INFRASTRUCTURE

Project

Newtownmoynaghy SHD

Report Title

Infrastructure Design Report

Client

McGarrell Reilly Homes

December 2019

DBFL CONSULTING ENGINEERS

Job Title: Newtownmoynaghty SHD

Job Number: 190009

Report Reference: 190009-rep-001

Author: Jack Butler

Approved by: Brendan Manning

Date: December 2019

Distribution: Planning
Client
Architect
Planning Consultant
File

DBFL Consulting Engineers
Ormond House
Upper Ormond Quay
Dublin 7

Tel 01 4004000
Fax 01 4004050
Email info@dbfl.ie
Web www.dbfl.ie

Revision	Issue Date	Description	Prepared	Reviewed	Approved
	30/04/2019	Draft	JLB	BCM	DJR
	16/10/2019	Draft 2	JLB	BCM	DJR
	19/11/2019	Draft 3	JLB	BCM	DJR
	13/12/2019	Final	JLB	BCM	DJR

TABLE OF CONTENTS

Appendices

1.0 INTRODUCTION

1.1 Background

DBFL were commissioned to undertake an infrastructure design report to accompany a planning submission for a residential development at Millerstown, Newtownmoyaghy, Co. Meath.

The application comprises 575 new residential units, creche, GAA clubhouse, street layout, access and associated site services on a greenfield site. The proposed development is served by enabling infrastructure approved by Meath County Council under Reg Ref DA/100614 and ABP Ref PL17.238370. These enabling infrastructure works are now substantially complete.

1.2 Objectives

This report aims to consider the proposed development's main infrastructure elements, including the following;

- Surface water strategy and servicing.
- Foul sewer strategy and servicing.
- Water supply and servicing.
- Street Layout/Site access.

1.3 Site Location

The site, of approximately 24.77 Ha, is located at Millerstown, Newtownmoyaghy, Kilcock, Co. Meath. It is situated on the Meath/Kildare border, approximately 6km northwest of Maynooth along the R148. It is currently a greenfield site.

The subject site is located to the north of the Royal Canal and the Rye Water River. The R148 runs in the same direction and is located next to the Royal Canal. The Moyglare Road is located to the north of the site and the R125 is located to the west of the site. The site is primarily bounded by farmland, residential dwellings and the ongoing Millerstown Phase 1 development.

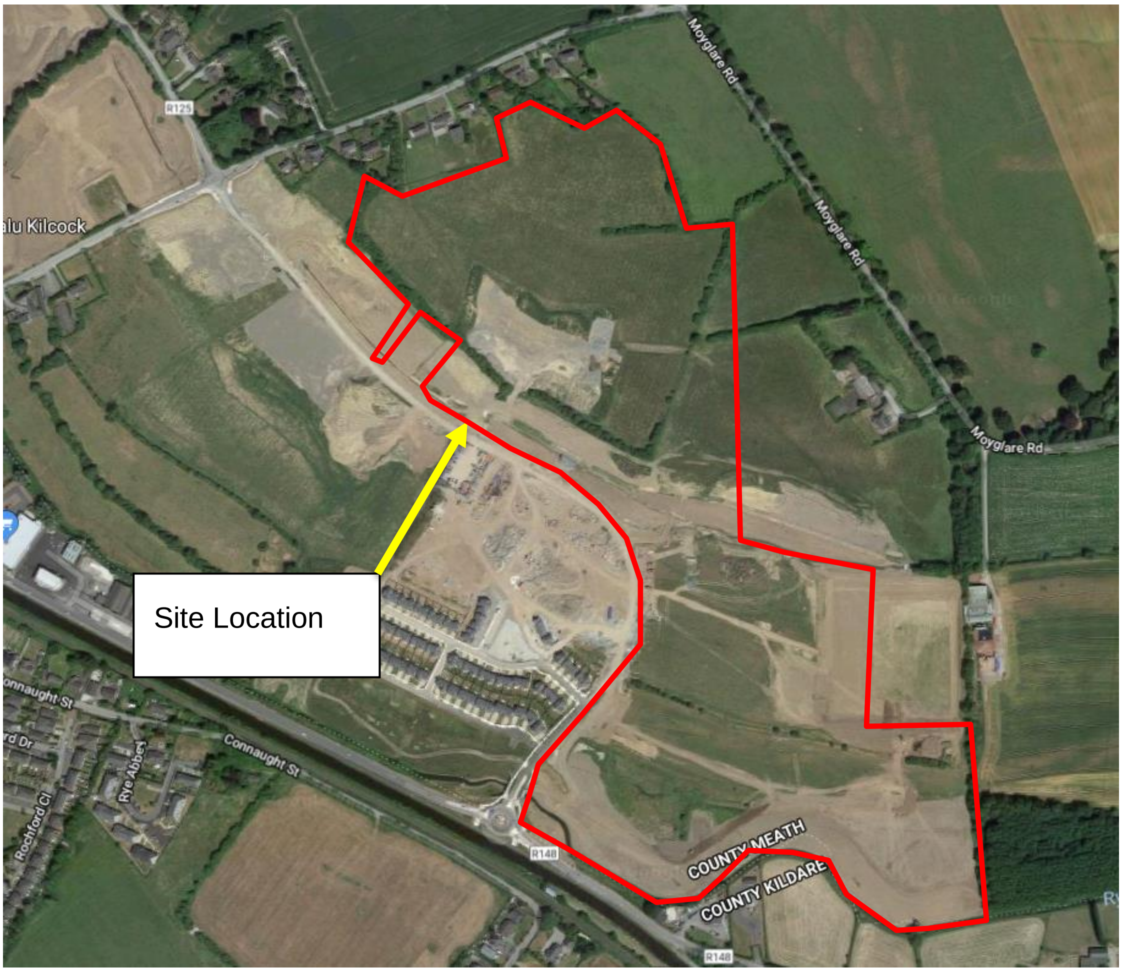


Figure 1.1: Site Location

1.4 Proposed Development

It is proposed to construct 575 new residential units on a greenfield site. Full details of the scheme layout are included on the architectural plans, elevations, sections etc.

The development will also comprise associated infrastructure including access roads, new streets, roads, footpaths, driveways, a GAA clubhouse and associated site services.

1.5 Flood Risk

A separate Site-Specific Flood Risk Assessment is included within the application documentation.

2.0 ACCESS AND STREETS

2.1 Overall Street and Access Layout

The proposed development will be accessed via the Link Street that is currently being constructed as part of the Millerstown Phase 1 development under MCC REF RA 150205 and ABP Ref PL 17.246141. The Link Street is located along the southern and western boundaries of the subject site and provides a link between the R125 and the R148 Maynooth Road. The Link Street forms part of the overall spine route between the R148 (Maynooth Road) and the R158 (Trim Road) through the overall Kilcock Environs Lands in Co. Meath. The link road serves the overall Kilcock Environs Lands, including the proposed school site. Construction of the link road is anticipated to be finished by Q1 2020. The section of the Link Street accessing Millerstown Phase 1 is already complete including the new roundabout which facilitates the R148 Maynooth Road.

Within the development a clear hierarchy of streets in accordance with the principles of DMURS has been provided. Refer to DBFL drawings 190009-DBFL-XX-XX-DR-C-2000 to 2004 with the hierarchy clearly defined between link streets, primary local access, secondary local access and homezones. The development layout has been designed, based on the recommendations of DMURS, to provide 'self-regulating' streets. A design speed limits have been applied throughout the development as per Design Manual for Urban Roads and Streets (DMURS). A statement of consistency with DMURS is also provided with this application.

2.2 Street Layout Design

The proposed development's street layout and hierarchy is shown on drawings 190009-DBFL-XX-XX-DR-C-2000 to 2004. The standard street cross-sections are detailed on drawing 190009-DBFL-XX-XX-DR-C-2010 and comprise the following;

- Primary Local Access – typically 5.5m wide carriageway with 2.0m footpaths.
- Secondary Local Access – typically 5.0 - 5.5m wide carriageway with 2.0m footpaths.
- Homeszone – Typically 5m wide carriageway with 2m footpaths.

The development layout can also facilitate an element of on street parking for visitors within the 5.5m wide carriageways. Typical street cross sections also include 2.0m wide footpaths. Maximum road corner radii of 4.5m are provided at junctions to the Link Street and junction radii of between 1-3m within the site are provided as per DMURS.

2.3 Pavement Design Standards

Drawings 190009-DBFL-XX-XX-DR-C-2010 to 2012 details the proposed road construction thicknesses based on an existing ground minimum design CBR of 3%. Actual CBRs and ground conditions will be confirmed by site investigations prior to construction.

2.4 Traffic and Transportation

Traffic and Transportation are discussed separately in DBFL report “Traffic and Transportation Assessment”.

2.5 Vehicle Tracking

The proposed development has been tracked to show that the development circulation layout will accommodate a large refuse vehicle with a turning head provided to the rear of the site, refer to DBFL drawings 190009-DBFL-XX-XX-DR-C-2000 and 2004.

3.0 SURFACE WATER DRAINAGE

3.1 Existing Surface Water

The topography of the site generally slopes from North to South. Surface water drainage within the vicinity of the proposed development comprises the following;

- Rye Water River which forms the southern site boundary and flows in a south-easterly direction parallel to the R148 before turning east towards Leixlip, where it discharges to the River Liffey.
- Upper Ditch which traverses the centre of the subject site. Although generally dry it falls in an easterly direction and eventually merges with the Rye Water to the east of the site.
- Existing surface water drainage constructed/under construction in the Link Street as part of Millerstown Phase 1.

3.2 General Design

The proposed surface water drainage system will collect storm-water run-off from the proposed residential development via a traditional pipe-work and manhole system laid within the proposed street network. Run-off from impermeable streets will be collected by gullies roofs and driveways will be collected via individual connections. Sustainable Urban Drainage Systems (SUDS) will be incorporated to reduce run-off volumes and improve run-off water quality. Based on the sites underlying ground conditions, groundwater recharge will be facilitated in the design of the surface water / SUDS systems for the subject site.

3.2.1 Compliance with Surface Water Policy

Surface water management for the proposed development is designed to comply with the Greater Dublin Strategic Drainage Study (GDSDS) policies and guidelines and the requirements of Meath County Council. The GDSDS guidelines require the following main 4 main criteria to be provided by the development's surface water design;

- Criterion 1: River Water Quality Protection – satisfied by providing interception storage and treatment of run-off within the SUDS features e.g. permeable paving, swales, detention basins, oil separators, and on-line infiltration basin.
- Criterion 2: River Regime Protection – satisfied by attenuating run-off with flow control device prior to discharge to the Rye Water River
- Criterion 3: Level of Service (flooding) for the site – satisfied by the Site being outside the 1000 year coastal and fluvial flood levels. Pluvial flood risk addressed by development designed to accommodate a 100-year storm as per

GDSDS. Planned flood routing for storms greater than 100-year level considered in design and development run-off contained within site.

- Criterion 4: River flood protection – attenuation and long-term storage provided within the SUDS features e.g. permeable paving construction and on-line infiltration basin attenuation systems etc.

3.2.2 Surface Water Design

Run-off from individual houses is designed to discharge to the surface water network. In accordance with SUDS principal's in curtilage SUDS is provided in the form of permeable paving for all driveways facilitating attenuation, storage and infiltration potential for run-off from these areas. A stone storage reservoir is provided within the build up for each driveway which housing roof drainage discharges to. The stone reservoir includes an overflow outlet which is connected to the surface water network. Typical details for in curtilage SUDS features are shown on DBFL drawings 190009-DBFL-XX-XX-DR-C-3010 to 3015.

Surface water discharge rates from the site's main collection network will be controlled by Hydrobrake flow control devices downstream of the attenuation storage areas comprising open infiltration basins. The infiltration basins will provide storage for a 100-year storm in accordance with GDSDS with a 20% allowance for climate change. These attenuation systems will serve the whole of the development; layouts for same are shown on drawings 190009- DBFL-XX-XX-DR-C-3000 to 3003.

3.3 SUDS

In accordance with the GDSDS it is proposed to use Sustainable Urban Drainage systems (SUDS) for managing storm-water for the proposed development. The aim of the SUDS strategy for the site will be to;

- Attenuate storm-water runoff.
- Reduce storm-water runoff.
- Reduce pollution impact.
- Replicate the natural characteristics of rainfall runoff for the site.

The proposed drainage/SUDS layouts are detailed on drawings 190009-DBFL-XX-XX-DR-C-3000 to 3003.

An assessment of the potential SUDS that could be incorporated within the site was conducted using the https://uksuds.worldsecuresystems.com/ website and the SUDS Manual, refer to evaluation report in Appendix A. Since the proposed development drainage will be constructed to a taking in charge standard, the range of SUDS features available are restricted but include the following;

1. General extents of impermeable areas reduced where possible.
2. Permeable, self-draining areas incorporated in landscaped areas.
3. All off street parking to be constructed using permeable paving. Run-off from these permeable areas is allowed to infiltrate to the sub-soil and provide attenuation, storage and soakage for run-off generated by adjacent impermeable surfaces.
4. Attenuation storage systems provided using on-line infiltration basins which promote infiltration to ground and to improve water quality.

Final petrol interceptors / downstream defenders to be provided upstream of the final outfall points to the Rye Water and Upper Ditch. Headwalls and non-return valves will be provided at discharge points to the Rye River and Upper ditch.

3.4 Sustainable Urban Drainage Systems Proposals

In line with the recommendations of the GDSDS, Greater Dublin Regional Code of Practice for Drainage Works and the SuDS manual, it is proposed to provide a multi-stage attenuation system aimed at providing storm storage facilities and enhancing the quality of surface water runoff from the development. This would be achieved by intercepting rainfall and other runoff, treating the water by filtration through natural materials and conveying this water to storage facilities also having the capacity for secondary treatment. The SUDS approach seeks to mirror the greenfield run-off levels of existing catchments by restricting and maintaining the allowable surface water outflow from all new developments.

A ‘SuDS Treatment Train’ for the proposed development is shown below. By providing at least two separate treatment stages, this plan is in accordance with Table 3.3 of the SuDS manual.

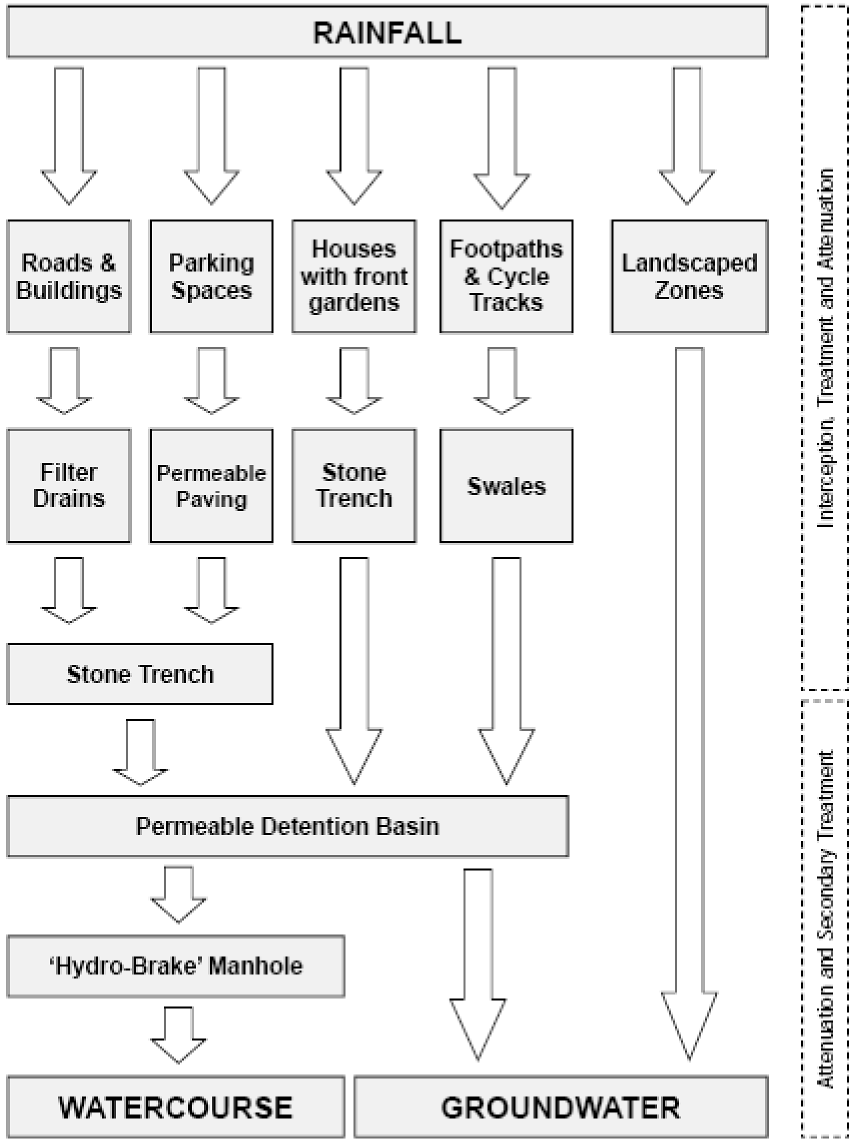


Figure 3.1: SuDS Treatment Train

A breakdown of the various sustainable drainage systems is provided below:

3.4.1 Permeable Paving

It is proposed to provide permeable paving on driveways within the proposed development. Upon contact with the paved upper layer, surface water runoff infiltrates to an underlying stone reservoir. This process of interception and filtration is capable of removing pollutants before the surface water drains directly downwards or discharges to a nearby sewer network. The most significant benefit of permeable paving is its capacity to control both the quantity and quality of surface water runoff. It should be noted that manufacturers suggest a dissipation rate through paving joints of 2000 l/s/Ha can be achieved.

3.4.2 Stone Storage Under Permeable Driveways

In order to maximise groundwater recharge and to facilitate a reduction in the volume of runoff generated by the development surface water collected from the roof area of each property would drain to a stone storage layer located below the property driveway and would also be utilised for discharge to ground. The mobilisation of the storage layer within each property affords an additional opportunity for groundwater recharge to occur, particularly in times of heavy rainfall, and would contribute to a reduction in the overall volume of surface water runoff. The surface water drainage network within the proposed development has been designed allow for 50% run off from each driveway (Run off co-efficient of 0.5). A runoff co-efficient of 1.0 (100%) has been assumed for all roof areas even though they will be partially attenuated within the stone reservoir under each driveway. This would be considered a conservative approach and ultimately lead to an effective and high-performance drainage system.

Typical 'in-curtilage' SuDS details are shown on drawings 190009-DBFL-XX-XX-DR-C-3010 to 3015.

3.4.3 Infiltration / Detention Basin

In addition to being an effective storage facility, permeable infiltration basins have the ability to facilitate both water treatment and groundwater recharge. Detention / Infiltration basins can also be aesthetically pleasing, encourage biodiversity and are unobtrusive and relatively inexpensive.

To facilitate maintenance bank slopes on the infiltration / detention basin have been set at maximum of 1:3. The infiltration / detention basin would generally be dry however during extreme rainfall events the basins would fill to the 100-year (plus climate change) design water depth. This flood event water level would quickly recede as the storm / rainfall event abates. Infiltration basins facilitate both groundwater recharge and evapotranspiration and provide a second treatment stage for runoff as well as providing the majority of the overall attenuation storage for the site.

For rainfall events in excess of the 100-year (plus climate change) storm water would overtop the bank of the basin and flow overland towards the Rye Water River. In compliance terms, the 100-year, plus 20% for climate change flood, event is retained on the development site as per the requirements of the GDSDS.

An example of a similar infiltration basin can be seen in the adjacent Phase 1 in Millerstown. The basin has matured and is used by residents as an active landscape.

3.4.4 Swales

Shallow swales are proposed on the edge of the street which adjoins the main open spaces within the site. These shallow swales would generally be dry overland flow routes with slide slopes of 1:4. During extreme rainfall events the swale could potentially fill to a depth of 200mm. The water level would quickly recede as the storm abates. Runoff from the adjacent section of street would flow into the swales facilitating both groundwater recharge and evapotranspiration. Swales can provide interception and treatment storage for runoff in addition to providing a portion of the overall attenuation storage.

Swales would be connected at identified points to the surface water sewer network serving the site, using ‘Brio’ manhole covers with connecting pipework.

While the extent and quality of the SuDS features utilised within sites surface water catchment generally negates the need for an interceptor/separator devices at the outfall point, it is proposed to provide ‘Downstream Defenders’ downstream of the proposed flow control ‘Hydro-Brake’ manhole as show on drawing 190009-DBFL-XX-XX-DR-C-3012. These will provide a level of treatment before discharge to the Rye Water and Upper Ditch.

