INFRASTRUCTURE

Project

Residential Development at Roebuck Road, Clonskeagh, Dublin 14

Report Title

Engineering Services Report

Document Reference

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DBFL CONSULTING ENGINEERS

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DBFL CONSULTING ENGINEERS

Dublin Office

Ormond House
Upper Ormond Quay
Dublin 7
D07 W704
Ireland

+353 1 400 4000
info@dbfl.ie
www.dbfl.ie

Cork Office

14 South Mall
Cork
T12 CT91
Ireland

+353 21 202 4538
info@dbfl.ie
www.dbfl.ie

Waterford Office

Suite 8b, The Atrium
Maritana Gate, Canada Street
Waterford
X91 W028
Ireland

+353 51 309 500
info@dbfl.ie
www.dbfl.ie

Contents

1 Introduction

DBFL Consulting Engineers were commissioned by the Applicant, Dun Laoghaire-Rathdown County Council (DLRCC), to prepare an Engineering Services Report (ESR) for the proposed residential development at the junction of White Oaks and Roebuck Road, Clonskeagh, Dublin 14.

The application site is a brownfield site, comprises approximately of 0.068 hectares and has been used in recent years as a car park – see Figure 1 below.

The site is bordered to the northwest by an open watercourse and residential development, to the south by the White Oaks Tudor Homes residential development and to the southeast by White Oaks Road and a car wash. The site is bordered to the northeast by Roebuck Road (R825) and has vehicular access from White Oaks on its south eastern border.

The existing site slopes at an approximate gradient of 1:65 from southwest to northeast with the Dodder River located approximately 1.0km to the northwest of the site and the Irish Sea approximately 2.4km to the east.

Figure 1: Site Location, Roebuck Road, Clonskeagh, Dublin 14

The proposed residential development consists of 4 no. housing units within a 3 storey development on the site.

The associated site and infrastructural works include watermains, foul and surface water drainage, parking facilities, permeable paving, bin store, landscaping, boundary walls and fences.

The objective of this report is to provide information on the calculations, estimates and assumptions used to design the foul sewers, surface water sewers, surface water attenuation and Sustainable Drainage Systems (SuDS), watermains and road access for the proposed development.

2 Foul Sewers

2.1 Existing Services

The site currently exists as a small car park. There is no foul infrastructure located within the boundary of the proposed site.

See Appendix A for the Existing Irish Water Records.

2.2 Proposed Services

Foul sewage within the site will be drained via individual inspection chambers at each dwelling to a proposed 150mm diameter foul sewer which will traverse the site and exit across the eastern boundary to discharge into the existing foul sewer located within White Oaks Lane.

Refer to drawing 210013-DBFL-CS-SP-DR-C-1001 for details of the proposed foul sewer network.

Foul sewers have been designed and will be constructed in accordance with the Irish Water's 'Standard Details for wastewater infrastructure' and 'Code of practice for wastewater infrastructure'. In addition, foul sewers have been designed to Building Regulations and specifically in accordance with the principles and methods set out in EN 752:2008 and DOE *'Recommendations for Site Development Works'.* In addition, HR Wallingford 'Tables for the hydraulic design of pipes, sewers and channels' and Water UK/WRc 'Sewers for Adoption – 6th Edition' have been applied. Values for roughness of uPVC pipes were obtained from Wallingford "Tables for the Hydraulic Design of Pipes, Sewers and Channels" and Wavinsewer systems catalogue.

Using Irish Water parameters, the peak flow from the site is calculated as 0.124 l/s. The following minimum gradients were used:

No. of Houses	Minimum Pipe Gradient
1	100mm dia. @ 1:60 or self-cleansing gradient (private connection)
2-9	150mm dia. @ 1:60 or self-cleansing gradient
>10	Min 150mm dia. or self-cleansing gradient

Sewers and drains shall be laid to comply with the requirements of the Building Regulations 1997 in accordance with the recommendations contained in the Technical Guidance Documents, Section H (revised 2005). Standard drainage details will be in accordance with the Greater Dublin Regional Code of Practice for Drainage Works and Irish Water Standard Details for Wastewater infrastructure.

See Appendix B for the Foul Sewerage calculations.

Refer to drawing number 210013-DBFL-CS-SP-DR-C-1001 for Proposed Foul Sewer Layout.

3 Surface Water

3.1 Existing Services

Irish water existing drainage records show that there may be an existing 225mm diameter stormwater connection at the northern boundary of the proposed site. More survey information will be required to determine the origin of this connection but it is thought to service the previous brownfield site. All redundant surface water infrastructure that may be located within the site boundary will be investigated and removed. There is an existing open watercourse that runs along the rear of the site, and existing 225mm diameter public surface water sewers located on Roebuck Road northeast of the site and White Oaks Lane located to the southeast of the proposed site.

Refer to Appendix A for existing Irish Water records.

3.2 Proposed Services

Surface water management for the proposed development 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 GDSDS guidelines require the following 4 main criteria to be provided by the development's surface water design;

- Criterion 1: River Water Quality Protection - satisfied by providing interception storage and treatment of run-off within the SuDS features e.g. permeable paving and filter drains.
- Criterion 2: River Regime Protection – satisfied by attenuating run-off with flow control device prior to discharge to the existing surface water manhole in White Oaks Lane.
- Criterion 3: Level of Service (flooding) for the site – satisfied by the site being outside the 1000 year coastal and fluvial flood levels. Pluvial flood risk addressed by development designed to accommodate a 100-year storm (plus climate change) as per GDSDS. Planned flood routing for storms greater than 100-year level considered in the design and development run-off contained within site.
- Criterion 4: River flood protection – attenuation provided within the SuDS features e.g. permeable paving construction and filter drains.

3.3 Sustainable Drainage Systems (SuDS)

It is proposed to use a sustainable urban drainage system (SuDS) approach to stormwater management throughout the site. The overall strategy aims to provide an effective system to mitigate the adverse effects of urban stormwater runoff on the environment by reducing runoff rates, volumes and frequency, reducing pollutant concentrations in stormwater, contributing to amenity, aesthetics and biodiversity enhancement and allow for the maximum collection of rainwater for re-use where possible. In addition,

SuDS features aim to replicate the natural characteristics of rainfall runoff for any site by providing control of run-off at source and this has been achieved by the current proposals.

