Engineering Assessment Report

Barrington Tower SHD, Brennanstown Road, Dublin 18.

April 2022

Waterman Moylan Consulting Engineers Limited
Block S, EastPoint Business Park, Alfie Byrne Road, Dublin 3
www.watermangroup.com

Waterman Moylan
Engineering Consultants

Client Name: Cairn Homes Properties Ltd.
Document Reference: 20-040r.004
Project Number: 20-040

Quality Assurance – Approval Status

This document has been prepared and checked in accordance with
Waterman Group's IMS (BS EN ISO 9001: 2015, BS EN ISO 14001: 2015)

Issue	Date	Prepared by	Checked by	Approved by
No. 1	Apr '22	L.Ruiz	I.Worrell	E.Caulwell

Comments

Disclaimer

This report has been prepared by Waterman Moylan, with all reasonable skill, care and diligence within the terms of the Contract with the Client, incorporation of our General Terms and Condition of Business and taking account of the resources devoted to us by agreement with the Client.

We disclaim any responsibility to the Client and others in respect of any matters outside the scope of the above.

This report is confidential to the Client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at its own risk.

Content

List of Figures

List of Tables

Appendices

1. Introduction

Waterman Moylan have been appointed by Cairn Homes Properties Ltd. to provide Engineering services on the Strategic Housing Development at Brennanstown Road, Co. Dublin. This report has been prepared as part of a planning submission to An Bord Pleanála for the proposed SHD development of 534 No. residential apartments on the south side of Brennanstown Road (Barrington Tower). It is also proposed to build 1 No. creche and 1 No. 318 sqm (exclu. Bin Storage) retail facility along with resident support facilities/resident services and amenities.

This report describes the criteria used to design the storm water discharge, disposal of foul water, water supply and vehicular access to the developed site.

2. Site Description

2.1 Site Location

The site is in Cabinteely, Dublin 18. It is bounded to the north by Brennanstown Road, to the south by Carrickmines Stream and the Brennanstown Luas stop (not yet open) and to the west by Brennanstown Vale. The proposed development is approximately 4.85 km from Dún Laoghaire Harbour, 1km (c.13-minute walk) east of the Carrickmines Luas station and 3.24 km west from the coastline. Refer to Figure 2-1 for the location of the proposed development.

Figure 2-1. Site Location Map (Google Images)

2.2 Existing Development

The total site area is approximately 3.81 hectares. There are two existing houses on the site which will be demolished as part of the development and Barrington Tower which will be retained. The remainder of the site is currently greenfield. The site falls from northwest to southeast with the highest ground level of 80.00m OD Malin and the lowest ground level of 63.00m OD Malin.

There are two no. existing vehicular accesses to the site. A large vehicular access with two gates to the east of the site boundary and a smaller vehicular access to the west.

2.3 Proposed Development

The proposed 'Build-to-Rent' (BTR) development will consist of the construction of 8 no. blocks in heights up to 10 storeys comprising 534 residential units, a creche, a retail unit, residential support facilities and residential services and amenities. The proposal also includes car and cycle parking, public and communal open spaces, landscaping, bin stores, plant areas, substations, switch rooms, and all associated site development works and services provision. A full description of the development is provided in the statutory notes and in Chapter 3 of the EIAR submitted with this application.

3. Foul Water Drainage

3.1 Receiving Environment

There is an existing 225 mm Ø foul sewer to the south of the site running to the north of the Luas line. This foul water pipe discharges to the 900mm Ø combined trunk sewer approximately 120m to the east of site. See Appendix A for Irish Water Record Maps.

A Pre-Connection Enquiry form was submitted to Irish Water on January 2022 which outlined the proposals for the drainage of wastewater from the development. Irish Water responded with the Confirmation of Feasibility (COF) on 4th February 2022, with reference no. CDS2000317, stating that an upgrade of the existing 225mmØ and 300mmØ gravity sewer (from the development connection point up to the 900mm trunk sewer) may be required. Any upgrade works will be confirmed following future surveys by Irish Water to be undertaken to establish the integrity and capacity of the existing foul sewer line. Please refer to Appendix B for the Irish Water Confirmation of Feasibility.

It is proposed to drain the site to this existing 900mm trunk sewer network at the southern corner of the subject lands in accordance with Irish Water's requirements.

A Statement of Design Acceptance for the proposed drainage design has been received from Irish Water in March 2022 and is included in Appendix C.

3.2 Proposed Foul Water Drainage

The proposed development will consist of 534 residential apartments 1 No. Creche and 1 No. 318 sqm (exclu. Bin Storage) retail facility. Based on Irish Waters Code of Practice, the calculation of the peak foul flow from the proposed development can be seen in Tables 3.1 and 3.2 below.

Table 3-1 Calculation of Proposed Foul Water Flow

Description	No. of Units	Flow l/h/day	Population per Unit	Infiltration Factor	Total Discharge
Residential Units	534	150	2.7	1.1	237,897
Creche	1	50	119	1.1	6,545
Retail	1	45	10	1.1	495
				Totals	**244,937 l/d**

Table 3-2 Calculation of Proposed Peak Foul Flow

Calculation of Proposed Peak Foul Flow		Units
Dry Weather Flow Residential (DWF)	2.753	l/s
Dry Weather Flow Commercial (DWF)	0.081	l/s
Peak Foul Flow Residential (=6 x DWF)	16.518	l/s
Peak Foul Flow Commercial (=4.5 x DWF)	0.365	l/s
Total Peak Foul Flow	***16.88***	***l/s***

Waterman Moylan Drawing's *BRR-WM-ZZ-00-DR-C-P200 Proposed Drainage Layout* illustrates the proposed layout for the foul water sewer outfall for the subject site.

3.3 Network Design

Foul Water Drains will be uPVC to Irish Water specification or concrete socket and spigot pipes (to IS 6).

Drains will be laid to comply with the Building Regulations 2010, and in accordance with the recommendations contained in the Technical Guidance Documents, Section H.

Foul water sewers will consist of uPVC or concrete socket and spigot pipes (to IS 6) and will be laid strictly in accordance with Irish Waters code of practice for Wastewater Infrastructure and Irish Water requirements for taking in charge.

All manholes will be constructed in block work, precast or cast in-situ concrete. Construction details for the proposed drainage systems are included in the accompanying planning submission drawing.

4. Surface Water Drainage

4.1 Introduction

The following section deals with surface water drainage design including details of the SuDS measures proposed as part of the development.

The Surface Water Drainage design and SUDS Assessment carried out in the following sections has been undertaken in compliance with the requirements of the DLRCC County Development Plan 2022-2028, the guidelines set by the Greater Dublin Strategic Drainage Study (GDSDS) and CIRIA documents.

As part of the Stage 2 Pre-Planning response from ABP, the DLRCC Drainage Department issued a list of items to be taken into account for the Surface Water Drainage design to be in compliance with the County policy. All of the items have been agreed with Johanne Codd and John Cunniffee of DLRCC prior to the final submission to ABP and are addressed within this report and the Flood Risk Assessment Report which is submitted with this application under separate cover.

4.2 Receiving Environment

The existing site drains surface water, unrestricted, to the Carrickmines Stream to the south of the site. It is proposed that the development will attenuate the surface water on-site before discharging at the existing greenfield rate into the Carrickmines Stream.

The existing run-off rate for the existing hardstanding areas on site was estimated for the 1 in 1, 1 in 30 and 1 in 100 year return periods using the modified rational method:

Q = 2.78 x A x i (where A is the total pre-development area being drained in Hectares and I is the rainfall intensity in mm/h as estimated for the 60min storm from Flow using Met Eireann Data)

A = 0.057 ha (current hardstanding as measured from topographical survey)

i – 1 year return period = 11.362 mm/h

30 year return period = 24.804 mm/h

100 year return period = 38.681 mm/h

The greenfield run-off rates for the greenfield area of the site have been calculated in accordance with the Institute of Hydrology report No 124 "Flood Estimation for Small Catchments", using the UK SUDS Website for the remaining area of the site which is currently a greenfield and equates to 3.753ha. The greenfield runoff rates for the 1 in 1 year, 1 in 30 years and 1 in 100 years can be seen in Appendix D.

Table 4-1 Existing Run-off Rates from site

Rainfall Event	Existing development run-off (l/sec) – Hardstanding Areas	Existing development run-off (l/sec) – Greenfield Areas	Total Existing development run-off (l/sec)
Q1	2.78 x 0.057 x 11.362 = 3.88	12.17	16.05
Q30	2.78 x 0.057 x 24.804 = 3.93	30.49	34.42
Q100	2.78 x 0.057 x 38.681 = 6.13	37.37	43.50

4.3 Site Characteristics

The Carrickmines Stream flows from west to east adjacent to the southern boundary of the proposed development and then discharges into Loughlinstown River to the southeast of the site and ultimately to the Irish Sea at Killiney Bay. The site, which is predominant greenfield, forms part of the Carrickmines Stream Catchment area. It is proposed that the development will discharge surface water runoff at a rate (equivalent of the existing agricultural runoff) into the Carrickmines Stream.

The following parameters have been used to determine the greenfield run-off rate of the proposed hardstanding area on site. The results can been seen in Appendix E.

Table 4-2 Surface Water Catchment Details

	Catchment
Hardstanding Area - Ha	2.3
SAAR – mm*1	892
SOIL Index*2	0.37
Climate Change	30%

*1 – From Met Éireann data.

*2 – The Soil type of Ireland Map indicates Soil Type 1 however the 2 No Site investigations carried out on site would suggest this is not correct for this particular site with soil conditions being an overburden, generally made of made ground or cobbles and boulders and granite bedrock at a depth between 0.2m and 10.10 m below ground level. These soil conditions are expected for Soil Type 3 and therefore 0.37 is used as the Soil Index for this site. In addition, there is a natural average slope of c. 1:22 across the site which will increase the existing rate of run-off from site, even in a greenfield state. The 2 No. Site Investigations are submitted under a separate cover with this application.

4.4 Greenfield run-off rates

The Local Authority requirements are that post-development run-off rates are limited to greenfield run-off rates for the site. The greenfield run-off rates for the site have been calculated in accordance with the Institute of Hydrology report No 124 “Flood Estimation for Small Catchments”, using the UK SUDS Website. The Greenfield run-off for the site is 8.77 l/s (Qbar) based on a total hardstanding of 2.3 ha. Refer to Appendix E for the Greenfield runoff rate report.

It is proposed to limit the discharge from the subject site to the Greenfield run-off rate of 8.8l/s.

4.5 SuDS Assessment

As per Dun Laoghaire County Council guidelines surface water should be managed in accordance with the Greater Dublin Strategic Drainage Study (GDSDS) Regional Drainage Policies Volume 6, for New Developments and CIRIA documents. These documents specify that surface water run-off should be managed as close to its source as possible, with the re-use of rainwater within the buildings prioritised.

Sustainable Urban Drainage Systems (SUDS) have been developed and are in use to alleviate the detrimental effects of traditional urban storm water drainage practice that typically consisted of piping run-off of rainfall from developments to the nearest receiving watercourse. Surface water drainage methods that take account of quantity, quality and amenity issues are collectively referred to as SUDS. They are typically made up of one or more structures, built to manage surface water run-off. The use of SUDS to control run-off also provides the additional benefit of reducing pollutants in the surface water by settling out suspended solids, and in some cases providing biological treatment.

A stormwater management or treatment train approach ensures that run-off quantity and quality is improved. The following objectives of the treatment train provide an integrated and balanced approach to help mitigate the changes in stormwater run-off flows that occur as land is urbanised and to help mitigate the impacts of stormwater quality on receiving systems:

1) **Source control:** conveyance and infiltration of run-off; and
2) **Site Control:** reduction in volume and rate of surface run-off, with some additional treatment provided.

Table 4-3 SuDs Measures

SUDS Stage	SUDS Measure	Measure Outline	Use on Site
Source Control	Permeable Pavements	Permeable pavements are alternative paving surfaces to standard finishes that allow stormwater run-off to filter through voids in the pavement surface into an underlying stone reservoir, where it is temporarily stored and/or infiltrated.	Permeable paving will be utilised for the surface level carparking area to provide treatment and storage to rainwater falling on these areas. Soakaways test carried out in August 2020 found that the subsoil is not suitable for the use of infiltration techniques as the 4 No. soakaways tests held water and therefore failed. The permeable paving will be wrapped with a permeable geotextile which will allow any surface water that can soakway into the ground to do so. Should the tank be 5.0m of a building or 1.0m (vertically) of groundwater, an impermeable geomembrane will be used. The primary use of the permeable paving sub-base will be used for attenuation purposes and interception. The design will include a perforated pipe to convey surface water to the site wide drainage system. Permeable paving will be provided for the footpaths within the site as indicated in drawing *BRR-WM-ZZ-*

			00-DR-C-P203 Proposed SUDS Drainage Layout.
	Swales	Swales are shallow, landscaped depressions designed to store and/or convey run-off and remove pollutants. They may be used as conveyance structures to pass the run-off to the next stage of the treatment train and can be designed to promote infiltration where soil and groundwater conditions allow.	Swales will be used for access road surface water treatment, where possible, to treat water at source before conveying it to a downstream attenuation tank.
	Green Roofs	As well as providing ecological benefits, green roofs contribute the following positive effects to surface water drainage design: • The retention of water, through storage in the growing medium and evapotranspiration from the roof's plants and substrate, reducing run-off volumes and the burden on the drainage network. • Due to the time for water to infiltrate and permeate the substrate, there is also a reduction in peak rates of run-off, helping to reduce the risk of flooding. • They improve water quality through the filtration of pollutants during the process of water infiltration. This provides treatment in line with CIRIA SuDS Manual management train.	The locations of the green roofs are illustrated on the accompanying Waterman Moylan SuDS Drawing BRR-WM-ZZ-00-DR-C-P203 Proposed SUDS Drainage Layout. Refer to section 4.6 of this report for further details on the Green Roof proposals for this development.
	Filter Drains	Filter Drains are shallow trenches filled with gravel and wrapped in a geotextile membrane to treat and temporarily store surface water run-off.	Filter Drains are provided for the footpath and podium level surface water treatment to treat surface water at source before conveying it to the site wide surface water drainage network.

SUDS Stage	SUDS Measure	Measure Outline	Use on Site
Site Control	Attenuation Tank and Hydrobreak	Attenuation tanks are used to create a below ground void space for the temporary storage of surface water before controlled release to the Carrickmines Stream. Hydrobreaks are used to restrict the outfall from the surface water drainage system to the equivalent of the existing agricultural run-off. This ensures the development will not give rise to flooding downstream of the site.	Due to the proposed development layout and topography it is proposed to provide below ground attenuation in 3 No. pluvial cube tanks located on landscape areas and 1 No. concrete tank below the basement slab to store surface water on site before discharging to the Carrickmines Stream via hydrobrakes. The pluvial cube tanks will be wrapped with a permeable geotextile which will allow any surface water that can soakway into the ground to do so. Should the tank be 5.0m of a building or 1.0m (vertically) of groundwater, an impermeable geomembrane will be used. Loading Calculations for the pluvial cube attenuation tanks are included in Appendix I.
	Permeable Paving with Attenuation Area Beneath	Attenuation areas are excavations filled with a void-forming material that allows the temporary storage of water before discharging it at a controlled rate to a drainage network. They can be grouped and linked together to drain large areas. Attenuation area provide stormwater attenuation and stormwater treatment.	It is proposed to use an stone filled attenuation area to the south of the site before discharging via a hydrobreak to the Carrickmines Stream. This stone filled area will collect water from a swale that would treat water upstream of the network and water will be infiltrated through permeable paving into the attenuation area.
	Petrol Interceptor	A petrol interceptor is a trap used to filter out hydrocarbon pollutants from rainwater run-off. It is typically used in road construction to prevent fuel contamination of water courses carrying away the run-off. Petrol interceptors work on the premise that some hydrocarbons such as petroleum and diesel float on	Petrol Interceptors will be installed, upstream of the proposed Attenuation tanks as a final treatment level before discharging to the attenuation tank.

		the top of water. The contaminated water enters the interceptor typically after flowing off roads and entering a drain before being deposited into the first tank inside the interceptor. The first tank builds up a layer of the hydrocarbon as well as other scum preventing it from entering the water course.	