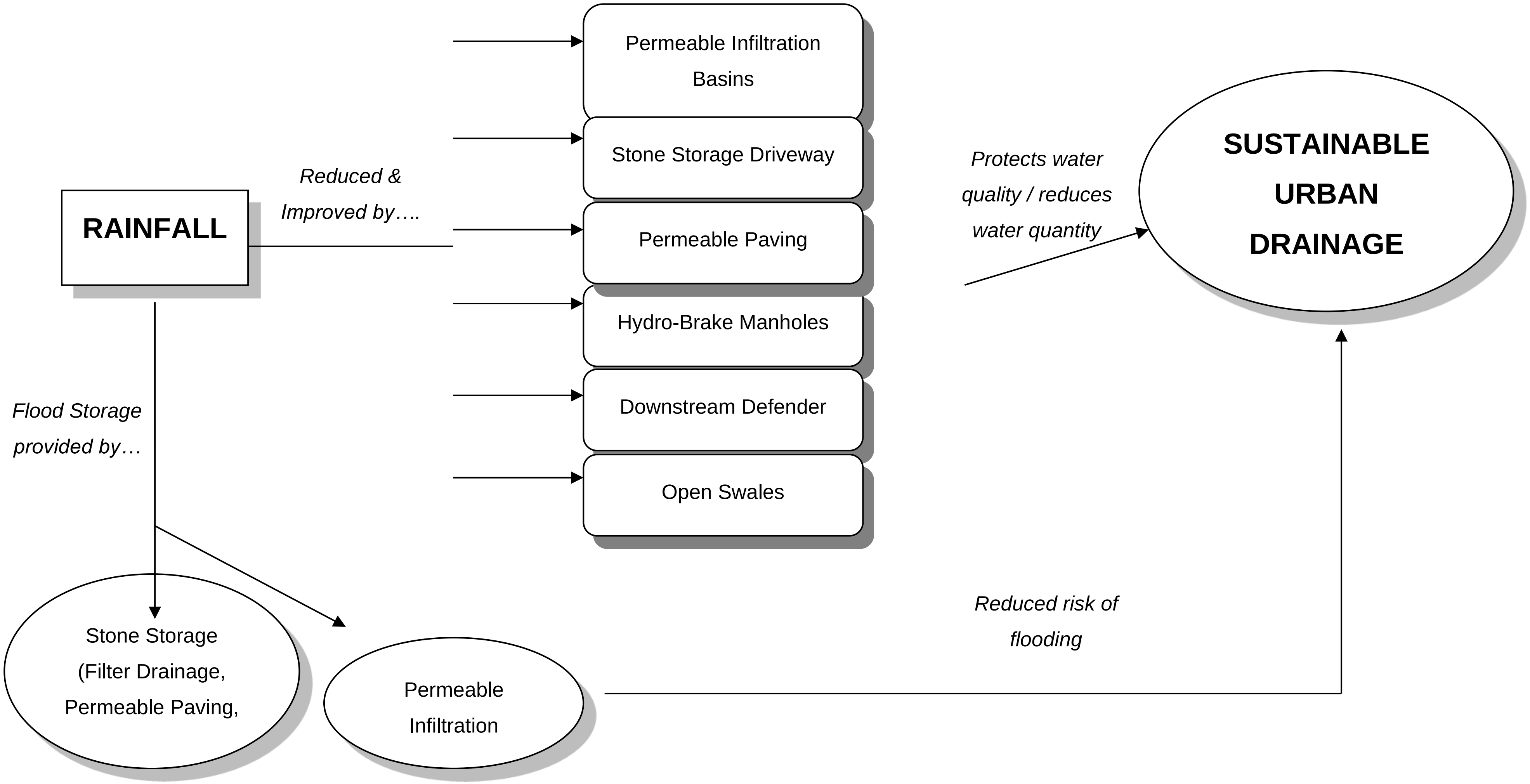


Figure 3.2: Predicted Surface Water Flow Chart

3.5 Attenuation Calcs

Run-off from the proposed development will be limited / attenuated to existing greenfield run-off rates as per the Millerstown Phase 1 using vortex flow control devices (Hydrobrake or equivalent) limiting discharge to 33.9 l/s for the entire site in accordance with the GDSDS (Total area 15.2 Ha). Please refer to allowable site discharge calculations in Appendix D for the north and south site. The resultant design attenuation volumes, discharge limits, types of storage and storage volumes for each area are detailed in Table 3.1 below.

Catchment	Storage System Type	Discharge Limit (l/s)	100 Year Storage Volume
1 (North Site)	Infiltration Basin	20.1 l/s	1950m^3
2 (South Site)	Infiltration Basin	13.8 l/s	1570m^3
Total		33.9 l/s	3522m^3

Table 3.1 – Surface Water Attenuation Storage and Discharge Limits

Attenuation volumes have been designed using Microdrainage Windes analysis software taking account of design invert levels, ground levels and depth and type of system. The attenuation systems are designed to provide a total of 3520 m^3 of storage; refer to design run-off calculations in Appendix D.

Appendix G contains a copy of the ground investigation undertaken for the subject lands. Seven soil infiltration tests were undertaken in accordance with BRE Digest 365. SA05 was calculated to have an infiltration rate of 4.353 x 10^{-4} m/s. The other locations dropped too slowly to allow for a calculation of the infiltration rate as per BRE Digest 365. However, we do note that some infiltration and groundwater recharge will occur. Taking a conservative approach an infiltration rate of 0 m/h and a factor of safety of 10 has been used in the design of the infiltration basins proposed.

Based on the topography of the site relative to existing Rye Water and Upper Ditch flood levels etc, the hydrobrake flow controller devices has been designed for a submerged outlet scenario. As the risk of a submerged outlet is possible the hydrobrake will be fitted with a vent pipe which ensures that air is continuously available in the core of the vortex controller. This is similar to the flow control device installed for the adjacent Millerstown Phase 1.

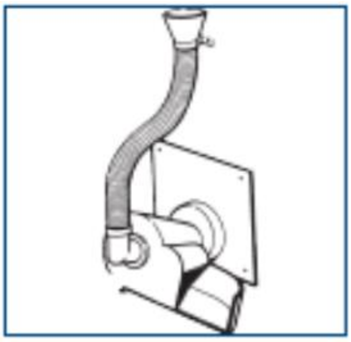


Figure 3.3: Typical Vortex Vent Pipe

Maintaining available air at this point ensures that the vortex motion within the hydrobrake is not inhibited by a submerged outlet condition. Vortex vent pipes are commonly used where developments discharge to existing watercourses with high flood levels or where downstream sewers may be at risk of surcharging.

Details of the various aspects of the proposed attenuation system are shown on DBFL drawings 190009- DBFL-XX-XX-DR-C-3014 and 3015.

3.6 Interception Volume

To prevent pollutants or sediments discharging into water courses the GDSDS requires “interception storage” to be incorporated into the development. This interception storage is designed to receive the run-off for rainfall depths of 5mm up to 10mm if possible. The SUDS features including permeable paving will provide the necessary interception volume required by the GDSDS.

3.7 Design Standards

All services have been designed in accordance with the Department of Environment ‘Recommendations for site development works for Housing Areas’. The allowable outflow from the whole of the development is limited in accordance with the GDSDS to 33.9l/s (i.e. Q_{bar}). Surface water pipe-work was sized using the Microdrainage Windes drainage modelling software. The following parameters apply:

- All main roads and footpaths assumed to be 100% impermeable.
- All roofs to houses assumed to be 100% impermeable.
- Permeable paving driveways assumed to be 50% impermeable.
- All open spaces and landscaped areas are not assumed to be contributing directly to the main surface water drain or attenuation systems.

- Return period for pipe work — 5 years,
  check 30-year 15 minute, no flooding.
  check 100-year flooding in designated areas.
- Time of entry — 5 minutes
- Pipe Friction (Ks) — 0.6 mm
- Minimum Velocity — 1.0 m/s
- Standard Average Annual Rainfall — 830mm
- M5-60 — 15.4mm (Source Met Eireann)
- Ratio r (M5-60/M5-2D) — 0.279
- Attenuation Systems Return Event — GDSDS Volume 2, p61, Criterion 3
  30 year no flooding on site.
  100 year check no internal property flooding. Flood routing plan. FFL freeboard above 100-year flood level. No flooding to adjacent areas.
- Climate Change — 20% increase in rainfall intensities as per the GDSDS)
- Factor of Safety for infiltration — 10

Surface water sewers are designed in accordance with IS EN 752 and the recommendations of the 'Greater Dublin Strategic Drainage Study', (GDSDS).

Standard surface water drainage details, as outlined on DBFL drawings 190009-DBFL-XX-XX-DR-C-3010 to 3012, are in accordance with the Greater Dublin Regional Code of Practice for Drainage Works.

The minimum pipe diameter for public surface water sewers is 225mm. Private drains within the proposed development will be 100mm.

Refer to drawing references 190009-DBFL-XX-XX-DR-C-3000 to 3003 for the proposed surface water layout.

Attenuation volume calculations for the main drainage network are included in Appendix B

3.8 Climate Change

Surface water calculations for the development made use of M5-60 rainfall data for Millerstown, Newtownmoyaghy, Co. Meath provided by Met Eireann. Rainfall intensities were increased by a factor of 20% to take account of climate change, as required by the GDSDS for attenuation storage design.

3.9 Pluvial Flooding Provision

The surface water network, attenuation storage and site levels are designed to accommodate a 100-year storm event and includes climate change provision. Floor levels of houses are set above the 100-year flood levels by a minimum of 0.5m for protection. For storms in excess of 100 years, the development has been designed to provide overland flood routes along the various development roads.

4.0 FOUL DRAINAGE

4.1 Existing Foul Drainage

There is an existing 375/450mm diameter trunk foul sewer which has been constructed as part of the granted Millerstown Phase 1 (MCC REF RA 150205 and ABP Ref PL 17.246141) to the south and west of the site located on the new link street. This 375/450mm trunk sewer discharges to the 600mm Irish Water foul sewer to the south of the subject site adjacent to the Rye Water. This 600mm sewer outfalls to the Kilcock pump station just east of the site. Proposed foul loading calculations for the development are detailed in Table 4.1 below

Development	No. of Residential Units	No. of Persons @ 2.7 per unit	Discharge per person per day	Peak Discharge (l/s)	Average Discharge (l/s)
North Site	309	834	150	9.56	1.593
South Site	266	718	150	8.229	1.372
Overall	575	1553	150	17.789	2.965

Table 4.1 – Proposed Developments Foul Loadings

4.2 Design Strategy

The general foul sewer strategy for the development will be to discharge by gravity to the existing 375/450mm diameter foul sewer to the south of the site which in turn discharges to the existing 600mm diameter Liffey Valley Sewerage Scheme Irish Water sewer. This, in turn, discharges to the existing Kilcock Foul Pump Station located to the south of the subject site. Refer to drawings 190009-DBFL-XX-XX-DR-C-3000 to 3003. The strategic foul sewer located in the link road serves the overall Kilcock Environs Lands, including the proposed school site. Irish Water in their Confirmation of Feasibility Letter, dated 18th of April 2019, attached in Appendix C have confirmed capacity is available to serve the proposed development subject to the applicant entering into a connection agreement.

Within the site foul sewer networks comprising 225mm and 150mm diameter sewers would serve the proposed development and discharge same to the existing 375/450mm sewer in the link street. Individual houses will connect to the 150/225mm diameter foul sewer via individual 100mm drains or per the Irish Water Code of Practice.

All foul drainage layouts and proposals have been designed in accordance with the Irish Water Code of Practice for Wastewater Infrastructure including pipe diameter, minimum gradients, layouts etc.

4.3 Design Calculation

Foul drains have been designed in accordance with Irish Water's Code of Practice, standard details and specifications.

The following criteria have been applied:

Demand	150 l/head/day
Discharge units	3.3 units per house (as EN752)
Pipe Friction (Ks)	1.5 mm
Minimum Velocity	0.75 m/s (self-cleansing velocity)
Maximum Velocity	3.0 m/s
Frequency Factor	0.5 for domestic use
Manhole Depths	< 5.0m

All construction details relating to foul sewer drainage are to be as per the Irish Water Standard details for same.

5.0 WATER SUPPLY AND DISTRIBUTION

5.1 Existing Water Supply

There is an existing public 280/315mm diameter PE 100 water main located in the new link street which runs along the subject sites southern and western boundaries. This 315 diameter PE 100 watermain was constructed as part of the granted Millerstown Phase 1 (MCC REF RA 150205 and ABP Ref PL 17.246141) in 2017 and 2018. This watermain will extend west to the R125 with all works to the watermain in the link street expected to be complete by Q1 of 2020. This strategic watermain will serve the Overall Kilcock Environs Lands, including the proposed school site.

5.2 Development Water Main Layout

The development's proposed water-main distribution system is indicated on drawing 190009-DBFL-XX-XX-DR-C-3005 and 3006. It is proposed to connect to the existing 280/315mm diameter water main to the site located on the link street as built in Phase 1 under *MCC REF RA 150205 and ABP Ref PL 17.246141*. The watermain layout within subject site consists of a primary 160/180mm diameter loop HDPE main with 110/125mm diameter secondary spurs connecting to same. All mains are generally looped where possible.

The connection to the public water main will include sluice valves, water meter, scour valve etc arrangement in accordance with the requirements of Irish Water. Confirmation of feasibility was granted by Irish Water on 18/04/2019, please refer to Appendix C.

A statement of design acceptance was issued by Irish water on 05/11/2019 and is attached in Appendix H.

The selected pipe material options for the development will be PE-100.

Individual houses will have their own connections to the distribution main via service connections and boundary boxes. Individual service boundary boxes will be of the type to suit Irish Water and to facilitate domestic meter installation.

5.3 Water Main Standards and Details

The water main layout and details are in accordance with Irish Water's Code of Practice and Standard Details. All valves, hydrant and metering fittings/details shall be in accordance with the requirements of Irish Water.

Hydrants are provided for fire-fighting at locations to ensure that each dwelling is within the required distance of a hydrant as per Irish Water Specification

5.4 Water Demand and Conservation

The estimated water demand for the proposed development is detailed below in table 5.1. Each house will provide 24 hours of cold-water storage in the header tank and houses will utilise water saving features for the fittings to reduce water demand.

Development	No. of Residential Units	No. of Persons @ 2.7 per unit	Discharge per person per day	Peak Demand (l/s)	Average Demand (l/s)
North Site	309	834	150	9.053	1.448
South Site	266	718	150	7.793	1.247
Overall	575	1553	150	16.846	2.695

Table 5.1 – Proposed Developments Water Demand.

Appendix A

Irish SUDS Report

Site Drainage Evaluation

Site name: Millerstown
Site location: Kilcock

Report Reference: 1555500830091
Date: 17/4/2019

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.

The groundwater beneath the site is designated as *SPZ I*, 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 *Rye River*. The riparian owner is: *Waterways Ireland.*

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.

If practicable, infiltration systems should be used to meet the Interception requirements for the site.

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.

Infiltration and rainwater harvesting, or the use of Long Term Storage provide the means to limit runoff to the greenfield volume. Where volume control is not practicable, flows discharged from the site will need to be constrained to Qbar or 2 l/s/ha (whichever is the greater).

Infiltration will manage runoff for all events. The safety of exceedance flow paths should be checked in case of drainage system failure.

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

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 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 groundwater systems
Runoff from roofs will need one effective treatment stage prior to disposal to groundwater. Where sediment and other litter is prevented from entering the infiltration device, and the underlying subsoils can be demonstrated to provide effective treatment, then the process of infiltration will usually be sufficient.

Runoff from roads and parking areas will need 3 effective treatment stages prior to disposal to groundwater. Where sediment and litter is prevented from entering the infiltration device, and the underlying subsoils can be demonstrated to provide effective treatment, then the process of infiltration will usually be deemed to constitute one treatment stage. Two further upstream treatment stages will also be required.

Infiltration may only be used where a risk assessment has been undertaken in accordance with http://www.netregs.gov.uk/netregs/100789.aspx, and the design effectively addresses the risks identified within the risk assessment.

6. SITE-SPECIFIC DRAINAGE DESIGN CONSIDERATIONS

The site is a high density residential site. The HR Wallingford documenet 'SuDS for high density developments' is a useful guidance document for efficient drainage design where space is heavily constrained.

Components likely to be particularly suitable for high density sites include:

• permeable pavement parking areas which can often manage roof runoff as well as rainfall falling on the parking surface;
• green roofs which limit runoff from roof surfaces;
• bioretention areas integrated within impermeable zones;
• individual property soakaways;
• subsurface infiltration and/or detention systems (eg beneath functional, permeable surfaces);
• infiltration/detention/retention ponds/basins/channels integrated within public open space areas.

The development is located within the floodplain. The design of the drainage is therefore likely to need to consider high ground water levels, downstream water level control during extreme events, and the possibity of inundation of the drainage infrastructure. To get more insight into this aspect, please use Joint Probability Analysis Tool.

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
Soakaways	Y	Y	S	Y	N	N(~)	N(~)	Y(")	Y(")	N
Infiltration Basins	Y	Y	S	Y	N	N(~)	N(~)	Y(")	Y(")	N
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

• *High density*
For large occupancy buildings (offices, supermarkets, etc.), communal rainwater harvesting systems may provide significant stormwater management benefits.

• *Roofs*
Rainwater harvesting systems can be used to effectively drain roofs and provide both water supply and stormwater management benefits.

Pervious Pavement

• *High density*
Pervious pavement systems provide an effective way to drain, store and treat the surface runoff, all within the footprint of the car park area. Larger areas of communal parking will provide the most cost effective systems.

• *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

• *High density*
Filter strips can be used as treatment for road or car park runoff where space allows.

• *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

• *High density*
Swales can be used for road or car park drainage where space allows. Underdrained swales (ie with a subsurface gravel filled conveyance and treatment trench) can provide a more efficient solution for hydraulic control and water quality treatment.

• *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

• *High density*
Trenches can provide treatment and runoff control for road or car park drainage.

• *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

• *High density*
Detention basins can be used in high density developments when effectively integrated within public open space areas.

• *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

• *High density*
It is unlikely that a pond would be suitable for high density development, unless it is an integral amenity feature within the public open space area.

• *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

• *High density*
It is unlikely that a wetland would be suitable for high density development, unless it is an integral amenity feature within the public open space area.

• *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.

Soakaways

• *High density*
Individual property soakaways can be built in garden areas. Attenuation storage can be built beneath impermeable surfaces such as roads or car parks or public spaces, thus minimising the use of space needed for the drainage system.

• *Roofs*
Soakaways can be used to store, treat, and dispose roof runoff.

• *Roads*
Upstream treatment is normally required if soakaways are used to manage road runoff directly. Sediments and litter should be prevented from entering the soakaway.

• *Car parks/other impermable surfaces*
Upstream treatment is normally required if soakaways are used to manage road runoff directly. Sediments and litter should be prevented from entering the soakaway.

• *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*
Consideration must be given to the risk of infiltrated water re-emerging further down the slope and causing a downstream flood hazard.

Infiltration Basins

• *HighDensity*
Infiltration basins can often be used in high density developments when effectively integrated within public open space areas.

• *Roofs*
Infiltration basins can be used to attenuate and treat roof runoff.

• *Roads*
Upstream treatment is normally required if infiltration basins are used to manage road runoff. Sediments should be prevented from entering the system.

• *Car parks/other impermable surfaces*
Upstream treatment is normally required if infiltration basins are used to manage runoff from trafficked surfaces. Sediments should be prevented from entering the system.

• *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 depth of stored water in the basin.

• *Steep site*

Consideration must be given to the risk of infiltrated water re-emerging further down the slope and causing a downstream flood hazard. Large basins may require embankments that may pose safety risks to downstream residents.

Green Roofs

• *HighDensity*
Green roofs can be implemented most cost-effectively on larger roofs. They provide a range of benefits in addition to stormwater management, including combatting the heat island effect, biodiversity and amenity functions.

• *Roofs*
Green roofs can be designed to provide interception, management and treatment of rainfall up to specified rainfall depths.

Bioretention Systems

• *High density*
Biorention systems (either cells or linear systems) can be used for road or car park drainage where space allows.

• *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

• *High density*
Proprietary treatment systems may be appropriate to use particularly where there is no space for surface, vegetated treatment systems. However, regular monitoring needs to be ensured so that they are maintained so that they continue to function effectively.

• *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

• *High density*
Subsurface storage of runoff is likely to be needed for high density developments. This can be implemented via a range of proprietary high void systems, or within gravels beneath permeable pavements which provide treatment as well. Sub-surface storage allows the land above the storage system to be used for car parking or public open space areas.

• *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

• *High density*
Subsurface conveyance systems may be an important means of connecting drainage components together and routing flows downstream. Space constraints in high density developments are likely to constrain the use of surface conveyance options.

HR Wallingford Ltd, the Environment Agency and any local authority are not liable for the performance of a drainage scheme which is based upon the output of this report.

