is not suitable for soakaway design due to the impermeable nature of the subsoils. Despite the low infiltration rates recorded on site, it is assumed that the various SuDS measures proposed will allow some amount of rainwater to percolate directly to ground. Runoff from larger storm events will be directed towards the dry pond. The dry pond has been designed to maintain a +500mm freeboard to the lowest finish floor level and +300mm freeboard to the lowest road level on the side.

The detention basin will be planted in order to promote settlement of silt particles. Runoff will also be treated through the absorption of particles by vegetation or by soil, and by biological activity. Detention basins can reduce the volumes of surface water through evapotranspiration and infiltration. They are very effective in delivering interception, treatment storage and attenuation.

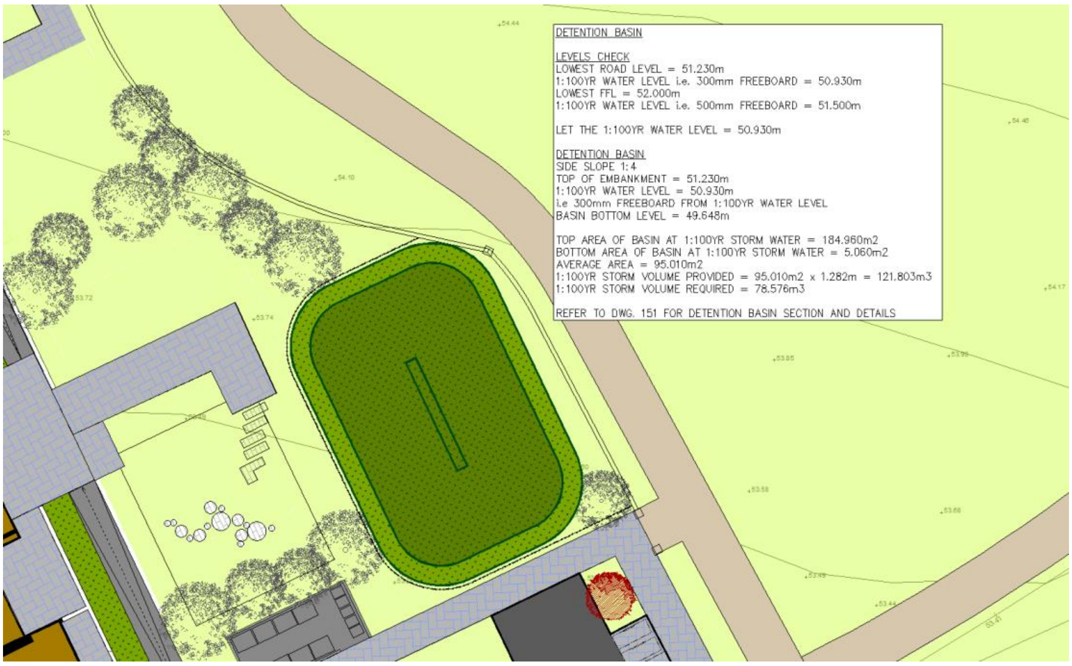

Figure 2-4 – Detention Basin

2.6.1 Groundwater Monitoring

The Site Investigation report shows water strike was encountered at 1.90m below ground level at TP01 and 2.30m bgl at TP02. The remaining boreholes and trial pits remained dry.

The proposed dry pond extends approximately 1.6m bgl. However, there is no indication of groundwater at the proposed location of the pond.

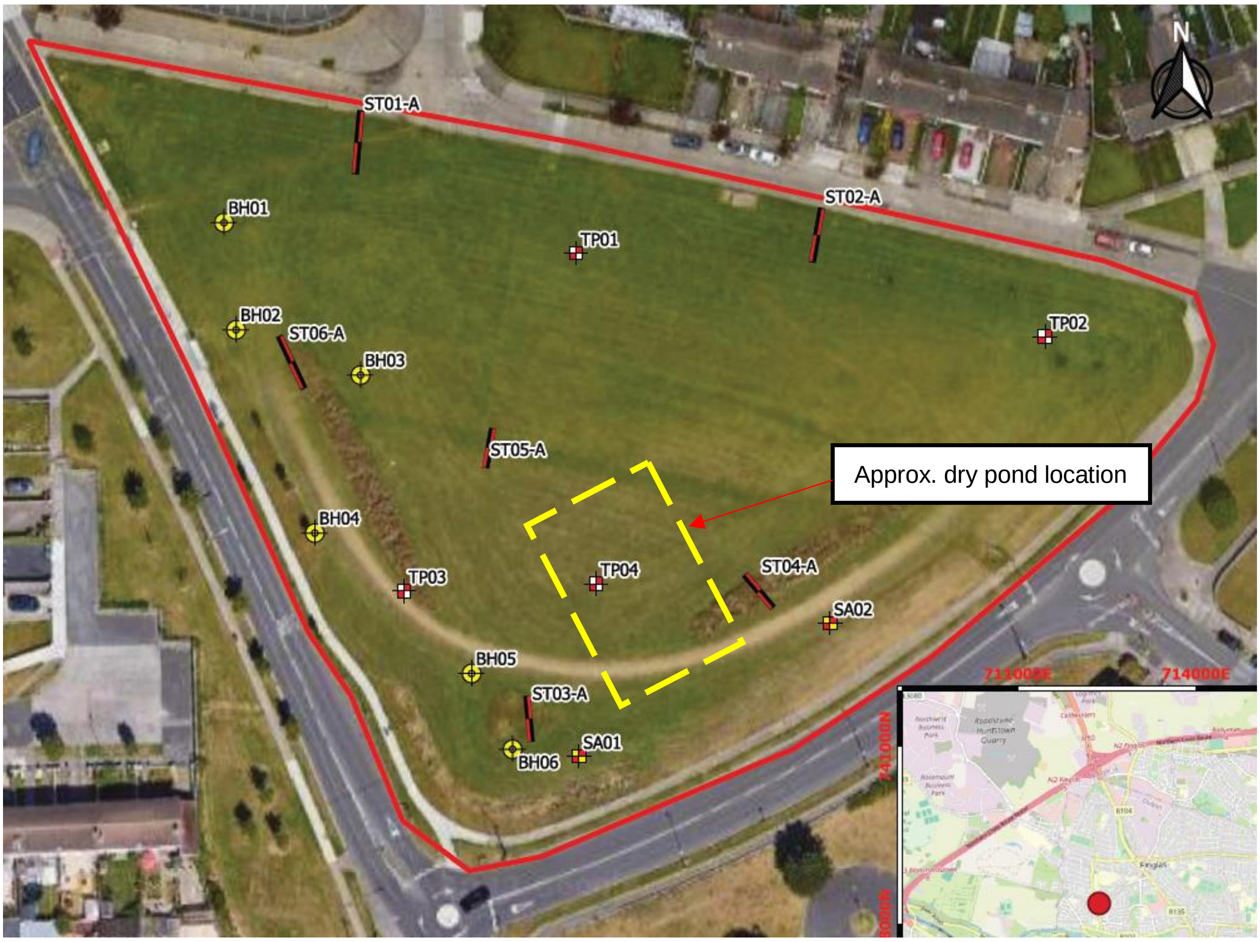

Figure 2-8 – Site Investigation Exploratory Holes Locations

2.7 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.

The required interception storage and provided interception storage is provided in Appendix B.

2.8 Attenuation Design

Attenuation storage is provided on the site using a detention basin. For the purposes of surface water attenuation design, the calculation only considers the proposed development site and not the public open space, as shown in Figure 2.1. The public open space is landscaping and free draining.

The volume of surface water storage required for the detention basin 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 dry pond located in the southeastern end of the site. The calculated storage capacity of the dry pond is **121.8m^3**.

The volume of runoff water that will be generated during a 1 in 100-year storm event has been calculated to be **78.6m^3**. This volume has been calculated accommodating a 20% increase in future rainfall intensities as a result of climate change while allowing for 10% urban creep. The attenuation storage has been assessed using the greenfield runoff rates applicable for the 1/100-year rainfall event. The overflow from the detention basin is limited by a Hydrobrake flow control device which restricts the flow to 2.64 litres/s.

2.9 GDSDS Criterion Compliance

2.9.1 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.

2.9.2 Criterion 2 River Regime Protection

Attenuation storage is provided to limit the discharge rate from the site into the public network. As per the GDSDS, the required attenuation volume has been calculated for the 1-year, 30-year and 100-year return periods, identifying the critical storm for each – refer to the calculations included in Appendix B.

The 1975 Flood Studies Report included a Soil Index map, a digitised version of which available at www.uksuds.com. This map indicated that the site lies within an area of Soil Type 2. Soil Type 2 corresponds with a very permeable soil such as sand and gravel with low runoff potential.

However, the site investigation carried out on site describes the cohesive deposit as brown to grey, brown slightly sandy slightly gravelly Clay with occasional cobbles and boulders. The strength of the cohesive deposits typically increased with depth and was firm or firm to stiff 1m below finished ground level. The results of these tests did not yield an infiltration rate as the water level dropped too slowly to allow calculation of the soil infiltration rate in both locations.

Stiff sandy gravelly clay allows for moderate runoff potential, and as such the attenuation calculations use a Soil Type 3 (SPR Index 0.37).

The calculations use a Standard Average Annual Rainfall (SAAR) value of 967mm, taken from HR Wallingfords SuDS map.

Based on these calculations, the required attenuation storage volume for the site is 78.6m^3. This volume is sufficient for the 1 in 100-year storm event, allowing for a 20% increase in future rainfall intensities as a result of climate change and 10% urban creep.

The proposed attenuation system provided on site is a dry pond located in a green open space to the south-east of the site. Surface water runoff will be restricted via a Hydro-brake or similar approved flow control device with discharge from the site limited to the greenfield equivalent rate of 2.64l/s, before discharging to the public combined network.