4.6 Green Roof Policy

Green Roofs have been considered and incorporated into the development proposals in accordance with Appendix 7.2 of DLRCC County Development Plan 2022-2028. There are 5 No. Green Roof Policy standards, all of which have been considered for this planning application as follows:

Standard GR1-Applicable development types

Planning applications which include roof areas of greater than 300 square metres for the following development types must make provision for a green and/ or blue roof (which includes a green component) as part of the development proposals.

- *Apartment Developments*
- *Employment Developments*
- *Retail and Ancillary Shopping*
- *Leisure Developments*
- *Education Facilities*

The proposed development has 8 No. apartment blocks and therefore green roof must be incorporated into the design. The locations of the green roofs are illustrated on the accompanying Waterman Moylan drawing *BRR-WM-ZZ-00-DR-C-P203 Proposed SUDS Drainage Layout.*

Standard GR2 – Aerial Coverage

To maximise the provision for biodiversity, green roofs must meet the following coverage requirements for all applicable buildings within the application boundary, subject to a reasonable allowance being made for the provision of services at roof level.

Table 4-4 Minimum Green Roof Coverage (Appendix 7.2 DLRCC Development Plan 2022-2028)

Type of Green Roof	***Minimum Coverage (% of Total Roof Area being developed)***
Extensive	*70%*
Intensive	*50%*

As described in the DLRCC Green Roof Policy document, the are two main types of green roof:

- ***Extensive*** *green roofs are more lightweight when compared with intensive green roofs with a shallow soil layer and are not normally designed to provide access for people.*
- ***Intensive*** *green roofs have a deep layer of soil, which can support a range of plants, trees and shrubs. Native species (plants which would grow naturally in the local area) can provide a ricj habitat for wildlife. Intensive Green Roofs can be designed to include access for people.*

Extensive roofs are defined having a minimum substrate depths of 80mm and Intensive roofs are defined as having a substrate minimum depth of 200mm (Source; the GRO Green Roof Guide).

The proposed development will comprise a mix of Extensive and Intensive green roofs. The exact location for each type of green roofs will be fully designed at detail design stage. For the purpose of this application, 60% Green Roof will be provided of which a minimum of 50% will be intensive and the location of Green Roof is indicated on Waterman Moylan Drawing *BRR-WM-ZZ-00-DR-C-P203 Proposed SUDS Drainage Layout.*

Standard GR3 – Hydraulic Requirements

Where the green/blue roof provides attenuation and management of storm runoff the applicant should demonstrate

- *Compliance with the Greater Dublin Strategic Drainage Study 2005 (GDSDS) Criterion 1-4.*
- *Provision for climate change allowance and urban creep as appropriate.*
- *Provision for overflow and exceedance as part of the drainage design.*

It is not proposed to provide attenuation within the proposed Green Roofs. Although green roof space can reduce peak flow rates in the small storm events and aid in reducing the volume of run-off from the site, they operate as conventional roofs during higher storm events. Therefore, green roofs cannot be considered in the surface water drainage run-off calculations for the development. As stated in CIRIA C697 *"although green roofs absorb most of the rainfall that they receive during ordinary events, there is still the need to discharge excess water to the building's drainage system. This is because their hydraulic performance during extreme events tends to be fairly similar to standard roofs*."

Standard GR4 – Design in accordance with best practice Industry guidance

Designs for green and blue roofs should demonstrate that the designer has applied an abundance of caution as part of the design process and that designs are in adherence with current best practice design guidance.

The green roof will be designed at detail design stage by a green roof specialist designer with a good reputation within the industry. The developer will ensure that designs are in adherence with current best practice design guidance.

Standard GR5 – Design for access, operation and maintenance

Green and blue roof designs should be designed to ensure that any required maintenance or operation activities can be undertaken in a safe and cost-effective manner.

A Maintenance and Operation Manual will be provided by the green roof manufacturer to the Management company to ensure proper and safe operation of the Green Roofs. Refer to Table 5-3 below for the proposed green roof maintenance schedule.

Access to each of the green roofs is crucial not only for installation and ongoing maintenance but also for bringing up materials, soils and plants in a safe manner. Access to the green roof is provided from the Automatic Opening Vent (AOV) of the stair cores of the roof. A fixed ladder from the AOV's gives easy access for maintenance to the green roofs in all blocks. Specific access for each of the Green Roofs is shown in the accompanying architect's drawings.

4.7 Mitigation Measures

The Pollution Hazard Indices, shown in Table 4.5 below, for the different proposed land uses have been derived from Table 26.2 of CIRIA C753.

Table 4-5 Pollution Hazard Indices for Different Land Uses

	TSS	Metals	Hydro-carbons
Apartment roof	0.2	0.2	0.05
Residential road/car park/ Podium	0.5	0.4	0.4
Main access road	0.7	0.6	0.7

In order to ensure the proposed SUDS strategy will appropriately mitigate against the potential pollution derived from these areas the Pollution Mitigation Indices (PMI) in Table 26.3 and 26.15 of CIRIA C753 have been reviewed and laid out in Table 4.6 below;

Table 4-6 Indicative SuDs Mitigation Indices for Discharge to Surface Waters

	TSS (PMI)	Metals (PMI)	Hydro-carbons
Permeable Paving	0.7	0.6	0.7
Swale	0.5	0.6	0.6
Green Roof	0.8	0.7	0.9
Filter Strips	0.4	0.4	0.5

For each land use different mitigations have been applied. Below are shown the calculations for the total pollution prevention for each type of hard standing on site. The calculation has been made in line with CIRIA C753 as follows:

- The following formula has been used to calculate the total mitigation in line with CIRIA C753.

  Total SUDS Mitigation index = Mitigation Index $_1$ + 0.5(Mitigation Index $_2$) +0.5(Mitigation Index $_3$) *[1]*

- Total Mitigation index is then taking away from the pollution hazard indices for the land use in order to determine if sufficient treatment has been provided. A negative number indicates that enough treatment has been provided and a positive number indicated additional forms of treatment are required.

Total SUDS mitigation = Pollution Harzard $_{Table\ 4.5}$ – Total SUDS Mitigation Index $_{[1]}$ *[2]*

Below are shown the calculations for the total pollution prevention for each type of hard standing on site.

- **Apartment Roofs:** surface water from the apartment roofs will be treated by green roofs.

Table 4-7 SuDs Mitigation Indices for Apartment Roofs

SUDS Mitigation Indices			
	TSS	Metals	H-C
Green Roof	0.8	0.7	0.9
Total Index $_{[1]}$	0.8	0.7	0.9

Table 4-8 SuDs Mitigation for Apartment Roofs

SUDS Mitigation Indices			
	TSS	Metals	H-C
Pollution Hazard $_{Table\ 4.5}$	0.2	0.2	0.05
Total SUDS Mitigation $_{[2]}$	-0.6	-0.5	-0.85

- **Surface Car Park:** surface water from the carpark spaces will be treated through permeable pavement and subsequently by swales.

Table 4-9 SuDs Mitigation Indices for Surface Car Park

SUDS Mitigation Indices			
	TSS	Metals	H-C
Permeable Pavement	0.7	0.6	0.7
Swales (x0.5)	0.25	0.3	0.3
Total Index $_{[1]}$	0.95	0.9	1.0

Table 4-10 SuDs Mitigation for Surface Car Park

Total SUDS Mitigation			
	TSS	Metals	H-C
Pollution Hazard Table 4.5	0.5	0.4	0.4
Total SUDS Mitigation [2]	-0.45	-0.5	-0.6

- **Main Access Road:** water on main road will be mainly treated through permeable paving and swales.

Table 4-11 SuDs Mitigation Indices for Main Access Road

Total SUDS Mitigation			
	TSS	Metals	H-C
Permeable Pavement	0.7	0.6	0.7
Swales(x0.5)	0.25	0.3	0.3
Total Index [1]	0.95	0.9	1.0

Table 4-12 SuDs Mitigation for Main Access Road

Total SUDS Mitigation			
	TSS	Metals	H-C
Pollution Hazard Table 4.5	0.7	0.6	0.7
Total SUDS Mitigation [2]	-0.25	-0.3	-0.3
	Appropriate treatment is provided using a Class I Petrol Interceptor		

The sections of the main access road that do not discharge through a swale and/or permeable paving will receive appropriate treatment through the petrol interceptor on site.

- **Podium (residential/road carpark):** top level of podium composed by footpaths, cycle paths and public open space will be treated through filter strips before discharging into the attenuation tank at basement level.,

Table 4-13 SuDs Mitigation Indices for Podium

SUDS Mitigation Indices			
	TSS	Metals	H-C
Green podium	0.8	0.7	0.9
Total Index [1]	0.8	0.7	0.9

Table 4-14 SuDs Mitigation for Podium

Total SUDS Mitigation			
	TSS	Metals	H-C
Pollution Hazard Table 4.5	0.2	0.2	0.05
Total SUDS Mitigation [2]	-0.6	-0.5	-0.85

As described above all the hardstanding on site passes through adequate levels of treatment to remove the Total Suspended Solids, Metals and Hydrocarbons present before discharge to the watercourse. In conclusion the water quality from this catchment should be high.

4.8 Stormwater Calculations

The total impermeable area of the catchment including roads, car-parking and roofs, is approximately 23,200 m^2, and peak outflow will be limited to 8.8 l/s for the 1 in 100-year event. The 1 in 100 year critical design storm plus an additional 30% in line with the DLRCC Development Plan 2022-2028 for climate change has been used for storm water attenuation calculations. The proposed surface water drainage network can be seen on Waterman Moylan drawings *BRR-WM-ZZ-00-DR-C-P200 Proposed Drainage Layout.*

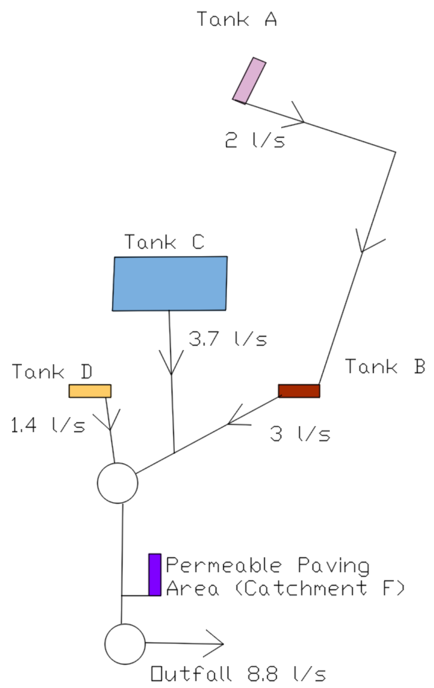
The drainage for the proposed development and attenuation systems have been sub-divided into five catchment areas with an attenuation tank for each catchment due to the proposed development layout and topography. The proposed catchments areas can be seen on Waterman Moylan drawing *BRR-WM-ZZ-00-DR-C-P206 Surface Water Catchment Areas.* The final discharge point is located to the south of the development.

Table 4.15 shows a summary of impermeable areas, volume provided, volume required and outflow rate for each catchment. Additionally, volume storage calculations can be found in Appendix F.

Table 4-15 Surface Water Summary

Catchment	Imp. Area (ha)	Critical Storm	Volume Required (m^3)	Volume Provided (m^3)	Outflow Rate (l/s)
A	0.32	720 min Winter	190.8	204	2
B	0.40	1440 min Winter	216.3	224	3
C	1.33	2160 min Winter	1,129.5	1,134	3.7
D	0.20	960 min Winter	140.7	156	1.4
F	0.05	15 min winter	1.33	4.5	N/A*1
Total	2.3	N/A	N/A	N/A	8.8

Figure 4-1 Tank Cascade Sketch



*1 – A final Hydrobrake manhole located prior to the headwall will control the outfall rate to 8.8 l/s as per the greenfield runoff for the site. This last hydrobrake will allow any surface water going through catchment F to be attenuated prior to discharging to the Carrickmines Stream.

Surcharged Outfall

An additional calculation has been carried out to show the behaviour of the surface water network having a surcharged outfall on the Carrickmines Stream during the 1 in 100 year storm plus an additional 30% for climate change. The results can be found in Appendix G. It has been assumed that the outfall is surcharged by 1.5m during a critical storm lasting 6 hours. The results show minimal flooding of 0.8 m^3 in SW MH33, which is the manhole prior to the outfall headwall. Given that the flooding volume is minimal and that there are no residential units adjacent to where the flooding occurs, it can be considered that the level of service to the development is maintained during a surcharged outfall event and the risk of flooding within the development remains low.

Urban Creep Factor

The new DLRCC Development Plan 2022-2028 states that all development must apply a 1.1 factor to the drainage design and attenuation volumes to accommodate urban creep. The proposed development is comprised of apartment blocks and therefore it will be fully managed by a Management Company. Residents will not be able to change hardstanding areas for the site and therefore there is no need to apply an urban creep factor for this development. This has been agreed with John Cunniffe from DLRCC and email can be found in Appendix H.

4.9 Interception Storage

Interception storage is defined in the SuDS Manual as *"the capture and retention on site of the first 5mm of the majority of rainfall events"*. In accordance with the table 24.6 of the SuDS Manual CIRIA C753 the following guidelines have been used in calculating the area of the site benefiting from interception storage;

Table 4-16 Interception Mechanisms (Table 24.6 The SuDs Manual)

Systems	Interception methods assumed compliant for zero runoff from the first 5mm of rainfall for 80% of events during the summer and 50% in winter.
Green Roofs	All surfaces that have green roofs
Permeable Paving	All permeable pavements, whether lined or not, can be assumed to comply, provided there is no extra area drained to the permeable pavement. Where the pavement also drains an adjacent impermeable area, compliance can be assumed for all soil types where the pavement is unlined, as long as the extra paved area is no greater than the permeable pavement area
Filter strips/Swales	Roads drained by filters strips/swales, where the longitudinal gradient of the vegetated area is less than 1:100, are suitable for Interception delivery for impermeable surface areas up to 5 times the base of the vegetated surface area receiving the runoff. Components steeper than 1 in 100 cannot be deemed to provide Interception unless additional effective Interception design can be demonstrated.

As described in Section 4.4 and 4.5 the proposed development will provide, green roofs, permeable paving, green podium, filter strips and swales. In order to calculate the percentage area of site benefiting from each form of interception storage the site areas are described in Table 4-17 below and demonstrated on Waterman Moylan drawing *BRR-WM-ZZ-00-DR-C-P203 Proposed SUDS Drainage Layout*;

Table 4-17 Interception Storage Provided

Within the basement carpark area, any rainwater entering the system as a result of snow melt or raindrops from cars will pass through a petrol interceptor providing treatment prior to discharging to the foul sewer network.

<table>
<tr><th>Area</th><th>Total Hard standing Area m2</th><th>Interception mechanism</th><th>Interception Area m2</th><th>green roof %</th><th>Percentage Benefiting %</th></tr>
<tr><td rowspan="3">Blocks AB-CD</td><td>1737.5</td><td>Green Roof</td><td>1120.7</td><td>64.5</td><td rowspan="3">63.5</td></tr>
<tr><td rowspan="2">1156.5</td><td>Permeable Paving</td><td>391.8</td><td rowspan="2">N/A</td></tr>
<tr><td>Filter Strips</td><td>325.5</td></tr>
<tr><td rowspan="2">Podium Level</td><td rowspan="2">6633.0</td><td></td><td></td><td rowspan="2">N/A</td><td rowspan="2">100.0</td></tr>
<tr><td>Green podium</td><td>6633.0</td></tr>
<tr><td rowspan="3">Roof Blocks E-J</td><td>4866.2</td><td>Green Roof</td><td>3338.5</td><td>68.6</td><td rowspan="3">56.4</td></tr>
<tr><td rowspan="2">2457.8</td><td>Filter Strips</td><td>168.3</td><td rowspan="2">N/A</td></tr>
<tr><td>Permeable paving</td><td>621.3</td></tr>
<tr><td rowspan="3">Main Road and Footpaths</td><td rowspan="3">6324.0</td><td>Swales</td><td>875.0</td><td rowspan="3">N/A</td><td rowspan="3">97.4</td></tr>
<tr><td>Filter strips</td><td>909.7</td></tr>
<tr><td>Permeable Paving</td><td>4375.2</td></tr>
<tr><td></td><td>23175.0</td><td></td><td>18758.9</td><td>67.5</td><td>80.9</td></tr>
</table>

5. SuDS Maintenance

For the SuDS strategy to work as designed it is important that the entire drainage system is well maintained. It will be the responsibility of the site management team to ensure the drainage system is maintained. Maintenance and cleaning of gullies, drain manholes (including catch pits) and attenuation tanks will ensure adequate performance. The recommended program is outlined in the tables below.

