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Woodbrook Phase 1

Stormwater Impact Assessment Report

Aeval

October 2019

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1. Introduction

The purpose of this Stormwater Impact Assessment report is to provide details of the Storm Water elements associated with the proposed development at Lands at Woodbrook.

For the purposes of planning, the Woodbrook Development lands have been split into two Phases; Phase 1 (to which this planning application applies) and Phase 2 which will be delivered at a later stage. The storm water drainage design has been undertaken for the overall Woodbrook development site including Phase 1 and allowance for the future Phase 2 to ensure that there is adequate capacity and connectivity within the proposed storm system.

The proposed Phase 1 development (21.9ha to which this planning application applies within the red line) consists of a residential-led development comprising 685no. residential units (207 no. houses, 48 no. duplexes & 430 no. apartments) and 1 no. creche facility (429 m^2) in buildings ranging from 2 to 8-storeys. The proposed Phase 1 development also includes the provision of 2 no. replacement golf holes for Woodbrook Golf Club and a 164-no. space temporary car park adjacent to the future Woodbrook Dart Station. A detailed description of the development is included in the Architectural Design Statement associated with this application.

It is currently proposed that the allowance for the future Phase 2 development will consist of 803no. residential units (53 no. houses, 53 no. duplexes & 697 no. apartments), a 720 no. pupil primary school and a commercial use area within the neighbourhood centre (1,200 m^2).

This report deals with the following aspects associated with this development:

- Existing Site and Hydrological Features
- Site Investigation Testing
- Soil Type Classification
- Storm Water Drainage Design
- Sustainable urban Drainage Systems (SuDS)
- Flood Risk Assessment and Exceedance Flows
- SuDS Maintenance

1.1. Site Location

The proposed development site is located at Woodbrook, Co Dublin. The proposed development site is located on existing agricultural lands and a section of the existing golf course (Phase 1 site area approx. 21.9ha).

The residential site is bound to the North by a cemetery and greenfields, to the East by Woodbrook Golf Course and an active railway line, to the south by greenfields and a small number of residential and business developments, and to the west by a church and the R119 Dublin Road.

The site location is indicated on Atkins drawing 5154251_HTR_DR_0001.

1.2. Existing Site Description

The proposed residential site and surrounding lands are moderate sloping from the highest point located to the North East of the site and falls gradually to the South West. The existing site elevations range from 24.910m.OD to 14.93m.OD Malin. The site is currently accessed via a field access gate from the R119 Dublin Road.

1.3. Principle Design Considerations

During the design of the storm water drainage for the proposed site, including SuDS, the following key documents / standards were taken into consideration;

- Dún Laoghaire Rathdown County Development Plan, 2016 - 2022
- Shanganagh Woodbrook Local Area Plan (LAP)
- Greater Dublin Strategic Drainage Study (GDSDS)
- CIRIA report C753 The SuDS Manual-v6

The proposed stormwater drainage has been developed in consultation with the relevant authorities including Dún Laoghaire Rathdown County Council (DLRCC) Municipal services department.

2. Surface Water Design

The storm drainage system has been designed in accordance with the key documents and standards listed in Section 1.3 above.

Surface water generated from the proposed residential development will be conveyed through a proposed surface water network including SuDS and attenuated / managed on site prior to final discharge at Qbar greenfield run-off rates. The restricted discharge from the proposed site will be conveyed via a new surface water sewer on the Dublin Road before discharge to the receiving Crinken / Rathmichael Stream. The proposed storm drainage network for the development is as indicated on the planning drawings 5154251_EWE_DR_0501 – 0507.

The principles behind the proposed design were discussed and agreed with DLRCC Municipal services department at multiple stages in advance of making this application. Aspects of the proposed development that were discussed and agreed have been incorporated within this design.

In accordance with the DLRCC Development Plan, a Stage 1 Stormwater Audit has been carried out by Punch Consulting Engineers in October 2019. Refer to Section 11 of this report for a summary of the main audit findings and Appendix A for a copy of the report comments and feedback.

In advanced of this application a full copy of the Audit has been issued by Punch Consulting Engineers to DLRCC.

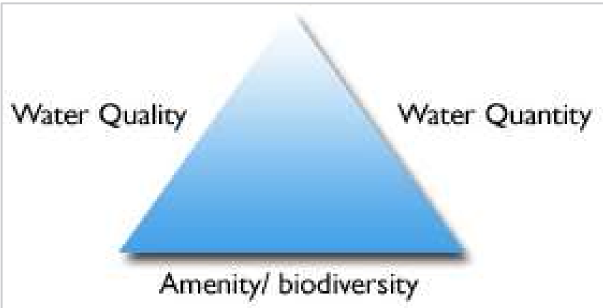
The proposed measures included within the design proposal are as follows:

- Swales within Open Space / Park areas adjacent to roads
- Permeable paving in light traffic areas (parking bays) and Temporary Car Park
- Green roofs to suitable apartment blocks
- Green courtyards to suitable apartment blocks
- Underground modular system within green corridors / park areas
- Filter drains in rear gardens
- Tree pits along the main avenue
- Flow control devices including vortex and orifice plates

2.1. Proposed Sustainable Urban Drainage (SuDS) Strategy

For the proposed development a “SuDS triangle” was utilised to ensure all three functions are provided for within the SuDS strategy.

Figure 2-1 - SuDS Triangle

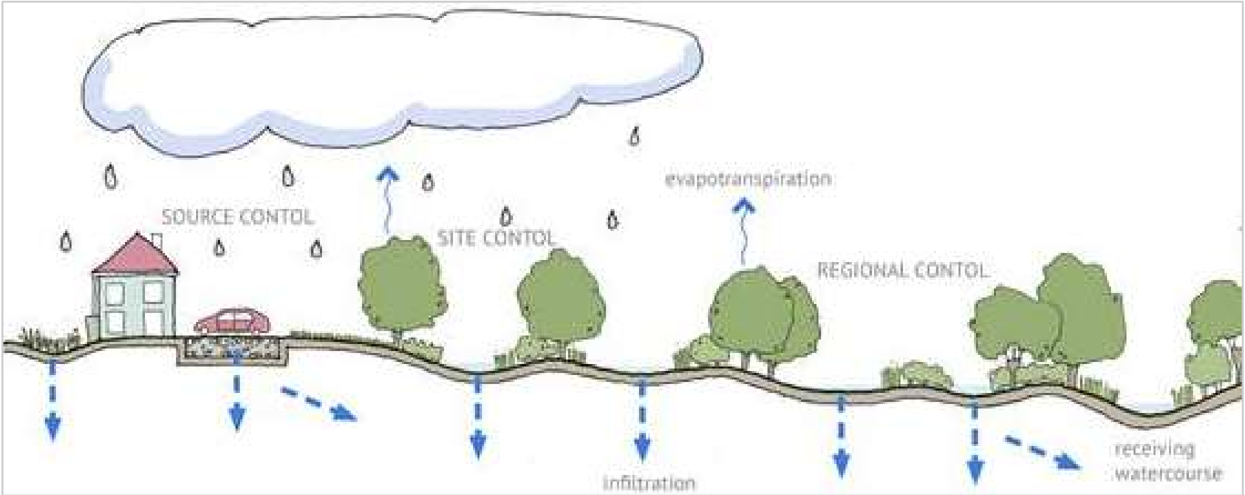


By considering the three functions of the triangle, a SuDS system will allow for water quality treatment through natural processes by;

- Encouraging infiltration (where appropriate) and attenuating peak flows
- Improving water quality by providing treatment to storm water prior to discharge
- Providing habitat and function were possible for those using the area (including wildlife)

The principles of a SuDS treatment train were used during the design of the surface water drainage system. The treatment train as illustrated in the image below provides an understanding of prevention and source control to reduced water run-off from a site and improve water quality.

Figure 2-2 - SuDS Treatment Train



The treatment train principles include;

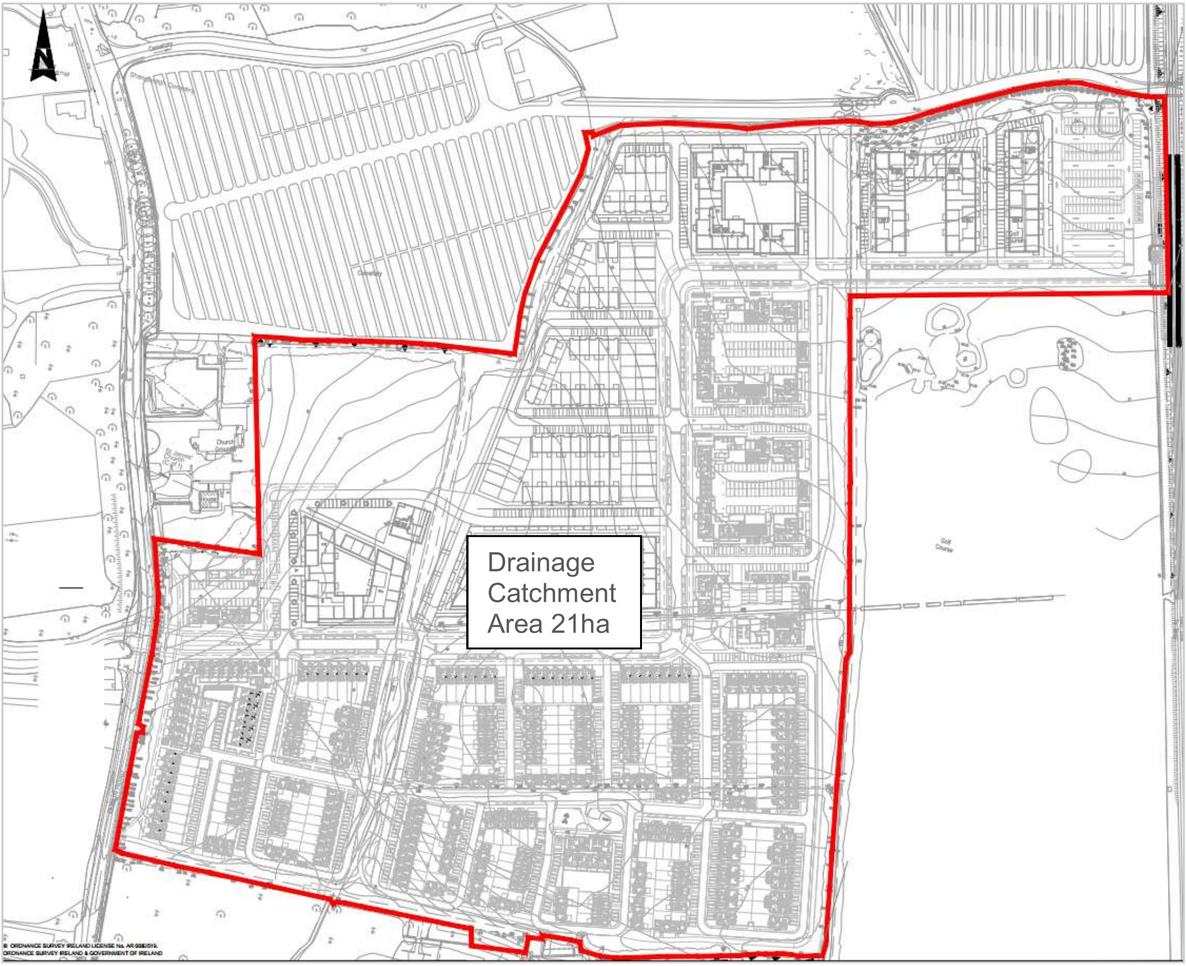
- Prevention of surface water run-off from the proposed site by use of filter drains, swales, permeable paving, tree pits, extensive green roofs, intensive green courtyards and modular attenuation systems with a permeable base (where appropriate)
- Minimising impermeable paved areas using permeable paving, extensive green roofs, intensive green courtyards and modular grass road proprietary product.
- Infiltration by use of filter drains, swales, permeable paving and tree pits.
- Site control using underground modular attenuation storage and vortex flow control devices to manage flows and agreed final Qbar runoff rate.

Each of the items outlined above will help to improve water quality, reduce storm water runoff quantity from the proposed site and ensure that there is no increased risk to downstream flooding where discharging to the Crinken / Rathmichael Stream.

Drawings 5154251_EWE_DR_0501 – 0505 & 5154251_EWE_DR_0510 – 0513 inclusive outline the proposed details of the storm-water network and longitudinal sections for the proposed development excluding the golf course.

For the purposes of designing the storm water network for the entire development (Phase 1 & 2) and including associated Qbar calculations a total overall catchment area of 21ha has been calculated as indicated below in Figure 2-3. This area excludes the 2no. replacement golf holes (which are discussed separately in Section 8 below), the section of rising main travelling north through Shanganagh Park and the area along the Dublin Road.

Figure 2-3 - Overall Catchment Area



There are 10 No. proposed drainage sub-catchment areas (Catchments A – J) within the proposed development for the purpose of site control as outlined on planning drawing 5154251_EWE_DR_0500. The catchments are segregated by use of a vortex control device to limit / manage discharge from each catchment. Section 7 provides further details on catchment areas.

The SuDS techniques proposed within the development are as outlined below:

- Swales are to be used within the site as conveyance systems for surface water runoff from sections of road, footpaths or shared surfaces. Discharge into the swale will be via drop kerbs / side inlet gully's or over edge flows.
- Permeable paving will be used in light traffic areas to the front of residential units, courtyards and carparks. The permeable paving will allow for attenuation, infiltration to ground, reduction of peak flow rates and improved water quality. Roof run-off from the front roof area of residential housing units will discharge directly into the sub base below each permeable paving area allowing for reduced runoff from these roof areas.
- Extensive green roof and intensive green courtyards will be provided on suitable buildings as indicated on drawing 5154251_EWE_DR_0600 in accordance with Dún Laoghaire Rathdown County Development Plan, 2016 – 2022 and Woodbrook – Shanganagh LAP. The green roofs / courtyards will provide reduced peak flow rates, attenuation, evaporation and improved water quality.
- Underground modular systems will be used within public green corridors / park areas. The modular systems will allow for storm water attenuation underground for storm events up to 1 in 100-year events. The modular systems will also allow for infiltration to ground were suitable.
- Filter drains within rear gardens of the housing units will allow for infiltration to ground, reduced peak flow rates and improved water quality. Only roof run-off from the rear roof of the residential

unit will discharge into the filter drain. The filter drain will allow for infiltration to ground and reduce the overall site runoff.

- Vortex flow control devices will be used throughout the site to allow for storm water control and reduce peak runoff.

The storm water drainage network will be assessed for compliance with the key design parameters as set out in Table 2-1 below.

Table 2-1 – Key Design Parameters

Parameter	Value/Requirement
Minimum depth	1.2m cover under highways 0.9m elsewhere*
Maximum depth	5.0m
Minimum sewer size for main drainage	225mm
DLRCC Municipal services agreed co-efficient runoff factors for pipe sizing and storage requirements	100% - Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network) 75% - Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains 60% - Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving 85% - Extensive Green Roof (> 150mm thk.) 70% - Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)
Max. velocity at pipe full	3.0 m/s
Min. velocity in	0.75 m/s (1.0 m/s used where achievable)
Roughness	0.6mm
DLRCC Municipal services agreed Maximum discharge rate	56.34 l/s at final discharge location (56.34 l/s/21ha** = 2.68 l/s/ha)
Level of Service Critical Storm 1 in 2 yr return period	No surcharge within the pipe network, no flooding
Level of Service Critical Storm 1 in 30 yr return period	Surcharge allowed, no flooding
Level of Service Critical Storm 1 in 100 yr return period	No flooding unless planned and contained on site.

**Without recourse to concrete. Absolute minimum cover in roads is 0.9m. Pipes with cover between 0.9m and 1.2m shall be bedded and surrounded in concrete, 150mm thick, Class E, in accordance with Clause 1502 of the Specification for Roadworks.*

***Overall catchment area for storm water design purposes is 21ha as discussed in Section 2.1 above.*

“Micro Drainage”, which is an industry standard tool for the design and assessment of gravity sewer drainage networks, has been used to simulate the proposed storm drainage network including flow controls and attenuation requirements. Outputs from the model for the proposed storm network are contained in Appendix B-G of this report.

3. Site Investigations

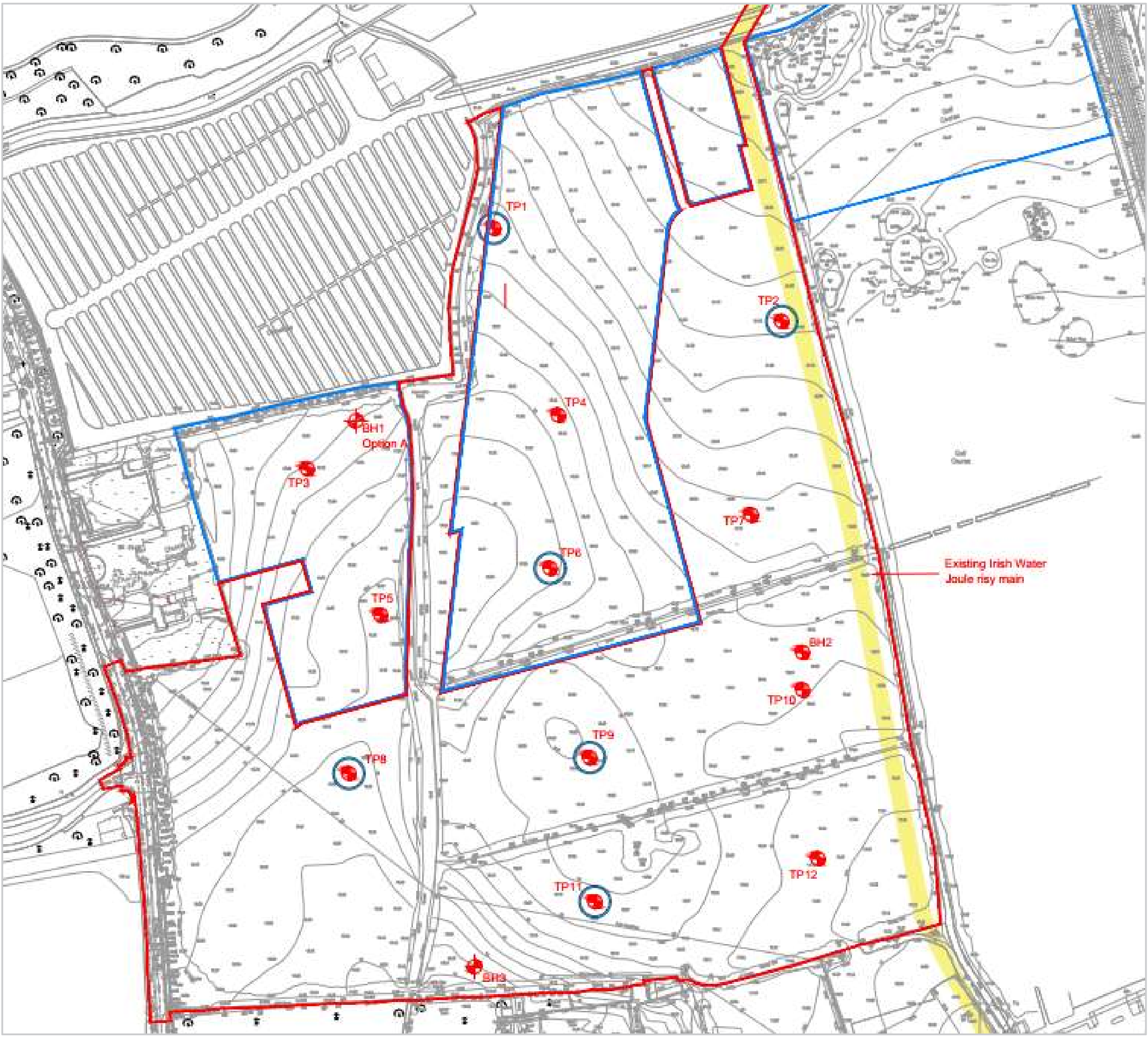
Site Investigations were carried out by Ground Investigations Ireland Ltd, between June and August 2018. Refer to Appendix H for a copy of the Ground Investigations Report.

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

- 12 No. Trial Pits to a maximum depth of 3.0m BGL
- 6 No. Soakaways to determine a soil infiltration value to BRE digest 365
- 3 No. Cable Percussion boreholes to a maximum depth of 10.0m BGL
- 3 No. Groundwater monitoring wells
- Geotechnical & Environmental Laboratory testing

The locations for the site investigation testing including soakaways and ground water monitoring wells were discussed and agreed with DLRCC Municipal services prior to works commencing on site. Refer to Figure 3-1 below for borehole and trial pit locations. Soakaway tests were also carried out in the following trial pits; TP1, TP2, TP6, TP8, TP9 & TP11.

Figure 3-1 - SI Testing Locations



Review of the SI results including Trial Pit (TP) logs indicate that out of the 12No. TP, ground water was encountered within 4No. TP's. The ground water levels within the TP logs varied between 1.70m – 2.50m in depth.

The location of trial pits, ground levels and ground water levels are indicated on the storm water layout drawings 5154251_EWE_DR_0501 – 0505.

DLRCC indicated concerns in relation to high water table levels to the North – North East of the site along the boundary with the existing Shanganagh Cemetery in addition to queries relating to underground flow-paths. An assessment to determine ground water flows was undertaken and included the installation of groundwater monitoring wells on site. Refer to Appendix I for a copy of the Technical Note carried out by an experienced Hydrogeologist.

The report concluded that based on site-specific geological and hydrogeological data, there will be no perceptible impacts on surface water levels, surface water flows, groundwater levels or groundwater flows, specifically in the vicinity of the areas in question. Furthermore, the report notes that potential impacts to the onsite field ditch or groundwater flow paths do not warrant further consideration.

4. Existing Site Hydrology

An existing ditch traverses the site from North to South along an existing hedge and treeline as indicated in Figure 4-1 below. This ditch has a long-established existence and functions in draining the fields within the site. A review of Historical Ordinance Survey Ireland information (www.osi.ie) was then carried out to determine if the OSI 6-inch Maps indicated historic water courses / surface water features within the site. The maps do not indicate any record of a water course onsite.

The ditch ultimately discharges to a local watercourse Crinken \ Rathmichael Stream (EPA 10R18) located to the South of the proposed Woodbrook Development via 3rd party lands.

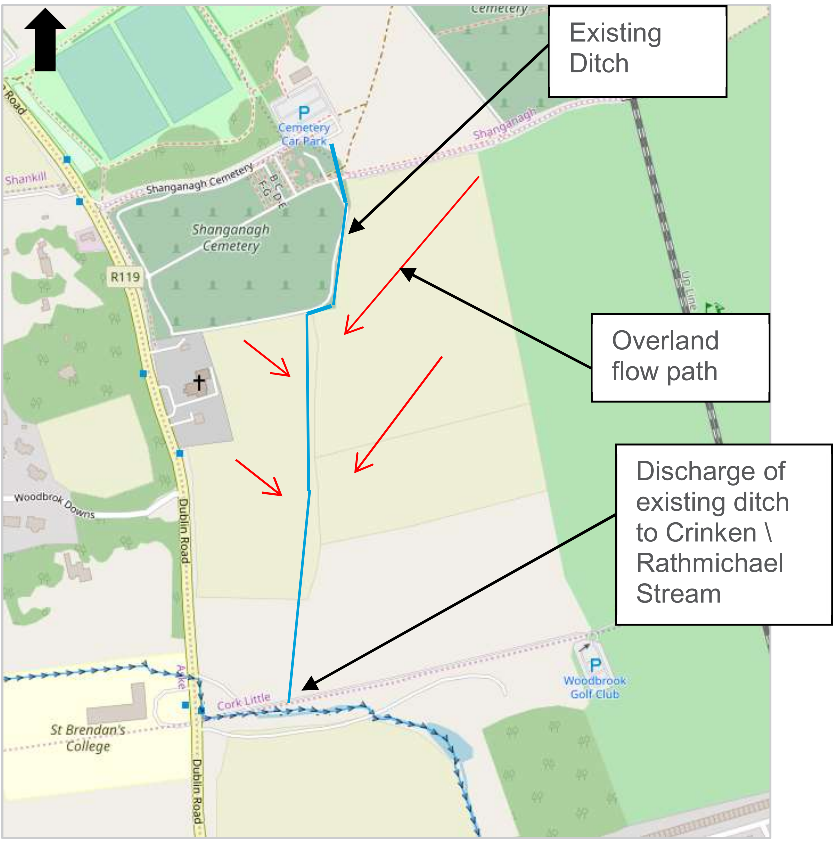
The Crinken \ Rathmichael Stream flows from North-West to East approx. 150 metres from the southern boundary of the proposed development site. The stream then discharges to the Irish Sea approximately 1km south east of the site boundary.

Lands within the proposed Woodbrook Development drain to the existing ditch as indicated by the flow arrows indicated in Figure 4-1 below.

During pre-planning discussions with DLRCC, concerns were raised in relation to the existing drainage ditch on site. DLRCC requested confirmation that the existing onsite drainage ditch is a field ditch and not a stream or river. Refer to Appendix I for a copy of the Technical Note carried out by an experienced Hydrogeologist.

The Technical Note concluded that having reviewed all available desk-based information, including historical mapping and aerial photography, and based on the observations of an experienced Hydrogeologist during a walkover survey of the Site, the drainage feature is a field ditch. Furthermore, there is no evidence that this drainage feature was historically a stream or a river.

Figure 4-1 - Site Hydrology Overview



5. Soil Type Classification

To determine the allowable Qbar discharge rate from the proposed site, the SOIL value for the existing site was classified using the 'Winter Rain Acceptance Potential classification' Table 2.1 from the Institute of Hydrology Report No. 126, see Figure 5-1 below.

Figure 5-1 - WRAP Table

Water regime class	Depth to impermeable horizon(cm)	Slope Classes < 2° Rapid	< 2° Medium	< 2° Slow	2-8° Rapid	2-8° Medium	2-8° Slow	> 8° Rapid	> 8° Medium	> 8° Slow
		Permeability class (above impermeable horizon)								
1	> 80	1	1	2	1	1	2	1	2	3
1	80-40	1	1	2	2	2	3	3	3	4
1	< 40	-	-	-	-	-	-	-	-	-
2	> 80	2	2	3	3	3	4	-	4	5
2	80-40	2	3	3	3	4	4	4	4	5
2	< 40	3	4	4	4	4	4	4	5	5
3	> 80	4	4	5	5	5	5	-	5	5
3	80-40	4	5	5	5	5	5	-	5	5
3	< 40	5	5	5	5	5	5	5	5	5

Winter Rain Acceptance Class		Winter Run-off Potential	
1	Very high	1	Very Low
2	High	2	Low
3	Moderate	3	Moderate
4	Low	4	High
5	Very low	5	Very high

The table considers four main soil and site properties which include:

- Soil water regime
- Depth to an impermeable layer
- Slope class
- Permeability of the soil horizons above the impermeable layer

5.1. Soil Water Regime

The water regime class is taken from the Soil Survey Field Handbook (Hodgson 1974). The classes are identified as:

Figure 5-2 - Water Regime Classes

1) soils rarely waterlogged within 40 cm depth, and for less than 90 days within 70 cm in most years,

2) soils commonly waterlogged within 40 cm, but for less than 335 days within 70 cm in most years, and

3) soils waterlogged within 40 cm for more than 180 days, and for more than 335 days within 70 cm in most years.

The Site Investigations findings indicated a ranging depth of topsoil for each of the 12No. Trial Pits including the 6 Soakaway Trial Pits from 250mm to 400mm in depth.

Due to the maximum depth of the topsoil (400mm thk.) and the depth to impermeable layer discussed in Section 5.2 below, it was determined that water regime Class 2 "soils commonly waterlogged within 40cm, but for less than 335 days within the 70mm in most years" is the most suitable selection for this site.

5.2. Depth to an Impermeable Layer

Site Investigations were carried out on site as previously discussed in Section 3 of this report. During the Site Investigations 6No. soakaway tests were performed in accordance with BRE digest 365 at specified locations to determine the suitability of the soils for the infiltration of surface water.

The Site Investigations findings indicated a depth of topsoil for each of the 6No. soakaway Trial Pits ranging from 250mm to 400mm in depth.

Below the topsoil the test medium varied from slightly sandy slightly gravelly CLAY with occasional subrounded cobbles to firm to stiff brown slightly gravelly CLAY.

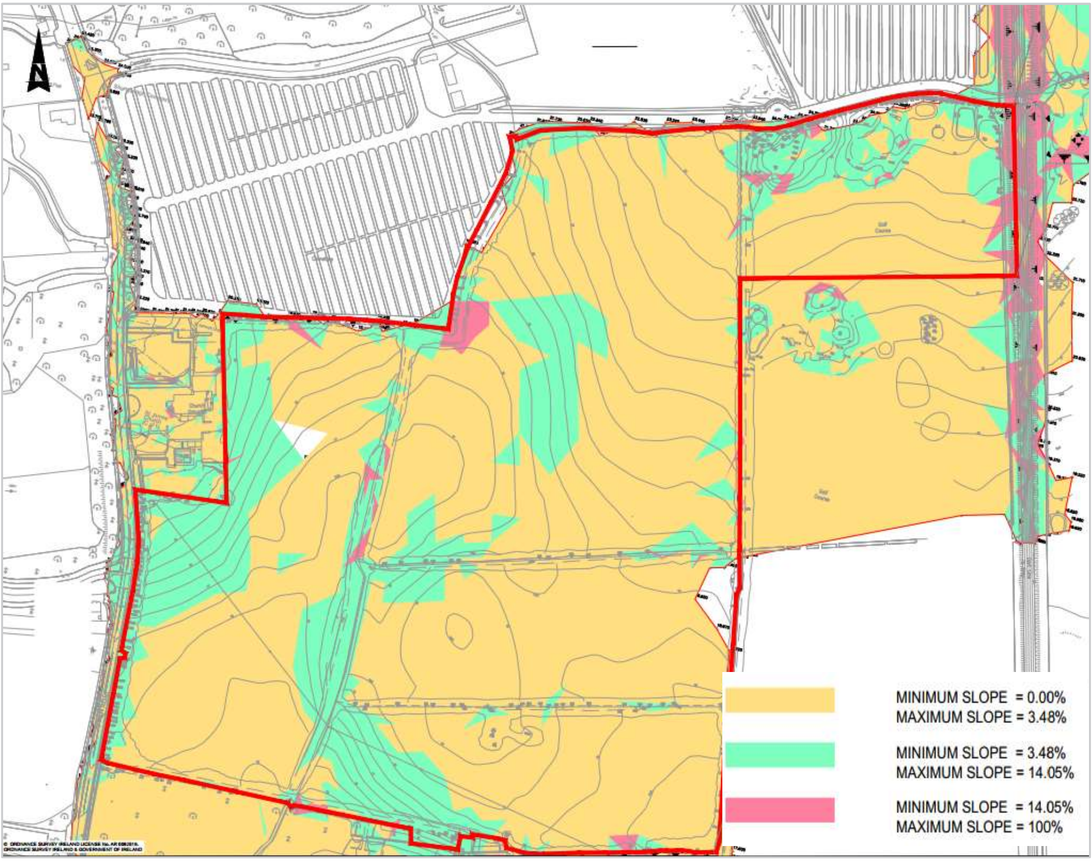
The Institute of Hydrology Report No. 126 outlines that "an impermeable layer is defined as a layer with a hydraulic conductivity of less than 0.1 m/day".

Based on this information with predominant soil type for each of the soakaway tests being CLAY, the depth to an impermeable layer is determined to be located between 250mm and 400mm below surface level or at the underside of the topsoil or, accordance with the WRAP table a depth to impermeable horizon of <40cm.

5.3. Slope Class

Following a review of the topographical survey a 3D heatmap model of the existing site gradients was generated. The 3D model allowed for identification of the slopes on site between the ranges set out in the 'Winter Rain Acceptance Potential classification', see Figure 5-3 below for slope classifications.

Figure 5-3 - Site Slope Classifications



The majority of the site has a slope of < 2 degrees indicated in yellow. It is noted however that parts of the site have a slope of between 2 – 8 degrees indicated in green with some minor areas having a slope of > 8 degrees indicated in red. For this assessment based on the predominate, a < 2 degrees slope will therefore be used.

5.4. Permeability Class

The Handbook of Soils for Landscape Architects by Robert F. Keeler Table 6.1 provides a soil characterisation for permeability from slow to rapid as outlined in Figure 5-4 below:

Figure 5-4 - Permeability Classifications

Table 6.1 Soil Permeability Class Related to Flow of Water through a Saturated Soil

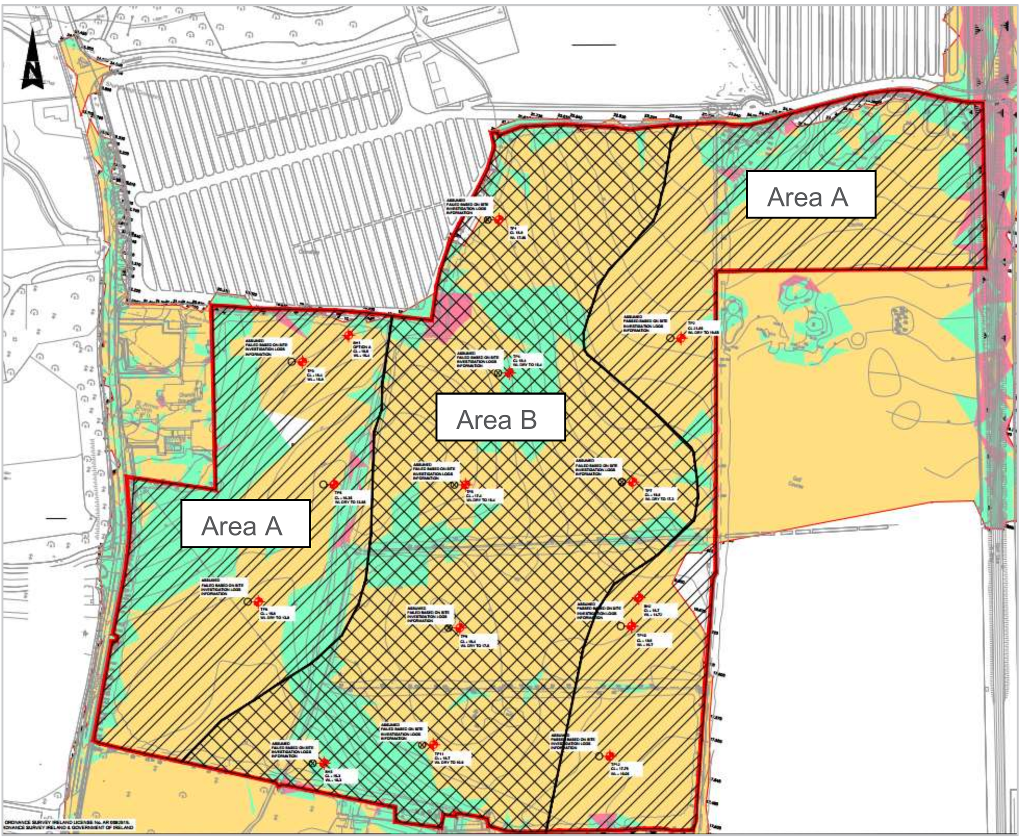
Permeability Class	Rate of Flow (inches per hour)
Very slow	Less than 0.06
Slow	0.06–0.2
Moderately slow	0.2–0.6
Moderate	0.6–2.0
Moderately rapid	2.0–6.0
Rapid	6.0–20.0
Very rapid	More than 20

From review of the soakaway test results, the site has been subdivided into two areas based on permeability classes as per Figure 5-5 below and planning drawing 5154251_EWE_DR_0540. Area A to the east and west of the site encompasses an area of 11.02ha and Area B in the middle of the site encompasses an area of 10.08ha.

The soakaway tests in Area A indicate results between 0.325 inch / hour and 0.444 inch / hour. Based on this it is determined that permeability class is ‘Moderately Slow’.

The Site Investigations indicate that for Area B *‘water level dropped too slowly to allow for calculations of ‘f’ the soil infiltration rate’.* For Area B it is determined that the permeability class is ‘Slow’.

Figure 5-5 - Site Permeability Classification

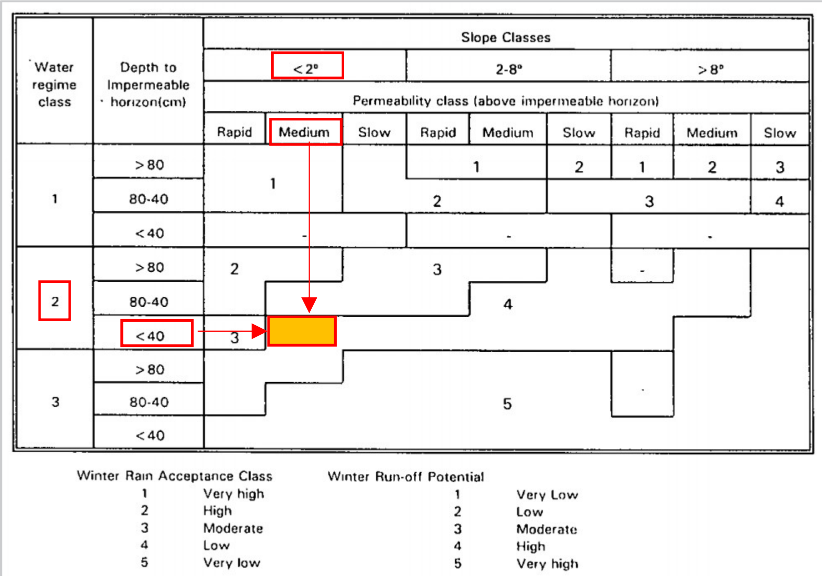


5.5. Soil Type Classification

5.5.1. Area A

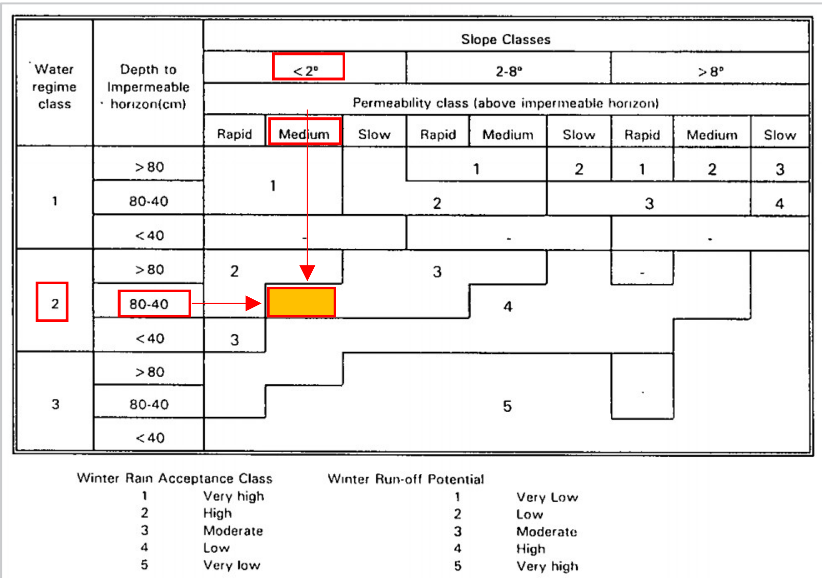
Based on the rational discussed in Sections 5.1- 5.4 above, Area A would fall into the Soil Type 4 classification as per Figure 5-6 below.

Figure 5-6 - Area A Soil Type Classification (Original)



However, DLRCC Municipal services opinion is that the depth to impermeable horizon across the site is in the range of 80cm – 40cm. Based on this Area A has been reclassified to Soil Type 3 for the purpose of Qbar discharge rate calculations, as per Figure 5-7 below.

Figure 5-7 - Area A Soil Type Classification (Amended)

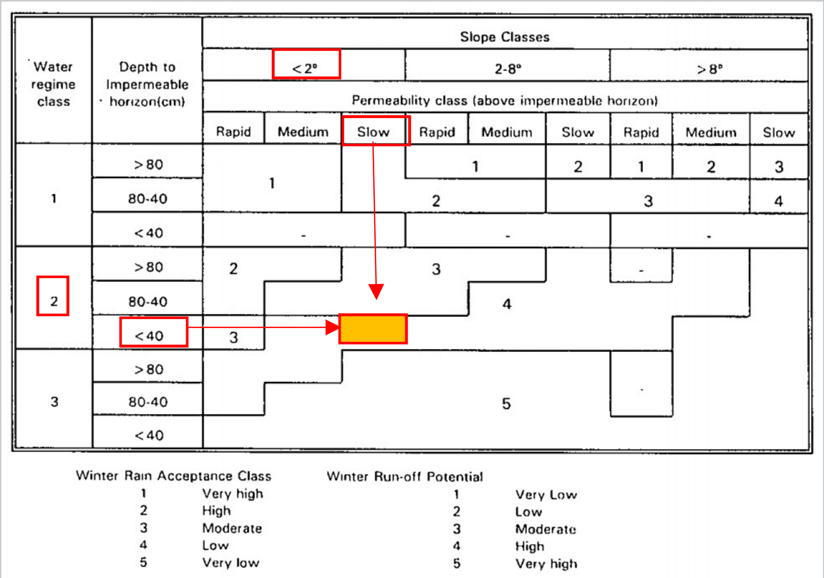


The reclassification of Soil Type 4 to Soil Type 3 provides a lower Qbar runoff rate and increases the attenuation volume requirements on site. The use of Soil Type 3 is therefore considered to be more onerous.

5.5.2. Area B

Based on the rational discussed in Sections 5.1- 5.4 above, Area B would fall into the Soil Type 4 classification as per Figure 5-8 below.

Figure 5-8 – Area B Soil Type Classification (Original)



DLRCC Municipal services opinion is that the depth to impermeable horizon across the site is in the range of 80cm – 40cm and that possibly Soil Type 3 should be used. However, it was further considered that as each of the soakaway tests within Area B failed due to poor infiltration rates the area should classified as Soil Type 4. DLRCC Municipal services agreed that Soil Type 4 was acceptable within this area of the site, as per Figure 5-8 above.

The Qbar value for the proposed site will therefore be determined using a combination of Soil Type Classification 3 and 4.

6. Surface Water Storage Requirements

As agreed with DLRCC Municipal services, the www.uksuds.com surface water storage volume estimation tool was used to determine the maximum Qbar discharge rate from the site for a 1 in 100-year storm event. Site specific data was confirmed using Met Eireann rainfall data as indicated below;

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 325915, Northing: 220611,

	Interval		Years													
DURATION	6months	1year	2	3	4	5	10	20	30	50	75	100	150	200	250	500
5 mins	2.7	3.8	4.4	5.2	5.8	6.2	7.7	9.3	10.3	11.8	13.1	14.1	15.6	16.8	17.8	N/A
10 mins	3.8	5.3	6.1	7.3	8.1	8.7	10.7	12.9	14.4	16.4	18.2	19.6	21.8	23.4	24.8	N/A
15 mins	4.5	6.3	7.2	8.6	9.5	10.2	12.6	15.2	16.9	19.3	21.4	23.1	25.6	27.6	29.2	N/A
30 mins	6.0	8.2	9.3	11.0	12.2	13.1	15.9	19.1	21.2	24.0	26.6	28.5	31.5	33.8	35.7	N/A
1 hours	7.9	10.6	12.1	14.2	15.6	16.7	20.2	24.0	26.5	29.9	33.0	35.3	38.8	41.5	43.8	N/A
2 hours	10.4	13.9	15.7	18.3	20.0	21.3	25.6	30.2	33.2	37.3	40.9	43.6	47.8	51.0	53.6	N/A
3 hours	12.3	16.2	18.2	21.2	23.1	24.6	29.4	34.5	37.8	42.4	46.4	49.4	54.0	57.5	60.3	N/A
4 hours	13.8	18.1	20.3	23.5	25.7	27.3	32.4	38.0	41.5	46.4	50.7	53.9	58.8	62.6	65.6	N/A
6 hours	16.2	21.1	23.6	27.3	29.7	31.5	37.2	43.4	47.4	52.8	57.5	61.1	66.4	70.5	73.9	N/A
9 hours	19.1	24.7	27.5	31.6	34.3	36.3	42.8	49.7	54.1	60.0	65.2	69.1	75.0	79.5	83.2	N/A
12 hours	21.4	27.6	30.7	35.1	38.0	40.2	47.2	54.6	59.3	65.8	71.3	75.5	81.8	86.6	90.5	N/A
18 hours	25.2	32.2	35.7	40.7	44.0	46.5	54.2	62.5	67.7	74.8	80.9	85.5	92.4	97.6	101.8	N/A
24 hours	28.3	35.9	39.8	45.2	48.8	51.4	59.8	68.7	74.3	81.9	88.4	93.3	100.7	106.2	110.8	126.0
2 days	35.7	44.5	48.9	55.0	59.0	62.0	71.2	81.0	87.1	95.3	102.2	107.5	115.3	121.1	125.9	141.8
3 days	41.7	51.4	56.2	62.9	67.2	70.5	80.5	90.9	97.4	106.1	113.5	119.0	127.2	133.4	138.4	155.0
4 days	46.9	57.5	62.6	69.8	74.4	77.9	88.5	99.5	106.4	115.6	123.3	129.1	137.7	144.1	149.3	166.6
6 days	56.2	68.1	73.8	81.9	87.0	90.8	102.5	114.6	122.0	132.0	140.3	146.6	155.8	162.7	168.2	186.6
8 days	64.4	77.4	83.7	92.5	98.0	102.1	114.7	127.7	135.7	146.3	155.2	161.8	171.6	178.8	184.7	204.0
10 days	71.9	86.0	92.7	102.1	108.0	112.4	125.8	139.6	148.0	159.2	168.6	175.6	185.8	193.4	199.5	219.8
12 days	79.0	94.0	101.2	111.1	117.4	122.0	136.2	150.6	159.5	171.2	181.0	188.3	199.0	206.9	213.3	234.3
16 days	92.1	108.8	116.8	127.7	134.6	139.7	155.1	170.9	180.5	193.1	203.7	211.5	223.0	231.5	238.3	260.7
20 days	104.3	122.5	131.1	143.0	150.4	155.9	172.5	189.4	199.6	213.1	224.4	232.7	244.8	253.8	261.0	284.7
25 days	118.7	138.6	147.9	160.8	168.8	174.8	192.7	210.8	221.8	236.2	248.2	257.0	270.0	279.6	287.2	312.2

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

A SAAR Value of 825mm was utilised to calculate the green field runoff rate as confirmed by DLRCC Municipal services.

