MALONE O'REGAN
CONSULTING ENGINEERS

PROPOSED PART 8 RESIDENTIAL DEVELOPMENT

OLDTOWN MILL, CELBRIDGE.

ENGINEERING REPORT

KILDARE COUNTY COUNCIL

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1 INTRODUCTION

1.1 Introduction

This report is prepared on behalf of the NDFA and Kildare County Council to accompany a Part 8 proposal for the development of 60 no. residential units at Oldtown Mill Road, Celbridge, Co. Kildare

The proposed development includes:

i. 60 no. residential units including 40 no. houses and 20 no. apartments comprising 20 no. one bed units; 15 no. two bed units; 21 no. three bed units; and 4 no. four bed units; with renewable energy design measures (which may be provided externally) for each housing unit.
ii. Landscaping works including provision of (a) open space and kick about areas; (b) natural play features; and (c) new pedestrian and cycle connections.
iii. Associated site and infrastructural works including provision for (a) 2 no. ESB substations and switchrooms; (b) car and bicycle parking; (d) public lighting; (e) temporary construction signage; (f) estate signage; and (g) varied site boundary treatment comprising walls and fencing.
iv. All associated site development works, including removal of existing spoil from the site in advance of construction works.

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

Figure 1.1 – Site location

1.2 Site Description

The location of the proposed development is illustrated in Figure 1.1 above. The site is situated on the outskirts of Celbridge town, approximately 1.5km to the west of the town centre. The new residential development is located beside existing housing estates, the Paddock to the east of the site and the Orchard to the south of the site. The site is bound to the west by undeveloped greenfield sites, some of these lands are used for agricultural purposes. The lands to the north of the site are in development from a greenfield site to a residential development.

Figure 1.2 – Site Plan

2 SURFACE WATER DRAINAGE DESIGN

2.1 Introduction

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

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

The SuDS strategy will be developed with the following steps:

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

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

Parameter Description	Assigned Value
Surface Water Drainage Pipework Design Return Period	2 years (Ref IS EN 752 Table 2 for 'Domestic')
Attenuation Pond Design Return Period	100 years
Allowance for climate change	20% (Ref. OPW Flood Risk Management Climate Change Sectoral Adaptation Plan, High-End Future Scenario)
M5-60	16.2mm (Met Eireann data)
M5-2D	58mm (Met Eireann data)
Ratio, r	0.28
Time of Entry	4 min
Pipe roughness, Ks	0.6mm (Ref. GDSDS Volume 2, Table 6.4)
Minimum velocity	1.0 m/s (Ref. GDSDS Volume 2, Table 6.4)

Table 2.1 Surface Water Design Parameters

2.2 Existing Services

The Oldtown Mill Road runs along 0.65Km from the eastern boundary of the site, connecting to the Shackleton Road. Existing surface water sewers run from Oldtown Mill Road in a 225mm concrete pipe out towards Shackleton Road. These underground sewers carry surface water runoff from other catchments adjacent to the site. Due to the relative levels of the existing drainage and the proposed site levels, it is possible to achieve a gravity connection to the surface water drainage pipework installed.

2.3 Proposed Services

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

The proposed surface water drainage layout for the development is indicated on Malone O'Regan drawings SHB5-OCK-DR-MOR-CS-P3-130, 150 and 151. Surface water runoff from new internal road surfaces, footpaths, other areas of hardstanding and the roofs of buildings will be collected within a gravity drainage network and directed towards the attenuation system; a pond at the southwest corner. The attenuation system is sized to cater for a 1 in 100-year storm event.

The outfall from the attenuation pond will be restricted to the applicable 'greenfield' runoff rate using a Hydrobrake flow control device.

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

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

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

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

Table 2.2: Runoff Coefficients

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

2.4 Permissible Runoff

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

$$QBAR_{rural} = 0.00108[(Areax0.01)^{\wedge}0.89] \times [SAAR^{\wedge}1.17] \times [Soil^{\wedge}2.17]$$

Where:

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

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

Standard Average Annual Rainfall for the site in Oldtown Mill was taken from the Flood Studies Report as 924mm.

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

In October 2023, Causeway Geotech Ltd. completed a comprehensive programme of site investigations for the site. These investigations showed that ground conditions were consistent across the site. Generally, topsoil over made ground over glacial till over bedrock. The glacial till consists of sandy gravelly clay frequently with low cobble content typically firm or stiff in the upper horizons, becoming very stiff with increasing depth. A weak grey mudstone rockhead was encountered at depths ranging from 1.6m to 1.7m. A strong dark grey limestone rockhead was encountered at a depth of 1.9m. Two number infiltration tests were conducted across the site. An infiltration rate of f=0.06 m/hr at one test location was achieved but no infiltration rate was achieved for the second test as the water level dropped too slowly indicating poor infiltration. The report prepared by Causeway Geotech concludes that the site is not suitable for infiltration drainage systems.

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

For 50ha area $QBAR_{rural}$ $= 0.00108\ [0.5]^{0.89} \times [924]^{1.17} \times [0.3]^{2.17}$

$= 0.126\ m^3/s$

$= 126.0$ l/s (for 50ha)

$QBAR_{rural}$ = 4.315 l/s

For the purposes of surface water attenuation design, the site is dealt with as one catchment as shown in Figure 2.1 draining to a pond in the rear southwest of the site. A breakdown of the impermeable areas contributing to the surface water drainage network in the total catchment with applied runoff coefficients is provided in Table 2.3 below.

Total Area sq.m	Type of Surface	Area sq.m	Run-off Coefficient	Equivalent Impermeable	Urban Creep Allowance	Oberall Impermeable
17110.5	Roof (Note 1)	2492.5	0.50	1246.3	1370.9	6219.1
	Roof	735.4	0.95	698.6	768.5	
	Permeable Paving inc. areas from hardstanding	2675.7	0.50	1337.9	1471.6	
ha	Landscaped Areas inc. areas from hardstanding	11021.7	0.20	2204.3	2424.8	ha
1.71						0.5
	Hardstanding	185.2	0.90	166.7	183.3	

Table 2.3 Breakdown of Impermeable Areas for Proposed Development

Figure 2.1 – Surface Water Drainage Catchment Area

2.5 Sustainable Drainage Systems (SuDS)

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

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

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

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

2.5.1 Compliance with the principles of the CIRIA C753 SuDS Manual

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

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

Table 2.4 below includes a list of all current SuDS measures which would typically be considered when designing a new residential development such as that which is now proposed. This table also outlines the rationale behind the selection of SuDS measures and why other measures would not be appropriate.

The runoff generated from the catchment will be attenuated in storage structures within and below ground. The proposed attenuation systems are explained in section 2.5. A wide range of SuDS measures are proposed across the site to maximise interception and treatment.

SUDS Measure	Measure Adopted?	Rationale for Selecting / Not Selecting Measure
Bioretention Swales *Shallow landscaped depressions that serve to reduce runoff rates / volumes as well as providing interception storage, treatment of runoff and encouraging biodiversity*	Yes	Bioretention swales are proposed in areas beside roads, footpaths and green spaces within the site.
Tree pits *Attenuate surface water runoff by utilising voids within the root zone*	Yes	Tree pits have been specified in suitable areas beside the development roads and car parking.
Green Roofs *Vegetated roofs used to reduce the rate and volume of runoff as well as encouraging biodiversity*	No	It is not proposed to provide green roofs for roofs above housing and duplex buildings due to the roof pitch.
Blue Roofs *Provide attenuation storage, reducing requirement for storage elsewhere on site*	No	It is not proposed to provide blue roofs for roofs above housing and duplex buildings due to the roof pitch.
Green Living Walls *Planted walls which improve air quality and encourage biodiversity*	No	Green walls are not considered appropriate given the proposed residential building use.
Rain Gardens *Localised depressions in the ground that collect runoff from roofs/hard surfaces and allow infiltration, absorption*	Yes	The proposed residential development aims to provide rain gardens, particularly in gardens of the housing units and grass verges.
Rainwater harvesting *Runoff captured from roofs is reused for non-potable purposes, thereby reducing overall runoff volume.*	Yes	In the case of the proposed residential development, it is considered viable to gather the water for grey water usage. Refer to M&E details.
Permeable paving *Allows runoff to percolate into the subsoil, reducing overall runoff volume*	Yes	Permeable paving is proposed within the development in driveways and car parking spaces.
Porous asphalt *Allows runoff to percolate into the subsoil, reducing overall runoff volume*	No	Porous asphalt is not considered suitable for use in roads within the development as it does not comply with the Local Authority roads standards.
Integrated Constructed Wetlands (ICWs) *System of shallow ponds, planted to treat water, removing nutrients and harmful impurities*	Yes	ICWs are considered appropriate due to the space available, rural nature of the site and the adequate levels available.

Table 2.4 Proposed SuDS Features

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

2.5.2 Bioretention Swales

It is proposed to provide a number of discrete, shallow landscaped areas, adjacent to the access roads in the site where feasible. Runoff from the roads will be directed towards these bioretention swales and will be able to run directly into them via short cut-out sections within the road kerbs. Refer to the details on drawing SHB5-OCK-DR-MOR-CS-P3-130, 150 and 151. These features will provide a level of storage to attenuate the runoff flows and also permit settlement of coarse silts. As described in Section 2.3 above, the permeability of the underlying soils varies across the site. However, it is anticipated that runoff from minor rainfall events will be able to percolate directly into the soil. An overflow from the swales will be provided. This will take the form of a manhole with an open-grated access cover. During larger storm events, the water in the bioretention areas will be able to overflow through the grated access cover and will then drain towards the attenuation system.

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

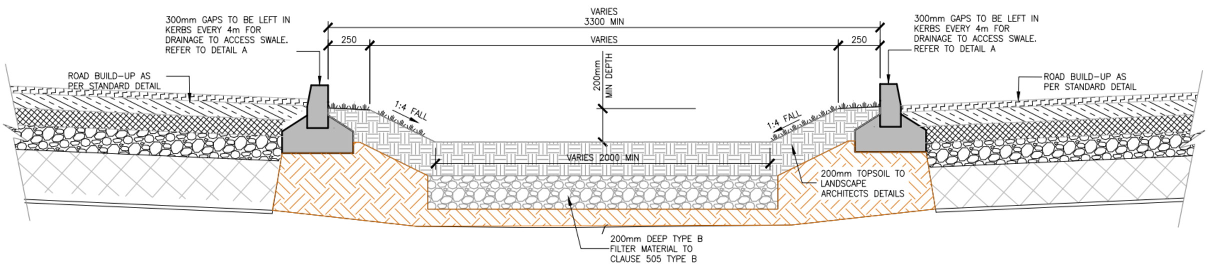


Figure 2.2 – Bio-Retention Area Detail

2.5.3 Tree Pit

It is proposed to provide a number of tree pits adjacent to car parking and footpaths where feasible within the development. Runoff from the roads and footpaths will be directed towards these tree pits. Refer to the details on drawing SHB5-OCK-DR-MOR-CS-P3-130, 150 and 151. These features will provide a level of storage to attenuate the runoff flows. It is anticipated that runoff from minor rainfall events will be able to percolate directly into the soil. An overflow from the tree pits will be provided. During larger storm events, the water in the bioretention areas will be able to overflow and drain towards the attenuation system.

The bioretention areas will be planted in order to promote biodiversity. Runoff will also be treated through the adsorption of particles by vegetation or by soil, and by biological activity.

Tree pits can reduce the runoff rates and volumes of surface water although the area contributing is small. They are effective in delivering interception and treatment storage.

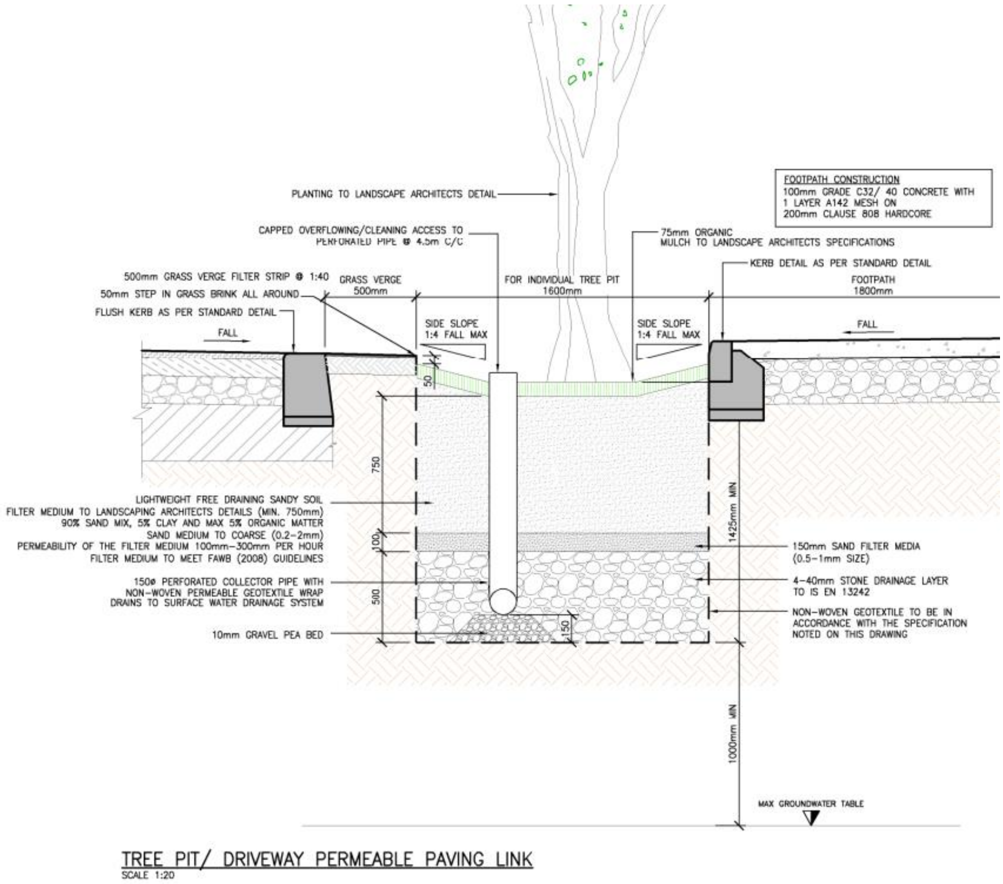
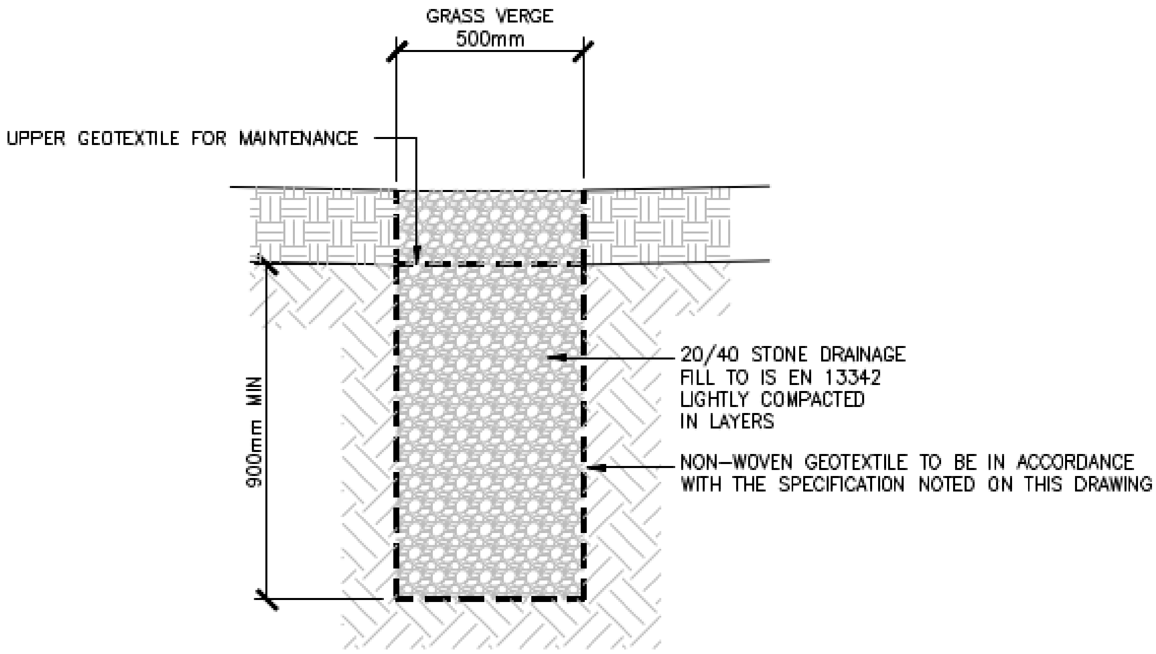


Figure 2.3 – Tree Pit

2.5.4 Rain Garden / Bioretention Area

It is proposed to provide a number of discrete, shallow landscaped areas in gardens of the housing units and landscape areas. Runoff from the roofs/hard surfaces will be directed towards these bioretention gardens. Refer to the details on drawing SHB5-OCK-DR-MOR-CS-P3-130, 150 and 151. These features will provide a level of storage to attenuate the runoff flows. It is anticipated that runoff from minor rainfall events will be able to percolate directly into the soil. An overflow from the rain gardens will be provided. During larger storm events, the water in the bioretention areas will be able to overflow and drain towards the attenuation system.

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



TYPICAL SECTION THROUGH
RAINGARDEN/BIORETENTION AREA
SCALE 1:20

Figure 2.4 – Rain Garden

2.5.5 Permeable Paving

It is proposed to use permeable paving to surface the parking spaces and driveways in the development. It is anticipated that most of the rainwater will be able to percolate through the permeable paving and infiltrate into the underlying soils. However, it is proposed to provide a number of overflow outlets within the permeable paving build-up which will ensure the parking area is not flooded during severe rainfall events. The outlet from the permeable paving areas will be raised 100mm above formation level to provide interception storage within the stone sub-base; this gives 30mm interception storage @ 30% voids in the gravel.