2.9.3 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.

2.9.4 Criterion 4 River Flood Protection

The long-term storage volume is a comparison of pre- and post- development runoff volumes. The objective is to limit the runoff discharged after development to the same as that which occurred prior to the development.

Of the three methods described in the GDSDS for establishing River Flood Protection by comparison of the pre- and post- development runoff volumes, (Criteria 4.1, 4.2 and 4.3 respectively), Criteria 4.3 is selected for use as the most practical criteria at this stage in the design.

The Criteria 4.3 approach is for all runoff to be limited to either QBAR or to 2l/s/ha, whichever is greater. As noted in Section 2.4, in this instance QBAR is the higher value and has been adopted as the limiting discharge rate.

The proposed drainage system includes a flow control device to ensure that the discharge rate is limited to the greenfield equivalent and ample attenuation is provided for the 1-in-100 year storm, accounting for 20% increase due to climate change.

2.10 Enhanced Biodiversity

Bioretention areas 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 bioretention area offers the opportunity to create a planted vegetation zone for plants and animals which will encourage biodiversity on the site.

2.11 SuDS CIRIA Pillars of Design

2.11.1 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)

2.11.2 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.

2.11.3 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.

2.11.4 Biodiversity

The encouragement of biodiverse environments within urban environments is incredibly important. 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/blue roofs throughout the site and the bio- retention areas, biodiversity on site is promoted.

2.11.5 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.

Finally, the chosen SuDS measures have been analysed for various rainfall scenarios to ensure that all the SuDS design criteria are met an extensive 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.

2.12 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).

On 13th December 2023, 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.

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 and process water drainage infrastructure.

Parameter Description	Assigned Value
Hydraulic Loading (Foul associated with domestic)	150 litres / person / day
Pipe Friction	1.5 mm
Minimum Velocity	0.7 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 and process water pipe networks 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 sewers carry foul water runoff towards existing treatment areas in North Dublin. 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 300mm concrete sewer running parallel to the northern boundary and a 225mm concrete sewer starts halfway down the western boundary towards the southern end.

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 no. SHB4-WRF-DR-MOR-CS-P3-130-Foul Sewer and Surface Water Drainage Layout. Foul water from new housing units will be collected within a gravity drainage network and directed towards the existing public sewer system.

3.4 Foul Water Demand Calculations

3.4.1 Residential Foul Water Demand

In accordance with the Irish Water Code of Practice for Wastewater Infrastructure works which carry domestic wastewater shall be designed to carry a wastewater volume of between 6 times the dry weather flow.

Dry weather flow (DWF) should be taken as 446 litres per dwelling.

DWF = 77 units x 446 l/dwelling = 34,342 l/day = 0.397 l/sec

Peak discharge = 6 x DWF = 2.382 l/sec

3.4.2 Community Centre Foul Water Demand

There is provision of 135m^2 of community, cultural and arts space within the development.

The average and peak water demand rates were calculated in accordance with the Irish Water Code of Practice for Water Infrastructure guidelines which assumes a loading rater of 40 l/person/day for a Local Community Sports Club.

Total persons = 68 people (Assumed 1 person per 2m^2 of floor area)

Average water demand = 40litres/person/day

Total daily discharge = 68 people x 40litres/person/day = 2,720 litres/day

Average Hour Demand = 2,720 litres/day / (24hr x 60min x 60sec)
= 0.031 l/s

In accordance with Table 2.7 Commercial Peaking Factors, the peaking factor applied to commercial wastewater flow for an area of 0 – 5.5ha is 4.5 x DWF.

Peak discharge = 4.5 x DWF = 0.140 l/s

Average and peak discharge rates for all existing and proposed developments are summarised in the Table below.

Development Description	Average Demand (l/s)	Peak Demand (l/s)
Proposed development of residential units	0.397	2.382
Community Centre	0.031	0.140
Total	**0.428**	**2.522**

Table 3-2 - *Average and Peak Foul Discharge Rates for All Development*

3.5 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 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).

On 13th December 2023, 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. The letter further notes that Irish Water have reviewed the proposed details and determined that no upgrades are required to the Irish Water network.

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

A 225mm diameter watermain is located under the footpath in Cardiffsbridge Road to the west of the proposed development and on Wellmount Drive to the north of the development. An existing 450mm diameter watermain is located through the centre of the proposed development – this will need to be diverted to run around the new apartment building.

The proposed watermain layout is indicated on drawing no. SHB4-WRF-DR-MOR-CS-P3-140-Watermain Layout which accompanies this planning application. Irish Water have noted that the diversion of the two existing watermains on the site are to be approved by Irish Water Diversion Team prior to any works being undertaken on site.

4.3 Water Demand Calculations

4.3.1 Residential Water Demand

The average and peak water demand rates were calculated in accordance with the Irish Water Code of Practice for Water Infrastructure guidelines which assumes a loading rate of 150 litres per person per day and an occupancy rate of 2.7 persons per dwelling..

The average day/ peak week demand is taken as 1.25 times the average daily domestic demand. The peak demand is taken to be 5 times the average day/ peak week demand.

Total Daily Water Demand = 77 dwellings x 2.7 persons x 150 litres per day per person
= 31,185 litres/day

Average Hour Demand = 31,185 litres/day / (24hr x 60min x 60sec)
= 0.361 litres/sec

Average Day / Peak Week Demand = 0.361 litres/sec x 1.25
= 0.451 litres/sec

Peak Demand = 5 x 0.451 litres/sec = 2.256 litres/sec

4.3.2 Community Centre Water Demand

There is provision of 135m^2 of community, cultural and arts space.

Total persons = 68 people (Assumed 1person per 2m^2 of floor area)

Average water demand = 90litres/person/day

Total daily discharge = 68 people x 90litres/person/day = 6,120 litres/day = 0.071 litres/sec

Average Day Peak Week Demand = 0.071 x 1.25 = 0.089 litres/ sec

Peak Demand = 5 x 0.089 litres/sec = 0.445 litres/sec

Average and peak discharge rates for all existing and proposed developments are summarised in the Table below.

Development Description	Average Demand (l/s)	Peak Demand (l/s)
Proposed development of residential units	0.451	2.256
Community Centre	0.089	0.445
Total	**0.540**	**2.701**

Table 4.1 Average and Peak Foul Discharge Rates for All Developments

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.

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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

CONFIRMATION OF FEASIBILITY

Ray O'Connor

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

19 February 2024

Our Ref: CDS24000423 Pre-Connection Enquiry
Residential Development at Wellmount Rd, Wellmount Road, Dublin 11

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 98 unit(s) at Residential Development at Wellmount Rd, Wellmount Road, Dublin 11 (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 12'' and 9'' Asbestos watermain diversions has to be approved by Uisce Éireann Diversion Team, prior a planning submission and/or any activities 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. Drawings (showing clearance distances, changing to ground levels) and Method Statements should be included in the Detailed Design of the Development. A wayleave in favour of Uisce Éireann will be required over the assets that are not located within the Public Space. 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

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

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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 VOLUME CALCULATIONS

Job Title	B4 08 Wellmount Road Finglas	Job no.	23006
By:	MG	Checked by:	DW
Date	25/06/2024	Rev number	1

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 m^3/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	16.4	
M5-2D (2 days - 5 years) mm	59.3	
Ratio "r" (M5-60/ M5-2D)	0.28	
SAAR mm	967	
Soil/ SPR mm	0.37	Soil type 3 - very fine sands, silts, clays; permeable soils; moderate runoff potential

For 50 Ha Area ~ QBARrural =	0.210	m^3/s	
For 0.63 Ha Area ~ QBARrural =	4.193	l/s/ha	Discharge should be limited to QBAR or 2 l/s/ha
For 0.63 Ha Area ~ QBARrural =	2.638	l/s	whichever is greater.

Part 2 Impermeable Area

Breakdown of the impermeable areas contributing to the surface water drainage network in each catchment with applied runoff coeifficients 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
6293	Roof	Standard roof - 30%					751.48
		Blue/Green Roof - 70%	1138.61	0.60	683.17	751.48	
	Permeable Paving inc. areas from hardstanding						
ha	Landscaped Areas inc. areas from hardstanding						ha
0.63							0.08
	Hardstanding (not including strip of access road with area of 334m2)						

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	2.0	1.15	1	2.250	1.691	0.158304315	1.533
2min	5.7	3.4	1.16	1	3.921	2.946	0.31660863	2.630
5 min	10.3	6.1	1.18	1	7.207	5.416	0.791521575	4.625
10 min	14.8	8.8	1.18	1	10.356	7.782	1.583043151	6.199
15 min	17.7	10.5	1.18	1	12.385	9.307	2.374564726	6.933
30 min	23.3	13.8	1.18	1	16.304	12.252	4.749129452	7.503
60 min	30	17.8	1.17	1	20.814	15.642	9.498258904	6.143
2 hour	38	22.5	1.16	1	26.139	19.643	18.99651781	0.647
4 hour	48	28.5	1.15	1	32.734	24.599	37.99303562	-13.394
6 hour	55	32.6	1.14	1	37.181	27.941	56.98955342	-29.049
12 hour	68	40.3	1.14	1	45.969	34.545	113.9791068	-79.434
24 hour	85	50.4	1.13	1	56.958	42.803	227.9582137	-185.156
48 hour	106	62.9	1.12	1	70.401	52.905	455.9164274	-403.011
Size of Attenuation for 1 in 10 year flood event m^3								**7.503**