Refer to Appendix J for the output from the www.uksuds.com surface water storage volume estimation tool and maximum Qbar discharge rate.

A summary of the calculations is outlined below (see Table 7-3 for further breakdown of areas)

- Total site (overall catchment) area; 21ha
- Total area drained; 12.199ha
- Total impermeable area based on reduced coefficient runoff rate; 9.094ha
- Total % of drainage area that is impermeable; 75%

Significant public open space (public open spaces, rear gardens etc.) has been calculated by subtracting the total site area from the total positively drained area; 8.801ha.

As discussed in Section 5.5 above and displayed on planning drawing 5154251_EWE_DR_0540, the overall catchment area has been divided into two areas based on the corresponding soil types. These figures have been utilised to calculate the Qbar runoff rate (including 10% allowance for climate change) as summarised in Table 6-1 below and displayed in the UK SuDS output included within Appendix J.

Table 6-1 - Qbar Calculation Summary

Area Ref.	Soil Type	Area Size (ha)	% of Total Area (21ha)	Resulting Qbar (l/s)	Total Qbar (l/s)
A	3	11.02	52	22.08	**56.34**
B	4	10.08	48	34.26	

The calculated Qbar rate of 56.34l/s has been discussed and agreed with DLRCC Municipal services. The figure is the final permittable discharge from the Woodbrook site (Phase 1 & 2).

7. Proposed Site Characteristics

The proposed overall catchment area of 21ha has been split into 10No. catchment areas (catchment A – J) as indicated in Figure 7-1 below and on planning drawing 5154251_EWE_DR_0500. All catchments have incorporated multiple SuDS features as outlined in Section 2 above. Each catchment will have a flow control device to limit discharge rates to the maximum allowable Qbar runoff rate from the site (56.34l/s) and attenuation storage.

Figure 7-1 – Site Catchment Areas

Based on a maximum allowable Qbar final runoff rate from the site of 56.34l/s (including 10% allowance for climate change) over a 21ha area, the runoff per hectare has been calculated as 2.68l/s/ha. In the first instance, the maximum discharge rates for each catchment were calculated based on the equivalent runoff per hectare, see Table 7-1 below for a summary of the results.

Two final flow control devices are proposed due to the topography and layout of the site. Attenuated flows from Catchment's A – I will pass through the final flow control device downstream of Catchment I. Catchment J will also have a flow control device to restrict flows before combining with the proposed storm water drainage network exiting the site at the south western corner as indicated on the planning drawings 5154251_EWE_DR_0501 – 0505.

Its is proposed that the final discharge from the overall site will be directly to the Crinkeen / Woodbrook Stream culvert via a new storm water network along the Dublin Road as indicated on drawing 5154251_EWE_DR_0502. The outfall will be downsteam of flow controls in catchment I and J.

In addition, due to the natural drainage routes, drainage design and catchment configuration within the proposed site, attenuated storm water will travel in a north east to south west direction through a series of catchments. Therefore, the initial discharge rates calculated are based on the cumulative value of the upstream discharge rate and the discharge rate for the current catchment, see Table 7-1 below for details.

Table 7-1 – Initial Catchment Area Discharge Rates

Catchment	Area	% of Total Site Area	Maximum Discharge rates per catchment based on Qbar 2.68 l/s/ha	Maximum Cumulative Discharge rates
A	2.64ha	12.6%	7.09l/s	**7.09l/s** (A only)
B	1.95ha	9.3%	5.24l/s	**12.33l/s** (A+B)
C	1.90ha	9.0%	5.09l/s	**17.42l/s** (A+B+C)
D	1.74ha	8.3%	4.67l/s	**4.67l/s** (D only)
E	2.15ha	10.2%	5.77l/s	**5.77l/s** (E only)
F (School Site)	1.21ha	5.7%	3.24l/s	**3.24l/s** (F only)
G	1.81ha	8.6%	4.86l/s	**13.87l/s** (E+F+G)
H	2.30ha	11.0%	6.17l/s	**24.71l/s** (D+E+F+G+H)
I	4.30ha	20.5%	11.53l/s	**53.66l/s** (A+B+C+D+E+F+G+H+I)
J	1.00ha	4.8%	2.68l/s	**2.68l/s** (I only)
Total	**21ha**	**100**	**56.34l/s**	**56.34l/s (final discharge from site)**

Upon review of the green open space within each catchment it was not possible to attenuate storm water within each of the catchments to achieve the cumulative discharge rates listed in Table 7-1 above. Therefore, catchment discharge rates have been revised to either decrease upstream discharge rates thus reducing the volume of water into the downstream catchment or by increasing the discharge rates from the current catchment thus increasing attenuation volume being provided downstream.

Changes to catchment flow rates within the site are managed locally and have no effect on the ultimate discharge rate from the entire site which is limited to 56.34l/s, as agreed with DLRCC Municipal services.

Based on attenuation space available throughout the site and ensuring the maximum ultimate discharge rate from the entire site of 56.34l/s is achieved, catchment discharge rates have been revised as per Table 7-2 below.

Table 7-2 – Amended Catchment Areas Discharge rates

Catchment	Area	% of Total Site Area	Maximum Discharge rates per catchment based on Qbar 2.68 l/s/ha	Maximum Cumulative Discharge rates	Maximum Discharge rates per catchment-based attenuation volume available
A	2.64ha	12.6%	7.09l/s	7.09l/s (A only)	**2.0l/s**
B	1.95ha	9.3%	5.24l/s	12.33l/s (A+B)	**14.2l/s**
C	1.90ha	9.0%	5.09l/s	17.42l/s (A+B+C)	**19l/s**
D	1.74ha	8.3%	4.67l/s	4.67l/s (D only)	**29.0l/s**
E	2.15ha	10.2%	5.77l/s	5.77l/s (E only)	**2.0l/s**
F (School Site)	1.21ha	5.7%	3.24l/s	3.24l/s (F only)	**3.2l/s**
G	1.81ha	8.6%	4.86l/s	13.87l/s (E+F+G)	**13.0l/s**
H	2.30ha	11.0%	6.17l/s	24.71l/s (D+E+F+G+H)	**20.0l/s**
I	4.30ha	20.5%	11.53l/s	53.66l/s (A+B+C+D+E+F+G+H+I)	**53.8l/s**
J	1.00ha	4.8%	2.68l/s	2.68l/s (I only)	**2.5l/s**
Total	**21ha**	**100**	**56.34l/s**	**56.34l/s (final discharge from site)**	**56.3l/s (final discharge from site)**

The total Site Impermeable Areas and reduced Impermeable Areas based on coefficient runoff factors are indicated below in table 7-3.

Table 7-3 – Site Impermeable Areas

	Total Impermeable Area	Impermeable Area based on co-efficient runoff factors (Table 2-1)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	1.77ha	1.77ha
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	1.843ha	1.383ha
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	4.807ha	2.887ha
Extensive Green Roof (> 150mm thk.)	2.735ha	2.322ha
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	1.044ha	0.732ha
Total	**12.199ha**	**9.094ha**

7.1. Catchment Design Details

Attenuation is proposed in each catchment using underground modular attenuation system. Refer to drawing 5154251_EWE_SCD_0021 - 0027 for details.

A controlled discharge from each catchment will be via a vortex flow control device downstream of the underground modular system. Each flow control devise has been designed based on the maximum head of water within the underground modular attenuation systems. The design head has been calculated for each catchment to ensure the flows rates indicated in Table 7-2 are not exceeded for the 1 in 100-year 6-hour storm event. It is noted that penstock will be installed within the hydro break chambers to allow maintenance when required. Flow control devices will not have bypass doors or high-level overflows as required by DLRCC.

A catch pit manhole will be provided at all inlets to the underground modular attenuation systems to reduce the levels of silts entering the system.

Where swales are provided, they are used for the conveyance of surface water runoff from the adjoining roads / footpaths. Discharge into the swale will be via drop kerbs / side inlet gully’s. Discharge from the swales to the storm water network will be via a perforated manhole cover. The manhole cover has been designed to be 50mm above the base on the swale to provide for interception volumes.

Porous paving provided will cater for runoff from the porous paving surface, adjacent roads / footpaths and roof runoff from the front of residential units. The subbase below the porous paving will allow for infiltration, reduced peak flows and 30% storage capacity within the subbase voids. An orifice plate / flow control will be used in the outfall chamber from each porous paving area to reduce the flow and increase the overall storage capacity of the subbase.

Filter Drains with a perforated pipe will be provided in private rear gardens to drain storm water from roof runoff from the rear of the proposed associated dwellings.

Tree pits will be used at locations as indicated. Runoff from adjacent roads / footpaths and excess runoff from adjoining impermeable surface will discharge into the pit via a dropped kerb. The tree pit will allow for interception and percolation to ground. An overflow pipe with a raised level of 50mm above the finished surface level will allow for overflow into the storm drainage network during high intensity rainfall events. It is noted that tree pit interception volumes have not been included within the interception calculations below however, a minimum interception volume of 0.1m^3 will be provided with each tree pit.

Extensive green roofs and Intensive green courtyards will be provided to suitable apartment blocks and retail units. A run-off factor of 80% has been used within the calculations.

7.2. Catchment A - Design Details

Attenuation is proposed in catchment A using an underground modular attenuation system. It was determined during modelling of the network that based a maximum discharge rate of 2l/s via a vortex flow control device that a volume of 216m^3 is required for 1 in 100-year 6-hour storm event including 10% for climate change.

Modelling of the 1 in 30-year storm for up to 24-hour event confirmed that the attenuation storage volume of 216m^3 provided was also sufficient.

Table 7-4 – Design Summary – Catchment A

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Resulting Maximum Design Flow for 1 in 100 yr	Resulting Maximum Design Flow for 1 in 30 yr	Minimum Tank Volume
Catchment A	2.0 l/s	2.0 l/s	2.0 l/s	216 m^3

Table 7-5 – Site Impermeable Areas – Catchment A

	Total Impermeable Area (m2)	Impermeable Area based on co-efficient runoff factors (Table 2-1) (m2)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	1720	1720
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	1140	855
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	8770	5262
Extensive Green Roof (> 150mm thk.)	4590	3901
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	1190	833
Total	**17410**	**12571**

Table 7-6 – Interception Volume Requirement– Catchment A

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	1.257ha
Volume of Interception Required	12571 x 0.005 x 0.8 = 50m^3

Table 7-7 – Interception Volume Provided – Catchment A

SuDS	Volume
Extensive Green Roof (> 150mm thk.)	3901m^2 x 0.005 = 20m^3
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	833m^2 x 0.005 = 4m^3
Permeable paving	3200m^2 x 0.05 = 160m^3 160 x 30% Voids = 48m^3
Underground modular attenuation system	3.16(W) x 19.18(L) = 60m^2 0.23(D) x 60m^2 = 13.8m^3 13.8 x 30% Voids = 4.14m^3
Swales A1 – A12	274(L) x 1(W) x 0.05(D) = 13.7m^3
Total	90m^3 provide > 50m^3 required (OK)

Interception Volume in catchment A has been provided using a series of SuDS. The overall volume being provide is 90m^3 which is greater than the 50m^3 required.

7.3. Catchment B - Design Details

Attenuation is proposed in catchment B using an underground modular attenuation system. It was determined during modelling of the network that based a maximum discharge rate of 14.2l/s via a vortex flow control device that a volume of 270m^3 is required for 1 in 100-year 6-hour storm event including 10% for climate change.

Modelling of the 1 in 30-year storm for up to 24-hour event confirmed that the attenuation storage volume of 270m^3 provided was also sufficient.

Table 7-8 – Design Summary – Catchment B

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Resulting Maximum Design Flow for 1 in 100 yr	Resulting Maximum Design Flow for 1 in 30 yr	Minimum Tank Volume
Catchment B	14.2 l/s	14.2 l/s	14.2 l/s	270 m^3

Table 7-9 – Site Impermeable Areas – Catchment B

	Total Impermeable Area (m2)	Impermeable Area based on co-efficient runoff factors (Table 2-1) (m2)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	0	0
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	780	585
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	460	0
Extensive Green Roof (> 150mm thk.)	6780	5763
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	3780	2646
Total	**11800**	**8994**

Table 7-10 – Interception Volume – Catchment B

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	0.8994ha
Volume of Interception Required	8994x 0.005 x 0.8 = 36m^3

Table 7-11 – Interception Volume Provided – Catchment B

SuDS	Volume
Extensive Green Roof (> 150mm thk.)	$5763m^2$ x 0.005 = $29m^3$
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	$2646m^2$ x 0.005 = $13m^3$
Permeable paving	$240m^2$ x 0.05 = $12m^3$ 12 x 30% Voids = $3.6m^3$
Underground modular attenuation system	5.34(W) x 36.62(L) = $196m^2$ 0.23(D) x 196m2 = $45m^3$ 45 x 30% Voids = $13m^3$
Swales B1 – B7	111(L) x 1(W) x 0.05(D) = 5.55m3
Total	$65m^3$ provide > $36m^3$ required (OK)

Interception Volume in catchment B has been provided using a series of SuDS. The overall volume being provide is $65m^3$ which is greater than the $36m^3$ required

7.4. Catchment C - Design Details

Attenuation is proposed in catchment C using an underground modular attenuation system. It was determined during modelling of the network that based a maximum discharge rate of 19l/s via a vortex flow control device that a volume of 144m^3 is required for 1 in 100-year 6-hour storm event including 10% for climate change.

Modelling of the 1 in 30-year storm for up to 24-hour event confirmed that the attenuation storage volume of 144m^3 provided was also sufficient.

Table 7-12 – Design Summary – Catchment C

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Resulting Maximum Design Flow for 1 in 100 yr	Resulting Maximum Design Flow for 1 in 30 yr	Minimum Tank Volume
Catchment C	19 l/s	18 l/s	19 l/s	144 m^3

Table 7-13 – Site Impermeable Areas – Catchment C

	Total Impermeable Area (m2)	Impermeable Area based on co-efficient runoff factors (Table 2-1) (m2)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	1010	1010
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	1830	1372
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	6100	3660
Extensive Green Roof (> 150mm thk.)	850	722
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	0	0
Total	**9790**	**6764**

Table 7-14 – Interception Volume – Catchment C

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	0.6764ha
Volume of Interception Required	6764 x 0.005 x 0.8 = 27m^3

Table 7-15 – Interception Volume Provided – Catchment C

SuDS	Volume
Extensive Green Roof (> 150mm thk.)	$722m^2$ x 0.005 = $4m^3$
Permeable paving	$176m^2$ x 0.05 = $8.8m^3$ 8.8 x 30% Voids = $3m^3$
Underground modular attenuation system	Not provided due to impermeable membrane
Filter drains (rear gardens)	232 (L) x 0.5 (w) x 0.5 (d) = $58m^2$ 58 x 30% Voids = $17m^3$
Total	$29m^3$ provide > $27m^3$ required (OK)

Interception Volume in catchment C has been provided using a series of SuDS. The overall volume being provide is $29m^3$ which is greater than the $27m^3$ required

7.5. Catchment D - Design Details

Attenuation is proposed in catchment D using an underground modular attenuation system. It was determined during modelling of the network that based a maximum discharge rate of 29l/s via a vortex flow control device that a volume of 160m^3 is required for 1 in 100-year 6-hour storm event including 10% for climate change.

Modelling of the 1 in 30-year storm for up to 24-hour event confirmed that the attenuation storage volume of 160m^3 provided was also sufficient.

Table 7-16 – Design Summary – Catchment D

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Resulting Maximum Design Flow for 1 in 100 yr	Resulting Maximum Design Flow for 1 in 30 yr	Minimum Tank Volume
Catchment D	29.0 l/s	28.9 l/s	28.9 l/s	160 m^3

Table 7-17 – Site Impermeable Areas – Catchment D

	Total Impermeable Area (m2)	Impermeable Area based on co-efficient runoff factors (Table 2-1) (m2)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	3310	3310
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	420	315
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	6120	3672
Extensive Green Roof (> 150mm thk.)	3150	2677
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	1190	833
Total	**14190**	**10807**

Table 7-18 – Interception Volume – Catchment D

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	1.0807ha
Volume of Interception required	10807x 0.005 x 0.8 = 43m^3

Table 7-19 – Interception Volume Provided – Catchment D

SuDS	Volume
Extensive Green Roof (> 150mm thk.)	$2677m^2$ x 0.005 = $13m^3$
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	833m2 x 0.005 = $4m^3$
Permeable paving	$173m^2$ x 0.05 = $8.65m^3$ 8.65 x 30% Voids = $3m^3$
Underground modular attenuation system	7.53(W) x 17(L) = $128m^2$ 0.55(D) x $128m^2$ = $70m^3$ 70 x 30% Voids = $21m^3$
Swales D1 – D3	41(L) x 1(W) x 0.05(D) = $2m^3$
Total	$43m^3$ provide > $43m^3$ required (OK)

Interception Volume in catchment D has been provided using a series of SuDS. The overall volume being provide is $43m^3$ which is equal to the $43m^3$ required.

7.6. Catchment E - Design Details

Attenuation is proposed in catchment E using an underground modular attenuation system. It was determined during modelling of the network that based a maximum discharge rate of 2.0l/s via a vortex flow control device that a volume of 368m^3 is required for 1 in 100-year 6-hour storm event including 10% for climate change.

Modelling of the 1 in 30-year storm for up to 24-hour event confirmed that the attenuation storage volume of 368m^3 provided was also sufficient.

Table 7-20 – Design Summary – Catchment E

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Resulting Maximum Design Flow for 1 in 100 yr	Resulting Maximum Design Flow for 1 in 30 yr	Minimum Tank Volume
Catchment E	2.0 l/s	1.4 l/s	1.5 l/s	368 m^3

Table 7-21 – Site Impermeable Areas – Catchment E

	Total Impermeable Area (m2)	Impermeable Area based on co-efficient runoff factors (Table 2-1) (m2)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	2550	2550
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	2980	2235
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	3690	2214
Extensive Green Roof (> 150mm thk.)	0	0
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	0	0
Total	**9220**	**6999**

Table 7-22 – Interception Volume – Catchment E

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	0.6999ha
Volume of Interception Required	6999x 0.005 x 0.8 = 28m^3

Table 7-23 – Interception Volume Provided – Catchment E

SuDS	Volume
Permeable paving	$1215m^2$ x 0.05 = $61m^3$ 18 x 30% Voids = $18m^3$
Underground modular attenuation system	Not provided due to impermeable membrane
Filter drains (rear gardens)	160 (L) x 0.5 (w) x 0.5 (d) = $40m^2$ 40 x 30% Voids = $12m^3$
Swales E1 – E4	41(L) x 1(W) x 0.05(D) = $2m^3$
Total	$32m^3$ provide > $28m^3$ required (OK)

Interception Volume in catchment E has been provided using a series of SuDS. The overall volume being provide is $32m^3$ which is greater than the $28m^3$ required

7.7. Catchment F - Design Details

Attenuation is proposed in catchment F using an underground modular attenuation system. It was determined during modelling of the network that based a maximum discharge rate of 3.2l/s via a vortex flow control device that a volume of 500m^3 is required for 1 in 100-year 6-hour storm event including 10% for climate change.

Modelling of the 1 in 30-year storm for up to 24-hour event confirmed that the attenuation storage volume of 500m^3 provided was also sufficient.

Note that a future allowance for the school site has been made including extents of hard standing areas, permeable paving as indicated below in Table 7-15. Discharge rates from the school site was calculated to be 3.2l/s (Qbar) with no increased or reduction applied to manage flows downstream. The downstream model is sized on the basis of a maximum discharge rate of 3.2l/s. Final attenuation volumes should be reviewed prior to planning application of the school site.

Table 7-24 – Design Summary – Catchment F

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Resulting Maximum Design Flow for 1 in 100 yr	Resulting Maximum Design Flow for 1 in 30 yr	Minimum Tank Volume
Catchment F	3.2 l/s	3.1 l/s	3.2 l/s	500 m^3

Table 7-25 – Site Impermeable Areas – Catchment F

	Total Impermeable Area (m2)	Impermeable Area based on co-efficient runoff factors (Table 2-1) (m2)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	2410	2410
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	3780	2835
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	1570	942
Extensive Green Roof (> 150mm thk.)	5660	4811
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	920	644
Total	**14340**	**11642**

Table 7-26 – Interception Volume – Catchment F

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	1.1642ha
Volume of Interception Required	11642x 0.005 x 0.8 = 47m^3

As noted above a future allowance for the school site has been made within the downstream storm network. It is assumed that 47m^3 of interception will be provided. Final Interception volumes should be agreed with DLRCC prior to planning application of the school site.

7.8. Catchment G - Design Details

Attenuation is proposed in catchment G using an underground modular attenuation system. It was determined during modelling of the network that based a maximum discharge rate of 13.0l/s via a vortex flow control device that a volume of 480m^3 is required for 1 in 100-year 6-hour storm event including 10% for climate change.

Modelling of the 1 in 30-year storm for up to 24-hour event confirmed that the attenuation storage volume of 480m^3 provided was also sufficient.

Table 7-27 – Design Summary – Catchment G

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Resulting Maximum Design Flow for 1 in 100 yr	Resulting Maximum Design Flow for 1 in 30 yr	Minimum Tank Volume
Catchment G	13.0 l/s	10.9 l/s	12.1 l/s	480 m^3

Table 7-28 – Site Impermeable Areas – Catchment G

	Total Impermeable Area (m2)	Impermeable Area based on co-efficient runoff factors (Table 2-1) (m2)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	0	0
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	330	247
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	2020	1212
Extensive Green Roof (> 150mm thk.)	2740	2329
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	2930	2051
Total	**8020**	**5839**

Table 7-29 – Interception Volume – Catchment G

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	5.8395ha
Volume of Interception Required	5839x 0.005 x 0.8 = 23m^3

Table 7-30 – Interception Volume Provided – Catchment G

SuDS	Volume
Extensive Green Roof (> 150mm thk.)	2329m^2 x 0.005 = 12m^3
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	2051m^2 x 0.005 = 10m^3
Permeable paving	434m^2 x 0.05 = 22m^3 22 x 30% Voids = 7m^3
Underground modular attenuation system	7.53(W) x 51.88(L) = 391m^2 0.23(D) x 391m2 = 90m^3 90 x 30% Voids = 27m^3
Existing Ditch to be retained (Swale)	145(L) x 1(W) x 0.05(D) = 7m^3
Total	75m^3 provide > 23m^3 required (OK)

Interception Volume in catchment G has been provided using a series of SuDS. The overall volume being provide is 75m^3 which is greater than the 23m^3 required

7.9. Catchment H - Design Details

Attenuation is proposed in catchment H using an underground modular attenuation system. It was determined during modelling of the network that based a maximum discharge rate of 20 l/s via a vortex flow control device that a volume of 720m^3 is required for 1 in 100-year 6-hour storm event including 10% for climate change.

Modelling of the 1 in 30-year storm for up to 24-hour event confirmed that the attenuation storage volume of 720m^3 provided was also sufficient.

Table 7-31 – Design Summary – Catchment H

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Resulting Maximum Design Flow for 1 in 100 yr	Resulting Maximum Design Flow for 1 in 30 yr	Minimum Tank Volume
Catchment H	20.0 l/s	19.9 l/s	19.9 l/s	720 m^3

Table 7-32 – Site Impermeable Areas – Catchment H

	Total Impermeable Area (m2)	Impermeable Area based on co-efficient runoff factors (Table 2-1) (m2)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	3420	3420
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	1310	982.5
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	4490	2694
Extensive Green Roof (> 150mm thk.)	1200	1020
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	430	301
Total	**10850**	**8417.5**

Table 7-33 – Interception Volume – Catchment H

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	8.4175ha
Volume of Interception Required	8417.5x 0.005 x 0.8 = 34m^3

Table 7-34 – Interception Volume Provided – Catchment H

SuDS	Volume
Permeable paving	$892m^2$ x 0.05 = $45m^3$ 45 x 30% Voids = $13m^3$
Underground modular attenuation system	60.60(W) x 9.71(L) = $590m^2$ 0.28(D) x 590m2 = $165m^3$ 165 x 30% Voids = $50m^3$
Swales H1 – H2	19(L) x 1(W) x 0.05(D) = $1m^3$
Total	$64m^3$ provide > $64m^3$ required (OK)

Interception Volume in catchment I has been provided using a series of SuDS. The overall volume being provide is $64m^3$ which is equal to the $64m^3$ required.

7.10. Catchment I - Design Details

Attenuation is proposed in catchment I using an underground modular attenuation system. It was determined during modelling of the network that based a maximum discharge rate of 53.8 l/s via a vortex flow control device that a volume of 675m^3 is required for 1 in 100-year 6-hour storm event including 10% for climate change.

Modelling of the 1 in 30-year storm for up to 24-hour event confirmed that the attenuation storage volume of 675m^3 provided was also sufficient.

Table 7-35 – Design Summary – Catchment I

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Resulting Maximum Design Flow for 1 in 100 yr	Resulting Maximum Design Flow for 1 in 30 yr	Minimum Tank Volume
Catchment I	53.8 l/s	53.8 l/s	53.7 l/s	675 m^3

Table 7-36 – Site Impermeable Areas – Catchment I

	Total Impermeable Area (m2)	Impermeable Area based on co-efficient runoff factors (Table 2-1) (m2)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	2870	2870
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	5500	4421
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	13350	8010
Extensive Green Roof (> 150mm thk.)	810	688.5
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	0	0
Total	**22530**	**15989.5**

Table 7-37 – Interception Volume – Catchment I

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	1.5989ha
Volume of Interception Required	15989.5 x 0.005 x 0.8 = 64m^3

Table 7-38 – Interception Volume Provided – Catchment I

SuDS	Volume
Extensive Green Roof (> 150mm thk.)	688m2 x 0.005 = 3m^3
Permeable paving	3642m2 x 0.05 = 182m^3 182 x 30% Voids = 55m^3
Underground modular attenuation system	7.53(W) x 14.82(L) = 111m^2 14.08(W) x 19.18(L) = 270m^2 7.53(W) x 23.54(L) = 177m^2 0.23(D) x 558m2 = 128m^3 128 x 30% Voids = 39m^3
Filter drains (rear gardens)	608 (L) x 0.5 (w) x 0.5 (d) = 152m^2 152 x 30% Voids = 47m^3
Swales I1 – I5	115(L) x 1(W) x 0.05(D) = 6m^3
Total	150m^3 provide > 64m^3 required (OK)

Interception Volume in catchment I has been provided using a series of SuDS. The overall volume being provide is 150m^3 which is greater than the 64m^3 required.

7.11. Catchment J - Design Details

Attenuation is proposed in catchment J using an underground modular attenuation system. It was determined during modelling of the network that based a maximum discharge rate of 2.5 l/s via a vortex flow control device that a volume of 88m^3 is required for 1 in 100-year 6-hour storm event including 10% for climate change.

Modelling of the 1 in 30-year storm for up to 24-hour event confirmed that the attenuation storage volume of 88m^3 provided was also sufficient.

Table 7-39 – Design Summary – Catchment J

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Resulting Maximum Design Flow for 1 in 100 yr	Resulting Maximum Design Flow for 1 in 30 yr	Minimum Tank Volume
Catchment J	2.5 l/s	2.4 l/s	2.0 l/s	88 m^3

Table 7-40 – Site Impermeable Areas – Catchment J

	Total Impermeable Area (m2)	Impermeable Area based on co-efficient runoff factors (Table 2-1) (m2)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	410	410
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	360	270
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	1500	900
Extensive Green Roof (> 150mm thk.)	1570	1334
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	0	0
Total	**3840**	**2914**

Table 7-41 – Interception Volume – Catchment J

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	0.29145ha
Volume of Interception Required	2914.5 x 0.005 x 0.8 = 12m^3

Table 7-42 – Interception Volume Provided – Catchment J

SuDS	Volume
Extensive Green Roof (> 150mm thk.)	1334m^2 x 0.005 = 7m^3

Permeable paving	$591m^2$ x 0.05 = $30m^3$ 30 x 30% Voids = $9m^3$
Underground modular attenuation system	3.16(W) x 19.18(L) = $61m^2$ 0.23(D) x 60.60m2 = $14m^3$ 14 x 30% Voids = $4m^3$
Filter drains (rear gardens)	107 (L) x 0.5 (w) x 0.5 (d) = $27m^2$ 27 x 30% Voids = $8m^3$
Swales J1 – J4	83(L) x 1(W) x 0.05(D) = $4m^3$
Total	$32m^3$ provide > $12m^3$ required (OK)

Interception Volume in catchment J has been provided using a series of SuDS. The overall volume being provide is $32m^3$ which is greater than the $12m^3$ required.

7.12. Compliance with GDSDS Design Criteria

Outfall Section 6.3.4 of the GDSDS Volume 2 New Development sets out four design criterion which are required to be met by the proposed drainage system. Compliance with these criteria are outlined below:

7.12.1. Interception Volume – Criterion 1.1

Interception storage volume is based on 80% runoff from paved areas and 0% runoff from pervious surfaces for the first 5mm of rainfall.

Table 7-43 – Interception Volume

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	9.094ha
Volume of Interception Required	90,940 x 0.005 x 0.8 = 363.76m^3

Interception Volume 627m^3 is being provided for the overall site which is > than 363.76m^3 required for the site. Interception volume has been provided on the proposed site using the SuDS features noted below and as indicated in sections 7.2 – 7.11.

- Filter Drains
- Permeable pavement to parking bays
- Conveyance Swales
- Green roofs (to apartment buildings only)
- Green courtyards (to apartment buildings only)
- Tree pits (along main avenue)
- Underground modular systems (within green open spaces)

7.12.2. Treatment Volume – Criterion 1.2

Interception storage volume is based on 80% runoff from paved areas and 0% runoff from pervious surfaces for the first 15mm of rainfall.

Table 7-44 – Treatment Volume

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	9.094ha
Volume of Treatment Storage Required	90,940 x 0.015 x 0.8 = 1091.28m^3

Due to site constraints including open space set out in the Local Area Plan (LAP) and density requirements there is insufficient space on site to provide the Treatment Volume (retention pond or wetland) and therefore Criterion 1.2 cannot be successfully met for this site.

In accordance with Table 6.3 of the Regional Drainage Policies – Volume 2 New Development, as Criterion 1.1 is being achieved, Criterion 1.2 is not required.

7.12.3. River Regime Protection – Criterion 2

An allowable outflow rate for Qbar of 56.34l/s has been calculated for the site and agreed with DLRCC drainage department.

The overall site attenuation volume is > 3621m^3 as outlined in the table below which is provided for the appropriate throttle rate.

Table 7-45 - Attenuation Tanks

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Minimum Tank Volume	Excavation Dimensions W x L x D
Catchment A	2.0 l/s	216 m^3	5.34 x 27.90 x 1.8m
Catchment B	14.2 l/s	270 m^3	5.34 x 36.62 x 1.8m
Catchment C	17.6 l/s	144 m^3	5.34 x 19.18 x 1.8m
Catchment D	29.0 l/s	160 m^3	20.64 x 6.10 x 1.6m
Catchment E	2.0 l/s	368 m^3	7.53 x 38.80 x 1.6m
Catchment F (School Site)	3.2 l/s	500 m^3	22.73 x 28.91 x 1.0m
Catchment G	13.0 l/s	480 m^3	7.53 x 51.88 x 1.6m
Catchment H	20.0 l/s	720 m^3	9.71 x 60.60 x 1.6m
Catchment I	53.8 l/s	675 m^3	Section 1 7.53 x 14.82 x 1.5m Section 2 14.08 x 19.18 x 1.5m Section 3 7.53 x 23.54 x 1.5m
Catchment J	2.5 l/s	88 m^3	3.16 x 19.18 x 1.6m
Total	**56.3l/s (final discharge from site)**	**3,621m^3**	

7.12.4. Levels of Service – Criterion 3

The four criteria for levels of service are as follows:

- Criterion 3.1: No external flooding (30 year high intensity rainfall event)
- Criterion 3.2: No internal flooding (100 year high intensity rainfall event)
- Criterion 3.3: No internal flooding (100 year river event and critical duration for site storage)
- Criterion 3.4: No flood routing off site except where specifically planned (100 year high intensity rainfall event)

Criteria 3.1, 3.2, 3.3 & 3.4: All potential flooding has been reviewed and modelled using micro drainage for up to the required 1 in 100 year storm event including 10% for climate change. Outputs from the model for the proposed storm network are contained in Appendix B-G of this report.

7.12.5. River Flood Protection – Criterion 4

Of the three methods referred to in the GDSDS for establishing River Flood Protection, by comparison of the pre and post development runoff volumes, (Criteria 4.1, 4.2 and 4.3 respectively), Criteria 4.3 has been selected most suitable for use on this proposed site. An extract from the GDSDS for Criterion 4 is indicated in Figure 7-2 below.

Figure 7-2 - GDSDS River Flood Protection

Criterion 4 River flood protection (Criterion 4.1, or 4.2 or 4.3 to be applied)	4.1	100	"Long-term" floodwater accommodated on site for development runoff volume which is in excess of the greenfield runoff volume. Temporary flood storage drained by infiltration on a designated flooding area brought into operation by extreme events only. 100 year, 6 hour duration storm to be used for assessment of the additional volume of runoff.
	4.2	100	Infiltration storage provided equal in volume to "long term" storage. Usually designed to operate for all events. 100year, 6-hour duration storm to be used for assessment of the additional volume of runoff.
	4.3	100	Maximum discharge rate of QBAR or 2 l/s/ha, whichever is the greater, for all attenuation storage where separate "long term" storage cannot be provided.

Criterion 4.3 has been satisfied for the proposed site by providing an agreed Maximum discharge rate of Qbar (56.3l/s) and on-site attenuation for up to the 1 in 100 year storm event including 10% for climate change.

8. Woodbrook Golf Club Replacement Golf Holes

This section of the Stormwater Impact Assessment report exclusively provides details of the Storm Water elements associated with the proposed Woodbrook Golf Course located south of Shankill, South Dublin. As part of this Phase 1 planning application permission is requested for the development of 2No. new holes to the east of the existing railway track which is set on an area of approx. 5.7ha.

Drawings 5154251_EWE_DR_0506 – 0507 & 5154251_EWE_DR_0514 inclusive outline the proposed details of the storm-water network and longitudinal sections for the proposed golf course.

8.1. Existing Storm Drainage Infrastructure

The area in which it is proposed to construct the 2No. Golf holes currently drains via existing ditches on site. The existing ditches flow from both North to South and from East to West as indicated on planning drawings 5154251_EWE_DR_0506 & 507. Both ditches then combine to the South Eastern end of the proposed site. The existing ditches then discharge into an existing storm drainage system which outfalls to the sea to the East of the Woodbrook Golf Course.

8.2. Proposed Storm Drainage Infrastructure

The new storm drainage system to drain the new 2 No. Golf holes has been designed in accordance with the '*Greater Dublin Regional Code of Practice for Drainage Works V.6*' incorporating SuDS strategies.

The fairways, tee boxes and putting greens will be drained via land drains at a minimum spacing of 10m c/c for fairways and 3m c/c for tee boxes and putting greens in accordance with '*United States Golf Association recommendations for a method of putting green construction*' as indicated on planning drawings 5154251_EWE_DR_0506 & 507. The layout of the proposed drainage network has been designed to follow the natural topography of the existing ground where possible

The overall drainage design strategy includes SuDS treatment train, to improve water quality, reduce run off, and to ensure no downstream flooding occurs when discharging into the existing water course. Planning drawings 5154251_EWE_DR_0506 & 507 indicate the proposed SuDS strategies to be implemented and incorporates integration of both land drains within the fairway, tee boxes and putting greens, along with detention basins prior to discharging into the existing ditch.

The storm water drainage network will be assessed for compliance with the key design parameters as set out in Table 2-1 below.

Table 8-1 – Key Design Parameters

Parameter	Value/Requirement
Minimum depth	1.2m cover under highways 0.9m elsewhere*
Maximum depth	5.0m
Minimum sewer size for main drainage	225mm
Co-efficient runoff factors for pipe sizing and storage requirements	75% - Drained Areas
Max. velocity at pipe full	3.0 m/s
Min. velocity in	0.75 m/s (1.0 m/s used where achievable)
Roughness	0.6mm

DLRCC Municipal services agreed Maximum discharge rate	9.8l/s at final discharge location
Level of Service Critical Storm 1 in 2 yr return period	No surcharge within the pipe network, no flooding
Level of Service Critical Storm 1 in 30 yr return period	Surcharge allowed, no flooding
Level of Service Critical Storm 1 in 100 yr return period	No flooding unless planned and contained on site.

A coefficient runoff of 75% has been used for this assessment which is similar to the agreed rate of 70% for Intensive Green Courtyard. While no guidance is provided within the CIRIA SuDS manual, further research estimates a variable runoff rate been 40% and 75%.

There are 3 detention basins located within the proposed site. Each detention pond has been designed as part of the golf course features and incorporate storage volumes allowing for attenuation of storm water flows during storm events. Basins will have a maximum water depth and a minimum attenuation volume provided as indicated below

Table 8-2 – Minimum Attenuation Volumes Provided

Detention Basin	Volume	Maximum Water Level
A	1243m^3	550mm
B	536m^3	400mm
C	80m^3	400mm

A vortex flow control device will be installed at the outlet to each pond to allow for reduced discharge from the pond during storm events. The discharge rate from the final detention basin to the existing drainage ditch will be limited to 9.2l/s as agreed with DLRCC Municipal services department.

Land drains and detention ponds will allow for infiltration to ground.

Refer to drawings 5154251_EWE_DR_0506 & 507 for the proposed drainage layout.

8.3. Compliance with GDSDS Design Criteria

Outfall Section 6.3.4 of the GDSDS Volume 2 New Development sets out four design criterion which are required to be met by the proposed drainage system. Compliance with these criteria are outlined below:

8.3.1. Interception Volume – Criterion 1.1

Interception storage volume is based on 80% runoff from paved areas and 0% runoff from pervious surfaces for the first 5mm of rainfall.

Table 8-3 – Interception Volume

	Total Paved Site
Drained Areas	1.594ha
Volume of Interception Required	15940 x 0.005 x 0.8 = 63.76m^3

It is considered that the first 5mm of rainfall throughout the proposed drained golf course site will no discharge from the site as there is no hard-standing areas. The first 5mm of rainfall be used by planting etc. as part of the Transpiration process and infiltration into the top layers of soil. Therefore, infiltration is being provided.

8.3.2. Treatment Volume – Criterion 1.2

Interception storage volume is based on 80% runoff from paved areas and 0% runoff from pervious surfaces for the first 15mm of rainfall.

Table 8-4 – Treatment Volume

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	1.594ha
Volume of Treatment Storage Required	15940 x 0.015 x 0.8 = 191m^3

While it is considered that the first 15mm of rainfall throughout the proposed drained golf course site will not fully discharge into the detention basin as there is no hard-standing areas, Treatment Volume using a semi-permanent wetlands is being provided at the outlet from each of the dentation basins by reducing ground levels to 200mm below the outfall level for the areas indicated on drawings 5154251_EWE_DR_0506 & 507. This volume does not form part of the overall attenuation requirements for the proposed golf course

Therefore Criterion 1.2 has been successfully met for this site.

8.3.3. River Regime Protection – Criterion 2

An allowable outflow rate for Qbar of 9.2l/s has been with DLRCC drainage department for the Golf Course Site.

The overall site attenuation volume is > 1,859 m^3 as outlined in section 8.2 which is provided for within the site using detention basins.

8.3.4. Levels of Service – Criterion 3

The four criteria for levels of service are as follows:

- Criterion 3.1: No external flooding (30 year high intensity rainfall event)
- Criterion 3.2: No internal flooding (100 year high intensity rainfall event)
- Criterion 3.3: No internal flooding (100 year river event and critical duration for site storage)
- Criterion 3.4: No flood routing off site except where specifically planned (100 year high intensity rainfall event)

Criteria 3.1, 3.2, 3.3 & 3.4: All potential flooding has been reviewed and modelled using micro drainage for up to the required 1 in 100 year storm event including 10% for climate change. Outputs from the model for the proposed storm network are contained in Appendix M of this report.

8.3.5. River Flood Protection – Criterion 4

Of the three methods referred to in the GDSDS for establishing River Flood Protection, by comparison of the pre and post development runoff volumes, (Criteria 4.1, 4.2 and 4.3 respectively), Criteria 4.3 has been selected most suitable for use on this proposed site. An extract from the GDSDS for Criterion 4 is indicated in figure 8-1 below.

Figure 8-1 - GDSDS River Flood Protection

Criterion 4 River flood protection (Criterion 4.1, or 4.2 or 4.3 to be applied)	4.1	100	"Long-term" floodwater accommodated on site for development runoff volume which is in excess of the greenfield runoff volume. Temporary flood storage drained by infiltration on a designated flooding area brought into operation by extreme events only. 100 year, 6 hour duration storm to be used for assessment of the additional volume of runoff.
	4.2	100	Infiltration storage provided equal in volume to "long term" storage. Usually designed to operate for all events. 100year, 6-hour duration storm to be used for assessment of the additional volume of runoff.
	4.3	100	Maximum discharge rate of QBAR or 2 l/s/ha, whichever is the greater, for all attenuation storage where separate "long term" storage cannot be provided.

Criterion 4.3 has been satisfied for the proposed site by providing an agreed Maximum agreed discharge rate of Qbar (9.2l/s) and on-site attenuation for up to the 1 in 100-year storm event including 10% for climate change.

It is noted that the outfall from the site discharges to sea and not into an existing river. Following discussions with DLRCC it was considered that to protect and reduce possible impact of erosion at the outfall to the sea additional interception volume would be provided within the existing golf course lands. This is above the volume being provided due to the limited greenfield runoff rates.

The existing manhole cover level will be raised by 300mm within an existing natural depression on site that will be used as a detention basin. This area will allow for increased storage of circa 99m^3, infiltration to ground and reduced runoff volumes. Where water levels within the detention basin are > 300mm the stormwater will overflow into the existing manhole via a perforated manhole lid.

9. Flooding & Exceedance Flows

9.1. Flood Risk Assessment

A Flood Risk Assessment (FRA) Atkins Document No. 5157801DG0003 has been undertaken for the site to satisfy the requirements of the Planning System and Flood Risk Management Guidelines. The report aimed at scoping sources of flooding, assessing whether any significant flood risk issues exist and proposing appropriate flood risk management measures as required. The flood risk assessment can be considered to satisfy the Stage 1 – Flood Risk identification as set out in The Guidelines. It is considered that this level of assessment is sufficient given the nature of the development and the level of flood risk identified for the site. Therefore, the FRA was not required to progress to Stage 2 & 3.

The FRA conclusion identifies that there is no potential flood risk identified in the vicinity of the proposed residential development site.

9.2. Exceedance Flows

Surface Water exceedance flows from the site have been considered as part of the drainage design. A modelling exercise was carried out with a 50% blockage within vortex flow control units at 3 locations. The locations selected are based on importance or proposed site level following a review of the Surface Water Flow Paths 5154251_EWE_DR_0515 & 516.

The table below outlines the catchments and Vortex flow control that had a restriction applied.

Table 9-1 – Exceedance Flows

Catchment	Votex Flow Control Restriction	Storm Event	Maximum Flood Volume
Catchment I	50%	1 in 100-year 6-hour event	184m^3
Catchment D	50%	1 in 100-year 6-hour event	291m^3
Catchment E	50%	1 in 100-year 6-hour event	No flooding

Catchment I

From a review of the model output a flood volume of 184m^3 was indicated for a 1 in 100-year storm event at the vortex flow control manhole S141. From a review of site levels, flooding that occurs within this area due to a blockage within the vortex flow control will have a surface flow path towards the south of the site. An existing ditch to the south of the site that will remain post development would be capable of containing the maximum flood volume indicated.

Catchment D

From a review of the model output a flood volume of 291m^3 was indicated for a 1 in 100-year storm event at the vortex flow control manhole S67. From a review of site levels, flooding that occurs within this area will flow west along the proposed road to a low point as indicated on drawing 5154251_EWE_DR_516. A double gully has been placed at the low pint to ensure that exceedance flows can be catered for. Exceedance flows will be discharge into the existing drainage ditch as indicated on drawing 5154251_EWE_DR_514.