Appendix B

Attenuation Storage Calculations

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

Half Drain Time : 844 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	63.836	0.136	0.0	18.3	18.3	589.3	O K
30 min Summer	63.887	0.187	0.0	18.5	18.5	811.9	O K
60 min Summer	63.938	0.238	0.0	18.8	18.8	1041.5	O K
120 min Summer	63.988	0.288	0.0	19.0	19.0	1269.6	O K
180 min Summer	64.016	0.316	0.0	19.2	19.2	1397.2	O K
240 min Summer	64.034	0.334	0.0	19.3	19.3	1479.6	O K
360 min Summer	64.055	0.355	0.0	19.4	19.4	1574.6	O K
480 min Summer	64.064	0.364	0.0	19.4	19.4	1618.1	O K
600 min Summer	64.067	0.367	0.0	19.4	19.4	1631.6	O K
720 min Summer	64.066	0.366	0.0	19.4	19.4	1626.6	O K
960 min Summer	64.062	0.362	0.0	19.4	19.4	1607.6	O K
1440 min Summer	64.055	0.355	0.0	19.4	19.4	1573.8	O K
2160 min Summer	64.042	0.342	0.0	19.3	19.3	1516.8	O K
2880 min Summer	64.027	0.327	0.0	19.2	19.2	1445.4	O K
4320 min Summer	63.991	0.291	0.0	19.1	19.1	1284.0	O K
5760 min Summer	63.954	0.254	0.0	18.9	18.9	1116.1	O K
7200 min Summer	63.918	0.218	0.0	18.7	18.7	954.6	O K
8640 min Summer	63.885	0.185	0.0	18.5	18.5	803.4	O K
10080 min Summer	63.853	0.153	0.0	18.3	18.3	665.2	O K
15 min Winter	63.853	0.153	0.0	18.3	18.3	663.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	80.658	0.0	614.4	26
30 min Summer	55.866	0.0	851.6	41
60 min Summer	36.471	0.0	1112.5	70
120 min Summer	23.036	0.0	1405.3	128
180 min Summer	17.461	0.0	1600.0	188
240 min Summer	14.308	0.0	1747.2	248
360 min Summer	10.777	0.0	1975.3	366
480 min Summer	8.802	0.0	2150.4	484
600 min Summer	7.518	0.0	2297.1	604
720 min Summer	6.607	0.0	2422.5	690
960 min Summer	5.386	0.0	2633.0	804
1440 min Summer	4.036	0.0	2959.9	1060
2160 min Summer	3.024	0.0	3324.6	1476
2880 min Summer	2.462	0.0	3613.4	1884
4320 min Summer	1.841	0.0	4050.2	2724
5760 min Summer	1.496	0.0	4391.7	3512
7200 min Summer	1.273	0.0	4672.4	4264
8640 min Summer	1.116	0.0	4912.5	5024
10080 min Summer	0.998	0.0	5122.4	5752
15 min Winter	80.658	0.0	688.1	26

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	63.910	0.210	0.0	18.6	18.6	914.6	O K
60 min Winter	63.968	0.268	0.0	18.9	18.9	1175.7	O K
120 min Winter	64.026	0.326	0.0	19.2	19.2	1441.4	O K
180 min Winter	64.059	0.359	0.0	19.4	19.4	1593.4	O K
240 min Winter	64.081	0.381	0.0	19.5	19.5	1695.1	O K
360 min Winter	64.108	0.408	0.0	19.6	19.6	1820.2	O K
480 min Winter	64.131	0.431	0.0	19.7	19.7	1888.1	O K
600 min Winter	64.153	0.453	0.0	19.9	19.9	1923.2	O K
720 min Winter	64.176	0.476	0.0	20.0	20.0	1937.1	O K
960 min Winter	64.156	0.456	0.0	19.9	19.9	1926.1	O K
1440 min Winter	64.118	0.418	0.0	19.7	19.7	1855.1	O K
2160 min Winter	64.096	0.396	0.0	19.6	19.6	1764.1	O K
2880 min Winter	64.070	0.370	0.0	19.4	19.4	1644.2	O K
4320 min Winter	64.011	0.311	0.0	19.2	19.2	1374.6	O K
5760 min Winter	63.952	0.252	0.0	18.9	18.9	1105.4	O K
7200 min Winter	63.896	0.196	0.0	18.6	18.6	854.9	O K
8640 min Winter	63.845	0.145	0.0	18.3	18.3	629.5	O K
10080 min Winter	63.800	0.100	0.0	18.1	18.1	432.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	55.866	0.0	954.2	40
60 min Winter	36.471	0.0	1245.9	70
120 min Winter	23.036	0.0	1574.4	126
180 min Winter	17.461	0.0	1790.8	184
240 min Winter	14.308	0.0	1957.3	244
360 min Winter	10.777	0.0	2211.8	358
480 min Winter	8.802	0.0	2408.1	472
600 min Winter	7.518	0.0	2573.2	586
720 min Winter	6.607	0.0	2712.2	696
960 min Winter	5.386	0.0	2948.0	906
1440 min Winter	4.036	0.0	3158.7	1134
2160 min Winter	3.024	0.0	3726.3	1604
2880 min Winter	2.462	0.0	4045.4	2056
4320 min Winter	1.841	0.0	4538.1	2944
5760 min Winter	1.496	0.0	4916.6	3752
7200 min Winter	1.273	0.0	5230.8	4544
8640 min Winter	1.116	0.0	5503.3	5280
10080 min Winter	0.998	0.0	5742.1	5960

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	15.400	Shortest Storm (mins)	15
Ratio R	0.279	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 4.077

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.294	4	8	2.331	8	12	1.381	12	16	0.070

Model Details

Storage is Online Cover Level (m) 64.700

Infiltration Basin Structure

Invert Level (m) 63.700 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	4260.0	0.700	0.0	1.400	0.0	2.100	0.0
0.100	4360.0	0.800	0.0	1.500	0.0	2.200	0.0
0.200	4460.0	0.900	0.0	1.600	0.0	2.300	0.0
0.300	4560.0	1.000	0.0	1.700	0.0	2.400	0.0
0.400	4660.0	1.100	0.0	1.800	0.0	2.500	0.0
0.500	0.0	1.200	0.0	1.900	0.0		
0.600	0.0	1.300	0.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0184-2010-2002-2010
Design Head (m)	2.002
Design Flow (l/s)	20.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	184
Invert Level (m)	62.198
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.002	20.1
Flush-Flo™	0.580	20.1
Kick-Flo®	1.235	16.0
Mean Flow over Head Range	-	17.5

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	6.5	0.800	19.7	2.000	20.1	4.000	28.0
0.200	16.7	1.000	18.8	2.200	21.0	4.500	29.6
0.300	18.7	1.200	16.6	2.400	21.9	5.000	31.1
0.400	19.6	1.400	16.9	2.600	22.7	5.500	32.6
0.500	20.0	1.600	18.0	3.000	24.4	6.000	34.0
0.600	20.1	1.800	19.1	3.500	26.2	6.500	35.3

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
7.000	36.6	8.000	39.1	9.000	41.3		
7.500	37.9	8.500	40.2	9.500	42.4		

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

Half Drain Time : 1000 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	62.331	0.131	0.0	12.5	12.5	458.9	O K
30 min Summer	62.379	0.179	0.0	12.7	12.7	633.3	O K
60 min Summer	62.429	0.229	0.0	12.9	12.9	814.6	O K
120 min Summer	62.478	0.278	0.0	13.0	13.0	998.7	O K
180 min Summer	62.506	0.306	0.0	13.1	13.1	1104.0	O K
240 min Summer	62.525	0.325	0.0	13.2	13.2	1174.4	O K
360 min Summer	62.548	0.348	0.0	13.3	13.3	1260.1	O K
480 min Summer	62.560	0.360	0.0	13.3	13.3	1306.1	O K
600 min Summer	62.566	0.366	0.0	13.3	13.3	1328.4	O K
720 min Summer	62.567	0.367	0.0	13.3	13.3	1335.2	O K
960 min Summer	62.565	0.365	0.0	13.3	13.3	1324.3	O K
1440 min Summer	62.558	0.358	0.0	13.3	13.3	1300.3	O K
2160 min Summer	62.549	0.349	0.0	13.3	13.3	1264.1	O K
2880 min Summer	62.537	0.337	0.0	13.2	13.2	1219.5	O K
4320 min Summer	62.509	0.309	0.0	13.1	13.1	1112.5	O K
5760 min Summer	62.478	0.278	0.0	13.0	13.0	997.1	O K
7200 min Summer	62.447	0.247	0.0	12.9	12.9	882.3	O K
8640 min Summer	62.417	0.217	0.0	12.8	12.8	771.7	O K
10080 min Summer	62.388	0.188	0.0	12.7	12.7	667.3	O K
15 min Winter	62.347	0.147	0.0	12.6	12.6	516.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	80.658	0.0	477.1	30
30 min Summer	55.866	0.0	662.6	44
60 min Summer	36.471	0.0	865.4	72
120 min Summer	23.036	0.0	1093.5	132
180 min Summer	17.461	0.0	1243.9	190
240 min Summer	14.308	0.0	1358.9	250
360 min Summer	10.777	0.0	1535.9	370
480 min Summer	8.802	0.0	1672.0	488
600 min Summer	7.518	0.0	1785.7	606
720 min Summer	6.607	0.0	1883.4	724
960 min Summer	5.386	0.0	2047.0	864
1440 min Summer	4.036	0.0	2153.7	1118
2160 min Summer	3.024	0.0	2587.6	1520
2880 min Summer	2.462	0.0	2807.7	1940
4320 min Summer	1.841	0.0	3150.1	2772
5760 min Summer	1.496	0.0	3410.8	3576
7200 min Summer	1.273	0.0	3631.3	4336
8640 min Summer	1.116	0.0	3819.5	5112
10080 min Summer	0.998	0.0	3984.7	5864
15 min Winter	80.658	0.0	535.2	30

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	62.401	0.201	0.0	12.8	12.8	713.3	O K
60 min Winter	62.457	0.257	0.0	13.0	13.0	919.7	O K
120 min Winter	62.514	0.314	0.0	13.2	13.2	1132.1	O K
180 min Winter	62.547	0.347	0.0	13.3	13.3	1256.6	O K
240 min Winter	62.569	0.369	0.0	13.3	13.3	1341.4	O K
360 min Winter	62.597	0.397	0.0	13.4	13.4	1450.3	O K
480 min Winter	62.617	0.417	0.0	13.5	13.5	1514.6	O K
600 min Winter	62.635	0.435	0.0	13.6	13.6	1553.1	O K
720 min Winter	62.652	0.452	0.0	13.6	13.6	1574.5	O K
960 min Winter	62.671	0.471	0.0	13.7	13.7	1585.2	O K
1440 min Winter	62.629	0.429	0.0	13.5	13.5	1542.6	O K
2160 min Winter	62.606	0.406	0.0	13.5	13.5	1481.9	O K
2880 min Winter	62.586	0.386	0.0	13.4	13.4	1408.0	O K
4320 min Winter	62.539	0.339	0.0	13.2	13.2	1228.5	O K
5760 min Winter	62.489	0.289	0.0	13.1	13.1	1039.7	O K
7200 min Winter	62.440	0.240	0.0	12.9	12.9	856.9	O K
8640 min Winter	62.394	0.194	0.0	12.7	12.7	686.6	O K
10080 min Winter	62.351	0.151	0.0	12.6	12.6	531.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	55.866	0.0	741.9	44
60 min Winter	36.471	0.0	968.7	72
120 min Winter	23.036	0.0	1224.7	130
180 min Winter	17.461	0.0	1393.3	188
240 min Winter	14.308	0.0	1521.8	246
360 min Winter	10.777	0.0	1720.3	362
480 min Winter	8.802	0.0	1872.8	478
600 min Winter	7.518	0.0	1999.4	592
720 min Winter	6.607	0.0	2109.5	704
960 min Winter	5.386	0.0	2200.1	922
1440 min Winter	4.036	0.0	2191.4	1192
2160 min Winter	3.024	0.0	2897.4	1644
2880 min Winter	2.462	0.0	3144.1	2112
4320 min Winter	1.841	0.0	3526.8	2992
5760 min Winter	1.496	0.0	3820.1	3864
7200 min Winter	1.273	0.0	4067.3	4688
8640 min Winter	1.116	0.0	4277.7	5448
10080 min Winter	0.998	0.0	4460.9	6160

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	15.400	Shortest Storm (mins)	15
Ratio R	0.279	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 3.170

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.078	8	12	1.703	16	20	0.046
4	8	0.797	12	16	0.545			

Model Details

Storage is Online Cover Level (m) 63.200

Infiltration Basin Structure

Invert Level (m) 62.200 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	3450.0	0.700	0.0	1.400	0.0	2.100	0.0
0.100	3550.0	0.800	0.0	1.500	0.0	2.200	0.0
0.200	3650.0	0.900	0.0	1.600	0.0	2.300	0.0
0.300	3750.0	1.000	0.0	1.700	0.0	2.400	0.0
0.400	3850.0	1.100	0.0	1.800	0.0	2.500	0.0
0.500	0.0	1.200	0.0	1.900	0.0		
0.600	0.0	1.300	0.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0154-1380-2000-1380
Design Head (m)	2.000
Design Flow (l/s)	13.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	154
Invert Level (m)	60.700
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	13.8
Flush-Flo™	0.584	13.7
Kick-Flo®	1.211	10.9
Mean Flow over Head Range	-	12.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.5	0.800	13.5	2.000	13.8	4.000	19.2
0.200	11.4	1.000	12.7	2.200	14.4	4.500	20.3
0.300	12.7	1.200	11.0	2.400	15.0	5.000	21.3
0.400	13.4	1.400	11.6	2.600	15.6	5.500	22.3
0.500	13.6	1.600	12.4	3.000	16.7	6.000	23.3
0.600	13.7	1.800	13.1	3.500	18.0	6.500	24.2

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
7.000	25.1	8.000	26.7	9.000	28.3		
7.500	25.9	8.500	27.5	9.500	29.0		

Appendix C

Confirmation of feasibility from Irish Water

Uisce Éireann
Bosca OP 6000
Baile Átha Cliath 1
Éire

Irish Water
PO Box 6000
Dublin 1
Ireland

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

Brendan Manning
Ormond House
Upper Ormond Quay
Dublin 7

18 April 2019

Dear Brendan Manning,

Re: Connection Reference No CDS19000027 pre-connection enquiry - Subject to contract | Contract denied

Connection for Housing Development of 600 unit(s) at Millerstown, Kilcock, Meath.

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

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

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

If you have any further questions, please contact us on **1850 278 278** or **+353 1 707 2828, 8.00am-4.30pm, Mon-Fri** or email **newconnections@water.ie**. For further information, visit **www.water.ie/connections.**

Yours sincerely,

M O'Dwyer

Maria O'Dwyer

Connections and Developer Services

Appendix D

Surface Water Permissible Outflow

PROJECT			JOB REF.
Residential Development at Millerstown, Kilcock			p190009
SUBJECT			Calc. Sheet No.
Surface Water Calculations - Permissible Site Discharge			1
Drawing ref.	Calculations by	Checked by	Date
190009	JLB	BCM	16-Oct-19

OBFL

PERMISSIBLE SURFACE WATER DISCHARGE CALCULATIONS

Site Area

What is the overall site area? **9.00** Hectares (ha) Site is Less than 50 Hectares

Pre-Development Catchment Soil Characteristics

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

Catchment (This refers to the entire site area)	1	
Area	9.00	Hectares (ha)
Drainage Group	2	Class
Depth to Impermeable Layers	2	Class
Permeability Group above Impermeable Layers	2	Class
Slope (o)	1	Class
SOIL Type	2	
[1]SOIL Index	0.30	

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

Site SOIL Index Value **0.30**

Site SPR Value **0.30**

Post-Development Catchment Characteristics

Is the development divided into sub-catchments? No

What is the overall site area for catchment? 9.00 Hectares (ha)

Catchment 1	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)	19517.5	1.00	19517.5
Roofs - Type 2 (Draining to SUDS features)	0.0	0.70	0.0
Green Roofs	0.0	0.60	0.0
Roads and Footpaths - Type 1 (Draining to gullies)	17627.0	1.00	17627.0
Roads and Footpaths - Type 2 (Draining to Suds features)	0.0	1.00	0.0
Paved Areas	0.0	0.80	0.0
Permeable Paving	7250.0	0.50	3625.0
Bioretention Areas	0.0	0.70	0.0
Grassed Areas	45605.5	0.00	0.0

Include Public Open Space in Effective Catchment Area?

Effective Catchment Area **40769.5** m^2

Effective Catchment Runoff Coefficient **0.45**

Long-Term Storage

Is long-term Storage provided? Yes

Permissible Site Discharge

What is the Standard Average Annual Rainfall (SAAR)? 830.0 mm From Met Eireann, Co-ordinates N217970, E289843

Is the overall site area less than 50 hectares? Yes

[5]$QBAR_{Rural}$ calculated for 50 ha and linearly interpolated for area of site 20.10 Litres/sec

[7]Site Discharge = **20.10** Litres/sec

Notes and Formulae

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

PROJECT			JOB REF.
Residential Development at Millerstown, Kilcock			p190009
SUBJECT			Calc. Sheet No.
Surface Water Calculations - Permissible Site Discharge			1
Drawing ref.	Calculations by	Checked by	Date
190009	JLB	BCM	16-Oct-19

PERMISSIBLE SURFACE WATER DISCHARGE CALCULATIONS

Site Area

What is the overall site area? **6.20** Hectares (ha) — Site is Less than 50 Hectares

Pre-Development Catchment Soil Characteristics

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

Catchment (This refers to the entire site area)	1	
Area	6.20	Hectares (ha)
Drainage Group	2	Class
Depth to Impermeable Layers	2	Class
Permeability Group above Impermeable Layers	2	Class
Slope (o)	1	Class
SOIL Type	**2**	
[1]SOIL Index	0.30	

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

Site SOIL Index Value **0.30**

Site SPR Value **0.30**

Post-Development Catchment Characteristics

Is the development divided into sub-catchments? No

What is the overall site area for catchment? 6.20 Hectares (ha)

Catchment 1	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)	14857.0	1.00	14857.0
Roofs - Type 2 (Draining to SUDS features)	0.0	0.70	0.0
Green Roofs	0.0	0.60	0.0
Roads and Footpaths - Type 1 (Draining to gullies)	14304.0	1.00	14304.0
Roads and Footpaths - Type 2 (Draining to Suds features)	0.0	0.50	0.0
Paved Areas	0.0	0.80	0.0
Permeable Paving	5212.5	0.50	2606.3
Bioretention Areas	0.0	0.70	0.0
Grassed Areas	27626.5	0.00	0.0

Include Public Open Space in Effective Catchment Area?

Effective Catchment Area **31767.3** m^2

Effective Catchment Runoff Coefficient **0.51**

Long-Term Storage

Is long-term Storage provided? Yes

Permissible Site Discharge

What is the Standard Average Annual Rainfall (SAAR)? 830.0 mm — From Met Eireann, Co-ordinates N217970, E289843

Is the overall site area less than 50 hectares? Yes

[5]$QBAR_{Rural}$ calculated for 50 ha and linearly interpolated for area of site 13.80 Litres/sec

[7]Site Discharge = **13.80** Litres/sec

Notes and Formulae

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

Appendix E

Surface Water Network Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for SW_1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	5	PIMP (%)	100
M5-60 (mm)	15.400	Add Flow / Climate Change (%)	20
Ratio R	0.279	Minimum Backdrop Height (m)	0.250
Maximum Rainfall (mm/hr)	100	Maximum Backdrop Height (m)	2.000
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)	500

Designed with Level Soffits

Time Area Diagram for SW_1

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.239	4-8	2.242	8-12	1.498	12-16	0.098

Total Area Contributing (ha) = 4.077

Total Pipe Volume (m³) = 269.123

Network Design Table for SW_1

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	9.255	0.080	115.7	0.022	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	9.800	0.120	81.7	0.017	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	12.413	0.150	82.8	0.027	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.003	16.832	0.200	84.2	0.019	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.004	13.443	0.100	134.4	0.053	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.005	17.532	0.210	83.5	0.028	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.006	22.894	0.340	67.3	0.045	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)
S1.000	57.59	5.13	68.375	0.022	0.0	0.0	0.7	1.21	48.3	4.0
S1.001	57.12	5.24	68.295	0.039	0.0	0.0	1.2	1.45	57.6	7.2
S1.002	56.54	5.38	68.175	0.066	0.0	0.0	2.0	1.44	57.2	12.2
S1.003	55.76	5.58	68.025	0.085	0.0	0.0	2.6	1.43	56.7	15.5
S1.004	55.01	5.78	67.825	0.138	0.0	0.0	4.1	1.13	44.8	24.7
S1.005	54.26	5.98	67.725	0.166	0.0	0.0	4.9	1.43	56.9	29.3
S1.006	53.42	6.22	67.515	0.211	0.0	0.0	6.1	1.60	63.5	36.7

Network Design Table for SW_1

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
S1.007	17.488	0.100	174.9	0.060	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.008	15.207	0.151	100.7	0.041	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.009	10.885	0.151	72.1	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S2.000	10.935	0.080	136.7	0.043	5.00	0.0	0.600	o	225	Pipe/Conduit	
S2.001	13.171	0.120	109.8	0.029	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.002	14.991	0.100	149.9	0.047	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.003	13.235	0.100	132.4	0.028	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.004	17.334	0.102	169.9	0.025	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.010	26.329	0.148	177.9	0.060	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.011	28.921	0.240	120.5	0.095	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.012	20.098	0.110	182.7	0.031	0.00	0.0	0.600	o	375	Pipe/Conduit	
S3.000	9.490	0.100	94.9	0.069	5.00	0.0	0.600	o	225	Pipe/Conduit	
S3.001	12.090	0.130	93.0	0.003	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.002	31.642	0.330	95.9	0.090	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.003	21.209	0.190	111.6	0.060	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.004	21.831	0.220	99.2	0.070	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.005	34.393	0.330	104.2	0.090	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.013	13.173	0.090	146.4	0.014	0.00	0.0	0.600	o	450	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)
S1.007	52.58	6.47	67.100	0.272	0.0	0.0	7.7	1.19	83.8	46.4
S1.008	52.05	6.63	67.000	0.312	0.0	0.0	8.8	1.57	110.7	52.8
S1.009	51.73	6.73	66.849	0.312	0.0	0.0	8.8	1.85	131.1	52.8
S2.000	57.43	5.16	67.275	0.043	0.0	0.0	1.4	1.12	44.4	8.1
S2.001	56.71	5.34	67.195	0.073	0.0	0.0	2.2	1.25	49.6	13.4
S2.002	55.79	5.57	67.075	0.120	0.0	0.0	3.6	1.07	42.4	21.7
S2.003	55.05	5.77	66.975	0.148	0.0	0.0	4.4	1.13	45.1	26.5
S2.004	54.00	6.06	66.875	0.173	0.0	0.0	5.1	1.00	39.8	30.4
S1.010	50.72	7.05	66.623	0.546	0.0	0.0	15.0	1.36	149.7	90.0
S1.011	49.85	7.34	66.475	0.642	0.0	0.0	17.3	1.65	182.2	103.9
S1.012	49.14	7.59	66.235	0.672	0.0	0.0	17.9	1.34	147.7	107.4
S3.000	57.62	5.12	67.575	0.069	0.0	0.0	2.2	1.34	53.4	13.0
S3.001	57.01	5.27	67.475	0.072	0.0	0.0	2.2	1.36	53.9	13.3
S3.002	55.45	5.66	67.345	0.162	0.0	0.0	4.9	1.34	53.1	29.3
S3.003	54.39	5.95	67.015	0.223	0.0	0.0	6.6	1.24	49.2	39.4
S3.004	53.41	6.22	66.825	0.293	0.0	0.0	8.5	1.31	52.2	50.8
S3.005	52.16	6.60	66.530	0.383	0.0	0.0	10.8	1.54	108.8	64.8
S1.013	48.77	7.73	66.050	1.069	0.0	0.0	28.2	1.68	266.9	169.4