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	2.0	1.39	1	2.720	2.044	0.158304315	1.886
2min	5.7	3.4	1.41	1	4.766	3.582	0.31660863	3.265
5 min	10.3	6.1	1.44	1	8.795	6.610	0.791521575	5.818
10 min	14.8	8.8	1.46	1	12.814	9.629	1.583043151	8.046
15 min	17.7	10.5	1.48	1	15.534	11.674	2.374564726	9.299
30 min	23.3	13.8	1.49	1	20.587	15.471	4.749129452	10.722
60 min	30	17.8	1.48	1	26.329	19.786	9.498258904	10.288
2 hour	38	22.5	1.47	1	33.125	24.893	18.99651781	5.896
4 hour	48	28.5	1.45	1	41.273	31.016	37.99303562	-6.977
6 hour	55	32.6	1.44	1	46.966	35.294	56.98955342	-21.696
12 hour	68	40.3	1.42	1	57.260	43.030	113.9791068	-70.949
24 hour	85	50.4	1.38	1	69.559	52.272	227.9582137	-175.686
48 hour	106	62.9	1.34	1	84.230	63.297	455.9164274	-392.619
Size of Attenuation for 1 in 30 year flood event m³								**10.722**

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	2.0	1.87	1	3.659	2.750	0.158304315	2.592
2min	5.7	3.4	1.88	1	6.355	4.775	0.31660863	4.459
5 min	10.3	6.1	1.97	1	12.033	9.042	0.791521575	8.251
10 min	14.8	8.8	1.98	1	17.377	13.059	1.583043151	11.476
15 min	17.7	10.5	1.95	1	20.467	15.381	2.374564726	13.006
30 min	23.3	13.8	1.91	1	26.390	19.832	4.749129452	15.083
60 min	30	17.8	1.85	1	32.912	24.732	9.498258904	15.234
2 hour	38	22.5	1.78	1	40.111	30.142	18.99651781	11.146
4 hour	48	28.5	1.73	1	49.243	37.005	37.99303562	-0.988
6 hour	55	32.6	1.71	1	55.772	41.911	56.98955342	-15.078
12 hour	68	40.3	1.62	1	65.325	49.090	113.9791068	-64.889
24 hour	85	50.4	1.58	1	79.640	59.848	227.9582137	-168.110
48 hour	106	62.9	1.53	1	96.173	72.272	455.9164274	-383.644
Size of Attenuation for 1 in 100 year flood event m³								**15.234**

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.

<u>Required Interception Storage</u>

Overall Impermeable area is 751.5 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' 3.61 m³

<u>Interception Storage Provided</u> *Only fill in SuDS on your site

Green Roof A 'Bauder Sedume' or equivalent design to retain 30 l/m² of rainwater will be used on roof level	Area	1138.6	m²
	Interception Store 30 l/m²	0.03	l/m²
	Storage Volume	34.16	m³

Total interception volume provided for the overall site 34.16 m³
which exceeds the required volume calculated of 3.61 m³

Job Title	B4 08 Wellmount Road Finglas	Job no.	23006
By:	MG	Checked by:	DW
Date	25/06/2024	Rev number	1

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	16.4	
M5-2D (2 days - 5 years) mm	59.3	
Ratio "r" (M5-60/ M5-2D)	0.28	
SAAR mm	967	
Soil/ SPR mm	0.37	Soil type 3 - very fine sands, silts, clays; permeable soils; moderate runoff potential

For 50 Ha Area ~ QBARrural =	0.210	m³/s	
For 0.63 Ha Area ~ QBARrural =	4.193	l/s/ha	Discharge should be limited to QBAR or 2 l/s/ha
For 0.63 Ha Area ~ QBARrural =	2.638	l/s	whichever is greater.

Part 2 Impermeable Area

Breakdown of the impermeable areas contributing to the surface water drainage network in each catchment with applied runoff coeifficients 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
6293	Roof	Standard roof - 30%	487.98	0.95	463.58	509.93	2367.24
		Blue/Green Roof - 70%					
	Permeable Paving inc. areas from hardstanding		1987.90	0.50	993.95	1093.35	
ha	Landscaped Areas inc. areas from hardstanding		2451.70	0.20	490.34	539.37	ha
0.63							0.24
	Hardstanding (not including strip of access road with area of 334m2)		226.86	0.90	204.17	224.59	

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	2.0	1.15	1	2.250	5.327	0.158304315	5.169
2min	5.7	3.4	1.16	1	3.921	9.282	0.31660863	8.965
5 min	10.3	6.1	1.18	1	7.207	17.061	0.791521575	16.270
10 min	14.8	8.8	1.18	1	10.356	24.516	1.583043151	22.932
15 min	17.7	10.5	1.18	1	12.385	29.319	2.374564726	26.945
30 min	23.3	13.8	1.18	1	16.304	38.595	4.749129452	33.846
60 min	30	17.8	1.17	1	20.814	49.273	9.498258904	39.774
2 hour	38	22.5	1.16	1	26.139	61.878	18.99651781	42.882
4 hour	48	28.5	1.15	1	32.734	77.488	37.99303562	39.495
6 hour	55	32.6	1.14	1	37.181	88.017	56.98955342	31.027
12 hour	68	40.3	1.14	1	45.969	108.821	113.9791068	-5.158
24 hour	85	50.4	1.13	1	56.958	134.833	227.9582137	-93.126
48 hour	106	62.9	1.12	1	70.401	166.656	455.9164274	-289.260
Size of Attenuation for 1 in 10 year flood event m³								**42.882**

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	2.0	1.39	1	2.720	6.439	0.158304315	6.281
2min	5.7	3.4	1.41	1	4.766	11.282	0.31660863	10.966
5 min	10.3	6.1	1.44	1	8.795	20.821	0.791521575	20.029
10 min	14.8	8.8	1.46	1	12.814	30.333	1.583043151	28.750
15 min	17.7	10.5	1.48	1	15.534	36.773	2.374564726	34.399
30 min	23.3	13.8	1.49	1	20.587	48.735	4.749129452	43.986
60 min	30	17.8	1.48	1	26.329	62.328	9.498258904	52.829
2 hour	38	22.5	1.47	1	33.125	78.415	18.99651781	59.418
4 hour	48	28.5	1.45	1	41.273	97.703	37.99303562	59.710
6 hour	55	32.6	1.44	1	46.966	111.179	56.98955342	54.189
12 hour	68	40.3	1.42	1	57.260	135.549	113.9791068	21.569
24 hour	85	50.4	1.38	1	69.559	164.663	227.9582137	-63.295
48 hour	106	62.9	1.34	1	84.230	199.392	455.9164274	-256.524
Size of Attenuation for 1 in 30 year flood event m³								**59.710**

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	2.0	1.87	1	3.659	8.663	0.158304315	8.504
2min	5.7	3.4	1.88	1	6.355	15.043	0.31660863	14.726
5 min	10.3	6.1	1.97	1	12.033	28.484	0.791521575	27.692
10 min	14.8	8.8	1.98	1	17.377	41.136	1.583043151	39.553
15 min	17.7	10.5	1.95	1	20.467	48.451	2.374564726	46.077
30 min	23.3	13.8	1.91	1	26.390	62.472	4.749129452	57.723
60 min	30	17.8	1.85	1	32.912	77.910	9.498258904	68.411
2 hour	38	22.5	1.78	1	40.111	94.951	18.99651781	75.955
4 hour	48	28.5	1.73	1	49.243	116.569	37.99303562	78.576
6 hour	55	32.6	1.71	1	55.772	132.025	56.98955342	75.035
12 hour	68	40.3	1.62	1	65.325	154.640	113.9791068	40.661
24 hour	85	50.4	1.58	1	79.640	188.527	227.9582137	-39.431
48 hour	106	62.9	1.53	1	96.173	227.664	455.9164274	-228.252
Size of Attenuation for 1 in 100 year flood event m³								**78.576**

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.

<u>Required Interception Storage</u>

Overall Impermeable area is 2367.2 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' 11.36 m³

<u>Interception Storage Provided</u> *Only fill in SuDS on your site

Permeable Paving	Area	1323.0	m²	
	Stone Layer 100mm deep	0.1	m	
	Void Ratio	30%		
	Storage Volume	39.68994	m³	*Storage depth will depend on your site

Bio-Retention Area/ Raingarden	Area	367.6	m²
	Depth of subgrade	0.15	m
	Storage Volume	55.14	m³

Total interception volume provided for the overall site 94.83 m³

which exceeds the required volume calculated of 11.36 m³

APPENDIX C – SURFACE WATER PIPE NETWORK CALCULATIONS

CAUSEWAY

Drainage Design Report

Flow+

v10.8

Network	Storm Network
Filename	2024-07-01 Flow.pfd
Username	Kezia Adanza (kadanza@morce.ie)
Last analysed	01/07/2024 12:51:32
Report produced on	01/07/2024 12:55:14

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Technical support web portal:

http://support.causeway.com

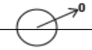
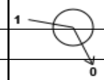
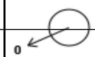
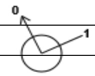
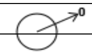
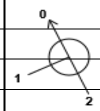
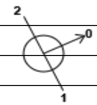
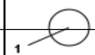
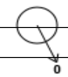
Rainfall Methodology	FSR
Return Period (years)	2
Additional Flow (%)	0
FSR Region	Scotland and Ireland
M5-60 (mm)	16.400
Ratio-R	0.280
CV	0.750
Time of Entry (mins)	4.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Inverts
Minimum Backdrop Height (m)	0.500
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	Yes
Enforce best practice design rules	Yes