Catchment E

From a review of the model output no flooding was indicated for the 1 in 100-year storm event at the vortex flow control manhole upstream of manhole S84. From further investigation review of the model output data it was determined why no flooding had occurred it was determined that maximum while the maximum flow rate design was set to 2l/s (under normal conditions) the flow rate only reached

1.4l/s for the 1 in 100 year event as indicated in section 7.6. The restricted flow rate from 1.4l/s to 1l/s had no negative effects on the drainage system and no flooding was indicated.

10. SuDS Maintenance

Regular checks and maintenance of the SuDS systems is required and have been considered as part of the overall drainage design for the proposed development. This will ensure both the design life of the SuDS systems, ongoing improved water quality, reduced water runoff and reduce the risk of onsite flooding and exceedance flows.

10.1. Permeable Paving

Paving should be inspected regularly, preferable during and after heavy rainfall to ensure effective operation.

Vacuum brushing or jetting of the permeable paving should be carried out once a year. Cleaning is generally carried out after Autumn leaf fall to remove silts and sediments.

10.2. Green Roofs / Green Courtyards

All components (soil substrate, vegetation, drains, membranes and rood structure) should be inspected annually and after severe storms.

Underside of roof should also be inspected annually and after severe storms for evidence of leakage.

Debris, fallen leaves and litter should be regularly removed to prevent clogging of inlet drains.

10.3. Underground modular attenuation systems

Inspection of the system should be carried out monthly for the first 3 months and then annually to ensure the system is working correctly.

Debris should be removed monthly from the catchment surface where is may cause risk to the performance of the underground attenuation system

As required sediment from pre-treatment (catch pit) manholes prior to the attenuation system should be removed to ensure on going performance of the system.

The inside of the tank should be surveyed every 5 years or as required if performance is reduced. Sediment build up removed if necessary.

10.4. Tree Pits

Maintenance of trees will be greatest in the first few years, which will include regular inspection of tree condition including inlets and outlets, removal of invasive vegetation and possibly irrigation during long dry periods.

10.5. Swales

Mowing in the first year is critical to eliminate competition from weeds. Lawn-mowing to an ideal height of 100mm should be maintained as grasses tend to flatten down when water is flowing over them, reducing sedimentation. Maintenance of the swale should include:

- Periodic litter removal with the swale and self-clearing inlet grid.
- Occasional stabilisation of eroded side slopes and base.
- Check and Removal of Sediment build up.
- Ongoing maintenance should form part of the site landscaping proposals.

10.6. Filter Drains

Inspection of the system should be carried out monthly on the inlet / outlet pipework and any control systems for blockages.

Inspection of pre-treatment systems including should be carried out every 6 months for catch pits manholes prior to the filter drain with removal of silt or other build-ups. Removal of silt build-up may be required more frequent.

Annual cleaning of roof runoff gutters etc should be part of the generally maintenance of the drainage system to ensure debris is removed prior to entering the network.

Perforated pipework should be cleared of blockage if required.

11. SuDS Audit Overview

The Stage 1 Surface Water Audit was carried out by Punch Consulting Engineers in October 2019.

The total site area noted within the Surface Water Audit was approximal 21.2Ha however the final site area lodged for planning is 21.9ha. This change in area has not impact on the Surface Water Audit.

The Audit highlighted 28No. items including recommended measures. It is noted that each item highlighted was considered and fully addressed or discussed further.

Atkins carried out amendments to the storm drainage design where required, in a number of circumstances alternative measure were proposed and accepted by the Auditors.

The Audit was completed and signed off by Atkins and Punches on the 18th of October 2019.

Refer to Appendix A for a copy of the report comments and feedback.

Appendices

Appendix A. Stage 1 - Stormwater Audit Report

PUNCH
consulting engineers

Proposed Residential Development at Woodbrook, Co. Dublin

Stage 1 Surface Water Audit

October 2019

Document Control

Document Number: 192169-R0

Revision	Date	Prepared	Checked	Approved
R0 (Draft)	04.10.2019	D. Murphy Design Engineer BEng (Hons) P Grad Dip MIEI	M.C. Daly Senior Engineer BEng (Hons) HDSDA CEng MIEI	L. Brennan Technical Director BE Dip Hy&Geo Eng PGDipHSC CEng MIEI

Report by: ______________________ Date: 18th October 2019

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1 Introduction

1.1 Purpose of Report

This report presents a Stage 1 Surface Water Audit carried out for a proposed residential development and associated infrastructure at Woodbrook, Co. Dublin. The pre-planning file application number for this development is 302965-18.

1.2 Site Details

The proposed development at Woodbrook has a site area of approximately 21.2 hectares. The site is bordered by an existing cemetery and green fields to the north. To the east is Woodbrook Golf Club, and to the south and west are green fields and small number of residential and business developments. The land generally falls from the north east to the south west of the site. The existing levels within the area range from 24.91m to 14.93m OD Malin.

This stage 1 surface water audit report details the surface water drainage system for the proposed residential development at Woodbrook only.

1.3 Report Details

The audit was carried out by Donnagh Murphy and Marie-Claire Daly between the dates of September 4th and October 18th 2019.

This Stage 1 Audit has been carried out in accordance with the Dún Laoghaire-Rathdown County Council (DLRCC) Stormwater Audit Procedure Rev 0 January 2012. The auditor has examined only those issues within the design relating to surface water drainage implications of the scheme and has therefore not examined or verified the compliance of the design to any other criteria.

Appendix A contains copies of drawings and documents examined by the auditor. The drawings in Appendix B correspond to the Stage 1 Audit findings outlined in Section 2 of this report. Appendix C contains the Surface Water Audit Feedback form.

All of the findings outlined in Section 2 of this report are considered by the auditor to require action in order to improve the stormwater credentials of the scheme.

2 Stage 1 Audit Findings

2.1 Proposed Residential Develpoment at Woodbrook, Co. Dublin.

2.1.1 Bio-Retention Systems

Problem: The proposed road, a number of car parking spaces and driveways are impermeable. There is a risk that the surface water will overrun the impermeable surfacing designated for car parking.

Recommendation: Consider incorporating bio-retention systems, swales or detention basins with water compatible planting in green areas in close proximity to the impermeable surfaces within the site of the proposed development to take the additional runoff. This is an added aesthetic benefit as plants establish within the bio-retention area.

2.1.2 Roads surfacing/Porous Asphalt

Problem: The proposed roads' surfacing has potential to increase the surface water runoff from the development.

Recommendation: Consider utilising porous asphalt or porous concrete surfacing throughout the development as a roads surfacing. This would allow surface water runoff from all areas subject to vehicular traffic to achieve an enhanced environmental quality level as well as a greater opportunity for infiltration.

2.1.3 Permeable Paving

Problem: Although permeable paving is located in some private driveways and some parking spaces, it should be considered in greater quantity. Impermeable surfaces do not allow water to infiltrate to the ground.

Recommendation: Consider inclusion of permeable paving for all the proposed private driveways and proposed parking spaces. The stone layer within the build-up would have a dual effect of cleaning the surface water run-off contaminants, and attenuating the flow reducing the rate at which surface water would flow from the surface areas.

2.1.4 Proposed Permeable Paving System – Tanked or permeable

Problem: It is not clear on the drawings provided whether the proposed permeable paving system is a tanked system or a permeable system.

Recommendation: Consider utilising a permeable paving system, incorporating a geotextile with proven capabilities for hydrocarbon pollution treatment in sustainable drainage systems (SuDS). The stone layer within the build-up of the permeable system will have a dual effect of the cleaning the surface water run-off from contaminants, and attenuating the flow, reducing the rate at which surface water would flow from these areas.

2.1.5 Ponds/Wetlands/Settlement Ponds

Problem: There is potential to reduce the surface water runoff and to improve runoff quality from the drainage output from the development by incorporating ponds in lieu of the proposed attenuation tanks.

Recommendation: Consider incorporating ponds in viable locations on the site; consider replacing some underground attenuation tanks with ponds. Incorporating ponds can provide both attenuation and treatment of surface water runoff. It can support aquatic vegetation which further enhances the treatment process, enhances biodiversity and offers aesthetic benefits to the site.

2.1.6 Bypass Interceptors - Locations

Problem: The proposed bypass interceptor is located downstream of the attenuation tanks. As these tanks allow for infiltration to ground, the water needs to be treated before flowing into the attenuation tanks to prevent hydrocarbons entering the ground.

Recommendation: Bypass interceptors to be located upstream of each attenuation tank close to the potential pollution source.

2.1.7 Bypass Interceptors - Specification

Problem: Bypass Interceptor details have not been included in the documents provided.

Recommendation: Details of bypass interceptors are to be provided to ensure appropriate sizing.

2.1.8 Attenuation Storage Tanks

Problem: As outlined in item 2.1.5, attenuation tanks have been designed to allow for infiltration to ground. Do existing ground conditions on site allow for sufficient infiltration rates for each individual tank? It is also important to note; construction activities can severely affect infiltration rates if care is not taken to protect against compaction or blockage from fines.

Recommendation: Atkins to confirm soil investigation results and infiltration testing carried out on site have confirmed that existing ground conditions are suitable to allow for infiltration of surface water.

2.1.9 Typical Details

Problem: No details provided for proposed SuDS components including permeable paving, flow control devices, tree pits, attenuation systems etc.

Recommendation: The above details to be provided.

2.1.10 Sump Manholes

Problem: Silt entering the surface water drainage system including the attenuation tanks has the potential to cause blockages.

Recommendation: Consider utilisation of sump manholes upstream of all attenuation tanks to capture any excess silt therefore preventing entry into the tanked systems. This is crucial for the efficient running of the attenuation tank where filter drains or swales are located upstream of the network as they have a higher potential to carry silts.

2.1.11 Check dams

Problem: As outlined in 2.1.10, silt has the potential to enter the surface water drainage system including the attenuation tanks and has the potential to cause blockages.

Recommendation: Consider utilisation of check dams within the swales to trap silt and prevent it from entering proposed storm drainage further downstream including entry into the attenuation tanks. The check dams will capture any excess silt therefore preventing entry into the tanks systems.

2.1.12 Road Gullies

Problem: There is potential to reduce the surface water runoff and to improve runoff quality from the minor roads around the park by incorporating SuDS measures in lieu of road gullies.

Recommendation: Road gully locations have not been highlighted on proposed stormwater layouts. In place of connecting proposed gullies directly into the proposed surface water network, consider connecting proposed gullies to a SuDS measure such as an infiltration drain, tree pits, swale, filter drains or soakaway with an overflow to the surface water network, as a means to further reduce the quantity and improve the quality of surface water runoff from the site.

2.1.13 Water Table

Problem: Although no ground water is encountered, the designer should ensure the formation level of the permeable paving is 1000mm above the highest ground water level.

Recommendation: Atkins to confirm formation level of permeable paving is 1000mm above highest ground water level.

2.1.14 CBR Values – Permeable Paving

Problem: Californian bearing ration (CBR) varies inversely with moisture content (as the latter increases the CBR value decreases). The equilibrium CBR value is the long-term value that occurs once the pavement is constructed and the moisture content of the subgrade soil comes in to equilibrium with the suction forces within the subgrade air spaces. These CBR tests will allow for appropriate permeable paving design including capping material if and where required. This capping is typically quite impermeable when compacted.

Recommendation: CBR tests to be performed on site to allow for appropriate permeable paving design. These CBR tests are to be carried out in accordance with BS 1377-4:1990.

2.1.15 Tree Pit Systems

Problem: There is potential to reduce the surface water runoff and to improve runoff quality from the development further by providing a greater amount of SuDS measures in the form of tree pit systems.

Recommendation: Consider incorporating an additional amount of tree pit systems for areas in close proximity to the impermeable surfaces. Connect road gullies to these systems rather than directly to the main surface water drainage system.

2.1.16 Hydrobrake – Tank H

Problem: It is unclear on drawing no. 5154251/EWE/DR/0502 the position of the Hydrobrake in relation to proposed attenuation tank H.

Recommendation: Review and revise drawing to reflect the size and location of the Hydrobrake in relation to the proposed attenuation tank.

2.1.17 Attenuation tank I

Problem: A significant area of impermeable surfacing is contributing/outfalling to proposed attenuation tank I.

Recommendation: Please confirm tank has been sized accordingly and that sufficient cover has been provided. Tank should have minimum cover, as outlined in the manufacturer's installation guidelines. Aside from minimum cover required for trafficked areas, it is also important that minimum cover is achieved when the tank is installed in landscaped areas to ensure vegetation and certain types of trees/bushes can grow, and the tank avoids associated roots etc.

2.1.18 Stormwater Impact Assessment Report – Figure 7.1

Problem: Figure 7.1 of Stormwater Impact Assessment Report does not reflect proposed storm water layout drawings received.

Recommendation: Review and update Figure 7.1 to reflect most up to date drawings

2.1.19 Stormwater Impact Assessment Report – Table 7.1

Problem: Table 7.1 of Stormwater Impact Assessment Report does not reflect proposed storm water layout drawings.

Recommendation: Atkins to review and confirm table is up to date in accordance with most up to date drawings as outlined on 5154251 – EWE - Drawing Register.

2.1.20 Outfall Details

Problem: Atkins drawing no. 5154251 – EWE – DR – 0502 shows the proposed storm network outfalling to an existing culvert downstream of manhole MH S43. MH S43 has a proposed invert level (IL) of 12.658m, while the existing culvert has a downstream invert of 13.610m.

Recommendation: Atkins to confirm proposed storm network can outfall by gravity to existing culvert downstream of manhole S43 and provide detail of same.

2.1.21 Maintenance

Problem: The report does not make reference to system maintenance relating to blockages.

Recommendation: Set out maintenance/inspection requirements for management of the surface water system. Maintenance management to include life-span of SuDS measures, inspection/monitoring details, grass and vegetation management, litter removal and excessive sediment removal. Ensure there are a sufficient amount of inspection chambers/manholes specified for the proposed SuDS measures in order to achieve access for maintenance including rodding, etc.

2.1.22 Utility Survey

Problem: As per Chapter 29.3.6, Section E of The SuDS Manual, the location of all existing utilities and other site infrastructure should be confirmed before locating proposed SuDS measures.

Recommendation: Existing underground services are particularly challenging to locate in construction projects. Asset databases of buried infrastructure should not be considered as definite and should be checked with appropriate utility surveys and on-site checks.

2.1.23 Existing Natural Features on Site

Problem: Existing natural features on site include trees, hedgerows, or habitats of ecological value. For this proposed development, some of these features may potentially be affected.

Recommendation: Existing trees, hedgerows and habitats should be subject to pre-development surveys in accordance with relevant standards and undertaken by a qualified and competent person. If required, based on the relevant pre-development surveys, the construction of SuDS measures are to be co-ordinated with the existing features of the site.

Appendix C Storm Water Audit Feedback Form

STORM WATER AUDIT FEEDBACK FORM

Scheme: Proposed Residential Development at Woodbrook, Co. Dublin

Area:

Audit Stage: 1 **Date Audit Completed:** 04/10/2019 **Our Ref :** 192169

Paragraph No. in Audit Report	Issue Accepted (Yes/No)	Recommended Measure Accepted (Yes/No)	Alternative Measures (described) [or reason problem not accepted]	Alternative Measures Accepted by Auditors (Yes/No)
2.1.1	No	Yes	All car parking spaces and driveways have been designed with a permeable surface. Where enough space is available along the Avenue (main access road through the site) Tree Pits have been provided where the runoff is not to a permeable road surface. Tree pits (similar to other suggested SuDS) will allow for infiltration to ground and Interception. An overflow has been provided for excess flows as per the tree pit details.	YES
2.1.2	Yes	No	Porous Aphalt along carriageways / access roads not proposed due to 'Taken in charge' requirements with DLRCC.	YES
2.1.3	No	Yes	All car parking spaces and driveways have been designed with a permeable surface. Extent of permeable surface is circa 11% of total site hardstanding area and is deemed to be sufficient.	YES
2.1.4	Yes	Yes	A permeable paving system is proposed as opposed to a tanked system. Please refer to drawing 5154251_EWE_SCD_003 for a typical parking bay permeable block paving cross section.	✓
2.1.5	Yes	No	Issue noted. Due to both the Woodbrook - Shanganagh LAP 2017 -2023 and DLRCC requirements sufficient space was determined not to be available for ponds. The option of combined underground attenuation and surface level storage was considered at an early stage of the design and due to DLRCC requirements was determined not to be suitable.	YES

STORM WATER AUDIT FEEDBACK FORM

Paragraph No. in Audit Report	Issue Accepted (Yes/No)	Recommended Measure Accepted (Yes/No)	Alternative Measures (described) [or reason problem not accepted]	Alternative Measures Accepted by Auditors (Yes/No)
2.1.6	No	No	The design does not propose any bypass petrol interceptors on site. The site has been designed with all parking areas having a permeable surface. Treatment will be provided within the build-up and geotextiles of the permeable surface thus providing treatment, reducing the risk and removing the need for a bypass petrol interceptor.	YES
2.1.7	No	No	As all of the parking areas have been design with permeable surface. Treatment will be provided within the build-up on the permeable surface thus reducing the risk and removing the need for a bypass petrol interceptor.	YES
2.1.8	No	No	The storm drainage modelling has been carried out without any allowance made for infiltration to ground from the attenuation tanks. Details of the results from SI testing carried out by Ground Investigations Ireland which includes infiltration testing is summarised within the Stormwater Impact Assessment report. The complete SI report has also been included within the appendices of the SIA report. Please refer to the following drawings for tank details; 5154251_EWE_SCD_0021 - 5154251_EWE_SCD_0027 Tanks A, B, D, F, G, H, I and J will allow for partial infiltration. Tanks C and E are tanked due to ground water levels.	YES
2.1.9	Yes	Yes	Please refer to the following drawings; 5154251_EWE_SCD_0001 - 5154251_EWE_SCD_0004 5154251_EWE_SCD_0021 - 5154251_EWE_SCD_0027	—
2.1.10	Yes	Yes	Please refer to the following drawings for details of sump manholes upstream of attenuation tanks. 5154251_EWE_SCD_0021 - 5154251_EWE_SCD_0027	—

STORM WATER AUDIT FEEDBACK FORM

Paragraph No. in Audit Report	Issue Accepted (Yes/No)	Recommended Measure Accepted (Yes/No)	Alternative Measures (described) [or reason problem not accepted]	Alternative Measures Accepted by Auditors (Yes/No)
2.1.11	Yes	Yes	The potential of silt to enter the surface water drainage system is noted. Outfall perforated manholes within the swales have been raised 50mm above the invest level of the swale to allow both for silt to be captured within the swale and interception requirements. Details of the outfall from swales are indicated on the detail drawings.	✓
2.1.12	Yes	Yes	Please refer to the following drawing for road gully locations; 5154251_EWE_DR_0501 - 5154251_EWE_DR_0507 Road gullies have been incorporated within the storm drainage design at locations where there is no outfall to proposed SuDS (permeable paving, swale or tree pits)	✓
2.1.13	Yes	No	A review of the Site Investigations has been carried out including ground water table levels within each of the Boreholes / Trial Pits carried out on site. At locations where water levels were encountered during testing it is noted the that BH1 had a water level of 1950mm below existing ground level. The proposed overall build up for permeable paving from surface level to formation level is circa 600mm. Based on the proposed build up the depth of water will be > 1000mm below formation level.	YES
2.1.14	Yes	Yes	Capping layer depths to be determined at detail design / construction stage following CBR testing in accordance with BS 1377-4:1990.	✓
2.1.15	Yes	Yes	Where enough space is available along the Avenue (main access road through the site) Tree Pits have been provided with inlet via drop kerbs in lieu of standard gully pots.	✓
2.1.16	Yes	Yes	Proposed Hydrobrakes are located in the manhole downstream of all proposed underground attenuation tanks Refer to drawings indicated below for locations of all proposed Hydrobrakes; 5154251_EWE_DR_0501 - 5154251_EWE_DR_0507 5154251_EWE_SCD_0021 - 5154251_EWE_SCD_0027	✓

STORM WATER AUDIT FEEDBACK FORM

Paragraph No. in Audit Report	Issue Accepted (Yes/No)	Recommended Measure Accepted (Yes/No)	Alternative Measures (described) [or reason problem not accepted]	Alternative Measures Accepted by Auditors (Yes/No)
2.1.17	No	Yes	The storm drainage modelling demonstrates that the tank has been sized accordingly, model outputs are included within the SIA report appendices. Please refer to tank detail drawings indicated below for depth of cover to tanks in accordance with manufactures installation guidelines; 5154251_EWE_SCD_0021 - 5154251_EWE_SCD_0027 Root barriers will be installed to each tank adjacent to landscape architects' trees. A minimum distance of 2m from the centre of the tree to the edge of the tank was confirmed acceptable by DLRCC and is indicated on the design drawings.	YES
2.1.18	Yes	Yes	Report and drawings updated since previous issued. Please refer to updated report and drawings issued with this submission.	✓
2.1.19	Yes	Yes	Report and drawings updated since previous issued. Please refer to updated report and drawings issued with this submission.	✓
2.1.20	Yes	Yes	We confirm that the proposed network can outfall by gravity to the existing culvert. Refer to drawings indicated final proposed network design including discharge levels to the existing culvert. 5154251_EWE_DR_0502 and outfall details within the Stormwater Impact Assessment Report.	✓
2.1.21	Yes	Yes	Please refer to updated report 5154251DG0011 - Chapter 10 - SuDS Maintenance.	✓

STORM WATER AUDIT FEEDBACK FORM

Paragraph No. in Audit Report	Issue Accepted (Yes/No)	Recommended Measure Accepted (Yes/No)	Alternative Measures (described) [or reason problem not accepted]	Alternative Measures Accepted by Auditors (Yes/No)
2.1.22	Yes	No	A review of all existing underground services within the proposed site was carried out at the early stage of the design and issued to DLRCC as a SuDS Site Characterisation Report. • The report indicated the following existing services on site. • A storm drainage network is located to the west of the proposed site long the Dublin road. • An existing IW 600dia foul rising main is located within the site boundary to the east of the site. Associated wayleaves to be reviewed at design stage. • A review of topographical survey and site walkover also indicates existing OH ESB infrastructure to the South / South West of the site. No further existing services have been identified on site. The existing IW 600dia foul rising main has been identified on relevant storm layout drawings 5154251_EWE_DR_0503 - 5154251_EWE_DR_0505. As built details of the IW 600dia foul rising main.	YES
2.1.23	Yes	No	A full set of required ecological surveys on existing trees, hedgerows and habitats has been carried out as part of the Woodbrook Development SHD planning application.	YES
2.1.24	Yes	Yes	Road contours / levels has been design (where possible) to allow for SuDS measures to be located in appropriated areas to ensure adequate drainage of the site.	✓
2.1.25	Yes	Yes	It is proposed that all SuDS systems in public areas are to be adopted or provided with a wayleave by DLRCC. Taken in charge drawings will be submitted as part of the final Woodbrook Development SHD planning application.	✓

Paragraph No. in Audit Report	Issue Accepted (Yes/No)	Recommended Measure Accepted (Yes/No)	Alternative Measures (described) [or reason problem not accepted]	Alternative Measures Accepted by Auditors (Yes/No)
2.1.26	Yes	Yes	Atkins note that discussions and site visits with DLRCC have taken place on the crossing and discharging to the existing ditch. DLRCC requested additional storage downstream of the existing ditch which has been provided.	✓
2.1.27	Yes	Yes	An exercise on exceedance flows and blockages has been carried out at 3No locations and will be discussed further within the Stormwater Impact Assessment Report. High level overflows above the 1 in 100-year storm event (maximum head for flow control) where considered however, it is our understanding that DLRCC will not accept high level overflows.	✓
2.2.1	No	No	Both Extensive and Intensive green roofs / courtyard area have been provided as indicated on drawing 5154251_EWE_DR_0600. The extents of Intensive green roofs is > than 60% as set out in the DLRCC Development plan and also meets the clients requirements. Area calculations have been provided on drawings 5154251_EWE_DR_0600	YES
2.2.2	Yes	No	Rainwater Harvesting has not been provided within the development as per the clients' requirements.	YES

Signed: [signature]

AILIS CORRIGAN
Design Team Project Manager
ATKINS

Date: 18/10/2019

Please complete and return to the auditor

Auditor Signed Off: DONAGH MURPHY

DONAGH MURPHY
PUNCH CONSULTING ENG

Date: 18/10/2019.

Appendix B. Simulation Criteria

Simulation Criteria for Storm

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

Number of Input Hydrographs	0	Number of Storage Structures	58
Number of Online Controls	11	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	5	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.700	Storm Duration (mins)	30
Ratio R	0.269		

M5-60 and Ratio 'R' as per Met Eireann Return Period Rainfall Depths for sliding Durations Data

Appendix C. Outfall Details

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.043	S	15.260	13.610	13.610	0	0

INVERT LEVEL OF EXISTING CULVERT
AS PER TOPOGRAPHICAL SURVEY

Appendix D. Pipeline Schedules

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	225	S1	24.025	22.600	1.200	Open Manhole	1200
S1.001	o	225	S2	23.250	21.825	1.200	Open Manhole	1200
S1.002	o	225	S3	22.525	21.090	1.210	Open Manhole	1200
S2.000	o	225	S4	24.350	22.925	1.200	Open Manhole	1200
S2.001	o	225	S5	23.500	22.066	1.209	Open Manhole	1200
S1.003	o	225	S6	22.775	20.849	1.701	Open Manhole	1350
S3.000	o	225	S7	24.300	22.875	1.200	Open Manhole	1200
S3.001	o	225	S8	24.075	22.645	1.205	Open Manhole	1200
S3.002	o	225	S9	23.450	22.024	1.201	Open Manhole	1200
S1.004	o	225	S10	22.975	20.641	2.109	Open Manhole	1350
S4.000	o	225	S11	24.025	22.600	1.200	Open Manhole	1200
S4.001	o	225	S12	23.750	22.317	1.208	Open Manhole	1200
S4.002	o	225	S13	23.525	22.091	1.209	Open Manhole	1200
S4.003	o	225	S14	22.850	21.418	1.207	Open Manhole	1200
S1.005	o	225	S15	22.175	19.904	2.046	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	51.903	67.0	S2	23.250	21.825	1.200	Open Manhole	1200
S1.001	52.161	71.0	S3	22.525	21.090	1.210	Open Manhole	1200
S1.002	48.237	200.0	S6	22.775	20.849	1.701	Open Manhole	1350
S2.000	51.558	60.0	S5	23.500	22.066	1.209	Open Manhole	1200
S2.001	54.350	75.0	S6	22.775	21.341	1.209	Open Manhole	1350
S1.003	41.603	200.0	S10	22.975	20.641	2.109	Open Manhole	1350
S3.000	34.481	150.0	S8	24.075	22.645	1.205	Open Manhole	1200
S3.001	47.831	77.0	S9	23.450	22.024	1.201	Open Manhole	1200
S3.002	50.545	105.0	S10	22.975	21.543	1.207	Open Manhole	1350
S1.004	87.210	200.0	S15	22.175	20.205	1.745	Open Manhole	1200
S4.000	45.250	160.0	S12	23.750	22.317	1.208	Open Manhole	1200
S4.001	31.640	140.0	S13	23.525	22.091	1.209	Open Manhole	1200
S4.002	44.436	66.0	S14	22.850	21.418	1.207	Open Manhole	1200
S4.003	43.609	65.0	S15	22.175	20.747	1.203	Open Manhole	1200
S1.005	21.937	241.1	S16	21.950	19.813	1.912	Open Manhole	1200

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.006	o	225	S16	21.950	19.813	1.912	Open Manhole	1200
S1.007	o	225	S17	22.075	19.755	2.095	Open Manhole	1200
S5.000	o	225	S18	23.500	22.075	1.200	Open Manhole	1200
S5.001	o	225	S19	23.400	22.030	1.145	Open Manhole	1200
S5.002	o	225	S20	23.400	20.020	3.155	Open Manhole	1200
S1.008	o	225	S21	22.525	19.620	2.680	Open Manhole	1200
S1.009	o	225	S22	22.750	19.598	2.927	Open Manhole	1200
S1.010	o	225	S23	21.775	19.373	2.177	Open Manhole	1200
S1.011	o	225	S24	21.375	19.228	1.922	Open Manhole	1350
S1.012	o	225	S25	20.800	19.023	1.552	Open Manhole	1350
S1.013	o	225	S26	20.325	18.728	1.372	Open Manhole	1350
S1.014	o	225	S27	19.800	17.050	2.525	Open Manhole	1350
S1.015	o	300	S28	19.600	17.000	2.300	Open Manhole	1350
S1.016	o	225	S29	19.100	16.830	2.045	Open Manhole	1350
S1.017	o	225	S30	18.775	16.800	1.750	Open Manhole	1200
S6.000	o	225	S31	18.475	17.075	1.175	Open Manhole	1350
S6.001	o	225	S32	18.600	16.944	1.431	Open Manhole	1350

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.006	13.922	241.1	S17	22.075	19.755	2.095	Open Manhole	1200
S1.007	32.459	241.1	S21	22.525	19.620	2.680	Open Manhole	1200
S5.000	5.353	118.9	S19	23.400	22.030	1.145	Open Manhole	1200
S5.001	5.781	115.6	S20	23.400	21.980	1.195	Open Manhole	1200
S5.002	31.386	320.3	S21	22.525	19.922	2.378	Open Manhole	1200
S1.008	5.252	241.1	S22	22.750	19.598	2.927	Open Manhole	1200
S1.009	54.213	241.1	S23	21.775	19.373	2.177	Open Manhole	1200
S1.010	34.894	241.1	S24	21.375	19.228	1.922	Open Manhole	1350
S1.011	49.511	241.1	S25	20.800	19.023	1.552	Open Manhole	1350
S1.012	39.607	134.3	S26	20.325	18.728	1.372	Open Manhole	1350
S1.013	47.179	133.3	S27	19.800	18.374	1.201	Open Manhole	1350
S1.014	3.570	71.4	S28	19.600	17.000	2.375	Open Manhole	1350
S1.015	49.040	288.5	S29	19.100	16.830	1.970	Open Manhole	1350
S1.016	8.694	289.8	S30	18.775	16.800	1.750	Open Manhole	1200
S1.017	9.832	265.7	S33	18.775	16.763	1.787	Open Manhole	1500
S6.000	26.258	200.4	S32	18.600	16.944	1.431	Open Manhole	1350
S6.001	36.176	199.9	S33	18.775	16.763	1.787	Open Manhole	1500

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.018	o	225	S33	18.775	16.763	1.787	Open Manhole	1500
S1.019	o	225	S34	18.400	16.546	1.629	Open Manhole	1500
S7.000	o	225	S35	17.425	16.025	1.175	Open Manhole	1200
S1.020	o	225	S36	17.850	15.841	1.784	Open Manhole	1500
S8.000	o	225	S37	18.500	17.075	1.200	Open Manhole	1200
S8.001	o	225	S38	18.275	16.841	1.209	Open Manhole	1200
S9.000	o	225	S39	17.875	16.450	1.200	Open Manhole	1200
S1.021	o	225	S40	18.150	15.600	2.325	Open Manhole	1500
S1.022	o	225	S41	18.525	15.450	2.850	Open Manhole	1500
S1.023	o	300	S42	18.600	15.335	2.965	Open Manhole	1500
S1.024	o	300	S43	19.000	15.200	3.500	Open Manhole	1500
S1.025	o	300	S44	19.075	15.150	3.625	Open Manhole	1500
S10.000	o	225	S45	18.300	16.875	1.200	Open Manhole	1200
S10.001	o	225	S46	18.750	16.488	2.037	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.018	43.308	200.0	S34	18.400	16.546	1.629	Open Manhole	1500
S1.019	56.391	200.0	S36	17.850	16.264	1.361	Open Manhole	1500
S7.000	36.874	200.4	S36	17.850	15.841	1.784	Open Manhole	1500
S1.020	66.599	276.3	S40	18.150	15.600	2.325	Open Manhole	1500
S8.000	44.415	189.8	S38	18.275	16.841	1.209	Open Manhole	1200
S8.001	44.071	200.3	S40	18.150	16.621	1.304	Open Manhole	1500
S9.000	31.674	200.5	S40	18.150	16.292	1.633	Open Manhole	1500
S1.021	43.010	286.7	S41	18.525	15.450	2.850	Open Manhole	1500
S1.022	11.628	290.7	S42	18.600	15.410	2.965	Open Manhole	1500
S1.023	29.403	217.8	S43	19.000	15.200	3.500	Open Manhole	1500
S1.024	14.857	297.1	S44	19.075	15.150	3.625	Open Manhole	1500
S1.025	7.546	150.9	S47	19.150	15.100	3.750	Open Manhole	1500
S10.000	77.322	200.0	S46	18.750	16.488	2.037	Open Manhole	1200
S10.001	34.772	200.0	S47	19.150	16.314	2.611	Open Manhole	1500

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.026	o	300	S47	19.150	15.100	3.750	Open Manhole	1500
S11.000	o	225	S48	18.825	17.400	1.200	Open Manhole	1200
S1.027	o	300	S49	18.875	15.000	3.575	Open Manhole	1500
S1.028	o	300	S50	18.500	14.920	3.280	Open Manhole	1500
S1.029	o	300	S51	17.925	14.800	2.825	Open Manhole	1500
S12.000	o	225	S52	17.300	15.875	1.200	Open Manhole	1200
S1.030	o	375	S53	17.025	14.475	2.175	Open Manhole	1500
S13.000	o	225	S54	21.750	20.325	1.200	Open Manhole	1200
S14.000	o	225	S55	23.425	22.000	1.200	Open Manhole	1200
S14.001	o	225	S56	21.950	20.498	1.227	Open Manhole	1200
S14.002	o	225	S57	21.400	19.970	1.205	Open Manhole	1200
S14.003	o	225	S58	21.025	19.780	1.020	Open Manhole	1200
S13.001	o	225	S164	21.100	19.590	1.285	Open Manhole	1200
S13.002	o	225	S165	21.000	19.369	1.406	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.026	27.729	277.3	S49	18.875	15.000	3.575	Open Manhole	1500
S11.000	79.108	199.8	S49	18.875	17.004	1.646	Open Manhole	1500
S1.027	17.396	217.4	S50	18.500	14.920	3.280	Open Manhole	1500
S1.028	24.743	206.2	S51	17.925	14.800	2.825	Open Manhole	1500
S1.029	30.110	301.1	S53	17.025	14.700	2.025	Open Manhole	1500
S12.000	75.165	199.9	S53	17.025	15.499	1.301	Open Manhole	1500
S1.030	11.981	199.7	S111	16.650	14.415	1.860	Open Manhole	1800
S13.000	66.114	91.2	S164	21.100	19.600	1.275	Open Manhole	1200
S14.000	76.624	51.0	S56	21.950	20.498	1.227	Open Manhole	1200
S14.001	50.652	95.9	S57	21.400	19.970	1.205	Open Manhole	1200
S14.002	18.992	100.0	S58	21.025	19.780	1.020	Open Manhole	1200
S14.003	19.860	104.5	S164	21.100	19.590	1.285	Open Manhole	1200
S13.001	8.848	40.0	S165	21.000	19.369	1.406	Open Manhole	1200
S13.002	39.363	178.1	S59	20.575	19.148	1.202	Open Manhole	1200

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S13.003	o	225	S59	20.575	19.148	1.202	Open Manhole	1200
S15.000	o	225	S60	20.775	19.350	1.200	Open Manhole	1200
S13.004	o	225	S61	20.125	18.695	1.205	Open Manhole	1350
S13.005	o	225	S62	19.675	18.250	1.200	Open Manhole	1350
S16.000	o	225	S63	19.675	18.300	1.150	Open Manhole	1200
S13.006	o	225	S64	19.225	17.797	1.203	Open Manhole	1350
S13.007	o	225	S65	18.800	16.700	1.875	Open Manhole	1350
S13.008	o	300	S66	18.650	16.600	1.750	Open Manhole	1350
S13.009	o	300	S67	18.650	16.531	1.819	Open Manhole	1200
S13.010	o	300	S68	18.600	16.389	1.911	Open Manhole	1200
S13.011	o	300	S69	18.600	15.971	2.329	Open Manhole	1200
S13.012	o	300	S70	17.525	15.649	1.576	Open Manhole	1200
S17.000	o	225	S71	21.900	20.465	1.210	Open Manhole	1200
S17.001	o	225	S72	21.325	19.896	1.204	Open Manhole	1200
S18.000	o	225	S73	21.350	19.900	1.225	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S13.003	45.862	101.9	S61	20.125	18.698	1.202	Open Manhole	1350
S15.000	71.390	109.0	S61	20.125	18.695	1.205	Open Manhole	1350
S13.004	45.403	102.0	S62	19.675	18.250	1.200	Open Manhole	1350
S13.005	44.145	98.0	S64	19.225	17.800	1.200	Open Manhole	1350
S16.000	74.890	148.9	S64	19.225	17.797	1.203	Open Manhole	1350
S13.006	42.393	100.0	S65	18.800	17.373	1.202	Open Manhole	1350
S13.007	16.604	166.0	S66	18.650	16.600	1.825	Open Manhole	1350
S13.008	15.999	231.9	S67	18.650	16.531	1.819	Open Manhole	1200
S13.009	28.207	198.6	S68	18.600	16.389	1.911	Open Manhole	1200
S13.010	83.647	200.0	S69	18.600	15.971	2.329	Open Manhole	1200
S13.011	64.404	200.0	S70	17.525	15.649	1.576	Open Manhole	1200
S13.012	19.251	129.0	S103	17.000	15.500	1.200	Open Manhole	1500
S17.000	25.583	45.0	S72	21.325	19.896	1.204	Open Manhole	1200
S17.001	58.327	52.0	S74	20.200	18.774	1.201	Open Manhole	1200
S18.000	50.700	45.0	S74	20.200	18.773	1.202	Open Manhole	1200

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S17.002	o	225	S74	20.200	18.700	1.275	Open Manhole	1200
S17.003	o	225	S75	20.300	18.600	1.475	Open Manhole	1200
S17.004	o	225	S76	18.900	17.462	1.213	Open Manhole	1200
S19.000	o	225	S77	20.475	18.850	1.400	Open Manhole	1200
S17.005	o	225	S78	18.700	17.252	1.223	Open Manhole	1200
S20.000	o	225	S79	19.850	18.425	1.200	Open Manhole	1200
S20.001	o	225	S80	18.900	17.456	1.219	Open Manhole	1200
S20.002	o	225	S81	18.075	16.642	1.208	Open Manhole	1200
S17.006	o	225	S82	18.325	16.493	1.607	Open Manhole	1350
S17.007	o	300	S83	18.400	15.350	2.750	Open Manhole	1350
S17.008	o	300	S84	17.000	15.200	1.500	Open Manhole	1350
S21.000	o	225	S85	17.850	16.450	1.175	Open Manhole	1200
S22.000	o	300	S86	17.300	15.633	1.367	Open Manhole	1200
S22.001	o	300	S87	17.325	15.600	1.425	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S17.002	13.513	150.1	S75	20.300	18.610	1.465	Open Manhole	1200
S17.003	51.157	45.0	S76	18.900	17.462	1.213	Open Manhole	1200
S17.004	8.432	45.0	S78	18.700	17.275	1.200	Open Manhole	1200
S19.000	71.897	45.0	S78	18.700	17.252	1.223	Open Manhole	1200
S17.005	35.714	118.3	S82	18.325	16.950	1.150	Open Manhole	1350
S20.000	47.463	49.0	S80	18.900	17.456	1.219	Open Manhole	1200
S20.001	46.387	57.0	S81	18.075	16.642	1.208	Open Manhole	1200
S20.002	29.709	200.0	S82	18.325	16.493	1.607	Open Manhole	1350
S17.006	17.974	199.7	S83	18.400	16.403	1.772	Open Manhole	1350
S17.007	68.646	457.6	S84	17.000	15.200	1.500	Open Manhole	1350
S17.008	29.819	149.1	S93	16.600	15.000	1.300	Open Manhole	1500
S21.000	25.990	47.0	S88	17.325	15.897	1.203	Open Manhole	1200
S22.000	6.683	202.5	S87	17.325	15.600	1.425	Open Manhole	1200
S22.001	6.683	202.5	S88	17.325	15.567	1.458	Open Manhole	1200

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S21.001	o	225	S88	17.325	15.567	1.533	Open Manhole	1200
S21.002	o	225	S89	16.675	15.242	1.208	Open Manhole	1200
S23.000	o	225	S90	19.125	17.700	1.200	Open Manhole	1200
S23.001	o	225	S91	17.900	16.475	1.200	Open Manhole	1200
S23.002	o	225	S92	16.600	15.171	1.204	Open Manhole	1200
S17.009	o	300	S93	16.600	14.900	1.400	Open Manhole	1500
S17.010	o	300	S94	16.650	14.850	1.500	Open Manhole	1250
S17.011	o	300	S95	17.100	14.690	2.110	Open Manhole	1500
S24.000	o	225	S96	18.425	17.000	1.200	Open Manhole	1200
S24.001	o	225	S97	17.800	16.375	1.200	Open Manhole	1200
S25.000	o	225	S98	19.350	17.300	1.825	Open Manhole	1200
S25.001	o	225	S99	18.125	16.698	1.202	Open Manhole	1200
S25.002	o	225	S100	18.025	16.596	1.204	Open Manhole	1200
S24.002	o	225	S101	17.275	15.700	1.350	Open Manhole	1350
S24.003	o	225	S102	16.725	15.299	1.201	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S21.001	32.564	100.2	S89	16.675	15.242	1.208	Open Manhole	1200
S21.002	17.305	71.5	S93	16.600	15.000	1.375	Open Manhole	1500
S23.000	58.472	47.7	S91	17.900	16.475	1.200	Open Manhole	1200
S23.001	61.930	47.5	S92	16.600	15.171	1.204	Open Manhole	1200
S23.002	14.138	55.0	S93	16.600	14.914	1.461	Open Manhole	1500
S17.009	5.227	104.5	S94	16.650	14.850	1.500	Open Manhole	1250
S17.010	67.644	422.8	S95	17.100	14.690	2.110	Open Manhole	1500
S17.011	14.957	373.9	S103	17.000	14.650	2.050	Open Manhole	1500
S24.000	44.141	70.6	S97	17.800	16.375	1.200	Open Manhole	1200
S24.001	46.388	88.0	S101	17.275	15.848	1.202	Open Manhole	1350
S25.000	27.090	45.0	S99	18.125	16.698	1.202	Open Manhole	1200
S25.001	15.328	150.0	S100	18.025	16.596	1.204	Open Manhole	1200
S25.002	70.636	94.0	S101	17.275	15.845	1.205	Open Manhole	1350
S24.002	58.918	147.0	S102	16.725	15.299	1.201	Open Manhole	1200
S24.003	15.435	200.0	S103	17.000	15.222	1.553	Open Manhole	1500

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S13.013	o	375	S103	17.000	14.650	1.975	Open Manhole	1500
S13.014	o	375	S104	16.775	14.570	1.830	Open Manhole	1500
S13.015	o	225	S105	16.450	14.415	1.810	Open Manhole	1800
S26.000	o	225	S106	17.200	15.775	1.200	Open Manhole	1200
S26.001	o	225	S107	17.075	15.620	1.230	Open Manhole	1200
S26.002	o	225	S108	15.950	14.715	1.010	Open Manhole	1200
S27.000	o	225	S109	16.675	15.250	1.200	Open Manhole	1200
S26.003	o	370	S110	16.300	14.450	1.480	Open Manhole	1200
S1.031	o	375	S111	16.650	14.400	1.875	Open Manhole	1800
S1.032	o	375	S112	16.525	14.380	1.770	Open Manhole	1800
S28.000	o	225	S113	17.275	15.900	1.150	Open Manhole	1200
S28.001	o	225	S114	17.175	15.675	1.275	Open Manhole	1200
S29.000	o	225	S115	17.825	16.400	1.200	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S13.013	11.072	369.1	S104	16.775	14.620	1.780	Open Manhole	1500
S13.014	74.340	479.6	S105	16.450	14.415	1.660	Open Manhole	1800
S13.015	6.073	404.9	S111	16.650	14.400	2.025	Open Manhole	1800
S26.000	15.265	120.0	S107	17.075	15.648	1.202	Open Manhole	1200
S26.001	52.930	58.5	S108	15.950	14.715	1.010	Open Manhole	1200
S26.002	61.092	321.5	S110	16.300	14.525	1.550	Open Manhole	1200
S27.000	75.683	200.0	S110	16.300	14.872	1.203	Open Manhole	1200
S26.003	11.797	235.9	S111	16.650	14.400	1.880	Open Manhole	1800
S1.031	6.384	319.2	S112	16.525	14.380	1.770	Open Manhole	1800
S1.032	34.514	493.1	S140	16.105	14.310	1.420	Open Manhole	1800
S28.000	30.203	134.2	S114	17.175	15.675	1.275	Open Manhole	1200
S28.001	65.244	372.8	S116	17.525	15.500	1.800	Open Manhole	1200
S29.000	39.436	130.0	S116	17.525	16.097	1.203	Open Manhole	1200

