ROGER MULLARKEY & ASSOCIATES
CONSULTING STRUCTURAL and CIVIL ENGINEERS

DRAINAGE and WATER INFRASTRUCTURE ENGINEERING REPORT for a Residential Development at Boherboy, Saggart, Co. Dublin

PROJECT: **BOHERBOY - 1324B**
CLIENT: **DURKAN/KELLAND**
DATE: **FEB 2022**
ISSUE NO: **PLANNING**
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1.0 Introduction

1.1 This document relates to the Drainage and Water Infrastructure design for a proposed residential development located on greenfield lands at Boherboy, Saggart, Co. Dublin.

1.2 We, Roger Mullarkey & Associates, were appointed by Durkan Estates Ireland Ltd/Kelland Homes Ltd, to carry out the drainage and water supply infrastructure report to accompany the suite of other drawings and documentation relating to a proposed residential development at the above noted address. The report has authored by Roger Mullarkey *(BSc.Eng.Dip.Eng,C.Eng,MIEI,Eur.Ing, FconsEI)* who has over 27 years of consulting civil and structural engineering experience primarily in the residential housing market in Ireland.

1.3 The planning application will consist of 655No.residential units and a c.680m^2 of Crèche space and the associated ancillary roads, drainage, pumping and services infrastructure on a c.17.6Ha site. The residential units will consist of semi-detached and terraced houses, duplex apartments and 6No. apartment blocks. A full description of the application details are contained in the main application documentation noted by Fenton Associates Planning consultants and MCORM/Davey Smith Architects.

2.0 Key Objectives

2.1 This document relates to the Drainage and Water Infrastructure engineering that incorporates the design, background and detail of the following aspects.

- Road and Block Levels
- Storm Water Site Drainage
- Foul Water Site Drainage
- Sustainable Drainage Systems (SuDS)
- Attenuation
- Water Supply Infrastructure

2.2 In accordance with the OPW's *The Planning System and Flood Risk Management- Guidelines for Local Authorities 2009* (the Guidelines), Kilgallen & Partners Consulting Engineers have assessed and prepared a Site Specific Flood Risk Assessment (SSFRA) which forms part of the planning application. Mitigation measures proposed in detail in the SSFRA include the development of a flood compensatory area along the northern site boundary and the raising of the stream bank along the north-eastern boundary. The SSFRA concluded that implementation of the mitigation measures will increase the available flood storage capacity, that the application was subject to and passed the Development Management Justification Test as required under the Guidelines, that the proposed development will not be at risk of flooding and will not increase flood risk elsewhere and that the development is therefore appropriate from a flood risk perspective. Reference can be made to the separate SSFRA document that forms part of the overall planning submission documentation for greater detail in this regards.

2.3 Traffic/transportation assessments and the Boherboy Road upgrade are contained in the separate submission documentation by Pinnacle Consulting Engineers included in the overall planning submission.

2.4 Reference should be made to all drainage drawings and designs included in the Appendix of this report and all other consultant's reports and drawings as part of the overall application documentation.

2.5 This report will outline in detail that;

- The surface water drainage design incorporates several SuDS measures upstream of the 7No.below ground attenuation storage systems before outfalling the attenuated flows into the Corbally Stream bounding the site.
- The foul water drainage system outfalls by gravity flow into the existing Irish Water infrastructure located to the east of the subject site at

Verschoyle Green. The lower level north end of the site incorporates a pumping station to drain the apartment Blocks A and C via a rising main into the outfalling gravity pipe.

- Potable water supply is to be supplied from the existing 400mm DI Irish Water owned infrastructure on Boherboy Road to the south of the site

3.0 Site Location and Topography

3.1 The proposed development is located along the Boherboy Road, Saggart, Co. Dublin and the lands are zoned objective A1: *"To provide for new Residential Communities in accordance with approved Area Plans"* in the current South Dublin County Development Plan (CDP).

3.2 The site is currently a c.17.6Ha Greenfield with some remaining farm sheds/outbuildings. The site is located just south of the Carrigmore and just west of Corbally residential developments. To the north-west of the site lies the Saggart golf course and the Boherboy Road bounds the southern elevation of the subject lands.

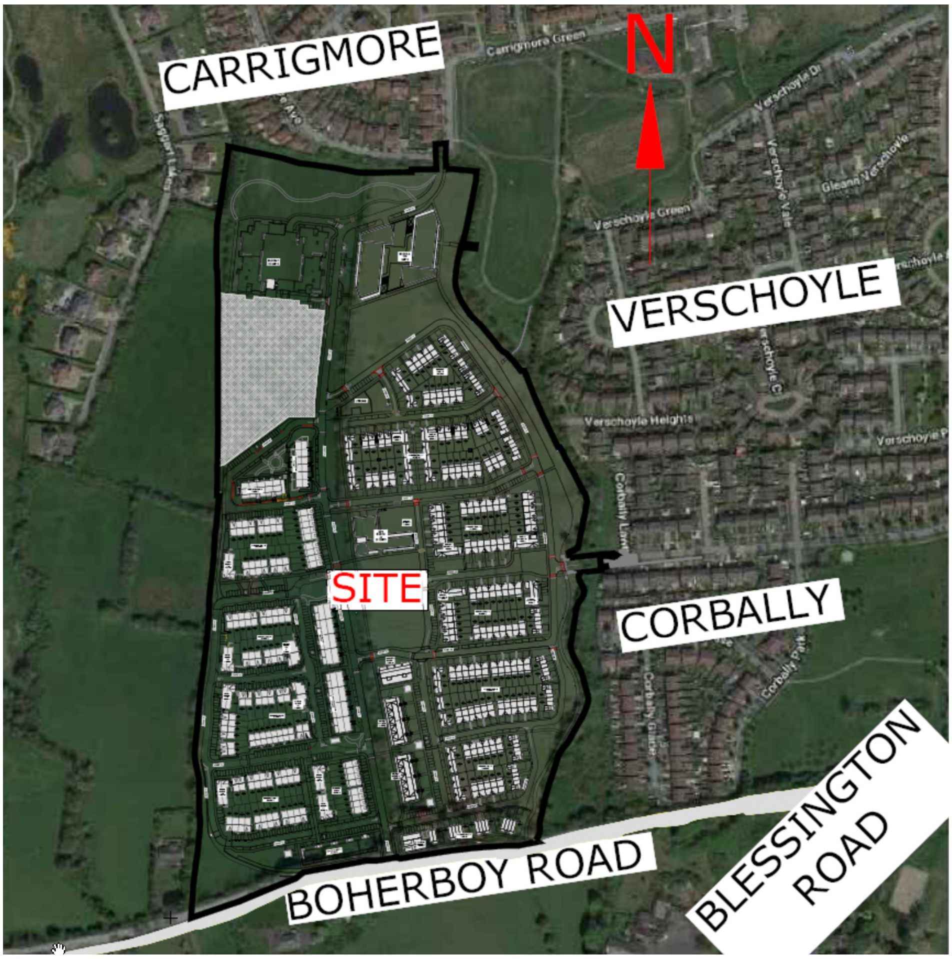


Fig. 1 – Site Location

3.3 A topographical survey was carried out on the site and indicates that the lands slopes sharply downwards from the south end of the site towards the north. The existing ground level gradients range from 1/7 to 1/30 generally. There is an approximate drop in level of 38m from the highest portion (SW) of the site to the lowest point (NW).

3.4 The existing ground topography forms a natural catchment with approximately 75% of the site draining towards the north-west and the remainder draining towards the north-east of the lands. All catchments drain to existing natural watercourses either side of the site.

3.5 A site survey drawing is included in the application and can be viewed as background on the Road & Block Levels drawing Dwg.No.'s 1324B/301-303.

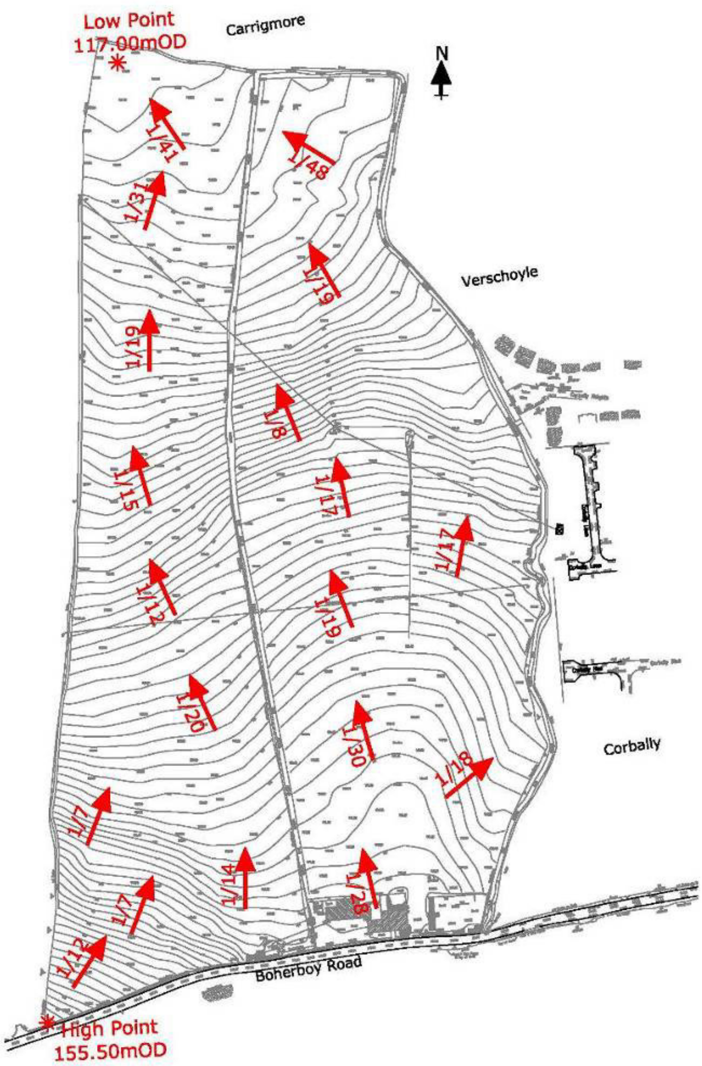


Fig.2 – Existing Topography

3.6 The site is bounded by a hedgerow and fencing to the southern edge along the Boherboy Road, by a treeline/hedgerow and dry open field ditch along the western boundary (Ref; Coldwater 09C62), by the Corbally open course stream (Ref; 09C10) and hedgerow facing onto the Corbally and Verschoyle residential schemes to the east and by the same open course stream along the northern boundary to hedgerows/trees to the northwest and north. There is also a dry local field ditch located centrally on the site and is referred to as the Cooldown (EPA code 09C60).

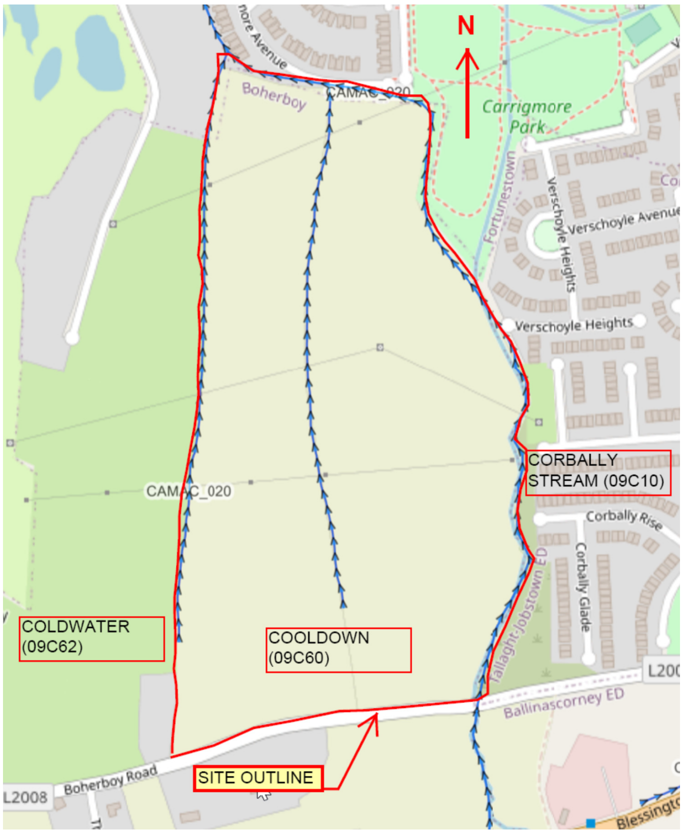


Fig.3 – EPA noted Existing Watercourses

3.7 A Road and Block levels design has been prepared as part of this application and reference should be made to Dwg.No.1324B/301-303 in this regards. Generally, the proposed road levels and house levels follow the existing contours of the site topography where possible.

3.8 Proposed road gradients vary between 1/120 (0.83%) and 1/14(7.1%) which are in accordance with the DOELG Recommendations for Site Development Works for Housing Areas and the Dept. Of Transport's Design Manual for Urban Roads and Streets (DMURS) documentation.

3.9 In relation to road gradients, the Design Manual for Urban Roads and Streets (DMURS) section 4.4.6 on page 112 states"...*vertical alignment should be considered at the network level as a response to the topography* *of a site".* As the existing topography of the subject site is steep up to a maximum gradient of 1/7 (14.3%), the proposed development will provide road gradients, in limited locations, of 1/14 (7.1%) is a *response to the topography of the site* and in accordance with the DMURS standards.

3.10 The DMURS document further allows that the normal recommended maximum gradient of 1/20 (5%) can be exceeded on "*hilly terrain*" up to a maximum of 1/12 (8.3%), section 4.4.6 on page 113. The subject application includes gradients in limited areas up to a maximum of 1/14 (7.1%) and is therefore in accordance with the DMURS standards document.

3.11 The DOELG Recommendations for Site Development Works for Housing Areas document allows road gradients to 1/10 (1%) vertical alignment and as noted above, the limited use of 1/14 (7.1%) gradients on the site is therefore in accordance with DOELG document.

3.12 Given that the existing topography in parts of the site are approximately 1/7 and 1/8, the proposed developments road gradients are an improvement on the existing topography and are in accordance with both the DOELG and DMURS documents.

3.13 A roads and DMURS compliance audit and road safety assessment (RSA) has been carried out by Pinnacle Consulting Engineers, which includes vehicle tracking and speed attenuation measures. The results of those studies are contained under separate heading and are included in the overall development application.

3.14 A Traffic and Transport Assessment study and report has been carried out by Pinnacle Consulting Engineers and is included in the overall application under separate heading and the reader is referred to that document for further information in that regards.

3.15 The proposed upgrade of the Boherboy Road and traffic access is detailed in the submission by Pinnacle Consulting Engineers.

3.16 The proposed development includes 4No.crossings of the Corbally Stream connecting the proposed development with the adjoining Corbally and Carrigmore housing estates and the public Carrigmore Park. These are discussed in further detail in Section 5.9 below and in greater detail in the SSFRA.

4.0 Existing Drainage and Water Services

4.1 Records drawings were obtained from SDCC/IW in preparation for this planning application and are included in Appendix 12.9 of this document.

4.2 There are no known public drainage services on the subject lands (refer to 4.8 and 4.9 below for watermains).

4.3 The proposed S/W outfall will be into the existing Corbally stream bounding the site.

4.4 There is no foul water sewer located on the subject lands. Therefore, it is proposed to service the subject lands by providing a new gravity foul sewer across the SDCC park to the southeast of the site connecting into the existing Irish Water (IW) foul infrastructure in Verschoyle Green. This has been agreed with Irish Water and approved by them under Ref.CDS20004359, see Appendix 12.12 of this document for Confirmation of Feasibility and Statement of Design Acceptance letters.

4.5 Due to the sloping topography of the subject lands it is not feasible to drain the apartment Blocks A and C or the potential future school site by gravity. Therefore, a foul water pumping station is proposed as part of this application to drain the above blocks from lower NE corner of the site into the gravity (4.4 above) sewer to be constructed connecting into Verschoyle Green. The foul pumping station is to be in accordance with the Irish Water Code of Practice for Wastewater Infrastructure 2020.

4.6 Irish Water have issued a Confirmation of Feasibility letter (refer to Appendix 12.12 of this document) for this planning application noting that the water connection is “*feasible without infrastructure upgrade*” and the wastewater connection is “*feasible subject to upgrades*”.

4.7 Following extensive consultation with Irish Water , detailed design and/drawing drawings were submitted IW subsequently confirmed their approval in issuing the Statement of Design acceptance letter (Ref.CDS20004359) dated 19/08/21. A copy of the IW design acceptance letter can be viewed in the Appendix 12.12 of this report.

4.8 Refer to Dwg.No.’s 1324B/307-309 and 323 for details of the proposed foul sewer infrastructure.

4.9 There are 3No.existing watermains (4inch uPVC/400mmDI/600mmDI) in Boherboy Road along the site frontage. This application proposes to make a new water connection to the Boherboy watermain in the Boherboy Road.

4.10 There are 5No.existing trunk watermains crossing the subject land. A 1.2m Ø (1982 Concrete), a 27inch Ø (1938 Steel) and a 24inch (AC 1975) lie parallel to each other in the northern third of the site and also a 1.2m Ø (1983 Concrete) and 24inch Ø (1952 Cast Iron) lie parallel approximately in the middle of the site. Please refer to drawing No.1324/201-203 for location of these existing trunk watermains.

4.11 These trunk watermains are in the control of Irish Water. The set-back requirements from these mains are in accordance with the Irish Water Code of Practice for Water Infrastructure 2020 document and extensive discussions were held with Irish Water relating to development in proximity to same. Based on those discussions and design/drawing submissions IW confirmed their approval in issuing the Statement of Design acceptance letter (Ref.CDS20004359) dated. A copy of the IW design acceptance letter can be viewed in the Appendix 12.12 of this report.

4.12 In order to precisely locate these existing trunk watermains, excavation of silt trenches was carried out with the permission of the then overseeing authority of Dublin City Council and South Dublin County Councils *EWCC Dept*. All mains were located, surveyed, mapped and the results issued to both SDCC, DCC and Irish Water for their records. Furthermore, recent GPR(ground penetrating radar) surveys were carried confirming the watermain locations offsite through the SDCC park to the NE of the subject lands. The surveyed location of the existing watermains are as shown on the submission drawings 1324B/301-312.

4.13 It was discovered during the excavations to precisely locate the existing trunk mains that one of the existing watermains (1.2m Ø 1982 main) was in a different location to that as was shown on the Local Authority records drawings. This records anomaly was brought to the attention of each of SDCC, DCC and Irish Water and the actual correct position of the 1.2m Ø 1982 main was surveyed-in and issued to all the relevant authorities. The correct and surveyed location of each the existing watermains are as shown on the submission drawings 1324B/301-312.

5.0 Surface Water Drainage Summary

5.1 As was requested by the SDCC Environment, Water and Climate Change Department (hitherto referred to as *EWCC Dept*.) during the Stage 1 and 2 pre-planning discussions, this Chapter 5 of the report is intended as an executive summary of the surface water drainage design. More detailed information on aspects relating to GDSDS compliance, SuDS measures, determination of Qbar and design calculations are discussed in Chapters 7, 8 and 9 and the Appendices 12.1-12.3, 12.5-12.11 and 12.14 of this report.

5.2 As part of the design of the storm water network and SuDS components, the following documentation were the principal references;

- South Dublin Council Development Plan 2016 – 2022
- CIRIA Report c753 "The SuDS Manual" 2015
- Greater Dublin Strategic Drainage Study (GDSDS) 2005
- The Greater Dublin Regional Code of Practice for Drainage Works
- DOELG Recommendations for Site Development Works for Housing Areas.
- SDCC Drainage and Water Records maps
- Available OPW flood maps and reports (from *floodmaps.ie*)
- OPW Eastern CFRAM study
- OPW PFRM mapping
- Geological Survey of Ireland (GSI) website
- Teagasc soils data sets
- Ordnance Survey mapping
- Topographical survey
- Site Investigation reports
- Site walkover visits
- Discussions with SDCC *EWCC Dept*. *("water & drainage")*
- Discussions with DCC Water Department
- Discussions/correspondence with Irish Water

5.3 The design of the storm water network has been carried out in accordance with and in conjunction with the requirements of South Dublin County *EWCC Dept*. as were ascertained in meetings and discussions as part of the pre-planning process. During the Pre-App process, a full set of RMA documentation and drawings were submitted to the SDCC *EWCC Dept*. for their review. After their review, SDCC determined that the drainage proposals were agreed.

5.4 The Stage 2 pre-application review carried out by the SDCC *EWCC Dept*. noted a number of observations as published in their Surface Water Report dated 21/10/20.

5.5 Each of the observations made in that report have been addressed and agreed with the *EWCC Dept*. during Sept'21. The following is a summary of the observations and response to same;

SDCC Water Services (*EWCC Dept.*) - Surface Water Report Observations		
Ref.	Summary	Response
1.1	Detailed breakdown of surface types for each sub-catchment to be submitted and agreed	Completed, submitted and agreed. Refer to paragraph 5.30
1.2	Submit summary table of storage volumes	Completed, submitted and agreed. Refer to paragraph 5.30
1.3	Clarify site area – v – drained area for determination Qbar	Noted that Qbar is calculated based on surfaces draining into the surface water system and does not include grassed areas on the site edges that slope away from the piped infrastructure nor off-site "red lined" areas which are not draining into the system. The unshaded areas on Dwg.1324B/314 refer to these undrained grassed areas that fall away from the piped system into the Corbally Stream. This was discussed and agreed with the *EWCC Dept*.
1.4	Storage unit "3" located below road	This Storage unit was removed from the system and is no longer relevant. Refer to Dwg's.1324B/304-306
1.5	Attenuation system to be outside of watermain wayleaves and no sewers or watermain to pass over attenuation	All Storage units are set back from existing trunk watermains and were specifically agreed with Irish Water who are in charge of same. Refer to Dwg's.1324B/304-306
1.6	Submit drawing showing SuDS features and details	Completed, submitted and agreed. Refer to Dwg.1324B/317
1.7	Side slopes to be shallow as possible for maintenance purposes	Side slopes generally max. 1 in 3. Refer to Dwg.No.1324B/317. The landscape consultant Ronan Mac Diarmada + Associates Ltd. held discussions with SDCC Public Realm Department and refer to the Ronan Mac Diarmada + Associates Ltd. submission for details of same.

1.8	Each S/W outfall to be detailed	Completed, submitted and agreed. Refer to Dwg.No.1324B/318
1.9	No tree planting above attenuation storage unit	None planned. Refer to Ronan Mac Diarmada + Associates Ltd. landscape drawings.
1.10	Submit drawings in A1 format	Submitted as part of Stage 3 planning application
SDCC Water Services (*EWCC Dept.*) – Flood Risk Report Observations		
2.1	Clarify if existing land drains and overland flow	No known land drains. Central dry-ditch maintained as drainage swale. West dry-ditch maintained unchanged as a field drain from south to north into Corbally Stream. Refer to Kilgallen & Partners Consulting Engineers SSFRA for further details.
2.2	Obtain Section 50 form OPW	Obtained and submitted with Kilgallen & Partners Consulting Engineers SSFRA planning submission.
2.3	Side slopes to be shallow as possible for maintenance purposes	Side slopes generally max. 1 in 3. Refer to Dwg.No.1324B/317. The landscape consultant Ronan Mac Diarmada + Associates Ltd. held discussions with SDCC Public Realm Department and refer to the Ronan Mac Diarmada + Associates Ltd. submission for details of same. Refer also to Kilgallen & Partners Consulting Engineers SSFRA planning submission

5.6 In accordance with the OPW's *The Planning System and Flood Risk Management- Guidelines for Local Authorities 2009* (the Guidelines), Kilgallen & Partners Consulting Engineers have assessed and prepared a Site Specific Flood Risk Assessment (SSFRA) which forms part of the planning application. The SSFRA determined that the site was not subject to flooding from either Pluvial or Groundwater flooding. However, it was determined that there was a risk of Fluvial flooding from the Corbally Stream along the northern boundary of the site and thus that part of the site is categorised under the Guidelines as being in a flood risk zone A & B.

It was also identified in the SSFRA that there is a flood risk of the Corbally Stream overtopping the bank in the northeast portion of the site.

Mitigation measures proposed in detail in the SSFRA include the development of a flood compensatory area along the northern site boundary and the raising of the western stream bank along the north-eastern boundary and the reader is also referred to the SSFRA for specific details of the mitigation measures.

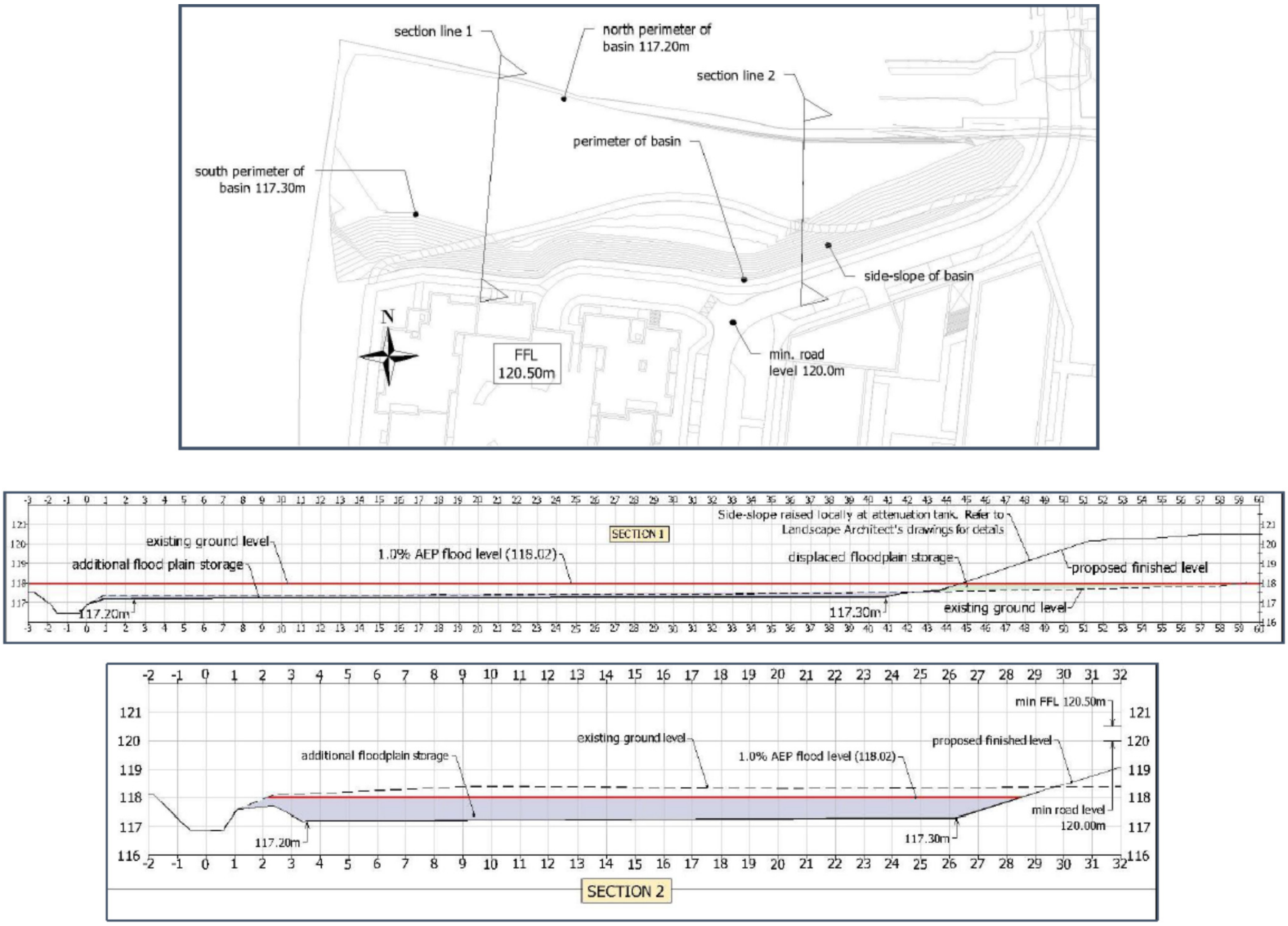


Fig.4 – Extract from SSFRA fig.5.2 Plan and Typical Section for Compensatory Basin

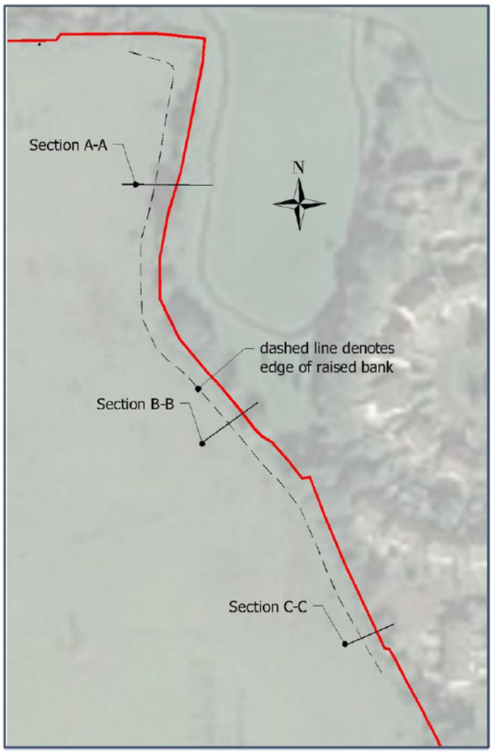


Fig.5 – Extract from SSFRA fig.5.4 – Raised Bank at east Boundary

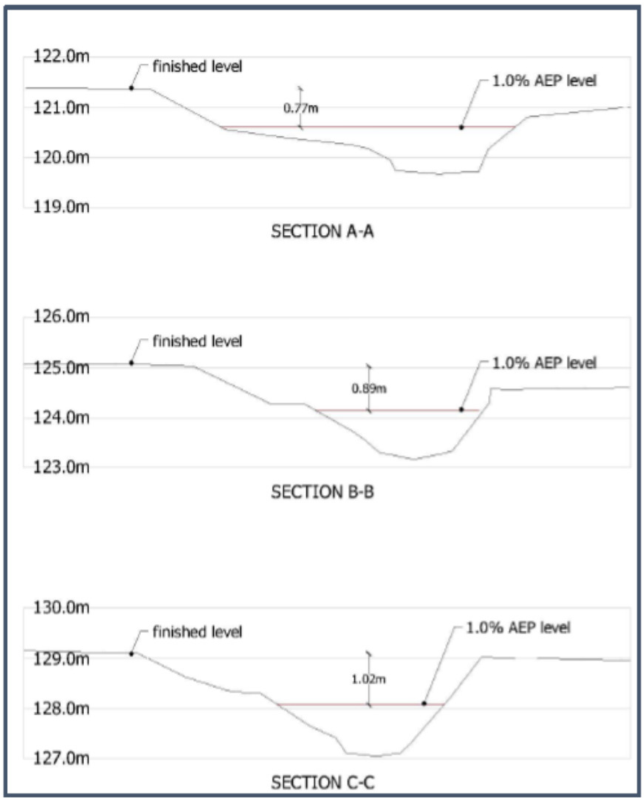


Fig.6 – Extract from SSFRA fig.5.6 – Sections showing 1%AEP flood level at raised Bank

The SSFRA concluded that implementation of the mitigation measures will increase the available flood storage capacity, that the application was subject to and passed the Development Management Justification Test as required under the Guidelines, that the proposed development will not be at risk of flooding and will not increase flood risk elsewhere and that the development is therefore appropriate from a flood risk perspective.

Reference can be made to the separate SSFRA document that forms part of the overall planning submission documentation for greater detail in this regards.

5.7 The SSFRA analysis determined that the top water level from the 100-year event otherwise know as the 1% Annual Exceedance Probability (1% AEP) at the lower northern end of the site was 118.02mOD. The *Flood Risk Management Guidelines* recommend that a freeboard of 500mm and 250mm be applied for 1% AEP event for floors and roads respectively.

5.8 In this application the lowest proposed floor level is 120.50mOD resulting in a freeboard of 2.48m above the Q100 + 10% Climate Change event, well above the minimum 500mm recommended. The lowest proposed road level on the site is 120.00mOD which results in a 1.98m freeboard, again well above the minimum recommended 250mm.

5.9 There are 4No. pedestrian and vehicular access connections between the proposed development and Carrigmore, Carrigmore Park to the north and northeast and Corbally to the east.

Fig.7 – Extract from SSFRA fig.5.7 – Stream Crossings

5.10 The SSFRA has determined the top water level in the Corbally Stream for the 1.0% AEP rainfall event at each of the 4No.crossing locations and the minimum recommend soffit levels of the conveying culverts as summarised in Table 1 below;

Crossing	1.0% AEP water level (m OD)	min. soffit Level m OD
1	118.84m	119.44m
2	120.29m	120.79m
3	124.64m	125.14m
4	132.88m	133.38m

Table 1 – Extract from SSFRA Table 5.2 – Crossing Details

5.11 The OPW requires that there be a minimum of 300mm freeboard between the estimated top water level during the 1%AEP event and the soffit of the inlet to the culvert conveying the flow. The SSFRA has calculated the top water level at all crossings for the 1%AEP event and determined that the soffit levels of the proposed crossings are more that 500mm above the 1%AEP top water level and therefore comfortably comply with the recommendations given in the Guidelines. Fig.8 below illustrates a typical crossing detail to the north of the site.

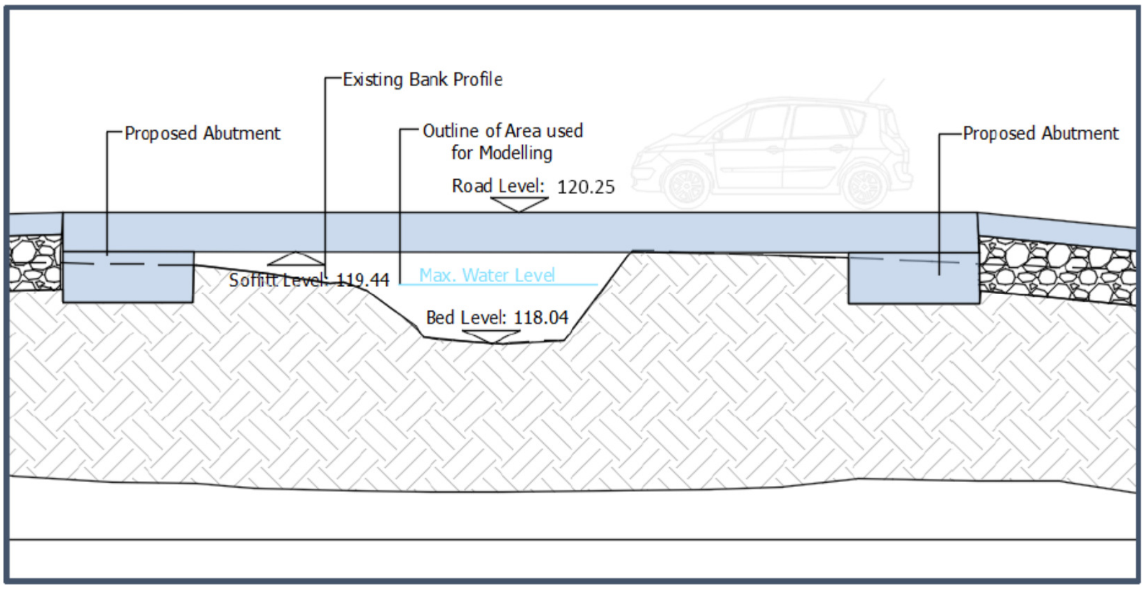


Fig.8 – Extract from SSFRA fig.5.8 – Typical section at Stream Crossing

5.12 The SSFRA concluded that implementation of the mitigation measures will increase the available flood storage capacity, that the application was subject to and passed the Development Management Justification Test as required under the Guidelines, that the proposed development will not be at risk of flooding and will not increase flood risk elsewhere and that the development is therefore appropriate from a flood risk perspective.

5.13 The reader is referred to Site Specific Flood Risk Assessment (SSFRA) prepared by Kilgallen & Partners Consulting Engineers for further information.

5.14 The existing topography ground falls steeply downhill from the Boherboy Road towards the Corbally stream along the northern boundary.

5.15 As part of the design process, Soakaway Testing was commissioned by the applicants and were carried out by Ground Investigations Ltd. 4No.soakaway tests were carried out and 3No.of the tests failed to allow any infiltration. Refer to the GII Ltd report in Appendix 12.7 of this document.

5.16 The surface water drainage design has been carried out in accordance with the Greater Dublin Regional Code of Practice, the GDSDS and the CIRIA Report c753 "The SuDS Manual" 2015. Attenuation and SuDS are included in the design.

5.17 The MicroDrainage analysis and design software was used to generate the surface water drainage computer models and flow simulations, the results of which can be viewed in Appendix 12.1 of this report.

5.18 Refer to Dwg.No.1324B/304-306 for the surface water general arrangement layouts and to Dwg.No.1324B/314-318 for attenuation and SuDS details.

5.19 A full SuDS treatment train approach has been implemented in accordance with the CIRIA SuDS Manual as described in detail in Chapter 7 of this report.

Replicating the natural characteristics and providing amenity/biodiversity has been achieved in the SuDS elements included in this application.

The SuDS elements included in this application are summarised as follows and please refer to Chapter 7 of this report for detailed information;

- Filter drains to the rear of the housing
- Permeable paving to all private parking areas
- Rainwater butts (200l) to the rear downpipes of the houses
- Filter Swales (15No.) adjacent to roadways where feasible
- Tree pits (18No.)where practically feasible
- Use of the existing central dry-ditch as a drainage swale
- Bio-Retention area

- Silt-trap/catchpit manholes
- Hydrobrakes limiting flow to the total Qbar greenfield rate
- Petrol interceptors upstream of all outfall points
- Stone lined voided arch retention storage devices

With the inclusion of these measures, it is proposed that the SuDS treatment of the run-off has been adequately addressed.

5.20 During the Stage 1 and Stage 2 pre-planning process, a full set of RMA documentation and drawings were submitted to the *EWCC Dept*. of South Dublin County Council for their review. Subsequently SDCC determined that the drainage proposals were agreed.

5.21 Private house surface water drainage is limited to 8No.units per pipe run and is to be in accordance with the DOELG Recommendations for Site Development Works for Housing Areas and in accordance with best practice, the internal drainage system has been designed as a completely separate foul and surface water system.

5.22 The surface water drainage infrastructure for the development will collect the rainfall on the site and convey the storm water run-off via roadside swales, tree pits, bio-retention area, rear garden filter drains, gullies, underground pipes, manholes, catchpit manholes and direct the flows via void arched attenuation systems towards vortex flow restricting devices (Hydrobrake or similar) and petrol interceptors before outfalling to the existing on site open watercourses.

5.23 The total site surface water outfall rate **QBar** is determined from the existing greenfield run-off rate based on the drained surface area (15.9Ha) of the site and on the known soil conditions and is calculated in accordance with IH124 as per the GDSDS Section 6.6.1.2. This is discussed in great detail in Chapter 9 of this report but is synopsised in Table 2 below. Noting that the site application area is larger than the drained area as areas on the edge of the site and outside the site do not drain into the S/W infrastructure and are excluded from the Qbar calculation. This principle has been agreed with the SDCC *EWCC Dept*.

ROGER MULLARKEY & ASSOCIATES Duncreevan, Kilcock, Co.Kildare Tel 01 610 3755, Mob. 087 2324917	Project: Boherboy	Job No: 1324B	Date: 01/03/2021
	Element: Overall Site Qbar Estimate	Made By: RM	

Site Charactistics			
Site Area (Ha)	15.85	Ha	
Standard Average Annual Rainfall (SAAR), mm	882	mm	Met Eireann
Soil Type	3		SI report
SPR Value	0.37		GDSDS Table 6.7

50Ha Qbar Estimate from Institute of Hydrology Report No.124				
SITE AREA (km^2)	0.5			
SAAR (mm)	882			
ERS SPR Soil Index	0.37			
Qbar rural 50Ha, l/s =	$(0.00108 x Area^{0.89} x SAAR^{1.17} x SOIL^{2.17}) x 1000$ =	188.2	l/s	IH124, GDSDS 6.6.1.2
	Qbar per Ha =	3.76	l/s	
Allowable Outflow (Site Area x Qbar)		59.67	l/s	
	TOTAL Site QBar =	59.7	l/s	

Table 2- Qbar calculation

5.24 The **total site Qbar is 59.7 l/s** has been sub-divided into smaller quantities split between the 8No catchments, but the overall site QBar remains the same. For detailed analysis of the derivation of QBar please refer to Chapter 9 of this report. The sub-division of the overall Qbar rate is summarised in Table 3 below;

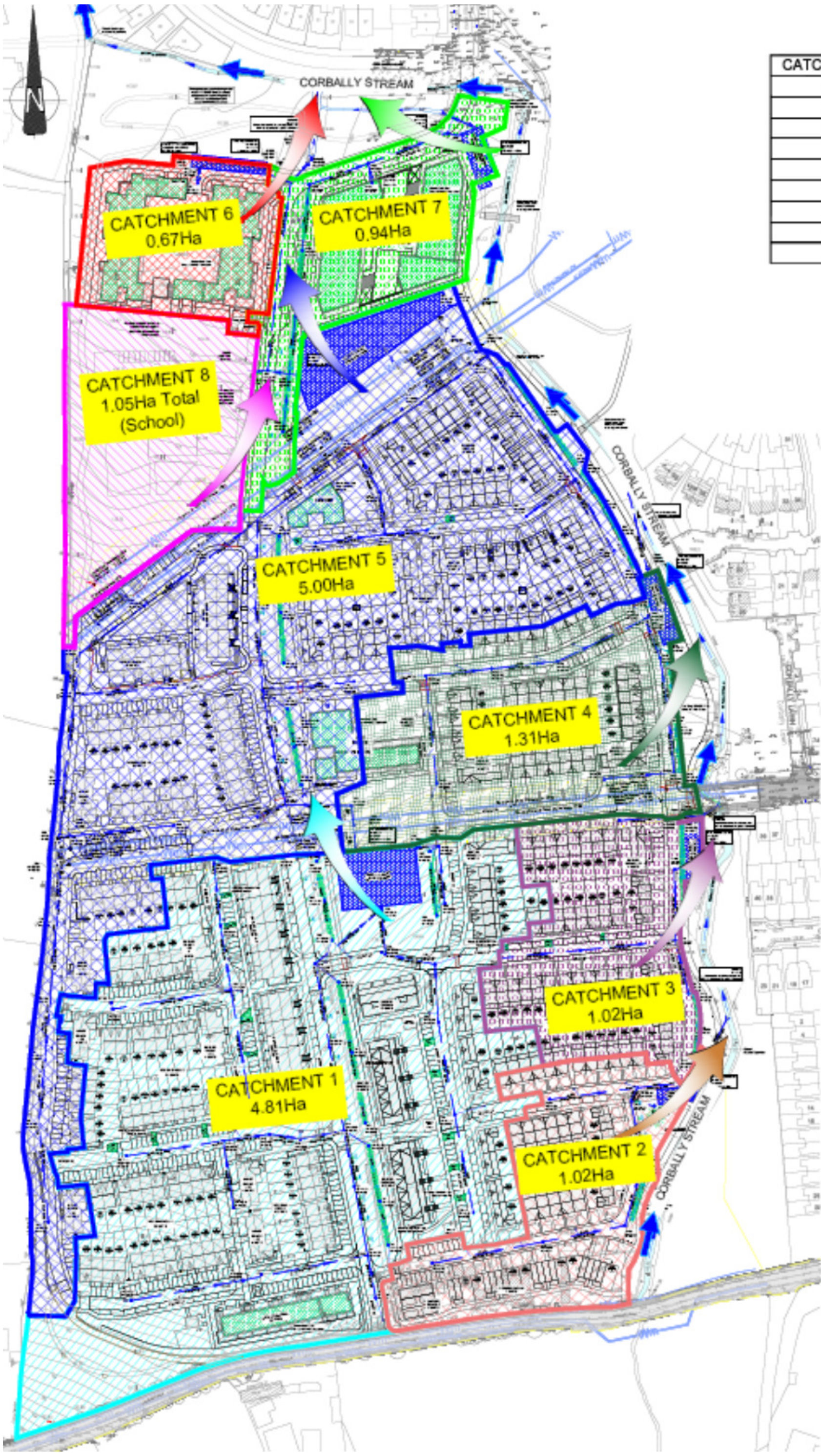
Summary of the Sub-Division of Qbar into 8 Catchments			
Total Site Qbar = 59.7l/s (refer to Table 1 above)			
Catchment Ref.	**Gross Drained Area (Ha)**	**QBar per Catchment (l/s)**	**Applied Outfall per Catchment (l/s)**
1	4.81	18.11	15
2	1.02	3.84	5.2
3	1.02	3.84	2
4	1.31	4.93	4
5	5.01	18.86	22.5
6	0.67	2.52	5
7	0.97	3.65	4
8	1.05	3.95	2
Totals	15.86	59.71	59.7
		Total Applied Outfall Rate =	**59.7**
		Allowed Qbar Outfall =	**59.7**
Therefore Outfall Rate Applied = Qbar			

Table 3- Qbar Sub-Division

5.25 The sub-division of the S/W catchments is as follows;

- Catchment 1 is attenuated and outfalls the attenuated flow (15l/s) downstream into Catchment 5.
- Catchment 5 in turn is attenuated (22.5l/s) and outfalls downstream into an existing open drain in the landscaped public open space to the northern boundary of site before outfalling into the Corbally Stream.
- Catchment 6 is attenuated (5l/s) and outfalls the attenuated flow downstream into the same pipe draining catchment 1 and 5.
- Catchments 2, 3 and 4 are each independently attenuated (5.2l/s, 2l/s and 4l/s) and each outfalls downstream into the Corbally Stream along the eastern boundary of the site.
- Catchment 7 is independently attenuated (4l/s) and outfalls downstream into a landscaped open drain in the open space along the northern boundary of site before outfalling into the Corbally Stream.
- Catchment 8 does not form part of this planning application and is reserved as a possible future school site. However, the future S/W outflow (2l/s) from this Catchment 8 is included in the MicroDrainage S/W design model and outfalls into the same pipe draining Catchments 1 and 5.

A drawing representing the above narrative is shown in Fig.9 below;



CATCHMENT	AREA
1	4.81Ha
2	1.02Ha
3	1.02Ha
4	1.31Ha
5	5.00Ha
6	0.67Ha
7	0.94Ha
8	1.05Ha
TOTAL	15.85Ha

Fig.9 – S/W Catchment Areas

5.26 Each of the 5No.surface water outfall locations are to include a wing-wall outfall detail, each of which is detailed on Dwg.No.1324B/318. A non-return valve is to be included at each outfall location to prevent backflow in the event of a swamped outfall condition.

5.27 Each of the 8No. catchments have the S/W outflow attenuated and the backed-up storm water is to be stored in separate holding chambers using the StormTech system as agreed in principle with the SDCC *EWCC Dept*. during a pre-planning meeting held on 30/04/20 and in other phone and email correspondences with SDCC *EWCC Dept*. in September 2021.

5.28 The MicroDrainage software was used to generate drainage simulation models for storm events for 1 year, 30 year and 100 year return events over multiple time periods ranging between 15 minutes to 7 day durations. An allowance of and additional 10% for climate change was applied to the Q100 storm event in accordance with the requirements of the GDSDS.