Table 5-1 Concrete Attenuation Tank Maintenance Schedule

SUDS Element	Maintenance		
Attenuation Tanks	Maintenance Issues	Failure of components, blockage from debris	
	Maintenance Period	Maintenance Task	Frequency
	Regular	Inspect and identify any elements that are not operating correctly. If required, take remedial action.	Monthly for three months, then annually
		Remove sediment/debris from catchment surface that may lead to blockage of structures.	Monthly or as required
		Remove sediment/debris from catch pits/ gullies and control structures.	Annually, after severe storms or as required
	Remedial Work	Repair inlets, outlets, vents, overflows and control structures.	As required
	Monitoring	Inspect all inlets, outlets, vents, overflows and control structures to ensure they are in good condition and operating as designed.	Annually or after severe storms
		Survey inside of tank for sediment build-up and remove if necessary	Every five years or as required

Table 5-2 Permeable Paving Maintenance Schedule

SUDS Element	Maintenance		
Permeable Paving	Maintenance period	Maintenance Task	Frequency
	Regular	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or as required, based on site specific observations of clogging or manufacturer's recommendations.
	Occasional	Removal of weeds	As required
	Remedial work	Remediation work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users	As required
	Monitoring	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
		Monitor inspection chambers	Annually

Table 5-3 Green Roof Maintenance Schedule

SUDS Element	Maintenance		
Green Roof	Maintenance Issues	Vegetation becoming either overgrown or dying	
	Maintenance Period	Maintenance Task	Frequency
	Regular	Inspect all components including soil substrate, vegetation, drains, membranes and roof structure for proper operation, integrity of waterproofing and structural stability	Annually and after severe storms
		Inspect soil substrate for evidence of erosion channels and identify any sediment source	Annually and after severe storms
		Inspect drain inlets to ensure unrestricted run-off from the drainage layer to conveyance or roof drain system.	Annually and after severe storms
		Inspect underside of roof for evidence of leakage.	Annually and after severe storms
		Remove debris and litter to prevent clogging of inlet drains and interference with plant growth.	Six monthly and annually or as required
		During establishment (i.e. year one), replace dead plants as required.	Monthly
		Post-establishment, replace dead plants as required (where >5% of coverage)	Annually (in autumn)
		Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
		Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
		Mow grasses, prune shrubs and manage other planting (if appropriate) as required – clippings should be removed and not allowed to accumulate.	Six monthly or as required
	Remedial Work	If erosion channels are evident, these should be established with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled	As required
		If drain inlet has settled, cracked or moved, investigate and repair as appropriate	As required

Table 5-4 Swale and Filter Strips Maintenance Schedule

	Maintenance period	Maintenance Task	Frequency
Swale/Filter Strips	Regular	Remove the litter and debris	Monthly, or as required
		Cut grass – to retain height within specified design range.	Monthly (during growing season), or as required
		Manage other vegetation and remove nuisance plants.	Monthly at start, then as required
		Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
		Inspect infiltration coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
		Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
	Occasional	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if soil is exposed over 10% or more of the swale treatment area
	Remedial actions	Repair erosion or other damage by re-turfing or re-seeding	As required
		Re-level uneven surfaces and reinstate design levels	As required
		Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
		Remove and dispose of oils or petrol residues using safe standards practices	As required

6. Benefits to the surrounding Existing Drainage Network

It is important to note the very significant benefit the proposed development will have on the existing drainage network. The site currently discharges surface water, unrestricted to the Carrickmines Stream. The proposed development will significantly reduce the surface water run-off to the watercourse as demonstrated in Table 6-1 below. The introduction of the SUDS measures outlined earlier will also improve the quality of the discharge.

Table 6-1 Surface Water Run-off Rates

Rainfall Event	Existing development run-off (l/sec)	Proposed run-off (l/sec)	Difference (%)
Q1	16.05 l/s	8.8 l/s	-45.17%
Q30	34.42 l/s	8.8 l/s	-74.40%
Q100	43.50 l/s	8.8 l/s	-79.77%

7. Water Supply

7.1 Water Supply – General

There is an existing 6-inch uPVC watermain on Brennanstown Road to the north of the subject site. See Appendix A for Irish Water record maps.

A Pre-Connection Enquiry form was submitted to Irish Water on January 2022 which outlined the proposals for the provision of water supply to the development. Irish Water responded with the Confirmation of Feasibility (COF) on 4th February 2022, with reference no. CDS2000317. Please refer to Appendix B for the Irish Water Confirmation of Feasibility.

A Statement of Design Acceptance for the proposed water supply design has been received from Irish Water in March 2022 and is included in Appendix C.

It is proposed to supply the proposed development using 1 No. 200mmØ connection which will connect into the existing watermain north of the site in accordance with Irish Water's requirements..

The water demand for the proposed development is calculated according to the Irish Water Code of Practice and can be seen in Table 7.1 below.

Table 7-1 Total Water Demand

Description	No. of Units	Flow l/h/day	Population per Unit	Total Discharge (l/d)
Residential Units	534	150	2.7	216,270
Crèche	1	50	119	5,950
Retail	1	45	10	450
Total				***222,670 l/d***

The total water requirement from the public supply, for the development, is estimated at 223 m^3/day.

Waterman Moylan Drawing *BRR-WM-ZZ-00-DR-C-P300 Proposed Watermain Layout* shows the proposed indicative water supply layout for the subject site.

8. Transport

8.1 Introduction

A site-specific Transport and Traffic Assessment (TTA) has been carried out by Waterman Moylan. This is included under separate cover as part of this application.

8.2 Site Access

The site will be accessed via a new junction on to Brennanstown Road to the north east of the site. This new entrance is also described in more detail in the accompanying TTA. The site access from Brennanstown Road is in a 50 km/h zone. A 2.4m x 45m sightline, in line with the Department of Transport 'Design Manual for Urban Roads and Streets' recommendation can provided as shown on the accompanying drawings. No development works will infringe upon this sightline provision.

8.3 Car Parking

Section 12.4.5 of the Dun Laoghaire Rathdown County Council Development Plan 2022 – 2028 consider the car parking requirements for various types of development. Specifically, Tables 12.6 set out the car parking standards for residential developments.

Based on these standards, Table 8.1 below details the maximum car parking spaces permitted for the proposed development.

Table 8-1 DLRCC Maximum Car Parking Required

Land Use	Units	Parking Standards (Zone 2 Near Public Transport)	Car Parking Required
Apartments – 1 Bed	165	1 per unit	165
Apartments – 2 Bed	318	1 per unit	318
Apartments – 3 Bed+	51	2 per unit	102
Total	534	-	585

As per the Design Standards for New Apartments – Guidelines for Planning authorities – December 2020, the subject proposed development meets criteria for reasonable grounds to minimise car parking provisions. It is located within a 5-minute walk of a bus stop and the site provides direct access to the Brennanstown Luas Stop which is expected to be opened on foot of this development and within 13-min walk of Carrickmines Luas Stop.

In suburban/urban locations served by public transport or close to town centres or employment areas and particularly for housing schemes with more than 45 dwellings per hectare net (18 per acre), as per guidelines mentioned above, planning authorities must consider a reduced overall car parking standard and apply an appropriate maximum car parking standard.

The development will provide 419 No. car parking spaces for the proposed 534 residential apartments. This equates to 0.78 car parking spaces per apartment. There are 6 No. dedicated spaces provided for the Crèche and retail facility in addition to two setdown areas. There will be 17no. motorcycle spaces provided.

Included in the Proposed Parking shown in Table 26 there will be 17 No. disabled parking spaces and 84 No. electric car spaces to meet the current Development Plan requirements. In addition, ducting will be provided to all carparking spaces to allow for future EV Charging points.

One of the carparking spaces at surface level will be a dedicated spaces for car sharing (GoCar). Provision of car sharing spaces will provide access to a car for residents and avoid the need to own a car. A Letter of support has been provided by Go-Car for provision of 1 No. space at this development and this letter is included in Appendix J.

8.4 Cycle Parking

Section 4.1 of the 'Standard for Cycle Parking and Associated Cycling Facilities for New Developments – Dun Laoghaire-Rathdown County Council 2018' sets out the cycle parking requirements as follows:

Table 8-2 Total Cycle Parking Spaces Required (DLRCC)

Land Use	No. of Units	Standards	Long Stay parking required	Short Stay Parking Required	Total Parking Required
Apartments	534	1 space per unit- Long Stay 1 space per every 5 units – Short Stay	534	107	641
Creche	20 staff 99 children	1 space per every 5 staff – Long Stay 1 space per every 10 children – Short Stay	4	10	14
Retail Unit	10 staff 318 sqm (exclu. Bin storage)	1 space per every 5 staff – Long Stay 1 space per every 100 sqm GFA	2	3	5
Total	534	-	540	130	660

The Design Standards for New Apartments, sets out a requirement of 1 long stay space per bedroom and 1 visitor space for every two units, have also been reviewed with regards to cycle parking requirements and are set out in table 7.3 below.

Table 8-3 Total Cycle Parking Spaces Required (National Standards)

Land Use	No. of Units	Standards	Long Stay Parking Required	Short Stay Parking Required	Total Parking Required
Residential – 1 Bed	165	1 space per 1-bed unit – Long Stay 1 space per 2 units – Short Stay	165	82	248
Residential – 2 Bed	318	2 spaces per 2-bed unit - Long Stay 1 space per 2 units – Short Stay	636	159	795
Residential – 3 Bed	51	3 spaces per 3-bed unit - Long Stay 1 space per 2 units – Short Stay	153	26	179
Total	534 units		954	267	1,221

As can be seen on Table 8-2 above, the total number of cycle parking spaces required by the County Development Plan is 660. Table 8-3 shows a requirement for 1,221 cycle parking spaces according to the National Standards. There are proposed a total of 1,266 spaces. In total, 208 cycle spaces are being provided at surface level of which 26 spaces will be provided for the Luas commuters to the south of the site and a further 19 of these spaces will be allocated for creche users. The cycle parking space provision is set out in Table 8-4 below. This number proposed is in excess of the Dun Laoghaire Rathdown County Council cycle standards, and generally in line with the national standards.

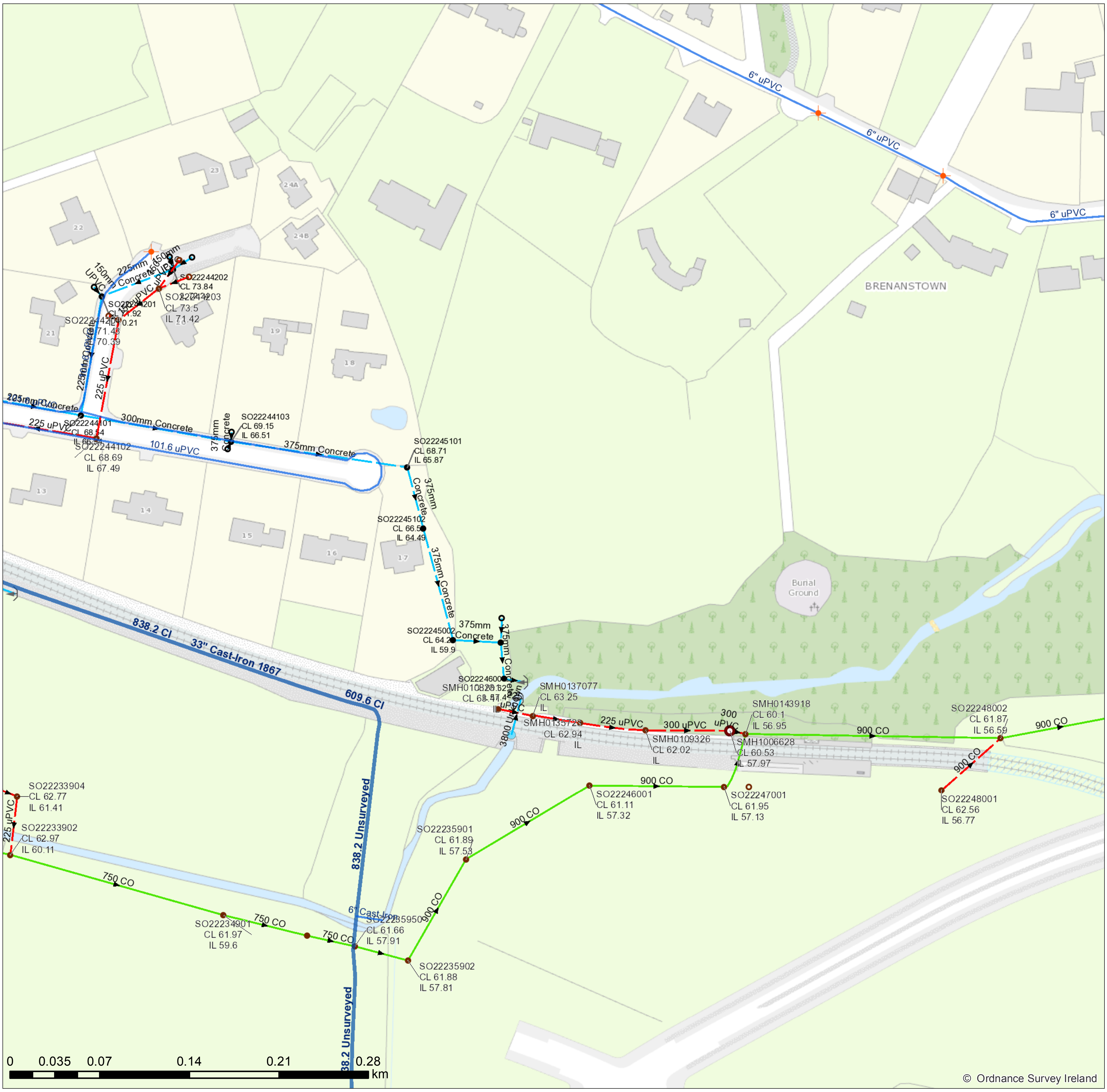
Table 8-4 Total Cycle Parking Spaces Provided

Parking Area	No. of Cycle Parking
Residential Parking at basement level	1,058
Visitor Parking at surface level	208 (incl. 45 for Luas / creche)
Total	1,266

APPENDICES

A. Irish Water Records Map

brennanstown road



Water Distribution Network
- Water Treatment Plant
- Water Pump Station
- Storage Cell/Tower
- Dosing Point
- Meter Station
- Abstraction Point
- Telemetry Kiosk

Reservoir
- Potable
- Raw Water

Water Distribution Mains
- Irish Water
- Private

Trunk Water Mains
- Irish Water
- Private

Water Lateral Lines
- Irish Water
- Non IW
- Water Casings
- Water Abandoned Lines
- Boundary Meter
- Bulk/Check Meter
- Group Scheme
- Source Meter
- Waste Meter
- Unknown Meter ; Other Meter
- Non-Return
- PRV
- PSV
- Sluice Line Valve Open/Closed
- Butterfly Line Valve Open/Closed
- Sluice Boundary Valve Open/Closed
- Butterfly Boundary Valve Open/Closed
- Scour Valves
- Single Air Control Valve
- Double Air Control Valve
- Water Stop Valves
- Water Service Connections
- Water Distribution Chambers
- Water Network Junctions
- Pressure Monitoring Point
- Fire Hydrant
- Fire Hydrant/Washout