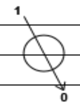
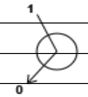
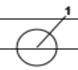
	Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Width (mm)	Sump (m)	Easting (m)	Northing (m)	Depth (m)	Notes
✓	SW10	0.030	4.00		54.140	Manhole	Adoptable	1200			712301.598	738387.099	1.425	
✓	SW09	0.030	4.00		54.140	Manhole	Adoptable	1200			712313.776	738392.932	1.505	
✓	SW08	0.030	4.00		54.190	Manhole	Adoptable	1200			712328.559	738390.069	1.644	
✓	SW07	0.030	4.00		51.240	Manhole	Adoptable	1200			712384.213	738313.441	1.225	
✓	SW06	0.030	4.00		51.380	Manhole	Adoptable	1200			712368.822	738306.010	1.450	
✓	SW05	0.030	4.00		51.900	Manhole	Adoptable	1200			712341.116	738304.018	1.825	
✓	SW04	0.030	4.00		51.950	Manhole	Adoptable	1200			712364.427	738315.184	2.071	
✓	SW03	0.030	4.00		52.370	Manhole	Adoptable	1200			712358.819	738326.893	2.556	
✓	IN				51.230	Manhole	Adoptable	1200			712370.717	738332.593	1.482	
✓	OUT		4.00		51.230	Manhole	Adoptable	1200			712379.368	738327.866	1.482	
✓	SW02-HB				51.230	Manhole	Adoptable	1200			712382.639	738321.036	1.527	
✓	SW01				51.260	Manhole	Adoptable	1200			712390.859	738303.874	1.670	
✓	EX SWMH				51.060	Manhole	Adoptable	1200			712386.357	738298.473	1.512	

	Name	US Node	DS Node	Length (m)	ks (mm) / n	Velocity Equation	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	T of C (mins)	Rain (mm/hr)	Con Offset (m)	Min DS IL (m)	Lateral Area (ha)	Lateral Ins Point (%)	Lateral T of E (mins)
✓	1.000	SW10	SW09	13.503	0.600	Colebrook-White	52.715	52.635	0.080	168.8	225	Circular	4.22	50.0					
✓	1.001	SW09	SW08	15.058	0.600	Colebrook-White	52.635	52.546	0.089	169.2	225	Circular	4.47	50.0					
✓	1.002	SW08	SW03	70.049	0.600	Colebrook-White	52.546	50.945	1.601	43.8	225	Circular	5.06	49.5					
?	2.000	SW07	SW06	17.091	0.600	Colebrook-White	50.015	49.930	0.085	200.0	225	Circular	4.31	50.0					
?	2.001	SW06	SW04	10.172	0.600	Colebrook-White	49.930	49.879	0.051	200.0	225	Circular	4.49	50.0					
✓	3.000	SW05	SW04	25.847	0.600	Colebrook-White	50.075	49.879	0.196	131.9	225	Circular	4.38	50.0					
✓	2.002	SW04	SW03	12.983	0.600	Colebrook-White	49.879	49.814	0.065	200.0	300	Circular	4.69	50.0					
?	1.003	SW03	IN	13.193	0.600	Colebrook-White	49.814	49.748	0.066	200.0	300	Circular	5.26	48.8					
✓	4.000	OUT	SW02-HB	7.573	0.600	Colebrook-White	49.748	49.703	0.045	168.3	225	Circular	4.13	50.0					
✓	4.001	SW02-HB	SW01	19.029	0.600	Colebrook-White	49.703	49.590	0.113	168.4	225	Circular	4.44	50.0					
✓	4.002	SW01	EX SWMH	7.031	0.600	Colebrook-White	49.590	49.548	0.042	167.4	225	Circular	4.56	50.0					

	Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)	Notes
✓	1.000	SW10	SW09	1.003	39.9	4.1	1.200	1.280	1.200	1.280	0.030	0.0	48	0.645	
✓	1.001	SW09	SW08	1.002	39.8	8.1	1.280	1.419	1.280	1.419	0.060	0.0	69	0.792	
✓	1.002	SW08	SW03	1.983	78.8	12.1	1.419	1.200	1.200	1.419	0.090	0.0	59	1.445	
?	2.000	SW07	SW06	0.921	36.6	4.1	1.000	1.225	1.000	1.225	0.030	0.0	51	0.611	Velocity is less than the specified minimum | Upstream Depth is less than the specified minimum
?	2.001	SW06	SW04	0.921	36.6	8.1	1.225	1.846	1.225	1.846	0.060	0.0	72	0.742	Velocity is less than the specified minimum
✓	3.000	SW05	SW04	1.137	45.2	4.1	1.600	1.846	1.600	1.846	0.030	0.0	45	0.708	
✓	2.002	SW04	SW03	1.108	78.3	16.3	1.771	2.256	1.771	2.256	0.120	0.0	92	0.879	
?	1.003	SW03	IN	1.108	78.3	31.8	2.256	1.182	1.182	2.256	0.240	0.0	133	1.051	Downstream Depth is less than the specified minimum
✓	4.000	OUT	SW02-HB	1.005	40.0	0.0	1.257	1.302	1.257	1.302	0.000	0.0	0	0.000	
✓	4.001	SW02-HB	SW01	1.004	39.9	0.0	1.302	1.445	1.302	1.445	0.000	0.0	0	0.000	
✓	4.002	SW01	EX SWMH	1.007	40.1	0.0	1.445	1.287	1.287	1.445	0.000	0.0	0	0.000	

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)	US Node	Dia (mm)	Width (mm)	Sump (m)	Node Type	MH Type	DS Node	Dia (mm)	Width (mm)	Sump (m)	Node Type	MH Type
1.000	13.503	168.8	225	Circular	54.140	52.715	1.200	54.140	52.635	1.280	SW10	1200			Manhole	Adoptable	SW09	1200			Manhole	Adoptable
1.001	15.058	169.2	225	Circular	54.140	52.635	1.280	54.190	52.546	1.419	SW09	1200			Manhole	Adoptable	SW08	1200			Manhole	Adoptable
1.002	70.049	43.8	225	Circular	54.190	52.546	1.419	52.370	50.945	1.200	SW08	1200			Manhole	Adoptable	SW03	1200			Manhole	Adoptable
2.000	17.091	200.0	225	Circular	51.240	50.015	1.000	51.380	49.930	1.225	SW07	1200			Manhole	Adoptable	SW06	1200			Manhole	Adoptable
2.001	10.172	200.0	225	Circular	51.380	49.930	1.225	51.950	49.879	1.846	SW06	1200			Manhole	Adoptable	SW04	1200			Manhole	Adoptable
3.000	25.847	131.9	225	Circular	51.900	50.075	1.600	51.950	49.879	1.846	SW05	1200			Manhole	Adoptable	SW04	1200			Manhole	Adoptable
2.002	12.983	200.0	300	Circular	51.950	49.879	1.771	52.370	49.814	2.256	SW04	1200			Manhole	Adoptable	SW03	1200			Manhole	Adoptable
1.003	13.193	200.0	300	Circular	52.370	49.814	2.256	51.230	49.748	1.182	SW03	1200			Manhole	Adoptable	IN	1200			Manhole	Adoptable
4.000	7.573	168.3	225	Circular	51.230	49.748	1.257	51.230	49.703	1.302	OUT	1200			Manhole	Adoptable	SW02-HB	1200			Manhole	Adoptable
4.001	19.029	168.4	225	Circular	51.230	49.703	1.302	51.260	49.590	1.445	SW02-HB	1200			Manhole	Adoptable	SW01	1200			Manhole	Adoptable
4.002	7.031	167.4	225	Circular	51.260	49.590	1.445	51.060	49.548	1.287	SW01	1200			Manhole	Adoptable	EX SWMH	1200			Manhole	Adoptable

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Width (mm)	Sump (m)	Node Type	MH Type	Connections		Link	IL (m)	Dia (mm)	Link Type
SW10	712301.598	738387.099	54.140	1.425	1200			Manhole	Adoptable						
											0	1.000	52.715	225	Circular
SW09	712313.776	738392.932	54.140	1.505	1200			Manhole	Adoptable		1	1.000	52.635	225	Circular
											0	1.001	52.635	225	Circular
SW08	712328.559	738390.069	54.190	1.644	1200			Manhole	Adoptable		1	1.001	52.546	225	Circular
											0	1.002	52.546	225	Circular
SW07	712384.213	738313.441	51.240	1.225	1200			Manhole	Adoptable						
											0	2.000	50.015	225	Circular
SW06	712368.822	738306.010	51.380	1.450	1200			Manhole	Adoptable		1	2.000	49.930	225	Circular
											0	2.001	49.930	225	Circular
SW05	712341.116	738304.018	51.900	1.825	1200			Manhole	Adoptable						
											0	3.000	50.075	225	Circular
SW04	712364.427	738315.184	51.950	2.071	1200			Manhole	Adoptable		1	3.000	49.879	225	Circular
											2	2.001	49.879	225	Circular
											0	2.002	49.879	300	Circular
SW03	712358.819	738326.893	52.370	2.556	1200			Manhole	Adoptable		1	2.002	49.814	300	Circular
											2	1.002	50.945	225	Circular
											0	1.003	49.814	300	Circular
IN	712370.717	738332.593	51.230	1.482	1200			Manhole	Adoptable		1	1.003	49.748	300	Circular
OUT	712379.368	738327.866	51.230	1.482	1200			Manhole	Adoptable						
											0	4.000	49.748	225	Circular

SW02-HB	712382.639	738321.036	51.230	1.527	1200			Manhole	Adoptable		1	4.000	49.703	225	Circular
											0	4.001	49.703	225	Circular
SW01	712390.859	738303.874	51.260	1.670	1200			Manhole	Adoptable		1	4.001	49.590	225	Circular
											0	4.002	49.590	225	Circular
EX SWMH	712386.357	738298.473	51.060	1.512	1200			Manhole	Adoptable		1	4.002	49.548	225	Circular