5.29 To reflect the SuDS elements noted in paragraph 5.16 above, and in agreed with The *EWCC Dept*. Of SDCC as part of the pre-planning process, Paved Area Factors (PAF) reflecting the surface permeability are applied to the various surfaces generating surface water run-off and are used in the used in the detailed MicroDrainage analysis model. Table 4 below summarises the PAF's applied:

Surface Type	*PIMP (%)*	*PAF*
Roads, Roofs and Paths to piped drainage	90	0.9
Green Roofs	72	0.72
Rear roofs/Patios via SuDS Filter Drains	71	0.71
Roads/Paths via SuDS Swale or Tree pits	70	0.7
Permeable Paving in private parking bays	60	0.6
Grassland to Public Open Spaces and Front Gardens	25	0.25
Grassed House Rear Gardens	15	0.15

Table 4 – Paved Area Factors

5.30 As was requested by The *EWCC Dept*. of SDCC as part of the pre-planning process and the Stage 2 Planning Report, summary results tables of the drained surfaces from each catchment have been generated and are shown below rather than in the Appendix. Noting that the attenuated storage capacity for Catchments 6 and 7 have been increased as requested by SDCC *EWCC Dept*. as part of the Pre-App process. The total site and then each separate catchment are summarised as follows;

TOTAL SITE SUMMARY					
Surface Type (see Dwg.1324B/314)		Area Summary			
		Impermeability %	Gross Area (Ha)	Paved Area Factor	Nett Area (Ha)
Roads, Roofs & Paths to piped drainage		90	4.92	0.9	4.43
Green Roof		72	0.58	0.72	0.42
Rear Roofs/Patios to SuDS Filter Drain		71	1.23	0.71	0.87
Roads & Paths to SuDS Swale or Tree Pits		70	0.90	0.7	0.63
Peremable Paving (private)		60	1.03	0.6	0.62
Grassland to Public Areas and Front Gardens		25	4.15	0.25	1.04
Rear Gardens		15	1.99	0.15	0.30
Possible Future School Site (Catchment 8)			1.05*	N/A	2l/s runoff allowed in model
		Totals	15.85		8.30
		Required Attenuation Storage (m^3)		Attenuation Volume Provided (m^3)	Additional Storage in SuDS Elements (m^3)
Qbar (l/s)	Applied Outfall Rate (l/s)	Q30	Q100 +10% CC		
59.7	59.7	3,517	5,201	**5,549**	**669**

* A 2l/s attenuated run-off from Catchment 8 is allowed for in the drainage model for the possible future school site which is not part of this planning application and on-site storage will be subject to future application not included here

Table 5 - Total Site

CATCHMENT 1 SUMMARY					
Surface Type (see Dwg.1324B/314)		Area Summary			
		Impermeability %	Gross Area (Ha)	Paved Area Factor	Nett Area (Ha)
Roads, Roofs & Paths to piped drainage		90	1.49	0.9	1.34
Green Roof		72	0.05	0.72	0.04
Rear Roofs/Patios to SuDS Filter Drain		71	0.51	0.71	0.36
Roads & Paths to SuDS Swale or Tree Pits		70	0.30	0.7	0.21
Peremable Paving (private)		60	0.38	0.6	0.23
Grassland to Public Areas and Front Gardens		25	1.43	0.25	0.36
Rear Gardens		15	0.65	0.15	0.10
		Totals	4.81		2.63
		Required Attenuation Storage (m^3)		Attenuation Volume Provided (m^3)	Additional Storage in SuDS Elements (m^3)
Qbar (l/s)	Applied Outfall Rate (l/s)	Q30	Q100 +10% CC		
18.11	15	979	1492	**1505**	**228**

Table 6- Catchment 1

CATCHMENT 2 SUMMARY				
Surface Type (see Dwg.1324B/314)	Area Summary			
	Impermeability %	Gross Area (Ha)	Paved Area Factor	Nett Area (Ha)
Roads, Roofs & Paths to piped drainage	90	0.34	0.9	0.31
Green Roof	72	0.00	0.72	0.00
Rear Roofs/Patios to SuDS Filter Drain	71	0.10	0.71	0.07
Roads & Paths to SuDS Swale or Tree Pits	70	0.04	0.7	0.03
Peremable Paving (private)	60	0.12	0.6	0.07
Grassland to Public Areas and Front Gardens	25	0.26	0.25	0.06
Rear Gardens	15	0.16	0.15	0.02
	Totals	**1.02**		**0.56**

Qbar (l/s)	Applied Outfall Rate (l/s)	Required Attenuation Storage (m^3) Q30	Required Attenuation Storage (m^3) Q100 +10% CC	Attenuation Volume Provided (m^3)	Additional Storage in SuDS Elements (m^3)
3.84	5.2	168	256	**264**	**72**

Table 7- Catchment 2

CATCHMENT 3 SUMMARY				
Surface Type (see Dwg.1324B/314)	Area Summary			
	Impermeability %	Gross Area (Ha)	Paved Area Factor	Nett Area (Ha)
Roads, Roofs & Paths to piped drainage	90	0.23	0.9	0.21
Green Roof	72	0.00	0.72	0.00
Rear Roofs/Patios to SuDS Filter Drain	71	0.17	0.71	0.12
Roads & Paths to SuDS Swale or Tree Pits	70	0.10	0.7	0.07
Peremable Paving (private)	60	0.10	0.6	0.06
Grassland to Public Areas and Front Gardens	25	0.13	0.25	0.03
Rear Gardens	15	0.29	0.15	0.04
	Totals	**1.02**		**0.53**

Qbar (l/s)	Applied Outfall Rate (l/s)	Required Attenuation Storage (m^3) Q30	Required Attenuation Storage (m^3) Q100 +10% CC	Attenuation Volume Provided (m^3)	Additional Storage in SuDS Elements (m^3)
3.84	2	266	379	**388**	**70**

Table 8- Catchment 3

CATCHMENT 4 SUMMARY					
Surface Type (see Dwg.1324B/314)		Area Summary			
		Impermeability %	Gross Area (Ha)	Paved Area Factor	Nett Area (Ha)
Roads, Roofs & Paths to piped drainage		90	0.49	0.9	0.44
Green Roof		72	0.00	0.72	0.00
Rear Roofs/Patios to SuDS Filter Drain		71	0.10	0.71	0.07
Roads & Paths to SuDS Swale or Tree Pits		70	0.07	0.7	0.05
Peremable Paving (private)		60	0.11	0.6	0.07
Grassland to Public Areas and Front Gardens		25	0.36	0.25	0.09
Rear Gardens		15	0.17	0.15	0.03
		Totals	**1.31**		**0.75**
		Required Attenuation Storage (m^3)		Attenuation Volume Provided (m^3)	Additional Storage in SuDS Elements (m^3)
Qbar (l/s)	Applied Outfall Rate (l/s)	Q30	Q100 +10% CC		
4.93	4	317	459	**463**	**67**

Table 9- Catchment 4

CATCHMENT 5 SUMMARY					
Surface Type (see Dwg.1324B/314)		Area Summary			
		Impermeability %	Gross Area (Ha)	Paved Area Factor	Nett Area (Ha)
Roads, Roofs & Paths to piped drainage		90	1.72	0.9	1.55
Green Roof		72	0.11	0.72	0.08
Rear Roofs/Patios to SuDS Filter Drain		71	0.35	0.71	0.25
Roads & Paths to SuDS Swale or Tree Pits		70	0.23	0.7	0.16
Peremable Paving (private)		60	0.28	0.6	0.17
Grassland to Public Areas and Front Gardens		25	1.59	0.25	0.40
Rear Gardens		15	0.72	0.15	0.11
		Totals	**5.00**		**2.71**
		Required Attenuation Storage (m^3)		Attenuation Volume Provided (m^3)	Additional Storage in SuDS Elements (m^3)
Qbar (l/s)	Applied Outfall Rate (l/s)	Q30	Q100 +10% CC		
18.86	22.5	1421	2076	**2102**	**184**

Table 10- Catchment 5

CATCHMENT 6 SUMMARY					
Surface Type (see Dwg.1324B/314)		Area Summary			
		Impermeability %	Gross Area (Ha)	Paved Area Factor	Nett Area (Ha)
Roads, Roofs & Paths to piped drainage		90	0.34	0.9	0.30
Green Roof		72	0.20	0.72	0.14
Rear Roofs/Patios to SuDS Filter Drain		71	0.00	0.71	0.00
Roads & Paths to SuDS Swale or Tree Pits		70	0.00	0.7	0.00
Peremable Paving (private)		60	0.02	0.6	0.01
Grassland to Public Areas and Front Gardens		25	0.11	0.25	0.03
Rear Gardens		15	0.00	0.15	0.00
		Totals	0.67		0.49
		Required Attenuation Storage (m^3)		Attenuation Volume Provided (m^3)	Additional Storage in SuDS Elements (m^3)
Qbar (l/s)	Applied Outfall Rate (l/s)	Q30	Q100 +10% CC		
2.52	5	140	211	371	16

Note that the attenuation tank for Catchment 6 has an increased storage capacity as was requested by SDCC *EWCC Dept*. during the Pre-App process

Table 11- Catchment 6

CATCHMENT 7 SUMMARY					
Surface Type (see Dwg.1324B/314)		Area Summary			
		Impermeability %	Gross Area (Ha)	Paved Area Factor	Nett Area (Ha)
Roads, Roofs & Paths to piped drainage		90	0.28	0.9	0.25
Green Roof		72	0.22	0.72	0.16
Rear Roofs/Patios to SuDS Filter Drain		71	0.00	0.71	0.00
Roads & Paths to SuDS Swale or Tree Pits		70	0.16	0.7	0.11
Peremable Paving (private)		60	0.03	0.6	0.02
Grassland to Public Areas and Front Gardens		25	0.26	0.25	0.06
Rear Gardens		15	0.00	0.15	0.00
		Totals	0.94		0.60
		Required Attenuation Storage (m^3)		Attenuation Volume Provided (m^3)	Additional Storage in SuDS Elements (m^3)
Qbar (l/s)	Applied Outfall Rate (l/s)	Q30	Q100 +10% CC		
3.65	4	226	328	456	32

Note that the attenuation tank for Catchment 7 has an increased storage capacity as was requested by SDCC EWCC Dept. during the Pre-App process

Table 12- Catchment 7

CATCHMENT 8 (Possible Future School Site)					
Surface Type (see Dwg.1324B/314)		Area Summary			
		Impermeability %	Gross Area (Ha)	Paved Area Factor	Nett Area (Ha)
Roads, Roofs & Paths to piped drainage		There is no planning application for the school site included here and therefore there is no detailed breakdown of the paved areas available. However, the gross area of this Catchment 8 (c.1.05Ha) has been included in the drainage model with outflow limited to 2l/s from this catchment.			
Green Roof					
Rear Roofs/Patios to SuDS Filter Drain					
Roads & Paths to SuDS Swale or Tree Pits					
Peremable Paving (private)					
Grassland to Public Areas and Front Gardens					
Rear Gardens					
		Required Attenuation Storage (m^3)		Attenuation Volume Provided (m^3)	Additional Storage in SuDS Elements (m^3)
Qbar (l/s)	Applied Outfall Rate (l/s)	Q30	Q100 +10% CC		
3.95	2	c.465	c.580	None - Future Application Depends	

Table 13- Catchment 8

5.31 As can been seen from each of the above tables, the attenuated storage required for the Q100 +10% climate change event can be stored below ground in the proposed voided arch retention systems. Refer to Appendix 12.2 of this report for calculations of each storage chamber and to paragraph 7.3.2 for more detail of the retention system.

5.32 There is additional storage provided in each catchment in the various SuDS elements. This additional storage is available in the excess of the interception volume provided as detailed in the Interception calculations shown in Table 14 below for the total site (refer to Chapter 8 for detailed calculations of the individual Catchments).

INTERCEPTION CALCULATION- TOTAL DRAINED SITE							
Paved Surfaces connected to the drainage system (Ha) =	**8.66**		**Volume of Interception Required (m^3)**		Gross Paved Area x 5% x 0.8 **346.3**	(GDSDS E2.1.1 - Criterion 1)	
Volume of Interception Provided (m^3)	**Length**	**Width (m)**	**Area (m^2)**	**Quantity**	**Stone Depth (m)**	**Void Ratio**	**Volume (m^3)**
Rainwater Butts (200l) @ 2No.per block	1.25		0.45	192		1	108.0
Voids of stone below Peremable Paving overflow			10,330		0.15	0.3	464.9
Voids of stone below Filter Drain overflow	1383	0.6			0.15	0.4	49.8
Voids of stone below Swale overflow	556	0.6			0.15	0.4	20.0
Tree Pit depression			6.25	18	0.05	1	5.6
Voids of stone below Attenuation Tank			3,747		0.3	0.4	449.6
			Volume of Interception Provided (m^3) =				**1,097.9**
			Volume of Interception Required (m^3) =				**346.3**
			Interception provided > Required				**OK**

Table 14- Interception for Total Drained Site

5.33 It is relevant to note that the additional storage provided is over and above the GDSDS required interception volume, which makes this design a conservative and more safe approach to volume estimation.

5.34 In accordance with the GDSDS Volume 2, Section 6.3.4, the four principal design criteria set out are summarised as follows;

- **Criterion 1** - River water quality protection
- **Criterion 2** – River regime protection
- **Criterion 3** – Level of service (flooding) for the site
- **Criterion 4** – River flood protection

5.35 Compliance with those above note 4No.criterion is summarised in Table 15 below and is discussed in detail in Section 8 of this report.

Criterion	Method	Required	Provided	Compliance
1	Interception	347m³	1,092m³	**Yes**
2	Qbar and storage	59.7l/s and 5,207m³	59.7/s and >5,537m³	**Yes**
3	Flooding	No flooding and 500mm freeboard	No flooding and >500mm freeboard	**Yes**
4	River Flood Protection	Qbar rate applied	Qbar rate applied	**Yes**

Table 15 – GDSDS Criterion

5.36 The undercroft ground level car-parking to the apartment blocks will each have a Class 1 Light Liquid Separator included upstream of the connection to the S/W infrastructure.

6.0 Surface Water Drainage Design Conclusions

6.1 Both the Q30 and Q100 + 10% climate change attenuated storage volumes are summarised in paragraph 5.27, Table 4 above. Refer to the MicroDrainage simulation modelling software calculations in Appendix 12.1 of this report for the detailed calculations.

6.2 The maximum required attenuation storage of **5,201m³** for Catchments 1-7 (Catchment 8 relates to a possible future school site and is not proposed as part of this application) are stored below ground in the **5,549m³** StormTech attenuation systems. Refer to Appendix 12.2 of this report for calculations of the storage systems and to Dwg.No.1324B/319. for typical details of same.

6.3 Further to the spare capacity of storage provided in the attenuation systems noted above, there is an additional storage volume provided in the **interception** elements equal to **669m³** (refer to Tables 4 and 11) and is therefore considered to be a safer conservative approach to attenuation storage estimation.

6.4 The maximum top water levels in each of the 8 separate catchments is more than 500mm below the lowest floor level of any dwelling drained by that network.

6.5 The 4No.GDSDS criterion have been complied with.

6.6 Full SuDS treatment train approach has been implemented in accordance with the CIRIA SuDS Manual as described in Chapter 7 below.

6.7 A thorough examination of the site characteristics were undertaken in determination of the soil type and greenfield run off rate as described in Chapter 9 below.

6.8 The drainage design and attenuation storage volumes have been determined using the MicroDrainage software, an industry standard program for modelling drainage networks, the results of which are included in Appendix 12.1 of this report.

6.9 In accordance with the OPW's *The Planning System and Flood Risk Management- Guidelines for Local Authorities 2009* (the Guidelines), Kilgallen & Partners Consulting Engineers have assessed and prepared a Site Specific Flood Risk Assessment (SSFRA) which forms part of the planning application. The SSFRA concluded that implementation of the mitigation measures will increase the available flood storage capacity by c.870m^3, that the application was subject to and passed the Development Management Justification Test as required under the Guidelines, that the proposed development will not be at risk of flooding and will not increase flood risk elsewhere and that the development is therefore appropriate from a flood risk perspective. Reference can be made to the separate SSFRA document that forms part of the overall planning submission documentation for greater detail in this regards.

6.10 Pre-planning Stage 1 and Stage 2 consultations were held with the SDCC *EWCC Dept*. and their requirements were ascertained and complied with in this document and the accompanying drawings. A full set of application drawings/calculations/reports were submitted to that department and were subsequently determined to be agreed and no significant issues were identified.

7.0 Sustainable Drainage Systems - SuDS

7.0.1 SuDS addresses the water quality, water quantity, amenity and biodiversity by the management of surface water run off in a sequence of treatment processes along the drainage infrastructure network.

7.0.2 The SuDS philosophy is illustrated in the GDSDS Volume 3 Section 6.3 as the “SuDS triangle”, shown below. The principle is to reduce the storm water run-off through managed processes, improve the quality of the run-off and to replicate the natural characteristics of the rainfall run off.

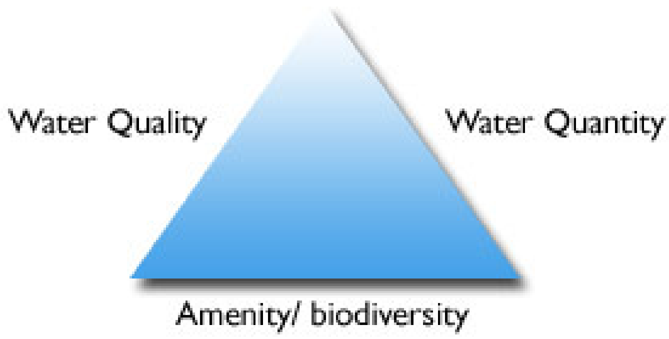


Fig.10 – The SuDS Triangle

7.0.3 Using the www.uksuds.com website, an assessment of the appropriate applicable SuDS features were evaluated and the resulting report is included in Appendix 12.6 of this document.

7.0.4 The appropriate SuDS features included in this proposal include the following;

- Filter drains to the rear of the housing
- Permeable paving to all private parking areas
- Rainwater butts (200l) to the rear downpipes of the houses
- Filter Swales (15No.) adjacent to roadways where feasible
- Tree pits (18No.)where practically feasible
- Use of the existing central dry-ditch as a drainage swale
- Bio-Retention area
- Silt-trap/catchpit manholes
- Hydrobrakes limiting flow to the total Qbar greenfield rate

- Petrol interceptors upstream of all outfall points
- Stone lined voided arch retention storage devices
- Petrol interceptor upstream of all outfall points

7.0.5 The SuDS management train approach to designing the storm water network has been applied in this proposed developments design, similar in principle to Fig.11 below

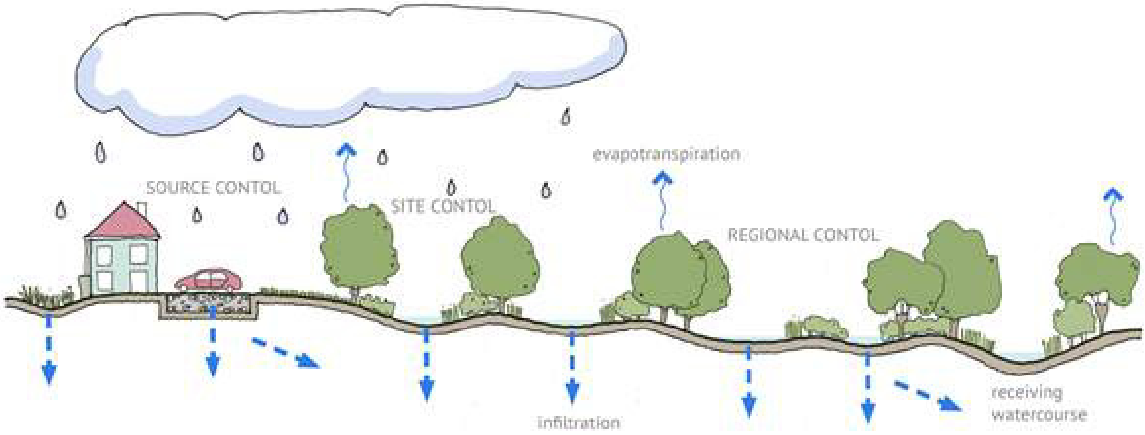


Fig.11 – Treatment Train

7.1 Source control

7.1.1 Source Control aims to detain or infiltrate runoff as close as possible to the point of origin.

7.1.2 The site investigation results (see Appendix 12.7 of this report) suggest that in one location there is some but limited ($1.38x10^{-5}$ mm/s) scope for infiltration of surface water flows. Of the 4No.tests carried out, only 1No.yielded a positive infiltration value. Even if the infiltration is limited there is still scope to provide some level of interception storage, time delay and treatment as the surface water flows through the stone medium of the following SuDS features in accordance with the UKSuDS.com report (included in Appendix 12.6 of this report).

7.1.3 It is proposed to use **filter drains** in the rear gardens of the houses to cater for run off from the rear roofs and patios. The use of these filter drains will encourage run-off to infiltrate directly to ground and will also provide interception storage in the c.40% voids ratio stone below the high-level slotted drain. Any run-off that cannot infiltrate to ground will overflow to the high-level drain and connect to the main drainage system. The surface water run-off rate is also attenuated by the use of these filter drains.

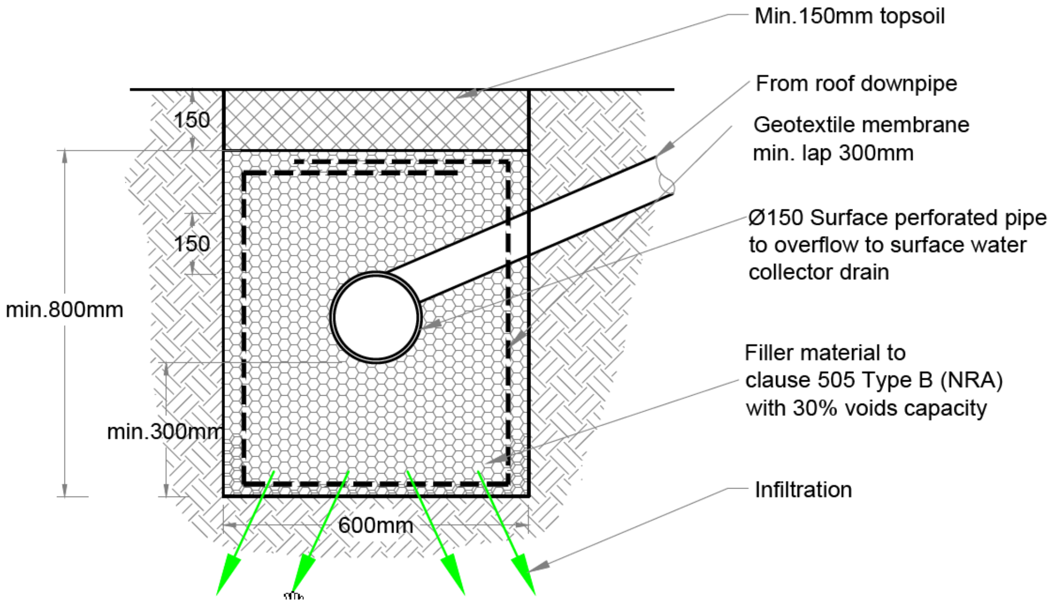


Fig.12 – Filter Drain

7.1.4 It is proposed to use drained **tree pits (18No.)** and a **bio-retention** area where possible to collect run-off from the single camber road surface. The use of these tree pits will encourage run off to infiltrate directly to ground and will also provide interception storage below the high-level connection to the main S/W drainage. Any run-off that cannot infiltrate to ground will overflow to the high-level drain and connect to the main drainage system. The surface water runoff rate is also attenuated by the use of these tree pits.

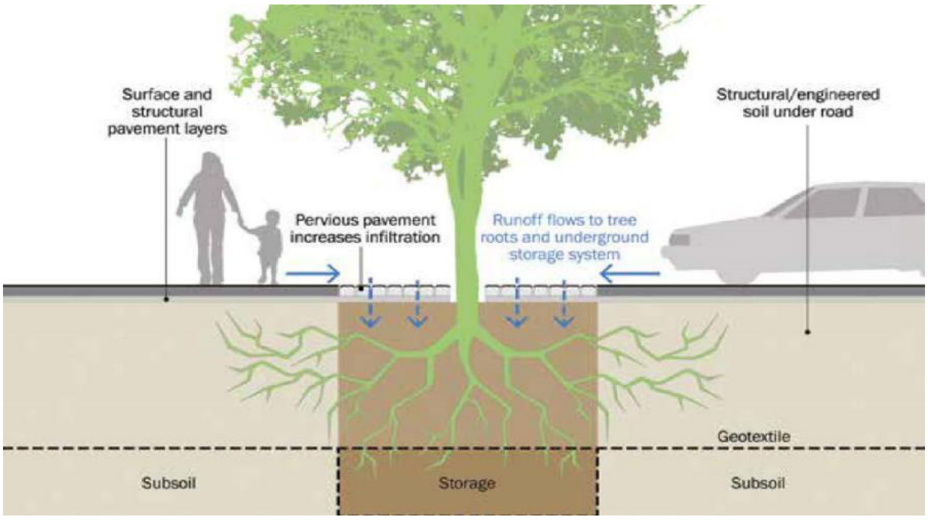


Fig.13 – Tree Pit (ex. SuDS Manual fig.19.3)

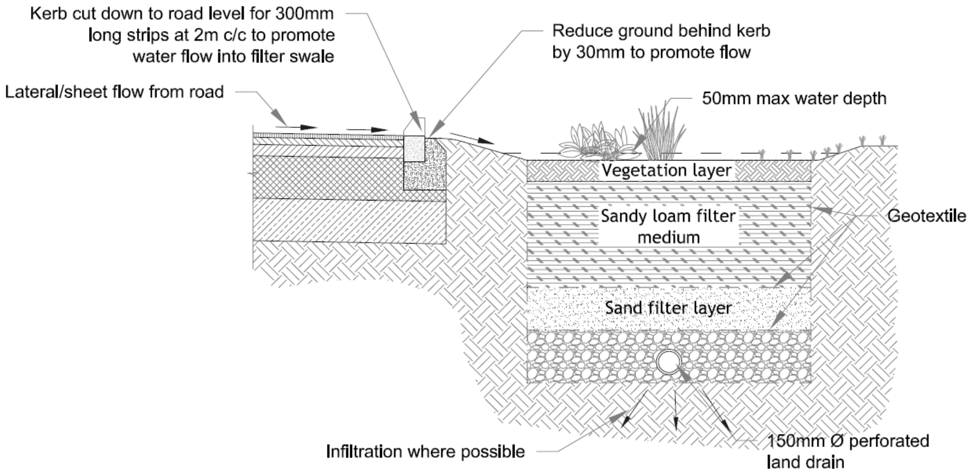


Fig.14 – Bio-Retention (ex.Dwg.1324B/317)

7.1.5 A PAF of 0.7 (70%) will apply to areas or paths/roads draining to these tree pits and bio-retention areas as was agreed in principle with the SDCC *EWCC Dept*. as part of the pre-planning discussions. Refer to Dwg.No.1324B/317 for details.

7.1.6 It is proposed to use **permeable paving** surfacing to the private driveways of the houses and in the car parking spaces of the duplex and apartment units. This allows for the rainfall to percolate through open joints in the pavement and be strained through the unwoven geo-textile membrane beneath the paved surface. This method of surface water collection will improve water quality and prevent excessive sedimentation. There is a natural interception, attenuation and storage of surface waters flowing through the permeable paving system and an outfall pipe is provided 150mm above the bottom of the system to drain the overflow filtered/attenuated run off into the main drainage system.

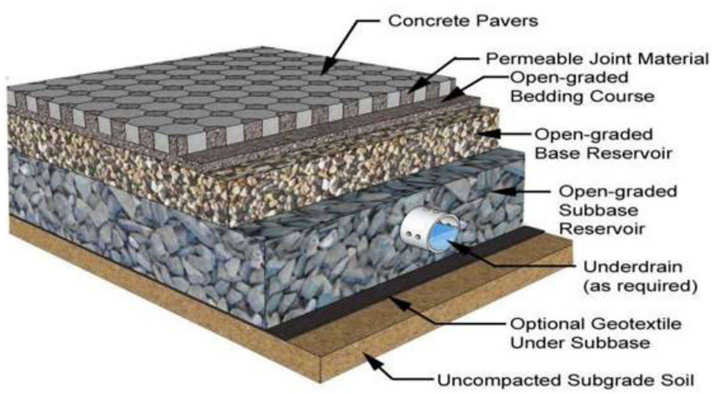


Fig.15 – Permeable Paving

7.1.7 In accordance with the CIRIA SuDS Manual 2015, **green roofs** can be used to treat and attenuate runoff in their substrate and support root uptake of water with appropriate planting and are an integral part of source control on a site. Green roofs can increase the indigenous biodiversity and is an encouraging environmentally design strategy, which is in accordance with the objectives as specified in the Greater Dublin Strategic Drainage Strategy (GDSDS).

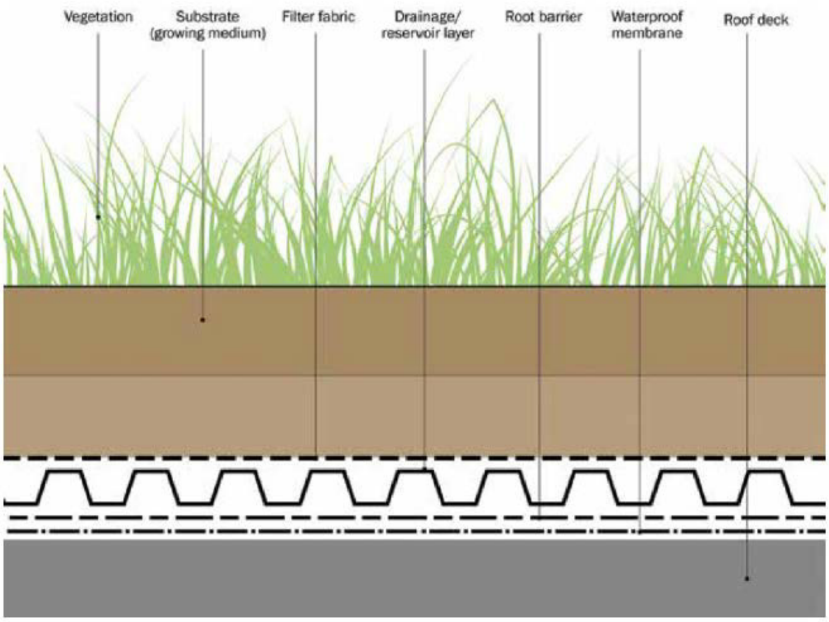


Fig.16– Green Roof

7.1.8 Green roofs with extensive planting are proposed for the flat roof areas of the apartment Blocks A, B and C, the roof of the creche and Duplex Block A, totalling some 0.58Ha of green roof.

7.1.9 In providing a suitable substrate depth to the green roof system, a run-off rate of 72% (0.72 paved area factor applied) has been applied in the surface water calculations as was agreed in principle with the SDCC *EWCC Dept*. as part of the pre-planning discussions. Refer to Appendix 12.11 of this report and Dwg.No.1324B/317 for details.

7.1.10 Access for maintenance to the green roof is to be facilitated via opening hatches in the stair cores of the apartment blocks. A fall arrest system is to be included in the design of the roof.

7.1.11 The use of **rainwater butts** is another source control method in the SuDS treatment train process. It is proposed to provide 1No.rainwater 200l butt per semi-detached dwelling to collect rainwater from the house roofs for use as garden irrigation, therefore reducing potable water demand and decreasing run-off from the site. It is proposed to use a rainwater butt to the end units in the terraced blocks where the rear roof downpipes are to be located.

Fig 17 – Rainwater Butt

7.1.12 Bypass oil separators are important SuDS devices that significantly reduce any potential hydrocarbons and suspended solids from surface water run-off. and are included upstream of each S/W outfall and downstream of each undercroft car-parking area.

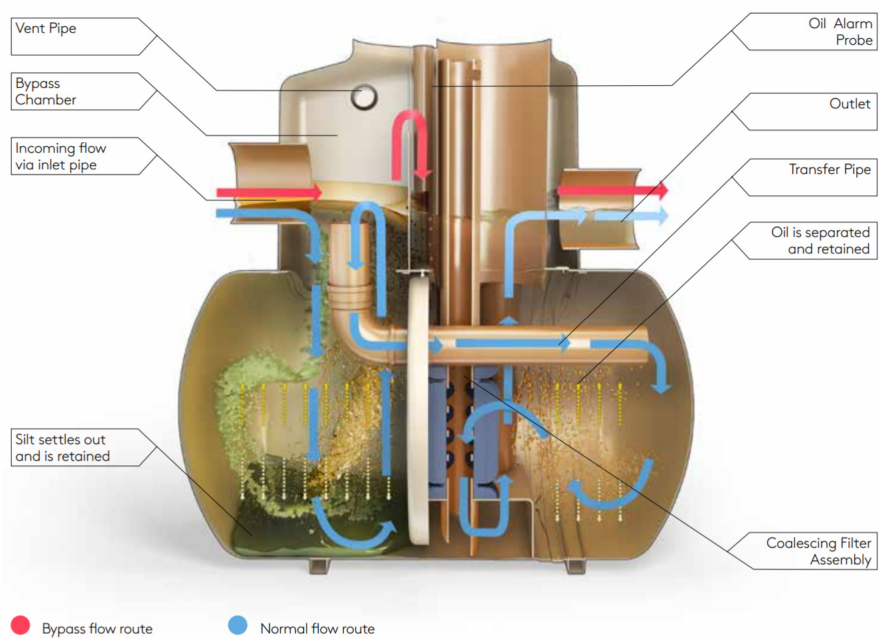


Fig 18 – Bypass Separator

7.1.13 An important aspect of Source Control is reducing pollution by prevention of chemicals and other pollutants from coming into contact with rainfall runoff. In this respect, it is proposed that the homeowner will be provided with information regarding the appropriate usage of the proposed drainage system.

7.2 Site Control

7.2.1 Site control in the treatment train process involves the reduction in volume and rate of surface water run-off and also provides some treatment of the run-off.

7.2.2 Roadside **filter swales** are a method of site control that reduces harmful chemical pollutants and sediment reaching the piped network. These pollutants are trapped in the grassed areas leading to the filter strip. Filter swales reduce the surface water runoff rate and attenuate flows locally, therefore reducing stress on downstream facilities. Filter swales also facilitate interception of the "first flush" of rainfall. Fig.19 below from the CIRIA SuDS Manual illustrates the principle.

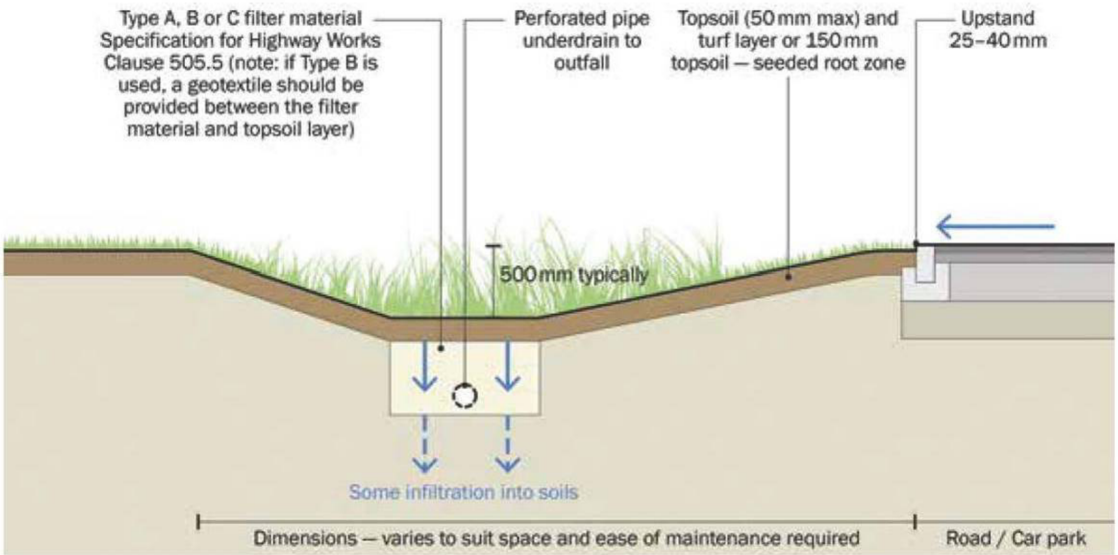


Fig.19 – Filter Swale

7.2.3 As part of the site control it is proposed to construct 15 No. **filter swales** along the site roads at specified locations which will allow surface water runoff from roads to be intercepted and infiltrate to ground. In the event the ground is saturated, there are also positive drainage connections from the filter swales into the piped network. Refer to Dwg.No.'s 1324B/304-306 for proposed locations of the filter swales and to Dwg.1324B/317 for details of this proposal. Typical calculations for these features are included in Appendix 12.3 of this report.

7.2.4 A PAF of 0.7 (70%) will apply to areas draining to these swales as was agreed in principle with the SDCC *EWCC Dept*. as part of the pre-planning discussions. Refer to Dwg.No.1324B/317 for details.

7.2.5 Single camber roads are to be constructed to drain into these filter swales where appropriate to maximize the drained area. Road cambers are shown on Dwg.No.'s 1324B/301-303 and details on Dwg.No.'s 1324B/317 and 318.

7.2.6 Included in the layout design of the proposed development is the existing hedgerow forming a central north/south spine to the site and thus creating a Bio-Retention feature replicating the natural drainage characteristics of the existing site. Incorporating a swale into this feature provides an important role of intercepting rainfall run-off and managing same through evapotranspiration as well as infiltration to vegetation roots. The addition of landscaping and planting throughout the development is also an important aspect of site control in providing biodiversity, run off reduction, interception, infiltration and amenity. Refer to the landscape architects' drawings for more information.

7.2.7 The quality of the run-off is to be maintained by minimizing the impermeable surfaces especially in the car parking areas, and also where possible by diverting road generated surface water runoff into filter swales.

7.2.8 Silt-trap/catchpit manholes are provided upstream of each of the below ground attenuation storage systems which will remove sediments and silts and forms part of the site control methodology used in the proposed development.

7.3 Regional Control

7.3.1 Regional control comprises of treatment facilities to reduce pollutants from runoff and control the surface water runoff rate to pre-development rates.

7.3.2 As part of the overall regional control for the site it is proposed to use void arched **attenuation systems**, such as the StormTech MC4500 system (Fig.20). These attenuation areas are located at the bottom of each catchment.

Fig.20 – StormTech Attenuation System

7.3.3 The reduced flow rate of the run-off from the attenuation systems is to be controlled using a vortex control devices such as a Hydrobrake. The total site outfall rate is restricted to the equivalent of the existing greenfield runoff rate , Qbar, of 59.7l/s - refer to paragraph 5.23-5.25 for more detail.

7.3.4 Interception of the "first flush" of rainfall is captured in the voided stone beneath the rear garden filter swales, the roadside swales, the permeable paving and the attenuation systems and can infiltrate to ground where possible.

7.3.5 A petrol interceptor is to be provided immediately downstream of each of the Hydrobrake flow restricting manholes and upstream of the outfalls. The PI will further remove any pollutants not already captured in the above noted interception and treatment train elements.

7.3.6 Prevention of pollutants and sediments entering the receiving watercourse has been achieved in providing Interception Storage throughout the proposed development. The interception will take place from the head of the catchment right down to the Hydrobrake manhole on the application lands.

7.3.7 Non return valves and concrete wing wall details are to be used at each of the attenuated outfall points.

7.4 SuDS Summary

7.4.1 The interception storage will be within the stone base of the permeable paving, in the stone below the filter drain pipework and swales, in the sub-strata of the green roof systems and in the stone base of the attenuation storage areas. In accordance with the GDSDS, the volume of interception storage provided is greater that generated by 5mm of rainfall on the site and up to 10mm if possible. Calculations of the interception volumes are shown in paragraph 8.4 of this document.

7.4.2 Replicating the natural characteristics and providing amenity/biodiversity will be encouraged by creating the roadside grassed swales, green roofs, filter drains and grassed detention basin.

7.4.3 The surface water runoff rate has been restricted to the greenfield runoff rate, Qbar and calculations for same can be viewed in Chapter 9 of this report.

7.4.4 Refer to Appendices 12.1-12.3, 12.5, 12.6, 12.9, 12.11. 12.14 of this report and to Dwg. No's 1324B/304-306 and Dwg.No.'s 1324B/317-319 for the drainage layout and SuDS features details.

7.4.5 In providing the above noted rear garden filter drains, roadside filter swales, tree pits, bio-retention area, house rainwater butts, permeable paving systems, catchpits, attenuation storage, greenfield run off vortex control and petrol interceptors it is proposed that the SuDS treatment of the run-off has been adequately addressed. The above noted proposals have been discussed and agreed in principle with SDCC *EWCC Dept*. during the pre-planning process.

8.0 GDSDS Criterion and Design Standards

8.1 In accordance with best practice, the internal drainage system has been designed as a completely separate foul and surface water system.

8.2 In accordance with the Greater Dublin Regional Code of Practice for Drainage Works (GDSDS) the surface water drainage infrastructure was designed to the parameters as outlined in Table 16 below;

Time of entry	**4mins**
Return periods for pipework	1 years- no surcharge (site slope >1%)
	Q30 15min no flooding
	Q100 15min – storage in designated areas only
Climate Change	10%
Min.velocity	0.75m/s
Max.velocity	3m/s
Min.sewer size for TIC	225mm diameter
Pipe friction (Ks)	0.6mm
Minimum pipe depth	1.2m below roads 0.9m in open/grassed spaces Concrete bed and surround otherwise
Standard Annual Average Rainfall (SAAR)	882mm (Met Eireann data)
M5-60	19.3mm
Ratio r (M5-60/M5-2Day)	0.256
Outfall Rate	Total Drained Site Qbar = 59.7l/s
Attenuation storage	Q30 – no flooding on site Q100 – overflow into detention basin only, 500mm freeboard to FFLs of houses, flood routing plan.
Paved Area Runoff percentage	90% from roads and paths not drained to SuDS features 72% green roofs 71% roof runoff and private path drained via rear garden filter drains 70% from roads and paths drained to filter swales 60% parking permeable paving areas 25% public open space grassland and front gardens 15% rear garden grassland

Table 16 – S/W Design Parameters

8.3 In accordance with the GDSDS, the four principal design criteria as set out in section 6.3.4 of volume 2 of GDSDS are summarized as follows;

- **Criterion 1** - River water quality protection
- **Criterion 2** – River regime protection
- **Criterion 3** – Level of service (flooding) for the site
- **Criterion 4** – River Flood protection

8.4 **Criterion 1** has been complied with by inclusion of **Interception** of at least 5mm of rainfall to prevent runoff to the receiving water. The interception storage will be within the stone base of the permeable paving, in the stone below the filter drain pipework and swales, in the sub-strata of the green roof systems and in the stone base of the attenuation storage area. As per the parameters laid out in the GDSDS the interception volume was calculated for the total site as per Table 17 below;

INTERCEPTION CALCULATION- TOTAL DRAINED SITE							
Paved Surfaces connected to the drainage system (Ha) =	**8.67**	**Volume of Interception Required (m^3)**		Gross Paved Area x 5% x 0.8	(GDSDS E2.1.1 - Criterion 1)		
				346.7			
Volume of Interception Provided (m^3)	**Length**	**Width (m)**	**Area (m^2)**	**Quantity**	**Stone Depth (m)**	**Void Ratio**	**Volume (m^3)**
Rainwater Butts (200l) @ 2No.per block	1.25		0.45	192		1	108.0
Voids of stone below Peremable Paving overflow			10,330		0.15	0.3	464.9
Voids of stone below Filter Drain overflow	1383	0.6			0.15	0.4	49.8
Voids of stone below Swale overflow	556	0.6			0.15	0.4	20.0
Tree Pit depression			6.25	18	0.05	1	5.6
Voids of stone below Attenuation Tank			3,698		0.3	0.4	443.8
			Volume of Interception Provided (m^3) =				**1,092.0**
			Volume of Interception Required (m^3) =				**346.7**
			Interception provided > Required				**OK**

Table 17 - Interception Storage Calculation (Ref.GSDS E2.1.1)

8.5 Interception calculations for each individual catchment are included in Appendix 12.14 of this report. The following Table 18 is a summary of the interception provided for each catchment and the reader is referred to the Appendix 12.14 for the detailed calculation of each;

INTERCEPTION SUMMARY			
Catchment No.	Interception Required (m^3)	Interception Provided (m^3)	Provided > Required
1	109.1	355.4	YES
2	23.8	92.5	YES
3	24.0	101.5	YES
4	31.0	104.3	YES
5	107.5	369.9	YES
6	22.3	28.3	YES
7	27.4	40.5	YES
*8	N/A	N/A	N/A

*Catchment 8 is for a possible future school site and in not part of this application

Table 18 - Summary of Catchment Interception

8.6 **Criterion 2** is complied with in applying the Qbar outfall rates and providing the more than required volume of 5,207m^3 of attenuation storage in the below ground StormTech systems and SuDS features. Note that there is c.979m^3 of additional storage provided over and above the MicroDrainage model simulation calculated which is achieved in the spare capacity both of the attenuation systems and the interception elements (see Table 4). This makes the overall design a conservative and more safe approach to volume estimation.

8.7 **Criterion 3** is satisfied with as each of the 4No.sub-criterion design objectives have been met as per Table 19 the below;

Sub-criterion	Design objective	Satisfied
3.1	No flooding on site for the Q30 except where specifically planned	OK
3.2	No internal property flooding for site critical duration storm event.	OK
3.3	No internal property flooding satisfied as 500mm freeboard to house FFL's is achieved.	OK
3.4	No flooding of adjacent areas unless specific routing planned for the Q100 + 10% climate change	OK
Refer to the MicroDrainage surface water model results (Q1-Q100+10%) included in Appendix 12.1 of this report for further detail		

Table 19 - GDSDS Sub-criterion

8.8 **Criterion 4** River flood protection is satisfied under GDSDS sub-criterion 4.3 in accordance with the application of the Qbar outfall rates and therefore long-term storage is not required.

9.0 Determination of Qbar

9.1 The total allowable surface water outfall rate is based on the existing greenfield run off rate, Qbar as specified in the GDSDS Volume 2 Section 6.6.1.2.

9.2 Qbar is determined from the Institute of Hydrology Report No.124 (IH124) in accordance with the following formula;

$$Qbar = 0.00108 AREA^{0.89} SAAR^{1.17} SOIL^{2.17}$$

Where;

Qbar is the mean annual flood flow from a 50Ha rural catchment in m^3/s
AREA is the area of the catchment in km^2
SAAR is the standard average annual rainfall in mm
SOIL is the soil index, which is a composite index determined from soil survey maps that accompany the Flood Studies Report

9.3 The area drained of surface water in the application area is 15.85Ha

9.4 The Standard Annual Average Rainfall for the Boherboy Site is 882mm as determined from Met Eireann 1km^2 grid dataset.

9.5 The value for SOIL used in the IH 124 Qbar formula noted above is derived from the pervious surface runoff factor (SPR) using the formula

$$SOIL = \frac{(0.1S1 + 0.3S2 + 0.4S3 + 0.45S4 + 0.5S5)}{S1 + S2 + S3 + S4 + S5}$$

9.6 Where the soil type S1-S5 is determined using data obtained from the following sources;

- Trial hole investigation
- Soakaway testing
- Topographical survey
- Geological Survey of Ireland
- Teagasc soils map
- the Flood Studies Report (FSR - NERC, 1975)
- the Winter Rainfall Acceptance Potential (WRAP)
- the Wallingford Procedure Volume 3 Maps
- Transport Infrastructure Ireland (TII, formerly NRA) – Drainage of Runoff from Natural Catchments 2015

- HR Wallingford website
- Site visits by the design engineer
- GDSDS

9.7 Site investigations were undertaken including trial hole opening and soakaway testing. Refer to Appendix 12.7 of this report for the SI results.

9.8 The sub-soil conditions as determined by trial hole opening noted topsoil over variable cohesive and granular deposits of clays and silts overlying above the course greywacke and shale bedrock.

9.9 In total 4No.soakaway tests were carried out in accordance with BRE Digest 365 and the results indicated infiltration rates varied between unobtainable f values up to $1.38x10^{-5}$ mm/s. These results indicate limited but some availability for infiltration across the site. Refer to the soakaway test results in Appendix 12.7 of this report for further information.

9.10 A review of the Geological Survey of Ireland website http://www.gsi.ie and that of the Teagasc sub specific http://gis.teagasc.ie/soils/map.php websites both of which provide publicly available soils and bedrock datasets.

9.11 The soil association composition as determined from the Teagasc data is noted as loamy and clayey drift with limestones. Refer Fig.21 below and to Appendix 12.8 of this report for the summary extracts from the GSI/Teagasc datasets.