Water Fittings
- Cap
- Reducer
- Tap
- Other Fittings

Sewer Foul Combined Network
- Waste Water Treatment Plant
- Waste Water Pump station

Sewer Mains Irish Water
- Gravity - Combined
- Gravity - Foul
- Gravity - Unknown
- Pumping - Combined
- Pumping - Foul
- Pumping - Unknown
- Syphon - Combined
- Syphon - Foul
- Overflow

Sewer Mains Private
- Gravity - Combined
- Gravity - Foul
- Gravity - Unknown
- Pumping - Combined
- Pumping - Foul
- Pumping - Unknown
- Syphon - Combined
- Syphon - Foul
- Overflow
- Sewer Lateral Lines
- Sewer Casings

Sewer Manholes
- Standard
- Backdrop
- Cascade
- Catchpit
- Bifurcation
- Hatchbox
- Lamphole
- Hydrobrake
- Other; Unknown

Discharge Type
- Outfall
- Overflow
- Soakaway
- Standard Outlet
- Other; Unknown

Cleanout Type
- Rodding Eye
- Flushing Structure
- Other; Unknown

Sewer Inlets
- Catchpit
- Gully
- Standard
- Other; Unknown

Sewer Fittings
- Vent/Col
- Other; Unknown

Storm Water Network

Surface Water Mains
- Surface Gravity Mains
- Surface Gravity Mains Private
- Surface Water Pressurised Mains
- Surface Water Pressurised Mains Private

Inlet Type
- Gully
- Standard
- Other; Unknown

Storm Manholes
- Standard
- Backdrop
- Cascade
- Catchpit
- Bifurcation
- Hatchbox
- Lamphole
- Hydrobrake
- Other; Unknown
- Storm Culverts
- Storm Clean Outs
- Stormwater Chambers

Discharge Type
- Outfall
- Overflow
- Soakaway
- Other; Unknown

Gas Networks Ireland
- Transmission High Pressure Gasline
- Distribution Medium Pressure Gasline
- Distribution Low Pressure Gasline

ESB Networks

ESB HV Lines
- HV Underground
- HV Overhead
- HV Abandoned

ESB MVLV Lines
- MV Overhead Three Phase
- MV Overhead Single Phase
- LV Overhead Three Phase
- LV Overhead Single Phase
- MVLV Underground
- Abandoned

Non Service Categories
- Proposed
- Under Construction
- Out of Service
- Decommissioned

Water Non Service Assets
- Water Point Feature
- Water Pipe
- Water Structure

Waste Non Service Assets
- Waste Point Feature
- Sewer
- Waste Structure

UISCE ÉIREANN : IRISH WATER

Print Date: 21/04/2020

Printed by:Irish Water

B. Irish Water Confirmation of Feasibility

UISCE ÉIREANN : IRISH WATER

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

Irish Water
PO Box 448,
South City
Delivery Office,
Cork City.

www.water.ie

Laura Ruiz

Eastpoint Business Park Block S
Alfie Byrne Road
Dublin 3
Dublin
D03H3F4

4 February 2022

Re: CDS22000317 pre-connection enquiry - Subject to contract | Contract denied

Connection for Multi/Mixed Use Development of 570 apartments, 1 creche and 1 retail unit at Brennanstown Road, Cabinteely, Dublin 18, Co. Dublin

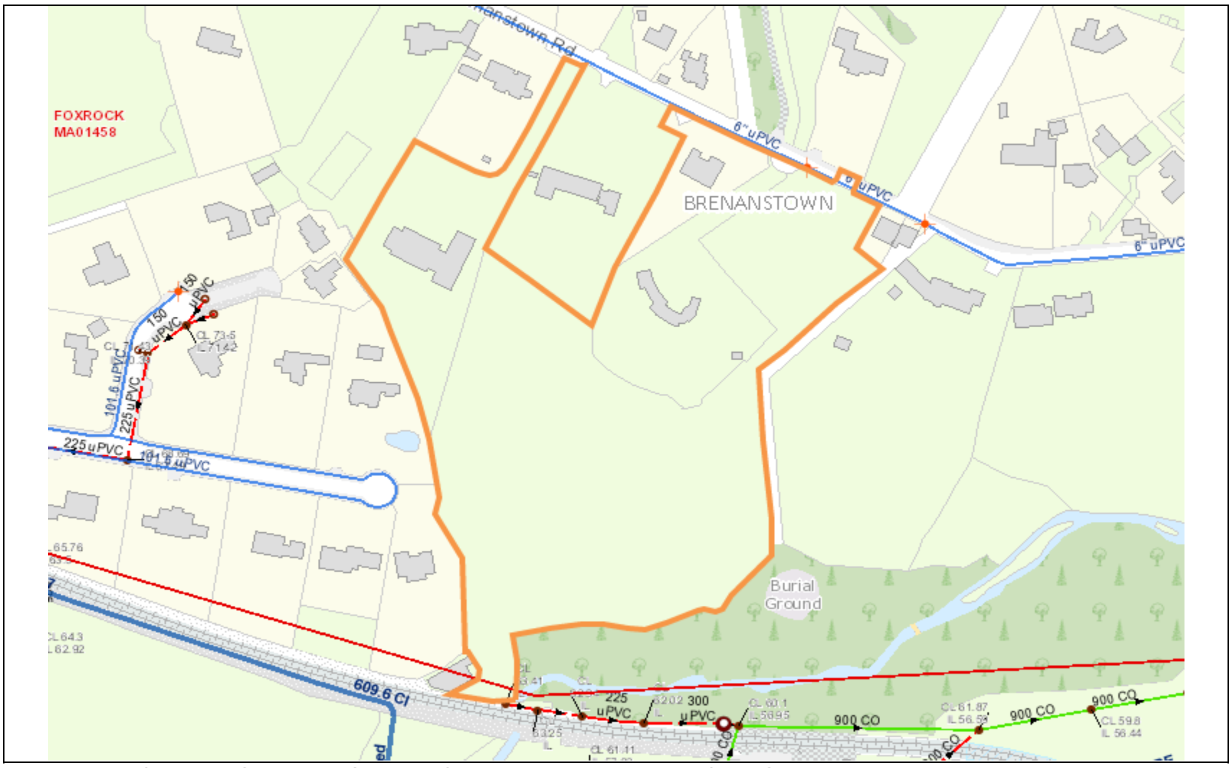
Dear Sir/Madam,

Irish Water has reviewed your pre-connection enquiry in relation to a Water & Wastewater connection at Brennanstown Road, Cabinteely, Dublin 18, Co. Dublin (the **Premises**). Based upon the details you have provided with your pre-connection enquiry and on our desk top analysis of the capacity currently available in the Irish Water network(s) as assessed by Irish Water, we wish to advise you that your proposed connection to the Irish Water network(s) can be facilitated at this moment in time.

SERVICE	**OUTCOME OF PRE-CONNECTION ENQUIRY** **THIS IS NOT A CONNECTION OFFER. YOU MUST APPLY FOR A CONNECTION(S) TO THE IRISH WATER NETWORK(S) IF YOU WISH TO PROCEED.**
Water Connection	Feasible without infrastructure upgrade by Irish Water
Wastewater Connection	Feasible subject to upgrades
SITE SPECIFIC COMMENTS	
Water Connection	This Confirmation of Feasibility to connect to the Irish Water infrastructure does not extend to your fire flow requirements. Please note that Irish Water cannot guarantee a flow rate to meet fire flow requirements and in order to guarantee a flow to meet the Fire Authority requirements, you should provide adequate fire storage capacity within your development. A bulk meter is required on both connections to the 6” uPVC main to the North of the site and linked up with telemetry online.

Wastewater Connection	Upgrade of the existing 225mm/300mm gravity sewer line (from the connection point up to the 900mm trunk sewer) may be required. The sewer has to be surveyed to confirm the capacity and integrity. Should you wish to progress with the connection, you will be required to fund the works and the fee will be calculated in the connection offer or in a separate survey/upgrade project agreement.
The design and construction of the Water & Wastewater pipes and related infrastructure to be installed in this development shall comply with the Irish Water Connections and Developer Services Standard Details and Codes of Practice that are available on the Irish Water website. Irish Water reserves the right to supplement these requirements with Codes of Practice and these will be issued with the connection agreement.	

The map included below outlines the current Irish Water infrastructure adjacent to your site:



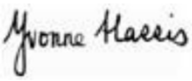
Whilst every care has been taken in its compilation Irish Water gives this information as to the position of its underground network as a general guide only on the strict understanding that it is based on the best available information provided by each Local Authority in Ireland to Irish Water. Irish Water can assume no responsibility for and give no guarantees, undertakings or warranties concerning the accuracy, completeness or up to date nature of the information provided and does not accept any liability whatsoever arising from any errors or omissions. This information should not be relied upon in the event of excavations or any other works being carried out in the vicinity of the Irish Water underground network. The onus is on the parties carrying out excavations or any other works to ensure the exact location of the Irish Water underground network is identified prior to excavations or any other works being carried out. Service connection pipes are not generally shown but their presence should be anticipated.

General Notes:

1) The initial assessment referred to above is carried out taking into account water demand and wastewater discharge volumes and infrastructure details on the date of the assessment. **The availability of capacity may change at any date after this assessment.**
2) This feedback does not constitute a contract in whole or in part to provide a connection to any Irish Water infrastructure. All feasibility assessments are subject to the constraints of the Irish Water Capital Investment Plan.
3) The feedback provided is subject to a Connection Agreement/contract being signed at a later date.
4) A Connection Agreement will be required to commencing the connection works associated with the enquiry this can be applied for at https://www.water.ie/connections/get-connected/
5) A Connection Agreement cannot be issued until all statutory approvals are successfully in place.
6) Irish Water Connection Policy/ Charges can be found at https://www.water.ie/connections/information/connection-charges/
7) Please note the Confirmation of Feasibility does not extend to your fire flow requirements.
8) Irish Water is not responsible for the management or disposal of storm water or ground waters. You are advised to contact the relevant Local Authority to discuss the management or disposal of proposed storm water or ground water discharges
9) To access Irish Water Maps email datarequests@water.ie
10) All works to the Irish Water infrastructure, including works in the Public Space, shall have to be carried out by Irish Water.

If you have any further questions, please contact Kevin McManmon from the design team at kmcmanmon@water.ie For further information, visit **www.water.ie/connections.**

Yours sincerely,



Yvonne Harris

Head of Customer Operations

C. Irish Water Statement of Design Acceptance

UISCE
ÉIREANN : IRISH
WATER

Laura Ruiz
Eastpoint Business Park Block S
Alfie Byrne Road
Dublin 3, Dublin D03H3F4

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

Irish Water
PO Box 448,
South City
Delivery Office,
Cork City.

www.water.ie

23 March 2022

Re: Design Submission for Brennanstown Road, Cabinteely, Dublin 18, Co. Dublin (the "Development")
(the "Design Submission") / Connection Reference No: CDS22000317

Dear Laura Ruiz,

Many thanks for your recent Design Submission.

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

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

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

If you have any further questions, please contact your Irish Water representative:
Name: Kevin McManmon
Phone: 018230374
Email: kmcmanmon@water.ie

Yours sincerely,

Yvonne Harris

Yvonne Harris
Head of Customer Operations

Appendix A

Document Title & Revision

- BRR-WM-ZZ-00-DR-C-P200
- BRR-WM-ZZ-00-DR-C-P300

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

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

D. Greenfield Run-off Rate Calculations for Existing Site

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Laura Ruiz
Site name:	Barrington
Site location:	

Site Details

Latitude:	53.25394° N
Longitude:	6.16384° W
Reference:	405267799
Date:	Apr 05 2022 16:36

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 3.753

Methodology

Q_{BAR} estimation method: Calculate from SPR and SAAR

SPR estimation method: Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	1	3
HOST class:	N/A	N/A
SPR/SPRHOST:	0.1	0.37

Hydrological characteristics

	Default	Edited
SAAR (mm):	920	892
Hydrological region:	12	12
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.13	2.13
Growth curve factor 100 years:	2.61	2.61
Growth curve factor 200 years:	2.86	2.86

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	0.87	14.32
1 in 1 year (l/s):	0.74	12.17
1 in 30 years (l/s):	1.85	30.49
1 in 100 year (l/s):	2.27	37.37
1 in 200 years (l/s):	2.48	40.95

E. Greenfield Run-off Rate Calculations for Proposed Site

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Laura Ruiz
Site name:	Barrington
Site location:	

Site Details

Latitude:	
Longitude:	
Reference:	3567823703
Date:	Mar 09 2022 10:33

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 2.3

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics	Default	Edited
SOIL type:	0	3
HOST class:	N/A	N/A
SPR/SPRHOST:	0.00	0.37

Hydrological characteristics	Default	Edited
SAAR (mm):	0	892
Hydrological region:	1	1
Growth curve factor 1 year:	-	0.85
Growth curve factor 30 years:	-	1.95
Growth curve factor 100 years:	-	2.48
Growth curve factor 200 years:	-	2.84

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s):	0	8.77
1 in 1 year (l/s):		7.46
1 in 30 years (l/s):		17.11
1 in 100 year (l/s):		21.76
1 in 200 years (l/s):		24.92

F. Surface Water Attenuation Calculations

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	5	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	16.400	Minimum Backdrop Height (m)	0.200
Ratio-R	0.272	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	4.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
17_Tank C	1.386	4.00	66.250	1350	722545.830	724165.251	1.650
7	0.031	4.00	74.300	1200	722683.319	724329.475	1.493
8	0.054	4.00	73.072	1200	722682.980	724295.703	1.425
9	0.049	4.00	72.910	1200	722676.857	724278.022	1.425
10	0.012	4.00	72.470	1200	722662.069	724260.114	1.545
4	0.079	4.00	74.800	1200	722645.030	724340.869	1.425
6_Tank A	0.079	4.00	75.300	1200	722619.787	724289.116	2.213
11	0.051	4.00	71.686	1200	722645.304	724243.936	1.500
12	0.051	4.00	70.625	1200	722644.232	724195.456	1.425
13	0.051	4.00	69.250	1200	722644.496	724140.444	2.350
14			67.000	1200	722620.094	724138.303	1.645
15_Tank B			66.250	1200	722610.210	724128.056	2.400
16			66.710	1200	722599.526	724117.282	3.087
18			65.190	1350	722546.058	724116.480	1.892
21	0.022	4.00	74.000	1200	722500.387	724240.013	1.350
22	0.022	4.00	70.200	1200	722504.603	724201.298	1.350
23	0.022	4.00	67.500	1200	722507.902	724148.413	1.350
23A			68.500	1200	722501.418	724171.442	1.151
24	0.022	4.00	66.790	1200	722516.099	724129.948	2.772
31			64.400	1350	722521.815	724116.287	2.900
32			63.200	1350	722522.946	724076.195	2.944
Headwall			58.500	1350	722535.853	724075.459	0.575
30_Tank D	0.030	4.00	64.400		722528.941	724121.573	2.250
3	0.079	4.00	75.800	1200	722597.558	724291.404	2.177
Permeable paving	0.050	4.00	63.828		722525.445	724095.728	0.528
33			63.100	1350	722525.744	724075.958	4.163
5	0.079	4.00	74.800	1200	722638.098	724324.071	1.516
19	0.022	4.00	75.500	1200	722523.049	724268.133	1.350
20	0.015	4.00	74.200	1200	722498.589	724253.649	1.350
25	0.015	4.00	67.840	650	722642.593	724134.125	1.350
26	0.015	4.00	66.000	650	722625.468	724122.470	1.350
27	0.015	4.00	66.000	650	722600.155	724113.228	1.618
28	0.015	4.00	64.800	650	722543.173	724112.472	0.988
29			65.000	1200	722537.898	724119.390	1.350
1	0.009	4.00	75.000	1200	722613.653	724354.352	1.025
2	0.009	4.00	75.500	1200	722590.598	724299.010	1.825
3A			75.300	1200	722615.004	724288.921	1.765

