Belgard Gardens, Tallaght, Phase 1

ENGINEERING SERVICES REPORT
for ATLAS GP LIMITED

PROJECT NO. A557
19th December 2018

O'CONNOR | SUTTON | CRONIN
Multidisciplinary Consulting Engineers

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for

Belgard Gardens, Belgard Square,

Tallaght, Dublin 24.

Phase 1

OCSC

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1 INTRODUCTION

1.1 Appointment

O'Connor Sutton Cronin & Associates (OCSC) have been appointed by *Atlas GP Limited*; to carry out the design of the civil engineering services associated with Phase I of the proposed mixed-use development, located west of Belgard Road, Tallaght, Dublin 24.

1.2 Administrative Jurisdiction

The proposed development is located in the jurisdiction of South Dublin County Council (SDCC), and therefore the engineering services design was carried out with reference to the following:

- South Dublin County Council Development Plan 2016 – 2022;
- Strategic Flood Risk Assessment for South Dublin County Council Development Plan 2016 – 2022;
- Tallaght Local Area Plan 2008 (South Dublin County Council) (now expired);
- Greater Dublin Strategic Drainage Study (GDSDS);
- The Planning System and Flood Risk Management Guidelines for Planning Authorities (Department of Environment, Heritage and Local Government and the Office of Public Works);

1.3 Site Location

The subject site is located west of Belgard Road, Tallaght, Dublin 24; less than 500m north of The Square, Tallaght, as shown in *Figure 1.1 - Site Location*, and is immediately bound by:

- Airton Road and Belgard Retail Park, to the north;
- R113, Belgard Road, to the east;

- SDCC St. Maelruans Site, to the west;
- Belgard Square North road, to the south.

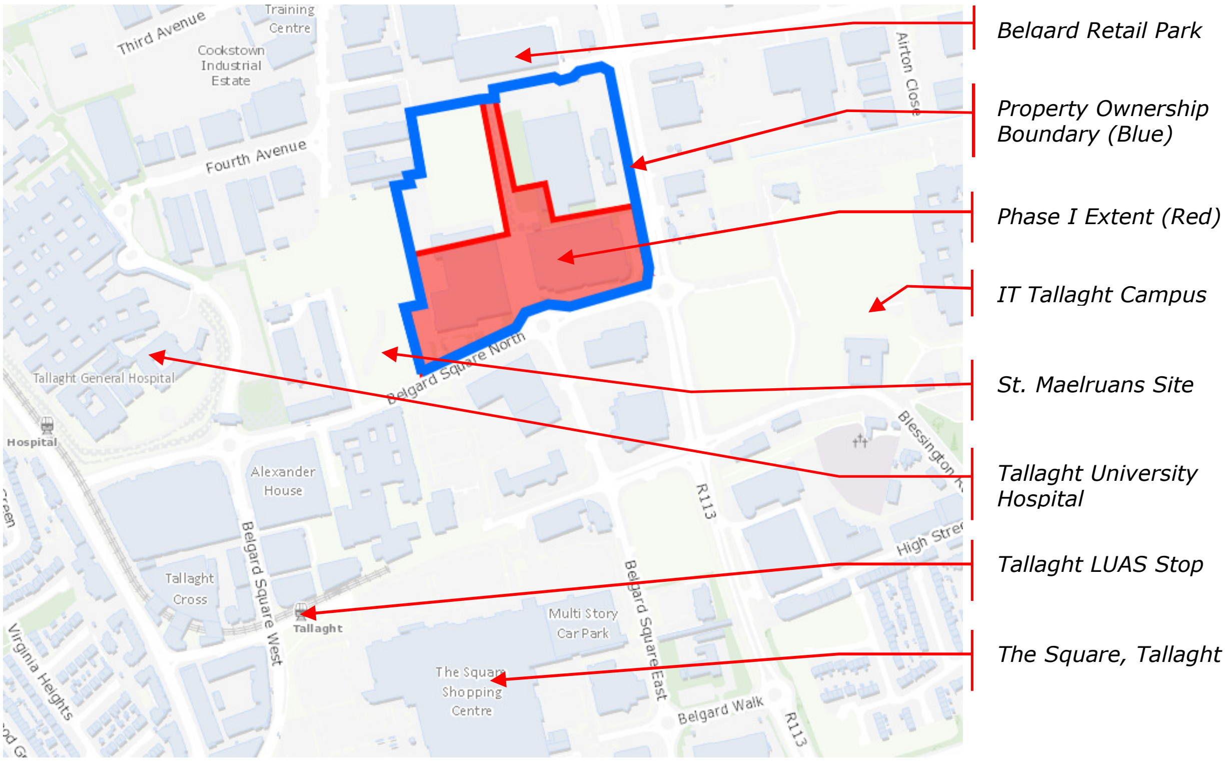


Figure 1.1 - Site Location

1.4 Existing Site Overview

The overall site area (property ownership) is **c6.64 hectares**, and is zoned by South Dublin County Council for ***Regeneration***. This zoning seeks to *'To facilitate enterprise and / or residential led regeneration'*. Additional works are to be carried out in the public area, in order to facilitate upgrades to the adjoining Belgrade Square North road, resulting in a total development area of c7.2 hectares.

The existing site comprises three former commercial / industrial properties, which had been previously occupied by Kerry Group, Cuisine de France and UniPhar, along with associated hardstanding, landscaping and infrastructure.

The existing building's footprints and hardstanding area cover approximately 75% of the site area, with approximately 1.5-hectare of existing green open space in the north-west area of the site.

The existing ground levels across the overall site are typically graded in an east to north-east direction, with a local high-point of approximately +102.50m near the mid-west of the site.

Adjacent to the site, the existing road levels are as follows:

1. Airton Road, along the northern boundary, is graded from +98.8m to +97.3m AOD from the west;
2. Belgard Square North Rd, along the southern boundary, is graded from +101.3m AOD to +99.1m AOD from the west;
3. The R113 Belgard Road, along the eastern boundary, is graded from +99.1m AOD to +97.3m AOD from the south.

The above illustrates that the existing site is typically at a raised level relative to the adjacent public roads. It is intended that the new development will retain a similar profile to the existing.

1.5 Proposed Development Context

The proposed development will consist of the demolition of all existing buildings on the site ranging from one to three storeys in height and the removal of hardstanding throughout. The development itself is to consist of the construction of:

- 5 no. blocks ranging from 4 – 10 storeys comprising a new urban quarter and streets to provide 438 no. apartment units consisting of 158 no. 1 beds, 230 no. 2 beds and 50 no. 3 beds (total apartment units include 8 no. live/work units;
- 403nr. bed-space student accommodation and associated student amenity space and staff facilities;
- Childcare facility and external playing area;
- 6nr. retail / commercial units;
- Security Room;
- 107nr. below podium car parking spaces (a temporary car park at grade will be provided until such time as the completion of the permanent below podium car park);

- 22nr. surface level car parking spaces;
- 1,227nr. bicycle parking spaces located below podium and at surface level;
- An additional 20nr dockless bicycle rental spaces
- Civic Plaza and associated public realm & landscaping.

The proposed development will include the provision of a new north – south street bisecting the site (to later connect to the planned Airton Road Extension), a shared surface street running west east from Belgard Road (no vehicular connection to Belgard Road) to later connect to lands in ownership of SDCC if required, and works to public realm and public roads to include upgraded signalised junction to Belgard Square North and Belgard Square East, cycle track on Belgard Square North and new pedestrian crossing at Belgard Road.

The proposed development will also include boundary treatments, green roofs, solar panels, ESB substations and switch rooms, CHP plant, commercial and residential waste facilities and all ancillary works and services necessary to facilitate construction and operation. The proposed development will also include provision of site boundary protection where required to facilitate development phasing.

2 SCOPE OF SERVICES REPORT

This Engineering Services Report was prepared by reviewing the available data from the Local Authority sources and national bodies *i.e.* South Dublin County Council, Irish Water, The OPW, and the wider Design Team. The report addresses the following services with respect to the proposed development:

- Surface Water Drainage;
- Wastewater Drainage;
- Potable Water Supply;
- Road Design.

This report should be read in conjunction with the following OCSC Civil Engineering design drawings:

A557-OCSC-XX-XX-DR-C-0100 – Site Location;
A557-OCSC-XX-XX-DR-C-0110 – Proposed Road Layout. Sheet 1 of 2;
A557-OCSC-XX-XX-DR-C-0111 – Proposed Road Layout. Sheet 2 of 2;
A557-OCSC-XX-XX-DR-C-0112 – Road Long Sections. BL01, BL02 & BL03;
A557-OCSC-XX-XX-DR-C-0113 – Road Long Sections. Belgard Square North, BL06 & BL07;
A557-OCSC-XX-XX-DR-C-0117 – Swept Path Analysis. Fire Tender – Phase 1;
A557-OCSC-XX-XX-DR-C-0118 – Swept Path Analysis. Refuse Vehicle – Phase 1;
A557-OCSC-XX-XX-DR-C-0119 – Taking in Charge Area;
A557-OCSC-XX-XX-DR-C-0120 – Application Phasing – Phase 1;
A557-OCSC-XX-XX-DR-C-0121 – Application Phasing – Phase 2;
A557-OCSC-XX-XX-DR-C-0122 – Construction Phasing – Phase 1;
A557-OCSC-XX-XX-DR-C-0123 – Construction Phasing – Phase 2;
A557-OCSC-XX-XX-DR-C-0124 – Construction Phasing – Phase 3;
A557-OCSC-XX-XX-DR-C-0500 – Proposed Drainage Layout. Sheet 1 of 2;
A557-OCSC-XX-XX-DR-C-0501 – Proposed Drainage Layout. Sheet 2 of 2;
A557-OCSC-XX-XX-DR-C-0502 – Proposed Car Park Drainage Layout;
A557-OCSC-XX-XX-DR-C-0505 – Existing Site Layout;
A557-OCSC-XX-XX-DR-C-0506 – Drainage Catchments & Roof Areas;
A557-OCSC-XX-XX-DR-C-0510 – Proposed Surface Water Drainage

Longitudinal Sections;
A557-OCSC-XX-XX-DR-C-0511 – Proposed Wastewater Drainage
Longitudinal Sections;
A557-OCSC-XX-XX-DR-C-0515 – Proposed Attenuation Tank.
General Arrangement and section details;
A557-OCSC-XX-XX-DR-C-0520 – Proposed Drainage – Typical Details;
A557-OCSC-XX-XX-DR-C-0550 – Proposed Watermain Layout – Phase 1;
A557-OCSC-XX-XX-DR-C-0701 – Cross Sections A-A & B-B;
A557-OCSC-XX-XX-DR-C-0702 – Cross Sections C-C & D-D;
A557-OCSC-XX-XX-DR-C-0703 – Cross Sections E-E & F-F;
A557-OCSC-XX-XX-DR-C-1200 – Proposed Road Markings & Signs. Sheet 1 of 2;
A557-OCSC-XX-XX-DR-C-1201 – Proposed Road Markings & Signs. Sheet 2 of 2;
A557-OCSC-XX-XX-DR-C-1202 –Proposed Traffic Signal Layout;
A557-OCSC-XX-XX-DR-C-2600 – Road Classification. Sheet 1 of 2;
A557-OCSC-XX-XX-DR-C-2601 – Road Classification. Sheet 2 of 2.

The proposed design, for the aforementioned services, have been carried out in accordance with the following technical guidelines and information:

- South Dublin County Council Development Plan (2016 – 2022);
- Greater Dublin Strategic Drainage Study (GDSDS);
- Greater Dublin Regional Code of Practice for Drainage Works (GDRCOP);
- Irish Water Code of Practice for Wastewater, IW-CDS-5030-03;
- Irish Water Code of Practice for Water Supply, IW-CDS-5020-03;
- The Building Regulations – Technical Guidance Document Part H;
- BE EN 752 – Drainage Outside Buildings;
- BS 7533-13 – Guide for Design of Permeable Pavements;
- CIRIA C644 – Building Greener (Guidance on the use of Green Roofs);
- CIRIA C753 – The SuDS Manual;
- Green Roofs over Dublin – Guidance Policy;
- FLL's Guidelines for the Planning, Execution and Upkeep of Green-Roof Sites;

- The Green Roof Organisation's Code of Best Practice for the UK;
- The Office of Public Works, the Planning System and Flood Risk Management;
- South Dublin County Council and Irish Water Drainage and Watermain Records.

Members of the wider design team cover all other elements of the application pertaining to traffic and transport, mechanical and electrical engineering, sustainability, landscaping, planning and architectural detail.

3 SURFACE WATER DRAINAGE

3.1 Overview

Any planning permission sought on the subject lands are required to adhere to the Local Authority requirements, the South Dublin County Council Development Plan 2016 - 2022 and the Greater Dublin Strategic Drainage Study (Dublin City Council, 2005).

New development must ensure that a comprehensive Sustainable Drainage System, SuDS, is incorporated into the development. SuDS requires that post development run-off rates be maintained at equivalent, or lower, levels than pre-development levels. Thus, the development must be able to retain, within its boundaries, surface water volumes from extreme rainfall events up to a 1 in 100-year rainfall event, more commonly expressed as a 1.0% AEP (Annual Exceedance Probability), *while also allowing for an additional climate change factor of 10% increase in rainfall intensity*. Any new development must also have the physical capacity to retain surface water volumes as directed under the Greater Dublin Strategic Drainage Strategy (GDSDS) and, if necessary, release these attenuated surface water volumes to an outfall at a controlled flow rate.

A further component of the SuDS protocol is to increase the overall water quality of surface water runoff before it enters a natural watercourse or a public sewer, which ultimately discharges to a water body. This is to ensure the highest possible standard of surface water quality.

3.2 Consultation

O'Connor Sutton Cronin held the following pre-planning consultation with South Dublin County Council Representatives, in relation to the surface water drainage strategy for the proposed development:

1. Pre-Planning Meeting with SDCC Drainage Department (Mr. Brian Harkin), on 26th September 2017, to discuss and agree the proposed drainage design concept.

2. Pre-Planning Meeting with SDCC Drainage Department (Mr. Brian Harkin) and Parks (Ms Suzanne Furlong, Mr. Laurence Colleran and Mr. Brendan Redmond) Departments, on 29th March 2018, at SDCC offices to discuss and agree the proposed drainage and landscape design strategy. The minuted findings from this meeting, which were distributed to all attendees, formed the baseline of the drainage design that is detailed within this report and associated drawings.
3. Email and telephone correspondence with SDCC Drainage Department (Mr. Brian Harkin) on the 25th and 26th April 2018, to discuss and agree the proposed drainage design details further.
4. Meeting with SDCC Drainage Department, (Mr. Brian Harkin and Mr. Chris Galvin) on 7th August 2018 at SDCC offices, followed by several emails and telephone correspondence, where the proposed design approach and outcomes were explained and agreed. Refer to a copy of the email correspondence in **Appendix F**.

3.3 Existing Site Drainage

3.3.1 Existing Site Catchment Areas

As detailed earlier in *Section 1.4*, the existing c6.64 hectare site comprises 3nr. dis-used industrial premises on 3nr. separate sites along with 0.66 hectares of works to existing road off-site. Approximately 25% (1.6 hectares) of the existing overall site (6.64 ha) is considered green area / grassed, with the remaining areas consisting of building structures or paved areas.

Catchment Type	Gross Area
Grass	1.6 ha
Building	2.2 ha
Paving	2.8 ha
Total Site Area	**6.64 ha**
Work outside Site	*0.56 ha*
Total Development Area	**7.2 ha**

Table 1 – Existing Catchment Areas

This is further illustrated on drawing on *Figure 3.1,* which is a snapshot of drawing ***A557-OCSC-XX-XX-DR-C-0505***.

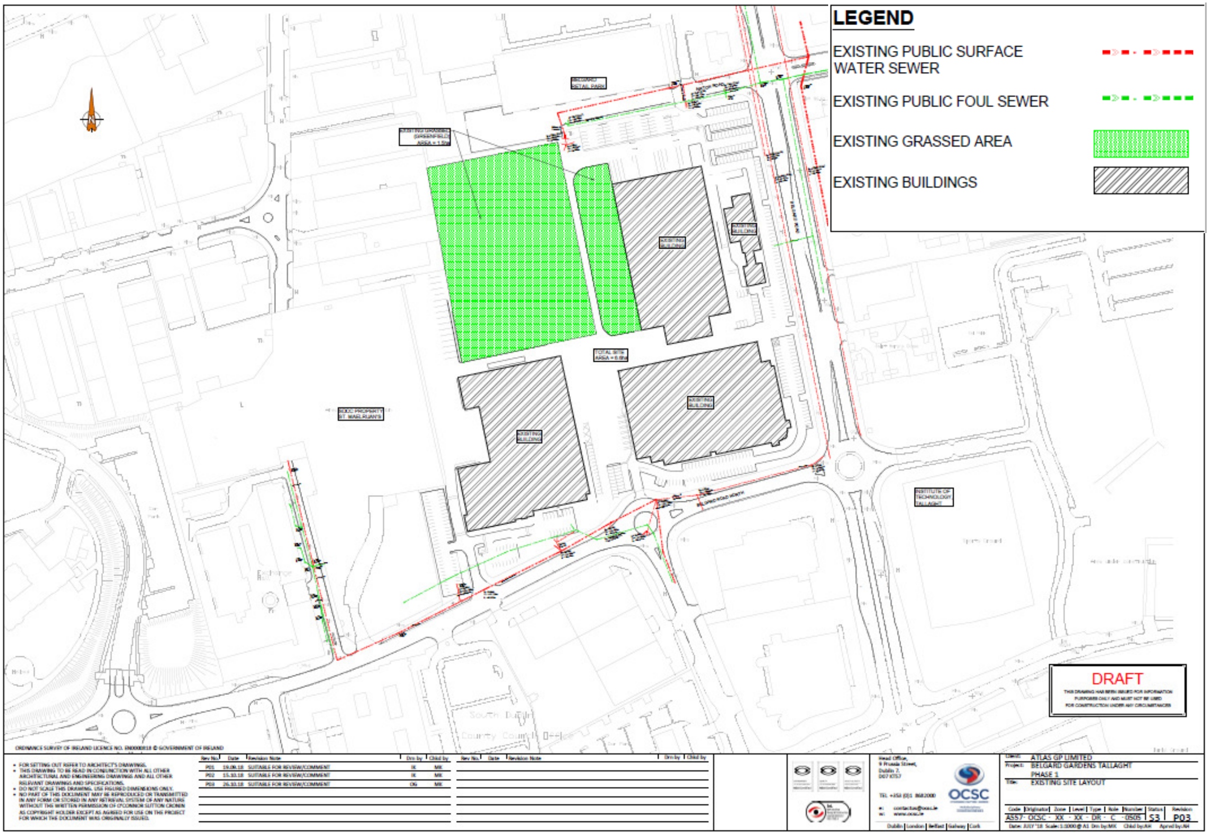


Figure 3.1 - Snapshot of Drawing A557-OCSC-XX-XX-DR-C-0505, Existing Site Layout

3.3.2 Existing Surface Water Drainage Infrastructure

The overall site is currently served by individual surface water drainage networks within each individual property, which convey the local rainfall runoff, from the buildings downpipes and gullies in the paved areas, to the public surface water drainage networks adjacent.

There is a significant existing public surface water sewer network in the immediate vicinity of the site. Refer to *Figure 3.2* for existing surface water drainage infrastructure overview and ***Appendix A*** for a copy of South Dublin County Council and Irish Water drainage records.

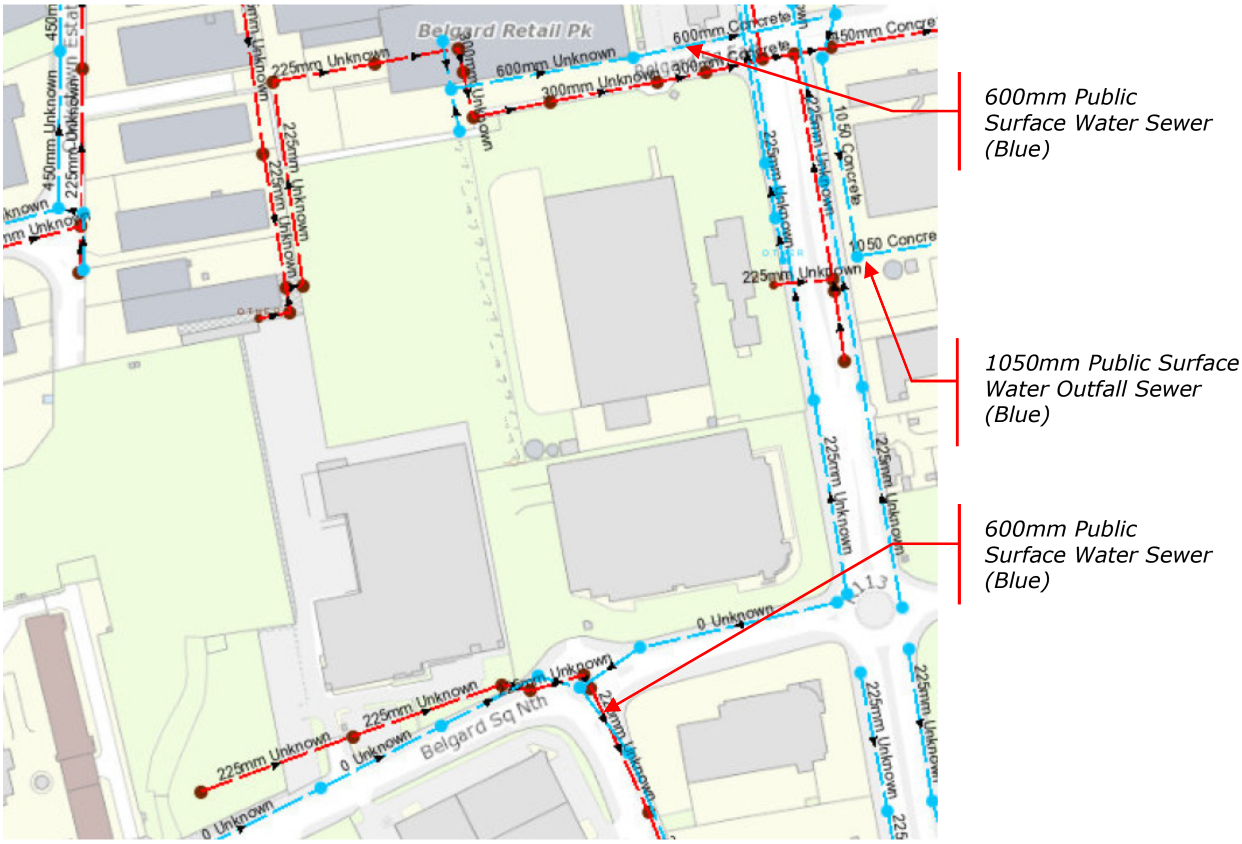


Figure 3.2 - Existing Surface Water Drainage Infrastructure

Further topographical and ground penetrating radar surveys were also carried out to confirm the existing drainage infrastructure, where accessible, in the immediate vicinity of the site.

The existing site is currently served by its own internal surface water drainage networks that discharge to the public surface water network at 5nr. locations i.e. 2nr. at the northern end of the site to an existing 600mm diameter sewer and 3nr. at the southern end of the site to an existing 600mm diameter sewer.

The above public drainage, within the immediate vicinity of the subject site, was verified by topographical survey and GPR Survey.

The 600mm diameter concrete sewer, to the south of the site, augments to a 1050mm diameter pipe downstream prior to discharging to the branch of the River Dodder, located to the south of the N81.

The 600mm dimeter concrete sewer, to the north of the site, augments to a 1050mm diameter pipe downstream prior to discharging to the River Tymon, within the grounds of the Institute of Technology, Tallaght, located to the east of the proposed development.

3.3.3 Existing Site Rainfall Runoff

All existing roof and hardstanding, within the site boundary, currently discharges un-attenuated and un-treated flows to the public surface water drainage network via the aforementioned connections. Refer to *Section 1.4* and *Section 3.3.1* for further details of existing site context.

Using the ICPSuDS Input, (Flood Studies Report (FSR)) Method, the rainfall runoff discharging from the brownfield site in its existing condition has been estimated at $QBAR_{URBAN}$ = **88.7 l/s**, based on a 75% partly urbanised catchment. Refer to *Figure 3.3* for an excerpt of the results from the MicroDrainage Runoff Calculator, which also provides the calculated QBAR runoff rate along with the discharge rate for varying Annual Recurrence Intervals (ARI).

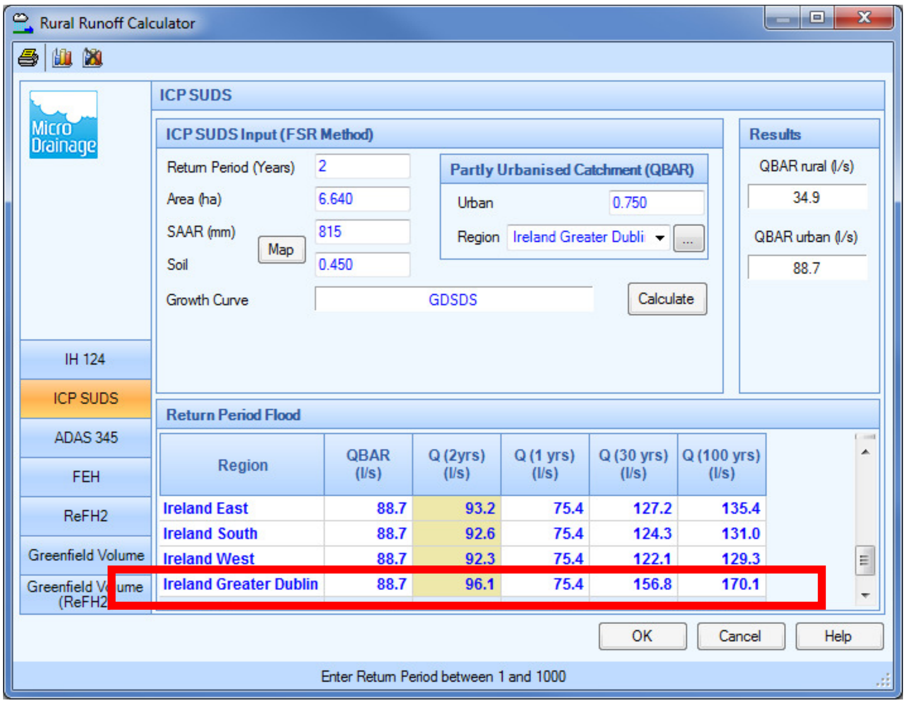


Figure 3.3 - Existing Site Runoff Calculator Results

3.4 Proposed Surface Water Drainage Design Strategy

3.4.1 Proposed Drainage Strategy Overview

It is proposed to separate the surface water and wastewater drainage networks, which will serve the proposed development, and provide independent connections to the adjacent public surface water and wastewater sewer networks respectively. Refer to *Section 4* for details of the proposed wastewater drainage design.

3.4.2 Proposed Drainage Catchment Areas

The overall development site is to be served by 3nr. separate drainage catchments, as indicated on drawing ***A557-OCSC-XX-XX-DR-C-0506***. These are summarised as follows:

1. *Main Attenuation Catchment (4.93 hectares)*

   The development's main drainage network serves the entirety of the private areas, 3.15 hectares, within this Phase 1 application, along with 1.78 hectares from the future Phase 2.
2. *Taken In Charge Road (0.57 hectares)*

   The proposed North-South road is to be offered to be taken in charge by SDCC. The drainage associated with this road and the adjoining paved area, which are drained via bio-retention strips and filter trenches, is to form part of a separate drainage catchments, with outfalls to the public sewer being provided at both Airton Road and Belgard Road North.
3. *North East Corner of Site (1.14 hectares) – Future Phase 2*

   The north eastern corner of the site, which is part of the future Phase 2 development, is at a relatively lower level than the site's main drainage catchment and therefore cannot utilise a common attenuation system. Therefore, this area must be drained independently with its own limiting discharge and attenuation system. This is to be designed in detail as part of the Phase 2 application.

Refer to *Figure 3.4* for a snapshot of drawing A557-OCSC-XX-XX-DR-C-0506, which shows a summary overview of the proposed catchment areas.