SuDS are a requirement of 'The Greater Dublin Strategic Drainage Study' and are recommended under the 2009 guidelines, 'The Planning System and Flood Risk Management'.

There are a number of SuDS features proposed which have been designed in accordance with CIRIA documents C753, C697 and C609 as follows:

- Permeable Pavers: Porous surfacing (paving block or open graded material) which can treat rainwater at source, and allow infiltration through to an underlying porous subbase where water can be stored within the voids before being slowly released to the drainage collection system through natural flow via the porous medium. These systems will allow some form of storage for small rainfall events and will result in interception, water evaporation and adsorption in small quantities, therefor there will be less runoff from these areas in small rainfall event thus mimicking the natural response for this catchment. As well as reducing the amount of runoff from the surface, permeable paving will slow down the rate of runoff from the pavement in extreme rainfall events contributing to attenuation flows. In addition, permeable paving will increase the quality of water which is intercepted by the system through filtration, biodegradation, pollutant adsorption and settlement and retention of solids, also the reduction in peak flows to the outfall will enhance settlement and biodegradation of pollutants.
- Filter Drains: Trenches filled with permeable stone material and a perforated collection pipe at the invert with an optional permeable 'sandy' topsoil at surface. These can treat, convey and attenuate runoff, at source, and can infiltrate to the ground where the subgrade is suitable. These systems will allow some form of storage for small rainfall events and can result in water evaporation and adsorption in small quantities, therefore there will be less run-off from these areas in small rainfall events thus mimicking the natural response for this catchment. These will be located in the rear-gardens of each unit and will result in an improvement in the quality of surface water draining from roofs of houses and paved areas in rear gardens and will also allow groundwater to recharge to its natural state.

See Appendix C for the Permeable Paving calculations

See Appendix D for the Filter Drain calculations

See Appendix E for the SUDs Summary calculations

Refer to drawing number 210013-DBFL-CS-SP-DR-C-1001 for Proposed Surface Water Layout.

3.3.1 Permissible Site Discharge

According to the GDSDS, the method used for determining peak flow rates for small greenfield catchments is the UK 'Institute of Hydrology Report 124, Flood Estimation for Small Catchments'. This method calculates $QBAR_{rural}$ which is the mean annual flood flow from a rural catchment.

Where long-term storage can be provided or is not necessary, surface water can be discharged at a higher value than $QBAR_{rural}$, this discharge rate ($QBAR_{growth}$) is dependent on the design return period and the corresponding growth factor from the GDSDS Table 6.6. However, if long-term storage cannot be provided on-site the discharge rate from the site should be kept to $QBAR_{rural}$ or 2 l/s/ha. This is the case for this proposed development.

The IH124 method calculates $QBAR_{rural}$ which is the mean annual flood flow from a rural catchment. As the subject site area is less than 50 hectares, the calculated QBAR is to be linearly interpolated from the calculated value to produce a reduced allowable outflow based on the actual site area, as per GDSDS section 6.6.1.

$$QBAR_{rural} = 0.00108 \times (Area)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$$

where:-

$QBAR_{rural}$ = Mean Annual Flood (m^3/s)
Area = Catchment Area (km^2)
SAAR = Standard Average Annual Rainfall (mm)
SOIL = SOIL index from Flood Studies Report

Using data received from Met Eireann for Irish Grid co-ordinates E 317000, N 229000 (site co-ordinates are: E 317648, N 229653), the SAAR is determined as 772mm.

The soil value can be determined from the Flood Studies Report - Winter Rainfall Acceptance Maps (WRAP). A more accurate approach is to use the '*The Classification of Soils from Winter Rainfall Acceptance Rate, Flood Studies Report Table 4.5*' to determine soil type and determine the soil value from Table 6.7 from the GDSDS. The latter method is adopted for this site.

Permissible site discharge for the site has been determined as follows:

Total Application Site Area = 0.07 Ha
Actual Catchment Area = 0.07 Ha
SAAR = 772mm
SOIL Value = 0.37 (for soil type 3 from Table 6.7 from the GDSDS)

The calculated permissible site discharge is 0.3l/s.

However, the minimum recommended orifice size for a Hydrobrake is 50mm which is to protect it against blockages over the lifetime of the product. Therefore, the discharge will be raised to 2.0l/s to obtain this minimum orifice size.

See Appendix F for the Permissible Site Discharge calculations.

3.3.2 Surface Water Runoff Coefficients

As a large proportion of runoff is routed through SuDS features these will have an attenuating effect which reduce the rate of stormwater runoff for every rainfall event. Also, SuDS features will reduce the runoff volume through evaporation, transpiration, infiltration and depression storage of the water within each system.

The following runoff coefficients have been applied as follows:

Roofs - Type 1 (Draining to traditional gullies) = 1.00
Roofs – Type 2 (Draining to SuDS features) = 0.75
Roads and Footpaths - Type 1 (Draining to traditional gullies) = 0.95
Roads and Footpaths - Type 2 (Draining to SuDS features) = 0.70
Permeable Paving = 0.70
Grassed Areas = 0.37 (soil type 3 SPR- Flood Studies Report)

3.3.3 Surface Water Attenuation

GDSDS requires flood waters for a 100 year return period to be managed on-site, therefore this return period is adopted for attenuation calculations. Surface water attenuation for the site will be provided within the permeable paving at the front of the development.

In order to ensure that the proposed design provides similar or improved benefits, the design proposal is for the inclusion of traditional roof areas to drain to filter drains located to the rear of the development and to the permeable paving to the front the proposed development. The interception and treatment volumes of the above proposed designs are discussed in greater detail below.

The development drainage infrastructure system, including Sustainable Drainage System features (SuDS) with underground attenuation, will be designed such that the catchment will drain to the open water course to that runs to along the back of the site via an existing drainage network in White Oaks located to the south of the site. Surface water runoff from this catchment will be restricted as noted above.