Network Design Table for SW_1

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
S4.000	44.851	0.264	169.9	0.164	5.00	0.0	0.600	o	225	Pipe/Conduit	
S4.001	25.871	0.152	170.2	0.023	0.00	0.0	0.600	o	225	Pipe/Conduit	
S4.002	10.231	0.071	144.1	0.012	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.014	15.060	0.218	69.1	0.040	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.015	16.053	0.171	93.9	0.030	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.016	30.569	0.382	80.0	0.092	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.017	14.101	0.176	80.1	0.019	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.018	13.229	0.165	80.2	0.043	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.019	28.482	0.428	66.5	0.017	0.00	0.0	0.600	o	450	Pipe/Conduit	
S5.000	23.010	0.135	170.4	0.064	5.00	0.0	0.600	o	225	Pipe/Conduit	
S5.001	14.671	0.086	170.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S5.002	10.532	0.062	169.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S6.000	52.341	0.300	174.5	0.225	5.00	0.0	0.600	o	300	Pipe/Conduit	
S6.001	21.457	0.250	85.8	0.066	0.00	0.0	0.600	o	300	Pipe/Conduit	
S6.002	18.809	0.450	41.8	0.052	0.00	0.0	0.600	o	300	Pipe/Conduit	
S6.003	7.126	0.110	64.8	0.011	0.00	0.0	0.600	o	300	Pipe/Conduit	
S5.003	10.357	0.032	323.7	0.014	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)
S4.000	55.13	5.75	65.525	0.164	0.0	0.0	4.9	1.00	39.8	29.4
S4.001	53.57	6.18	65.261	0.187	0.0	0.0	5.4	1.00	39.7	32.6
S4.002	53.03	6.34	65.109	0.199	0.0	0.0	5.7	1.09	43.2	34.3
S1.014	48.49	7.83	64.813	1.308	0.0	0.0	34.3	2.45	389.5	206.1
S1.015	48.15	7.96	64.595	1.338	0.0	0.0	34.9	2.10	333.8	209.3
S1.016	47.56	8.18	64.424	1.430	0.0	0.0	36.8	2.27	361.7	221.0
S1.017	47.29	8.28	64.042	1.448	0.0	0.0	37.1	2.27	361.5	222.6
S1.018	47.05	8.38	63.866	1.492	0.0	0.0	38.0	2.27	361.4	228.1
S1.019	46.57	8.57	63.701	1.508	0.0	0.0	38.0	2.50	396.8	228.3
S5.000	56.53	5.38	67.325	0.064	0.0	0.0	2.0	1.00	39.7	11.7
S5.001	55.58	5.63	67.190	0.064	0.0	0.0	2.0	1.00	39.7	11.7
S5.002	54.92	5.80	67.104	0.064	0.0	0.0	2.0	1.00	39.8	11.7
S6.000	55.18	5.73	68.750	0.225	0.0	0.0	6.7	1.19	83.9	40.3
S6.001	54.40	5.95	68.450	0.290	0.0	0.0	8.6	1.70	120.0	51.3
S6.002	53.94	6.07	68.200	0.342	0.0	0.0	10.0	2.44	172.4	59.9
S6.003	53.72	6.13	67.750	0.353	0.0	0.0	10.3	1.96	138.3	61.6
S5.003	53.13	6.31	66.892	0.431	0.0	0.0	12.4	1.00	110.6	74.4

Network Design Table for SW_1

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
S5.004	17.800	0.055	323.6	0.024	0.00	0.0	0.600	o	375	Pipe/Conduit	
S5.005	32.455	0.662	49.0	0.055	0.00	0.0	0.600	o	375	Pipe/Conduit	
S5.006	28.349	0.741	38.3	0.011	0.00	0.0	0.600	o	375	Pipe/Conduit	
S7.000	12.291	0.300	41.0	0.056	5.00	0.0	0.600	o	225	Pipe/Conduit	
S7.001	27.319	0.700	39.0	0.042	0.00	0.0	0.600	o	225	Pipe/Conduit	
S7.002	10.522	0.223	47.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S5.007	29.469	0.690	42.7	0.016	0.00	0.0	0.600	o	375	Pipe/Conduit	
S8.000	24.431	0.190	128.6	0.068	5.00	0.0	0.600	o	225	Pipe/Conduit	
S8.001	22.129	0.130	170.2	0.066	0.00	0.0	0.600	o	225	Pipe/Conduit	
S8.002	26.963	0.159	169.6	0.024	0.00	0.0	0.600	o	225	Pipe/Conduit	
S8.003	20.598	0.121	170.2	0.050	0.00	0.0	0.600	o	225	Pipe/Conduit	
S8.004	45.830	0.187	245.1	0.052	0.00	0.0	0.600	o	300	Pipe/Conduit	
S8.005	8.867	0.036	246.3	0.006	0.00	0.0	0.600	o	300	Pipe/Conduit	
S8.006	10.991	0.045	244.2	0.006	0.00	0.0	0.600	o	300	Pipe/Conduit	
S5.008	12.368	0.031	405.0	0.007	0.00	0.0	0.600	o	450	Pipe/Conduit	
S9.000	15.009	0.088	170.6	0.050	5.00	0.0	0.600	o	225	Pipe/Conduit	
S9.001	12.910	0.076	169.9	0.012	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)
S5.004	52.14	6.60	66.860	0.454	0.0	0.0	12.8	1.00	110.6	77.0
S5.005	51.47	6.81	66.805	0.509	0.0	0.0	14.2	2.59	286.4	85.2
S5.006	50.97	6.97	66.143	0.521	0.0	0.0	14.4	2.94	324.4	86.2
S7.000	57.70	5.10	66.775	0.056	0.0	0.0	1.7	2.05	81.5	10.5
S7.001	56.81	5.32	66.475	0.098	0.0	0.0	3.0	2.10	83.5	18.1
S7.002	56.44	5.41	65.775	0.098	0.0	0.0	3.0	1.91	75.9	18.1
S5.007	50.43	7.15	65.402	0.635	0.0	0.0	17.3	2.78	307.0	104.0
S8.000	56.66	5.35	64.275	0.068	0.0	0.0	2.1	1.15	45.8	12.4
S8.001	55.22	5.72	64.085	0.134	0.0	0.0	4.0	1.00	39.7	24.0
S8.002	53.59	6.17	63.955	0.158	0.0	0.0	4.6	1.00	39.8	27.5
S8.003	52.43	6.52	63.796	0.208	0.0	0.0	5.9	1.00	39.7	35.4
S8.004	50.04	7.28	63.600	0.260	0.0	0.0	7.0	1.00	70.7	42.2
S8.005	49.61	7.43	63.413	0.265	0.0	0.0	7.1	1.00	70.5	42.8
S8.006	49.09	7.61	63.377	0.271	0.0	0.0	7.2	1.00	70.8	43.3
S5.008	48.52	7.82	63.182	0.913	0.0	0.0	24.0	1.00	159.7	144.0
S9.000	57.07	5.25	68.675	0.050	0.0	0.0	1.5	1.00	39.7	9.2
S9.001	56.21	5.47	68.587	0.061	0.0	0.0	1.9	1.00	39.8	11.2

Network Design Table for SW_1

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
S9.002	16.039	0.094	170.6	0.049	0.00	0.0	0.600	o	225	Pipe/Conduit	
S9.003	10.601	0.062	171.0	0.036	0.00	0.0	0.600	o	225	Pipe/Conduit	
S9.004	22.545	0.179	125.9	0.074	0.00	0.0	0.600	o	225	Pipe/Conduit	
S9.005	15.010	0.200	75.1	0.019	0.00	0.0	0.600	o	225	Pipe/Conduit	
S9.006	14.435	0.220	65.6	0.035	0.00	0.0	0.600	o	225	Pipe/Conduit	
S9.007	19.328	0.330	58.6	0.020	0.00	0.0	0.600	o	225	Pipe/Conduit	
S9.008	28.524	0.450	63.4	0.083	0.00	0.0	0.600	o	225	Pipe/Conduit	
S9.009	29.154	0.900	32.4	0.051	0.00	0.0	0.600	o	225	Pipe/Conduit	
S9.010	30.236	1.200	25.2	0.045	0.00	0.0	0.600	o	225	Pipe/Conduit	
S5.009	14.247	0.030	482.3	0.005	0.00	0.0	0.600	o	525	Pipe/Conduit	
S10.000	17.318	0.102	169.8	0.102	5.00	0.0	0.600	o	225	Pipe/Conduit	
S10.001	19.643	0.116	169.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S10.002	14.649	0.086	170.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S10.003	24.118	0.224	107.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S5.010	75.455	0.128	590.0	0.027	0.00	0.0	0.600	o	600	Pipe/Conduit	
S5.011	5.260	0.009	590.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
S11.000	34.359	1.050	32.7	0.174	5.00	0.0	0.600	o	225	Pipe/Conduit	
S11.001	7.539	0.300	25.1	0.010	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)
S9.002	55.18	5.73	68.511	0.110	0.0	0.0	3.3	1.00	39.7	19.8
S9.003	54.52	5.91	68.417	0.146	0.0	0.0	4.3	1.00	39.6	25.9
S9.004	53.38	6.23	68.355	0.220	0.0	0.0	6.4	1.16	46.3	38.2
S9.005	52.81	6.40	68.176	0.239	0.0	0.0	6.8	1.51	60.1	41.1
S9.006	52.32	6.55	67.976	0.274	0.0	0.0	7.8	1.62	64.3	46.6
S9.007	51.71	6.74	67.756	0.295	0.0	0.0	8.3	1.71	68.1	49.5
S9.008	50.80	7.03	67.426	0.378	0.0	0.0	10.4	1.65	65.4	62.4
S9.009	50.17	7.24	66.976	0.429	0.0	0.0	11.7	2.31	91.7	70.0
S9.010	49.61	7.43	66.076	0.474	0.0	0.0	12.7	2.62	104.1	76.5
S5.009	47.90	8.05	63.076	1.393	0.0	0.0	36.1	1.01	219.3	216.8
S10.000	56.92	5.29	63.875	0.102	0.0	0.0	3.1	1.00	39.8	18.8
S10.001	55.63	5.62	63.773	0.102	0.0	0.0	3.1	1.00	39.8	18.8
S10.002	54.71	5.86	63.657	0.102	0.0	0.0	3.1	1.00	39.7	18.8
S10.003	53.57	6.18	63.571	0.102	0.0	0.0	3.1	1.26	50.1	18.8
S5.010	44.83	9.31	62.972	1.522	0.0	0.0	36.9	1.00	281.4	221.7
S5.011	44.63	9.40	62.844	1.522	0.0	0.0	36.9	1.00	281.4	221.7
S11.000	57.08	5.25	66.625	0.174	0.0	0.0	5.4	2.30	91.3	32.4
S11.001	56.88	5.30	65.575	0.184	0.0	0.0	5.7	2.62	104.2	34.0

Network Design Table for SW_1

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
S11.002	14.271	0.500	28.5	0.014	0.00	0.0	0.600	o	225	Pipe/Conduit	
S11.003	9.911	0.400	24.8	0.037	0.00	0.0	0.600	o	225	Pipe/Conduit	
S11.004	5.694	0.200	28.5	0.009	0.00	0.0	0.600	o	225	Pipe/Conduit	
S5.012	6.067	0.010	590.0	0.106	0.00	0.0	0.600	o	600	Pipe/Conduit	
S5.013	60.838	0.103	590.7	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
S12.000	39.416	1.230	32.0	0.082	5.00	0.0	0.600	o	225	Pipe/Conduit	
S12.001	5.270	0.195	27.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S5.014	32.586	0.055	592.5	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
S13.000	35.198	0.207	170.0	0.059	5.00	0.0	0.600	o	225	Pipe/Conduit	
S13.001	30.520	0.180	169.6	0.034	0.00	0.0	0.600	o	225	Pipe/Conduit	
S13.002	17.017	0.100	170.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S13.003	22.604	0.286	79.0	0.025	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.020	54.770	0.061	900.0	0.063	0.00	0.0	0.600	o	900	Pipe/Conduit	
S14.000	17.920	0.200	89.6	0.054	5.00	0.0	0.600	o	225	Pipe/Conduit	
S14.001	6.838	0.090	76.0	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)
S11.002	56.49	5.39	65.275	0.198	0.0	0.0	6.1	2.46	97.7	36.4
S11.003	56.25	5.46	64.775	0.235	0.0	0.0	7.2	2.64	104.9	43.0
S11.004	56.09	5.50	64.375	0.245	0.0	0.0	7.4	2.46	97.9	44.6
S5.012	44.41	9.50	62.835	1.873	0.0	0.0	45.0	1.00	281.4	270.3
S5.013	42.32	10.52	62.825	1.873	0.0	0.0	45.0	0.99	281.3	270.3
S12.000	56.94	5.28	65.000	0.082	0.0	0.0	2.5	2.32	92.2	15.2
S12.001	56.80	5.32	63.770	0.082	0.0	0.0	2.5	2.53	100.5	15.2
S5.014	41.29	11.07	62.722	1.955	0.0	0.0	45.0	0.99	280.8	270.3
S13.000	55.74	5.59	63.815	0.059	0.0	0.0	1.8	1.00	39.8	10.6
S13.001	53.86	6.09	63.608	0.093	0.0	0.0	2.7	1.00	39.8	16.2
S13.002	52.88	6.38	63.428	0.093	0.0	0.0	2.7	1.00	39.7	16.2
S13.003	52.03	6.63	63.328	0.118	0.0	0.0	3.3	1.47	58.6	19.9
S1.020	39.76	11.95	62.367	3.644	0.0	0.0	78.5	1.04	659.2	470.9
S14.000	57.22	5.22	64.975	0.054	0.0	0.0	1.7	1.38	54.9	10.0
S14.001	56.91	5.29	64.775	0.054	0.0	0.0	1.7	1.50	59.7	10.0

Network Design Table for SW_1

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
S15.000	19.662	0.450	43.7	0.051	5.00	0.0	0.600	o	225	Pipe/Conduit	
S15.001	8.044	0.090	89.4	0.034	0.00	0.0	0.600	o	225	Pipe/Conduit	
S14.002	27.514	0.660	41.7	0.044	0.00	0.0	0.600	o	225	Pipe/Conduit	
S14.003	13.528	0.150	90.2	0.028	0.00	0.0	0.600	o	225	Pipe/Conduit	
S14.004	21.213	0.200	106.1	0.060	0.00	0.0	0.600	o	225	Pipe/Conduit	
S14.005	16.924	0.144	117.5	0.028	0.00	0.0	0.600	o	300	Pipe/Conduit	
S16.000	24.405	0.144	169.5	0.011	5.00	0.0	0.600	o	225	Pipe/Conduit	
S14.006	20.318	0.083	244.8	0.078	0.00	0.0	0.600	o	300	Pipe/Conduit	
S14.007	7.114	0.029	245.3	0.004	0.00	0.0	0.600	o	300	Pipe/Conduit	
S14.008	8.375	0.026	325.0	0.040	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.021	58.270	0.065	900.0	0.000	0.00	0.0	0.600	o	900	Pipe/Conduit	
S1.022	30.797	0.034	900.0	0.000	0.00	0.0	0.600	o	900	Pipe/Conduit	
S1.023	3.887	0.004	900.0	0.000	0.00	0.0	0.600	o	900	Pipe/Conduit	
S1.024	4.556	0.005	900.0	0.000	0.00	0.0	0.600	o	900	Pipe/Conduit	
S1.025	8.491	0.038	225.0	0.000	0.00	0.0	0.600	o	900	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)
S15.000	57.43	5.17	65.225	0.051	0.0	0.0	1.6	1.98	78.9	9.6
S15.001	57.03	5.26	64.775	0.085	0.0	0.0	2.6	1.38	55.0	15.8
S14.002	56.01	5.52	64.685	0.184	0.0	0.0	5.6	2.03	80.8	33.4
S14.003	55.38	5.68	64.025	0.211	0.0	0.0	6.3	1.38	54.8	38.0
S14.004	54.35	5.96	63.875	0.271	0.0	0.0	8.0	1.27	50.5	47.9
S14.005	53.65	6.15	63.600	0.299	0.0	0.0	8.7	1.45	102.4	52.2
S16.000	56.45	5.41	63.675	0.011	0.0	0.0	0.3	1.00	39.8	2.1
S14.006	52.50	6.49	63.456	0.389	0.0	0.0	11.1	1.00	70.7	66.3
S14.007	52.11	6.61	63.373	0.393	0.0	0.0	11.1	1.00	70.6	66.5
S14.008	51.66	6.75	63.269	0.433	0.0	0.0	12.1	1.00	110.4	72.7
S1.021	38.28	12.89	62.306	4.077	0.0	0.0	84.5	1.04	659.2	507.2
S1.022	37.55	13.38	62.241	4.077	0.0	0.0	84.5	1.04	659.2	507.2
S1.023	37.46	13.45	62.207	4.077	0.0	0.0	84.5	1.04	659.2	507.2
S1.024	37.36	13.52	62.203	4.077	0.0	0.0	84.5	1.04	659.2	507.2
S1.025	37.26	13.59	62.198	4.077	0.0	0.0	84.5	2.08	1326.3	507.2

Free Flowing Outfall Details for SW_1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.025	SSA0	64.000	62.160	0.000	0	0

Storage Structures for SW_1

Infiltration Basin Manhole: SSA4, DS/PN: S1.022

Invert Level (m) 62.800 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	4260.0	0.700	0.0	1.400	0.0	2.100	0.0
0.100	4360.0	0.800	0.0	1.500	0.0	2.200	0.0
0.200	4460.0	0.900	0.0	1.600	0.0	2.300	0.0
0.300	4560.0	1.000	0.0	1.700	0.0	2.400	0.0
0.400	4660.0	1.100	0.0	1.800	0.0	2.500	0.0
0.500	0.0	1.200	0.0	1.900	0.0		
0.600	0.0	1.300	0.0	2.000	0.0		

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for SW_2

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	5	PIMP (%)	100
M5-60 (mm)	15.400	Add Flow / Climate Change (%)	20
Ratio R	0.279	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	100	Maximum Backdrop Height (m)	2.000
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)	500

Designed with Level Soffits

Time Area Diagram for SW_2

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.098	4-8	0.875	8-12	1.680	12-16	0.480	16-20	0.036

Total Area Contributing (ha) = 3.170

Total Pipe Volume (m³) = 242.781

Network Design Table for SW_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
1.000	67.145	0.395	170.0	0.178	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	49.439	0.291	169.9	0.058	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	10.672	0.063	169.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
2.000	30.628	0.449	68.2	0.035	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	31.169	0.127	245.4	0.056	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	53.78	6.12	63.706	0.178	0.0	0.0	5.2	1.00	39.8	31.1
1.001	51.06	6.94	63.311	0.236	0.0	0.0	6.5	1.00	39.8	39.2
1.002	50.51	7.12	63.020	0.236	0.0	0.0	6.5	1.00	39.8	39.2
2.000	56.78	5.32	63.481	0.035	0.0	0.0	1.1	1.59	63.0	6.5
1.003	49.01	7.64	62.882	0.328	0.0	0.0	8.7	1.00	70.6	52.2

Network Design Table for SW_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
1.004	27.815	0.114	244.0	0.019	0.00	0.0	0.600	o	300	Pipe/Conduit	
3.000	29.056	0.715	40.6	0.090	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.005	11.290	0.046	245.4	0.009	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.006	9.259	0.038	243.7	0.015	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.007	8.022	0.025	320.9	0.021	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.008	16.774	0.052	322.6	0.016	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.009	18.110	0.096	188.6	0.052	0.00	0.0	0.600	o	375	Pipe/Conduit	
4.000	27.089	0.487	55.6	0.067	5.00	0.0	0.600	o	225	Pipe/Conduit	
5.000	23.351	0.137	170.4	0.073	5.00	0.0	0.600	o	225	Pipe/Conduit	
4.001	7.118	0.042	169.5	0.017	0.00	0.0	0.600	o	225	Pipe/Conduit	
4.002	4.702	0.043	109.3	0.048	0.00	0.0	0.600	o	225	Pipe/Conduit	
4.003	6.852	0.029	236.3	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
4.004	31.114	0.184	169.1	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
4.005	10.413	0.350	29.8	0.042	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.010	19.353	0.048	405.0	0.011	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.011	9.407	0.023	409.0	0.069	0.00	0.0	0.600	o	450	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)
1.004	47.76	8.10	62.755	0.346	0.0	0.0	9.0	1.00	70.8	53.8
3.000	57.14	5.24	63.503	0.090	0.0	0.0	2.8	2.06	81.8	16.7
1.005	47.27	8.29	62.641	0.445	0.0	0.0	11.4	1.00	70.6	68.4
1.006	46.88	8.45	62.595	0.461	0.0	0.0	11.7	1.00	70.9	70.2
1.007	46.55	8.58	62.482	0.482	0.0	0.0	12.2	1.01	111.1	72.9
1.008	45.88	8.86	62.457	0.498	0.0	0.0	12.4	1.00	110.8	74.3
1.009	45.34	9.09	62.405	0.550	0.0	0.0	13.5	1.32	145.3	81.1
4.000	57.05	5.26	63.594	0.067	0.0	0.0	2.1	1.76	69.9	12.4
5.000	56.51	5.39	63.313	0.073	0.0	0.0	2.2	1.00	39.7	13.4
4.001	56.04	5.51	63.107	0.157	0.0	0.0	4.8	1.00	39.8	28.7
4.002	55.80	5.57	63.065	0.205	0.0	0.0	6.2	1.25	49.7	37.3
4.003	55.37	5.68	62.947	0.205	0.0	0.0	6.2	1.02	72.0	37.3
4.004	53.80	6.11	62.918	0.205	0.0	0.0	6.2	1.21	85.3	37.3
4.005	53.59	6.17	62.734	0.247	0.0	0.0	7.2	2.89	204.5	43.0
1.010	44.62	9.41	62.234	0.809	0.0	0.0	19.5	1.00	159.7	117.3
1.011	44.28	9.56	62.186	0.878	0.0	0.0	21.1	1.00	158.9	126.3