These permeable surfaces, together with their associated substructures, are an efficient means of managing surface water runoff close to source – intercepting runoff, reducing the volume and frequency of runoff, and providing treatment medium. Refer to the Malone O'Regan SuDS detail drawing no. SHB5-OCK-DR-MOR-CS-P3-130, 150 and 151 for typical permeable paving details.

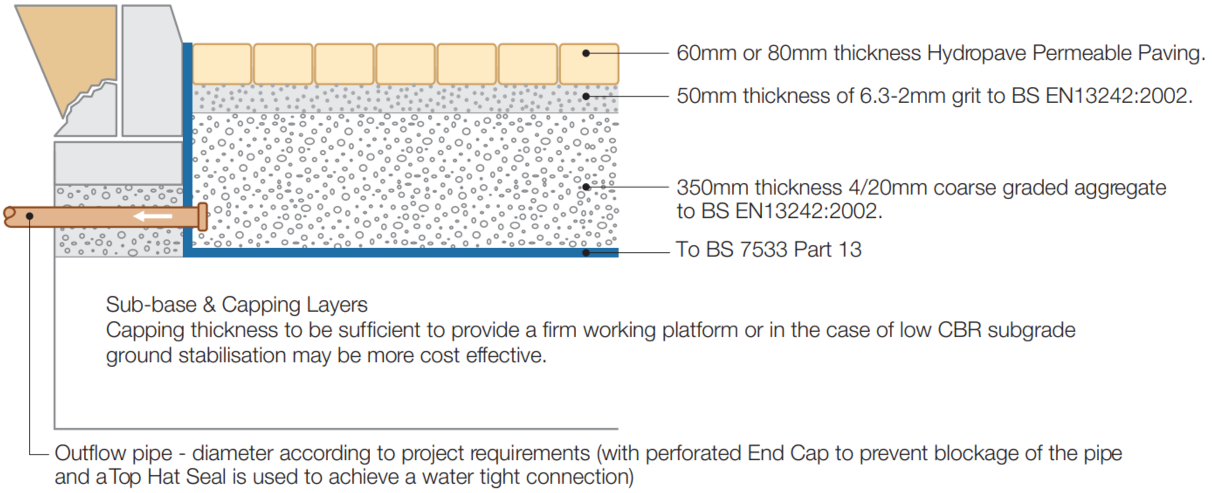


Figure 2.5 – Typical Section Through Permeable Paving in Parking Spaces

2.5.6 Integrated Constructed Wetlands

It is proposed to provide an Integrated Constructed Wetland (IWC) adjacent to the access road in the southwestern area of the site. This system may also be referred to as a pond. Runoff from the roofs, footpaths and roads will be directed towards this IWC via other SuDS drainage methods in the surface water drainage scheme. Refer to the details on drawing SHB5-OCK-DR-MOR-CS-P3-130, 150 and 151. These features will provide a level of storage to attenuate the runoff flows and also permit settlement of coarse silts. As described in Section 2.3 above, the permeability of the underlying soils varies across the site. However, it is anticipated that runoff from minor rainfall events will be able to percolate directly into the soil. During larger storm events, the 1 in 30-year or 1 in 100-year storm water in the pond will rise but will maintain a 500mm freeboard to the lowest FFL of any residence.

The IWC's will be planted in order to promote settlement of silt particles. Runoff will also be treated through the adsorption of particles by vegetation or by soil, and by biological activity. IWC's can reduce the volumes of surface water through evapotranspiration. They are very effective in delivering interception, treatment storage and attenuation. There is an overflow from the pond into the public sewer on Oldtown Mill Road to allow for extreme conditions beyond the 1/100-year storm event to minimise the risk of flooding to the dwellings.

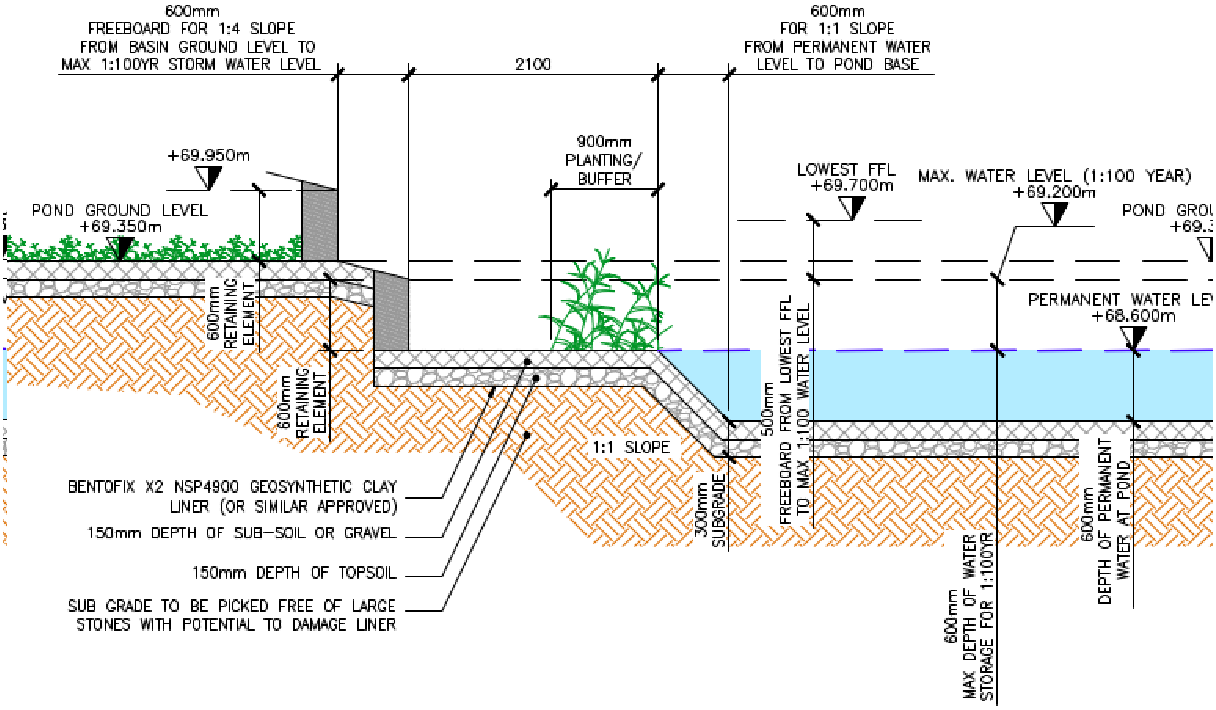


Figure 2.6 – Wetland / Pond Section

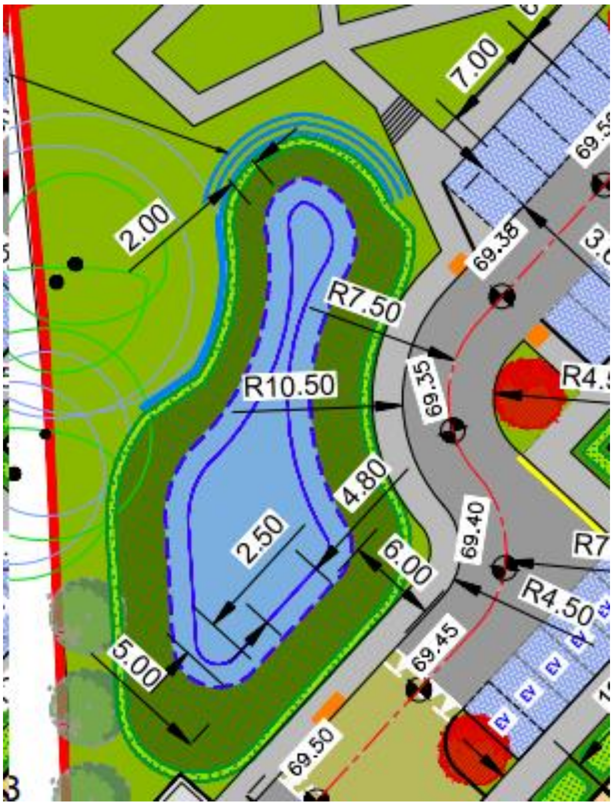


Figure 2.7 – Wetland / Pond Plan

2.6 Interception Storage

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

2.6.1 Required Interception Storage

The total equivalent impermeable area is 6219.1m^2 including 10% allowance for urban creep (refer to Table 2.2)

Therefore, the total interception storage required = 6219.1 x 0.8 x 0.005 x 1.2 = **32.34m^3**.

2.6.2 Interception Storage Provided

<u>Car Parking (Permeable Paving)</u>

Area = 1278.3m^2

Stone layer 100mm deep below outlet;

Void Ratio = 30%

Storage Volume = 1278.3 x 0.1 x 0.3 = 38.35m^3

<u>Bio-Retention Areas</u>

Plan Area = 466.6+947.4 = 1414.0m^2

Minimum storage depth = 75 or 100mm

Storage Volume = 466.6 x 0.075 + 947.4 x 0.10 = 129.73m^3

The total interception volume provided for the overall site is **168.08m^3** which exceeds the required volume calculated in Section 2.6.1.

2.7 Attenuation Design

The site roads and footpaths are draining into bioretention areas, swales, tree pits and permeable paving. The roofs of the houses are drained to bioretention areas in the front curtilage space. These elements provide storage and infiltration through the porous surface and stone medium below. Runoff is then collected from the various SuDS elements through porous pipes – this is to allow for overflow for 1/30 and 1/100 year rainfall events. These porous pipes connect to the SW drainage system and are falling to an attenuation system. Attenuation storage is provided on the site using an attenuation storage pond allowing for storage based on a 1/100 year rainfall event. An overflow SW pipe is laid between the pond and the main SW sewer out on Oldtown Mill Road to allow for any outflow beyond the 1/100 year rainfall event. For the purposes of surface water attenuation design, the site is one single catchment as shown in Figure 2.1. The volume of surface water storage required within the site has been calculated in accordance with the SuDS Manual Ciria C697, taking account of design invert levels, ground levels, attenuation storage pond depth and allowable discharge rate. Calculations for the attenuation system is provided in Appendix B.

Surface water runoff from the site areas will drain by gravity to an attenuation storage pond located at the southwestern end of the site. During a 1 in 100-year storm event, the storage system will store a maximum of 190.55m^3 of surface water runoff. This volume has been calculated including a 20% increase in future rainfall intensities as a result of climate change and 10% urban creep allowance.

The outflow from the attenuation pond is limited by a Hydrobrake flow control device which restricts the flow to 3.42 litres/s.

2.8 Attenuation Design Discussion

Upon review of the site investigation information the site bedrock is between 1.6m to 1.9m below existing ground level. Regarding ground conditions the site can be dealt with in two halves effectively. The eastern half has quite good ground giving +200kPa at 1.0-1.9m depth and has reasonable soakaway test results giving an infiltration rate of 0.06m/hr, refer to IT01 in Figure 2.9 below. The trial pits and boreholes also replicate this information for the site in this upper half. Thus, this section of the site will work well with bioretention areas, tree pits and swales allowing for natural infiltration. Ground water in this area is between 2.26-2.94m below finished ground level approx. based on groundwater monitoring results during the winter period, taking the lowest road level in this part as 70.50 then the water table can be taken as approx. 67.550-68.250m OD approx.

A typical check was done on a linear bioretention area within the grass verge beside a road and footpath 600mm wide x 1100mm deep and this natural interception area can discharge half of its volume in 24hours, it is also effective for storing the total volume of the road and footpath area draining to it. The 1m separation depth above the water table to the base of the bioretention area has been maintained. A typical check was also done on a 1.8m wide x 200mm deep stone section of swale and the swale can infiltrate half of its volume in 24hours, but it is not effective for storing the total volume of the road and footpath area draining to it. Thus, this overflow is then passed via porous pipes to the attenuation pond. This pond is designed to hold the required volume for a 1/100-year event. In the case of this rainfall event being exceeded then there is an overflow from the pond into the main SW sewers on Oldtown Mill Road.

For the western half of the site the ground is yielding +120kPa at 1.2m depth and has failed the soakaway test deeming it unsuitable for infiltration systems, refer to IT02 in Figure 2.9 below. The trial pits and boreholes also replicate this information for the site in this lower half. Thus, the swales and bioretention areas in this half of the site will be used to delay and clean the runoff prior to entering into the drains but they will not infiltrate and attenuate the runoff fully as required. Thus, the porous pipes drain to the attenuation pond. This pond is designed to hold the required volume for a 1/100-year event. In the case of this rainfall event being exceeded then there is an overflow from the pond into the main SW sewers on Oldtown Mill Road.

The attenuation pond is located in the southwestern half of the site. The bedrock in this area is approx. 1.9m below ground level. The infiltration is poor in the area and the water table is within the bedrock. Standpipe in BH06 is flooded; the cover of the standpipe is now below about 100mm of water which is ponding on the soil area in question due to poor infiltration thus, this is not indicative of groundwater levels. The water level for the 1/100year rainfall event is based on the lowest finished floor level less a 500mm freeboard 69.700 - 0.500 = 69.200m OD. For the area chosen for the pond and the required 600mm deep storage depth for the 1/100-year rainfall event with a minimum 600mm pond depth required to support a natural aquatic environment gives a minimum base level of 68.000m OD. A water table level of approx. 67.000m OD or lower is required. The water table is estimated to be within the bedrock and taking the highest recorded level from the groundwater monitoring results which is approx. 2.26m below finished ground level in the vicinity of the pond yields an estimated water table level of at 65.190m OD. The required 1m difference can be achieved satisfactorily from the base of the storage area to the ground water table. However, with poor infiltration capabilities of the soil it is proposed to use an attenuation pond as the main back up storage system. The water levels are presented in the site investigations report with an excerpt outlined in Figure 2.8 below.

Date	Water Level (mbgl)	
	BH06	RC02
02/11/2023	0.00*	-
30/11/2023	0.00*	2.94
07/12/2023	0.00*	2.84
15/12/2023	0.00*	2.26
17/01/2024	0.00*	2.92
20/02/2024	0.00*	2.45
13/03/2024	0.00*	2.56

Figure 2.8 – Ground Water Monitoring Results (Source: Causeway Geotech site investigation report No. 23-0881E Table 1)

Figure 2.9 – Site plan for site investigation works (Source: Causeway Geotech site investigation report No. 23-0881E)

3no. additional soakaway tests were undertaken on site at the end of February 2024. The three results failed to yield an infiltration rate. Thus, the low permeability fine grained soils are deemed unsuitable for the implementation of infiltration drainage systems. Refer to the site investigation report for full details and see excerpt outlined in Figure 2.10 below.

GI Ref	Depth (m)	Strata	Infiltration Rate (m/hr)	Comments
SA01	1.50	CLAY	n/a	Water level did not drop sufficiently in 1.5 hours to derive a result
SA02	1.50	CLAY	n/a	Water level did not drop sufficiently in 3 hours to derive a result
SA03	1.40	CLAY	n/a	Water level did not drop sufficiently in 3 hours to derive a result

Figure 2.10 – Summary of Soakaway Tests (Source: Causeway Geotech Oldtown Mill Soakaway Testing Report No. 24-0215)

Due to the poor permeability of the soil on the site a storage pond is recommended to provide for adequate and suitable storage for the 1/100-year rainfall event. The short and medium term rainfall events will be assisted by the swales, bioretention areas and will infiltrate as much as possible naturally back into the soil. However, during a more severe rainfall event it is assumed that the SuDS measures on the site will already be full and will then overflow into the pond. This storage pond can then store up to the amount estimated for the 1/100-year rainfall event. Any event beyond this severity will overflow into the main sewer connection on Oldtown Mill Road. The attenuation pond will not have negative impacts on the site groundwater table as the storage is protected by liners and stored effectively within the pond. Similarly, the groundwater will not have adverse effects on the attenuation storage as it is a lined pond which will be designed to account for uplift in detailed design stage.

2.9 Existing SW Sewer Capacity Assessment

The estimated outflow at the connection point from the new proposed development based on design information attached in Appendix C is limited to 3.42l/s. The proposed connection is to the existing 600mm concrete SW sewer on the Oldtown Mill Road running at varying falls from the site towards the Shackleton Road; refer to Appendix F for further calculation details. The sewer increases to a 750mm concrete sewer before it leaves Oldtown Mill Road and enters the sewer system on Shackleton Road.

The catchment entering the 600mm diameter sewer is outlined in Appendix F drawing SHB5-OCK-DR-MOR-CS-P3-160 Rev 0 Shackleton Road Drainage Network Capacity taken from the Uisce Eireann area maps. The SW sewer is currently estimated to be running at 10% of its capacity and should have further capacity to accommodate the overflow from a rainfall event greater than the 1/100-year event outflow from the proposed development. Thus, it can be seen that the additional flow will not compromise the capacity of the existing drainage network.

2.10 GDSDS Criterion Compliance

2.10.1 Criterion 1 River Water Quality Protection

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

2.10.2 Criterion 3 Site Flooding

The GDSDS requires that no flooding should occur on site for storms up to and including the 1 in 30-year event. The pipe network and the attenuation storage volumes should, therefore, be checked for such storms to ensure that no site flooding occurs although partial surcharging of the system is allowed if it does not threaten to flood.
For the 1 in 100-year event, the pipe network can fully surcharge and cause site flooding, but the top water level due to any such flooding must be at least 500mm below any vulnerable internal floor levels, and the flood waters should be contained within the site.

Surface water drains have been sized to ensure the following:
The system does not surcharge for the 1-year event.
The system surcharges but does not flood for the 30-year event. The system surcharges but does not flood for the 100-year event.

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

2.10.3 Criterion 2 & 4 River Regime & Flood Protection

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

Qbar for the site has been calculated in accordance with the IH124 method as 4.315 l/s, based on the drained areas of the site. As the surface runoff flow rate discharged from the site does not exceed Qbar, there is a requirement for long-term storage to limit the impact on the receiving watercourse. Please refer to section 2.3.2 of this report for the Qbar calculation.

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

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

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

Significant long-term storage will be provided in the form of interception storage. This does not, however, equate to full long term storage volumes and it is not feasible to provide additional storage areas elsewhere on site to achieve the required volume.
Option (2) has therefore been used to comply with Criterion 4 and an attenuation volume will be provided in the proposed attenuation tank to limit the rate of discharge in the 1 in 100-year storm +20% event to QBAR without growth factors applied.