Rainfall Methodology	FSR		Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
FSR Region	England and Wales		2	20	0	0
M5-60 (mm)	16.400		30	20	0	0
Ratio-R	0.280		100	20	0	0
Summer CV	0.750					
Winter CV	0.840					
Analysis Speed	Normal					
Skip Steady State	No					
Drain Down Time (mins)	240					
Additional Storage (m^3/ha)	20.0					
Storm Durations (mins)	15					
	30					
	60					
	120					
	180					
	240					
	360					
	480					
	600					
	720					
	960					
	1440					
	2160					
	2880					
	4320					
	5760					
	7200					
	8640					
	10080					
Check Discharge Rate(s)	No					
Check Discharge Volume	No					
100 year 360 minute (m^3)						

Hydro-Brake®													
Node	**Flap Valve**	**Online / Offline**	**Downstream Link**	**Replaces Downstream Link**	**Loop to Node**	**Invert Level (m)**	**Design Depth (m)**	**Design Flow (l/s)**	**Objective**	**Sump Available**	**Product Number**	**Min Outlet Diameter (m)**	**Min Node Diameter (mm)**
SW02-HB	No	Online		Yes		49.703	1.200	2.6	(HE) Minimise upstream storage	Yes	CTL-SHE-0074-2600-1200-2600	0.100	1200

Flow through Pond													
Node	**Base Inf Coefficient (m/hr)**	**Side Inf Coefficient (m/hr)**	**Safety Factor**	**Porosity**	**Invert Level (m)**	**Time to half empty (mins)**	**Main Channel Length (m)**	**Main Channel Slope (1:X)**	**Main Channel n**	**Inlets**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
OUT	0.00000	0.00000	2.0	1.00	49.748	0	20.000	999999.0	0.025	IN	0.000	48.3	0.0
											0.600	161.1	0.0
											0.601	161.1	0.0

Default Values			Overrides					
Entry Loss (manhole)	0.250		Link	Entry Loss	Exit Loss		Node	Flood Risk (m)
Exit Loss (manhole)	0.250							
Entry Loss (junction)	0.000							
Exit Loss (junction)	0.000							
Apply Recommended Losses	No							
Flood Risk (m)	0.300							

Node Size	Yes
Node Losses	Yes
Link Size	Yes
Minimum Diameter (mm)	150
Link Length	Yes
Maximum Length (m)	100.000
Coordinates	Yes
Accuracy (m)	1.000
Crossings	Yes
Cover Depth	Yes
Minimum Cover Depth (m)	
Maximum Cover Depth (m)	3.000
Backdrops	Yes
Minimum Backdrop Height (m)	
Maximum Backdrop Height (m)	1.500
Full Bore Velocity	Yes
Minimum Full Bore Velocity (m/s)	
Maximum Full Bore Velocity (m/s)	3.000
Proportional Velocity	Yes
Return Period (years)	
Minimum Proportional Velocity (m/s)	0.750
Maximum Proportional Velocity (m/s)	3.000
Surcharged Depth	Yes
Return Period (years)	
Maximum Surcharged Depth (m)	0.100
Flooding	Yes
Return Period (years)	30
Time to Half Empty	No
Return Period (years)	
Discharge Rates	Yes
Discharge Volume	Yes
100 year 360 minute (m^3)	

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year +20% CC 15 minute summer	123.513	34.950
2 year +20% CC 15 minute winter	86.676	34.950
2 year +20% CC 30 minute summer	84.312	23.857
2 year +20% CC 30 minute winter	59.166	23.857
2 year +20% CC 60 minute summer	59.784	15.799
2 year +20% CC 60 minute winter	39.719	15.799
2 year +20% CC 120 minute summer	38.909	10.282
2 year +20% CC 120 minute winter	25.850	10.282
2 year +20% CC 180 minute summer	30.954	7.965
2 year +20% CC 180 minute winter	20.121	7.965
2 year +20% CC 240 minute summer	25.125	6.640
2 year +20% CC 240 minute winter	16.692	6.640
2 year +20% CC 360 minute summer	19.931	5.129
2 year +20% CC 360 minute winter	12.956	5.129
2 year +20% CC 480 minute summer	16.110	4.257
2 year +20% CC 480 minute winter	10.703	4.257
2 year +20% CC 600 minute summer	13.470	3.684
2 year +20% CC 600 minute winter	9.204	3.684
2 year +20% CC 720 minute summer	12.216	3.274
2 year +20% CC 720 minute winter	8.210	3.274
2 year +20% CC 960 minute summer	10.320	2.718
2 year +20% CC 960 minute winter	6.836	2.718
2 year +20% CC 1440 minute summer	7.802	2.091
2 year +20% CC 1440 minute winter	5.243	2.091
2 year +20% CC 2160 minute summer	5.817	1.608
2 year +20% CC 2160 minute winter	4.008	1.608
2 year +20% CC 2880 minute summer	4.979	1.334
2 year +20% CC 2880 minute winter	3.346	1.334
2 year +20% CC 4320 minute summer	3.928	1.027
2 year +20% CC 4320 minute winter	2.587	1.027

2 year +20% CC 5760 minute summer	3.329	0.852
2 year +20% CC 5760 minute winter	2.155	0.852
2 year +20% CC 7200 minute summer	2.887	0.736
2 year +20% CC 7200 minute winter	1.863	0.736
2 year +20% CC 8640 minute summer	2.563	0.654
2 year +20% CC 8640 minute winter	1.654	0.654
2 year +20% CC 10080 minute summer	2.317	0.591
2 year +20% CC 10080 minute winter	1.496	0.591
30 year +20% CC 15 minute summer	231.032	65.374
30 year +20% CC 15 minute winter	162.128	65.374
30 year +20% CC 30 minute summer	160.001	45.275
30 year +20% CC 30 minute winter	112.281	45.275
30 year +20% CC 60 minute summer	113.986	30.123
30 year +20% CC 60 minute winter	75.730	30.123
30 year +20% CC 120 minute summer	73.849	19.516
30 year +20% CC 120 minute winter	49.064	19.516
30 year +20% CC 180 minute summer	58.191	14.975
30 year +20% CC 180 minute winter	37.826	14.975
30 year +20% CC 240 minute summer	46.705	12.343
30 year +20% CC 240 minute winter	31.029	12.343
30 year +20% CC 360 minute summer	36.264	9.332
30 year +20% CC 360 minute winter	23.572	9.332
30 year +20% CC 480 minute summer	28.952	7.651
30 year +20% CC 480 minute winter	19.235	7.651
30 year +20% CC 600 minute summer	23.961	6.554
30 year +20% CC 600 minute winter	16.371	6.554
30 year +20% CC 720 minute summer	21.537	5.772
30 year +20% CC 720 minute winter	14.474	5.772
30 year +20% CC 960 minute summer	17.925	4.720
30 year +20% CC 960 minute winter	11.874	4.720
30 year +20% CC 1440 minute summer	13.240	3.548
30 year +20% CC 1440 minute winter	8.898	3.548
30 year +20% CC 2160 minute summer	9.633	2.662

30 year +20% CC 2160 minute winter	6.637	2.662
30 year +20% CC 2880 minute summer	8.091	2.169
30 year +20% CC 2880 minute winter	5.438	2.169
30 year +20% CC 4320 minute summer	6.202	1.622
30 year +20% CC 4320 minute winter	4.084	1.622
30 year +20% CC 5760 minute summer	5.153	1.319
30 year +20% CC 5760 minute winter	3.335	1.319
30 year +20% CC 7200 minute summer	4.408	1.125
30 year +20% CC 7200 minute winter	2.845	1.125
30 year +20% CC 8640 minute summer	3.870	0.987
30 year +20% CC 8640 minute winter	2.497	0.987
30 year +20% CC 10080 minute summer	3.466	0.884
30 year +20% CC 10080 minute winter	2.237	0.884
100 year +20% CC 15 minute summer	295.846	83.714
100 year +20% CC 15 minute winter	207.611	83.714
100 year +20% CC 30 minute summer	207.600	58.744
100 year +20% CC 30 minute winter	145.684	58.744
100 year +20% CC 60 minute summer	149.255	39.444
100 year +20% CC 60 minute winter	99.161	39.444
100 year +20% CC 120 minute summer	97.135	25.670
100 year +20% CC 120 minute winter	64.534	25.670
100 year +20% CC 180 minute summer	76.460	19.676
100 year +20% CC 180 minute winter	49.701	19.676
100 year +20% CC 240 minute summer	61.171	16.166
100 year +20% CC 240 minute winter	40.641	16.166
100 year +20% CC 360 minute summer	47.112	12.123
100 year +20% CC 360 minute winter	30.624	12.123
100 year +20% CC 480 minute summer	37.411	9.887
100 year +20% CC 480 minute winter	24.855	9.887
100 year +20% CC 600 minute summer	30.822	8.431
100 year +20% CC 600 minute winter	21.060	8.431
100 year +20% CC 720 minute summer	27.598	7.397
100 year +20% CC 720 minute winter	18.548	7.397

100 year +20% CC 960 minute summer	22.820	6.009
100 year +20% CC 960 minute winter	15.117	6.009
100 year +20% CC 1440 minute summer	16.687	4.472
100 year +20% CC 1440 minute winter	11.215	4.472
100 year +20% CC 2160 minute summer	12.007	3.318
100 year +20% CC 2160 minute winter	8.273	3.318
100 year +20% CC 2880 minute summer	10.000	2.680
100 year +20% CC 2880 minute winter	6.721	2.680
100 year +20% CC 4320 minute summer	7.566	1.978
100 year +20% CC 4320 minute winter	4.982	1.978
100 year +20% CC 5760 minute summer	6.227	1.594
100 year +20% CC 5760 minute winter	4.031	1.594
100 year +20% CC 7200 minute summer	5.291	1.350
100 year +20% CC 7200 minute winter	3.415	1.350
100 year +20% CC 8640 minute summer	4.619	1.178
100 year +20% CC 8640 minute winter	2.981	1.178
100 year +20% CC 10080 minute summer	4.119	1.051
100 year +20% CC 10080 minute winter	2.658	1.051