Network Design Table for SW_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
1.012	26.429	0.065	406.6	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
6.000	25.409	0.708	35.9	0.024	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.013	4.580	0.017	269.4	0.033	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.014	4.591	0.017	270.1	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
7.000	23.993	0.702	34.2	0.048	5.00	0.0	0.600	o	225	Pipe/Conduit	
7.001	7.578	0.345	22.0	0.008	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.015	32.479	0.087	373.3	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.016	65.007	0.311	209.0	0.148	0.00	0.0	0.600	o	450	Pipe/Conduit	
8.000	21.027	0.124	169.6	0.052	5.00	0.0	0.600	o	225	Pipe/Conduit	
8.001	26.934	0.353	76.3	0.049	0.00	0.0	0.600	o	225	Pipe/Conduit	
8.002	28.083	0.368	76.3	0.052	0.00	0.0	0.600	o	225	Pipe/Conduit	
8.003	9.795	0.128	76.3	0.009	0.00	0.0	0.600	o	225	Pipe/Conduit	
9.000	23.356	0.137	170.5	0.047	5.00	0.0	0.600	o	225	Pipe/Conduit	
9.001	38.724	0.228	169.8	0.133	0.00	0.0	0.600	o	225	Pipe/Conduit	
9.002	8.360	0.049	170.6	0.009	0.00	0.0	0.600	o	225	Pipe/Conduit	
9.003	13.010	0.077	169.0	0.019	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)
1.012	43.35	10.00	62.163	0.878	0.0	0.0	21.1	1.00	159.4	126.3
6.000	57.31	5.19	63.268	0.024	0.0	0.0	0.7	2.19	87.1	4.4
1.013	43.22	10.07	62.098	0.934	0.0	0.0	21.9	1.23	196.2	131.2
1.014	43.10	10.13	62.081	0.934	0.0	0.0	21.9	1.23	196.0	131.2
7.000	57.37	5.18	63.336	0.048	0.0	0.0	1.5	2.25	89.3	8.9
7.001	57.19	5.22	62.634	0.055	0.0	0.0	1.7	2.80	111.5	10.3
1.015	42.08	10.65	62.064	0.990	0.0	0.0	22.6	1.05	166.4	135.3
1.016	40.67	11.42	61.977	1.137	0.0	0.0	25.0	1.40	223.0	150.3
8.000	56.67	5.35	63.713	0.052	0.0	0.0	1.6	1.00	39.8	9.6
8.001	55.50	5.65	63.589	0.101	0.0	0.0	3.0	1.50	59.6	18.2
8.002	54.34	5.96	63.236	0.153	0.0	0.0	4.5	1.50	59.6	27.0
8.003	53.95	6.07	62.868	0.162	0.0	0.0	4.7	1.50	59.6	28.4
9.000	56.51	5.39	63.720	0.047	0.0	0.0	1.4	1.00	39.7	8.6
9.001	54.08	6.04	63.583	0.179	0.0	0.0	5.3	1.00	39.8	31.5
9.002	53.58	6.17	63.355	0.188	0.0	0.0	5.5	1.00	39.7	32.8
9.003	52.84	6.39	63.306	0.207	0.0	0.0	5.9	1.00	39.9	35.6

Network Design Table for SW_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
9.004	6.934	0.073	95.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
10.000	19.324	0.114	169.5	0.080	5.00	0.0	0.600	o	225	Pipe/Conduit	
10.001	10.566	0.123	85.9	0.004	0.00	0.0	0.600	o	225	Pipe/Conduit	
9.005	7.417	0.030	247.2	0.064	0.00	0.0	0.600	o	300	Pipe/Conduit	
9.006	61.313	0.250	245.3	0.084	0.00	0.0	0.600	o	300	Pipe/Conduit	
9.007	23.860	0.136	175.4	0.029	0.00	0.0	0.600	o	300	Pipe/Conduit	
8.004	20.111	0.062	324.4	0.024	0.00	0.0	0.600	o	375	Pipe/Conduit	
8.005	44.903	0.787	57.1	0.090	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.017	10.654	0.018	590.0	0.008	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.018	10.259	0.017	590.0	0.015	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.019	13.405	0.023	590.0	0.013	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.020	11.122	0.019	590.0	0.043	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.021	36.422	0.062	590.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.022	6.513	0.011	590.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
11.000	83.181	0.553	150.4	0.140	5.00	0.0	0.600	o	225	Pipe/Conduit	
11.001	7.020	0.041	171.2	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)
9.004	52.55	6.48	63.229	0.207	0.0	0.0	5.9	1.34	53.4	35.6
10.000	56.79	5.32	63.393	0.080	0.0	0.0	2.5	1.00	39.8	14.8
10.001	56.29	5.45	63.279	0.084	0.0	0.0	2.6	1.41	56.1	15.4
9.005	52.14	6.60	63.081	0.355	0.0	0.0	10.0	1.00	70.4	60.2
9.006	49.05	7.62	63.051	0.439	0.0	0.0	11.7	1.00	70.6	69.9
9.007	48.14	7.96	62.801	0.468	0.0	0.0	12.2	1.18	83.7	73.1
8.004	47.26	8.29	62.590	0.653	0.0	0.0	16.7	1.00	110.5	100.3
8.005	46.48	8.61	62.528	0.743	0.0	0.0	18.7	2.40	265.4	112.2
1.017	40.36	11.60	61.516	1.887	0.0	0.0	41.3	1.00	281.4	247.6
1.018	40.07	11.77	61.498	1.902	0.0	0.0	41.3	1.00	281.4	247.7
1.019	39.69	11.99	61.480	1.915	0.0	0.0	41.3	1.00	281.4	247.7
1.020	39.39	12.18	61.458	1.959	0.0	0.0	41.8	1.00	281.4	250.7
1.021	38.43	12.79	61.439	1.959	0.0	0.0	41.8	1.00	281.4	250.7
1.022	38.27	12.90	61.377	1.959	0.0	0.0	41.8	1.00	281.4	250.7
11.000	53.14	6.30	63.874	0.140	0.0	0.0	4.0	1.06	42.3	24.3
11.001	52.74	6.42	63.321	0.140	0.0	0.0	4.0	1.00	39.6	24.3

Network Design Table for SW_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
1.023	40.812	0.069	590.0	0.064	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.024	9.221	0.016	576.3	0.063	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.025	21.851	0.037	590.0	0.024	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.026	24.990	0.042	590.0	0.035	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.027	36.657	0.113	325.3	0.023	0.00	0.0	0.600	o	600	Pipe/Conduit	
12.000	51.267	1.282	40.0	0.129	5.00	0.0	0.600	o	225	Pipe/Conduit	
12.001	7.342	0.245	30.0	0.013	0.00	0.0	0.600	o	225	Pipe/Conduit	
12.002	12.719	0.585	21.7	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.028	39.395	0.067	588.0	0.049	0.00	0.0	0.600	o	600	Pipe/Conduit	
13.000	15.075	0.089	169.4	0.026	5.00	0.0	0.600	o	225	Pipe/Conduit	
13.001	12.686	0.075	169.1	0.009	0.00	0.0	0.600	o	225	Pipe/Conduit	
13.002	13.531	0.080	169.1	0.010	0.00	0.0	0.600	o	225	Pipe/Conduit	
13.003	18.466	0.109	169.4	0.014	0.00	0.0	0.600	o	225	Pipe/Conduit	
14.000	47.043	0.641	73.4	0.092	5.00	0.0	0.600	o	225	Pipe/Conduit	
15.000	23.855	0.140	170.4	0.055	5.00	0.0	0.600	o	225	Pipe/Conduit	
15.001	6.035	0.036	167.6	0.004	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)
1.023	37.27	13.58	61.366	2.164	0.0	0.0	43.7	1.00	281.4	262.1
1.024	37.06	13.73	61.297	2.227	0.0	0.0	44.7	1.01	284.8	268.2
1.025	36.56	14.10	61.281	2.251	0.0	0.0	44.7	1.00	281.4	268.2
1.026	36.01	14.52	61.244	2.286	0.0	0.0	44.7	1.00	281.4	268.2
1.027	35.43	14.97	61.201	2.310	0.0	0.0	44.7	1.34	380.2	268.2
12.000	56.42	5.41	63.576	0.129	0.0	0.0	3.9	2.07	82.5	23.6
12.001	56.22	5.46	62.294	0.142	0.0	0.0	4.3	2.40	95.4	25.9
12.002	55.93	5.54	62.049	0.142	0.0	0.0	4.3	2.82	112.1	25.9
1.028	34.64	15.63	61.089	2.500	0.0	0.0	46.9	1.00	281.9	281.4
13.000	57.07	5.25	63.200	0.026	0.0	0.0	0.8	1.00	39.8	4.9
13.001	56.23	5.46	63.111	0.035	0.0	0.0	1.1	1.00	39.9	6.5
13.002	55.36	5.69	63.036	0.046	0.0	0.0	1.4	1.00	39.9	8.2
13.003	54.22	5.99	62.956	0.060	0.0	0.0	1.8	1.00	39.8	10.5
14.000	56.03	5.51	63.680	0.092	0.0	0.0	2.8	1.53	60.8	16.8
15.000	56.48	5.40	63.000	0.055	0.0	0.0	1.7	1.00	39.7	10.1
15.001	56.08	5.50	62.860	0.059	0.0	0.0	1.8	1.01	40.0	10.8

Network Design Table for SW_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
14.001	22.918	0.135	169.8	0.020	0.00	0.0	0.600	o	225	Pipe/Conduit	
14.002	16.264	0.096	169.4	0.031	0.00	0.0	0.600	o	225	Pipe/Conduit	
13.004	17.157	0.070	245.1	0.013	0.00	0.0	0.600	o	300	Pipe/Conduit	
13.005	16.780	0.068	246.8	0.013	0.00	0.0	0.600	o	300	Pipe/Conduit	
13.006	10.875	0.044	247.2	0.008	0.00	0.0	0.600	o	300	Pipe/Conduit	
13.007	19.330	0.112	172.6	0.035	0.00	0.0	0.600	o	300	Pipe/Conduit	
16.000	26.734	0.510	52.4	0.045	5.00	0.0	0.600	o	225	Pipe/Conduit	
13.008	14.931	0.061	244.8	0.012	0.00	0.0	0.600	o	300	Pipe/Conduit	
13.009	21.108	0.086	245.4	0.042	0.00	0.0	0.600	o	300	Pipe/Conduit	
13.010	27.177	0.111	244.8	0.016	0.00	0.0	0.600	o	300	Pipe/Conduit	
13.011	28.058	0.086	326.3	0.049	0.00	0.0	0.600	o	375	Pipe/Conduit	
13.012	25.281	0.078	324.1	0.056	0.00	0.0	0.600	o	375	Pipe/Conduit	
17.000	36.150	0.889	40.7	0.087	5.00	0.0	0.600	o	225	Pipe/Conduit	
17.001	7.382	0.060	123.0	0.032	0.00	0.0	0.600	o	225	Pipe/Conduit	
13.013	29.384	0.091	322.9	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
13.014	147.175	0.453	324.9	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
14.001	54.58	5.89	62.824	0.172	0.0	0.0	5.1	1.00	39.8	30.5
14.002	53.61	6.17	62.689	0.203	0.0	0.0	5.9	1.00	39.8	35.4
13.004	52.64	6.45	62.518	0.275	0.0	0.0	7.9	1.00	70.7	47.1
13.005	51.72	6.73	62.448	0.288	0.0	0.0	8.1	1.00	70.4	48.4
13.006	51.15	6.91	62.380	0.296	0.0	0.0	8.2	1.00	70.4	49.3
13.007	50.32	7.18	62.336	0.332	0.0	0.0	9.0	1.19	84.4	54.3
16.000	57.09	5.25	62.809	0.045	0.0	0.0	1.4	1.81	72.0	8.3
13.008	49.60	7.43	62.224	0.389	0.0	0.0	10.4	1.00	70.7	62.6
13.009	48.61	7.78	62.163	0.430	0.0	0.0	11.3	1.00	70.6	68.0
13.010	47.41	8.24	62.077	0.446	0.0	0.0	11.5	1.00	70.7	68.7
13.011	46.24	8.71	61.891	0.495	0.0	0.0	12.4	1.00	110.2	74.3
13.012	45.25	9.13	61.805	0.551	0.0	0.0	13.5	1.00	110.5	81.0
17.000	56.90	5.29	63.430	0.087	0.0	0.0	2.7	2.06	81.8	16.1
17.001	56.48	5.40	62.541	0.119	0.0	0.0	3.6	1.18	46.8	21.8
13.013	44.17	9.62	61.727	0.670	0.0	0.0	16.0	1.00	110.8	96.1
13.014	39.57	12.07	61.636	0.670	0.0	0.0	16.0	1.00	110.4	96.1

Network Design Table for SW_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
1.029	36.986	0.049	750.0	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.030	20.764	0.028	750.0	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.031	3.227	0.004	750.0	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.032	3.277	0.004	750.0	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.033	36.885	0.164	225.0	0.000	0.00	0.0	0.600	o	750	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)
1.029	33.94	16.24	60.808	3.170	0.0	0.0	58.3	1.01	448.0	349.7
1.030	33.57	16.58	60.759	3.170	0.0	0.0	58.3	1.01	448.0	349.7
1.031	33.51	16.63	60.731	3.170	0.0	0.0	58.3	1.01	448.0	349.7
1.032	33.45	16.69	60.727	3.170	0.0	0.0	58.3	1.01	448.0	349.7
1.033	33.10	17.02	60.722	3.170	0.0	0.0	58.3	1.86	822.4	349.7

Free Flowing Outfall Details for SW_2

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.033	SB0	62.500	60.558	0.000	0	0

Storage Structures for SW_2

Infiltration Basin Manhole: SB3, DS/PN: 1.031

Invert Level (m) 62.000 Safety Factor 10.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	3450.0	0.700	0.0	1.400	0.0	2.100	0.0
0.100	3550.0	0.800	0.0	1.500	0.0	2.200	0.0
0.200	3650.0	0.900	0.0	1.600	0.0	2.300	0.0
0.300	3750.0	1.000	0.0	1.700	0.0	2.400	0.0
0.400	3850.0	1.100	0.0	1.800	0.0	2.500	0.0
0.500	0.0	1.200	0.0	1.900	0.0		
0.600	0.0	1.300	0.0	2.000	0.0		

Appendix F

Foul Sewer Network Calculations

FOUL SEWERAGE DESIGN

Design Criteria for FS_1

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	10
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.200
Calculation Method	EN 752	Maximum Backdrop Height (m)	2.000
Frequency Factor	0.50	Min Design Depth for Optimisation (m)	1.200
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	0.75
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for FS_1

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	20.154	0.438	46.0	0.000	9.9	0.0	1.500	o	150	Pipe/Conduit	
1.001	16.886	0.272	62.1	0.000	9.9	0.0	1.500	o	150	Pipe/Conduit	
1.002	20.800	0.277	75.1	0.000	9.9	0.0	1.500	o	150	Pipe/Conduit	
1.003	20.971	0.280	74.9	0.000	9.9	0.0	1.500	o	225	Pipe/Conduit	
1.004	14.459	0.181	79.9	0.000	6.6	0.0	1.500	o	225	Pipe/Conduit	
1.005	14.675	0.173	84.8	0.000	9.9	0.0	1.500	o	225	Pipe/Conduit	
1.006	15.538	0.173	89.8	0.000	6.6	0.0	1.500	o	225	Pipe/Conduit	
1.007	9.128	0.272	33.6	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
2.000	13.488	0.346	39.0	0.000	6.6	0.0	1.500	o	150	Pipe/Conduit	
2.001	13.147	0.212	62.0	0.000	13.2	0.0	1.500	o	150	Pipe/Conduit	
2.002	11.445	0.164	69.8	0.000	6.6	0.0	1.500	o	150	Pipe/Conduit	
2.003	11.392	0.146	78.0	0.000	6.6	0.0	1.500	o	150	Pipe/Conduit	
2.004	20.185	0.297	68.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	68.350	0.000	0.0	9.9	0.2	28	0.75	1.29	22.9	1.7
1.001	67.912	0.000	0.0	19.8	0.2	36	0.75	1.11	19.7	2.4
1.002	67.640	0.000	0.0	29.7	0.3	42	0.75	1.01	17.9	3.0
1.003	67.288	0.000	0.0	39.6	0.3	39	0.75	1.33	52.8	3.5
1.004	67.008	0.000	0.0	46.2	0.3	41	0.75	1.28	51.1	3.7
1.005	66.827	0.000	0.0	56.1	0.4	44	0.75	1.25	49.6	4.1
1.006	66.654	0.000	0.0	62.7	0.4	46	0.75	1.21	48.2	4.4
1.007	66.481	0.000	0.0	62.7	0.4	36	1.06	1.98	78.9	4.4
2.000	67.450	0.000	0.0	6.6	0.1	25	0.75	1.41	24.8	1.4
2.001	67.104	0.000	0.0	19.8	0.2	36	0.75	1.11	19.7	2.4
2.002	66.892	0.000	0.0	26.4	0.3	40	0.75	1.05	18.5	2.8
2.003	66.728	0.000	0.0	33.0	0.3	43	0.75	0.99	17.5	3.2
2.004	66.507	0.000	0.0	33.0	0.3	37	0.75	1.39	55.4	3.2

Network Design Table for FS_1

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.008	26.816	0.233	115.1	0.000	16.5	0.0	1.500	o	225	Pipe/Conduit	
1.009	33.204	0.266	124.8	0.000	26.4	0.0	1.500	o	225	Pipe/Conduit	
1.010	15.762	0.126	125.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
3.000	16.838	0.234	72.0	0.000	26.4	0.0	1.500	o	150	Pipe/Conduit	
3.001	21.927	0.274	80.0	0.000	23.1	0.0	1.500	o	225	Pipe/Conduit	
3.002	24.040	0.253	95.0	0.000	19.8	0.0	1.500	o	225	Pipe/Conduit	
3.003	22.597	0.222	101.8	0.000	16.5	0.0	1.500	o	225	Pipe/Conduit	
3.004	33.239	0.316	105.2	0.000	16.5	0.0	1.500	o	225	Pipe/Conduit	
1.011	13.918	0.127	109.6	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
4.000	46.078	0.576	80.0	0.000	49.5	0.0	1.500	o	225	Pipe/Conduit	
4.001	22.303	0.279	79.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
4.002	8.086	0.101	80.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.012	16.327	0.096	170.1	0.000	13.2	0.0	1.500	o	225	Pipe/Conduit	
1.013	16.688	0.098	170.3	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.014	27.234	0.156	174.6	0.000	26.4	0.0	1.500	o	225	Pipe/Conduit	
5.000	15.376	0.394	39.0	0.000	6.6	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.008	66.209	0.000	0.0	112.2	0.5	56	0.75	1.07	42.5	5.8
1.009	65.976	0.000	0.0	138.6	0.6	61	0.75	1.03	40.8	6.5
1.010	65.710	0.000	0.0	138.6	0.6	61	0.75	1.03	40.8	6.5
3.000	67.550	0.000	0.0	26.4	0.3	40	0.75	1.03	18.3	2.8
3.001	67.241	0.000	0.0	49.5	0.4	42	0.75	1.28	51.0	3.9
3.002	66.967	0.000	0.0	69.3	0.4	48	0.75	1.18	46.8	4.6
3.003	66.714	0.000	0.0	85.8	0.5	51	0.75	1.14	45.2	5.1
3.004	65.900	0.000	0.0	102.3	0.5	54	0.76	1.12	44.5	5.6
1.011	65.584	0.000	0.0	240.9	0.8	68	0.85	1.10	43.6	8.5
4.000	65.515	0.000	0.0	49.5	0.4	42	0.75	1.28	51.1	3.9
4.001	64.939	0.000	0.0	49.5	0.4	42	0.75	1.28	51.1	3.9
4.002	64.660	0.000	0.0	49.5	0.4	42	0.75	1.28	51.0	3.9
1.012	64.559	0.000	0.0	303.6	0.9	80	0.75	0.88	34.9	9.6
1.013	64.463	0.000	0.0	303.6	0.9	80	0.75	0.88	34.9	9.6
1.014	64.365	0.000	0.0	330.0	0.9	83	0.75	0.87	34.5	10.0
5.000	64.950	0.000	0.0	6.6	0.1	25	0.75	1.41	24.8	1.4