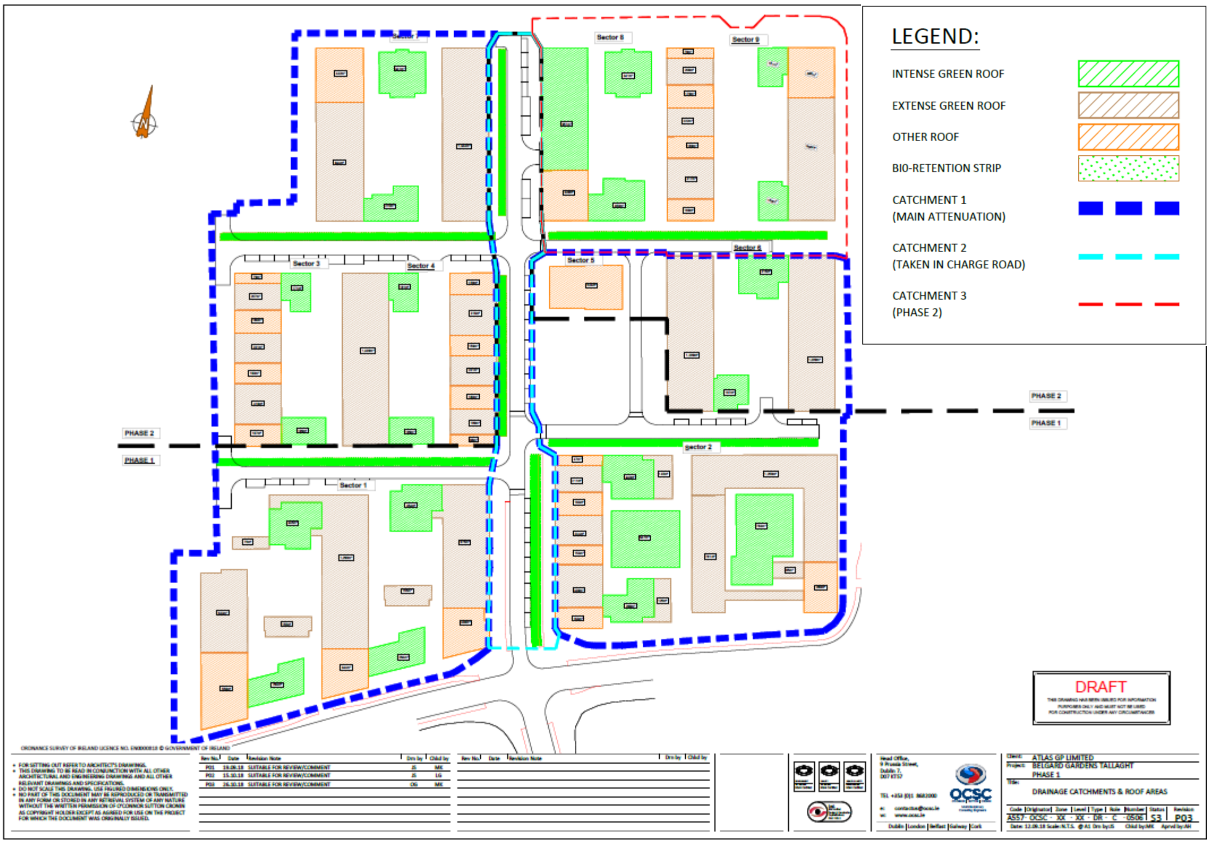


Figure 3.4 - Snapshot of Drawing A557-OCSC-XX-XX-DR-C-0506, Drainage Catchments & Roof Areas

For the purpose of the network design, we have considered all external (roads & landscaping) areas as being 100% impermeable; giving a winter global runoff coefficient, C_v, of 0.84, in accordance with the HR Wallingford and Modified Rational Method for runoff. This is as the soft landscaping areas are subject to change and cannot be accurately calculated; ensuring an upper bound attenuation volume is provided.

The green roof areas are inputted into the drainage network design program using input Time Area Diagrams, which is detailed further in *Section 3.4.8*. A summary of the differing catchments, sub-catchments and design input method is shown in *Table 2*.

	Gross Area (hectares)	% Area Impermeable	Design Input Method
CATCHMENT 1			
Roof Areas			
Intensive Green Roof	0.38	100	Time Area Diagram
Extensive Green Roof	1.39	100	Time Area Diagram
Other Roof Area	0.43	100	Contributing Area
Podium Soft Landscaping	0.14	100	Time Area Diagram
External Areas			
Private Road (Incl. parking)	0.29	100	Contributing Area
Bio Retention Area (with Filter Trench Underneath)	0.10	100	Contributing Area
Landscaping (Public Space Incl. Pavement / Trees / Plants …etc)	2.20	100	Contributing Area
Catchment 1 Total	**4.93**		
CATCHMENT 2			
Taken In Charge Road	0.23		Contributing Area
Bio Retention Area (with Filter Trench Underneath)	0.07		Contributing Area
Landscaping (Public Space Incl. Pavement / Trees / Plants …etc)	0.26	100	Contributing Area
Catchment 2 Total	**0.57**		
CATCHMENT 3			
Roof Areas			
Intensive Green Roof	0.20	100	Time Area Diagram
Extensive Green Roof	0.17	100	Time Area Diagram
Other Roof Area	0.10	100	Contributing Area
Podium Soft Landscaping	tbc		
External Areas			
Private Road (Incl. parking)	0.14	100	Contributing Area
Bio Retention Area (with Filter Trench Underneath)	0.03	100	Contributing Area
Landscaping (Public Space Incl. Pavement / Trees / Plants …etc)	0.50	100	Contributing Area
Catchment 3 Total	**1.14**		
Overall Catchment Area	**6.64**		

Table 2 – Catchment Type and Area overview

Improvement works are also to be carried out to the Belgard Square North road, which aligns to the southern boundary of the subject site. This is to include junction upgrades and widening of the existing road. All affected existing road gullies are to be repositioned onto the realigned kerb, resulting in no adverse impact on the existing drainage infrastructure.

3.4.3 Proposed Development Rainfall Runoff

As discussed and agreed at the various meetings with SDCC Drainage Department, noted in *Section 3.2*, it is proposed to reduce and restrict the rainfall runoff, discharging from the proposed development, to the equivalent $QBAR_{URBAN}$ runoff rate with an Urbanisation Factor of 0.5, as per the FSR ICP SuDS method, which is based on the IH124 method for catchments smaller than $25km^2$ in area.

This is to be achieved with the provision of a flow restrictor (Hydro-Brake Optimum by Hydro-International, or similar approved) prior to discharging to the proposed outfall manhole near the north eastern corner of the site, with the appropriate measures of attenuation provided.

Refer to *Figure 3.5* for an excerpt from the results MicroDrainage Runoff Calculator for the entire development area (6.64 hectares), which indicates the $QBAR_{URBAN}$ value of **68.2 l/s** along with the calculated runoff for varying Average Recurrence Intervals (ARI). The maximum total site runoff is to be split among the 3nr. proposed catchment areas (Refer *Section 3.4.2* for detailed catchment areas overview), with the individual maximum allowable runoff from each catchment being:

1. Catchment 1: **50.7 l/s** (Phase 1 Development & Partial Phase 2)
2. Catchment 2: **5.9 l/s** (Phase 1 Development)
3. Catchment 3: **11.6 l/s** (subject to future Phase 2 Design)

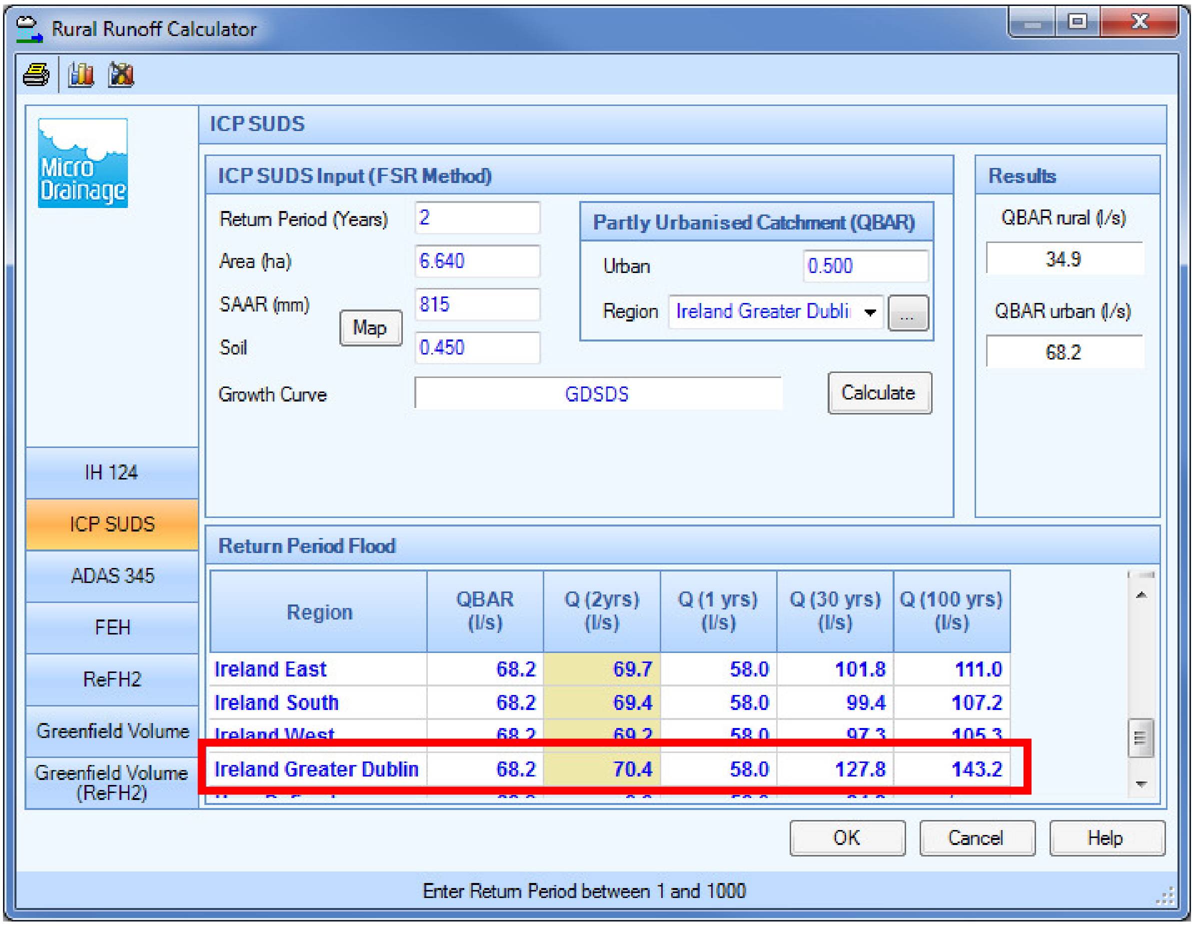


Figure 3.5 - Proposed Site Runoff Rate

The proposed main-attenuation, to be located at the central plaza area, is to receive the surface water drainage from the Phase I development and part of Phase II; with a combined catchment area of 4.93-hectares. The flow rate from this catchment area (Catchment 1) is to be restricted to a maximum **50.7 l/s** with the overall site catchment (6.64ha) outflows being restricted to a maximum total of **68.2 l/s**, which is less than the calculated existing site runoff (Refer *Section 3.3.3* for details of rainfall runoff from existing site).

Full calculation results for the limit discharge rates for the 3nr. drainage catchments, along with the overall site area, are included in **Appendix B**, as produced by the MicroDrainage MDSuDS Runoff Calculator.

3.4.4 Proposed Road Drainage Design (Bio-Retention)

It is proposed to provide a super-elevated cross-section profile to all the roads within the proposed development, with all roads and adjacent hardstanding draining laterally, by overland flow, to linear bio-retention strips. The bio-retention strips are to be provided along the length of one side of each road, with a typical overall width of 3.0m. This will intercept the initial rainfall and reduce the overall time of concentration to the drainage network rate by promoting infiltration through the selected fill layers underneath to a 1m x 1m (typical) filter trench.

An over flow gully, to the perforated filter drain, will be provided at each bio-retention strip, for exceedance events, so that excessive runoff will overflow to the underlying filter trench. The filter trench will act as primary attenuation for the road catchment areas, prior to conveying the runoff to the main drainage network.

Refer to the planning design drawings **A557-OCSC-XX-XX-DR-C-0702**, **A557-OCSC-XX-XX-DR-C-0703** and **A557-OCSC-XX-XX-DR-C-0704** for cross section and typical details of the proposed bio-retention strips and road profile. An excerpt from these drawings, showing a typical profile of the bio-retention strip, is shown in *Figure 3.6*.

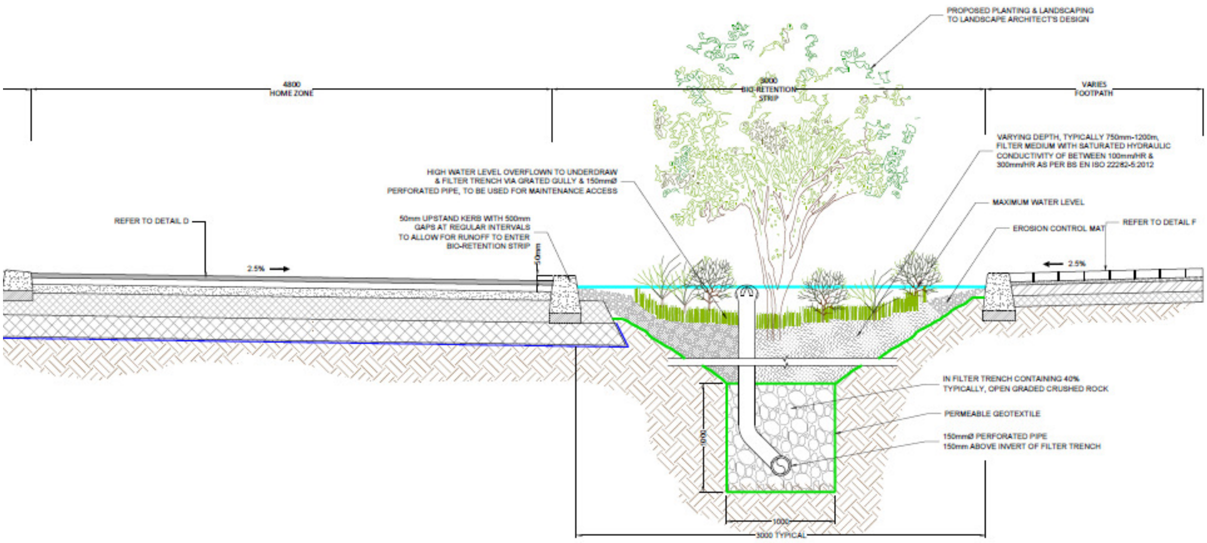


Figure 3.6 - Excerpt from Drawing A557-OCSC-XX-XX-DR-C-0702, Typical Bio-Retention Strip Profile

3.4.5 Green Roof Design

It is proposed to provide green roofs throughout the proposed development, where practicable. These are to be provided at accessible roof areas, in the form of both *extensive green roofs* and *intensive green roofs*. Refer to *Figure 3.7* for diagrammatic detail of typical green roof build-up.

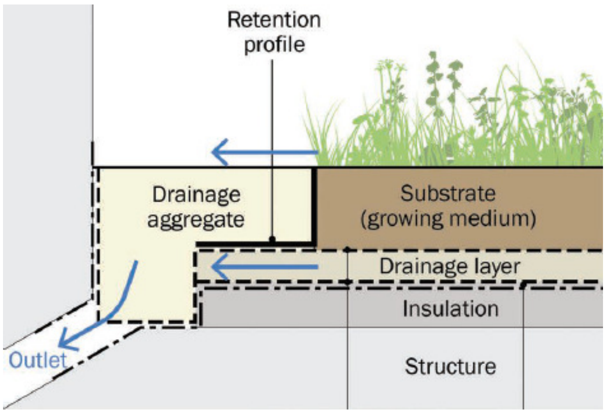


Figure 3.7 - Typical Green Roof Section

a. Extensive Green Roof

Extensive green roofs comprise durable, slow growing, low maintenance planting with a substrate depth of typically **100mm depth** of free-draining growing medium to support plant growth. These are to be provided on the roof areas of the higher blocks and will typically have a sedum-type planting.

b. Intensive Green Roof

Intensive green roofs (roof gardens) are designed to sustain more complex landscape environments, with a wide range of intensive plants, grasses, shrubs and trees available for selection. Intensive green roof systems have deep substrate of typically **500mm depth** or greater, as a growing and filtration medium, which also provides very good water retention capacity.

Refer to *Figure 3.4* and *Table 2*, in *Section 3.4.2*, for a summary of the Green Roof areas. Refer also to drawing **A557-OCSC-XX-XX-DR-C-0506** for locations of proposed extensive and intensive green roof areas.

The green roofs have been designed and modelled, taking account of the guidance material listed in *Section 2*, using MicroDrainage MDSuDS computer design product, by Innovyze Incorporated, which allows for the design of green infrastructure that can be integrated into the overall surface water network design.

In order to model the rainfall runoff volumes and rates for the proposed development, we have applied the Green Roof Runoff Method design approach that is utilised within the MicroDrainage MDSuDS software, which was discussed with SDCC Water Services Department, as noted in *Section 3.2*.

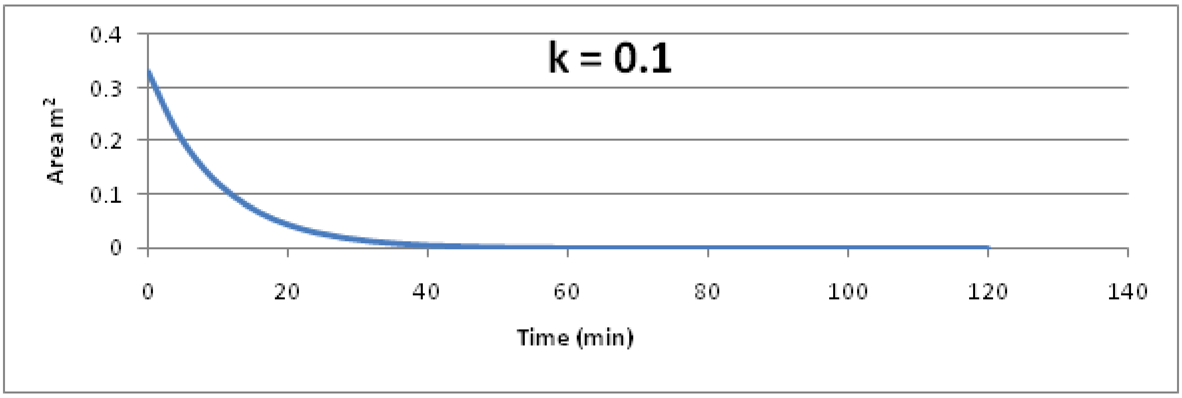
This methodology has been developed by MicroDrainage, in collaboration with *Sheffield University*, based on a review of best current practice and extensive research that was carried out by the *Sheffield University Green Roof Centre*. The design approach uses the following design inputs to the MDSuDS software for the various green roofs:

- <u>Evapotranspiration Rate</u> of **1mm/day** (typical of winter period i.e. worst case);
- <u>Depression storage</u> within the green roof build-up. This has been inputted as **2mm** within the *extensive green roof* substrate (100mm depth typical) and **4mm** within the *intensive green roof* substrate (500mm depth typical). These figures are less than the recommended value of **5%** of substrate depth, as a conservative design measure;
- <u>Decay Coefficient</u> of **0.1** (maximum value) for *extensive green roofs* and **0.05** for *intensive green roofs* – to represent the rate of runoff from the green roof (higher the value, the quicker the runoff), with the runoff typically occurring over a period of 120minutes, represented as a Time Area Diagram (Refer to *Figure 3.8*).

The Evapotranspiration Rate, noted above, represents the amount of water that is lost to the environment due to evaporation and transpiration. (Typical values for UK & Ireland are 3mm/day for summer and 1mm/day for winter).

The Depression Storage, noted above, represents the amount of runoff falling on the green roof area that does not enter the drainage system i.e. interception – rainfall that soaks into the substrate build up.

The Decay Coefficient, noted above, is a drawdown factor that represents the exponential Time Area Diagram at which the runoff falling on the green roof area discharges to the surface water drainage network (Refer to graphs in *Figure 3.8* for example). The higher the value (max k = 0.1), the quicker the runoff rate, which has been derived from the research carried out by the **Sheffield University Green Roof Centre**.



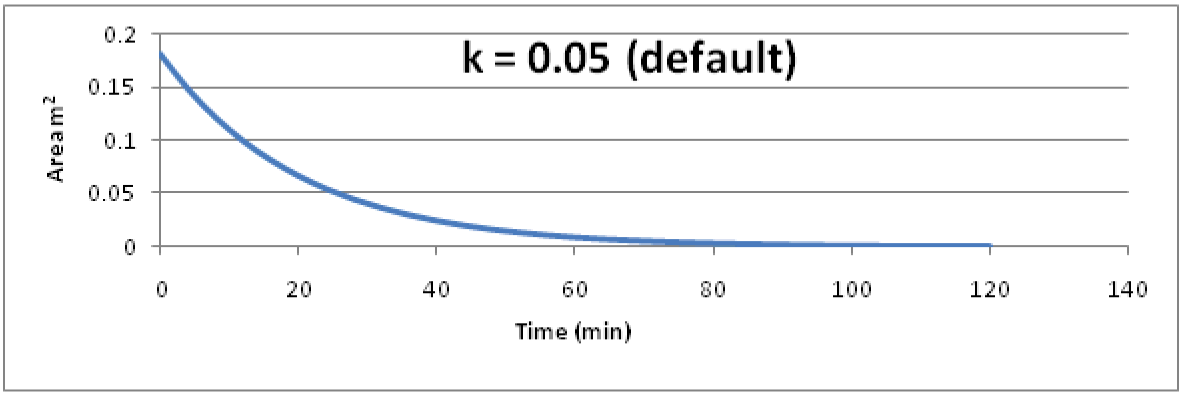


Figure 3.8 - Green Roof Drawdown Factor (k)

The above design approach uses the resulting individual Time Area Diagrams, for each green roof area, to contribute to the main surface water drainage network, at a typically slower rate than conventional hardstanding runoff; in order to best represent the behaviour of green roofs.

Refer to drawing **A557-OCSC-XX-XX-DR-C-0506** along with the architect's and landscape architect's design drawings for further details of the proposed green roof areas and provisions.

3.4.6 Attenuation Storage

The primary attenuation storage for **Catchment 1**, the main surface water drainage network, is to be provided at the central plaza area and has been designed to accommodate rainfall events up to, and including, the 1 in 100-year ARI rainfall event, with an additional 10% allowance for climate change.

It is proposed to route the surface water drainage network through an in-line underground storage structure (Stormtech SC-740 chambers, or similar approved) to a flow control chamber (Hydro-brake Optimum, or similar approved), which will restrict flows to the design **50.7 l/s** for this catchment. The underground storage structure has been designed to accommodate flows generated by rainfall events in the order of the 1 in 30-year ARI rainfall event.

Rainfall events that exceed the design 1 in 30-year ARI event, up to and including the 1 in 100 year ARI rainfall event, will overflow from the flow control chamber to the recessed plaza area, which will act as a temporary storage pond with a maximum design water level of +99m AOD. This provides a temporary maximum depth of water of up to 1.2m during the more significant design rainfall events.

For reference, the proposed lowest relative finished floor level is +99.5mAOD.

The critical design storm duration for the open attenuation within the plaza has been calculated as the 480-minute 100-year winter event however, water does not begin to overflow from the flow-control chamber to the attenuation area until after approximately 250-minutes of the storm event. *Figure 3.8*, below, which illustrates the Time vs Depth relationship for the critical storm event within the open attenuation area (referenced chamber number SW/MH-115 in the MicroDrainage Network Design); resulting in an approximate total submergence time of 10-hours.

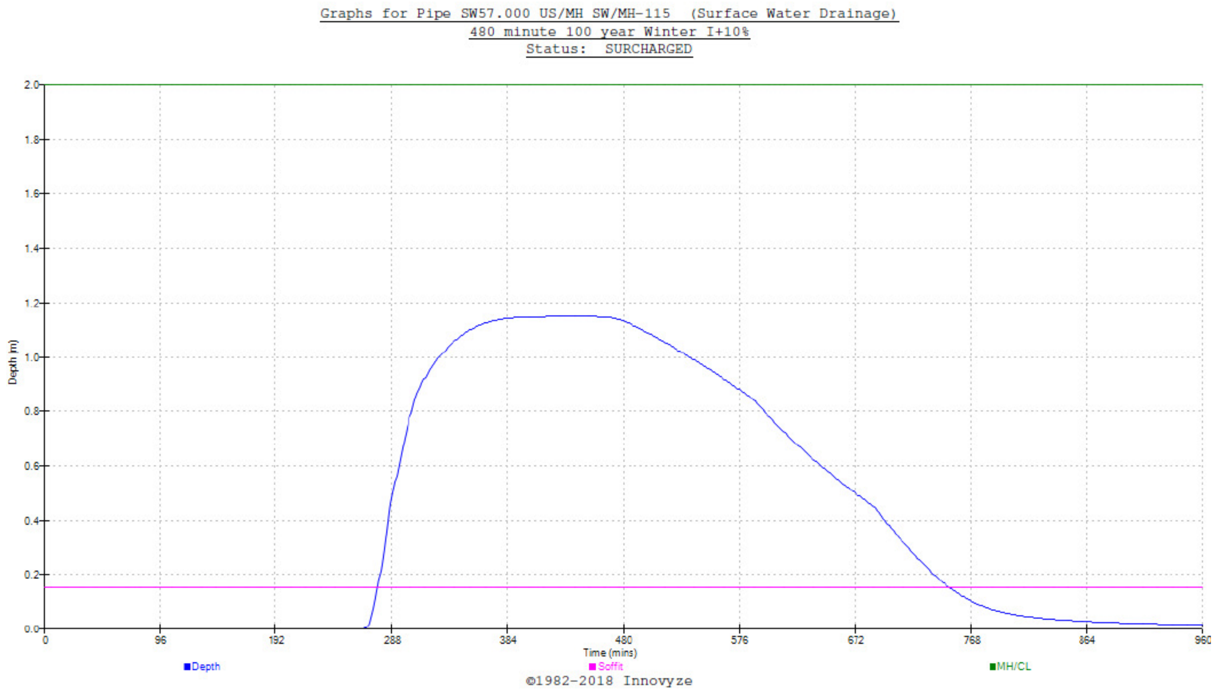


Figure 3.9 - Time vs Depth Relationship of Attenuation Area

Refer to drawing **A557-OCSC-XX-XX-DR-C-0515** for cross section across proposed attenuation and **Appendix C** for design calculations and results, as carried out using the MicroDrainage Network Design computer software program, by Innovyze Inc.

As noted in *Section 3.4.4*, all road areas are attenuated using bio-retention strips and filter drains prior to discharging to the main surface water drainage network, which has a beneficial impact on the required primary attenuation volume.

3.5 Taking in Charge

All new surface water drainage infrastructure, installed to serve the proposed development is to **remain private**, as far as the development outfall, and **not** be taken-in-charge, under the operation of a designated building management group. Notwithstanding this, all infrastructure is to be designed and constructed in accordance with relevant guidelines and codes of practice, as listed in *Section 2*.

The drainage, which is to serve the proposed main access road and adjacent hardstanding areas (i.e. bio-retention strip and filter trench), **is** to be offered to be taken in charge by South Dublin County Council.

3.6 Maintenance

The significant provision of green roofs, bio-retention strips and public realm landscaping will require regular upkeep and maintenance; in order to ensure that the surface water drainage performance of these SuDS measures are not compromised.

Refer to the Building Life Cycle Report and Planning Stage Estate Management Strategy that has been developed by Aramark Property, on behalf of the client, which has been submitted under separate cover as part of this application. Chapter 11 of the aforementioned report details the proposed maintenance strategy required for the proposed development.

3.7 Specific SuDS Measures Proposed

The proposed development is to contain the following measures of Sustainable Drainage Systems:

Limiting discharge. The design outflow from the overall development (6.64 ha overall catchment) is to be restricted to a maximum total outflow rate of **68.2 l/s**. The discharge from site is to be sub-divided into:

1. **50.7 l/s** from Catchment 1 (Phase 1 and partial Phase 2 development);
2. **5.9 l/s** from the main access road that is to be taken in charge (Phase 1);
3. **11.6 l/s** from the additional future Phase 2 development catchment.

The overall combined maximum flow rate, for the overall 6.64 hectare site, of **68.2 l/s** is less than the existing site runoff rate of **88.7 l/s**. Refer to *Section 3.3.3 and Section 3.4.3* for further details.

Attenuation Storage will be provided using the following proposed measures, in order to restrict development flow rates to those outlined above:

- Green Roofs – porosity within the build-up and reduction of runoff rate (refer to *Section 05* for further details);

- Bio-retention Strips – cross section profile and porosity within the build-up (refer to *Section 3.4.44* for further details);
- Filter Trench – located under the bio-retention strips, serving all road drainage (refer to *Section 3.4.4* for further details);
- Underground attenuation – Stormtech, or similar approved (refer to *Section 3.4.6* for further details);
- Open pond, above the underground storage for more significant (>1 in 30-year) events (refer to *Section 3.4.6* for further details).

Interception will be provided in the form of intensive and extensive green roofs, bio-retention strips and public realm landscaping. These areas will intercept the initial rainfall and thus reducing the overall volume of runoff discharging from site.