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S28.002	o	225	S116	17.525	15.500	1.800	Open Manhole	1200
S28.003	o	225	S117	17.500	15.450	1.825	Open Manhole	1200
S28.004	o	225	S118	18.025	15.350	2.450	Open Manhole	1200
S30.000	o	225	S119	18.475	17.050	1.200	Open Manhole	1200
S28.005	o	225	S120	18.050	15.300	2.525	Open Manhole	1200
S28.006	o	225	S121	17.900	15.200	2.475	Open Manhole	1200
S31.000	o	225	S122	18.875	17.450	1.200	Open Manhole	1200
S31.001	o	225	S123	18.550	17.124	1.201	Open Manhole	1200
S28.007	o	225	S124	17.875	15.100	2.550	Open Manhole	1200
S28.008	o	225	S125	17.225	15.000	2.000	Open Manhole	1200
S28.009	o	225	S126	16.875	14.900	1.750	Open Manhole	1200
S32.000	o	225	S127	18.300	16.690	1.385	Open Manhole	1200
S32.001	o	225	S128	16.825	15.350	1.250	Open Manhole	1200
S28.010	o	225	S129	16.650	14.850	1.575	Open Manhole	1200
S28.011	o	225	S130	15.550	14.500	0.825	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S28.002	11.768	235.4	S117	17.500	15.450	1.825	Open Manhole	1200
S28.003	37.508	375.1	S118	18.025	15.350	2.450	Open Manhole	1200
S28.004	3.072	61.4	S120	18.050	15.300	2.525	Open Manhole	1200
S30.000	70.659	155.9	S120	18.050	16.597	1.228	Open Manhole	1200
S28.005	40.982	409.8	S121	17.900	15.200	2.475	Open Manhole	1200
S28.006	14.295	143.0	S124	17.875	15.100	2.550	Open Manhole	1200
S31.000	22.193	68.0	S123	18.550	17.124	1.201	Open Manhole	1200
S31.001	41.205	56.7	S124	17.875	16.397	1.253	Open Manhole	1200
S28.007	27.861	278.6	S125	17.225	15.000	2.000	Open Manhole	1200
S28.008	9.768	97.7	S126	16.875	14.900	1.750	Open Manhole	1200
S28.009	12.799	256.0	S129	16.650	14.850	1.575	Open Manhole	1200
S32.000	58.107	45.0	S128	16.825	15.399	1.201	Open Manhole	1200
S32.001	5.786	28.2	S129	16.650	15.145	1.280	Open Manhole	1200
S28.010	47.746	136.4	S130	15.550	14.500	0.825	Open Manhole	1200
S28.011	10.708	107.1	S131	15.575	14.400	0.950	Open Manhole	1200

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S28.012	o	225	S131	15.575	14.400	0.950	Open Manhole	1200
S33.000	o	225	S132	16.850	15.420	1.205	Open Manhole	1200
S28.013	o	225	S133	16.125	14.340	1.560	Open Manhole	1200
S34.000	o	225	S134	15.915	14.790	0.900	Open Manhole	1200
S34.001	o	225	S135	15.575	14.630	0.720	Open Manhole	1200
S34.002	o	225	S136	15.935	14.470	1.240	Open Manhole	1200
S34.003	o	225	S137	15.985	14.445	1.315	Open Manhole	1200
S35.000	o	225	S138	16.300	14.875	1.200	Open Manhole	1200
S34.004	o	225	S139	16.085	14.395	1.465	Open Manhole	1200
S1.033	o	375	S140	16.105	14.310	1.420	Open Manhole	1800
S1.034	o	375	S141	16.105	14.265	1.465	Open Manhole	1800
S1.035	o	375	S142	15.885	14.230	1.280	Open Manhole	1800
S1.036	o	375	S143	15.625	14.125	1.125	Open Manhole	1800
S1.037	o	375	S144	15.695	14.100	1.220	Open Manhole	1800
S1.038	o	375	S145	15.776	14.070	1.331	Open Manhole	1800

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S28.012	22.373	372.9	S133	16.125	14.340	1.560	Open Manhole	1200
S33.000	33.663	45.0	S133	16.125	14.672	1.228	Open Manhole	1200
S28.013	8.826	294.2	S140	16.105	14.310	1.570	Open Manhole	1800
S34.000	55.014	343.8	S135	15.575	14.630	0.720	Open Manhole	1200
S34.001	55.890	349.3	S136	15.935	14.470	1.240	Open Manhole	1200
S34.002	8.634	345.4	S137	15.985	14.445	1.315	Open Manhole	1200
S34.003	16.740	334.8	S139	16.085	14.395	1.465	Open Manhole	1200
S35.000	33.828	155.0	S139	16.085	14.657	1.203	Open Manhole	1200
S34.004	9.169	107.9	S140	16.105	14.310	1.570	Open Manhole	1800
S1.033	21.787	484.2	S141	16.105	14.265	1.465	Open Manhole	1800
S1.034	16.190	462.6	S142	15.885	14.230	1.280	Open Manhole	1800
S1.035	47.914	456.3	S143	15.625	14.125	1.125	Open Manhole	1800
S1.036	11.682	467.3	S144	15.695	14.100	1.220	Open Manhole	1800
S1.037	13.374	445.8	S145	15.776	14.070	1.331	Open Manhole	1800
S1.038	33.617	420.2	S159	16.263	13.990	1.898	Open Manhole	1200

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S36.000	o	225	S146	17.900	16.475	1.200	Open Manhole	1200
S36.001	o	225	S147	17.450	15.980	1.245	Open Manhole	1200
S36.002	o	225	S148	16.525	15.100	1.200	Open Manhole	1200
S36.003	o	225	S149	16.400	14.955	1.220	Open Manhole	1200
S37.000	o	225	S150	17.350	14.800	2.325	Open Manhole	1200
S37.001	o	225	S151	17.075	14.690	2.160	Open Manhole	1200
S38.000	o	225	S152	16.300	14.650	1.425	Open Manhole	1200
S37.002	o	225	S153	16.850	14.550	2.075	Open Manhole	1200
S37.003	o	225	S154	16.450	14.400	1.825	Open Manhole	1200
S37.004	o	225	S155	16.125	14.250	1.650	Open Manhole	1200
S37.005	o	225	S156	16.150	14.200	1.725	Open Manhole	1200
S36.004	o	300	S157	16.300	14.100	1.900	Open Manhole	1200
S36.005	o	300	S158	16.263	14.050	1.913	Open Manhole	1200
S1.039	o	375	S159	16.263	13.990	1.898	Open Manhole	1200
S1.040	o	375	S160	16.375	13.918	2.082	Open Manhole	1800

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S36.000	50.707	102.4	S147	17.450	15.980	1.245	Open Manhole	1200
S36.001	59.821	68.0	S148	16.525	15.100	1.200	Open Manhole	1200
S36.002	9.279	64.0	S149	16.400	14.955	1.220	Open Manhole	1200
S36.003	10.750	69.4	S157	16.300	14.800	1.275	Open Manhole	1200
S37.000	31.809	289.2	S151	17.075	14.690	2.160	Open Manhole	1200
S37.001	7.647	191.2	S153	16.850	14.650	1.975	Open Manhole	1200
S38.000	18.460	184.6	S153	16.850	14.550	2.075	Open Manhole	1200
S37.002	32.366	215.8	S154	16.450	14.400	1.825	Open Manhole	1200
S37.003	29.502	196.7	S155	16.125	14.250	1.650	Open Manhole	1200
S37.004	4.630	92.6	S156	16.150	14.200	1.725	Open Manhole	1200
S37.005	11.513	115.1	S157	16.300	14.100	1.975	Open Manhole	1200
S36.004	3.410	68.2	S158	16.263	14.050	1.913	Open Manhole	1200
S36.005	3.410	68.2	S159	16.263	14.000	1.963	Open Manhole	1200
S1.039	33.617	466.9	S160	16.375	13.918	2.082	Open Manhole	1800
S1.040	8.098	476.4	S161	16.230	13.901	1.954	Open Manhole	1800

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.041	o	375	S161	16.230	13.901	1.954	Open Manhole	1800
S1.042	o	375	S162	15.310	13.785	1.150	Open Manhole	1800
S1.043	o	375	S163	15.050	13.680	0.995	Open Manhole	1800

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.041	57.941	499.5	S162	15.310	13.785	1.150	Open Manhole	1800
S1.042	51.569	491.1	S163	15.050	13.680	0.995	Open Manhole	1800
S1.043	34.741	496.3	S	15.260	13.610	1.275	Open Manhole	0

Appendix E. Storage Structures

Storage Structures for Storm

Porous Car Park Manhole: S6, DS/PN: S1.003

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	55.0
Membrane Percolation (mm/hr)	1	Length (m)	55.0
Max Percolation (l/s)	0.8	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	20.849	Membrane Depth (mm)	275

Porous Car Park Manhole: S7, DS/PN: S3.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1	Length (m)	22.0
Max Percolation (l/s)	0.0	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	22.875	Membrane Depth (mm)	275

Porous Car Park Manhole: S8, DS/PN: S3.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	7.5
Membrane Percolation (mm/hr)	1	Length (m)	72.0
Max Percolation (l/s)	0.2	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	22.645	Membrane Depth (mm)	275

Porous Car Park Manhole: S10, DS/PN: S1.004

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.5
Membrane Percolation (mm/hr)	1	Length (m)	82.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	20.641	Membrane Depth (mm)	275

Porous Car Park Manhole: S11, DS/PN: S4.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1	Length (m)	28.0
Max Percolation (l/s)	0.0	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	22.600	Membrane Depth (mm)	275

Porous Car Park Manhole: S13, DS/PN: S4.002

Infiltration Coefficient Base (m/hr)	0.00000	Max Percolation (l/s)	0.1
Membrane Percolation (mm/hr)	1	Safety Factor	2.0

Porous Car Park Manhole: S13, DS/PN: S4.002

Porosity	0.30	Slope (1:X)	60.0
Invert Level (m)	22.091	Depression Storage (mm)	5
Width (m)	5.0	Evaporation (mm/day)	3
Length (m)	58.0	Membrane Depth (mm)	275

Porous Car Park Manhole: S17, DS/PN: S1.007

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.3
Membrane Percolation (mm/hr)	1	Length (m)	30.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	20.025	Membrane Depth (mm)	275

Porous Car Park Manhole: S18, DS/PN: S5.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.3
Membrane Percolation (mm/hr)	1	Length (m)	47.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	22.075	Membrane Depth (mm)	275

Tank or Pond Manhole: S21, DS/PN: S1.008

TANK A (CATCHMENT A)

Invert Level (m) 19.620

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	120.0	0.600	120.0	1.200	120.0	1.800	120.0
0.200	120.0	0.800	120.0	1.400	120.0	2.000	0.0
0.400	120.0	1.000	120.0	1.600	120.0		

Porous Car Park Manhole: S23, DS/PN: S1.010

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.5
Membrane Percolation (mm/hr)	1	Length (m)	36.0
Max Percolation (l/s)	0.0	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.683	Membrane Depth (mm)	275

Porous Car Park Manhole: S24, DS/PN: S1.011

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.5
Membrane Percolation (mm/hr)	1	Length (m)	30.0
Max Percolation (l/s)	0.0	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.509	Membrane Depth (mm)	275

Porous Car Park Manhole: S25, DS/PN: S1.012

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.5
Membrane Percolation (mm/hr)	1	Length (m)	18.0
Max Percolation (l/s)	0.0	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.142	Membrane Depth (mm)	275

Porous Car Park Manhole: S26, DS/PN: S1.013

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.5
Membrane Percolation (mm/hr)	1	Length (m)	12.0
Max Percolation (l/s)	0.0	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	18.670	Membrane Depth (mm)	275

Tank or Pond Manhole: S28, DS/PN: S1.015

TANK B (CATCHMENT B)

Invert Level (m) 17.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	150.0	1.400	150.0	2.800	0.0	4.200	0.0
0.200	150.0	1.600	150.0	3.000	0.0	4.400	0.0
0.400	150.0	1.800	150.0	3.200	0.0	4.600	0.0
0.600	150.0	2.000	0.0	3.400	0.0	4.800	0.0
0.800	150.0	2.200	0.0	3.600	0.0	5.000	0.0
1.000	150.0	2.400	0.0	3.800	0.0		
1.200	150.0	2.600	0.0	4.000	0.0		

Porous Car Park Manhole: S31, DS/PN: S6.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1	Length (m)	60.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	16.672	Membrane Depth (mm)	275

Porous Car Park Manhole: S37, DS/PN: S8.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1	Length (m)	80.0
Max Percolation (l/s)	0.2	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	17.075	Membrane Depth (mm)	275

Porous Car Park Manhole: S39, DS/PN: S9.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1	Length (m)	20.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	16.450	Membrane Depth (mm)	275

Tank or Pond Manhole: S43, DS/PN: S1.024

TANK C (CATCHMENT C)

Invert Level (m) 15.200

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	80.0	1.400	80.0	2.800	0.0	4.200	0.0
0.200	80.0	1.600	80.0	3.000	0.0	4.400	0.0
0.400	80.0	1.800	80.0	3.200	0.0	4.600	0.0
0.600	80.0	2.000	0.0	3.400	0.0	4.800	0.0
0.800	80.0	2.200	0.0	3.600	0.0	5.000	0.0
1.000	80.0	2.400	0.0	3.800	0.0		
1.200	80.0	2.600	0.0	4.000	0.0		

Porous Car Park Manhole: S45, DS/PN: S10.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1	Length (m)	70.0
Max Percolation (l/s)	0.2	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	16.875	Membrane Depth (mm)	275

Porous Car Park Manhole: S47, DS/PN: S1.026

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.5
Membrane Percolation (mm/hr)	1	Length (m)	23.0
Max Percolation (l/s)	0.0	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	14.976	Membrane Depth (mm)	275

Porous Car Park Manhole: S48, DS/PN: S11.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1	Length (m)	70.0
Max Percolation (l/s)	0.2	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	17.400	Membrane Depth (mm)	275

Porous Car Park Manhole: S52, DS/PN: S12.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1	Length (m)	55.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	15.875	Membrane Depth (mm)	275

Porous Car Park Manhole: S54, DS/PN: S13.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.5
Membrane Percolation (mm/hr)	1	Length (m)	100.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	20.325	Membrane Depth (mm)	275

Porous Car Park Manhole: S55, DS/PN: S14.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1	Length (m)	58.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	22.000	Membrane Depth (mm)	275

Porous Car Park Manhole: S164, DS/PN: S13.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.5
Membrane Percolation (mm/hr)	1	Length (m)	56.0
Max Percolation (l/s)	0.0	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.525	Membrane Depth (mm)	275

Porous Car Park Manhole: S59, DS/PN: S13.003

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.5
Membrane Percolation (mm/hr)	1	Length (m)	32.0
Max Percolation (l/s)	0.0	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.074	Membrane Depth (mm)	275

Porous Car Park Manhole: S60, DS/PN: S15.000

Infiltration Coefficient Base (m/hr)	0.00000	Invert Level (m)	19.350
Membrane Percolation (mm/hr)	1	Width (m)	8.0
Max Percolation (l/s)	0.2	Length (m)	73.0
Safety Factor	2.0	Slope (1:X)	60.0
Porosity	0.30	Depression Storage (mm)	5

Porous Car Park Manhole: S60, DS/PN: S15.000

Evaporation (mm/day) 3 Membrane Depth (mm) 275

Porous Car Park Manhole: S61, DS/PN: S13.004

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.5
Membrane Percolation (mm/hr)	1	Length (m)	90.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	18.615	Membrane Depth (mm)	275

Porous Car Park Manhole: S63, DS/PN: S16.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1	Length (m)	72.0
Max Percolation (l/s)	0.2	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	18.300	Membrane Depth (mm)	275

Porous Car Park Manhole: S64, DS/PN: S13.006

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1	Length (m)	75.0
Max Percolation (l/s)	0.1	Slope (1:X)	30.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	17.649	Membrane Depth (mm)	275

Tank or Pond Manhole: S66, DS/PN: S13.008

TANK D (CATCHMENT D)

Invert Level (m) 16.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	100.0	1.400	100.0	2.800	0.0	4.200	0.0
0.200	100.0	1.600	100.0	3.000	0.0	4.400	0.0
0.400	100.0	1.800	0.0	3.200	0.0	4.600	0.0
0.600	100.0	2.000	0.0	3.400	0.0	4.800	0.0
0.800	100.0	2.200	0.0	3.600	0.0	5.000	0.0
1.000	100.0	2.400	0.0	3.800	0.0		
1.200	100.0	2.600	0.0	4.000	0.0		

Porous Car Park Manhole: S67, DS/PN: S13.009

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.5
Membrane Percolation (mm/hr)	1	Length (m)	45.0
Max Percolation (l/s)	0.0	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	17.150	Membrane Depth (mm)	275

Porous Car Park Manhole: S69, DS/PN: S13.011

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.5
Membrane Percolation (mm/hr)	1	Length (m)	25.0
Max Percolation (l/s)	0.0	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	16.746	Membrane Depth (mm)	275

Porous Car Park Manhole: S71, DS/PN: S17.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1	Length (m)	25.0
Max Percolation (l/s)	0.0	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	20.400	Membrane Depth (mm)	275

Porous Car Park Manhole: S72, DS/PN: S17.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1	Length (m)	5.0
Max Percolation (l/s)	0.0	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.898	Membrane Depth (mm)	275

Porous Car Park Manhole: S73, DS/PN: S18.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.3
Membrane Percolation (mm/hr)	1	Length (m)	38.0
Max Percolation (l/s)	0.1	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.900	Membrane Depth (mm)	0

Porous Car Park Manhole: S77, DS/PN: S19.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1	Length (m)	52.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	18.850	Membrane Depth (mm)	275

Porous Car Park Manhole: S79, DS/PN: S20.000

Infiltration Coefficient Base (m/hr)	0.00000	Invert Level (m)	18.375
Membrane Percolation (mm/hr)	1	Width (m)	10.0
Max Percolation (l/s)	0.2	Length (m)	76.0
Safety Factor	2.0	Slope (1:X)	60.0
Porosity	0.30	Depression Storage (mm)	5

Porous Car Park Manhole: S79, DS/PN: S20.000

Evaporation (mm/day) 3 Membrane Depth (mm) 275

Tank or Pond Manhole: S83, DS/PN: S17.007

TANK E (CATCHMENT E)

Invert Level (m) 15.350

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	230.0	1.400	230.0	2.800	0.0	4.200	0.0
0.200	230.0	1.600	230.0	3.000	0.0	4.400	0.0
0.400	230.0	1.800	0.0	3.200	0.0	4.600	0.0
0.600	230.0	2.000	0.0	3.400	0.0	4.800	0.0
0.800	230.0	2.200	0.0	3.600	0.0	5.000	0.0
1.000	230.0	2.400	0.0	3.800	0.0		
1.200	230.0	2.600	0.0	4.000	0.0		

Porous Car Park Manhole: S85, DS/PN: S21.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1	Length (m)	42.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	16.450	Membrane Depth (mm)	275

Tank or Pond Manhole: S87, DS/PN: S22.001

TANK F (CATCHMENT F)

Invert Level (m) 15.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	500.0	1.400	0.0	2.800	0.0	4.200	0.0
0.200	500.0	1.600	0.0	3.000	0.0	4.400	0.0
0.400	500.0	1.800	0.0	3.200	0.0	4.600	0.0
0.600	500.0	2.000	0.0	3.400	0.0	4.800	0.0
0.800	500.0	2.200	0.0	3.600	0.0	5.000	0.0
1.000	500.0	2.400	0.0	3.800	0.0		
1.200	0.0	2.600	0.0	4.000	0.0		

Porous Car Park Manhole: S90, DS/PN: S23.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.3
Membrane Percolation (mm/hr)	1	Length (m)	100.0
Max Percolation (l/s)	0.2	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	17.700	Membrane Depth (mm)	275

Tank or Pond Manhole: S95, DS/PN: S17.011

TANK G (CATCHMENT G)

Invert Level (m) 14.690

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	300.0	1.400	300.0	2.800	0.0	4.200	0.0
0.200	300.0	1.600	300.0	3.000	0.0	4.400	0.0
0.400	300.0	1.800	0.0	3.200	0.0	4.600	0.0
0.600	300.0	2.000	0.0	3.400	0.0	4.800	0.0
0.800	300.0	2.200	0.0	3.600	0.0	5.000	0.0
1.000	300.0	2.400	0.0	3.800	0.0		
1.200	300.0	2.600	0.0	4.000	0.0		

Porous Car Park Manhole: S96, DS/PN: S24.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1	Length (m)	70.0
Max Percolation (l/s)	0.2	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	17.000	Membrane Depth (mm)	275

Porous Car Park Manhole: S101, DS/PN: S24.002

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1	Length (m)	46.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	15.700	Membrane Depth (mm)	275

Tank or Pond Manhole: S105, DS/PN: S13.015

TANK H (CATCHMENT H)

Invert Level (m) 14.415

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	450.0	0.600	450.0	1.200	450.0	1.800	0.0
0.200	450.0	0.800	450.0	1.400	450.0	2.000	0.0
0.400	450.0	1.000	450.0	1.600	450.0		

Porous Car Park Manhole: S106, DS/PN: S26.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.3
Membrane Percolation (mm/hr)	1	Length (m)	55.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	15.775	Membrane Depth (mm)	275

Porous Car Park Manhole: S109, DS/PN: S27.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1	Length (m)	65.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	15.250	Membrane Depth (mm)	275

Porous Car Park Manhole: S113, DS/PN: S28.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1	Length (m)	30.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	15.900	Membrane Depth (mm)	275

Porous Car Park Manhole: S115, DS/PN: S29.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1	Length (m)	75.0
Max Percolation (l/s)	0.2	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	16.400	Membrane Depth (mm)	275

Porous Car Park Manhole: S119, DS/PN: S30.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	6.3
Membrane Percolation (mm/hr)	1	Length (m)	50.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	17.050	Membrane Depth (mm)	275

Porous Car Park Manhole: S122, DS/PN: S31.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	2.5
Membrane Percolation (mm/hr)	1	Length (m)	40.0
Max Percolation (l/s)	0.0	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	17.450	Membrane Depth (mm)	275

Porous Car Park Manhole: S127, DS/PN: S32.000

Infiltration Coefficient Base (m/hr)	0.00000	Invert Level (m)	16.690
Membrane Percolation (mm/hr)	1	Width (m)	6.3
Max Percolation (l/s)	0.1	Length (m)	50.0
Safety Factor	2.0	Slope (1:X)	60.0
Porosity	0.30	Depression Storage (mm)	5

Porous Car Park Manhole: S127, DS/PN: S32.000

Evaporation (mm/day) 3 Membrane Depth (mm) 275

Porous Car Park Manhole: S132, DS/PN: S33.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1	Length (m)	54.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	15.350	Membrane Depth (mm)	275

Porous Car Park Manhole: S134, DS/PN: S34.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1	Length (m)	50.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	14.350	Membrane Depth (mm)	275

Porous Car Park Manhole: S138, DS/PN: S35.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1	Length (m)	50.0
Max Percolation (l/s)	0.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	13.287	Membrane Depth (mm)	275

Tank or Pond Manhole: S141, DS/PN: S1.034

TANK I (CATCMENT I)

Invert Level (m) 14.265

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	450.0	0.700	450.0	1.400	450.0	2.100	0.0
0.100	450.0	0.800	450.0	1.500	450.0	2.200	0.0
0.200	450.0	0.900	450.0	1.600	0.0	2.300	0.0
0.300	450.0	1.000	450.0	1.700	0.0	2.400	0.0
0.400	450.0	1.100	450.0	1.800	0.0	2.500	0.0
0.500	450.0	1.200	450.0	1.900	0.0		
0.600	450.0	1.300	450.0	2.000	0.0		

Tank or Pond Manhole: S158, DS/PN: S36.005

TANK J (CATCMENT J)

Invert Level (m) 14.050

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	55.0	0.400	55.0	0.800	55.0	1.200	55.0
0.200	55.0	0.600	55.0	1.000	55.0	1.400	55.0

Tank or Pond Manhole: S158, DS/PN: S36.005

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
1.600	55.0	2.600	0.0	3.600	0.0	4.600	0.0
1.800	0.0	2.800	0.0	3.800	0.0	4.800	0.0
2.000	0.0	3.000	0.0	4.000	0.0	5.000	0.0
2.200	0.0	3.200	0.0	4.200	0.0		
2.400	0.0	3.400	0.0	4.400	0.0		

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	Woodbrook Development
LOCATION:	Catchment / Tank A
DATE:	11-Sep-19
CREATED BY:	Ailis Corrigan / Garry Hanratty

SYSTEM PARAMETERS

Required Total Storage	216	m^3
Stormtech chamber model	MC3500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	43%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.657	m	0.30
Stone Below Chambers	0.23	m	0.23
In-between Row Spacing	0.23	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	Yes	
Orientation of Header Pipe	Parrallel to IR	
Diameter of Header Pipe	0.3	m
Length of Header Pipe	60	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		2	ea
Number of units per Row		12	ea
System Installed Storage Depth (effective storage depth)	2.032		m
Tank overall installed Width at base	5.34	5.34	m
Tank overall installed Length at Base	27.9	27.9	m
Total Effective System Storage	**217.2**	**217.2**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC3500	
Unit Width	1.955	m
Unit Length	2.18	m
Unit Height	1.145	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.4	m
Chamber Internal Storage Vol.	3.11	m^3
Header Pipe Internal Storage Vol in Excavation	4.2	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	388	m^3
Width at base	5.34	m
Width at top	7.69	m
Length at base	27.90	m
Length at top	30.25	m
Depth Of System	2.03	m
Area of Dig at Base of System	149	m^2
Area of Dig at Top of System	232	m^2
Void Ratio	56%	
Stone Requirement - m3	308	m^3
Stone Requirement - tonne	506	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	Woodbrook Development
LOCATION:	Catchment / Tank B
DATE:	11-Sep-19
CREATED BY:	Ailis Corrigan / Garry Hanratty

SYSTEM PARAMETERS

Required Total Storage	270	m^3
Stormtech chamber model	MC3500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	43%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.657	m	0.30
Stone Below Chambers	0.23	m	0.23
In-between Row Spacing	0.23	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	Yes	
Orientation of Header Pipe	Parralell to IR	
Diameter of Header Pipe	0.3	m
Length of Header Pipe	60	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		2	ea
Number of units per Row		16	ea
System Installed Storage Depth (effective storage depth)	2.032		m
Tank overall installed Width at base	5.34	5.34	m
Tank overall installed Length at Base	36.62	36.62	m
Total Effective System Storage	**281.0**	**281.0**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC3500	
Unit Width	1.955	m
Unit Length	2.18	m
Unit Height	1.145	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.4	m
Chamber Internal Storage Vol.	3.11	m^3
Header Pipe Internal Storage Vol in Excavation	4.2	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	503	m^3
Width at base	5.34	m
Width at top	7.69	m
Length at base	36.62	m
Length at top	38.97	m
Depth Of System	2.03	m
Area of Dig at Base of System	196	m^2
Area of Dig at Top of System	300	m^2
Void Ratio	56%	
Stone Requirement - m3	399	m^3
Stone Requirement - tonne	654	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	Woodbrook Development
LOCATION:	Catchment / Tank C
DATE:	11-Sep-19
CREATED BY:	Ailis Corrigan / Garry Hanratty

SYSTEM PARAMETERS

Required Total Storage	144	m^3
Stormtech chamber model	MC3500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	43%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.657	m	0.30
Stone Below Chambers	0.23	m	0.23
In-between Row Spacing	0.23	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	Yes	
Orientation of Header Pipe	Parralel to IR	
Diameter of Header Pipe	0.3	m
Length of Header Pipe	60	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		2	ea
Number of units per Row		8	ea
System Installed Storage Depth (effective storage depth)	2.032		m
Tank overall installed Width at base	5.34	5.34	m
Tank overall installed Length at Base	19.18	19.18	m
Total Effective System Storage	**153.4**	**153.4**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC3500	
Unit Width	1.955	m
Unit Length	2.18	m
Unit Height	1.145	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.4	m
Chamber Internal Storage Vol.	3.11	m^3
Header Pipe Internal Storage Vol in Excavation	4.2	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	272	m^3
Width at base	5.34	m
Width at top	7.69	m
Length at base	19.18	m
Length at top	21.53	m
Depth Of System	2.03	m
Area of Dig at Base of System	102	m^2
Area of Dig at Top of System	165	m^2
Void Ratio	56%	
Stone Requirement - m3	218	m^3
Stone Requirement - tonne	357	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	Woodbrook Development
LOCATION:	Catchment / Tank D
DATE:	11-Sep-19
CREATED BY:	Ailis Corrigan / Garry Hanratty

SYSTEM PARAMETERS

Required Total Storage	160	m^3
Stormtech chamber model	MC3500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	43%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.457	m	0.30
Stone Below Chambers	0.23	m	0.23
In-between Row Spacing	0.23	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	Yes	
Orientation of Header Pipe	Parrallel to IR	
Diameter of Header Pipe	0.3	m
Length of Header Pipe	60	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		3	ea
Number of units per Row		7	ea
System Installed Storage Depth (effective storage depth)	1.832		m
Tank overall installed Width at base	7.53	7.53	m
Tank overall installed Length at Base	17	17	m
Total Effective System Storage	**169.4**	**169.4**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC3500	
Unit Width	1.955	m
Unit Length	2.18	m
Unit Height	1.145	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.4	m
Chamber Internal Storage Vol.	3.11	m^3
Header Pipe Internal Storage Vol in Excavation	4.2	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	286	m^3
Width at base	7.53	m
Width at top	9.65	m
Length at base	17.00	m
Length at top	19.12	m
Depth Of System	1.83	m
Area of Dig at Base of System	128	m^2
Area of Dig at Top of System	184	m^2
Void Ratio	59%	
Stone Requirement - m3	216	m^3
Stone Requirement - tonne	354	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	Woodbrook Development
LOCATION:	Catchment / Tank E
DATE:	11-Sep-19
CREATED BY:	Ailis Corrigan / Garry Hanratty

SYSTEM PARAMETERS

Required Total Storage	368	m^3
Stormtech chamber model	MC3500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	43%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.457	m	*0.30*
Stone Below Chambers	0.23	m	*0.23*
In-between Row Spacing	0.23	m	*0.23*
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	Yes	
Orientation of Header Pipe	Parrallel to IR	
Diameter of Header Pipe	0.3	m
Length of Header Pipe	60	m

CHAMBER SYSTEM DIMENSIONS	Calculated	Adopted	
Number of Rows		3	ea
Number of units per Row		17	ea
System Installed Storage Depth (effective storage depth)	1.832		m
Tank overall installed Width at base	7.53	7.53	m
Tank overall installed Length at Base	38.8	38.8	m
Total Effective System Storage	**369.9**	**370.1**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC3500	
Unit Width	1.955	m
Unit Length	2.18	m
Unit Height	1.145	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.4	m
Chamber Internal Storage Vol.	3.11	m^3
Header Pipe Internal Storage Vol in Excavation	4.2	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	629	m^3
Width at base	7.53	m
Width at top	9.65	m
Length at base	38.80	m
Length at top	40.92	m
Depth Of System	1.83	m
Area of Dig at Base of System	292	m^2
Area of Dig at Top of System	395	m^2
Void Ratio	59%	
Stone Requirement - m3	466	m^3
Stone Requirement - tonne	764	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	Woodbrook Development
LOCATION:	Catchment / Tank F (School Site)
DATE:	11-Sep-19
CREATED BY:	Ailis Corrigan / Garry Hanratty

SYSTEM PARAMETERS

Required Total Storage	500	m^3
Stormtech chamber model	DC780	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	43%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.238	m	0.15
Stone Below Chambers	0.23	m	0.23
In-between Row Spacing	0.15	m	0.15
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	Yes	
Orientation of Header Pipe	Parralel to IR	
Diameter of Header Pipe	0.3	m
Length of Header Pipe	60	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		15	ea
Number of units per Row		13	ea
System Installed Storage Depth (effective storage depth)	1.228		m
Tank overall installed Width at base	22.73	22.73	m
Tank overall installed Length at Base	28.91	28.91	m
Total Effective System Storage	**520.5**	**520.6**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	DC780	
Unit Width	1.295	m
Unit Length	2.17	m
Unit Height	0.76	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	3.7	m
Chamber Internal Storage Vol.	1.3	m^3
Header Pipe Internal Storage Vol in Excavation	4.2	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	853	m^3
Width at base	22.73	m
Width at top	24.15	m
Length at base	28.91	m
Length at top	30.33	m
Depth Of System	1.23	m
Area of Dig at Base of System	657	m^2
Area of Dig at Top of System	732	m^2
Void Ratio	61%	
Stone Requirement - m3	597	m^3
Stone Requirement - tonne	979	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	Woodbrook Development
LOCATION:	Catchment /Tank G
DATE:	11-Sep-19
CREATED BY:	Ailis Corrigan / Garry Hanratty

SYSTEM PARAMETERS

Required Total Storage	480	m^3
Stormtech chamber model	MC3500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	43%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.457	m	0.30
Stone Below Chambers	0.23	m	0.23
In-between Row Spacing	0.23	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	Yes	
Orientation of Header Pipe	Parralel to IR	
Diameter of Header Pipe	0.3	m
Length of Header Pipe	60	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		3	ea
Number of units per Row		23	ea
System Installed Storage Depth (effective storage depth)	1.832		m
Tank overall installed Width at base	7.53	7.53	m
Tank overall installed Length at Base	51.88	51.88	m
Total Effective System Storage	**490.3**	**490.5**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC3500	
Unit Width	1.955	m
Unit Length	2.18	m
Unit Height	1.145	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.4	m
Chamber Internal Storage Vol.	3.11	m^3
Header Pipe Internal Storage Vol in Excavation	4.2	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	835	m^3
Width at base	7.53	m
Width at top	9.65	m
Length at base	51.88	m
Length at top	54.00	m
Depth Of System	1.83	m
Area of Dig at Base of System	391	m^2
Area of Dig at Top of System	521	m^2
Void Ratio	59%	
Stone Requirement - m3	616	m^3
Stone Requirement - tonne	1010	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	Woodbrook Development
LOCATION:	Catchment / Tank H
DATE:	11-Sep-19
CREATED BY:	Ailis Corrigan / Garry Hanratty

SYSTEM PARAMETERS

Required Total Storage	720	m^3
Stormtech chamber model	MC3500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	43%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.457	m	0.30
Stone Below Chambers	0.23	m	0.23
In-between Row Spacing	0.23	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	Yes	
Orientation of Header Pipe	Parralell to IR	
Diameter of Header Pipe	0.3	m
Length of Header Pipe	60	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		4	ea
Number of units per Row		27	ea
System Installed Storage Depth (effective storage depth)	1.832		m
Tank overall installed Width at base	9.71	9.71	m
Tank overall installed Length at Base	60.6	60.6	m
Total Effective System Storage	**725.4**	**725.4**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC3500	
Unit Width	1.955	m
Unit Length	2.18	m
Unit Height	1.145	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.4	m
Chamber Internal Storage Vol.	3.11	m^3
Header Pipe Internal Storage Vol in Excavation	4.2	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	1218	m^3
Width at base	9.71	m
Width at top	11.83	m
Length at base	60.60	m
Length at top	62.72	m
Depth Of System	1.83	m
Area of Dig at Base of System	588	m^2
Area of Dig at Top of System	742	m^2
Void Ratio	60%	
Stone Requirement - m3	877	m^3
Stone Requirement - tonne	1438	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	Woodbrook Development
LOCATION:	Catchment / Tank I (Section 1)
DATE:	11-Sep-19
CREATED BY:	Ailis Corrigan / Garry Hanratty

SYSTEM PARAMETERS

Required Total Storage	142.5	m^3
Stormtech chamber model	MC3500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	43%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.357	m	0.30
Stone Below Chambers	0.23	m	0.23
In-between Row Spacing	0.23	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	Yes	
Orientation of Header Pipe	Parralel to IR	
Diameter of Header Pipe	0.3	m
Length of Header Pipe	60	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		3	ea
Number of units per Row		6	ea
System Installed Storage Depth (effective storage depth)	1.732		m
Tank overall installed Width at base	7.53	7.53	m
Tank overall installed Length at Base	14.82	14.82	m
Total Effective System Storage	**142.4**	**142.5**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC3500	
Unit Width	1.955	m
Unit Length	2.18	m
Unit Height	1.145	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.4	m
Chamber Internal Storage Vol.	3.11	m^3
Header Pipe Internal Storage Vol in Excavation	4.2	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	235	m^3
Width at base	7.53	m
Width at top	9.53	m
Length at base	14.82	m
Length at top	16.82	m
Depth Of System	1.73	m
Area of Dig at Base of System	112	m^2
Area of Dig at Top of System	160	m^2
Void Ratio	61%	
Stone Requirement - m3	175	m^3
Stone Requirement - tonne	287	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	Woodbrook Development
LOCATION:	Catchment / Tank I (Section 2)
DATE:	11-Sep-19
CREATED BY:	Ailis Corrigan / Garry Hanratty

SYSTEM PARAMETERS

Required Total Storage	324.4	m^3
Stormtech chamber model	MC3500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	43%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.357	m	0.30
Stone Below Chambers	0.23	m	0.23
In-between Row Spacing	0.23	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	Yes	
Orientation of Header Pipe	Parralell to IR	
Diameter of Header Pipe	0.3	m
Length of Header Pipe	60	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		6	ea
Number of units per Row		8	ea
System Installed Storage Depth (effective storage depth)	1.732		m
Tank overall installed Width at base	14.08	14.08	m
Tank overall installed Length at Base	19.18	19.18	m
Total Effective System Storage	**324.4**	**324.4**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC3500	
Unit Width	1.955	m
Unit Length	2.18	m
Unit Height	1.145	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.4	m
Chamber Internal Storage Vol.	3.11	m^3
Header Pipe Internal Storage Vol in Excavation	4.2	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	529	m^3
Width at base	14.08	m
Width at top	16.08	m
Length at base	19.18	m
Length at top	21.18	m
Depth Of System	1.73	m
Area of Dig at Base of System	270	m^2
Area of Dig at Top of System	341	m^2
Void Ratio	61%	
Stone Requirement - m3	373	m^3
Stone Requirement - tonne	611	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	Woodbrook Development
LOCATION:	Catchment / Tank I (Section 3)
DATE:	11-Sep-19
CREATED BY:	Ailis Corrigan / Garry Hanratty

SYSTEM PARAMETERS

Required Total Storage	208	m^3
Stormtech chamber model	MC3500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	43%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.357	m	0.30
Stone Below Chambers	0.23	m	0.23
In-between Row Spacing	0.23	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	Yes	
Orientation of Header Pipe	Parrallel to IR	
Diameter of Header Pipe	0.3	m
Length of Header Pipe	60	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		3	ea
Number of units per Row		10	ea
System Installed Storage Depth (effective storage depth)	1.732		m
Tank overall installed Width at base	7.53	7.53	m
Tank overall installed Length at Base	23.54	23.54	m
Total Effective System Storage	**219.0**	**219.1**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC3500	
Unit Width	1.955	m
Unit Length	2.18	m
Unit Height	1.145	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.4	m
Chamber Internal Storage Vol.	3.11	m^3
Header Pipe Internal Storage Vol in Excavation	4.2	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	364	m^3
Width at base	7.53	m
Width at top	9.53	m
Length at base	23.54	m
Length at top	25.54	m
Depth Of System	1.73	m
Area of Dig at Base of System	177	m^2
Area of Dig at Top of System	243	m^2
Void Ratio	60%	
Stone Requirement - m3	267	m^3
Stone Requirement - tonne	437	tonne

STORMTECH Stormwater Management System Design Tool

ver: Jan18

PROJECT REF:	Woodbrook Development
LOCATION:	Catchment / Tank J
DATE:	11-Sep-19
CREATED BY:	Ailis Corrigan / Garry Hanratty

SYSTEM PARAMETERS

Required Total Storage	88	m^3
Stormtech chamber model	MC3500	
Filtration Permeable Geo or Impermeable Geo	Filter geo	
Number of Isolator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	43%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.457	m	0.30
Stone Below Chambers	0.23	m	0.23
In-between Row Spacing	0.23	m	0.23
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	Yes	
Orientation of Header Pipe	Parrallel to IR	
Diameter of Header Pipe	0.3	m
Length of Header Pipe	60	m

CHAMBER SYSTEM DIMENSIONS

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	Calculated	Adopted	
Number of Rows		1	ea
Number of units per Row		8	ea
System Installed Storage Depth (effective storage depth)	1.832		m
Tank overall installed Width at base	3.16	3.16	m
Tank overall installed Length at Base	19.18	19.18	m
Total Effective System Storage	**89.6**	**89.7**	m^3

STORMTECH SYSTEM DETAIL

StormTech Chamber Model	MC3500	
Unit Width	1.955	m
Unit Length	2.18	m
Unit Height	1.145	m
Min Cover Over System	0.3	m
Max Cover Over Chamber (see StormTech for greater cover)	2.4	m
Chamber Internal Storage Vol.	3.11	m^3
Header Pipe Internal Storage Vol in Excavation	4.2	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	158	m^3
Width at base	3.16	m
Width at top	5.28	m
Length at base	19.18	m
Length at top	21.30	m
Depth Of System	1.83	m
Area of Dig at Base of System	61	m^2
Area of Dig at Top of System	112	m^2
Void Ratio	57%	
Stone Requirement - m3	131	m^3
Stone Requirement - tonne	214	tonne

STORMTECH SC-160LP CHAMBER

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for commercial and municipal activities.

The SC-160LP chamber was developed for infiltration and detention in shallow cover applications

- Only 14" (350 mm) required from top of chamber to bottom of pavement
- Only 12" (300 mm) tall
- Installs toe to toe - no additional spacing between rows

StormTech SC-160LP (not to scale)

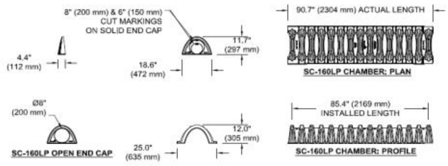
Nominal Chamber Specifications

Size (LxWxH)	85.4" x 25.0" x 12.0" (2170 x 635 x 305 mm)
Chamber Storage	6.85 ft³ (0.19 m³)
Min. Installed Storage*	15.0 ft³ (0.42 m³)
Weight	24.0 lbs. (10.9 kg)

*Assumes 6" (150 mm) stone above, 4" (100 mm) below and stone between chambers with 40% stone porosity

Shipping

132 chambers/pallet
144 end caps/pallet
12 pallets/truck



STORMTECH SC-310 CHAMBER

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for private (commercial) and public applications.

StormTech SC-310 Chamber (not to scale)

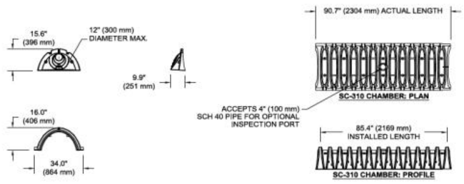
Nominal Chamber Specifications

Size (L x W x H)	85.4" x 34.0" x 16.0" (2170 x 864 x 406 mm)
Chamber Storage	14.7 ft³ (0.42 m³)
Min. Installed Storage*	31.0 ft³ (0.88 m³)
Weight	37.0 lbs (16.8 kg)

*Assumes 6" (150 mm) stone above, below and between chambers and 40% stone porosity.

Shipping

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



STORMTECH SC-740 CHAMBER

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for private (commercial) and public applications.

StormTech SC-740 Chamber (not to scale)

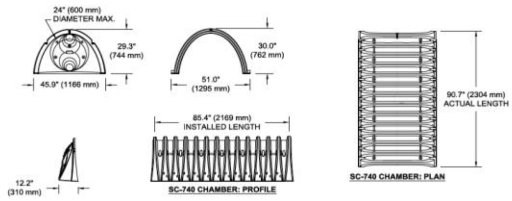
Nominal Chamber Specifications

Size (Lx W x H)	85.4" x 51.0" x 30.0" (2170 x 1295 x 762 mm)
Chamber Storage	45.9 ft³ (1.30 m³)
Min. Installed Storage*	74.9 ft³ (2.12 m³)
Weight	74.0 lbs (33.6 kg)

*Assumes 6" (150 mm) stone above, below and between chambers and 40% stone porosity.

Shipping

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



STORMTECH DC-780 CHAMBER

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for private (commercial) and public applications.

- 12' Deep Cover applications.
- Designed in accordance with ASTM F 2787 and produced to meet the ASTM 2418 product standard.
- AASHTO safety factors provided for AASHTO Design Truck (H20) and deep cover conditions

StormTech DC-780 Chamber (not to scale)

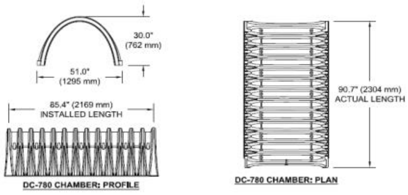
Nominal Chamber Specifications

Size (Lx W x H)	85.4" x 51.0" x 30.0" (2169 x 1295 x 762 mm)
Chamber Storage	46.2 ft3 (1.30 m3)
Min. Installed Storage*	78.4 ft3 (2.2 m3)

*Assumes 9" (230 mm) stone below, 6" (150 mm) stone above, 6" (150 mm) row spacing and 40% stone porosity.