As required by Dun Laoghaire-Rathdown County Council, a climate change allowance of 20% will be applied to the surface water drainage design.

The hydraulic modelling software system ‘MicroDrainage’ was used to calculate attenuation volumes, using maximum rainfall data from Extreme Rainfall Return Period values produced by Met Eireann to calculate maximum flood volumes for the 1 in 100 year rainfall event.

Rainfall data for the site was sourced from Annual average Rainfall (AAR) Grid (1981-2010) and a Depth Duration Frequency model produced by Met Eireann (Available from: http://www.met.ie/climate/products03.asp).

SAAR	=	772mm
Ratio M560/M52d	=	0.278
M5/60	=	17.8mm

It should be noted that the attenuation volume required is based on the results of the MICRODRAINAGE hydraulic simulation summary of Critical Results by Maximum Level. Hydrobrake maximum head and discharge is based on results of MICRODRAINAGE hydraulic simulation summary of Critical Results by Maximum Outflow.

Also, it should be noted that within the site, overland flow paths will be provided to direct run-off from high intensity, short duration storms which might fail to enter the drainage system.

The Attenuation Volume was calculated as 4.5m^3.

See Appendix G for surface water attenuation calculations.

Refer to drawing number 210013-DBFL-CS-SP-DR-C-1001 for Proposed Surface Water Layout.

3.3.4 Interception Volume

The GDSDS requires that no run-off should directly pass to the receiving watercourse/systems for rainfall depths of 5mm, therefore interception should be provided at source where practicable. The volume of interception required is based on 5mm of rainfall depth from 80% of the runoff from impermeable areas as defined in the GDSDS (Appendix E section E2.1.1).

The interception volume attributable to each SuDS feature consists of the volume of water that can infiltrate to the ground, what will evaporate into the atmosphere and what can transpirate through plants and vegetation. Additionally, there will some losses of water due to absorption and wetting of stone and soil media.

Not all SuDS features will be able to achieve infiltration, evaporation, transpiration and losses due to absorption/wetting. The limits for each SuDS feature type are taken into account when calculating interception volumes.

The interception storage attributable to the losses in stone and soil media, such as the stone media used in filter drains was not included in the calculations.

The total interception volume required (as calculated) for the site is 1.5m^3. The volume provided for the site by means of permeable paving is 9.6 m^3.

See Appendix H for the Interception Volume Requirement.

Refer to drawing number 210013-DBFL-CS-SP-DR-C-1001 for Proposed Surface Water Layout.

3.3.5 Treatment Volume

The GDSDS requires that a "treatment volume" (Vt) be provided in order to prevent any pollutants or sediments discharging into river systems, additionally a 'treatment train' stormwater runoff management system is required. According to CIRIA document C697 the following treatment train approach is necessary:

Roofs – 1 Treatment Stage

Road Areas – 2 Treatment Stages

Paved Areas excluding Roads - 1 Treatment Stage

The treatment volume required is based on treatment 15mm of rainfall depth from 80% of the runoff from impermeable areas as defined in the GDSDS (Appendix E section E2.1.2).

All run-off areas will pass through the required number of treatment stages prior to discharging to the downstream outfall. Treatment methods include filter drains, permeable paving and silt traps.

The total treatment volume required (as calculated) for the site is 4.6m3. The volume provided for the site by means of permeable paving is 20.2m3.

See Appendix I for the Treatment Volumes Calculations.

Refer to drawing number 210013-DBFL-CS-SP-DR-C-1001 for Proposed Surface Water Layout.

3.3.6 Surface Water Sewers

Surface water from the proposed development will be discharged at a rate of 2.0l/s to the existing open water course to rear of development.

Surface water sewers are designed in MICRODRAINAGE using the Modified Rational Method. The return period for sizing pipes is based on the following;

- Department of Environment – Recommendations for Site Development Works for Housing Areas (1998), Table 3.1;
- GDSDS – Regional Drainage Policies – Volume 2 – New Development (2005), Section 6.5;
- IS EN 752:2008 - Drain and Sewer Systems Outside Buildings, Table 2;
- Building Regulations (2005) – Section H - Drainage and Wastewater Disposal, Section 1.5.7.

In addition, the pipe system was checked for the 30year return period where no flooding from manholes was encountered.

The following parameters applied:

Return period	2 year (flooding check for 30 year event)
Time of entry	4 minutes
Pipe Ks	0.6mm (concrete); 0.15mm (uPVC)
Minimum velocity	0.75 m/s
Maximum velocity	3.0 m/s

Effective runoff coefficients for each pipe catchment have been determined based on the runoff characteristics for each surface contributing to flows within the catchment.

The minimum pipe diameter for public surface water sewers is 225mm.

Values for roughness of uPVC pipes were obtained from Wallingford “Tables for the Hydraulic Design of Pipes, Sewers and Channels” and Wavinsewer systems catalogue.

Surface water within the development will drain by way of filter drains and permeable paving into the hydro brake manhole proposed to discharge to the existing surface water manhole in White Oaks Lane.

Refer to drawing number 210013-DBFL-CS-SP-DR-C-1001 for Proposed Surface Water Layout.

4 Watermains

4.1 Existing Services

Existing topographical survey information shows existing watermain infrastructure within Roebuck Road. Further survey information is needed to fully identify the location of existing watermain infrastructure in surrounding the site. The Irish water records show an existing 100mm UPVC line running along the White Oaks Lane and connecting to watermain within Roebuck Road.

4.2 Proposed Services

The estimated peak demand from the development will be 0.117 l/s with the average daily demand being 0.19l/s.

Each unit will join the existing watermain line within the White Oaks Lane individually.

See Appendix J for the water demand calculations.

Refer to drawing number 20016-DBFL-CS-SP-DR-C-1001 for Proposed Watermain Layout.