Water Quality of the surface water, discharging from site, is to be improved with the following provisions:

- Both *Intensive* and *Extensive Green Roofs* (in accordance with CIRIA Report C644 and other best practice guidelines) are to be provided, where practicable, as first-level treatment of rainwater falling at roof level. The green roofs will naturally filter the rainwater and reduce the overall runoff rate, prior to entering the proposed surface water drainage network as well as providing interception for the initial rainfall. Refer to *Section 3.4.8* for further design details of green roof provision and refer to drawing **A557-OCSC-XX-XX-DR-C-0506** for proposed green roof location details.
- All road and car-parking pavement, along with associated footpaths and other hardstanding, are to drain to the proposed surface water network via bio-retention strips that have a high-level overflow to a filter trench. These bio-retention strips will naturally remove gross pollutants, hydrocarbons and other impurities from the surface water runoff originating in these areas prior to entering the proposed drainage network. Refer to *Section 3.4.4* for further details of bio-retention provision.

Refer to drawings **A557-OCSC-XX-XX-DR-C-0702** & **A557-OCSC-XX-X-DR-C-0703** for cross section details of proposed bio-retention strips. Refer also to landscape architect's design drawings for further details of green roof and bio-retention provision.

3.8 Proposed Piped Network Design

The overall surface water drainage system, serving the proposed development, is to consist of a gravity sewer network that will convey runoff from the roofs and paved areas to the outfall manhole, which will discharge a controlled flow rate to the public surface water network at Airton Road, to the north of the proposed development.

The proposed piped-network has been designed in accordance with BS EN 752 and all new infrastructure is to be compliant with the requirements of the GDSDS and the GDRCOP for Drainage Works, with minimum full bore velocities of 1.0 m/s achieved throughout.

All main surface water carrier pipes have been sized to ensure no surcharging of the proposed drainage network for rainfall events up to, and including, the 1 in 5-year ARI event, with a projected climate change allowance of 10% increase in rainfall intensity.

3.9 GDSDS Surface Water Infrastructure Review

The design criteria for the drainage system are established in GDSDS-RDP Volume 2, Section 6.3.4 and explained further in GDSDS-RDP Volume 2, Appendix E. There are four design criteria, each of which has been considered for the subject site:

- River Water Quality Protection;
- River Regime Protection;
- Level of Service (flooding) for the site and;
- River Flood Protection.

3.10 Criterion 1 – River Water Quality Protection

It is proposed that the overall drainage system, serving this development, will contain a range of surface water treatment methods, as outlined previously in *Section 3.6*, which will improve the quality of surface water being discharged from the proposed development.

Gross pollutants, sediments, hydrocarbons, and other impurities, will be removed at source with the following provisions:

a) Intensive and extensive green roofs, where practicable;
b) Bio-retention strips and filter drains to serve all road and car parking areas;
c) Silt-traps prior to attenuation storage area.
d) Any gullies used on site are to be trapped.

The basement drainage is also to discharge to the proposed foul sewer network via a Class I bypass fuel separator and pump system.

3.11 Criterion 2 – River Regime Protection

Surface water discharge from the overall development I development will be restricted to an equivalent urban runoff rate of **68.2 l/s**, as previously discussed with SDCC, which is lower than the calculated existing runoff rate of **88.7 l/s**. The total site runoff rate is contributed by the 3nr. separate sub-catchments, as follows:

1. Catchment 1 (Main attenuation – Phase 1 & Phase 2) 50.7 l/s
2. Catchment 2 (Road to be taken in Charge – Phase 1) 5.9 l/s
3. Catchment 3 (Future Phase 2 development) 11.6 l/s

Refer to *Section 3.4.3* for further details. This will be achieved with the provision of a flow restrictor (Hydro-Brake Optimum, by Hydro-International, or similar approved) upstream of the outfall manhole.

Refer also to **Appendix B** for results $QBAR_{URBAN}$ calculation results, which have been carried out using the ICP SUDS Method on MicroDrainage software.

3.12 Criterion 3 – Level of Service (Flooding) Site

There are four sub-criteria for the required level of service, for a new development; as set out in the *GDSDS Volume 2, Section 6.3.4 (Table 6.3).*

- No flooding on site except where planned (30-year high intensity rainfall event);
- No internal property flooding (100-year high intensity rainfall event);
- No internal property flooding (100-year river event and critical duration for site) and;
- No flood routing off site except where specifically planned. (100-year high intensity rainfall event).

3.12.1 Sub-Criterion 3.1

The surface water drainage systems, serving the proposed development, have been designed to accommodate the 100-year return period rainfall event (including an allowance of 10% increase in rainfall intensity for climate change) without flooding. Therefore, the system has capacity for the 30-year return period rainfall event without flooding.

The performance of the proposed drainage system has been analysed for design rainfall events up to, and including, the 1% AEP event (incl. 10% climate change allowance) using the *MicroDrainage Network Design Software*, by Innovyze Inc. Refer to **Appendix C** for details of design criteria, calculations and results. The analyses indicate that no flooding will occur for design rainfall events up to, and including, the 1% AEP.

3.12.2 Sub-Criterion 3.2

The surface water drainage systems, serving the proposed development, have been designed to accommodate the 100-year return period rainfall event (including an allowance of 10% increase in rainfall intensity for climate change) without flooding.

The performance of the proposed drainage system in 100-year return period storm events (incl. 10% climate change allowance) has been analysed – Refer **Appendix C** for calculations. The analyses show that no flooding will occur in 100-year return period storm events.

3.12.3 Sub-Criterion 3.3

A separate *Site-Specific Flood Risk Assessment* report, **A557-OCSC-XX-XX-RP-C-0002**, has been prepared and submitted under separate cover with this planning application. The assessment indicates that no internal property flooding will occur in a 100-year return period fluvial flood event (including 20% climate change allowance).

3.12.4 Sub-Criterion 3.4

The surface water drainage systems, serving the proposed development, have been designed to accommodate the 100-year return period rainfall event (including an allowance of 10% increase in rainfall intensity for climate change) without flooding.

The performance of the proposed drainage system in 100-year return period storm events (incl. 10% climate change allowance) has been analysed – Refer **Appendix C** for calculations. The analyses show that no flooding will occur in 100-year return period storm events.

A separate Site-Specific Flood Risk Assessment Report, **A557-OCSC-XX-XX-RP-C-0002**, has been prepared and submitted under separate cover with this planning application. This assessment, along with the design simulation results from the MicroDrainage Network Analysis, indicates that no internal property flooding will occur in a 100-year return period fluvial flood event (including 10% climate change allowance).

3.13 Criterion 4 – River Flood Protection

As outlined in *Section 3.11* (Criterion 2), the runoff from the total site catchment serving this phase of the development will be limited to a maximum of **68.2 l/s**, contributed by 3nr. separate sub-catchments:

1. Catchment 1 (Main attenuation – Phase 1 & Phase 2) 50.7 l/s
2. Catchment 2 (Road to be taken in Charge – Phase 1) 5.9 l/s

3. Catchment 3 (Future Phase 2 development) 11.6 l/s

Refer to *Section 3.4.3* and *Section 3.7* for further details on the limiting discharge rates. The *GDSDS Volume 2, Appendix E* states that this practice ensures *"that sufficient stormwater runoff retention is achieved to protect the river during extreme events".*

Attenuation storage is to be provided for the 100-year return period rainfall event (including an increased 10% rainfall intensity; to allow for climate change). Discharge from site is to be achieved through the use of a vortex flow control device (e.g. Hydro-Brake Optimum, by Hydro-International, or similar approved), which will reduce the risk of blockage present with other flow devices.

Refer to **Appendix C** for details of hydraulic modelling calculations of attenuation and flow control facilities, as carried out using MicroDrainage software by Innovyze Inc.

4 WASTEWATER DRAINAGE

4.1 Overview

All proposed wastewater sewer design has been carried out in accordance with Irish Water's Code of Practice for Wastewater Infrastructure. The pre-existing site was typically commercial and industrial in nature with all wastewater discharging directly to the local public foul sewer network.

A Pre-Connection Enquiry Form ***(IW Ref Nr. 052158350)*** was submitted to Irish Water for the overall masterplan development, based on revised Phase 2 design details, with feasibility for the connection confirmed by returned of letter, issued on 12th November 2018.

A further letter was issued by Irish Water on 24th November 2018 outlining acceptance of the proposed wastewater design.

Refer to **Appendix E** for a copy of the Confirmation of Feasibility letters and Statement of Design Acceptance letter.

4.2 Existing Wastewater Drainage

The Irish Water public drainage records indicate that there is an existing 300mm diameter public foul sewer network along Airton Road, to the north, a 225mm diameter public foul sewer along the R113, to the east and an existing 225mm diameter public foul sewer along Belgard Road North, to the south of the proposed development (Refer to **Appendix A** for details).

The existing buildings within the overall site boundary currently discharge to the existing public wastewater infrastructure using independent connections.

There is also an existing foul sewer, which originates in the southern section of the adjacent SDCC St. Maelruan's site, which was previously occupied by members of the travelling community but is currently unused. This sewer traverses the subject site and receives the wastewater discharges from the existing building. As the adjacent site is no longer serving its intended use and the existing building on the subject site is to be demolished as part of the proposed development, it is proposed to decommission the existing sewer as far as the southern site boundary.

SDCC Water Services advised, by email on 3rd November 2017, an annual total site water consumption volume of approximately 62,300m^3 for the year 2008, which is equivalent to **6.65 l/s** average flow rate based on a 10-hour and 5-day working week. There is insufficient information to compare with other years due to flow meters only being installed in the south Dublin area from 2007 and the properties no longer being fully utilised in the years following.

It is noted that all existing foul / combined sewer infrastructure, which serves the existing development, will be decommissioned and grubbed up as part of the proposed development works.

4.3 Proposed Wastewater Drainage

It is proposed to separate the wastewater and surface water drainage networks, which will serve the proposed development, and provide independent connections to the local public foul sewer and surface water sewer networks respectively. Please refer to *Section 3* for details of the proposed surface water drainage design.

The wastewater drainage from each block is to discharge to a gravity pipe network, within the proposed development and connect to the existing public foul sewer network at two proposed locations. A new connection to the existing 225mm diameter public foul sewer, to the south of the site, will be provided; in order to serve Phase I and part of Phase II. An additional connection to the existing 300mm diameter public foul sewer, to the north of the site, will also be provided; in order to serve the majority of the proposed Phase II part of the development, which will be designed and detailed further as part of a separate planning application.

Refer to the proposed drainage design layout drawings **A577-OCSC-XX-XX-DR-C-0500** and **A557-OCSC-XX-XX-DR-C-0501** for further details.

The new connections to the existing public foul sewer network, to the north of the proposed development, will be carried out in accordance with the Greater

Dublin Code of Practice for Drainage Works and Irish Water's Code of Practice for Drainage Infrastructure.

4.4 Taking In Charge

All new wastewater drainage infrastructure, installed to serve the proposed development is to remain private as far as the outfall manholes, and **not** be taken-in-charge, under the operation of a designated building management group. Notwithstanding this, all infrastructure is to be designed and constructed in accordance with relevant guidelines and codes of practice, as listed in *Section 2*.

4.5 Calculations

As outline earlier, it is proposed to outfall the wastewater flows, from the proposed Phase I of this development, to the existing public foul sewer at Belgard Road North, to the south of the site.

The **total peak design flow** from Phase I of the proposed development has been calculated as **10.44 l/s**; with independent peak flows of 8.72 l/s and 9.26 l/s discharging from Sector 1 and Sector 2 respectively.

Please refer to **Appendix D** for details of foul drainage flow rate calculations, which have been carried out in accordance with Irish Water's Code of Practice for Wastewater Infrastructure, IW-CDS-5030-03.

4.6 Consultation

SDCC Water Services advised, by email on 3rd November 2017 of an existing annual total site water consumption volume of approximately 62,300m^3 for the year 2008, which is equivalent to **6.65 l/s** average flow rate based on a 10-hour and 5-day working week. There is insufficient information to compare with other years due to flow meters only being installed in the south Dublin area from 2007 and the properties no longer being fully utilised in the years following.

OCSC have met with Irish Water representatives on 20th September 2017 to discuss the proposed development and foul drainage strategy. Further, a Pre-

Connection Enquiry Form (***IW Ref Nr. 052158350***) was submitted to Irish Water for the masterplan development (Phase 1 and Phase 2), with feasibility for the proposed development connection confirmed by returned of letter, issued on 15th November 2018. Refer to **Appendix E** for a copy of the letter, as issued by Irish Water.

The approved PCEF was based on the provision of an overall 1,530 domestic units and 403 student residential units along with some commercial development; in order to provide context for the overall masterplan development.

Following further consultation with Irish Water, a Statement of Design Acceptance was issued by letter, dated 24th November 2018. Refer to **Appendix E** for a copy of the letter, as issued by Irish Water.

We confirm that all wastewater, to serve the proposed development, has been designed in accordance with Irish Water's Code of Practice for Wastewater Infrastructure and is to be constructed in accordance with their standard design details. All phasing details have been indicated on the approved Pre-Connection Enquire Form along with confirmation of the proposed connection locations.

5 POTABLE WATER SUPPLY

All proposed potable water design has been carried out in accordance with Irish Water's Code of Practice for Water Infrastructure, IW-CDS-5020-03. The pre-existing site was typically commercial and industrial in nature with all water usage sourced directly from the local public water infrastructure.

A Pre-Connection Enquiry Form (***IW Ref Nr. 052158350***) was submitted to Irish Water for the overall masterplan development, with confirmation of feasibility for the proposed development connection returned by letter, issued on 12th November 2018. Refer to **Appendix E** for a copy of the letter, as issued by Irish Water.

Irish Water have also confirmed acceptance of the proposed watermain design by providing a Statement of Design Acceptance. Refer to **Appendix E** for a copy of the letter, as issued by Irish Water.

5.1 Connection to the existing network

As advised on the Confirmation of Feasibility Letter, included in **Appendix E**, it is proposed to provide a 300mm high density polyethylene connection from the existing 24-inch asbestos watermain, located alongside the eastern carriageway of R113, Belgard Road (Refer to **Appendix A** for details of existing watermain infrastructure records), using a pressure reducing valve; in order to serve the proposed development. The proposed connection is to supply water to each of the individual blocks using 150mm diameter HDPE watermains, which form part of the proposed development.

An additional contingency supply main will also be provided, as suggested in Irish Water's Confirmation of Feasibility Letter, on the western side of the site. This will be detailed as part of the proposed Phase II application.

Refer to drawing **A557-OCSC-XX-XX-DR-C-0550** for details of the proposed watermain design layout, including proposed connection location.

The connection is to be carried out in accordance with Irish Water's Code of Practice for Water Infrastructure, following agreement with Irish Water.

It is noted that there are a number of existing connections to the local watermain, in the vicinity of the proposed development, which serve the existing premises within the subject site. All individual connections will be disconnected, capped and decommissioned, in accordance with the Irish Water Code of Practice for Water Infrastructure.

5.2 Water Saving Devices

Water saving devices are to be considered for use within the proposed development, in order to conserve the use of water, as part of the internal fit-out.

5.3 Water Meters

A bulk water meter is to be provided at the connection to the public watermain along with at the entrance to each Sector of the development, as indicated on drawing **A557-OCSC-XX-XX-DR-C-0550**. Further details for the requirements of water meters to individual buildings and units, within the development, are to be agreed with Irish Water.

5.4 Layout

Refer to drawing **A557-OCSC-XX-XX-DR-C-0550** for the proposed external watermain design layout, which has been approved by Irish Water as per Statement of Design Acceptance in **Appendix E**. All internal building watermain infrastructure forms part of the mechanical engineering design, with further requirements such as fire safety to be advised by the fire consulting specialists.

5.5 Consultation

SDCC Water Services advised, by email on 3rd November 2017, an annual total site water consumption volume of approximately 62,300m^3 for the year 2008, which is equivalent to 6.65 l/s average flow rate based on a 10-hour and 5-day working week. There is insufficient information to compare with other years due to flow meters only being installed in the south Dublin area from 2007 and the properties no longer being fully utilised in the following years.

A Pre-Connection Enquiry Form (***IW Ref Nr. 052158350***) was submitted to Irish Water for the masterplan development (Phase 1 and Phase 2), with feasibility for the proposed development connection confirmed by returned of letter, issued on 15th November 2018. Refer to **Appendix E** for a copy of the letter, as issued by Irish Water.

The approved PCEF was based on the provision of an overall 1,530 domestic units and 403 student residential units along with some commercial development; in order to provide context for the overall masterplan development.

We confirm that all wastewater, to serve the proposed development, has been designed in accordance with Irish Water's Code of Practice for Water Infrastructure and is to be constructed in accordance with their standard design details. All phasing details and connection locations have been indicated on the approved Pre-Connection Enquire Form.

Further correspondence with Irish Water resulted in confirmation of design acceptance, as indicated in the Irish Water Statement of Design Acceptance letter in **Appendix E**.

6 ROAD DESIGN

6.1 Road Design Standards

The roads elements of this project are designed to comply with the following standards. It is noted that the Design Manual for Urban Roads and Streets (DMURS) and the National Cycle Manual (NCM) are the principle design guidelines for this scheme. The list of the main standard documents relied on is:

- DMURS;
- National Cycle Manual;
- Traffic Signs Manual 2010 with Amendments (July 2013);
- DN-PAV-03021: Pavement & Foundation Design;
- GE-STY-01024: Road Safety Audit;
- NRA Design Manual for Roads and Bridges (NRA DMRB);
- NRA IAN 02/11 Interim Requirements for the Use of Eurocodes for the Design of Road Structures Amendment No. 1.

6.1.1 Road Classification

The roads will be classified in accordance with table 3.1 of DMURS

DMURS Description	Roads Act/NRA DMRB	Traffic Management Guidelines	National Cycle Manual
Arterial	National	Primary Distributor Roads	Distributor
Link	Regional (see note 1)	District Distributor Local Collector (see Notes 1 and 2)	Local Collector
Local	Local	Access	Access

Notes

Note 1: Larger Regional/District Distributors may fall into the category of *Arterial* where they are the main links between major centres (i.e. towns) or have an orbital function.

Note 2: Local Distributors may fall into the category of *Local* street where they are relatively short in length and simply link a neighbourhood to the broader street network.

Table 3.1: Terminology used within this Manual compared with other key publications.

6.2 Road Design Speeds

The Design Speed will be 10-30kph for the internal roads and 50 kph for the external roads. DMURS Chapter 4 (P64) states *"The design speed of a road or street must not be up-designed so that it is higher than the posted speed limit".* The speed selected is in compliance with Table 4.1 of DMURS.

PEDESTRIAN PRIORITY — VEHICLE PRIORITY

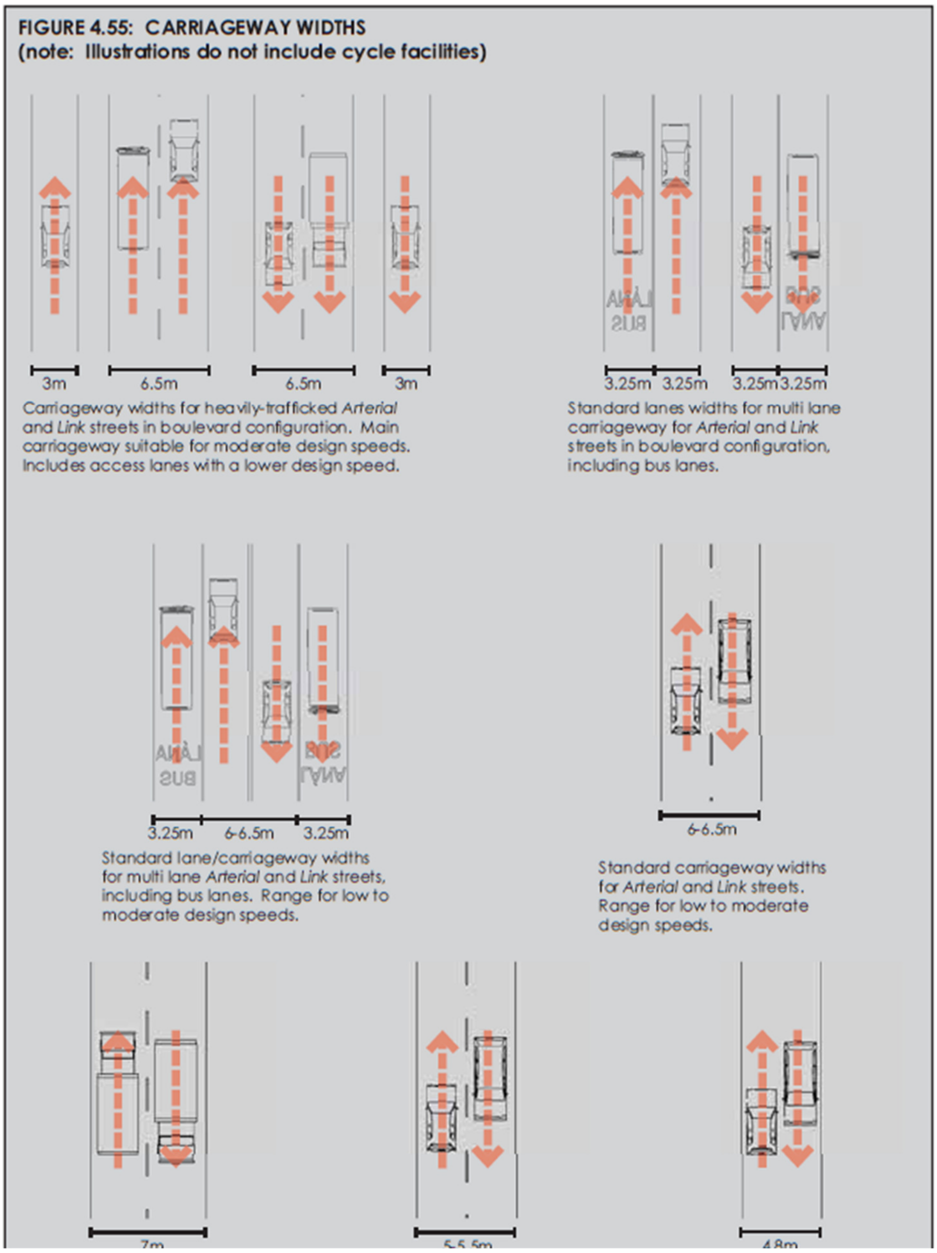
FUNCTION	CENTRE	N'HOOD	SUBURBAN	BUSINESS/ INDUSTRIAL	RURAL FRINGE
ARTERIAL	30-40 KM/H	40-50 KM/H	40-50 KM/H	50-60 KM/H	60-80 KM/H
LINK	30 KM/H	30-50 KM/H	30-50 KM/H	50-60 KM/H	60-80 KM/H
LOCAL	10-30 KM/H	10-30 KM/H	10-30 KM/H	30-50 KM/H	60 KM/H

CONTEXT

Table 4.1: Design speed selection matrix indicating the links between place, movement and speed that need to be taken into account in order to achieve effective and balanced design solutions.

6.3 Road Cross Sections

The carriageway width is selected from Figure 4.55 of DMURS (refer excerpt below).



The width of the footpaths is determined by reference to DMURS Section 4.3.1. The roads are defined as urban in character and as such a minimum footpath width of 2m is provided throughout the development. In most areas a greater footpath width has been provided to accommodate higher levels of pedestrian activity.

The width of cycle facilities will be determined on the basis of the National Cycle Manual (June 2011).

Verge and rear strip widths will be determined from DMURS Section 4.3.1. Verges and strips have been combined with SuDS measures. This has been developed as part of the design of the drainage system.

6.4 Horizontal and Vertical Geometry

The alignment of the roads has been designed so that the various geometric elements including horizontal and vertical curvature, super elevation and sight distance have at least the minimum values consistent with the chosen design speed of the road. This is as set out in Section 4.4 *Carriageway Conditions* of DMURS. A standard carriageway cross fall of 2.5% has been adopted throughout with super elevation applied on internal roads to facilitate draining them to SuDS measures, it is noted that the adverse camber is allowable under DMURS designs in accordance with Table 4.3. A cross fall of 2.5% has been used for footpaths and cycle facilities.

HORIZONTAL CURVATURE

Design Speed (km/h)	10	20	30	40	50	60
Minimum Radius with adverse camber of 2.5%	-	11	26	56	104	178
Minimum Radius with superelevation of 2.5 %	-	-	-	46	82	136

VERTICAL CURVATURE

Design Speed (km/h)	10	20	30	40	50	60
Crest Curve K Value	N/A	N/A	N/A	2.6	4.7	8.2
Sag Curve K Value	N/A	N/A	2.3	4.1	6.4	9.2

Table 4.3: Carriageway geometry parameters for horizontal and vertical curvature.

6.5 Road Junctions

The development's junctions have been designed with the primary principle of providing safe and consistent layouts in order to present a uniformity of approach to drivers and other road users. In addition junctions will have sufficient capacity to accommodate design year peak traffic flows thus optimising network capacity. The primary junction strategy objectives has been:

- To optimise road safety by ensuring adequate visibility and consistency;
- To ensure capacity for the design year;
- To function as traffic calming measures;
- To provide safe crossing facilities for pedestrians and cyclists;
- To provide an economic solution, so that the cost of implementing the design will be, to the maximum possible extent, offset by the economic benefits derived;
- To optimise road construction costs;
- To minimise environmental impacts, such as air pollution and engine noise, by minimising fuel consumption through reductions in the number of speed changes and the number of stop/starts required.
- To provide toucan crossings where appropriate to provide connectivity to the existing road network and that proposed for the Greater Dublin Area Cycle Network Plan

Internal junctions have been created at points appropriate to the development masterplan. In accordance with DMURS 4.4.1 these roads have widths ranging from 5m to 6m. Given the local access nature of these roads, and in the interest of predictability of junction type, these junctions will form simple cross roads or priority T-junctions as appropriate.

6.6 External Roads

In relation to the external roads OCSC considered the following items:

- LAP requirement for a high quality pedestrian and cycle facility from ITT to Tallaght University Hospital;

- Requirement to change the entrance junction typology;
- Roads Dept. guidance to connect the scheme to a second external road;
- Discussions with NTA regarding BusConnects project.
- Discussions with the NTA regarding Cycle Facilities

In relation to the roads network and external works which are desired/required in the area there are a number of key goals for the local authority that OCSC have not fully addressed in the presentation of strategy regarding external roads they are:

- The cycle infrastructure on Belgard Square North. This road is designated a secondary cycle route for the city and the current infrastructure is not at the standard that would be expected to achieve this designation.
- The cycle infrastructure on Belgard Road. This road is designated a primary cycle route for the city and the current infrastructure is not at the standard that would be expected to achieve this designation.
- Airton Road Extension. This road is an objective of the SDCC Development Plan and is of strategic importance to the upgrading of Tallaght University Hospital. It may require some land at the northern end of our site with the balance of the land primarily coming from Third Party Ownership.
- Cookstown Way Extension. South Dublin County Council are awaiting a decision on Part 8 planning approval for this scheme and it is not certain how they expect the construction to be delivered.

- We have planned on the basis that the pedestrian and cycle link to the hospital through the SDCC lands would be delivered by SDCC as part of their development of their lands.

6.7 Internal Roads

In relation to the internal roads OCSC have considered the following:

- A desire to supply high quality pedestrian and cycling facilities
- Roads Department guidance to connect the scheme to a second external road;
- The SDCC desire to take in charge the North South main spine road;
- The cycle and pedestrian requirements of the development plan and the previous LAP;
- The SuDS features;
- Defensible space for residents;
- The interaction with the main square.

As per DMURS Table 3.1 the roads have been classified as local streets.

6.8 Road to be Taken-In-Charge

The main spine is to be built to SDCC taking in charge standards. The design team have met with roads, public lighting, landscape and drainage in relation to the features and design decisions to be taken in relation to the finishes and the materials to be used in this main spine road. This is reflected in the drawings, which accompany this submission.

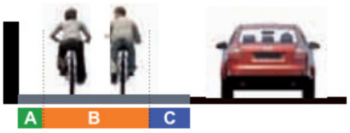
In relation to the delivery of the Main Spine road it is suggested that the section of the main spine road in the Phase 2 lands be built no later than three years after initial commencement of works. This timeline has been selected to balance the local authorities desire to ensure that critical infrastructure is built in a timely manner with the Developer's build out programme and the feasibility of construction sequences.

6.9 Cycle Facilities

The cycle facilities have been designed by OCSC to create a legible environment in accordance with the National Cycle Manual June 2010 (NCM). In this scheme there are four principle areas that cycle facilities have been provided. They are existing external roads, the new north-south taking in charge road, the shared street to the west incorporating the cycle linkage from ITT to Tallaght University Hospital and other streets. A key factor in the design of the cycle facilities is that the NCM guidance states that all dedicated cycle facilities should have a horizontal or vertical separation from pedestrian facilities (in roads with high traffic they must also be separated from vehicles vertically). During discussions with the NTA it was noted that it is their preference that vertical separations are incorporated into the design where the cycletrack is adjacent to the footpath. This is the approach that OCSC have taken. It is however noted that SDCC expressed a preference for no vertical separation.