Shipping

24 chambers/pallet
60 end caps/pallet
12 pallets/truck



STORMTECH MC-3500 CHAMBER

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for private (commercial) and public applications.

StormTech MC-3500 Chamber (not to scale)

Nominal Chamber Specifications

Size (Lx W x H)	90" (2286 mm) x 77" (1956 mm) x 45" (1143 mm)
Chamber Storage	109.9 ft³ (3.11 m³)
Min. Installed Storage*	178.9 ft³ (5.1 m³)
Weight	134 lbs (60.8 kg)

*Assumes a minimum of 12" (300 mm) of stone above, 9" (230 mm) of stone below chambers, 9" (230 mm) of stone between chambers/end caps and 40% stone porosity.

StormTech MC-3500 End Cap (not to scale)

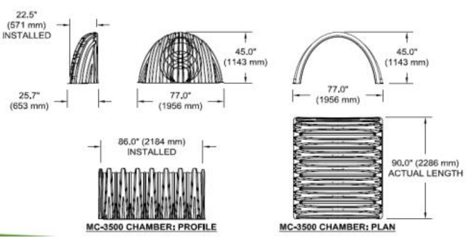
Nominal Chamber Specifications

Size (Lx W x H)	26.5" (673 mm) x 71" (1803 mm) x 45.1" (1145 mm)
End Cap Storage	14.9 ft³ (0.42 m³)
Min. Installed Storage*	46.0 ft³ (1.30 m³)
Weight	49 lbs (22.2 kg)

*Assumes a minimum of 12" (300 mm) of stone above, 9" (230 mm) of stone below, 6" (150 mm) of stone perimeter, 9" (230 mm) of stone between chambers/end caps and 40% stone porosity.

Shipping

15 chambers/pallet
7 end caps/pallet
7 pallets/truck



STORMTECH MC-4500 CHAMBER

Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots thus maximizing land usage for private (commercial) and public applications.

StormTech MC-4500 Chamber (not to scale)

Nominal Chamber Specifications

Size (Lx W x H)	52" (1321 mm) x 100" (2540 mm) x 60" (1524 mm)
Chamber Storage	106.5 ft³ (3.01 m³)
Min. Installed Storage*	162.6 ft³ (4.60 m³)
Weight	120 lbs (54.4 kg)

*Assumes a minimum of 12" (300 mm) of stone above, 9" (230 mm) of stone below chambers, 9" (230 mm) of stone between chambers/end caps and 40% stone porosity.

StormTech MC-4500 End Cap (not to scale)

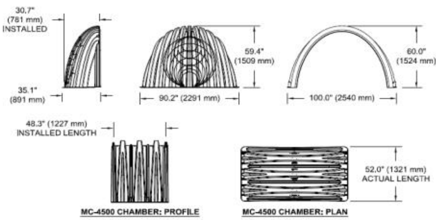
Nominal Chamber Specifications

Size (Lx W x H)	35.1" (891 mm) x 90.2" (2291 mm) x 59.4" (1509 mm)
End Cap Storage	35.7 ft³ (1.01 m³)
Min. Installed Storage*	108.7 ft³ (3.08 m³)
Weight	120 lbs (54.4 kg)

*Assumes a minimum of 12" (300 mm) of stone above, 9" (230 mm) of stone below, 12" (300 mm) of stone perimeter, 9" (230 mm) of stone between chambers/end caps and 40% stone porosity.

Shipping

7 chambers/pallet
7 end caps/pallet
11 pallets/truck



Appendix F. Online Controls

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S6, DS/PN: S1.003, Volume (m³): 6.7

CARPARK FLOW CONTROL (PART OF CATCHMENT A)

Unit Reference	MD-SHE-0076-2000-0400-2000
Design Head (m)	0.400
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	76
Invert Level (m)	20.849
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.400	2.0
Flush-Flo™	0.124	2.0
Kick-Flo®	0.286	1.7
Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0	1.200	3.3	3.000	5.1	7.000	7.6
0.200	1.9	1.400	3.5	3.500	5.4	7.500	7.9
0.300	1.8	1.600	3.8	4.000	5.8	8.000	8.2
0.400	2.0	1.800	4.0	4.500	6.1	8.500	8.4
0.500	2.2	2.000	4.2	5.000	6.5	9.000	8.7
0.600	2.4	2.200	4.4	5.500	6.8	9.500	8.9
0.800	2.7	2.400	4.6	6.000	7.1		
1.000	3.0	2.600	4.7	6.500	7.4		

Hydro-Brake® Optimum Manhole: S21, DS/PN: S1.008, Volume (m³): 5.7

DOWNSTREAM OF TANK A (CATCHMENT A)

Unit Reference	MD-SHE-0058-2000-1800-2000
Design Head (m)	1.800
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	58
Invert Level (m)	19.620
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Hydro-Brake® Optimum Manhole: S21, DS/PN: S1.008, Volume (m^3): 5.7

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.800	2.0
Flush-Flo™	0.257	1.4
Kick-Flo®	0.521	1.1
Mean Flow over Head Range	-	1.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.2	1.200	1.7	3.000	2.5	7.000	3.7
0.200	1.4	1.400	1.8	3.500	2.7	7.500	3.9
0.300	1.4	1.600	1.9	4.000	2.9	8.000	4.0
0.400	1.3	1.800	2.0	4.500	3.1	8.500	4.1
0.500	1.2	2.000	2.1	5.000	3.2	9.000	4.2
0.600	1.2	2.200	2.2	5.500	3.3	9.500	4.3
0.800	1.4	2.400	2.3	6.000	3.5		
1.000	1.5	2.600	2.4	6.500	3.6		

Hydro-Brake® Optimum Manhole: S28, DS/PN: S1.015, Volume (m^3): 3.8

DOWNSTREAM OF TANK B (CATCHMENT B)

Unit Reference	MD-SHE-0159-1420-1800-1420
Design Head (m)	1.800
Design Flow (l/s)	14.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	159
Invert Level (m)	17.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.800	14.2
Flush-Flo™	0.527	14.2
Kick-Flo®	1.114	11.3
Mean Flow over Head Range	-	12.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.7	0.300	13.4	0.500	14.2	0.800	13.7
0.200	12.2	0.400	14.0	0.600	14.2	1.000	12.6

Hydro-Brake® Optimum Manhole: S28, DS/PN: S1.015, Volume (m^3): 3.8

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
1.200	11.7	2.400	16.3	5.000	23.1	8.000	28.9
1.400	12.6	2.600	16.9	5.500	24.2	8.500	29.8
1.600	13.4	3.000	18.1	6.000	25.2	9.000	30.6
1.800	14.2	3.500	19.5	6.500	26.2	9.500	31.4
2.000	14.9	4.000	20.7	7.000	27.1		
2.200	15.6	4.500	21.9	7.500	28.1		

Hydro-Brake® Optimum Manhole: S43, DS/PN: S1.024, Volume (m^3): 8.7

DOWNSTREAM OF TANK C (CATCHMENT C)

Unit Reference	MD-SHE-0176-1760-1800-1760
Design Head (m)	1.800
Design Flow (l/s)	17.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	176
Invert Level (m)	15.200
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.800	17.6
Flush-Flo™	0.528	17.6
Kick-Flo®	1.124	14.1
Mean Flow over Head Range	-	15.3

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	6.2	1.200	14.5	3.000	22.5	7.000	33.7
0.200	15.2	1.400	15.6	3.500	24.2	7.500	34.9
0.300	16.7	1.600	16.6	4.000	25.8	8.000	36.0
0.400	17.4	1.800	17.6	4.500	27.3	8.500	37.1
0.500	17.6	2.000	18.5	5.000	28.7	9.000	38.1
0.600	17.5	2.200	19.4	5.500	30.0	9.500	39.1
0.800	17.0	2.400	20.2	6.000	31.3		
1.000	15.8	2.600	21.0	6.500	32.6		

Hydro-Brake® Optimum Manhole: S66, DS/PN: S13.008, Volume (m^3): 3.5

DOWNSTREAM OF TANK D (CATCHMENT D)

Unit Reference	MD-SHE-0225-2900-1600-2900
Design Head (m)	1.600
Design Flow (l/s)	29.0
Flush-Flo™	Calculated

Hydro-Brake® Optimum Manhole: S66, DS/PN: S13.008, Volume (m³): 3.5

Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	225
Invert Level (m)	16.600
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.600	29.0
Flush-Flo™	0.482	28.9
Kick-Flo®	1.062	23.8
Mean Flow over Head Range	-	24.9

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	7.5	1.200	25.3	3.000	39.2	7.000	59.1
0.200	22.4	1.400	27.2	3.500	42.2	7.500	61.1
0.300	27.9	1.600	29.0	4.000	45.1	8.000	63.0
0.400	28.8	1.800	30.7	4.500	47.7	8.500	64.9
0.500	28.9	2.000	32.3	5.000	50.2	9.000	66.8
0.600	28.7	2.200	33.8	5.500	52.6	9.500	68.5
0.800	27.8	2.400	35.2	6.000	54.8		
1.000	25.4	2.600	36.6	6.500	57.0		

Hydro-Brake® Optimum Manhole: S83, DS/PN: S17.007, Volume (m³): 5.0

DOWNSTREAM OF TANK E (CATCHMENT E)

Unit Reference	MD-SHE-0059-2000-1700-2000
Design Head (m)	1.700
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	59
Invert Level (m)	16.403
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.700	2.0
Flush-Flo™	0.257	1.5
Kick-Flo®	0.527	1.2
Mean Flow over Head Range	-	1.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a

Hydro-Brake® Optimum Manhole: S83, DS/PN: S17.007, Volume (m³): 5.0

Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.3	1.200	1.7	3.000	2.6	7.000	3.8
0.200	1.4	1.400	1.8	3.500	2.8	7.500	4.0
0.300	1.4	1.600	1.9	4.000	3.0	8.000	4.1
0.400	1.4	1.800	2.1	4.500	3.1	8.500	4.2
0.500	1.3	2.000	2.2	5.000	3.3	9.000	4.3
0.600	1.3	2.200	2.2	5.500	3.4	9.500	4.4
0.800	1.4	2.400	2.3	6.000	3.6		
1.000	1.6	2.600	2.4	6.500	3.7		

Hydro-Brake® Optimum Manhole: S87, DS/PN: S22.001, Volume (m³): 2.3

DOWNSTREAM OF TANK F (CATCHMENT F)

Unit Reference	MD-SHE-0085-3200-1000-3200
Design Head (m)	1.000
Design Flow (l/s)	3.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	85
Invert Level (m)	15.600
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	3.2
Flush-Flo™	0.296	3.2
Kick-Flo®	0.624	2.6
Mean Flow over Head Range	-	2.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.6	1.200	3.5	3.000	5.3	7.000	7.9
0.200	3.1	1.400	3.7	3.500	5.7	7.500	8.2
0.300	3.2	1.600	4.0	4.000	6.1	8.000	8.5
0.400	3.1	1.800	4.2	4.500	6.4	8.500	8.7
0.500	3.0	2.000	4.4	5.000	6.8	9.000	8.9
0.600	2.7	2.200	4.6	5.500	7.1	9.500	9.2
0.800	2.9	2.400	4.8	6.000	7.4		
1.000	3.2	2.600	5.0	6.500	7.7		

Hydro-Brake® Optimum Manhole: S95, DS/PN: S17.011, Volume (m³): 8.9

DOWNSTREAM OF TANK G (CATCHMENT G)

Unit Reference	MD-SHE-0158-1300-1400-1300
Design Head (m)	1.400
Design Flow (l/s)	13.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	158
Invert Level (m)	14.690
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.400	13.0
Flush-Flo™	0.418	13.0
Kick-Flo®	0.902	10.5
Mean Flow over Head Range	-	11.3

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	5.7	1.200	12.0	3.000	18.6	7.000	27.9
0.200	11.9	1.400	13.0	3.500	20.0	7.500	28.9
0.300	12.7	1.600	13.8	4.000	21.4	8.000	29.8
0.400	13.0	1.800	14.6	4.500	22.6	8.500	30.7
0.500	12.9	2.000	15.3	5.000	23.8	9.000	31.5
0.600	12.7	2.200	16.1	5.500	24.9	9.500	32.4
0.800	11.7	2.400	16.7	6.000	25.9		
1.000	11.1	2.600	17.4	6.500	27.0		

Hydro-Brake® Optimum Manhole: S105, DS/PN: S13.015, Volume (m³): 13.2

DOWNSTREAM OF TANK H (CATCHMENT H)

Unit Reference	MD-SHE-0190-2000-1600-2000
Design Head (m)	1.600
Design Flow (l/s)	20.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	190
Invert Level (m)	14.415
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.600	20.0
Flush-Flo™	0.472	20.0

Hydro-Brake® Optimum Manhole: S105, DS/PN: S13.015, Volume (m³): 13.2

Control Points	Head (m)	Flow (l/s)
Kick-Flo®	1.027	16.2
Mean Flow over Head Range	-	17.3

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	6.6	1.200	17.4	3.000	27.0	7.000	40.6
0.200	17.5	1.400	18.8	3.500	29.1	7.500	42.0
0.300	19.3	1.600	20.0	4.000	31.0	8.000	43.3
0.400	19.9	1.800	21.2	4.500	32.8	8.500	44.6
0.500	20.0	2.000	22.2	5.000	34.5	9.000	45.9
0.600	19.8	2.200	23.3	5.500	36.2	9.500	47.1
0.800	19.0	2.400	24.3	6.000	37.7		
1.000	16.8	2.600	25.2	6.500	39.2		

Hydro-Brake® Optimum Manhole: S141, DS/PN: S1.034, Volume (m³): 6.9

DOWNSTREAM OF TANK I (CATCHMENT I)

Unit Reference	MD-SHE-0298-5380-1500-5380
Design Head (m)	1.500
Design Flow (l/s)	53.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	298
Invert Level (m)	14.265
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	2100

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	53.8
Flush-Flo™	0.514	53.8
Kick-Flo®	1.075	45.8
Mean Flow over Head Range	-	45.3

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	9.1	0.500	53.8	1.200	48.3	2.000	61.8
0.200	30.6	0.600	53.6	1.400	52.0	2.200	64.7
0.300	51.3	0.800	52.1	1.600	55.5	2.400	67.5
0.400	53.2	1.000	48.7	1.800	58.7	2.600	70.2

Hydro-Brake® Optimum Manhole: S141, DS/PN: S1.034, Volume (m^3): 6.9

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
3.000	75.2	5.000	96.4	7.000	113.6	9.000	128.5
3.500	81.1	5.500	101.0	7.500	117.5	9.500	131.9
4.000	86.5	6.000	105.4	8.000	121.3		
4.500	91.6	6.500	109.6	8.500	124.9		

Hydro-Brake® Optimum Manhole: S158, DS/PN: S36.005, Volume (m^3): 2.7

DOWNSTREAM OF TANK J (CATCHMENT J)

Unit Reference	MD-SHE-0067-2500-1600-2500
Design Head (m)	1.600
Design Flow (l/s)	2.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	14.050
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.600	2.5
Flush-Flo™	0.297	2.0
Kick-Flo®	0.601	1.6
Mean Flow over Head Range	-	1.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.6	1.200	2.2	3.000	3.3	7.000	5.0
0.200	1.9	1.400	2.3	3.500	3.6	7.500	5.1
0.300	2.0	1.600	2.5	4.000	3.8	8.000	5.3
0.400	1.9	1.800	2.6	4.500	4.0	8.500	5.4
0.500	1.8	2.000	2.8	5.000	4.2	9.000	5.6
0.600	1.6	2.200	2.9	5.500	4.4	9.500	5.7
0.800	1.8	2.400	3.0	6.000	4.6		
1.000	2.0	2.600	3.1	6.500	4.8		

Appendix G. Summary of Results

G.1. Results Status Description

OK when the maximum water level is lower than the pipe's soffit.

SURCHARGED when the maximum water level is above the pipe's soffit and to within 300mm of the manhole cover level. (Allowable for 1 in 30 year storm events and greater in accordance with the GDSDS, refer to table 2-1)

FLOOD RISK when the maximum water level is above the pipe's soffit but below the manhole cover by the depth specified in the Preferences.

FLOOD when the maximum water level is above the manhole cover (No Flooding has been indicated within Summary of Results for up to the 1 in 100 year storm event)

G.2. 1 in 100 year Outputs

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Storage Structures 58
Number of Online Controls 11 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.277
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 16.300 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 360
Return Period(s) (years) 100
Climate Change (%) 10

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	360 Summer	100	+10%					22.677
S1.001	S2	360 Summer	100	+10%					21.906
S1.002	S3	360 Winter	100	+10%	100/360 Summer				21.564
S2.000	S4	360 Summer	100	+10%					22.997
S2.001	S5	360 Summer	100	+10%					22.160
S1.003	S6	360 Winter	100	+10%	100/360 Summer				21.564
S3.000	S7	360 Summer	100	+10%					22.939
S3.001	S8	360 Summer	100	+10%					22.746
S3.002	S9	360 Summer	100	+10%					22.141
S1.004	S10	360 Winter	100	+10%	100/360 Summer				21.650
S4.000	S11	360 Summer	100	+10%					22.710
S4.001	S12	360 Summer	100	+10%					22.423
S4.002	S13	360 Summer	100	+10%					22.190
S4.003	S14	360 Winter	100	+10%	100/360 Winter				21.654
S1.005	S15	360 Winter	100	+10%	100/360 Summer				21.647
S1.006	S16	360 Winter	100	+10%	100/360 Summer				21.645
S1.007	S17	360 Winter	100	+10%	100/360 Summer				21.643
S5.000	S18	360 Summer	100	+10%					22.111
S5.001	S19	360 Summer	100	+10%					22.065
S5.002	S20	360 Winter	100	+10%	100/360 Summer				21.685
S1.008	S21	360 Winter	100	+10%	100/360 Summer				21.695
S1.009	S22	360 Summer	100	+10%					19.671

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.148	0.000	0.26		15.8	OK	
S1.001	S2	-0.144	0.000	0.28		16.6	OK	
S1.002	S3	0.249	0.000	0.34		12.1	SURCHARGED	
S2.000	S4	-0.153	0.000	0.23		14.6	OK	
S2.001	S5	-0.131	0.000	0.37		21.3	OK	
S1.003	S6	0.490	0.000	0.06		2.0	SURCHARGED	CARPARK FLOW CONTROL (WITHIN CATCHMENT A)
S3.000	S7	-0.161	0.000	0.18		7.1	OK	
S3.001	S8	-0.124	0.000	0.42		23.8	OK	
S3.002	S9	-0.108	0.000	0.53		25.9	OK	
S1.004	S10	0.784	0.000	0.54		19.2	SURCHARGED	
S4.000	S11	-0.115	0.000	0.48		18.7	OK	
S4.001	S12	-0.119	0.000	0.46		18.7	OK	
S4.002	S13	-0.126	0.000	0.40		24.4	OK	
S4.003	S14	0.011	0.000	0.30		18.2	SURCHARGED	
S1.005	S15	1.518	0.000	1.20		36.6	SURCHARGED	
S1.006	S16	1.607	0.000	1.25		36.4	SURCHARGED	
S1.007	S17	1.663	0.000	0.81		25.3	SURCHARGED	
S5.000	S18	-0.189	0.000	0.06		1.9	OK	
S5.001	S19	-0.190	0.000	0.06		1.9	OK	
S5.002	S20	1.440	0.000	0.04		1.2	SURCHARGED	
S1.008	S21	1.850	0.000	0.09		2.1	SURCHARGED	CATCHMENT A
S1.009	S22	-0.152	0.000	0.06		2.0	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.010	S23	360 Summer	100	+10%	100/360 Summer			
S1.011	S24	360 Summer	100	+10%	100/360 Summer			
S1.012	S25	360 Summer	100	+10%	100/360 Summer			
S1.013	S26	360 Summer	100	+10%	100/360 Summer			
S1.014	S27	360 Winter	100	+10%	100/360 Summer			
S1.015	S28	360 Winter	100	+10%	100/360 Summer			
S1.016	S29	360 Winter	100	+10%	100/360 Summer			
S1.017	S30	360 Winter	100	+10%	100/360 Summer			
S6.000	S31	360 Winter	100	+10%	100/360 Summer			
S6.001	S32	360 Winter	100	+10%	100/360 Summer			
S1.018	S33	360 Winter	100	+10%	100/360 Summer			
S1.019	S34	360 Winter	100	+10%	100/360 Summer			
S7.000	S35	360 Winter	100	+10%	100/360 Summer			
S1.020	S36	360 Winter	100	+10%	100/360 Summer			
S8.000	S37	360 Winter	100	+10%	100/360 Winter			
S8.001	S38	360 Winter	100	+10%	100/360 Summer			
S9.000	S39	360 Winter	100	+10%	100/360 Summer			
S1.021	S40	360 Winter	100	+10%	100/360 Summer			
S1.022	S41	360 Winter	100	+10%	100/360 Summer			
S1.023	S42	360 Winter	100	+10%	100/360 Summer			
S1.024	S43	360 Winter	100	+10%	100/360 Summer			
S1.025	S44	360 Winter	100	+10%				
S10.000	S45	360 Summer	100	+10%				
S10.001	S46	360 Summer	100	+10%				
S1.026	S47	360 Winter	100	+10%				
S11.000	S48	360 Summer	100	+10%				
S1.027	S49	360 Winter	100	+10%	100/360 Winter			
S1.028	S50	360 Winter	100	+10%	100/360 Summer			
S1.029	S51	360 Winter	100	+10%	100/360 Summer			
S12.000	S52	360 Summer	100	+10%				
S1.030	S53	360 Winter	100	+10%	100/360 Summer			
S13.000	S54	360 Summer	100	+10%				
S14.000	S55	360 Summer	100	+10%				
S14.001	S56	360 Summer	100	+10%				
S14.002	S57	360 Summer	100	+10%	100/360 Summer			
S14.003	S58	360 Summer	100	+10%	100/360 Summer			
S13.001	S164	360 Summer	100	+10%	100/360 Summer			
S13.002	S165	360 Summer	100	+10%	100/360 Summer			
S13.003	S59	360 Summer	100	+10%	100/360 Summer			
S15.000	S60	360 Summer	100	+10%				
S13.004	S61	360 Summer	100	+10%	100/360 Summer			
S13.005	S62	360 Summer	100	+10%	100/360 Summer			
S16.000	S63	360 Winter	100	+10%	100/360 Winter			
S13.006	S64	360 Winter	100	+10%	100/360 Summer			
S13.007	S65	360 Winter	100	+10%	100/360 Summer			
S13.008	S66	360 Winter	100	+10%	100/360 Summer			
S13.009	S67	360 Summer	100	+10%				
S13.010	S68	360 Summer	100	+10%				
S13.011	S69	360 Winter	100	+10%				

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.010	S23	19.666	0.068	0.000	0.39		12.1	SURCHARGED	
S1.011	S24	19.634	0.181	0.000	0.89		28.3	SURCHARGED	
S1.012	S25	19.473	0.225	0.000	0.97		41.0	SURCHARGED	
S1.013	S26	19.198	0.245	0.000	1.31		56.3	SURCHARGED	
S1.014	S27	18.865	1.590	0.000	1.53		48.1	SURCHARGED	
S1.015	S28	18.858	1.558	0.000	0.23		14.2	SURCHARGED	CATCHMENT B
S1.016	S29	17.504	0.449	0.000	0.73		18.0	SURCHARGED	
S1.017	S30	17.488	0.463	0.000	0.68		17.9	SURCHARGED	
S6.000	S31	17.472	0.172	0.000	0.13		4.5	SURCHARGED	
S6.001	S32	17.471	0.302	0.000	0.12		4.1	SURCHARGED	
S1.018	S33	17.470	0.482	0.000	0.79		27.6	SURCHARGED	
S1.019	S34	17.425	0.654	0.000	0.73		25.9	SURCHARGED	
S7.000	S35	17.376	1.126	0.000	0.06		2.0	FLOOD RISK	
S1.020	S36	17.375	1.309	0.000	0.96		28.8	SURCHARGED	
S8.000	S37	17.314	0.014	0.000	0.14		4.9	SURCHARGED	
S8.001	S38	17.312	0.246	0.000	0.27		9.4	SURCHARGED	
S9.000	S39	17.309	0.634	0.000	0.05		1.7	SURCHARGED	
S1.021	S40	17.309	1.484	0.000	1.36		39.4	SURCHARGED	
S1.022	S41	17.254	1.579	0.000	1.59		41.1	SURCHARGED	
S1.023	S42	17.226	1.591	0.000	0.60		40.6	SURCHARGED	
S1.024	S43	17.205	1.705	0.000	0.33		18.0	SURCHARGED	CATCHMENT C
S1.025	S44	15.405	-0.045	0.000	0.30		18.2	OK	
S10.000	S45	16.961	-0.139	0.000	0.31		11.2	OK	
S10.001	S46	16.607	-0.106	0.000	0.55		18.9	OK	
S1.026	S47	15.396	-0.004	0.000	0.54		32.6	OK	
S11.000	S48	17.480	-0.145	0.000	0.27		9.7	OK	
S1.027	S49	15.366	0.066	0.000	0.63		40.2	SURCHARGED	
S1.028	S50	15.338	0.118	0.000	0.62		42.7	SURCHARGED	
S1.029	S51	15.305	0.205	0.000	0.74		42.8	SURCHARGED	
S12.000	S52	15.928	-0.172	0.000	0.13		4.6	OK	
S1.030	S53	15.268	0.418	0.000	0.42		45.3	SURCHARGED	
S13.000	S54	20.402	-0.148	0.000	0.26		13.6	OK	
S14.000	S55	22.089	-0.136	0.000	0.33		23.6	OK	
S14.001	S56	20.633	-0.090	0.000	0.67		34.1	OK	
S14.002	S57	20.212	0.017	0.000	0.71		33.1	SURCHARGED	
S14.003	S58	20.138	0.133	0.000	0.70		32.2	SURCHARGED	
S13.001	S164	20.062	0.247	0.000	0.75		49.5	SURCHARGED	
S13.002	S165	19.950	0.356	0.000	1.33		49.2	SURCHARGED	
S13.003	S59	19.618	0.245	0.000	0.92		45.3	SURCHARGED	
S15.000	S60	19.402	-0.173	0.000	0.12		5.9	OK	
S13.004	S61	19.270	0.350	0.000	1.00		49.0	SURCHARGED	
S13.005	S62	18.862	0.387	0.000	1.03		51.8	SURCHARGED	
S16.000	S63	18.536	0.011	0.000	0.11		4.7	SURCHARGED	
S13.006	S64	18.530	0.508	0.000	1.07		53.0	SURCHARGED	
S13.007	S65	18.320	1.395	0.000	1.52		54.3	SURCHARGED	
S13.008	S66	18.250	1.350	0.000	0.47		28.9	SURCHARGED	CATCHMENT D
S13.009	S67	16.706	-0.125	0.000	0.64		45.6	OK	
S13.010	S68	16.557	-0.132	0.000	0.60		45.6	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S13.011	S69	16.256	-0.015	0.000	0.62		46.1	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm		Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S13.012	S70	360	Winter	100	+10%	100/360 Summer			
S17.000	S71	360	Summer	100	+10%				
S17.001	S72	360	Summer	100	+10%				
S18.000	S73	360	Summer	100	+10%				
S17.002	S74	360	Summer	100	+10%				
S17.003	S75	360	Summer	100	+10%				
S17.004	S76	360	Summer	100	+10%				
S19.000	S77	360	Summer	100	+10%				
S17.005	S78	360	Summer	100	+10%				
S20.000	S79	360	Summer	100	+10%				
S20.001	S80	360	Summer	100	+10%				
S20.002	S81	360	Summer	100	+10%	100/360 Summer			
S17.006	S82	360	Summer	100	+10%	100/360 Summer			
S17.007	S83	360	Winter	100	+10%	100/360 Summer			
S17.008	S84	360	Winter	100	+10%	100/360 Summer			
S21.000	S85	360	Summer	100	+10%				
S22.000	S86	360	Winter	100	+10%	100/360 Summer			
S22.001	S87	360	Winter	100	+10%	100/360 Summer			
S21.001	S88	360	Winter	100	+10%	100/360 Summer			
S21.002	S89	360	Winter	100	+10%	100/360 Summer			
S23.000	S90	360	Summer	100	+10%				
S23.001	S91	360	Summer	100	+10%				
S23.002	S92	360	Winter	100	+10%	100/360 Summer			
S17.009	S93	360	Winter	100	+10%	100/360 Summer			
S17.010	S94	360	Winter	100	+10%	100/360 Summer			
S17.011	S95	360	Winter	100	+10%	100/360 Summer			
S24.000	S96	360	Summer	100	+10%				
S24.001	S97	360	Summer	100	+10%				
S25.000	S98	360	Summer	100	+10%				
S25.001	S99	360	Summer	100	+10%				
S25.002	S100	360	Summer	100	+10%				
S24.002	S101	360	Winter	100	+10%	100/360 Summer			
S24.003	S102	360	Winter	100	+10%	100/360 Summer			
S13.013	S103	360	Winter	100	+10%	100/360 Summer			
S13.014	S104	360	Winter	100	+10%	100/360 Summer			
S13.015	S105	360	Winter	100	+10%	100/360 Summer			
S26.000	S106	360	Summer	100	+10%				
S26.001	S107	360	Summer	100	+10%				
S26.002	S108	360	Winter	100	+10%	100/360 Summer			
S27.000	S109	360	Summer	100	+10%				
S26.003	S110	360	Winter	100	+10%	100/360 Summer			
S1.031	S111	360	Winter	100	+10%	100/360 Summer			
S1.032	S112	360	Winter	100	+10%	100/360 Summer			
S28.000	S113	360	Summer	100	+10%				
S28.001	S114	360	Summer	100	+10%				
S29.000	S115	360	Summer	100	+10%				
S28.002	S116	360	Summer	100	+10%	100/360 Summer			
S28.003	S117	360	Summer	100	+10%	100/360 Summer			
S28.004	S118	360	Summer	100	+10%	100/360 Summer			

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S13.012	S70	16.223	0.274	0.000	0.54		46.1	SURCHARGED	
S17.000	S71	20.499	-0.191	0.000	0.06		4.0	OK	
S17.001	S72	19.941	-0.180	0.000	0.09		6.2	OK	
S18.000	S73	19.950	-0.175	0.000	0.11		8.2	OK	
S17.002	S74	18.804	-0.121	0.000	0.43		15.9	OK	
S17.003	S75	18.674	-0.151	0.000	0.24		17.8	OK	
S17.004	S76	17.545	-0.142	0.000	0.29		17.8	OK	
S19.000	S77	18.913	-0.162	0.000	0.18		13.3	OK	
S17.005	S78	17.396	-0.081	0.000	0.73		33.0	OK	
S20.000	S79	18.506	-0.144	0.000	0.28		19.9	OK	
S20.001	S80	17.540	-0.141	0.000	0.30		19.9	OK	
S20.002	S81	16.964	0.097	0.000	0.70		24.0	SURCHARGED	
S17.006	S82	16.890	0.172	0.000	1.73		56.9	SURCHARGED	
S17.007	S83	16.830	1.180	0.000	0.03		1.4	SURCHARGED	CATCHMENT E
S17.008	S84	16.189	0.689	0.000	0.02		1.5	SURCHARGED	
S21.000	S85	16.562	-0.113	0.000	0.49		34.8	OK	
S22.000	S86	16.285	0.352	0.000	0.79		44.2	SURCHARGED	
S22.001	S87	16.283	0.383	0.000	0.06		3.1	SURCHARGED	CATCHMENT F
S21.001	S88	16.194	0.402	0.000	0.57		27.8	SURCHARGED	(SCHOOL SITE)
S21.002	S89	16.190	0.723	0.000	0.49		27.2	SURCHARGED	
S23.000	S90	17.805	-0.120	0.000	0.44		32.2	OK	
S23.001	S91	16.608	-0.092	0.000	0.66		48.0	OK	
S23.002	S92	16.187	0.791	0.000	0.57		35.0	SURCHARGED	
S17.009	S93	16.187	0.987	0.000	1.00		61.4	SURCHARGED	
S17.010	S94	16.186	1.036	0.000	1.19		61.0	SURCHARGED	
S17.011	S95	16.181	1.191	0.000	0.26		11.0	SURCHARGED	CATCHMENT G
S24.000	S96	17.059	-0.166	0.000	0.15		9.1	OK	
S24.001	S97	16.446	-0.154	0.000	0.22		11.6	OK	
S25.000	S98	17.351	-0.174	0.000	0.12		8.4	OK	
S25.001	S99	16.770	-0.153	0.000	0.22		8.4	OK	
S25.002	S100	16.696	-0.125	0.000	0.41		21.4	OK	
S24.002	S101	16.185	0.260	0.000	0.74		30.8	SURCHARGED	
S24.003	S102	16.193	0.669	0.000	0.95		30.7	SURCHARGED	
S13.013	S103	16.201	1.176	0.000	1.20		84.1	SURCHARGED	
S13.014	S104	16.194	1.249	0.000	0.97		83.6	SURCHARGED	
S13.015	S105	16.177	1.537	0.000	0.89		19.9	FLOOD RISK	CATCHMENT H
S26.000	S106	15.819	-0.181	0.000	0.09		3.6	OK	
S26.001	S107	15.670	-0.175	0.000	0.11		7.4	OK	
S26.002	S108	15.270	0.330	0.000	0.30		8.4	SURCHARGED	
S27.000	S109	15.304	-0.171	0.000	0.13		4.6	OK	
S26.003	S110	15.257	0.437	0.000	0.12		11.1	SURCHARGED	
S1.031	S111	15.254	0.479	0.000	0.98		69.4	SURCHARGED	
S1.032	S112	15.238	0.483	0.000	0.86		69.2	SURCHARGED	
S28.000	S113	15.942	-0.183	0.000	0.08		3.4	OK	
S28.001	S114	15.897	-0.003	0.000	0.27		7.0	OK	
S29.000	S115	16.450	-0.175	0.000	0.11		5.0	OK	
S28.002	S116	15.878	0.153	0.000	0.41		11.7	SURCHARGED	
S28.003	S117	15.861	0.186	0.000	0.48		12.1	SURCHARGED	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S28.004	S118	15.829	0.254	0.000	0.39		12.2	SURCHARGED	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S30.000	S119	360 Summer	100	+10%				
S28.005	S120	360 Summer	100	+10%	100/360 Summer			
S28.006	S121	360 Summer	100	+10%	100/360 Summer			
S31.000	S122	360 Summer	100	+10%				
S31.001	S123	360 Summer	100	+10%				
S28.007	S124	360 Summer	100	+10%	100/360 Summer			
S28.008	S125	360 Summer	100	+10%	100/360 Summer			
S28.009	S126	360 Summer	100	+10%	100/360 Summer			
S32.000	S127	360 Summer	100	+10%				
S32.001	S128	360 Summer	100	+10%				
S28.010	S129	360 Summer	100	+10%	100/360 Summer			
S28.011	S130	360 Summer	100	+10%	100/360 Summer			
S28.012	S131	360 Winter	100	+10%	100/360 Summer			
S33.000	S132	360 Summer	100	+10%				
S28.013	S133	360 Winter	100	+10%	100/360 Summer			
S34.000	S134	360 Winter	100	+10%	100/360 Summer			
S34.001	S135	360 Winter	100	+10%	100/360 Summer			
S34.002	S136	360 Winter	100	+10%	100/360 Summer			
S34.003	S137	360 Winter	100	+10%	100/360 Summer			
S35.000	S138	360 Winter	100	+10%	100/360 Winter			
S34.004	S139	360 Winter	100	+10%	100/360 Summer			
S1.033	S140	360 Winter	100	+10%	100/360 Summer			
S1.034	S141	360 Winter	100	+10%	100/360 Summer			
S1.035	S142	360 Winter	100	+10%				
S1.036	S143	360 Winter	100	+10%	100/360 Summer			
S1.037	S144	360 Summer	100	+10%				
S1.038	S145	360 Winter	100	+10%				
S36.000	S146	360 Summer	100	+10%				
S36.001	S147	360 Summer	100	+10%				
S36.002	S148	360 Winter	100	+10%	100/360 Summer			
S36.003	S149	360 Winter	100	+10%	100/360 Summer			
S37.000	S150	360 Winter	100	+10%	100/360 Summer			
S37.001	S151	360 Winter	100	+10%	100/360 Summer			
S38.000	S152	360 Winter	100	+10%	100/360 Summer			
S37.002	S153	360 Winter	100	+10%	100/360 Summer			
S37.003	S154	360 Winter	100	+10%	100/360 Summer			
S37.004	S155	360 Winter	100	+10%	100/360 Summer			
S37.005	S156	360 Winter	100	+10%	100/360 Summer			
S36.004	S157	360 Winter	100	+10%	100/360 Summer			
S36.005	S158	360 Winter	100	+10%	100/360 Summer			
S1.039	S159	360 Winter	100	+10%				
S1.040	S160	360 Summer	100	+10%				
S1.041	S161	360 Winter	100	+10%				
S1.042	S162	360 Winter	100	+10%				
S1.043	S163	360 Winter	100	+10%				

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded	
S30.000	S119	17.109	-0.166	0.000	0.15		6.2	OK		
S28.005	S120	15.823	0.298	0.000	0.79		19.0	SURCHARGED		
S28.006	S121	15.760	0.335	0.000	0.50		19.0	SURCHARGED		
S31.000	S122	17.496	-0.179	0.000	0.09		5.5	OK		
S31.001	S123	17.182	-0.167	0.000	0.15		9.9	OK		
S28.007	S124	15.727	0.402	0.000	0.94		27.0	SURCHARGED		
S28.008	S125	15.636	0.411	0.000	0.65		28.4	SURCHARGED		
S28.009	S126	15.593	0.468	0.000	1.01		28.2	SURCHARGED		
S32.000	S127	16.734	-0.181	0.000	0.08		6.3	OK		
S32.001	S128	15.546	-0.029	0.000	0.10		6.2	OK		
S28.010	S129	15.542	0.467	0.000	0.86		36.6	SURCHARGED		
S28.011	S130	15.301	0.576	0.000	0.86		36.4	FLOOD RISK		
S28.012	S131	15.261	0.636	0.000	1.25		30.4	SURCHARGED		
S33.000	S132	15.455	-0.190	0.000	0.06		4.3	OK		
S28.013	S133	15.219	0.654	0.000	1.35		33.3	SURCHARGED		
S34.000	S134	15.181	0.166	0.000	0.12		3.2	SURCHARGED		
S34.001	S135	15.179	0.324	0.000	0.18		4.7	SURCHARGED		
S34.002	S136	15.174	0.479	0.000	0.20		4.3	SURCHARGED		
S34.003	S137	15.172	0.502	0.000	0.16		4.1	SURCHARGED		
S35.000	S138	15.171	0.071	0.000	0.05		2.1	SURCHARGED		
S34.004	S139	15.170	0.550	0.000	0.10		4.1	SURCHARGED		
S1.033	S140	15.197	0.512	0.000	1.38		100.1	SURCHARGED		
S1.034	S141	15.163	0.523	0.000	0.86		53.8	SURCHARGED		CATCHMENT I
S1.035	S142	14.568	-0.037	0.000	0.78		66.5	OK		+ 12.7L/S BASE FLOW
S1.036	S143	14.505	0.005	0.000	1.18		66.5	SURCHARGED		
S1.037	S144	14.475	0.000	0.000	1.10		66.4	OK		
S1.038	S145	14.398	-0.047	0.000	0.77		66.5	OK		
S36.000	S146	16.541	-0.159	0.000	0.19		9.3	OK		
S36.001	S147	16.048	-0.157	0.000	0.20		12.0	OK		
S36.002	S148	15.781	0.456	0.000	0.17		9.0	SURCHARGED		
S36.003	S149	15.779	0.599	0.000	0.17		8.9	SURCHARGED		
S37.000	S150	15.788	0.763	0.000	0.11		3.1	SURCHARGED		
S37.001	S151	15.786	0.871	0.000	0.09		2.7	SURCHARGED		
S38.000	S152	15.786	0.911	0.000	0.01		0.3	SURCHARGED		
S37.002	S153	15.786	1.011	0.000	0.19		6.4	SURCHARGED		
S37.003	S154	15.783	1.158	0.000	0.20		7.0	SURCHARGED		
S37.004	S155	15.780	1.305	0.000	0.21		6.8	SURCHARGED		
S37.005	S156	15.779	1.354	0.000	0.16		6.5	SURCHARGED		
S36.004	S157	15.777	1.377	0.000	0.24		14.5	SURCHARGED		
S36.005	S158	15.776	1.426	0.000	0.04		2.4	SURCHARGED		CATCHMENT J
S1.039	S159	14.349	-0.016	0.000	0.84		68.8	OK		
S1.040	S160	14.293	0.000	0.000	1.15		68.6	OK		
S1.041	S161	14.162	-0.114	0.000	0.83		68.8	OK		
S1.042	S162	14.046	-0.114	0.000	0.83		68.8	OK		
S1.043	S163	13.949	-0.106	0.000	0.86		68.8	OK		

A BASE FLOW OF 12.7 L/S HAS BEEN ADDED TO THE MODEL TO SIMULATE EMERGENCY SCREEN DISCHARGE FROM THE FOUL EMERGENCY HOLDING TANK DURING A 1 IN 100 YEAR STORM EVENT INCLUDING 10% FOR CLIMATE CHANGE.