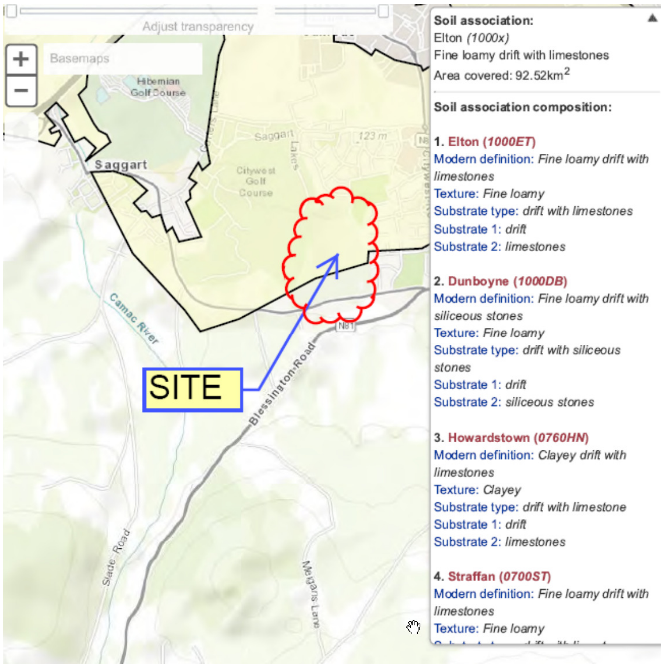


Fig.21 – Teagasc Soil Map

9.12 SOIL indices (1 to 5) are defined in the Flood Studies Report (NERC, 1975). The index broadly describes the maximum runoff potential and was derived by a consideration of soil permeability and topographic slope, as summarised in Table 20 below;

FSR Soil Indices	
Soil Type 1	Well drained permeable sandy or loamy soils and shallower analogues over highly permeable limestone, chalk, sandstone and related drifts. Earth peat soils drained by dykes and pumps Less permeable loamy over clayey soils on plateaux adjacent to very permeable soils in valleys
Soil Type 2	Very permeable soils with shallow ground water Permeable soils over rock or fragipan, commonly on slopes in western Britain associated with smaller areas of less permeable wet soils. Moderately permeable soils, some with slowly permeable sub-soils
Soil Type 3	Relatively impermeable soils in boulder and sedimentary clays, and in alluvium. Permeable soils with shallow ground water in low lying areas. Mixed areas of impermeable and permeable soils in approximately equal proportions.
Soil Type 4	Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.
Soil Type 5	Soils of wet uplands with peaty or humose surface horizons and impermeable layers at shallow depth Deep raw peat associated with gentle upland slopes or basin sites Bare rock cliffs and screes (iv) shallow, permeable rocky soils on steep slopes.
Based on the above definitions a SOIL Type 3 or 4 could be chosen for the Boherboy site	

Table 20 – FSR Soil Indices

9.13 The WRAP map gives a broad-spectrum overview of the soil type location across the entire country as per Fig.22 below;

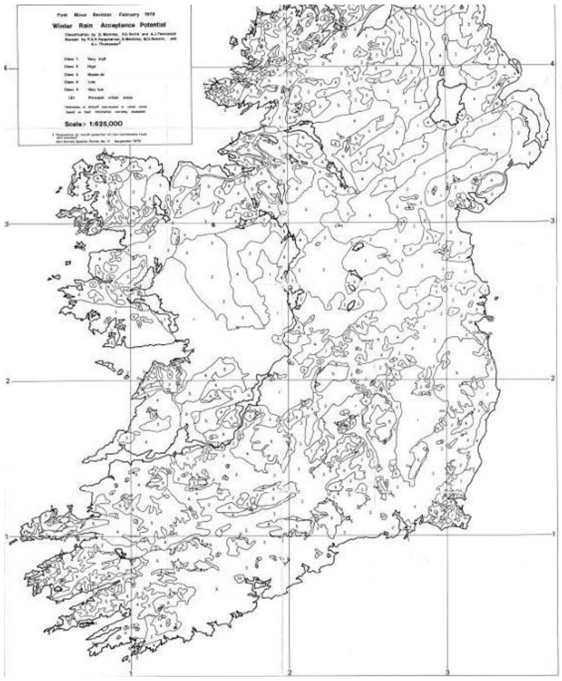


Fig.22 – WRAP Map - Full

9.14 At an expanded scale and overlaid with the Boherboy site specific location the WRAP map and Soil index is as Fig.23 below;

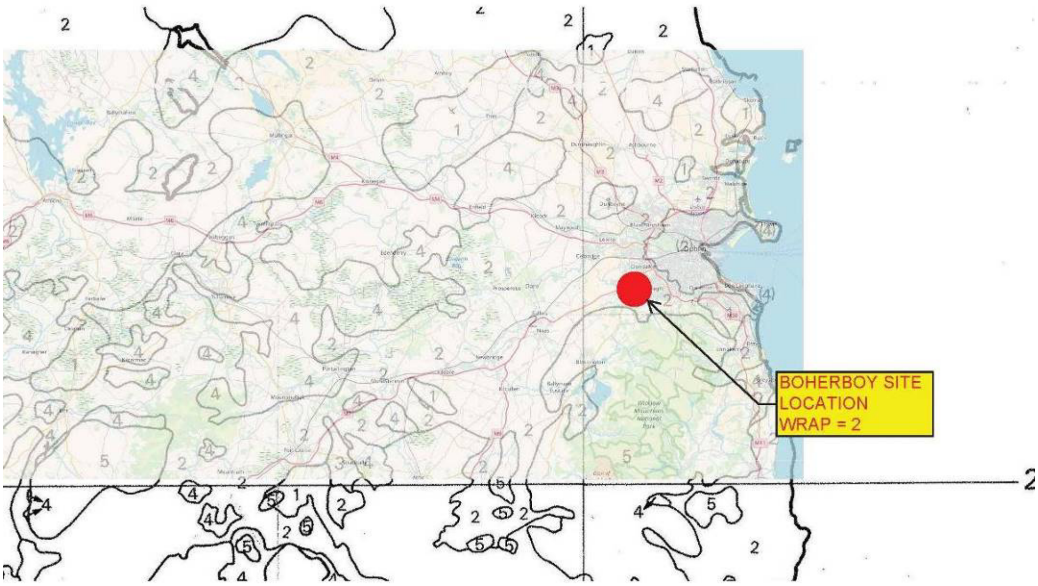


Fig.23 – WRAP Map – Local

9.15 Based on the WRAP map a **SOIL value of 2** could be interpreted but is not applied for this site based on site specific conditions and soakaway test results reveal a type 3 or 4 soil value.

9.16 From the FSR table, reproduced in Fig.24 below, showing the noted drainage and slope classes, the **Soil type could be interpolated as a type 4 soil**.

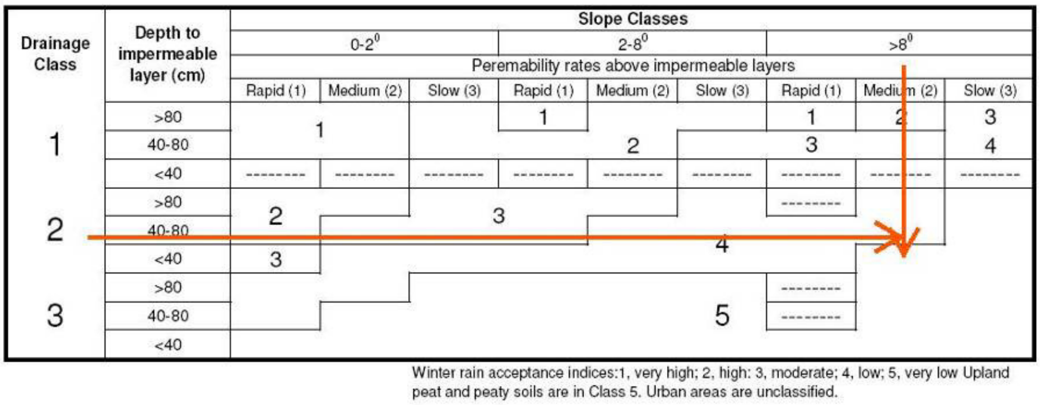


Fig.24 – Soil Type Table

9.17 Reference to the Transport Infrastructure Ireland -TII (formerly the National Roads Authority – NRA) publication Drainage of Runoff from Natural Catchments 2015, Volume 4 Sections 2 of the Design Manual for Roads and Bridges (DMRB) the following table was noted (Fig.25).

General soil description	Runoff potential	Soil class
Well drained sandy, loamy or earthy peat soils Less permeable loamy soils over clayey soils on plateaux adjacent to very permeable soils in valleys	Very low	S_1
Very permeable soils (e.g. gravel, sand) with shallow groundwater Permeable soils over rocks Moderately permeable soils some with slowly permeable subsoils	Low	S_2
Very fine sands, silts and sedimentary clays Permeable soils (e.g. gravel, sand) with shallow groundwater in low lying areas Mixed areas of permeable and impermeable soils in similar proportions	Moderate	S_3
Clayey or loamy soils	High	S4
Soils of the wet uplands: Bare rocks or cliffs Shallow, permeable rocky soils on steep slopes Peats with impermeable layers at shallow depth	Very high	S_5

Fig.25 – TII Soil Class

9.18 Using the results of the site investigation trial holes as well as the Teagasc data sets noted previously, a **Soil class of S4** could be interpolated from the TII Fig.17 above.

9.19 The site is steeply sloped from the south towards the north with existing gradients up to c.1/7(14%). The underlying soil type evidenced from the trialhole logs is variable cohesive and granular deposits of clays and silts overlying above the course greywacke and shale bedrock. Refer to Appendix 12.7 of this report for the trial hole and soakaway test results.

9.20 Based on interpretation of each of the above data sets a Soil Type 2, 3 or 4 could be interpreted and in agreement with SDCC *EWCC Dept*., a **Type 3 soil** was chosen as appropriate for this site. The decision to choose a type 3 is deemed as conservative and yields a lower outfall rate than of a soil type 4.

9.21 From the GDSDS Volume 2, Table 6.7, shown in Fig.26 below, using a Soil value of 3 equates to an SPR value of 0.37.

SOIL	SPR value (% runoff)
1	0.1
2	0.3
3	0.37
4	0.47
5	0.53

Fig.26 – GDSDS SPR Values

9.22 This SPR value of 0.37 was used in the Institute of Hydrology Report No.124 formula (***$Qbar = 0.00108AREA^{0.89}SAAR^{1.17}SOIL^{2.17}$***) to determine the appropriate Qbar as per Table 21 below. Note the Qbar is calculated using the area of the site that is drained to the surface water piped system.

ROGER MULLARKEY & ASSOCIATES Duncreevan, Kilcock, Co.Kildare Tel 01 610 3755, Mob. 087 2324917	**Project:**	**Boherboy**	**Job No:**	**1324B**	
			Date:	**01/03/2021**	
	Element:	**Overall Site Qbar Estimate**	**Made By:**	**RM**	

Site Charactistics				
Site Area (Ha)		15.85	Ha	
Standard Average Annual Rainfall (SAAR), mm		882	mm	Met Eireann
Soil Type		3		SI report
SPR Value		**0.37**		GDSDS Table 6.7

50Ha Qbar Estimate from Institute of Hydrology Report No.124					
SITE AREA (km^2)	0.5				
SAAR (mm)	882				
ERS SPR Soil Index	0.37				
Qbar rural 50Ha, l/s =	(0.00108xArea^$^{0.89}$xSAAR^$^{1.17}$xSOIL^$^{2.17}$)x1000 =		188.2	l/s	IH124, GDSDS 6.6.1.2
		Qbar per Ha =	**3.76**	**l/s**	
Allowable Outflow (Site Area x Qbar)			59.67	l/s	
		TOTAL Site QBar =	**59.7**	**l/s**	

Table 21 – Overall Site Qbar Calculation

9.23 Therefore the calculated Qbar for the total drained area of site was determined to be **59.7l/s.** This total runoff rate was sub-divided into each of the 8No.site sub-catchments as discussed in paragraphs 5.20-5.22 of this report.

10.0 Wastewater Site Drainage

10.1 Foul drainage records drawings were obtained from IW/SDCC in preparation for this planning application and are included in Appendix 12.9 of this document.

10.2 A Pre-Connection Enquiry Form application (PCEA) was submitted to Irish Water and a Confirmation of Feasibility(CoF) was received (Ref.CDS20004359) from IW noting that the wastewater connection was "*feasible subject to upgrades*". A copy of the IW confirmation letter can be viewed in Appendix 12.12 of this report.

10.3 Further to the CoF received from IW, extensive discussions were subsequently held with Irish Water and full design submissions were made both for the wastewater and water infrastructure. Subsequently agreement was reached and was confirmed by IW in the Statement of Design acceptance letter (Ref.CDS20004359) issued on 19/08/21. A copy of the IW design acceptance letter can be viewed in Appendix 12.12 of this report.

10.4 The minimum public sewer diameter is to be 225mm and the foul drains/sewer are to be in accordance with the Irish Water Code of Practice for Wastewater Infrastructure 2017 and the criteria applied in the design is as per Table 22 below.

Foul Sewer Design Criteria	
Min.velocity	0.75m/s
Max.velocity	3m/s
Min.sewer size for TIC	225mm diameter
Pipe friction (Ks)	1.5mm
Minimum pipe depth	1.2m below roads 0.9m in open/grassed spaces
Ave.Occupancy	2.7 persons/unit
Residential loading/person/day	150 l/day
Commercial loading/person/day	50 l/d

Table 22- Foul Sewer Design Criteria

10.5 The foul water drainage system is to outfall by gravity into the existing Irish Water infrastructure located to the east of the subject site at Verschoyle Green as was agreed with Irish Water.

10.6 The lower level north end of the site incorporates a pumping station to drain the apartment Blocks A and C and the possible future school site via a rising main into the outfalling gravity pipe. This has been agreed with Irish Water.

10.7 The proposed foul pumping station is to be in accordance with the Irish Water Code of Practice for Wastewater Infrastructure 2017 – Part 5 – Pumping Stations. The details of which can be viewed on the provided drawing No.1324B/321.Please note that the foul pumping station is below ground and is proposed to have only 2No.above ground kiosks visible as per the IW standard shown in Fig.27 and 28 below;

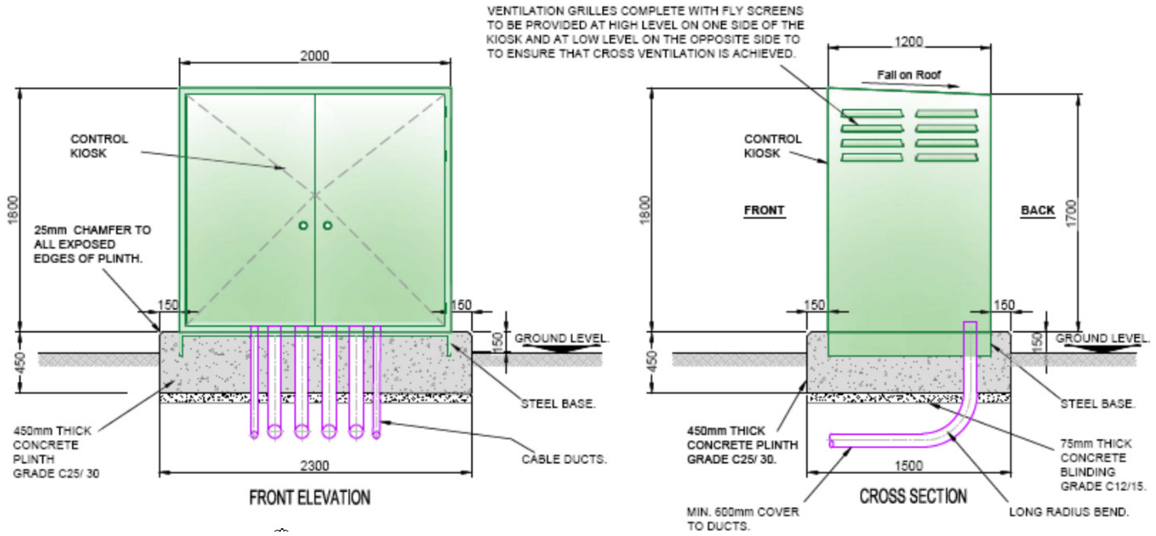


Fig.27 – ex.IW STD-WW-30A

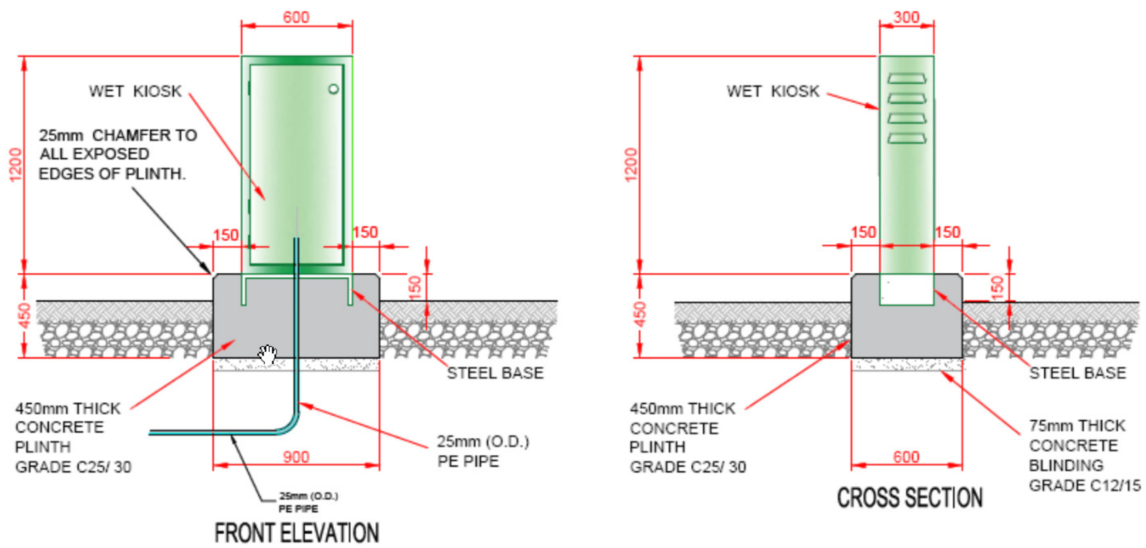


Fig.28 – ex.IW STD-WW-31A

10.8 The calculations for the site foul estimates and pumping station are included in Appendix 12.4 of the document. Please refer to Dwg.No.1324B/321 for details of the foul pumping station and to Dwg.No.'s 1324B/307-309 for the site foul drainage layouts.

10.9 Each individual house connection is to be in accordance with the Irish Water Code of Practice for Wastewater Infrastructure 2020 which requires individual house connections to each dwelling. Each individual house is to be connected to the main public foul sewer using a 100mm diameter drain with a minimum gradient of 1/80 in any one drain. Refer also to IW-STD-WW-02.

10.10 Details of manholes are to be as per Dwg.No.1324B/329 and in accordance with the Irish Water Code of Practice for Wastewater Infrastructure 2020 and Standard Details documents.

11.0 Site Potable Watermain

11.1 Water infrastructure records drawings were obtained from SDCC/IW in preparation for this planning application and are included in Appendix 12.9 of this document.

11.2 A Pre-Connection Enquiry Form application (PCEA) was submitted to Irish Water and a Confirmation of Feasibility(CoF) was received (Ref.CDS20004359) from IW noting that the water connection was "*feasible without infrastructure upgrade*". A copy of the IW confirmation letter can be viewed in Appendix 12.12 of this report.

11.3 Further to the CoF received from IW, extensive discussions were subsequently held with Irish Water and full design submissions were made for the water infrastructure. Subsequently agreement was reached and was confirmed by IW in the Statement of Design acceptance letter (Ref.CDS20004359) issued on 19/08/21. A copy of the IW design acceptance letter can be viewed in Appendix 12.12 of this report.

11.4 The proposed water supply for the development is to be made by connecting to an existing 400mm diameter main located in the Boherboy Road (L2008) to the south of the site.

11.5 A single 200mm diameter connection has been approved by Irish Water and will supply the proposed development via a 200mm diameter spine watermain with interconnecting 150mm and 100mm diameter looped branch watermains connected to it. Individual houses are to be supplied with a 25mm connection.

11.6 There are 3No.existing watermains (4inch uPVC/400mmDI/600mmDI) in Boherboy Road along the southern site frontage. This application proposes to make a new water connection to the 400mm DI watermain in the Boherboy Road. This has been agreed with Irish Water.

11.7 There are 5No.existing trunk watermains crossing the applicant's lands. A 1.2m Ø (1982 Concrete), a 27inch Ø (1938 Steel) and a 24inch (AC 1975) lie approximately parallel to each other in the northern third of the site and also a 1.2m Ø (1983 Concrete) and 24inch Ø (1952 Cast Iron) lie parallel approximately in the middle of the site. Please refer to drawing No.'s 1324B/310-312 for location of these existing trunk watermains.

11.8 These trunk watermains are in the control of Irish Water. The set-back requirements from these mains is in accordance with the Irish Water Code of Practice for Water Infrastructure 2020 document and extensive discussions were held with Irish Water relating to development in proximity to same. Based on those discussions and design/drawing submissions IW confirmed their approval in issuing the Statement of Design acceptance letter (Ref.CDS20004359) dated. A copy of the IW design acceptance letter can be viewed in Appendix 12.12 of this report.

11.9 In order to precisely locate these existing trunk watermains, excavation of silt trenches was carried out in Dec 2013 with the permission of the then overseeing authorities of Dublin City Council and South Dublin County Council *EWCC Dept*. All mains were located, surveyed, mapped and the results issued to both SDCC, DCC and Irish Water for their records.

11.10 It was discovered during the excavations to precisely locate the existing trunk mains that one of the existing watermains (1.2m Ø 1982 main) was in a different location to that as was shown on the Local Authority records drawings. This record anomaly was brought to the attention of each of SDCC, DCC and Irish Water and the actual correct position of the 1.2m Ø 1982 main was surveyed-in and issued to all the relevant authorities. The correct and surveyed location of each the existing watermains are as shown on the submission drawings 1324B/301-312.

11.11 Refer to Dwg.No.'s 1324B/310-312 for the watermain layout and to Dwg.1324B/316 for sections across the existing trunk watermains which have been reviewed and approved by Irish Water.

11.12 In reference to the Irish Water Code of Practice for Water Infrastructure (July 2020) document, each individual residential dwelling within the development is to be provided with a boundary box. The type and configuration of the boundary box is to be in accordance with the IW STW-W-03.

11.13 Each dwelling will be fitted with a cold-water storage tank to provide 24 hours of supply.

11.14 In accordance with best practice, the use of water conservation appliances in the buildings are to be employed as part of this scheme to reduce the water demand. Although the consumption of treated water depends a lot on the behaviour of consumers, demand on the network is limited in the scheme by incorporating water saving tap valves, eco-flush toilet system and water saving appliances.

11.15 As a further measure of demand reduction, it is proposed to provide 200l **rainwater butts** to the rear of each gabling property. This will collect rainwater from the house roofs for use in garden irrigation, therefore reducing potable water demand and decreasing run-off from the site. Refer to Appendix 12.5 for more information.

11.16 All watermain layout and details are to be in accordance with the Irish Water Code of Practice for Water Infrastructure 2020 and the Water Infrastructure Standard details 2020.

12.0 APPENDIX

Contents:

Appendix 12.1

MicroDrainage S/W Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 1 and 5 and 6 and 8

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.300	Add Flow / Climate Change (%)	0
Ratio R	0.256	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	3.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	180

Designed with Level Soffits

Time Area Diagram for Catchment 1 and 5 and 6 and 8

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.354	4-8	3.035	8-12	2.324	12-16	0.097	16-20	0.009

Total Area Contributing (ha) = 5.819

Total Pipe Volume (m³) = 258.898

Network Design Table for Catchment 1 and 5 and 6 and 8

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	54.873	0.631	87.0	0.253	4.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S1.001	60.900	0.508	119.9	0.151	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S2.000	21.197	1.054	20.1	0.008	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S1.002	33.543	1.198	28.0	0.039	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S1.003	27.205	1.360	20.0	0.048	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	4.54	142.720	0.253	0.0	0.0	0.0	1.69	119.2	34.3
S1.001	50.00	5.25	142.089	0.404	0.0	0.0	0.0	1.43	101.4	54.7
S2.000	50.00	4.12	143.400	0.008	0.0	0.0	0.0	2.93	116.6	1.1
S1.002	50.00	5.44	141.450	0.452	0.0	0.0	0.0	2.98	210.8	61.2
S1.003	50.00	5.55	140.230	0.500	0.0	0.0	0.0	4.07	449.2	67.7

Network Design Table for Catchment 1 and 5 and 6 and 8

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S3.000	21.472	1.074	20.0	0.051	10.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S3.001	27.186	0.544	50.0	0.037	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S3.002	13.858	0.237	58.5	0.045	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S4.000	47.327	0.464	102.0	0.198	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S5.000	32.390	1.620	20.0	0.074	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S4.001	22.651	0.206	110.0	0.049	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S4.002	14.831	0.144	103.0	0.038	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S4.003	21.190	0.206	103.0	0.020	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S1.004	40.854	1.277	32.0	0.030	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S1.005	40.712	1.404	29.0	0.059	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S6.000	34.439	1.722	20.0	0.063	10.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S6.001	34.315	0.686	50.0	0.119	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S6.002	14.357	0.245	58.6	0.021	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S1.006	33.850	1.167	29.0	0.001	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S7.000	48.038	1.298	37.0	0.114	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S7.001	47.724	1.136	42.0	0.133	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S3.000	41.85	10.12	142.300	0.051	0.0	0.0	0.0	2.94	116.9	5.7
S3.001	41.39	10.37	140.800	0.088	0.0	0.0	0.0	1.85	73.7	9.8
S3.002	41.14	10.50	139.800	0.133	0.0	0.0	0.0	1.71	68.1	14.8
S4.000	50.00	4.61	139.720	0.198	0.0	0.0	0.0	1.29	51.5	26.8
S5.000	50.00	4.18	140.620	0.074	0.0	0.0	0.0	2.94	116.9	10.0
S4.001	50.00	4.86	139.010	0.321	0.0	0.0	0.0	1.50	105.9	43.4
S4.002	50.00	5.02	138.800	0.358	0.0	0.0	0.0	1.55	109.5	48.5
S4.003	50.00	5.25	138.640	0.379	0.0	0.0	0.0	1.55	109.5	51.3
S1.004	40.80	10.69	138.430	1.041	0.0	0.0	0.0	3.60	573.2	115.0
S1.005	40.48	10.87	137.140	1.100	0.0	0.0	0.0	3.79	602.2	120.6
S6.000	41.71	10.20	139.300	0.063	0.0	0.0	0.0	2.94	116.9	7.1
S6.001	41.14	10.50	137.300	0.182	0.0	0.0	0.0	1.85	73.7	20.3
S6.002	40.88	10.64	136.400	0.203	0.0	0.0	0.0	1.71	68.1	22.5
S1.006	40.27	10.99	135.650	1.304	0.0	0.0	0.0	4.53	1281.8	142.2
S7.000	50.00	4.37	140.960	0.114	0.0	0.0	0.0	2.16	85.8	15.5
S7.001	50.00	4.76	139.650	0.248	0.0	0.0	0.0	2.02	80.5	33.6

Network Design Table for Catchment 1 and 5 and 6 and 8

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S7.002	26.356	0.753	35.0	0.062	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S7.003	25.116	0.866	29.0	0.025	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S7.004	19.539	0.977	20.0	0.034	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S1.007	32.751	0.131	250.0	0.021	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S8.000	52.758	2.638	20.0	0.077	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S9.000	57.682	0.560	103.0	0.221	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S8.001	31.505	0.768	41.0	0.134	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S8.002	29.954	1.362	22.0	0.116	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S8.003	36.420	0.243	149.9	0.075	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S8.004	18.547	0.124	149.6	0.056	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S10.000	19.198	0.960	20.0	0.065	10.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S10.001	19.248	0.962	20.0	0.019	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S10.002	5.973	0.299	20.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S8.005	13.890	0.093	149.4	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	🔒
S11.000	27.823	1.210	23.0	0.080	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S12.000	30.995	1.348	23.0	0.025	10.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S7.002	50.00	4.93	138.500	0.310	0.0	0.0	0.0	2.67	188.5	42.0
S7.003	50.00	5.07	137.750	0.335	0.0	0.0	0.0	2.93	207.2	45.4
S7.004	50.00	5.16	135.750	0.369	0.0	0.0	0.0	3.53	249.6	50.0
S1.007	39.66	11.35	132.150	1.694	0.0	0.0	0.0	1.54	434.2	182.0
S8.000	50.00	4.30	138.200	0.077	0.0	0.0	0.0	2.94	116.9	10.5
S9.000	50.00	4.75	135.300	0.221	0.0	0.0	0.0	1.29	51.2	30.0
S8.001	50.00	4.96	134.650	0.432	0.0	0.0	0.0	2.46	174.1	58.5
S8.002	50.00	5.11	133.870	0.548	0.0	0.0	0.0	3.37	238.0	74.2
S8.003	50.00	5.47	132.400	0.623	0.0	0.0	0.0	1.66	263.8	84.4
S8.004	50.00	5.66	132.160	0.680	0.0	0.0	0.0	1.66	264.0	92.0
S10.000	41.87	10.11	135.700	0.065	0.0	0.0	0.0	2.94	116.9	7.4
S10.001	41.67	10.22	134.700	0.084	0.0	0.0	0.0	2.94	116.8	9.5
S10.002	41.60	10.25	133.700	0.084	0.0	0.0	0.0	2.94	116.9	9.5
S8.005	41.41	10.35	132.040	0.764	0.0	0.0	0.0	2.29	1010.7	92.0
S11.000	50.00	4.17	136.550	0.080	0.0	0.0	0.0	2.74	109.0	10.9
S12.000	41.72	10.19	137.000	0.025	0.0	0.0	0.0	2.74	109.0	2.8

Network Design Table for Catchment 1 and 5 and 6 and 8

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S12.001	5.090	0.087	58.5	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S11.001	12.364	0.495	25.0	0.040	0.00	0.0	0.600	o	225	Pipe/Conduit	
S11.002	27.582	0.471	58.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.008	20.865	0.161	130.0	0.035	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.009	31.735	0.264	120.1	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S13.000	14.538	0.162	90.0	0.033	4.00	0.0	0.600	o	225	Pipe/Conduit	
S1.010	23.690	0.198	119.7	0.024	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.011	32.644	1.625	20.1	0.047	0.00	0.0	0.600	o	225	Pipe/Conduit	
S14.000	44.172	1.469	30.1	0.182	4.00	0.0	0.600	o	225	Pipe/Conduit	
S15.000	18.602	0.930	20.0	0.052	10.00	0.0	0.600	o	225	Pipe/Conduit	
S15.001	18.615	0.931	20.0	0.038	0.00	0.0	0.600	o	225	Pipe/Conduit	
S15.002	14.972	0.749	20.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.012	39.538	1.803	21.9	0.052	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.013	41.939	2.097	20.0	0.064	0.00	0.0	0.600	o	375	Pipe/Conduit	
S16.000	47.238	2.249	21.0	0.095	4.00	0.0	0.600	o	225	Pipe/Conduit	
S16.001	30.919	1.472	21.0	0.075	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S12.001	41.63	10.24	135.650	0.025	0.0	0.0	0.0	1.71	68.1	2.8
S11.001	41.48	10.32	135.330	0.145	0.0	0.0	0.0	2.63	104.5	16.3
S11.002	40.99	10.58	132.500	0.145	0.0	0.0	0.0	1.71	68.1	16.3
S1.008	39.17	11.65	130.850	2.638	0.0	0.0	0.0	1.15	45.5«	279.9
S1.009	38.47	12.10	130.690	2.638	0.0	0.0	0.0	1.19	47.4«	279.9
S13.000	50.00	4.18	132.150	0.033	0.0	0.0	0.0	1.38	54.8	4.4
S1.010	37.97	12.43	130.420	2.695	0.0	0.0	0.0	1.19	47.5«	279.9
S1.011	37.69	12.61	130.230	2.742	0.0	0.0	0.0	2.93	116.6«	279.9
S14.000	50.00	4.31	130.060	0.182	0.0	0.0	0.0	2.39	95.2	24.6
S15.000	41.88	10.11	132.300	0.052	0.0	0.0	0.0	2.94	116.9	5.9
S15.001	41.68	10.21	131.200	0.090	0.0	0.0	0.0	2.94	116.9	10.2
S15.002	41.52	10.30	130.000	0.090	0.0	0.0	0.0	2.94	116.9	10.2
S1.012	37.41	12.81	127.800	3.066	0.0	0.0	0.0	3.37	238.4«	310.6
S1.013	37.17	12.98	124.790	3.129	0.0	0.0	0.0	4.07	449.3	315.0
S16.000	50.00	4.27	141.850	0.095	0.0	0.0	0.0	2.87	114.0	12.9
S16.001	50.00	4.45	138.600	0.170	0.0	0.0	0.0	2.87	114.0	23.1

Network Design Table for Catchment 1 and 5 and 6 and 8

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S16.002	28.164	1.408	20.0	0.033	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S16.003	36.605	1.830	20.0	0.024	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S16.004	23.388	1.169	20.0	0.052	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S16.005	20.523	0.150	136.8	0.074	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S17.000	50.137	1.567	32.0	0.119	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S17.001	5.129	0.088	58.3	0.003	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S16.006	28.657	0.191	150.0	0.019	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S16.007	39.247	1.121	35.0	0.083	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S18.000	48.243	1.419	34.0	0.138	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S16.008	17.931	0.299	60.0	0.003	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
S16.009	41.985	1.499	28.0	0.150	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
S16.010	39.146	0.851	46.0	0.022	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
S16.011	28.968	0.630	46.0	0.119	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
S19.000	24.308	1.215	20.0	0.045	8.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S19.001	24.034	1.202	20.0	0.032	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S19.002	12.637	0.632	20.0	0.011	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S19.003	12.707	0.318	40.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S1.014	59.054	0.492	120.0	0.085	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S16.002	50.00	4.61	136.940	0.204	0.0	0.0	0.0	2.94	116.9	27.6
S16.003	50.00	4.82	134.790	0.228	0.0	0.0	0.0	2.94	116.9	30.8
S16.004	50.00	4.95	132.500	0.280	0.0	0.0	0.0	2.94	116.8	37.9
S16.005	50.00	5.26	128.350	0.354	0.0	0.0	0.0	1.12	44.4«	47.9
S17.000	50.00	4.36	131.330	0.119	0.0	0.0	0.0	2.32	92.3	16.1
S17.001	50.00	4.41	129.763	0.122	0.0	0.0	0.0	1.72	68.2	16.5
S16.006	50.00	5.63	128.125	0.494	0.0	0.0	0.0	1.28	90.6	66.9
S16.007	50.00	5.88	127.925	0.578	0.0	0.0	0.0	2.67	188.5	78.2
S18.000	50.00	4.36	127.840	0.138	0.0	0.0	0.0	2.25	89.5	18.6
S16.008	50.00	6.01	126.300	0.719	0.0	0.0	0.0	2.34	258.8	97.3
S16.009	50.00	6.21	125.980	0.868	0.0	0.0	0.0	3.44	379.4	117.6
S16.010	50.00	6.45	124.460	0.890	0.0	0.0	0.0	2.68	295.7	120.5
S16.011	50.00	6.63	123.600	1.009	0.0	0.0	0.0	2.68	295.8	136.6
S19.000	46.13	8.14	127.800	0.045	0.0	0.0	0.0	2.94	116.8	5.6
S19.001	45.80	8.27	126.200	0.077	0.0	0.0	0.0	2.94	116.9	9.5
S19.002	45.63	8.35	124.500	0.088	0.0	0.0	0.0	2.94	116.9	10.8
S19.003	45.39	8.45	123.750	0.088	0.0	0.0	0.0	2.08	82.5	10.8
S1.014	36.56	13.42	122.450	4.310	0.0	0.0	0.0	2.22	628.2	426.8

Network Design Table for Catchment 1 and 5 and 6 and 8

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S20.000	33.840	0.282	120.0	0.124	4.00	0.0	0.600	o	225	Pipe/Conduit	
S21.000	20.519	0.342	60.0	0.151	4.00	0.0	0.600	o	225	Pipe/Conduit	
S20.001	20.209	0.203	99.5	0.069	0.00	0.0	0.600	o	300	Pipe/Conduit	
S20.002	24.071	1.204	20.0	0.036	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.015	37.691	0.251	150.2	0.134	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.016	39.415	0.264	149.3	0.084	0.00	0.0	0.600	o	600	Pipe/Conduit	
S22.000	28.623	1.431	20.0	0.019	8.00	0.0	0.600	o	225	Pipe/Conduit	
S22.001	28.739	0.958	30.0	0.013	0.00	0.0	0.600	o	225	Pipe/Conduit	
S22.002	10.564	0.105	100.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S23.000	14.698	0.735	20.0	0.005	8.00	0.0	0.600	o	225	Pipe/Conduit	
S23.001	21.373	0.611	35.0	0.013	0.00	0.0	0.600	o	225	Pipe/Conduit	
S23.002	18.221	0.792	23.0	0.011	0.00	0.0	0.600	o	225	Pipe/Conduit	
S23.003	16.758	0.591	28.3	0.009	0.00	0.0	0.600	o	225	Pipe/Conduit	
S23.004	5.179	0.053	98.3	0.007	0.00	0.0	0.600	o	225	Pipe/Conduit	
S24.000	38.935	1.947	20.0	0.056	4.00	0.0	0.600	o	225	Pipe/Conduit	
S25.000	29.170	1.167	25.0	0.110	4.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S20.000	50.00	4.47	124.150	0.124	0.0	0.0	0.0	1.19	47.4	16.7
S21.000	50.00	4.20	124.700	0.151	0.0	0.0	0.0	1.69	67.3	20.5
S20.001	50.00	4.69	123.793	0.344	0.0	0.0	0.0	1.58	111.4	46.6
S20.002	50.00	4.80	123.290	0.381	0.0	0.0	0.0	3.53	249.7	51.6
S1.015	36.14	13.74	121.960	4.825	0.0	0.0	0.0	1.99	561.3	472.3
S1.016	35.73	14.07	121.700	4.910	0.0	0.0	0.0	1.99	562.9	475.1
S22.000	46.07	8.16	124.400	0.019	0.0	0.0	0.0	2.94	116.9	2.4
S22.001	45.59	8.36	122.969	0.032	0.0	0.0	0.0	2.40	95.3	4.0
S22.002	45.27	8.50	122.011	0.032	0.0	0.0	0.0	1.30	51.8	4.0
S23.000	46.26	8.08	127.750	0.005	0.0	0.0	0.0	2.94	116.9	0.7
S23.001	45.87	8.24	126.800	0.019	0.0	0.0	0.0	2.22	88.2	2.3
S23.002	45.61	8.35	126.180	0.029	0.0	0.0	0.0	2.74	108.9	3.6
S23.003	45.34	8.47	125.350	0.038	0.0	0.0	0.0	2.47	98.1	4.7
S23.004	45.19	8.53	124.750	0.045	0.0	0.0	0.0	1.32	52.4	5.5
S24.000	50.00	4.22	126.040	0.056	0.0	0.0	0.0	2.94	116.9	7.5
S25.000	50.00	4.19	125.120	0.110	0.0	0.0	0.0	2.63	104.5	14.8

Network Design Table for Catchment 1 and 5 and 6 and 8

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S23.005	43.034	1.450	29.7	0.009	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S23.006	29.555	0.591	50.0	0.040	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S1.017	16.055	0.214	75.0	0.023	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S1.018	12.541	0.172	72.9	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S1.019	4.299	0.072	59.7	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S1.020	81.477	0.326	249.9	0.034	0.00	0.0	0.600	o	750	Pipe/Conduit	🔒
S1.021	14.256	0.095	150.0	0.065	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S26.000	6.567	0.054	121.6	0.000	8.00	2.0	0.600	o	225	Pipe/Conduit	🔒
S1.022	51.760	0.345	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S1.023	39.219	0.261	150.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S27.000	7.210	0.060	120.2	0.439	8.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S27.001	32.832	0.217	151.3	0.052	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S27.002	12.035	0.213	56.5	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S1.024	15.092	0.101	149.4	0.005	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S23.005	44.51	8.83	123.950	0.219	0.0	0.0	0.0	2.41	95.8	26.4
S23.006	43.93	9.10	122.460	0.259	0.0	0.0	0.0	1.85	73.7	30.8
S1.017	35.61	14.16	121.440	5.224	0.0	0.0	0.0	2.81	795.6	503.8
S1.018	35.52	14.24	119.980	5.224	0.0	0.0	0.0	2.85	807.0	503.8
S1.019	35.49	14.26	119.250	5.224	0.0	0.0	0.0	3.16	892.2	503.8
S1.020	34.59	15.03	118.350	5.258	0.0	0.0	0.0	1.77	780.0	503.8
S1.021	34.33	15.25	118.000	5.323	0.0	0.0	0.0	1.07	42.4«	503.8
S26.000	46.24	8.09	117.970	0.000	2.0	0.0	0.0	1.18	47.1	2.0
S1.022	33.46	16.06	117.900	5.323	2.0	0.0	0.0	1.07	42.4«	503.8
S1.023	32.83	16.68	117.550	5.323	2.0	0.0	0.0	1.06	42.3«	503.8
S27.000	46.26	8.08	118.050	0.439	0.0	0.0	0.0	1.43	101.3	55.0
S27.001	45.46	8.42	118.000	0.491	0.0	0.0	0.0	1.65	262.5	60.5
S27.002	45.19	8.53	117.783	0.491	0.0	0.0	0.0	1.74	69.3	60.5
S1.024	32.60	16.91	117.290	5.819	2.0	0.0	0.0	1.07	42.4«	515.7

Free Flowing Outfall Details for Catchment 1 and 5 and 6 and 8

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.024	SOutfall 1	120.000	117.189	117.220	0	0

Simulation Criteria for Catchment 1 and 5 and 6 and 8

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

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	3	Number of Storage Structures	3	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	19.200	Storm Duration (mins)	30
Ratio R	0.256		

Online Controls for Catchment 1 and 5 and 6 and 8

Hydro-Brake® Optimum Manhole: S41, DS/PN: S1.008, Volume (m³): 27.6

Unit Reference	MD-SHE-0147-1500-2956-1500
Design Head (m)	2.956
Design Flow (l/s)	15.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	147
Invert Level (m)	130.850
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.956	15.0	Kick-Flo®	1.309	10.2
Flush-Flo™	0.635	13.0	Mean Flow over Head Range	-	12.1

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.3	1.200	11.3	3.000	15.1	7.000	22.6
0.200	10.6	1.400	10.5	3.500	16.3	7.500	23.4
0.300	11.8	1.600	11.2	4.000	17.3	8.000	24.1
0.400	12.5	1.800	11.9	4.500	18.3	8.500	24.9
0.500	12.9	2.000	12.5	5.000	19.3	9.000	25.6
0.600	13.0	2.200	13.0	5.500	20.2	9.500	26.2
0.800	12.8	2.400	13.6	6.000	21.0		
1.000	12.4	2.600	14.1	6.500	21.9		

Hydro-Brake® Optimum Manhole: S94, DS/PN: S1.021, Volume (m³): 42.2

Unit Reference	MD-SHE-0197-2250-1850-2250
Design Head (m)	1.850
Design Flow (l/s)	22.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	197
Invert Level (m)	118.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.850	22.5	Kick-Flo®	1.170	18.1
Flush-Flo™	0.545	22.5	Mean Flow over Head Range	-	19.5

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

Hydro-Brake® Optimum Manhole: S94, DS/PN: S1.021, Volume (m^3): 42.2

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.8	1.200	18.3	3.000	28.4	7.000	42.7
0.200	18.4	1.400	19.7	3.500	30.5	7.500	44.1
0.300	21.2	1.600	21.0	4.000	32.6	8.000	45.5
0.400	22.1	1.800	22.2	4.500	34.5	8.500	46.9
0.500	22.5	2.000	23.4	5.000	36.3	9.000	48.2
0.600	22.5	2.200	24.4	5.500	38.0	9.500	49.5
0.800	21.9	2.400	25.5	6.000	39.6		
1.000	20.7	2.600	26.5	6.500	41.2		

Hydro-Brake® Optimum Manhole: S100, DS/PN: S27.002, Volume (m^3): 8.2

Unit Reference	MD-SHE-0099-5000-1450-5000
Design Head (m)	1.450
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	99
Invert Level (m)	117.783
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.450	5.0	Kick-Flo®	0.882	4.0
Flush-Flo™	0.432	5.0	Mean Flow over Head Range	-	4.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.2	1.200	4.6	3.000	7.0	7.000	10.5
0.200	4.5	1.400	4.9	3.500	7.5	7.500	10.8
0.300	4.9	1.600	5.2	4.000	8.0	8.000	11.2
0.400	5.0	1.800	5.5	4.500	8.5	8.500	11.5
0.500	5.0	2.000	5.8	5.000	8.9	9.000	11.8
0.600	4.9	2.200	6.1	5.500	9.3	9.500	12.1
0.800	4.4	2.400	6.3	6.000	9.7		
1.000	4.2	2.600	6.6	6.500	10.1		

Storage Structures for Catchment 1 and 5 and 6 and 8

Cellular Storage Manhole: S41, DS/PN: S1.008

Invert Level (m) 132.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.71
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	1150.0	0.0	1.860	0.0	0.0
1.850	1150.0	0.0			

Cellular Storage Manhole: S94, DS/PN: S1.021

Invert Level (m) 118.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.71
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	1600.0	0.0	1.851	0.0	0.0
1.850	1600.0	0.0			

Cellular Storage Manhole: S100, DS/PN: S27.002

Invert Level (m) 117.800 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.71
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	200.0	0.0	1.851	0.0	0.0
1.850	200.0	0.0			

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 1 and 5 and 6 and 8

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 3 Number of Storage Structures 3 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.256
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 19.200 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S1.000	S1	15 minute 1 year Winter I+0%	144.220	142.834	0.30	0.123	34.1	OK
S1.001	S2	15 minute 1 year Winter I+0%	143.590	142.244	0.53	0.393	50.7	OK
S2.000	S3	15 minute 1 year Summer I+0%	145.360	143.412	0.01	0.008	1.2	OK
S1.002	S4	15 minute 1 year Winter I+0%	144.000	141.560	0.29	0.120	55.7	OK
S1.003	S5	15 minute 1 year Winter I+0%	141.880	140.328	0.15	0.146	60.4	OK
S3.000	S6	30 minute 1 year Winter I+0%	143.500	142.330	0.04	0.028	4.6	OK
S3.001	S7	15 minute 1 year Winter I+0%	142.000	140.852	0.12	0.053	8.3	OK
S3.002	S8	15 minute 1 year Winter I+0%	141.000	139.872	0.22	0.076	13.1	OK
S4.000	S9	15 minute 1 year Winter I+0%	141.220	139.839	0.55	0.129	27.1	OK
S5.000	S10	15 minute 1 year Winter I+0%	142.120	140.666	0.09	0.046	10.1	OK
S4.001	S11	15 minute 1 year Winter I+0%	140.760	139.152	0.45	0.204	41.8	OK
S4.002	S12	15 minute 1 year Winter I+0%	140.570	138.952	0.51	0.415	46.4	OK
S4.003	S13	15 minute 1 year Winter I+0%	140.400	138.792	0.51	0.351	48.8	OK
S1.004	S14	15 minute 1 year Winter I+0%	140.500	138.581	0.24	0.435	124.6	OK
S1.005	S15	15 minute 1 year Winter I+0%	138.880	137.291	0.24	0.291	130.0	OK
S6.000	S16	30 minute 1 year Winter I+0%	140.500	139.333	0.05	0.031	5.7	OK
S6.001	S17	15 minute 1 year Winter I+0%	138.500	137.378	0.26	0.083	18.2	OK
S6.002	S18	15 minute 1 year Winter I+0%	137.700	136.491	0.34	0.098	20.4	OK
S1.006	S19	15 minute 1 year Winter I+0%	137.400	135.801	0.14	0.276	151.0	OK
S7.000	S20	15 minute 1 year Winter I+0%	142.460	141.026	0.19	0.069	15.7	OK
S7.001	S21	15 minute 1 year Winter I+0%	141.150	139.748	0.39	0.123	29.7	OK
S7.002	S22	15 minute 1 year Winter I+0%	140.000	138.595	0.22	0.120	36.6	OK
S7.003	S23	15 minute 1 year Winter I+0%	139.350	137.844	0.21	0.130	39.5	OK
S7.004	S24	15 minute 1 year Winter I+0%	138.480	135.841	0.20	0.097	43.2	OK
S1.007	S25	15 minute 1 year Winter I+0%	136.750	132.468	0.55	0.552	195.9	OK