Network Design Table for FS_1

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
5.001	10.885	0.209	52.1	0.000	6.6	0.0	1.500	o	150	Pipe/Conduit	
5.002	13.973	0.269	51.9	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
1.015	8.735	0.049	178.3	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.016	12.246	0.068	180.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.017	12.671	0.070	181.0	0.000	13.2	0.0	1.500	o	225	Pipe/Conduit	
1.018	25.979	0.153	170.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
6.000	12.038	0.177	68.0	0.000	23.1	0.0	1.500	o	150	Pipe/Conduit	
6.001	6.892	0.101	68.2	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
7.000	18.290	0.345	53.0	0.000	13.2	0.0	1.500	o	150	Pipe/Conduit	
7.001	8.976	0.280	32.1	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
6.002	7.445	0.099	75.2	0.000	6.6	0.0	1.500	o	225	Pipe/Conduit	
6.003	20.456	0.436	46.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
6.004	12.742	0.159	80.1	0.000	6.6	0.0	1.500	o	225	Pipe/Conduit	
6.005	20.770	0.219	94.8	0.000	23.1	0.0	1.500	o	225	Pipe/Conduit	
6.006	15.111	0.194	77.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
8.000	28.272	0.321	88.1	0.000	59.4	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
5.001	64.556	0.000	0.0	13.2	0.2	31	0.76	1.22	21.5	2.0
5.002	63.900	0.000	0.0	13.2	0.2	31	0.76	1.22	21.5	2.0
1.015	63.556	0.000	0.0	343.2	0.9	84	0.75	0.86	34.1	10.2
1.016	63.507	0.000	0.0	343.2	0.9	84	0.75	0.85	34.0	10.2
1.017	63.439	0.000	0.0	356.4	0.9	85	0.75	0.85	33.9	10.4
1.018	63.369	0.000	0.0	356.4	0.9	84	0.77	0.88	35.0	10.4
6.000	65.250	0.000	0.0	23.1	0.2	38	0.75	1.06	18.8	2.6
6.001	65.073	0.000	0.0	23.1	0.2	38	0.75	1.06	18.8	2.6
7.000	65.100	0.000	0.0	13.2	0.2	31	0.75	1.20	21.3	2.0
7.001	64.300	0.000	0.0	13.2	0.2	28	0.89	1.55	27.4	2.0
6.002	63.945	0.000	0.0	42.9	0.3	40	0.75	1.32	52.7	3.6
6.003	63.846	0.000	0.0	42.9	0.3	36	0.89	1.68	66.7	3.6
6.004	63.410	0.000	0.0	49.5	0.4	42	0.75	1.28	51.0	3.9
6.005	63.251	0.000	0.0	72.6	0.4	48	0.75	1.18	46.9	4.7
6.006	63.032	0.000	0.0	72.6	0.4	46	0.81	1.30	51.7	4.7
8.000	63.300	0.000	0.0	59.4	0.4	45	0.75	1.22	48.6	4.2

Network Design Table for FS_1

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
6.007	23.263	0.191	121.8	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
6.008	6.250	0.051	122.5	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
6.009	58.160	0.477	121.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.000	39.894	0.407	98.0	0.000	56.1	0.0	1.500	o	150	Pipe/Conduit	
9.001	28.354	0.334	84.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.002	21.055	0.409	51.5	0.000	6.6	0.0	1.500	o	225	Pipe/Conduit	
9.003	6.611	0.063	104.9	0.000	29.7	0.0	1.500	o	225	Pipe/Conduit	
10.000	21.742	0.473	46.0	0.000	9.9	0.0	1.500	o	150	Pipe/Conduit	
10.001	17.401	0.378	46.0	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
10.002	12.648	0.275	46.0	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
9.004	7.170	0.065	110.3	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.005	16.330	0.148	110.3	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.006	61.967	0.553	112.1	0.000	6.6	0.0	1.500	o	225	Pipe/Conduit	
11.000	12.798	0.328	39.0	0.000	6.6	0.0	1.500	o	150	Pipe/Conduit	
11.001	36.756	0.525	70.0	0.000	19.8	0.0	1.500	o	150	Pipe/Conduit	
9.007	23.144	0.210	110.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
6.007	62.838	0.000	0.0	132.0	0.6	60	0.75	1.04	41.3	6.3
6.008	62.647	0.000	0.0	132.0	0.6	60	0.75	1.04	41.2	6.3
6.009	62.596	0.000	0.0	132.0	0.6	60	0.75	1.04	41.3	6.3
9.000	69.000	0.000	0.0	56.1	0.4	53	0.75	0.88	15.6	4.1
9.001	68.518	0.000	0.0	56.1	0.4	44	0.75	1.25	49.6	4.1
9.002	68.184	0.000	0.0	62.7	0.4	40	0.91	1.60	63.7	4.4
9.003	67.775	0.000	0.0	92.4	0.5	52	0.75	1.12	44.5	5.3
10.000	67.350	0.000	0.0	9.9	0.2	28	0.75	1.29	22.9	1.7
10.001	66.877	0.000	0.0	9.9	0.2	28	0.75	1.29	22.9	1.7
10.002	66.499	0.000	0.0	9.9	0.2	28	0.75	1.29	22.9	1.7
9.004	66.149	0.000	0.0	102.3	0.5	54	0.75	1.09	43.4	5.6
9.005	66.084	0.000	0.0	102.3	0.5	54	0.75	1.09	43.4	5.6
9.006	64.500	0.000	0.0	108.9	0.5	56	0.75	1.08	43.1	5.7
11.000	66.850	0.000	0.0	6.6	0.1	25	0.75	1.41	24.8	1.4
11.001	66.522	0.000	0.0	26.4	0.3	40	0.75	1.05	18.5	2.8
9.007	63.947	0.000	0.0	135.3	0.6	58	0.78	1.09	43.5	6.4

Network Design Table for FS_1

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
12.000	20.898	0.279	74.9	0.000	39.6	0.0	1.500	o	225	Pipe/Conduit	
12.001	51.171	0.502	101.9	0.000	46.2	0.0	1.500	o	225	Pipe/Conduit	
12.002	19.073	0.166	114.9	0.000	33.0	0.0	1.500	o	225	Pipe/Conduit	
12.003	46.002	0.368	125.0	0.000	26.4	0.0	1.500	o	225	Pipe/Conduit	
12.004	7.921	0.063	125.7	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
12.005	12.163	0.097	125.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.008	16.918	0.112	151.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
13.000	16.357	0.419	39.0	0.000	6.6	0.0	1.500	o	150	Pipe/Conduit	
13.001	22.413	0.423	53.0	0.000	6.6	0.0	1.500	o	150	Pipe/Conduit	
13.002	32.915	0.387	85.1	0.000	26.4	0.0	1.500	o	150	Pipe/Conduit	
13.003	16.584	0.188	88.2	0.000	23.1	0.0	1.500	o	225	Pipe/Conduit	
13.004	8.107	0.092	88.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
13.005	8.738	0.099	88.3	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
13.006	14.832	0.151	98.2	0.000	13.2	0.0	1.500	o	225	Pipe/Conduit	
13.007	14.425	0.147	98.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
13.008	39.321	0.777	50.6	0.000	23.1	0.0	1.500	o	225	Pipe/Conduit	
13.009	29.432	0.655	44.9	0.000	26.4	0.0	1.500	o	225	Pipe/Conduit	
13.010	23.059	1.000	23.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.009	20.568	0.108	190.4	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
12.000	63.955	0.000	0.0	39.6	0.3	39	0.75	1.33	52.8	3.5
12.001	63.676	0.000	0.0	85.8	0.5	51	0.75	1.14	45.2	5.1
12.002	63.174	0.000	0.0	118.8	0.5	57	0.75	1.07	42.6	6.0
12.003	63.008	0.000	0.0	145.2	0.6	61	0.75	1.03	40.8	6.6
12.004	62.640	0.000	0.0	145.2	0.6	62	0.75	1.02	40.7	6.6
12.005	62.577	0.000	0.0	145.2	0.6	61	0.75	1.03	40.8	6.6
9.008	62.480	0.000	0.0	280.5	0.8	76	0.77	0.93	37.1	9.2
13.000	68.570	0.000	0.0	6.6	0.1	25	0.75	1.40	24.8	1.4
13.001	68.151	0.000	0.0	13.2	0.2	31	0.75	1.21	21.3	2.0
13.002	67.728	0.000	0.0	39.6	0.3	46	0.75	0.95	16.8	3.5
13.003	67.266	0.000	0.0	62.7	0.4	46	0.76	1.22	48.6	4.4
13.004	67.078	0.000	0.0	62.7	0.4	45	0.75	1.22	48.6	4.4
13.005	66.986	0.000	0.0	62.7	0.4	46	0.76	1.22	48.6	4.4
13.006	66.887	0.000	0.0	75.9	0.4	49	0.75	1.16	46.1	4.8
13.007	66.736	0.000	0.0	75.9	0.4	49	0.75	1.16	46.1	4.8
13.008	66.589	0.000	0.0	99.0	0.5	45	0.98	1.62	64.2	5.5
13.009	65.812	0.000	0.0	125.4	0.6	46	1.06	1.72	68.2	6.2
13.010	65.157	0.000	0.0	125.4	0.6	39	1.34	2.40	95.3	6.2
9.009	62.368	0.000	0.0	405.9	1.0	90	0.75	0.83	33.0	11.1

Network Design Table for FS_1

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
9.010	72.721	0.373	195.0	0.000	39.6	0.0	1.500	o	225	Pipe/Conduit	
9.011	11.263	0.058	194.2	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
14.000	17.280	0.580	29.8	0.000	19.8	0.0	1.500	o	150	Pipe/Conduit	
14.001	19.625	0.600	32.7	0.000	26.4	0.0	1.500	o	150	Pipe/Conduit	
14.002	7.853	0.250	31.4	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
14.003	7.990	0.450	17.8	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
14.004	14.060	0.900	15.6	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
14.005	6.297	0.400	15.7	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.012	56.847	0.284	200.2	0.000	26.4	0.0	1.500	o	225	Pipe/Conduit	
9.013	42.264	0.214	197.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.019	26.511	0.133	199.3	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.020	16.955	0.085	199.5	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.021	31.175	0.156	199.8	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.022	51.028	0.255	200.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.023	6.660	0.033	201.8	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
9.010	62.260	0.000	0.0	445.5	1.1	93	0.75	0.82	32.6	11.6
9.011	61.887	0.000	0.0	445.5	1.1	93	0.75	0.82	32.7	11.6
14.000	66.730	0.000	0.0	19.8	0.2	30	0.98	1.61	28.4	2.4
14.001	66.150	0.000	0.0	46.2	0.3	38	1.07	1.54	27.1	3.7
14.002	65.550	0.000	0.0	46.2	0.3	37	1.09	1.57	27.7	3.7
14.003	65.300	0.000	0.0	46.2	0.3	32	1.33	2.09	36.9	3.7
14.004	64.775	0.000	0.0	46.2	0.3	28	1.32	2.91	115.8	3.7
14.005	63.875	0.000	0.0	46.2	0.3	28	1.32	2.90	115.4	3.7
9.012	61.829	0.000	0.0	518.1	1.1	97	0.76	0.81	32.2	12.5
9.013	61.545	0.000	0.0	518.1	1.1	97	0.76	0.81	32.4	12.5
1.019	61.331	0.000	0.0	1006.5	1.6	118	0.83	0.81	32.3	17.4
1.020	61.198	0.000	0.0	1006.5	1.6	118	0.83	0.81	32.3	17.4
1.021	61.113	0.000	0.0	1006.5	1.6	118	0.83	0.81	32.2	17.4
1.022	60.957	0.000	0.0	1006.5	1.6	118	0.83	0.81	32.2	17.4
1.023	60.702	0.000	0.0	1006.5	1.6	118	0.82	0.81	32.1	17.4

Free Flowing Outfall Details for FS_1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.023	0	0.000	60.669	0.000	0	0

FOUL SEWERAGE DESIGN

Design Criteria for FS_2

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	10
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.200
Calculation Method	EN 752	Maximum Backdrop Height (m)	2.000
Frequency Factor	0.50	Min Design Depth for Optimisation (m)	1.200
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	0.75
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for FS_2

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	30.170	0.262	115.2	0.000	115.5	0.0	1.500	o	225	Pipe/Conduit	
1.001	41.872	0.349	120.0	0.000	9.9	0.0	1.500	o	225	Pipe/Conduit	
1.002	21.383	0.178	120.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
2.000	33.892	0.527	64.3	0.000	56.1	0.0	1.500	o	225	Pipe/Conduit	
1.003	17.541	0.125	140.3	0.000	6.6	0.0	1.500	o	225	Pipe/Conduit	
1.004	9.112	0.065	140.2	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.005	25.424	0.169	150.4	0.000	23.2	0.0	1.500	o	225	Pipe/Conduit	
1.006	30.467	0.203	150.1	0.000	16.5	0.0	1.500	o	225	Pipe/Conduit	
3.000	22.893	0.432	53.0	0.000	13.2	0.0	1.500	o	150	Pipe/Conduit	
3.001	6.546	0.124	53.0	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
3.002	6.849	0.129	53.0	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	63.629	0.000	0.0	115.5	0.5	57	0.75	1.07	42.5	5.9
1.001	63.367	0.000	0.0	125.4	0.6	58	0.75	1.05	41.7	6.2
1.002	63.018	0.000	0.0	125.4	0.6	58	0.75	1.05	41.6	6.2
2.000	63.492	0.000	0.0	56.1	0.4	41	0.83	1.43	57.0	4.1
1.003	62.240	0.000	0.0	188.1	0.7	68	0.75	0.97	38.5	7.5
1.004	62.115	0.000	0.0	188.1	0.7	68	0.75	0.97	38.5	7.5
1.005	62.050	0.000	0.0	211.3	0.7	71	0.75	0.93	37.2	8.0
1.006	61.881	0.000	0.0	227.8	0.8	72	0.75	0.94	37.2	8.3
3.000	63.463	0.000	0.0	13.2	0.2	31	0.75	1.21	21.3	2.0
3.001	63.031	0.000	0.0	13.2	0.2	31	0.75	1.21	21.3	2.0
3.002	62.907	0.000	0.0	13.2	0.2	31	0.75	1.21	21.3	2.0

Network Design Table for FS_2

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
3.003	29.615	0.423	70.0	0.000	13.2	0.0	1.500	o	150	Pipe/Conduit	
3.004	7.277	0.074	98.3	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
1.007	20.097	0.186	108.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.008	21.784	0.136	160.0	0.000	9.9	0.0	1.500	o	225	Pipe/Conduit	
1.009	26.281	0.159	165.0	0.000	26.4	0.0	1.500	o	225	Pipe/Conduit	
1.010	28.115	0.165	170.0	0.000	13.2	0.0	1.500	o	225	Pipe/Conduit	
1.011	8.410	0.049	170.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
4.000	66.036	0.858	77.0	0.000	33.0	0.0	1.500	o	150	Pipe/Conduit	
4.001	51.265	0.583	87.9	0.000	26.4	0.0	1.500	o	225	Pipe/Conduit	
4.002	12.491	0.136	91.8	0.000	6.6	0.0	1.500	o	225	Pipe/Conduit	
1.012	25.918	0.144	180.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
5.000	61.023	1.526	40.0	0.000	26.4	0.0	1.500	o	150	Pipe/Conduit	
1.013	17.726	0.094	188.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.014	25.058	0.133	188.0	0.000	6.6	0.0	1.500	o	225	Pipe/Conduit	
6.000	85.442	1.135	75.3	0.000	33.0	0.0	1.500	o	150	Pipe/Conduit	
6.001	6.526	0.085	76.8	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
3.003	62.250	0.000	0.0	26.4	0.3	40	0.75	1.05	18.5	2.8
3.004	61.827	0.000	0.0	26.4	0.3	43	0.67	0.88	15.6	2.8
1.007	61.678	0.000	0.0	254.2	0.8	68	0.86	1.10	43.9	8.8
1.008	61.492	0.000	0.0	264.1	0.8	76	0.75	0.91	36.0	8.9
1.009	61.356	0.000	0.0	290.5	0.9	79	0.75	0.89	35.5	9.4
1.010	61.197	0.000	0.0	303.7	0.9	80	0.75	0.88	35.0	9.6
1.011	61.031	0.000	0.0	303.7	0.9	80	0.75	0.88	35.0	9.6
4.000	63.478	0.000	0.0	33.0	0.3	43	0.75	1.00	17.7	3.2
4.001	62.545	0.000	0.0	59.4	0.4	45	0.75	1.22	48.7	4.2
4.002	61.962	0.000	0.0	66.0	0.4	47	0.75	1.20	47.6	4.5
1.012	60.982	0.000	0.0	369.7	1.0	86	0.75	0.85	34.0	10.6
5.000	63.833	0.000	0.0	26.4	0.3	34	0.92	1.39	24.5	2.8
1.013	60.838	0.000	0.0	396.1	1.0	89	0.75	0.84	33.2	10.9
1.014	60.743	0.000	0.0	402.7	1.0	89	0.75	0.84	33.2	11.0
6.000	63.921	0.000	0.0	33.0	0.3	43	0.76	1.01	17.9	3.2
6.001	62.786	0.000	0.0	33.0	0.3	43	0.75	1.00	17.7	3.2

Network Design Table for FS_2

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
7.000	36.896	0.335	110.0	0.000	105.6	0.0	1.500	o	225	Pipe/Conduit	
7.001	6.915	0.098	70.6	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
6.002	5.924	0.047	126.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
6.003	39.505	0.316	125.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
6.004	4.816	0.051	94.4	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
8.000	50.815	0.956	53.2	0.000	33.0	0.0	1.500	o	150	Pipe/Conduit	
8.001	6.522	0.108	60.4	0.000	13.2	0.0	1.500	o	225	Pipe/Conduit	
8.002	45.859	0.573	80.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
8.003	29.012	0.363	80.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
8.004	20.899	0.237	88.0	0.000	13.2	0.0	1.500	o	225	Pipe/Conduit	
6.005	6.481	0.045	144.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
6.006	65.719	0.387	170.0	0.000	105.6	0.0	1.500	o	225	Pipe/Conduit	
6.007	11.351	0.065	175.0	0.000	9.9	0.0	1.500	o	225	Pipe/Conduit	
6.008	28.474	0.163	175.0	0.000	19.8	0.0	1.500	o	225	Pipe/Conduit	
6.009	32.416	0.185	175.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
6.010	22.966	0.131	175.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
6.011	18.167	0.101	179.9	0.000	13.2	0.0	1.500	o	225	Pipe/Conduit	
6.012	10.600	0.059	179.7	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
7.000	63.855	0.000	0.0	105.6	0.5	55	0.75	1.09	43.5	5.7
7.001	63.520	0.000	0.0	105.6	0.5	49	0.88	1.37	54.4	5.7
6.002	62.626	0.000	0.0	138.6	0.6	61	0.75	1.02	40.6	6.5
6.003	62.579	0.000	0.0	138.6	0.6	61	0.75	1.03	40.8	6.5
6.004	62.263	0.000	0.0	138.6	0.6	56	0.83	1.18	47.0	6.5
8.000	63.657	0.000	0.0	33.0	0.3	39	0.86	1.20	21.3	3.2
8.001	62.626	0.000	0.0	46.2	0.3	39	0.82	1.48	58.8	3.7
8.002	62.518	0.000	0.0	46.2	0.3	41	0.75	1.28	51.1	3.7
8.003	61.945	0.000	0.0	46.2	0.3	41	0.75	1.28	51.1	3.7
8.004	61.582	0.000	0.0	59.4	0.4	45	0.75	1.22	48.7	4.2
6.005	60.900	0.000	0.0	198.0	0.7	69	0.75	0.96	38.0	7.7
6.006	60.855	0.000	0.0	303.6	0.9	80	0.75	0.88	35.0	9.6
6.007	60.468	0.000	0.0	313.5	0.9	82	0.75	0.87	34.5	9.7
6.008	60.404	0.000	0.0	333.3	0.9	83	0.75	0.87	34.5	10.0
6.009	60.241	0.000	0.0	333.3	0.9	83	0.75	0.87	34.5	10.0
6.010	60.056	0.000	0.0	333.3	0.9	83	0.75	0.87	34.5	10.0
6.011	59.924	0.000	0.0	346.5	0.9	85	0.75	0.85	34.0	10.2
6.012	59.823	0.000	0.0	346.5	0.9	85	0.75	0.86	34.0	10.2

Network Design Table for FS_2

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.015	25.267	0.126	200.0	0.000	9.9	0.0	1.500	o	225	Pipe/Conduit	
1.016	12.808	0.064	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.017	17.444	0.087	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.018	36.996	0.185	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.019	25.536	0.128	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.000	35.427	0.521	68.0	0.000	23.1	0.0	1.500	o	150	Pipe/Conduit	
10.000	21.962	0.314	69.9	0.000	82.5	0.0	1.500	o	225	Pipe/Conduit	
10.001	6.345	0.091	69.7	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
10.002	7.071	0.146	48.4	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.001	5.431	0.049	110.8	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.002	38.907	0.354	109.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.003	37.483	0.288	130.1	0.000	49.5	0.0	1.500	o	225	Pipe/Conduit	
9.004	7.908	0.061	129.6	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.005	11.241	0.083	135.4	0.000	19.8	0.0	1.500	o	225	Pipe/Conduit	
9.006	7.603	0.056	135.8	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.007	9.626	0.071	135.6	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.008	65.597	0.452	145.1	0.000	33.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.015	59.764	0.000	0.0	759.1	1.4	108	0.80	0.81	32.2	15.2
1.016	59.638	0.000	0.0	759.1	1.4	108	0.80	0.81	32.2	15.2
1.017	59.574	0.000	0.0	759.1	1.4	108	0.80	0.81	32.2	15.2
1.018	59.487	0.000	0.0	759.1	1.4	108	0.80	0.81	32.2	15.2
1.019	59.302	0.000	0.0	759.1	1.4	108	0.80	0.81	32.2	15.2
9.000	63.398	0.000	0.0	23.1	0.2	38	0.75	1.06	18.8	2.6
10.000	63.000	0.000	0.0	82.5	0.5	46	0.85	1.37	54.6	5.0
10.001	62.686	0.000	0.0	82.5	0.5	46	0.86	1.38	54.7	5.0
10.002	62.595	0.000	0.0	82.5	0.5	42	0.97	1.65	65.7	5.0
9.001	62.449	0.000	0.0	105.6	0.5	55	0.75	1.09	43.3	5.7
9.002	62.400	0.000	0.0	105.6	0.5	55	0.76	1.09	43.5	5.7
9.003	62.046	0.000	0.0	155.1	0.6	63	0.75	1.01	40.0	6.8
9.004	61.758	0.000	0.0	155.1	0.6	63	0.75	1.01	40.1	6.8
9.005	61.697	0.000	0.0	174.9	0.7	66	0.75	0.99	39.2	7.3
9.006	61.614	0.000	0.0	174.9	0.7	66	0.75	0.98	39.1	7.3
9.007	61.558	0.000	0.0	174.9	0.7	66	0.75	0.99	39.2	7.3
9.008	61.487	0.000	0.0	207.9	0.7	70	0.75	0.95	37.9	7.9