MAXIMUM DISCHARGE UNDER NORMAL STORM CONDITIONS = 53.8L/S + 2.4L/S = 56.2L/S

G.3. 1 in 30 year Outputs

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

Number of Input Hydrographs	0	Number of Storage Structures	58
Number of Online Controls	11	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.277
Region	Scotland and Ireland	Cv (Summer)	0.750
M5-60 (mm)	16.300	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	30
Climate Change (%)	10

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	30	+10%					22.762
S1.001	S2	15 Winter	30	+10%	30/15 Winter				22.054
S1.002	S3	1440 Winter	30	+10%	30/15 Summer				21.618
S2.000	S4	15 Winter	30	+10%					23.078
S2.001	S5	15 Winter	30	+10%	30/15 Summer				22.542
S1.003	S6	1440 Winter	30	+10%	30/15 Summer				21.617
S3.000	S7	15 Winter	30	+10%					22.999
S3.001	S8	15 Winter	30	+10%	30/15 Summer				22.932
S3.002	S9	15 Winter	30	+10%	30/15 Summer				22.412
S1.004	S10	1440 Winter	30	+10%	30/15 Summer				21.673
S4.000	S11	15 Winter	30	+10%	30/15 Summer				22.916
S4.001	S12	15 Winter	30	+10%	30/15 Summer				22.557
S4.002	S13	15 Winter	30	+10%					22.261
S4.003	S14	30 Winter	30	+10%	30/30 Winter				21.691
S1.005	S15	1440 Winter	30	+10%	30/15 Summer				21.675
S1.006	S16	1440 Winter	30	+10%	30/15 Summer				21.670
S1.007	S17	1440 Winter	30	+10%	30/15 Summer				21.667
S5.000	S18	30 Summer	30	+10%					22.137
S5.001	S19	30 Summer	30	+10%					22.090
S5.002	S20	1440 Winter	30	+10%	30/30 Summer				21.794
S1.008	S21	1440 Winter	30	+10%	30/15 Summer				21.800

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.063	0.000	0.84		51.2	OK	
S1.001	S2	0.004	0.000	0.86		51.0	SURCHARGED	
S1.002	S3	0.303	0.000	0.11		3.7	SURCHARGED	
S2.000	S4	-0.072	0.000	0.79		51.1	OK	
S2.001	S5	0.251	0.000	1.16		67.3	SURCHARGED	
S1.003	S6	0.543	0.000	0.06		1.9	SURCHARGED	CARPARK FLOW CONTROL (WITHIN CATCHMENT A)
S3.000	S7	-0.101	0.000	0.57		22.7	OK	
S3.001	S8	0.062	0.000	0.92		52.3	SURCHARGED	
S3.002	S9	0.163	0.000	1.16		56.6	SURCHARGED	
S1.004	S10	0.807	0.000	0.20		7.3	SURCHARGED	
S4.000	S11	0.091	0.000	1.14		44.6	SURCHARGED	
S4.001	S12	0.015	0.000	1.05		43.2	SURCHARGED	
S4.002	S13	-0.055	0.000	0.91		55.9	OK	
S4.003	S14	0.048	0.000	0.85		52.2	SURCHARGED	
S1.005	S15	1.546	0.000	0.42		12.7	SURCHARGED	
S1.006	S16	1.632	0.000	0.43		12.6	FLOOD RISK	
S1.007	S17	1.687	0.000	0.29		9.2	SURCHARGED	
S5.000	S18	-0.163	0.000	0.17		5.0	OK	
S5.001	S19	-0.165	0.000	0.16		5.0	OK	
S5.002	S20	1.549	0.000	0.01		0.3	SURCHARGED	
S1.008	S21	1.955	0.000	0.09		2.1	SURCHARGED	CATCHMENT A

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.009	S22	30 Winter	30	+10%	30/15 Summer				20.209
S1.010	S23	30 Winter	30	+10%	30/15 Summer				20.219
S1.011	S24	30 Winter	30	+10%	30/15 Summer				20.193
S1.012	S25	30 Winter	30	+10%	30/15 Summer				20.038
S1.013	S26	30 Winter	30	+10%	30/15 Summer				19.678
S1.014	S27	240 Winter	30	+10%	30/15 Summer				18.347
S1.015	S28	240 Winter	30	+10%	30/15 Summer				18.341
S1.016	S29	60 Winter	30	+10%	30/15 Summer				17.346
S1.017	S30	60 Winter	30	+10%	30/15 Summer				17.322
S6.000	S31	60 Winter	30	+10%					17.241
S6.001	S32	60 Winter	30	+10%	30/30 Summer				17.269
S1.018	S33	60 Winter	30	+10%	30/15 Summer				17.296
S1.019	S34	720 Winter	30	+10%	30/15 Summer				17.188
S7.000	S35	720 Winter	30	+10%	30/15 Summer				17.133
S1.020	S36	720 Winter	30	+10%	30/15 Summer				17.133
S8.000	S37	30 Summer	30	+10%					17.191
S8.001	S38	720 Winter	30	+10%	30/720 Winter				17.068
S9.000	S39	720 Winter	30	+10%	30/60 Winter				17.066
S1.021	S40	720 Winter	30	+10%	30/15 Summer				17.065
S1.022	S41	720 Winter	30	+10%	30/15 Summer				17.012
S1.023	S42	720 Winter	30	+10%	30/15 Summer				16.985
S1.024	S43	720 Winter	30	+10%	30/15 Summer				16.964
S1.025	S44	30 Winter	30	+10%	30/30 Winter				15.458
S10.000	S45	15 Winter	30	+10%					17.053
S10.001	S46	30 Summer	30	+10%	30/15 Summer				16.817
S1.026	S47	30 Winter	30	+10%	30/30 Summer				15.452
S11.000	S48	15 Winter	30	+10%					17.555
S1.027	S49	30 Winter	30	+10%	30/15 Winter				15.382
S1.028	S50	30 Winter	30	+10%	30/15 Winter				15.293
S1.029	S51	600 Winter	30	+10%	30/15 Summer				15.174
S12.000	S52	15 Winter	30	+10%					15.981
S1.030	S53	600 Winter	30	+10%	30/15 Summer				15.144
S13.000	S54	30 Winter	30	+10%	30/15 Winter				20.612
S14.000	S55	15 Winter	30	+10%	30/15 Summer				22.359
S14.001	S56	15 Winter	30	+10%	30/15 Summer				21.832
S14.002	S57	30 Winter	30	+10%	30/15 Summer				21.108
S14.003	S58	30 Winter	30	+10%	30/15 Summer				20.836
S13.001	S164	30 Winter	30	+10%	30/15 Summer				20.588
S13.002	S165	30 Winter	30	+10%	30/15 Summer				20.410
S13.003	S59	60 Winter	30	+10%	30/15 Summer				19.897
S15.000	S60	15 Winter	30	+10%					19.450
S13.004	S61	60 Winter	30	+10%	30/15 Summer				19.395
S13.005	S62	120 Winter	30	+10%	30/15 Summer				18.850
S16.000	S63	120 Winter	30	+10%					18.417
S13.006	S64	120 Winter	30	+10%	30/15 Summer				18.415
S13.007	S65	120 Winter	30	+10%	30/15 Summer				18.104
S13.008	S66	120 Winter	30	+10%	30/15 Summer				18.006
S13.009	S67	60 Summer	30	+10%					16.737
S13.010	S68	60 Summer	30	+10%					16.582

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.009	S22	0.386	0.000	0.11		3.5	SURCHARGED	
S1.010	S23	0.621	0.000	0.53		16.6	SURCHARGED	
S1.011	S24	0.740	0.000	1.12		35.7	SURCHARGED	
S1.012	S25	0.790	0.000	1.19		50.8	SURCHARGED	
S1.013	S26	0.725	0.000	1.75		75.4	SURCHARGED	
S1.014	S27	1.072	0.000	1.55		48.8	SURCHARGED	
S1.015	S28	1.041	0.000	0.23		14.2	SURCHARGED	CATCHMENT B
S1.016	S29	0.291	0.000	0.84		20.7	SURCHARGED	
S1.017	S30	0.297	0.000	0.76		20.1	SURCHARGED	
S6.000	S31	-0.059	0.000	0.22		7.4	OK	
S6.001	S32	0.100	0.000	0.24		8.4	SURCHARGED	
S1.018	S33	0.308	0.000	0.99		34.4	SURCHARGED	
S1.019	S34	0.417	0.000	0.62		21.9	SURCHARGED	
S7.000	S35	0.883	0.000	0.03		0.9	FLOOD RISK	
S1.020	S36	1.067	0.000	0.77		23.2	SURCHARGED	
S8.000	S37	-0.109	0.000	0.49		17.6	OK	
S8.001	S38	0.002	0.000	0.13		4.6	SURCHARGED	
S9.000	S39	0.391	0.000	0.12		4.2	SURCHARGED	
S1.021	S40	1.240	0.000	1.04		30.4	SURCHARGED	
S1.022	S41	1.337	0.000	1.21		31.1	SURCHARGED	
S1.023	S42	1.350	0.000	0.45		30.9	SURCHARGED	
S1.024	S43	1.464	0.000	0.33		17.6	SURCHARGED	CATCHMENT C
S1.025	S44	0.008	0.000	0.33		20.4	SURCHARGED	
S10.000	S45	-0.047	0.000	0.78		27.6	OK	
S10.001	S46	0.104	0.000	1.28		44.2	SURCHARGED	
S1.026	S47	0.052	0.000	0.89		53.5	SURCHARGED	
S11.000	S48	-0.070	0.000	0.80		28.5	OK	
S1.027	S49	0.082	0.000	1.06		68.3	SURCHARGED	
S1.028	S50	0.073	0.000	1.05		72.4	SURCHARGED	
S1.029	S51	0.074	0.000	0.56		32.3	SURCHARGED	
S12.000	S52	-0.119	0.000	0.44		15.6	OK	
S1.030	S53	0.294	0.000	0.31		33.5	SURCHARGED	
S13.000	S54	0.062	0.000	0.66		34.9	SURCHARGED	
S14.000	S55	0.134	0.000	0.82		58.3	SURCHARGED	
S14.001	S56	1.109	0.000	1.32		67.2	FLOOD RISK	
S14.002	S57	0.913	0.000	1.30		60.9	FLOOD RISK	
S14.003	S58	0.831	0.000	1.30		59.7	FLOOD RISK	
S13.001	S164	0.773	0.000	0.97		64.2	SURCHARGED	
S13.002	S165	0.816	0.000	1.72		63.3	SURCHARGED	
S13.003	S59	0.524	0.000	1.06		52.3	SURCHARGED	
S15.000	S60	-0.125	0.000	0.36		17.3	OK	
S13.004	S61	0.475	0.000	1.11		54.7	SURCHARGED	
S13.005	S62	0.375	0.000	1.08		54.2	SURCHARGED	
S16.000	S63	-0.108	0.000	0.17		6.9	OK	
S13.006	S64	0.393	0.000	1.22		60.6	SURCHARGED	
S13.007	S65	1.179	0.000	1.76		62.8	SURCHARGED	
S13.008	S66	1.106	0.000	0.47		28.9	SURCHARGED	CATCHMENT D
S13.009	S67	-0.094	0.000	0.78		55.1	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S13.010	S68	-0.107	0.000	0.72		54.3	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S13.011	S69	60 Summer	30	+10%					16.190
S13.012	S70	960 Winter	30	+10%					15.875
S17.000	S71	15 Winter	30	+10%					20.530
S17.001	S72	15 Winter	30	+10%					19.979
S18.000	S73	30 Summer	30	+10%					19.978
S17.002	S74	15 Winter	30	+10%	30/15 Winter				18.937
S17.003	S75	15 Winter	30	+10%					18.763
S17.004	S76	15 Winter	30	+10%	30/15 Summer				18.458
S19.000	S77	15 Winter	30	+10%					18.978
S17.005	S78	15 Winter	30	+10%	30/15 Summer				18.381
S20.000	S79	15 Winter	30	+10%					18.602
S20.001	S80	15 Winter	30	+10%	30/15 Summer				18.283
S20.002	S81	30 Winter	30	+10%	30/15 Summer				17.982
S17.006	S82	30 Winter	30	+10%	30/15 Summer				17.700
S17.007	S83	1440 Winter	30	+10%	30/15 Summer				17.028
S17.008	S84	30 Winter	30	+10%	30/15 Summer				16.093
S21.000	S85	15 Winter	30	+10%	30/15 Summer				16.939
S22.000	S86	15 Winter	30	+10%	30/15 Summer				16.567
S22.001	S87	960 Winter	30	+10%	30/60 Winter				16.186
S21.001	S88	15 Winter	30	+10%	30/15 Summer				16.615
S21.002	S89	30 Winter	30	+10%	30/15 Summer				16.286
S23.000	S90	15 Winter	30	+10%	30/15 Summer				18.191
S23.001	S91	15 Winter	30	+10%	30/15 Summer				17.772
S23.002	S92	30 Winter	30	+10%	30/15 Summer				16.444
S17.009	S93	30 Winter	30	+10%	30/15 Summer				16.093
S17.010	S94	960 Winter	30	+10%	30/15 Summer				16.031
S17.011	S95	960 Winter	30	+10%	30/15 Summer				16.016
S24.000	S96	15 Winter	30	+10%					17.116
S24.001	S97	15 Winter	30	+10%					16.516
S25.000	S98	15 Winter	30	+10%					17.400
S25.001	S99	15 Winter	30	+10%	30/15 Summer				17.239
S25.002	S100	15 Winter	30	+10%	30/15 Summer				17.196
S24.002	S101	30 Winter	30	+10%	30/15 Summer				16.387
S24.003	S102	960 Winter	30	+10%	30/15 Summer				15.871
S13.013	S103	960 Winter	30	+10%	30/15 Summer				15.866
S13.014	S104	960 Winter	30	+10%	30/15 Summer				15.857
S13.015	S105	960 Winter	30	+10%	30/15 Summer				15.837
S26.000	S106	15 Winter	30	+10%					15.859
S26.001	S107	15 Winter	30	+10%					15.718
S26.002	S108	600 Winter	30	+10%	30/15 Summer				15.143
S27.000	S109	15 Winter	30	+10%					15.356
S26.003	S110	600 Winter	30	+10%	30/15 Summer				15.134
S1.031	S111	600 Winter	30	+10%	30/15 Summer				15.132
S1.032	S112	600 Winter	30	+10%	30/15 Summer				15.118
S28.000	S113	30 Winter	30	+10%	30/15 Winter				16.237
S28.001	S114	30 Winter	30	+10%	30/15 Summer				16.296
S29.000	S115	30 Summer	30	+10%					16.488
S28.002	S116	30 Winter	30	+10%	30/15 Summer				16.440
S28.003	S117	30 Winter	30	+10%	30/15 Summer				16.449

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S13.011	S69	-0.081	0.000	0.86		64.5	OK	
S13.012	S70	-0.074	0.000	0.38		32.1	OK	
S17.000	S71	-0.160	0.000	0.18		13.0	OK	
S17.001	S72	-0.142	0.000	0.29		19.9	OK	
S18.000	S73	-0.147	0.000	0.26		19.2	OK	
S17.002	S74	0.012	0.000	1.12		41.2	SURCHARGED	
S17.003	S75	-0.062	0.000	0.59		44.1	OK	
S17.004	S76	0.771	0.000	0.68		41.4	SURCHARGED	
S19.000	S77	-0.097	0.000	0.59		44.7	OK	
S17.005	S78	0.904	0.000	1.49		67.4	SURCHARGED	
S20.000	S79	-0.048	0.000	0.83		59.3	OK	
S20.001	S80	0.602	0.000	0.71		47.1	SURCHARGED	
S20.002	S81	1.115	0.000	1.41		48.2	FLOOD RISK	
S17.006	S82	0.982	0.000	3.47		114.0	SURCHARGED	
S17.007	S83	1.378	0.000	0.03		1.5	SURCHARGED	CATCHMENT E
S17.008	S84	0.593	0.000	0.31		25.8	SURCHARGED	
S21.000	S85	0.264	0.000	1.02		71.4	SURCHARGED	
S22.000	S86	0.634	0.000	3.63		202.1	SURCHARGED	
S22.001	S87	0.286	0.000	0.06		3.2	SURCHARGED	CATCHMENT F (SCHOOL SITE)
S21.001	S88	0.823	0.000	1.22		59.5	SURCHARGED	
S21.002	S89	0.819	0.000	1.01		55.5	SURCHARGED	
S23.000	S90	0.266	0.000	0.85		61.5	SURCHARGED	
S23.001	S91	1.072	0.000	1.12		81.8	FLOOD RISK	
S23.002	S92	1.048	0.000	1.18		72.4	FLOOD RISK	
S17.009	S93	0.893	0.000	1.97		120.6	SURCHARGED	
S17.010	S94	0.881	0.000	0.50		25.9	SURCHARGED	
S17.011	S95	1.026	0.000	0.27		11.4	SURCHARGED	CATCHMENT G
S24.000	S96	-0.109	0.000	0.51		29.9	OK	
S24.001	S97	-0.084	0.000	0.68		36.2	OK	
S25.000	S98	-0.125	0.000	0.41		29.7	OK	
S25.001	S99	0.316	0.000	0.64		23.8	SURCHARGED	
S25.002	S100	0.375	0.000	1.12		58.5	SURCHARGED	
S24.002	S101	0.462	0.000	1.34		55.5	SURCHARGED	
S24.003	S102	0.347	0.000	0.38		12.3	SURCHARGED	
S13.013	S103	0.841	0.000	0.70		49.5	SURCHARGED	
S13.014	S104	0.912	0.000	0.57		49.4	SURCHARGED	
S13.015	S105	1.197	0.000	0.89		19.9	SURCHARGED	CATCHMENT H
S26.000	S106	-0.141	0.000	0.28		11.9	OK	
S26.001	S107	-0.127	0.000	0.37		24.3	OK	
S26.002	S108	0.203	0.000	0.17		4.7	SURCHARGED	
S27.000	S109	-0.119	0.000	0.44		15.8	OK	
S26.003	S110	0.314	0.000	0.06		6.2	SURCHARGED	
S1.031	S111	0.357	0.000	0.82		58.0	SURCHARGED	
S1.032	S112	0.363	0.000	0.72		57.8	SURCHARGED	
S28.000	S113	0.112	0.000	0.48		19.9	SURCHARGED	
S28.001	S114	0.396	0.000	0.86		22.1	SURCHARGED	
S29.000	S115	-0.137	0.000	0.32		13.7	OK	
S28.002	S116	0.715	0.000	0.89		25.7	SURCHARGED	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S28.003	S117	0.774	0.000	1.04		26.3	SURCHARGED	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S28.004	S118	30 Winter	30	+10%	30/15 Summer			
S30.000	S119	15 Winter	30	+10%				
S28.005	S120	30 Winter	30	+10%	30/15 Summer			
S28.006	S121	30 Winter	30	+10%	30/15 Summer			
S31.000	S122	15 Summer	30	+10%				
S31.001	S123	15 Winter	30	+10%				
S28.007	S124	30 Winter	30	+10%	30/15 Summer			
S28.008	S125	30 Winter	30	+10%	30/15 Summer			
S28.009	S126	30 Winter	30	+10%	30/15 Summer			
S32.000	S127	15 Winter	30	+10%				
S32.001	S128	30 Winter	30	+10%	30/15 Summer			
S28.010	S129	30 Winter	30	+10%	30/15 Summer			
S28.011	S130	30 Winter	30	+10%	30/15 Summer			
S28.012	S131	30 Winter	30	+10%	30/15 Summer			
S33.000	S132	15 Winter	30	+10%				
S28.013	S133	600 Winter	30	+10%	30/15 Summer			
S34.000	S134	600 Winter	30	+10%	30/240 Winter			
S34.001	S135	600 Winter	30	+10%	30/60 Winter			
S34.002	S136	600 Winter	30	+10%	30/15 Summer			
S34.003	S137	600 Winter	30	+10%	30/15 Summer			
S35.000	S138	960 Winter	30	+10%				
S34.004	S139	600 Winter	30	+10%	30/15 Summer			
S1.033	S140	600 Winter	30	+10%	30/15 Summer			
S1.034	S141	600 Winter	30	+10%	30/30 Winter			
S1.035	S142	600 Winter	30	+10%				
S1.036	S143	600 Winter	30	+10%	30/120 Winter			
S1.037	S144	600 Summer	30	+10%				
S1.038	S145	600 Winter	30	+10%				
S36.000	S146	15 Winter	30	+10%				
S36.001	S147	15 Winter	30	+10%				
S36.002	S148	720 Winter	30	+10%	30/360 Winter			
S36.003	S149	720 Winter	30	+10%	30/180 Winter			
S37.000	S150	720 Winter	30	+10%	30/120 Winter			
S37.001	S151	720 Winter	30	+10%	30/60 Winter			
S38.000	S152	720 Winter	30	+10%	30/60 Winter			
S37.002	S153	720 Winter	30	+10%	30/30 Winter			
S37.003	S154	720 Winter	30	+10%	30/15 Winter			
S37.004	S155	720 Winter	30	+10%	30/15 Summer			
S37.005	S156	720 Winter	30	+10%	30/15 Summer			
S36.004	S157	720 Winter	30	+10%	30/15 Summer			
S36.005	S158	720 Winter	30	+10%	30/15 Summer			
S1.039	S159	600 Winter	30	+10%				
S1.040	S160	1440 Summer	30	+10%				
S1.041	S161	600 Winter	30	+10%				
S1.042	S162	600 Winter	30	+10%				
S1.043	S163	600 Winter	30	+10%				

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S28.004	S118	16.454	0.879	0.000	0.89		28.0	SURCHARGED	
S30.000	S119	17.167	-0.108	0.000	0.52		20.9	OK	
S28.005	S120	16.454	0.929	0.000	1.18		28.4	SURCHARGED	
S28.006	S121	16.388	0.963	0.000	0.80		30.4	SURCHARGED	
S31.000	S122	17.540	-0.135	0.000	0.34		19.4	OK	
S31.001	S123	17.241	-0.108	0.000	0.53		35.0	OK	
S28.007	S124	16.351	1.026	0.000	1.41		40.7	SURCHARGED	
S28.008	S125	16.193	0.968	0.000	0.96		41.8	SURCHARGED	
S28.009	S126	16.110	0.985	0.000	1.46		40.7	SURCHARGED	
S32.000	S127	16.774	-0.141	0.000	0.29		21.8	OK	
S32.001	S128	16.013	0.438	0.000	0.26		16.3	SURCHARGED	
S28.010	S129	16.006	0.931	0.000	1.27		54.1	SURCHARGED	
S28.011	S130	15.447	0.722	0.000	1.27		53.8	FLOOD RISK	
S28.012	S131	15.285	0.660	0.000	2.20		53.7	FLOOD RISK	
S33.000	S132	15.489	-0.156	0.000	0.19		14.2	OK	
S28.013	S133	15.094	0.529	0.000	0.80		19.7	SURCHARGED	
S34.000	S134	15.085	0.070	0.000	0.08		2.1	SURCHARGED	
S34.001	S135	15.081	0.226	0.000	0.11		3.0	SURCHARGED	
S34.002	S136	15.073	0.378	0.000	0.13		2.8	SURCHARGED	
S34.003	S137	15.071	0.401	0.000	0.11		2.8	SURCHARGED	
S35.000	S138	14.992	-0.108	0.000	0.03		1.1	OK	
S34.004	S139	15.067	0.447	0.000	0.07		2.8	SURCHARGED	
S1.033	S140	15.081	0.396	0.000	1.07		77.5	SURCHARGED	
S1.034	S141	15.048	0.408	0.000	0.85		53.6	SURCHARGED	CATCHMENT I
S1.035	S142	14.567	-0.038	0.000	0.77		66.3	OK	+ 12.7L/S BASE FLOW
S1.036	S143	14.504	0.004	0.000	1.18		66.3	SURCHARGED	
S1.037	S144	14.475	0.000	0.000	1.09		66.0	OK	
S1.038	S145	14.397	-0.048	0.000	0.76		66.3	OK	
S36.000	S146	16.605	-0.095	0.000	0.61		30.2	OK	
S36.001	S147	16.113	-0.092	0.000	0.63		38.3	OK	
S36.002	S148	15.360	0.035	0.000	0.08		4.4	SURCHARGED	
S36.003	S149	15.358	0.178	0.000	0.08		4.4	SURCHARGED	
S37.000	S150	15.366	0.341	0.000	0.06		1.6	SURCHARGED	
S37.001	S151	15.365	0.450	0.000	0.05		1.5	SURCHARGED	
S38.000	S152	15.364	0.489	0.000	0.01		0.2	SURCHARGED	
S37.002	S153	15.364	0.589	0.000	0.10		3.2	SURCHARGED	
S37.003	S154	15.362	0.737	0.000	0.09		3.2	SURCHARGED	
S37.004	S155	15.359	0.884	0.000	0.10		3.1	SURCHARGED	
S37.005	S156	15.358	0.933	0.000	0.07		3.0	SURCHARGED	
S36.004	S157	15.357	0.957	0.000	0.12		7.2	SURCHARGED	
S36.005	S158	15.356	1.006	0.000	0.03		2.0	SURCHARGED	CATCHMENT J
S1.039	S159	14.349	-0.016	0.000	0.83		68.3	OK	
S1.040	S160	14.293	0.000	0.000	1.14		67.6	OK	
S1.041	S161	14.161	-0.115	0.000	0.82		68.3	OK	
S1.042	S162	14.045	-0.115	0.000	0.82		68.3	OK	
S1.043	S163	13.947	-0.108	0.000	0.85		68.3	OK	

A BASE FLOW OF 12.7 L/S HAS BEEN ADDED TO THE MODEL TO SIMULATE EMERGENCY SCREEN DISCHARGE FROM THE FOUL EMERGENCY HOLDING TANK DURING A 1 IN 30 YEAR STORM EVENT INCLUDING 10% FOR CLIMATE CHANGE.

MAXIMUM DISCHARGE UNDER NORMAL STORM CONDITIONS = 53.6L/S + 2.0L/S = 55.6L/S

Appendix H. Site Investigation Report

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Ground Investigations Ireland

Woodbrook

Ground Investigation Report

DOCUMENT CONTROL SHEET

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APPENDICES

Appendix 1 Site Location Plan
Appendix 2 Trial Pit Records
Appendix 3 Cable Percussion Borehole Records
Appendix 4 Groundwater Monitoring
Appendix 5 Soakaway Test Results

1.0 Preamble

On the instructions of Atkins Consulting engineers, a site investigation was carried out by Ground Investigations Ireland Ltd., between June and August 2018 at the site of the proposed development in Bray, Co. Dublin.

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 to the north or Bray town. 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 12 No. Trial Pits to a maximum depth of 3.0m BGL
- Carry out 6 No. Soakaways to determine a soil infiltration value to BRE digest 365
- Carry out 3 No. Cable Percussion boreholes to a maximum depth of 10.0m BGL
- Installation of 3 No. Groundwater monitoring wells
- Geotechnical & Environmental Laboratory testing
- 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 JCB 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 a Geotechnical Engineer/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.

3.4. Cable Percussion Boreholes

The Cable Percussion Boreholes were drilled using a Dando 2000 drilling rig with regular in-situ testing and sampling undertaken to facilitate the production of geotechnical logs and laboratory testing.
The standard method of boring in soil for site investigation is known as the Cable Percussion method. It consists of using a Shell in non cohesive soils and a clay cutter in cohesive soils, both operated on a wire cable. Very hard soils, boulders and other hard obstructions are broken up by chiselling and the fragments removed with the Shell. Where ground conditions made it necessary, the borehole was lined with 200mm diameter steel casing. While the use of the Cable Percussion method of boring gives the maximum data on soil conditions, some mixing of laminated soil is inevitable. For this reason, thin lenses of granular material may not be noticed. Disturbed samples were taken from the boring tools at suitable depths, so that there is a representative sample at the top of each change in stratum and thereafter at regular intervals down the borehole until the next stratum was encountered. The disturbed samples were then sealed and sent to the laboratory where they were visually examined to confirm the description of the relevant strata.

3.5. Surveying

The exploratory hole locations have been recorded using a Trimble R10 GNSS System which records the coordinates and elevation of the locations to ITM or Irish National Grid as required by the project specification. The coordinates and elevations are provided on the exploratory hole logs in the appendices of this Report.

3.6. Groundwater/Gas Monitoring Installations

Groundwater and or Gas Monitoring Installation were installed upon the completion of the boreholes to enable sampling and the determination of the equilibrium groundwater level. The typical groundwater monitoring installation consists of a 50mm HDPE slotted pipe with a pea gravel response zone and bentonite seal installed to the Engineers specification. Where required the standpipe is sealed with a gas tap and finished with a durable steel cover fixed in place with a concrete surround. The installation details are provided on the exploratory hole logs in the appendices 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
- Granular Deposits
- Cohesive Deposits

TOPSOIL: Topsoil was encountered in all the exploratory holes and was present to a maximum depth of 0.35m BGL.

COHESIVE DEPOSITS: Cohesive deposits were encountered beneath the TOPSOIL and were described typically as *brown sandy gravelly CLAY with occasional cobbles* overlying a *soft to firm greyish brown sandy gravelly CLAY with occasional cobbles*. The secondary sand and gravel constituents varied across the site and with depth, with granular lenses occasionally present in the cohesive matrix. 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 *Greyish brown very sandy slightly clayey sub angular to rounded 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.

4.2. Groundwater

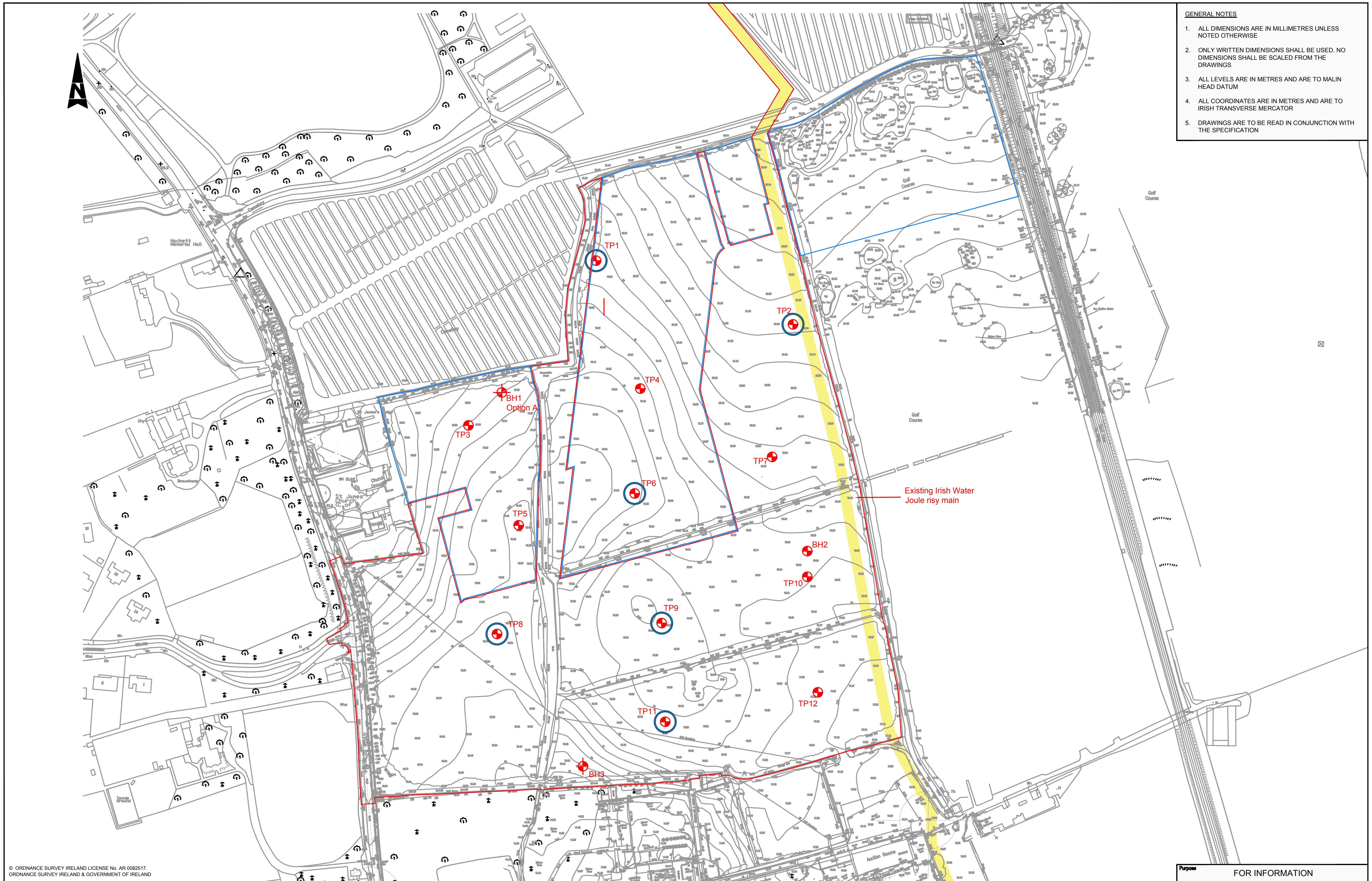
Groundwater strikes are noted on the exploratory hole logs where they occurred and where possible drilling was suspended for twenty minutes to allow the subsequent rise in groundwater to be recorded. We would point out that these exploratory holes did not remain open for sufficiently long periods of time to establish the hydrogeological regime and groundwater levels would be expected to vary with the tide, time of year, rainfall, nearby construction and other factors. For this reason, standpipes were installed in BH1A, BH2 and BH3 to allow the equilibrium groundwater level to be determined. The groundwater monitoring is included in Appendix 6 of this Report.

4.3. Soakaway Design

Infiltration rates of 3.137×10^{-6} and 2.298×10^{-6} m/s respectively were calculated for the soakaway locations TP02 and TP06 for the design and construction of soakaways.
At the locations of TP01, TP06, TP09 and TP11 the water level dropped too slowly to allow calculation of 'f' the soil infiltration rate.

APPENDIX 1 - Site Location Plan

A1



GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ONLY WRITTEN DIMENSIONS SHALL BE USED. NO DIMENSIONS SHALL BE SCALED FROM THE DRAWINGS
3. ALL LEVELS ARE IN METRES AND ARE TO MALIN HEAD DATUM
4. ALL COORDINATES ARE IN METRES AND ARE TO IRISH TRANSVERSE MERCATOR
5. DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE SPECIFICATION

LEGEND

- PERCOLATION TEST IN ACCORDANCE WITH BRE365.
- TRIAL PIT 2.5–3M DEPTH
- (BH1 – BH3) S+A (Cable Percussive)

NOTES

1. PERCOLATION TEST TO BE CARRIED OUT IN ACCORDANCE WITH BRE DIGEST 365 SOAKAWAY DESIGN.
2. TRIAL PIT TO A DEPTH OF 2.5–3M AND TO LOG STRATA CLASSIFICATION INCLUDING DEPTH AND CHANGE IN STRATA.
3. WATER STRIKE DEPTHS.

~ Depth 10m

– all to be committed to groundwater monitoring wells (raised covers)

Rev	Description	By	Date	Chk'd	Auth

U:\5163122\6 Dwgs\64 XRefs\641 Title Blocks\Blue_Atkins_logo.jpg

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Purpose	FOR INFORMATION
Client	AEVAL
Title	PROPOSED GROUNDWATER MONITORING WELL
Project	WOODBROOK DEVELOPMENT
Original Scale	NTS
Design/Drawn	GH, Date 04/18
Checked	JN, Date 04/18
Authorised	JN, Date 04/18
Status	DR
Drawing Number	5154251_EWE_SK_0005
Rev	

APPENDIX 2 – Trial Pit Records

Ground Investigations Ireland Ltd
www.gii.ie

Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.40m X 0.70m X 2.00	**Ground Level (mOD)** 19.91	**Site** Woodbrook **Client** Castlethorn	**Trial Pit Number** TP01 **Job Number** 7757-05-18
	Location 725776.1 E 720639.5 N	**Dates** 26/06/2018	**Project Contractor** Ground Investigations Ireland	**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 rootlets.		
				19.56	0.35 (0.20)	Firm brown slightly sandy slightly gravelly CLAY.		
				19.36	0.55 (1.05)	Dark greyish brown sandy slightly clayey subangular to subrounded fine to coarse GRAVEL with occasional subrounded cobbles.		
				18.31	1.60 (0.40)	Soft to firm dark greyish brown very sandy slightly gravelly CLAY.		∇1
			Medium Seepage(1) at 1.95m.	17.91	2.00	Trial pit terminated at scheduled depth.		
						Complete at 2.00m		

Plan

Remarks

Groundwater encountered at 1.95m BGL.
Trial pit side walls spalling.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP01

Ground Investigations Ireland Ltd
www.gii.ie

Site	Woodbrook
Trial Pit Number	TP02
Machine	JCB JCX
Method	Trial Pit
Dimensions	2.50m X 0.70m X 2.00m
Ground Level (mOD)	21.71
Client	Castlethorn
Job Number	7757-05-18
Location	725947.4 E 720584.4 N
Dates	26/06/2018
Project Contractor	Ground Investigations Ireland
Sheet	1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				21.31	0.40 (0.60)	Firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
				20.71	1.00 (1.00)	Brown slightly clayey gravelly fine to coarse SAND with some grey fine sand lenses.		
				19.71	2.00	Trial pit terminated at scheduled depth.		

Complete at 2.00m

Plan

Remarks

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

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP02

Ground Investigations Ireland Ltd
www.gii.ie

Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.90m X 0.70m X 3.00m	**Ground Level (mOD)** 18.43	**Site** Woodbrook **Client** Castlethorn	**Trial Pit Number** TP03 **Job Number** 7757-05-18
	Location 725665.2 E 720495.3 N	**Dates** 26/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.25)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				18.18	0.25	Firm brown slightly sandy slightly gravelly CLAY		
					(0.35)			
0.50	B							
				17.83	0.60	Soft to firm greyish brown sandy gravelly CLAY.		
					(0.60)			
				17.23	1.20	Dark greyish brown very gravelly slightly clayey fine to coarse SAND with occasional subrounded cobbles.		
					(0.55)			
				16.68	1.75	Greyish brown very sandy slightly clayey subangular to subrounded fine to coarse GRAVEL with occasional subrounded cobbles.		
2.20	B							
					(1.25)			
			Slight seepage(1) at 2.50m.					∇1
			Slight seepage(2) at 2.70m.					∇2
			Slow ingress(3) at 3.00m, rose to 2.90m in 20 mins.					▼3 ∇3
				15.43	3.00	Complete at 3.00m		

Plan

Remarks

Groundwater encountered at 2.50m, 2.70m and 3.00m BGL.
Trial pit stable.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP03

Ground Investigations Ireland Ltd
www.gii.ie

Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.90m X 0.70m X 3.00m	**Ground Level (mOD)** 18.35	**Site** Woodbrook **Client** Castlethorn	**Trial Pit Number** TP04 **Job Number** 7757-05-18
	Location 725813.1 E 720528.3 N	**Dates** 26/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				18.10	(0.25) 0.25	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				17.90	(0.20) 0.45	Firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
				17.70	(0.20) 0.65	Brown slightly sandy clayey subangular to subrounded fine to coarse GRAVEL.		
0.65	B			17.05	(0.65) 1.30	Dark greyish brown slightly sandy slightly clayey subangular to subrounded fine to coarse GRAVEL.		
1.30	B			16.65	(0.40) 1.70	Soft to firm greyish brown sandy gravelly CLAY.		
				15.60	(1.05) 2.75	Grey sandy subrounded to rounded fine to coarse GRAVEL.		
				15.35	(0.25) 3.00	Grey slightly gravelly slightly silty fine SAND.		
						Complete at 3.00m		

Plan

Remarks

No Groundwater encountered.
Trial pit stable.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP04

Ground Investigations Ireland Ltd www.gii.ie	Site: Woodbrook	Trial Pit Number: TP05

Machine : JCB JCX Method : Trial Pit	Dimensions: 2.70m X 0.70m X 2.50	Ground Level (mOD): 16.39	Client: Castlethorn	Job Number: 7757-05-18
	Location: 725708.8 E 720410.1 N	Dates: 25/06/2018	Project Contractor: Ground Investigations Ireland	Sheet: 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
0.50	B			15.99	0.40 (0.20)	Firm brown slightly sandy slightly gravelly CLAY.		
				15.79	0.60 (0.50)	Brown slightly sandy clayey subangular to rounded fine to coarse GRAVEL with some subrounded cobbles.		
				15.29	1.10 (0.40)	Brown gravelly slightly clayey fine to coarse SAND with occasional subangular cobbles.		
2.00	B			14.89	1.50 (0.70)	Dark brown slightly gravelly slightly clayey fine to coarse SAND.		
				14.19	2.20 (0.30)	Brown very sandy slightly clayey subrounded to rounded fine to coarse GRAVEL with occasional subrounded cobbles.		
				13.89	2.50	Complete at 2.50m		

Plan

Remarks

No Groundwater encountered.
Trial pit side walls spalling.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP05

Ground Investigations Ireland Ltd
www.gii.ie

Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.30m X 0.70m X 2.00m	**Ground Level (mOD)** 17.43	**Site** Woodbrook	**Trial Pit Number** **TP06**
	Location 725805.4 E 720435.7 N	**Dates** 25/06/2018	**Client** Castlethorn	**Job Number** 7757-05-18
			Project Contractor Ground Investigations Ireland	**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 rootlets.		
				17.13	0.30 (0.50)	Soft to firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
				16.63	0.80 (0.50)	Soft to firm dark dark brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles and boulders.		
				16.13	1.30 (0.50)	Soft to firm dark brown slightly sandy gravelly CLAY with some subangular to subrounded cobbles and boulders.		
				15.63	1.80 (0.20)	Brown slightly gravelly slightly clayey fine to medium SAND.		
				15.43	2.00	Trial pit terminated at scheduled depth.		
						Complete at 2.00m		

Plan

Remarks

No Groundwater encountered.
Trial pit side walls spalling.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP06

Ground Investigations Ireland Ltd
www.gii.ie

Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 3.40m X 0.70m X 2.50m	**Ground Level (mOD)** 19.90	**Site** Woodbrook **Client** Castlethorn	**Trial Pit Number** TP07 **Job Number** 7757-05-18
	Location 725927.9 E 720469.6 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**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.		
				19.60	0.30 (0.30)	Firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
0.50	B							
				19.30	0.60 (0.60)	Soft to firm dark brown slightly sandy gravelly CLAY with occasional subrounded cobbles.		
				18.70	1.20 (0.80)	Soft to firm grey mottled brown sandy gravelly CLAY with occasional subangular to subrounded cobbles.		
1.90	B							
				17.90	2.00 (0.10)	Brown gravelly slightly clayey fine to coarse SAND with occasional cobbles.		
				17.80	2.10 (0.40)	Brown very gravelly slightly clayey fine to coarse SAND with occasional cobbles.		
				17.40	2.50	Complete at 2.50m		

Plan

Remarks

No Grounwater encountered.
Trial pit stable.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP07

Ground Investigations Ireland Ltd
www.gii.ie

Machine : JCB JCX Method : Trial Pit	Dimensions 2.40m X 0.70m X 2.00	Ground Level (mOD) 15.81	Site Woodbrook Client Castlethorn	Trial Pit Number TP08 Job Number 7757-05-18
	Location 725689.9 E 720316.1 N	Dates 25/06/2018	Project Contractor Ground Investigations Ireland	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 rootlets.		
				15.46	0.35 (0.45)	Firm to stiff brown slightly sandy slightly gravelly CLAY.		
				15.01	0.80 (1.00)	Brown very sandy slightly clayey subangular to rounded fine to coarse GRAVEL with some subrounded cobbles.		
				14.01	1.80 (0.20)	Soft to firm brown sandy slightly gravelly CLAY with occasional subrounded cobbles.		
				13.81	2.00	Trial pit terminated at scheduled depth.		

Complete at 2.00m

Plan

Remarks

No Groundwater encountered.
Trial pit side walls spalling.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP08

Ground Investigations Ireland Ltd www.gii.ie		Site Woodbrook	Trial Pit Number **TP09**
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.40m X 0.70m X 1.90m	**Ground Level (mOD)** 19.41	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725832.8 E 720325.1 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
					(0.35)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.
				19.06	0.35	Soft to firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.
					(0.65)	
1.00	B			18.41	1.00	Soft to firm greyish brown sandy gravelly CLAY.
					(0.70)	
				17.71	1.70	Soft to firm greyish brown slightly sandy gravelly CLAY.
1.80	B				(0.20)	
				17.51	1.90	Trial pit terminated at scheduled depth.
						Complete at 1.90m

Plan

Remarks

No Groundwater encountered.
Trial pit side walls spalling.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP09

Ground Investigations Ireland Ltd
www.gii.ie

Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.40m X 0.70m X 2.40m	**Ground Level (mOD)** 18.54	**Site** Woodbrook **Client** Castlethorn	**Trial Pit Number** **TP10** **Job Number** 7757-05-18
	Location 725957.4 E 720361.8 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**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.		
				18.24	0.30 (0.20)	Firm brown slightly sandy slightly gravelly CLAY.		
0.50	B			18.04	0.50 (1.10)	Soft to firm dark greyish brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles and boulders.		
1.50	B							
			Slight seepage(1) at 1.90m. Medium ingress(2) at 2.20m.	16.94	1.60 (0.80)	Greyish brown sandy slightly clayey subrounded to rounded fine to coarse GRAVEL with occasional subrounded cobbles and boulders.		∇1 ∇2
				16.14	2.40	Trial pit terminated due to excessive groundwater. Complete at 2.40m		

Plan

Remarks

Groundwater encountered at 1.90m and 2.20m BGL.
Trial pit side walls spalling.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP10

Ground Investigations Ireland Ltd www.gii.ie	Site: Woodbrook	Trial Pit Number: **TP11**
Machine : JCB JCX Method : Trial Pit	Dimensions: 2.40m X 0.70m X 1.90m	Ground Level (mOD): 18.87
	Client: Castlethorn	Job Number: 7757-05-18
	Location: 725836 E 720237.6 N	Dates: 25/06/2018
	Project Contractor: Ground Investigations Ireland	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.		
				18.57	0.30	Soft to firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
					(0.90)			
1.00	B							
				17.67	1.20	Soft to firm dark brown slightly sandy gravelly CLAY.		
					(0.70)			
1.80	B							
				16.97	1.90	Trial pit terminated at scheduled depth.		
						Complete at 1.90m		

Plan

Remarks

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

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP11

Ground Investigations Ireland Ltd www.gii.ie	Site: Woodbrook	Trial Pit Number: **TP12**

Machine : JCB JCX Method : Trial Pit	Dimensions: 2.50m X 0.70m X 2.90m	Ground Level (mOD): 17.69	Client: Castlethorn	Job Number: 7757-05-18
	Location: 725968.8 E 720265.1 N	Dates: 25/06/2018	Project Contractor: Ground Investigations Ireland	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.		
				17.39	0.30 (0.20)	Firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles		
				17.19	0.50 (0.60)	Soft to firm dark greyish brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles		
1.00	B							
				16.59	1.10 (0.60)	Soft to firm grey mottled brown slightly sandy gravelly CLAY with occasional subrounded cobbles.		
			Slight seepage(1) at 1.70m.	15.99	1.70 (0.60)	Greyish brown gravelly slightly clayey SAND.		∇1
2.00	B							
			Slow ingress(2) at 2.40m.	15.39	2.30 (0.60)	Grey very sandy slightly clayey subangular to rounded fine to coarse GRAVEL.		∇2
				14.79	2.90	Complete at 2.90m		

Plan

Remarks

Grounwater encountered at 1.70m and 2.40m.
Trial pit stable.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP12

Woodbrook, Bray - Trial Pit Photographs

TP01

TP02

TP02

TP03

TP03

TP04

TP04

TP05

TP05

TP06

TP06

TP07

TP07

TP08

TP08

TP09

TP09

TP10

TP10

TP11

TP11

TP12

TP12

APPENDIX 3 – Cable Percussion Borehole Records

Ground Investigations Ireland Ltd www.gii.ie	Site Woodbrook	Borehole Number BH01

Machine : Dando2000 Method : Cable Percussion	Casing Diameter 200mm to 5.00m	Ground Level (mOD) 18.95	Client Castlethorn	Job Number 7757-05-18
	Location 725691.3 E 720522.8 N	Dates 27/06/2018	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					18.65	(0.30) 0.30	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
1.00	B				17.25	(1.40) 1.70	Brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
2.00	B				15.95	(1.30) 3.00	Brown slightly sandy very gravelly CLAY with occasional subrounded cobbles.		▼1
3.00 4.00 5.00	B B B			Water strike(1) at 3.10m, rose to 2.40m in 20 mins, sealed at 3.60m.	13.95	(2.00) 5.00	Brown slightly sandy slightly gravelly CLAY.		∇1
							End of Borehole.		