6.9.1 External Streets

Running along the northern kerbside of Belgard Square North an off-road cycle track has been designed. This cycle track is 2m wide in accordance with the NCM's width calculator. The track is vertically separated from the carriageway and footpath; as per Section 1.9.3 of the NCM the kerb here will also ensure the visually impaired may navigate the footpath safely.



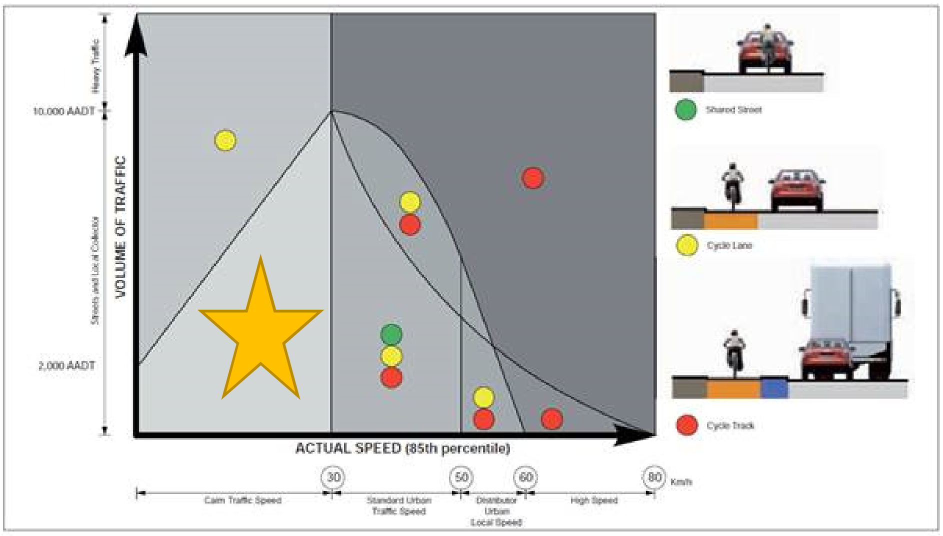
A Inside Edge		B Cycling Regime		C Outside Edge		D Additional Features	
Kerb	0.25m	Single File	0.75m	30kph, 3.0m wide lane	0.50m	Uphill	0.25m
						Sharp bends	0.25m
Channel Gully	0.25m	Single File + Overtaking, Partially using next lane	1.25m	50kph, 3.0m wide lane	0.75m	Cyclist stacking, Stopping and starting	0.50m
Wall, Fence or Crash Barrier	0.65m	Basic Two-Way	1.75m	Raised kerb, dropped Kerb or physical barrier	0.50m	Around primary schools, interchanges, or for larger tourist bikes	0.25m
Poles or Bollards	0.50m	Single File + Overtaking, Partially using next lane	2.00m	Kerb to vegetation etc. (ie. cycleway)	0.25m	Taxi ranks, loading, line of parked cars	1.00m (min 0.8m)
		2 Abreast + overtaking (tracks and cycleways)	2.50m			Turning pocket cyclists	0.50m

6.9.2 North-South Taking In-Charge Road

The main access road which runs north-south through Belgard Gardens has been designed with off-road one-way cycle tracks running parallel, from Belgard Square North to the linkage with Tallaght University Hospital. Both of these are 2m wide and are in keeping with the recommendations of the NCM. A buffer of at least 0.75m exists between the cycle track and any parallel parking and as a minimum there is 0.5m clearance on all sides to any infrastructure.

6.9.3 The Shared Streets

The internal road running west-east that connects with the future Cookstown Industrial Estate Link Road has been designed as a shared street according to the NCM's guidance graph.



6.9.4 Other Streets

All other streets in the development are low volume, short and low speed environments and hence the most appropriate form of cycle facility for these areas is shared with the public road.

6.10 Servicing

The servicing of the development has been designed by the design team including expert opinion from AWN on waste management and JGA on Fire Consultancy. The routes for the bin truck and the fire engines have been modelled in AutoTrack and these drawings are contained within the planning package.

6.11 Traffic Lights

There are two sets of traffic lights in the development. The pedestrian crossing at Belgard Roundabout and the new signalised junction at the site entrance. The junction designs will be contained in the planning submission. The junctions will be controlled with SCOOT and MOVA capabilities as required by SDCC Traffic Section.

6.12 Consultation

OCSC met Robert Roache and Adrian Barrett of SDCC on three separate occasions to discuss the roads layout and transportation strategy for the scheme (13/09/2017, 11/10/2017 & 12/03/2018). OCSC have also discussed the updated layout with the roads department regularly on the design development of the scheme. OCSC met with roads with the Cookstown Way extension design team prior to the issuance of the Part 8 and agreed interfaces which may occur in the future. OCSC can confirm that the development layout, taking in charge areas, storm drainage, junction typologies, parking, cycling and pedestrian facilities have been discussed in detail with SDCC and that the requests of SDCC have been incorporated into the development. OCSC have discussed the scheme in detail with the NTA in relation to BusConnects and cycle facilities.

Mark Killian & **Anthony Horan**

(MSc BE CEng MIEI) **(BE, P.Cert RSA, P. Dip. PM, CEng)**

For OCSC MULTIDISCIPLINARY CONSULTING ENGINEERS

O'CONNOR | SUTTON | CRONIN
Multidisciplinary Consulting Engineers

APPENDIX A. SOUTH DUBLIN COUNTY COUNCIL AND IRISH WATER PUBLIC RECORDS

Appendix A

South Dublin Co.Co. & Irish Water Public Records

UISCE ÉIREANN : IRISH WATER

Legend

- Pump Stations
- Irish Water
- Private
- Irish Water
- Non IW
- Gravity - Combined
- Gravity - Foul
- Gravity - Overflow
- Gravity - Unknown
- Pumping - Combined
- Pumping - Foul
- Pumping - Overflow
- Pumping - Unknown
- Syphon - Combined
- Syphon - Foul
- Syphon - Overflow
- Overflow
- Gravity - Combined
- Gravity - Foul
- Gravity - Overflow
- Gravity - Unknown
- Pumping - Combined
- Pumping - Foul
- Pumping - Overflow
- Pumping - Unknown
- Syphon - Combined
- Syphon - Foul
- Syphon - Overflow
- Overflow
- Surface Gravity Mains
- Surface Gravity Mains Private
- Surface Water Pressurised Mains
- Surface Water Pressurised Mains Private

APPENDIX B. QBAR RUNOFF CALCULATIONS

Appendix B

QBAR Runoff Calculations

ICP SUDS Mean Annual Flood

Input

Return Period (years)	2	Soil	0.450
Area (ha)	6.640	Urban	0.500
SAAR (mm)	815	Region Number	User Defined

User Defined Growth Curve

Filename gdsds_Growth Curve.gcfx Description GDSDS

Return Period (years)	Growth Curve Factor
1	0.850
2	0.000
5	0.000
10	1.700
20	0.000
25	0.000
30	2.100
50	0.000
100	2.600
200	2.900
500	0.000
1000	0.000

Results	l/s
QBAR Rural	34.9
QBAR Urban	68.2
Q2 years	0.0
Q1 year	58.0
Q30 years	34.3
Q100 years	n/a

ICP SUDS Mean Annual Flood

Input

Return Period (years)	2	Soil	0.450
Area (ha)	4.930	Urban	0.500
SAAR (mm)	815	Region Number	User Defined

User Defined Growth Curve

Filename gdsds_Growth Curve.gcfx Description GDSDS

Return Period (years)	**Growth Curve Factor**
1	0.850
2	0.000
5	0.000
10	1.700
20	0.000
25	0.000
30	2.100
50	0.000
100	2.600
200	2.900
500	0.000
1000	0.000

Results	**l/s**
QBAR Rural	25.9
QBAR Urban	50.7
Q2 years	0.0
Q1 year	43.1
Q30 years	25.5
Q100 years	n/a

ICP SUDS Mean Annual Flood

Input

Return Period (years)	2	Soil	0.450
Area (ha)	0.570	Urban	0.500
SAAR (mm)	815	Region Number	User Defined

User Defined Growth Curve

Filename gdsds_Growth Curve.gcfx Description GDSDS

Return Period (years)	**Growth Curve Factor**
1	0.850
2	0.000
5	0.000
10	1.700
20	0.000
25	0.000
30	2.100
50	0.000
100	2.600
200	2.900
500	0.000
1000	0.000

Results	**l/s**
QBAR Rural	3.0
QBAR Urban	5.9
Q2 years	0.0
Q1 year	5.0
Q30 years	2.9
Q100 years	n/a

APPENDIX C. SURFACE WATER DESIGN & ATTENUATION CALCULATIONS

- Design Criteria;
- Area Summery & Green Roof Time Area Diagrams;
- Network Design & Results Table;
- Simulation Criteria;
- Hydrobrake / Controls & Storage Design;
- Summary of Results.

Appendix C

Surface Water Design and Attenuation Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Water Drainage

Pipe Sizes GDSDS Manhole Sizes GDSDS

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	5	Foul Sewage (l/s/ha)	0.000	Maximum Backdrop Height (m)	5.000
M5-60 (mm)	17.000	Volumetric Runoff Coeff.	0.750	Min Design Depth for Optimisation (m)	1.200
Ratio R	0.300	PIMP (%)	100	Min Vel for Auto Design only (m/s)	1.00
Maximum Rainfall (mm/hr)	75	Add Flow / Climate Change (%)	10	Min Slope for Optimisation (1:X)	500
Maximum Time of Concentration (mins)	300	Minimum Backdrop Height (m)	0.000		

Designed with Level Soffits

Time Area Diagram for Surface Water Drainage

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.015	4-8	1.424	8-12	1.793	12-16	0.117

Total Area Contributing (ha) = 3.348

Total Pipe Volume (m³) = 895.569

Network Design Table for Surface Water Drainage

« - Indicates pipe capacity < flow

PN	**Length (m)**	**Fall (m)**	**Slope (1:X)**	**I.Area (ha)**	**T.E. (mins)**	**Base Flow (l/s)**	**k (mm)**	**n**	**HYD SECT**	**DIA (mm)**	**Section Type**	**Auto Design**

Network Results Table

PN	**Rain (mm/hr)**	**T.C. (mins)**	**US/IL (m)**	**Σ I.Area (ha)**	**Σ Base Flow (l/s)**	**Foul (l/s)**	**Add Flow (l/s)**	**Vel (m/s)**	**Cap (l/s)**	**Flow (l/s)**

Network Design Table for Surface Water Drainage

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
SW1.000	10.663	0.267	39.9	0.017	6.00	0.0	0.600		o	225	Pipe/Conduit	
SW2.000	4.737	0.118	40.1	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW3.000	16.280	0.096	170.0	0.033	6.00	0.0	0.600		o	225	Pipe/Conduit	
SW4.000	3.879	0.097	40.0	0.055	6.00	0.0	0.600		o	225	Pipe/Conduit	
SW5.000	10.359	0.061	170.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW3.001	15.693	0.092	170.0	0.065	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW6.000	4.414	0.110	40.1	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW3.002	21.567	0.108	200.0	0.137	0.00	0.0	0.600		o	300	Pipe/Conduit	
SW3.003	9.528	0.048	200.0	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW1.000	61.65	6.09	100.075	0.017	0.0	0.0	0.3	2.08	82.6	3.1
SW2.000	71.97	4.04	100.075	0.000	0.0	0.0	0.0	2.07	82.3	0.0
SW3.000	60.89	6.27	100.275	0.033	0.0	0.0	0.5	1.00	39.8	6.0
SW4.000	61.88	6.03	100.275	0.055	0.0	0.0	0.9	2.07	82.5	10.1
SW5.000	71.16	4.17	100.275	0.000	0.0	0.0	0.0	1.00	39.8	0.0
SW3.001	59.85	6.53	100.178	0.153	0.0	0.0	2.5	1.00	39.8	27.4
SW6.000	71.98	4.04	100.275	0.000	0.0	0.0	0.0	2.07	82.4	0.0
SW3.002	58.63	6.86	100.011	0.291	0.0	0.0	4.6	1.11	78.3	50.8
SW3.003	58.11	7.00	99.903	0.291	0.0	0.0	4.6	1.11	78.3	50.8

Network Design Table for Surface Water Drainage

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
SW7.000	49.284	0.290	170.0	0.089	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW7.001	16.757	0.099	170.0	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW2.001	15.260	0.076	200.0	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
SW8.000	15.777	0.394	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW9.000	2.691	0.067	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW2.002	22.377	0.112	199.8	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
SW1.001	26.790	0.134	200.0	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
SW1.002	21.058	0.105	200.0	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
SW10.000	11.628	0.291	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW7.000	67.55	4.82	100.275	0.089	0.0	0.0	1.6	1.00	39.8	17.9
SW7.001	66.13	5.10	99.985	0.089	0.0	0.0	1.6	1.00	39.8	17.9
SW2.001	57.29	7.23	99.812	0.380	0.0	0.0	5.9	1.11	78.3	64.8
SW8.000	71.43	4.13	100.075	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW9.000	72.07	4.02	100.000	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW2.002	56.15	7.57	99.606	0.380	0.0	0.0	5.9	1.11	78.4	64.8
SW1.001	54.85	7.97	99.494	0.397	0.0	0.0	5.9	1.11	78.3	64.8
SW1.002	53.88	8.29	99.360	0.397	0.0	0.0	5.9	1.11	78.3	64.8
SW10.000	71.63	4.09	100.075	0.000	0.0	0.0	0.0	2.07	82.5	0.0

Network Design Table for Surface Water Drainage

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
SW11.000	15.461	0.387	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW1.003	9.839	0.049	200.0	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
SW12.000	6.154	0.154	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW13.000	9.821	0.246	40.0	0.033	6.00	0.0	0.600		o	225	Pipe/Conduit	
SW12.001	18.497	0.123	150.0	0.069	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW12.002	20.862	0.139	150.0	0.082	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW12.003	38.710	0.194	200.0	0.059	0.00	0.0	0.600		o	300	Pipe/Conduit	
SW1.004	24.543	0.098	250.0	0.000	0.00	0.0	0.600		o	375	Pipe/Conduit	
SW14.000	11.126	0.278	40.0	0.000	6.00	0.0	0.600		o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW11.000	71.45	4.12	100.500	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW1.003	53.45	8.43	99.254	0.397	0.0	0.0	5.9	1.11	78.3	64.8
SW12.000	71.90	4.05	100.075	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW13.000	61.68	6.08	100.075	0.033	0.0	0.0	0.6	2.07	82.5	6.1
SW12.001	60.50	6.37	99.829	0.102	0.0	0.0	1.7	1.07	42.4	18.4
SW12.002	59.24	6.69	99.706	0.184	0.0	0.0	3.0	1.07	42.4	32.6
SW12.003	57.13	7.28	99.492	0.243	0.0	0.0	3.8	1.11	78.3	41.4
SW1.004	52.42	8.79	99.130	0.640	0.0	0.0	9.1	1.14	126.1	100.0
SW14.000	61.64	6.09	100.075	0.000	0.0	0.0	0.0	2.07	82.5	0.0

Network Design Table for Surface Water Drainage

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
SW15.000	7.798	0.195	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW1.005	17.191	0.069	250.0	0.000	0.00	0.0	0.600		o	375	Pipe/Conduit	
SW16.000	7.789	0.195	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW1.006	14.610	0.058	250.0	0.009	0.00	0.0	0.600		o	375	Pipe/Conduit	
SW1.007	15.795	0.063	250.0	0.000	0.00	0.0	0.600		o	375	Pipe/Conduit	
SW17.000	22.051	0.221	99.8	0.108	6.00	0.0		0.012	→|o|→		Filter Drain	
SW17.001	22.051	0.221	100.0	0.041	0.00	0.0		0.012	→|o|→		Filter Drain	
SW17.002	22.051	0.221	100.0	0.050	0.00	0.0		0.012	→|o|→		Filter Drain	
SW17.003	22.051	0.221	100.0	0.037	0.00	0.0		0.012	→|o|→		Filter Drain	
SW17.004	15.439	0.154	100.0	0.000	0.00	0.0		0.012	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW15.000	71.82	4.06	100.075	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW1.005	51.73	9.04	99.032	0.640	0.0	0.0	9.1	1.14	126.1	100.0
SW16.000	71.82	4.06	100.075	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW1.006	51.16	9.26	98.963	0.649	0.0	0.0	9.1	1.14	126.1	100.0
SW1.007	50.56	9.49	98.905	0.649	0.0	0.0	9.1	1.14	126.1	100.0
SW17.000	61.18	6.20	99.750	0.108	0.0	0.0	1.8	1.83	751.0	19.7
SW17.001	60.37	6.40	99.529	0.149	0.0	0.0	2.4	1.83	750.2	26.9
SW17.002	59.58	6.60	99.308	0.199	0.0	0.0	3.2	1.83	750.2	35.4
SW17.003	58.82	6.80	99.087	0.236	0.0	0.0	3.8	1.83	750.2	41.4
SW17.004	58.06	7.01	98.791	0.236	0.0	0.0	3.8	1.22	48.6	41.4

Network Design Table for Surface Water Drainage

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
SW18.000	7.354	0.184	40.0	0.000	6.00	0.0	0.600		o	225	Pipe/Conduit	
SW1.008	17.716	0.089	200.0	0.000	0.00	0.0	0.600		o	375	Pipe/Conduit	
SW19.000	24.788	0.165	150.0	0.077	4.00	0.0		0.012	→|o|→		Filter Drain	
SW19.001	24.788	0.165	150.0	0.044	0.00	0.0		0.012	→|o|→		Filter Drain	
SW19.002	24.788	0.165	150.0	0.034	0.00	0.0		0.012	→|o|→		Filter Drain	
SW19.003	25.378	0.169	150.0	0.022	0.00	0.0		0.012	→|o|→		Filter Drain	
SW19.004	5.384	0.036	149.6	0.000	0.00	0.0	0.600		o	150	Pipe/Conduit	
SW20.000	11.796	0.295	40.0	0.028	6.00	0.0	0.600		o	225	Pipe/Conduit	
SW21.000	17.930	0.448	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW22.000	11.333	0.283	40.0	0.048	4.00	0.0	0.600		o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW18.000	61.76	6.06	99.575	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW1.008	49.98	9.72	98.487	0.885	0.0	0.0	12.0	1.28	141.1	131.8
SW19.000	70.55	4.28	97.669	0.077	0.0	0.0	1.5	1.49	612.5	16.3
SW19.001	68.98	4.55	97.504	0.122	0.0	0.0	2.3	1.49	612.5	25.0
SW19.002	67.50	4.83	97.339	0.155	0.0	0.0	2.8	1.49	612.5	31.3
SW19.003	66.06	5.11	97.174	0.177	0.0	0.0	3.2	1.49	612.5	34.9
SW19.004	65.52	5.22	97.005	0.177	0.0	0.0	3.2	0.82	14.5«	34.9
SW20.000	61.61	6.09	98.100	0.028	0.0	0.0	0.5	2.07	82.5	5.2
SW21.000	71.33	4.14	97.900	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW22.000	71.65	4.09	98.100	0.048	0.0	0.0	0.9	2.07	82.5	10.3

Network Design Table for Surface Water Drainage

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
SW23.000	5.967	0.060	99.4	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW24.000	5.105	0.051	100.1	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW23.001	36.708	0.245	149.8	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW23.002	14.407	0.096	150.1	0.143	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW20.001	13.301	0.089	150.0	0.048	0.00	0.0	0.600		o	300	Pipe/Conduit	
SW25.000	27.371	0.684	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW26.000	8.393	0.210	40.0	0.000	6.00	0.0	0.600		o	225	Pipe/Conduit	
SW20.002	12.120	0.081	150.0	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
SW27.000	10.791	0.270	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW23.000	71.74	4.08	97.850	0.000	0.0	0.0	0.0	1.31	52.1	0.0
SW24.000	71.80	4.07	98.150	0.000	0.0	0.0	0.0	1.31	52.0	0.0
SW23.001	68.46	4.65	97.790	0.000	0.0	0.0	0.0	1.07	42.4	0.0
SW23.002	67.27	4.88	97.545	0.143	0.0	0.0	2.6	1.06	42.3	28.8
SW20.001	60.90	6.27	97.374	0.267	0.0	0.0	4.4	1.28	90.6	48.5
SW25.000	70.88	4.22	98.100	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW26.000	61.73	6.07	98.100	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW20.002	60.27	6.43	97.285	0.267	0.0	0.0	4.4	1.28	90.6	48.5
SW27.000	71.67	4.09	98.100	0.000	0.0	0.0	0.0	2.07	82.5	0.0

Network Design Table for Surface Water Drainage

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
SW28.000	8.599	0.215	40.0	0.000	6.00	0.0	0.600		o	225	Pipe/Conduit	
SW20.003	11.908	0.079	150.0	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
SW29.000	14.344	0.359	40.0	0.016	6.00	0.0	0.600		o	225	Pipe/Conduit	
SW30.000	3.547	0.089	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW31.000	5.438	0.136	40.0	0.015	6.00	0.0	0.600		o	225	Pipe/Conduit	
SW29.001	30.787	0.205	150.0	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW32.000	13.122	0.328	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW33.000	6.083	0.152	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW28.000	61.72	6.07	98.100	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW20.003	59.67	6.58	97.205	0.267	0.0	0.0	4.4	1.28	90.6	48.5
SW29.000	61.53	6.12	98.250	0.016	0.0	0.0	0.3	2.07	82.5	3.0
SW30.000	72.03	4.03	98.650	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW31.000	61.83	6.04	98.650	0.015	0.0	0.0	0.3	2.07	82.5	2.8
SW29.001	59.61	6.60	97.891	0.032	0.0	0.0	0.5	1.07	42.4	5.6
SW32.000	71.56	4.11	98.650	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW33.000	71.90	4.05	98.650	0.000	0.0	0.0	0.0	2.07	82.5	0.0

Network Design Table for Surface Water Drainage

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
SW29.002	29.525	0.197	150.0	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW34.000	5.034	0.126	40.0	0.018	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW35.000	7.754	0.194	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW36.000	7.704	0.193	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW34.001	28.528	0.190	150.0	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW37.000	4.007	0.100	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW38.000	4.012	0.100	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW29.003	22.331	0.149	149.9	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW29.002	57.90	7.06	97.686	0.032	0.0	0.0	0.5	1.07	42.4	5.6
SW34.000	71.95	4.04	98.650	0.018	0.0	0.0	0.4	2.07	82.5	3.9
SW35.000	71.82	4.06	98.650	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW36.000	71.82	4.06	98.650	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW34.001	69.23	4.51	98.456	0.018	0.0	0.0	0.4	1.07	42.4	3.9
SW37.000	72.00	4.03	98.300	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW38.000	72.00	4.03	98.300	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW29.003	56.68	7.41	97.489	0.050	0.0	0.0	0.8	1.07	42.4	8.4

Network Design Table for Surface Water Drainage

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
SW39.000	4.678	0.031	150.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW29.004	8.176	0.055	150.0	0.091	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW20.004	25.880	0.173	150.0	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
SW40.000	11.489	0.287	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW41.000	11.652	0.291	40.0	0.008	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW20.005	20.288	0.135	150.0	0.100	0.00	0.0	0.600		o	300	Pipe/Conduit	
SW1.009	7.231	0.048	150.0	0.050	0.00	0.0	0.600		o	450	Pipe/Conduit	
SW42.000	14.072	0.352	40.0	0.000	6.00	0.0	0.600		o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW39.000	71.75	4.07	98.000	0.000	0.0	0.0	0.0	1.07	42.4	0.0
SW29.004	56.25	7.54	97.340	0.141	0.0	0.0	2.1	1.07	42.4	23.6
SW20.004	55.16	7.87	97.125	0.408	0.0	0.0	6.1	1.28	90.6	67.1
SW40.000	71.64	4.09	98.000	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW41.000	71.63	4.09	98.000	0.008	0.0	0.0	0.2	2.07	82.5	1.7
SW20.005	54.34	8.14	96.953	0.516	0.0	0.0	7.6	1.28	90.6	83.5
SW1.009	49.80	9.79	96.800	1.629	0.0	0.0	22.0	1.66	263.6	241.6
SW42.000	61.54	6.11	100.450	0.000	0.0	0.0	0.0	2.07	82.5	0.0

Network Design Table for Surface Water Drainage

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
SW43.000	6.333	0.158	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW43.001	24.334	0.162	150.0	0.016	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW44.000	7.420	0.186	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW45.000	8.852	0.221	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW43.002	15.629	0.104	150.0	0.018	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW43.003	19.847	0.132	150.0	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW46.000	4.886	0.122	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW47.000	10.335	0.258	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW43.004	9.895	0.066	150.0	0.130	0.00	0.0	0.600		o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW43.000	71.89	4.05	100.750	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW43.001	69.66	4.43	100.592	0.016	0.0	0.0	0.3	1.07	42.4	3.3
SW44.000	71.84	4.06	100.750	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW45.000	71.77	4.07	100.750	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW43.002	68.32	4.68	100.429	0.034	0.0	0.0	0.6	1.07	42.4	6.9
SW43.003	66.70	4.99	100.325	0.034	0.0	0.0	0.6	1.07	42.4	6.9
SW46.000	71.96	4.04	100.500	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW47.000	71.70	4.08	101.000	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW43.004	65.93	5.14	100.193	0.164	0.0	0.0	2.9	1.07	42.4	32.2

Network Design Table for Surface Water Drainage

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
SW48.000	20.159	0.504	40.0	0.189	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW42.001	41.015	0.820	50.0	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW49.000	5.050	0.126	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW49.001	26.225	0.175	150.0	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW50.000	4.915	0.123	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW49.002	2.719	0.018	150.0	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW49.003	17.217	0.115	150.0	0.000	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW51.000	7.032	0.176	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW49.004	9.977	0.499	20.0	0.130	0.00	0.0	0.600		o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW48.000	71.22	4.16	100.750	0.189	0.0	0.0	3.6	2.07	82.5	40.0
SW42.001	60.05	6.48	100.098	0.353	0.0	0.0	5.7	1.85	73.7	63.1
SW49.000	71.95	4.04	100.500	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW49.001	69.55	4.45	100.374	0.000	0.0	0.0	0.0	1.07	42.4	0.0
SW50.000	71.96	4.04	100.500	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW49.002	69.32	4.49	100.199	0.000	0.0	0.0	0.0	1.07	42.4	0.0
SW49.003	67.86	4.76	100.181	0.000	0.0	0.0	0.0	1.07	42.4	0.0
SW51.000	71.86	4.06	100.300	0.000	0.0	0.0	0.0	2.08	82.5	0.0
SW49.004	67.56	4.82	99.800	0.130	0.0	0.0	2.4	2.94	116.9	26.1

Network Design Table for Surface Water Drainage

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
SW52.000	5.407	0.135	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW52.001	48.677	0.325	150.0	0.043	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW53.000	6.982	0.175	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW52.002	12.960	0.324	40.0	0.163	0.00	0.0	0.600		o	225	Pipe/Conduit	
SW42.002	32.533	0.930	35.0	0.000	0.00	0.0	0.600		o	300	Pipe/Conduit	
SW54.000	16.519	0.413	40.0	0.000	4.00	0.0	0.600		o	225	Pipe/Conduit	
SW55.000	40.889	0.273	150.0	0.103	6.00	0.0		0.012	→|o|→		Filter Drain	
SW55.001	22.870	0.152	150.0	0.057	0.00	0.0		0.012	→|o|→		Filter Drain	
SW55.002	23.415	0.156	150.0	0.050	0.00	0.0		0.012	→|o|→		Filter Drain	
SW55.003	23.467	0.156	150.0	0.052	0.00	0.0		0.012	→|o|→		Filter Drain	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW52.000	71.94	4.04	100.600	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW52.001	67.63	4.81	100.465	0.043	0.0	0.0	0.8	1.07	42.4	8.7
SW53.000	71.86	4.06	100.500	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW52.002	67.09	4.91	100.140	0.206	0.0	0.0	3.7	2.07	82.5	41.2
SW42.002	59.27	6.69	99.203	0.689	0.0	0.0	11.1	2.67	188.5	121.6
SW54.000	71.40	4.13	99.000	0.000	0.0	0.0	0.0	2.07	82.5	0.0
SW55.000	60.15	6.46	99.500	0.103	0.0	0.0	1.7	1.49	612.5	18.5
SW55.001	59.17	6.71	99.347	0.160	0.0	0.0	2.6	1.49	612.5	28.2
SW55.002	58.20	6.97	99.194	0.210	0.0	0.0	3.3	1.49	612.5	36.4
SW55.003	57.27	7.24	99.041	0.262	0.0	0.0	4.1	1.49	612.5	44.7