Refer to Appendix C for surface water network design calculations.

2.11 Enhanced Biodiversity

An attenuation pond will be included as part of the proposed development. Biodiversity has been carefully considered when determining both the location and the detailed design of this pond. The proposed attenuation area offers the opportunity to create a wetland habitat for plants and animals which will encourage biodiversity on the site.

The pond will typically hold 0.6m depth of water although this depth will increase in order to attenuate storm events and will include enhanced biodiversity features such as aquatic planting.

2.12 SuDS CIRIA Pillars of Design

2.12.1 Water Quantity

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

- How fast the runoff is discharged from the site (ie the peak runoff rate) and
- How much runoff is discharged from the site (ie the runoff volume)

2.12.2 Water Quality

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

2.12.3 Amenity

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

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

2.12.4 Biodiversity

The encouragement of biodiverse environments within urban environments is incredibly important. The SuDS measures must not only replicate the pre-development surface water runoff systems and treatment for rainfall, but they should also aim to replicate the existing habitats from the pre- development stage.

By incorporating large landscaped areas throughout the site and the bio-retention areas, biodiversity on site is promoted. In addition, a large number of mature trees have been retained on site.

2.12.5 SuDS Conclusion

This section of the report has comprehensively discussed the various SuDS measures which can be applied to the site and then selected the applicable systems, based on the site layout. A wide range of measures have been employed.

Finally, the chosen SuDS measures have been analysed for various rainfall scenarios to ensure that all the SuDS design criteria are met an extensive range of SuDS measures are proposed with extensive coverage of the developed area of the site. These measures will be effective in treating rainfall on the site to meet GDSDS and CIRIA.

2.13 Maintenance and Management Plan

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

2.14 Potential Future Expansion

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

3 FOUL WATER DRAINAGE DESIGN

3.1 General

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

On 10th November 2023, a Pre-Connection Enquiry Form was submitted to Irish Water in respect of this development. Irish Water provided a Confirmation of Feasibility letter which confirms that, subject to a valid connection agreement being put in place, the proposed connection to the public sewer network can be facilitated. The letter further notes that Irish Water have reviewed the wastewater characteristics and hydraulic discharge load and determined that no upgrades are required to the Irish Water network.

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

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

Parameter Description	Assigned Value
Hydraulic Loading (Foul associated with domestic dwellings)	150 litres / person / day
Pipe Friction	1.5 mm
Minimum Velocity	0.7 m/s
Maximum Velocity	3.0 m/s
Peaking Factor (for domestic foul flows)	6.0

Table 3.1 Foul Water Design Parameters

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

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

3.2 Existing Services

Existing foul water sewers run from Oldtown Mill Road in a 225mm uPVC pipe out towards Shackleton Road. These underground sewers carry foul water from other areas adjacent to the site. Due to the relative levels of the existing drainage and the proposed site levels, it is possible to achieve a gravity connection to the foul water drainage pipework installed.

3.3 Proposed Services

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

The proposed foul water drainage layout for the development is indicated on Malone O'Regan drawings SHB5-OCK-DR-MOR-CS-P3-130. Foul water from new housing units will be collected within a gravity drainage network and directed towards the main sewer.

3.4 Potential Future Expansion

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

4 WATER SUPPLY

4.1 General

The Proposed Development will use mains water.

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

On 10th November 2023, a Pre-Connection Enquiry Form was submitted to Irish Water in respect of this development. Irish Water provided a Confirmation of Feasibility (CoF) letter which confirms that, subject to a valid connection agreement being put in place, the proposed connection to the public water supply network can be facilitated.

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

4.2 Existing & Proposed Services

A 150mm diameter watermain is located under the footpath in Oldtown Mill Road to the east of the proposed development. It is proposed to provide a potable water supply to the development off the existing main in Oldtown Mill Road.

The proposed watermain layout is indicated on drawing SHB5-OCK-DR-MOR-CS-P3-140 which accompanies this planning application.

4.3 Water Demand Calculations

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

<u>Domestic Water Demand</u>

Total no. staff and visitors = 233

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

Total Daily Water Demand = 233 people x 150 litres per day per person
= 34,950 litres/day

Average Hour Demand = 34,950 litres/day / (24hr x 60min x 60sec)
= 0.41 litres/sec

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

Average Day / Peak Week Demand = 0.41 litres/sec x 1.25
= 0.51 litres/sec

The above figures were provided to Irish Water within the Pre-Connection Enquiry Form dated 10th November 2023. Irish Water's response to the Pre-Connection Enquiry, outlined in their Confirmation of Feasibility Letter, is therefore based on these figures.

APPENDIX A – IRISH WATER CONFIRMATION OF FEASIBILITY

CONFIRMATION OF FEASIBILITY

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

Uisce Éireann
PO Box 448
South City
Delivery Office
Cork City

www.water.ie

Patrice Brewster

2B Richview Office Park
Clonskeagh
Dublin 14
D14XT57

30 January 2024

Our Ref: CDS23008427 Pre-Connection Enquiry
Oldtown Mill, Celbridge, Co. Kildare

Dear Applicant/Agent,

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

Uisce Éireann has reviewed the pre-connection enquiry in relation to a Water & Wastewater connection for a Multi/Mixed Use Development of 50 unit(s) at Oldtown Mill, Celbridge, Co. Kildare, (the **Development)**.

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

- **Water Connection** - Feasible without infrastructure upgrade by Uisce Éireann
- **Wastewater Connection** - Feasible without infrastructure upgrade by Uisce Éireann

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

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

Stiúrthóirí / Directors: Tony Keohane (Cathaoirleach / Chairman), Niall Gleeson (POF / CEO), Christopher Banks, Fred Barry, Gerard Britchfield, Liz Joyce, Patricia King, Eileen Maher, Cathy Mannion, Michael Walsh.
Oifig Chláraithe / Registered Office: Teach Colvill, 24-26 Sráid Thalbóid, Baile Átha Cliath 1, D01 NP86 / Colvill House, 24-26 Talbot Street, Dublin, Ireland D01NP86
Is cuideachta ghníomhaíochta ainmnithe atá faoi theorainn scaireanna é Uisce Éireann / Uisce Éireann is a design activity company, limited by shares. Cláraithe in Éirinn Uimh.: 530363 / Registered in Ireland No.: 530363.

Where can you find more information?

- **Section A -** What is important to know?

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

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

Yours sincerely,

D. Phelan

Dermot Phelan
Connections Delivery Manager

Section A - What is important to know?

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

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

APPENDIX B – ATTENUATION VOLUME CALCULATIONS

Job Title	B5 05 Oldtown Mill	Job no.	23006
By:	Kezia Adanza	Checked by:	
Date	Sept' 23	Rev number	0

Part 1 **Permissible Runoff**

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

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

Rainfall Data	
M5-60 (1 hour - 5 years) mm	16.2
M5-2D (2 days - 5 years) mm	58
Ratio "r" (M5-60/ M5-2D)	0.28
SAAR mm	924
Soil/ SPR mm	0.3

For 50 Ha Area ~ QBARrural =	0.126	m³/s		
For 1.710 Ha Area ~ QBARrural =	4.315	l/s		
Allowable outflow from the site (Council recommendation)	2	l/s/ha	3.4221	l/s

Part 2 **Impermeable Area**

*Note 1: the catchement from the roof of the standard houses are considered half going into the rain garden and half is considered to be going into the drainage system.

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

Total Area sq.m	Type of Surface	Area sq.m	Run-off Coefficient	Equivalent Impermeable	Urban Creep Allowance	Oberall Impermeable
17110.5	Roof (Note 1)	2492.5	0.50	1246.3	1370.9	6219.1
	Roof	735.4	0.95	698.6	768.5	
	Permeable Paving inc. areas from hardstanding	2675.7	0.50	1337.9	1471.6	
ha	Landscaped Areas inc. areas from hardstanding	11021.7	0.20	2204.3	2424.8	ha
1.71						0.5
	Hardstanding	185.2	0.90	166.7	183.3	

Part 3 **Attenuation Volume Required**

1 in 10 Years								
Time	%	M5	Growth	Area	MT	Inflow	Outflow	Capacity Required
			Factor (10 Years)	Factor	Factor	"I"	"O"	"I"-"O" ="S"
note	1	2	3	4	5	6	7	8
1 min	3.3	1.9	1.15	1	2.201	10.671	0.205326	10.466
2min	5.7	3.3	1.16	1	3.835	18.593	0.410652	18.182
5 min	10.3	6.0	1.18	1	7.049	34.177	1.02663	33.150
10 min	14.8	8.6	1.18	1	10.129	49.109	2.05326	47.055
15 min	17.7	10.3	1.18	1	12.114	58.731	3.07989	55.651
30 min	23.3	13.5	1.18	1	15.947	77.313	6.15978	71.153
60 min	30	17.4	1.17	1	20.358	98.701	12.31956	86.381
2 hour	38	22.0	1.16	1	25.566	123.952	24.63912	99.313

4 hour	48	27.8	1.15	1	32.016	155.222	49.27824	105.943
6 hour	55	31.9	1.14	1	36.366	176.311	73.91736	102.394
12 hour	68	39.4	1.14	1	44.962	217.985	147.83472	70.150
24 hour	85	49.3	1.13	1	55.709	270.091	295.66944	-25.578
48 hour	106	61.5	1.12	1	68.858	333.839	591.33888	-257.500
Size of Attenuation for 1 in 10 year flood event m³								**105.943**

1 in 30 Years								
Time	**%**	**M5**	**Growth**	**Area**	**MT**	**Inflow**	**Outflow**	**Capacity Required**
			Factor (30 Years)	**Factor**	**Factor**	**"I"**	**"O"**	**"I"-"O" ="S"**
note	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1 min	3.3	1.9	1.39	1	2.660	12.899	0.205326	12.693
2min	5.7	3.3	1.41	1	4.661	22.600	0.410652	22.189
5 min	10.3	6.0	1.44	1	8.603	41.707	1.02663	40.681
10 min	14.8	8.6	1.46	1	12.533	60.761	2.05326	58.708
15 min	17.7	10.3	1.48	1	15.194	73.663	3.07989	70.583
30 min	23.3	13.5	1.49	1	20.136	97.624	6.15978	91.464
60 min	30	17.4	1.48	1	25.752	124.852	12.31956	112.533
2 hour	38	22.0	1.47	1	32.399	157.077	24.63912	132.438
4 hour	48	27.8	1.45	1	40.368	195.714	49.27824	146.436
6 hour	55	31.9	1.44	1	45.936	222.709	73.91736	148.792
12 hour	68	39.4	1.42	1	56.005	271.525	147.83472	123.691
24 hour	85	49.3	1.38	1	68.034	329.846	295.66944	34.176
48 hour	106	61.5	1.34	1	82.383	399.414	591.33888	-191.925
Size of Attenuation for 1 in 30 year flood event m³								**148.792**

1 in 100 Years								
Time	**%**	**M5**	**Growth**	**Area**	**MT**	**Inflow**	**Outflow**	**Capacity Required**
			Factor (30 Years)	**Factor**	**Factor**	**"I"**	**"O"**	**"I"-"O" ="S"**
note	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1 min	3.3	1.9	1.87	1	3.579	17.353	0.205326	17.147
2min	5.7	3.3	1.88	1	6.215	30.133	0.410652	29.723
5 min	10.3	6.0	1.97	1	11.769	57.058	1.02663	56.031
10 min	14.8	8.6	1.98	1	16.996	82.402	2.05326	80.349
15 min	17.7	10.3	1.95	1	20.019	97.056	3.07989	93.976
30 min	23.3	13.5	1.91	1	25.812	125.142	6.15978	118.982
60 min	30	17.4	1.85	1	32.190	156.065	12.31956	143.746
2 hour	38	22.0	1.78	1	39.231	190.203	24.63912	165.564
4 hour	48	27.8	1.73	1	48.163	233.507	49.27824	184.229
6 hour	55	31.9	1.71	1	54.549	264.467	73.91736	190.550
12 hour	68	39.4	1.62	1	63.893	309.768	147.83472	161.934
24 hour	85	49.3	1.58	1	77.894	377.650	295.66944	81.980
48 hour	106	61.5	1.53	1	94.064	456.048	591.33888	-135.291
Size of Attenuation for 1 in 100 year flood event m³								**190.550**

Part 4 Interception Storage

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

Required Interception Storage

Overall Impermeable area is 6219.1 m² including 10% for urban creep

Therefore, the total interception storage required is 'overall impermeable area x 80% x 0.005 x 1.3 for climate change' 32.34 m³

Interception Storage Provided *Only fill in SuDS on your site

Permeable Paving	Area	1278.3	m²
	Stone Layer 100mm deep	0.1	m
	Void Ratio	30%	
	Storage Volume	38.3487	m³

Swale	Area	466.6	m²
	*75mm	0.075	m
	Storage Volume	34.994625	m³

*Storage depth will depend on your site

Bio-Retention Area/ Raingarden	Area	947.4	m²
	Depth of Subgrade	0.1	m
	Storage Volume	94.7362	m³

Green Roof A 'Bauder Sedume' or equivalent design to retain 38 l/m² of rainwater will be used on roof level	Area	0.0	m²
	Interception Store 38 l/m²	0.038	l/m²
	Storage Volume	0	m³

Total interception volume provided for the overall site 168.08 m³

which exceeds the required volume calculated of 32.34 m³

APPENDIX C – SURFACE WATER PIPE NETWORK CALCULATIONS

Drainage Design Report

Flow+

v10.8

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Network	Storm Network
Filename	B5 05 Oldtown Mill - Surface Drainage
Username	Kezia Adanza (kadanza@morce.ie)
Last analysed	01/02/2024 09:13:40
Report produced on	01/02/2024 09:17:34

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Rainfall Methodology	FSR
Return Period (years)	2
Additional Flow (%)	0
FSR Region	Scotland and Ireland
M5-60 (mm)	16.200
Ratio-R	0.280
CV	0.750
Time of Entry (mins)	4.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Inverts
Minimum Backdrop Height (m)	0.500
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	No
Enforce best practice design rules	Yes

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	Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Width (mm)	Sump (m)	Easting (m)	Northing (m)	Depth (m)	Notes
✓	SW21	0.036	4.00		71.410	Manhole	Adoptable	1200			696185.929	734030.199	1.425	
✓	SW20	0.036	4.00		70.995	Manhole	Adoptable	1200			696202.145	734015.331	1.425	
✓	SW19	0.036	4.00		70.720	Manhole	Adoptable	1200			696223.983	734029.599	1.425	
✓	SW18	0.036	4.00		70.780	Manhole	Adoptable	1200			696220.219	734027.622	1.511	
✓	SW17	0.036	4.00		70.930	Manhole	Adoptable	1200			696205.846	734011.939	1.874	
✓	SW16	0.036	4.00		70.565	Manhole	Adoptable	1200			696177.317	733980.807	1.758	
✓	SW15	0.036	4.00		70.500	Manhole	Adoptable	1200			696174.346	733974.310	1.736	
✓	SW14	0.036	4.00		69.880	Manhole	Adoptable	1200			696145.058	733942.351	1.500	
✓	SW13	0.036	4.00		69.815	Manhole	Adoptable	1200			696138.922	733938.851	1.500	
✓	SW12	0.036	4.00		69.365	Manhole	Adoptable	1200			696112.155	733909.693	1.500	
✓	SW11	0.036	4.00		69.575	Manhole	Adoptable	1200			696091.539	733867.212	1.500	
✓	SW10	0.036	4.00		69.400	Manhole	Adoptable	1200			696115.171	733892.998	1.675	
✓	SW09	0.036	4.00		69.400	Manhole	Adoptable	1200			696113.707	733895.838	1.707	
✓	SW08	0.036	4.00		69.350	Manhole	Adoptable	1200			696110.643	733901.529	1.765	
✓	IN				69.350	Manhole	Adoptable	1200			696105.782	733896.668	2.070	
✓	OUT		4.00		69.350	Manhole	Adoptable	1200			696104.259	733898.491	2.070	
✓	SW07-HB				69.380	Manhole	Adoptable	1200			696114.211	733909.314	2.345	
✓	SW06				69.815	Manhole	Adoptable	1200			696140.013	733937.378	2.936	
✓	SW05				69.880	Manhole	Adoptable	1200			696145.308	733940.404	3.026	
✓	SW04				70.500	Manhole	Adoptable	1200			696176.454	733974.342	3.835	
✓	SW03				70.565	Manhole	Adoptable	1200			696179.084	733980.515	3.928	
✓	SW02				70.780	Manhole	Adoptable	1200			696221.453	734026.749	4.400	
✓	SW01				70.675	Manhole	Adoptable	1200			696227.701	734030.031	4.324	
✓	EXSW MH				70.590	Manhole	Adoptable	1200			696232.504	734038.635	4.280	