Appendix A

Existing Irish Water Services Records

Roebuck Road

03/04/2019 12:16:16

Legend

Stormwater Gravity Mains (Irish Water Owned)
- Surface

Stormwater Gravity Mains (Non-Irish Water Owned)
- Surface

Storm Manholes
- Cascade
- Catchpit
- Hatchbox
- Lamphole
- Standard
- Other; Unknown

Storm Inlets
- Gully
- Standard
- Other; Unknown

Storm Fittings
- Vent/Col
- Other; Unknown

Storm Discharge Points
- Outfall
- Overflow
- Soakaway
- Other; Unknown
- Storm Culverts
- Storm Clean Outs
- Storm Water Network Junctions
- Storm Network Structures
- Storm System Valves
- Stormwater Weirs
- Storm Open Drains
- Stormwater Chambers
- Kisok
- Storm Casings
- SUDsArea
- Storm Detention Areas

Sewer Gravity Mains (Irish Water owned)
- Combined
- Foul
- Overflow
- Unknown

Sewer Gravity Mains (Non-Irish Water owned)
- Combined
- Foul
- Overflow
- Unknown

Irish Water gives this information as to the position of its underground network as a general guide only on the strict understanding that it is based on the best available information provided by each Local Authority in Ireland. It should not be relied upon in the event of excavations or other works being carried out in the vicinity of the network. The onus is on the parties carrying out the works to ensure the exact location of the network is identified prior to mechanical works being carried out. Service pipes are not generally shown but their presence should be anticipated.

"Gas Networks Ireland (GNI), their affiliates and assigns, accept no responsibility for any information contained in this document concerning location and technical designation of the gas distribution and transmission network ("the Information"). Any representations and warranties express or implied, are excluded to the fullest extent permitted by law. No liability shall be accepted for any loss or damage including, without limitation, direct, indirect, special, incidental, punitive or consequential loss including loss of profits, arising out of or in connection with the use of the Information (including maps or mapping data). NOTE: DIAL BEFORE YOU DIG Phone 1850 427 747 or e-mail dig@gasnetworks.ie – The actual position of the gas/electricity distribution and transmission network must be verified on site before any mechanical excavating takes place. If any mechanical excavation is proposed, hard copy maps must be requested from GNI re gas. All work in the vicinity of the gas distribution and transmission network must be completed in accordance with the current edition of the Health & Safety Authority publication, 'Code of Practice For Avoiding Danger From Underground Services' which is available from the Health and Safety Authority (1890 28 93 89) or can be downloaded free of charge at www.hsa.ie."

Appendix B

Foul Sewer Calculations

TITLE	Job Reference
Proposed Residential Development at Roebuck	210013
SUBJECT	**Calc. Sheet No.**
Wastewater Hydraulic Load - Irish Water - Residential	1

DRAWING NUMBER	Calculations by	Checked by	Date
210013-DBFL-CS-SP-DR-C-1000	RSP	LMCL	22.04.21

Foul Drainage

Housing Units	4	no.
Dry Weather Flow (DWF)[1]	150	litres/person/day
Average Occupancy Ratio[2]	2.7	person/unit
Total Site Occupancy (i.e. population)	11	person
Total Daily Wastewater Discharge + 10% Unit Consumption Allowance[3]	1,782	l/day
Peak Flow Factor[4]	6.0	

Post Development Average Discharge	**0.021**	l/s
Post Development Peak Discharge[5]	**0.124**	l/s

Foul Sewer Organic Loading

	Average Concentration[6]	Maximum Concentration[7]
BOD (mg/l)	168	422
SS (mg/l)	163	435
N (mg/l)	40.6	78.6
P (mg/l)	7.1	15.5
COD (mg/l)	389	1000

Notes:

1. Dry Weather Flow (DWF) is 150 litres/person/day from the Irish Water "Code of Practice for Wastewater Infrastructure".
2. Occupancy ratio of 2.7 persons per dwelling from Irish Water Code of Practice for Wastewater Infrastructure.
3. The unit consumption allowance is 10% in accordance with the Irish Water "Code of Practice for Wastewater Infrastructure".
4. The Peak Flow factor is taken as 6 times Dry Weather Flow (0 to 750 population), 4.5 DWF for 751 to 1000 and 3.0 DWF for 1001 to 5000
5. The peak discharge is equal to the Total Wastewater Discharge multiplied by the peak flow factor, expressed in litres/second.
6. The average concentrations of wastewater parameters taken from EPA "Wastewater Treatment Manuals, Treatment Systems for Small Communities, Business, Leisure Centres and Hotels".
7. Assumed Maximum concentration is equal to the average concentration plus 2 times the standard deviation (for the 95%ile) taken from EPA "Wastewater Treatment Manuals, Treatment Systems for Small Communities, Business, Leisure Centres and Hotels".

Appendix C

Permeable Paving Calculations

TITLE		Job Reference	
Residential Development at Roebuck		210013	
SUBJECT		**Calc. Sheet No.**	
Permeable Paving Design		1	
DRAWING NUMBER	**Calculations by**	**Checked by**	**Date**
210013-DBFL-CS-SP-DR-C-1000	RSP	LMCL	22.04.21

FLAT SITES

INPUT DATA

Pavement Area (A)	168.0	m^2
Pavement Perimeter (P)	0.0	m
Sub-base Depth (d)	0.400	m
[1]Sub-base Voids Ratio (η)	0.30	
Sub-base Infiltration Rate per hour	1000	mm/hr
Sub-base Infiltration Rate (k)	0.278	mm/s
Subgrade Infiltration Rate per hour	5.0	mm/hr
Subgrade Infiltration Rate (f)	0.001	mm/s

VOLUME (STORAGE AND TREATMENT)

Permeable Paving Storage Volume per m^2	0.120	m^3/m^2
Total Permeable Paving Treatment Volume	**20.2**	m^3

INFILTRATION / INTERCEPTION VOLUME

Approx. Permeable Paving Infiltration per m^2	0.001	$l/s/m^2$
[2]Total Permeable Paving Infiltration Rate	0.233	l/s
[3]Additional Reservoir Storage below Outlet Invert	0.005	m
[4]Total Permeable Paving Interception Volume	**9.6**	m^3

FLOW

Average Distance between Outlet Drains	6.0	m
Flow Velocity through Permeable Paving	0.000038	m/s
Trench Retention Time	44.2	hr

TITLE	Job Reference
Residential Development at Roebuck	210013
SUBJECT	**Calc. Sheet No.**
Permeable Paving Design	1

DRAWING NUMBER	Calculations by	Checked by	Date
210013-DBFL-CS-SP-DR-C-1000	RSP	LMCL	22.04.21

Notes:

1 Sub-base material has a void ratio of approximately 30%, source 'BRE Digest 365'.

2 Wetted perimeter assuming 50% of trench depth, source 'BRE Digest 365'.

3 Volume of reservoir for total permeable paving area infiltrates to ground over 18 hours

4 Volume calculated using 6 hour storm event.

5 For Paving on slopes includes infiltration, provide 500mmx500mm trenches at 10m centres along slope with 1000mmx500mm at base of slope. source 'Formpave - Aquaflow Permeable Paving System'.