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 1 and 5 and 6 and 8

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S8.000	S26	15 minute 1 year Winter I+0%	139.700	138.246	0.09	0.047	10.6	OK
S9.000	S27	15 minute 1 year Winter I+0%	136.800	135.428	0.60	0.139	29.5	OK
S8.001	S28	15 minute 1 year Winter I+0%	137.050	134.772	0.34	0.148	54.4	OK
S8.002	S29	15 minute 1 year Winter I+0%	135.470	133.985	0.31	0.162	66.9	OK
S8.003	S30	15 minute 1 year Winter I+0%	134.000	132.577	0.32	0.256	75.3	OK
S8.004	S31	720 minute 1 year Winter I+0%	134.760	132.464	0.06	2.568	11.9	OK
S10.000	S32	30 minute 1 year Winter I+0%	136.900	135.734	0.06	0.033	5.9	OK
S10.001	S33	15 minute 1 year Winter I+0%	136.000	134.740	0.07	0.041	7.6	OK
S10.002	S34	15 minute 1 year Winter I+0%	135.300	133.747	0.10	0.050	7.6	OK
S8.005	S35	720 minute 1 year Winter I+0%	135.500	132.463	0.02	3.342	13.0	OK
S11.000	S36	15 minute 1 year Winter I+0%	138.050	136.599	0.11	0.050	11.0	OK
S12.000	S37	30 minute 1 year Winter I+0%	138.250	137.023	0.02	0.020	2.2	OK
S12.001	S38	30 minute 1 year Winter I+0%	136.600	135.683	0.05	0.037	2.2	OK
S11.001	S39	15 minute 1 year Winter I+0%	136.830	135.397	0.19	0.078	17.2	OK
S11.002	S40	15 minute 1 year Winter I+0%	136.500	132.580	0.27	0.085	17.1	OK
S1.008	S41	720 minute 1 year Winter I+0%	135.750	132.463	0.30	391.814	12.6	SURCHARGED
S1.009	S42	2880 minute 1 year Winter I+0%	134.900	130.773	0.29	0.156	12.8	OK
S13.000	S43	15 minute 1 year Summer I+0%	133.650	132.196	0.09	0.047	4.5	OK
S1.010	S44	15 minute 1 year Winter I+0%	133.490	130.522	0.42	0.180	18.5	OK
S1.011	S45	15 minute 1 year Winter I+0%	132.180	130.301	0.22	0.143	23.5	OK
S14.000	S46	15 minute 1 year Winter I+0%	131.560	130.140	0.27	0.085	25.0	OK
S15.000	S47	30 minute 1 year Winter I+0%	133.500	132.330	0.04	0.029	4.7	OK
S15.001	S48	15 minute 1 year Winter I+0%	132.500	131.243	0.08	0.043	8.5	OK
S15.002	S49	15 minute 1 year Winter I+0%	131.000	130.043	0.08	0.044	8.5	OK
S1.012	S50	15 minute 1 year Winter I+0%	130.100	127.909	0.28	0.117	61.9	OK
S1.013	S51	15 minute 1 year Winter I+0%	127.590	124.893	0.17	0.141	68.6	OK
S16.000	S52	15 minute 1 year Winter I+0%	143.350	141.902	0.12	0.053	13.1	OK
S16.001	S53	15 minute 1 year Winter I+0%	141.090	138.668	0.20	0.071	21.3	OK
S16.002	S54	15 minute 1 year Winter I+0%	138.880	137.013	0.23	0.077	24.9	OK
S16.003	S55	15 minute 1 year Winter I+0%	137.030	134.866	0.25	0.081	27.3	OK
S16.004	S56	15 minute 1 year Winter I+0%	134.400	132.586	0.31	0.092	33.1	OK
S16.005	S57	15 minute 1 year Winter I+0%	133.000	128.575	1.00	0.249	40.3	OK
S17.000	S58	15 minute 1 year Winter I+0%	132.830	131.395	0.18	0.068	16.3	OK
S17.001	S59	15 minute 1 year Winter I+0%	131.500	129.862	0.40	0.127	16.6	OK
S16.006	S60	15 minute 1 year Winter I+0%	131.500	128.314	0.71	0.339	58.3	OK
S16.007	S61	15 minute 1 year Winter I+0%	130.250	128.053	0.38	0.347	66.6	OK
S18.000	S62	15 minute 1 year Winter I+0%	129.340	127.911	0.22	0.075	18.9	OK
S16.008	S63	15 minute 1 year Winter I+0%	128.370	126.463	0.39	0.235	84.2	OK
S16.009	S64	15 minute 1 year Winter I+0%	127.810	126.117	0.29	0.279	99.8	OK
S16.010	S65	15 minute 1 year Winter I+0%	126.160	124.620	0.38	0.288	101.3	OK
S16.011	S66	15 minute 1 year Winter I+0%	125.400	123.775	0.44	0.396	113.4	OK
S19.000	S67	15 minute 1 year Winter I+0%	129.000	127.830	0.04	0.028	4.5	OK
S19.001	S68	15 minute 1 year Winter I+0%	127.600	126.240	0.07	0.040	7.9	OK
S19.002	S69	15 minute 1 year Winter I+0%	126.250	124.546	0.09	0.046	9.1	OK
S19.003	S70	15 minute 1 year Winter I+0%	124.850	123.803	0.13	0.055	9.1	OK
S1.014	S71	15 minute 1 year Winter I+0%	124.740	122.697	0.35	0.429	196.9	OK
S20.000	S72	15 minute 1 year Winter I+0%	125.630	124.246	0.38	0.103	16.8	OK
S21.000	S73	15 minute 1 year Summer I+0%	126.360	124.790	0.34	0.097	20.8	OK
S20.001	S74	15 minute 1 year Winter I+0%	125.800	123.937	0.46	0.214	45.1	OK
S20.002	S75	15 minute 1 year Winter I+0%	125.400	123.385	0.22	0.102	48.8	OK
S1.015	S76	15 minute 1 year Winter I+0%	124.000	122.276	0.54	2.980	255.4	OK
S1.016	S77	15 minute 1 year Winter I+0%	123.640	122.017	0.54	3.197	259.2	OK

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 1 and 5 and 6 and 8

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S22.000	S78	15 minute 1 year Winter I+0%	125.600	124.419	0.02	0.016	1.9	OK
S22.001	S79	15 minute 1 year Winter I+0%	124.450	122.997	0.04	0.029	3.3	OK
S22.002	S80	15 minute 1 year Winter I+0%	123.000	122.052	0.08	0.048	3.3	OK
S23.000	S81	15 minute 1 year Winter I+0%	129.150	127.756	0.01	0.001	0.5	OK
S23.001	S82	15 minute 1 year Winter I+0%	128.000	126.824	0.02	0.021	2.0	OK
S23.002	S83	15 minute 1 year Winter I+0%	127.350	126.206	0.03	0.028	3.1	OK
S23.003	S84	15 minute 1 year Winter I+0%	126.500	125.381	0.05	0.031	4.1	OK
S23.004	S85	15 minute 1 year Winter I+0%	125.750	124.808	0.15	0.068	4.8	OK
S24.000	S86	15 minute 1 year Winter I+0%	127.540	126.079	0.07	0.038	7.7	OK
S25.000	S87	15 minute 1 year Winter I+0%	126.620	125.179	0.15	0.061	15.1	OK
S23.005	S88	15 minute 1 year Winter I+0%	125.750	124.036	0.31	0.104	28.1	OK
S23.006	S89	15 minute 1 year Winter I+0%	123.960	122.569	0.47	0.126	32.2	OK
S1.017	S90	15 minute 1 year Winter I+0%	123.340	121.787	0.63	4.152	291.6	OK
S1.018	S91	15 minute 1 year Winter I+0%	122.950	120.354	0.70	0.652	292.4	OK
S1.019	S92	15 minute 1 year Winter I+0%	121.750	119.674	0.84	0.740	292.5	OK
S1.020	S93	15 minute 1 year Winter I+0%	121.000	118.688	0.42	0.849	295.2	OK
S1.021	S94	960 minute 1 year Winter I+0%	120.750	118.534	0.60	623.991	22.4	SURCHARGED
S26.000	S95	960 minute 1 year Winter I+0%	120.750	118.029	0.06	0.061	2.0	OK
S1.022	S96	960 minute 1 year Winter I+0%	120.840	118.026	0.60	0.344	24.4	OK
S1.023	S97	960 minute 1 year Winter I+0%	120.350	117.677	0.61	0.317	24.4	OK
S27.000	S98	15 minute 1 year Winter I+0%	120.450	118.240	0.73	0.210	44.6	OK
S27.001	S99	240 minute 1 year Winter I+0%	120.420	118.153	0.07	0.401	16.9	OK
S27.002	S100	240 minute 1 year Winter I+0%	120.000	118.151	0.08	53.248	5.0	SURCHARGED
S1.024	S101	720 minute 1 year Winter I+0%	120.130	117.440	0.78	0.458	29.2	OK

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 1 and 5 and 6 and 8

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 3 Number of Storage Structures 3 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.256
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 19.200 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S1.000	S1	15 minute 30 year Winter I+0%	144.220	142.903	0.67	0.201	76.1	OK
S1.001	S2	15 minute 30 year Winter I+0%	143.590	142.541	1.13	2.290	109.4	SURCHARGED
S2.000	S3	15 minute 30 year Winter I+0%	145.360	143.424	0.02	0.021	2.6	OK
S1.002	S4	15 minute 30 year Winter I+0%	144.000	141.624	0.62	0.219	120.1	OK
S1.003	S5	15 minute 30 year Winter I+0%	141.880	140.381	0.34	0.258	132.3	OK
S3.000	S6	30 minute 30 year Winter I+0%	143.500	142.346	0.09	0.047	10.1	OK
S3.001	S7	15 minute 30 year Winter I+0%	142.000	140.884	0.29	0.090	20.1	OK
S3.002	S8	15 minute 30 year Winter I+0%	141.000	139.923	0.57	0.134	33.6	OK
S4.000	S9	15 minute 30 year Winter I+0%	141.220	140.100	1.14	0.424	56.3	SURCHARGED
S5.000	S10	15 minute 30 year Winter I+0%	142.120	140.689	0.21	0.072	22.5	OK
S4.001	S11	15 minute 30 year Winter I+0%	140.760	139.312	0.96	0.515	89.7	SURCHARGED
S4.002	S12	15 minute 30 year Winter I+0%	140.570	139.131	1.07	1.476	98.2	SURCHARGED
S4.003	S13	15 minute 30 year Winter I+0%	140.400	138.967	1.07	1.131	103.0	SURCHARGED
S1.004	S14	15 minute 30 year Winter I+0%	140.500	138.666	0.53	0.900	270.0	OK
S1.005	S15	15 minute 30 year Winter I+0%	138.880	137.375	0.53	0.560	285.1	OK
S6.000	S16	30 minute 30 year Winter I+0%	140.500	139.350	0.11	0.051	12.6	OK
S6.001	S17	15 minute 30 year Winter I+0%	138.500	137.438	0.68	0.150	47.1	OK
S6.002	S18	15 minute 30 year Winter I+0%	137.700	136.569	0.90	0.185	53.3	OK
S1.006	S19	15 minute 30 year Winter I+0%	137.400	135.882	0.32	0.483	337.8	OK
S7.000	S20	15 minute 30 year Winter I+0%	142.460	141.062	0.43	0.110	34.9	OK
S7.001	S21	15 minute 30 year Winter I+0%	141.150	139.828	0.97	0.281	74.6	OK
S7.002	S22	15 minute 30 year Winter I+0%	140.000	138.661	0.55	0.253	93.0	OK
S7.003	S23	15 minute 30 year Winter I+0%	139.350	137.909	0.54	0.274	99.7	OK
S7.004	S24	15 minute 30 year Winter I+0%	138.480	135.903	0.50	0.168	108.9	OK
S1.007	S25	720 minute 30 year Winter I+0%	136.750	133.177	0.16	1.806	55.8	SURCHARGED

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 1 and 5 and 6 and 8

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S8.000	S26	15 minute 30 year Winter I+0%	139.700	138.270	0.21	0.073	23.7	OK
S9.000	S27	15 minute 30 year Winter I+0%	136.800	135.823	1.21	0.586	59.5	SURCHARGED
S8.001	S28	15 minute 30 year Winter I+0%	137.050	134.849	0.75	0.305	119.1	OK
S8.002	S29	15 minute 30 year Winter I+0%	135.470	134.061	0.71	0.343	153.3	OK
S8.003	S30	720 minute 30 year Winter I+0%	134.000	133.178	0.09	1.874	20.3	SURCHARGED
S8.004	S31	720 minute 30 year Winter I+0%	134.760	133.177	0.11	7.030	21.2	SURCHARGED
S10.000	S32	30 minute 30 year Winter I+0%	136.900	135.752	0.12	0.053	12.9	OK
S10.001	S33	15 minute 30 year Winter I+0%	136.000	134.762	0.17	0.066	17.5	OK
S10.002	S34	15 minute 30 year Winter [illegible]	[illegible]	[illegible]	0.23	0.080	17.5	OK
S8.005	S35	720 minute 30 year Winter [illegible]	[illegible]	[illegible]	0.04	5.586	23.6	SURCHARGED
S11.000	S36	15 minute 30 year Winter [illegible]	[illegible]	[illegible]	0.24	0.079	24.6	OK
S12.000	S37	30 minute 30 year Winter I+0%	138.250	137.032	0.05	0.030	4.9	OK
S12.001	S38	30 minute 30 year Winter I+0%	136.600	135.701	0.12	0.059	4.9	OK
S11.001	S39	15 minute 30 year Winter I+0%	136.830	135.437	0.46	0.129	41.1	OK
S11.002	S40	720 minute 30 year Winter I+0%	136.500	133.177	0.07	0.760	4.7	SURCHARGED
S1.008	S41	720 minute 30 year Winter I+0%	135.750	133.175	0.32	980.527	13.4	SURCHARGED
S1.009	S42	720 minute 30 year Winter I+0%	134.900	130.774	0.30	0.159	13.4	OK
S13.000	S43	15 minute 30 year Winter I+0%	133.650	132.219	0.21	0.073	10.1	OK
S1.010	S44	15 minute 30 year Summer I+0%	133.490	130.553	0.65	0.303	28.4	OK
S1.011	S45	15 minute 30 year Summer I+0%	132.180	130.327	0.39	0.196	42.5	OK
S14.000	S46	15 minute 30 year Winter I+0%	131.560	130.187	0.61	0.138	55.5	OK
S15.000	S47	30 minute 30 year Winter I+0%	133.500	132.347	0.10	0.048	10.3	OK
S15.001	S48	15 minute 30 year Winter I+0%	132.500	131.268	0.20	0.072	20.7	OK
S15.002	S49	15 minute 30 year Winter I+0%	131.000	130.069	0.20	0.073	20.5	OK
S1.012	S50	15 minute 30 year Winter I+0%	130.100	127.970	0.61	0.186	134.1	OK
S1.013	S51	15 minute 30 year Winter I+0%	127.590	124.949	0.37	0.221	153.0	OK
S16.000	S52	15 minute 30 year Winter I+0%	143.350	141.929	0.27	0.083	29.2	OK
S16.001	S53	15 minute 30 year Winter I+0%	141.090	138.711	0.49	0.120	52.1	OK
S16.002	S54	15 minute 30 year Summer I+0%	138.880	137.063	0.57	0.133	62.3	OK
S16.003	S55	15 minute 30 year Summer I+0%	137.030	134.921	0.63	0.143	69.6	OK
S16.004	S56	15 minute 30 year Winter I+0%	134.400	132.653	0.80	0.167	85.2	OK
S16.005	S57	15 minute 30 year Winter I+0%	133.000	129.823	2.57	1.661	103.4	SURCHARGED
S17.000	S58	15 minute 30 year Winter I+0%	132.830	131.430	0.41	0.108	36.2	OK
S17.001	S59	15 minute 30 year Winter I+0%	131.500	129.929	0.89	0.257	37.1	OK
S16.006	S60	15 minute 30 year Winter I+0%	131.500	128.811	1.75	1.539	143.1	SURCHARGED
S16.007	S61	15 minute 30 year Winter I+0%	130.250	128.156	0.93	1.013	162.9	OK
S18.000	S62	15 minute 30 year Winter I+0%	129.340	127.951	0.49	0.120	42.0	OK
S16.008	S63	15 minute 30 year Winter I+0%	128.370	126.589	0.95	0.486	201.7	OK
S16.009	S64	15 minute 30 year Winter I+0%	127.810	126.213	0.70	0.653	240.8	OK
S16.010	S65	15 minute 30 year Winter I+0%	126.160	124.745	0.92	0.660	245.4	OK
S16.011	S66	15 minute 30 year Winter I+0%	125.400	124.032	1.04	1.743	271.4	SURCHARGED
S19.000	S67	15 minute 30 year Winter I+0%	129.000	127.846	0.09	0.047	10.1	OK
S19.001	S68	15 minute 30 year Winter I+0%	127.600	126.264	0.18	0.067	19.1	OK
S19.002	S69	15 minute 30 year Winter I+0%	126.250	124.572	0.22	0.076	22.3	OK
S19.003	S70	15 minute 30 year Winter I+0%	124.850	123.838	0.31	0.094	22.1	OK
S1.014	S71	15 minute 30 year Winter I+0%	124.740	123.135	0.79	1.880	443.1	SURCHARGED
S20.000	S72	15 minute 30 year Winter I+0%	125.630	124.313	0.84	0.179	37.3	OK
S21.000	S73	15 minute 30 year Winter I+0%	126.360	124.847	0.76	0.161	46.3	OK
S20.001	S74	15 minute 30 year Winter I+0%	125.800	124.117	1.05	0.962	101.8	SURCHARGED
S20.002	S75	15 minute 30 year Winter I+0%	125.400	123.443	0.51	0.168	112.3	OK
S1.015	S76	15 minute 30 year Winter I+0%	124.000	122.865	1.13	17.985	535.9	SURCHARGED
S1.016	S77	15 minute 30 year Winter I+0%	123.640	122.545	1.15	11.685	549.5	SURCHARGED

Q30 TANK 1
1,505m³ provided

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 1 and 5 and 6 and 8

Q30 TANK 5
2,102m³ provided

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S22.000	S78	15 minute 30 year Wi[illegible]	[illegible]	[illegible]4.429	0.04	0.027	4.3	OK
S22.001	S79	15 minute 30 year Wi[illegible]	[illegible]	[illegible]3.015	0.09	0.052	8.0	OK
S22.002	S80	15 minute 30 year Winter I+0%	123.000	122.197	0.18	0.290	7.8	OK
S23.000	S81	15 minute 30 year Winter I+0%	129.150	127.762	0.01	0.008	1.2	OK
S23.001	S82	15 minute 30 year Winter I+0%	128.000	126.837	0.06	0.037	5.2	OK
S23.002	S83	15 minute 30 year Winter I+0%	127.350	126.225	0.09	0.052	8.4	OK
S23.003	S84	15 minute 30 year Winter I+0%	126.500	125.403	0.13	0.057	11.1	OK
S23.004	S85	15 minute 30 year Winter I+0%	125.750	124.849	0.40	0.121	13.0	OK
S24.000	S86	15 minute 30 year Winter I+0%	127.540	126.099	0.15	0.061	17.0	OK
S25.000	S87	15 minute 30 year Winter I+0%	126.620	125.211	0.34	0.097	33.5	OK
S23.005	S88	15 minute 30 year Winter I+0%	125.750	124.093	0.72	0.198	66.0	OK
S23.006	S89	15 minute 30 year Winter I+0%	123.960	122.808	1.09	0.607	75.1	SURCHARGED
S1.017	S90	15 minute 30 year Winter I+0%	123.340	122.187	1.33	12.396	617.9	SURCHARGED
S1.018	S91	15 minute 30 year Winter I+0%	122.950	120.765	1.49	1.379	618.8	SURCHARGED
S1.019	S92	15 minute 30 year Winter I+0%	121.750	120.128	1.77	2.649	615.7	SURCHARGED
S1.020	S93	1440 minute 30 year Winter I+0%	121.000	119.224	0.09	2.221	65.9	SURCHARGED
S1.021	S94	1440 minute 30 year Winter I+0%	120.750	119.221	0.61	1425.172	22.5	SURCHARGED
S26.000	S95	7200 minute 30 year Winter I+0%	120.750	118.029	0.06	0.061	2.0	OK
S1.022	S96	7200 minute 30 year Winter I+0%	120.840	118.026	0.60	0.345	24.5	OK
S1.023	S97	7200 minute 30 year Winter I+0%	120.350	117.677	0.61	0.318	24.5	OK
S27.000	S98	360 minute 30 year Winter I+0%	120.450	118.745	0.36	0.780	22.0	SURCHARGED
S27.001	S99	360 minute 30 year Winter I+0%	120.420	118.743	0.11	1.490	24.2	SURCHARGED
S27.002	S100	360 minute 30 year Winter I+0%	120.000	118.741	0.08	139.953	5.0	SURCHARGED
S1.024	S101	960 minute 30 year Summer I+0%	120.130	117.441	0.79	0.464	29.5	OK

Q30 TANK 6
371m³ provided

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 1 and 5 and 6 and 8

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 3 Number of Storage Structures 3 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.256
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 19.200 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S1.000	S1	15 minute 100 year Winter I+10%	144.220	143.420	0.81	0.787	91.6	SURCHARGED
S1.001	S2	15 minute 100 year Winter I+10%	143.590	143.016	1.47	4.831	141.4	SURCHARGED
S2.000	S3	15 minute 100 year Winter I+10%	145.360	143.427	0.03	0.025	3.7	OK
S1.002	S4	15 minute 100 year Winter I+10%	144.000	141.658	0.80	0.278	155.5	OK
S1.003	S5	15 minute 100 year Winter I+10%	141.880	140.405	0.43	0.311	170.0	OK
S3.000	S6	30 minute 100 year Winter I+10%	143.500	142.355	0.14	0.056	14.5	OK
S3.001	S7	15 minute 100 year Winter I+10%	142.000	140.903	0.42	0.111	28.9	OK
S3.002	S8	15 minute 100 year Winter I+10%	141.000	139.958	0.81	0.173	48.2	OK
S4.000	S9	15 minute 100 year Winter I+10%	141.220	140.685	1.45	1.085	71.6	SURCHARGED
S5.000	S10	15 minute 100 year Winter I+10%	142.120	140.703	0.29	0.088	32.2	OK
S4.001	S11	15 minute 100 year Winter I+10%	140.760	139.701	1.21	2.533	113.5	SURCHARGED
S4.002	S12	15 minute 100 year Winter I+10%	140.570	139.399	1.37	2.188	125.4	SURCHARGED
S4.003	S13	15 minute 100 year Winter I+10%	140.400	139.123	1.38	1.500	132.0	SURCHARGED
S1.004	S14	15 minute 100 year Winter I+10%	140.500	138.710	0.69	1.197	354.8	OK
S1.005	S15	15 minute 100 year Winter I+10%	138.880	137.420	0.70	0.743	375.4	OK
S6.000	S16	30 minute 100 year Winter I+10%	140.500	139.361	0.16	0.063	18.0	OK
S6.001	S17	15 minute 100 year Winter I+10%	138.500	137.479	0.97	0.196	67.4	OK
S6.002	S18	15 minute 100 year Winter I+10%	137.700	136.783	1.27	0.546	75.8	SURCHARGED
S1.006	S19	15 minute 100 year Winter I+10%	137.400	135.922	0.42	0.611	449.9	OK
S7.000	S20	15 minute 100 year Winter I+10%	142.460	141.087	0.61	0.138	50.0	OK
S7.001	S21	15 minute 100 year Winter I+10%	141.150	140.445	1.22	1.850	93.7	SURCHARGED
S7.002	S22	15 minute 100 year Winter I+10%	140.000	138.686	0.69	0.309	117.1	OK
S7.003	S23	15 minute 100 year Winter I+10%	139.350	137.935	0.68	0.334	126.7	OK
S7.004	S24	15 minute 100 year Winter I+10%	138.480	135.928	0.65	0.196	139.9	OK
S1.007	S25	960 minute 100 year Winter I+10%	136.750	133.803	0.17	2.912	62.3	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 1 and 5 and 6 and 8

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S8.000	S26	15 minute 100 year Winter I+10%	139.700	138.284	0.30	0.090	33.9	OK
S9.000	S27	15 minute 100 year Winter I+10%	136.800	136.486	1.62	1.336	79.8	SURCHARGED
S8.001	S28	15 minute 100 year Winter I+10%	137.050	134.943	1.00	0.679	158.7	OK
S8.002	S29	15 minute 100 year Winter I+10%	135.470	134.159	0.95	0.668	204.6	OK
S8.003	S30	960 minute 100 year Winter I+10%	134.000	133.804	0.10	3.699	22.6	SURCHARGED
S8.004	S31	960 minute 100 year Winter I+10%	134.760	133.802	0.12	7.926	24.5	SURCHARGED
S10.000	S32	30 minute 100 year Winter I+10%	136.900	135.763	0.18	0.066	18.5	OK
S10.001	S33	15 minute 100 year Winter I+10%	136.000	134.775	0.24	0.082	25.0	OK
S10.002	S34	960 minute 100 year Winter I+10%	135.300	133.801	0.04	0.113	3.1	OK
S8.005	S35	960 minute 100 year Winter I+[illegible]	[illegible]	[illegible]	0.05	7.328	27.3	SURCHARGED
S11.000	S36	15 minute 100 year Winter I+[illegible]	[illegible]	[illegible]	0.35	0.098	35.1	OK
S12.000	S37	30 minute 100 year Winter I+[illegible]	[illegible]	[illegible]	0.07	0.038	7.1	OK
S12.001	S38	30 minute 100 year Winter I+10%	136.600	135.712	0.17	0.073	7.0	OK
S11.001	S39	15 minute 100 year Winter I+10%	136.830	135.464	0.66	0.175	58.8	OK
S11.002	S40	960 minute 100 year Winter I+10%	136.500	133.803	0.08	1.468	5.2	SURCHARGED
S1.008	S41	960 minute 100 year Winter I+10%	135.750	133.800	0.36	1492.700	15.0	SURCHARGED
S1.009	S42	960 minute 100 year Winter I+10%	134.900	130.780	0.34	0.171	15.0	OK
S13.000	S43	15 minute 100 year Winter I+10%	133.650	132.234	0.30	0.089	14.4	OK
S1.010	S44	15 minute 100 year Summer I+10%	133.490	130.576	0.81	0.399	35.5	OK
S1.011	S45	15 minute 100 year Summer I+10%	132.180	130.344	0.51	0.268	55.8	OK
S14.000	S46	15 minute 100 year Winter I+10%	131.560	130.223	0.88	0.179	79.5	OK
S15.000	S47	30 minute 100 year Winter I+10%	133.500	132.356	0.14	0.058	14.8	OK
S15.001	S48	15 minute 100 year Winter I+10%	132.500	131.282	0.28	0.087	29.6	OK
S15.002	S49	15 minute 100 year Winter I+10%	131.000	130.083	0.29	0.089	29.4	OK
S1.012	S50	15 minute 100 year Winter I+10%	130.100	128.014	0.84	0.236	186.9	OK
S1.013	S51	15 minute 100 year Winter I+10%	127.590	124.984	0.52	0.270	214.0	OK
S16.000	S52	15 minute 100 year Winter I+10%	143.350	141.946	0.38	0.103	41.8	OK
S16.001	S53	15 minute 100 year Winter I+10%	141.090	138.739	0.70	0.152	74.6	OK
S16.002	S54	15 minute 100 year Summer I+10%	138.880	137.097	0.82	0.172	89.2	OK
S16.003	S55	15 minute 100 year Summer I+10%	137.030	134.959	0.90	0.185	99.6	OK
S16.004	S56	15 minute 100 year Winter I+10%	134.400	133.043	1.12	0.621	119.7	SURCHARGED
S16.005	S57	15 minute 100 year Winter I+10%	133.000	131.594	3.41	3.773	137.3	SURCHARGED
S17.000	S58	15 minute 100 year Winter I+10%	132.830	131.454	0.59	0.135	51.9	OK
S17.001	S59	15 minute 100 year Summer I+10%	131.500	130.036	1.27	0.497	53.1	SURCHARGED
S16.006	S60	15 minute 100 year Winter I+10%	131.500	129.807	2.31	2.725	189.1	SURCHARGED
S16.007	S61	15 minute 100 year Winter I+10%	130.250	128.798	1.22	2.923	213.8	SURCHARGED
S18.000	S62	15 minute 100 year Winter I+10%	129.340	127.980	0.70	0.152	60.1	OK
S16.008	S63	15 minute 100 year Winter I+10%	128.370	127.097	1.18	2.203	252.5	SURCHARGED
S16.009	S64	15 minute 100 year Winter I+10%	127.810	126.720	0.84	2.883	292.5	SURCHARGED
S16.010	S65	15 minute 100 year Winter I+10%	126.160	125.754	1.07	5.083	288.2	SURCHARGED
S16.011	S66	15 minute 100 year Winter I+10%	125.400	124.843	1.27	5.942	330.6	SURCHARGED
S19.000	S67	15 minute 100 year Winter I+10%	129.000	127.855	0.13	0.056	14.5	OK
S19.001	S68	15 minute 100 year Winter I+10%	127.600	126.277	0.25	0.082	27.3	OK
S19.002	S69	15 minute 100 year Winter I+10%	126.250	124.588	0.32	0.094	32.0	OK
S19.003	S70	15 minute 100 year Winter I+10%	124.850	124.022	0.45	0.339	31.8	SURCHARGED
S1.014	S71	15 minute 100 year Winter I+10%	124.740	123.964	0.93	8.413	519.0	SURCHARGED
S20.000	S72	15 minute 100 year Winter I+10%	125.630	124.691	1.11	0.606	49.5	SURCHARGED
S21.000	S73	15 minute 100 year Summer I+10%	126.360	124.976	1.06	0.307	64.9	SURCHARGED
S20.001	S74	15 minute 100 year Winter I+10%	125.800	124.333	1.45	1.871	141.0	SURCHARGED
S20.002	S75	15 minute 100 year Winter I+10%	125.400	123.982	0.64	1.992	141.9	SURCHARGED
S1.015	S76	15 minute 100 year Winter I+10%	124.000	123.565	1.45	20.707	685.2	SURCHARGED
S1.016	S77	15 minute 100 year Winter I+10%	123.640	123.042	1.47	12.595	702.6	SURCHARGED

Q100 TANK 1
1,505m^3 provided

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 1 and 5 and 6 and 8

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S22.000	S78	15 minute [illegible]	[illegible]	124.434	0.06	0.033	6.1	OK
S22.001	S79	15 minute [illegible]	[illegible]	123.023	0.13	0.062	11.5	OK
S22.002	S80	15 minute [illegible]	[illegible]	122.471	0.26	0.906	11.3	SURCHARGED
S23.000	S81	15 minute 100 year Winter I+10%	129.150	127.768	0.02	0.015	1.7	OK
S23.001	S82	15 minute 100 year Winter I+10%	128.000	126.846	0.09	0.047	7.5	OK
S23.002	S83	15 minute 100 year Winter I+10%	127.350	126.233	0.12	0.063	12.1	OK
S23.003	S84	15 minute 100 year Winter I+10%	126.500	125.415	0.18	0.070	15.9	OK
S23.004	S85	15 minute 100 year Winter I+10%	125.750	124.873	0.58	0.161	18.7	OK
S24.000	S86	15 minute 100 year Winter I+10%	127.540	126.111	0.22	0.075	24.4	OK
S25.000	S87	15 minute 100 year Winter I+10%	126.620	125.232	0.49	0.121	48.0	OK
S23.005	S88	15 minute 100 year Winter I+10%	125.750	124.618	0.91	1.588	82.9	SURCHARGED
S23.006	S89	15 minute 100 year Winter I+10%	123.960	123.491	1.38	2.161	91.5	SURCHARGED
S1.017	S90	15 minute 100 year Winter I+10%	123.340	122.458	1.75	13.767	809.4	SURCHARGED
S1.018	S91	15 minute 100 year Winter I+10%	122.950	121.061	1.95	1.901	810.4	SURCHARGED
S1.019	S92	15 minute 100 year Winter I+10%	121.750	120.400	2.33	4.707	808.8	SURCHARGED
S1.020	S93	2160 minute 100 year Winter I+10%	121.000	119.802	0.10	4.375	67.6	SURCHARGED
S1.021	S94	2160 minute 100 year Winter I+10%	120.750	119.798	0.61	2081.949	22.5	SURCHARGED
S26.000	S95	2880 minute 100 year Summer I+10%	120.750	118.029	0.06	0.061	2.0	OK
S1.022	S96	2880 minute 100 year Summer I+10%	120.840	118.026	0.60	0.345	24.5	OK
S1.023	S97	2880 minute 100 year Winter I+10%	120.350	117.677	0.61	0.318	24.5	OK
S27.000	S98	480 minute 100 year Winter I+10%	120.450	119.242	0.41	1.342	25.2	SURCHARGED
S27.001	S99	480 minute 100 year Winter I+10%	120.420	119.239	0.12	2.201	28.0	SURCHARGED
S27.002	S100	480 minute 100 year Winter I+10%	120.000	119.237	0.08	211.145	5.0	SURCHARGED
S1.024	S101	960 minute 100 year Summer I+10%	120.130	117.442	0.79	0.464	29.5	OK

Q100 TANK 5
2,102m³ provided

Q100 TANK 6
371m³ provided

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 2

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.200	Add Flow / Climate Change (%)	0
Ratio R	0.256	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	3.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	180

Designed with Level Soffits

Time Area Diagram for Catchment 2

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.375	4-8	0.181	8-12	0.006

Total Area Contributing (ha) = 0.562

Total Pipe Volume (m³) = 16.995

Network Design Table for Catchment 2

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S28.000	42.361	1.926	22.0	0.136	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S29.000	54.372	1.110	49.0	0.137	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S29.001	40.018	1.177	34.0	0.105	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S29.002	32.033	1.232	26.0	0.051	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S30.000	27.659	0.473	58.5	0.019	10.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S28.000	50.00	4.25	139.520	0.136	0.0	0.0	0.0	2.80	111.4	18.4
S29.000	50.00	4.48	141.920	0.137	0.0	0.0	0.0	1.87	74.5	18.6
S29.001	50.00	4.78	140.800	0.242	0.0	0.0	0.0	2.25	89.5	32.7
S29.002	50.00	4.95	139.610	0.293	0.0	0.0	0.0	3.10	218.8	39.6
S30.000	41.35	10.27	139.550	0.019	0.0	0.0	0.0	1.71	68.1	2.1

Network Design Table for Catchment 2

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S30.001	2.701	0.046	58.7	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S29.003	29.717	0.425	69.9	0.049	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S29.004	7.032	0.207	34.0	0.026	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S28.001	20.569	0.709	29.0	0.025	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S28.002	20.944	0.105	199.5	0.015	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S28.003	17.702	0.091	194.5	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S30.001	41.31	10.30	139.000	0.019	0.0	0.0	0.0	1.71	68.0	2.1
S29.003	40.82	10.56	138.378	0.361	0.0	0.0	0.0	1.88	133.1	39.9
S29.004	40.75	10.60	137.953	0.387	0.0	0.0	0.0	2.71	191.3	42.7
S28.001	40.54	10.72	137.390	0.547	0.0	0.0	0.0	2.93	207.1	60.1
S28.002	40.11	10.96	136.200	0.562	0.0	0.0	0.0	1.44	228.4	61.1
S28.003	39.58	11.28	136.050	0.562	0.0	0.0	0.0	0.93	37.1«	61.1

Free Flowing Outfall Details for Catchment 2

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S28.003	S	137.500	135.959	135.800	225	0

Simulation Criteria for Catchment 2

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	19.200	Storm Duration (mins)	30
Ratio R	0.256		

Online Controls for Catchment 2

Hydro-Brake® Optimum Manhole: S112, DS/PN: S28.003, Volume (m^3): 6.6

Unit Reference	MD-SHE-0101-5200-1470-5200
Design Head (m)	1.470
Design Flow (l/s)	5.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	101
Invert Level (m)	136.050
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.470	5.2	Kick-Flo®	0.898	4.1
Flush-Flo™	0.440	5.2	Mean Flow over Head Range	-	4.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.3	1.200	4.7	3.000	7.3	7.000	10.8
0.200	4.7	1.400	5.1	3.500	7.8	7.500	11.2
0.300	5.1	1.600	5.4	4.000	8.3	8.000	11.6
0.400	5.2	1.800	5.7	4.500	8.8	8.500	11.9
0.500	5.2	2.000	6.0	5.000	9.2	9.000	12.2
0.600	5.1	2.200	6.3	5.500	9.7	9.500	12.5
0.800	4.6	2.400	6.5	6.000	10.1		
1.000	4.3	2.600	6.8	6.500	10.5		

Storage Structures for Catchment 2

Cellular Storage Manhole: S112, DS/PN: S28.003

Invert Level (m) 136.100 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.71
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	250.0	0.0	1.851	0.0	0.0
1.850	250.0	0.0			

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 2

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.256
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 19.200 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S28.000	S102	15 minute 1 year Winter I+0%	141.310	139.583	0.18	0.066	18.7	OK
S29.000	S103	15 minute 1 year Winter I+0%	143.420	141.998	0.26	0.083	18.7	OK
S29.001	S104	15 minute 1 year Winter I+0%	142.250	140.893	0.35	0.123	29.5	OK
S29.002	S105	15 minute 1 year Winter I+0%	141.110	139.695	0.18	0.104	35.3	OK
S30.000	S106	30 minute 1 year Winter I+0%	140.750	139.574	0.03	0.022	1.7	OK
S30.001	S107	30 minute 1 year Winter I+0%	140.200	139.034	0.06	0.034	1.7	OK
S29.003	S108	15 minute 1 year Winter I+0%	140.000	138.501	0.35	0.171	42.3	OK
S29.004	S109	15 minute 1 year Winter I+0%	139.590	138.084	0.40	0.262	45.1	OK
S28.001	S110	15 minute 1 year Winter I+0%	139.280	137.515	0.36	0.136	64.7	OK
S28.002	S111	240 minute 1 year Winter I+0%	138.320	136.431	0.11	0.324	19.3	OK
S28.003	S112	240 minute 1 year Winter I+0%	138.500	136.429	0.16	60.978	5.2	SURCHARGED

Q1 TANK 2
264m³ provided

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 2

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.256
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 19.200 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S28.000	S102	15 minute 30 year Winter I+0%	141.310	139.618	0.39	0.105	41.6	OK
S29.000	S103	15 minute 30 year Winter I+0%	143.420	142.044	0.58	0.134	41.5	OK
S29.001	S104	15 minute 30 year Winter I+0%	142.250	140.962	0.85	0.275	72.5	OK
S29.002	S105	15 minute 30 year Winter I+0%	141.110	139.750	0.44	0.199	87.4	OK
S30.000	S106	30 minute 30 year Winter I+0%	140.750	139.585	0.06	0.034	3.8	OK
S30.001	S107	30 minute 30 year Winter I+0%	140.200	139.053	0.12	0.054	3.8	OK
S29.003	S108	15 minute 30 year Winter I+0%	140.000	138.598	0.86	0.377	104.3	OK
S29.004	S109	15 minute 30 year Winter I+0%	139.590	138.195	0.99	0.718	112.5	OK
S28.001	S110	15 minute 30 year Winter I+0%	139.280	137.612	0.87	0.248	157.5	OK
S28.002	S111	360 minute 30 year Winter I+0%	138.320	137.022	0.16	1.528	29.3	SURCHARGED
S28.003	S112	360 minute 30 year Winter I+0%	138.500	137.020	0.16	167.879	5.2	SURCHARGED

Q30 TANK 2
264m³ provided

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 2

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.256
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 19.200 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S28.000	S102	15 minute 100 year Winter I+10%	141.310	139.641	0.56	0.131	59.5	OK
S29.000	S103	15 minute 100 year Winter I+10%	143.420	142.078	0.83	0.174	59.5	OK
S29.001	S104	15 minute 100 year Winter I+10%	142.250	141.314	1.12	1.310	94.9	SURCHARGED
S29.002	S105	15 minute 100 year Winter I+10%	141.110	139.774	0.57	0.246	114.1	OK
S30.000	S106	30 minute 100 year Winter I+10%	140.750	139.594	0.09	0.044	5.4	OK
S30.001	S107	30 minute 100 year Winter I+10%	140.200	139.064	0.18	0.067	5.4	OK
S29.003	S108	15 minute 100 year Winter I+10%	140.000	138.924	1.13	1.305	136.5	SURCHARGED
S29.004	S109	15 minute 100 year Winter I+10%	139.590	138.374	1.27	1.731	145.3	SURCHARGED
S28.001	S110	15 minute 100 year Winter I+10%	139.280	137.908	1.14	0.820	207.1	SURCHARGED
S28.002	S111	480 minute 100 year Winter I+10%	138.320	137.514	0.18	3.107	33.0	SURCHARGED
S28.003	S112	480 minute 100 year Winter I+10%	138.500	137.512	0.16	255.872	5.2	SURCHARGED

Q100 TANK 2
264m³ provided

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 3

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.300	Add Flow / Climate Change (%)	0
Ratio R	0.256	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	3.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	180

Designed with Level Soffits

Time Area Diagram for Catchment 3

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.392	4-8	0.141

Total Area Contributing (ha) = 0.533

Total Pipe Volume (m³) = 15.584

Network Design Table for Catchment 3

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S31.000	39.457	0.383	103.0	0.137	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S31.001	45.652	1.574	29.0	0.129	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S32.000	15.524	0.776	20.0	0.013	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S32.001	17.479	0.324	53.9	0.008	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S32.002	2.874	0.049	58.7	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S32.003	26.238	0.255	102.9	0.032	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S31.000	50.00	4.51	137.670	0.137	0.0	0.0	0.0	1.29	51.2	18.6
S31.001	50.00	4.82	137.287	0.266	0.0	0.0	0.0	2.44	97.0	36.1
S32.000	50.00	4.09	137.300	0.013	0.0	0.0	0.0	2.94	116.9	1.8
S32.001	50.00	4.25	136.524	0.022	0.0	0.0	0.0	1.78	71.0	2.9
S32.002	50.00	4.28	136.200	0.022	0.0	0.0	0.0	1.71	68.0	2.9
S32.003	50.00	4.62	136.130	0.053	0.0	0.0	0.0	1.29	51.2	7.2

Network Design Table for Catchment 3

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S31.002	33.898	0.368	92.1	0.022	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S31.003	28.795	0.144	200.0	0.045	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S33.000	26.814	0.447	60.0	0.081	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S33.001	12.343	0.206	59.9	0.032	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S34.000	38.637	1.431	27.0	0.034	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S34.001	9.445	0.157	60.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S31.004	8.392	0.056	149.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S31.002	50.00	5.24	134.900	0.341	0.0	0.0	0.0	1.36	54.2	46.2
S31.003	50.00	5.57	132.750	0.386	0.0	0.0	0.0	1.43	228.1	52.3
S33.000	50.00	4.26	134.050	0.081	0.0	0.0	0.0	1.69	67.3	11.0
S33.001	50.00	4.39	133.603	0.113	0.0	0.0	0.0	1.69	67.3	15.3
S34.000	50.00	4.25	135.400	0.034	0.0	0.0	0.0	2.53	100.5	4.6
S34.001	50.00	4.35	133.969	0.034	0.0	0.0	0.0	1.69	67.2	4.6
S31.004	50.00	5.70	132.580	0.533	0.0	0.0	0.0	1.07	42.4«	72.2

Free Flowing Outfall Details for Catchment 3

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S31.004	S	134.000	132.524	132.650	225	0

Simulation Criteria for Catchment 3

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Return Period (years) 2

Synthetic Rainfall Details

Region	Scotland and Ireland	Cv (Summer)	0.750
M5-60 (mm)	19.200	Cv (Winter)	0.840
Ratio R	0.256	Storm Duration (mins)	30
Profile Type	Summer		

Online Controls for Catchment 3

Hydro-Brake® Optimum Manhole: S127, DS/PN: S31.004, Volume (m^3): 9.0

Unit Reference	MD-SHE-0060-2000-1650-2000
Design Head (m)	1.650
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	60
Invert Level (m)	132.580
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.650	2.0	Kick-Flo®	0.532	1.2
Flush-Flo™	0.262	1.5	Mean Flow over Head Range	-	1.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.3	1.200	1.7	3.000	2.6	7.000	3.9
0.200	1.5	1.400	1.9	3.500	2.8	7.500	4.0
0.300	1.5	1.600	2.0	4.000	3.0	8.000	4.2
0.400	1.4	1.800	2.1	4.500	3.2	8.500	4.3
0.500	1.3	2.000	2.2	5.000	3.3	9.000	4.4
0.600	1.3	2.200	2.3	5.500	3.5	9.500	4.5
0.800	1.4	2.400	2.4	6.000	3.6		
1.000	1.6	2.600	2.5	6.500	3.8		

Storage Structures for Catchment 3

Cellular Storage Manhole: S127, DS/PN: S31.004

Invert Level (m) 132.600 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	240.0	0.0	1.851	0.0	0.0
1.850	240.0	0.0			

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 3

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.256
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 19.200 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S31.000	S115	15 minute 1 year Winter I+0%	139.170	137.767	0.38	0.104	18.6	OK
S31.001	S116	15 minute 1 year Winter I+0%	138.800	137.380	0.35	0.162	32.4	OK
S32.000	S117	15 minute 1 year Summer I+0%	138.500	137.319	0.02	0.016	1.8	OK
S32.001	S118	15 minute 1 year Winter I+0%	138.000	136.554	0.04	0.031	2.7	OK
S32.002	S119	15 minute 1 year Winter I+0%	137.700	136.245	0.09	0.060	2.7	OK
S32.003	S120	15 minute 1 year Winter I+0%	137.630	136.184	0.13	0.062	6.2	OK
S31.002	S121	15 minute 1 year Winter I+0%	137.300	135.055	0.81	0.169	41.3	OK
S31.003	S122	1440 minute 1 year Winter I+0%	136.230	133.109	0.02	0.507	4.4	OK
S33.000	S123	15 minute 1 year Winter I+0%	135.550	134.114	0.18	0.066	11.1	OK
S33.001	S124	15 minute 1 year Winter I+0%	135.200	133.680	0.25	0.110	14.6	OK
S34.000	S125	15 minute 1 year Winter I+0%	136.600	135.432	0.05	0.030	4.7	OK
S34.001	S126	15 minute 1 year Summer I+0%	135.300	134.013	0.08	0.052	4.7	OK
S31.004	S127	1440 minute 1 year Winter I+0%	135.300	133.109	0.04	120.889	1.5	SURCHARGED