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Name	US Node	DS Node	Length (m)	ks (mm) / n	Velocity Equation	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	T of C (mins)	Rain (mm/hr)	Con Offset (m)	Min DS IL (m)	Lateral Area (ha)	Lateral Ins Point (%)	Lateral T of E (mins)
2.000	SW21	SW20	22.000	0.600	Colebrook-White	69.985	69.570	0.415	53.0	225	Circular	4.20	50.0					
2.001	SW20	SW17	5.020	0.600	Colebrook-White	69.570	69.498	0.072	70.0	225	Circular	4.26	50.0					
3.000	SW19	SW18	4.252	0.600	Colebrook-White	69.295	69.269	0.026	163.5	225	Circular	4.07	50.0					
3.001	SW18	SW17	21.273	0.600	Colebrook-White	69.269	69.056	0.213	100.0	225	Circular	4.34	50.0					
2.002	SW17	SW16	42.227	0.600	Colebrook-White	69.056	68.807	0.249	169.6	225	Circular	5.04	49.0					
2.003	SW16	SW15	7.144	0.600	Colebrook-White	68.807	68.764	0.043	166.1	225	Circular	5.16	48.6					
2.004	SW15	SW14	43.349	0.600	Colebrook-White	68.764	68.380	0.384	112.9	300	Circular	5.65	46.9					
2.005	SW14	SW13	7.064	0.600	Colebrook-White	68.380	68.315	0.065	108.7	300	Circular	5.73	46.7					
2.006	SW13	SW12	39.581	0.600	Colebrook-White	68.315	67.865	0.450	88.0	300	Circular	6.12	45.5					
2.007	SW12	SW08	8.303	0.600	Colebrook-White	67.865	67.585	0.280	29.7	300	Circular	6.17	45.3					
4.000	SW11	SW10	34.977	0.600	Colebrook-White	68.075	67.725	0.350	100.0	300	Circular	4.37	50.0					
4.001	SW10	SW09	3.195	0.600	Colebrook-White	67.725	67.693	0.032	100.0	300	Circular	4.40	50.0					
4.002	SW09	SW08	6.463	0.600	Colebrook-White	67.693	67.585	0.108	60.0	300	Circular	4.46	50.0					
2.008	SW08	IN	6.874	0.600	Colebrook-White	67.585	67.300	0.285	24.1	300	Circular	6.21	45.2					
1.000	OUT	SW07-HB	14.703	0.600	Colebrook-White	67.280	67.035	0.245	60.0	300	Circular	4.12	50.0					
1.001	SW07-HB	SW06	38.123	0.600	Colebrook-White	67.035	66.879	0.156	244.4	300	Circular	4.76	50.0					
1.002	SW06	SW05	6.099	0.600	Colebrook-White	66.879	66.854	0.025	243.9	300	Circular	4.86	49.7					
1.003	SW05	SW04	46.064	0.600	Colebrook-White	66.854	66.665	0.189	243.7	300	Circular	5.62	47.0					
1.004	SW04	SW03	6.710	0.600	Colebrook-White	66.665	66.637	0.028	239.6	300	Circular	5.73	46.7					
1.005	SW03	SW02	62.711	0.600	Colebrook-White	66.637	66.380	0.257	244.0	300	Circular	6.78	43.6					
1.006	SW02	SW01	7.058	0.600	Colebrook-White	66.380	66.351	0.029	243.4	300	Circular	6.89	43.3					
1.007	SW01	EXSW MH	9.854	0.600	Colebrook-White	66.351	66.310	0.041	240.3	300	Circular	7.06	42.9					

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Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)	Notes
2.000	SW21	SW20	1.800	71.6	4.9	1.200	1.200	1.200	1.200	0.036	0.0	40	1.043	
2.001	SW20	SW17	1.565	62.2	9.8	1.200	1.207	1.200	1.207	0.072	0.0	60	1.149	
3.000	SW19	SW18	1.019	40.5	4.9	1.200	1.286	1.200	1.286	0.036	0.0	52	0.690	
3.001	SW18	SW17	1.307	52.0	9.8	1.286	1.649	1.286	1.649	0.072	0.0	65	1.005	
2.002	SW17	SW16	1.001	39.8	23.9	1.649	1.533	1.533	1.649	0.180	0.0	126	1.046	
2.003	SW16	SW15	1.011	40.2	28.4	1.533	1.511	1.511	1.533	0.216	0.0	140	1.095	
2.004	SW15	SW14	1.479	104.5	32.0	1.436	1.200	1.200	1.436	0.252	0.0	114	1.307	
2.005	SW14	SW13	1.507	106.5	36.4	1.200	1.200	1.200	1.200	0.288	0.0	120	1.368	
2.006	SW13	SW12	1.677	118.5	39.9	1.200	1.200	1.200	1.200	0.324	0.0	120	1.518	
2.007	SW12	SW08	2.897	204.8	44.2	1.200	1.465	1.200	1.465	0.360	0.0	94	2.325	Fall increased to remove backdrop
4.000	SW11	SW10	1.572	111.1	4.9	1.200	1.375	1.200	1.375	0.036	0.0	42	0.797	
4.001	SW10	SW09	1.572	111.1	9.8	1.375	1.407	1.375	1.407	0.072	0.0	59	0.976	
4.002	SW09	SW08	2.033	143.7	14.6	1.407	1.465	1.407	1.465	0.108	0.0	64	1.321	
2.008	SW08	IN	3.214	227.2	61.8	1.465	1.750	1.465	1.750	0.504	0.0	106	2.747	Velocity is more than 3 m/s
1.000	OUT	SW07-HB	2.033	143.7	0.0	1.770	2.045	1.770	2.045	0.000	0.0	0	0.000	
1.001	SW07-HB	SW06	1.001	70.8	0.0	2.045	2.636	2.045	2.636	0.000	0.0	0	0.000	Downstream Depth is more than twice the specified minimum
1.002	SW06	SW05	1.002	70.8	0.0	2.636	2.726	2.636	2.726	0.000	0.0	0	0.000	Upstream Depth is more than twice the specified minimum | Downstream Depth is more than twice the specified minimum
1.003	SW05	SW04	1.002	70.9	0.0	2.726	3.535	2.726	3.535	0.000	0.0	0	0.000	Upstream Depth is more than twice the specified minimum | Downstream Depth is more than twice the specified minimum
1.004	SW04	SW03	1.011	71.5	0.0	3.535	3.628	3.535	3.628	0.000	0.0	0	0.000	Upstream Depth is more than twice the specified minimum | Downstream Depth is more than twice the specified minimum
1.005	SW03	SW02	1.002	70.8	0.0	3.628	4.100	3.628	4.100	0.000	0.0	0	0.000	Upstream Depth is more than twice the specified minimum | Downstream Depth is more than twice the specified minimum
1.006	SW02	SW01	1.003	70.9	0.0	4.100	4.024	4.024	4.100	0.000	0.0	0	0.000	Upstream Depth is more than twice the specified minimum | Downstream Depth is more than twice the specified minimum
1.007	SW01	EXSW MH	1.010	71.4	0.0	4.024	3.980	3.980	4.024	0.000	0.0	0	0.000	Upstream Depth is more than twice the specified minimum | Downstream Depth is more than twice the specified minimum

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Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
2.000	22.000	53.0	225	Circular	71.410	69.985	1.200	70.995	69.570	1.200	SW21	1200	Manhole	Adoptable	SW20	1200	Manhole	Adoptable
2.001	5.020	70.0	225	Circular	70.995	69.570	1.200	70.930	69.498	1.207	SW20	1200	Manhole	Adoptable	SW17	1200	Manhole	Adoptable
3.000	4.252	163.5	225	Circular	70.720	69.295	1.200	70.780	69.269	1.286	SW19	1200	Manhole	Adoptable	SW18	1200	Manhole	Adoptable
3.001	21.273	100.0	225	Circular	70.780	69.269	1.286	70.930	69.056	1.649	SW18	1200	Manhole	Adoptable	SW17	1200	Manhole	Adoptable
2.002	42.227	169.6	225	Circular	70.930	69.056	1.649	70.565	68.807	1.533	SW17	1200	Manhole	Adoptable	SW16	1200	Manhole	Adoptable
2.003	7.144	166.1	225	Circular	70.565	68.807	1.533	70.500	68.764	1.511	SW16	1200	Manhole	Adoptable	SW15	1200	Manhole	Adoptable
2.004	43.349	112.9	300	Circular	70.500	68.764	1.436	69.880	68.380	1.200	SW15	1200	Manhole	Adoptable	SW14	1200	Manhole	Adoptable
2.005	7.064	108.7	300	Circular	69.880	68.380	1.200	69.815	68.315	1.200	SW14	1200	Manhole	Adoptable	SW13	1200	Manhole	Adoptable
2.006	39.581	88.0	300	Circular	69.815	68.315	1.200	69.365	67.865	1.200	SW13	1200	Manhole	Adoptable	SW12	1200	Manhole	Adoptable
2.007	8.303	29.7	300	Circular	69.365	67.865	1.200	69.350	67.585	1.465	SW12	1200	Manhole	Adoptable	SW08	1200	Manhole	Adoptable
4.000	34.977	100.0	300	Circular	69.575	68.075	1.200	69.400	67.725	1.375	SW11	1200	Manhole	Adoptable	SW10	1200	Manhole	Adoptable
4.001	3.195	100.0	300	Circular	69.400	67.725	1.375	69.400	67.693	1.407	SW10	1200	Manhole	Adoptable	SW09	1200	Manhole	Adoptable
4.002	6.463	60.0	300	Circular	69.400	67.693	1.407	69.350	67.585	1.465	SW09	1200	Manhole	Adoptable	SW08	1200	Manhole	Adoptable
2.008	6.874	24.1	300	Circular	69.350	67.585	1.465	69.350	67.300	1.750	SW08	1200	Manhole	Adoptable	IN	1200	Manhole	Adoptable
1.000	14.703	60.0	300	Circular	69.350	67.280	1.770	69.380	67.035	2.045	OUT	1200	Manhole	Adoptable	SW07-HB	1200	Manhole	Adoptable
1.001	38.123	244.4	300	Circular	69.380	67.035	2.045	69.815	66.879	2.636	SW07-HB	1200	Manhole	Adoptable	SW06	1200	Manhole	Adoptable
1.002	6.099	243.9	300	Circular	69.815	66.879	2.636	69.880	66.854	2.726	SW06	1200	Manhole	Adoptable	SW05	1200	Manhole	Adoptable
1.003	46.064	243.7	300	Circular	69.880	66.854	2.726	70.500	66.665	3.535	SW05	1200	Manhole	Adoptable	SW04	1200	Manhole	Adoptable
1.004	6.710	239.6	300	Circular	70.500	66.665	3.535	70.565	66.637	3.628	SW04	1200	Manhole	Adoptable	SW03	1200	Manhole	Adoptable
1.005	62.711	244.0	300	Circular	70.565	66.637	3.628	70.780	66.380	4.100	SW03	1200	Manhole	Adoptable	SW02	1200	Manhole	Adoptable
1.006	7.058	243.4	300	Circular	70.780	66.380	4.100	70.675	66.351	4.024	SW02	1200	Manhole	Adoptable	SW01	1200	Manhole	Adoptable
1.007	9.854	240.3	300	Circular	70.675	66.351	4.024	70.590	66.310	3.980	SW01	1200	Manhole	Adoptable	EXSW MH	1200	Manhole	Adoptable

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Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Width (mm)	Sump (m)	Node Type	MH Type	Connections	Link	IL (m)	Dia (mm)	Link Type
SW21	696185.929	734030.199	71.410	1.425	1200			Manhole	Adoptable					
										0	2.000	69.985	225	Circular
SW20	696202.145	734015.331	70.995	1.425	1200			Manhole	Adoptable	1	2.000	69.570	225	Circular
										0	2.001	69.570	225	Circular
SW19	696223.983	734029.599	70.720	1.425	1200			Manhole	Adoptable					
										0	3.000	69.295	225	Circular
SW18	696220.219	734027.622	70.780	1.511	1200			Manhole	Adoptable	1	3.000	69.269	225	Circular
										0	3.001	69.269	225	Circular
SW17	696205.846	734011.939	70.930	1.874	1200			Manhole	Adoptable	1	3.001	69.056	225	Circular
										2	2.001	69.498	225	Circular
										0	2.002	69.056	225	Circular
SW16	696177.317	733980.807	70.565	1.758	1200			Manhole	Adoptable	1	2.002	68.807	225	Circular
										0	2.003	68.807	225	Circular
SW15	696174.346	733974.310	70.500	1.736	1200			Manhole	Adoptable	1	2.003	68.764	225	Circular
										0	2.004	68.764	300	Circular
SW14	696145.058	733942.351	69.880	1.500	1200			Manhole	Adoptable	1	2.004	68.380	300	Circular
										0	2.005	68.380	300	Circular
SW13	696138.922	733938.851	69.815	1.500	1200			Manhole	Adoptable	1	2.005	68.315	300	Circular
										0	2.006	68.315	300	Circular
SW12	696112.155	733909.693	69.365	1.500	1200			Manhole	Adoptable	1	2.006	67.865	300	Circular
										0	2.007	67.865	300	Circular

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SW11	696091.539	733867.212	69.575	1.500	1200			Manhole	Adoptable						
											0	4.000	68.075	300	Circular
SW10	696115.171	733892.998	69.400	1.675	1200			Manhole	Adoptable		1	4.000	67.725	300	Circular
											0	4.001	67.725	300	Circular
SW09	696113.707	733895.838	69.400	1.707	1200			Manhole	Adoptable		1	4.001	67.693	300	Circular
											0	4.002	67.693	300	Circular
SW08	696110.643	733901.529	69.350	1.765	1200			Manhole	Adoptable		1	4.002	67.585	300	Circular
											2	2.007	67.585	300	Circular
											0	2.008	67.585	300	Circular
IN	696105.782	733896.668	69.350	2.070	1200			Manhole	Adoptable		1	2.008	67.300	300	Circular
OUT	696104.259	733898.491	69.350	2.070	1200			Manhole	Adoptable						
											0	1.000	67.280	300	Circular
SW07-HB	696114.211	733909.314	69.380	2.345	1200			Manhole	Adoptable		1	1.000	67.035	300	Circular
											0	1.001	67.035	300	Circular
SW06	696140.013	733937.378	69.815	2.936	1200			Manhole	Adoptable		1	1.001	66.879	300	Circular
											0	1.002	66.879	300	Circular
SW05	696145.308	733940.404	69.880	3.026	1200			Manhole	Adoptable		1	1.002	66.854	300	Circular
											0	1.003	66.854	300	Circular
SW04	696176.454	733974.342	70.500	3.835	1200			Manhole	Adoptable		1	1.003	66.665	300	Circular
											0	1.004	66.665	300	Circular
SW03	696179.084	733980.515	70.565	3.928	1200			Manhole	Adoptable		1	1.004	66.637	300	Circular

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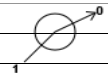
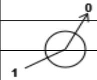
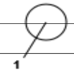
											0	1.005	66.637	300	Circular
SW02	696221.453	734026.749	70.780	4.400	1200			Manhole	Adoptable		1	1.005	66.380	300	Circular
															
											0	1.006	66.380	300	Circular
SW01	696227.701	734030.031	70.675	4.324	1200			Manhole	Adoptable		1	1.006	66.351	300	Circular
											0	1.007	66.351	300	Circular
EXSW MH	696232.504	734038.635	70.590	4.280	1200			Manhole	Adoptable		1	1.007	66.310	300	Circular
															

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Rainfall Methodology	FSR		Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
FSR Region	Scotland and Ireland		2	20	0	0
M5-60 (mm)	16.200		30	20	0	0
Ratio-R	0.280		100	20	0	0
Summer CV	0.750					
Winter CV	0.840					
Analysis Speed	Normal					
Skip Steady State	No					
Drain Down Time (mins)	240					
Additional Storage (m³/ha)	20.0					
Storm Durations (mins)	15					
	30					
	60					
	120					
	180					
	240					
	360					
Check Discharge Rate(s)	No					
Check Discharge Volume	No					
100 year 360 minute (m³)						

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Hydro-Brake®													
Node	**Flap Valve**	**Online / Offline**	**Downstream Link**	**Replaces Downstream Link**	**Loop to Node**	**Invert Level (m)**	**Design Depth (m)**	**Design Flow (l/s)**	**Objective**	**Sump Available**	**Product Number**	**Min Outlet Diameter (m)**	**Min Node Diameter (mm)**
SW07-HB	No	Online		Yes		67.035	1.200	3.4	(HE) Minimise upstream storage	Yes	CTL-SHE-0085-3400-1200-3400	0.100	1200

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Flow through Pond													
Node	Base Inf Coefficient (m/hr)	Side Inf Coefficient (m/hr)	Safety Factor	Porosity	Invert Level (m)	Time to half empty (mins)	Main Channel Length (m)	Main Channel Slope (1:X)	Main Channel n	Inlets	Depth (m)	Area (m²)	Inf. Area (m²)
OUT	0.00000	0.00000	2.0	1.00	67.280	0	30.000	999999.0	0.025	IN	0.000	89.4	0.0
											1.000	321.6	0.0

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

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

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Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
2 year +20% CC 15 minute summer	126.640	35.835
2 year +20% CC 15 minute winter	88.870	35.835
2 year +20% CC 30 minute summer	86.394	24.447
2 year +20% CC 30 minute winter	60.628	24.447
2 year +20% CC 60 minute summer	61.232	16.182
2 year +20% CC 60 minute winter	40.681	16.182
2 year +20% CC 120 minute summer	39.750	10.505
2 year +20% CC 120 minute winter	26.409	10.505
2 year +20% CC 180 minute summer	31.374	8.074
2 year +20% CC 180 minute winter	20.394	8.074
2 year +20% CC 240 minute summer	25.401	6.713
2 year +20% CC 240 minute winter	16.876	6.713
2 year +20% CC 360 minute summer	20.153	5.186
2 year +20% CC 360 minute winter	13.100	5.186
30 year +20% CC 15 minute summer	232.591	65.815
30 year +20% CC 15 minute winter	163.222	65.815
30 year +20% CC 30 minute summer	159.526	45.140
30 year +20% CC 30 minute winter	111.948	45.140
30 year +20% CC 60 minute summer	111.314	29.417
30 year +20% CC 60 minute winter	73.954	29.417
30 year +20% CC 120 minute summer	70.722	18.690
30 year +20% CC 120 minute winter	46.986	18.690
30 year +20% CC 180 minute summer	55.299	14.230
30 year +20% CC 180 minute winter	35.946	14.230
30 year +20% CC 240 minute summer	44.300	11.707
30 year +20% CC 240 minute winter	29.432	11.707
30 year +20% CC 360 minute summer	34.472	8.871
30 year +20% CC 360 minute winter	22.408	8.871
100 year +20% CC 15 minute summer	301.448	85.299
100 year +20% CC 15 minute winter	211.542	85.299

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100 year +20% CC 30 minute summer	208.206	58.915
100 year +20% CC 30 minute winter	146.109	58.915
100 year +20% CC 60 minute summer	144.702	38.241
100 year +20% CC 60 minute winter	96.137	38.241
100 year +20% CC 120 minute summer	91.213	24.105
100 year +20% CC 120 minute winter	60.600	24.105
100 year +20% CC 180 minute summer	70.901	18.245
100 year +20% CC 180 minute winter	46.087	18.245
100 year +20% CC 240 minute summer	56.549	14.944
100 year +20% CC 240 minute winter	37.570	14.944
100 year +20% CC 360 minute summer	43.709	11.248
100 year +20% CC 360 minute winter	28.412	11.248