Network Design Table for Surface Water Drainage

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
SW55.004	9.566	0.319	30.0	0.000	0.00	0.0		0.012	o	225	Pipe/Conduit	
SW42.003	65.323	0.261	250.0	0.030	0.00	0.0	0.600		o	450	Pipe/Conduit	
SW42.004	17.775	0.071	250.0	0.050	0.00	0.0		0.012	o	450	Pipe/Conduit	
SW1.010	32.863	0.005	6572.6	0.000	0.00	0.0		0.012	→[↓]		Cellular Storage	
SW56.000	17.663	0.093	189.9	0.389	6.00	0.0	0.600		o	375	Pipe/Conduit	
SW1.011	14.393	0.036	400.0	0.300	0.00	0.0		0.012	o	450	Pipe/Conduit	
SW57.000	6.025	0.040	150.0	0.000	4.00	0.0	0.600		o	150	Pipe/Conduit	
SW57.001	11.442	0.076	150.0	0.000	0.00	0.0	0.600		o	150	Pipe/Conduit	
SW1.012	40.956	0.126	325.0	0.000	0.00	0.0	0.600		o	375	Pipe/Conduit	
SW1.013	76.010	0.234	325.0	0.000	0.00	0.0	0.600		o	375	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW55.004	57.03	7.31	98.888	0.262	0.0	0.0	4.1	2.23	88.8	44.7
SW42.003	54.27	8.16	98.123	0.981	0.0	0.0	14.4	1.28	203.8	158.5
SW42.004	53.55	8.40	97.862	1.031	0.0	0.0	14.9	1.23	195.3	164.4
SW1.010	47.16	10.93	96.650	2.659	0.0	0.0	34.0	0.48	9634.8	373.6
SW56.000	61.08	6.22	98.325	0.389	0.0	0.0	6.4	1.31	144.8	70.8
SW1.011	46.64	11.18	96.645	3.348	0.0	0.0	42.3	0.97	154.4«	465.2
SW57.000	71.46	4.12	97.750	0.000	0.0	0.0	0.0	0.82	14.5	0.0
SW57.001	70.09	4.36	97.641	0.000	0.0	0.0	0.0	0.82	14.5	0.0
SW1.012	68.28	4.68	96.609	0.000	30.0	0.0	2.7	1.00	110.4	30.0
SW1.013	65.31	5.27	96.483	0.000	30.0	0.0	2.7	1.00	110.4	30.0

Network Design Table for Surface Water Drainage

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	n	HYD SECT	DIA (mm)	Section Type	Auto Design
SW1.014	10.887	0.033	325.0	0.000	0.00	0.0	0.600		o	375	Pipe/Conduit	
SW1.015	79.428	0.244	325.0	0.000	0.00	0.0	0.600		o	375	Pipe/Conduit	
SW1.016	5.479	0.017	325.0	0.000	0.00	0.0	0.600		o	375	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW1.014	71.11	4.18	96.249	0.000	30.0	0.0	2.7	1.00	110.4	30.0
SW1.015	65.04	5.32	96.216	0.000	30.0	0.0	2.7	1.00	110.4	30.0
SW1.016	71.65	4.09	95.971	0.000	30.0	0.0	2.7	1.00	110.4	30.0

Area Summary for Surface Water Drainage

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	Classification	Inaccessible Roof	100	0.017	0.017	0.017
2.000	-	-	100	0.000	0.000	0.000
3.000	Classification	Inaccessible Roof	100	0.033	0.033	0.033
4.000	Classification	Inaccessible Roof	100	0.055	0.055	0.055
5.000	-	-	100	0.000	0.000	0.000
3.001	Classification	Landscape	100	0.065	0.065	0.065
6.000	-	-	100	0.000	0.000	0.000
3.002	Classification	Landscape	100	0.137	0.137	0.137
3.003	-	-	100	0.000	0.000	0.000
7.000	Classification	Landscape	100	0.089	0.089	0.089
7.001	-	-	100	0.000	0.000	0.000
2.001	-	-	100	0.000	0.000	0.000
8.000	-	-	100	0.000	0.000	0.000
9.000	-	-	100	0.000	0.000	0.000
2.002	-	-	100	0.000	0.000	0.000
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
10.000	-	-	100	0.000	0.000	0.000
11.000	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.000	0.000	0.000
12.000	-	-	100	0.000	0.000	0.000
13.000	Classification	Inaccessible Roof	100	0.033	0.033	0.033
12.001	Classification	Landscape	100	0.069	0.069	0.069
12.002	Classification	Landscape	100	0.082	0.082	0.082
12.003	Classification	Landscape	100	0.059	0.059	0.059
1.004	-	-	100	0.000	0.000	0.000
14.000	-	-	100	0.000	0.000	0.000
15.000	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.000	0.000	0.000
16.000	-	-	100	0.000	0.000	0.000
1.006	Classification	Inaccessible Roof	100	0.009	0.009	0.009
1.007	-	-	100	0.000	0.000	0.000
17.000	Classification	Road / Pavement	100	0.046	0.046	0.046
	Classification	Landscape	100	0.018	0.018	0.063
	Classification	Landscape	100	0.045	0.045	0.108
17.001	Classification	Road / Pavement	100	0.015	0.015	0.015
	Classification	Landscape	100	0.018	0.018	0.032
	Classification	Landscape	100	0.009	0.009	0.041

Area Summary for Surface Water Drainage

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
17.002	Classification	Road / Pavement	100	0.011	0.011	0.011
	Classification	Landscape	100	0.028	0.028	0.040
	Classification	Landscape	100	0.010	0.010	0.050
17.003	Classification	Road / Pavement	100	0.011	0.011	0.011
	Classification	Landscape	100	0.019	0.019	0.031
	Classification	Landscape	100	0.006	0.006	0.037
17.004	-	-	100	0.000	0.000	0.000
18.000	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
19.000	Classification	Road / Pavement	100	0.035	0.035	0.035
	Classification	Landscape	100	0.029	0.029	0.064
	Classification	Landscape	100	0.013	0.013	0.077
19.001	Classification	Road / Pavement	100	0.017	0.017	0.017
	Classification	Landscape	100	0.016	0.016	0.034
	Classification	Landscape	100	0.011	0.011	0.044
19.002	Classification	Road / Pavement	100	0.012	0.012	0.012
	Classification	Landscape	100	0.019	0.019	0.031
	Classification	Landscape	100	0.003	0.003	0.034
19.003	Classification	Landscape	100	0.022	0.022	0.022
19.004	-	-	100	0.000	0.000	0.000
20.000	Classification	Inaccessible Roof	100	0.028	0.028	0.028
21.000	-	-	100	0.000	0.000	0.000
22.000	Classification	Landscape	100	0.048	0.048	0.048
23.000	-	-	100	0.000	0.000	0.000
24.000	-	-	100	0.000	0.000	0.000
23.001	-	-	100	0.000	0.000	0.000
23.002	Classification	Landscape	100	0.143	0.143	0.143
20.001	Classification	Landscape	100	0.048	0.048	0.048
25.000	-	-	100	0.000	0.000	0.000
26.000	-	-	100	0.000	0.000	0.000
20.002	-	-	100	0.000	0.000	0.000
27.000	-	-	100	0.000	0.000	0.000
28.000	-	-	100	0.000	0.000	0.000
20.003	-	-	100	0.000	0.000	0.000
29.000	Classification	Inaccessible Roof	100	0.016	0.016	0.016
30.000	-	-	100	0.000	0.000	0.000
31.000	Classification	Inaccessible Roof	100	0.015	0.015	0.015
29.001	-	-	100	0.000	0.000	0.000

Area Summary for Surface Water Drainage

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
32.000	-	-	100	0.000	0.000	0.000
33.000	-	-	100	0.000	0.000	0.000
29.002	-	-	100	0.000	0.000	0.000
34.000	Classification	Inaccessible Roof	100	0.018	0.018	0.018
35.000	-	-	100	0.000	0.000	0.000
36.000	-	-	100	0.000	0.000	0.000
34.001	-	-	100	0.000	0.000	0.000
37.000	-	-	100	0.000	0.000	0.000
38.000	-	-	100	0.000	0.000	0.000
29.003	-	-	100	0.000	0.000	0.000
39.000	-	-	100	0.000	0.000	0.000
29.004	Classification	Landscape	100	0.091	0.091	0.091
20.004	-	-	100	0.000	0.000	0.000
40.000	-	-	100	0.000	0.000	0.000
41.000	Classification	Inaccessible Roof	100	0.008	0.008	0.008
20.005	-	-	100	0.100	0.100	0.100
1.009	-	-	100	0.050	0.050	0.050
42.000	-	-	100	0.000	0.000	0.000
43.000	-	-	100	0.000	0.000	0.000
43.001	Classification	Inaccessible Roof	100	0.016	0.016	0.016
44.000	-	-	100	0.000	0.000	0.000
45.000	-	-	100	0.000	0.000	0.000
43.002	Classification	Inaccessible Roof	100	0.018	0.018	0.018
43.003	-	-	100	0.000	0.000	0.000
46.000	-	-	100	0.000	0.000	0.000
47.000	-	-	100	0.000	0.000	0.000
43.004	Classification	Landscape	100	0.130	0.130	0.130
48.000	Classification	Landscape	100	0.052	0.052	0.052
	Classification	Landscape	100	0.112	0.112	0.164
	Classification	Inaccessible Roof	100	0.008	0.008	0.171
	Classification	Landscape	100	0.017	0.017	0.189
42.001	-	-	100	0.000	0.000	0.000
49.000	-	-	100	0.000	0.000	0.000
49.001	-	-	100	0.000	0.000	0.000
50.000	-	-	100	0.000	0.000	0.000
49.002	-	-	100	0.000	0.000	0.000
49.003	-	-	100	0.000	0.000	0.000
51.000	-	-	100	0.000	0.000	0.000

Area Summary for Surface Water Drainage

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
49.004	Classification	Landscape	100	0.130	0.130	0.130
52.000	-	-	100	0.000	0.000	0.000
52.001	Classification	Inaccessible Roof	100	0.043	0.043	0.043
53.000	-	-	100	0.000	0.000	0.000
52.002	Classification	Landscape	100	0.163	0.163	0.163
42.002	-	-	100	0.000	0.000	0.000
54.000	-	-	100	0.000	0.000	0.000
55.000	Classification	Road / Pavement	100	0.044	0.044	0.044
	Classification	Landscape	100	0.059	0.059	0.103
55.001	Classification	Road / Pavement	100	0.024	0.024	0.024
	Classification	Landscape	100	0.019	0.019	0.043
	Classification	Landscape	100	0.014	0.014	0.057
55.002	Classification	Road / Pavement	100	0.020	0.020	0.020
	Classification	Landscape	100	0.018	0.018	0.038
	Classification	Landscape	100	0.012	0.012	0.050
55.003	Classification	Road / Pavement	100	0.018	0.018	0.018
	Classification	Landscape	100	0.013	0.013	0.030
	Classification	Landscape	100	0.022	0.022	0.052
55.004	-	-	100	0.000	0.000	0.000
42.003	-	-	100	0.030	0.030	0.030
42.004	-	-	100	0.050	0.050	0.050
1.010	-	-	100	0.000	0.000	0.000
56.000	Classification	Landscape	100	0.389	0.389	0.389
1.011	-	-	100	0.300	0.300	0.300
57.000	-	-	100	0.000	0.000	0.000
57.001	-	-	100	0.000	0.000	0.000
1.012	-	-	100	0.000	0.000	0.000
1.013	-	-	100	0.000	0.000	0.000
1.014	-	-	100	0.000	0.000	0.000
1.015	-	-	100	0.000	0.000	0.000
1.016	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				3.348	3.348	3.348

Free Flowing Outfall Details for Surface Water Drainage

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
SW1.016	SW/MH-	98.175	95.954	96.150	300	0

Simulation Criteria for Surface Water Drainage

Volumetric Runoff Coeff	0.750	Manhole Headloss Coeff (Global)	0.500	Inlet Coeffiecient	0.800
Areal Reduction Factor	1.000	Foul Sewage per hectare (l/s)	0.000	Flow per Person per Day (l/per/day)	0.000
Hot Start (mins)	0	Additional Flow - % of Total Flow	0.000	Run Time (mins)	60
Hot Start Level (mm)	0	MADD Factor * 10m³/ha Storage	2.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Offline Controls	2	Number of Time/Area Diagrams	39
Number of Online Controls	2	Number of Storage Structures	14	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	17.000	Cv (Summer)	0.750
Return Period (years)	5	Ratio R	0.300	Cv (Winter)	0.840
Region	Scotland and Ireland	Profile Type	Summer	Storm Duration (mins)	30

Online Controls for Surface Water Drainage

Non Return Valve Manhole: SW/MH-116, DS/PN: SW57.001, Volume (m³): 0.1

Hydro-Brake® Optimum Manhole: SW/MH-117, DS/PN: SW1.012, Volume (m³): 8.5

Unit Reference	MD-SHE-0262-4500-2390-4500	Sump Available	Yes
Design Head (m)	2.390	Diameter (mm)	262
Design Flow (l/s)	45.0	Invert Level (m)	96.609
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	300
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	2100
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.390	45.0	Kick-Flo®	1.513	36.1
Flush-Flo™	0.704	45.0	Mean Flow over Head Range	-	39.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.4	0.600	44.8	1.600	37.1	2.600	46.8	5.000	64.2	7.500	78.2
0.200	27.0	0.800	44.8	1.800	39.2	3.000	50.2	5.500	67.3	8.000	80.7
0.300	40.0	1.000	44.0	2.000	41.3	3.500	54.0	6.000	70.2	8.500	83.1
0.400	42.6	1.200	42.4	2.200	43.2	4.000	57.7	6.500	73.0	9.000	85.5
0.500	44.1	1.400	39.3	2.400	45.0	4.500	61.0	7.000	75.6	9.500	87.8

Offline Controls for Surface Water Drainage

Pipe Manhole: SW/MH-114, DS/PN: SW1.011, Loop to PN: SW57.000

Diameter (m)	0.225	Slope (1:X)	50.0	Roughness k (mm)	0.600	Coefficient of Contraction	0.600
Section Type	Pipe/Conduit	Length (m)	1.000	Entry Loss Coefficient	0.500	Upstream Invert Level (m)	98.150

Pipe Manhole: SW/MH-117, DS/PN: SW1.012, Loop to PN: SW57.000

Diameter (m)	0.225	Slope (1:X)	100.0	Roughness k (mm)	0.600	Coefficient of Contraction	0.600
Section Type	Pipe/Conduit	Length (m)	1.000	Entry Loss Coefficient	0.500	Upstream Invert Level (m)	98.595

Storage Structures for Surface Water Drainage

Filter Drain Pipe: SW17.000

Manning's N	0.012	Invert Level (m)	99.750	Number of Pipes	1
Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	1.0	Slope (1:X)	99.8
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	22.1	Cap Volume Depth (m)	1.000
Safety Factor	2.0	Pipe Diameter (m)	0.150	Cap Infiltration Depth (m)	0.000
Porosity	0.40	Pipe Depth above Invert (m)	0.150		

Filter Drain Pipe: SW17.001

Manning's N	0.012	Invert Level (m)	99.529	Number of Pipes	1
Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	1.0	Slope (1:X)	100.0
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	22.1	Cap Volume Depth (m)	1.000
Safety Factor	2.0	Pipe Diameter (m)	0.150	Cap Infiltration Depth (m)	0.000
Porosity	0.40	Pipe Depth above Invert (m)	0.150		

Filter Drain Pipe: SW17.002

Manning's N	0.012	Invert Level (m)	99.308	Number of Pipes	1
Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	1.0	Slope (1:X)	100.0
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	22.1	Cap Volume Depth (m)	1.000
Safety Factor	2.0	Pipe Diameter (m)	0.150	Cap Infiltration Depth (m)	0.000
Porosity	0.40	Pipe Depth above Invert (m)	0.150		

Filter Drain Pipe: SW17.003

Manning's N	0.012	Invert Level (m)	99.087	Number of Pipes	1
Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	1.0	Slope (1:X)	100.0
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	22.1	Cap Volume Depth (m)	1.000
Safety Factor	2.0	Pipe Diameter (m)	0.150	Cap Infiltration Depth (m)	0.000
Porosity	0.40	Pipe Depth above Invert (m)	0.150		

Filter Drain Pipe: SW19.000

Manning's N	0.012	Safety Factor	2.0	Trench Width (m)	1.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.40	Trench Length (m)	24.8
Infiltration Coefficient Side (m/hr)	0.00000	Invert Level (m)	97.669	Pipe Diameter (m)	0.150

Filter Drain Pipe: SW19.000

Pipe Depth above Invert (m)	0.150	Slope (1:X)	150.0	Cap Infiltration Depth (m)	0.000
Number of Pipes	1	Cap Volume Depth (m)	1.000		

Filter Drain Pipe: SW19.001

Manning's N	0.012	Invert Level (m)	97.504	Number of Pipes	1
Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	1.0	Slope (1:X)	150.0
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	24.8	Cap Volume Depth (m)	1.000
Safety Factor	2.0	Pipe Diameter (m)	0.150	Cap Infiltration Depth (m)	0.000
Porosity	0.40	Pipe Depth above Invert (m)	0.150		

Filter Drain Pipe: SW19.002

Manning's N	0.012	Invert Level (m)	97.339	Number of Pipes	1
Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	1.0	Slope (1:X)	150.0
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	24.8	Cap Volume Depth (m)	1.000
Safety Factor	2.0	Pipe Diameter (m)	0.150	Cap Infiltration Depth (m)	0.000
Porosity	0.40	Pipe Depth above Invert (m)	0.150		

Filter Drain Pipe: SW19.003

Manning's N	0.012	Invert Level (m)	97.174	Number of Pipes	1
Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	1.0	Slope (1:X)	150.0
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	25.4	Cap Volume Depth (m)	1.000
Safety Factor	2.0	Pipe Diameter (m)	0.150	Cap Infiltration Depth (m)	0.000
Porosity	0.40	Pipe Depth above Invert (m)	0.150		

Filter Drain Pipe: SW55.000

Manning's N	0.012	Invert Level (m)	99.500	Number of Pipes	1
Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	1.0	Slope (1:X)	150.0
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	40.9	Cap Volume Depth (m)	1.000
Safety Factor	2.0	Pipe Diameter (m)	0.150	Cap Infiltration Depth (m)	0.000
Porosity	0.40	Pipe Depth above Invert (m)	0.150		

Filter Drain Pipe: SW55.001

Manning's N	0.012	Invert Level (m)	99.347	Number of Pipes	1
Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	1.0	Slope (1:X)	150.0
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	22.9	Cap Volume Depth (m)	1.000
Safety Factor	2.0	Pipe Diameter (m)	0.150	Cap Infiltration Depth (m)	0.000
Porosity	0.40	Pipe Depth above Invert (m)	0.150		

Filter Drain Pipe: SW55.002

Manning's N	0.012	Invert Level (m)	99.194	Number of Pipes	1
Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	1.0	Slope (1:X)	150.0
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	23.4	Cap Volume Depth (m)	1.000
Safety Factor	2.0	Pipe Diameter (m)	0.150	Cap Infiltration Depth (m)	0.000
Porosity	0.40	Pipe Depth above Invert (m)	0.150		

Filter Drain Pipe: SW55.003

Manning's N	0.012	Invert Level (m)	99.041	Number of Pipes	1
Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	1.0	Slope (1:X)	150.0
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	23.5	Cap Volume Depth (m)	1.000
Safety Factor	2.0	Pipe Diameter (m)	0.150	Cap Infiltration Depth (m)	0.000
Porosity	0.40	Pipe Depth above Invert (m)	0.150		

Cellular Storage Pipe: SW1.010

Manning's N	0.012	Infiltration Coefficient Base (m/hr)	0.00000	Safety Factor	2.0
Invert Level (m)	96.650	Infiltration Coefficient Side (m/hr)	0.00000	Porosity	0.60

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	1000.0	0.0	1.100	1000.0	0.0	1.101	0.0	0.0

Tank or Pond Manhole: SW/MH-115, DS/PN: SW57.000

Invert Level (m) 97.750

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	252.0	0.450	252.0	0.451	440.0	0.850	440.0	0.851	700.0	1.250	1166.0	1.251	1166.0	2.000	1800.0

Time Area Diagram for Green Roof at Pipe Number SW2.000 (Surface Water Drainage)

Area (m³) 633 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.020869	20	24	0.002824	40	44	0.000382	60	64	0.000052	80	84	0.000007	100	104	0.000001
4	8	0.013989	24	28	0.001893	44	48	0.000256	64	68	0.000035	84	88	0.000005	104	108	0.000001
8	12	0.009377	28	32	0.001269	48	52	0.000172	68	72	0.000023	88	92	0.000003	108	112	0.000000
12	16	0.006286	32	36	0.000851	52	56	0.000115	72	76	0.000016	92	96	0.000002	112	116	0.000000
16	20	0.004213	36	40	0.000570	56	60	0.000077	76	80	0.000010	96	100	0.000001	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW5.000 (Surface Water Drainage)

Area (m³) 294 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.005343	20	24	0.001965	40	44	0.000723	60	64	0.000266	80	84	0.000098	100	104	0.000036
4	8	0.004374	24	28	0.001609	44	48	0.000592	64	68	0.000218	84	88	0.000080	104	108	0.000029
8	12	0.003581	28	32	0.001317	48	52	0.000485	68	72	0.000178	88	92	0.000066	108	112	0.000024
12	16	0.002932	32	36	0.001079	52	56	0.000397	72	76	0.000146	92	96	0.000054	112	116	0.000020
16	20	0.002401	36	40	0.000883	56	60	0.000325	76	80	0.000120	96	100	0.000044	116	120	0.000016

Time Area Diagram for Green Roof at Pipe Number SW6.000 (Surface Water Drainage)

Area (m³) 155 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.005110	20	24	0.000692	40	44	0.000094	60	64	0.000013	80	84	0.000002	100	104	0.000000
4	8	0.003425	24	28	0.000464	44	48	0.000063	64	68	0.000008	84	88	0.000001	104	108	0.000000
8	12	0.002296	28	32	0.000311	48	52	0.000042	68	72	0.000006	88	92	0.000001	108	112	0.000000
12	16	0.001539	32	36	0.000208	52	56	0.000028	72	76	0.000004	92	96	0.000001	112	116	0.000000
16	20	0.001032	36	40	0.000140	56	60	0.000019	76	80	0.000003	96	100	0.000000	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW8.000 (Surface Water Drainage)

Area (m³) 345 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.006269	20	24	0.002306	40	44	0.000848	60	64	0.000312	80	84	0.000115	100	104	0.000042
4	8	0.005133	24	28	0.001888	44	48	0.000695	64	68	0.000256	84	88	0.000094	104	108	0.000035
8	12	0.004202	28	32	0.001546	48	52	0.000569	68	72	0.000209	88	92	0.000077	108	112	0.000028
12	16	0.003441	32	36	0.001266	52	56	0.000466	72	76	0.000171	92	96	0.000063	112	116	0.000023
16	20	0.002817	36	40	0.001036	56	60	0.000381	76	80	0.000140	96	100	0.000052	116	120	0.000019

Time Area Diagram for Green Roof at Pipe Number SW9.000 (Surface Water Drainage)

Area (m³) 75 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.002473	20	24	0.000335	40	44	0.000045	60	64	0.000006	80	84	0.000001	100	104	0.000000
4	8	0.001657	24	28	0.000224	44	48	0.000030	64	68	0.000004	84	88	0.000001	104	108	0.000000
8	12	0.001111	28	32	0.000150	48	52	0.000020	68	72	0.000003	88	92	0.000000	108	112	0.000000
12	16	0.000745	32	36	0.000101	52	56	0.000014	72	76	0.000002	92	96	0.000000	112	116	0.000000
16	20	0.000499	36	40	0.000068	56	60	0.000009	76	80	0.000001	96	100	0.000000	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW10.000 (Surface Water Drainage)

Area (m³) 1290 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.042529	20	24	0.005756	40	44	0.000779	60	64	0.000105	80	84	0.000014	100	104	0.000002
4	8	0.028508	24	28	0.003858	44	48	0.000522	64	68	0.000071	84	88	0.000010	104	108	0.000001
8	12	0.019110	28	32	0.002586	48	52	0.000350	68	72	0.000047	88	92	0.000006	108	112	0.000001
12	16	0.012809	32	36	0.001734	52	56	0.000235	72	76	0.000032	92	96	0.000004	112	116	0.000001
16	20	0.008586	36	40	0.001162	56	60	0.000157	76	80	0.000021	96	100	0.000003	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW11.000 (Surface Water Drainage)

Area (m^3) 199 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.003616	20	24	0.001330	40	44	0.000489	60	64	0.000180	80	84	0.000066	100	104	0.000024
4	8	0.002961	24	28	0.001089	44	48	0.000401	64	68	0.000147	84	88	0.000054	104	108	0.000020
8	12	0.002424	28	32	0.000892	48	52	0.000328	68	72	0.000121	88	92	0.000044	108	112	0.000016
12	16	0.001985	32	36	0.000730	52	56	0.000269	72	76	0.000099	92	96	0.000036	112	116	0.000013
16	20	0.001625	36	40	0.000598	56	60	0.000220	76	80	0.000081	96	100	0.000030	116	120	0.000011

Time Area Diagram for Green Roof at Pipe Number SW12.000 (Surface Water Drainage)

Area (m^3) 294 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.005343	20	24	0.001965	40	44	0.000723	60	64	0.000266	80	84	0.000098	100	104	0.000036
4	8	0.004374	24	28	0.001609	44	48	0.000592	64	68	0.000218	84	88	0.000080	104	108	0.000029
8	12	0.003581	28	32	0.001317	48	52	0.000485	68	72	0.000178	88	92	0.000066	108	112	0.000024
12	16	0.002932	32	36	0.001079	52	56	0.000397	72	76	0.000146	92	96	0.000054	112	116	0.000020
16	20	0.002401	36	40	0.000883	56	60	0.000325	76	80	0.000120	96	100	0.000044	116	120	0.000016

Time Area Diagram for Green Roof at Pipe Number SW14.000 (Surface Water Drainage)

Area (m^3) 199 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.003616	20	24	0.001330	40	44	0.000489	60	64	0.000180	80	84	0.000066	100	104	0.000024
4	8	0.002961	24	28	0.001089	44	48	0.000401	64	68	0.000147	84	88	0.000054	104	108	0.000020
8	12	0.002424	28	32	0.000892	48	52	0.000328	68	72	0.000121	88	92	0.000044	108	112	0.000016
12	16	0.001985	32	36	0.000730	52	56	0.000269	72	76	0.000099	92	96	0.000036	112	116	0.000013
16	20	0.001625	36	40	0.000598	56	60	0.000220	76	80	0.000081	96	100	0.000030	116	120	0.000011

Time Area Diagram for Green Roof at Pipe Number SW15.000 (Surface Water Drainage)

Area (m^3) 354 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.006433	20	24	0.002367	40	44	0.000871	60	64	0.000320	80	84	0.000118	100	104	0.000043
4	8	0.005267	24	28	0.001938	44	48	0.000713	64	68	0.000262	84	88	0.000096	104	108	0.000035
8	12	0.004312	28	32	0.001586	48	52	0.000584	68	72	0.000215	88	92	0.000079	108	112	0.000029
12	16	0.003530	32	36	0.001299	52	56	0.000478	72	76	0.000176	92	96	0.000065	112	116	0.000024
16	20	0.002890	36	40	0.001063	56	60	0.000391	76	80	0.000144	96	100	0.000053	116	120	0.000019

Time Area Diagram for Green Roof at Pipe Number SW16.000 (Surface Water Drainage)

Area (m^3) 1130 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.037254	20	24	0.005042	40	44	0.000682	60	64	0.000092	80	84	0.000012	100	104	0.000002
4	8	0.024972	24	28	0.003380	44	48	0.000457	64	68	0.000062	84	88	0.000008	104	108	0.000001
8	12	0.016739	28	32	0.002265	48	52	0.000307	68	72	0.000041	88	92	0.000006	108	112	0.000001
12	16	0.011221	32	36	0.001519	52	56	0.000206	72	76	0.000028	92	96	0.000004	112	116	0.000001
16	20	0.007521	36	40	0.001018	56	60	0.000138	76	80	0.000019	96	100	0.000003	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW18.000 (Surface Water Drainage)

Area (m^3) 199 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.006561	20	24	0.000888	40	44	0.000120	60	64	0.000016	80	84	0.000002	100	104	0.000000
4	8	0.004398	24	28	0.000595	44	48	0.000081	64	68	0.000011	84	88	0.000001	104	108	0.000000
8	12	0.002948	28	32	0.000399	48	52	0.000054	68	72	0.000007	88	92	0.000001	108	112	0.000000
12	16	0.001976	32	36	0.000267	52	56	0.000036	72	76	0.000005	92	96	0.000001	112	116	0.000000
16	20	0.001325	36	40	0.000179	56	60	0.000024	76	80	0.000003	96	100	0.000000	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW21.000 (Surface Water Drainage)

Area (m³) 85 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.002802	20	24	0.000379	40	44	0.000051	60	64	0.000007	80	84	0.000001	100	104	0.000000
4	8	0.001878	24	28	0.000254	44	48	0.000034	64	68	0.000005	84	88	0.000001	104	108	0.000000
8	12	0.001259	28	32	0.000170	48	52	0.000023	68	72	0.000003	88	92	0.000000	108	112	0.000000
12	16	0.000844	32	36	0.000114	52	56	0.000015	72	76	0.000002	92	96	0.000000	112	116	0.000000
16	20	0.000566	36	40	0.000077	56	60	0.000010	76	80	0.000001	96	100	0.000000	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW23.000 (Surface Water Drainage)