Q1 TANK 3
388m³ provided

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 3

Simulation Criteria

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

Number of Input Hydrographs 0
Number of Offline Controls 0
Number of Time/Area Diagrams 0
Number of Online Controls 1
Number of Storage Structures 1
Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR
Ratio R 0.256
Region Scotland and Ireland
Cv (Summer) 0.750
M5-60 (mm) 19.200
Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0
DVD Status ON
Analysis Timestep Fine
Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S31.000	S115	15 minute 30 year Winter I+0%	139.170	137.832	0.85	0.177	41.3	OK
S31.001	S116	15 minute 30 year Winter I+0%	138.800	137.450	0.86	0.413	79.5	OK
S32.000	S117	15 minute 30 year Winter I+0%	138.500	137.329	0.04	0.027	4.1	OK
S32.001	S118	15 minute 30 year Summer I+0%	138.000	136.572	0.10	0.055	6.6	OK
S32.002	S119	15 minute 30 year Summer I+0%	137.700	136.271	0.21	0.098	6.6	OK
S32.003	S120	15 minute 30 year Winter I+0%	137.630	136.221	0.34	0.108	16.2	OK
S31.002	S121	15 minute 30 year Winter I+0%	137.300	136.058	1.88	1.895	95.7	SURCHARGED
S31.003	S122	2160 minute 30 year Winter I+0%	136.230	133.741	0.03	1.411	6.1	SURCHARGED
S33.000	S123	15 minute 30 year Winter I+0%	135.550	134.148	0.40	0.106	24.8	OK
S33.001	S124	2160 minute 30 year Winter I+0%	135.200	133.741	0.03	0.245	1.8	OK
S34.000	S125	15 minute 30 year Winter I+0%	136.600	135.449	0.11	0.050	10.4	OK
S34.001	S126	15 minute 30 year Summer I+0%	135.300	134.035	0.19	0.080	10.5	OK
S31.004	S127	2160 minute 30 year Winter I+0%	135.300	133.741	0.05	266.479	1.7	SURCHARGED

Q30 TANK 3
388m³ provided

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 3

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.256
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 19.200 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S31.000	S115	15 minute 100 year Winter I+10%	139.170	138.278	1.04	0.682	50.7	SURCHARGED
S31.001	S116	15 minute 100 year Winter I+10%	138.800	137.936	0.96	2.250	89.0	SURCHARGED
S32.000	S117	15 minute 100 year Winter I+10%	138.500	137.334	0.06	0.033	5.8	OK
S32.001	S118	15 minute 100 year Summer I+10%	138.000	136.582	0.15	0.067	9.5	OK
S32.002	S119	15 minute 100 year Winter I+10%	137.700	136.486	0.28	0.655	8.6	SURCHARGED
S32.003	S120	15 minute 100 year Winter I+10%	137.630	136.483	0.44	0.460	20.7	SURCHARGED
S31.002	S121	15 minute 100 year Winter I+10%	137.300	136.447	2.15	3.429	109.4	SURCHARGED
S31.003	S122	2160 minute 100 year Winter I+10%	136.230	134.231	0.04	2.113	8.1	SURCHARGED
S33.000	S123	2160 minute 100 year Winter I+10%	135.550	134.232	0.03	0.200	1.7	OK
S33.001	S124	2160 minute 100 year Winter I+10%	135.200	134.231	0.04	1.709	2.4	SURCHARGED
S34.000	S125	15 minute 100 year Winter I+10%	136.600	135.459	0.16	0.061	14.9	OK
S34.001	S126	2160 minute 100 year Winter I+10%	135.300	134.230	0.01	0.440	0.7	SURCHARGED
S31.004	S127	2160 minute 100 year Winter I+10%	135.300	134.230	0.06	379.202	2.0	SURCHARGED

Q100 TANK 3
388m³ provided

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 4

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.300	Add Flow / Climate Change (%)	0
Ratio R	0.256	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	3.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	180

Designed with Level Soffits

Time Area Diagram for Catchment 4

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.507	4-8	0.237	8-12	0.009

Total Area Contributing (ha) = 0.753

Total Pipe Volume (m³) = 22.916

Network Design Table for Catchment 4

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S35.000	41.979	1.049	40.0	0.061	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S35.001	47.216	0.843	56.0	0.097	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S35.002	25.874	1.294	20.0	0.016	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S35.003	29.641	1.482	20.0	0.024	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S36.000	23.041	1.152	20.0	0.030	10.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S36.001	19.342	0.967	20.0	0.002	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S35.000	50.00	4.34	134.800	0.061	0.0	0.0	0.0	2.07	82.5	8.2
S35.001	50.00	4.79	133.400	0.158	0.0	0.0	0.0	1.75	69.6	21.3
S35.002	50.00	4.93	132.200	0.174	0.0	0.0	0.0	2.94	116.9	23.5
S35.003	50.00	5.07	130.550	0.198	0.0	0.0	0.0	3.53	249.6	26.8
S36.000	41.83	10.13	132.500	0.030	0.0	0.0	0.0	2.94	116.9	3.4
S36.001	41.62	10.24	131.200	0.031	0.0	0.0	0.0	2.94	116.9	3.5

Network Design Table for Catchment 4

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S36.002	18.633	0.532	35.0	0.025	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S36.003	5.242	0.105	50.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S35.004	19.988	0.999	20.0	0.026	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S37.000	52.202	2.610	20.0	0.126	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S37.001	31.868	0.266	119.8	0.081	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S37.002	32.053	0.379	84.6	0.126	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S37.003	46.398	2.209	21.0	0.109	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S35.005	2.199	0.038	57.9	0.020	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S35.006	20.722	0.138	150.2	0.010	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S35.007	17.727	0.118	150.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S36.002	41.36	10.38	130.000	0.056	0.0	0.0	0.0	2.22	88.2	6.3
S36.003	41.28	10.43	129.400	0.056	0.0	0.0	0.0	1.85	73.7	6.3
S35.004	41.10	10.52	129.050	0.280	0.0	0.0	0.0	3.53	249.6	31.1
S37.000	50.00	4.30	132.950	0.126	0.0	0.0	0.0	2.94	116.9	17.1
S37.001	50.00	4.67	130.265	0.207	0.0	0.0	0.0	1.44	101.5	28.1
S37.002	50.00	4.98	129.999	0.334	0.0	0.0	0.0	1.71	120.9	45.2
S37.003	50.00	5.20	129.620	0.443	0.0	0.0	0.0	3.45	243.6	60.0
S35.005	41.07	10.54	127.250	0.743	0.0	0.0	0.0	2.07	146.4	82.6
S35.006	40.59	10.81	126.300	0.753	0.0	0.0	0.0	1.28	90.5	82.7
S35.007	40.11	11.09	126.200	0.753	0.0	0.0	0.0	1.06	42.3«	82.7

Free Flowing Outfall Details for Catchment 4

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S35.007	S	127.000	126.082	125.880	0	0

Simulation Criteria for Catchment 4

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

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	1	Number of Storage Structures	1	Number of Real Time Controls	0

Simulation Criteria for Catchment 4

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	19.200	Storm Duration (mins)	30
Ratio R	0.256		

Online Controls for Catchment 4

Hydro-Brake® Optimum Manhole: S145, DS/PN: S35.007, Volume (m³): 3.6

Unit Reference	MD-SHE-0084-4000-1750-4000
Design Head (m)	1.750
Design Flow (l/s)	4.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	84
Invert Level (m)	126.200
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.750	4.0	Kick-Flo®	0.752	2.7
Flush-Flo™	0.370	3.4	Mean Flow over Head Range	-	3.2

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.5	1.200	3.4	3.000	5.1	7.000	7.7
0.200	3.2	1.400	3.6	3.500	5.5	7.500	7.9
0.300	3.3	1.600	3.8	4.000	5.9	8.000	8.2
0.400	3.4	1.800	4.0	4.500	6.2	8.500	8.4
0.500	3.3	2.000	4.3	5.000	6.5	9.000	8.6
0.600	3.2	2.200	4.4	5.500	6.8	9.500	8.9
0.800	2.8	2.400	4.6	6.000	7.1		
1.000	3.1	2.600	4.8	6.500	7.4		

Storage Structures for Catchment 4

Cellular Storage Manhole: S145, DS/PN: S35.007

Invert Level (m) 126.200 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	270.0	0.0	1.851	0.0	0.0
1.850	270.0	0.0			

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 4

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.256
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 19.200 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S35.000	S130	15 minute 1 year Winter I+0%	136.300	134.849	0.11	0.050	8.4	OK
S35.001	S131	15 minute 1 year Winter I+0%	135.450	133.482	0.28	0.087	18.8	OK
S35.002	S132	15 minute 1 year Winter I+0%	134.060	132.267	0.19	0.070	20.6	OK
S35.003	S133	15 minute 1 year Winter I+0%	132.400	130.614	0.10	0.067	23.3	OK
S36.000	S134	30 minute 1 year Winter I+0%	133.700	132.524	0.02	0.021	2.7	OK
S36.001	S135	30 minute 1 year Winter I+0%	132.500	131.224	0.03	0.022	2.8	OK
S36.002	S136	15 minute 1 year Winter I+0%	131.250	130.038	0.07	0.038	5.3	OK
S36.003	S137	15 minute 1 year Winter I+0%	130.450	129.451	0.12	0.053	5.3	OK
S35.004	S138	15 minute 1 year Winter I+0%	130.650	129.126	0.14	0.087	31.4	OK
S37.000	S139	15 minute 1 year Winter I+0%	135.090	133.009	0.15	0.061	17.3	OK
S37.001	S140	15 minute 1 year Winter I+0%	131.840	130.373	0.28	0.118	25.7	OK
S37.002	S141	15 minute 1 year Winter I+0%	131.930	130.124	0.36	0.313	39.5	OK
S37.003	S142	15 minute 1 year Winter I+0%	131.700	129.716	0.22	0.167	51.3	OK
S35.005	S143	15 minute 1 year Winter I+0%	129.560	127.613	1.38	0.499	84.7	SURCHARGED
S35.006	S144	720 minute 1 year Winter I+0%	129.530	126.715	0.17	0.464	13.3	SURCHARGED
S35.007	S145	720 minute 1 year Winter I+0%	128.200	126.712	0.09	133.236	3.4	SURCHARGED

Q1 TANK 4
463m³ provided

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 4

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.256
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 19.200 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S35.000	S130	15 minute 30 year Winter I+0%	136.300	134.874	0.24	0.078	18.6	OK
S35.001	S131	15 minute 30 year Winter I+0%	135.450	133.542	0.72	0.155	48.1	OK
S35.002	S132	15 minute 30 year Winter I+0%	134.060	132.311	0.49	0.120	52.8	OK
S35.003	S133	15 minute 30 year Winter I+0%	132.400	130.655	0.26	0.113	59.7	OK
S36.000	S134	30 minute 30 year Winter I+0%	133.700	132.534	0.05	0.033	5.9	OK
S36.001	S135	30 minute 30 year Winter I+0%	132.500	131.235	0.06	0.034	6.2	OK
S36.002	S136	15 minute 30 year Winter I+0%	131.250	130.062	0.17	0.065	13.1	OK
S36.003	S137	15 minute 30 year Winter I+0%	130.450	129.484	0.28	0.090	13.0	OK
S35.004	S138	15 minute 30 year Winter I+0%	130.650	129.177	0.37	0.161	79.6	OK
S37.000	S139	15 minute 30 year Winter I+0%	135.090	133.041	0.34	0.097	38.6	OK
S37.001	S140	15 minute 30 year Winter I+0%	131.840	130.448	0.68	0.220	62.7	OK
S37.002	S141	15 minute 30 year Winter I+0%	131.930	130.225	0.89	0.902	98.4	OK
S37.003	S142	15 minute 30 year Winter I+0%	131.700	129.786	0.57	0.426	130.2	OK
S35.005	S143	15 minute 30 year Winter I+0%	129.560	128.264	3.53	2.244	216.9	SURCHARGED
S35.006	S144	15 minute 30 year Winter I+0%	129.530	127.494	2.73	1.407	216.5	SURCHARGED
S35.007	S145	1440 minute 30 year Winter I+0%	128.200	127.425	0.09	317.039	3.4	SURCHARGED

Q30 TANK 4
463m³ provided

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 4

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.256
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 19.200 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S35.000	S130	15 minute 100 year Winter I+10%	136.300	134.890	0.34	0.096	26.6	OK
S35.001	S131	15 minute 100 year Winter I+10%	135.450	133.653	1.01	0.281	67.4	SURCHARGED
S35.002	S132	15 minute 100 year Winter I+10%	134.060	132.338	0.68	0.150	73.7	OK
S35.003	S133	15 minute 100 year Winter I+10%	132.400	130.677	0.37	0.138	83.8	OK
S36.000	S134	30 minute 100 year Winter I+10%	133.700	132.542	0.08	0.042	8.4	OK
S36.001	S135	30 minute 100 year Winter I+10%	132.500	131.244	0.08	0.044	8.9	OK
S36.002	S136	15 minute 100 year Winter I+10%	131.250	130.075	0.24	0.080	18.8	OK
S36.003	S137	15 minute 100 year Winter I+10%	130.450	129.502	0.41	0.112	18.6	OK
S35.004	S138	15 minute 100 year Winter I+10%	130.650	129.341	0.51	0.493	111.5	OK
S37.000	S139	15 minute 100 year Winter I+10%	135.090	133.061	0.49	0.120	55.2	OK
S37.001	S140	15 minute 100 year Winter I+10%	131.840	130.720	0.91	0.713	83.9	SURCHARGED
S37.002	S141	15 minute 100 year Winter I+10%	131.930	130.551	1.15	2.767	126.7	SURCHARGED
S37.003	S142	15 minute 100 year Winter I+10%	131.700	130.093	0.68	2.286	155.2	SURCHARGED
S35.005	S143	15 minute 100 year Winter I+10%	129.560	129.101	4.26	5.482	261.4	SURCHARGED
S35.006	S144	15 minute 100 year Winter I+10%	129.530	128.032	3.33	2.024	263.7	SURCHARGED
S35.007	S145	1440 minute 100 year Winter I+10%	128.200	127.980	0.11	460.122	4.0	SURCHARGED

Q100 TANK 4
463m³ provided

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 7

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.300	Add Flow / Climate Change (%)	0
Ratio R	0.256	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	3.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	180

Designed with Level Soffits

Time Area Diagram for Catchment 7

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.460	4-8	0.163

Total Area Contributing (ha) = 0.623

Total Pipe Volume (m³) = 13.334

Network Design Table for Catchment 7

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S38.000	55.454	0.528	105.0	0.078	4.00	0.0	0.600	o	225	Pipe/Conduit	
S38.001	32.034	0.305	105.0	0.058	0.00	0.0	0.600	o	225	Pipe/Conduit	
S38.002	31.700	0.302	105.0	0.038	0.00	0.0	0.600	o	225	Pipe/Conduit	
S38.003	30.075	0.285	105.5	0.031	0.00	0.0	0.600	o	225	Pipe/Conduit	
S39.000	9.483	0.095	100.0	0.308	4.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S38.000	50.00	4.72	119.350	0.078	0.0	0.0	0.0	1.28	50.7	10.6
S38.001	50.00	5.14	118.820	0.136	0.0	0.0	0.0	1.28	50.7	18.4
S38.002	50.00	5.56	118.510	0.174	0.0	0.0	0.0	1.28	50.7	23.5
S38.003	50.00	5.95	118.210	0.204	0.0	0.0	0.0	1.27	50.6	27.7
S39.000	50.00	4.10	118.100	0.308	0.0	0.0	0.0	1.57	111.1	41.7

Network Design Table for Catchment 7

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S38.004	41.099	0.393	104.6	0.043	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
S38.005	3.854	0.039	98.8	0.023	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
S38.006	8.079	0.054	149.3	0.022	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S38.007	12.059	0.207	58.3	0.023	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S38.004	50.00	6.34	117.920	0.555	0.0	0.0	0.0	1.77	195.7	75.2
S38.005	50.00	6.37	117.450	0.578	0.0	0.0	0.0	1.82	201.3	78.3
S38.006	50.00	6.45	117.400	0.600	0.0	0.0	0.0	1.66	264.2	81.3
S38.007	50.00	6.57	117.300	0.623	0.0	0.0	0.0	1.72	68.3«	84.4

Free Flowing Outfall Details for Catchment 7

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S38.007	S	119.500	117.093	117.220	0	0

Simulation Criteria for Catchment 7

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

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	1	Number of Storage Structures	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	19.200	Storm Duration (mins)	30
Ratio R	0.256		

Online Controls for Catchment 7

Hydro-Brake® Optimum Manhole: S158, DS/PN: S38.007, Volume (m^3): 4.4

Unit Reference	MD-SHE-0084-4000-1800-4000
Design Head (m)	1.800
Design Flow (l/s)	4.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	84
Invert Level (m)	117.300
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.800	4.0	Kick-Flo®	0.745	2.7
Flush-Flo™	0.363	3.3	Mean Flow over Head Range	-	3.2

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.5	1.200	3.3	3.000	5.1	7.000	7.6
0.200	3.1	1.400	3.6	3.500	5.4	7.500	7.8
0.300	3.3	1.600	3.8	4.000	5.8	8.000	8.0
0.400	3.3	1.800	4.0	4.500	6.1	8.500	8.3
0.500	3.3	2.000	4.2	5.000	6.4	9.000	8.5
0.600	3.1	2.200	4.4	5.500	6.7	9.500	8.7
0.800	2.8	2.400	4.6	6.000	7.0		
1.000	3.0	2.600	4.7	6.500	7.3		

Storage Structures for Catchment 7

Cellular Storage Manhole: S158, DS/PN: S38.007

Invert Level (m) 117.300 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.71
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m^2)	Inf. Area (m^2)	Depth (m)	Area (m^2)	Inf. Area (m^2)
0.000	250.0	0.0	1.851	0.0	0.0
1.850	250.0	0.0			

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 7

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.256
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 19.200 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S38.000	S150	15 minute 1 year Winter I+0%	121.600	119.421	0.21	0.075	10.4	OK
S38.001	S151	15 minute 1 year Winter I+0%	120.500	118.913	0.35	0.161	16.6	OK
S38.002	S152	15 minute 1 year Winter I+0%	120.500	118.613	0.43	0.174	20.4	OK
S38.003	S153	15 minute 1 year Winter I+0%	120.070	118.323	0.50	0.225	23.4	OK
S39.000	S154	15 minute 1 year Summer I+0%	120.500	118.259	0.55	0.174	42.4	OK
S38.004	S155	15 minute 1 year Winter I+0%	120.310	118.081	0.37	0.494	66.8	OK
S38.005	S156	600 minute 1 year Winter I+0%	119.950	117.840	0.11	1.953	11.3	SURCHARGED
S38.006	S157	600 minute 1 year Winter I+0%	120.100	117.839	0.07	0.892	11.6	OK
S38.007	S158	600 minute 1 year Winter I+0%	119.600	117.837	0.06	97.082	3.3	SURCHARGED

Q1 Tank 7
456m³ provided

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 7

Simulation Criteria

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

Number of Input Hydrographs 0 | Number of Offline Controls 0 | Number of Time/Area Diagrams 0
Number of Online Controls 1 | Number of Storage Structures 1 | Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR | Ratio R 0.256
Region Scotland and Ireland | Cv (Summer) 0.750
M5-60 (mm) 19.200 | Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 | DVD Status ON
Analysis Timestep Fine | Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S38.000	S150	15 minute 30 year Winter I+0%	121.600	119.461	0.47	0.120	23.2	OK
S38.001	S151	15 minute 30 year Winter I+0%	120.500	118.985	0.82	0.421	39.1	OK
S38.002	S152	15 minute 30 year Winter I+0%	120.500	118.812	0.96	1.057	45.4	SURCHARGED
S38.003	S153	960 minute 30 year Winter I+0%	120.070	118.565	0.12	1.325	5.6	SURCHARGED
S39.000	S154	960 minute 30 year Winter I+0%	120.500	118.563	0.11	0.518	8.4	SURCHARGED
S38.004	S155	960 minute 30 year Winter I+0%	120.310	118.562	0.08	2.637	15.1	SURCHARGED
S38.005	S156	960 minute 30 year Winter I+0%	119.950	118.560	0.14	5.971	14.8	SURCHARGED
S38.006	S157	960 minute 30 year Winter I+0%	120.100	118.559	0.09	1.928	15.3	SURCHARGED
S38.007	S158	960 minute 30 year Winter I+0%	119.600	118.558	0.06	226.220	3.4	SURCHARGED

Q30 Tank 7
456m³ provided

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 7

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.256
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 19.200 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 10

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Flow / Cap.	Maximum Vol (m³)	Pipe Flow (l/s)	Status
S38.000	S150	15 minute 100 year Winter I+10%	121.600	119.662	0.68	0.347	33.0	SURCHARGED
S38.001	S151	15 minute 100 year Winter I+10%	120.500	119.539	0.90	2.953	42.9	SURCHARGED
S38.002	S152	15 minute 100 year Winter I+10%	120.500	119.318	1.10	2.135	52.4	SURCHARGED
S38.003	S153	960 minute 100 year Winter I+10%	120.070	119.134	0.15	2.254	7.3	SURCHARGED
S39.000	S154	960 minute 100 year Winter I+10%	120.500	119.132	0.14	1.162	11.0	SURCHARGED
S38.004	S155	960 minute 100 year Winter I+10%	120.310	119.131	0.11	3.451	19.2	SURCHARGED
S38.005	S156	960 minute 100 year Winter I+10%	119.950	119.128	0.19	6.785	19.9	SURCHARGED
S38.006	S157	960 minute 100 year Winter I+10%	120.100	119.127	0.12	2.742	20.5	SURCHARGED
S38.007	S158	960 minute 100 year Winter I+10%	119.600	119.126	0.07	327.847	4.0	SURCHARGED

Q100 Tank 7
456m³ provided

Appendix 12.2

StormTech Calculations

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	BOHERBOY, SAGGART
LOCATION:	Storage Unit 1
DATE:	Sept'21
CREATED BY:	RM 1324B

SYSTEM PARAMETERS

Required Total Storage	1492	m^3
Stormtech chamber model	MC4500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	40%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.3	m	0.30
Stone Below Chambers	0.3	m	0.23
In-between Row Spacing	0.25	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	No	
Orientation of Header Pipe	Parralel to IR	
Diameter of Header Pipe	0.6	m
Length of Header Pipe	0	m

CHAMBER SYSTEM DIMENSIONS	Calculated	Adopted	
Number of Rows		10	ea
Number of units per Row		28	ea
System Installed Storage Depth (effective storage depth)	2.125		m
Tank overall installed Width at base	28.25	28	m
Tank overall installed Length at Base	36.6	38	m
Total Effective System Storage	**1478.6**	**1505.4**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC4500	
Unit Width	2.54	m
Unit Length	1.23	m
Unit Height	1.525	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.1	m
Chamber Internal Storage Vol.	3.01	m^3
Header Pipe Internal Storage Vol in Excavation	0.0	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	2439	m^3
Width at base	28.00	m
Width at top	30.45	m
Length at base	38.00	m
Length at top	40.45	m
Depth Of System	2.13	m
Area of Dig at Base of System	1064	m^2
Area of Dig at Top of System	1232	m^2
Void Ratio	62%	
Stone Requirement - m3	1573	m^3
Stone Requirement - tonne	2580	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	BOHERBOY, SAGGART
LOCATION:	Storage Unit 2
DATE:	Sept'21
CREATED BY:	RM 1324B

SYSTEM PARAMETERS

Required Total Storage	262	m^3
Stormtech chamber model	MC4500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	40%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.3	m	0.30
Stone Below Chambers	0.3	m	0.23
In-between Row Spacing	0.25	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	No	
Orientation of Header Pipe	Parralel to IR	
Diameter of Header Pipe	0.6	m
Length of Header Pipe	0	m

CHAMBER SYSTEM DIMENSIONS	Calculated	Adopted	
Number of Rows		2	ea
Number of units per Row		21	ea
System Installed Storage Depth (effective storage depth)	2.125		m
Tank overall installed Width at base	5.93	6	m
Tank overall installed Length at Base	27.99	28	m
Total Effective System Storage	**262.6**	**264.4**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC4500	
Unit Width	2.54	m
Unit Length	1.23	m
Unit Height	1.525	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.1	m
Chamber Internal Storage Vol.	3.01	m^3
Header Pipe Internal Storage Vol in Excavation	0.0	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	452	m^3
Width at base	6.00	m
Width at top	8.45	m
Length at base	28.00	m
Length at top	30.45	m
Depth Of System	2.13	m
Area of Dig at Base of System	168	m^2
Area of Dig at Top of System	257	m^2
Void Ratio	58%	
Stone Requirement - m3	318	m^3
Stone Requirement - tonne	522	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	BOHERBOY, SAGGART
LOCATION:	Storage Unit 3
DATE:	Sept'21
CREATED BY:	RM 1324B

SYSTEM PARAMETERS

Required Total Storage	383	m^3
Stormtech chamber model	MC4500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	40%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.3	m	0.30
Stone Below Chambers	0.3	m	0.23
In-between Row Spacing	0.25	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	No	
Orientation of Header Pipe	Parralell to IR	
Diameter of Header Pipe	0.6	m
Length of Header Pipe	0	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		3	ea
Number of units per Row		21	ea
System Installed Storage Depth (effective storage depth)	2.125		m
Tank overall installed Width at base	8.72	9	m
Tank overall installed Length at Base	27.99	29	m
Total Effective System Storage	**371.9**	**387.6**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC4500	
Unit Width	2.54	m
Unit Length	1.23	m
Unit Height	1.525	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.1	m
Chamber Internal Storage Vol.	3.01	m^3
Header Pipe Internal Storage Vol in Excavation	0.0	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	660	m^3
Width at base	9.00	m
Width at top	11.45	m
Length at base	29.00	m
Length at top	31.45	m
Depth Of System	2.13	m
Area of Dig at Base of System	261	m^2
Area of Dig at Top of System	360	m^2
Void Ratio	59%	
Stone Requirement - m3	461	m^3
Stone Requirement - tonne	756	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	BOHERBOY, SAGGART
LOCATION:	Storage Unit 4
DATE:	Sept'21
CREATED BY:	RM 1324B

SYSTEM PARAMETERS

Required Total Storage	459	m^3
Stormtech chamber model	MC4500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	40%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.3	m	0.30
Stone Below Chambers	0.3	m	0.23
In-between Row Spacing	0.25	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	No	
Orientation of Header Pipe	Parralell to IR	
Diameter of Header Pipe	0.6	m
Length of Header Pipe	0	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		3	ea
Number of units per Row		26	ea
System Installed Storage Depth (effective storage depth)	2.125		m
Tank overall installed Width at base	8.72	9	m
Tank overall installed Length at Base	34.14	34.5	m
Total Effective System Storage	**450.9**	**462.5**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC4500	
Unit Width	2.54	m
Unit Length	1.23	m
Unit Height	1.525	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.1	m
Chamber Internal Storage Vol.	3.01	m^3
Header Pipe Internal Storage Vol in Excavation	0.0	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	780	m^3
Width at base	9.00	m
Width at top	11.45	m
Length at base	34.50	m
Length at top	36.95	m
Depth Of System	2.13	m
Area of Dig at Base of System	311	m^2
Area of Dig at Top of System	423	m^2
Void Ratio	59%	
Stone Requirement - m3	536	m^3
Stone Requirement - tonne	878	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	BOHERBOY, SAGGART
LOCATION:	Storage Unit 5
DATE:	Sept'21
CREATED BY:	RM 1324B

SYSTEM PARAMETERS

Required Total Storage	2076	m^3
Stormtech chamber model	MC4500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	40%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.3	m	0.30
Stone Below Chambers	0.3	m	0.23
In-between Row Spacing	0.25	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	No	
Orientation of Header Pipe	Parralell to IR	
Diameter of Header Pipe	0.6	m
Length of Header Pipe	0	m

CHAMBER SYSTEM DIMENSIONS	Calculated	Adopted	
Number of Rows		8	ea
Number of units per Row		48	ea
System Installed Storage Depth (effective storage depth)	2.125		m
Tank overall installed Width at base	22.67	25	m
Tank overall installed Length at Base	61.2	61	m
Total Effective System Storage	**1982.7**	**2101.9**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC4500	
Unit Width	2.54	m
Unit Length	1.23	m
Unit Height	1.525	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.1	m
Chamber Internal Storage Vol.	3.01	m^3
Header Pipe Internal Storage Vol in Excavation	0.0	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	3471	m^3
Width at base	25.00	m
Width at top	27.45	m
Length at base	61.00	m
Length at top	63.45	m
Depth Of System	2.13	m
Area of Dig at Base of System	1525	m^2
Area of Dig at Top of System	1742	m^2
Void Ratio	61%	
Stone Requirement - m3	2296	m^3
Stone Requirement - tonne	3765	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	BOHERBOY, SAGGART
LOCATION:	Storage Unit 6
DATE:	Sept'21
CREATED BY:	RM 1324B

SYSTEM PARAMETERS

Required Total Storage	370	m^3
Stormtech chamber model	MC4500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	40%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.3	m	0.30
Stone Below Chambers	0.3	m	0.23
In-between Row Spacing	0.25	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	No	
Orientation of Header Pipe	Parralell to IR	
Diameter of Header Pipe	0.6	m
Length of Header Pipe	0	m

CHAMBER SYSTEM DIMENSIONS	Calculated	Adopted	
Number of Rows		2	ea
Number of units per Row		30	ea
System Installed Storage Depth (effective storage depth)	2.125		m
Tank overall installed Width at base	5.93	6	m
Tank overall installed Length at Base	39.06	40	m
Total Effective System Storage	**362.5**	**370.7**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC4500	
Unit Width	2.54	m
Unit Length	1.23	m
Unit Height	1.525	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.1	m
Chamber Internal Storage Vol.	3.01	m^3
Header Pipe Internal Storage Vol in Excavation	0.0	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	636	m^3
Width at base	6.00	m
Width at top	8.45	m
Length at base	40.00	m
Length at top	42.45	m
Depth Of System	2.13	m
Area of Dig at Base of System	240	m^2
Area of Dig at Top of System	359	m^2
Void Ratio	58%	
Stone Requirement - m3	448	m^3
Stone Requirement - tonne	736	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	BOHERBOY, SAGGART
LOCATION:	TANK 7
DATE:	Sept'21
CREATED BY:	RM 1324B

SYSTEM PARAMETERS

Required Total Storage	440	m^3
Stormtech chamber model	MC4500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	40%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.3	m	0.30
Stone Below Chambers	0.3	m	0.23
In-between Row Spacing	0.25	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	No	
Orientation of Header Pipe	Parralel to IR	
Diameter of Header Pipe	0.6	m
Length of Header Pipe	0	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		4	ea
Number of units per Row		19	ea
System Installed Storage Depth (effective storage depth)	2.125		m
Tank overall installed Width at base	11.51	11.5	m
Tank overall installed Length at Base	25.53	27	m
Total Effective System Storage	**440.0**	**455.7**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC4500	
Unit Width	2.54	m
Unit Length	1.23	m
Unit Height	1.525	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.1	m
Chamber Internal Storage Vol.	3.01	m^3
Header Pipe Internal Storage Vol in Excavation	0.0	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	767	m^3
Width at base	11.50	m
Width at top	13.95	m
Length at base	27.00	m
Length at top	29.45	m
Depth Of System	2.13	m
Area of Dig at Base of System	311	m^2
Area of Dig at Top of System	411	m^2
Void Ratio	59%	
Stone Requirement - m3	527	m^3
Stone Requirement - tonne	864	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	BOHERBOY, SAGGART
LOCATION:	Catch 8 - Possible Future School Site
DATE:	Sept'21
CREATED BY:	RM 1324B

SYSTEM PARAMETERS

Required Total Storage	580	m^3
Stormtech chamber model	MC4500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	40%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.3	m	0.30
Stone Below Chambers	0.3	m	0.23
In-between Row Spacing	0.25	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	No	
Orientation of Header Pipe	Parralel to IR	
Diameter of Header Pipe	0.6	m
Length of Header Pipe	0	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		4	ea
Number of units per Row		25	ea
System Installed Storage Depth (effective storage depth)	2.125		m
Tank overall installed Width at base	11.51	12	m
Tank overall installed Length at Base	32.91	33	m
Total Effective System Storage	**563.3**	**578.5**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC4500	
Unit Width	2.54	m
Unit Length	1.23	m
Unit Height	1.525	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.1	m
Chamber Internal Storage Vol.	3.01	m^3
Header Pipe Internal Storage Vol in Excavation	0.0	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	965	m^3
Width at base	12.00	m
Width at top	14.45	m
Length at base	33.00	m
Length at top	35.45	m
Depth Of System	2.13	m
Area of Dig at Base of System	396	m^2
Area of Dig at Top of System	512	m^2
Void Ratio	60%	
Stone Requirement - m3	653	m^3
Stone Requirement - tonne	1071	tonne

StormTech® Subsurface Stormwater Management

The advanced design of StormTech s chambers allows stormwater professionals to create more profitable, environmentally sound installations. Compared with other subsurface systems, StormTech s innovative chambers offer lower overall installed costs, superior design flexibility and enhanced long-term performance.

Superior Design Flexibility for Optimal Land Use

StormTech chambers are ideal for commercial, municipal and residential applications. One of the key advantages of the StormTech chamber system is design flexibility. StormTech chambers can be configured into beds or trenches, in centralized or decentralized layouts to fit on nearly any site.

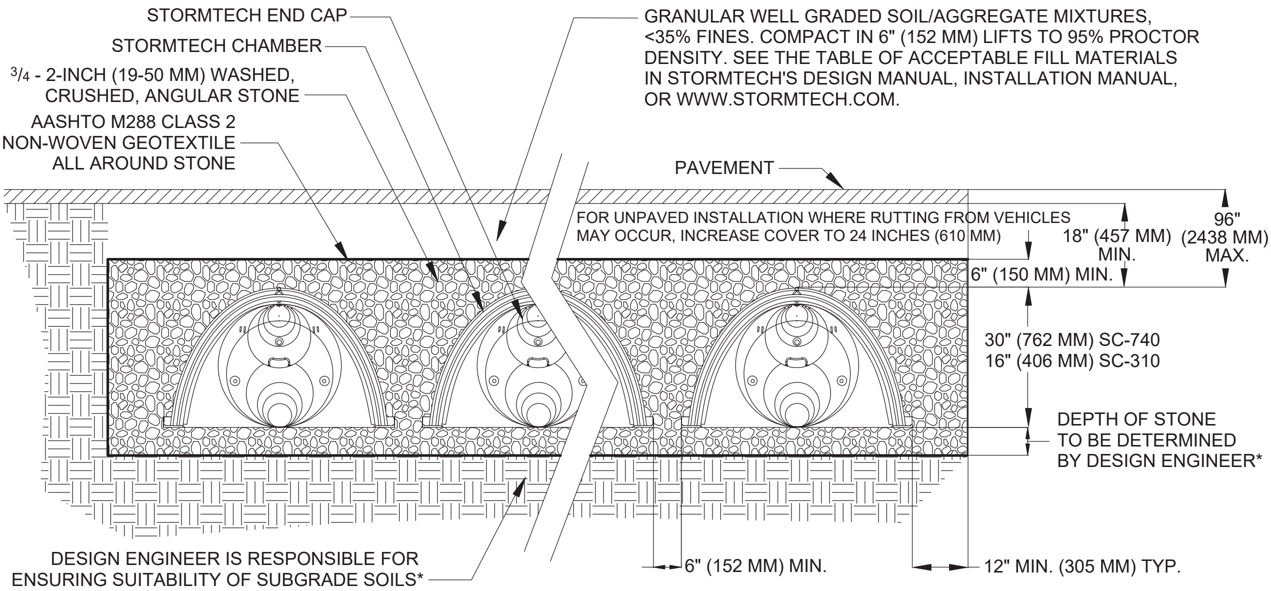
L to R: SC-310 chamber and SC-740 chamber

Product Features and Benefits

The advanced features and innovative technology of StormTech chambers streamline installations while lowering overall installed costs. StormTech chambers offer these unique advantages:

- Lightweight, two people can install chambers quickly and easily, saving time and money
- Extensive product research & development and rigorous testing ensure long term reliability and performance
- Versatile product design accommodates a wide range of site constraints with cost-effective system designs
- The chamber length can be cut in 6.5" (165 mm) increments – reducing waste and optimizing the use of available space
- Injection molded polypropylene ensures precise control of wall thickness and product consistency
- Isolator Row – a patent pending technique to inexpensively enhance total suspended solids (TSS) removal and provide easy access for inspection and maintenance
- Corrugated Arch Design – a proven geometry for structural integrity under H-20 live loads and deep burial loads, also provides high storage capacity

Typical Cross Section Detail (not to scale)



Detention-Retention-Recharge

The StormTech SC-740 chamber optimizes storage volumes in relatively small footprints by providing 2.2 ft^3/ft^2 (0.67 m^3/m^2) (minimum) of storage. This can decrease excavation, backfill and associated costs. The StormTech SC-310 chamber is ideal for systems requiring low-rise and wide-span solutions. The chamber allows the storage of large volumes, 1.3 ft^3/ft^2 (0.4 m^3/m^2) (minimum), at minimum depths.

StormTech SC-740 Chamber
(not to scale)

Nominal Chamber Specifications

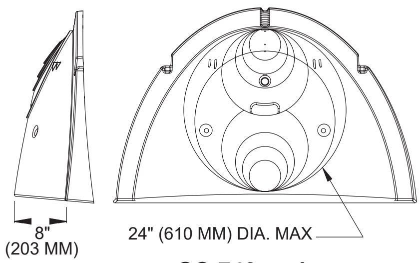
Size (L x W x H)
85.4" x 51.0" x 30.0"
(2169 x 1295 x 762 mm)

Chamber Storage
45.9 ft^3 (1.30 m^3)

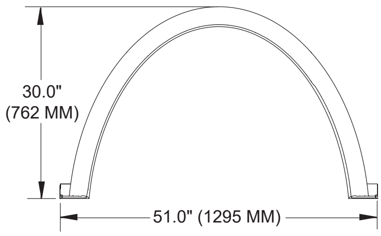
Minimum Installed Storage*
74.9 ft^3 (2.12 m^3)

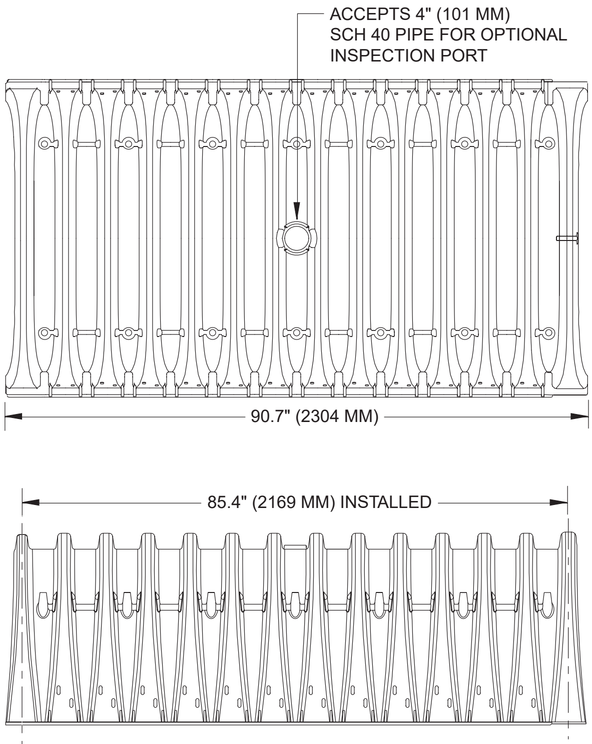
Weight
74.0 lbs (33.6 kg)

Shipping
30 chambers/pallet
60 end caps/pallet
12 pallets/truck



SC-740 end cap





SC-740 chamber

StormTech SC-310 Chamber
(not to scale)

Nominal Chamber Specifications

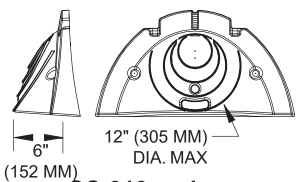
Size (L x W x H)
85.4" x 34.0" x 16.0"
(2169 x 864 x 406 mm)

Chamber Storage
14.7 ft^3 (0.42 m^3)

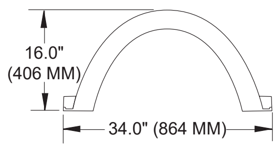
Minimum Installed Storage*
31.0 ft^3 (0.88 m^3)

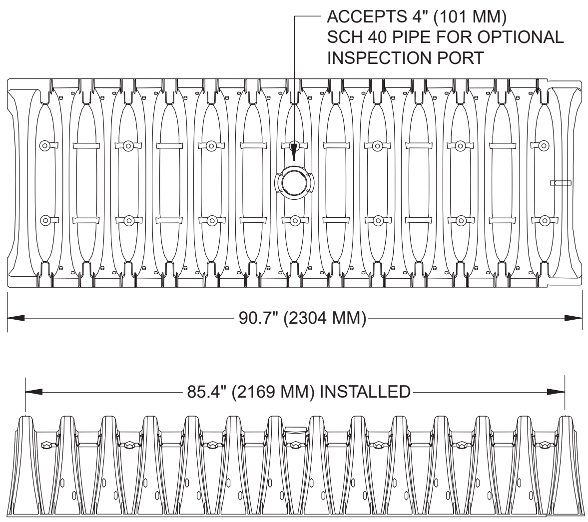
Weight
37.0 lbs (16.8 kg)

Shipping
41 chambers/pallet
108 end caps/pallet
18 pallets/truck



SC-310 end cap





SC-310 chamber

*This assumes a minimum of 6 inches (152 mm) of stone below, above and between chamber rows.

Advanced Structural Performance for Greater Long-Term Reliability

StormTech developed a state of the art chamber design through:

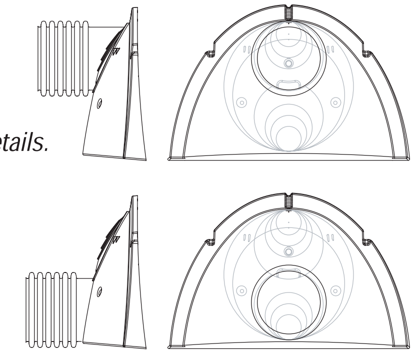
- Collaboration with world-renowned experts of buried drainage structures to develop and evaluate the structural testing program and product design
- Designing chambers to exceed AASHTO LRFD design specifications for HS-20 live loads and deep burial earth loads
- Subjecting the chambers to rigorous full scale testing, under severe loading conditions to verify the AASHTO safety factors for live load and deep burial applications

StormTech continues to conduct research and consult with outside experts to meet customer needs for alternative back-fill materials, designs for special loadings and other technical solutions.

Technical Assistance

StormTech s technical support staff is available to provide assistance to engineers, contractors and developers. Please contact one of our engineers or product managers to discuss your particular application. A wide variety of technical support material is available in print, electronic media or from our website at www.stormtech.com. For any questions, please call StormTech at 888-892-2694.

Fabricated End Caps
Contact StormTech for details.



StormTech®
Detention • Retention • Recharge
Subsurface Stormwater Management℠

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Appendix 12.3

Swale Calculations

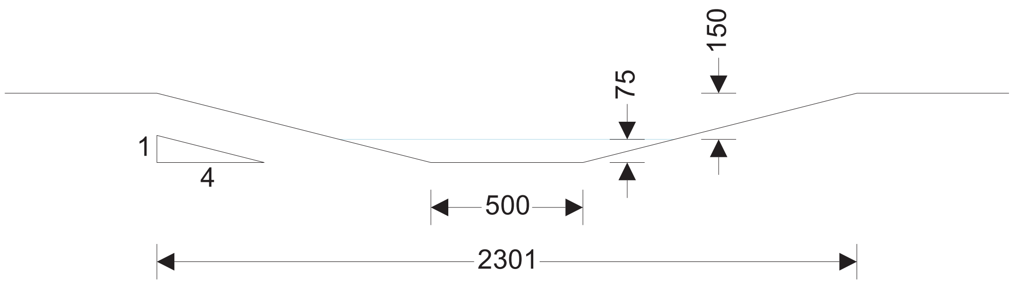
SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

Width of swale base	w = **0.500** m
Longitudinal gradient of swale	S = **0.020**
Side slope gradient of swale	s = **0.250**
Manning number	n = **0.25**
Length of swale	L = **28** m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert	d_{outlet} = **0** mm

Design rainfall intensity

Location of catchment area	Other
Storm duration	D = **10** min
Return period	Period = **1** yr
Ratio 60 min to 2 day rainfall of 5 yr return period	r = **0.256**
5-year return period rainfall of 60 minutes duration	M5_60min = **19.3** mm
Increase of rainfall intensity due to global warming	$p_{climate}$ = **0** %
Factor Z1 (Wallingford procedure)	Z1 = **0.47**
Rainfall for 10min storm with 5 year return period	$M5\_10min_i = Z1 \times M5\_60min$ = **9.1** mm
Factor Z2 (Wallingford procedure)	Z2 = **0.68**
Rainfall for 10min storm with 1 year return period	$M1\_10min = Z2 \times M5\_10min_i$ = **6.2** mm
Design rainfall intensity	I_{max} = M1_10min / D = **37.0** mm/hr

Maximum surface water runoff

Catchment area	A_{catch} = **520** m^2
Percentage of area that is impermeable	p = **90** %
Maximum surface water runoff	$Q_{max} = A_{catch} \times p \times I_{max}$ = **4.8** l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow	x = **75** mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow	$A = (w + x / s) \times x$ = **0.060** m^2
Perimeter of flow	$P = w + 2 \times \sqrt{(x^2 + (x / s)^2)}$ = **1.120** m
Hydraulic radius	R = A / P = **0.054** m

Roger Mullarkey & Associates Duncreevan Kilcock Co.Kildare	Project Boherboy				Job Ref. 1324B	
	Section Swale 1				Sheet no./rev. 2	
	Calc. by RM	Date 02/10/2021	Chk'd by	Date	App'd by	Date

Check flow using Manning equation $Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n =$ **4.8** l/s

Maximum velocity of flow $V_{max} = Q_{max} / A =$ **0.080** m/s

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard $d_{free} =$ **150** mm

Minimum required swale width $w_{total,min} = 2 \times (x + d_{free}) / s + w =$ **2.301** m

Storage

Infiltration capacity of the base f = **0.000014** m/s

Flow into swale $V_{in} = Q_{max} \times D =$ **2.9** m^3

Infiltration area of swale (assume flat base only) $A_{infil} = L \times w =$ **14.0** m^2

Infiltration volume of swale $V_{infil} = f \times D \times A_{infil} =$ **0.1** m^3

Interception storage volume required $V_{infil\_req} = V_{in} - V_{infil} =$ **2.8** m^3

Interception storage volume provided $V_{infil\_prov} = L \times w \times d_{outlet} / 2 =$ **0.0** m^3

Interception volume required exceeds volume provided. Additional interception storage will be required.

SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

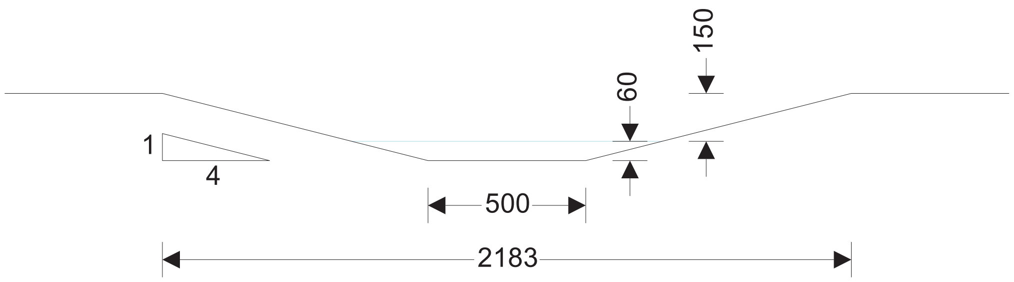
Width of swale base — w = **0.500** m

Longitudinal gradient of swale — S = **0.020**

Side slope gradient of swale — s = **0.250**

Manning number — n = **0.25**

Length of swale — L = **37** m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert — d_{outlet} = **0** mm

Design rainfall intensity

Location of catchment area — Other

Storm duration — D = **10** min

Return period — Period = **1** yr

Ratio 60 min to 2 day rainfall of 5 yr return period — r = **0.256**

5-year return period rainfall of 60 minutes duration — M5_60min = **19.3** mm

Increase of rainfall intensity due to global warming — $p_{climate}$ = **0** %

Factor Z1 (Wallingford procedure) — Z1 = **0.47**

Rainfall for 10min storm with 5 year return period — $M5\_10min_i = Z1 \times M5\_60min$ = **9.1** mm

Factor Z2 (Wallingford procedure) — Z2 = **0.68**

Rainfall for 10min storm with 1 year return period — $M1\_10min = Z2 \times M5\_10min_i$ = **6.2** mm

Design rainfall intensity — $I_{max} = M1\_10min / D$ = **37.0** mm/hr

Maximum surface water runoff

Catchment area — A_{catch} = **342** m^2

Percentage of area that is impermeable — p = **90** %

Maximum surface water runoff — $Q_{max} = A_{catch} \times p \times I_{max}$ = **3.2** l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow — x = **60** mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow — $A = (w + x / s) \times x$ = **0.045** m^2

Perimeter of flow — $P = w + 2 \times \sqrt{(x^2 + (x / s)^2)}$ = **0.998** m

Hydraulic radius — $R = A / P$ = **0.045** m

Check flow using Manning equation $Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n =$ **3.2** l/s

Maximum velocity of flow $V_{max} = Q_{max} / A =$ **0.071** m/s

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard $d_{free} =$ **150** mm

Minimum required swale width $w_{total,min} = 2 \times (x + d_{free}) / s + w =$ **2.183** m

Storage

Infiltration capacity of the base f = **0.000014** m/s

Flow into swale $V_{in} = Q_{max} \times D =$ **1.9** m^3

Infiltration area of swale (assume flat base only) $A_{infil} = L \times w =$ **18.5** m^2

Infiltration volume of swale $V_{infil} = f \times D \times A_{infil} =$ **0.2** m^3

Interception storage volume required $V_{infil\_req} = V_{in} - V_{infil} =$ **1.7** m^3

Interception storage volume provided $V_{infil\_prov} = L \times w \times d_{outlet} / 2 =$ **0.0** m^3

Interception volume required exceeds volume provided. Additional interception storage will be required.

SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

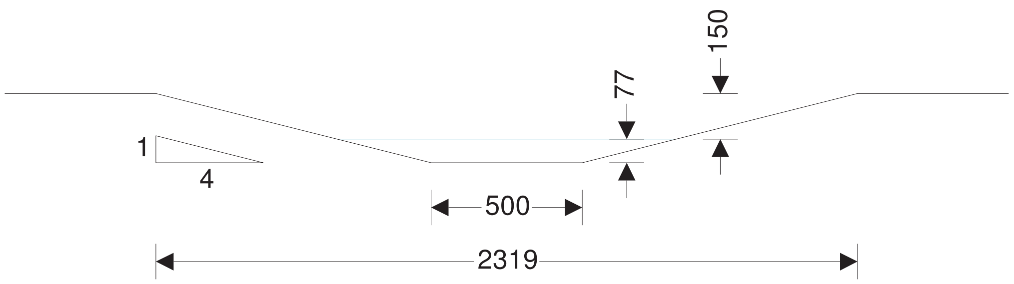
Width of swale base: w = **0.500** m

Longitudinal gradient of swale: S = **0.020**

Side slope gradient of swale: s = **0.250**

Manning number: n = **0.25**

Length of swale: L = **61** m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert: d_{outlet} = **0** mm

Design rainfall intensity

Location of catchment area: Other

Storm duration: D = **10** min

Return period: Period = **1** yr

Ratio 60 min to 2 day rainfall of 5 yr return period: r = **0.256**

5-year return period rainfall of 60 minutes duration: M5_60min = **19.3** mm

Increase of rainfall intensity due to global warming: $p_{climate}$ = **0** %

Factor Z1 (Wallingford procedure): Z1 = **0.47**

Rainfall for 10min storm with 5 year return period: $M5\_10min_i = Z1 \times M5\_60min$ = **9.1** mm

Factor Z2 (Wallingford procedure): Z2 = **0.68**

Rainfall for 10min storm with 1 year return period: $M1\_10min = Z2 \times M5\_10min_i$ = **6.2** mm

Design rainfall intensity: $I_{max} = M1\_10min / D$ = **37.0** mm/hr

Maximum surface water runoff

Catchment area: A_{catch} = **495** m^2

Percentage of area that is impermeable: p = **100** %

Maximum surface water runoff: $Q_{max} = A_{catch} \times p \times I_{max}$ = **5.1** l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow: x = **77** mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow: $A = (w + x / s) \times x$ = **0.063** m^2

Perimeter of flow: $P = w + 2 \times \sqrt{(x^2 + (x / s)^2)}$ = **1.138** m

Hydraulic radius: $R = A / P$ = **0.055** m

Check flow using Manning equation $Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n =$ **5.1** l/s

Maximum velocity of flow $V_{max} = Q_{max} / A =$ **0.081** m/s

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard $d_{free} =$ **150** mm

Minimum required swale width $w_{total,min} = 2 \times (x + d_{free}) / s + w =$ **2.319** m

Storage

Infiltration capacity of the base f = **0.000014** m/s

Flow into swale $V_{in} = Q_{max} \times D =$ **3.0** m^3

Infiltration area of swale (assume flat base only) $A_{infil} = L \times w =$ **30.5** m^2

Infiltration volume of swale $V_{infil} = f \times D \times A_{infil} =$ **0.3** m^3

Interception storage volume required $V_{infil\_req} = V_{in} - V_{infil} =$ **2.8** m^3

Interception storage volume provided $V_{infil\_prov} = L \times w \times d_{outlet} / 2 =$ **0.0** m^3

Interception volume required exceeds volume provided. Additional interception storage will be required.

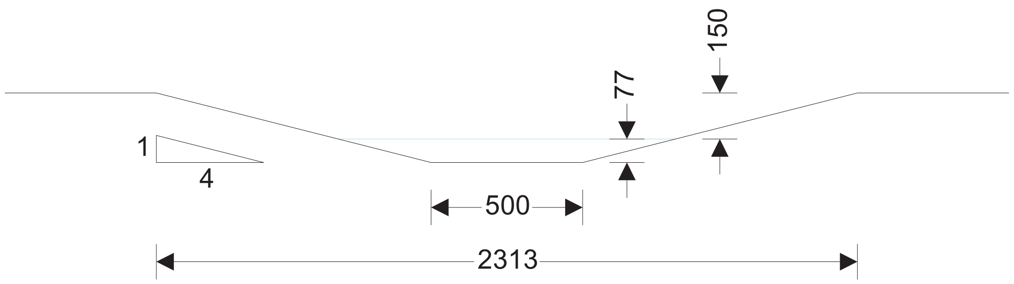
SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

Width of swale base	w = **0.500** m
Longitudinal gradient of swale	S = **0.020**
Side slope gradient of swale	s = **0.250**
Manning number	n = **0.25**
Length of swale	L = **40** m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert	d_{outlet} = **0** mm

Design rainfall intensity

Location of catchment area	Other
Storm duration	D = **10** min
Return period	Period = **1** yr
Ratio 60 min to 2 day rainfall of 5 yr return period	r = **0.256**
5-year return period rainfall of 60 minutes duration	M5_60min = **19.3** mm
Increase of rainfall intensity due to global warming	$p_{climate}$ = **0** %
Factor Z1 (Wallingford procedure)	Z1 = **0.47**
Rainfall for 10min storm with 5 year return period	$M5\_10min_i = Z1 \times M5\_60min$ = **9.1** mm
Factor Z2 (Wallingford procedure)	Z2 = **0.68**
Rainfall for 10min storm with 1 year return period	$M1\_10min = Z2 \times M5\_10min_i$ = **6.2** mm
Design rainfall intensity	I_{max} = M1_10min / D = **37.0** mm/hr

Maximum surface water runoff

Catchment area	A_{catch} = **540** m^2
Percentage of area that is impermeable	p = **90** %
Maximum surface water runoff	$Q_{max} = A_{catch} \times p \times I_{max}$ = **5.0** l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow	x = **77** mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow	$A = (w + x / s) \times x$ = **0.062** m^2
Perimeter of flow	$P = w + 2 \times \sqrt{x^2 + (x / s)^2}$ = **1.132** m
Hydraulic radius	R = A / P = **0.055** m

Check flow using Manning equation $Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n =$ **5.0** l/s

Maximum velocity of flow $V_{max} = Q_{max} / A =$ **0.081** m/s

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard $d_{free} =$ **150** mm

Minimum required swale width $w_{total,min} = 2 \times (x + d_{free}) / s + w =$ **2.313** m

Storage

Infiltration capacity of the base f = **0.000014** m/s

Flow into swale $V_{in} = Q_{max} \times D =$ **3.0** m^3

Infiltration area of swale (assume flat base only) $A_{infil} = L \times w =$ **20.0** m^2

Infiltration volume of swale $V_{infil} = f \times D \times A_{infil} =$ **0.2** m^3

Interception storage volume required $V_{infil\_req} = V_{in} - V_{infil} =$ **2.8** m^3

Interception storage volume provided $V_{infil\_prov} = L \times w \times d_{outlet} / 2 =$ **0.0** m^3

Interception volume required exceeds volume provided. Additional interception storage will be required.

SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

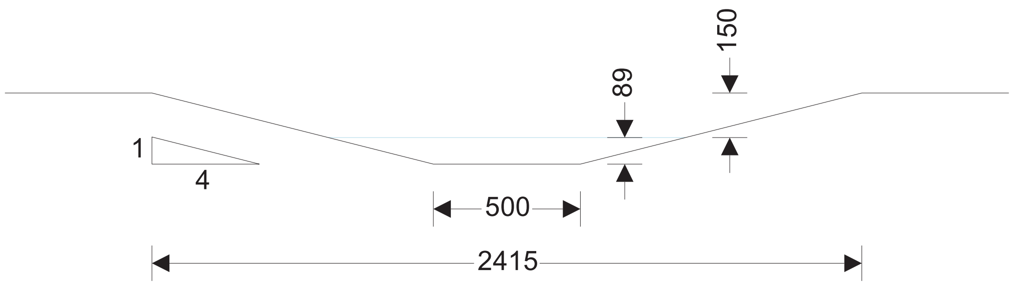
Width of swale base w = **0.500** m

Longitudinal gradient of swale S = **0.020**

Side slope gradient of swale s = **0.250**

Manning number n = **0.25**

Length of swale L = **61** m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert d_{outlet} = **0** mm

Design rainfall intensity

Location of catchment area Other

Storm duration D = **10** min

Return period Period = **1** yr

Ratio 60 min to 2 day rainfall of 5 yr return period r = **0.256**

5-year return period rainfall of 60 minutes duration M5_60min = **19.3** mm

Increase of rainfall intensity due to global warming $p_{climate}$ = **0** %

Factor Z1 (Wallingford procedure) Z1 = **0.47**

Rainfall for 10min storm with 5 year return period $M5\_10min_i = Z1 \times M5\_60min$ = **9.1** mm

Factor Z2 (Wallingford procedure) Z2 = **0.68**

Rainfall for 10min storm with 1 year return period $M1\_10min = Z2 \times M5\_10min_i$ = **6.2** mm

Design rainfall intensity $I_{max} = M1\_10min / D$ = **37.0** mm/hr

Maximum surface water runoff

Catchment area A_{catch} = **732** m^2

Percentage of area that is impermeable p = **90** %

Maximum surface water runoff $Q_{max} = A_{catch} \times p \times I_{max}$ = **6.8** l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow x = **89** mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow $A = (w + x / s) \times x$ = **0.077** m^2

Perimeter of flow $P = w + 2 \times \sqrt{(x^2 + (x / s)^2)}$ = **1.237** m

Hydraulic radius $R = A / P$ = **0.062** m

Check flow using Manning equation $Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n =$ **6.8** l/s

Maximum velocity of flow $V_{max} = Q_{max} / A =$ **0.088** m/s

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard $d_{free} =$ **150** mm

Minimum required swale width $w_{total,min} = 2 \times (x + d_{free}) / s + w =$ **2.415** m

Storage

Infiltration capacity of the base f = **0.000014** m/s

Flow into swale $V_{in} = Q_{max} \times D =$ **4.1** m^3

Infiltration area of swale (assume flat base only) $A_{infil} = L \times w =$ **30.5** m^2

Infiltration volume of swale $V_{infil} = f \times D \times A_{infil} =$ **0.3** m^3

Interception storage volume required $V_{infil\_req} = V_{in} - V_{infil} =$ **3.8** m^3

Interception storage volume provided $V_{infil\_prov} = L \times w \times d_{outlet} / 2 =$ **0.0** m^3

Interception volume required exceeds volume provided. Additional interception storage will be required.

SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

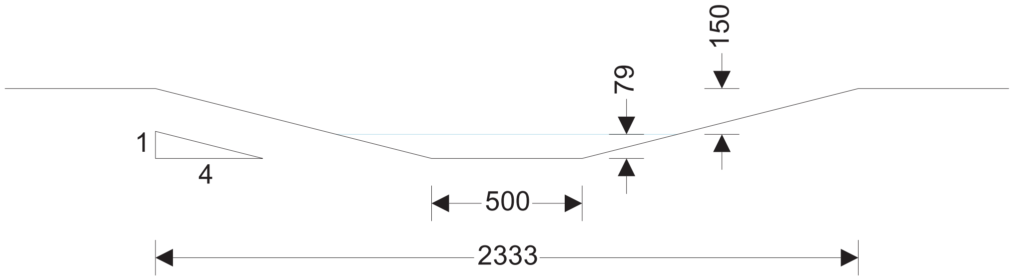
Width of swale base: w = **0.500** m

Longitudinal gradient of swale: S = **0.020**

Side slope gradient of swale: s = **0.250**

Manning number: n = **0.25**

Length of swale: L = **120** m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert: d_{outlet} = **0** mm

Design rainfall intensity

Location of catchment area: Other

Storm duration: D = **10** min

Return period: Period = **1** yr

Ratio 60 min to 2 day rainfall of 5 yr return period: r = **0.256**

5-year return period rainfall of 60 minutes duration: M5_60min = **19.3** mm

Increase of rainfall intensity due to global warming: $p_{climate}$ = **0** %

Factor Z1 (Wallingford procedure): Z1 = **0.47**

Rainfall for 10min storm with 5 year return period: $M5\_10min_i = Z1 \times M5\_60min$ = **9.1** mm

Factor Z2 (Wallingford procedure): Z2 = **0.68**

Rainfall for 10min storm with 1 year return period: $M1\_10min = Z2 \times M5\_10min_i$ = **6.2** mm

Design rainfall intensity: $I_{max} = M1\_10min / D$ = **37.0** mm/hr

Maximum surface water runoff

Catchment area: A_{catch} = **576** m^2

Percentage of area that is impermeable: p = **90** %

Maximum surface water runoff: $Q_{max} = A_{catch} \times p \times I_{max}$ = **5.3** l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow: x = **79** mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow: $A = (w + x / s) \times x$ = **0.065** m^2

Perimeter of flow: $P = w + 2 \times \sqrt{(x^2 + (x / s)^2)}$ = **1.153** m

Hydraulic radius: $R = A / P$ = **0.056** m

Check flow using Manning equation $Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n = \mathbf{5.4}$ l/s

Maximum velocity of flow $V_{max} = Q_{max} / A = \mathbf{0.082}$ m/s

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard $d_{free} = \mathbf{150}$ mm

Minimum required swale width $w_{total,min} = 2 \times (x + d_{free}) / s + w = \mathbf{2.333}$ m

Storage

Infiltration capacity of the base $f = \mathbf{0.000014}$ m/s

Flow into swale $V_{in} = Q_{max} \times D = \mathbf{3.2}\ m^3$

Infiltration area of swale (assume flat base only) $A_{infil} = L \times w = \mathbf{60.0}\ m^2$

Infiltration volume of swale $V_{infil} = f \times D \times A_{infil} = \mathbf{0.5}\ m^3$

Interception storage volume required $V_{infil\_req} = V_{in} - V_{infil} = \mathbf{2.7}\ m^3$

Interception storage volume provided $V_{infil\_prov} = L \times w \times d_{outlet} / 2 = \mathbf{0.0}\ m^3$

Interception volume required exceeds volume provided. Additional interception storage will be required.

Appendix 12.4

Foul Drainage & Pumping Station Calculations

Foul flow estimates – Domestic

BOHERBOY					
New Network - DOMESTIC Wastewater Flows					
Usage	**Quantity**	**Occupancy (h)**	**Population (P)**	**Consumption (G) (l/h/day)**	**Loading (PxG)(l/day)**
Residential	655 Units	2.7No./Unit	1769	150	265,275
				Total =	**265,275 l/day**

Flowrate per day (l/s)		**3.07 l/s**
Growth Rate	1	1
Infiltration (I)	10%	0.3
Dry Weather Flow	**PG + I**	**3.37 l/s**
Peaking Factor (Pf_{Dom})	3	
Design Foul Flow (l/s)	**Pf_{Dom} x PG**	**10.1 l/s**
Misconnection Allowance (SW)	1.5%	0.03 l/s
Design Flow (l/s)		**10.14 l/s**

Based on Irish Water Code of Practice Wastewater Infrastructure (Rev 4 Jul'20)

Residential Wastewater Calculations

Foul flow estimates – Commercial

BOHERBOY						
New Network – COMMERCIAL Wastewater Flows						
Usage	***Quantity***	***Occupancy (h)***	***Population (P)***	***Consumption (G) (l/h/day)***	***Loading (PxG)(l/day)***	
Possible School Site	1 Ha	16 Classes	450	50	22,500	
Crèche	$680m^2$	1child/$8m^2$ + Staff (20%) + support accommodation	102	50	5,100	
Total =					**27,600 l/day**	
Flowrate per 12 hr day (l/s)						**0.64 l/s**
Growth Rate					1	1
Infiltration (I)					10%	0.06
Dry Weather Flow					**PG + I**	**0.7 l/s**
Peaking Factor ($Pf_{Dom.Ind}$)					4.5	
Design Foul Flow (l/s)					**Pf_{DomInd} x PG**	**3.2 l/s**
Misconnection Allowance (SW)					1.5%	0.05l/s
Design Flow (l/s)						**3.25 l/s**

Based on Irish Water Code of Practice Wastewater Infrastructure (Rev 4 Jul'20)

Table 10 – Commercial Wastewater Calculations

Foul flow estimates into Pumping Station

BOHERBOY						
New Network – DOMESTIC AND SCHOOL Wastewater Flows						
Usage	***Quantity***	***Occupancy (h)***	***Population (P)***	***Consumption (G) (l/h/day)***	***Loading (PxG)(l/day)***	
Possible School Site	1 Ha	16 Classes	450	50	22,500	
Aptartment Blocks A & C	120+92 = 212	2.7No./Unit	572	150	85,860	
Total =					**108,360 l/day**	
Flowrate per 24 hr day (l/s)						**1.25 l/s**
Growth Rate					1	1
Infiltration (I)					10%	0.13
Dry Weather Flow					**PG + I**	**1.37 l/s**
Peaking Factor ($Pf_{Dom.Ind}$)					4.5	
Design Foul Flow (l/s)					**Pf_{DomInd} x PG**	**6.19 l/s**
Misconnection Allowance (SW)					1.5%	0.02l/s
Design Flow (l/s)						**6.2 l/s**

Based on Irish Water Code of Practice Wastewater Infrastructure (Rev 4 Jul'20)

Pumping Station Details

Inflow DWF (Blk A & C & School site only) = 1.25 l/s

Sump Area = 2 x 2.5m = 5m^2 – Refer to Dwg.1324B/321

Invert of sump = 114.96mOD; Inlet Invert = 116.72mOD

Overflow Storage

Overflow Storage Capacity Required			
DWF (l/s)	**Storage Time (hrs)**	**Calculation**	**Volume (m^3)**
1.25	24	1.25 x 24 x 60 x 60	108
		Total Overflow Storage Required =	**108m^3**

Inlet to overflow storage chamber = 116.88mOD

Outlet return from overflow storage into sump chamber = 115.46mOD

Overflow storage chamber depth = 116.88 – 115.46 = 1.42m

Area of storage chamber = 108m^3 / 1.42 = 76m^2 = **c.8.7m x 8.7m on plan**

Pump Starts per Hour

Pumps cut-in level = 115.60mOD; Pumps cut-out level = 115.10mOD

Volume in sump at 0.5m depth = 5m^2 x 0.5 = **2.5 m^3**

Pumps to be rated to maintain Velocity in rising main @ **1.2m/s**

Diameter of rising main to be 100mm Ø

Volume in 100mm Ø rising main per m run = πr^2 x 1m = **0.0078m^3**

Volume pumped in 1s (flowrate) = 1.2 m/s x 0.0078m^3 = 9.36 l

Time taken to pump (outflow) 2.5 m^3 = 2500 / 9.36 = **4.45 min**

Time taken to fill (inflow) 2.5 m^3 @ DWF = 2.5 x 10^3 / 1.25 = 1140 s = **33.3 min**

Therefore pump cycle time = inflow time + outflow time = 4.45+33.3 = **37.8min**

Cycles per hour = 60 / 37.8 = 1.6 starts per hour < 10 therefore OK

Time Taken to Clear Rising Main

Length of rising main = 119m

Volume of rising main = 119 x 0.0078 = 0.93 m^3

Volume pumped in 1 cycle = 2.5m^3 > 0.93m^3 ; therefore rising main is cleared during each pump cycle which is **< 6hrs therefore OK**

Appendix 12.5

Small Scale SuDS

SMALL SCALE SuDS FOR INDIVIDUAL BUILDINGS

SOURCE CONTROL

DESCRIPTION

Sustainable Drainage Systems for individual buildings focus on reducing the amount of stormwater leaving a property and/or conserving water. This can be achieved by a variety of methods which are generally low cost and low maintenance, i.e.:

- Avoiding misconnections
- Minimisation of impermeable areas and diversion of run-off to infiltration/soakaway devices
- Rainwater harvesting: Water butts, Rainwater Tanks
- Greywater re-use
- Rooftop greening

AVOIDING MISCONNECTIONS

Misconnections of stormwater to foul sewers and wastewater to storm sewers result in considerable polluting impact in receiving waters. It is the responsibility of the developer and property owner to ensure that there are no such misconnections from their development/property. Rigorous policing of connections by the local authority is required to eliminate inappropriate discharges.

MINIMISATION OF IMPERMEABLE AREAS

DIVERTING TO INFILTRATION/SOAKAWAY DEVICES

The minimisation of impermeable areas can be achieved through the use of permeable paving or gravelled surfaces instead of conventional paving/concrete. The diversion of stormwater, such as the first flush of roof run-off or from disconnected downpipes, to infiltration devices such as soakaways, reduces the volume of water discharge to receiving waters. Roofwater can be discharged directly to the sub-base of infiltration devices. Maintenance requirements and costs are low. See separate SuDS information sheets (Infiltration trenches & Soakaways/Permeable paving) for further details.

WATER BUTT

A water butt is a receptacle or tank, usually covered and placed at ground level, connected to a downpipe, to provide offline attenuation of runoff from roofs. Pollutant removal improves if used in conjunction with first flush devices to divert the first 2mm of roof rainfall run-off and screens to filter out leaves and insects. Desludging is recommended on a regular (annual/bi-ennial) basis.

RAINWATER TANKS

Rainwater tanks collect rainwater for re-use for car washing, gardens and firewater. Tanks can be placed on flat roofs of suitable bearing capacity or connected to downpipes and placed above or under ground. In the latter cases a pump will be required such that the water can be reused, for example, in toilet flushing.

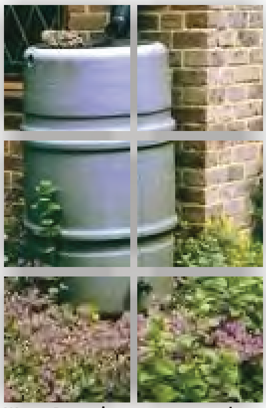
If connecting to the toilet or washing machine a minimum level of water must be maintained by a top-up system from the mains supply. A non-return valve is required to prevent backflow from the tank to the drinking water supply.

Effluent Discharge - Dry Weather Flow

Water Butt - (source: www.blackwell-ltd.com)

Gutter Filter
(LB Plastics Ltd.)

Leafeater
(City Rainwater Tanks Aust Pty Ltd.)



Water Butt - (source:www.southern water.co.uk)

Rainwater Tank

SMALL SCALE SuDS FOR INDIVIDUAL BUILDINGS

GREYWATER TANKS

Greywater is a term applied to all bath, dish and laundry water except toilet waste and food waste derived from garbage grinders. Greywater tanks are generally placed underground. A pump is required such that the water can be re-used, for example, in toilet flushing or for watering plants.

When properly managed, greywater is a valuable resource which horticultural and agricultural growers as well as home gardeners can benefit from. It can also be valuable to landscape planners, builders, developers and contractors. While phosphorous, potassium and nitrogen makes greywater a source of pollution for lakes, rivers and groundwater they are excellent nutrient sources for vegetation when this particular form of wastewater is made available for irrigation. Greywater irrigation has long been practiced in areas where water is in short supply.

A key to successful greywater treatment lies in its immediate processing before it turns anaerobic. The simplest, most appropriate treatment technique consists of directly introducing freshly generated greywater into an active, live topsoil environment. Pollutant removal is achieved by treating the greywater with aerobic pre-treatment or anaerobic to aerobic pre-treatment.
Refer www.clivusmultrum.com and www.greywater.com.

International Experience

Australia

The Healthy Homes project on Australia's Gold Coast is an environmentally sustainable demonstration project incorporating small scale SuDS. Refer to Case Study within this document and www.oca.nsw.gov.au/resource/wramsartwork.pdf.

ROOFTOP GREENING

Fleishman from www.ecocentre.com

DESCRIPTION

Rooftop greening involves vegetating urban walls and rooftops as a way of gaining access to valuable open space while making urban environments healthier more attractive places in which to live and work. Rooftop greening strategies aim to:

- reduce the quantity and increase the quality of surface water run-off
- improve indoor and outdoor comfort levels for residents
- conserve indigenous biodiversity (genetic, species and ecosystem)
- reduce energy demand for heating and cooling
- encourage environmentally responsive design strategies in the City.

Rooftop Greening is moving from the fringe to the mainstream for two reasons:

1)Increasing urban densities are leading to a desire for greater access to green open space; and
2)The role of urban vegetation in producing oxygen, fixing carbon dioxide and filtering urban air and water is becoming more widely recognised.

Rooftop Gardens can function as:
"Extensive" systems require little or no maintenance; are developed primarily for their environmental benefits; and normally consist of thin soils and hardy vegetation applied to large roof areas. The use of Sedum varieties is common.
"Intensive" systems require high levels of maintenance; are developed primarily for aesthetic enjoyment. Extensive greening is generally a much cheaper option than intensive greening. For design considerations refer www.roofmeadows.com. Also, Grodan (www.grodan.com) produce rockwool, a lightweight substrate.

International Experience

Germany

One in 10 flat roofs in German cities are of Esslingen in Germany has a by-law which requires that flat and sloping roofs (up to 15 degrees) must be vegetated. Similarly, in Mannheim, declining air quality prompted the City Council to impose a by-law in 1988 which requires all central business district buildings to be vegetated.

Japan

In Tokyo, guidelines encourage 20% of rooftop areas to be planted. From April 2001, companies that fail to meet these guidelines will face fines. Reductions have been implemented to fixed assets taxes for buildings with rooftop greening. These types of policies are expected to increase throughout Japan, as a consequence of revisions of city regulations.
The Takenaka Corporation have developed a "Thin Layer Rooftop Greening System," by using sedum varieties and a thin mat as a planting base, which reduces the live load on buildings and has limited maintenance requirements. Significant energy conservation has been achieved.
Refer www.takenaka.co.jp/takenaka_e/.

America

The award-winning Chicago City Hall green roof was installed for the Urban Heat Island Initiative project. The design includes a 3.5" deep **'extensive'** system to 24" deep **'intensive'** landscape islands. The project shows the benefit of green roofs in lowering summer temperatures within ultra-urban environments.
Refer www.cityofchicago.org .

Chicago City Hall 2002
Source www.roofmeadows.com

Appendix 12.6

UKSuDS Evaluation

Site Drainage Evaluation

Site name: Boherboy
Site location: Boherboy, Saggart

Report Reference: 1530459198342
Date: 1/7/2018

1. INTRODUCTION

This is a bespoke report providing initial guidance on potential implementation of SuDS for the development site in line with current best practice.

The use of this tool should be supplemented by more detailed guidance on SuDS best practice provided in a number of sources, principally the CIRIA SUDS Manual (2007), other CIRIA documents; the Use of SUDS in High Density Developments, HR Wallingford, (2005) and other HR Wallingford documents.

The objective is to provide some early guidance on the numbers and types of components that might be suitable for consideration within the site design. This may facilitate pre-application discussions with planners and other relevant authorities.

This guidance has been provided prior to the completion of the SUDS standards and the supporting guidance. However the principles of this tool are unlikely to be very different to the aims of the SUDS standards. HR Wallingford is not liable for the use of any output from the use of this tool and the performance of the drainage system. It is recommended that detailed design using appropriately experienced engineers professionals and tools is undertaken before finalising any drainage scheme arrangement for a site.

THE CONTENT OF THE REPORT

This report is split into 8 sections as follows:

2. Generic SuDS Best Practice Principles
3. Runoff Destination
4. Hydraulic Design Criteria
5. Water Quality Design Criteria
6. Site-Specific Drainage Design Considerations
7. SuDS Construction
8. SuDS Components Performance
9. Guidance on The Use of Individual Components

2. GENERIC SuDS BEST PRACTICE PRINCIPLES

To comply with current best practice, the drainage system should:

(i) manage runoff at or close to its source;
(ii) manage runoff at the surface;
(iii) be integrated with public open space areas and contribute towards meeting the objectives of the urban plan;
(iv) be cost-effective to operate and maintain.

The drainage system should endeavour to ensure that, for any particular site:

(i) natural hydrological processes are protected through maintaining Interception of an initial depth of rainfall and prioritising infiltration, where appropriate;
(ii) flood risk is managed through the control of runoff peak flow rates and volumes discharged from the site;
(iii) stormwater runoff is treated to prevent detrimental impacts to the receiving water body as a result of urban contaminants.

In addition, it is desirable to maximise the amenity and ecological benefits associated with the drainage system where there are appropriate opportunities. SuDS are green infrastructure components and can provide health benefits, and reduce the vulnerability of developments to the impacts of climate change.

3. RUNOFF DESTINATION

Introduction

Infiltration should be prioritised as the method of controlling surface water runoff from the development site, unless it can be demonstrated that the use of infiltration would have a detrimental environmental impact.

Groundwater (via Infiltration)
Infiltration may not be appropriate for managing runoff from this site. Robust studies are reqired to confirm the significance of the following constraints to infiltration:

(1) This is a steeply sloping site and full consideration must be given to the hydrogeological infiltration pathways, to ensure that there is no risk of water re-emerging on the site or on other sites and contributing to downstream flood risk.

(2) The subsurface geology is primarily impermeable and the use of infiltration is unlikely to be suitable. Where infiltration rates are confirmed via testing to be < 1 x 10-7 m/s, infiltration will be very limited. Where infiltration rates are between 1 x 10-7 and 1 x 10-5 m/s, then soils can still provide Interception and partial infiltration. If rates are confirmed to be > 1 x 10-5 m/s, full infiltration can be considered in the design.

The groundwater beneath the site is designated as , and this designation will define the treatment requirement for any infiltrated water (See Water Quality Design Criteria).

Surface water body
All runoff that cannot be discharged to groundwater will be managed on site and discharged to a surface water body.

The receiving surface water body for runoff from the site is: the *Opencourse Stream*. The riparian owner is: *SDCC.*

4. HYDRAULIC DESIGN CRITERIA

Introduction
Best practice criteria for hydraulic control require Interception, runoff and volume control.

Interception
To fulfill the requirements for Interception, there should normally be no runoff from the site for an initial depth of rainfall - usually 5mm. This is achieved through the use of infiltration, evapotranspiration, or rainwater harvesting.

Flow and Volume Control
The site is a greenfield development, therefore runoff from the site needs to be constrained to the equivalent greenfield rates and volumes.

Attenuation and hydraulic controls will be used to manage flow rates.

Rainwater harvesting, or the use of Long Term Storage can be used to achieve greenfield runoff volume control. Where volume control is not practicable, flows discharged from the site will be constrained to Qbar or 2 l/s/ha (whichever is the greater).

5. WATER QUALITY DESIGN CRITERIA

Introduction
Current best practice takes a risk-based approach to managing discharges of surface runoff to the receiving environment. The following text provides guidance on the extent of water quality management likely to be appropriate for the site.

Hazard Classification
Runoff from clean roof surfaces (ie not metal roofs, roofs close to polluted atmospheric discharges, or roofs close to populations of flocking birds) is classified as Low in terms of hazard status.

Runoff from roof surfaces that may be contaminated with metals or other pollutants (resulting from roof materials); deposited pollutants from atmospheric discharges (eg factory chimneys); or faeces from flocking birds (eg seagulls) is classified as Medium in terms of hazard.

Runoff from roads, parking and other areas of residential, commercial and industrial sites (that are not contaminated with waste, high levels of hydrocarbons, or other chemicals) is classified as Medium in terms of hazard status.

Treatment requirements for disposal to surface water systems
The catchment area of Opencourse Stream to the point of the discharge from the site is < 50 km2, therefore it is classified as a sensitive receptor.

The level of urbanisation of the catchment at the point of the discharge from the site is < 20%, therefore it may be classified as a sensitive receptor.

Roof runoff will require 1 treatment stage prior to discharge.

Runoff from other parts of this site such as roads, parking and other areas will require 3 treatment stages prior to discharge.

6. SITE-SPECIFIC DRAINAGE DESIGN CONSIDERATIONS

Where SuDS are being designed for sites with steep slopes, careful consideration of site layout planning and SUDS alignment is needed to minimise gradients of conveyance pathways and construction of large embankments, and to minimise flood risk when drainage systems are exceeded.

The design of SuDS with access to temporary or permanent water should consider public health and safety as well as issues associated with construction and operational management of the structures. Health and safety issues and risk mitigation features are presented in the CIRIA SuDS Manual.

Individual SuDS components should not be treated in isolation, but should be seen together as providing a suite of drainage features which are appropriate in different combinations for varying scales. It is always desirable to have a mix of SuDS components across the site as different components have different capacities for treatment of individual pollutants.

7. SuDS CONSTRUCTION

SuDS are a combination of civil engineering structures and landscaping practice. Due to the limited experience of building SuDS in the water industry, there are a number of key issues which need to be particularly considered as their construction requires a change in approach to some standard construction practices.

• SuDS components should be constructed in line with either the manufacturer's guidelines or best practice methods.
• The construction of SuDS usually only requires the use of fairly standard civil engineering construction and landscaping operations, such as excavation, filling, grading, top-soiling, seeding, planting etc. These operations are specified in various standard construction documents, such as the Civil Engineering Specification for the Water Industry (CESWI).
• Construction of soakaways is regulated by the Buildings Regulations part H (Drainage and waste disposal) which sets out the requirements for drainage of rainwater from the roofs of buildings.
• During construction, any surfaces which are intended to enable infiltration must be protected from compaction. This includes protecting from heavy traffic or storage of materials.
• Water contaminated with silt must not be allowed to enter a watercourse or drain as it can cause pollution. All parts of the drainage system must be protected from construction runoff to prevent silt clogging the system and causing pollution downstream. Measures to prevent this include soil stabilisation, early construction of sediment management basins, channelling run-off away from watercourses and surface water drains, and erosion prevention measures.
• After the end of the construction period and prior to handover to the site owner/operator:
  - Subsoil that has been compacted during construction activities should be broken up prior to the re-application of topsoil to garden areas and other areas of public open space to reinstate the natural infiltration performance of the ground;
  - Any areas of the SuDs that have been compacted during construction but are intended to permit infiltration must be completely refurbished;
  - Checks must be made for blockages or partial blockages of orifices or pipe systems;
  - Any silt deposited during the construction must be completely removed;
  - Soils must be stabilised and protected from erosion whilst planting becomes established.

Detailed guidance on the construction related issues for SuDS is available in the SuDS Manual and the associated Construction Site handbook (CIRIA, 2007).

8. SuDS COMPONENTS PERFORMANCE

	Interception	Peak flow control: Low	Peak flow control: High	Volume reduction	Volume control	Gross sediments	Fine sediments	Hydrocarbons/ PAHs	Metals	Nutrients
Rainwater Harvesting	Y	Y	S	Y	N	N	N	N	N	N
Pervious Pavement	Y	Y	Y	Y	Y	Y	Y	Y	Y	Var
Filter Strips	Y	N	N	N	N	Y	N	Y	Y	Var
Swales	Y	Y	S	Y(*)	N	Y	Y(+)	Y	Y	Y(-)
Trenches	Y	Y	S	Y(*)	N	N	N	Y	Y	Y(-)
Detention Basins	Y	Y	Y	N	Y	Y	Y(+)	Y	Y	Var
Ponds	N	Y	Y	N	Y	N(~)	Y	Limited	Y	Var
Wetlands	N	Y	S	N	Y	N(~)	Y	Limited	Y	Y

Green Roofs	Y	Y	N	N	N	N	N	Y	N	N
Bioretention Systems	Y	Y	S	Y(*)	N	N(~)	Y	Y	Y	Y
Proprietary Treatment Systems	N	N	N	N	N	Y	Y	Y(!)	Y(!)	Y(!)
Subsurface Storage	N	Y	Y	N	Y	N(~)	N	N	N	N
Subsurface Conveyance Pipes	N	N	N	N	Y	N(~)	N	N	N	N

Notes:
S: Not normally with standard designs, but possible where space is available and designs mitigate impact of high flow rates.
Y(*): Where infiltration is facilitated by the design.
N(~): Gross sediment retention is possible, but not recommended due to negative maintenance and performance implications.
Y(+): Where designs minimise the risk of fine sediment mobilisation during larger events.
Y(!): Where designs specifically promote the trapping and breakdown of oils and PAH based constitutents.
Y("): Where subsurface soil structure facilitates the trapping and breakdown of oils and PAH based constituents.
Var: The nutrient removal performance is variable, and can be negative in some situations.
Y(-): Good nutrient removal performance where subsurface biofiltration systems with a permanently saturated zone included within the design.

9. GUIDANCE ON THE USE OF INDIVIDUAL COMPONENTS

Rainwater Harvesting

• *Roofs*
Rainwater harvesting systems can be used to effectively drain roofs and provide both water supply and stormwater management benefits.

Pervious Pavement

• *Roofs*
Roof water can be drained into pervious pavement areas using diffusers to dissipate the point inflows. Detailed design of the pavement will need to take account of the additional impermeable roof area.

• *Roads*
Some types of pervious pavement can be used for relatively highly trafficked roads and pavement manufacturers should be consulted on the appropriate specification.

• *Car parks/other impermable surfaces*
Pervious pavements provide effective drainage, storage and treatment of car park surfacing,

• *Steep site*
Pervious pavements can be used on sloping sites, with the use of internal dams in order to attenuate and store the water effectively through a cascade system.

Filter Strips

• *Roads*
Filter strips can provide treatment for road runoff, upstream of swales or trench components. They can reduce the need for kerbing and runoff collection systems.

• *Car parks/other impermable surfaces*
Filter strips can provide treatment for runoff from impermeable surfaces, upstream of swales or trench components. They can reduce the need for kerbing and runoff collection systems.

• *Site size > 50 ha*
The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

• *Steep site*
Filter strips can be used on sloping sites, where implemented parallel to the contours. The consequences of exceedance and flood flow paths will need to be considered.

Swales

• *Roofs*
Swales can be used to convey roof water to other parts of the site.

• *Roads*
Swales provide treatment and conveyance of road runoff. There are a range of swale types - standard grass channels, underdrained swales, and wetland swales - depending on drainage requirements.

• *Car parks/other impermable surfaces*
Swales provide treatment and conveyance of runoff from impermeable areas. There are a range of swale types - standard grass channels, underdrained swales, and wetland swales - depending on drainage requirements.

• *Site size > 50 ha*
The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

• *Steep site*
Swales can be used on sloping sites, where implemented parallel to the contours. The consequences of exceedance and flood flow paths will need to be considered.

Trenches

• *Roofs*
Trenches can be used to convey roof water to other parts of the site.

• *Roads*
Trenches can provide treatment and conveyance of road runoff. They require effective pretreatment to minimise the risk of blockage.

• *Car parks/other impermable surfaces*
Trenches can provide treatment and conveyance of runoff for impermeable areas.

• *Site size > 50 ha*
The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

• *Steep site*
Trenches can be used on sloping sites, where implemented parallel to the contours. The consequences of exceedance and flood flow paths will need to be considered.

Detention Basins

• *Roofs*
Detention basins can be used to attenuate and treat runoff.

• *Roads*
Detention basins can be used to attenuate and treat runoff.

• *Car parks/other impermable surfaces*
Detention basins can be used to attenuate and treat runoff.

• *Site size > 50 ha*
The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria. A risk assessment should be used to determine the maximum appropriate depth of stored water in the basin.

• *Steep site*
Large basins may require embankments that may pose a safety risk to site residents.

Ponds

• *Roofs*
Ponds can be used to attenuate and treat roof runoff.

• *Roads*
Ponds can be used to attenuate and treat runoff. However, they are best implemented at the lower end of the treatment train as a 'polishing' component. They should not be used as sediment management devices, as sediment and wet vegetation is relatively costly to extract and dispose of. If poor quality water remains in ponds for extended periods, nutrient concentrations can rise - particularly in the summer months, and the pond can become unattractive with poor amenity and biodiversity potential.

• *Car parks/other impermable surfaces*
Ponds can be used to attenuate and treat runoff. However, they are best implemented at the lower end of the treatment train as a 'polishing' component. They should not be used as sediment management devices, as sediment and wet vegetation is relatively costly to extract and dispose of. If poor quality water remains in ponds for extended periods, nutrient concentrations can rise - particularly in the summer months, and the pond can become unattractive with poor amenity and biodiversity potential.

• *Site size > 50 ha*
The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

• *Steep site*
Large ponds may require embankments that may pose a safety risk to site residents.

• *Other*
Ponds built in permeable soils will require lining to maintain the water level of the permanent pool. The lining may be finished 100 or 200 mm lower than the outlet invert to encourage some infiltration to take place to contribute to interception.

Wetlands

• *Roofs*
Wetlands can be used to attenuate and treat roof runoff.

• *Roads*
Wetlands can be used to attenuate and treat runoff. However, they are best implemented at the lower end of the treatment train as a 'polishing' component. They should not be used as sediment management devices, as sediment and wet vegetation is relatively costly to extract and dispose of. If poor quality water remains in wetlands for extended periods, nutrient concentrations can rise - particularly in the summer months, and the wetland can become unattractive with poor amenity and biodiversity potential.

• *Car parks/other impermable surfaces*
Wetlands can be used to attenuate and treat runoff. However, they are best implemented at the lower end of the treatment train as a 'polishing' component. They should not be used as sediment management devices, as sediment and wet vegetation is relatively costly to extract and dispose of. If poor quality water remains in wetlands for extended periods, nutrient concentrations can rise - particularly in the summer months, and the wetland can become unattractive with poor amenity and biodiversity potential.

• *Site size > 50 ha*
The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

• *Steep site*
It is likely that wetlands would require embankments that may pose safety risks to site residents.

Green Roofs

• *Roofs*
Green roofs can be designed to provide interception, management and treatment of rainfall up to specified rainfall depths.

Bioretention Systems

• *Roofs*
Bioretention systems can be used to attenuate and treat roof runoff.

• *Roads*
Linear bioretention systems (ie biofiltration swales) can be used to attenuate and treat road runoff.

• *Car parks/other impermable surfaces*
Bioretention systems canbe used for car park drainage.

• *Site size > 50 ha*
Bioretention systems will tend to be suitable for managing small areas only.The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

• *Steep site*
Bioretention systems can be used on sloping sites, when implemented parallel to the contours. The consequences of exceedance and flood flow paths will need to be considered.

Proprietary Treatment Systems

• *Roads*
Proprietary treatment systems can be used where surface vegetated systems are impracticable. However, regular monitoring needs to be ensured so that they are maintained so that they continue to function effectively.

• *Car parks/other impermable surfaces*
Proprietary treatment systems could be used where surface vegetated systems are impracticable. However, regular monitoring needs to be ensured so that they are maintained so that they continue to function effectively.

• *Site size > 50 ha*
Proprietary treatment systems will tend to be suitable for managing small areas only. The size of area that can be drained will be limited by meeting the hydraulic and water quality criteria.

Subsurface Storage

• *Roofs*
Subsurface storage can be used to attenuate roof runoff.

• *Roads*
Subsurface storage can be used to attenuate road runoff.

• *Car parks/other impermable surfaces*
Subsurface storage can be used to attenuate car park runoff.

Subsurface Conveyance Pipes

Appendix 12.7

Site Investigation/Soakaway Report

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GROUND INVESTIGATIONS IRELAND LTD

BOHERBOY SAGGART

GROUND INVESTIGATION REPORT

DOCUMENT CONTROL SHEET

Engineer	Roger Mularkey
Project Title	Boherboy Saggart
Project No	4019-11-13
Document Title	Ground Investigation Report

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Saggart, Boherboy - Ground Investigation Report

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1.0 Preamble

On the instructions of Roger Mularkey Consulting Engineers, a site investigation was carried out by Ground Investigations Ireland Ltd., between the 9th and the 12th of December 2013 on a site in Boherboy, Saggart, Co. Dublin.

2.0 Overview

2.1 Background

The site consists of two greenfield sites which have been combined for the purpose of the proposed development. The site is located on the outskirts of Saggart as shown in the location plan in Appendix 1. It is proposed to develop a portion of the site closest to the road and to construct two and three story residential dwellings. The site slopes from the southern boundary along the road towards the north with the highest point at the south west corner. Earthworks and a retaining wall are proposed along the highest portion of the site to make it more accessible and suitable for construction. There are a series of two large diameter water mains passing through the centre of the site from east to west and a second series of three large diameter water mains along the same axis in the northern portion of the site.

2.2 Purpose and Scope

The purpose of the site investigation was to investigate subsurface soil conditions by means of trial pitting, dynamic probing and slit trenching. The scope of the work undertaken for this project included the following:

- Visit project site to observe existing conditions
- Carry out 8 No. Trial Pit to a maximum depth of 3.5m BGL
- Carry out 6 No. Slit Trenches to a maximum depth of 2.5m BGL
- Carry out 9 No. Dynamic Probes to a maximum depth of 3.3m BGL
- Carry out 4 No. Soakaway tests to BRE Digest 365
- Geotechnical and Environmental Laboratory testing

3.0 <u>Desk Study</u>

3.1 Sources of Information

A desk study has been carried out for the site and the surrounding area to determine the nature of the underlying bedrock geology and overburden materials, relevant geomorphological features, previous land use for the site and to identify any other geotechnical considerations for the area. This study comprised a search of relevant geotechnical, geological and hydrogeological information. The Geological Survey of Ireland (GSI) was consulted for this purpose and the following sources of information were reviewed:

<u>GSI Publications:</u>

- Geology of Kildare Wicklow, GSI, 1994, B. McConnell, M.E. Philcox,

- Bedrock Geology 1:100,000 Scale Map Series, Sheet 16: Kildare - Wicklow.

GSI Online Mapping:

- GSI Drift Geology Maps
- GSI Hydrogeological Mapping
- GSI Groundwater Well Database
- GSI Karst Database
- GSI Quarries Database

In addition, the Ordnance Survey of Ireland (OSI) was also consulted and the following sources of information reviewed.

OSI Online Mapping:

- Historical Mapping – 6 Inch Sheets
- Historical Mapping – 25 Inch Sheets
- Ortho Mapping
- Historical Land Use Mapping Database

3.2 Land Use

The OSI mapping indicates that the site has historically been used as agricultural land. A number of agricultural and/or accommodation buildings are shown on the 6" and 25" Historic Mapping close to the road, with little change from the current site layout. A drain or watercourse is shown on the 25" Mapping feeding into the current watercourse from the west between the two field boundaries. Based on the current

Orthophotographs this section of the drain or watercourse has been in-filled. Caution should be exercised with foundations in area of this in-filled stream. The 1995, 200 and 2005 Orthophotographs show little or no discernable change to the land use in the recent past.

3.3 Superficial Geology

The GSI publications and mapping indicate that the estate and surrounding area is underlain primarily by glacial till derived from Sandstone and Shale. The soils mapping indicates that glacial till derived from Limestone are present to the north of the site and rock outcrops or is very near to the surface to the north and north west of the site, coinciding with areas of extreme groundwater vulnerability and the locations of historic quarries on the historic mapping.