Network Design Table for FS_2

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
11.000	21.395	0.405	52.8	0.000	13.2	0.0	1.500	o	150	Pipe/Conduit	
9.009	10.448	0.070	149.3	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.010	18.263	0.122	149.7	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
12.000	9.950	0.136	73.2	0.000	29.7	0.0	1.500	o	150	Pipe/Conduit	
9.011	22.874	0.143	160.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.020	24.419	0.122	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
11.000	62.580	0.000	0.0	13.2	0.2	31	0.75	1.21	21.3	2.0
9.009	61.035	0.000	0.0	221.1	0.7	72	0.75	0.94	37.3	8.2
9.010	60.965	0.000	0.0	221.1	0.7	72	0.75	0.94	37.3	8.2
12.000	62.380	0.000	0.0	29.7	0.3	41	0.76	1.02	18.1	3.0
9.011	60.843	0.000	0.0	250.8	0.8	75	0.75	0.91	36.0	8.7
1.020	59.174	0.000	0.0	1009.9	1.6	118	0.83	0.81	32.2	17.5

Free Flowing Outfall Details for FS_2

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.020	FA0	63.700	59.052	0.000	0	0

Appendix G

Ground Investigation Information

Ground Investigations Ireland Ltd.,
Catherinestown House,
Hazelhatch Road,
Newcastle, Co Dublin.
Tel: 01 601 5175 / 5176 | Fax: 01 601 5173
Email: info@gii.ie | Web: gii.ie

Ground Investigations Ireland

Branganstown Kilcock

Ground Investigation Report

DOCUMENT CONTROL SHEET

Project Title	Branganstown Kilcock
Engineer	DBFL
Project No	8559-03-19
Document Title	Ground Investigation Report

Rev.	Status	Author(s)	Reviewed By	Approved By	Office of Origin	Issue Date
A	Draft	S Kealy	F McNamara	F McNamara	Dublin	29 April 2019

Ground Investigations Ireland Ltd.,
Catherinestown House,
Hazelhatch Road,
Newcastle, Co Dublin.
Tel: 01 601 5175 / 5176 | Fax: 01 601 5173
Email: info@gii.ie | Web: gii.ie

CONTENTS

APPENDICES

1.0 Preamble

On the instructions of DBFL Consulting Engineers, a site investigation was carried out by Ground Investigations Ireland Ltd., in March 209 at the site of the proposed residential development in Branganstown, Kilcock Co. Kildare.

2.0 Overview

2.1. Background

It is proposed to construct a new residential development with associated services, access roads and car parking at the proposed site. The site is currently greenfield and is situated in Branganstown, Co. Kildare. The proposed construction is envisaged to consist of conventional foundations and pavement make up with some local excavations for services and plant.

2.2. Purpose and Scope

The purpose of the site investigation was to investigate subsurface conditions utilising a variety of investigative methods in accordance with the project specification. The scope of the work undertaken for this project included the following:

- Visit project site to observe existing conditions
- Carry out 9 No. Trial Pits to a maximum depth of 3.0m BGL
- Carry out 7 No. Soakaways to determine a soil infiltration value to BRE digest 365
- Report with recommendations

3.0 Subsurface Exploration

3.1. General

During the ground investigation a programme of intrusive investigation specified by the Consulting Engineer was undertaken to determine the sub surface conditions at the proposed site. Regular sampling and in-situ testing was undertaken in the exploratory holes to facilitate the geotechnical descriptions and to enable laboratory testing to be carried out on the soil samples recovered during excavation and drilling.
The procedures used in this site investigation are in accordance with Eurocode 7 Part 2: Ground Investigation and testing (ISEN 1997 – 2:2007) and B.S. 5930:2015.

3.2. Trial Pits

The trial pits were excavated using a 3CX excavator 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 sampled, logged and photographed by an Engineering

Geologist prior to backfilling with arisings. Notes were made of any services, inclusions, pit stability, groundwater encountered and the characteristics of the strata encountered and are presented on the trial pit logs which are provided in Appendix 2 of this Report.

3.3. Soakaway Testing

The soakaway testing was carried out in selected trial pits at the locations shown in the exploratory hole location plan in Appendix 1. These pits were carefully excavated 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 was recorded over time as required by BRE Digest 365. The pits were logged prior to completing the soakaway test and were backfilled with arising's upon completion. The soakaway test results are provided in Appendix 3 of this Report.

4.0 Ground Conditions

4.1. General

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 exploratory hole logs included in the appendices of this report.

The sequence of strata encountered were consistent across the site and are generally comprised;

- Topsoil
- Made Ground
- Cohesive Deposits
- Granular Deposits

TOPSOIL: Topsoil was encountered in all the exploratory holes and was present to a maximum depth of 0.3m BGL.

MADE GROUND: Made Ground deposits were encountered beneath the Topsoil in TP06 and SA07 and was present to a maximum depth of between 0.45m BGL. These deposits were described generally as *brown sandy slightly gravelly CLAY* or *a black slightly sandy gravelly clayey peat with rare fragments of brick.*

COHESIVE DEPOSITS: Cohesive deposits were encountered beneath the Made Ground and were described typically as *brown sandy gravelly CLAY with occasional cobbles and boulders*. The secondary sand and gravel constituents varied across the site and with depth, with granular lenses occasionally present in the glacial till matrix. The strength of the cohesive deposits varied across the site but typically increased with depth in the majority of the exploratory holes. These deposits had some, occasional or frequent cobble and boulder content where noted on the exploratory hole logs.

GRANULAR DEPOSITS: The granular deposits were encountered at the base of the cohesive deposits and were typically described as G*rey brown clayey sandy sub rounded to sub angular fine to coarse GRAVEL with occasional cobbles and rare boulders.* The secondary sand/gravel and silt/clay constituents varied across the site and with depth while occasional or frequent cobble and boulder content also present where noted on the exploratory hole logs.
It should be noted that many of the trial pits where granular deposits or groundwater were encountered, experienced instability indicating that the material is loose or medium dense. This was described either as side wall spalling or as side wall collapse in the remarks section at the base of the trial pit logs.

4.2. Groundwater

Groundwater strikes are noted on the exploratory hole logs where they occurred. 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.

5.0 Recommendations & Conclusions

5.1. General

The recommendations given and opinions expressed in this report are based on the findings as detailed in the exploratory hole 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. Limited information has been provided at the ground investigation stage and any designs based on the recommendations or conclusions should be completed in accordance with the current design codes, taking into account the variation and the specific details contained within the exploratory hole logs.

5.2. Foundations

Due to the presence of the granular material across the site we would recommended carrying out a sequence of dynamic probing to determine an allowable bearing capacity.

5.3. Excavations

Short term temporary excavations in the cohesive deposits will remain stable for a limited time only and will require to be appropriately battered or the sides supported if the excavation is below 1.25m BGL or is required to permit man entry.
Excavations in the Made Ground or soft Cohesive Deposits will require to be appropriately battered or the sides supported due to the low strength of these deposits.
Any excavations which penetrate the granular deposits will require to be appropriately battered or the sides supported and are likely to require dewatering due to the groundwater seepages noted in the exploratory hole logs in the Appendices of this Report.

5.4. Soakaway Design

An Infiltration rate of 4.353×10^{-4} m/s was calculated for the soakaway at the location of SA05. At the locations of SA01, SA02, SA03, SA04, SA06 and SA07 the water level dropped too slowly to allow calculation of ‘f’ the soil infiltration rate. These locations are therefore not recommended as suitable for soakaway design and construction.

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.

APPENDIX 1 - Site Location Plan

689200.000 689600.000 690000.000

689200.000 689600.000 690000.000

Site Location

Client:

Project Code:
8559-03-19

Project Title:
Branganstown Kilcock

Drawing Title:
Figure 1 Site Location

GROUND INVESTIGATIONS IRELAND

Ground Investigations Ireland Ltd.
Catherinstown House,
Hazelhatch Road,
Newcastle, Co. Dublin
www.gii.ie 01-6015175/5176

0 100 200 300 m

Drawn By:	Date:
SK	25/04/19

APPENDIX 2 – Trial Pit Records

Ground Investigations Ireland Ltd
www.gii.ie

Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 2.0m X 0.35m X 2.65m	**Ground Level (mOD)**	**Site** Branganstown, Kilcock	**Trial Pit Number** **SA01**
	Location	**Dates** 25/03/2019	**Client**	**Job Number** 8559-03-19
			Project Contractor GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.35)	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
					0.35 (0.45)	Firm brown slightly sandy slightly gravelly CLAY with occasional sub-angular to sub-rounded cobbles.		
1.30	B				0.80 (1.85)	Firm to stiff brown mottled grey slightly sandy gravelly CLAY with rare sub-angular to sub-rounded cobbles.		
					2.65	Trial pit terminated due to encountering groundwater.		
						Complete at 2.65m		

Plan

Remarks

Trial pit stable.
Soakaway completed in trial pit.
Soakaway backfilled on completeion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	8559-03-19.SA01

Ground Investigations Ireland Ltd www.gii.ie	Site Branganstown, Kilcock	Trial Pit Number SA02

Machine : JCB 3CX Method : Trial Pit	Dimensions 2.20m X 0.35m X 3.00m	Ground Level (mOD)	Client	Job Number 8559-03-19
	Location	Dates 25/03/2019	Project Contractor GII	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20) 0.20	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
					(0.45) 0.65	Firm light greyish brown slightly sandy slightly gravelly CLAY.		
					(1.05) 1.70	Firm to stiff grey mottled brown slightly sandy gravelly CLAY with occasional sub-angular to sub-rounded cobbles.		
					(0.20) 1.90	Stiff brown/dark grey slightly sandy gravelly CLAY with occasional cobbles.		
					(1.10) 3.00	Stiff greyish brown slightly sandy gravelly CLAY with occasional sub-rounded cobbles.		
						Complete at 3.00m		

Plan

Remarks

No Groundwater encountered.
Trial pit stable.
Soakaway completed in trial pit.
Soakaway backfilled on completeion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	8559-03-19.SA02

Ground Investigations Ireland Ltd www.gii.ie			Site Branganstown, Kilcock	Trial Pit Number **TP03**
Machine : JCB 3CX **Method :** Trial Pit	**Dimensions**	**Ground Level (mOD)**	**Client**	**Job Number** 8559-03-19
	Location	**Dates** 25/03/2019	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.25) 0.25	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
					(0.25) 0.50	Soft to firm light greyish brown slightly sandy slightly gravelly CLAY.		
					(0.40) 0.90	Firm to stiff grey mottled brown slightly sandy gravelly CLAY with rare sub-angular to sub-rounded cobbles.		
					(0.70) 1.60	Grey gravelly clayey fine to coarse SAND with rare cobbles.		
					(0.40) 2.00	Grey sandy very gravelly CLAY with occasional sub-angular to sub-rounded cobbles.		
			FI(1) at 2.10m.		(0.20) 2.20	Grey sandy sub-angular to sub-rounded fine to coarse GRAVEL with occasional sub-rounded to rounded cobbles.		∇1
						Trial pit terminated due to excessive groundwater and trial pit sidewall collapse. Complete at 2.20m		

Plan

Remarks

Groundwater encountered at 2.10m BGL - Fast Ingress.
Trial pit spalling from 1.0m BGL.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	8559-03-19.TP03

Ground Investigations Ireland Ltd www.gii.ie		Site Branganstown, Kilcock	Trial Pit Number SA03
Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 1.90m X 0.35m X 2.20m	**Ground Level (mOD)**	**Client**	**Job Number** 8559-03-19
	Location	**Dates** 25/03/2019	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.25) 0.25	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
					(0.75) 1.00	Soft to firm light greyish brown slightly sandy slightly gravelly CLAY with rare sub-angular cobbles.		
			SS(1) at 2.20m.		(1.25) 2.25	Dark grey slightly sandy very clayey sub-angular fine to coarse GRAVEL with occasional sub-angular cobbles.		∇1
						Trial pit terminated due to encountering groundwater. Complete at 2.25m		

Plan

Remarks

Groundwater encountered at 2.20m BGL - Slight seepage.
Trial pit sidewalls spalling below 1.0m BGL.
Soakaway completed in trial pit.
Soakaway backfilled on completeion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	8559-03-19.SA03

Ground Investigations Ireland Ltd www.gii.ie			Site Branganstown, Kilcock	Trial Pit Number **TP04**
Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 1.80m X 0.50m X 2.00m	**Ground Level (mOD)**	**Client**	**Job Number** 8559-03-19
	Location	**Dates** 25/03/2019	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.25) 0.25	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
0.40	B				(0.25) 0.50	Soft to firm light brown slightly sandy slightly gravelly CLAY.		
					(0.40) 0.90	Soft to firm grey mottled brown slightly sandy gravelly CLAY with occasional cobbles.		
					(0.25) 1.15	Dark grey sandy very clayey sub-angular to rounded fine to coarse GRAVEL with frequent sub-rounded to rounded cobbles.		▼1
1.50	B		MI(1) at 1.80m, rose to 1.20m in 20 mins.		(0.85) 2.00	Grey very sandy slightly clayey sub-angular to rounded fine to coarse GRAVEL with frequent sub-rounded to rounded cobbles.		∇1
						Trial pit terminated due to sidewalls collapsing. Complete at 2.00m		

Plan

Remarks

Groundwater encountered at 1.80m BGL - Medium Ingress.
Trial pit sidewalls spalling below 1.0m BGL.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	8559-03-19.SA04

Ground Investigations Ireland Ltd
www.gii.ie

Machine : JCB 3CX Method : Trial Pit	Dimensions 1.70m X 0.35m X 1.10m	Ground Level (mOD)	Client	Job Number 8559-03-19
	Location	Dates 25/03/2019	Project Contractor GII	Sheet 1/1

Site: Branganstown, Kilcock

Trial Pit Number: **SA04**

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30) 0.30	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
					(0.20) 0.50	Firm light brown slightly sandy slightly gravelly CLAY.		
					(0.30) 0.80	Firm grey mottled brown slightly sandy slightly gravelly CLAY with rare sub-angular to sub-rounded cobbles.		
					(0.30) 1.10	Dark grey slightly sandy very clayey angular to sub-rounded fine to coarse GRAVEL.		
						Complete at 1.10m		

Plan

Remarks

No Groundwater encountered.
Trial pit stable.
Soakaway completed in trial pit.
Soakaway backfilled on completeion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	8559-03-19.SA04A

Ground Investigations Ireland Ltd
www.gii.ie

Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 2.50m X 0.50m X 2.70m	**Ground Level (mOD)**	**Site** Branganstown, Kilcock	**Trial Pit Number** **SA05**
	Location	**Dates** 26/03/2019	**Client**	**Job Number** 8559-03-19
			Project Contractor GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
					0.30 (0.20)	Firm brown sandy gravelly CLAY with occasional cobbles.		
					0.50	Brown slightly clayey very sandy sub-rounded to rounded fine to coarse GRAVEL with occasional rounded cobbles.		
1.50	B				(2.20)			
					2.70	Trial pit terminated due to sidewall collapse.		
						Complete at 2.70m		

Plan

Remarks

No Groundwater encountered.
Trial pit collapsing below 0.50m.
Soakaway Test completed in trial pit.
Trial pit backfilled on completion of soakaway test.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	8559-03-19.SA05

Ground Investigations Ireland Ltd
www.gii.ie

Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 1.90m X 0.35m X 1.20m	**Ground Level (mOD)**	**Client**	**Job Number** 8559-03-19
	Location	**Dates** 26/03/2019	**Project Contractor** GII	**Sheet** 1/1

Site: Branganstown, Kilcock

Trial Pit Number: SA06

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20) 0.20	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
					(0.30) 0.50	Black slightly sandy slightly gravelly clayey PEAT.		
					(0.70) 1.20	Grey sandy clayey sub-rounded to rounded fine to coarse GRAVEL with rare sub-rounded to rounded cobbles.		
						Trial pit terminated above groundwater.		
						Complete at 1.20m		

Plan

Remarks

No Groundwater encountered.
Trial pit collapsing below 0.50m.
Soakaway Test completed in trial pit.
Trial pit backfilled on completion of soakaway test.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	8559-03-19.SA06

Ground Investigations Ireland Ltd

www.gii.ie

Site	Branganstown, Kilcock
Trial Pit Number	SA07
Machine	JCB 3CX
Method	Trial Pit
Dimensions	2.50m X 0.40m X 2.70m
Ground Level (mOD)	
Client	
Job Number	8559-03-19
Location	
Dates	26/03/2019
Project Contractor	GII
Sheet	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.45)	MADE GROUND: Brownish grey slightly sandy slightly gravelly CLAY.		
					0.45	Dark brown slightly sandy slightly gravelly peaty CLAY.		
					0.50 (0.80)	Soft to firm grey slightly sandy slightly gravelly silty CLAY.		
					1.30 (0.20)	Firm grey mottled light brown slightly sandy slightly gravelly silty CLAY.		
					1.50 (1.20)	Grey sandy clayey sub-rounded to rounded to rounded fine to coarse GRAVEL with rare sub-rounded cobbles.		
					2.70	Trial pit terminate due to sidewall collapse.		
						Complete at 2.70m		

Plan

Remarks

No Groundwater encountered.
Trial pit collapsing below 1.50m.
Soakaway Test completed in trial pit.
Trial pit backfilled on completion of soakaway test.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	8559-03-19.SA07

Branganstown, Kilcock – Trial Pit Photographs

SA01

SA02


SA03

TP03

SA04

TP04

SA05

SA06

TP06

SA07

APPENDIX 3 – Soakaway Records

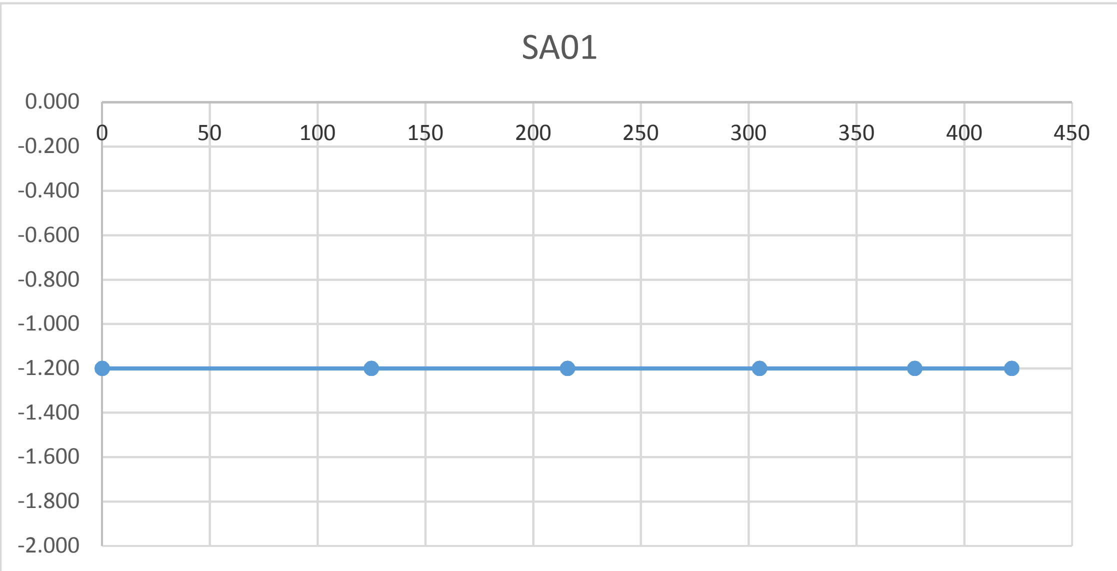
SA01

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.0m x 0.35m 2.65m (L x W x D)

Date	Time	Water level (m bgl)
25/03/2019	0	-1.200
25/03/2019	125	-1.200
25/03/2019	216	-1.200
25/03/2019	305	-1.200
25/03/2019	377	-1.200
25/03/2019	422	-1.200

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
1.20	2.650	1.450	1.5625	2.2875