Table: 1

Material	void Ratio, η
Clean stone	0.40 - 0.50
Uniform gravel	0.30 - 0.40
Graded sand or gravel	0.20 - 0.30
Source: The SUDS manual, Published by CIRIA.	

Table: 2

Pavement Type	Effective Depth (m)
Car-Parking	0.40
Footpath	0.20
Effective Depths are provided from source 'Formpave - Aquaflow Permeable Paving System' and may subject to change as per site requirement.	

Total Permeable Paving Outflow:

$= A \cdot k \cdot i$

where:

A = Cross Sectional Area of Subbase
k = Subbase Infiltration Rate
i = Hydraulic Gradient

Hydraulic gradient has been assumed as the pavement gradient with an additional 250mm fall per 100m length.

Table: 3

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1
Cutoff point for most infiltration drainage systems = 0.001 mm/hr Source: Microdrainage	

Total Trench Infiltration:

$= 1/2 \cdot D \cdot L \cdot f$

where:

L = Length
D = Depth to Invert
f = Subgrade infiltration rate

Appendix D

Filter Drain Calculations

TITLE		Job Reference	
Residential Development at Roebuck		210013	
SUBJECT		**Calc. Sheet No.**	
FILTER TRENCH DESIGN		1	
DRAWING NUMBER	**Calculations by**	**Checked by**	**Date**
210013-DBFL-CS-SP-DR-C-1000	RSP	LMCL	30.04.21

INPUT DATA

Pipe Diameter (∅)	0.150	m
Average Width (W)	0.600	m
Average Depth to Invert (D)	0.600	m
Length (L)	26.5	m
Slope (S)	150	1 in ….
[1]Trench Backfill Voids Ratio (η)	0.30	
Trench Backfill Infiltration Rate per hour	3600.0	mm/hr
Trench Backfill Infiltration Rate (k)	1.000	mm/s
Subgrade Infiltration Rate per hour	10.0	mm/hr
Subgrade Infiltration Rate (f)	0.003	mm/s

VOLUME (STORAGE AND TREATMENT)

Filter Trench Storage Volume per metre	0.123	m^3/m	
Total Filter Trench Storage Volume (V)	3.3	m^3	Provided Treatment Volume

INFILTRATION/ INTERCEPTION VOLUME

[2]Filter Trench Infiltration per metre	0.002	l/s/m
Total Filter Trench Infiltration Rate (I)	**0.044**	l/s/m
[3]Total Filter Trench Infiltration Volume	1.0	m^3

FLOW

Filter Trench Cross-Sectional Area (A)	0.24	m^2
Total Filter Trench Flow (Q)	**14.434**	l/s
Trench Retention Time	**0.1**	hr

Notes:

1 Trench backfill material has a void ratio of approximately 30%, source 'BRE Digest 365'.

2 Wetted perimeter assuming 50% of trench depth, source 'BRE Digest 365'.

3 Volume calculated using 6 hour storm event.

Table: 1

Material	void Ratio, η
Clean stone	0.40 - 050
Uniform gravel	0.30 - 0.40
Graded sand or gravel	0.20 - 0.30

Total Trench Flow:

$= A \cdot k \cdot i + \text{Pipe Flow}$

where:

A = Cross Sectional Area of Backfill

k = Trench Backfill Infiltration Rate

i = Hydraulic Gradient

Hydraulic gradient has been assumed as the trench gradient with an additional 250mm fall per 100m length.

Pipe Flow calculated using Colebrook White Eqn.

Table: 2

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1
Cutoff point for most infiltration drainage systems = 0.001 mm/hr	
Source: Microdrainage	

Total Trench Infiltration:

$= 1/2 \cdot D \cdot L \cdot f$

where:

L = Length

D = Depth to Invert

f = Subgrade infiltration rate

Appendix E

SUDs Summary

TITLE		**Job Reference**	
Residential Development at Roebuck		210013	
SUBJECT		**Calc. Sheet No.**	
Interception/Treatment Volume Summary		1	
DRAWING NUMBER	**Calculations by**	**Checked by**	**Date**
210013-DBFL-CS-SP-DR-C-1000	RSP	LMCL	22.04.21

INPUT DATA

Interception Volume Required	1.5	m^3
Treatment Volume Required	4.6	m^3

Catchment	**Interception Volumes**		**Treatment Volumes**	
Swales	0.0	m^3	0.0	m^3
Bio-Retention	0.0	m^3	0.0	m^3
Permeable Paving	9.6	m^3	20.2	m^3
Filter Drain	1.0	m^3	3.3	m^3
Catchpit Manholes	0.0	m^3	0.0	m^3
Bio Pond	0.0	m^3	0.0	m^3
Stormtech Isolator Row	0.0	m^3	0.0	m^3
Total Volumes Provided	10.6	m^3	23.5	m^3
Check Provided Volumes are greater than Required Volumes	PASS		PASS	

Appendix F

Permissible Site Discharge Calculations

PROJECT			JOB REF.
Residential Development at Roebuck			210013
SUBJECT			**Calc. Sheet No.**
Surface Water Calculations - Permissible Site Discharge			1
Drawing ref.	**Calculations by**	**Checked by**	**Date**
210013-info1	RSP	LMCL	22.04.21