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Results for 2 year +20% CC Critical Storm Duration. Lowest mass balance: 99.78%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link Event (Upstream Depth)	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)	Note
15 minute winter	SW21	10	70.030	0.045	6.2	0.0729	0.0000	OK	15 minute winter	2.000	SW20	6.2	0.727	0.087	0.1907		
15 minute winter	SW20	10	69.646	0.076	12.4	0.1243	0.0000	OK	15 minute winter	2.001	SW17	12.4	1.137	0.199	0.0547		
15 minute winter	SW19	10	69.364	0.069	6.2	0.1122	0.0000	OK	15 minute winter	3.000	SW18	6.2	0.573	0.153	0.0460		
15 minute winter	SW18	10	69.343	0.074	12.4	0.1193	0.0000	OK	15 minute winter	3.001	SW17	12.4	0.635	0.238	0.4223		
15 minute winter	SW17	10	69.207	0.151	31.0	0.2286	0.0000	OK	15 minute winter	2.002	SW16	30.6	1.006	0.769	1.2824		
15 minute winter	SW16	10	68.978	0.171	36.8	0.2640	0.0000	OK	15 minute winter	2.003	SW15	36.0	1.264	0.895	0.2034		
15 minute winter	SW15	10	68.897	0.133	42.1	0.2062	0.0000	OK	15 minute winter	2.004	SW14	42.1	1.212	0.403	1.5057		
15 minute winter	SW14	11	68.544	0.164	47.4	0.2636	0.0000	OK	15 minute winter	2.005	SW13	47.9	1.294	0.450	0.2616		
15 minute winter	SW13	11	68.464	0.149	53.2	0.2394	0.0000	OK	15 minute winter	2.006	SW12	53.5	1.716	0.452	1.2361		
15 minute winter	SW12	11	67.990	0.125	58.8	0.2008	0.0000	OK	15 minute winter	2.007	SW08	58.9	1.910	0.288	0.2623		
15 minute winter	SW11	10	68.123	0.048	6.2	0.0768	0.0000	OK	15 minute winter	4.000	SW10	6.2	0.565	0.056	0.3889		
15 minute summer	SW10	10	67.805	0.080	12.4	0.1255	0.0000	OK	15 minute summer	4.001	SW09	12.4	0.871	0.111	0.0481		
15 minute summer	SW09	10	67.773	0.080	18.6	0.1235	0.0000	OK	15 minute summer	4.002	SW08	18.7	0.805	0.130	0.1566		
240 minute winter	SW08	228	67.769	0.184	19.6	0.2832	0.0000	OK	240 minute winter	2.008	IN	34.1	1.386	0.150	0.3978		
240 minute winter	IN	224	67.767	0.487	48.6	0.5511	0.0000	OK	240 minute winter	Flow through pond	OUT	18.6	0.044	0.030	71.2233		
240 minute winter	OUT	232	67.767	0.487	18.6	0.5513	0.0000	SURCHARGED	240 minute winter	1.000	SW07-HB	11.4	0.325	0.079	1.0354		Surcharge due to flow behind Hydro-brake - Acceptable
240 minute winter	SW07-HB	232	67.767	0.732	11.4	0.8284	0.0000	SURCHARGED	240 minute winter	Hydro-Brake®	SW06	3.4					Surcharge due to flow behind Hydro-brake - Acceptable
15 minute summer	SW06	12	66.926	0.047	3.4	0.0533	0.0000	OK	15 minute summer	1.002	SW05	3.4	0.609	0.048	0.0421		
15 minute winter	SW05	11	66.900	0.046	3.4	0.0518	0.0000	OK	15 minute winter	1.003	SW04	3.5	0.633	0.049	0.3086		
30 minute winter	SW04	18	66.712	0.047	3.4	0.0529	0.0000	OK	30 minute winter	1.004	SW03	3.4	0.627	0.048	0.0457		
15 minute summer	SW03	15	66.682	0.045	3.4	0.0513	0.0000	OK	15 minute summer	1.005	SW02	3.5	0.607	0.049	0.4220		
15 minute winter	SW02	131	66.427	0.047	3.4	0.0530	0.0000	OK	15 minute winter	1.006	SW01	3.4	0.494	0.048	0.0487		
15 minute winter	SW01	131	66.397	0.046	3.4	0.0520	0.0000	OK	15 minute winter	1.007	EXSW MH	3.4	0.523	0.048	0.0642	37.2	
15 minute winter	EXSW MH	131	66.353	0.043	3.4	0.0000	0.0000	OK									

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Results for 30 year +20% CC Critical Storm Duration. Lowest mass balance: 99.78%																
Node Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m³)**	**Flood (m³)**	**Status**	**Link Event (Upstream Depth)**	**Link**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m³)**	**Discharge Vol (m³)**
15 minute winter	SW21	10	70.045	0.060	11.4	0.0989	0.0000	OK	15 minute winter	2.000	SW20	11.4	0.839	0.159	0.3029	
15 minute winter	SW20	10	69.679	0.109	22.8	0.1778	0.0000	OK	15 minute winter	2.001	SW17	22.8	1.320	0.366	0.0867	
15 minute winter	SW19	11	69.590	0.295	11.4	0.4831	0.0000	SURCHARGED	15 minute winter	3.000	SW18	10.6	0.633	0.262	0.1691	
15 minute winter	SW18	11	69.587	0.318	22.0	0.5114	0.0000	SURCHARGED	15 minute winter	3.001	SW17	21.9	0.688	0.421	0.8460	
15 minute winter	SW17	11	69.548	0.492	49.3	0.7456	0.0000	SURCHARGED	15 minute winter	2.002	SW16	49.3	1.239	1.238	1.6794	
15 minute winter	SW16	11	69.111	0.304	59.0	0.4678	0.0000	SURCHARGED	15 minute winter	2.003	SW15	59.1	1.508	1.470	0.2662	
15 minute winter	SW15	11	68.948	0.184	68.8	0.2843	0.0000	OK	15 minute winter	2.004	SW14	69.1	1.326	0.661	2.2479	
15 minute winter	SW14	11	68.612	0.232	78.8	0.3736	0.0000	OK	15 minute winter	2.005	SW13	79.1	1.436	0.743	0.3887	
15 minute winter	SW13	11	68.521	0.206	88.8	0.3321	0.0000	OK	15 minute winter	2.006	SW12	89.2	1.861	0.753	1.8996	
360 minute winter	SW12	352	68.091	0.226	18.8	0.3637	0.0000	OK	360 minute winter	2.007	SW08	18.8	1.530	0.092	0.5285	
15 minute winter	SW11	10	68.139	0.064	11.4	0.1036	0.0000	OK	15 minute winter	4.000	SW10	11.4	0.634	0.102	0.6485	
360 minute winter	SW10	352	68.091	0.366	3.8	0.5713	0.0000	SURCHARGED	360 minute winter	4.001	SW09	5.7	0.638	0.052	0.2250	
360 minute winter	SW09	344	68.092	0.399	7.6	0.6198	0.0000	SURCHARGED	360 minute winter	4.002	SW08	8.9	0.616	0.062	0.4551	
360 minute winter	SW08	352	68.090	0.505	29.6	0.7768	0.0000	SURCHARGED	360 minute winter	2.008	IN	24.8	1.261	0.109	0.4841	
360 minute winter	IN	352	68.091	0.811	24.8	0.9168	0.0000	OK	360 minute winter	Flow through pond	OUT	34.6	0.051	0.056	148.7580	
360 minute winter	OUT	352	68.091	0.811	34.6	0.9168	0.0000	SURCHARGED	360 minute winter	1.000	SW07-HB	11.9	0.408	0.083	1.0354	
360 minute winter	SW07-HB	352	68.090	1.055	11.9	1.1936	0.0000	SURCHARGED	360 minute winter	Hydro-Brake®	SW06	3.4				
30 minute winter	SW06	12	66.926	0.047	3.4	0.0533	0.0000	OK	30 minute winter	1.002	SW05	3.4	0.596	0.048	0.0420	
15 minute winter	SW05	10	66.900	0.046	3.4	0.0518	0.0000	OK	15 minute winter	1.003	SW04	3.4	0.632	0.049	0.3077	
30 minute summer	SW04	16	66.712	0.047	3.4	0.0529	0.0000	OK	30 minute summer	1.004	SW03	3.4	0.635	0.048	0.0457	
30 minute winter	SW03	15	66.682	0.045	3.4	0.0513	0.0000	OK	30 minute winter	1.005	SW02	3.5	0.604	0.049	0.4208	
60 minute winter	SW02	22	66.427	0.047	3.5	0.0530	0.0000	OK	60 minute winter	1.006	SW01	3.4	0.494	0.048	0.0487	
60 minute winter	SW01	22	66.397	0.046	3.4	0.0520	0.0000	OK	60 minute winter	1.007	EXSW MH	3.4	0.523	0.048	0.0642	49.1
60 minute winter	EXSW MH	22	66.353	0.043	3.4	0.0000	0.0000	OK								

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Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.78%																
Node Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m³)**	**Flood (m³)**	**Status**	**Link Event (Upstream Depth)**	**Link**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m³)**	**Discharge Vol (m³)**
15 minute summer	SW21	10	70.054	0.069	14.8	0.1130	0.0000	OK	15 minute summer	2.000	SW20	14.8	0.890	0.207	0.5387	
15 minute winter	SW20	11	69.858	0.288	29.6	0.4713	0.0000	SURCHARGED	15 minute winter	2.001	SW17	28.2	1.382	0.453	0.1997	
15 minute winter	SW19	11	69.897	0.602	14.8	0.9847	0.0000	SURCHARGED	15 minute winter	3.000	SW18	12.6	0.639	0.310	0.1691	
15 minute winter	SW18	11	69.892	0.623	26.9	1.0013	0.0000	SURCHARGED	15 minute winter	3.001	SW17	25.0	0.695	0.481	0.8460	
15 minute winter	SW17	11	69.837	0.781	60.3	1.1831	0.0000	SURCHARGED	15 minute winter	2.002	SW16	59.3	1.491	1.490	1.6794	
15 minute winter	SW16	11	69.201	0.394	71.9	0.6074	0.0000	SURCHARGED	15 minute winter	2.003	SW15	72.0	1.811	1.790	0.2794	
15 minute winter	SW15	10	68.973	0.209	84.6	0.3226	0.0000	OK	15 minute winter	2.004	SW14	84.9	1.352	0.812	2.6503	
15 minute winter	SW14	11	68.681	0.301	98.8	0.4853	0.0000	SURCHARGED	15 minute winter	2.005	SW13	98.3	1.476	0.922	0.4700	
15 minute winter	SW13	11	68.565	0.250	110.9	0.4025	0.0000	OK	15 minute winter	2.006	SW12	111.6	1.862	0.942	2.3859	
360 minute winter	SW12	352	68.264	0.399	23.8	0.6423	0.0000	SURCHARGED	360 minute winter	2.007	SW08	23.9	1.551	0.116	0.5847	
360 minute winter	SW11	352	68.264	0.189	2.4	0.3046	0.0000	OK	360 minute winter	4.000	SW10	2.4	0.429	0.022	2.0493	
360 minute winter	SW10	352	68.264	0.539	6.1	0.8408	0.0000	SURCHARGED	360 minute winter	4.001	SW09	5.7	0.666	0.051	0.2250	
360 minute winter	SW09	344	68.264	0.571	8.7	0.8872	0.0000	SURCHARGED	360 minute winter	4.002	SW08	10.7	0.616	0.074	0.4551	
360 minute winter	SW08	352	68.263	0.678	35.7	1.0435	0.0000	SURCHARGED	360 minute winter	2.008	IN	33.9	1.328	0.149	0.4841	
360 minute winter	IN	352	68.263	0.983	33.9	1.1121	0.0000	OK	360 minute winter	Flow through pond	OUT	64.7	0.051	0.105	200.2971	
360 minute winter	OUT	352	68.263	0.983	64.7	1.1121	0.0000	SURCHARGED	360 minute winter	1.000	SW07-HB	9.1	0.408	0.064	1.0354	
360 minute winter	SW07-HB	352	68.263	1.228	9.1	1.3889	0.0000	SURCHARGED	360 minute winter	Hydro-Brake®	SW06	3.4				
360 minute winter	SW06	352	66.926	0.047	3.4	0.0533	0.0000	OK	360 minute winter	1.002	SW05	3.4	0.507	0.049	0.0414	
30 minute winter	SW05	11	66.900	0.046	3.4	0.0517	0.0000	OK	30 minute winter	1.003	SW04	3.5	0.622	0.049	0.3095	
360 minute winter	SW04	352	66.712	0.047	3.4	0.0529	0.0000	OK	360 minute winter	1.004	SW03	3.4	0.510	0.048	0.0452	
30 minute winter	SW03	14	66.682	0.045	3.4	0.0513	0.0000	OK	30 minute winter	1.005	SW02	3.5	0.596	0.049	0.4201	
360 minute winter	SW02	352	66.427	0.047	3.4	0.0532	0.0000	OK	360 minute winter	1.006	SW01	3.4	0.495	0.048	0.0490	
360 minute winter	SW01	352	66.397	0.046	3.4	0.0522	0.0000	OK	360 minute winter	1.007	EXSW MH	3.4	0.525	0.048	0.0645	112.1
360 minute winter	EXSW MH	352	66.353	0.043	3.4	0.0000	0.0000	OK								

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Results for 2 year +20% CC 15 minute summer. 255 minute analysis at 1 minute timestep. Mass balance: 100.00%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status	Link Event	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	SW21	10	70.030	0.045	6.2	0.0729	0.0000	OK	15 minute summer	2.000	SW20	6.2	0.728	0.087	0.1906	
15 minute summer	SW20	10	69.646	0.076	12.4	0.1243	0.0000	OK	15 minute summer	2.001	SW17	12.4	1.137	0.199	0.0547	
15 minute summer	SW19	10	69.364	0.069	6.2	0.1122	0.0000	OK	15 minute summer	3.000	SW18	6.2	0.573	0.153	0.0460	
15 minute summer	SW18	10	69.343	0.074	12.4	0.1193	0.0000	OK	15 minute summer	3.001	SW17	12.4	0.638	0.238	0.4223	
15 minute summer	SW17	10	69.207	0.151	31.0	0.2286	0.0000	OK	15 minute summer	2.002	SW16	30.5	1.007	0.767	1.2788	
15 minute summer	SW16	10	68.977	0.170	36.7	0.2626	0.0000	OK	15 minute summer	2.003	SW15	35.7	1.263	0.888	0.2023	
15 minute summer	SW15	10	68.897	0.133	41.8	0.2052	0.0000	OK	15 minute summer	2.004	SW14	41.8	1.213	0.400	1.4959	
15 minute summer	SW14	11	68.543	0.163	46.9	0.2622	0.0000	OK	15 minute summer	2.005	SW13	47.5	1.292	0.446	0.2599	
15 minute summer	SW13	11	68.463	0.148	52.6	0.2381	0.0000	OK	15 minute summer	2.006	SW12	53.0	1.714	0.447	1.2255	
15 minute summer	SW12	11	67.989	0.124	58.1	0.1992	0.0000	OK	15 minute summer	2.007	SW08	58.2	1.916	0.284	0.2596	
15 minute summer	SW11	10	68.123	0.048	6.2	0.0768	0.0000	OK	15 minute summer	4.000	SW10	6.2	0.563	0.056	0.3907	
15 minute summer	SW10	10	67.805	0.080	12.4	0.1255	0.0000	OK	15 minute summer	4.001	SW09	12.4	0.871	0.111	0.0481	
15 minute summer	SW09	10	67.773	0.080	18.6	0.1235	0.0000	OK	15 minute summer	4.002	SW08	18.7	0.805	0.130	0.1566	
15 minute summer	SW08	11	67.735	0.150	80.4	0.2305	0.0000	OK	15 minute summer	2.008	IN	80.7	2.599	0.355	0.2218	
15 minute summer	IN	22	67.519	0.239	80.7	0.2702	0.0000	OK	15 minute summer	Flow through pond	OUT	55.7	0.187	0.091	28.1423	
15 minute summer	OUT	21	67.519	0.239	58.5	0.2708	0.0000	OK	15 minute summer	1.000	SW07-HB	22.0	0.707	0.153	0.9609	
15 minute summer	SW07-HB	20	67.529	0.494	22.0	0.5591	0.0000	SURCHARGED	15 minute summer	Hydro-Brake®	SW06	3.4				
15 minute summer	SW06	12	66.926	0.047	3.4	0.0533	0.0000	OK	15 minute summer	1.002	SW05	3.4	0.609	0.048	0.0421	
15 minute summer	SW05	12	66.900	0.046	3.4	0.0517	0.0000	OK	15 minute summer	1.003	SW04	3.5	0.607	0.049	0.3086	
15 minute summer	SW04	15	66.712	0.047	3.5	0.0527	0.0000	OK	15 minute summer	1.004	SW03	3.4	0.623	0.048	0.0457	
15 minute summer	SW03	15	66.682	0.045	3.4	0.0513	0.0000	OK	15 minute summer	1.005	SW02	3.5	0.607	0.049	0.4220	
15 minute summer	SW02	109	66.427	0.047	3.5	0.0530	0.0000	OK	15 minute summer	1.006	SW01	3.4	0.494	0.048	0.0487	
15 minute summer	SW01	109	66.397	0.046	3.4	0.0519	0.0000	OK	15 minute summer	1.007	EXSW MH	3.4	0.523	0.048	0.0642	33.1
15 minute summer	EXSW MH	109	66.353	0.043	3.4	0.0000	0.0000	OK								