3.4 Regional Bedrock Geology

The site is mapped as being underlain by coarse greywacke & shale of the Pollaphuca Formation. The Calp or Lucan formation is present to the north of the site.

3.5 Hydrogeology

GSI mapping indicates that the bedrock underlying the site (Pollaphuca Formation) is classified as a Poor Aquifer (P) - bedrock which is generally unproductive except only in local zones.

The aquifer vulnerability for the area ranges from Low to Extreme. At the site location, the area is classified as having a Low Vulnerability. An area of Moderate and High Vulnerability is present surrounding the area of the site area. Generally, the High/Extreme Vulnerability areas are close to areas where bedrock is shallow or where sand and gravel deposits are expected and/or there is a thin cover of cohesive material above the bedrock. The Moderate/Low Vulnerability areas are likely to coincide with areas where sufficient thicknesses of cohesive glacial deposits are present above the bedrock or where deeper bedrock is expected.

The GSI Karst database mapping confirms that no karst features are present on or around the site location.

There are no recorded mineral or aggregate extractive licences sites in the immediate vicinity of the site as shown in the GSI Quarries Database, however there are a number of metallic and non-metallic mineral locations in Belgard to the east and in Lugmore to the south east of the site.

4.0 Subsurface Exploration

4.1 General

During the ground investigation in December 2013 a programme of trial pitting, dynamic probing and slit trenching was undertaken to determine the sub surface conditions at the proposed site. Soakway testing was carried out in accordance with BRE Digest 365 to determine the infiltration characteristics of the site. Regular sampling and in-situ testing was undertaken in the trial pits to facilitate the geotechnical descriptions and to enable laboratory testing to be carried out on the soil samples recovered during excavation.

4.2 Trial Pits

Eight trial pits were excavated using a JCB 3 CX at the locations shown in the exploratory hole location plan in Appendix 1. The locations were checked using a CAT scan to minimise the potential for encountering services during the excavation. The trial pits were logged and photographed by a Geotechnical Engineer prior to backfilling with arisings.

The trial pit logs are provided in Appendix 2 of this Report.

4.3 Dynamic Probes

The dynamic probe tests (DPH) were carried out beside the trial pits using Terrier 2000 rig in accordance with B.S. 1377: Part 9 1990. The test consists of mechanically driving a cone with a 50kg weight in 100mm intervals and monitoring the number of blows required. An equivalent Standard Penetration Test (SPT) ‘N’ value may be calculated by dividing the total number of blows over a 300mm drive length by 2. The probes DP1 to DP8 were undertaken adjacent to the trial pits locations while DP9 was carried out beside SP4.

The dynamic probe logs are provided in Appendix 3 of this Report.

4.4 Soakaway Testing

The soakaway pits were excavated to a maximum depth of 2.2m BGL and filled with water to assess the infiltration characteristics of the proposed site. The pits were allowed to drain and the drop in water level recorded over time as required by BRE Digest 365. The pits were logged and photographed prior to completing the soakaway test and were backfilled with arisings and reinstated upon completion.

The soakaway test results are provided in Appendix 4 of this Report.

4.5 Slit Trenching

A number of slit trenches were excavated to determine the line and location of the large diameter water services which cross the site. Some of the trenches were completed as separate excavations to locate the services with minimum disturbance to the ground surface. Each of the services shown on the local authority plans were identified and logged. The services were marked using 6 foot posts and were surveyed by the project topographical surveyors. The line, depth and location of the services located are shown on the plan in Appendix 1.

The slit trench logs are provided in Appendix 5 of this Report.

The above notes outline the procedures used in this site investigation and are in accordance with Eurocode 7 Part 2: Ground Investigation and testing (ISEN 1997 – 2:2007) and B.S. 5930:1999 + A2:2010.

4.6 Laboratory Testing

Samples were selected from the trial pits for a range of geotechnical and chemical testing to assist in the classification of soils and to provide information for the proposed design. Testing consisting of Particle Size Distribution (PSD), moisture content, atterberg limits, CBR and compaction testing were sent to NTML's Geotechnical Laboratory for analysis. Environmental laboratory testing was carried out on samples of soil by Jones Environmental Laboratory in the UK. The results of the laboratory testing is included in Appendix 6 of this Report.

5.0 Ground Conditions

5.1 General

The recommendations given and opinions expressed in this report are based on the findings as detailed in the borehole and trial pit records. Where an opinion is expressed on the material between exploratory hole locations, this is for guidance only and no liability can be accepted for its accuracy. No responsibility can be accepted for conditions which have not been revealed by the exploratory holes.

5.2 Ground Conditions

The ground conditions encountered during the investigation are summarised below with reference to insitu and laboratory test results. The full details of the strata encountered during the ground investigation are provided in the trial pit and dynamic probe records included in the appendices of this report. The sequence of strata encountered are generally consistent across the site and are generally consisted of;

- Topsoil
- Cohesive Deposits
- Granular Deposits

Topsoil: Topsoil was encountered in the majority of exploratory holes and was present to a maximum depth of 0.3m BGL.

Cohesive Deposits: Cohesive deposits were encountered beneath the Topsoil and were quite variable, described typically as brown, grey brown or occasionally as black *slightly sandy slightly gravelly CLAY, slightly gravelly sandy CLAY/SILT, Laminated sandy SILT* and *sandy gravelly slightly organic CLAY*. The strength of the cohesive deposits generally increased with depth and was typically soft or soft to firm at shallow depths increasing to stiff or stiff to very stiff at the base of the majority of the trial pits. These deposits had occasional cobble and rare boulder content where noted on the trial pit logs.

Granular Deposits: Granular deposits were encountered in the trial pits in the south of the site either as lenses within the cohesive deposits or as strata underlying upper cohesive deposits to the base of the trial pits. These deposits were typically described as brown or dark grey *gravelly fine to coarse SAND and clayey sandy sub angular to sub rounded fine to coarse GRAVEL*. These deposits had occasional cobble and rare boulder content where noted on the trial pit logs.

5.3 **Groundwater**

The groundwater strikes were noted during the investigation and were generally encountered as slow seepage at depths between 2.0m and 3.0m BGL. We would point out that these exploratory holes did not remain open for sufficiently long periods of time to establish the hydrogeological regime and groundwater levels would be expected to vary with the time of year, rainfall nearby construction and other factors.

5.4 Soakaway Testing

At the test locations a trial pit was excavated and filled with water to a nominal invert level. The pits were allowed to drain and the rate of fall in water level was monitored to determine the time for the water level to drop from 75% to 25% the pit volume.

Based on the soakaway test results we would recommend that the soakaway design be based on a soil infiltration rate of $f = 1.38 \times 10^{-5}$ m/s in the vicinity of SP1.

The remaining test locations SP2 to SP4, indicate that the ground conditions are not favourable for soakaway design.

5.5 Laboratory Testing

A series of tests were completed on samples collected from the trial pits and were sent to GSTL's geotechnical laboratory in the UK.

The classification test results generally confirm the descriptions on the logs with the primary constituent for the cohesive deposits plotting as a CLAY of low to intermediate plasticity. The Particle Size Distribution tests confirm that generally the cohesive overburden strata have variable clay, silt, sand and gravel content. The granular deposits were generally well graded and had high fines content, typical of the granular glacial till deposits in the region.

Four samples were selected from the boreholes and trial pits and sent to Jones Environmental Laboratories in the UK for a range of contamination testing.

The results were assessed in accordance with European Council Directive 1999 131/EC Article 16 Annex II ‘Criteria and procedures for the acceptance of waste at landfills which lays down guidelines for the classification of waste as “Inert’ ‘Non Hazardous’ and ‘Hazardous’. The results classify the material tested as below the limits for inert waste at Murphy Environmental Landfill in Co. Dublin. Any material removed off site should be disposed of at a suitable licenced facility. The results of this testing can be found at the rear of this report.

6.0 Recommendations and Conclusions

6.1 General

The recommendations given and opinions expressed in this report are based on the findings as detailed in the trial pit records. Where an opinion is expressed on the material between exploratory hole locations, this is for guidance only and no liability can be accepted for its accuracy. No responsibility can be accepted for conditions which have not been revealed by the exploratory holes.

Earthworks are proposed in the south west corner of the site and a retaining wall is proposed to be constructed. The material excavated in this area, based on TP1 and TP2, will be suitable for re-use as landscaping fill within the proposed development. The material has a high fines content and the optimum moisture content is close to or above the natural moisture content. The CBR test results indicate that material reused from excavations will have a CBR value of 2% or below.

The retaining wall should be designed using the approach advocated in BS8002: Code of Practice for Earth Retaining Structures or Eurocode 7: Geotechnical Design. The appropriate design parameters should be determined from the trial pit logs for the depths retained.

Due to the presence of loose granular deposits and/or soft cohesive deposits foundations in the vicinity of TP1, TP2 & TP5 foundations are recommended to be taken to the firm to stiff cohesive deposits, or the medium dense granular deposits at a depth of 2.0m BGL. An allowable bearing capacity of $70kN/m^2$ is recommended at this depth based on the dynamic probe records in Appendix 5. Vibro compaction or other forms of ground improvement may be more economical than deep excavations for foundations, however depending on the proposed development levels and the earthworks proposed in the south west corner of the site, the proposed foundation levels may be more achievable.

An allowable bearing capacity of $70kN/m^2$ is recommended for the foundations at 1.0m BGL on the firm to stiff cohesive deposits in the vicinity of TP3, TP4 & TP6. An increased value of $100kN/m^2$ is recommended at 1.0m BGL for TP7 & TP8. Any soft spots encountered at this depth should be excavated and replaced with lean mix concrete.

Excavations for services which are required to be installed in the water bearing granular deposits may require temporary support and dewatering. Note should be taken of the stability of the trial pits recorded on the logs in Appendix 2.

The recommendations provided in this report should be verified in the design of the proposed buildings, using the full details of the loading conditions and taking into consideration the allowable tolerable settlements/movements that the building can accommodate. The founding strata should be inspected and verified by a suitably qualified engineer prior to construction of the building foundations.

****

TP 1
TP 2
TP 4
TP 5
TP 6
TP 7
TP 8
SP 1
SP 2
SP 3
SP 4
TRENCH 1
TRENCH 2
NCH 3
LAYOUT
Corbally R
Background unavailable
WAYLEAVE FOR SERVICES 1.00 ACRES APPROX
FOR SERVICES 1.23 ACRES APPROX
Meadow
304830, 226365

TRIAL PIT RECORD

Project Name: Saggart, Boherboy — **Hole ID: TP1**

Client: Pinnacle
Consultant: Roger Mullarkey & Associates
Location: Saggart
Date: 09/12/2013
Excavator used: JCB 3CX

Co-ordinates: 304720.00 226091.00
Elevation: 149.930
Project no. 4040-11-13
Logged by: C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests: Type	Samples / tests: Depth	Samples / tests: Result	Water Depth	Date
TOPSOIL		0.30	149.63					
Soft dark brown slightly sandy slightly gravelly CLAY		0.60	149.33					
Firm laminated brown and light brown slightly sandy slightly gravelly CLAY/SILT		0.90	149.03	T	0.90			
Loose brown slightly gravelly fine to medium SAND with lenses of slightly clayey slightly gravelly SAND				B T	1.00 1.00			
				B	2.00			
		2.70	147.23	B	2.70			
Stiff dark brown sandy gravelly CLAY with occasional cobbles and rare boulders				B	3.00			
		3.20	146.73					
End of Trial pit at 3.20 m								

Remarks:
Stability: Stable
Water: Slow seepage at 3.1m bgl
Remarks:

KEY
B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 3.00 × 0.70
Depth: 3.20

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy | **Hole ID: TP2**

Client:	Pinnacle	Co-ordinates:	304727.00 226146.00
Consultant:	Roger Mullarkey & Associates	Elevation:	144.800
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests Type	Samples / tests Depth	Samples / tests Result	Water Depth	Date
TOPSOIL		0.30	144.50					
Soft to firm grey brown slightly sandy slightly gravelly CLAY		0.50	144.30	T	0.50			
Firm grey sandy gravelly slightly organic CLAY		0.90	143.90					
Firm brown sandy gravelly CLAY with occasional cobbles and rare boulders				B	1.00			
				B	2.00			
		2.20	142.60					
Dark grey slightly gravelly fine to coarse SAND (wet)		2.50	142.30	B	2.50			
Stiff black slightly sandy gravelly CLAY with occasional cobbles and rare boulders		2.70	142.10					
End of Trial pit at 2.70 m								

Remarks:

Stability: Collapsing below 1.5m bgl
Water: Slow seepage at 2.0m bgl
Remarks:

KEY
B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 3.00
Depth: 0.70
2.70

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy | **Hole ID: TP3**

Client: Pinnacle
Consultant: Roger Mullarkey & Associates
Location: Saggart
Date: 09/12/2013
Excavator used: JCB 3CX

Co-ordinates: 304802.00 226242.00
Elevation: 137.700
Project no. 4040-11-13
Logged by: C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests Type	Samples / tests Depth	Samples / tests Result	Water Depth	Date
TOPSOIL		0.30	137.40					
Soft to firm brown slightly sandy slightly gravelly CLAY with occasional cobbles and rare boulders				T B LB	1.00 1.00 1.00			
		1.50	136.20					
Firm to stiff brown sligthly sandy gravelly CLAY with occasional cobbles and rare boulders				B	2.00			
		2.20	135.50					
Stiff to very stiff dark brown slightly sandy gravelly CLAY		3.00	134.70	B	3.00			
End of Trial pit at 3.00 m								

Remarks:
Stability: Stable
Water: No groundwater encountered
Remarks:

KEY
B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 3.00 × 0.70
Depth: 3.00

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy | **Hole ID: TP4**

Client:	Pinnacle	Co-ordinates:	304714.00 226270.00
Consultant:	Roger Mullarkey & Associates	Elevation:	134.700
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests Type	Samples / tests Depth	Samples / tests Result	Water Depth	Date
TOPSOIL		0.20	134.50					
Soft orange brown sandy slightly gravelly CLAY		0.30	134.40					
Soft to firm brown slightly sandy slightly gravelly CLAY with occasional cobbles and rare boulders		0.90	133.80					
Firm brown slightly sandy slightly gravelly CLAY with occasional cobbles and rare boulders				T B	1.00 1.00			
		1.50	133.20	LB	1.50			
Medium dense brown clayey sandy sub rounded to sub angular fine to coarse GRAVEL with occasional cobbles and rare boulders		2.70	132.00					
Medium dense to dense brown slighthly sandy clayey sub angular to sub rounded fine to coarse GRAVEL with frequent cobbles (wet)		3.00	131.70	LB	3.00			
End of Trial pit at 3.00 m								

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks:

KEY

B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 3.00
Depth: 0.70
3.00

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy — **Hole ID: TP5**

Client:	Pinnacle	Co-ordinates:	304883.00 226244.00
Consultant:	Roger Mullarkey & Associates	Elevation:	141.630
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests Type	Depth	Result	Water Depth	Date
TOPSOIL		0.30	141.33					
Soft orange brown sandy slightly gravelly CLAY				B	0.70			
		0.80	140.83					
Soft grey brown slightly sandy slightly gravelly CLAY		1.20	140.43					
Soft laminated grey brown sandy CLAY/SILT				B	1.50			
		1.70	139.93					
Soft to firm grey brown slightly gravelly sub fine to medium SAND with occasional lenses of sandy SILT				LB	2.00			
		2.30	139.33					
Medium dense grey brown sandy sub angular to sub rounded fine to coarse GRAVEL with occasional cobbles				LB	3.00			
		3.50	138.13					
End of Trial pit at 3.50 m								

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks:

KEY
B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 3.00 × 0.70
Depth: 3.50

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy — **Hole ID: TP6**

Client:	Pinnacle	Co-ordinates:	304963.00 226248.00
Consultant:	Roger Mullarkey & Associates	Elevation:	139.000
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests: Type	Samples / tests: Depth	Samples / tests: Result	Water Depth	Date
TOPSOIL		0.30	138.70					
Soft to firm brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders				B	0.70			
		1.10	137.90					
Firm to stiff brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders				B	1.50			
		2.00	137.00	LB	2.00			
End of Trial pit at 2.00 m								

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks:

KEY

B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 3.00 × 0.70
Depth: 2.00

TRIAL PIT RECORD

Project Name: Saggart, Boherboy — **Hole ID: TP7**

Client:	Pinnacle	Co-ordinates:	304883.00 226244.00
Consultant:	Roger Mullarkey & Associates	Elevation:	139.390
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests Type	Samples / tests Depth	Result	Water Depth	Date
TOPSOIL		0.30	139.09					
Soft to firm brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders		0.70	138.69					
Stiff brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders				B	1.00			
				T LB	1.50 1.50			
				B	2.00			
		2.60	136.79	B	2.60			
End of Trial pit at 2.60 m								

Depth scale: 1, 2, 3, 4

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks:

KEY

B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 3.00 × 0.70
Depth: 2.60

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy — **Hole ID: TP8**

Client:	Pinnacle	Co-ordinates:	304957.00 226309.00
Consultant:	Roger Mullarkey & Associates	Elevation:	137.000
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests Type	Samples / tests Depth	Result	Water Depth	Date
TOPSOIL		0.30	136.70					
Soft to firm brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders		0.70	136.30	LB	0.70			
Stiff brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders				T	1.00			
		1.50	135.50					
End of Trial pit at 2.00 m								

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks:

KEY

B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 3.00
Depth: 0.70
2.00

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy | **Hole ID: SP1**

Client:	Pinnacle	Co-ordinates:	304814.00 226147.00
Consultant:	Roger Mullarkey & Associates	Elevation:	141.000
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests: Type	Samples / tests: Depth	Samples / tests: Result	Water Depth	Date
TOPSOIL		0.30	140.70					
Soft to firm orange brown slightly sandy gravelly CLAY		0.70	140.30					
Soft brown slightly sandy slightly gravelly CLAY		1.50	139.50					
Brown gravelly fine to coarse SAND		2.00	139.00					
Brown sandy sub angular to sub rounded fine to coarse GRAVEL with occasional cobbles		2.20	138.80					

End of Trial pit at 2.20 m

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks: Soakaway test completed in accordance with BRE365.

KEY

B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 2.50 × 0.70
Depth: 2.20

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy | **Hole ID: SP2**

Client:	Pinnacle	Co-ordinates:	304714.00 262220.00
Consultant:	Roger Mullarkey & Associates	Elevation:	137.000
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests: Type	Depth	Result	Water Depth	Date
TOPSOIL		0.30	136.70					
Soft to firm orange brown slightly sandy gravelly CLAY		0.50	136.50					
Soft brown sandy gravelly CLAY with occasinal cobbles and boulders (damp)		1.50	135.50					
Brown clayey sandy sub angular to sub rounded fine to coarse GRAVEL with occasional cobbles and rare boulders (wet)		1.90	135.10					
End of Trial pit at 1.90 m								

Remarks:

Stability: Collapsing beow 0.5m BGL
Water: Slow groundwater seepage encountered below 2.0m BGL
Remarks: Soakaway test completed in accordance with BRE365.

KEY

B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 2.30 × 0.70
Depth: 1.90

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy — **Hole ID: SP3**

Client:	Pinnacle	Co-ordinates:	304939.00 226195.00
Consultant:	Roger Mullarkey & Associates	Elevation:	141.500
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests: Type	Samples / tests: Depth	Samples / tests: Result	Water Depth	Date
TOPSOIL		0.30	141.20					
Soft to firm brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders		1.00	140.50					
Firm to stiff grey brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders		2.00	139.50					
End of Trial pit at 2.00 m								

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks: Soakaway test completed in accordance with BRE365.

KEY

B	Bulk disturbed sample.
D	Small disturbed sample
U	Undisturbed sample

Dimensions: 2.20 x 0.70

Depth: 2.00

GROUND INVESTIGATIONS IRELAND

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy | **Hole ID: SP4**

Client:	Pinnacle	Co-ordinates:	304886.00 226304.00
Consultant:	Roger Mullarkey & Associates	Elevation:	138.000
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests: Type	Samples / tests: Depth	Samples / tests: Result	Water Depth	Date
TOPSOIL		0.30	137.70					
Soft to firm brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders		1.20	136.80					
Firm to stiff grey brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders		2.10	135.90					
End of Trial pit at 2.10 m								

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks: Soakaway test completed in accordance with BRE365.

KEY

B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 2.30 x 0.70
Depth: 2.10

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Soakaway Test

Saggart Soakaway Testing

SP01

Soakaway Test to BRE Digest 365

The Trial Pit was filled with water to 0.7m BGL and the drop in water level with time was recorded below.
*Note: Effective length of pit includes conservative correction for sloping end wall

Date	Elapsed Time	Mins	Fall of Water (m)
09/12/2013	12.17	0	-0.7
09/12/2013	12.23	6	-0.78
09/12/2013	12.31	14	-0.83
09/12/2013	12.54	37	-0.95
09/12/2013	13.12	55	-1.02
09/12/2013	13.20	63	-1.05
09/12/2013	14.32	135	-1.23
09/12/2013	16.45	268	-1.55

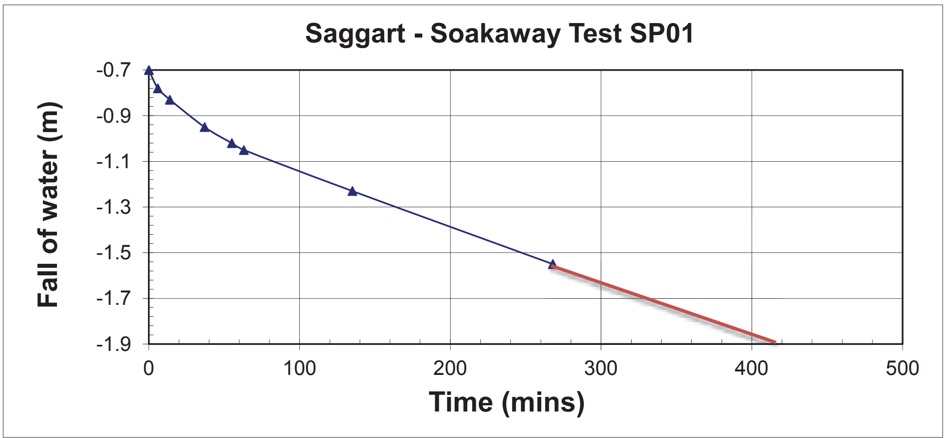
Start depth to water	**Depth of Hole**	**Δ [m]**	**75% full**	**25% full**	
0.70	2.200	1.500	**1.075**	**1.825**	**m bgl**

Effective length of pit (m)*	**Width of pit (m)**	**75-25H_t (m)**	**Vp_{75-25} (m^3)**
2.000	0.700	0.750	**1.05**

Effective length of pit (m)*	**Width of pit (m)**	**50% Eff Depth**	**Ap_{50} (m^2)**
2.000	0.700	0.375	**3.95**

tp_{75-25} seconds (from graph) **19200**

f = 1.38E-05 m/s



SP2

Soakaway Test to BRE Digest 365

The Trial pit was filled with water to 0.94m BGL and the drop in water level with time was recorded below.

Elapsed Time Minutes	**Water Level mBGL**	**Remarks**
0	0.94	Hole filled with water
6	0.92	
20	0.89	
50	0.88	
90	0.87	
150	0.86	
210	0.85	Test Failed

Water level is rising due to location of soakaway at the base of a hill. This Soakaway failed.

SP3

Soakaway Test to BRE Digest 365

The Trial pit was filled with water to 0.61m BGL and the drop in water level with time was recorded below.

Elapsed Time Minutes	**Water Level mBGL**	**Remarks**
0	0.55	Hole filled with water
48	0.61	
98	0.65	
173	0.69	
220	0.77	Test Failed

Test failed due to insufficient drop in water level to calculate infiltration value.

SP4

Soakaway Test to BRE Digest 365

The Trial pit was filled with water to 0.5m BGL and the drop in water level with time was recorded below.

Elapsed Time Minutes	**Water Level mBGL**	**Remarks**
0	0.5	Hole filled with water
20	0.55	
98	0.6	
173	0.68	
220	0.75	Test Failed

Test failed due to insufficient drop in water level to calculate infiltration value.

Soil Map

Map center: 305041, 226438

Legend

Quaternary

TLs — Till derived from Limestone

TLPSsS — Till derived from Sandstone

Bedrock

Map center: 305200, 226234

Minerals and Quarries

Map center: 305200, 226234

Legend

Mineral Localities

- Both
- Metallic
- Non-metallic

Quarries (Active 2001)

- Mine
- Pit
- Quarry
- Quarry&Pit

Irish National Seabed Survey Zones (50m-5000m)

Irish Designated Seabed Zone

Bathymetry

Bedrock Aquifer

Map center: 305200, 226234

Legend

Mineral Localities

- Both
- Metallic
- Non-metallic

Quarries (Active 2001)

- Mine
- Pit
- Quarry
- Quarry&Pit

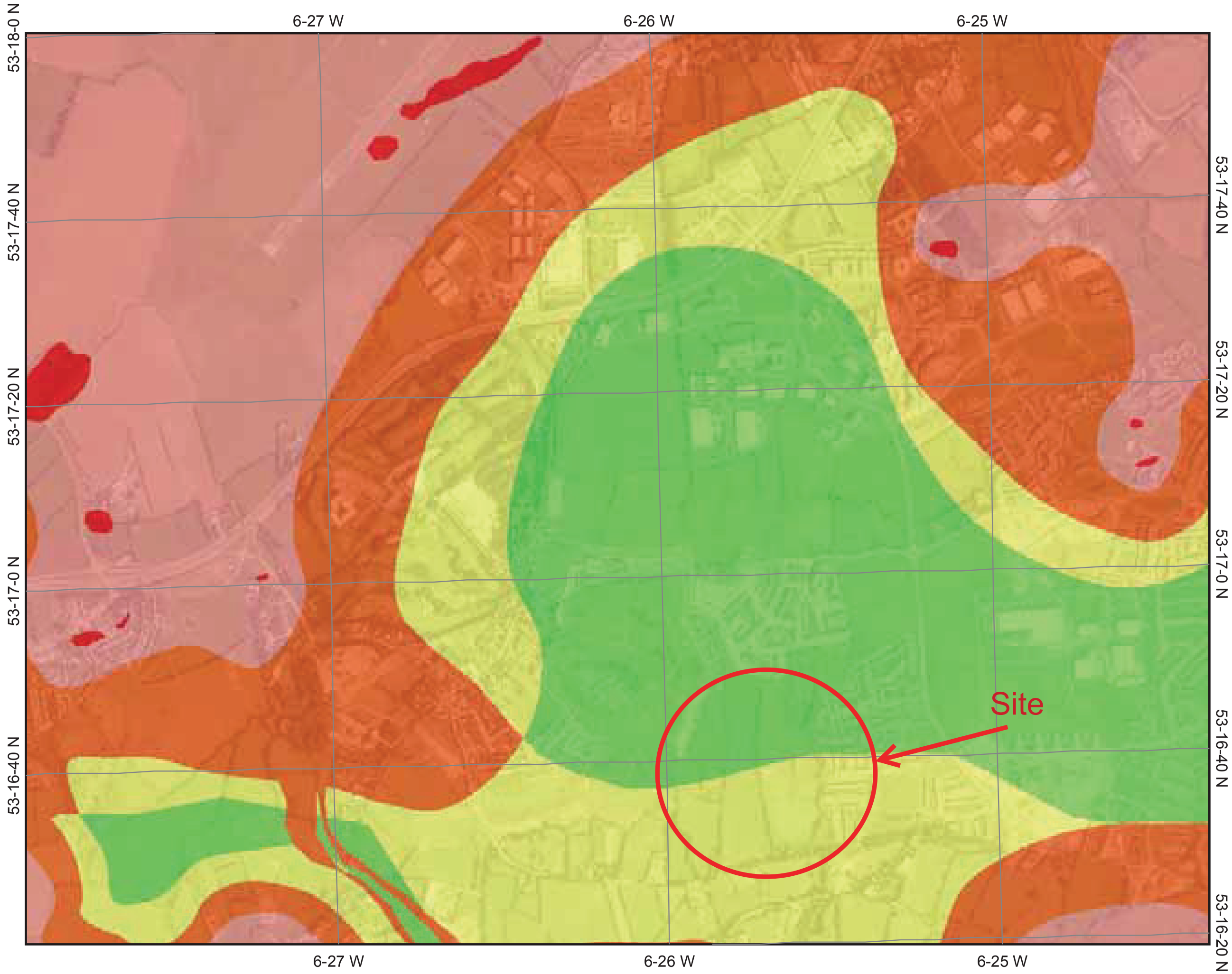
National Draft Bedrock Aquifer Map

- Rf - Regionally Important Aquifer - Fissured bedrock
- Rk - Regionally Important Aquifer - Karstified
- Rkd - Regionally Important Aquifer - Karstified (diffuse)
- Rkc - Regionally Important Aquifer - Karstified (conduit)
- Lm - Locally Important Aquifer - Bedrock which is Generally Moderately Productive
- Lk - Locally Important Aquifer - Karstified
- Ll - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- Pl - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
- Pu - Poor Aquifer - Bedrock which is Generally Unproductive
- Unclassified

Irish National Seabed Survey Zones (50m-5000m)

Irish Designated Seabed Zone

Aquifer Vunribility



Map center: 304329, 227328

Legend

Vulnerability

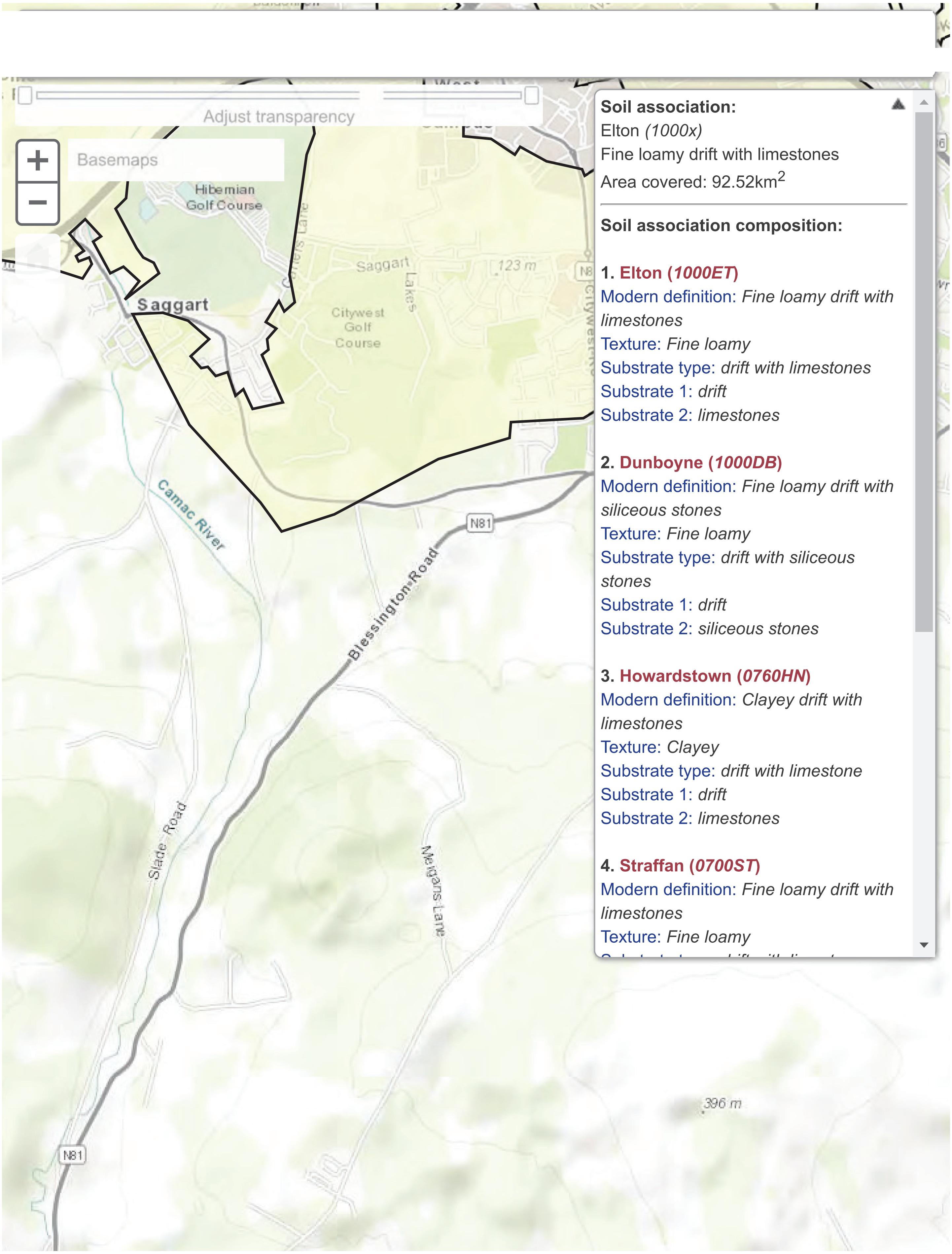
- X (Rock near Surface or Karst)
- E - Extreme
- H - High
- M - Moderate
- L - Low
- Water
- Irish National Seabed Survey Zones (50m-5000m)
- Irish Designated Seabed Zone
- Bathymetry

Karst

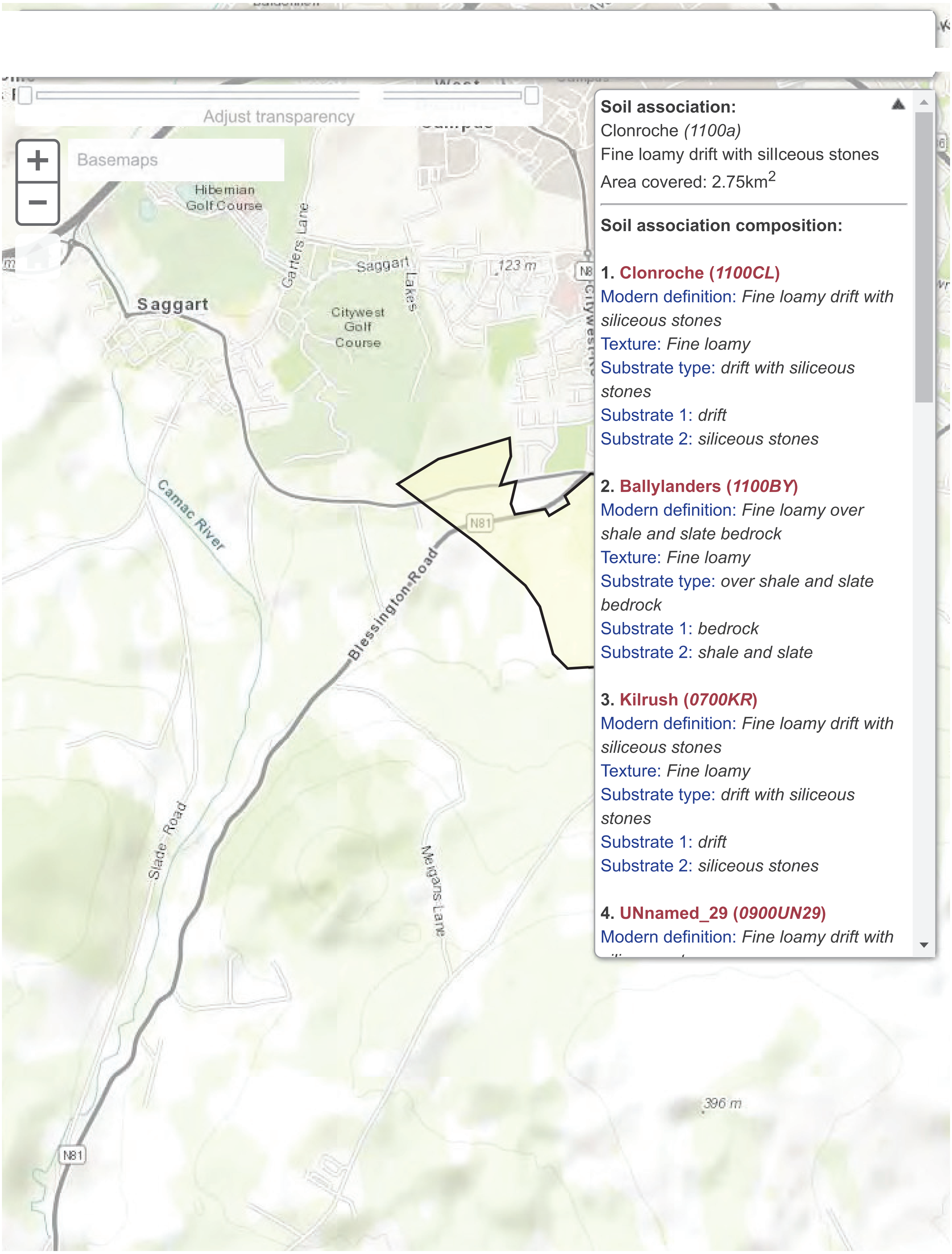

6-26-30 W
6-26-0 W
6-25-30 W
6-25-0 W
6-24-30 W
6-24-0 W
53-17-0 N
53-16-40 N
53-16-20 N
53-16-0 N
Site
Map center: 305200, 226234
Legend
Karst Features
Borehole
Cave
Dry Valley
Enclosed Depression
Estevelle
Spring
Superficial Solution Features
Swallow Hole
Turlough
Irish National Seabed Survey Zones (50m-5000m)
Irish Designated Seabed Zone
Bathymetry

Appendix 12.8

GSI Data


Adjust transparency
Basemaps
Hibernian Golf Course
Saggart
Saggart Lakes
Citywest Golf Course
123 m
Citywest Rd
N81
Camac River
Blessington Road
Slade Road
Meigans Lane
396 m
N81
Soil association:
Elton (1000x)
Fine loamy drift with limestones
Area covered: 92.52km2
Soil association composition:
1. Elton (1000ET)
Modern definition: Fine loamy drift with limestones
Texture: Fine loamy
Substrate type: drift with limestones
Substrate 1: drift
Substrate 2: limestones
2. Dunboyne (1000DB)
Modern definition: Fine loamy drift with siliceous stones
Texture: Fine loamy
Substrate type: drift with siliceous stones
Substrate 1: drift
Substrate 2: siliceous stones
3. Howardstown (0760HN)
Modern definition: Clayey drift with limestones
Texture: Clayey
Substrate type: drift with limestone
Substrate 1: drift
Substrate 2: limestones
4. Straffan (0700ST)
Modern definition: Fine loamy drift with limestones
Texture: Fine loamy

0 0.3 0.6km



Soil association:
Clonroche *(1100a)*
Fine loamy drift with sillceous stones
Area covered: 2.75km^2

Soil association composition:

1. Clonroche (*1100CL*)
Modern definition: *Fine loamy drift with siliceous stones*
Texture: *Fine loamy*
Substrate type: *drift with siliceous stones*
Substrate 1: *drift*
Substrate 2: *siliceous stones*

2. Ballylanders (*1100BY*)
Modern definition: *Fine loamy over shale and slate bedrock*
Texture: *Fine loamy*
Substrate type: *over shale and slate bedrock*
Substrate 1: *bedrock*
Substrate 2: *shale and slate*

3. Kilrush (*0700KR*)
Modern definition: *Fine loamy drift with siliceous stones*
Texture: *Fine loamy*
Substrate type: *drift with siliceous stones*
Substrate 1: *drift*
Substrate 2: *siliceous stones*

4. UNnamed_29 (*0900UN29*)
Modern definition: *Fine loamy drift with*

0 0.3 0.6km

SERIES: ELTON (1000ET) - REPRESENTATIVE PROFILE DESCRIPTION - **PDF version available**

Reference profile: RPS36RC18
Weather: Overcast

TOPOGRAPHY
Position: Middle slope
Form: Straight
Aspect: SW

PARENT MATERIAL
Substrate type: Drift
Substrate subgroup: Limestones

TEXTURAL CRITERIA
Texture 1: Fine loamy
Texture 2: -

LAND USE
Land use: Grassland improved
Human technologies: Slurry applications

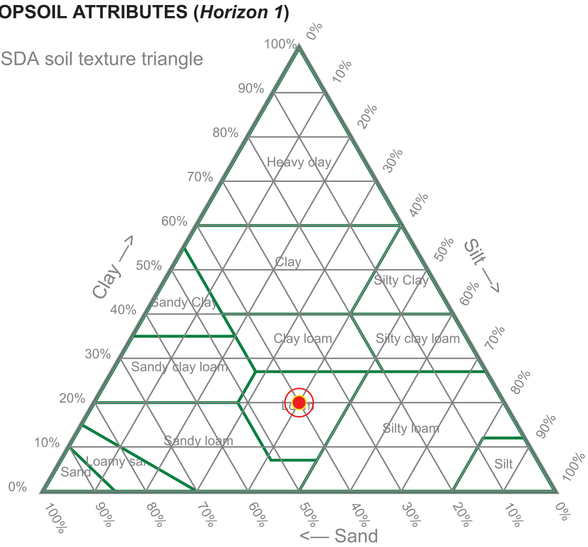
ROCK OUTCROPS None (0 %)

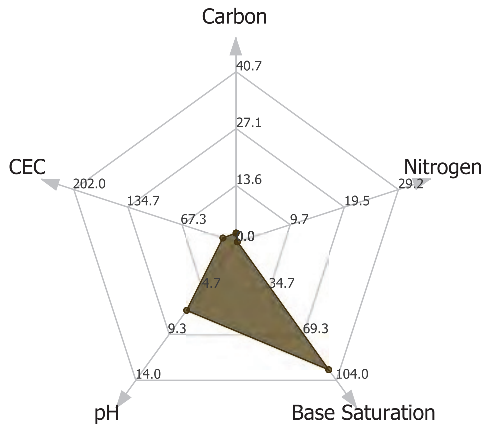
SURFACE STONE None (0 %)

IRISH CLASSIFICATION (2013)
Soil subgroup: 1000 Typical Luvisols
National Soil Series: Elton
Definition: Fine loamy drift with limestones

Download a PDF version of this profile description here

TOPSOIL ATTRIBUTES (*Horizon 1*)





Horizon 1: 0 - 25 cm

Humose: No
Matrix colour (moist): 10YR43
Texture: Fine loamy

Stones (% total): Few (2-5 %)
Stones details: Fine gravels (2-6 mm)
Stickiness: Sticky

HCL reaction: No reaction
Packing density: Medium
Plasticity: Slightly plastic

TOTAL %
Nitrogen: 0.24
Carbon: 2.21
Organic carbon: 1.94
Loss on ignition: -

PARTICLE SIZE %
Sand: 40%
Silt: 40%
Clay: 20%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.90

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.10
K: 0.17
Mg: 0.80
Ca: 14.69

CEC (cmol kg^{-1}): 16.46
Base saturation: 96%

Horizon 2: 25 - 60 cm

Humose: No
Matrix colour (moist): 75YR44
Texture: Fine loamy

Stones (% total): Common (5-15 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Very sticky

HCL reaction: No reaction
Packing density: Medium
Plasticity: Very plastic

TOTAL %
Nitrogen: 0.08
Carbon: 0.78
Organic carbon: 0.57
Loss on ignition: -

PARTICLE SIZE %
Sand: 37%
Silt: 37%
Clay: 26%

Textural Class (USDA): Loam
Bulk density: -
pH: 7.37

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})

CEC (cmol kg^{-1}): 9.42

Na:	0.08	**Base saturation:**	100%
K:	0.10		
Mg:	0.79		
Ca:	8.86		

Horizon 3: 60 - 120 cm

Humose:	No	**Stones (% total):**	Abundant (40-80 %)	**HCL reaction:**	Extremely strong (thick foam)
Matrix colour (moist):	10YR54	**Stones details:**	Medium gravels (6mm -2 cm)	**Packing density:**	High
Texture:	Coarse loamy	**Stickiness:**	Slightly sticky	**Plasticity:**	Non-plastic

TOTAL %		**PARTICLE SIZE %**			
Nitrogen:	0.01	**Sand:**	57%	**Textural Class (USDA):**	Sandy Loam
Carbon:	7.75	**Silt:**	29%	**Bulk density:**	-
Organic carbon:	0.25	**Clay:**	14%	**pH:**	8.56
Loss on ignition:	-				

EXCHANGEABLE COMPLEX

Exchangeable Bases (cmol kg^{-1})		**CEC (cmol kg^{-1}):**	8.63
Na:	0.08	**Base saturation:**	100%
K:	0.05		
Mg:	0.51		
Ca:	32.03		

SERIES: CLONROCHE (1100CL) - REPRESENTATIVE PROFILE DESCRIPTION - **PDF version available**

Reference profile: RPS62RC04
Weather: Overcast

TOPOGRAPHY
Position: Lower slope
Form: Straight
Aspect:

PARENT MATERIAL
Substrate type: Drift
Substrate subgroup: Siliceous stones

TEXTURAL CRITERIA
Texture 1: Fine loamy
Texture 2: -

LAND USE
Land use: Grassland improved
Human technologies: Fertilizer applications

ROCK OUTCROPS None (0 %)

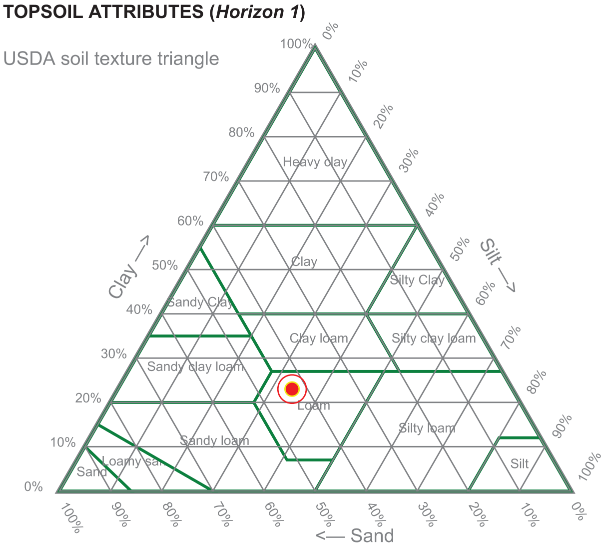
SURFACE STONE None (0 %)

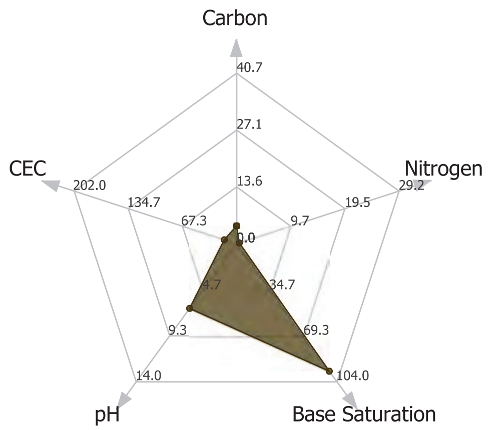
IRISH CLASSIFICATION (2013)
Soil subgroup: 1100 Typical Brown Earths
National Soil Series: Clonroche
Definition: Fine loamy drift with siliceous stones

Download a PDF version of this profile description here

TOPSOIL ATTRIBUTES (*Horizon 1*)

USDA soil texture triangle





Horizon 1: 0 - 21 cm

Humose: No
Matrix colour (moist): 10YR43
Texture: Fine loamy

Stones (% total): - (-)
Stones details: - (-)
Stickiness: Slightly sticky

HCL reaction: No reaction
Packing density: Low
Plasticity: Plastic

TOTAL %
Nitrogen: 0.48
Carbon: 4.27
Organic carbon: 3.57
Loss on ignition: -

PARTICLE SIZE %
Sand: 43%
Silt: 34%
Clay: 23%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.55

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.13
K: 0.59
Mg: 1.67
Ca: 12.35

CEC (cmol kg^{-1}): 15.30
Base saturation: 96%

Horizon 2: 21 - 48 cm

Humose: No
Matrix colour (moist): 10YR44
Texture: Fine loamy

Stones (% total): Common (5-15 %)
Stones details: - (-)
Stickiness: Sticky

HCL reaction: No reaction
Packing density: Low
Plasticity: Plastic

TOTAL %
Nitrogen: 0.29
Carbon: 2.42
Organic carbon: 1.40
Loss on ignition: -

PARTICLE SIZE %
Sand: 40%
Silt: 35%
Clay: 25%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.54