PERMISSIBLE SURFACE WATER DISCHARGE CALCULATIONS

Site Area

What is the overall site area? **0.07** Hectares (ha) Site is Less than 50 Hectares

Pre-Development Catchment Soil Characteristics

Are there different soil types present on the pre-developed site? No

Catchment This refers to the entire site area	1	
Area	0.07	Hectares (ha)
Drainage Group	1	Class
Depth to Impermeable Layers	2	Class
Permeability Group above Impermeable Layers	2	Class
Slope (o)	1	Class
SOIL Type	**3**	From FSR Table
[1]**SOIL Index**	0.40	

SOIL	SOIL Value	SPR
1	0.15	0.10
2	0.30	0.30
3	0.40	0.37
4	0.45	0.47
5	0.50	0.53

Site SOIL Index Value **0.40**

Site SPR Value **0.37**

Post-Development Catchment Characteristics

Is the development divided into sub-catchments? No

What is the overall site area for catchment? 0.07 Hectares (ha)

Catchment 1	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)	0	1.00	0.0
Roofs - Type 2 (Draining to SUDS features)	155	0.75	116.3
Green Roofs	0	0.50	0.0
Roads and Footpaths - Type 1 (Draining to gullies)	0	0.95	0.0
Roads and Footpaths - Type 2 (Draining to Suds features)	0	0.70	0.0
Paved Areas	63	0.80	50.4
Permeable Paving	169	0.70	118.0
Bioretention Areas	0	0.95	0.0
Grassed Areas	19	0.37	6.8
Public Open Space	262	0.37	97.0

Include Public Open Space in Effective Catchment Area? No Assumed open space area does not drain to surface water network

Effective Catchment Area **291.4** m^2

Effective Catchment Runoff Coefficient **0.72**

Long-Term Storage

Is long-term Storage provided? No

Permissible Site Discharge

What is the Standard Average Annual Rainfall (SAAR)? 772.0 mm From Met Eireann, Co-ordinates 320000, 254000

Is the overall site area less than 50 hectares? Yes

[5]$QBAR_{Rural}$ calculated for 50 ha and linearly interpolated for area of site 0.3 Litres/sec

[7]Site Discharge = **2.0** Litres/sec

Notes and Formulae

1. SOIL index value calculated from Flood Studies Report - The Classification of Soils from Winter Rainfall Acceptance Rate (Table 4.5).
2. SPR value calculated from GDSDS - Table 6.7.
3. Rainfall depth for 100 year return period, 6 hour duration with additional 10% for climate change.
4. Long-term storage Vol_{xs} (m^3) = Rainfall.Area.10.[(PIMP/100)(0.8.α)+(1-PIMP/100)(β.SPR)-SPR]. (GDSDS Section 6.7.3).
   Where long-term storage cannot be provided on-site due to ground conditions, Total Permissible Outflow is to be kept to $QBAR_{(Rural)}$.
5. Total Permissible Outflow - $QBAR_{(Rural)}$ calculated in accordance with GDSDS - Regional Drainage Policies
   (Volume 2 - Chapter 6), i.e. $QBAR(m3/s)=0.00108x(Area)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$ - For catchments greater than 50 hectares in area. Flow rates are linearly interpolated for areas samller than 50hectares.
6. Where Total Permissible Outflow is less than 2.0l/s and not achievable, use 2.0 l/s or closest value possible.
7. QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year and 2.6 for 100 year return period events, from GDSDS Figure C2.

Appendix G

Surface Water Attenuation Calculations

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

Half Drain Time : 24 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	31.523	0.103	0.0	1.9	3.0	O K
30 min Summer	31.538	0.118	0.0	2.0	3.8	O K
60 min Summer	31.541	0.121	0.0	2.0	4.0	O K
120 min Summer	31.532	0.112	0.0	2.0	3.5	O K
180 min Summer	31.519	0.099	0.0	1.9	2.9	O K
240 min Summer	31.507	0.087	0.0	1.9	2.3	O K
360 min Summer	31.484	0.064	0.0	1.9	1.2	O K
480 min Summer	31.462	0.042	0.0	1.9	0.5	O K
600 min Summer	31.442	0.022	0.0	1.8	0.1	O K
720 min Summer	31.420	0.000	0.0	1.8	0.0	O K
960 min Summer	31.420	0.000	0.0	1.4	0.0	O K
1440 min Summer	31.420	0.000	0.0	1.1	0.0	O K
2160 min Summer	31.420	0.000	0.0	0.8	0.0	O K
2880 min Summer	31.420	0.000	0.0	0.7	0.0	O K
4320 min Summer	31.420	0.000	0.0	0.5	0.0	O K
5760 min Summer	31.420	0.000	0.0	0.4	0.0	O K
7200 min Summer	31.420	0.000	0.0	0.3	0.0	O K
8640 min Summer	31.420	0.000	0.0	0.3	0.0	O K
10080 min Summer	31.420	0.000	0.0	0.3	0.0	O K
15 min Winter	31.533	0.113	0.0	2.0	3.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	94.152	0.0	4.2	20
30 min Summer	64.672	0.0	6.2	29
60 min Summer	41.735	0.0	8.3	46
120 min Summer	26.258	0.0	10.5	82
180 min Summer	19.869	0.0	12.0	114
240 min Summer	16.266	0.0	13.2	146
360 min Summer	12.240	0.0	15.0	204
480 min Summer	9.992	0.0	16.3	260
600 min Summer	8.532	0.0	17.5	316
720 min Summer	7.497	0.0	18.5	0
960 min Summer	6.112	0.0	20.1	0
1440 min Summer	4.582	0.0	22.6	0
2160 min Summer	3.430	0.0	25.3	0
2880 min Summer	2.791	0.0	27.3	0
4320 min Summer	2.084	0.0	30.3	0
5760 min Summer	1.693	0.0	32.5	0
7200 min Summer	1.440	0.0	34.2	0
8640 min Summer	1.262	0.0	35.7	0
10080 min Summer	1.129	0.0	36.9	0
15 min Winter	94.152	0.0	4.9	20