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Results for 2 year +20% CC 15 minute winter. 255 minute analysis at 1 minute timestep. Mass balance: 100.00%																
Node Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m³)**	**Flood (m³)**	**Status**	**Link Event**	**Link**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m³)**	**Discharge Vol (m³)**
15 minute winter	SW21	10	70.030	0.045	6.2	0.0729	0.0000	OK	15 minute winter	2.000	SW20	6.2	0.727	0.087	0.1907	
15 minute winter	SW20	10	69.646	0.076	12.4	0.1243	0.0000	OK	15 minute winter	2.001	SW17	12.4	1.137	0.199	0.0547	
15 minute winter	SW19	10	69.364	0.069	6.2	0.1122	0.0000	OK	15 minute winter	3.000	SW18	6.2	0.573	0.153	0.0460	
15 minute winter	SW18	10	69.343	0.074	12.4	0.1193	0.0000	OK	15 minute winter	3.001	SW17	12.4	0.635	0.238	0.4223	
15 minute winter	SW17	10	69.207	0.151	31.0	0.2286	0.0000	OK	15 minute winter	2.002	SW16	30.6	1.006	0.769	1.2824	
15 minute winter	SW16	10	68.978	0.171	36.8	0.2640	0.0000	OK	15 minute winter	2.003	SW15	36.0	1.264	0.895	0.2034	
15 minute winter	SW15	10	68.897	0.133	42.1	0.2062	0.0000	OK	15 minute winter	2.004	SW14	42.1	1.212	0.403	1.5057	
15 minute winter	SW14	11	68.544	0.164	47.4	0.2636	0.0000	OK	15 minute winter	2.005	SW13	47.9	1.294	0.450	0.2616	
15 minute winter	SW13	11	68.464	0.149	53.2	0.2394	0.0000	OK	15 minute winter	2.006	SW12	53.5	1.716	0.452	1.2361	
15 minute winter	SW12	11	67.990	0.125	58.8	0.2008	0.0000	OK	15 minute winter	2.007	SW08	58.9	1.910	0.288	0.2623	
15 minute winter	SW11	10	68.123	0.048	6.2	0.0768	0.0000	OK	15 minute winter	4.000	SW10	6.2	0.565	0.056	0.3889	
15 minute winter	SW10	10	67.805	0.080	12.4	0.1249	0.0000	OK	15 minute winter	4.001	SW09	12.4	0.870	0.111	0.0474	
15 minute winter	SW09	10	67.771	0.078	18.6	0.1216	0.0000	OK	15 minute winter	4.002	SW08	18.7	0.787	0.130	0.1590	
15 minute winter	SW08	11	67.736	0.151	81.6	0.2323	0.0000	OK	15 minute winter	2.008	IN	82.2	2.575	0.362	0.2494	
15 minute winter	IN	21	67.546	0.266	82.2	0.3007	0.0000	OK	15 minute winter	Flow through pond	OUT	57.8	0.186	0.094	31.9885	
15 minute winter	OUT	21	67.546	0.266	63.2	0.3004	0.0000	OK	15 minute winter	1.000	SW07-HB	19.3	0.769	0.134	1.0027	
15 minute winter	SW07-HB	18	67.555	0.520	19.3	0.5882	0.0000	SURCHARGED	15 minute winter	Hydro-Brake®	SW06	3.4				
15 minute winter	SW06	11	66.926	0.047	3.4	0.0533	0.0000	OK	15 minute winter	1.002	SW05	3.4	0.760	0.048	0.0421	
15 minute winter	SW05	11	66.900	0.046	3.4	0.0518	0.0000	OK	15 minute winter	1.003	SW04	3.5	0.633	0.049	0.3086	
15 minute winter	SW04	129	66.712	0.047	3.5	0.0527	0.0000	OK	15 minute winter	1.004	SW03	3.4	0.651	0.048	0.0455	
15 minute winter	SW03	14	66.682	0.045	3.4	0.0512	0.0000	OK	15 minute winter	1.005	SW02	3.4	0.602	0.049	0.4220	
15 minute winter	SW02	131	66.427	0.047	3.4	0.0530	0.0000	OK	15 minute winter	1.006	SW01	3.4	0.494	0.048	0.0487	
15 minute winter	SW01	131	66.397	0.046	3.4	0.0520	0.0000	OK	15 minute winter	1.007	EXSW MH	3.4	0.523	0.048	0.0642	37.2
15 minute winter	EXSW MH	131	66.353	0.043	3.4	0.0000	0.0000	OK								

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Results for 2 year +20% CC 30 minute summer. 270 minute analysis at 1 minute timestep. Mass balance: 99.92%																
Node Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m³)**	**Flood (m³)**	**Status**	**Link Event**	**Link**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m³)**	**Discharge Vol (m³)**
30 minute summer	SW21	17	70.027	0.042	5.6	0.0690	0.0000	OK	30 minute summer	2.000	SW20	5.5	0.709	0.077	0.1744	
30 minute summer	SW20	17	69.641	0.071	11.1	0.1161	0.0000	OK	30 minute summer	2.001	SW17	10.9	1.101	0.176	0.0499	
30 minute summer	SW19	17	69.359	0.064	5.6	0.1051	0.0000	OK	30 minute summer	3.000	SW18	5.5	0.559	0.136	0.0421	
30 minute summer	SW18	17	69.339	0.070	11.1	0.1121	0.0000	OK	30 minute summer	3.001	SW17	11.0	0.618	0.211	0.3822	
30 minute summer	SW17	18	69.194	0.138	27.5	0.2097	0.0000	OK	30 minute summer	2.002	SW16	27.4	0.981	0.689	1.1799	
30 minute summer	SW16	18	68.967	0.160	32.7	0.2471	0.0000	OK	30 minute summer	2.003	SW15	32.8	1.228	0.814	0.1899	
30 minute summer	SW15	18	68.890	0.126	38.0	0.1950	0.0000	OK	30 minute summer	2.004	SW14	38.0	1.184	0.363	1.3910	
30 minute summer	SW14	18	68.533	0.153	43.3	0.2462	0.0000	OK	30 minute summer	2.005	SW13	42.7	1.258	0.401	0.2404	
30 minute summer	SW13	18	68.454	0.139	48.0	0.2243	0.0000	OK	30 minute summer	2.006	SW12	47.5	1.676	0.400	1.1280	
30 minute summer	SW12	18	67.981	0.116	52.8	0.1862	0.0000	OK	30 minute summer	2.007	SW08	52.2	1.871	0.255	0.2372	
30 minute summer	SW11	17	68.120	0.045	5.6	0.0724	0.0000	OK	30 minute summer	4.000	SW10	5.5	0.551	0.049	0.3530	
30 minute summer	SW10	17	67.799	0.074	11.1	0.1161	0.0000	OK	30 minute summer	4.001	SW09	10.9	0.851	0.098	0.0431	
30 minute summer	SW09	17	67.767	0.074	16.4	0.1144	0.0000	OK	30 minute summer	4.002	SW08	16.4	0.763	0.114	0.1452	
30 minute summer	SW08	18	67.725	0.140	73.8	0.2149	0.0000	OK	30 minute summer	2.008	IN	73.6	2.480	0.324	0.2627	
30 minute summer	IN	35	67.583	0.303	73.6	0.3431	0.0000	OK	30 minute summer	Flow through pond	OUT	43.2	0.101	0.070	37.9493	
30 minute summer	OUT	35	67.584	0.304	46.7	0.3433	0.0000	SURCHARGED	30 minute summer	1.000	SW07-HB	12.3	0.566	0.085	1.0354	
30 minute summer	SW07-HB	36	67.585	0.550	12.3	0.6218	0.0000	SURCHARGED	30 minute summer	Hydro-Brake®	SW06	3.4				
30 minute summer	SW06	17	66.926	0.047	3.4	0.0531	0.0000	OK	30 minute summer	1.002	SW05	3.4	0.604	0.048	0.0415	
30 minute summer	SW05	15	66.899	0.045	3.4	0.0509	0.0000	OK	30 minute summer	1.003	SW04	3.4	0.577	0.048	0.3096	
30 minute summer	SW04	19	66.712	0.047	3.4	0.0528	0.0000	OK	30 minute summer	1.004	SW03	3.4	0.603	0.048	0.0456	
30 minute summer	SW03	18	66.682	0.045	3.4	0.0511	0.0000	OK	30 minute summer	1.005	SW02	3.5	0.596	0.049	0.4220	
30 minute summer	SW02	176	66.427	0.047	3.5	0.0530	0.0000	OK	30 minute summer	1.006	SW01	3.4	0.494	0.048	0.0487	
30 minute summer	SW01	176	66.397	0.046	3.4	0.0520	0.0000	OK	30 minute summer	1.007	EXSW MH	3.4	0.523	0.048	0.0642	45.1
30 minute summer	EXSW MH	176	66.353	0.043	3.4	0.0000	0.0000	OK								

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Results for 2 year +20% CC 30 minute winter. 270 minute analysis at 1 minute timestep. Mass balance: 99.86%																
Node Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m³)**	**Flood (m³)**	**Status**	**Link Event**	**Link**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m³)**	**Discharge Vol (m³)**
30 minute winter	SW21	17	70.025	0.040	4.9	0.0648	0.0000	OK	30 minute winter	2.000	SW20	4.9	0.685	0.068	0.1582	
30 minute winter	SW20	17	69.636	0.066	9.7	0.1081	0.0000	OK	30 minute winter	2.001	SW17	9.6	1.066	0.155	0.0453	
30 minute winter	SW19	17	69.355	0.060	4.9	0.0974	0.0000	OK	30 minute winter	3.000	SW18	4.9	0.542	0.120	0.0381	
30 minute winter	SW18	17	69.334	0.065	9.7	0.1048	0.0000	OK	30 minute winter	3.001	SW17	9.6	0.600	0.186	0.3461	
30 minute winter	SW17	18	69.183	0.127	24.2	0.1925	0.0000	OK	30 minute winter	2.002	SW16	24.1	0.950	0.606	1.0708	
30 minute winter	SW16	18	68.955	0.148	28.8	0.2276	0.0000	OK	30 minute winter	2.003	SW15	28.8	1.187	0.717	0.1733	
30 minute winter	SW15	18	68.881	0.117	33.5	0.1811	0.0000	OK	30 minute winter	2.004	SW14	33.5	1.150	0.321	1.2637	
30 minute winter	SW14	18	68.522	0.142	38.2	0.2288	0.0000	OK	30 minute winter	2.005	SW13	37.9	1.222	0.356	0.2195	
30 minute winter	SW13	18	68.445	0.130	42.6	0.2098	0.0000	OK	30 minute winter	2.006	SW12	42.4	1.632	0.358	1.0326	
30 minute winter	SW12	18	67.973	0.108	47.1	0.1742	0.0000	OK	30 minute winter	2.007	SW08	46.9	1.838	0.229	0.2147	
30 minute winter	SW11	17	68.117	0.042	4.9	0.0681	0.0000	OK	30 minute winter	4.000	SW10	4.8	0.538	0.043	0.3182	
30 minute winter	SW10	17	67.794	0.069	9.7	0.1074	0.0000	OK	30 minute winter	4.001	SW09	9.6	0.822	0.087	0.0383	
30 minute winter	SW09	17	67.760	0.067	14.4	0.1046	0.0000	OK	30 minute winter	4.002	SW08	14.4	0.734	0.100	0.1306	
30 minute winter	SW08	18	67.714	0.129	65.9	0.1980	0.0000	OK	30 minute winter	2.008	IN	65.9	2.371	0.290	0.2844	
30 minute winter	IN	35	67.616	0.336	65.9	0.3801	0.0000	OK	30 minute winter	Flow through pond	OUT	43.9	0.109	0.071	43.1836	
30 minute winter	OUT	35	67.616	0.336	48.2	0.3804	0.0000	SURCHARGED	30 minute winter	1.000	SW07-HB	14.1	0.601	0.098	1.0354	
30 minute winter	SW07-HB	37	67.616	0.581	14.1	0.6568	0.0000	SURCHARGED	30 minute winter	Hydro-Brake®	SW06	3.4				
30 minute winter	SW06	16	66.926	0.047	3.4	0.0532	0.0000	OK	30 minute winter	1.002	SW05	3.4	0.602	0.048	0.0416	
30 minute winter	SW05	14	66.899	0.045	3.4	0.0511	0.0000	OK	30 minute winter	1.003	SW04	3.4	0.595	0.049	0.3096	
30 minute winter	SW04	18	66.712	0.047	3.4	0.0529	0.0000	OK	30 minute winter	1.004	SW03	3.4	0.627	0.048	0.0457	
30 minute winter	SW03	17	66.682	0.045	3.4	0.0512	0.0000	OK	30 minute winter	1.005	SW02	3.5	0.594	0.049	0.4222	
30 minute winter	SW02	203	66.427	0.047	3.5	0.0530	0.0000	OK	30 minute winter	1.006	SW01	3.4	0.494	0.048	0.0487	
30 minute winter	SW01	204	66.397	0.046	3.4	0.0520	0.0000	OK	30 minute winter	1.007	EXSW MH	3.4	0.523	0.048	0.0642	49.8
30 minute winter	EXSW MH	204	66.353	0.043	3.4	0.0000	0.0000	OK								

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Results for 2 year +20% CC 60 minute summer. 300 minute analysis at 1 minute timestep. Mass balance: 99.78%																
Node Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m^3)**	**Flood (m^3)**	**Status**	**Link Event**	**Link**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m^3)**	**Discharge Vol (m^3)**
60 minute summer	SW21	32	70.022	0.037	4.3	0.0608	0.0000	OK	60 minute summer	2.000	SW20	4.3	0.664	0.060	0.1440	
60 minute summer	SW20	32	69.632	0.062	8.6	0.1009	0.0000	OK	60 minute summer	2.001	SW17	8.5	1.033	0.137	0.0413	
60 minute summer	SW19	32	69.350	0.055	4.3	0.0906	0.0000	OK	60 minute summer	3.000	SW18	4.3	0.525	0.105	0.0346	
60 minute summer	SW18	32	69.330	0.061	8.6	0.0984	0.0000	OK	60 minute summer	3.001	SW17	8.5	0.583	0.164	0.3155	
60 minute summer	SW17	33	69.174	0.118	21.3	0.1782	0.0000	OK	60 minute summer	2.002	SW16	21.3	0.922	0.536	0.9763	
60 minute summer	SW16	33	68.944	0.137	25.5	0.2108	0.0000	OK	60 minute summer	2.003	SW15	25.5	1.147	0.634	0.1585	
60 minute summer	SW15	33	68.873	0.109	29.7	0.1690	0.0000	OK	60 minute summer	2.004	SW14	29.6	1.119	0.283	1.1478	
60 minute summer	SW14	33	68.512	0.132	33.8	0.2122	0.0000	OK	60 minute summer	2.005	SW13	33.5	1.188	0.314	0.1995	
60 minute summer	SW13	33	68.436	0.121	37.7	0.1957	0.0000	OK	60 minute summer	2.006	SW12	37.4	1.588	0.315	0.9363	
60 minute summer	SW12	34	67.965	0.100	41.5	0.1614	0.0000	OK	60 minute summer	2.007	SW08	41.4	1.852	0.202	0.1930	
60 minute summer	SW11	32	68.115	0.040	4.3	0.0642	0.0000	OK	60 minute summer	4.000	SW10	4.2	0.521	0.038	0.2899	
60 minute summer	SW10	32	67.789	0.064	8.5	0.1004	0.0000	OK	60 minute summer	4.001	SW09	8.5	0.804	0.077	0.0351	
60 minute summer	SW09	32	67.757	0.064	12.7	0.0989	0.0000	OK	60 minute summer	4.002	SW08	12.8	0.728	0.089	0.1180	
60 minute summer	SW08	33	67.704	0.119	58.2	0.1826	0.0000	OK	60 minute summer	2.008	IN	58.0	1.990	0.255	0.2823	
60 minute summer	IN	64	67.641	0.361	58.0	0.4079	0.0000	OK	60 minute summer	Flow through pond	OUT	39.0	0.071	0.063	47.4412	
60 minute summer	OUT	64	67.640	0.360	40.3	0.4076	0.0000	SURCHARGED	60 minute summer	1.000	SW07-HB	11.6	0.488	0.080	1.0354	
60 minute summer	SW07-HB	64	67.640	0.605	11.6	0.6845	0.0000	SURCHARGED	60 minute summer	Hydro-Brake®	SW06	3.4				
60 minute summer	SW06	250	66.926	0.047	3.4	0.0531	0.0000	OK	60 minute summer	1.002	SW05	3.4	0.506	0.048	0.0411	
60 minute summer	SW05	250	66.898	0.044	3.4	0.0502	0.0000	OK	60 minute summer	1.003	SW04	3.4	0.520	0.048	0.3086	
60 minute summer	SW04	253	66.712	0.047	3.4	0.0527	0.0000	OK	60 minute summer	1.004	SW03	3.4	0.554	0.048	0.0450	
60 minute summer	SW03	254	66.681	0.044	3.4	0.0502	0.0000	OK	60 minute summer	1.005	SW02	3.4	0.556	0.048	0.4220	
60 minute summer	SW02	255	66.427	0.047	3.4	0.0530	0.0000	OK	60 minute summer	1.006	SW01	3.4	0.494	0.048	0.0487	
60 minute summer	SW01	255	66.397	0.046	3.4	0.0520	0.0000	OK	60 minute summer	1.007	EXSW MH	3.4	0.523	0.048	0.0642	55.8
60 minute summer	EXSW MH	256	66.353	0.043	3.4	0.0000	0.0000	OK								