Links (Input)

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.015	33	Headwall	10.121	0.600	58.937	57.925	1.012	10.0	375	8.54	0.0
1.013	31	32	40.108	0.600	61.500	60.256	1.244	32.2	375	8.48	49.3
1.012	18	31	24.244	0.600	63.298	62.692	0.606	40.0	375	8.27	49.9
5.007	30_Tank D	31	8.873	0.600	62.150	61.650	0.500	17.7	225	5.80	50.0
5.006	24	30_Tank D	15.332	0.600	64.018	63.450	0.568	27.0	150	5.32	50.0
5.005	23	24	20.203	0.600	66.150	65.477	0.673	30.0	150	5.19	50.0
5.003	22	23A	30.025	0.600	68.850	67.349	1.501	20.0	150	4.83	50.0
5.004	23A	23	23.924	0.600	67.349	66.150	1.199	20.0	150	5.01	50.0
5.002	21	22	38.944	0.600	72.650	68.850	3.800	10.2	150	4.61	50.0
4.000	17_Tank C	18	48.772	0.600	64.600	63.373	1.227	39.7	375	4.28	50.0
1.011	16	18	53.474	0.600	63.623	63.298	0.325	164.5	300	8.13	50.0
1.010	15_Tank B	16	15.173	0.600	63.850	63.698	0.152	100.0	300	7.40	50.0
1.009	14	15_Tank B	14.237	0.600	65.355	64.643	0.712	20.0	225	7.24	50.0
1.008	13	14	24.496	0.600	66.900	65.355	1.545	15.9	225	7.16	50.0
1.007	12	13	55.013	0.600	69.200	67.825	1.375	40.0	225	7.03	50.0
1.006	11	12	48.492	0.600	70.186	69.200	0.986	49.2	225	6.59	50.0
1.004	6_Tank A	10	51.273	0.600	73.087	71.000	2.087	24.6	225	5.99	50.0
1.005	10	11	23.298	0.600	70.925	70.186	0.739	31.5	225	6.16	50.0
3.002	9	10	23.225	0.600	71.485	70.925	0.560	41.5	225	4.68	50.0
3.001	8	9	18.711	0.600	71.647	71.485	0.162	115.5	225	4.49	50.0
3.000	7	8	33.774	0.600	72.807	71.647	1.160	29.1	225	4.23	50.0
2.001	5	6_Tank A	39.461	0.600	73.284	73.087	0.197	200.0	225	5.04	50.0
1.002	3	3A	17.622	0.600	73.623	73.535	0.088	200.0	225	5.59	50.0
2.000	4	5	18.172	0.600	73.375	73.284	0.091	200.0	225	4.33	50.0
6.000	25	26	20.715	0.600	66.490	64.650	1.840	11.3	150	4.11	50.0
6.001	26	27	26.947	0.600	64.650	64.382	0.268	100.6	150	4.56	50.0
6.002_1	27	28	56.987	0.600	64.382	63.812	0.570	100.0	150	5.51	50.0
6.003	28	29	8.700	0.600	63.812	63.650	0.162	53.7	150	5.61	50.0
6.004	29	30_Tank D	9.219	0.600	63.650	63.535	0.115	80.0	150	5.75	50.0
5.000	19	20	28.427	0.600	74.150	72.850	1.300	21.9	150	4.22	50.0
5.001	20	21	13.754	0.600	72.850	72.650	0.200	68.8	150	4.41	50.0
1.000	1	2	59.952	0.600	73.975	73.675	0.300	200.0	225	5.09	50.0
1.001	2	3	10.310	0.600	73.675	73.623	0.052	200.0	225	5.27	50.0
6.002	3A	6_Tank A	4.787	0.600	73.535	73.506	0.029	165.1	225	5.67	50.0
7.000	Permeable paving	33	19.772	0.600	63.300	62.311	0.989	20.0	150	4.15	50.0
1.014	32	33	2.808	0.600	60.256	60.242	0.014	200.0	375	8.51	0.0

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal
FSR Region	England and Wales	Skip Steady State	x
M5-60 (mm)	16.400	Drain Down Time (mins)	240
Ratio-R	0.272	Additional Storage (m³/ha)	20.0
Summer CV	0.750	Check Discharge Rate(s)	x
Winter CV	0.840	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

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

Node 6_Tank A Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	73.087	Product Number	CTL-SHE-0066-2000-1075-2000
Design Depth (m)	1.075	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node 15_Tank B Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	63.850	Product Number	CTL-SHE-0074-3000-1600-3000
Design Depth (m)	1.600	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	3.0	Min Node Diameter (mm)	1200

Node 17_Tank C Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	64.600	Product Number	CTL-SHE-0088-3700-1200-3700
Design Depth (m)	1.200	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	3.7	Min Node Diameter (mm)	1200

Node 30_Tank D Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	62.150	Product Number	CTL-SHE-0050-1400-1600-1400
Design Depth (m)	1.600	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	1.4	Min Node Diameter (mm)	1200

Node 33 Online Hydro-Brake® Control

Flap Valve	✓	Objective	(HE) Minimise upstream storage
Downstream Link	1.015	Sump Available	✓
Replaces Downstream Link	✓	Product Number	CTL-SHE-0104-8800-4000-8800
Invert Level (m)	58.937	Min Outlet Diameter (m)	0.150
Design Depth (m)	4.000	Min Node Diameter (mm)	1200
Design Flow (l/s)	8.8		

Node 30_Tank D Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	62.150
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.96	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	97.5	0.0	1.600	97.5	0.0	1.601	0.0	0.0

Node 6_Tank A Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	73.125
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.96	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	190.0	0.0	1.075	190.0	0.0	1.076	0.0	0.0

Node 15_Tank B Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	64.050
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.96	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	140.0	0.0	1.600	140.0	0.0	1.601	0.0	0.0

Node 17_Tank C Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	64.650
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	945.0	0.0	1.200	945.0	0.0	1.201	0.0	0.0

Node Permeable paving Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	63.300
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	0

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	50.0	0.0	0.300	50.0	0.0	0.301	0.0	0.0

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.14%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute winter	17_Tank C	1380	65.260	0.660	24.5	589.0435	0.0000	SURCHARGED
15 minute winter	7	10	72.851	0.044	8.0	0.0674	0.0000	OK
15 minute winter	8	10	71.759	0.112	22.0	0.2121	0.0000	OK
15 minute winter	9	10	71.593	0.108	34.6	0.1968	0.0000	OK
15 minute winter	10	10	71.026	0.101	39.4	0.1304	0.0000	OK
600 minute winter	4	570	73.664	0.289	2.6	0.6465	0.0000	SURCHARGED
600 minute winter	6_Tank A	570	73.663	0.576	10.6	99.3718	0.0000	SURCHARGED
15 minute winter	11	10	70.327	0.141	52.4	0.2561	0.0000	OK
15 minute winter	12	11	69.353	0.153	65.2	0.2825	0.0000	OK
15 minute winter	13	10	67.025	0.125	75.4	0.1962	0.0000	OK
15 minute winter	14	11	65.504	0.149	75.4	0.1681	0.0000	OK
1440 minute winter	15_Tank B	1350	64.932	1.082	7.2	119.8859	0.0000	SURCHARGED
60 minute summer	16	9	63.658	0.035	2.5	0.0401	0.0000	OK
8640 minute summer	18	6120	63.335	0.037	6.2	0.0525	0.0000	OK
15 minute winter	21	10	72.704	0.054	15.3	0.0780	0.0000	OK
15 minute winter	22	10	68.930	0.080	20.9	0.1160	0.0000	OK
15 minute winter	23	10	66.258	0.108	26.4	0.1578	0.0000	OK
15 minute winter	23A	10	67.426	0.077	20.8	0.0866	0.0000	OK
15 minute winter	24	10	64.136	0.118	31.5	0.1529	0.0000	OK
480 minute winter	31	320	61.983	0.483	7.0	0.6913	0.0000	SURCHARGED
480 minute winter	32	320	61.983	1.727	7.3	2.4706	0.0000	SURCHARGED
15 minute summer	Headwall	1	57.925	0.000	6.7	0.0000	0.0000	OK
960 minute winter	30_Tank D	915	62.936	0.786	5.2	73.7406	0.0000	SURCHARGED
15 minute winter	3	10	73.765	0.142	24.3	0.2639	0.0000	OK
15 minute winter	Permeable paving	10	63.358	0.058	13.0	0.9858	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
1440 minute winter	17_Tank C	Hydro-Brake®	18	3.7				
15 minute winter	7	3.000	8	8.0	0.661	0.083	0.4251	
15 minute winter	8	3.001	9	22.0	1.136	0.454	0.3616	
15 minute winter	9	3.002	10	34.6	1.910	0.427	0.4206	
15 minute winter	10	1.005	11	39.2	1.797	0.422	0.5081	
600 minute winter	4	2.000	5	2.6	0.394	0.071	0.7227	
600 minute winter	6_Tank A	Hydro-Brake®	10	1.9				
15 minute winter	11	1.006	12	52.0	1.900	0.700	1.3280	
15 minute winter	12	1.007	13	63.7	2.266	0.773	1.5478	
15 minute winter	13	1.008	14	75.4	2.994	0.574	0.6175	
15 minute winter	14	1.009	15_Tank B	76.0	2.927	0.650	0.3693	
1440 minute winter	15_Tank B	Hydro-Brake®	16	2.5				
60 minute summer	16	1.011	18	2.5	0.599	0.029	0.2489	
8640 minute summer	18	1.012	31	6.2	1.137	0.020	0.1322	
15 minute winter	21	5.002	22	15.2	2.020	0.272	0.2946	
15 minute winter	22	5.003	23A	20.8	2.251	0.521	0.2781	
15 minute winter	23	5.005	24	25.8	1.978	0.793	0.2647	
15 minute winter	23A	5.004	23	20.7	1.817	0.517	0.2709	
15 minute winter	24	5.006	30_Tank D	31.1	2.154	0.905	0.2223	
480 minute winter	31	1.013	32	7.3	0.792	0.021	4.4238	
480 minute winter	32	1.014	33	8.1	0.605	0.058	0.3097	
960 minute winter	30_Tank D	Hydro-Brake®	31	1.0				
15 minute winter	3	1.002	3A	23.6	0.913	0.645	0.4558	
15 minute winter	Permeable paving	7.000	33	12.3	1.975	0.309	0.1236	

Results for 30 year Critical Storm Duration. Lowest mass balance: 99.14%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	33	320	61.982	3.045	8.6	4.3579	0.0000	SURCHARGED
600 minute winter	5	570	73.664	0.380	5.2	0.8248	0.0000	SURCHARGED
15 minute winter	19	10	74.189	0.039	5.7	0.0571	0.0000	OK
15 minute winter	20	10	72.926	0.076	9.6	0.1031	0.0000	OK
15 minute summer	25	10	66.518	0.028	3.9	0.0152	0.0000	OK
15 minute summer	26	10	64.720	0.070	7.8	0.0386	0.0000	OK
15 minute winter	27	10	64.470	0.088	11.7	0.0455	0.0000	OK
15 minute winter	28	11	63.905	0.093	15.3	0.0593	0.0000	OK
15 minute winter	29	11	63.752	0.102	14.9	0.1157	0.0000	OK
15 minute winter	1	10	74.012	0.037	2.3	0.0483	0.0000	OK
15 minute winter	2	10	73.767	0.092	4.5	0.1129	0.0000	OK
15 minute winter	3A	11	73.673	0.138	23.6	0.1566	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
480 minute winter	33	Hydro-Brake®	Headwall	7.8				284.1
600 minute winter	5	2.001	6_Tank A	4.8	0.223	0.131	1.5694	
15 minute winter	19	5.000	20	5.7	0.923	0.149	0.1796	
15 minute winter	20	5.001	21	9.6	1.313	0.446	0.1005	
15 minute summer	25	6.000	26	3.9	0.804	0.073	0.1057	
15 minute summer	26	6.001	27	7.8	0.835	0.441	0.2521	
15 minute winter	27	6.002_1	28	11.4	1.024	0.640	0.6330	
15 minute winter	28	6.003	29	14.9	1.232	0.613	0.1058	
15 minute winter	29	6.004	30_Tank D	15.0	1.209	0.757	0.1147	
15 minute winter	1	1.000	2	2.2	0.298	0.059	0.5826	
15 minute winter	2	1.001	3	5.8	0.387	0.160	0.2145	
15 minute winter	3A	6.002	6_Tank A	23.5	0.988	0.583	0.1140	

Results for 100 year +30% CC Critical Storm Duration. Lowest mass balance: 99.14%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
2160 minute winter	17_Tank C	2100	65.821	1.221	29.6	1129.5520	0.0000	SURCHARGED
15 minute winter	7	10	72.863	0.056	13.4	0.0871	0.0000	OK
15 minute winter	8	10	71.805	0.158	36.7	0.2994	0.0000	OK
15 minute summer	9	10	71.636	0.151	57.8	0.2746	0.0000	OK
15 minute winter	10	11	71.129	0.204	65.2	0.2626	0.0000	OK
720 minute winter	4	690	74.160	0.785	3.8	1.7585	0.0000	SURCHARGED
720 minute winter	6_Tank A	690	74.160	1.073	15.4	190.8338	0.0000	SURCHARGED
15 minute winter	11	11	70.862	0.676	82.6	1.2243	0.0000	SURCHARGED
15 minute winter	12	11	69.792	0.592	97.1	1.0943	0.0000	SURCHARGED
15 minute winter	13	9	67.062	0.162	108.0	0.2533	0.0000	OK
1440 minute winter	14	1380	65.645	0.290	10.4	0.3274	0.0000	SURCHARGED
1440 minute winter	15_Tank B	1380	65.644	1.794	10.4	216.3087	0.0000	SURCHARGED
1440 minute winter	16	1350	63.662	0.039	3.2	0.0445	0.0000	OK
1440 minute winter	18	1410	63.337	0.039	6.9	0.0552	0.0000	OK
15 minute winter	21	10	72.721	0.071	25.5	0.1034	0.0000	OK
15 minute summer	22	10	68.963	0.113	34.9	0.1653	0.0000	OK
15 minute winter	23	11	66.706	0.556	42.8	0.8094	0.0000	SURCHARGED
15 minute winter	23A	11	67.534	0.185	35.2	0.2088	0.0000	SURCHARGED
15 minute winter	24	12	64.683	0.665	46.5	0.8578	0.0000	SURCHARGED
240 minute winter	31	168	62.949	1.449	7.2	2.0742	0.0000	SURCHARGED
240 minute winter	32	168	62.950	2.694	7.5	3.8552	0.0000	FLOOD RISK
15 minute summer	Headwall	1	57.925	0.000	6.9	0.0000	0.0000	OK
960 minute winter	30_Tank D	870	63.649	1.499	8.7	140.7298	0.0000	SURCHARGED
720 minute winter	3	690	74.160	0.537	4.6	0.9971	0.0000	SURCHARGED
15 minute winter	Permeable paving	10	63.379	0.079	21.6	1.3346	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
2160 minute winter	17_Tank C	Hydro-Brake®	18	3.7				
15 minute winter	7	3.000	8	13.4	0.728	0.138	0.6358	
15 minute winter	8	3.001	9	36.6	1.285	0.758	0.5435	
15 minute summer	9	3.002	10	58.0	2.081	0.717	0.6903	
15 minute winter	10	1.005	11	60.6	1.868	0.652	0.9047	
720 minute winter	4	2.000	5	3.6	0.394	0.099	0.7227	
720 minute winter	6_Tank A	Hydro-Brake®	10	2.0				
15 minute winter	11	1.006	12	75.1	1.974	1.010	1.9286	
15 minute winter	12	1.007	13	89.2	2.243	1.082	2.1873	
15 minute winter	13	1.008	14	108.3	3.143	0.825	0.8546	
1440 minute winter	14	1.009	15_Tank B	10.4	1.743	0.089	0.5662	
1440 minute winter	15_Tank B	Hydro-Brake®	16	3.2				
1440 minute winter	16	1.011	18	3.2	0.593	0.037	0.2860	
1440 minute winter	18	1.012	31	6.9	1.171	0.022	0.1421	
15 minute winter	21	5.002	22	25.4	2.258	0.455	0.4365	
15 minute summer	22	5.003	23A	35.1	2.458	0.877	0.4525	
15 minute winter	23	5.005	24	38.4	2.182	1.179	0.3521	
15 minute winter	23A	5.004	23	33.3	1.923	0.833	0.4212	
15 minute winter	24	5.006	30_Tank D	45.1	2.560	1.311	0.2672	
240 minute winter	31	1.013	32	7.5	0.797	0.021	4.4238	
240 minute winter	32	1.014	33	8.7	0.607	0.062	0.3097	
960 minute winter	30_Tank D	Hydro-Brake®	31	1.3				
720 minute winter	3	1.002	3A	4.6	0.600	0.125	0.7008	
15 minute winter	Permeable paving	7.000	33	20.9	2.256	0.522	0.1829	