Results for 2 year +20% CC Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link Event (Outflow)	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)	Notes
15 minute winter	SW10	10	52.768	0.053	5.0	0.0829	0.0000	OK	15 minute winter	1.000	SW09	5.0	0.509	0.125	0.1336		
15 minute summer	SW09	10	52.715	0.080	10.0	0.1222	0.0000	OK	15 minute summer	1.001	SW08	10.0	0.907	0.251	0.1668		
15 minute winter	SW08	10	52.612	0.066	15.0	0.0982	0.0000	OK	15 minute winter	1.002	SW03	14.4	1.513	0.182	0.6667		
15 minute winter	SW07	10	50.071	0.056	5.0	0.0904	0.0000	OK	15 minute winter	2.000	SW06	5.0	0.465	0.136	0.1866		
240 minute winter	SW06	184	50.059	0.129	2.4	0.1987	0.0000	OK	15 minute winter	2.001	SW04	9.9	0.583	0.270	0.1735		
15 minute winter	SW05	10	50.125	0.050	5.0	0.0733	0.0000	OK	15 minute winter	3.000	SW04	5.0	0.397	0.110	0.3426		
240 minute winter	SW04	184	50.059	0.180	4.8	0.2552	0.0000	OK	15 minute winter	2.002	SW03	19.5	0.653	0.249	0.3879		
240 minute winter	SW03	184	50.059	0.245	9.1	0.3341	0.0000	OK	15 minute winter	1.003	IN	38.2	1.471	0.488	0.5260		
240 minute winter	IN	184	50.059	0.311	8.8	0.3512	0.0000	OK	15 minute winter	Flow through pond	OUT	22.0	0.136	0.078	13.4853		
240 minute winter	OUT	184	50.059	0.311	5.6	0.3512	0.0000	SURCHARGED	15 minute winter	4.000	SW02-HB	5.5	0.527	0.136	0.2922		Surcharge due to flow behind hydrobrake - Acceptable
240 minute winter	SW02-HB	184	50.058	0.355	2.5	0.4018	0.0000	SURCHARGED	60 minute winter	Hydro-Brake®	SW01	2.4					Surcharge due to flow behind hydrobrake - Acceptable
60 minute winter	SW01	52	49.629	0.039	2.4	0.0443	0.0000	OK	60 minute winter	4.002	EX SWMH	2.4	0.547	0.061	0.0315	31.5	
60 minute winter	EX SWMH	52	49.586	0.038	2.4	0.0000	0.0000	OK									

Results for 30 year +20% CC Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m^3)	Flood (m^3)	Status	Link Event (Outflow)	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m^3)	Discharge Vol (m^3)
15 minute winter	SW10	10	52.789	0.074	9.4	0.1144	0.0000	OK	15 minute winter	1.000	SW09	9.4	0.602	0.236	0.2117	
15 minute winter	SW09	10	52.749	0.114	18.8	0.1737	0.0000	OK	15 minute winter	1.001	SW08	18.8	1.058	0.472	0.2677	
15 minute winter	SW08	10	52.639	0.093	28.2	0.1392	0.0000	OK	15 minute winter	1.002	SW03	27.5	1.801	0.349	1.0709	
240 minute winter	SW07	232	50.347	0.332	2.2	0.5381	0.0000	SURCHARGED	15 minute winter	2.000	SW06	9.4	0.510	0.257	0.3371	
240 minute winter	SW06	232	50.347	0.417	4.0	0.6442	0.0000	SURCHARGED	15 minute summer	2.001	SW04	18.1	0.617	0.494	0.3097	
240 minute winter	SW05	232	50.347	0.272	2.2	0.3970	0.0000	SURCHARGED	15 minute winter	3.000	SW04	9.4	0.441	0.208	0.5869	
240 minute winter	SW04	236	50.347	0.468	7.9	0.6650	0.0000	SURCHARGED	15 minute summer	2.002	SW03	35.6	0.713	0.454	0.6706	
240 minute winter	SW03	236	50.347	0.533	16.0	0.7280	0.0000	SURCHARGED	15 minute summer	1.003	IN	71.0	1.638	0.907	0.8511	
240 minute winter	IN	236	50.347	0.599	15.8	0.6774	0.0000	OK	15 minute winter	Flow through pond	OUT	45.2	0.146	0.161	25.8029	
240 minute winter	OUT	236	50.347	0.599	9.1	0.6774	0.0000	SURCHARGED	15 minute summer	4.000	SW02-HB	5.4	0.532	0.136	0.3012	
240 minute winter	SW02-HB	236	50.347	0.644	2.6	0.7281	0.0000	SURCHARGED	15 minute summer	Hydro-Brake®	SW01	2.4				
15 minute summer	SW01	14	49.629	0.039	2.4	0.0443	0.0000	OK	15 minute summer	4.002	EX SWMH	2.4	0.547	0.061	0.0315	28.8
15 minute summer	EX SWMH	14	49.586	0.038	2.4	0.0000	0.0000	OK								

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.72%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link Event (Outflow)	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SW10	10	52.802	0.087	12.1	0.1349	0.0000	OK	15 minute summer	1.000	SW09	12.1	0.631	0.303	0.2590	
15 minute winter	SW09	10	52.767	0.132	24.2	0.2022	0.0000	OK	15 minute winter	1.001	SW08	24.2	1.125	0.607	0.3237	
15 minute winter	SW08	10	52.654	0.108	36.3	0.1611	0.0000	OK	15 minute winter	1.002	SW03	35.5	1.922	0.450	1.2939	
360 minute winter	SW07	344	50.539	0.524	2.1	0.8487	0.0000	SURCHARGED	15 minute summer	2.000	SW06	11.5	0.535	0.314	0.5337	
360 minute winter	SW06	344	50.539	0.609	4.1	0.9403	0.0000	SURCHARGED	15 minute winter	2.001	SW04	20.7	0.618	0.567	0.4046	
360 minute winter	SW05	344	50.539	0.464	2.1	0.6768	0.0000	SURCHARGED	15 minute winter	3.000	SW04	12.1	0.457	0.268	0.6741	
360 minute winter	SW04	344	50.539	0.660	7.9	0.9372	0.0000	SURCHARGED	15 minute summer	2.002	SW03	42.9	0.737	0.547	0.8569	
360 minute winter	SW03	344	50.539	0.725	16.1	0.9897	0.0000	SURCHARGED	15 minute summer	1.003	IN	88.4	1.660	1.129	0.9267	
360 minute winter	IN	344	50.538	0.790	16.0	0.8940	0.0000	OK	15 minute winter	Flow through pond	OUT	45.6	0.166	0.162	33.4517	
360 minute winter	OUT	344	50.538	0.790	9.2	0.8940	0.0000	SURCHARGED	15 minute winter	4.000	SW02-HB	8.2	0.602	0.205	0.3012	
360 minute winter	SW02-HB	344	50.538	0.835	2.5	0.9447	0.0000	SURCHARGED	15 minute summer	Hydro-Brake®	SW01	2.4				
120 minute winter	SW01	52	49.629	0.039	2.4	0.0443	0.0000	OK	120 minute winter	4.002	EX SWMH	2.4	0.547	0.061	0.0315	43.9
120 minute winter	EX SWMH	52	49.586	0.038	2.4	0.0000	0.0000	OK								

Results for 2 year +20% CC 15 minute summer. 255 minute analysis at 1 minute timestep. Mass balance: 100.00%																
Node Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m³)**	**Flood (m³)**	**Status**	**Link Event**	**Link**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m³)**	**Discharge Vol (m³)**
15 minute summer	SW10	10	52.768	0.053	5.0	0.0829	0.0000	OK	15 minute summer	1.000	SW09	5.0	0.509	0.125	0.1336	
15 minute summer	SW09	10	52.715	0.080	10.0	0.1222	0.0000	OK	15 minute summer	1.001	SW08	10.0	0.907	0.251	0.1668	
15 minute summer	SW08	10	52.611	0.065	15.0	0.0977	0.0000	OK	15 minute summer	1.002	SW03	14.2	1.511	0.180	0.6614	
15 minute summer	SW07	10	50.071	0.056	5.0	0.0904	0.0000	OK	15 minute summer	2.000	SW06	5.0	0.466	0.136	0.1864	
15 minute summer	SW06	10	50.017	0.087	10.0	0.1344	0.0000	OK	15 minute summer	2.001	SW04	9.9	0.586	0.270	0.1730	
15 minute summer	SW05	10	50.125	0.050	5.0	0.0732	0.0000	OK	15 minute summer	3.000	SW04	5.0	0.406	0.110	0.3416	
15 minute summer	SW04	10	49.992	0.113	19.9	0.1600	0.0000	OK	15 minute summer	2.002	SW03	19.4	0.654	0.248	0.3853	
15 minute summer	SW03	11	49.965	0.151	38.6	0.2057	0.0000	OK	15 minute summer	1.003	IN	38.0	1.498	0.485	0.4634	
15 minute summer	IN	19	49.931	0.183	38.0	0.2074	0.0000	OK	15 minute summer	Flow through pond	OUT	20.2	0.129	0.072	12.0677	
15 minute summer	OUT	19	49.931	0.183	20.2	0.2070	0.0000	OK	15 minute summer	4.000	SW02-HB	5.4	0.522	0.135	0.2816	
15 minute summer	SW02-HB	19	49.932	0.229	5.4	0.2594	0.0000	SURCHARGED	15 minute summer	Hydro-Brake®	SW01	2.4				
15 minute summer	SW01	18	49.629	0.039	2.4	0.0438	0.0000	OK	15 minute summer	4.002	EX SWMH	2.4	0.544	0.060	0.0310	15.5
15 minute summer	EX SWMH	19	49.585	0.037	2.4	0.0000	0.0000	OK								