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	31.551	0.131	0.0	2.0	4.5	O K
60 min Winter	31.554	0.134	0.0	2.0	4.6	O K
120 min Winter	31.536	0.116	0.0	2.0	3.7	O K
180 min Winter	31.515	0.095	0.0	1.9	2.7	O K
240 min Winter	31.496	0.076	0.0	1.9	1.7	O K
360 min Winter	31.455	0.035	0.0	1.9	0.4	O K
480 min Winter	31.420	0.000	0.0	1.7	0.0	O K
600 min Winter	31.420	0.000	0.0	1.5	0.0	O K
720 min Winter	31.420	0.000	0.0	1.3	0.0	O K
960 min Winter	31.420	0.000	0.0	1.0	0.0	O K
1440 min Winter	31.420	0.000	0.0	0.8	0.0	O K
2160 min Winter	31.420	0.000	0.0	0.6	0.0	O K
2880 min Winter	31.420	0.000	0.0	0.5	0.0	O K
4320 min Winter	31.420	0.000	0.0	0.4	0.0	O K
5760 min Winter	31.420	0.000	0.0	0.3	0.0	O K
7200 min Winter	31.420	0.000	0.0	0.2	0.0	O K
8640 min Winter	31.420	0.000	0.0	0.2	0.0	O K
10080 min Winter	31.420	0.000	0.0	0.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	64.672	0.0	7.0	32
60 min Winter	41.735	0.0	9.2	50
120 min Winter	26.258	0.0	11.8	88
180 min Winter	19.869	0.0	13.6	122
240 min Winter	16.266	0.0	14.9	152
360 min Winter	12.240	0.0	16.9	206
480 min Winter	9.992	0.0	18.5	0
600 min Winter	8.532	0.0	19.7	0
720 min Winter	7.497	0.0	20.8	0
960 min Winter	6.112	0.0	22.6	0
1440 min Winter	4.582	0.0	25.4	0
2160 min Winter	3.430	0.0	28.5	0
2880 min Winter	2.791	0.0	30.8	0
4320 min Winter	2.084	0.0	34.2	0
5760 min Winter	1.693	0.0	36.7	0
7200 min Winter	1.440	0.0	38.8	0
8640 min Winter	1.262	0.0	40.5	0
10080 min Winter	1.129	0.0	41.9	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	17.800	Shortest Storm (mins)	15
Ratio R	0.278	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.029

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.000	4	8	0.029

Model Details

Storage is Online Cover Level (m) 31.870

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	16.8
Max Percolation (l/s)	46.7	Slope (1:X)	200.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	31.420	Membrane Depth (m)	0

Hydro-Brake® Optimum Outflow Control

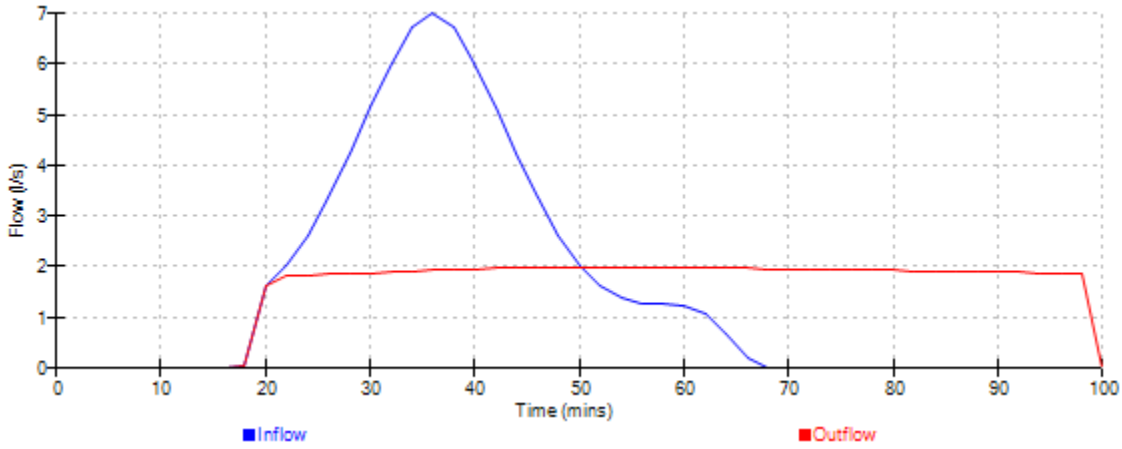
Unit Reference	MD-SHE-0071-2000-0750-2000
Design Head (m)	0.750
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	71
Invert Level (m)	30.820
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

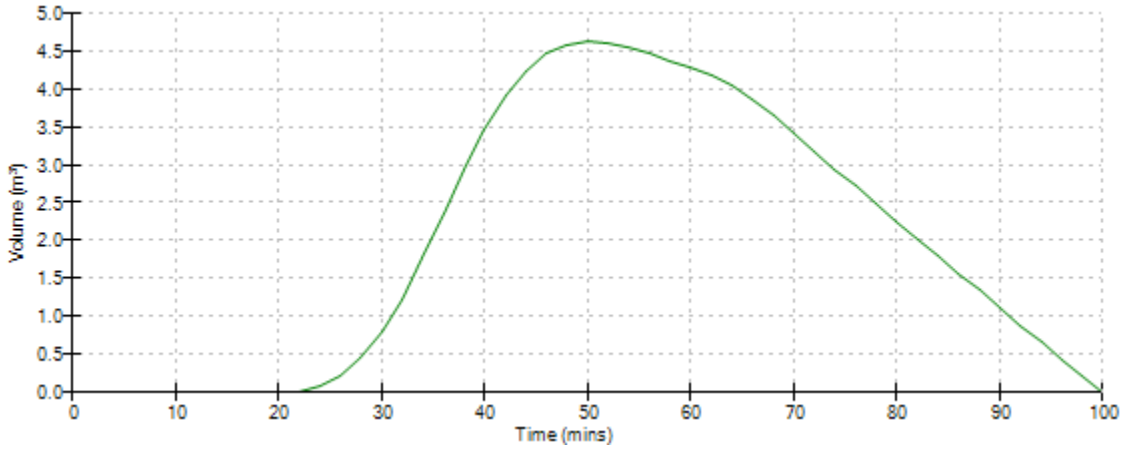
Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.750	2.0
Flush-Flo™	0.225	2.0
Kick-Flo®	0.480	1.6
Mean Flow over Head Range	-	1.7