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Results for 2 year +20% CC 60 minute winter. 300 minute analysis at 1 minute timestep. Mass balance: 99.92%																
Node Event	**US Node**	**Peak (mins)**	**Level (m)**	**Depth (m)**	**Inflow (l/s)**	**Node Vol (m³)**	**Flood (m³)**	**Status**	**Link Event**	**Link**	**DS Node**	**Outflow (l/s)**	**Velocity (m/s)**	**Flow/Cap**	**Link Vol (m³)**	**Discharge Vol (m³)**
60 minute winter	SW21	32	70.018	0.033	3.4	0.0542	0.0000	OK	60 minute winter	2.000	SW20	3.4	0.625	0.047	0.1206	
60 minute winter	SW20	32	69.624	0.054	6.8	0.0887	0.0000	OK	60 minute winter	2.001	SW17	6.7	0.971	0.108	0.0347	
60 minute winter	SW19	32	69.343	0.048	3.4	0.0792	0.0000	OK	60 minute winter	3.000	SW18	3.4	0.496	0.083	0.0290	
60 minute winter	SW18	32	69.323	0.054	6.8	0.0873	0.0000	OK	60 minute winter	3.001	SW17	6.7	0.551	0.129	0.2638	
60 minute winter	SW17	33	69.158	0.102	16.8	0.1545	0.0000	OK	60 minute winter	2.002	SW16	16.8	0.868	0.422	0.8173	
60 minute winter	SW16	33	68.926	0.119	20.1	0.1830	0.0000	OK	60 minute winter	2.003	SW15	20.1	1.076	0.500	0.1335	
60 minute winter	SW15	33	68.860	0.096	23.4	0.1483	0.0000	OK	60 minute winter	2.004	SW14	23.4	1.059	0.224	0.9585	
60 minute winter	SW14	33	68.495	0.115	26.7	0.1852	0.0000	OK	60 minute winter	2.005	SW13	26.6	1.122	0.249	0.1675	
60 minute winter	SW13	33	68.422	0.107	29.9	0.1727	0.0000	OK	60 minute winter	2.006	SW12	29.9	1.505	0.252	0.7870	
60 minute winter	SW12	33	67.953	0.088	33.1	0.1416	0.0000	OK	60 minute winter	2.007	SW08	33.1	1.828	0.162	0.1625	
60 minute winter	SW11	32	68.111	0.036	3.4	0.0574	0.0000	OK	60 minute winter	4.000	SW10	3.4	0.494	0.030	0.2417	
60 minute winter	SW10	32	67.781	0.056	6.8	0.0879	0.0000	OK	60 minute winter	4.001	SW09	6.7	0.763	0.060	0.0287	
60 minute winter	SW09	32	67.748	0.055	10.1	0.0857	0.0000	OK	60 minute winter	4.002	SW08	10.1	0.691	0.070	0.0980	
60 minute winter	SW08	59	67.699	0.114	46.4	0.1754	0.0000	OK	60 minute winter	2.008	IN	46.3	1.929	0.204	0.3270	
60 minute winter	IN	64	67.683	0.403	46.3	0.4562	0.0000	OK	60 minute winter	Flow through pond	OUT	26.6	0.080	0.043	54.7308	
60 minute winter	OUT	62	67.682	0.402	28.3	0.4551	0.0000	SURCHARGED	60 minute winter	1.000	SW07-HB	11.7	0.522	0.082	1.0354	
60 minute winter	SW07-HB	62	67.683	0.648	11.7	0.7329	0.0000	SURCHARGED	60 minute winter	Hydro-Brake®	SW06	3.4				
60 minute winter	SW06	289	66.926	0.047	3.4	0.0531	0.0000	OK	60 minute winter	1.002	SW05	3.4	0.528	0.048	0.0411	
60 minute winter	SW05	21	66.898	0.044	3.4	0.0502	0.0000	OK	60 minute winter	1.003	SW04	3.4	0.545	0.048	0.3086	
60 minute winter	SW04	293	66.712	0.047	3.4	0.0527	0.0000	OK	60 minute winter	1.004	SW03	3.4	0.583	0.048	0.0450	
60 minute winter	SW03	22	66.682	0.045	3.4	0.0504	0.0000	OK	60 minute winter	1.005	SW02	3.4	0.575	0.048	0.4220	
60 minute winter	SW02	295	66.427	0.047	3.4	0.0530	0.0000	OK	60 minute winter	1.006	SW01	3.4	0.494	0.048	0.0487	
60 minute winter	SW01	295	66.397	0.046	3.4	0.0520	0.0000	OK	60 minute winter	1.007	EXSW MH	3.4	0.523	0.048	0.0642	55.2
60 minute winter	EXSW MH	295	66.353	0.043	3.4	0.0000	0.0000	OK								

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

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

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APPENDIX D – FOUL WATER PIPE NETWORK CALCULATIONS

CAUSEWAY

Drainage Design Report

Flow+

v10.8

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Network	Foul Network
Filename	B5 05 Oldtown Mill - Foul Network
Username	Kezia Adanza (kadanza@morce.ie)

Report produced on 01/02/2024 09:17:56

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

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Name	Area (ha)	Dwellings	Units	Add Inflow (l/s)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Width (mm)	Easting (m)	Northing (m)	Depth (m)	Notes
FW13		3			69.600	Manhole	Adoptable	1200		696089.146	733860.208	1.425	
FW20					69.950	Manhole	Adoptable	1200		696140.450	733877.436	1.425	
FW19		3			69.950	Manhole	Adoptable	1200		696126.519	733890.202	1.740	
FW12		4			69.400	Manhole	Adoptable	1200		696118.939	733892.673	1.959	
FW11					69.350	Manhole	Adoptable	1200		696112.468	733904.866	2.139	
FW18					71.550	Manhole	Adoptable	1200		696108.053	733947.710	3.350	
FW10		4			69.630	Manhole	Adoptable	1200		696131.794	733925.953	2.610	
FW09		2			69.880	Manhole	Adoptable	1200		696141.789	733936.860	2.959	
FW08		3			69.940	Manhole	Adoptable	1200		696148.796	733941.382	3.061	
FW16					70.350	Manhole	Adoptable	1200		696177.219	733915.901	1.425	
FW15		3			70.350	Manhole	Adoptable	1200		696167.400	733924.899	1.647	
FW21					70.350	Manhole	Adoptable	1200		696203.439	733945.103	1.750	
FW14		3			70.350	Manhole	Adoptable	1200		696193.927	733953.845	2.301	
FW07		3			70.440	Manhole	Adoptable	1200		696175.570	733970.717	3.760	
FW06		3			70.565	Manhole	Adoptable	1200		696180.325	733979.206	3.934	
FW05		1			71.400	Manhole	Adoptable	1200		696184.219	734027.561	1.425	
FW04		6			70.980	Manhole	Adoptable	1200		696206.189	734007.427	4.540	
FW17					70.850	Manhole	Adoptable	1200		696238.943	733984.715	1.425	
FW03		4			70.950	Manhole	Adoptable	1200		696209.828	734011.398	4.537	
FW02		4			70.720	Manhole	Adoptable	1200		696223.575	734026.399	4.409	
FW01					70.630	Manhole	Adoptable	1200		696236.066	734028.215	4.382	

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Name	US Node	DS Node	Length (m)	ks (mm) / n	Velocity Equation	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	Link Type	Con Offset (m)	Min DS IL (m)
1.000	FW13	FW12	44.064	1.500	Colebrook-White	68.175	67.441	0.734	60.0	225	Circular		
2.000	FW20	FW19	18.896	1.500	Colebrook-White	68.525	68.210	0.315	60.0	225	Circular		
2.001	FW19	FW12	7.973	1.500	Colebrook-White	68.210	67.944	0.266	30.0	225	Circular		
1.001	FW12	FW11	13.804	1.500	Colebrook-White	67.441	67.211	0.230	60.0	225	Circular		
1.002	FW11	FW10	28.603	1.500	Colebrook-White	67.211	67.020	0.191	150.0	225	Circular		
3.000	FW18	FW10	32.203	1.500	Colebrook-White	68.200	67.556	0.644	50.0	225	Circular		
1.003	FW10	FW09	14.794	1.500	Colebrook-White	67.020	66.921	0.099	150.0	225	Circular		
1.004	FW09	FW08	8.339	1.500	Colebrook-White	66.921	66.879	0.042	200.0	225	Circular		
1.005	FW08	FW07	39.716	1.500	Colebrook-White	66.879	66.680	0.199	200.0	225	Circular		
4.000	FW16	FW15	13.318	1.500	Colebrook-White	68.925	68.703	0.222	60.0	225	Circular		
4.001	FW15	FW14	39.263	1.500	Colebrook-White	68.703	68.049	0.654	60.0	225	Circular		
5.000	FW21	FW14	12.919	1.500	Colebrook-White	68.600	68.049	0.551	23.4	225	Circular		
4.002	FW14	FW07	24.933	1.500	Colebrook-White	68.049	67.633	0.416	60.0	225	Circular		
1.006	FW07	FW06	9.730	1.500	Colebrook-White	66.680	66.631	0.049	200.0	225	Circular		
1.007	FW06	FW04	38.280	1.500	Colebrook-White	66.631	66.440	0.191	200.0	225	Circular		
6.000	FW05	FW04	29.800	1.500	Colebrook-White	69.975	69.478	0.497	60.0	225	Circular		
1.008	FW04	FW03	5.386	1.500	Colebrook-White	66.440	66.413	0.027	200.0	225	Circular		
7.000	FW17	FW03	39.493	1.500	Colebrook-White	69.425	68.767	0.658	60.0	225	Circular		
1.009	FW03	FW02	20.347	1.500	Colebrook-White	66.413	66.311	0.102	200.0	225	Circular		
1.010	FW02	FW01	12.622	1.500	Colebrook-White	66.311	66.248	0.063	200.0	225	Circular		

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Name	US Node	DS Node	Pro Vel @ 1/3 Q (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Minimum Depth (m)	Maximum Depth (m)	Σ Area (ha)	Σ Dwellings (ha)	Σ Units (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)	Notes
1.000	FW13	FW12	0.096	1.483	59.0	0.0	1.200	1.734	1.200	1.734	0.000	3	0.0	0.0	3	0.129	Proportional Velocity @ 1/3 Flow is less than the specified minimum
2.000	FW20	FW19	0.000	1.483	59.0	0.0	1.200	1.515	1.200	1.515	0.000	0	0.0	0.0	0	0.000	
2.001	FW19	FW12	0.138	2.100	83.5	0.0	1.515	1.231	1.231	1.515	0.000	3	0.0	0.0	3	0.185	Proportional Velocity @ 1/3 Flow is less than the specified minimum
1.001	FW12	FW11	0.129	1.483	59.0	0.1	1.734	1.914	1.734	1.914	0.000	10	0.0	0.0	6	0.215	Proportional Velocity @ 1/3 Flow is less than the specified minimum
1.002	FW11	FW10	0.099	0.936	37.2	0.1	1.914	2.385	1.914	2.385	0.000	10	0.0	0.0	7	0.150	Proportional Velocity @ 1/3 Flow is less than the specified minimum
3.000	FW18	FW10	0.000	1.625	64.6	0.0	3.125	1.849	1.849	3.125	0.000	0	0.0	0.0	0	0.000	Upstream Depth is more than twice the specified minimum
1.003	FW10	FW09	0.117	0.936	37.2	0.1	2.385	2.734	2.385	2.734	0.000	14	0.0	0.0	8	0.180	Proportional Velocity @ 1/3 Flow is less than the specified minimum | Downstream Depth is more than twice the specified minimum
1.004	FW09	FW08	0.116	0.810	32.2	0.1	2.734	2.836	2.734	2.836	0.000	16	0.0	0.0	9	0.168	Proportional Velocity @ 1/3 Flow is less than the specified minimum | Upstream Depth is more than twice the specified minimum | Downstream Depth is more than twice the specified minimum
1.005	FW08	FW07	0.116	0.810	32.2	0.1	2.836	3.535	2.836	3.535	0.000	19	0.0	0.0	10	0.179	Proportional Velocity @ 1/3 Flow is less than the specified minimum | Upstream Depth is more than twice the specified minimum | Downstream Depth is more than twice the specified minimum
4.000	FW16	FW15	0.000	1.483	59.0	0.0	1.200	1.422	1.200	1.422	0.000	0	0.0	0.0	0	0.000	
4.001	FW15	FW14	0.096	1.483	59.0	0.0	1.422	2.076	1.422	2.076	0.000	3	0.0	0.0	3	0.129	Proportional Velocity @ 1/3 Flow is less than the specified minimum
5.000	FW21	FW14	0.000	2.376	94.5	0.0	1.525	2.076	1.525	2.076	0.000	0	0.0	0.0	0	0.000	
4.002	FW14	FW07	0.129	1.483	59.0	0.0	2.076	2.582	2.076	2.582	0.000	6	0.0	0.0	5	0.188	Proportional Velocity @ 1/3 Flow is less than the specified minimum | Downstream Depth is more than twice the specified minimum
1.006	FW07	FW06	0.143	0.810	32.2	0.2	3.535	3.709	3.535	3.709	0.000	28	0.0	0.0	12	0.202	Proportional Velocity @ 1/3 Flow is less than the specified minimum | Upstream Depth is more than twice the specified minimum | Downstream Depth is more than twice the specified minimum
1.007	FW06	FW04	0.143	0.810	32.2	0.2	3.709	4.315	3.709	4.315	0.000	31	0.0	0.0	13	0.213	Proportional Velocity @ 1/3 Flow is less than the specified minimum | Upstream Depth is more than twice the specified minimum | Downstream Depth is more than twice the specified minimum
6.000	FW05	FW04	0.058	1.483	59.0	0.0	1.200	1.277	1.200	1.277	0.000	1	0.0	0.0	2	0.096	Proportional Velocity @ 1/3 Flow is less than the specified minimum
1.008	FW04	FW03	0.155	0.810	32.2	0.2	4.315	4.312	4.312	4.315	0.000	38	0.0	0.0	14	0.223	Proportional Velocity @ 1/3 Flow is less than the specified minimum | Upstream Depth is more than twice the specified minimum | Downstream Depth is more than twice the specified minimum
7.000	FW17	FW03	0.000	1.483	59.0	0.0	1.200	1.958	1.200	1.958	0.000	0	0.0	0.0	0	0.000	
1.009	FW03	FW02	0.155	0.810	32.2	0.2	4.312	4.184	4.184	4.312	0.000	42	0.0	0.0	15	0.233	Proportional Velocity @ 1/3 Flow is less than the specified minimum | Upstream Depth is more than twice the specified minimum | Downstream Depth is more than twice the specified minimum
1.010	FW02	FW01	0.168	0.810	32.2	0.3	4.184	4.157	4.157	4.184	0.000	46	0.0	0.0	15	0.233	Proportional Velocity @ 1/3 Flow is less than the specified minimum | Upstream Depth is more than twice the specified minimum | Downstream Depth is more than twice the specified minimum

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Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	44.064	60.0	225	Circular	69.600	68.175	1.200	69.400	67.441	1.734	FW13	1200	Manhole	Adoptable	FW12	1200	Manhole	Adoptable
2.000	18.896	60.0	225	Circular	69.950	68.525	1.200	69.950	68.210	1.515	FW20	1200	Manhole	Adoptable	FW19	1200	Manhole	Adoptable
2.001	7.973	30.0	225	Circular	69.950	68.210	1.515	69.400	67.944	1.231	FW19	1200	Manhole	Adoptable	FW12	1200	Manhole	Adoptable
1.001	13.804	60.0	225	Circular	69.400	67.441	1.734	69.350	67.211	1.914	FW12	1200	Manhole	Adoptable	FW11	1200	Manhole	Adoptable
1.002	28.603	150.0	225	Circular	69.350	67.211	1.914	69.630	67.020	2.385	FW11	1200	Manhole	Adoptable	FW10	1200	Manhole	Adoptable
3.000	32.203	50.0	225	Circular	71.550	68.200	3.125	69.630	67.556	1.849	FW18	1200	Manhole	Adoptable	FW10	1200	Manhole	Adoptable
1.003	14.794	150.0	225	Circular	69.630	67.020	2.385	69.880	66.921	2.734	FW10	1200	Manhole	Adoptable	FW09	1200	Manhole	Adoptable
1.004	8.339	200.0	225	Circular	69.880	66.921	2.734	69.940	66.879	2.836	FW09	1200	Manhole	Adoptable	FW08	1200	Manhole	Adoptable
1.005	39.716	200.0	225	Circular	69.940	66.879	2.836	70.440	66.680	3.535	FW08	1200	Manhole	Adoptable	FW07	1200	Manhole	Adoptable
4.000	13.318	60.0	225	Circular	70.350	68.925	1.200	70.350	68.703	1.422	FW16	1200	Manhole	Adoptable	FW15	1200	Manhole	Adoptable
4.001	39.263	60.0	225	Circular	70.350	68.703	1.422	70.350	68.049	2.076	FW15	1200	Manhole	Adoptable	FW14	1200	Manhole	Adoptable
5.000	12.919	23.4	225	Circular	70.350	68.600	1.525	70.350	68.049	2.076	FW21	1200	Manhole	Adoptable	FW14	1200	Manhole	Adoptable
4.002	24.933	60.0	225	Circular	70.350	68.049	2.076	70.440	67.633	2.582	FW14	1200	Manhole	Adoptable	FW07	1200	Manhole	Adoptable
1.006	9.730	200.0	225	Circular	70.440	66.680	3.535	70.565	66.631	3.709	FW07	1200	Manhole	Adoptable	FW06	1200	Manhole	Adoptable
1.007	38.280	200.0	225	Circular	70.565	66.631	3.709	70.980	66.440	4.315	FW06	1200	Manhole	Adoptable	FW04	1200	Manhole	Adoptable
6.000	29.800	60.0	225	Circular	71.400	69.975	1.200	70.980	69.478	1.277	FW05	1200	Manhole	Adoptable	FW04	1200	Manhole	Adoptable
1.008	5.386	200.0	225	Circular	70.980	66.440	4.315	70.950	66.413	4.312	FW04	1200	Manhole	Adoptable	FW03	1200	Manhole	Adoptable
7.000	39.493	60.0	225	Circular	70.850	69.425	1.200	70.950	68.767	1.958	FW17	1200	Manhole	Adoptable	FW03	1200	Manhole	Adoptable
1.009	20.347	200.0	225	Circular	70.950	66.413	4.312	70.720	66.311	4.184	FW03	1200	Manhole	Adoptable	FW02	1200	Manhole	Adoptable
1.010	12.622	200.0	225	Circular	70.720	66.311	4.184	70.630	66.248	4.157	FW02	1200	Manhole	Adoptable	FW01	1200	Manhole	Adoptable