Area (m³) 1209 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.039859	20	24	0.005394	40	44	0.000730	60	64	0.000099	80	84	0.000013	100	104	0.000002
4	8	0.026718	24	28	0.003616	44	48	0.000489	64	68	0.000066	84	88	0.000009	104	108	0.000001
8	12	0.017910	28	32	0.002424	48	52	0.000328	68	72	0.000044	88	92	0.000006	108	112	0.000001
12	16	0.012005	32	36	0.001625	52	56	0.000220	72	76	0.000030	92	96	0.000004	112	116	0.000001
16	20	0.008047	36	40	0.001089	56	60	0.000147	76	80	0.000020	96	100	0.000003	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW24.000 (Surface Water Drainage)

Area (m³) 315 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.005724	20	24	0.002106	40	44	0.000775	60	64	0.000285	80	84	0.000105	100	104	0.000039
4	8	0.004687	24	28	0.001724	44	48	0.000634	64	68	0.000233	84	88	0.000086	104	108	0.000032
8	12	0.003837	28	32	0.001412	48	52	0.000519	68	72	0.000191	88	92	0.000070	108	112	0.000026
12	16	0.003141	32	36	0.001156	52	56	0.000425	72	76	0.000156	92	96	0.000058	112	116	0.000021
16	20	0.002572	36	40	0.000946	56	60	0.000348	76	80	0.000128	96	100	0.000047	116	120	0.000017

Time Area Diagram for Green Roof at Pipe Number SW25.000 (Surface Water Drainage)

Area (m³) 783 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.025814	20	24	0.003494	40	44	0.000473	60	64	0.000064	80	84	0.000009	100	104	0.000001
4	8	0.017304	24	28	0.002342	44	48	0.000317	64	68	0.000043	84	88	0.000006	104	108	0.000001
8	12	0.011599	28	32	0.001570	48	52	0.000212	68	72	0.000029	88	92	0.000004	108	112	0.000001
12	16	0.007775	32	36	0.001052	52	56	0.000142	72	76	0.000019	92	96	0.000003	112	116	0.000000
16	20	0.005212	36	40	0.000705	56	60	0.000095	76	80	0.000013	96	100	0.000002	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW26.000 (Surface Water Drainage)

Area (m³) 197 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.003580	20	24	0.001317	40	44	0.000484	60	64	0.000178	80	84	0.000066	100	104	0.000024
4	8	0.002931	24	28	0.001078	44	48	0.000397	64	68	0.000146	84	88	0.000054	104	108	0.000020
8	12	0.002400	28	32	0.000883	48	52	0.000325	68	72	0.000119	88	92	0.000044	108	112	0.000016
12	16	0.001965	32	36	0.000723	52	56	0.000266	72	76	0.000098	92	96	0.000036	112	116	0.000013
16	20	0.001609	36	40	0.000592	56	60	0.000218	76	80	0.000080	96	100	0.000029	116	120	0.000011

Time Area Diagram for Green Roof at Pipe Number SW27.000 (Surface Water Drainage)

Area (m³) 1259 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.041507	20	24	0.005617	40	44	0.000760	60	64	0.000103	80	84	0.000014	100	104	0.000002
4	8	0.027823	24	28	0.003765	44	48	0.000510	64	68	0.000069	84	88	0.000009	104	108	0.000001
8	12	0.018650	28	32	0.002524	48	52	0.000342	68	72	0.000046	88	92	0.000006	108	112	0.000001
12	16	0.012502	32	36	0.001692	52	56	0.000229	72	76	0.000031	92	96	0.000004	112	116	0.000001
16	20	0.008380	36	40	0.001134	56	60	0.000153	76	80	0.000021	96	100	0.000003	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW28.000 (Surface Water Drainage)

Area (m^3) 1209 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.039859	20	24	0.005394	40	44	0.000730	60	64	0.000099	80	84	0.000013	100	104	0.000002
4	8	0.026718	24	28	0.003616	44	48	0.000489	64	68	0.000066	84	88	0.000009	104	108	0.000001
8	12	0.017910	28	32	0.002424	48	52	0.000328	68	72	0.000044	88	92	0.000006	108	112	0.000001
12	16	0.012005	32	36	0.001625	52	56	0.000220	72	76	0.000030	92	96	0.000004	112	116	0.000001
16	20	0.008047	36	40	0.001089	56	60	0.000147	76	80	0.000020	96	100	0.000003	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW30.000 (Surface Water Drainage)

Area (m^3) 339 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.011176	20	24	0.001513	40	44	0.000205	60	64	0.000028	80	84	0.000004	100	104	0.000001
4	8	0.007492	24	28	0.001014	44	48	0.000137	64	68	0.000019	84	88	0.000003	104	108	0.000000
8	12	0.005022	28	32	0.000680	48	52	0.000092	68	72	0.000012	88	92	0.000002	108	112	0.000000
12	16	0.003366	32	36	0.000456	52	56	0.000062	72	76	0.000008	92	96	0.000001	112	116	0.000000
16	20	0.002256	36	40	0.000305	56	60	0.000041	76	80	0.000006	96	100	0.000001	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW32.000 (Surface Water Drainage)

Area (m^3) 288 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.009495	20	24	0.001285	40	44	0.000174	60	64	0.000024	80	84	0.000003	100	104	0.000000
4	8	0.006365	24	28	0.000861	44	48	0.000117	64	68	0.000016	84	88	0.000002	104	108	0.000000
8	12	0.004266	28	32	0.000577	48	52	0.000078	68	72	0.000011	88	92	0.000001	108	112	0.000000
12	16	0.002860	32	36	0.000387	52	56	0.000052	72	76	0.000007	92	96	0.000001	112	116	0.000000
16	20	0.001917	36	40	0.000259	56	60	0.000035	76	80	0.000005	96	100	0.000001	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW33.000 (Surface Water Drainage)

Area (m^3) 125 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.004121	20	24	0.000558	40	44	0.000075	60	64	0.000010	80	84	0.000001	100	104	0.000000
4	8	0.002762	24	28	0.000374	44	48	0.000051	64	68	0.000007	84	88	0.000001	104	108	0.000000
8	12	0.001852	28	32	0.000251	48	52	0.000034	68	72	0.000005	88	92	0.000001	108	112	0.000000
12	16	0.001241	32	36	0.000168	52	56	0.000023	72	76	0.000003	92	96	0.000000	112	116	0.000000
16	20	0.000832	36	40	0.000113	56	60	0.000015	76	80	0.000002	96	100	0.000000	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW35.000 (Surface Water Drainage)

Area (m^3) 211 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.006956	20	24	0.000941	40	44	0.000127	60	64	0.000017	80	84	0.000002	100	104	0.000000
4	8	0.004663	24	28	0.000631	44	48	0.000085	64	68	0.000012	84	88	0.000002	104	108	0.000000
8	12	0.003126	28	32	0.000423	48	52	0.000057	68	72	0.000008	88	92	0.000001	108	112	0.000000
12	16	0.002095	32	36	0.000284	52	56	0.000038	72	76	0.000005	92	96	0.000001	112	116	0.000000
16	20	0.001404	36	40	0.000190	56	60	0.000026	76	80	0.000003	96	100	0.000000	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW36.000 (Surface Water Drainage)

Area (m^3) 234 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.007715	20	24	0.001044	40	44	0.000141	60	64	0.000019	80	84	0.000003	100	104	0.000000
4	8	0.005171	24	28	0.000700	44	48	0.000095	64	68	0.000013	84	88	0.000002	104	108	0.000000
8	12	0.003466	28	32	0.000469	48	52	0.000063	68	72	0.000009	88	92	0.000001	108	112	0.000000
12	16	0.002324	32	36	0.000314	52	56	0.000043	72	76	0.000006	92	96	0.000001	112	116	0.000000
16	20	0.001558	36	40	0.000211	56	60	0.000029	76	80	0.000004	96	100	0.000001	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW37.000 (Surface Water Drainage)

Area (m³) 647 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.011757	20	24	0.004325	40	44	0.001591	60	64	0.000585	80	84	0.000215	100	104	0.000079
4	8	0.009626	24	28	0.003541	44	48	0.001303	64	68	0.000479	84	88	0.000176	104	108	0.000065
8	12	0.007881	28	32	0.002899	48	52	0.001067	68	72	0.000392	88	92	0.000144	108	112	0.000053
12	16	0.006453	32	36	0.002374	52	56	0.000873	72	76	0.000321	92	96	0.000118	112	116	0.000043
16	20	0.005283	36	40	0.001943	56	60	0.000715	76	80	0.000263	96	100	0.000097	116	120	0.000036

Time Area Diagram for Green Roof at Pipe Number SW38.000 (Surface Water Drainage)

Area (m³) 781 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.025748	20	24	0.003485	40	44	0.000472	60	64	0.000064	80	84	0.000009	100	104	0.000001
4	8	0.017260	24	28	0.002336	44	48	0.000316	64	68	0.000043	84	88	0.000006	104	108	0.000001
8	12	0.011569	28	32	0.001566	48	52	0.000212	68	72	0.000029	88	92	0.000004	108	112	0.000001
12	16	0.007755	32	36	0.001050	52	56	0.000142	72	76	0.000019	92	96	0.000003	112	116	0.000000
16	20	0.005198	36	40	0.000704	56	60	0.000095	76	80	0.000013	96	100	0.000002	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW39.000 (Surface Water Drainage)

Area (m³) 145 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.004780	20	24	0.000647	40	44	0.000088	60	64	0.000012	80	84	0.000002	100	104	0.000000
4	8	0.003204	24	28	0.000434	44	48	0.000059	64	68	0.000008	84	88	0.000001	104	108	0.000000
8	12	0.002148	28	32	0.000291	48	52	0.000039	68	72	0.000005	88	92	0.000001	108	112	0.000000
12	16	0.001440	32	36	0.000195	52	56	0.000026	72	76	0.000004	92	96	0.000000	112	116	0.000000
16	20	0.000965	36	40	0.000131	56	60	0.000018	76	80	0.000002	96	100	0.000000	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW40.000 (Surface Water Drainage)

Area (m³) 340 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.006178	20	24	0.002273	40	44	0.000836	60	64	0.000308	80	84	0.000113	100	104	0.000042
4	8	0.005059	24	28	0.001861	44	48	0.000685	64	68	0.000252	84	88	0.000093	104	108	0.000034
8	12	0.004142	28	32	0.001524	48	52	0.000560	68	72	0.000206	88	92	0.000076	108	112	0.000028
12	16	0.003391	32	36	0.001247	52	56	0.000459	72	76	0.000169	92	96	0.000062	112	116	0.000023
16	20	0.002776	36	40	0.001021	56	60	0.000376	76	80	0.000138	96	100	0.000051	116	120	0.000019

Time Area Diagram for Green Roof at Pipe Number SW43.000 (Surface Water Drainage)

Area (m³) 316 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.010418	20	24	0.001410	40	44	0.000191	60	64	0.000026	80	84	0.000003	100	104	0.000000
4	8	0.006983	24	28	0.000945	44	48	0.000128	64	68	0.000017	84	88	0.000002	104	108	0.000000
8	12	0.004681	28	32	0.000634	48	52	0.000086	68	72	0.000012	88	92	0.000002	108	112	0.000000
12	16	0.003138	32	36	0.000425	52	56	0.000057	72	76	0.000008	92	96	0.000001	112	116	0.000000
16	20	0.002103	36	40	0.000285	56	60	0.000039	76	80	0.000005	96	100	0.000001	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW44.000 (Surface Water Drainage)

Area (m³) 231 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.007616	20	24	0.001031	40	44	0.000139	60	64	0.000019	80	84	0.000003	100	104	0.000000
4	8	0.005105	24	28	0.000691	44	48	0.000093	64	68	0.000013	84	88	0.000002	104	108	0.000000
8	12	0.003422	28	32	0.000463	48	52	0.000063	68	72	0.000008	88	92	0.000001	108	112	0.000000
12	16	0.002294	32	36	0.000310	52	56	0.000042	72	76	0.000006	92	96	0.000001	112	116	0.000000
16	20	0.001538	36	40	0.000208	56	60	0.000028	76	80	0.000004	96	100	0.000001	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW45.000 (Surface Water Drainage)

Area (m³) 207 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.006824	20	24	0.000924	40	44	0.000125	60	64	0.000017	80	84	0.000002	100	104	0.000000
4	8	0.004575	24	28	0.000619	44	48	0.000084	64	68	0.000011	84	88	0.000002	104	108	0.000000
8	12	0.003066	28	32	0.000415	48	52	0.000056	68	72	0.000008	88	92	0.000001	108	112	0.000000
12	16	0.002055	32	36	0.000278	52	56	0.000038	72	76	0.000005	92	96	0.000001	112	116	0.000000
16	20	0.001378	36	40	0.000186	56	60	0.000025	76	80	0.000003	96	100	0.000000	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW46.000 (Surface Water Drainage)

Area (m³) 1339 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.044144	20	24	0.005974	40	44	0.000809	60	64	0.000109	80	84	0.000015	100	104	0.000002
4	8	0.029591	24	28	0.004005	44	48	0.000542	64	68	0.000073	84	88	0.000010	104	108	0.000001
8	12	0.019835	28	32	0.002684	48	52	0.000363	68	72	0.000049	88	92	0.000007	108	112	0.000001
12	16	0.013296	32	36	0.001799	52	56	0.000244	72	76	0.000033	92	96	0.000004	112	116	0.000001
16	20	0.008913	36	40	0.001206	56	60	0.000163	76	80	0.000022	96	100	0.000003	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW47.000 (Surface Water Drainage)

Area (m³) 171 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.003107	20	24	0.001143	40	44	0.000421	60	64	0.000155	80	84	0.000057	100	104	0.000021
4	8	0.002544	24	28	0.000936	44	48	0.000344	64	68	0.000127	84	88	0.000047	104	108	0.000017
8	12	0.002083	28	32	0.000766	48	52	0.000282	68	72	0.000104	88	92	0.000038	108	112	0.000014
12	16	0.001705	32	36	0.000627	52	56	0.000231	72	76	0.000085	92	96	0.000031	112	116	0.000011
16	20	0.001396	36	40	0.000514	56	60	0.000189	76	80	0.000070	96	100	0.000026	116	120	0.000009

Time Area Diagram for Green Roof at Pipe Number SW49.000 (Surface Water Drainage)

Area (m³) 231 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.007616	20	24	0.001031	40	44	0.000139	60	64	0.000019	80	84	0.000003	100	104	0.000000
4	8	0.005105	24	28	0.000691	44	48	0.000093	64	68	0.000013	84	88	0.000002	104	108	0.000000
8	12	0.003422	28	32	0.000463	48	52	0.000063	68	72	0.000008	88	92	0.000001	108	112	0.000000
12	16	0.002294	32	36	0.000310	52	56	0.000042	72	76	0.000006	92	96	0.000001	112	116	0.000000
16	20	0.001538	36	40	0.000208	56	60	0.000028	76	80	0.000004	96	100	0.000001	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW50.000 (Surface Water Drainage)

Area (m³) 316 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.010418	20	24	0.001410	40	44	0.000191	60	64	0.000026	80	84	0.000003	100	104	0.000000
4	8	0.006983	24	28	0.000945	44	48	0.000128	64	68	0.000017	84	88	0.000002	104	108	0.000000
8	12	0.004681	28	32	0.000634	48	52	0.000086	68	72	0.000012	88	92	0.000002	108	112	0.000000
12	16	0.003138	32	36	0.000425	52	56	0.000057	72	76	0.000008	92	96	0.000001	112	116	0.000000
16	20	0.002103	36	40	0.000285	56	60	0.000039	76	80	0.000005	96	100	0.000001	116	120	0.000000

Time Area Diagram for Green Roof at Pipe Number SW51.000 (Surface Water Drainage)

Area (m³) 181 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.003289	20	24	0.001210	40	44	0.000445	60	64	0.000164	80	84	0.000060	100	104	0.000022
4	8	0.002693	24	28	0.000991	44	48	0.000364	64	68	0.000134	84	88	0.000049	104	108	0.000018
8	12	0.002205	28	32	0.000811	48	52	0.000298	68	72	0.000110	88	92	0.000040	108	112	0.000015
12	16	0.001805	32	36	0.000664	52	56	0.000244	72	76	0.000090	92	96	0.000033	112	116	0.000012
16	20	0.001478	36	40	0.000544	56	60	0.000200	76	80	0.000074	96	100	0.000027	116	120	0.000010

Time Area Diagram for Green Roof at Pipe Number SW52.000 (Surface Water Drainage)

Area (m³) 341 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.006197	20	24	0.002280	40	44	0.000839	60	64	0.000309	80	84	0.000113	100	104	0.000042
4	8	0.005073	24	28	0.001866	44	48	0.000687	64	68	0.000253	84	88	0.000093	104	108	0.000034
8	12	0.004154	28	32	0.001528	48	52	0.000562	68	72	0.000207	88	92	0.000076	108	112	0.000028
12	16	0.003401	32	36	0.001251	52	56	0.000460	72	76	0.000169	92	96	0.000062	112	116	0.000023
16	20	0.002784	36	40	0.001024	56	60	0.000377	76	80	0.000139	96	100	0.000051	116	120	0.000019

Time Area Diagram for Green Roof at Pipe Number SW53.000 (Surface Water Drainage)

Area (m³) 270 Depression Storage (mm) 4 Evaporation (mm/day) 1 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.004906	20	24	0.001805	40	44	0.000664	60	64	0.000244	80	84	0.000090	100	104	0.000033
4	8	0.004017	24	28	0.001478	44	48	0.000544	64	68	0.000200	84	88	0.000074	104	108	0.000027
8	12	0.003289	28	32	0.001210	48	52	0.000445	68	72	0.000164	88	92	0.000060	108	112	0.000022
12	16	0.002693	32	36	0.000991	52	56	0.000364	72	76	0.000134	92	96	0.000049	112	116	0.000018
16	20	0.002205	36	40	0.000811	56	60	0.000298	76	80	0.000110	96	100	0.000040	116	120	0.000015

Time Area Diagram for Green Roof at Pipe Number SW54.000 (Surface Water Drainage)

Area (m³) 1344 Depression Storage (mm) 2 Evaporation (mm/day) 1 Decay Coefficient 0.100

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.044309	20	24	0.005997	40	44	0.000812	60	64	0.000110	80	84	0.000015	100	104	0.000002
4	8	0.029701	24	28	0.004020	44	48	0.000544	64	68	0.000074	84	88	0.000010	104	108	0.000001
8	12	0.019909	28	32	0.002694	48	52	0.000365	68	72	0.000049	88	92	0.000007	108	112	0.000001
12	16	0.013346	32	36	0.001806	52	56	0.000244	72	76	0.000033	92	96	0.000004	112	116	0.000001
16	20	0.008946	36	40	0.001211	56	60	0.000164	76	80	0.000022	96	100	0.000003	116	120	0.000000

Summary of Critical Results by Maximum Level (Rank 1) for Surface Water Drainage

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 0.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 2 Number of Time/Area Diagrams 39
Number of Online Controls 2 Number of Storage Structures 14 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 16.800 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.300 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 0.0 DVD Status ON
Analysis Timestep 2.5 Second Increment (Extended) Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 100
Climate Change (%) 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
SW1.000	SW/MH-1	30 minute 100 year Winter I+10%	101.500	100.675	0.375	0.000	0.07		0.042	4.026	4.8	SURCHARGED
SW2.000	SW/MH-2	30 minute 100 year Winter I+10%	101.500	100.925	0.625	0.000	0.23		0.060	13.766	11.1	SURCHARGED
SW3.000	SW/MH-3	30 minute 100 year Winter I+10%	101.500	101.192	0.692	0.000	0.22		0.258	7.914	7.8	SURCHARGED
SW4.000	SW/MH-4	30 minute 100 year Winter I+10%	101.500	101.186	0.686	0.000	0.31		0.064	13.028	13.6	SURCHARGED
SW5.000	SW/MH-5	30 minute 100 year Winter I+10%	101.500	101.184	0.684	0.000	0.13		0.064	5.798	4.4	SURCHARGED
SW3.001	SW/MH-6	30 minute 100 year Winter I+10%	101.500	101.179	0.776	0.000	1.02		1.435	42.337	35.8	SURCHARGED
SW6.000	SW/MH-7	30 minute 100 year Winter I+10%	101.500	101.094	0.594	0.000	0.06		0.058	3.371	2.8	SURCHARGED
SW3.002	SW/MH-8	30 minute 100 year Winter I+10%	101.500	101.092	0.781	0.000	1.05		1.951	78.423	72.5	SURCHARGED
SW3.003	SW/MH-9	30 minute 100 year Winter I+10%	101.500	100.998	0.795	0.000	1.13		2.673	78.423	68.5	SURCHARGED
SW7.000	SW/MH-10	30 minute 100 year Winter I+10%	101.500	100.992	0.492	0.000	0.70		0.201	21.242	26.6	SURCHARGED
SW7.001	SW/MH-11	30 minute 100 year Winter I+10%	101.500	100.946	0.736	0.000	0.55		2.206	21.241	19.5	SURCHARGED
SW2.001	SW/MH-12	30 minute 100 year Winter I+10%	101.500	100.917	0.805	0.000	1.39		2.622	113.429	91.4	SURCHARGED

Summary of Critical Results by Maximum Level (Rank 1) for Surface Water Drainage

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
SW8.000	SW/MH-13	30 minute 100 year Winter I+10%	101.500	100.814	0.514	0.000	0.07		0.052	6.804	5.0	SURCHARGED
SW9.000	SW/MH-14	30 minute 100 year Winter I+10%	101.500	100.807	0.582	0.000	0.04		0.057	1.631	1.4	SURCHARGED
SW2.002	SW/MH-15	60 minute 100 year Winter I+10%	101.500	100.158	0.252	0.000	0.98		2.591	157.035	76.6	SURCHARGED*
SW1.001	SW/MH-16	30 minute 100 year Winter I+10%	101.506	100.670	0.876	0.000	1.28		3.258	125.886	90.2	SURCHARGED
SW1.002	SW/MH-17	30 minute 100 year Winter I+10%	101.323	100.449	0.789	0.000	1.31		3.035	125.883	90.2	SURCHARGED
SW10.000	SW/MH-18	30 minute 100 year Winter I+10%	101.500	100.301	0.001	0.000	0.33		0.251	28.053	23.1	SURCHARGED
SW11.000	SW/MH-19	30 minute 100 year Winter I+10%	101.500	100.528	-0.197	0.000	0.03		0.002	3.925	2.4	OK
SW1.003	SW/MH-20	30 minute 100 year Winter I+10%	101.184	100.267	0.712	0.000	1.88		2.962	157.861	115.5	SURCHARGED*
SW12.000	SW/MH-21	30 minute 100 year Winter I+10%	101.500	100.393	0.093	0.000	0.07		0.022	5.798	4.0	SURCHARGED
SW13.000	SW/MH-22	30 minute 100 year Winter I+10%	101.500	100.401	0.101	0.000	0.14		0.023	7.905	9.4	SURCHARGED
SW12.001	SW/MH-23	30 minute 100 year Winter I+10%	101.340	100.390	0.336	0.000	0.71		1.204	30.140	27.1	SURCHARGED
SW12.002	SW/MH-24	30 minute 100 year Winter I+10%	101.456	100.310	0.379	0.000	1.28		1.365	49.742	49.3	SURCHARGED
SW12.003	SW/MH-25	30 minute 100 year Winter I+10%	101.397	100.159	0.367	0.000	0.82		1.531	63.783	59.7	SURCHARGED
SW1.004	SW/MH-26	30 minute 100 year Winter I+10%	101.118	100.063	0.558	0.000	1.48		4.354	221.653	161.2	SURCHARGED
SW14.000	SW/MH-27	30 minute 100 year Winter I+10%	101.500	100.102	-0.198	0.000	0.03		0.002	3.925	2.4	OK
SW15.000	SW/MH-28	30 minute 100 year Winter I+10%	101.500	100.116	-0.184	0.000	0.07		0.003	6.982	4.2	OK
SW1.005	SW/MH-29	30 minute 100 year Winter I+10%	100.953	99.847	0.440	0.000	1.57		3.462	232.564	168.0	SURCHARGED*
SW16.000	SW/MH-30	30 minute 100 year Winter I+10%	101.000	100.163	-0.137	0.000	0.33		0.006	24.574	20.4	OK
SW1.006	SW/MH-31	30 minute 100 year Winter I+10%	100.837	99.662	0.324	0.000	1.75		2.593	259.226	188.0	SURCHARGED*
SW1.007	SW/MH-32	30 minute 100 year Winter I+10%	100.746	99.430	0.150	0.000	1.85		2.136	259.226	188.1	SURCHARGED
SW17.000	SW/MH-33	15 minute 100 year Winter I+10%	101.450	99.861	-0.889	0.000	0.06		0.030	18.947	37.5	OK
SW17.001	SW/MH-34	15 minute 100 year Winter I+10%	101.216	99.670	-0.859	0.000	0.08		0.584	26.141	52.7	OK
SW17.002	SW/MH-35	15 minute 100 year Winter I+10%	101.060	99.479	-0.829	0.000	0.11		0.830	34.889	69.6	OK
SW17.003	SW/MH-36	15 minute 100 year Winter I+10%	100.887	99.415	-0.672	0.000	0.11		2.038	41.314	70.9	OK
SW17.004	SW/MH-37	15 minute 100 year Winter I+10%	100.756	99.403	0.387	0.000	1.46		4.488	41.315	63.4	SURCHARGED
SW18.000	SW/MH-38	30 minute 100 year Winter I+10%	101.000	99.610	-0.190	0.000	0.06		0.002	4.328	3.6	OK
SW1.008	SW/MH-39	240 minute 100 year Winter I+10%	100.612	99.178	0.316	0.000	0.94		3.098	637.324	109.6	SURCHARGED
SW19.000	SW/MH-40	240 minute 100 year Winter I+10%	99.550	99.097	0.428	0.000	0.01		1.609	34.823	6.3	SURCHARGED
SW19.001	SW/MH-41	240 minute 100 year Winter I+10%	100.105	99.096	0.592	0.000	0.02		10.231	52.217	9.4	SURCHARGED
SW19.002	SW/MH-42	240 minute 100 year Winter I+10%	100.105	99.096	0.757	0.000	0.02		10.396	62.920	10.8	SURCHARGED
SW19.003	SW/MH-43	240 minute 100 year Winter I+10%	100.105	99.094	0.920	0.000	0.02		10.444	66.481	10.9	SURCHARGED
SW19.004	SW/MH-44	240 minute 100 year Winter I+10%	100.105	99.093	1.938	0.000	0.88		12.380	63.220	10.4	SURCHARGED
SW20.000	SW/MH-45	240 minute 100 year Winter I+10%	99.500	99.473	1.148	0.000	0.03		0.097	13.070	2.3	SURCHARGED
SW21.000	SW/MH-46	240 minute 100 year Winter I+10%	99.500	99.472	1.347	0.000	0.01		0.111	3.767	0.6	SURCHARGED
SW22.000	SW/MH-47	240 minute 100 year Winter I+10%	99.500	99.474	1.149	0.000	0.06		0.097	22.350	3.9	SURCHARGED
SW23.000	SW/MH-48	30 minute 100 year Winter I+10%	100.000	99.543	1.468	0.000	0.55		0.477	26.292	18.9	SURCHARGED