Results for 2 year +20% CC 15 minute winter. 255 minute analysis at 1 minute timestep. Mass balance: 100.00%																
Node Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m³)**	**Flood (m³)**	**Status**	**Link Event**	**Link**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m³)**	**Discharge Vol (m³)**
15 minute winter	SW10	10	52.768	0.053	5.0	0.0829	0.0000	OK	15 minute winter	1.000	SW09	5.0	0.509	0.125	0.1336	
15 minute winter	SW09	10	52.715	0.080	10.0	0.1222	0.0000	OK	15 minute winter	1.001	SW08	10.0	0.901	0.251	0.1673	
15 minute winter	SW08	10	52.612	0.066	15.0	0.0982	0.0000	OK	15 minute winter	1.002	SW03	14.4	1.513	0.182	0.6667	
15 minute winter	SW07	10	50.071	0.056	5.0	0.0904	0.0000	OK	15 minute winter	2.000	SW06	5.0	0.465	0.136	0.1866	
15 minute winter	SW06	10	50.017	0.087	10.0	0.1346	0.0000	OK	15 minute winter	2.001	SW04	9.9	0.583	0.270	0.1735	
15 minute winter	SW05	10	50.125	0.050	5.0	0.0733	0.0000	OK	15 minute winter	3.000	SW04	5.0	0.397	0.110	0.3426	
15 minute winter	SW04	10	49.992	0.113	19.9	0.1605	0.0000	OK	15 minute winter	2.002	SW03	19.5	0.653	0.249	0.3879	
15 minute winter	SW03	11	49.967	0.153	38.8	0.2091	0.0000	OK	15 minute winter	1.003	IN	38.2	1.471	0.488	0.5260	
15 minute winter	IN	19	49.948	0.200	38.2	0.2257	0.0000	OK	15 minute winter	Flow through pond	OUT	22.0	0.136	0.078	13.4853	
15 minute winter	OUT	18	49.949	0.201	22.0	0.2269	0.0000	OK	15 minute winter	4.000	SW02-HB	5.5	0.527	0.136	0.2922	
15 minute winter	SW02-HB	21	49.945	0.242	5.5	0.2731	0.0000	SURCHARGED	15 minute winter	Hydro-Brake®	SW01	2.4				
15 minute winter	SW01	19	49.629	0.039	2.4	0.0440	0.0000	OK	15 minute winter	4.002	EX SWMH	2.4	0.545	0.060	0.0312	17.2
15 minute winter	EX SWMH	19	49.585	0.037	2.4	0.0000	0.0000	OK								

Results for 2 year +20% CC 30 minute summer. 270 minute analysis at 1 minute timestep. Mass balance: 100.00%																
Node Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m³)**	**Flood (m³)**	**Status**	**Link Event**	**Link**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m³)**	**Discharge Vol (m³)**
30 minute summer	SW10	17	52.766	0.051	4.6	0.0789	0.0000	OK	30 minute summer	1.000	SW09	4.5	0.496	0.113	0.1241	
30 minute summer	SW09	17	52.710	0.075	9.1	0.1155	0.0000	OK	30 minute summer	1.001	SW08	8.9	0.879	0.224	0.1545	
30 minute summer	SW08	18	52.609	0.063	13.5	0.0939	0.0000	OK	30 minute summer	1.002	SW03	13.2	1.477	0.168	0.6280	
30 minute summer	SW07	17	50.068	0.053	4.6	0.0859	0.0000	OK	30 minute summer	2.000	SW06	4.5	0.456	0.123	0.1702	
30 minute summer	SW06	18	50.011	0.081	9.1	0.1250	0.0000	OK	30 minute summer	2.001	SW04	8.9	0.576	0.242	0.1588	
30 minute summer	SW05	17	50.123	0.048	4.6	0.0696	0.0000	OK	30 minute summer	3.000	SW04	4.5	0.389	0.099	0.3154	
30 minute summer	SW04	18	49.985	0.106	17.9	0.1508	0.0000	OK	30 minute summer	2.002	SW03	17.7	0.629	0.226	0.3721	
30 minute summer	SW03	33	49.972	0.158	35.2	0.2163	0.0000	OK	30 minute summer	1.003	IN	34.8	1.202	0.445	0.6214	
30 minute summer	IN	33	49.972	0.224	34.8	0.2536	0.0000	OK	30 minute summer	Flow through pond	OUT	21.9	0.076	0.078	15.5795	
30 minute summer	OUT	33	49.972	0.224	21.9	0.2535	0.0000	OK	30 minute summer	4.000	SW02-HB	4.0	0.402	0.099	0.3010	
30 minute summer	SW02-HB	33	49.972	0.269	4.0	0.3041	0.0000	SURCHARGED	30 minute summer	Hydro-Brake®	SW01	2.4				
30 minute summer	SW01	33	49.629	0.039	2.4	0.0442	0.0000	OK	30 minute summer	4.002	EX SWMH	2.4	0.546	0.061	0.0313	21.4
30 minute summer	EX SWMH	33	49.585	0.037	2.4	0.0000	0.0000	OK								

Results for 2 year +20% CC 30 minute winter. 270 minute analysis at 1 minute timestep. Mass balance: 100.00%																
Node Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m^3)**	**Flood (m^3)**	**Status**	**Link Event**	**Link**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m^3)**	**Discharge Vol (m^3)**
30 minute winter	SW10	17	52.763	0.048	4.0	0.0739	0.0000	OK	30 minute winter	1.000	SW09	4.0	0.478	0.100	0.1131	
30 minute winter	SW09	17	52.706	0.071	8.0	0.1080	0.0000	OK	30 minute winter	1.001	SW08	7.9	0.843	0.198	0.1422	
30 minute winter	SW08	18	52.605	0.059	11.9	0.0885	0.0000	OK	30 minute winter	1.002	SW03	11.8	1.429	0.149	0.5775	
30 minute winter	SW07	17	50.065	0.050	4.0	0.0806	0.0000	OK	30 minute winter	2.000	SW06	4.0	0.443	0.108	0.1544	
30 minute winter	SW06	18	50.005	0.075	8.0	0.1160	0.0000	OK	30 minute winter	2.001	SW04	7.9	0.565	0.216	0.1505	
30 minute winter	SW05	17	50.120	0.045	4.0	0.0654	0.0000	OK	30 minute winter	3.000	SW04	4.0	0.375	0.088	0.2873	
30 minute winter	SW04	33	49.994	0.115	15.8	0.1628	0.0000	OK	30 minute winter	2.002	SW03	15.7	0.603	0.200	0.4457	
30 minute winter	SW03	33	49.993	0.179	31.3	0.2450	0.0000	OK	30 minute winter	1.003	IN	31.0	1.111	0.396	0.6964	
30 minute winter	IN	32	49.993	0.245	31.0	0.2774	0.0000	OK	30 minute winter	Flow through pond	OUT	18.2	0.085	0.065	17.5755	
30 minute winter	OUT	32	49.993	0.245	18.2	0.2775	0.0000	SURCHARGED	30 minute winter	4.000	SW02-HB	4.2	0.423	0.106	0.3012	
30 minute winter	SW02-HB	32	49.993	0.290	4.2	0.3281	0.0000	SURCHARGED	30 minute winter	Hydro-Brake®	SW01	2.4				
30 minute winter	SW01	32	49.629	0.039	2.4	0.0443	0.0000	OK	30 minute winter	4.002	EX SWMH	2.4	0.547	0.061	0.0314	23.9
30 minute winter	EX SWMH	32	49.585	0.037	2.4	0.0000	0.0000	OK								

Results for 2 year +20% CC 60 minute summer. 300 minute analysis at 1 minute timestep. Mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m^3)	Flood (m^3)	Status	Link Event	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m^3)	Discharge Vol (m^3)
60 minute summer	SW10	32	52.760	0.045	3.5	0.0692	0.0000	OK	60 minute summer	1.000	SW09	3.5	0.461	0.087	0.1026	
60 minute summer	SW09	32	52.701	0.066	7.0	0.1006	0.0000	OK	60 minute summer	1.001	SW08	6.9	0.814	0.173	0.1289	
60 minute summer	SW08	33	52.601	0.055	10.4	0.0825	0.0000	OK	60 minute summer	1.002	SW03	10.3	1.373	0.130	0.5233	
60 minute summer	SW07	32	50.061	0.046	3.5	0.0753	0.0000	OK	60 minute summer	2.000	SW06	3.5	0.430	0.095	0.1387	
60 minute summer	SW06	59	50.001	0.071	7.0	0.1102	0.0000	OK	60 minute summer	2.001	SW04	6.9	0.555	0.188	0.1668	
60 minute summer	SW05	32	50.117	0.042	3.5	0.0612	0.0000	OK	60 minute summer	3.000	SW04	3.5	0.368	0.076	0.2975	
60 minute summer	SW04	59	50.001	0.122	13.8	0.1736	0.0000	OK	60 minute summer	2.002	SW03	13.7	0.570	0.175	0.4745	
60 minute summer	SW03	59	50.001	0.187	27.4	0.2554	0.0000	OK	60 minute summer	1.003	IN	27.2	0.854	0.348	0.7225	
60 minute summer	IN	61	50.001	0.253	27.2	0.2861	0.0000	OK	60 minute summer	Flow through pond	OUT	14.9	0.059	0.053	18.2939	
60 minute summer	OUT	61	50.001	0.253	14.9	0.2861	0.0000	SURCHARGED	60 minute summer	4.000	SW02-HB	3.0	0.356	0.075	0.3012	
60 minute summer	SW02-HB	61	50.001	0.298	3.0	0.3367	0.0000	SURCHARGED	60 minute summer	Hydro-Brake®	SW01	2.4				
60 minute summer	SW01	61	49.629	0.039	2.4	0.0443	0.0000	OK	60 minute summer	4.002	EX SWMH	2.4	0.547	0.061	0.0314	28.0
60 minute summer	EX SWMH	61	49.585	0.037	2.4	0.0000	0.0000	OK								