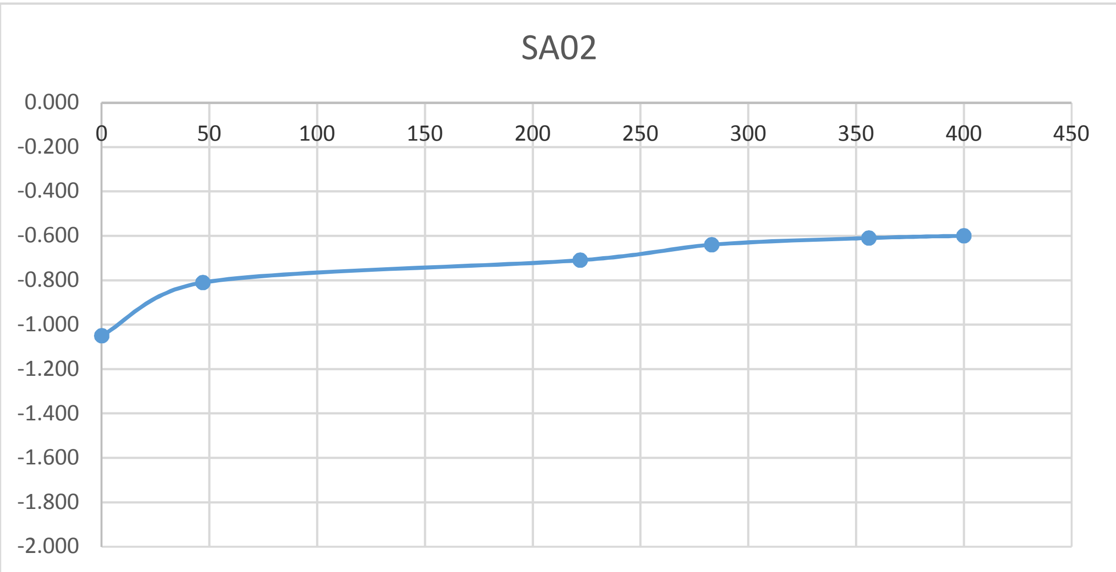
SA02

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.2m x 0.35m 3.0m (L x W x D)

Date	Time	Water level (m bgl)
25/03/2019	0	-1.050
25/03/2019	47	-0.810
25/03/2019	222	-0.710
25/03/2019	283	-0.640
25/03/2019	356	-0.610
25/03/2019	400	-0.600

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
1.05	3.000	1.950	1.5375	2.5125



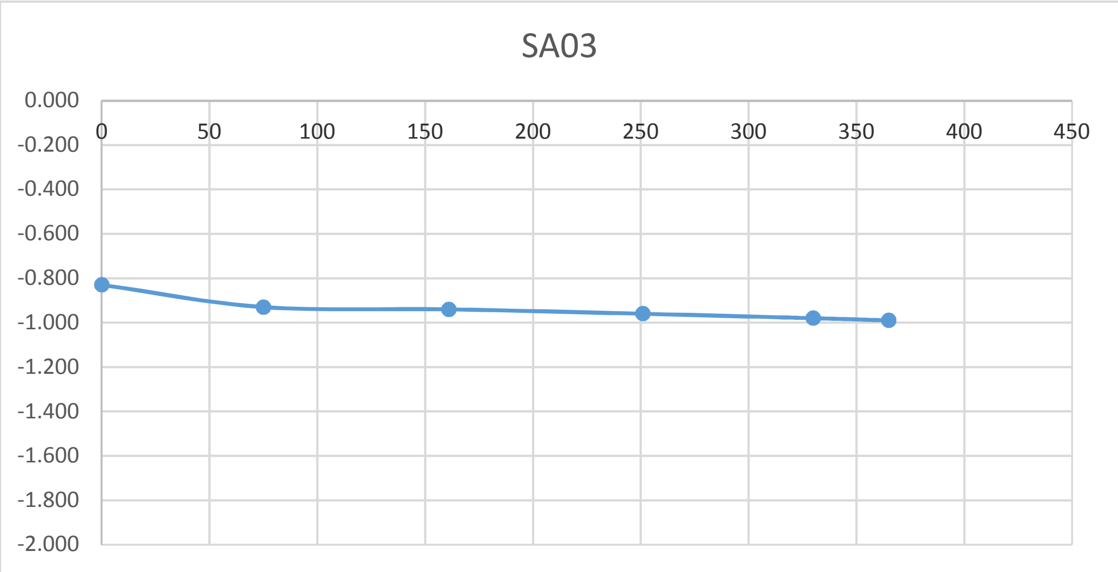
SA03

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 1.9m x 0.35m 2.25m (L x W x D)

Date	Time	Water level (m bgl)
25/03/2019	0	-0.830
25/03/2019	75	-0.930
25/03/2019	161	-0.940
25/03/2019	251	-0.960
25/03/2019	330	-0.980
25/03/2019	365	-0.990

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
0.83	2.250	1.420	1.185	1.895



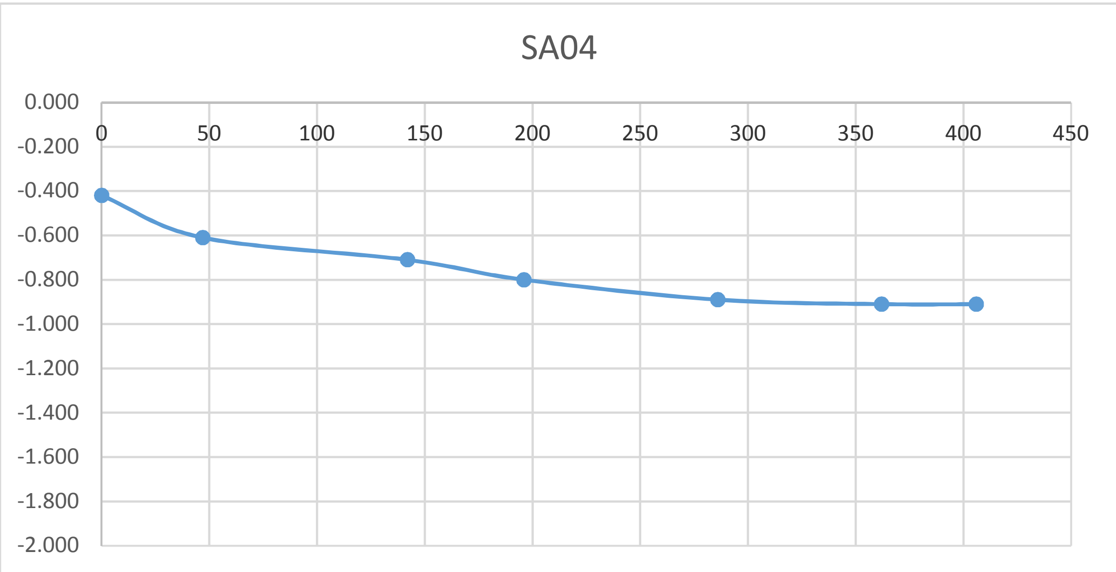
SA04

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 1.7m x 0.35m 1.10m (L x W x D)

Date	Time	Water level (m bgl)
25/03/2019	0	-0.420
25/03/2019	47	-0.610
25/03/2019	142	-0.710
25/03/2019	196	-0.800
25/03/2019	286	-0.890
25/03/2019	362	-0.910
25/03/2019	406	-0.910
25/03/2019		

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
0.42	**1.100**	**0.680**	**0.59**	**0.93**



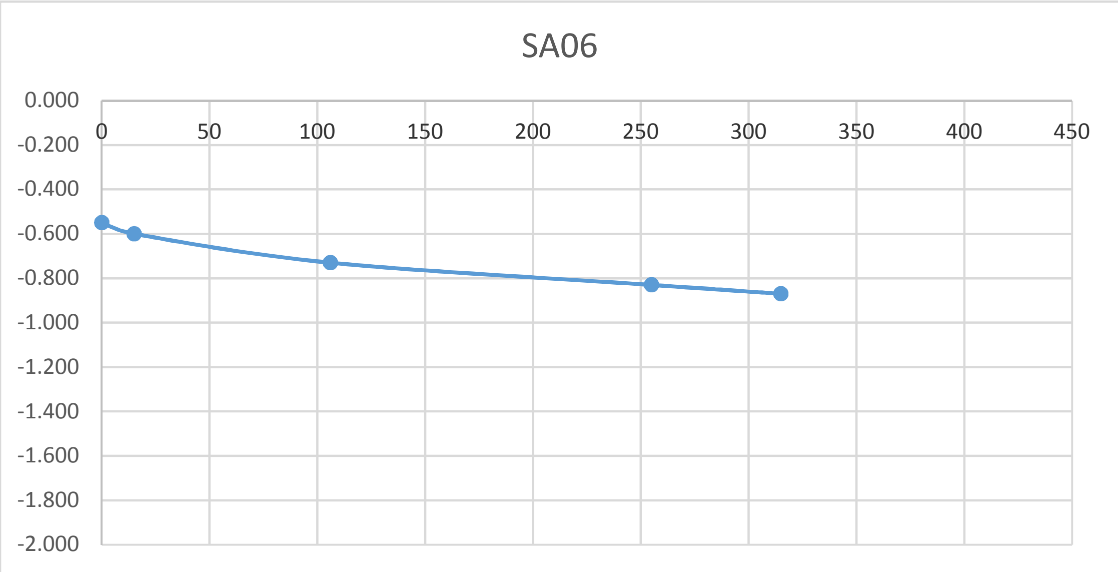
SA06

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 1.9m x 0.35m 1.20m (L x W x D)

Date	Time	Water level (m bgl)
26/03/2019	0	-0.550
26/03/2019	15	-0.600
26/03/2019	106	-0.730
26/03/2019	255	-0.830
26/03/2019	315	-0.870

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
0.55	1.200	0.650	0.7125	1.0375



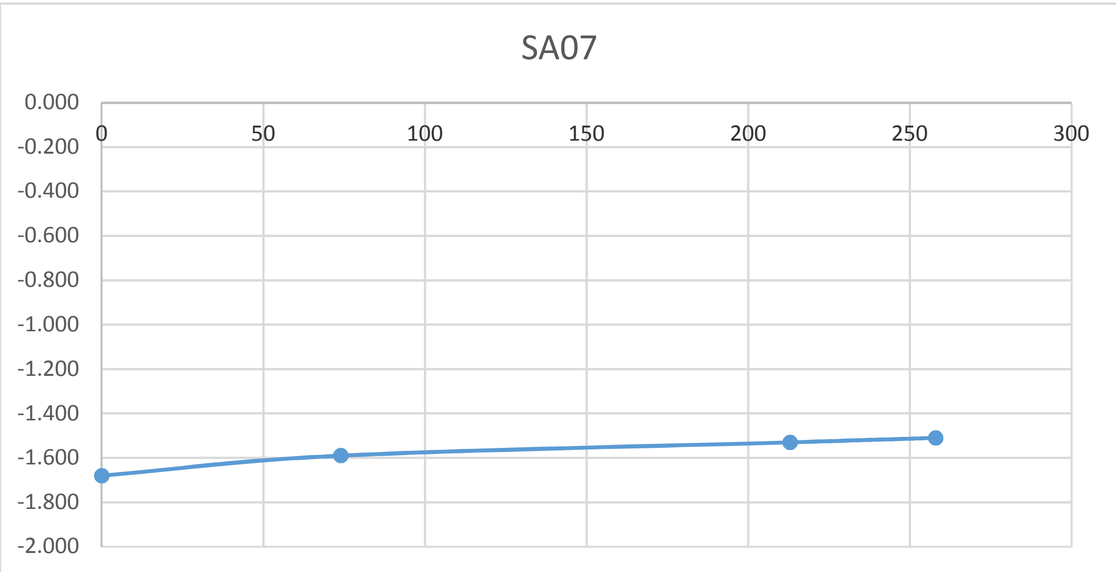
SA07

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.5m x 0.40m 2.7m (L x W x D)

Date	Time	Water level (m bgl)
26/03/2019	0	-1.680
26/03/2019	74	-1.590
26/03/2019	213	-1.530
26/03/2019	258	-1.510

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
1.68	2.700	1.020	1.935	2.445



SA03 1st Fill

Soakaway Test to BRE Digest 365

Trial Pit Dimensions: 2.50m x 0.50m 2.70m (L x W x D)

Date	Time	Water level (m bgl)
26/03/2019	0	-1.600
26/03/2019	1	-1.890
26/03/2019	2.5	-2.090
26/03/2019	3.5	-2.160
26/03/2019	4.5	-2.450

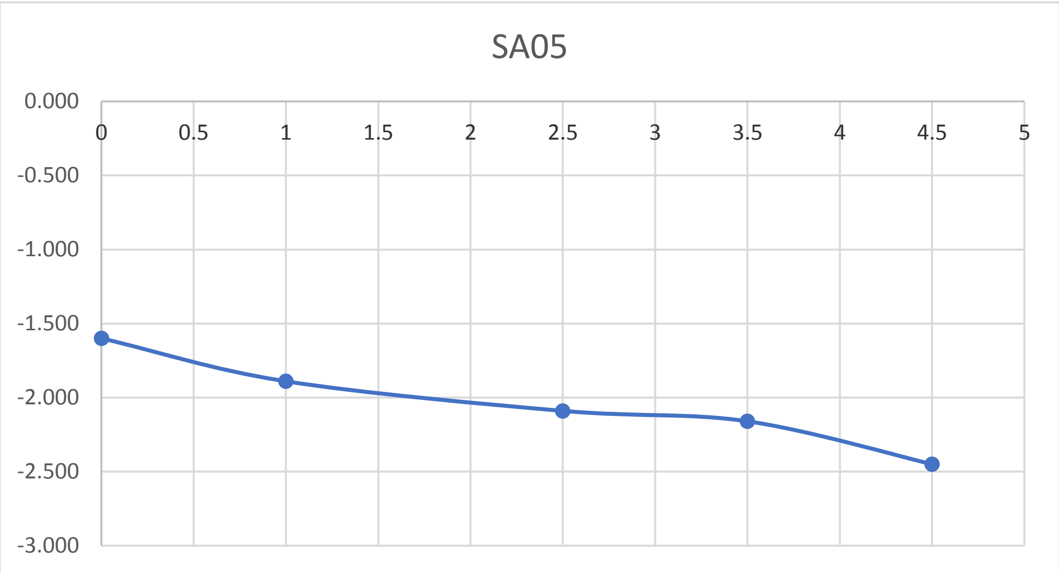
Start depth	Depth of Pit	Diff	75% full	25%full
1.60	**2.450**	**0.850**	**1.8125**	**2.2375**

Length of pit (m)	Width of pit (m)	75-25Ht (m)	Vp75-25 (m3)
2.500	0.500	0.425	0.53

Tp75-25 (from graph) (s) **150**

50% Eff Depth	ap50 (m2)
0.425	3.8

f = 9.320E-04 m/s



SA05 2nd Fill

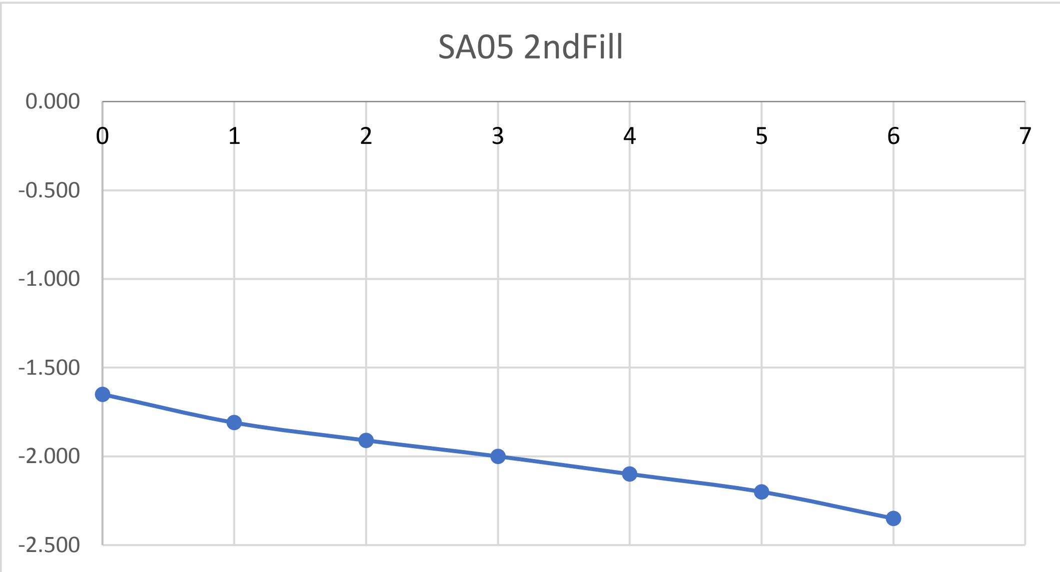
Soakaway Test to BRE Digest 365

Trial Pit Dimensions: 2.50m x 0.50m 2.35m (L x W x D)

Date	Time	Water level (m bgl)
26/03/2019	0	-1.650
26/03/2019	1	-1.810
26/03/2019	2	-1.910
26/03/2019	3	-2.000
26/03/2019	4	-2.100
26/03/2019	5	-2.200
26/03/2019	6	-2.350

Start depth	Depth of Pit		Diff	75% full	25%full
1.65	**2.350**		**0.700**	**1.825**	**2.175**
Length of pit (m)	Width of pit (m)			75-25Ht (m)	Vp75-25 (m3)
2.500	0.500			0.350	0.44
Tp75-25 (from graph) (s)		**191.5**		50% Eff Depth	ap50 (m2)
				0.350	3.35

f = 6.820E-04 m/s

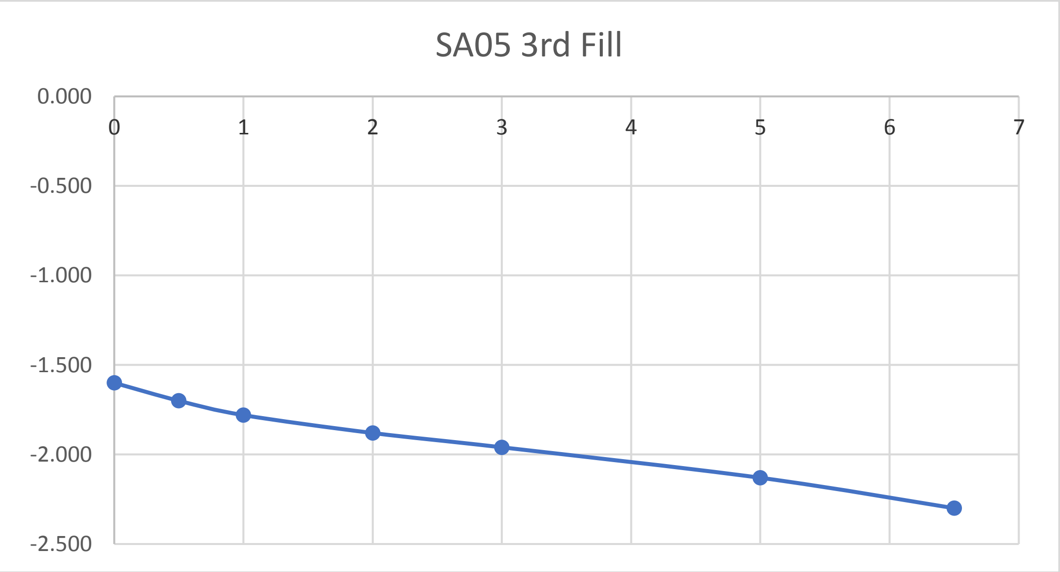


SA05 3rd Fill

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.50m x 0.50m 2.70m (L x W x D)

Date	Time	Water level (m bgl)
26/03/2019	0	-1.600
26/03/2019	0.5	-1.700
26/03/2019	1	-1.780
26/03/2019	2	-1.880
26/03/2019	3	-1.960
26/03/2019	5	-2.130
26/03/2019	6.5	-2.300

Start depth	Depth of Pit		Diff	75% full	25%full
1.60	**2.300**		**0.700**	**1.775**	**2.125**
Length of pit (m)	Width of pit (m)			75-25Ht (m)	Vp75-25 (m3)
2.500	0.500			0.350	0.44
Tp75-25 (from graph) (s)		**300**		50% Eff Depth	ap50 (m2)
				0.350	3.35
f =	**4.353E-04**	**m/s**			



Appendix H

Statement of Design Acceptance

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

Brendan Manning
Ormond House
Upper Ormond Quay
Dublin 7

5 November 2019

Re: Design Submission for Millerstown, Kilcock, Meath (the "Development") (the "Design Submission") / Connection Reference No: CDS19000027

Dear Brendan Manning,

Many thanks for your recent Design Submission.

We have reviewed your proposal for the connection 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 (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: Fionan Ginty
Phone: 01 89 25734
Email: fginty@water.ie

Yours sincerely,

M O'Dwyer

Maria O'Dwyer
Connections and Developer Services

Appendix A

Document Title & Revision

- 190009-DBFL-XX-XX-DR-C-3000 Site Services Layout Sheet 1 of 3
- 190009-DBFL-XX-XX-DR-C-3001 Site Services Layout Sheet 2 of 3
- 190009-DBFL-XX-XX-DR-C-3002 Site Services Layout Sheet 3 of 3
- 190009-DBFL-XX-XX-DR-C-3005 Watermain Layout Sheet 1 of 2
- 190009-DBFL-XX-XX-DR-C-3006 Watermain Layout Sheet 2 of 2
- 190009-DBFL-XX-XX-DR-C-3031 Longitudinal Sections Through Foul Sewer Sheet 1 of 6
- 190009-DBFL-XX-XX-DR-C-3032 Longitudinal Sections Through Foul Sewer Sheet 2 of 6
- 190009-DBFL-XX-XX-DR-C-3033 Longitudinal Sections Through Foul Sewer Sheet 3 of 6
- 190009-DBFL-XX-XX-DR-C-3034 Longitudinal Sections Through Foul Sewer Sheet 4 of 6
- 190009-DBFL-XX-XX-DR-C-3035 Longitudinal Sections Through Foul Sewer Sheet 5 of 6
- 190009-DBFL-XX-XX-DR-C-3036 Longitudinal Sections Through Foul Sewer Sheet 6 of 6

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.