Results for 100 year +30% CC Critical Storm Duration. Lowest mass balance: 99.14%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	33	168	62.948	4.011	10.0	5.7399	0.0000	FLOOD RISK
720 minute winter	5	690	74.160	0.876	7.4	1.9036	0.0000	SURCHARGED
15 minute winter	19	10	74.201	0.051	9.5	0.0743	0.0000	OK
15 minute winter	20	10	72.956	0.106	16.0	0.1438	0.0000	OK
15 minute winter	25	10	66.525	0.035	6.5	0.0196	0.0000	OK
15 minute summer	26	10	64.745	0.095	13.0	0.0528	0.0000	OK
15 minute winter	27	11	64.583	0.201	19.5	0.1037	0.0000	SURCHARGED
15 minute winter	28	11	64.019	0.207	23.6	0.1316	0.0000	SURCHARGED
15 minute winter	29	11	63.833	0.183	22.2	0.2071	0.0000	SURCHARGED
720 minute winter	1	690	74.160	0.185	0.4	0.2417	0.0000	OK
720 minute winter	2	690	74.160	0.485	0.8	0.5965	0.0000	SURCHARGED
720 minute winter	3A	690	74.160	0.625	4.6	0.7068	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute winter	33	Hydro-Brake®	Headwall	8.8				208.5
720 minute winter	5	2.001	6_Tank A	7.3	0.252	0.199	1.5694	
15 minute winter	19	5.000	20	9.5	1.033	0.249	0.2647	
15 minute winter	20	5.001	21	16.0	1.474	0.744	0.1482	
15 minute winter	25	6.000	26	6.5	0.888	0.122	0.1549	
15 minute summer	26	6.001	27	13.0	0.926	0.736	0.3833	
15 minute winter	27	6.002_1	28	17.1	1.078	0.965	1.0032	
15 minute winter	28	6.003	29	22.2	1.295	0.914	0.1532	
15 minute winter	29	6.004	30_Tank D	22.2	1.260	1.115	0.1577	
720 minute winter	1	1.000	2	0.4	0.238	0.011	2.2393	
720 minute winter	2	1.001	3	0.8	0.186	0.022	0.4100	
720 minute winter	3A	6.002	6_Tank A	4.4	0.632	0.109	0.1904	

G. Surface Water Attenuation Calculations with Surcharged Outfall

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	5	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	16.400	Minimum Backdrop Height (m)	0.200
Ratio-R	0.272	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	4.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
17_Tank C	1.386	4.00	66.250	1350	722545.830	724165.251	1.650
7	0.031	4.00	74.300	1200	722683.319	724329.475	1.493
8	0.054	4.00	73.072	1200	722682.980	724295.703	1.425
9	0.049	4.00	72.910	1200	722676.857	724278.022	1.425
10	0.012	4.00	72.470	1200	722662.069	724260.114	1.545
4	0.079	4.00	74.800	1200	722645.030	724340.869	1.425
6_Tank A	0.079	4.00	75.300	1200	722619.787	724289.116	2.213
11	0.051	4.00	71.686	1200	722645.304	724243.936	1.500
12	0.051	4.00	70.625	1200	722644.232	724195.456	1.425
13	0.051	4.00	69.250	1200	722644.496	724140.444	2.350
14			67.000	1200	722620.094	724138.303	1.645
15_Tank B			66.250	1200	722610.210	724128.056	2.400
16			66.710	1200	722599.526	724117.282	3.087
18			65.190	1350	722546.058	724116.480	1.892
21	0.022	4.00	74.000	1200	722500.387	724240.013	1.350
22	0.022	4.00	70.200	1200	722504.603	724201.298	1.350
23	0.022	4.00	67.500	1200	722507.902	724148.413	1.350
23A			68.500	1200	722501.418	724171.442	1.151
24	0.022	4.00	66.790	1200	722516.099	724129.948	2.772
31			64.400	1350	722521.815	724116.287	2.900
32			63.200	1350	722522.946	724076.195	2.944
Headwall			58.500	1350	722535.853	724075.459	0.575
30_Tank D	0.030	4.00	64.400		722528.941	724121.573	2.250
3	0.079	4.00	75.800	1200	722597.558	724291.404	2.177
Permeable paving	0.050	4.00	63.828		722525.445	724095.728	0.528
33			63.100	1350	722525.744	724075.958	4.163
5	0.079	4.00	74.800	1200	722638.098	724324.071	1.516
19	0.022	4.00	75.500	1200	722523.049	724268.133	1.350
20	0.015	4.00	74.200	1200	722498.589	724253.649	1.350
25	0.015	4.00	67.840	650	722642.593	724134.125	1.350
26	0.015	4.00	66.000	650	722625.468	724122.470	1.350
27	0.015	4.00	66.000	650	722600.155	724113.228	1.618
28	0.015	4.00	64.800	650	722543.173	724112.472	0.988
29			65.000	1200	722537.898	724119.390	1.350
1	0.009	4.00	75.000	1200	722613.653	724354.352	1.025
2	0.009	4.00	75.500	1200	722590.598	724299.010	1.825
3A			75.300	1200	722615.004	724288.921	1.765

Links (Input)

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.015	33	Headwall	10.121	0.600	58.937	57.925	1.012	10.0	375	8.54	0.0
1.013	31	32	40.108	0.600	61.500	60.256	1.244	32.2	375	8.48	49.3
1.012	18	31	24.244	0.600	63.298	62.692	0.606	40.0	375	8.27	49.9
5.007	30_Tank D	31	8.873	0.600	62.150	61.650	0.500	17.7	225	5.80	50.0
5.006	24	30_Tank D	15.332	0.600	64.018	63.450	0.568	27.0	150	5.32	50.0
5.005	23	24	20.203	0.600	66.150	65.477	0.673	30.0	150	5.19	50.0
5.003	22	23A	30.025	0.600	68.850	67.349	1.501	20.0	150	4.83	50.0
5.004	23A	23	23.924	0.600	67.349	66.150	1.199	20.0	150	5.01	50.0
5.002	21	22	38.944	0.600	72.650	68.850	3.800	10.2	150	4.61	50.0
4.000	17_Tank C	18	48.772	0.600	64.600	63.373	1.227	39.7	375	4.28	50.0
1.011	16	18	53.474	0.600	63.623	63.298	0.325	164.5	300	8.13	50.0
1.010	15_Tank B	16	15.173	0.600	63.850	63.698	0.152	100.0	300	7.40	50.0
1.009	14	15_Tank B	14.237	0.600	65.355	64.643	0.712	20.0	225	7.24	50.0
1.008	13	14	24.496	0.600	66.900	65.355	1.545	15.9	225	7.16	50.0
1.007	12	13	55.013	0.600	69.200	67.825	1.375	40.0	225	7.03	50.0
1.006	11	12	48.492	0.600	70.186	69.200	0.986	49.2	225	6.59	50.0
1.004	6_Tank A	10	51.273	0.600	73.087	71.000	2.087	24.6	225	5.99	50.0
1.005	10	11	23.298	0.600	70.925	70.186	0.739	31.5	225	6.16	50.0
3.002	9	10	23.225	0.600	71.485	70.925	0.560	41.5	225	4.68	50.0
3.001	8	9	18.711	0.600	71.647	71.485	0.162	115.5	225	4.49	50.0
3.000	7	8	33.774	0.600	72.807	71.647	1.160	29.1	225	4.23	50.0
2.001	5	6_Tank A	39.461	0.600	73.284	73.087	0.197	200.0	225	5.04	50.0
1.002	3	3A	17.622	0.600	73.623	73.535	0.088	200.0	225	5.59	50.0
2.000	4	5	18.172	0.600	73.375	73.284	0.091	200.0	225	4.33	50.0
6.000	25	26	20.715	0.600	66.490	64.650	1.840	11.3	150	4.11	50.0
6.001	26	27	26.947	0.600	64.650	64.382	0.268	100.6	150	4.56	50.0
6.002_1	27	28	56.987	0.600	64.382	63.812	0.570	100.0	150	5.51	50.0
6.003	28	29	8.700	0.600	63.812	63.650	0.162	53.7	150	5.61	50.0
6.004	29	30_Tank D	9.219	0.600	63.650	63.535	0.115	80.0	150	5.75	50.0
5.000	19	20	28.427	0.600	74.150	72.850	1.300	21.9	150	4.22	50.0
5.001	20	21	13.754	0.600	72.850	72.650	0.200	68.8	150	4.41	50.0
1.000	1	2	59.952	0.600	73.975	73.675	0.300	200.0	225	5.09	50.0
1.001	2	3	10.310	0.600	73.675	73.623	0.052	200.0	225	5.27	50.0
6.002	3A	6_Tank A	4.787	0.600	73.535	73.506	0.029	165.1	225	5.67	50.0
7.000	Permeable paving	33	19.772	0.600	63.300	62.311	0.989	20.0	150	4.15	50.0
1.014	32	33	2.808	0.600	60.256	60.242	0.014	200.0	375	8.51	0.0

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal
FSR Region	England and Wales	Skip Steady State	x
M5-60 (mm)	16.400	Drain Down Time (mins)	240
Ratio-R	0.272	Additional Storage (m^3/ha)	20.0
Summer CV	0.750	Check Discharge Rate(s)	x
Winter CV	0.840	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

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

Node Headwall Surcharged Outfall

Overrides Design Area	x	Depression Storage Area (m²)	0	Evapo-transpiration (mm/day)	0
Overrides Design Additional Inflow	x	Depression Storage Depth (mm)	0		

Applies to All storms

Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)	Time (mins)	Depth (m)
0	1.500	120	1.500	240	1.500	360	1.500
60	1.500	180	1.500	300	1.500		

Node 6_Tank A Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	73.087	Product Number	CTL-SHE-0066-2000-1075-2000
Design Depth (m)	1.075	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node 15_Tank B Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	63.850	Product Number	CTL-SHE-0074-3000-1600-3000
Design Depth (m)	1.600	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	3.0	Min Node Diameter (mm)	1200

Node 17_Tank C Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	64.600	Product Number	CTL-SHE-0088-3700-1200-3700
Design Depth (m)	1.200	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	3.7	Min Node Diameter (mm)	1200

Node 30_Tank D Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	62.150	Product Number	CTL-SHE-0050-1400-1600-1400
Design Depth (m)	1.600	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	1.4	Min Node Diameter (mm)	1200

Node 33 Online Hydro-Brake® Control

Flap Valve	✓	Objective	(HE) Minimise upstream storage
Downstream Link	1.015	Sump Available	✓
Replaces Downstream Link	✓	Product Number	CTL-SHE-0104-8800-4000-8800
Invert Level (m)	58.937	Min Outlet Diameter (m)	0.150
Design Depth (m)	4.000	Min Node Diameter (mm)	1200
Design Flow (l/s)	8.8		

Node 30_Tank D Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	62.150
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.96	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	97.5	0.0	1.600	97.5	0.0	1.601	0.0	0.0

Node 6_Tank A Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	73.125
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.96	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	190.0	0.0	1.075	190.0	0.0	1.076	0.0	0.0

Node 15_Tank B Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	64.050
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.96	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	140.0	0.0	1.600	140.0	0.0	1.601	0.0	0.0

Node 17_Tank C Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	64.650
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	945.0	0.0	1.200	945.0	0.0	1.201	0.0	0.0

Node Permeable paving Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	63.300
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	0

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	50.0	0.0	0.300	50.0	0.0	0.301	0.0	0.0

Results for 30 year Critical Storm Duration. Lowest mass balance: 98.40%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute winter	17_Tank C	1380	65.260	0.660	24.5	589.0435	0.0000	SURCHARGED
15 minute winter	7	10	72.851	0.044	8.0	0.0674	0.0000	OK
15 minute winter	8	10	71.759	0.112	22.0	0.2121	0.0000	OK
15 minute winter	9	10	71.593	0.108	34.6	0.1968	0.0000	OK
15 minute winter	10	10	71.026	0.101	39.4	0.1304	0.0000	OK
600 minute winter	4	570	73.664	0.289	2.6	0.6465	0.0000	SURCHARGED
600 minute winter	6_Tank A	570	73.663	0.576	10.6	99.3720	0.0000	SURCHARGED
15 minute winter	11	10	70.327	0.141	52.4	0.2561	0.0000	OK
15 minute winter	12	11	69.353	0.153	65.2	0.2825	0.0000	OK
15 minute winter	13	10	67.025	0.125	75.5	0.1962	0.0000	OK
15 minute winter	14	11	65.504	0.149	75.4	0.1681	0.0000	OK
1440 minute winter	15_Tank B	1350	64.932	1.082	7.2	119.8858	0.0000	SURCHARGED
60 minute summer	16	9	63.658	0.035	2.5	0.0401	0.0000	OK
8640 minute summer	18	6120	63.335	0.037	6.2	0.0525	0.0000	OK
15 minute winter	21	10	72.704	0.054	15.3	0.0780	0.0000	OK
15 minute winter	22	10	68.930	0.080	20.9	0.1160	0.0000	OK
15 minute winter	23	10	66.258	0.108	26.4	0.1578	0.0000	OK
15 minute winter	23A	10	67.426	0.077	20.8	0.0866	0.0000	OK
15 minute winter	24	10	64.137	0.118	31.5	0.1529	0.0000	OK
480 minute winter	31	312	62.591	1.091	7.0	1.5609	0.0000	SURCHARGED
480 minute winter	32	320	62.590	2.334	7.0	3.3400	0.0000	SURCHARGED
15 minute summer	Headwall	1	59.425	1.500	6.6	0.0000	0.0000	OK
960 minute winter	30_Tank D	915	62.936	0.786	5.2	73.8171	0.0000	SURCHARGED
15 minute winter	3	10	73.765	0.142	24.3	0.2639	0.0000	OK
15 minute winter	Permeable paving	10	63.358	0.058	13.0	0.9858	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
1440 minute winter	17_Tank C	Hydro-Brake®	18	3.7				
15 minute winter	7	3.000	8	8.0	0.661	0.083	0.4251	
15 minute winter	8	3.001	9	22.0	1.136	0.454	0.3617	
15 minute winter	9	3.002	10	34.6	1.910	0.427	0.4206	
15 minute winter	10	1.005	11	39.2	1.797	0.422	0.5081	
600 minute winter	4	2.000	5	2.6	0.394	0.071	0.7227	
600 minute winter	6_Tank A	Hydro-Brake®	10	1.9				
15 minute winter	11	1.006	12	52.0	1.900	0.700	1.3280	
15 minute winter	12	1.007	13	63.7	2.266	0.773	1.5478	
15 minute winter	13	1.008	14	75.4	2.994	0.574	0.6175	
15 minute winter	14	1.009	15_Tank B	76.0	2.927	0.650	0.3693	
1440 minute winter	15_Tank B	Hydro-Brake®	16	2.5				
60 minute summer	16	1.011	18	2.5	0.599	0.029	0.2489	
8640 minute summer	18	1.012	31	6.2	1.137	0.020	0.1322	
15 minute winter	21	5.002	22	15.2	2.020	0.272	0.2946	
15 minute winter	22	5.003	23A	20.8	2.251	0.521	0.2781	
15 minute winter	23	5.005	24	25.8	1.978	0.793	0.2647	
15 minute winter	23A	5.004	23	20.7	1.817	0.517	0.2709	
15 minute winter	24	5.006	30_Tank D	31.1	2.154	0.905	0.2223	
480 minute winter	31	1.013	32	7.0	0.785	0.020	4.4238	
480 minute winter	32	1.014	33	8.2	0.599	0.058	0.3097	
960 minute winter	30_Tank D	Hydro-Brake®	31	1.0				
15 minute winter	3	1.002	3A	23.6	0.913	0.645	0.4558	
15 minute winter	Permeable paving	7.000	33	12.3	1.975	0.309	0.1236	