Complete at 5.00m

Remarks	Scale (approx)	Logged By
Groundwater encountered at 3.10m BGL. Standpipe installed, borehole backfilled to 3.40m with bentonite ,slotted standpipe installed from 3.40m to 1.90m with a gravel filter, sealed standpipe from 1.90m to ground level with a raised cover.	1:50	Tmcl
	Figure No. 7757-05-18.BH01	

Ground Investigations Ireland Ltd www.gii.ie			Site: Woodbrook	Borehole Number: **BH02**
Machine : Dando2000 **Method :** Cable Percussion	**Casing Diameter**	**Ground Level (mOD)** 19.16	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725957.9 E 720383.4 N	**Dates** 28/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					18.76	(0.40) 0.40	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
1.00	B				17.76	(1.00) 1.40	Brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles and boulders.		
2.00	B				16.16	(1.60) 3.00	Brown slightly sandy gravelly CLAY with occasional subrounded cobbles and boulders.		
3.00	B				15.16	(1.00) 4.00	Brown slightly sandy very gravelly CLAY with occasional cobbles.		▼1 ∇1
4.00	B			Water strike(1) at 3.98m, rose to 3.50m in 20 mins, sealed at 2.40m.	14.16	(1.00) 5.00	Brown slightly sandy slightly gravelly CLAY.		
5.00	B						End of Borehole.		
							Complete at 5.00m		

Remarks
Grounwater encountered at 3.98m BGL.
Stanpipe installed, slotted stanpipe installed from 5.0m to 3.50m with a gravel filter, sealed from 3.50m to ground level with a raised cover.

Scale (approx)	Logged By
1:50	Tmcl

Figure No. 7757-05-18.BH02

Ground Investigations Ireland Ltd
www.gii.ie

Site Woodbrook				**Borehole Number** BH03
Machine : Dando2000 **Method :** Cable Percussion	**Casing Diameter**	**Ground Level (mOD)** 15.90	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725764.2 E 720201.8 N	**Dates** 29/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					15.50	(0.40) 0.40	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
1.00	B				14.70	(0.80) 1.20	Brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
2.00	B				13.90	(0.80) 2.00	Brown slightly sandy very gravelly CLAY with occasional subrounded cobbles.		
3.00	B				12.90	(1.00) 3.00	Brown slightly sandy gravelly CLAY with occasional subrounded cobbles.		
4.00	B				11.90	(1.00) 4.00	Greyish brown sandy slightly clayey subangular to rounded fine to coarse GRAVEL.		
5.00	B			Water strike(1) at 5.00m, rose to 4.40m in 20 mins.	10.90	(1.00) 5.00	Brown sandy slightly gravelly CLAY with occasional lenses of fine to coarse sand.		▼1 (4.40) ∇1 (5.00)
							End of Borehole.		
							Complete at 5.00m		

Remarks
Groundwater encountered at 5.0m BGL.
Standpipe installed, slotted from 5.0m to 3.5m with a gravel filter, sealed from 3.50m to ground level with a rasied cover

Scale (approx)	Logged By
1:50	Tmcl

Figure No. 7757-05-18.BH03

APPENDIX 4 – Groundwater Monitoring

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

GROUNDWATER MONITORING

Woodbrook

BOREHOLE	DATE	TIME	GROUNDWATER (mBGL)	Comments
BH1	16/07/2018	17.00	2.18	Depths from Ground level
BH2	16/07/2018	17.05	2.37	
BH3	16/07/2018	17.15	4.55	

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

GROUNDWATER MONITORING

Woodbrook Bray

BOREHOLE	DATE	TIME	GROUNDWATER (mBGL)	Comments
BH1	16/08/2918	12:02:00	2.28m	
BH2	16/08/2018	12:11:00	3.32m	
BH3	16/08/2918	12:25:00	5.00m	No Water

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

GROUNDWATER MONITORING

Woodbrook

BOREHOLE	DATE	TIME	GROUNDWATER (mBGL)	Comments
				Depths from Ground level
BH1	13/09/2018	11.14	2.36	
BH2	13/09/2018	11.21	3.08	
BH3	13/09/2018	11.27	5.00	No Groundwater

APPENDIX 5 – Soakaway Results

TP02

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.50m x 0.70m 2.00m (L x W x D)

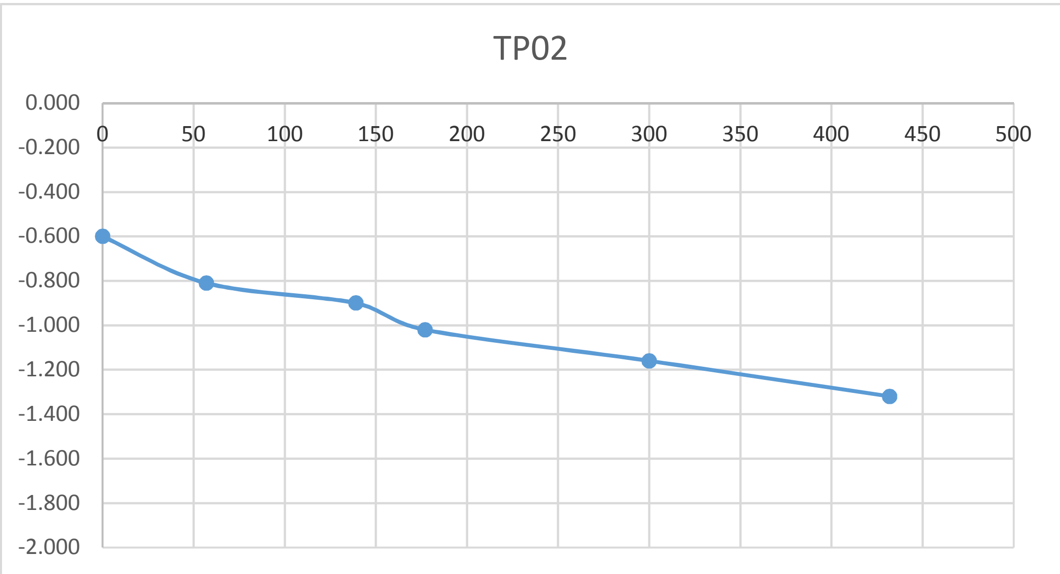
Date	Time	Water level (m bgl)
14/09/2016	0	-0.600
14/09/2016	57	-0.810
14/09/2016	139	-0.900
14/09/2016	177	-1.020
14/09/2016	300	-1.160
14/09/2016	432	-1.320

Start depth	Depth of Pit	Diff	75% full	25%full
0.60	**2.000**	**1.400**	**0.95**	**1.65**

Length of pit (m)	Width of pit (m)	75-25Ht (m)	Vp75-25 (m3)
2.500	0.700	0.700	1.23

Tp75-25 (from graph) (s)	**62686**	50% Eff Depth	ap50 (m2)
		0.700	6.23

f = 3.137E-06 m/s



TP08

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.40m x 0.70m 2.00m (L x W x D)

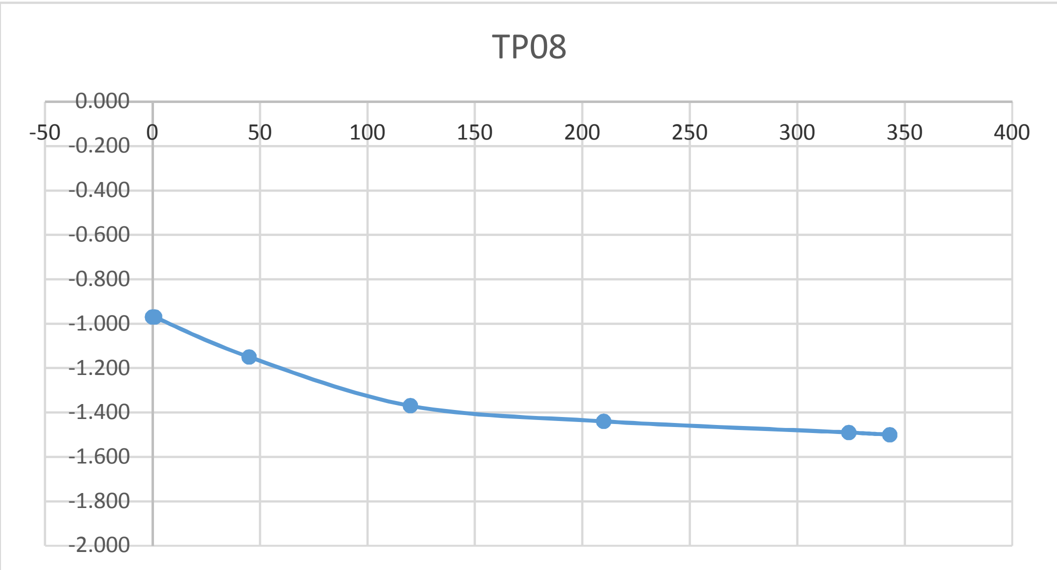
Date	Time	Water level (m bgl)
14/09/2016	0	-0.970
14/09/2016	1	-0.970
14/09/2016	45	-1.150
14/09/2016	120	-1.370
14/09/2016	210	-1.440
14/09/2016	324	-1.490
14/09/2016	343	-1.500

Start depth	Depth of Pit	Diff	75% full	25%full
0.97	**2.000**	**1.030**	**1.2275**	**1.7425**

Length of pit (m)	Width of pit (m)	75-25Ht (m)	Vp75-25 (m3)
2.400	0.700	0.515	0.87

Tp75-25 (from graph) (s)	**77250**	50% Eff Depth	ap50 (m2)
		0.515	4.873

f = 2.298E-06 m/s



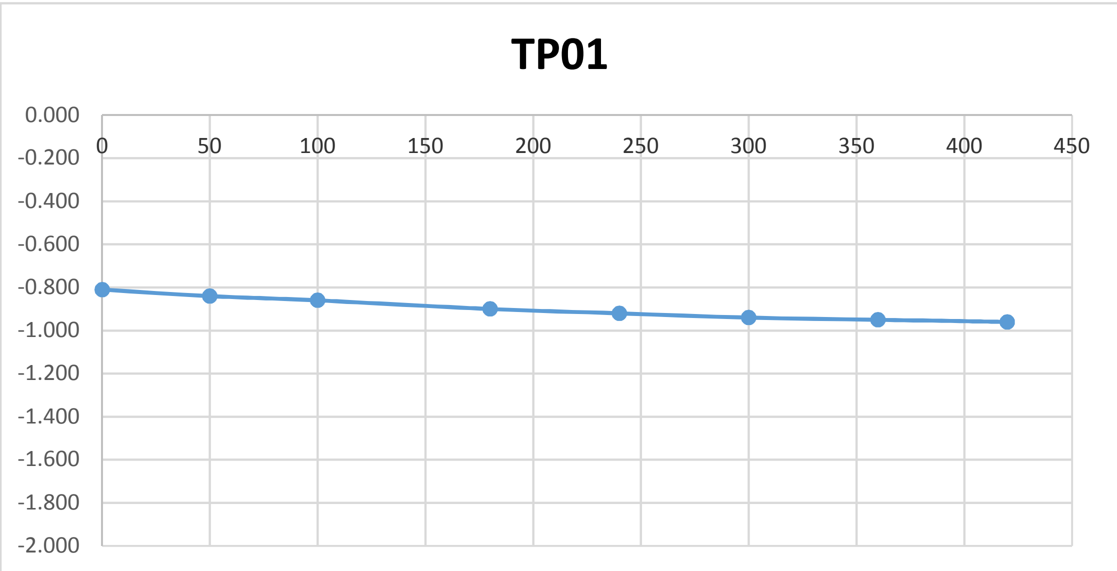
TP01

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.40m x 0.70m 2.0m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.810
14/09/2016	50	-0.840
14/09/2016	100	-0.860
14/09/2016	180	-0.900
14/09/2016	240	-0.920
14/09/2016	300	-0.940
14/09/2016	360	-0.950
14/09/2016	420	-0.960

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
0.81	2.000	1.190	1.1075	1.7025



TP11

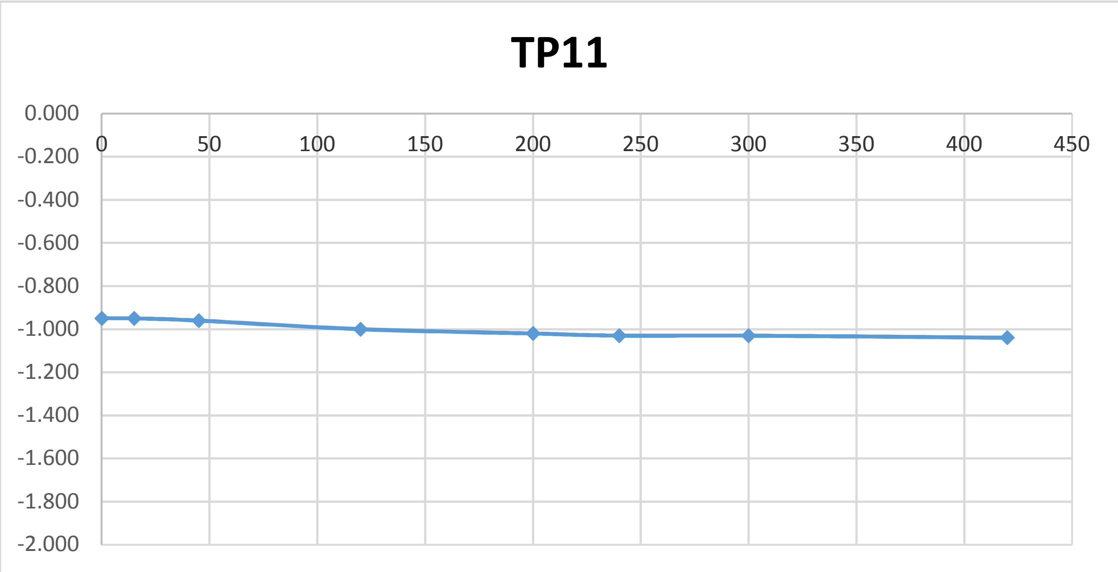
Soakaway Test to BRE Digest 365

Trial Pit Dimensions: 2.4m x 0.70m 1.9m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.950
14/09/2016	15	-0.950
14/09/2016	45	-0.960
14/09/2016	120	-1.000
14/09/2016	200	-1.020
14/09/2016	240	-1.030
14/09/2016	300	-1.030
14/09/2016	420	-1.040

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
0.95	**1.900**	**0.950**	**1.1875**	**1.6625**



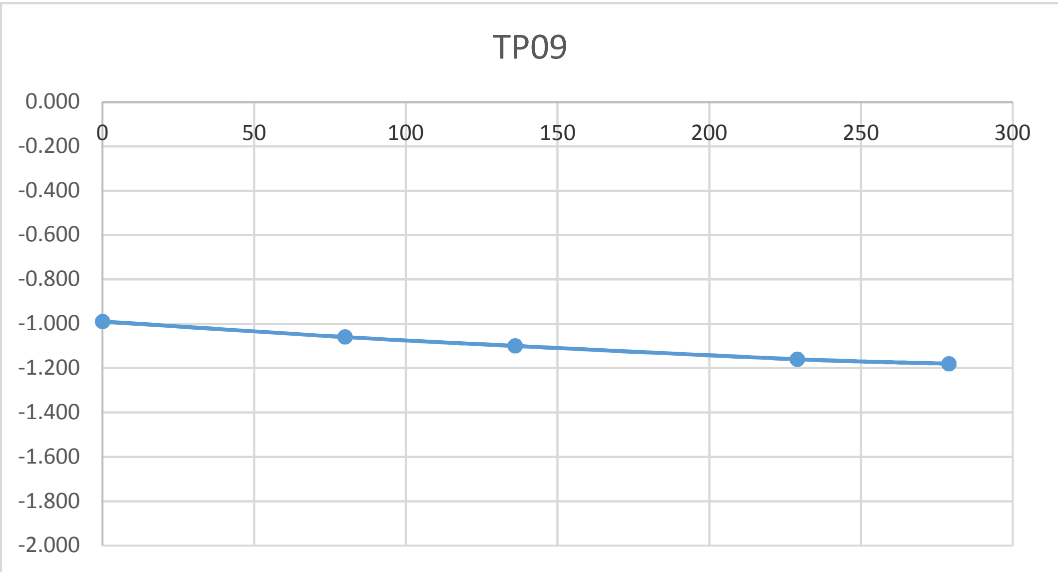
TP09

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 12.40m x 0.70m 1.90m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.990
14/09/2016	80	-1.060
14/09/2016	136	-1.100
14/09/2016	229	-1.160
14/09/2016	279	-1.180

*Soakaway failed - Pit backfilled

Start depth	Depth of Pit	Diff	75% full	25%full
0.99	**1.900**	**0.910**	**1.2175**	**1.6725**



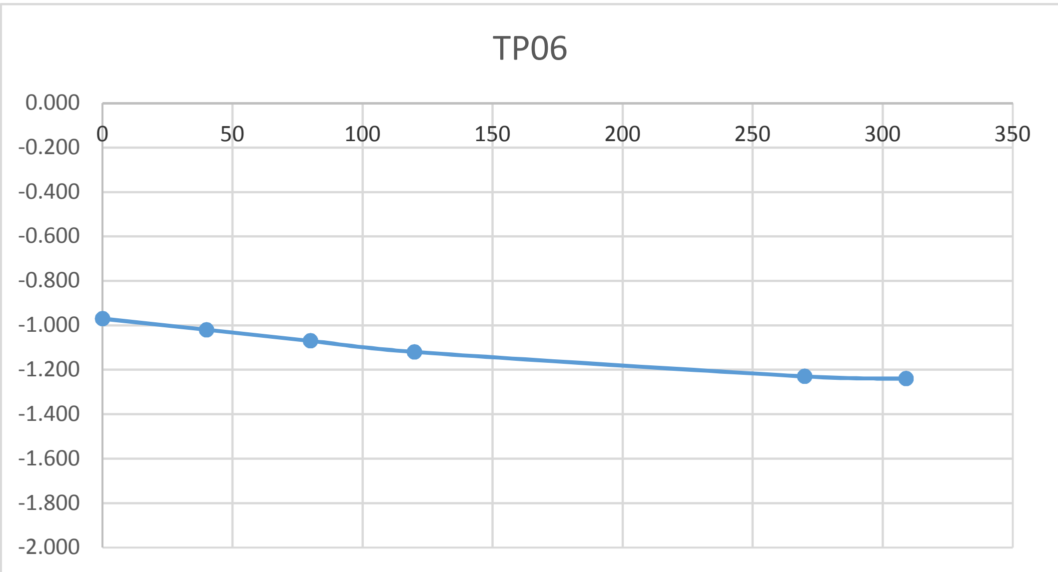
TP06

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.30m x 0.70m 2.00m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.970
14/09/2016	40	-1.020
14/09/2016	80	-1.070
14/09/2016	120	-1.120
14/09/2016	270	-1.230
14/09/2016	309	-1.240

*Soakaway failed - Pit backfilled

Start depth	Depth of Pit	Diff	75% full	25%full
0.97	2.000	1.030	1.2275	1.7425



Appendix I. Hydrogeologist Technical Note

SNC·LAVALIN

ATKINS
Member of the SNC-Lavalin Group

Technical Note

Project:	Woodbrook Proposed Strategic Housing Development		
Subject:	Technical Response to DLRCC Drainage Queries		
Author:	Deirdre Larkin & Garry Hanratty	Atkins No.:	5154251DG0010 Rev2
Date:	13/04/2019	Icepac No.:	N/A
		Project No.:	5154251
Distribution:	Drainage Department	Representing:	DLRCC

Atkins have prepared this technical note on behalf of Aeval in relation to a proposed residential development on existing greenfield lands and a golf course, located at Woodbrook, Co. Dublin (hereafter referred to as the Site). The purpose of this technical assessment is to address queries raised by Dún Laoghaire–Rathdown County Council (DLRCC) in relation to the existing Site drainage system, and shallow groundwater flow paths in the vicinity of an existing onsite drainage ditch.

Specifically, DLRCC have requested a response to the following;

1. Confirmation that the existing onsite drainage ditch is a field ditch and not a stream or river (as discussed during a pre-application meeting with DLRCC); and,

2. A request that '*the applicant …be required to undertake further investigations to determine the (underground?) flowpaths of the outflow from the existing watercourse / ditch which terminates near the proposed school site. The proximity and possible flow interaction of the proposed attenuation tanks nos. 4 and 5 in Zone B with the above mentioned watercourse / ditch needs further examination'* (Item no. 25, pg 34 of DLRCC Report File Ref: SHD/PAC/86/18).

This detailed technical response has been prepared based on the following scope of works;

- Review of all available desk-based information, including historic mapping and aerial photography;
- Site walkover survey undertaken by an experienced Hydrogeologist on 12th June and 18th September 2018;
- Groundwater investigation works undertaken by Ground Investigations Ltd. between 13th to 15th June 2018;
- Baseline groundwater level monitoring carried out between 16th June to 13th September 2018; and,
- A Hydrological and Hydrogeological Impact Assessment completed by Atkins (2019).

This assessment should be read in conjunction with the following documents;

- Atkins Stage 1 Flood Risk Assessment
- Atkins Stormwater Impact Assessment Report
- Atkins Environmental Impact Assessment Report (EIAR) – Chapter 5: Water Impact Assessment

Response to Query Item No. 1:
Characterisation of the onsite Drainage Feature

Desk-based Review

The subject existing field drain indicated in Figure 1 traversing the Site from North to South has a long-established existence and function in draining the fields down to the local watercourse outside of the proposed Woodbrook Development. Topographic levels across the Site have been mapped, and likely overland storm water flow paths have been evaluated for the current baseline setting, as presented in Figure 1. It should be noted that green colours denote higher Site levels, red colours denote lower Site levels, and the black arrows denote likely natural water flow paths within the overall Site.

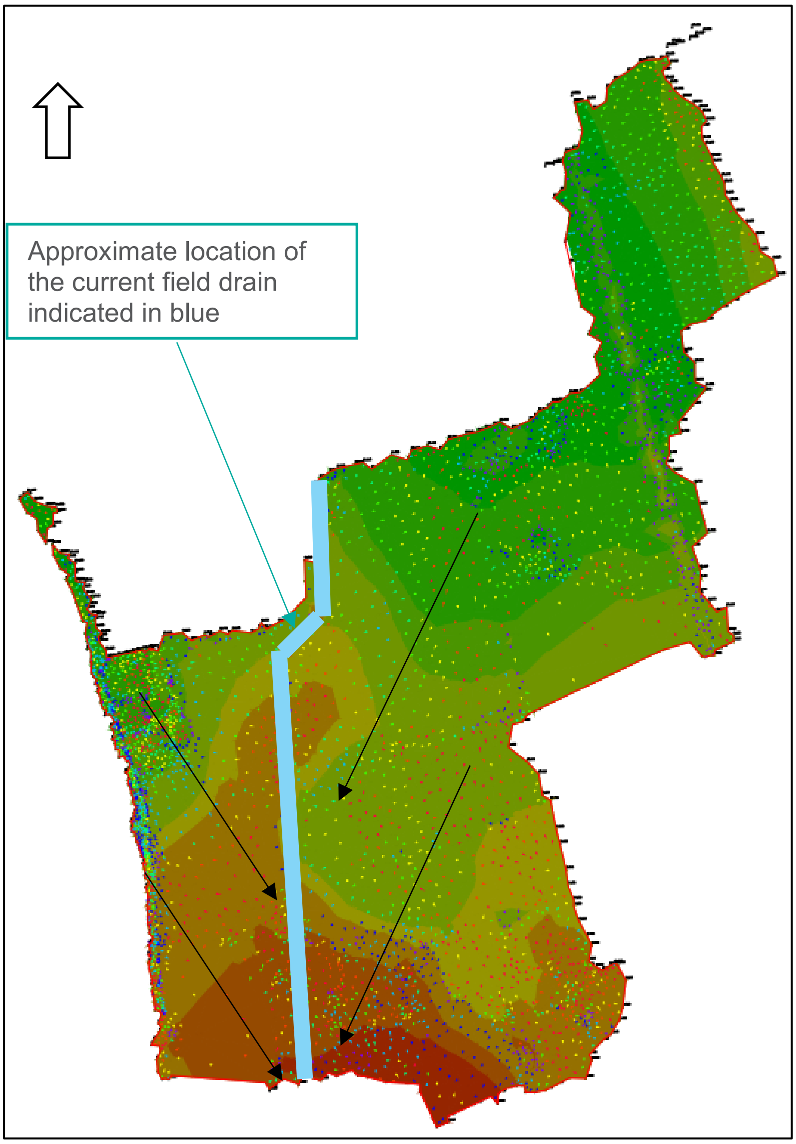


Figure 1 - Site Topography Heat Map

A review of Historical Ordinance Survey Ireland information (www.osi.ie) was then carried out to determine if the OSI 6 inch Maps indicated historic water courses / surface water features within the Site. The image below does not indicate any record of a water course onsite.

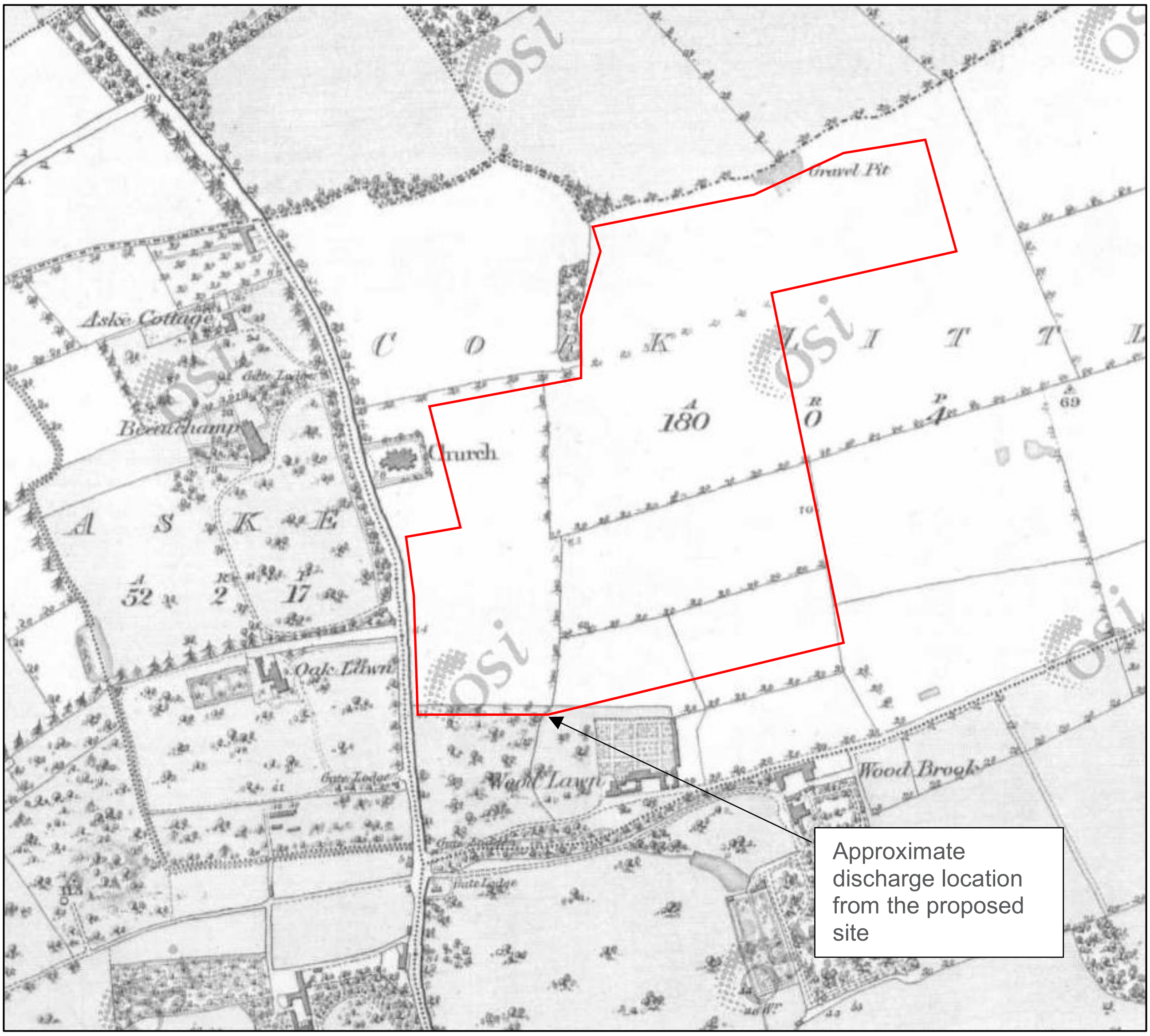


Figure 2 - OSI 6 Inch Colour Map

A review of the OPW CFRAM study Flood Maps (www.floodinfo.ie) was carried out to determine if the onsite field drain / water course formed part of the study. The CFRAM Flood Maps do not indicate flooding for 1 in 10, 1 in 100 or 1 in 1000-year flood events. It is noted that no part of the proposed Site formed part of the CFRAM study, as clearly presented in Figure 3.

Figure 3 - CFRAM Flood Study Map

A review of the EPA Maps (www.epa.ie) was also carried out to determine if the onsite field drain / water course is indicated as part of the river features water networks. The maps name the Rathmichael river to the south of the Site to which the existing Woodbrook lands drain into. However, the EPA mapping resource does not identify any water features within the existing Site. Refer to Figure 4.

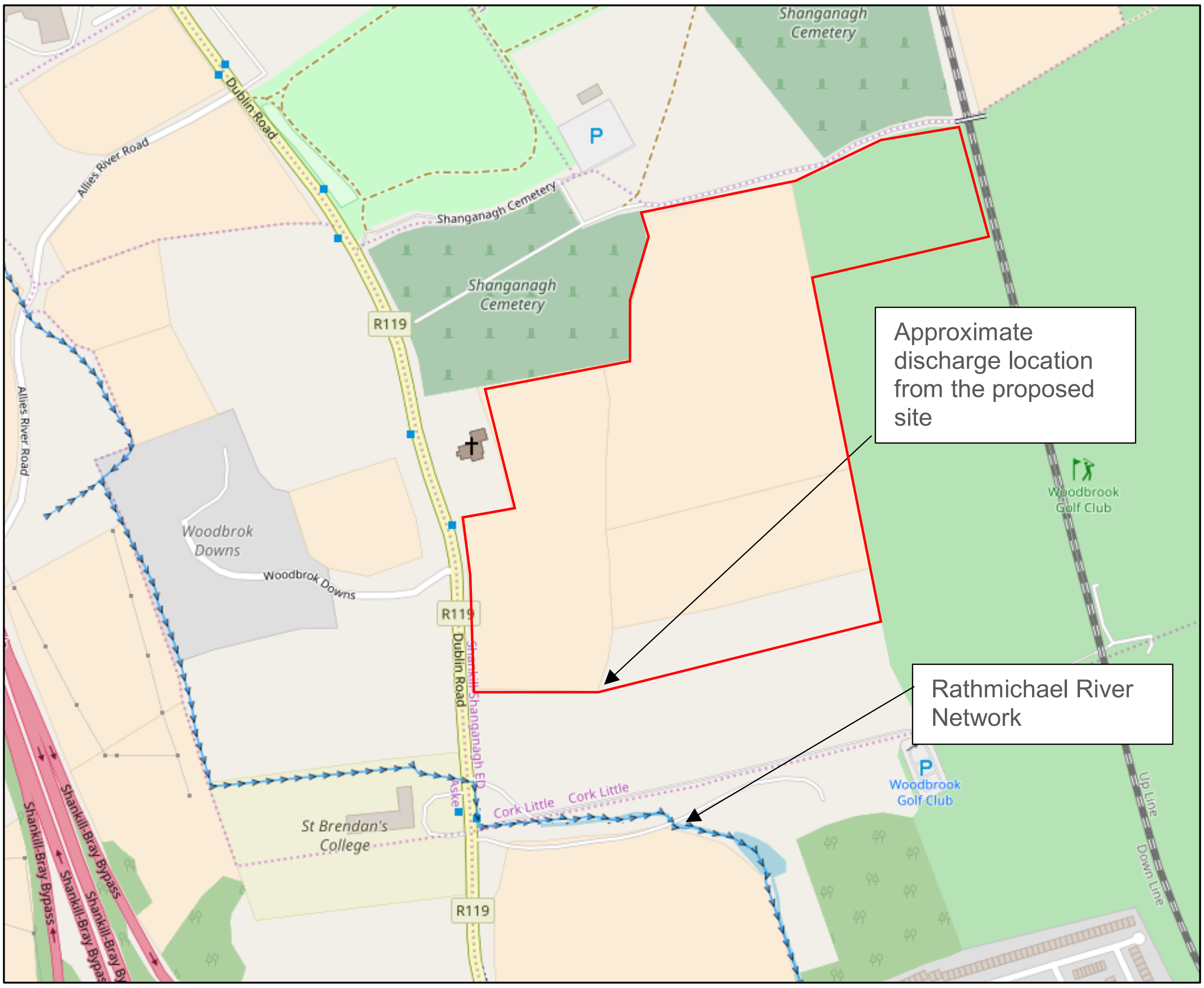
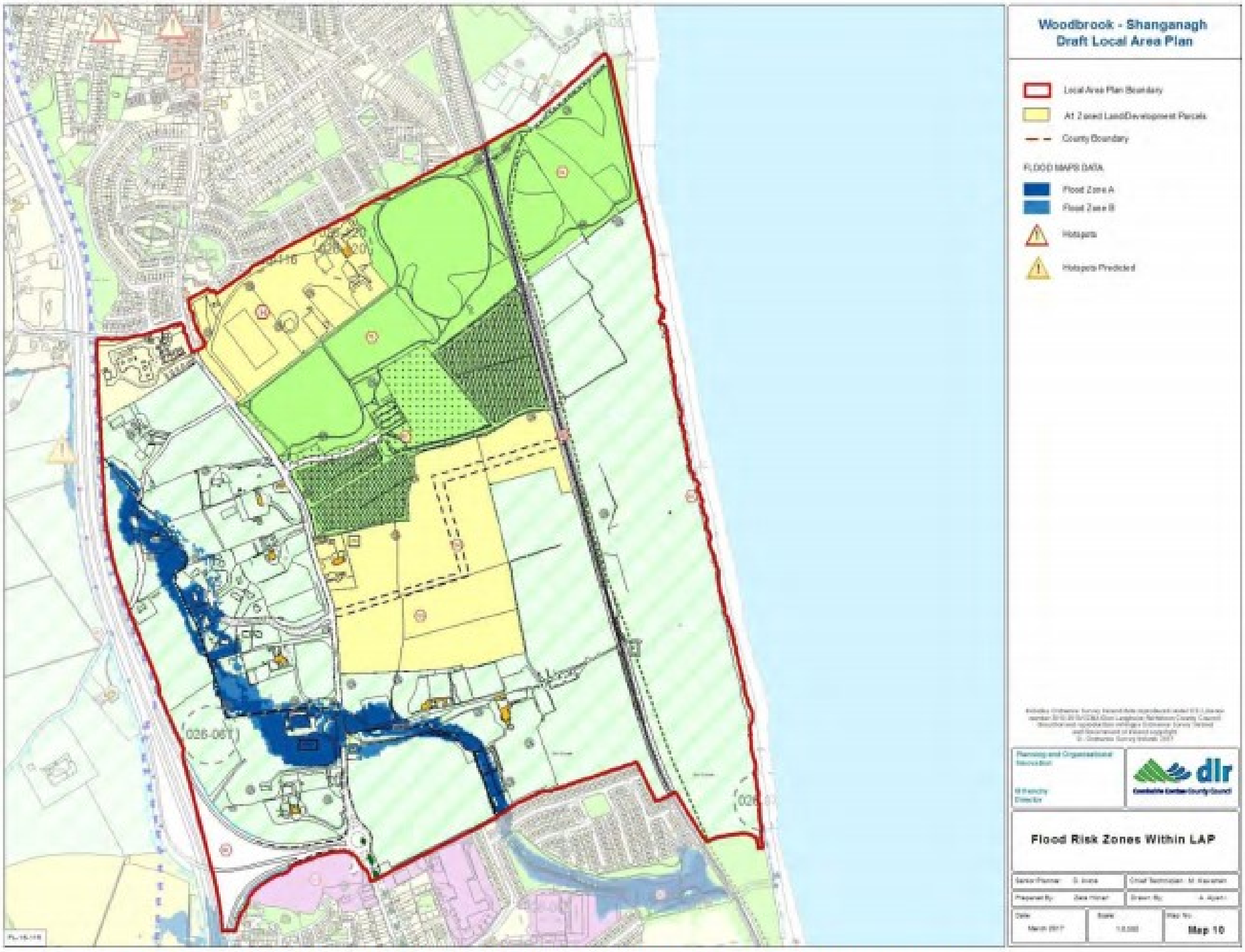


Figure 4 – EPA Mapping

A review of the Woodbrook-Shanganagh Local Area Plan (LAP) 2017-2023 Strategic Flood Risk Assessment (SFRA) was carried out to determine if the onsite field drain / water course is indicated as part the LAP SFRA that was prepared and informed having regard to '*The Planning System and Flood Risk Management Guidelines for Planning Authorities*'. However, the Woodbrook-Shanganagh LAP 2017-2023 SFRA does not indicate any existing water features within the zoned lands of the Site. Refer to Figure 5.

Fig 2: Flood Zones



Source: Extract from SFRA Dún Laoghaire Rathdown County Development Plan 2016-2022)

Figure 5 – Woodbrook-Shanganagh LAP 2017-2023: Flood Risk Zones Map

Site Walkover Survey

In order to verify the desk-based review, a Site walkover survey was conducted by an experienced Atkins Hydrogeologist on two separate occasions (26th June 2018 and 18th September). The onsite field drain / water course transecting the Site was visually checked at all accessible locations. No flowing or standing water was encountered during the survey. Based on the geology of the exposed open channel, the orientation of the channel, and existing land use, it is considered that this feature is a manmade field / drainage ditch.

Conclusion

Having reviewed all available desk-based information, including historic mapping and aerial photography, and based on the observations of an experienced Hydrogeologist during a walkover survey of the Site, it is concluded that this drainage feature is a field ditch. Furthermore there is no evidence that this drainage feature was historically a stream or a river.

Response to Query Item No. 2:
Investigation to Determine Groundwater Flow paths in the vicinity of Proposed Attenuation Tanks nos. 4 and 5 in Zone B, and Potential Impacts

(Note; Tanks 4 & 5 are now referred to as Tanks E and G within the final submitted design report)

Groundwater Investigation to Determine Groundwater Flow paths

Groundwater investigation works were undertaken by Ground Investigations Ireland Ltd. (GIIL) between 27th June and 29th June 2018, and are summarised as follows;

- 3no. boreholes were drilled to a target depth using a Dando 2000 drilling rig; each borehole was then converted to a groundwater monitoring well and screened across the shallow groundwater zone (within saturated subsoils generally gravel / sandy gravelly clay).
- All drilling and installation works were supervised full-time by a Hydrogeologist, who also designed each well installation based on encountered Site conditions at each location.
- Wells were positioned in order to obtain representative baseline data, taking account of the topography of the Site (and therefore likely groundwater flow direction), and adjacent land-uses (which may potentially impact groundwater quality beneath the site).
- One offsite borehole (BH1) was located upgradient of the site, while two boreholes (BH2, BH3) were located onsite, in the eastern and southern portions respectively.
- All wells were screened within the shallow groundwater zone (within saturated subsoils i.e. gravel / sandy gravelly clay).
- All onsite drainage ditches were observed to be dry during both Site walkover surveys carried out by Atkins on 26th June and 18th September.
- Baseline groundwater level monitoring was carried out by GIIL between 16th July and 13th September at groundwater monitoring wells BH1 to BH3.

The following key findings arising from the groundwater investigation were made;

- The results of the groundwater level monitoring programme, undertaken by GIIL over a three-month monitoring period, are presented in Table 1. Shallow groundwater levels ranged from 2.18 meters below ground level (mbgl) (BH1) to >5.00m (BH3) during this period.

Monitoring Location	16th July 2018		19th August 2018		13th September 2018	
	Water Level (mbgl)*	Water Level (mOD)**	Water Level (mbgl)	Water Level (mOD)	Water Level (mbgl)	Water Level (mOD)
BH1	2.18	16.77	2.28	16.67	2.36	16.59
BH2	2.37	16.79	3.32	15.84	3.08	16.08
BH3	4.55	11.35	Assumed Dry	-	Assumed Dry	-

**mbgl denotes meters below ground level, ** mOD denotes meters above Ordnance Datum*

Table 1 - Measured Groundwater Levels (July 2018 to September 2018).

- Shallow groundwater flow is expected to be a subdued reflection of the topography of the Site (refer to Figure 1). Therefore based on topographic levels shallow groundwater from the western portion of the Site will flow in a south-easterly direction. Shallow groundwater from the eastern portion of the Site will flow in a south-westerly direction.
- This is confirmed by site-specific groundwater level monitoring data which verifies that groundwater flow beneath the Site is towards the field ditch. Refer to Figure 6.
- Locally shallow groundwater is likely to discharge to the Rathmichael River (also referred to as the Crinkeen / Woodbrook Stream) further south of the Site.

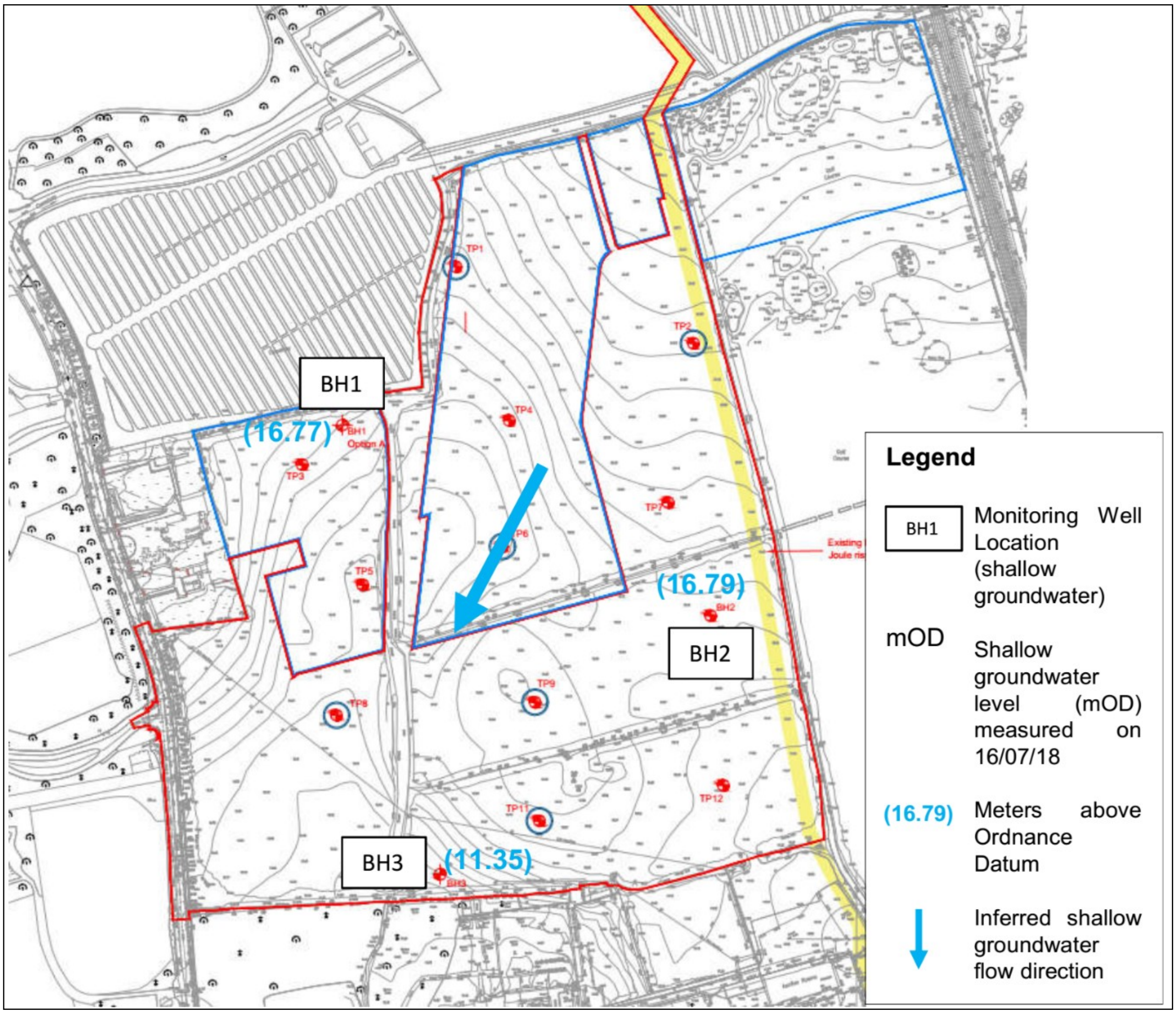


Figure 6 - Piezometric Map Showing Shallow Groundwater Monitoring Locations and Inferred Shallow Groundwater Flow Direction. *(Note shallow groundwater flow confirmed to follow topography as presented in Figure 1).*

Current Hydrogeological Conceptual Site Model – Zone B

Based on the findings of the Groundwater Investigation the following Hydrogeological Conceptual Site Model (CSM) has been derived for the Site;

- Existing rainfall recharge occurs across the greenfield site;
- Recharge is partitioned between overland flow (which discharges to the field ditch north of Zone B), and discharge to ground (via. layers and lenses of sand and gravel, encountered beneath the site). The field ditch north of Zone B also discharges to ground in the vicinity of Zone B, as observed during a number of Site walkover surveys carried out by Atkins Engineers
- Based on groundwater piezometry mapping, shallow water levels specifically in the vicinity of Zone B are estimated to range from approximately 2.0 to 3.5m below ground level (mbgl).
- Shallow groundwater flow will likely follow the topographic contours of the site, towards the field ditch in Zone B; albeit based on site specific data, as evidenced in Figure 7 (a) and (b), this ditch is not groundwater fed. Shallow groundwater flows beneath the ditch, and follows the topography of the site. Shallow groundwater from the western portion of the Site flows in

a south-easterly direction, and from the eastern portion of the Site flows in a south-westerly direction.