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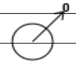
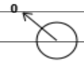
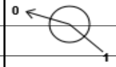
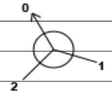
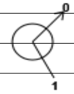
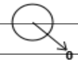
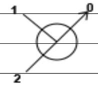
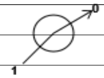
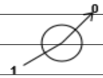
Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Width (mm)	Sump (m)	Node Type	MH Type	Connections		Link	IL (m)	Dia (mm)	Link Type
FW13	696089.146	733860.208	69.600	1.425	1200			Manhole	Adoptable						
											0	1.000	68.175	225	Circular
FW20	696140.450	733877.436	69.950	1.425	1200			Manhole	Adoptable						
											0	2.000	68.525	225	Circular
FW19	696126.519	733890.202	69.950	1.740	1200			Manhole	Adoptable		1	2.000	68.210	225	Circular
											0	2.001	68.210	225	Circular
FW12	696118.939	733892.673	69.400	1.959	1200			Manhole	Adoptable		1	2.001	67.944	225	Circular
											2	1.000	67.441	225	Circular
											0	1.001	67.441	225	Circular
FW11	696112.468	733904.866	69.350	2.139	1200			Manhole	Adoptable		1	1.001	67.211	225	Circular
											0	1.002	67.211	225	Circular
FW18	696108.053	733947.710	71.550	3.350	1200			Manhole	Adoptable						
											0	3.000	68.200	225	Circular
FW10	696131.794	733925.953	69.630	2.610	1200			Manhole	Adoptable		1	3.000	67.556	225	Circular
											2	1.002	67.020	225	Circular
											0	1.003	67.020	225	Circular
FW09	696141.789	733936.860	69.880	2.959	1200			Manhole	Adoptable		1	1.003	66.921	225	Circular
											0	1.004	66.921	225	Circular
FW08	696148.796	733941.382	69.940	3.061	1200			Manhole	Adoptable		1	1.004	66.879	225	Circular
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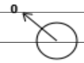
FW16	696177.219	733915.901	70.350	1.425	1200			Manhole	Adoptable						
											0	4.000	68.925	225	Circular

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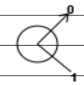
FW15	696167.400	733924.899	70.350	1.647	1200			Manhole	Adoptable		1	4.000	68.703	225	Circular
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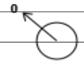
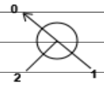
FW21	696203.439	733945.103	70.350	1.750	1200			Manhole	Adoptable						
											0	5.000	68.600	225	Circular
FW14	696193.927	733953.845	70.350	2.301	1200			Manhole	Adoptable		1	5.000	68.049	225	Circular
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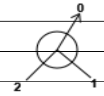
FW07	696175.570	733970.717	70.440	3.760	1200			Manhole	Adoptable		1	4.002	67.633	225	Circular
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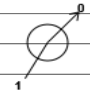
FW06	696180.325	733979.206	70.565	3.934	1200			Manhole	Adoptable		1	1.006	66.631	225	Circular
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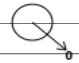
FW05	696184.219	734027.561	71.400	1.425	1200			Manhole	Adoptable						
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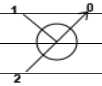
FW04	696206.189	734007.427	70.980	4.540	1200			Manhole	Adoptable		1	6.000	69.478	225	Circular
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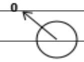
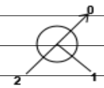
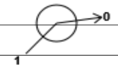
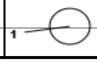
											0	1.008	66.440	225	Circular
FW17	696238.943	733984.715	70.850	1.425	1200			Manhole	Adoptable						
											0	7.000	69.425	225	Circular
FW03	696209.828	734011.398	70.950	4.537	1200			Manhole	Adoptable		1	7.000	68.767	225	Circular
											2	1.008	66.413	225	Circular
											0	1.009	66.413	225	Circular
FW02	696223.575	734026.399	70.720	4.409	1200			Manhole	Adoptable		1	1.009	66.311	225	Circular
											0	1.010	66.311	225	Circular
FW01	696236.066	734028.215	70.630	4.382	1200			Manhole	Adoptable		1	1.010	66.248	225	Circular

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APPENDIX E – MAINTENANCE AND MANAGEMENT PLAN

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

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

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

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

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

SuDS Component	Maintenance Responsibility	Maintenance Schedule	Required Action	Typical Frequency
Pond	PPP management company for 25 years then Kildare County Council	Regular Inspections	Inspect surfaces for silting, record water levels of the facility and assess actual versus predicted levels, determine if modifications are necessary.	Quarterly for first year, then every 6 months thereafter
			Check operation of underdrains by inspection of flows after rain.	Annually
			Inspect inlets and outlets for blockage.	Quarterly
		Regular Maintenance	Remove sediment, litter and debris build-up from around inlets/outlets.	As required

APPENDIX F – EXISTING SW SEWER CAPACITY ASSESSMENT

FILE NOTE

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MALONE O'REGAN
CONSULTING ENGINEERS

Project:	23006 NDFA Social Housing Bundle - Oldtown Road
By:	Kezia Adanza
Date:	March 2024

Re:	Oldtown Mill Road Drainage Network Capacity Check

A pipe capacity assessment was carried out on the existing surface water drainage network located on Oldtown Mill Road. This assessment was based on surface water drainage map records received from Kildare County Council. These maps indicate that a 600mm diameter concrete pipe is located at the northern end of Oldtown Mill Road. The drain connects to a 750mm diameter drain at the southern end of Oldtown Mill Road before connecting to the downstream drainage network on Shackleton Road. A further 525mm diameter concrete pipe runs along Oldtown Mill Road, parallel to the 600/750mm diameter drain.

Catchment areas contributing runoff to the existing drainage network were estimated based on Ordnance Survey mapping. The various contributing catchment areas are illustrated on Malone O'Regan drawing no. SHB5-OCK-DR-MOR-CS-P3-160.

Following consultation with Kildare County Council, it was agreed that the rate of discharge from each catchment area could be calculated on the basis that it is limited to the QBAR greenfield runoff rate. This QBAR value is obtained from the Institute of Hydrology Report 124 and is the mean annual flood flow from a rural catchment in m^3/s and is given by the following equation:

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

Where:

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

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

Standard Average Annual Rainfall for the site in Celbridge was taken from the Flood Studies Report as 924mm.

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

FILE NOTE

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Rainfall Data	
M5-60 (1 hour - 5 years) mm	16.2
M5-2D (2 days - 5 years) mm	58
Ratio "r" (M5-60/ M5-2D)	0.28
SAAR mm	924
Soil/ SPR mm	0.3

For 50 Ha Area ~ QBARrural =	0.126	m³/s
	2.522	l/s/ha

Using the above formula, the discharge rate from each catchment area was calculated to be:

2.522 litres / sec / hectare

This value was multiplied by the area of each catchment to obtain the receiving surface water discharge rates in Table 1.

The hydraulic flow capacity of the receiving pipe network was calculated using the Colebrook White Equation:

$$Q = 2\sqrt{2gDS}\,\log[\frac{ks}{3.7D} + \frac{2.51v}{D\sqrt{2gDS}}$$

Where:

$$Q - pipe\ flow\ rate$$
$$S - hydralic\ gradient;$$
$$v - kinematic\ viscosity;$$
$$D - \ internal\ diameter;$$
$$Ks - roughness\ coefficient;$$
$$g - gravity;$$
$$A - Area\ of\ Section;$$

The two pipe runs on Oldtown Mill Road have been assessed separately. Table 1 considers the 600/750mm diameter pipework and Table 2 considers the 525mm diameter pipe.

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MALONE O'REGAN CONSULTING ENGINEERS

Table 1 - 600 & 750mm Diameter Pipe

Contributing Area			Receiving Surface Water Discharge (l/s) = QBARrural *Area	Diameter (mm)	Gradient (1 in X)	Pipe Flow Capacity, Q (l/s) = Colebrook White Equation
Catchments	m^2	ha				
A	17243	1.72	**4.4**	600	109.8	**585.5**
A to B	23095	2.31	**5.8**	600	82.6	**675.3**
A to C	28036	2.80	**7.1**	600	129.0	**540.0**
A to D	34402	3.44	**8.7**	600	64.8	**762.4**
A to E	55896	5.59	**14.1**	600	300.0	**353.6**
A to F	66358	6.64	**16.7**	600	165.5	**476.6**
A to G	87852	8.79	**22.2**	600	165.5	**476.6**
A to H	98314	9.83	**24.8**	600	54.9	**828.6**
A to I	119807	11.98	**30.2**	750	135.7	**948.2**
A to J	130270	13.03	**32.9**	750	93.0	**1145.9**

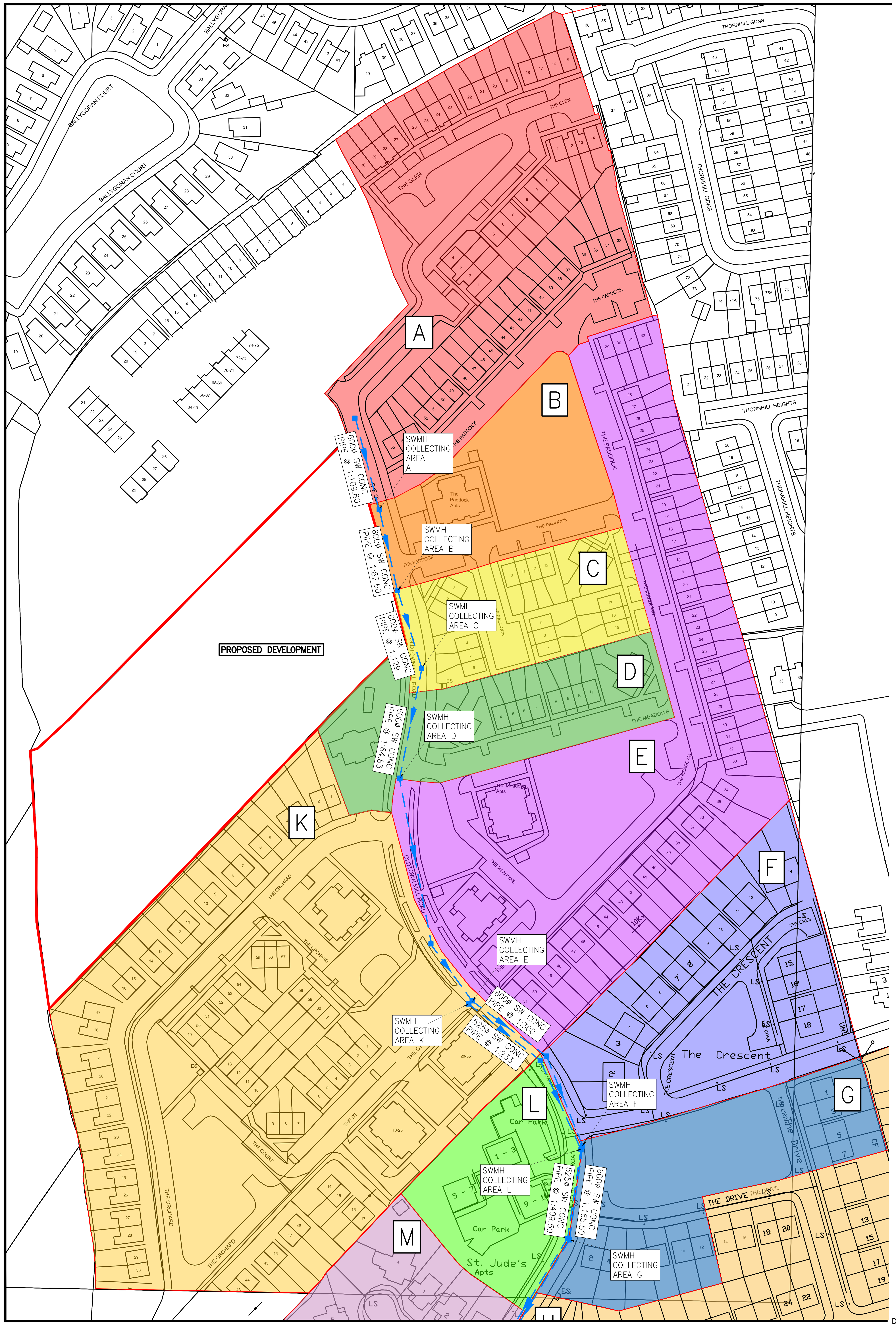
Table 2 - 525mm Diameter Pipe

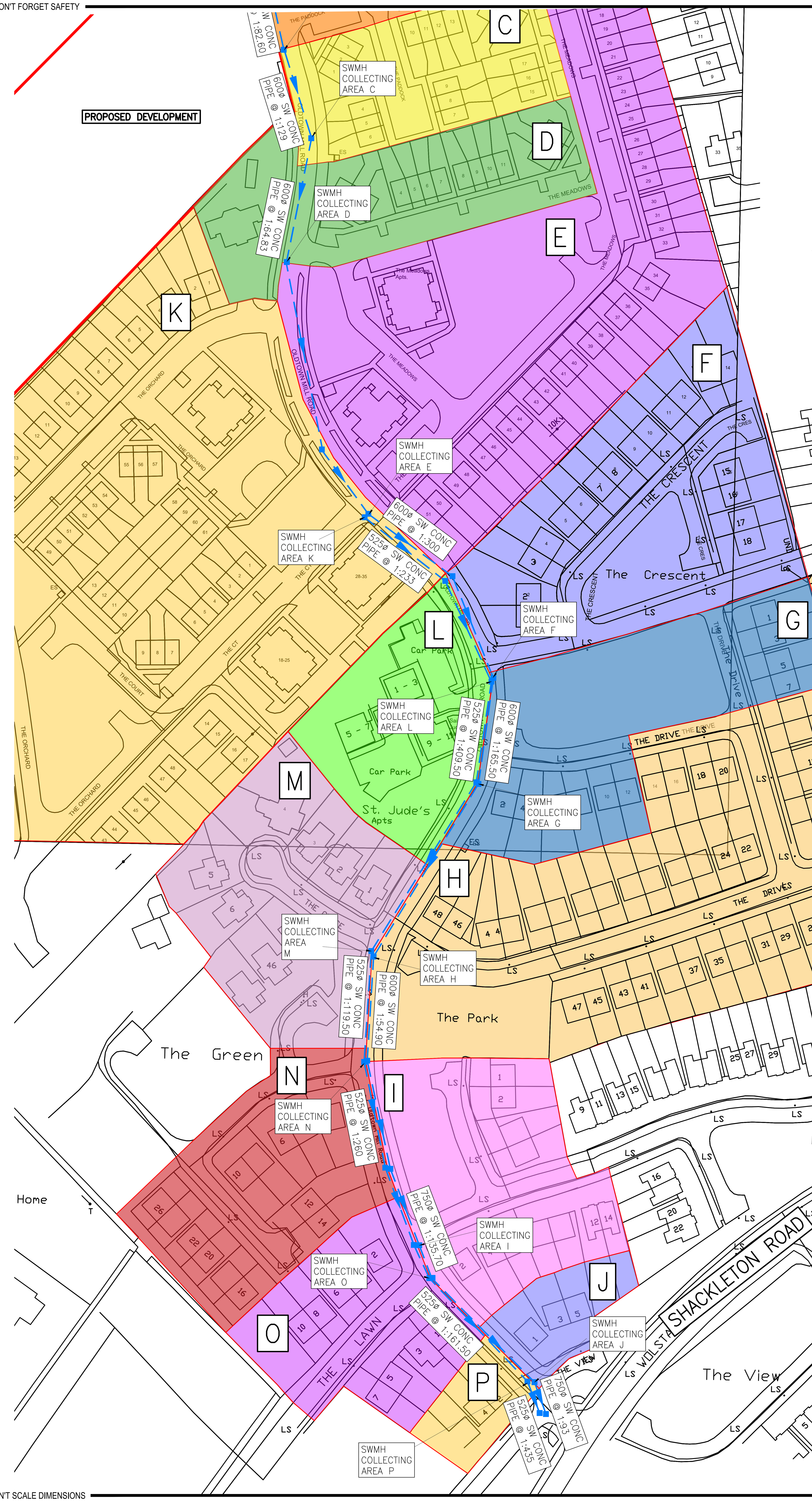
Contributing Area			Receiving Surface Water Discharge (l/s) = QBARrural *Area	Diameter (mm)	Gradient (1 in X)	Pipe Flow Capacity, Q (l/s) = Colebrook White Equation
Refer to Map	m2	ha				
K	30858	3.09	**7.8**	525	233.0	**282.2**
K to L	35741	3.57	**9.0**	525	409.5	**212.6**
K to M	43029	4.30	**10.9**	525	119.5	**394.4**
K to N	49451	4.95	**12.5**	525	260.0	**267.0**
K to O	54315	5.43	**13.7**	525	161.5	**339.1**
K to P	55585	5.56	**14.0**	525	435.0	**206.2**

By comparing the rate of discharge into the drainage pipe work against the capacity of the pipework, it can be seen that all sections of the existing drainage network have sufficient capacity to cater for runoff from the contributing catchment areas. The minimum capacity of the 600/750mm diameter pipe run is 353.6 l/s and the highest existing flow rate is just 32.9 l/s. The minimum capacity of the 525mm diameter pipe run is 212.6 l/s and the highest existing flow rate is just 14.0 l/s.

It is proposed to connect surface water discharge from the development into the existing 600mm diameter drain. A hydrobrake flow control device will be installed on the storage pond overflow in order to limit the rate of discharge to 3.42 litres / sec. Referring to the existing discharge rates in Table 1, it can be seen that this additional flow will not compromise the capacity of the existing drainage network.

DON'T FORGET SAFETY





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NOTES

BY	DRAWING No. & REFERENCE	DATE
SURVEY		
ARCH		

REV	DESCRIPTION	DATE	BY	CHK
0	ISSUED FOR INFORMATION	11.03.24	KA	DW

STATUS

P3 – FOR PLANNING

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CLIENT

NDFA – SOCIAL HOUSING BUNDLES 4 & 5

JOB NAME

OLDTOWN MILL, CELBRIDGE

DRG. NAME

SHACKLETON ROAD DRAINAGE NETWORK CAPACITY

JOB REF	SHEET	SCALE	DATE	BY	ENG	APP	REV.
23006	A1	1:1000	MAR' 24	KA	KA	DW	0

DRG. NO.

SHB5-OCK-DR-MOR-CS-P3-160