Results for 30 year Critical Storm Duration. Lowest mass balance: 98.40%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	33	312	62.589	3.652	9.4	5.2259	0.0000	SURCHARGED
600 minute winter	5	570	73.664	0.380	5.2	0.8248	0.0000	SURCHARGED
15 minute winter	19	10	74.189	0.039	5.7	0.0571	0.0000	OK
15 minute winter	20	10	72.926	0.076	9.6	0.1031	0.0000	OK
15 minute winter	25	10	66.518	0.028	3.9	0.0152	0.0000	OK
15 minute summer	26	10	64.720	0.070	7.8	0.0386	0.0000	OK
15 minute winter	27	10	64.470	0.088	11.7	0.0455	0.0000	OK
15 minute winter	28	11	63.905	0.093	15.3	0.0593	0.0000	OK
15 minute winter	29	11	63.752	0.102	14.9	0.1157	0.0000	OK
15 minute winter	1	10	74.012	0.037	2.3	0.0483	0.0000	OK
15 minute winter	2	10	73.767	0.092	4.5	0.1129	0.0000	OK
15 minute winter	3A	11	73.673	0.138	23.6	0.1566	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
480 minute winter	33	Hydro-Brake®	Headwall	7.9				279.8
600 minute winter	5	2.001	6_Tank A	4.8	0.223	0.131	1.5694	
15 minute winter	19	5.000	20	5.7	0.923	0.149	0.1796	
15 minute winter	20	5.001	21	9.6	1.313	0.446	0.1005	
15 minute winter	25	6.000	26	3.9	0.803	0.073	0.1056	
15 minute summer	26	6.001	27	7.8	0.835	0.441	0.2521	
15 minute winter	27	6.002_1	28	11.4	1.024	0.640	0.6330	
15 minute winter	28	6.003	29	14.9	1.232	0.613	0.1058	
15 minute winter	29	6.004	30_Tank D	15.0	1.209	0.757	0.1147	
15 minute winter	1	1.000	2	2.2	0.298	0.059	0.5826	
15 minute winter	2	1.001	3	5.8	0.387	0.160	0.2145	
15 minute winter	3A	6.002	6_Tank A	23.5	0.988	0.583	0.1140	

Results for 100 year +30% CC Critical Storm Duration. Lowest mass balance: 98.40%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
2160 minute winter	17_Tank C	2100	65.821	1.221	29.6	1129.5520	0.0000	SURCHARGED
15 minute winter	7	10	72.863	0.056	13.4	0.0871	0.0000	OK
15 minute winter	8	10	71.805	0.158	36.7	0.2994	0.0000	OK
15 minute summer	9	10	71.636	0.151	57.8	0.2746	0.0000	OK
15 minute winter	10	11	71.129	0.204	65.2	0.2625	0.0000	OK
720 minute winter	4	690	74.160	0.785	3.8	1.7585	0.0000	SURCHARGED
720 minute winter	6_Tank A	690	74.160	1.073	15.4	190.8337	0.0000	SURCHARGED
15 minute winter	11	11	70.862	0.676	82.6	1.2243	0.0000	SURCHARGED
15 minute winter	12	11	69.792	0.592	97.1	1.0941	0.0000	SURCHARGED
15 minute winter	13	9	67.062	0.162	108.0	0.2533	0.0000	OK
1440 minute winter	14	1380	65.645	0.290	10.4	0.3274	0.0000	SURCHARGED
1440 minute winter	15_Tank B	1380	65.644	1.794	10.4	216.3087	0.0000	SURCHARGED
1440 minute winter	16	1350	63.662	0.039	3.2	0.0447	0.0000	OK
2160 minute winter	18	2160	63.336	0.038	6.9	0.0550	0.0000	OK
15 minute winter	21	10	72.721	0.071	25.5	0.1034	0.0000	OK
15 minute summer	22	10	68.963	0.113	34.9	0.1653	0.0000	OK
15 minute winter	23	11	66.705	0.555	42.8	0.8092	0.0000	SURCHARGED
15 minute winter	23A	11	67.534	0.185	35.2	0.2091	0.0000	SURCHARGED
15 minute winter	24	12	64.683	0.665	46.5	0.8579	0.0000	SURCHARGED
240 minute winter	31	152	63.101	1.601	7.2	2.2912	0.0000	SURCHARGED
240 minute winter	32	160	63.102	2.846	7.6	4.0719	0.0000	FLOOD RISK
15 minute summer	Headwall	1	59.425	1.500	6.8	0.0000	0.0000	OK
960 minute winter	30_Tank D	930	63.689	1.539	8.7	144.4459	0.0000	SURCHARGED
720 minute winter	3	690	74.160	0.537	4.6	0.9971	0.0000	SURCHARGED
15 minute winter	Permeable paving	10	63.379	0.079	21.6	1.3346	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
2160 minute winter	17_Tank C	Hydro-Brake®	18	3.7				
15 minute winter	7	3.000	8	13.4	0.728	0.138	0.6358	
15 minute winter	8	3.001	9	36.6	1.286	0.758	0.5435	
15 minute summer	9	3.002	10	58.0	2.081	0.717	0.6904	
15 minute winter	10	1.005	11	60.6	1.868	0.652	0.9045	
720 minute winter	4	2.000	5	3.6	0.394	0.099	0.7227	
720 minute winter	6_Tank A	Hydro-Brake®	10	2.0				
15 minute winter	11	1.006	12	75.1	1.974	1.010	1.9286	
15 minute winter	12	1.007	13	89.2	2.243	1.082	2.1873	
15 minute winter	13	1.008	14	108.3	3.142	0.825	0.8546	
1440 minute winter	14	1.009	15_Tank B	10.4	1.743	0.089	0.5662	
1440 minute winter	15_Tank B	Hydro-Brake®	16	3.2				
1440 minute winter	16	1.011	18	3.2	0.599	0.037	0.2842	
2160 minute winter	18	1.012	31	6.9	1.169	0.022	0.3295	
15 minute winter	21	5.002	22	25.4	2.259	0.455	0.4365	
15 minute summer	22	5.003	23A	35.1	2.458	0.877	0.4518	
15 minute winter	23	5.005	24	38.4	2.182	1.179	0.3521	
15 minute winter	23A	5.004	23	33.3	1.923	0.833	0.4212	
15 minute winter	24	5.006	30_Tank D	45.1	2.560	1.311	0.2672	
240 minute winter	31	1.013	32	7.6	0.789	0.021	4.4238	
240 minute winter	32	1.014	33	8.5	0.602	0.061	0.3097	
960 minute winter	30_Tank D	Hydro-Brake®	31	1.1				
720 minute winter	3	1.002	3A	4.6	0.600	0.125	0.7008	
15 minute winter	Permeable paving	7.000	33	20.9	2.256	0.522	0.1829	

Results for 100 year +30% CC Critical Storm Duration. Lowest mass balance: 98.40%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
480 minute winter	33	288	63.100	4.163	9.0	5.9573	0.8236	FLOOD
720 minute winter	5	690	74.160	0.876	7.4	1.9036	0.0000	SURCHARGED
15 minute winter	19	10	74.201	0.051	9.5	0.0743	0.0000	OK
15 minute winter	20	10	72.956	0.106	16.0	0.1438	0.0000	OK
15 minute winter	25	10	66.525	0.035	6.5	0.0196	0.0000	OK
15 minute summer	26	10	64.745	0.095	13.0	0.0528	0.0000	OK
15 minute winter	27	11	64.583	0.201	19.5	0.1038	0.0000	SURCHARGED
15 minute winter	28	11	64.019	0.207	23.6	0.1316	0.0000	SURCHARGED
15 minute winter	29	11	63.833	0.183	22.2	0.2071	0.0000	SURCHARGED
720 minute winter	1	690	74.160	0.185	0.4	0.2417	0.0000	OK
720 minute winter	2	690	74.160	0.485	0.8	0.5965	0.0000	SURCHARGED
720 minute winter	3A	690	74.160	0.625	4.6	0.7068	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
480 minute winter	33	Hydro-Brake®	Headwall	8.5				309.1
720 minute winter	5	2.001	6_Tank A	7.3	0.252	0.199	1.5694	
15 minute winter	19	5.000	20	9.5	1.033	0.249	0.2647	
15 minute winter	20	5.001	21	16.0	1.474	0.744	0.1482	
15 minute winter	25	6.000	26	6.5	0.888	0.122	0.1549	
15 minute summer	26	6.001	27	13.0	0.926	0.736	0.3833	
15 minute winter	27	6.002_1	28	17.1	1.078	0.965	1.0032	
15 minute winter	28	6.003	29	22.2	1.295	0.914	0.1532	
15 minute winter	29	6.004	30_Tank D	22.2	1.260	1.115	0.1577	
720 minute winter	1	1.000	2	0.4	0.238	0.011	2.2393	
720 minute winter	2	1.001	3	0.8	0.186	0.022	0.4100	
720 minute winter	3A	6.002	6_Tank A	4.4	0.632	0.109	0.1904	

H. Urban Creep Factor Confirmation email

Laura Ruiz Garrido

From: Cunniffe John <jcunniffe@DLRCOCO.IE>
Sent: Thursday 31 March 2022 14:40
To: Laura Ruiz Garrido; Codd Johanne
Subject: RE: 20-040 Urban Creep Factor

Hi Laura,

I can confirm for this specific site that the urban creep factor can be omitted.

Regards,

John

From: Laura Ruiz Garrido <L.Ruiz@waterman-moylan.ie>
Sent: Wednesday 30 March 2022 16:26
To: Codd Johanne <jcodd@DLRCOCO.IE>
Cc: Cunniffe John <jcunniffe@DLRCOCO.IE>
Subject: 20-040 Urban Creep Factor

Hi Johanne,

I am writing to you regarding an SHD in Barrington, Brennanstown Road. The proposed development is an apartment complex over a basement with a podium level.

We have not applied an urban creep factor of 1.1 to the drainage design since, as mentioned above, the development is composed of apartment blocks that will be managed by a private management company and there will not be an opportunity for the residents to add hardstanding areas to the development. Can you confirm that this approach is ok in this case?

Thank you

Regards,

Laura Ruiz Garrido
Project Engineer
Waterman Moylan

Block S, EastPoint Business Park,
Alfie Byrne Road, Dublin D03 H3F4
t + 353 1 664 8900
www.waterman-moylan.ie | LinkedIn | Twitter | YouTube

I. Attenuation Tank Loading Calculations

Project	BARRINGTON SHD				
Revision	R0	Date	10/03/2022		
Description	1.075m PLUVIAL CUBE TANK A				
Draiange Layout No.	BRR-WM-ZZ-00-DR-C-P200 / R(-)				
Contractor					
Tank Information (m)	Tank Depth	BOT	TOT	CL	Cover
	1.075	73.087	74.162	75.300	1.138
				74.762	0.600
Groundwater (m)	0.00			TBC	MIN.
	TBC				

Load Distribution on Pluvial Cube (Vertical Load)

Strength of Pluvial Cube modules

Compressive Strength P_{ck} = 317 kN/m^2

Partial factor of safety for materials (Υ_m) = 2.75

Allowable load on Pluvial Cube modules = 115.27 kN/m^2

Weight of cover fill and surcharge load over Pluvial Cube module

Unit weight Backfill (Υa)	=	20	kN/m^3	*Backfill Materials must be well compacted & finishing surface must be finished with suitable materials for trafficed areas*
Depth of Backfill (z1)	=	1.138	m	
Depth of Backfill (z2)		0.600	m	
Surcharge load	=	5	kN/m^2	
Load from each wheel	=	0.15	tons	*Drive on mowers*
(Pedestrian footpath or Landscaped area where drive on mowers used)	=	1.5	kN	*GVW DIN 1072 Classification None)*

Area of applied load on Pluvial Cube modules

Considering the soil is well compacted, the load distribution to be (degrees): 26.5

Depth of cover on the modules	(D_1)	=	1.138	m Max.
	(D_2)		0.600	m Min.

Considering the area of contact of the wheel and the road is 150 x 150 mm

L (m) = 0.15
B (m) = 0.15

The total area of load applied on the modules = 0.57 + 0.15 + 0.57 m
0.57 + 0.15 + 0.57 m

B` = 1.288 m
L` = 1.288 m

Contact area **A'** = **1.29 x 1.29 m**

The total area of load applied on the modules = 0.3 + 0.15 + 0.3 m
0.3 + 0.15 + 0.3 m

B` = 0.75 m
L` = 0.75 m

Contact area **A'** = **0.75 x 0.75 m**

$Q`_w$= 1.5 kN

Equivalent pressure per wheel at a depth of (D_1)

$$Q`_w = \frac{Q_W}{B` \times L`}$$

$Q`_w$=

$\boldsymbol{Q`_w}$= 0.9 kN/m^2 ***Max. Cover***

$Q`_w$= 2.7 kN/m^2 ***Min. Cover***

Additional UDL = 5 kN/m^2 *Landscaped*

$$Q_{max,k} = Q_{OL} + Additiional\ UDL$$

$Q_{max,k}$ = 5.9 kN/m^2 ***Max. Cover***

$Q_{max,k}$ = 7.7 kN/m^2 ***Min. Cover***

Calculation of design Factors of safety

Permanent Action unfavourable loading $\gamma_G =$ 1.4

Variable Action unfavourable loading $\gamma_Q =$ 1.6

Dynamic Factor for z1 = 1

Dynamic Factor for z2 = 1
(Dynamic Factor for z1 & z2/ Speed < 15mph)

Design vertical traffic loading:

$$Q_b = (\Upsilon a \times z1 \times \gamma_G) + (Q_{max,k} \times \gamma_Q)$$

$$Q_b = (\Upsilon a \times z2 \times \gamma_G) + (Q_{max,k} \times \gamma_Q)$$

= **41.31** **kN/m²** **<** **115.27** **kN/m²**

= **29.07** **kN/m²** **<** **115.27** **kN/m²**

Loading design is safe ***Allowable load with F.O.S***

CALCULATION OF HORIZONTAL EARTH PRESSURE LOADING (ULS)

Compressive strength of Pluvial Cube modules

Compressive Strength	P_{ck}	=	201 kN/m^2
Partial factor of safety for materials (F_m)		=	2.75
Allowable load on Pluvial Cube modules		=	**73.09 kN/m^2**

Horizontal earth pressure on Pluvial Cube Modules

Total horizontal pressure =

Where,
Ka - is the co-efficient of active earth pressure = (1 - sinΦ) / (1 + sinΦ)
Φ - angle of shearing resistance of soil
d - is the height of fill material till the base of the tank, m
y - is the unit weight of fill material, kN/m^3
w - water pressure
$\sigma_{surcharge\ load}$ - is the surcharge load, kN/m^2

Considering the soil is well compacted, the load distribution to be 30^0
(Soil type assumed loss sand and gravel - TBC By Engineer)

Co-efficient of active earth pressure (Ka) = (1 - sinΦ) / (1 + sinΦ)
= (1 - sin30^o) / (1 + sin30^o)
= 0.333

Unit weight fill material (y)	=	20	kN/m^3
Depth of fill till the (d) bottom of the tank	=	2.213	m
		1.675	m
Water pressure (W)	=	0	kN/m^2

Assumed NO Groundwater - TBC by engineer or site team.