Results for 2 year +20% CC 60 minute winter. 300 minute analysis at 1 minute timestep. Mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m^3)	Flood (m^3)	Status	Link Event	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m^3)	Discharge Vol (m^3)
60 minute winter	SW10	33	52.754	0.039	2.7	0.0612	0.0000	OK	60 minute winter	1.000	SW09	2.7	0.429	0.068	0.0858	
60 minute winter	SW09	33	52.693	0.058	5.4	0.0885	0.0000	OK	60 minute winter	1.001	SW08	5.4	0.754	0.136	0.1083	
60 minute winter	SW08	33	52.595	0.049	8.1	0.0730	0.0000	OK	60 minute winter	1.002	SW03	8.1	1.283	0.102	0.4407	
60 minute winter	SW07	33	50.056	0.041	2.7	0.0667	0.0000	OK	60 minute winter	2.000	SW06	2.7	0.405	0.074	0.1558	
60 minute winter	SW06	60	50.030	0.100	5.4	0.1542	0.0000	OK	60 minute winter	2.001	SW04	5.4	0.535	0.148	0.2301	
60 minute winter	SW05	33	50.112	0.037	2.7	0.0542	0.0000	OK	60 minute winter	3.000	SW04	2.7	0.349	0.060	0.3790	
60 minute winter	SW04	60	50.030	0.151	10.8	0.2141	0.0000	OK	60 minute winter	2.002	SW03	10.8	0.545	0.138	0.5815	
60 minute winter	SW03	60	50.030	0.215	21.6	0.2944	0.0000	OK	60 minute winter	1.003	IN	21.1	0.893	0.270	0.8100	
60 minute winter	IN	61	50.030	0.282	21.1	0.3185	0.0000	OK	60 minute winter	Flow through pond	OUT	11.8	0.066	0.042	21.0877	
60 minute winter	OUT	61	50.030	0.282	11.8	0.3185	0.0000	SURCHARGED	60 minute winter	4.000	SW02-HB	2.9	0.379	0.072	0.3012	
60 minute winter	SW02-HB	61	50.029	0.326	2.9	0.3691	0.0000	SURCHARGED	60 minute winter	Hydro-Brake®	SW01	2.4				
60 minute winter	SW01	52	49.629	0.039	2.4	0.0443	0.0000	OK	60 minute winter	4.002	EX SWMH	2.4	0.547	0.061	0.0315	31.5
60 minute winter	EX SWMH	52	49.586	0.038	2.4	0.0000	0.0000	OK								

Adoptable						
Max Width (mm)	**Diameter (mm)**	**Width (mm)**		**Max Depth (m)**	**Diameter (mm)**	**Width (mm)**
374	1200			1.500	1050	
499	1350			99.999	1200	
749	1500					
900	1800					
>900	Link+900 mm					

Circular			
Shape	Circular		**Dia (mm)**
Barrels	1		100
Height (mm)			150
Width (mm)			
Side Slope (1:X)			
Auto Increment (mm)	75		
Preferred Cover (m)			
Steep Slope (1:X)			
Follow Ground	No		
Velocity	Default		
ks (mm) / n			
uPVC			
Shape	Circular		**Dia (mm)**
Barrels	1		225
Height (mm)			
Width (mm)			
Side Slope (1:X)			
Auto Increment (mm)	75		
Preferred Cover (m)			
Steep Slope (1:X)			
Follow Ground	No		
Velocity	Colebrook-White		
ks (mm) / n	0.150		

APPENDIX D – FOUL WATER PIPE NETWORK CALCULATIONS

Drainage Design Report

Flow+

v10.8

Network	Foul Network
Filename	2024-07-01 Flow.pfd
Username	Kezia Adanza (kadanza@morce.ie)

Report produced on	01/07/2024 12:57:00

Causeway Sales

Tel:	+44(0) 1628 552000
Fax:	+44(0) 1628 552001
Email:	marketing@causeway.com
Web:	www.causeway.com

Technical support web portal:

http://support.causeway.com

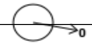
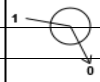
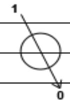
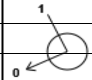
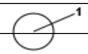
Frequency of use (kDU)	0.50
Flow per dwelling per day (l/day)	446
Domestic Flow (l/s/ha)	0.0
Industrial Flow (l/s/ha)	0.0
Additional Flow (%)	10
Minimum Velocity (m/s)	0.75
Connection Type	Level Inverts
Minimum Backdrop Height (m)	0.500
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	Yes

	Name	Area (ha)	Dwellings	Units	Add Inflow (l/s)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Notes
✓	FW05			19.0		54.250	Manhole	Adoptable	1200		712299.443	738394.486	1.425	
✓	FW04			20.0		54.190	Manhole	Adoptable	1200		712327.310	738389.089	1.838	
✓	FW03			20.0		52.370	Manhole	Adoptable	1200		712357.549	738325.957	1.425	
✓	FW02			19.0		50.720	Manhole	Adoptable	1200		712375.545	738288.385	1.425	
✓	FW01					50.200	Manhole	Adoptable	1200		712345.165	738273.833	1.466	

	Name	US Node	DS Node	Length (m)	ks (mm) / n	Velocity Equation	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	Con Offset (m)	Min DS IL (m)
?	1.000	FW05	FW04	28.385	1.500	Colebrook-White	52.825	52.352	0.473	60.0	225	Circular		
?	1.001	FW04	FW03	70.000	1.500	Colebrook-White	52.352	50.945	1.407	49.8	225	Circular		
√	1.002	FW03	FW02	41.659	1.500	Colebrook-White	50.945	49.295	1.650	25.2	225	Circular		
?	1.003	FW02	FW01	33.685	1.500	Colebrook-White	49.295	48.734	0.561	60.0	225	Circular		

	Name	US Node	DS Node	Pro Vel @ 1/3 Q (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Σ Area (ha)	Σ Dwellings (ha)	Σ Units (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)	Notes
?	1.000	FW05	FW04	0.517	1.483	59.0	2.4	1.200	1.613	1.200	1.613	0.000	0	19.0	0.0	31	0.722	Proportional Velocity @ 1/3 Flow is less than the specified minimum
?	1.001	FW04	FW03	0.604	1.629	64.8	3.4	1.613	1.200	1.200	1.613	0.000	0	39.0	0.0	36	0.864	Proportional Velocity @ 1/3 Flow is less than the specified minimum
✓	1.002	FW03	FW02	0.825	2.289	91.0	4.2	1.200	1.200	1.200	1.200	0.000	0	59.0	0.0	33	1.156	
?	1.003	FW02	FW01	0.640	1.483	59.0	4.9	1.200	1.241	1.200	1.241	0.000	0	78.0	0.0	44	0.891	Proportional Velocity @ 1/3 Flow is less than the specified minimum

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)	US Node	Dia (mm)	Width (mm)	Sump (m)	Node Type	MH Type	DS Node	Dia (mm)	Width (mm)	Sump (m)	Node Type	MH Type
1.000	28.385	60.0	225	Circular	54.250	52.825	1.200	54.190	52.352	1.613	FW05	1200			Manhole	Adoptable	FW04	1200			Manhole	Adoptable
1.001	70.000	49.8	225	Circular	54.190	52.352	1.613	52.370	50.945	1.200	FW04	1200			Manhole	Adoptable	FW03	1200			Manhole	Adoptable
1.002	41.659	25.2	225	Circular	52.370	50.945	1.200	50.720	49.295	1.200	FW03	1200			Manhole	Adoptable	FW02	1200			Manhole	Adoptable
1.003	33.685	60.0	225	Circular	50.720	49.295	1.200	50.200	48.734	1.241	FW02	1200			Manhole	Adoptable	FW01	1200			Manhole	Adoptable

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Width (mm)	Sump (m)	Node Type	MH Type	Connections		Link	IL (m)	Dia (mm)	Link Type
FW05	712299.443	738394.486	54.250	1.425	1200			Manhole	Adoptable						
											0	1.000	52.825	225	Circular
FW04	712327.310	738389.089	54.190	1.838	1200			Manhole	Adoptable		1	1.000	52.352	225	Circular
											0	1.001	52.352	225	Circular
FW03	712357.549	738325.957	52.370	1.425	1200			Manhole	Adoptable		1	1.001	50.945	225	Circular
											0	1.002	50.945	225	Circular
FW02	712375.545	738288.385	50.720	1.425	1200			Manhole	Adoptable		1	1.002	49.295	225	Circular
											0	1.003	49.295	225	Circular
FW01	712345.165	738273.833	50.200	1.466	1200			Manhole	Adoptable		1	1.003	48.734	225	Circular

APPENDIX E – MAINTENANCE AND MANAGEMENT PLAN

SuDS Component	Maintenance Responsibility	Maintenance Schedule	Required Action	Typical Frequency
Permeable Paving	PPP management company for 25 years then Dublin City Council	Regular Maintenance	Brushing (Standard cosmetic sweep over whole surface) Visual check on inspection chambers and removal of debris.	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
			High pressure jetting of permeable pavement underdrains in the event of blockages. Inspections chambers provided to facilitate this work.	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	November 2023

SuDS Component	Maintenance Responsibility	Maintenance Schedule	Required Action	Typical Frequency
Bioretention Areas – Tree Pits / Rain Gardens / Filter Drains	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	November 2023

SuDS Component	Maintenance Responsibility	Maintenance Schedule	Required Action	Typical Frequency
Detention Basin	PPP management company for 25 years then Dublin City Council	Regular Inspections	Inspect surfaces for silting, record water levels of the facility and assess actual versus predicted levels, determine if modifications are necessary.	Quarterly for first year, then every 6 months thereafter
			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/outlets.	As required