Summary of Critical Results by Maximum Level (Rank 1) for Surface Water Drainage

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
SW24.000	SW/MH-49	240 minute 100 year Winter I+10%	100.000	99.516	1.141	0.000	0.07		0.096	13.321	2.1	SURCHARGED
SW23.001	SW/MH-50	30 minute 100 year Winter I+10%	99.500	98.324	0.309	0.000	0.53		2.120	32.502	22.5	SURCHARGED*
SW23.002	SW/MH-51	240 minute 100 year Winter I+10%	99.500	99.494	1.724	0.000	0.55		4.865	132.185	20.4	SURCHARGED
SW20.001	SW/MH-52	30 minute 100 year Winter I+10%	99.320	98.042	0.368	0.000	0.86		4.108	97.995	63.9	SURCHARGED*
SW25.000	SW/MH-53	240 minute 100 year Winter I+10%	99.500	99.468	1.143	0.000	0.08		0.096	33.136	6.0	SURCHARGED
SW26.000	SW/MH-54	240 minute 100 year Winter I+10%	99.500	99.461	1.136	0.000	0.02		0.096	8.331	1.3	SURCHARGED
SW20.002	SW/MH-55	30 minute 100 year Winter I+10%	99.384	98.115	0.530	0.000	1.03		4.291	117.342	73.3	SURCHARGED*
SW27.000	SW/MH-56	240 minute 100 year Winter I+10%	99.505	99.402	1.077	0.000	0.14		0.092	55.798	9.7	SURCHARGED
SW28.000	SW/MH-57	240 minute 100 year Winter I+10%	99.500	99.400	1.075	0.000	0.14		0.092	53.582	9.3	SURCHARGED
SW20.003	SW/MH-58	30 minute 100 year Winter I+10%	99.519	98.110	0.605	0.000	1.54		3.543	171.013	108.6	SURCHARGED*
SW29.000	SW/MH-59	240 minute 100 year Winter I+10%	99.500	99.390	0.915	0.000	0.02		0.080	7.560	1.3	SURCHARGED
SW30.000	SW/MH-60	240 minute 100 year Winter I+10%	99.500	99.389	0.514	0.000	0.06		0.052	15.024	2.6	SURCHARGED
SW31.000	SW/MH-61	240 minute 100 year Winter I+10%	99.500	99.389	0.514	0.000	0.02		0.052	7.139	1.3	SURCHARGED
SW29.001	SW/MH-62	240 minute 100 year Winter I+10%	99.500	99.388	1.272	0.000	0.13		2.526	29.724	5.0	SURCHARGED
SW32.000	SW/MH-63	240 minute 100 year Winter I+10%	99.500	99.384	0.509	0.000	0.03		0.052	12.188	2.2	SURCHARGED
SW33.000	SW/MH-64	240 minute 100 year Winter I+10%	99.500	99.382	0.507	0.000	0.02		0.051	5.540	1.0	SURCHARGED
SW29.002	SW/MH-65	240 minute 100 year Winter I+10%	99.500	99.382	1.471	0.000	0.18		3.793	47.269	7.3	SURCHARGED
SW34.000	SW/MH-66	240 minute 100 year Winter I+10%	99.500	99.378	0.503	0.000	0.03		0.051	8.491	1.5	SURCHARGED
SW35.000	SW/MH-67	240 minute 100 year Winter I+10%	99.500	99.378	0.503	0.000	0.03		0.051	9.351	1.6	SURCHARGED
SW36.000	SW/MH-68	240 minute 100 year Winter I+10%	99.500	99.378	0.503	0.000	0.03		0.051	10.371	1.8	SURCHARGED
SW34.001	SW/MH-69	240 minute 100 year Winter I+10%	99.500	99.377	0.696	0.000	0.12		1.762	28.216	4.9	SURCHARGED
SW37.000	SW/MH-70	240 minute 100 year Winter I+10%	99.500	99.373	0.848	0.000	0.10		0.076	27.361	4.6	SURCHARGED
SW38.000	SW/MH-71	240 minute 100 year Winter I+10%	99.500	99.373	0.848	0.000	0.13		0.076	34.613	6.0	SURCHARGED
SW29.003	SW/MH-72	240 minute 100 year Winter I+10%	99.500	99.371	1.657	0.000	0.57		4.595	136.268	22.1	SURCHARGED
SW39.000	SW/MH-73	240 minute 100 year Winter I+10%	99.500	99.342	1.117	0.000	0.04		0.094	6.426	1.1	SURCHARGED
SW29.004	SW/MH-74	240 minute 100 year Winter I+10%	99.500	99.341	1.776	0.000	0.89		3.254	183.292	29.2	SURCHARGED
SW20.004	SW/MH-75	240 minute 100 year Winter I+10%	99.652	99.294	1.869	0.000	1.01		3.524	521.106	81.8	SURCHARGED
SW40.000	SW/MH-76	240 minute 100 year Winter I+10%	99.500	99.188	0.963	0.000	0.03		0.084	14.379	2.4	SURCHARGED
SW41.000	SW/MH-77	240 minute 100 year Winter I+10%	99.500	99.186	0.961	0.000	0.01		0.083	3.735	0.7	SURCHARGED
SW20.005	SW/MH-78	240 minute 100 year Winter I+10%	99.943	99.186	1.933	0.000	1.15		5.125	582.389	91.1	SURCHARGED
SW1.009	SW/MH-79	240 minute 100 year Winter I+10%	100.172	99.080	1.830	0.000	1.23		8.960	1301.957	206.4	SURCHARGED
SW42.000	SW/MH-80	30 minute 100 year Winter I+10%	102.000	101.613	0.938	0.000	0.00		0.082	0.001	0.2	SURCHARGED
SW43.000	SW/MH-81	30 minute 100 year Winter I+10%	102.000	101.910	0.935	0.000	0.11		0.082	6.872	6.3	SURCHARGED
SW43.001	SW/MH-82	30 minute 100 year Winter I+10%	102.000	101.905	1.089	0.000	0.23		0.604	10.676	8.9	SURCHARGED
SW44.000	SW/MH-83	30 minute 100 year Winter I+10%	102.000	101.892	0.917	0.000	0.08		0.080	5.023	4.7	SURCHARGED
SW45.000	SW/MH-84	30 minute 100 year Winter I+10%	102.089	101.892	0.917	0.000	0.06		0.080	4.501	4.1	SURCHARGED

Summary of Critical Results by Maximum Level (Rank 1) for Surface Water Drainage

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
SW43.002	SW/MH-85	30 minute 100 year Winter I+10%	102.000	101.888	1.234	0.000	0.63		1.966	24.494	23.4	SURCHARGED
SW43.003	SW/MH-86	30 minute 100 year Winter I+10%	102.000	101.849	1.299	0.000	0.72		2.303	24.493	27.7	SURCHARGED
SW46.000	SW/MH-87	30 minute 100 year Winter I+10%	102.000	101.872	1.147	0.000	0.51		0.097	29.119	25.3	SURCHARGED
SW47.000	SW/MH-88	30 minute 100 year Winter I+10%	102.000	101.816	0.591	0.000	0.05		0.057	3.372	3.3	SURCHARGED
SW43.004	SW/MH-89	30 minute 100 year Winter I+10%	102.000	101.813	1.395	0.000	1.97		3.113	87.963	69.3	SURCHARGED
SW48.000	SW/MH-90	15 minute 100 year Winter I+10%	102.262	101.726	0.751	0.000	0.80		1.099	32.965	59.6	SURCHARGED
SW42.001	SW/MH-91	30 minute 100 year Winter I+10%	101.757	101.613	1.290	0.000	1.41		3.337	132.878	98.9	SURCHARGED
SW49.000	SW/MH-92	30 minute 100 year Winter I+10%	101.500	100.543	-0.182	0.000	0.08		0.003	5.023	4.2	OK
SW49.001	SW/MH-93	30 minute 100 year Winter I+10%	101.500	100.422	-0.176	0.000	0.11		0.024	5.023	4.2	OK
SW50.000	SW/MH-94	30 minute 100 year Winter I+10%	101.500	100.551	-0.174	0.000	0.12		0.003	6.872	5.7	OK
SW49.002	SW/MH-95	15 minute 100 year Winter I+10%	101.500	100.324	-0.100	0.000	0.40		0.222	8.433	10.9	OK
SW49.003	SW/MH-96	15 minute 100 year Winter I+10%	101.500	100.320	-0.085	0.000	0.30		0.188	8.433	11.5	OK
SW51.000	SW/MH-97	30 minute 100 year Winter I+10%	101.500	100.329	-0.196	0.000	0.04		0.002	3.570	2.2	OK
SW49.004	SW/MH-98	15 minute 100 year Winter I+10%	101.500	100.312	0.287	0.000	0.51		0.690	33.536	49.2	SURCHARGED
SW52.000	SW/MH-99	30 minute 100 year Winter I+10%	101.500	100.644	-0.181	0.000	0.08		0.003	6.725	4.1	OK
SW52.001	SW/MH-100	15 minute 100 year Winter I+10%	101.500	100.567	-0.123	0.000	0.41		0.053	12.118	16.7	OK
SW53.000	SW/MH-101	30 minute 100 year Winter I+10%	101.500	100.536	-0.189	0.000	0.05		0.002	5.325	3.2	OK
SW52.002	SW/MH-102	15 minute 100 year Winter I+10%	101.500	100.458	0.092	0.000	1.04		1.311	44.261	74.1	SURCHARGED
SW42.002	SW/MH-103	15 minute 100 year Winter I+10%	100.734	100.202	0.699	0.000	1.11		3.403	174.001	190.5	SURCHARGED
SW54.000	SW/MH-104	240 minute 100 year Winter I+10%	101.000	99.201	-0.024	0.000	0.14		0.014	59.565	10.4	OK
SW55.000	SW/MH-105	15 minute 100 year Winter I+10%	102.480	99.623	-0.877	0.000	0.07		0.133	17.894	36.4	OK
SW55.001	SW/MH-106	15 minute 100 year Winter I+10%	101.750	99.512	-0.835	0.000	0.10		2.658	27.441	54.8	OK
SW55.002	SW/MH-107	15 minute 100 year Winter I+10%	101.200	99.401	-0.793	0.000	0.13		1.278	36.208	68.7	OK
SW55.003	SW/MH-108	15 minute 100 year Winter I+10%	100.650	99.369	-0.672	0.000	0.14		2.507	45.294	75.3	OK
SW55.004	SW/MH-109	15 minute 100 year Winter I+10%	100.500	99.354	0.241	0.000	0.94		4.287	45.295	70.9	SURCHARGED
SW42.003	SW/MH-110	240 minute 100 year Winter I+10%	99.850	99.189	0.615	0.000	0.62		3.937	672.886	116.4	SURCHARGED
SW42.004	SW/MH-111	240 minute 100 year Winter I+10%	99.750	99.078	0.765	0.000	0.76		11.567	696.372	120.3	SURCHARGED
SW1.010	SW/MH-112	240 minute 100 year Winter I+10%	100.261	98.984	1.233	0.000	0.02		9.380	1394.454	214.3	SURCHARGED
SW56.000	SW/MH-113	240 minute 100 year Winter I+10%	99.750	98.993	0.293	0.000	0.27		0.750	181.027	31.7	SURCHARGED
SW1.011	SW/MH-114	240 minute 100 year Winter I+10%	100.085	98.984	1.889	0.000	1.11	117.6	1258.861	975.510	114.5	SURCHARGED
SW57.000	SW/MH-115	480 minute 100 year Winter I+10%	99.750	98.899	0.999	0.000	2.00		548.141	276.073	24.1	SURCHARGED
SW57.001	SW/MH-116	240 minute 100 year Winter I+10%	99.750	97.860	0.069	0.000	1.65		1.284	204.976	23.8	SURCHARGED*
SW1.012	SW/MH-117	240 minute 100 year Winter I+10%	100.158	98.945	1.961	0.000	0.45	69.6	6.358	1043.803	44.9	SURCHARGED
SW1.013	SW/MH-118	2160 minute 100 year Summer I+10%	99.759	96.683	-0.175	0.000	0.47		1.618	3856.430	49.1	OK
SW1.014	SW/MH-119	2160 minute 100 year Summer I+10%	99.137	96.458	-0.166	0.000	0.60		1.969	3856.430	47.8	OK
SW1.015	SW/MH-120	2160 minute 100 year Summer I+10%	98.600	96.393	-0.197	0.000	0.45		0.551	3856.429	46.8	OK

Summary of Critical Results by Maximum Level (Rank 1) for Surface Water Drainage

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
SW1.016	SW/MH-121	2160 minute 100 year Summer I+10%	98.500	96.184	-0.162	0.000	0.61		2.066	3856.359	46.3	OK

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Multidisciplinary Consulting Engineers

APPENDIX D. WASTEWATER CALCULATIONS

- As per Irish Water Code of Practice for Wastewater Infrastructure, IW-CDS-5030-03.

Appendix D

Wastewater Calculations

24.10.2018

Wastewater

PHASE 1

SECTOR 1

Block A1 - Domestic

Nr. of Beds	Nr. of Units	Total Beds	Occupancy Loading	PE	DWF (l/day)
1	34	34	2.7	91.8	13,770
2	41	82	2.7	110.7	16,605
3	13	39	2.7	35.1	5,265
Total	**88**	**155**		**237.6**	**35,640**

Block A1 - Other / Mixed Use

	Retail Floor Area (m^2)	Créche Floor Area (m^2)	Amenities Floor Area (m^2)
			385
Total			**385**
PE			7.7
Total Flow (l/s)			0.11

Block A2 - Domestic

Nr. of Beds	Nr. of Units	Total Beds	Occupancy Loading	PE	DWF (l/day)
1	27	27	2.7	72.9	10,935
2	77	154	2.7	207.9	31,185
3	15	45	2.7	40.5	6,075
Total	**119**	**226**		**321.3**	**48,195**

Block A2 - Other / Mixed Use

	Retail Floor Area (m^2)	Créche Floor Area (m^2)	Amenities Floor Area (m^2)
		418.9	313
Total		**418.9**	**313**
PE		8.4	6.26
Total Flow (l/s)		0.03	0.09

Block A3 - Domestic

Nr. of Beds	Nr. of Units	Total Beds	Occupancy Loading	PE	DWF (l/day)
1	51	51	2.7	137.7	20,655
2	58	116	2.7	156.6	23,490
3	7	21	2.7	18.9	2,835
Total	**116**	**188**		**313.2**	**46,980**

Block A3 - Other / Mixed Use

	Retail Floor Area (m^2)	Créche Floor Area (m^2)	Amenities Floor Area (m^2)
			101.6
Total			**101.6**
PE			2.03
Total Flow (l/s)			0.03

Sector 1 Results

Domestic PE	872.1	persons
Mixed Use PE	24.4	persons
Domestic Flow (DWF)	1.51	litres / second
Mixed Use Flow (DWF)	0.25	litres / second
Peaking Factor	4.5	
Sector 1 Peak Design Flow*	8.72	litres / second

SECTOR 2

Block B1 - Domestic

Nr. of Beds	Nr. of Units	Total Beds	Occupancy Loading	PE	DWF (l/day)
1	46	46	2.7	124.2	18,630
2	54	108	2.7	145.8	21,870
3	15	45	2.7	40.5	6,075
Total	**115**	**199**		**310.5**	**46,575**

Block B1 - Other / Mixed Use

	Retail Floor Area (m^2)	Créche Floor Area (m^2)	Amenities Floor Area (m^2)
	632		518
Total	**632**		**518**
PE	6.32		10.36
Total Flow (l/s)	0.02		0.14

Block B2 - Student Residential

	Nr. of Rooms	Beds per room	Total Beds	PE	DWF (l/day)
	403	1	403	403	40,300
Total	**403**		**403**	**403**	**40,300**

Block B2 - Other / Mixed Use

	Retail Floor Area (m^2)	Créche Floor Area (m^2)	Amenities Floor Area (m^2)
			847.9
Total			**847.9**
PE			17.0
Total Flow (l/s)			0.24

Sector 2 Results

Domestic PE	311 persons
Mixed Use PE	34 persons
Student Residential PE	403 persons
Domestic Flow (DWF)	1.01 litres / second
Mixed Use Flow (DWF)	0.40 litres / second
Peaking Factor	6
Sector 2 Peak Design Flow*	9.26 litres / second

Phase 1 Results

Domestic PE	1,183 persons
Student Residential PE	403 persons
Mixed Use PE	58 persons
Domestic Flow (DWF)	2.52 litres / second
Mixed Use Flow (DWF)	0.65 litres / second
Peaking Factor	3
Total Ph1 Peak Design Flow*	10.44 litres / second

Flow Rates from been calculated using the following guidance from Irish Water Code of Practice for Wastewater Infrastructure

Residential - 2.7 persons per unit at 150 litres / person / day

Student Residential - 1 person per unit at 100 litres / person / day

Retail - Assume 1 staff per 100m^2 at a rate of 45-litres (per 4.5hr shift)

Amenity - Assume peak usage of 1 person per 50m^2 at a rate of 50 litres / hour

Créche - Assume occupancy of 8-staff at 90 litres / 8-hours

**a 10% unit comsumption allowance has also been added to the Total Design Flows; in accordance with section 3.6.3 of Code of Practice*

PHASE 2

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APPENDIX E. IRISH WATER STATEMENT OF DESIGN ACCEPTANCE

Appendix E

Irish Water Statement of Design Acceptance Letter

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

Irish Water
PO Box 448
South City
Delivery Office
Cork City

www.water.ie

Letter Ref: CDSSDA1

Atlas GP Limited c/o Mark Killian,
O'Connor Sutton Cronin,
9 Prussia Street,
Dublin 7

24 November 2018

Re: Design Submission for (Phase 1, Belgard Gardens, Belgard Square, Tallaght, Dublin 24)(the "Development")(the "Design Submission")/Customer Reference No. 052158350

Dear Sir Madam,

Many thanks for your recent Design Submission.

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

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

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

If you have any further questions, please contact your Irish Water representative:

Name: Marina Zivanovic Byrne
Phone: 018925991
Email: mzbyrne@water.ie

Yours sincerely,

Maria O'Dwyer
Connections and Developer Services

Appendix A

Document Title & Revision

1. ***Proposed Drainage Layout (Sheet 1 of 2) (Drawing No. A557-OCSC-XX-XX-DR-C-0500-A1-C03)***

2. ***Proposed Wastewater Drainage Longitudinal Sections (Drawing No. A557-OCSC-XX-XX-DR-C-0511- A2-C03)***

3. ***Proposed Watermain Phase 1 Layout (Drawing No. A557-OCSC-XX-XX-DR-C-0550-A2-C03)***

Standard Details/Code of Practice Exemption:
N/A

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

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

UISCE
ÉIREANN : IRISH
WATER

Uisce Éireann
Bosca OP 6000
Baile Átha Cliath 1
Éire

Irish Water
PO Box 6000
Dublin 1
Ireland

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

Your Ref: ABP-301909-18
Our Ref: CUST17692

An Bord Pleanála,
64 Marlborough Street,
Dublin 1
17/07/2018

Dear Sir/ Madam,

Re: Demolition of buildings and construction of phase 1 of mixed use residential development (427no. apartments, 358no. bed space student accommodation), childcare facility, new roads, accesses and associated site works.
Belgard Gardens, Belgard Square North, Tallaght, Dublin 24

Irish Water has received notification of a request to enter into consultations under Section 5 of the Planning and Development (Housing) and Residential Tenancies Act 2016 in respect of the above mentioned proposed development.

Irish Water has issued a Confirmation of Feasibility for this development for 1400 residential units.

The proposed development, as assessed for the Confirmation of Feasibility, is a standard connection, requiring no network or treatment plant upgrades for water or wastewater by either the customer or Irish Water. No third party consents are required for these connections to take place

Therefore, based upon the Confirmation of Feasibility issued by Irish Water, Irish Water confirms that subject to a compliant water and wastewater layout and a valid connection agreement being put in place between Irish Water and the developer, the proposed connections to the Irish Water networks can be facilitated.

pp Michael Galvin

Maria O'Dwyer
Connections and Developer Services Manager

Atlas GP Limited c/o Mark Killian
O Connor Sutton Cronin,
9 Prussia Street
Dublin

Uisce Éireann
Bosca OP 6000
Baile Átha Cliath 1
Éire

Irish Water
PO Box 6000
Dublin 1
Ireland

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

12 November 2018

Dear Sir/Madam,

Re: Customer Reference No 052158350 pre-connection enquiry - Subject to contract | Contract denied

[Connection for 1530 domestic units]

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

In the case of wastewater connections this assessment does not confirm that a gravity connection is achievable. Therefore a suitably sized pumping station may be required to be installed on your site. All infrastructure should be designed and installed in accordance with the Irish Water Code of Practice.

Water:
New Connection to the existing network is feasible without network upgrade. The Site should be connected to existing 24'' AC main across the R113 road.
Please note that Irish Water can not guarantee a flow rate to meet fire flow requirements and in order to guarantee a flow to meet the Fire Authority requirements, you should provide adequate fire storage capacity within your development.

Wastewater:
New Connection to the existing network is feasible without network upgrade.
Phase 1 of the Development should be connected to existing 225mm sewer at the most upstream point/manhole.
Phase 2 of the Development should be connected to existing 300mm sewer.

Irish Water notes that the scale of this development dictates that it is subject to the Strategic Housing Development planning process. Therefore: In advance of submitting your full application to An Bord Pleanala for assessment, you must have reviewed this development with Irish Water and received a Statement of Design Acceptance in relation to the layout of water and wastewater services. All infrastructure should be designed and installed in accordance with the Irish Water Codes of Practice and Standard Details.

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

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

If you have any further questions, please contact Marina Byrne from the design team on 018925991 or email mzbyrne@water.ie. For further information, visit **www.water.ie/connections**

Yours sincerely,

Maria O'Dwyer
Connections and Developer Services

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APPENDIX F. EMAIL CORRESPONDENCE WITH SOUTH DUBLIN COUNTY COUNCIL WATER SERVICES DEPARTMENT

Appendix F

Correspondence with South Dublin County Council

Water Services Department

Mark Killian

From: Brian Harkin <bharkin@SDUBLINCOCO.ie>
Sent: 31 October 2018 15:21
To: Mark Killian
Cc: Chris Galvin
Subject: RE: A557 - Belgard Gardens - Proposed Drainage Strategy Overview (SDCC Ref: SPP001/18, ABP Ref: ABP-301909-18) email 2

Categories: Submitted to Gekko - Received

Mark,
I acknowledge receipt of your email.
Thank you.

Brian Harkin
Snr Executive Engineer
Water Services
Tel: 01-414 9000 Ext 4234

From: Mark Killian [mailto:mark.killian@ocsc.ie]
Sent: Tuesday 30 October 2018 08:52
To: Brian Harkin <bharkin@SDUBLINCOCO.ie>
Subject: RE: A557 - Belgard Gardens - Proposed Drainage Strategy Overview (SDCC Ref: SPP001/18, ABP Ref: ABP-301909-18) email 2

Brian,

As requested, please find a copy of CIRIA guideline C644 attached. Refer to Section 10.3 for information on runoff coefficients, as outlined in earlier email.

Regards,
Mark

From: Mark Killian
Sent: 25 October 2018 17:48
To: 'Brian Harkin' <bharkin@SDUBLINCOCO.ie>
Cc: 'Chris Galvin' <cgalvin@SDUBLINCOCO.ie>; Anthony Horan <anthony.horan@ocsc.ie>
Subject: RE: A557 - Belgard Gardens - Proposed Drainage Strategy Overview (SDCC Ref: SPP001/18, ABP Ref: ABP-301909-18) email 2

Brian,

Further to our most recent phone call, I have amended the catchment overview table to provide typical runoff coefficients that would be representative of the catchment areas:

	Gross Area (hectares)	% Area Impermeable	Design Input Method	Typical Equivalent Runoff Coefficient
CATCHMENT 1				
Roof Areas				
Intensive Green Roof	0.38	100	Time Area Diagram	0.1
Extensive Green Roof	1.39	100	Time Area Diagram	0.4

Other Roof Area	0.43	100	Contributing Area	0.84
Podium Soft Landscaping	0.14	100	Time Area Diagram	0.1
External Areas				
Private Road (Incl. parking)	0.29	100	Contributing Area	0.84
Bio Retention Area (with Filter Trench Underneath)	0.10	100	Contributing Area	0.84
Landscaping (Public Space Incl. Pavement / Trees / Plants …etc)	2.20	100	Contributing Area	0.84
Catchment 1 Total	**4.93**			
CATCHMENT 2				
Taken In Charge Road	0.23		Contributing Area	0.84
Bio Retention Area (with Filter Trench Underneath)	0.07		Contributing Area	0.84
Landscaping (Public Space Incl. Pavement / Trees / Plants …etc)	0.26	100	Contributing Area	0.84
Catchment 2 Total	**0.57**			
CATCHMENT 3				
Roof Areas				
Intensive Green Roof	0.20	100	Time Area Diagram	0.1
Extensive Green Roof	0.17	100	Time Area Diagram	0.4
Other Roof Area	0.10	100	Contributing Area	0.84
Podium Soft Landscaping	tbc			
External Areas				
Private Road (Incl. parking)	0.14	100	Contributing Area	0.84
Bio Retention Area (with Filter Trench Underneath)	0.03	100	Contributing Area	0.84
Landscaping (Public Space Incl. Pavement / Trees / Plants …etc)	0.50	100	Contributing Area	0.84
Catchment 3 Total	**1.14**			
Overall Total Area	**6.64**			

As discussed and as detailed in earlier emails, we have developed the integrated network design model, for the proposed surface water drainage network, using MicroDrainage design software, by Innovyze Inc, which simulates the overall drainage network including the sub-catchment bio-retention strips and filter trenches and allows for design of green roofs using the MDSuDS plug-in. The below hyperlinks will provide further information from their website.

http://www.innovyze.com/products/microdrainage/
http://www.innovyze.com/products/microdrainage/mdsuds/

This software simulates the green roof areas by inputting its runoff to the main network as a Time Area Diagram, while the bio-retention strips and filter trenches attenuates the runoff from the road and adjacent paved areas prior to entering the main SW drainage network. This all accumulatively results in an overall beneficial impact on the required main attenuation storage volume required, when simulated along with the main drainage network as part of the same overall integrated drainage network.

We hope that this further clarifies the proposed drainage design however, please do not hesitate to contact me, should you require any further information.

Regards,
Mark

From: Mark Killian
Sent: 25 October 2018 17:18
To: Brian Harkin <bharkin@SDUBLINCOCO.ie>
Cc: Chris Galvin <cgalvin@SDUBLINCOCO.ie>; Anthony Horan <anthony.horan@ocsc.ie>
Subject: RE: A557 - Belgard Gardens - Proposed Drainage Strategy Overview (SDCC Ref: SPP001/18, ABP Ref: ABP-301909-18) email 2

Hi Brian,

Thanks again for your time on the phone earlier and we understand your approach regarding the attenuation size, if it was to be derived as a singular 'end of line' attenuation.

Wallingford Procedure's Modified Rational Methodology suggests typical global runoff coefficients of 0.84 for winter rainfall events and 0.75 for summer rainfall events on typical catchment areas (houses, roads and pavements). We have applies these runoff coefficients to all hardstanding areas.

Typical runoff coefficients are outlined in accepted green roof guidance e.g:

- Ciria Guideline C644;
- DCC's Green Roofs Over Dublin;
- The Green Roof Organisation's Code of Practice for the UK;
- FLL's Guidelines for the Planning, Execution and Upkeep of Green Roof Sites

An extract from CIRIA C644 provides the following typical runoff coefficients, based on the FLL guidelines:

Table 10.1 *Coefficient of discharge for green roofs (FLL, 2002)*

	Runoff coefficient (%)	
Roof construction	Roof gradient up to 15°	Roof gradient greater than 15°
Greater than 500 mm substrate depth	10	n/a
250–500 mm substrate depth	20	n/a
150–250 mm substrate depth	30	n/a
100–150 mm substrate depth	40	50
60–100 mm substrate depth	50	60
40–60 mm substrate depth	60	70
20–40 mm substrate depth	70	80

Please note, as discussed previously, that we are proposing intensive green roofs (typical substrate >500mm) and extensive green roofs (100mm substrate) as part of the proposed development, which would therefore have an equivalent runoff of 10% and 40% respectively, based on the above. We however, have used a different design approach as discussed previously.

As our proposed development contains a significant number of SuDS features, such as intensive and extensive green roofs, bio-retention strips with filter drain under (Refer drawing **A557-OCSC-XX-XX-DR-C-0506**, attached again for reference), all of which act as interception for initial rainfall and varies the time of concentration entering the drainage network, we have provided a more detailed design approach, with several sub-attenuation areas as well as the main attenuation.

Our design approach, as outlined in more detail in the earlier emails, involved developing an integrated drainage network model, which inputs the rainfall runoff from the green roof areas, using the Green Roof calculator in the MicroDrainage design software, as a Time Area Diagram. This, rather than applying a significantly reduced runoff coefficient, better represents the rainfall acting on a green roof further to research that was carried out at Sheffield University Green Roof Centre, which is where the UK's Code of Practice for Green Roofs was developed.

Further, all road areas drain laterally to bio-retention strips, which both delays the time of concentration and attenuates the flow to the main drainage network, upstream of the main attenuation area (i.e. provides sub-catchment attenuation, prior to the main attenuation and thus having an overall beneficial effect on the overall volume required).
All these areas use a runoff coefficient of 0.84 for Winter rainfall and 0.75 for Summer rainfall, again as part of the developed network design model and as per Modified Rational Method for hardstanding areas. The bio-retention and filter drains also throttle the rainfall runoff and provide attenuation for their contributing catchments.

The green roof areas, bio-retention (with filter trench), and the main drainage network (which contains the main attenuation area) all form part of the same integrated network design model, using the industry standard MicroDrainage Network computer software, by Innovyze Inc (outlined in further detail in earlier emails); resulting in the proposed attenuation volumes being required.

The results of the network model simulation (MicroDrainage) indicate that no flooding is evident for the critical 1%AEP design rainfall event (including climate change allowance).

We hope that the above provides further clarification on your request.

Regards,
Mark

From: Brian Harkin [mailto:bharkin@SDUBLINCOCO.ie]
Sent: 25 October 2018 15:39
To: Mark Killian <mark.killian@ocsc.ie>
Cc: Chris Galvin <cgalvin@SDUBLINCOCO.ie>
Subject: RE: A557 - Belgard Gardens - Proposed Drainage Strategy Overview (SDCC Ref: SPP001/18, ABP Ref: ABP-301909-18) email 2

To: Mark Killian OCSC Engineers Dublin

Would you provide estimates of run off coefficients for each surface type in proposed development.