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})

CEC (cmol kg^{-1}): 9.63

Na: 0.14
K: 0.63
Mg: 1.26
Ca: 6.29

Base saturation: 86%

Horizon 3: 48 - 75 cm

Humose: No
Matrix colour (moist): 10YR44
Texture: Fine loamy

Stones (% total): Many (15-40 %)
Stones details: Coarse gravels (2-6 cm)
Stickiness: Sticky

HCL reaction: No reaction
Packing density: Low
Plasticity: Plastic

TOTAL %
Nitrogen: 0.18
Carbon: 1.23
Organic carbon: 0.80
Loss on ignition: -

PARTICLE SIZE %
Sand: 35%
Silt: 41%
Clay: 24%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.50

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.10
K: 0.42
Mg: 1.14
Ca: 4.19

CEC (cmol kg^{-1}): 8.05
Base saturation: 73%

Horizon 4: 75 - 100 cm

Humose: No
Matrix colour (moist): 25Y54
Texture: Fine loamy

Stones (% total): Many (15-40 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Sticky

HCL reaction: No reaction
Packing density: Medium
Plasticity: Plastic

TOTAL %
Nitrogen: 0.06
Carbon: 0.32
Organic carbon: 0.18
Loss on ignition: -

PARTICLE SIZE %
Sand: 53%
Silt: 33%
Clay: 14%

Textural Class (USDA): Sandy Loam
Bulk density: -
pH: 6.53

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.23
Mg: 0.65
Ca: 1.82

CEC (cmol kg^{-1}): 4.35
Base saturation: 64%

SERIES: BALLYLANDERS (1100BY) - REPRESENTATIVE PROFILE DESCRIPTION - **PDF version available**

Reference profile: RPS62RC05
Weather: Overcast

TOPOGRAPHY
Position: Middle slope
Form: Straight
Aspect: NNE

PARENT MATERIAL
Substrate type: Bedrock
Substrate subgroup: Shale/slate

TEXTURAL CRITERIA
Texture 1: Fine loamy
Texture 2: -

LAND USE
Land use: Grassland improved
Human technologies: Fertilizer applications

ROCK OUTCROPS None (0 %)

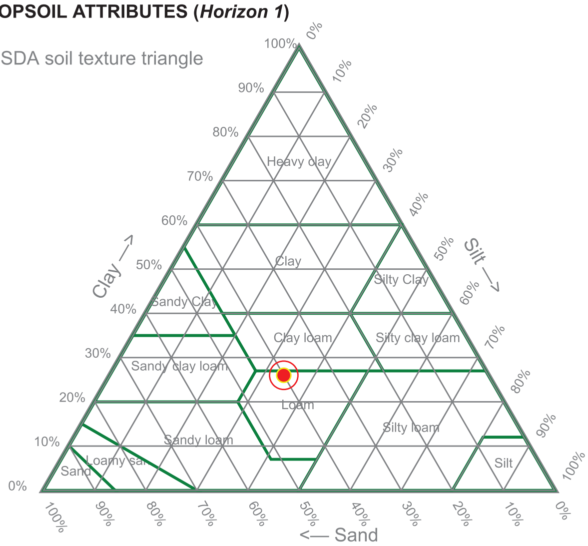
SURFACE STONE Common (5-15 %)

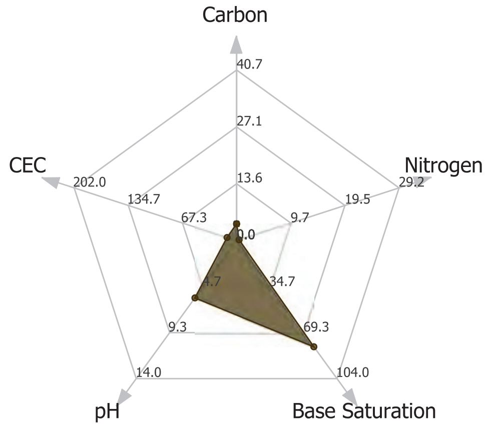
IRISH CLASSIFICATION (2013)
Soil subgroup: 1100 Typical Brown Earths
National Soil Series: Ballylanders
Definition: Fine loamy over shale and slate bedrock

Download a PDF version of this profile description here

TOPSOIL ATTRIBUTES (*Horizon 1*)

USDA soil texture triangle





Horizon 1: 0 - 25 cm

Humose: No
Matrix colour (moist): 10YR44
Texture: Fine loamy

Stones (% total): Common (5-15 %)
Stones details: Coarse gravels (2-6 cm)
Stickiness: Slightly sticky

HCL reaction: No reaction
Packing density: Low
Plasticity: Slightly plastic

TOTAL %
Nitrogen: 0.45
Carbon: 3.99
Organic carbon: 2.81
Loss on ignition: -

PARTICLE SIZE %
Sand: 40%
Silt: 34%
Clay: 26%

Textural Class (USDA): Loam
Bulk density: -
pH: 5.81

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.14
Mg: 0.68
Ca: 8.62

CEC (cmol kg^{-1}): 11.86
Base saturation: 80%

Horizon 2: 25 - 45 cm

Humose: No
Matrix colour (moist): 75YR44
Texture: Fine loamy

Stones (% total): Many (15-40 %)
Stones details: Stones (6-20 cm)
Stickiness: Slightly sticky

HCL reaction: No reaction
Packing density: Low
Plasticity: Slightly plastic

TOTAL %
Nitrogen: 0.23
Carbon: 2.02
Organic carbon: 1.14
Loss on ignition: -

PARTICLE SIZE %
Sand: 43%
Silt: 36%
Clay: 21%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.11

EXCHANGEABLE COMPLEX

Exchangeable Bases (cmol kg^{-1}) **CEC (cmol kg^{-1}):** 6.31

Na:	0.08	**Base saturation:**	84%
K:	0.05		
Mg:	0.63		
Ca:	4.55		

Horizon 3: 45 - 75 cm

Humose:	No	**Stones (% total):**	Many (15-40 %)	**HCL reaction:**	-
Matrix colour (moist):	5YR44	**Stones details:**	Stones (6-20 cm)	**Packing density:**	Medium
Texture:	Fine loamy	**Stickiness:**	-	**Plasticity:**	-

TOTAL %		**PARTICLE SIZE %**			
Nitrogen:	0.17	**Sand:**	49%	**Textural Class (USDA):**	Loam
Carbon:	1.80	**Silt:**	34%	**Bulk density:**	-
Organic carbon:	0.89	**Clay:**	17%	**pH:**	6.13
Loss on ignition:	-				

EXCHANGEABLE COMPLEX

Exchangeable Bases (cmol kg^{-1}) **CEC (cmol kg^{-1}):** 7.19

Na:	0.08	**Base saturation:**	49%
K:	0.03		
Mg:	0.45		
Ca:	2.92		

Horizon 4: 75 - 85 cm

Humose:	No	**Stones (% total):**	Abundant (40-80 %)	**HCL reaction:**	-
Matrix colour (moist):	10YR44	**Stones details:**	Boulders (20-60 cm)	**Packing density:**	Medium
Texture:	Fine loamy	**Stickiness:**	Sticky	**Plasticity:**	Plastic

TOTAL %		**PARTICLE SIZE %**			
Nitrogen:	0.14	**Sand:**	59%	**Textural Class (USDA):**	Sandy Loam
Carbon:	1.41	**Silt:**	32%	**Bulk density:**	-
Organic carbon:	0.48	**Clay:**	9%	**pH:**	6.15
Loss on ignition:	-				

EXCHANGEABLE COMPLEX

Exchangeable Bases (cmol kg^{-1}) **CEC (cmol kg^{-1}):** 4.34

Na:	0.08	**Base saturation:**	51%
K:	0.02		
Mg:	0.24		
Ca:	1.89		

SERIES: DUNBOYNE (1000DB) - REPRESENTATIVE PROFILE DESCRIPTION - **PDF version available**

Reference profile: RPR30BR02
Weather: Overcast

TOPOGRAPHY
Position: Upper slope
Form: Convex
Aspect: SSW

PARENT MATERIAL
Substrate type: Drift
Substrate subgroup: Siliceous stones

TEXTURAL CRITERIA
Texture 1: Fine loamy
Texture 2: -

LAND USE
Land use: Grassland improved
Human technologies: Fertilizer applications

ROCK OUTCROPS None (0 %)

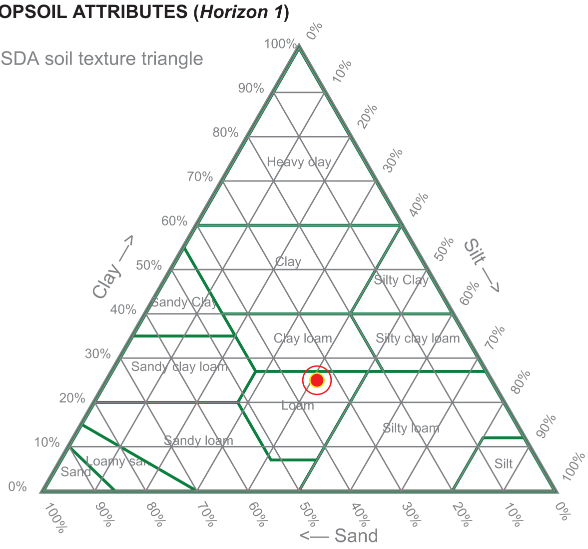
SURFACE STONE None (0 %)

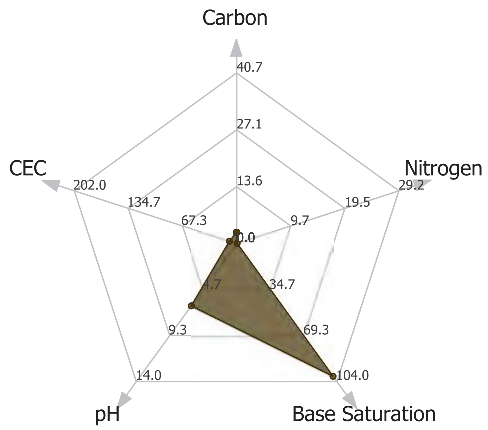
IRISH CLASSIFICATION (2013)
Soil subgroup: 1000 Typical Luvisols
National Soil Series: Dunboyne
Definition: Fine loamy drift with siliceous stones

Download a PDF version of this profile description here

TOPSOIL ATTRIBUTES (*Horizon 1*)

USDA soil texture triangle





Horizon 1: 0 - 22 cm

Humose: No
Matrix colour (moist): 10YR44
Texture: Coarse loamy

Stones (% total): Common (5-15 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Non-sticky

HCL reaction: No reaction
Packing density: High
Plasticity: Non-plastic

TOTAL %
Nitrogen: 0.09
Carbon: 2.68
Organic carbon: 2.02
Loss on ignition: -

PARTICLE SIZE %
Sand: 34%
Silt: 41%
Clay: 25%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.32

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.16
Mg: 0.65
Ca: 8.39

CEC (cmol kg^{-1}): 8.90
Base saturation: 100%

Horizon 2: 22 - 35 cm

Humose: No
Matrix colour (moist): 5YR56
Texture: Fine loamy

Stones (% total): Common (5-15 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Non-sticky

HCL reaction: No reaction
Packing density: Medium
Plasticity: Non-plastic

TOTAL %
Nitrogen: 0.08
Carbon: 0.83
Organic carbon: 0.38
Loss on ignition: -

PARTICLE SIZE %
Sand: 32%
Silt: 46%
Clay: 22%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.23

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})

CEC (cmol kg^{-1}): 4.56

Na: 0.08
K: 0.03
Mg: 0.26
Ca: 3.45

Base saturation: 84%

Horizon 3: 35 - 60 cm

Humose: No
Matrix colour (moist): 75YR56
Texture: Fine loamy

Stones (% total): Common (5-15 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Non-sticky

HCL reaction: No reaction
Packing density: High
Plasticity: Slightly plastic

TOTAL %
Nitrogen: 0.08
Carbon: 0.47
Organic carbon: 0.24
Loss on ignition: -

PARTICLE SIZE %
Sand: 27%
Silt: 46%
Clay: 27%

Textural Class (USDA): Clay Loam
Bulk density: -
pH: 6.33

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.05
Mg: 0.26
Ca: 3.13

CEC (cmol kg^{-1}): 3.74
Base saturation: 94%

Horizon 4: 60 - 85 cm

Humose: No
Matrix colour (moist): 10YR58
Texture: Coarse loamy

Stones (% total): Common (5-15 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Non-sticky

HCL reaction: No reaction
Packing density: Low
Plasticity: Slightly plastic

TOTAL %
Nitrogen: 0.08
Carbon: 0.37
Organic carbon: 0.19
Loss on ignition: -

PARTICLE SIZE %
Sand: 66%
Silt: 21%
Clay: 13%

Textural Class (USDA): Sandy Loam
Bulk density: -
pH: 6.35

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.07
Mg: 0.29
Ca: 3.18

CEC (cmol kg^{-1}): 3.65
Base saturation: 99%

Horizon 5: 85 - 100 cm

Humose: No
Matrix colour (moist): 75YR53
Texture: Coarse loamy

Stones (% total): Common (5-15 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Non-sticky

HCL reaction: No reaction
Packing density: Very High
Plasticity: Plastic

TOTAL %
Nitrogen: 0.37
Carbon: 0.18
Organic carbon: 0.10
Loss on ignition: -

PARTICLE SIZE %
Sand: 35%
Silt: 42%
Clay: 23%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.30

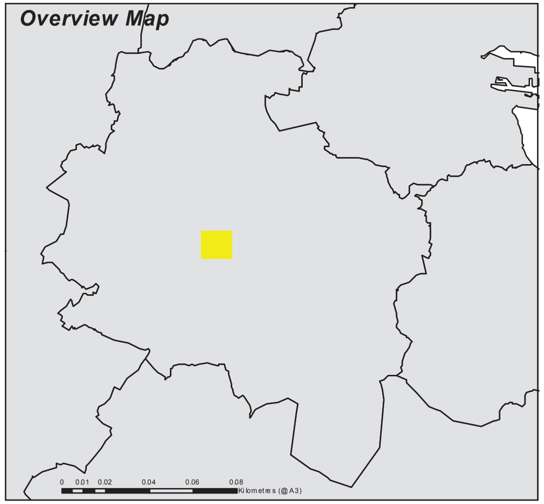
EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.14
Mg: 0.30
Ca: 3.53

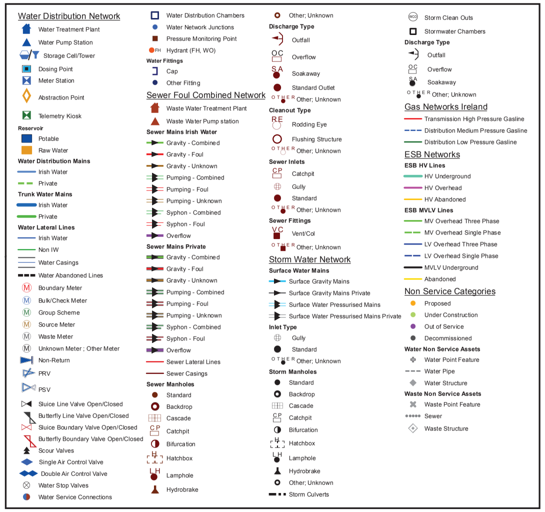
CEC (cmol kg^{-1}): 3.25
Base saturation: 100%

Appendix 12.9

SDCC/IW Records Drawings

IWGIS Water Utilities Network





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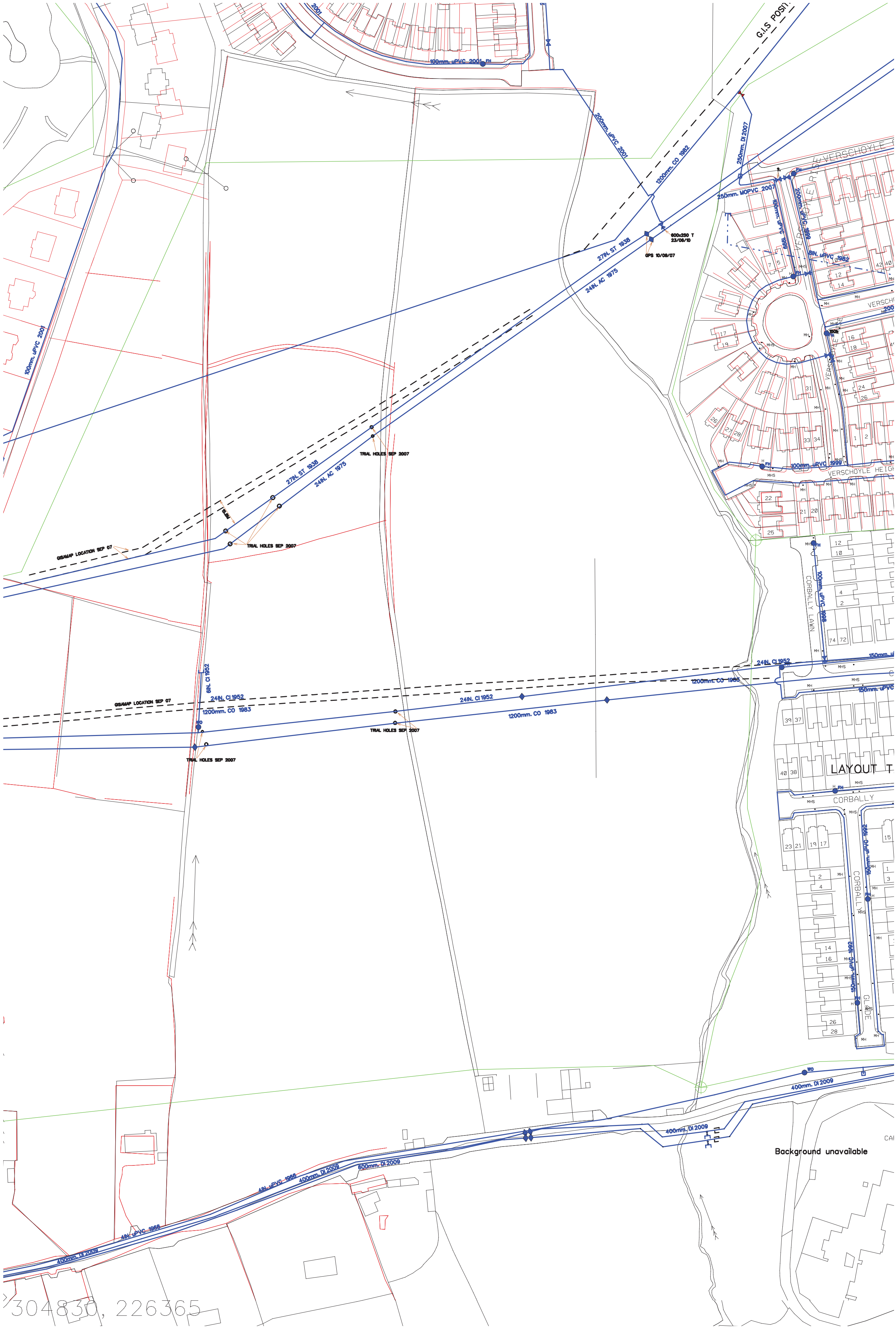
2. Whilst every care has been taken in its compilation, Irish Water gives this information as to the position of its underground network as a general guide only on the strict understanding that it is based on the best available information provided by each Local Authority in Ireland to Irish Water. Irish 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.

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

UISCE ÉIREANN : IRISH WATER

Print Date: 17/02/2020

Printed by: cbolger



N

Legend:

- Sluice Valve
- Pressure Reducing Valve
- Meter
- Bulk Meter
- Hydrant
- Cap End
- Air Valve
- Stop Tap
- Existing Main
- Proposed Abandoned Main

Aug 08 2013

Scale: 1:2000

South Dublin County Council gives this information as to the position of its underground apparatus by way of general guidance only on the strict understanding that it is based on the best information available and no warranty as to its correctness is relied upon in the event of excavations or other works made in vicinity of the Companys apparatus and any onus of locating the apparatus before carrying out any excavations rests entirely on you.

Service Pipes are not generally shown but their presence should be anticipated.

EXACT LOCATIONS OF ALL APPARATUS TO BE DETERMINED ON SITE.

Appendix 12.10

Met Eireann Data

Met Eireann

Return Period Rainfall Depths for sliding Durations

Irish Grid: Easting: 304775, Northing: 226378,

	Interval		Years													
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.6,	3.9,	4.6,	5.7,	6.4,	7.0,	8.9,	11.2,	12.7,	14.9,	16.9,	18.4,	20.9,	22.8,	24.4,	N/A ,
10 mins	3.7,	5.4,	6.4,	7.9,	8.9,	9.7,	12.4,	15.6,	17.7,	20.8,	23.5,	25.7,	29.1,	31.7,	34.0,	N/A ,
15 mins	4.3,	6.4,	7.5,	9.3,	10.5,	11.4,	14.6,	18.3,	20.8,	24.4,	27.7,	30.2,	34.2,	37.3,	39.9,	N/A ,
30 mins	5.7,	8.4,	9.8,	12.1,	13.6,	14.9,	18.9,	23.6,	26.8,	31.3,	35.4,	38.6,	43.6,	47.5,	50.8,	N/A ,
1 hours	7.5,	11.0,	12.9,	15.8,	17.8,	19.3,	24.5,	30.4,	34.4,	40.1,	45.3,	49.3,	55.5,	60.4,	64.5,	N/A ,
2 hours	10.0,	14.4,	16.9,	20.6,	23.1,	25.1,	31.7,	39.2,	44.3,	51.5,	57.9,	63.0,	70.8,	76.9,	82.0,	N/A ,
3 hours	11.7,	16.9,	19.7,	24.0,	26.9,	29.2,	36.8,	45.5,	51.3,	59.5,	66.9,	72.7,	81.6,	88.6,	94.4,	N/A ,
4 hours	13.2,	18.9,	22.1,	26.8,	30.1,	32.6,	41.0,	50.6,	56.9,	66.0,	74.1,	80.5,	90.3,	97.9,	104.3,	N/A ,
6 hours	15.5,	22.2,	25.8,	31.3,	35.1,	38.0,	47.6,	58.6,	66.0,	76.4,	85.6,	92.9,	104.1,	112.8,	120.1,	N/A ,
9 hours	18.3,	26.0,	30.2,	36.6,	40.9,	44.3,	55.4,	68.1,	76.5,	88.3,	99.0,	107.2,	120.0,	129.9,	138.2,	N/A ,
12 hours	20.5,	29.2,	33.8,	40.9,	45.7,	49.4,	61.7,	75.6,	84.9,	98.0,	109.6,	118.7,	132.8,	143.7,	152.7,	N/A ,
18 hours	24.2,	34.2,	39.6,	47.8,	53.3,	57.6,	71.7,	87.8,	98.4,	113.4,	126.7,	137.1,	153.1,	165.5,	175.9,	N/A ,
24 hours	27.1,	38.3,	44.3,	53.4,	59.5,	64.3,	79.9,	97.6,	109.3,	125.7,	140.4,	151.8,	169.4,	183.1,	194.4,	234.2,
2 days	34.4,	47.1,	53.8,	63.8,	70.4,	75.5,	92.1,	110.5,	122.6,	139.3,	154.1,	165.5,	182.9,	196.2,	207.3,	245.7,
3 days	40.3,	54.2,	61.5,	72.2,	79.2,	84.7,	102.1,	121.3,	133.7,	150.9,	165.9,	177.4,	195.0,	208.4,	219.5,	257.6,
4 days	45.5,	60.5,	68.2,	79.5,	86.9,	92.6,	110.7,	130.6,	143.4,	161.0,	176.3,	188.0,	205.8,	219.4,	230.5,	268.8,
6 days	54.6,	71.3,	79.8,	92.1,	100.2,	106.3,	125.8,	146.8,	160.3,	178.6,	194.5,	206.6,	224.9,	238.7,	250.1,	288.8,
8 days	62.7,	80.9,	90.0,	103.2,	111.8,	118.3,	138.9,	160.9,	174.9,	194.0,	210.4,	222.8,	241.5,	255.7,	267.3,	306.6,
10 days	70.2,	89.6,	99.4,	113.3,	122.4,	129.2,	150.7,	173.6,	188.1,	207.8,	224.7,	237.5,	256.6,	271.1,	282.8,	322.7,
12 days	77.2,	97.8,	108.0,	122.7,	132.1,	139.3,	161.6,	185.4,	200.3,	220.6,	237.9,	250.9,	270.5,	285.2,	297.2,	337.6,
16 days	90.2,	112.8,	124.0,	139.8,	150.0,	157.7,	181.6,	206.7,	222.5,	243.7,	261.8,	275.3,	295.6,	310.8,	323.2,	364.6,
20 days	102.3,	126.7,	138.7,	155.6,	166.4,	174.6,	199.7,	226.1,	242.5,	264.6,	283.4,	297.4,	318.3,	333.9,	346.6,	389.0,
25 days	116.5,	142.9,	155.8,	173.8,	185.4,	194.0,	220.6,	248.4,	265.6,	288.6,	308.1,	322.6,	344.2,	360.3,	373.4,	416.8,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

Boherboy, Saggart
304865E 226349N
SAAR = 882mm
M5/60 = 19.3
r= 0.256

Appendix 12.11

Green Roofs

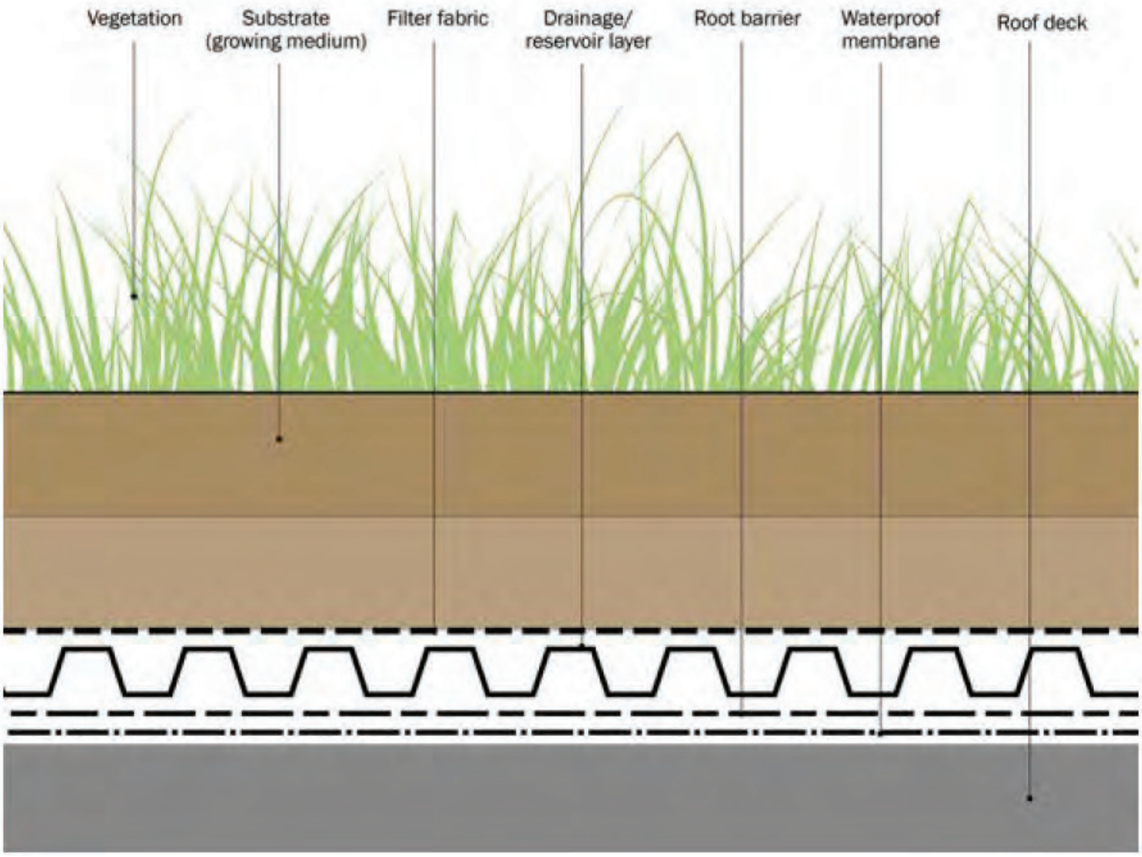


Figure 12.1 Section showing typical extensive green roof components

As mentioned earlier, there are two main types of green roof:

Extensive green roofs – These systems cover the entire roof area with hardy, slow growing, drought tolerant, low maintenance plants (eg mosses, succulents, herbs, grasses) often enhanced with wildflowers. Planting often establishes more slowly, but the long-term biodiversity can be of high value. They are only accessed for maintenance and can be flat or sloping. Extensive green roofs typically comprise a 20–150 mm thick growing medium and can be further divided into "single-layer" systems (which consist of a single medium designed to be free-draining and support plant growth), and "multi-layer" systems that include both a growing medium layer and a separate underlying drainage layer. They are lightweight and low cost to maintain, and can be used in a wide variety of locations with minimal intervention. They are often suitable for retrofit on existing structures due to their light weight. Biodiverse extensive green roofs are often planted with a mix of species supported by a range of soil depths.

Intensive green roofs (or roof gardens) – These are designed to sustain more complex landscaped environments that can provide high amenity or biodiversity benefits. They are planted with a range of plants including grasses, shrubs and/or trees, either as ground cover or within planters, and may also include water features and storage of rainwater for irrigation (ie blue roof elements). They are usually easily accessible, as they normally require a fairly high level of regular maintenance, and in some cases they are made accessible to the public. Intensive roofs have a deeper substrate, with >150 mm growing medium, and therefore impose greater loads on the roof structure.

Green roofs with substrate depths of 100–200 mm tend to be semi-intensive roofs, and can include characteristics of both extensive and intensive roofs, with plants that include shrubs and woody plants. Irrigation and maintenance requirements of this type of roof will be dependent upon the plant species chosen for the roof. There are also various combinations of green roof that combine both types in a single roof system.

A comparison of the main differences between extensive and intensive green roof systems is given in **Table 12.1**.

Extensive Green Roof

Blackdown extensive green roofs provide a lightweight, drought tolerant and low maintenance planting solution. They are suitable for lightweight roof decks, inaccessible roofs, flat or sloping roofs. Ongoing maintenance will keep extensive green roofs looking healthy and attractive

Vegetation
Extensive green roofs rely on hardy, drought tolerant sedum plants to form the majority of the planting. The sedums that Blackdown select and grow at the nursery in Somerset represent years of experience and horticultural knowledge.

There are three planting options to choose from – sedum NatureMat®, plugs or hydroplant (sedum cuttings).

Key Features

Substrate
Blackdown extensive substrates are made from carefully selected organic and inorganic materials. These materials are then blended to very specific proportions which enables plant material to establish as quickly as possible.

Waterproofing
Typical waterproofing options include suitable root-resistant bituminous membranes from the Derbigum and Euroroof ranges along with standing seam metal roofing.

Warranty
Warranties are available for the Alumasc waterproofing system used in the green roof build-up.

Build-up height	100mm
Drainage layer	25mm
Saturated weight	95-100 kg per m^2
Plant coverage at installation	<5 to 90%
Maximum pitch	45 degrees
Irrigation requirements	Not required once plant material is established
Maintenance requirements	Twice a year

Appendix 12.12

Irish Water PCEA Letter

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

Phillip Assaf

1st Floor Maple House
Lower Kilmacud Road
Stillorgan
Co. Dublin
A94E3F2

25 August 2020

Re: CDS20004359 pre-connection enquiry - Subject to contract | Contract denied

Connection for Housing Development of 700 units at Boherboy Road,, Saggart, Co. Dublin

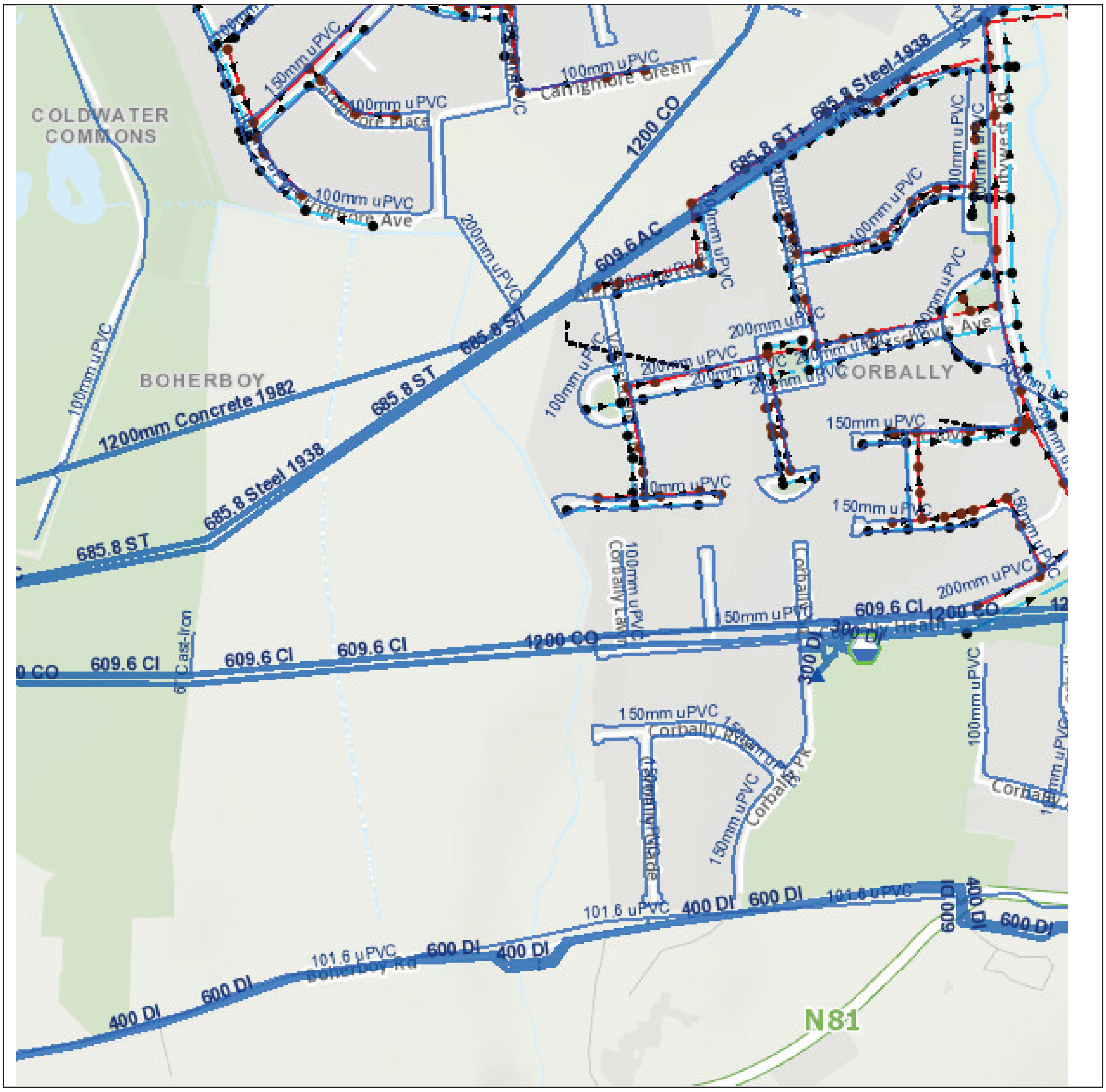
Dear Sir/Madam,

Irish Water has reviewed your pre-connection enquiry in relation to a Water & Wastewater connection at Boherboy Road,, Saggart, 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	Irish Water has several assets (strategic water trunk mains) running within the vicinity of the proposed works. Developer must demonstrate that proposed structures and works will not inhibit access for maintenance or endanger structural or functional integrity of the infrastructure during and after the works. Drawings (showing clearance distances, changing to ground levels) and method statements should be included in the detailed design of the Development. Appropriate wayleave in favour of Irish Water over the infrastructure will be required to ensure unrestricted access should future maintenance be required.
Wastewater Connection	In order to facilitate this connection, the network must be extended for approx.130m via private land/s. Any required consents will be agreed by the Customer.Also, approximately 510m of the 225 mm receiving sewer has to be upsized/twinned to accommodate the additional load as the sewer has no sufficient capacity to cater for the Development.

	Irish Water currently does not have any plans to commence extension or upgrade works to its network in this area. At connection application stage the network upgrade will be reviewed, and the works fee will be calculated in the connection offer fee or in a separate upgrade project agreement. A wayleave in favour of Irish Water will be required over the infrastructure that is not located within the Public Space.
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:



Reproduced from the Ordnance Survey of Ireland by Permission of the Government. License No. 3-3-34

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 Marina Zivanovic Byrne from the design team via email mzbyrne@water.ie For further information, visit **www.water.ie/connections.**

Yours sincerely,

Maria O'Dwyer

Connections and Developer Services

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

Phillip Assaf
1st Floor Maple House
Lower Kilmacud Road
Stillorgan,
Co. Dublin
A94E3F2

19 August 2021

Re: Design Submission for Boherboy Road,, Saggart, Co. Dublin (the "Development") (the "Design Submission") / Connection Reference No: CDS20004359

Dear Phillip Assaf,

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: Dario Alvarez
Email: dalvarez@water.ie

Yours sincerely,

Yvonne Harris

Yvonne Harris
Head of Customer Operations

Appendix A

Document Title & Revision

- [1324B-307 – V2 - Foul drainage layout]
- [1324B-308 – V2 - Foul drainage layout]
- [1324B-309 – V2 - Foul drainage layout]
- [1324B-310 – V2 - Watermain layout]
- [1324B-311 – V2 - Watermain layout]
- [1324B-312 – V2 - Watermain layout]
- [1324B-316 –Sections At Existing Watermains]
- [1324B-321 to 328–Foul Water sections]

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.

Appendix 12.13

Water Demand Calculations

New Network - DOMESTIC Water Demand								
Usage	Quantity	Occupancy	Population	Consumption (l//h/day)	Ave. Daily Domestic Demand (l/day)	Ave. Daily Domestic Demand (l/s)	Ave. Day/Peak Week (l/s)	Peak Hour Water Demand (l/s)
Resi'	655 Units	2.7 No./Unit	1,769	150	265,275	3.07	3.84	**19.2 l/s**
Peak Hour Water Demand (Domestic)								**19.2 /s**

Based on Irish Water Code of Practice for Water Infrastructure (Rev 4 Jul'20)

Residential Water Demand Calculations

New Network - COMMERCIAL Water Demand								
Usage	Quantity	Occupancy	Population	Consumption (l//h/day)	Ave. Daily Domestic Demand (l/day)	Ave. Daily(12hr) Domestic Demand (l/s)	Ave. Day/Peak Week (l/s)	Peak Hour Water Demand (l/s)
Possible School Site	1Ha	16 Classes	450	50	22,500	0.52	0.65	3.25
Crèche	680m^2	1child/8m^2 + Staff (20%) + support accommodation	102	50	5,100	0.12	0.15	0.74
Peak Hour Water Demand (Commercial)								**3.99 l/s**

Based on Irish Water Code of Practice for Water Infrastructure (Rev 4 Jul'20)

Commercial Water Demand Calculations

Appendix 12.14

Interception Calculations

INTERCEPTION - Catchment 1								
Paved Surfaces connected to the drainage system (Ha) =	2.73		Volume of Interception Required (m^3)		Gross Paved Area x 5% x 0.8 109.1		(GDSDS E2.1.1 - Criterion 1)	
Volume of Interception Provided (m^3)		Length	Width (m)	Area (m^2)	Quantity	Stone Depth (m)	Void Ratio	Volume (m^3)
Rainwater Butts (200l) @ 2No.per block		1.25		0.45	54		1	30.4
Voids of stone below Peremable Paving overflow				3,780		0.15	0.3	170.1
Voids of stone below Filter Drain overflow		473	0.6			0.15	0.4	17.0
Voids of stone below Swale overflow		181	0.6			0.15	0.4	6.5
Tree Pit depression				6.25	12	0.05	1	3.8
Voids of stone below Attenuation Tank				1,064		0.3	0.4	127.7
				Volume of Interception Provided (m^3) =				355.4
				Volume of Interception Required (m^3) =				109.1
				Interception provided > Required				OK

INTERCEPTION - Catchment 2								
Paved Surfaces connected to the drainage system (Ha) =	0.60		Volume of Interception Required (m^3)		Gross Paved Area x 5% x 0.8 23.8		(GDSDS E2.1.1 - Criterion 1)	
Volume of Interception Provided (m^3)		Length	Width (m)	Area (m^2)	Quantity	Stone Depth (m)	Void Ratio	Volume (m^3)
Rainwater Butts (200l) @ 2No.per block		1.25		0.45	24		1	13.5
Voids of stone below Peremable Paving overflow				1,190		0.15	0.3	53.6
Voids of stone below Filter Drain overflow		100	0.6			0.15	0.4	3.6
Voids of stone below Swale overflow		27	0.6			0.15	0.4	1.0
Tree Pit depression				14.5	1	0.05	1	0.7
Voids of stone below Attenuation Tank				168		0.3	0.4	20.2
				Volume of Interception Provided (m^3) =				92.5
				Volume of Interception Required (m^3) =				23.8
				Interception provided > Required				OK

INTERCEPTION - Catchment 3								
Paved Surfaces connected to the drainage system (Ha) =	0.60		Volume of Interception Required (m^3)		Gross Paved Area x 5% x 0.8 24.0		(GDSDS E2.1.1 - Criterion 1)	
Volume of Interception Provided (m^3)		Length	Width (m)	Area (m^2)	Quantity	Stone Depth (m)	Void Ratio	Volume (m^3)
Rainwater Butts (200l) @ 2No.per block		1.25		0.45	23		1	12.9
Voids of stone below Peremable Paving overflow				1,020		0.15	0.3	45.9
Voids of stone below Filter Drain overflow		220	0.6			0.15	0.4	7.9
Voids of stone below Swale overflow		68	0.6			0.15	0.4	2.4
Tree Pit depression				6.25	3	0.05	1	0.9
Voids of stone below Attenuation Tank				261		0.3	0.4	31.3
				Volume of Interception Provided (m^3) =				101.5
				Volume of Interception Required (m^3) =				24.0
				Interception provided > Required				OK

INTERCEPTION - Catchment 4

Paved Surfaces connected to the drainage system (Ha) =	0.77	Volume of Interception Required (m^3)		Gross Paved Area x 5% x 0.8 31.0	(GDSDS E2.1.1 - Criterion 1)	
Volume of Interception Provided (m^3)	**Length**	**Width (m)**	**Area (m^2)**	**Quantity**	**Stone Depth (m)**	**Void Ratio**	**Volume (m^3)**
Rainwater Butts (200l) @ 2No.per block	1.25		0.45	16		1	9.0
Voids of stone below Peremable Paving overflow			1,130		0.15	0.3	50.9
Voids of stone below Filter Drain overflow	140	0.6			0.15	0.4	5.0
Voids of stone below Swale overflow	60	0.6			0.15	0.4	2.2
Tree Pit depression			0	0	0.05	1	0.0
Voids of stone below Attenuation Tank			310		0.3	0.4	37.2
				Volume of Interception Provided (m^3) =			104.3
				Volume of Interception Required (m^3) =			31.0
				Interception provided > Required			OK

INTERCEPTION - Catchment 5

Paved Surfaces connected to the drainage system (Ha) =	2.69	Volume of Interception Required (m^3)		Gross Paved Area x 5% x 0.8 107.5	(GDSDS E2.1.1 - Criterion 1)		
Volume of Interception Provided (m^3)	**Length**	**Width (m)**	**Area (m^2)**	**Quantity**	**Stone Depth (m)**	**Void Ratio**	**Volume (m^3)**
Rainwater Butts (200l) @ 2No.per block	1.25		0.45	63		1	35.4
Voids of stone below Peremable Paving overflow			2,750		0.15	0.3	123.8
Voids of stone below Filter Drain overflow	450	0.6			0.15	0.4	16.2
Voids of stone below Swale overflow	220	0.6			0.15	0.4	7.9
Tree Pit depression			6.25	2	0.05	1	0.6
Voids of stone below Attenuation Tank			1,550		0.3	0.4	186.0
				Volume of Interception Provided (m^3) =			369.9
				Volume of Interception Required (m^3) =			107.5
				Interception provided > Required			OK

INTERCEPTION - Catchment 6

Paved Surfaces connected to the drainage system (Ha) =	0.56	Volume of Interception Required (m^3)		Gross Paved Area x 5% x 0.8 22.3	(GDSDS E2.1.1 - Criterion 1)		
Volume of Interception Provided (m^3)	**Length**	**Width (m)**	**Area (m^2)**	**Quantity**	**Stone Depth (m)**	**Void Ratio**	**Volume (m^3)**
Rainwater Butts (200l) @ 2No.per block	1.25		0.45	6		1	3.4
Voids of stone below Peremable Paving overflow			210		0.15	0.3	9.5
Voids of stone below Filter Drain overflow	0	0.6			0.15	0.4	0.0
Voids of stone below Swale overflow	0	0.6			0.15	0.4	0.0
Tree Pit depression			6.25	0	0.05	1	0.0
Voids of stone below Attenuation Tank			129		0.3	0.4	15.5
				Volume of Interception Provided (m^3) =			28.3
				Volume of Interception Required (m^3) =			22.3
				Interception provided > Required			OK

INTERCEPTION - Catchment 7							
Paved Surfaces connected to the drainage system (Ha) =	0.69	Volume of Interception Required (m^3)		Gross Paved Area x 5% x 0.8	27.4	(GDSDS E2.1.1 - Criterion 1)	
Volume of Interception Provided (m^3)	**Length**	**Width (m)**	**Area (m^2)**	**Quantity**	**Stone Depth (m)**	**Void Ratio**	**Volume (m^3)**
Rainwater Butts (200l) @ 2No.per block	1.25		0.45	6		1	3.4
Voids of stone below Peremable Paving overflow			250		0.15	0.3	11.3
Voids of stone below Filter Drain overflow	0	0.6			0.15	0.4	0.0
Voids of stone below Swale overflow	0	0.6			0.15	0.4	0.0
Tree Pit depression			6.25	0	0.05	1	0.0
Voids of stone below Attenuation Tank			265		0.3	0.4	31.8
				Volume of Interception Provided (m^3) =			**46.4**
				Volume of Interception Required (m^3) =			**27.4**
				Interception provided > Required			**OK**

INTERCEPTION CALCULATION- TOTAL DRAINED SITE							
Paved Surfaces connected to the drainage system (Ha) =	8.66	Volume of Interception Required (m^3)		Gross Paved Area x 5% x 0.8	346.3	(GDSDS E2.1.1 - Criterion 1)	
Volume of Interception Provided (m^3)	**Length**	**Width (m)**	**Area (m^2)**	**Quantity**	**Stone Depth (m)**	**Void Ratio**	**Volume (m^3)**
Rainwater Butts (200l) @ 2No.per block	1.25		0.45	192		1	108.0
Voids of stone below Peremable Paving overflow			10,330		0.15	0.3	464.9
Voids of stone below Filter Drain overflow	1383	0.6			0.15	0.4	49.8
Voids of stone below Swale overflow	556	0.6			0.15	0.4	20.0
Tree Pit depression			6.25	18	0.05	1	5.6
Voids of stone below Attenuation Tank			3,747		0.3	0.4	449.6
				Volume of Interception Provided (m^3) =			**1,097.9**
				Volume of Interception Required (m^3) =			**346.3**
				Interception provided > Required			**OK**

INTERCEPTION SUMMARY

Catchment No.	Interception Required (m^3)	Interception Provided (m^3)	Provided > Required
1	109.1	355.4	YES
2	23.8	92.5	YES
3	24.0	101.5	YES
4	31.0	104.3	YES
5	107.5	369.9	YES
6	22.3	28.3	YES
7	27.4	46.4	YES
*8	N/A	N/A	N/A

*Catchment 8 is for a possible future school site and in not part of this application