Surcharge load ($\sigma_{surcharge\ load}$)	=	5	kN/m^2

Partial factors applied to loading:

Permanent unfavourable loading $\gamma_G = 1.35$

Variable unfavourable loading, $\gamma_Q = 1.5$

Dynamic factor for speed γ_{DF} 1.0
(Dynamic Factor for Speed < 15mph)

Site importance factor for Class 1 site for ULS calculation γ_{SF} 1.0

Total horizontal pressure(σ_h) on module =

$$\sigma' h, a = Ka \; x \; [(\gamma \; x \; d) + \sigma surcharge \; load]$$

Including partial factors γ_{DF} , γ_{SF}, γ_G and γ_Q

$$\sigma' h, a = Ka \; x \; \gamma_{DF} \; x \; \gamma_{SF} \; x \; [(\gamma \; x \; d \; x \; \gamma_G) + (\sigma surcharge \; x \; \gamma_Q]$$

= (0.333 x (20 x 2.21)) + 0 + (0.333 x 5)

= (0.333 x (20 x 1.67)) + 0 + (0.333 x 5)

Design load on the module =

Max. Cover	**22.40**	**kN/m²**	**<**	**73.09** **kN/m²**
Min. Cover	**17.56**	**kN/m²**	**<**	**73.09** **kN/m²**
	Loading design is safe			***Allowable load with F.O.S***

Note:-The above calculations only apply when the relevant system is installed and signed off by an accredited contractor using Alderburgh membrane and connections.

Project	BARRINGTON SHD				
Revision	R0	**Date**	10/03/2022		
Description	1.6m PLUVIAL CUBE TANK B				
Draiange Layout No.	BRR-WM-ZZ-00-DR-C-P200 / R(-)				
Contractor					
Tank Information (m)	**Tank Depth**	**BOT**	**TOT**	**CL**	**Cover**
	1.6	63.850	65.450	66.250	0.800
				66.050	0.600
Groundwater (m)	0.00			*TBC*	*MIN.*
	TBC				

Load Distribution on Pluvial Cube (Vertical Load)

Strength of Pluvial Cube modules

Compressive Strength P_{ck} = 317 kN/m^2

Partial factor of safety for materials (Υ_m) = 2.75

Allowable load on Pluvial Cube modules = 115.27 kN/m^2

Weight of cover fill and surcharge load over Pluvial Cube module

Unit weight Backfill (Υa)	=	20	kN/m^3	*Backfill Materials must be well compacted & finishing surface must be finished with suitable materials for trafficed areas*
Depth of Backfill (z1)	=	0.800	m	
Depth of Backfill (z2)		0.600	m	
Surcharge load	=	5	kN/m^2	
Load from each wheel	=	0.15	tons	*Drive on mowers*
(Pedestrian footpath or Landscaped area where drive on mowers used)	=	1.5	kN	*GVW DIN 1072 Classification None)*

Area of applied load on Pluvial Cube modules

Considering the soil is well compacted, the load distribution to be (degrees): 26.5

Depth of cover on the modules (D_1) = 0.800 m Max.

(D_2) = 0.600 m Min.

Considering the area of contact of the wheel and the road is 150 x 150 mm

L (m) = 0.15

B (m) = 0.15

The total area of load applied on the modules = 0.4 + 0.15 + 0.4 m
0.4 + 0.15 + 0.4 m

B` = 0.950 m

L` = 0.950 m

Contact area **A'** = **0.95 x 0.95 m**

The total area of load applied on the modules = 0.3 + 0.15 + 0.3 m
0.3 + 0.15 + 0.3 m

B` = 0.75 m

L` = 0.75 m

Contact area **A'** = **0.75 x 0.75 m**

$Q`_w$= 1.5 kN

Equivalent pressure per wheel at a depth of (D_1)

$Q`_w = \frac{Q_W}{B` \times L`}$

$Q`_w$=

$\boldsymbol{Q`_w}$= 1.7 kN/m^2 ***Max. Cover***

$Q`_w$= 2.7 kN/m^2 ***Min. Cover***

Additional UDL = 5 kN/m^2 *Landscaped*

$$Q_{max,k} = Q_{OL} + Additiional\ UDL$$

$Q_{max,k}$ = 6.7 kN/m^2 ***Max. Cover***

$Q_{max,k}$ = 7.7 kN/m^2 ***Min. Cover***

Calculation of design Factors of safety

Permanent Action unfavourable loading	$\gamma_G =$	1.4
Variable Action unfavourable loading	$\gamma_Q =$	1.6
Dynamic Factor for z1	=	1
Dynamic Factor for z2	=	1

(Dynamic Factor for z1 & z2/ Speed < 15mph)

Design vertical traffic loading:

$$Q_b = (\Upsilon a \times z1 \times \gamma_G) + (Q_{max,k} \times \gamma_Q)$$

$$Q_b = (\Upsilon a \times z2 \times \gamma_G) + (Q_{max,k} \times \gamma_Q)$$

=	**33.06**	**kN/m²**	**<**	**115.27** **kN/m²**
=	**29.07**	**kN/m²**	**<**	**115.27** **kN/m²**
	Loading design is safe			***Allowable load with F.O.S***

CALCULATION OF HORIZONTAL EARTH PRESSURE LOADING (ULS)

Compressive strength of Pluvial Cube modules

Compressive Strength P_{ck} = 201 kN/m^2

Partial factor of safety for materials (F_m) = 2.75

Allowable load on Pluvial Cube modules = **73.09 kN/m^2**

Horizontal earth pressure on Pluvial Cube Modules

Total horizontal pressure =

Where,
Ka - is the co-efficient of active earth pressure = (1 - sinΦ) / (1 + sinΦ)
Φ - angle of shearing resistance of soil
d - is the height of fill material till the base of the tank, m
y - is the unit weight of fill material, kN/m^3
w - water pressure
$\sigma_{surcharge\ load}$ - is the surcharge load, kN/m^2

Considering the soil is well compacted, the load distribution to be 30^0
(Soil type assumed loss sand and gravel - TBC By Engineer)

Co-efficient of active earth pressure (Ka) = (1 - sinΦ) / (1 + sinΦ)

= (1 - sin30^o) / (1 + sin30^o)

= 0.333

Unit weight fill material (y) = 20 kN/m^3

Depth of fill till the (d) bottom of the tank = 2.400 m

2.200 m

Water pressure (W) = 0 kN/m^2
Assumed NO Groundwater - TBC by engineer or site team.

Surcharge load ($\sigma_{surcharge\ load}$) = 5 kN/m^2

Partial factors applied to loading:

Permanent unfavourable loading $\gamma_G = 1.35$

Variable unfavourable loading, $\gamma_Q = 1.5$

Dynamic factor for speed γ_{DF} 1.0
(Dynamic Factor for Speed < 15mph)

Site importance factor for Class 1 site for ULS calculation γ_{SF} 1.0

Total horizontal pressure(σ_h) on module =

$$\sigma' h, a = Ka \; x \; [(\gamma \; x \; d) + \sigma surcharge \; load]$$

Including partial factors γ_{DF} , $\gamma_{SF,}$ γ_G and γ_Q

$$\sigma' h, a = Ka \; x \; \gamma_{DF} \; x \; \gamma_{SF} \; x \; [(\gamma \; x \; d \; x \; \gamma_G) + (\sigma surcharge \; x \; \gamma_Q]$$

= (0.333 x (20 x 2.4)) + 0 + (0.333 x 5)

= (0.333 x (20 x 2.2)) + 0 + (0.333 x 5)

Design load on the module =

Max. Cover	**24.08**	**kN/m²**	**<**	**73.09** **kN/m²**
Min. Cover	**22.28**	**kN/m²**	**<**	**73.09** **kN/m²**
	Loading design is safe			***Allowable load with F.O.S***

Note:-The above calculations only apply when the relevant system is installed and signed off by an accredited contractor using Alderburgh membrane and connections.

Project	BARRINGTON SHD				
Revision	R0	**Date**	10/03/2022		
Description	1.6m PLUVIAL CUBE TANK D				
Draiange Layout No.	BRR-WM-ZZ-00-DR-C-P200 / R(-)				
Contractor					
Tank Information (m)	**Tank Depth**	**BOT**	**TOT**	**CL**	**Cover**
	1.6	62.150	63.750	64.400	0.650
				64.350	0.600
Groundwater (m)	0.00			*TBC*	*MIN.*
	TBC				

Load Distribution on Pluvial Cube (Vertical Load)

Strength of Pluvial Cube modules

Compressive Strength P_{ck} = 317 kN/m^2

Partial factor of safety for materials (Υ_m) = 2.75

Allowable load on Pluvial Cube modules = 115.27 kN/m^2

Weight of cover fill and surcharge load over Pluvial Cube module

Unit weight Backfill (Υa)	=	20	kN/m^3	*Backfill Materials must be well compacted & finishing surface must be finished with suitable materials for trafficed areas*
Depth of Backfill (z1)	=	0.650	m	
Depth of Backfill (z2)		0.600	m	
Surcharge load	=	5	kN/m^2	
Load from each wheel	=	0.15	tons	*Drive on mowers GVW DIN 1072 Classification None)*
(Pedestrian footpath or Landscaped area where drive on mowers used)	=	1.5	kN	

Area of applied load on Pluvial Cube modules

Considering the soil is well compacted, the load distribution to be (degrees): 26.5

Depth of cover on the modules	(D_1)	=	0.650	m Max.
	(D_2)		0.600	m Min.

Considering the area of contact of the wheel and the road is 150 x 150 mm

L (m) = 0.15
B (m) = 0.15

The total area of load applied on the modules = 0.33 + 0.15 + 0.33 m
0.33 + 0.15 + 0.33 m

B` = 0.800 m
L` = 0.800 m

Contact area **A'** = **0.8 x 0.8 m**

The total area of load applied on the modules = 0.3 + 0.15 + 0.3 m
0.3 + 0.15 + 0.3 m

B` = 0.75 m
L` = 0.75 m

Contact area **A'** = **0.75 x 0.75 m**

$Q`_w$= 1.5 kN

Equivalent pressure per wheel at a depth of (D_1)

$$Q`_w = \frac{Q_w}{B` \times L`}$$

$Q`_w$=
$\mathbf{Q`_w}$= 2.3 kN/m^2 ***Max. Cover***
$Q`_w$= 2.7 kN/m^2 ***Min. Cover***

Additional UDL = 5 kN/m^2 *Landscaped*

$$Q_{max,k} = Q_{OL} + Addittional\ UDL$$

$Q_{max,k}$ = 7.3 kN/m^2 ***Max. Cover***
$Q_{max,k}$ = 7.7 kN/m^2 ***Min. Cover***

Calculation of design Factors of safety

Permanent Action unfavourable loading	γ_G =	1.4
Variable Action unfavourable loading	γ_Q =	1.6
Dynamic Factor for z1	=	1
Dynamic Factor for z2	=	1

(Dynamic Factor for z1 & z2/ Speed < 15mph)

Design vertical traffic loading:

$$Q_b = (\Upsilon a \times z1 \times \gamma_G) + (Q_{max,k} \times \gamma_Q)$$

$$Q_b = (\Upsilon a \times z2 \times \gamma_G) + (Q_{max,k} \times \gamma_Q)$$

=	**29.95**	**kN/m^2**	**<**	**115.27** **kN/m^2**
=	**29.07**	**kN/m^2**	**<**	**115.27** **kN/m^2**
	Loading design is safe			***Allowable load with F.O.S***

CALCULATION OF HORIZONTAL EARTH PRESSURE LOADING (ULS)

Compressive strength of Pluvial Cube modules

Compressive Strength	P_{ck}	=	201 kN/m^2
Partial factor of safety for materials (F_m)		=	2.75
Allowable load on Pluvial Cube modules		=	**73.09 kN/m^2**

Horizontal earth pressure on Pluvial Cube Modules

Total horizontal pressure =

Where,
Ka - is the co-efficient of active earth pressure = (1 - sinΦ) / (1 + sinΦ)
Φ - angle of shearing resistance of soil
d - is the height of fill material till the base of the tank, m
y - is the unit weight of fill material, kN/m^3
w - water pressure
$\sigma_{surcharge\ load}$ - is the surcharge load, kN/m^2

Considering the soil is well compacted, the load distribution to be 30^0
(Soil type assumed loss sand and gravel - TBC By Engineer)

Co-efficient of active earth pressure (Ka) = (1 - sinΦ) / (1 + sinΦ)
= (1 - sin30^o) / (1 + sin30^o)
= 0.333

Unit weight fill material (y)	=	20	kN/m^3
Depth of fill till the (d) bottom of the tank	=	2.250	m
		2.200	m
Water pressure (W)	=	0	kN/m^2

Assumed NO Groundwater - TBC by engineer or site team.

Surcharge load ($\sigma_{surcharge\ load}$)	=	5	kN/m^2

Partial factors applied to loading:

Permanent unfavourable loading γ_G = 1.35

Variable unfavourable loading, γ_Q = 1.5

Dynamic factor for speed γ_{DF} 1.0
(Dynamic Factor for Speed < 15mph)

Site importance factor for Class 1 site for ULS calculation γ_{SF} 1.0

Total horizontal pressure(σ_h) on module =

$$\sigma'h, a = Ka\ x\ [(\gamma\ x\ d) + \sigma surcharge\ load]$$

Including partial factors γ_{DF} , γ_{SF}, γ_G and γ_Q

$$\sigma'h, a = Ka\ x\ \gamma_{DF}\ x\ \gamma_{SF}\ x\ [(\gamma\ x\ d\ x\ \gamma_G) + (\sigma surcharge\ x\ \gamma_Q]$$

= (0.333 x (20 x 2.25)) + 0 + (0.333 x 5)

= (0.333 x (20 x 2.2)) + 0 + (0.333 x 5)

Design load on the module =

Max. Cover	**22.73** **kN/m^2**	**<**	**73.09** **kN/m^2**
Min. Cover	**22.28** **kN/m^2**	**<**	**73.09** **kN/m^2**
	Loading design is safe		***Allowable load with F.O.S***

Note:-The above calculations only apply when the relevant system is installed and signed off by an accredited contractor using Alderburgh membrane and connections.

J. Go Car Letter of Consent

Cairn Homes
7 Grand Canal
Grand Canal Street Lower
Dublin 2

28/03/2022

To Whom It May Concern,

This is a letter to confirm that GoCar intends to provide a car sharing service in the “Barrington” residential development located just off the Brennanstown Road, Brenanstown, Cabinteely, Dublin. GoCar representatives have discussed the project with representatives of Cairn Homes and are excited to provide a car sharing service at this location. The development consists of approximately 534 dwellings within the Cabinteely area of Dublin. The developer proposes to have available 1 vehicle for public service at surface level within the development.

GoCar is Ireland’s leading car sharing service with over 60,000 members and over 850 cars and vans on fleet. Each GoCar which is placed in a community has the potential to replace the journeys of up to 15 private cars. The Department of Housing’s Design Standards for New Apartments - Guidelines for Planning Authorities 2018 outline: “For all types of location, where it is sought to eliminate or reduce car parking provision, it is necessary to ensure... provision is also to be made for alternative mobility solutions including facilities for car sharing club vehicles.”

Carsharing is a sustainable service. By allowing multiple people to use the same vehicle at different times, car sharing reduces car ownership, car dependency, congestion, noise, and air pollution. It frees up land which would otherwise be used for additional parking spaces. Most GoCar users only use a car when necessary and walk and use public transport more often than car owners.

By having GoCar car sharing vehicles in a development such as this, the residents therein will have access to pay-as-you-go driving, in close proximity to their homes, which will increase usership of the service.

I trust that this information is satisfactory. For any queries, please do not hesitate to contact me.

D Ralston

Daniel Ralston
Business Manager
GoCar Carsharing Ltd
Mobile: 086 0414 991
E: daniel.ralston@gocar.ie

UK and Ireland Office Locations