If I use a run off coefficient of 0.8 for all areas then the attenuation system is significantly undersized.

If you provide more information of run off coefficients for each surface type then I can better assess the application.

Brian Harkin
Senior Executive Engineer
Water Services
Tel: 01-414 9000 Ext 4234
SDCC

From: Mark Killian [mailto:mark.killian@ocsc.ie]
Sent: Wednesday 26 September 2018 11:38
To: Brian Harkin <bharkin@SDUBLINCOCO.ie>; Chris Galvin <cgalvin@SDUBLINCOCO.ie>
Subject: RE: A557 - Belgard Gardens - Proposed Drainage Strategy Overview (SDCC Ref: SPP001/18, ABP Ref: ABP-301909-18) email 2

Hi Brian / Chris,

Just following up on the emails below, as I am conscious of our client's willingness to submit to ABP soon.

Is it possible to get confirmation of SDCC's approval of our drainage design?

Please do not hesitate to contact me, should you require any further information. I can also make myself available, should you wish to discuss further over a meeting?

Thanks,
Mark

From: Mark Killian
Sent: 21 September 2018 12:08
To: 'Brian Harkin' <bharkin@SDUBLINCOCO.ie>; 'Chris Galvin' <cgalvin@SDUBLINCOCO.ie>
Subject: RE: A557 - Belgard Gardens - Proposed Drainage Strategy Overview (SDCC Ref: SPP001/18, ABP Ref: ABP-301909-18) email 2

Hi Brian / Chris,

Have you had the chance to review our drainage design proposal below any further? I have attached a copy of the finalised drainage design drawings for further context.

We would appreciate if you could please advise of SDCC's satisfaction of our design and / or advise of any further comment.

Please do not hesitate to contact me, should you require any further information.

Regards,
Mark

From: Mark Killian
Sent: 18 September 2018 17:16
To: 'Brian Harkin' <bharkin@SDUBLINCOCO.ie>; 'Chris Galvin' <cgalvin@SDUBLINCOCO.ie>
Subject: RE: A557 - Belgard Gardens - Proposed Drainage Strategy Overview (SDCC Ref: SPP001/18, ABP Ref: ABP-301909-18) email 2

Hi Brian / Chris,

Further to the correspondence below and our previous meeting at your office, have you any further queries in relation to the design concept and information provided for the surface water drainage at the proposed Belgard Road development?

We are currently finalising our revised Engineering Services Report and Drainage Design Drawings for planning submission and would like to ensure that SDCC Water Services are satisfied with our approach.

Thanks,
Mark

From: Mark Killian
Sent: 14 September 2018 11:23
To: Brian Harkin <bharkin@SDUBLINCOCO.ie>; Chris Galvin <cgalvin@SDUBLINCOCO.ie>
Subject: RE: A557 - Belgard Gardens - Proposed Drainage Strategy Overview (SDCC Ref: SPP001/18, ABP Ref: ABP-301909-18) email 2

Hi Brian,

1. Green Areas / Hardstanding

As outlined below, the existing total site area is 6.6 hectares, which consists of approximately:

- 1.6 hectares grassed area;
- 2.2 hectares building structure;
- 2.8 hectares road and car parking.

The breakdown of the proposed development is a little more complex than simplifying it into grassed / hardstanding, as previously discussed at our meeting. This is why we have approached the design using the MicroDrainage (including MDSuDS and Green Roof Calculator) Integrated Network Design so that we could incorporate the green roofs, bio-retention areas with filter trenches and the storage feature as part of a complete design.

The table below is a breakdown of the proposed areas, separating the roof, road and others and with reference the 3nr. catchment areas (Refer to the drawing A557-OCSC-XX-XX-DR-C-0506, attached again for reference):

1. Catchment 1 is the development's main drainage network, which incorporates all of Phase 1 and the majority of Phase 2.
2. Catchment 2 is the proposed north-south road, through the centre of the site that is to be taken in charge. We are proposing to keep the drainage system (bio-retention and filter trench) separate to the main network. Previous discussions with Parks Dept have indicated that the proposed building management team will maintain these bio-retention areas; for consistency with the overall development area.
3. Catchment 3 is the north east corner of the site that is relatively lower than the remaining site, which must be independent of the other network due to the relationship[of the proposed FFLs and the main network attenuation's maximum water level.

For the purpose of the network design, we have considered all external (roads & landscaping) areas as being 100% impermeable; giving a global runoff coefficient of 0.84. This is as the soft landscaping areas are subject to change and cannot be accurately calculated; ensuring an upper bound attenuation volume is provided.

As discussed previously, and outlined below, the methodology for the green roof design is based on the inputted Time Area Diagram, which result in the runoff from these areas entering the main network in a similar manner to the performance of a green roof as opposed to a paved area.

Please note that the Phase 2 areas are subject to detailed design prior to its planning submission however, we have accounted for maximum hardstanding in relation to our network design.

	Gross Area (hectares)	% Area Impermeable	Design Input Method
CATCHMENT 1			
Roof Areas			
Intensive Green Roof	0.38	100	Time Area Diagram
Extensive Green Roof	1.39	100	Time Area Diagram
Other Roof Area	0.43	100	Contributing Area
Podium Soft Landscaping	0.14	100	Time Area Diagram

External Areas			
Private Road (Incl. parking)	0.29	100	Contributing Area
Bio Retention Area (with Filter Trench Underneath)	0.10	100	Contributing Area
Landscaping (Public Space Incl. Pavement / Trees / Plants …etc)	2.20	100	Contributing Area
Catchment 1 Total	**4.93**		
CATCHMENT 2			
Taken In Charge Road	0.23		Contributing Area
Bio Retention Area (with Filter Trench Underneath)	0.07		Contributing Area
Landscaping (Public Space Incl. Pavement / Trees / Plants …etc)	0.26	100	Contributing Area
Catchment 2 Total	**0.57**		
CATCHMENT 3			
Roof Areas			
Intensive Green Roof	0.20	100	Time Area Diagram
Extensive Green Roof	0.17	100	Time Area Diagram
Other Roof Area	0.10	100	Contributing Area
Podium Soft Landscaping	tbc		
External Areas			
Private Road (Incl. parking)	0.14	100	Contributing Area
Bio Retention Area (with Filter Trench Underneath)	0.03	100	Contributing Area
Landscaping (Public Space Incl. Pavement / Trees / Plants …etc)	0.50	100	Contributing Area
Catchment 3 Total	**1.14**		
Overall Total Area	**6.64**		

2. Attenuation

The following attenuation volumes are to be provided, which have been estimated through the MicroDrainage Network Design computer; to ensure that there is no flooding throughout the development during the 1% AEP design rainfall event (Including a 10% increase for Climate Change allowance):

Catchment 1 (Main Network)
Filter Trench Under Bio-retention Areas: 150m^3
Underground Storage (1-in 30yr): 750m^3
Above Ground Storage (1in 30-yr <x> 1-in 100yr): 700m^3

Catchment 2 (to be taken in charge road)
Filter Trench Under Bio-retention Areas: 115m^3

Catchment 3
To be determined through detailed design of Phase 2

I hope the above clarifies our proposals a bit better.

Thanks and please do not hesitate to contact me, should you have any further queries.

Regards,
Mark

From: Brian Harkin [mailto:bharkin@SDUBLINCOCO.ie]
Sent: 13 September 2018 09:10
To: Mark Killian <mark.killian@ocsc.ie>
Cc: Chris Galvin <cgalvin@SDUBLINCOCO.ie>
Subject: RE: A557 - Belgard Gardens - Proposed Drainage Strategy Overview (SDCC Ref: SPP001/18, ABP Ref: ABP-301909-18) email 2

Mark,
Thank you for your email.

Questions.

1 What is the before and after:
- Green area/ grass Hectares
- Hardstanding areas Hectares
- Site area Hectares

2 What is the proposed
- Surface water attenuation provided m^3
- Surface water attenuation required m^3

Thank you

Brian

From: Mark Killian [mailto:mark.killian@ocsc.ie]
Sent: Wednesday 12 September 2018 16:01
To: Brian Harkin <bharkin@SDUBLINCOCO.ie>; Chris Galvin <cgalvin@SDUBLINCOCO.ie>
Subject: FW: A557 - Belgard Gardens - Proposed Drainage Strategy Overview (SDCC Ref: SPP001/18, ABP Ref: ABP-301909-18) email 2

Brian / Chris,

Drainage Layout drawing, as submitted for planning, attached for reference.

We would appreciate if you could please review and advise of further comment and / or approval, prior to our submission to An Bord Pleanala.

Regards,
Mark

From: Mark Killian
Sent: 12 September 2018 15:58
To: Brian Harkin <bharkin@SDUBLINCOCO.ie>; 'Chris Galvin' <cgalvin@SDUBLINCOCO.ie>
Subject: A557 - Belgard Gardens - Proposed Drainage Strategy Overview (SDCC Ref: SPP001/18, ABP Ref: ABP-301909-18) email 1 of 3

Hi Brian / Chris,

In relation to the proposed Belgard Gardens, Phase 1 development, at Belgard Square North (*SDCC Ref: SPP001/18, ABP Ref: ABP-301909-18*) and as previously discussed at the meeting held at your offices on Tuesday 7th August 2018, we provide an overview summary of the proposed Surface Water Drainage Infrastructure Strategy, with reference to the attached drawings and documents; as follows:

1.0 Development Phasing

The proposed mixed-use development is to be phased in two separate planning applications, **Phase 1** and **Phase 2**.

The current application, *Phase 1*, is to comprise a childcare facility, 436 residential units, 358 student accommodation units and associated residential amenity space, which are to be provided across the southern 3nr. sectors of the proposed development (refer attached layout **A557-OCSC-XX-XX-DR-C-0506**). The provision of the main north- south road, which is to be taken-in-charge and 2nr. minor access roads and the augmentation of the Belgard Square North road, which aligns the southern boundary of the development, are also to be delivered as part of this Phase 1 application.

Phase 2 of this development, which has yet to be submitted to An Bord Pleanala, is to comprise a further 1,104 residential units, 2,500m^2 commercial space (preliminary numbers only and subject to detailed design) and a civic centre across the remaining 6nr. sectors. This is to be delivered along with with all remaining roads and associated infrastructure and landscaping.

2.0 Existing Site Context

The overall site (both phases), which consists of 3nr existing industrial developments, is approximately 6.6 hectares in area, of which, approximately 75 %, i.e. 4.95 ha, is considered impermeable areas (buildings and hardstanding), with the remaining 25%, i.e. 1.65 ha considered green space (grassed / trees). Refer attached drawing **A557-XX-XX-DR-C-0505** for further context.

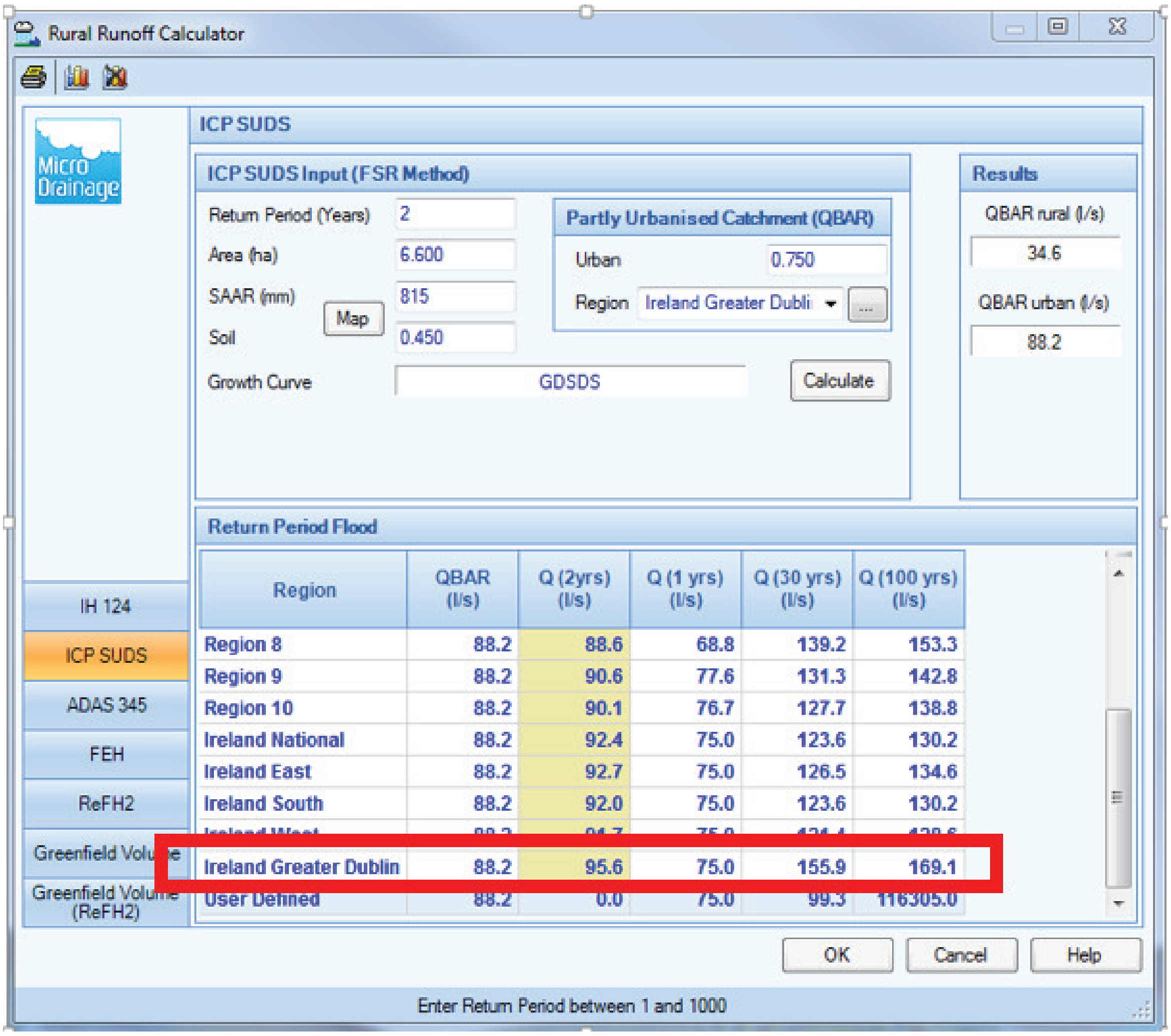
2.1 Proposed Site Context

The proposed development is to be separated into a total of 9nr. Sectors across the overall site area. As mentioned above, the *Phase 1* application is to comprise the initial 3nr. Sectors, associated landscaping and civil engineering infrastructure. Green roofs (intensive and extensive) are to be provided on all accessible roofs, with traditional flat roofs provided elsewhere (Refer Drawing **A557-OCSC-XX-XX-DR-C-0506**, attached for context).

3.0 Existing Surface Water Drainage Infrastructure

All existing roof and hardstanding, within the site boundary, currently discharges un-attenuated and un-treated flows to the public surface water drainage network via a number of locations on Airton Road, Belgard Road and Belgard Square North.

The maximum total existing rainfall runoff discharging from site has been calculated as **88.2 l/s** using the ICPSuDS $QBAR_{URBAN}$ Input, as per the Flood Studies Report (FSR Method) and as discussed at the pre-planning meetings on 26th September 2017 & 29th March 2018. Refer image below for results from Rural Runoff Design Calculator, from MicroDrainage (by Innovyze Inc.).



3.1 Proposed Surface Water Strategy (Overview of Proposals)

The overall site area is to be split into a total of 3 catchments (preliminary, pending detailed design of Phase 2) – refer attached drawing **A5757-OCSC-XX-XX-DR-0506**.

- Catchment 1 (4.9ha) – refers to the contributing catchment for the main drainage network, with the central attenuation;
- Catchment 2 (0.5ha) – refers to the contributing catchment from the road and adjacent pavement areas that are to be taken in charge;
- Catchment 3 (1.2ha) – refers to the catchment, which is within Phase 2 and is independent of Catchment 1; due to its relatively lower surface levels

	Area	% Area Impermeable	Input Method
Phase 1			
Roof Areas			
Intensive Green Roof	0.20	100	Time Area Diagram
Extensive Green Roof	0.64	100	Time Area Diagram
Other Roof Area	0.22	100	Contributing Area
Podium Courtyard	0.14	100	Time Area Diagram
Road / Pavement	0.67	100	Contributing Area
Taken in charge Road	0.50	100	Contributing Area
Landscaped / Public Space	1.09	100	Contributing Area
Total	**3.45**		

Phase 2 (Preliminary)			
Intensive Green Roof	0.39	100	Time Area Diagram
Extensive Green Roof	0.92	100	Time Area Diagram
Other Roof Area	0.35	100	Contributing Area
Road / Landscaped Area	1.49	100	Contributing Area
Total	**3.15**		

It is proposed to restrict the total rainfall runoff discharging from site to a maximum of **68.1 l/s**, which is the equivalent of the $QBAR_{URBAN}$ discharge rate for a 50% urbanised catchment, and is **a reduction on the current rate of discharge and Q (1yr)** – refer image above (Section 3.0). This is to be achieved largely through the provision of an integrated drainage network, complete with green roofs (intensive and extensive), bio-retention strips with filter drains under, a central underground attenuation storage (Stormtech, or similar approved) along with flow control chambers at the outfalls. These are summarised as follows:

Green Roofs

Intensive Green Roofs i.e. deep substrate (typically 500mm) are to be provided on all relatively low-lying roof areas. It should be noted that the proposed courtyard landscaping on podium level has been considered in a similar manner to the intensive green roof area, for the purpose of this design. These areas will typically comprise deep underlying soil and vegetation / planting, which will:

- reduce the rainfall runoff by absorption and evapotranspiration;
- reduce the runoff rate by attenuating the flows prior to entering the main drainage network and therefore not peaking at the same time as the rainfall on the more localised hardstanding area;
- improve the runoff quality by providing at-source treatment of the rainfall runoff, prior to discharging to the main drainage network.

Extensive Green Roofs i.e. shallower substrate (typically 100mm) are to be provided on higher accessible roof areas. These will typically comprise a 100mm substrate, underneath a layer of sedum moss (or similar). Some of the proposed extensive green roof areas are to contain PV Solar Panels, with gravel underneath, at the centre of the roof area but will not reduce the drainage efficiency of the green roof proposal.
The Extensive Green Roofs will provide similar outcomes to those outlined above for the Intensive Green Roof, but to a lesser extent.

Bio-Retention Strips

It is proposed to drain all road areas, and adjoining pavements, laterally to bio-retention strips that will contain a filter trench underneath. This will involve super-elevating all road profiles and providing a bio-retention strip on the 'low-side' to receive the rainfall runoff and allow it to percolate through to the filter trench underneath. These will discharge to the main drainage network, from the downstream end of the filter trench. The provision of the bio-retention strips will

- remove the need for road gullies;
- reduce the runoff rate by attenuating the flows prior to entering the main drainage network and therefore not peaking at the same time as the rainfall on the more localised hardstanding area;
- improve the runoff quality and remove the need for a fuel separator by providing at-source treatment of the rainfall runoff and hydrocarbons, prior to discharging to the main drainage network.

Attenuation

The proposed main drainage network, which has a total contributing catchment of approximately 4.9 hectares, is to discharge restricted flows to the public surface water drainage network, which will therefore require temporary storage; to attenuate the flows further to that outlined above. This will be achieved through the provision of an **in-line 750m^3 underground storage system** (Stormtech, or similar approved) along with a vortex flow control chamber (Hydro-brake Optimum, or similar). The underground storage will temporarily attenuate the rainfall runoff for rainfall events up to, and including, the **30-year design rainfall event**. More significant rainfall events will overflow to the recessed plaza (**750m³** volume), which has a design maximum depth of 1.25m for the 1% AEP and a 'wetted' duration of 480-minutes during the **critical 1% AEP design rainfall event**.

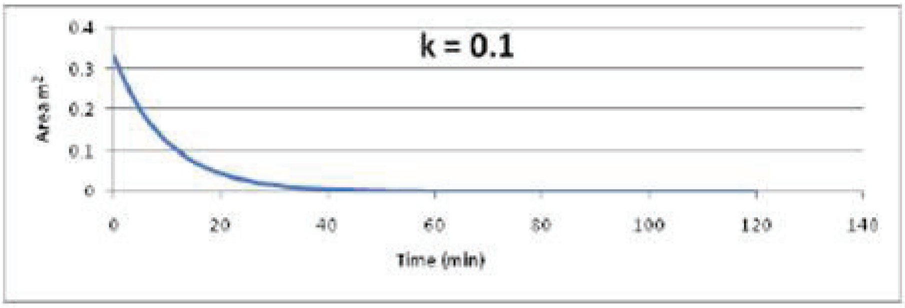
The proposed drainage associated with to-be taken-in-charge roads, with an associated contributing catchment of approximately 0.5 hectares, are attenuated through the bio-retention strips and underlying filter drains, which will also contain a flow control device at the outfall to the public surface water drainage network.

4.0 Proposed Drainage Network Simulation (Overview of computer design)

As discussed at the meeting on 7th August 2018, we have developed an integrated drainage design model for the development using the MicroDrainage computer design software, by XP Innovyze, which allows for provision of in-line filter drains and bio-retention strips, as well as Green Roof catchment design as part of their MDSuDS package.

As an overview, and as detailed within the submitted Engineering Services Report, the green roof calculator models the rainfall runoff from the green roof areas, to the main drainage network, over an extended time period during a rainfall event, rather than applying a conventional time of concentration with a reduced runoff coefficient.

This means that the roof area is considered 100% impermeable but it results in approximately the first 3-5mm (user defined) of rainfall being lost through storage and evapotranspiration, while discharging the rainfall runoff at a falling flow rate (initially fast discharge rate but slowly reduces over time); to simulate the performance of a green roof (refer graph below for indication of the unit-Time Area Diagram):



The computer design software, provided by Innovyze Inc. (formerly MicroDrainage and WinDes), carries out all designs based on the Wallingford procedure Modified Rational Method and in accordance with all best practice guidelines. The methodology within the green roof design calculator, used within the design software, has been developed in collaboration with Sheffield University and based on CIRIA C644 (Green Roof) Guidance, current best practice and research carried out at Sheffield University, the location of the Green Roof Centre.

All the above has been provided in more detail in the submitted Engineering Services Report but will be provided with more clarity in the revised submission that will be issued as part of the formal planning application. I will email you a copy of the original drainage design drawings (A557-OCSC-XX-XX-DR-C-0500 & 0501) separately due to size, as submitted initially to ABP, for context, but please note that the design levels and outfall route will are subject to a slight revision; due to development design changes.

We would greatly appreciate if you could review the above and advise of any comments and or acceptance of the design proposal?
We are anxious to smooth the process for submission to An Bord Pleanala and want to ensure that SDCC Water Services Dept. are satisfied with our proposals, prior to submission.

Please do not hesitate to contact me, should you require any further information.

Regards,
Mark Killian

Chartered Civil Engineer
MSc BE CEng MIEI

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Mark Killian

From: Mark Killian
Sent: 25 April 2018 15:07
To: Brian Harkin
Cc: Anthony Horan
Subject: A557 - Proposed Development at Belgard Gardens - Surface Water Design Approach
Attachments: 20180418_email from XPSolutions RE Design Approach.pdf; A557-OCSC-XX-XX-SK-C-0005-S1-P01.pdf

Categories: Filed using Gekko

Hi Brian.

Further to our meeting on 29th March 2018, regarding the proposed development at Belgard Gardens, we are currently developing our drainage design model using the guidance outlined in CIRIA C644 (*Guidance on the use of green roofs, green walls*
and complementary features on buildings) and CIRIA C753 (*The SuDS Manual*), the GDSDS and the Green Roof Code of Best Practice (Green Roof Organisation UK, 2014).

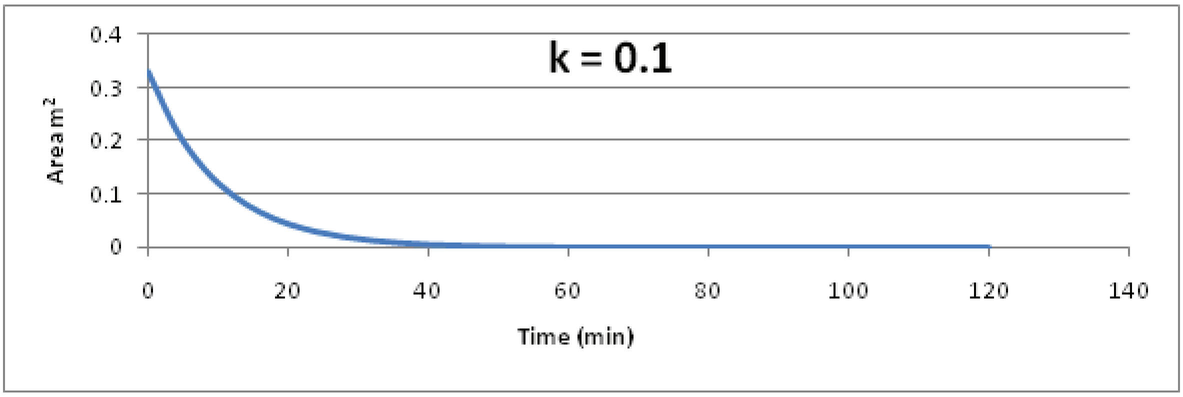
I have attached a copy of our preliminary Drainage Design Strategy Drawing (A557-OCSC-XX-XX-SK-C-0005), which we tabled at the above meeting, for reference.

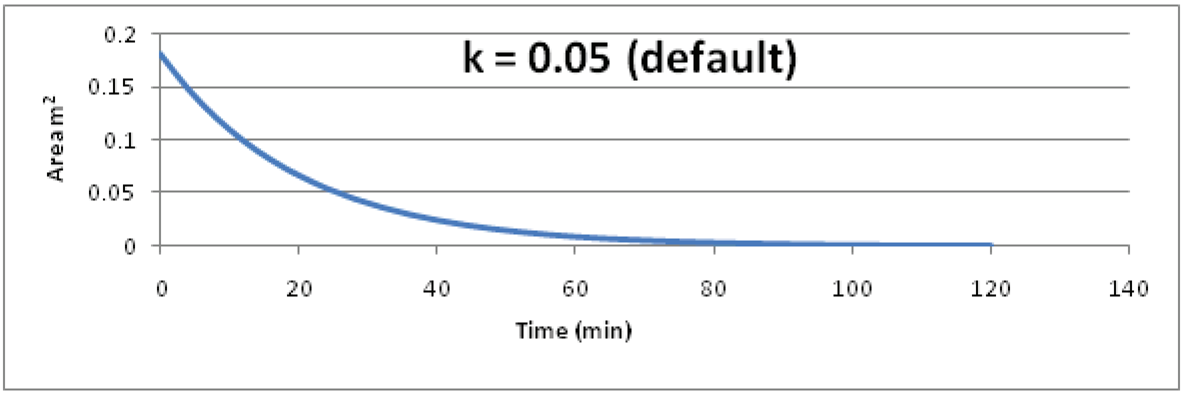
We have recently invested in a new software application (MDSuDS) for the ***XP Solutions MicroDrainage*** product that allows for the design of green infrastructure and other SuDS features, such as Green Roofs and Bio-retention Areas, which can be integrated into the overall surface water drainage network design.

In order to model the runoff for the proposed development, we have applied the Green Roof Runoff Method design approach that is utilised within the MicroDrainage MDSuDS software. This methodology has been developed based on research at Sheffield University into green roofs and a review of the best current practice. Our approach currently uses the following design inputs to the MDSuDS software, for the various green roofs:

- Evapotranspiration Rate of **1mm/day** (typical of winter period i.e. worst case);
- Depression storage within the green roof build-up of **2%** soil substrate depth for *extensive green roofs* and **4%** for *intensive green roofs* (less than the recommended value of **5%**; as a conservative measure);
- Decay Coefficient of **0.1** (maximum value) for *extensive green roofs* and **0.05** for *intensive green roofs* – to represent the rate of runoff from the green roof (higher the value, the quicker the runoff), with the runoff typically occurring over a period of 120minutes.

The Evapotranspiration Rate, noted above, represents the amount of water that is lost to the environment due to evaporation and transpiration. (Typical values for UK & Ireland are 3mm/day for summer and 1mm/day for winter).
The Depression Storage noted above represents the amount of runoff falling on the green roof area that does not enter the drainage system i.e. soaks into the substrate build up.
The Decay Coefficient, noted above, is a drawdown factor that represents the exponential rate at which the runoff falling on the green roof area discharges to the surface water drainage network (Refer graphs below for example).
The higher the value (max k = 0.1), the quicker the runoff rate.





Further, we have provided a preliminary copy of our design approach to the XP Solutions software support team; for validation of our design strategy. Please refer to correspondence attached.

If you have any queries on the above, please do not hesitate to contact me.

Regards,
Mark Killian
MSc BE CEng MIEI
Chartered Civil Engineer

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