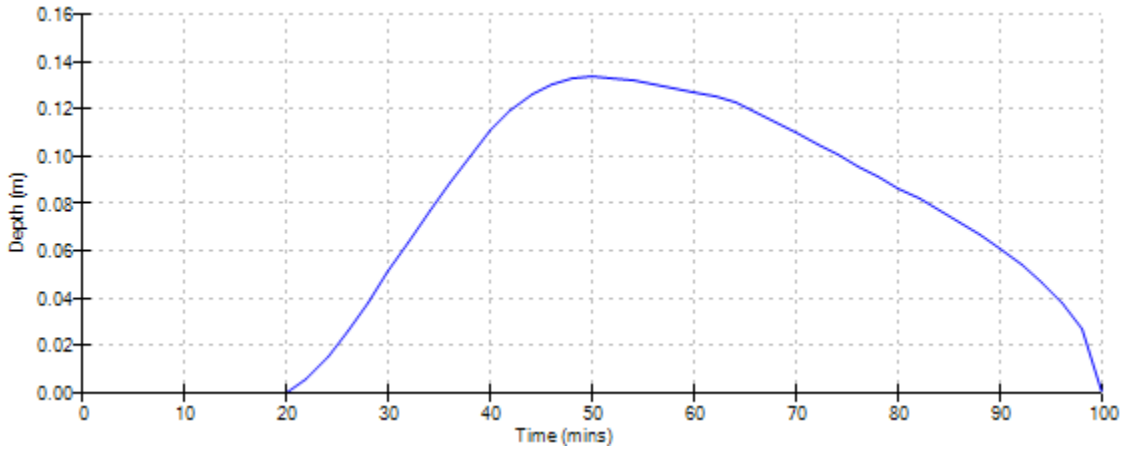
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.8	1.200	2.5	3.000	3.8	7.000	5.6
0.200	2.0	1.400	2.7	3.500	4.1	7.500	5.8
0.300	2.0	1.600	2.8	4.000	4.3	8.000	6.0
0.400	1.9	1.800	3.0	4.500	4.6	8.500	6.2
0.500	1.7	2.000	3.1	5.000	4.8	9.000	6.4
0.600	1.8	2.200	3.3	5.500	5.0	9.500	6.5
0.800	2.1	2.400	3.4	6.000	5.2		
1.000	2.3	2.600	3.5	6.500	5.4		

Event: 60 min Winter







Appendix H

Interception Volume Requirements

PROJECT			JOB REF.
Residential Development at Roebuck			210013
SUBJECT			**Calc. Sheet No.**
Surface Water Calculations - Interception Volume			3
Drawing ref.	**Calculations by**	**Checked by**	**Date**
210013-info1	RSP	LMCL	22.04.21

SURFACE WATER CALCULATIONS

Site Area

Total Site Area =	0.07	Hectares (ha)

Interception Volume (Post-Development)

Impermeable Area =	0.04	Hectares (ha)
Rainfall Depth =	5	mm
[1]**Interception Volume =**	1.5	m^3

Notes

1. Interception Volume (m^3) = Impermeable Area (ha) x 5mm x 10 (GDSDS Section 6.3.1.2.1). For sites where a pond is applicable.

80% runoff from impermeable areas assumed.

Appendix I

Treatment Volume Requirements

PROJECT			JOB REF.
Residential Development at Roebuck			210013
SUBJECT			**Calc. Sheet No.**
Surface Water Calculations - Treatment Volume			2
Drawing ref.	**Calculations by**	**Checked by**	**Date**
210013-info1	RSP	LMCL	22.04.21

SURFACE WATER CALCULATIONS

Site Area

Total Site Area =	0.07	Hectares (ha)

Pond Treatment Volume (Post-Development)

Impermeable Area =	0.039	Hectares (ha)
Rainfall Depth =	15	mm
[1]Treatment Volume (Vt) =	4.6	m^3

Notes

1. Treatment Volume Vt (m^3) = Impermeable Area (ha) x 15mm x 10 (GDSDS Section 6.3.1.2.1). For sites where a pond is applicable.

80% runoff from impermeable areas assumed.

Appendix J

Water Demand Calculations

TITLE		Job Reference
Proposed Residential Development at Roebuck		210013
SUBJECT		**Calc. Sheet No.**
Water Demand for Irish Water - Residential		1
DRAWING NUMBER	**Calculations by**	**Checked by**	**Date**
210013-DBFL-CS-SP-D	RSP	LMCL	22.04.21

DEMAND

Housing Units	4	no.
Daily Demand per person[1]	150	litres/person/day
Average Occupancy Ratio[2]	2.7	person/unit
Total Site Occupancy	11	people
Average Daily Demand	1,620	l/day
Average Day in Peak Week[3]	2,025	l/day
Normal Length of Day[4]	24	hours
Peak Factor[5]	5.0	

Post Development Peak Water Demand[6]	**0.117**	l/s
Post Development Average Water Demand	**0.019**	l/s
Normal Demand[7]	**0.019**	l/s

Notes:

1. Daily demand per person is 150 litres/person/day from the Irish Water Code of Practice for Wastewater Infrastructure.
2. Occupancy ratio of 2.7 persons per dwelling from Irish Water Pre-Connection Enquiry Form (PCEF Rev 2).
3. Average Day in Peak Week is 1.25 times the average daily demand.
4. Assumed normal demand is the total daily demand during the normal length of day.
5. Peak Factor for pipe sizing from Irish Water Code of Practice for Wastewater Infrastructure .
6. Peak Factor multiplied by Average Day in Peak Week flow.
7. Normal demand is the total daily demand during the normal length of day.
8. Fire flow is required at 25l/s as per B.S. 5306-1:1976.