- Locally shallow groundwater discharges to the Rathmichael River (also referred to as the Crinkeen / Woodbrook Stream) further south of the Site.

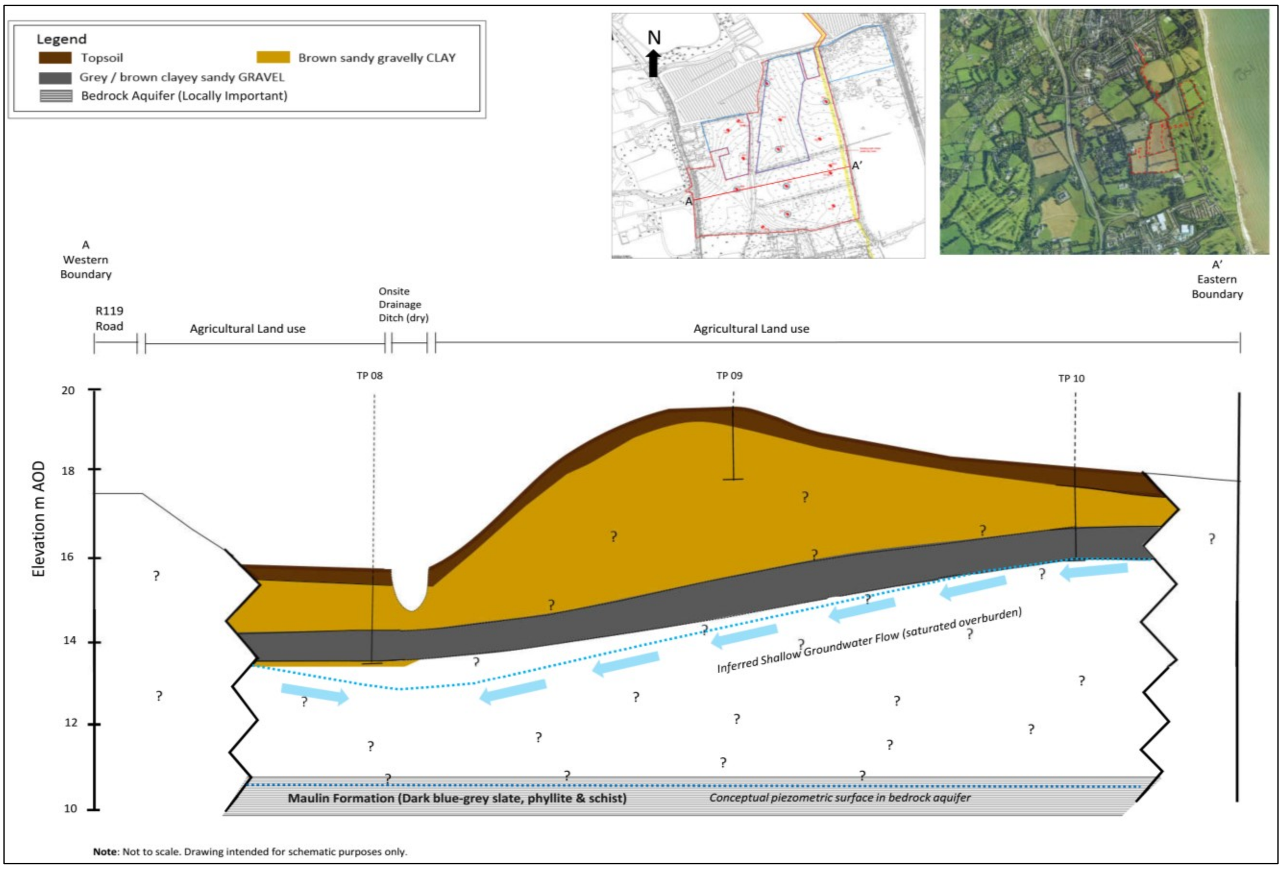
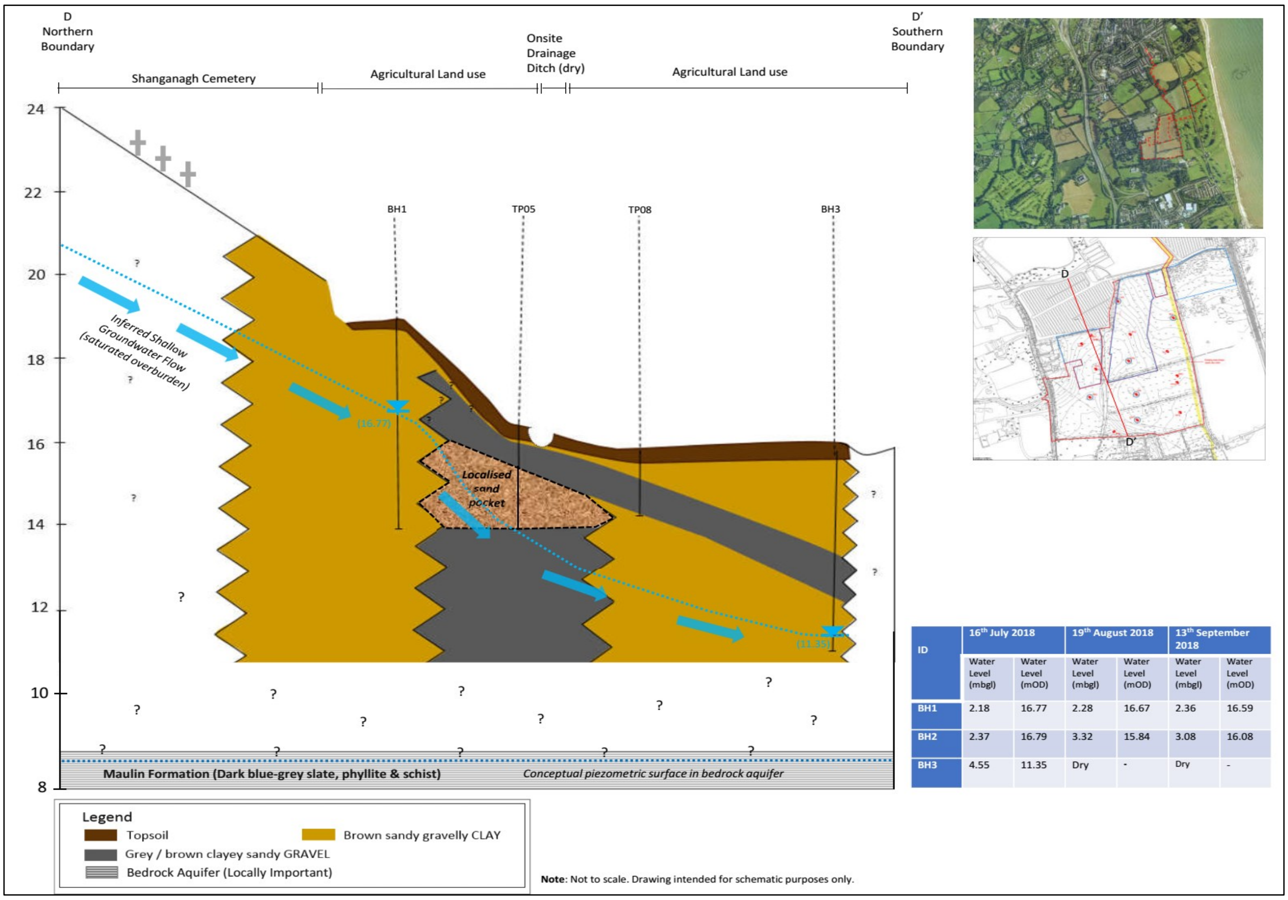


Figure 7 (a) - Site-Specific Geological Cross Sections (A-A') Showing Shallow Groundwater Flow Regime



ID	16th July 2018		19th August 2018		13th September 2018	
	Water Level (mbgl)	Water Level (mOD)	Water Level (mbgl)	Water Level (mOD)	Water Level (mbgl)	Water Level (mOD)
BH1	2.18	16.77	2.28	16.67	2.36	16.59
BH2	2.37	16.79	3.32	15.84	3.08	16.08
BH3	4.55	11.35	Dry	-	Dry	-

Figure 7 (b) - Site-Specific Geological Cross Sections (D-D') Showing Shallow Groundwater Flow Regime

In summary, any storm water drainage captured by the field ditch likely discharges to ground in the vicinity of Zone B, via. layers and lenses of sand and gravel in this area. From here, subsurface groundwater flow paths follow topography and are likely to ultimately discharge to the Rathmichael River (also referred to as the Crinkeen / Woodbrook Stream) further south of the site.

Potential Impacts of Proposed Attenuation Tanks nos. 4 and 5 in Zone B

The location of proposed attenuation tanks E and G (4 and 5) are presented in Figure 8. The installation of the proposed attenuation tanks in Zone B will not have any impact on the existing field ditch or groundwater flow paths based on the following facts: -

- The field ditch is not groundwater fed, as shown in site-specific geological cross sections through Zone B;
- There is no surface water flow in the field ditch downstream of this zone;
- Shallow water levels in this zone are estimated to range from approximately 2.0 to 3.5mbgl;
- The maximum depth of the tanks will not exceed 3m;
- Shallow groundwater flow follows topography across the site; flow paths occur within the saturated overburden comprising gravel and sandy gravelly clay. Groundwater flow across the Site is controlled by hydrostatic head, from areas of high to lower groundwater levels, as clearly shown in Figure 7 (a) and (b). The proposed development will not result in any significant change to the existing topography.
- The tanks have been designed to ensure that they are weighed down where required by increasing the volume of stone below the tank to counteract the hydrostatic head pressure as per design guidelines of the tank supplier. Shallow groundwater will continue to flow, following topography, around and beneath the proposed tanks in this localised area.

Therefore the installation of the proposed attenuation tanks will not have any perceptible impact on existing groundwater flow paths.

- During the construction phase, dewatering maybe required to facilitate the installation of the attenuation tanks (with a maximum excavation depth of approximately 3m). However, any dewatering will be localised and temporary and will not result in any permanent impacts to the existing groundwater flow regime or regional groundwater resource.

Similarly the installation of the proposed attenuation tanks downstream of Zone B, where the dry portions of the field ditch will be infilled as part of the proposed drainage design, will not have any perceptible impact on surface water flows, or groundwater flow paths, based on the above principles. Therefore, based on the hydrogeological conceptual understanding, and the drainage design for the proposed development, there will be no perceptible impacts on local or regional surface water levels, surface water flows, groundwater levels or groundwater flows.

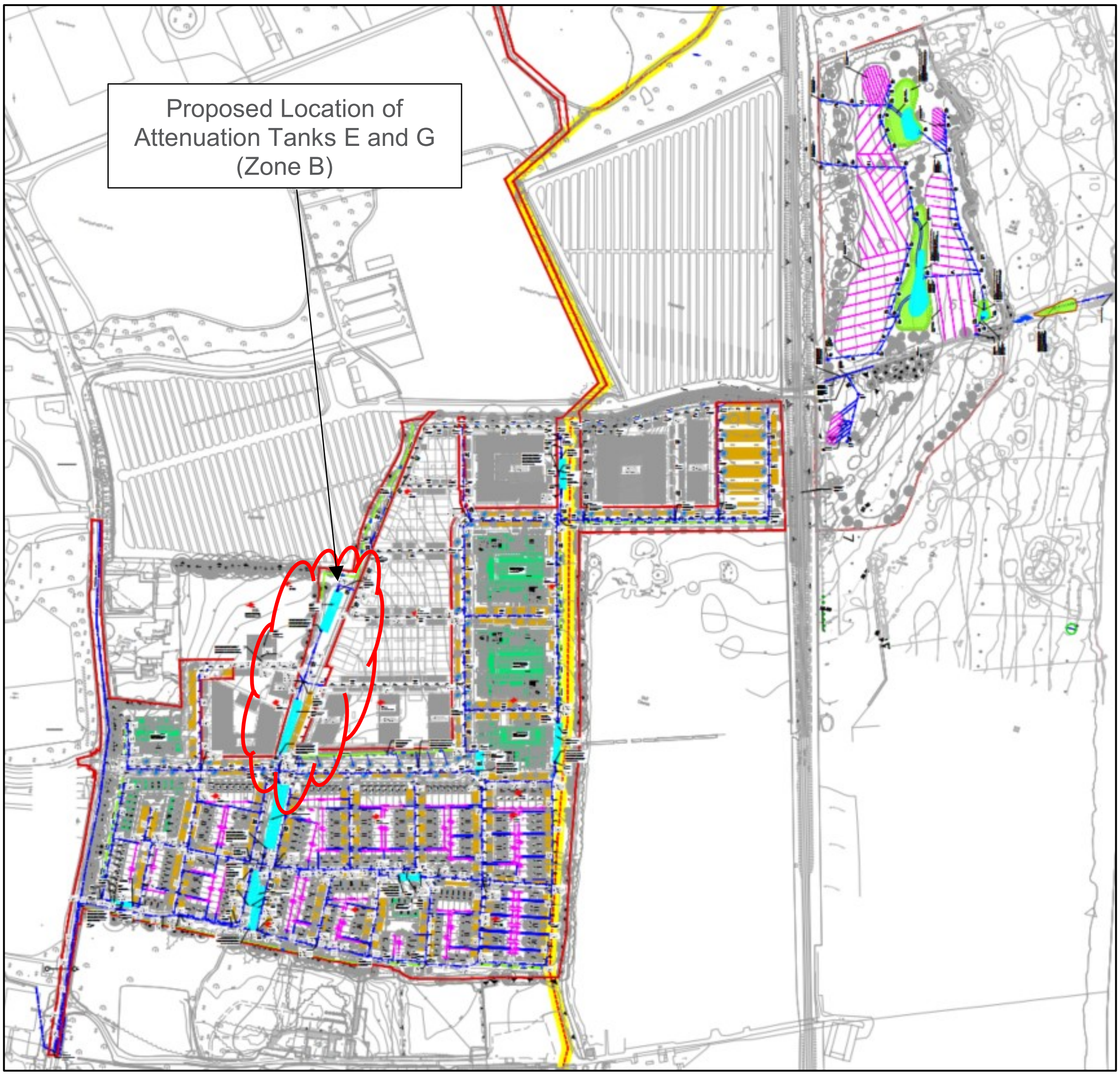


Figure 8 – Proposed Drainage Design and Development Layout

Conclusion

A detailed hydrogeological assessment has been undertaken as requested by DLRCC. This assessment has established shallow groundwater flow paths near the proposed school site, where standing storm water discharges to ground within the field ditch. The proximity and possible flow interaction of proposed attenuation tanks E and G with the field ditch have been fully evaluated. Based on site-specific geological and hydrogeological data, there will be no perceptible impacts on surface water levels, surface water flows, groundwater levels or groundwater flows, specifically in the vicinity of proposed attenuation tanks E and G in Zone B. Furthermore, no such impacts will occur on a local or regional scale associated with the proposed drainage design. Accordingly, potential impacts to the onsite field ditch or groundwater flow paths do not warrant further consideration.

Appendix J. UK SuDS Output

HR Wallingford
Working with water

Page 1
• Full site
• Soil Type 3

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	
Site name:	Woodbrook Development
Site location:	Woodbrook

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the drainage scheme.

Site coordinates

Latitude:	53.21897° N
Longitude:	6.1155° W
Reference:	
Date:	2019-08-21 13:23

Methodology	IH124

Site characteristics

Total site area (ha)	21
Significant public open space (ha)	8.801
Area positively drained (ha)	12.199
Pervious area contribution (%)	30
Impermeable area (ha)	9.094
Percentage of drained area that is impermeable (%)	75
Impervious area drained via infiltration (ha)	0
Return period for infiltration system design (year)	10
Impervious area drained to rainwater harvesting systems (ha)	0
Return period for rainwater harvesting system design (year)	10
Compliance factor for rainwater harvesting system design (%)	66
Net site area for storage volume design (ha)	12.2
Net impermeable area for storage volume design (ha)	9.44

* Where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50 % of the 'area positively drained', the 'net site area' and the estimates of Qbar and other flow rates will have been reduced accordingly.

Design criteria

Volume control approach: Flow control to max of 2 l/s/ha or

	Default	Edited
Climate change allowance factor	1.1	1.1
Urban creep allowance factor	1	1
Interception rainfall depth (mm)	5	5
Minimum flow rate (l/s)	5	5

Qbar estimation method: Calculate from SPR and SAAR
SPR estimation method: Calculate from SOIL type

	Default	Edited
Qbar total site area (l/s)	53.43	--
SOIL type	2	3
HOST class	N/A	N/A
SPR	0.3	0.37

Hydrology

	Default	Edited
SAAR (mm)	931	825
M5-60 Rainfall Depth (mm)	17	17
'r' Ratio M5-60/M5-2 day	0.3	0.3
Rainfall 100 yrs 6 hrs	61	
Rainfall 100 yrs 12 hrs	73	
FEH/FSR conversion factor	1	1
Hydrological region	12	
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 10 year	1.72	1.72
Growth curve factor: 30 year	2.13	2.13
Growth curve factor: 100 year	2.61	2.61

As Requested

Site discharge rates

	Default	Edited
Qbar total site area (l/s)	53.43	73.11
Qbar net site area (l/s)	31.04	42.47
1 in 1 year (l/s)	26.4	36.1
1 in 30 years (l/s)	31	42.5
1 in 100 years (l/s)	31	42.5

Estimated storage volumes

	Default	Edited
Interception storage (m^3)	364	364
Attenuation storage (m^3)	5968	5422
Long term storage (m^3)	0	0
Treatment storage (m^3)	1091	1091
Total storage *(excluding treatment)* (m^3)	6332	5786

HR Wallingford
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Page 2
• Full site
• Soil Type 4

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	
Site name:	Woodbrook Development
Site location:	Woodbrook

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the drainage scheme.

Site coordinates

Latitude:	53.21897° N
Longitude:	6.1155° W

Reference:	
Date:	2019-08-21 13:24

Methodology	IH124

Site characteristics

Total site area (ha)	21
Significant public open space (ha)	8.801
Area positively drained (ha)	12.199
Pervious area contribution (%)	30
Impermeable area (ha)	9.094
Percentage of drained area that is impermeable (%)	75
Impervious area drained via infiltration (ha)	0
Return period for infiltration system design (year)	10
Impervious area drained to rainwater harvesting systems (ha)	0
Return period for rainwater harvesting system design (year)	10
Compliance factor for rainwater harvesting system design (%)	66
Net site area for storage volume design (ha)	12.2
Net impermeable area for storage volume design (ha)	9.53

* Where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50 % of the 'area positively drained', the 'net site area' and the estimates of Qbar and other flow rates will have been reduced accordingly.

Design criteria

Volume control approach	Flow control to max of 2 l/s/ha or	

	Default	Edited
Climate change allowance factor	1.1	1.1
Urban creep allowance factor	1	1
Interception rainfall depth (mm)	5	5
Minimum flow rate (l/s)	5	5

Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type

	Default	Edited
Qbar total site area (l/s)	53.43	--
SOIL type	2	4
HOST class	N/A	N/A
SPR	0.3	0.47

Hydrology

As requested

	Default	Edited
SAAR (mm)	931	825
M5-60 Rainfall Depth (mm)	17	17
'r' Ratio M5-60/M5-2 day	0.3	0.3
Rainfall 100 yrs 6 hrs	61	
Rainfall 100 yrs 12 hrs	73	
FEH/FSR conversion factor	1	1
Hydrological region	12	
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 10 year	1.72	1.72
Growth curve factor: 30 year	2.13	2.13
Growth curve factor: 100 year	2.61	2.61

Site discharge rates

	Default	Edited
Qbar total site area (l/s)	53.43	122.87
Qbar net site area (l/s)	31.04	71.38
1 in 1 year (l/s)	26.4	60.7
1 in 30 years (l/s)	31	71.4
1 in 100 years (l/s)	31	71.4

Estimated storage volumes

	Default	Edited
Interception storage (m^3)	364	364
Attenuation storage (m^3)	5968	4488
Long term storage (m^3)	0	0
Treatment storage (m^3)	1091	1091
Total storage *(excluding treatment)* (m^3)	6332	4852

Page 3
- 52% of Site
- Soil Type 3

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Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:

Site name: Woodbrook Development

Site location: Woodbrook

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the drainage scheme.

Site coordinates

Latitude: 53.21897° N

Longitude: 6.1155° W

Reference:

Date: 2019-08-21 13:43

Methodology	IH124

Site characteristics

Total site area (ha)	10.920
Significant public open space (ha)	4.577
Area positively drained (ha)	6.343
Pervious area contribution (%)	30
Impermeable area (ha)	4.729
Percentage of drained area that is impermeable (%)	75
Impervious area drained via infiltration (ha)	0
Return period for infiltration system design (year)	10
Impervious area drained to rainwater harvesting systems (ha)	0
Return period for rainwater harvesting system design (year)	10
Compliance factor for rainwater harvesting system design (%)	66
Net site area for storage volume design (ha)	6.34
Net impermeable area for storage volume design (ha)	4.91

* Where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50 % of the 'area positively drained', the 'net site area' and the estimates of Qbar and other flow rates will have been reduced accordingly.

Design criteria

Volume control approach: Flow control to max of 2 l/s/ha or

	Default	Edited
Climate change allowance factor	1.1	1.1
Urban creep allowance factor	1	1
Interception rainfall depth (mm)	5	5
Minimum flow rate (l/s)	5	5

Qbar estimation method: Calculate from SPR and SAAR

SPR estimation method: Calculate from SOIL type

	Default	Edited
Qbar total site area (l/s)	27.78	--
SOIL type	2	3
HOST class	N/A	N/A
SPR	0.3	0.37

Hydrology

	Default	Edited
SAAR (mm)	931	825
M5-60 Rainfall Depth (mm)	17	17
'r' Ratio M5-60/M5-2 day	0.3	0.3
Rainfall 100 yrs 6 hrs	61	
Rainfall 100 yrs 12 hrs	73	
FEH/FSR conversion factor	1	1
Hydrological region	12	
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 10 year	1.72	1.72
Growth curve factor: 30 year	2.13	2.13
Growth curve factor: 100 year	2.61	2.61

Site discharge rates

	Default	Edited
Qbar total site area (l/s)	27.78	38.02
Qbar net site area (l/s)	16.14	22.08
1 in 1 year (l/s)	13.7	18.8
1 in 30 years (l/s)	16.1	22.1
1 in 100 years (l/s)	16.1	22.1

Estimated storage volumes

	Default	Edited
Interception storage (m^3)	189	189
Attenuation storage (m^3)	3103	2820
Long term storage (m^3)	0	0
Treatment storage (m^3)	567	567
Total storage *(excluding treatment)* (m^3)	3293	3009

Page 4
· 48% of Site
· Soil Type 4.

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Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:

Site name: Woodbrook Development

Site location: Woodbrook

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the drainage scheme.

Site coordinates

Latitude: 53.21897° N

Longitude: 6.1155° W

Reference:

Date: 2019-08-21 13:45

Methodology	IH124

Site characteristics

Total site area (ha)	10.080
Significant public open space (ha)	4.224
Area positively drained (ha)	5.856
Pervious area contribution (%)	30
Impermeable area (ha)	4.365
Percentage of drained area that is impermeable (%)	75
Impervious area drained via infiltration (ha)	0
Return period for infiltration system design (year)	10
Impervious area drained to rainwater harvesting systems (ha)	0
Return period for rainwater harvesting system design (year)	10
Compliance factor for rainwater harvesting system design (%)	66
Net site area for storage volume design (ha)	5.86
Net impermeable area for storage volume design (ha)	4.58

* Where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50 % of the 'area positively drained', the 'net site area' and the estimates of Qbar and other flow rates will have been reduced accordingly.

Design criteria

Volume control approach: Flow control to max of 2 l/s/ha or

	Default	Edited
Climate change allowance factor	1.1	1.1
Urban creep allowance factor	1	1
Interception rainfall depth (mm)	5	5
Minimum flow rate (l/s)	5	5

Qbar estimation method: Calculate from SPR and SAAR

SPR estimation method: Calculate from SOIL type

	Default	Edited
Qbar total site area (l/s)	25.65	--
SOIL type	2	4
HOST class	N/A	N/A
SPR	0.3	0.47

Hydrology

	Default	Edited
SAAR (mm)	931	825
M5-60 Rainfall Depth (mm)	17	17
'r' Ratio M5-60/M5-2 day	0.3	0.3
Rainfall 100 yrs 6 hrs	61	
Rainfall 100 yrs 12 hrs	73	
FEH/FSR conversion factor	1	1
Hydrological region	12	
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 10 year	1.72	1.72
Growth curve factor: 30 year	2.13	2.13
Growth curve factor: 100 year	2.61	2.61

Site discharge rates

	Default	Edited
Qbar total site area (l/s)	25.65	58.98
Qbar net site area (l/s)	14.9	34.26
1 in 1 year (l/s)	12.7	29.1
1 in 30 years (l/s)	14.9	34.3
1 in 100 years (l/s)	14.9	34.3

Estimated storage volumes

	Default	Edited
Interception storage (m^3)	175	175
Attenuation storage (m^3)	2864	2154
Long term storage (m^3)	0	0
Treatment storage (m^3)	524	524
Total storage *(excluding treatment)* (m^3)	3039	2329

Appendix K. Responses to Queries from DLRCC at pre planning stage

Item	DLRCC Comments	Atkins Responses
1	Prior to the submission of full planning application the applicant will be required to provide full supporting information for both of the surface water discharge options. In the case of the preferred option (SLA Stephen Little & Associates) of discharging through third party lands, the applicant will be required to provide the necessary consents and draft wayleave agreement between the applicant and the third party landowner. Any such wayleave shall be made transferable to Dun Laoghaire-Rathdown County Council upon completion of the development.	As outlined in the Atkins Stormwater Impact Assessment Report 5154251DG0011 and associated design drawings the outfall location has been revised to remove requirement to discharge through third party lands. Storm drainage from the site will discharge directly the Crinken / Rathmichael stream via a proposed storm drainage network along the Dublin Road. The revised outfall location was discussed and outlined to DLRCC prior to planning lodgement.
2	No details have been provided in the submission pack on the proposed Bioretention areas and swales. The applicant will be required to submit calculations that demonstrate that they have been designed in accordance with the recommendations of CIRIA C753 (The SuDS manual).	Bioretention areas have been removed from the design due to site constraints. Refer to design Atkins Stormwater Impact Assessment Report 5154251DG0011 and associated design drawings for proposed swale details in accordance with the recommendations of CIRIA C753 (The SuDS manual).
3	The surface water drainage network has been spilt into a number of sub-catchments. For clarity, the applicant will be required to submit a Site Services Layout showing the contributing areas to each of the proposed sub-catchments and shall submit Qbar calculations for each of the sub catchments that demonstrate that the requirement to limit runoff to 2l/s/ha or Qbar, whichever is greater, is being achieved. In identifying the sub-catchments, the applicant will be required to provide details of the locations of the connection(s) to the drainage network from the green roof runoff. (The sub- catchments are to be labelled and the same labelling is to be used in the supporting Microdrainage calculations).	Refer to the Atkins Stormwater Impact Assessment Report 5154251DG0011 and associated design drawings for contributing areas to each of the proposed sub-catchments, associated Qbar calculations for each of the sub catchments and connection locations to the drainage network from the green roofs. All sub catchments have been labelled with the same labelling highlighted within the Microdrainage calculations as discussed with DLRCC.
4	The applicant will be required to provide fully dimensioned plans and sections of the storage systems. All relevant inlet and outlet levels, dimensioned clearances between other utilities, and actual depths of cover to the tanks shall be provided. The applicant will be required to include confirmation from the chosen manufacturer of the storage systems that the specific model chosen, with the depth of cover being provided, has the required load bearing capacity to support vehicular traffic loading that the roadway above has been designed for.	As outlined in the Atkins Stormwater Impact Assessment Report 5154251DG0011 and associated design drawings. Minimum depths of tank have been designed in accordance with manufactures guidelines and recommendations for each model chosen.
5	It would appear from the information provided that certain sections of the surface water drainage system do not drain to in-line attenuation storage systems. All surface water drainage systems shall be in-line and the applicant will be required to amend the design to accord with this requirement.	Refer to the Atkins Stormwater Impact Assessment Report 5154251DG0011 and associated design drawings. All surface water attenuation systems are designed as in-line in accordance with DLRCC requirements.
6	The applicant is required to justify the excessive depth of some elements of the surface water drainage system as the necessity for same is not immediately apparent.	Refer to the Atkins Stormwater Impact Assessment Report 5154251DG0011 and associated design drawings for final storm drainage layout design. The storm network has been designed to ensure excessive depths are removed were possible and in accordance with design guidelines.

7	The applicant will be required to provide cross sections detailing all utilities and showing vertical and horizontal separation distances at critical locations.	Longitudinal sections have been provided on drawings 5154251 / EWE / DR / 0510 - 0514. Foul drainage network crossing area indicated on storm drainage longitudinal sections. A full clash detection exercise has also been carried out with IW to ensure no clashes between storm and foul drainage prior to issue of the letter of conformance.
8	The SAAR, and M5-60 chosen figures shall be supported by Met Eireann data.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 for SAAR values chosen and M5-60 figures support Met Eirean data and agreed with DLRCC
9	The applicant will be required to submit supporting calculations demonstrating how the interception and treatment volume requirements are being achieved across the site and for each sub-catchment.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011
10	On each drawing of the surface water drainage layout, the applicant will be required to provide a key to show the location of each particular drawing of the storm water layout, with reference to the other storm water layout drawings.	Refer to Atkins drawings 5154251 / EWE / DR / 0500 - 0507.
11	The applicant will be required to provide total roof areas to demonstrate that the minimum coverage requirement of 60% is being achieved. The applicant will also be required to provide details of maintenance access to the green roofs and should note that in the absence of a stairwell type access to the roof, provision should be made for alternative maintenance and access arrangements such as external mobile access that will be centrally managed. (Note: it would appear that access to some elements of green roofs is being proposed from hatches within buildings). In apartment blocks where green roofs are not being provided the applicant will be required to provide alternative soft SuDS measures, in accordance with Council policy, in lieu of Green roof coverage forgone.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 and associated drawing 5154251 / EWE / DR / 0600
12	The applicant will be required to submit details of the type(s) of green roof being proposed.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 and associated drawing 5154251 / EWE / DR / 0600
13	All of the surface water drainage elements will have to be constructed in advance of, and protected from potential damage during construction of, future phasing of the development. The applicant will be required to provide significant detail in the Construction Management Plan of the measures proposed to construct and protect the surface water drainage elements.	It is noted that based on the proposed phasing for phase 1 and phase 2 of the Woodbrook Development no elements of the surface water drainage system will need to be constructed in areas that will be used for construction phase 2 construction. All surface water drainage elements in phase 1 are in areas that will be completed as outlined in the planning application
14	Given that the applicant is proposing SuDS measures that incorporate the use of infiltration, the applicant will be required to provide details of each SuDS measure and confirm whether it will be lined/tanked or not. If lined/tanked systems are to be used then the applicant will be required to explain the rationale behind this.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 and associated drawings.
15	As standard, the applicant is required to provide Penstocks in the Hydrobrake chambers and to ensure that the Hydrobrakes provided do not have bypass doors.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011.

16	The applicant will be required to show the areas contributing to the swales and bioretention areas.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 for areas contributing to swales. Note that Bioretention areas have been removed from the design due to site constraints.
17	The applicant will be required to show the areas contributing to the permeable paving areas.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 for areas contributing to swales.
18	The applicant will be required to confirm that a bio-retention area, shown on Atkins Drawing SK/001, BSM Drawing No.307 and Section 5.6 of the Planning Statement but not on Atkins drawing DR/0502 (main Surface Water drainage drawing) is not being proposed above attenuation tank no.6.	Bioretention areas have been removed from the design due to site constraints.
19	The applicant will be required to check whether attenuation tank no.4 is partially located within a root protection zone. As standard, the applicant will be required to ensure that landscape drawings are compatible with engineering drawings, i.e. above ground drainage features are shown and labelled in the landscape key and that the planting is located so as not to hinder the effectiveness of drainage features, etc.	A full design check of root protection zones have been carried out on the final drainage design. Root protection zones are indicated on storm drainage drawings 5154251 / EWE / DR / 0501 - 507. Landscape layouts are indicated on storm drainage layout drawings. Root protection barriers have been indicated to attenuation tanks.
20	Some of the attenuation storage tanks operate in series. For clarity, the applicant will be required to identify the sections of the Micro drainage reports where the outflow values from the upstream catchments are inputted into the downstream attenuation storage volume calculations.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 and associated drawings.
21	The applicant will be required to make provision for surface water runoff from both the proposed DART station and School and to identify the sections of the Micro drainage reports where the outflow values from these locations are inputted into the downstream attenuation storage volume calculations.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 and associated drawings.
22	The applicant will be required to provide long sections of the surface water drainage system.	Refer to Atkins drawings 5154251 / EWE / DR / 0510 - 514.
23	The applicant will be required to agree runoff coefficients with Municipal Services.	Rates agreed with DLRCC and outlined in Atkins Stormwater Impact Assessment Report - 5154251DG0011
24	A Stormwater Audit will be required for this application. In accordance with the Stormwater Audit policy, the audit shall be forwarded to DLRCC **prior to** lodging the planning application. All recommendations shall be complied with, unless agreed in writing otherwise with DLRCC.	A Stormwater Audit has been completed for this application in accordance with the Stormwater Audit policy and submitted DLRCC prior to lodging the planning application. It is noted that there are no outstanding comments within the Audit.
25	The applicant will be required to undertake further investigations to determine the (underground?) flow paths of the outflow from the existing watercourse/ditch which terminates near the proposed school site. The proximity and possible flow interaction of the proposed attenuation tanks nos. 4 and 5 in Zone B with the above mentioned watercourse/ditch needs further examination.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 for details of investigations and reports carried out
26	The applicant will be required to submit groundwater monitoring and site investigation results in support of the surface water drainage design parameters chosen.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 for a full set of site investigations carried out and results supporting the surface water drainage design parameters chosen.

27	A proposal for alternative soft Suds measures will be required for Zone D in lieu of Green Roofs. Innovative solutions for an urban environment would be welcomed. It is not readily apparent from the submitted information as to whether this requirement has been fully addressed.	Design amended to include green roofs and courtyards to previous Zone D following pre planning meeting with ABP and uplift in density. Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 and associated drawing 5154251 / EWE / DR / 0600
28	The bioretention areas shown on drawing nos. DR/0503 and DR/0504 impinge upon, and should be relocated outside of, the existing Irish Water wayleave. Drawing no. SK/0001 should be updated to be consistent with the details shown on drawing nos. DR/0501 to DR/0506.	Note that Bioretention areas have been removed from the design due to site constraints.
29	Attenuation tank no.2 would appear to be in close proximity to a proposed apartment block. The applicant will be required to submit details demonstrating that the minimum separation distances are being achieved.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 and associated drawings. Layout of the storm drainage layout has been amended since previous review.
30	As standard, a surcharge analysis of the surface water drainage system will be required with commentary on the significance, if any, of possible surcharges with reference to the freeboard used in the calculations. A further analysis to determine the impact of a 50% blockage in the surface water drainage system will be required and shall be referenced in the Site Specific Flood Risk Assessment.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 appendix G.1 for comments on surcharging depths indicated on micro drainage outputs. A 50% blockage analysis has been carried out at 3No. Location within the site and discussed with DLRCC and is further discussed in the Atkins Stormwater Impact Assessment Report - 5154251DG0011. The FRA has been updated to include references in relation to the proposed storm drainage system.
31	The applicant has proposed a Stormtech attenuation storage solution for this site. Any alternative proposals will require the approval of DLRCC prior to the submission of a full planning application.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 and associated drawings for details of proposed Stormtech attenuations storage. It is noted that no other alternative systems have been proposed.
32	The proposal to provide a foul drainage holding tank and rising main(s) within the site is noted. As failure to maintain this arrangement could result in public health issues, the applicant will be required to provide certainty with regards Irish Water's responsibility for future maintenance and ownership of this foul drainage infrastructure.	A full report on the design of the foul drainage PS and holding tank has been issued and agreed with IW. Refer to Atkins report 5154251DG0053. The PS will be operated and maintained by IW and there agents.
33	The location of the proposed foul drainage holding tank adjacent to the proposed surface water drainage outfall to the existing ditch/watercourse is noted. The applicant will be required to provide details of proposed measures that will prevent pollution of the ditch/watercourse in the event of the storage capacity of the holding tank being exceeded. Given the location of the tank and pumphouse in a residential area and its close proximity to third party lands, the Bord may also consider it prudent for the applicant to undertake an odour and noise impact assessment.	A full report on the design of the foul drainage PS and holding tank has been issued and agreed with IW. Refer to Atkins report 5154251DG0053. The systems has been designed in accordance with IW COP including emergency overflow tank size, screened overflow requirements, odour control and minimum distances from dwellings
34	The applicant will be required to submit Qbar calculations for the New Golf Holes catchment that demonstrate that the requirement to limit runoff to 2l/s/ha or Qbar, whichever is greater, is being achieved. The Microdrainage calculations shall be clearly labelled as New Golf Holes catchment.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 and associated drawings for golf course design.

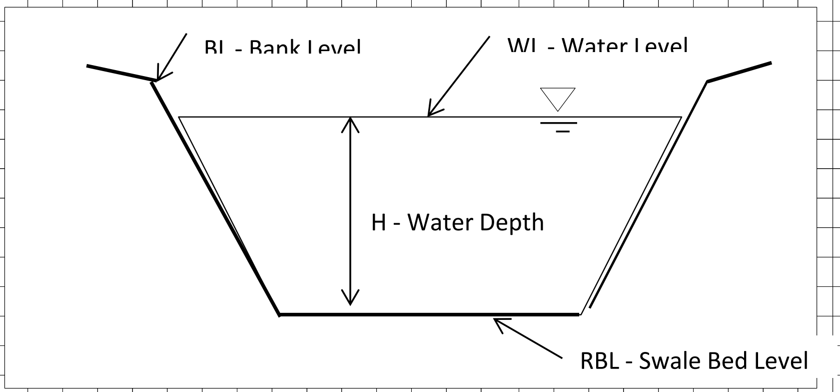
35	The applicant will be required to submit full details and design calculations for the proposed attenuation ponds shown in Atkins drawing No. 5138766/C/001 Rev A. The applicant will be required to ensure that the separation distance between the proposed location of inlet S8 and outlet S7 (larger pond) and the overall design is in accordance with CIRIA C753 guidance.	Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011 and associated drawings
36	On Atkins drawing No. 5138766/C/001 Rev A., notes attached to manholes S1, S12 and S9 reference “spur to be capped for possible future use”. The possible future use does not seem to have been described or quantified in the current submission. The applicant will be required to submit full details of possible future connections and to demonstrate that the proposed ponds have been sized for any such future use.	The "spur to be capped for possible future use" has been made available to allow for DLRCC to drain any future footpath along the railway line. Any additional runoff would be required to be agreed and attenuated prior to discharge into the proposed golf course network.
37	The applicant will be required to submit full details of the additional attenuation storage that is proposed within the natural valley of the existing golf course lands as referenced in Section 4.2 of the Woodbrook Phase 1 Planning statement submitted as part of this application	As agreed with DLRCC and outlined in Refer to Atkins Stormwater Impact Assessment Report - 5154251DG0011, the existing manhole cover has been raised by 300mm providing an additional volume of circa 99m3 above the attenuation volumes provided as part of the proposed golf course layouts

Appendix L. Swale Design for Phase 1

ATKINS	Project: **Woodbrook Development**		Sheet No. **1** Rev **-**
	Sub Section: **Storm Drainage - Conveyance Swale A1**		Job No: **5154251**
	Calc By **AC** Date **09/08/2019**		Check By **GH** Date **09/08/2019**

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0050	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.30 m/s

For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

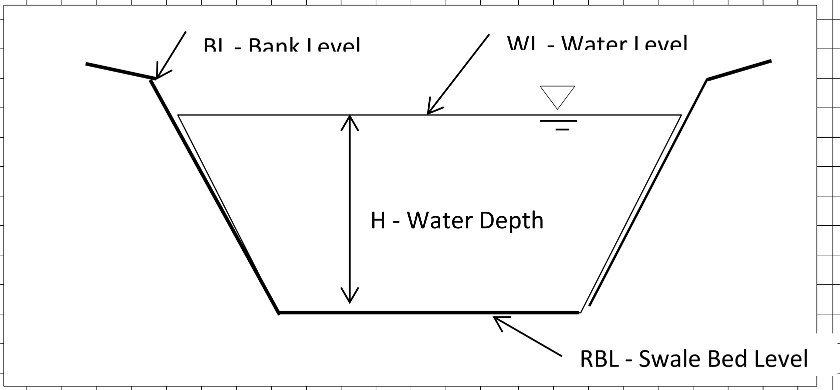
Maximum Contributing road area to Swale = 90m2
Swale Length 30m
Minimum Vegitated area receiving runoff = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

Project	Woodbrook Development	Sheet No. 2	Rev -
Sub Section	Storm Drainage - Conveyance Swale A2	Job No: 5154251	
Calc By AC	Date 09/08/2019	Check By GH	Date 09/08/2019

ATKINS

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3} S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0044	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.28 m/s

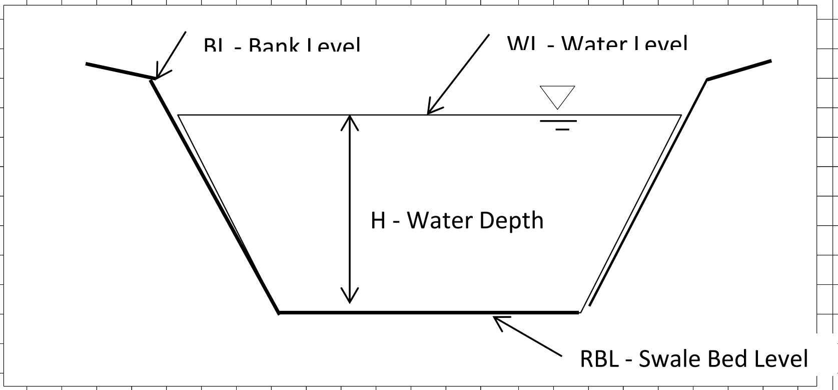
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing road area to Swale = 90m2
Swale Length 14m
Minimum Vegitated area receiving runoff = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: **Woodbrook Development**	Sheet No. 3 Rev -
	Sub Section: **Storm Drainage - Conveyance Swale A3**	Job No: **5154251**
	Calc By **AC** Date **09/08/2019**	Check By **GH** Date **09/08/2019**

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3} S^{1/2}}{n}$$

Parameters

n	=	Mannings Roughness Value
S	=	Slope
A	=	Area
P	=	Wetted Perimeter
R	=	Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0050	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.30 m/s

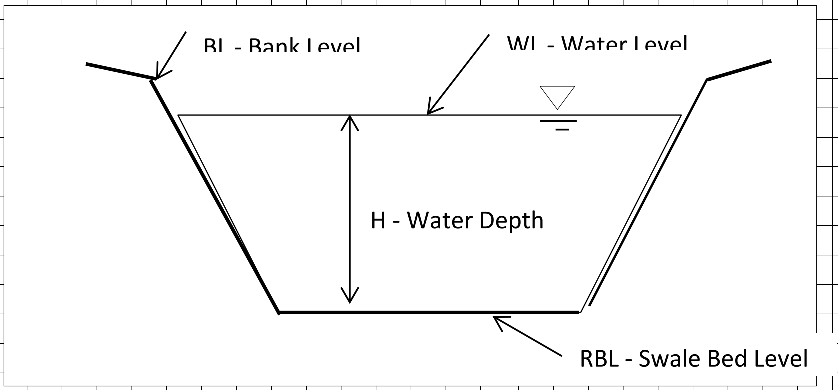
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 30m
Minimum Vegitated area receiving runoff = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: **Woodbrook Development**	Sheet No. 4	Rev -
	Sub Section: **Storm Drainage - Conveyance Swale A4**	Job No: **5154251**	
	Calc By **AC** Date **09/08/2019**	Check By **GH**	Date **09/08/2019**

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n	=	Mannings Roughness Value
S	=	Slope
A	=	Area
P	=	Wetted Perimeter
R	=	Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0030	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.23 m/s

For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

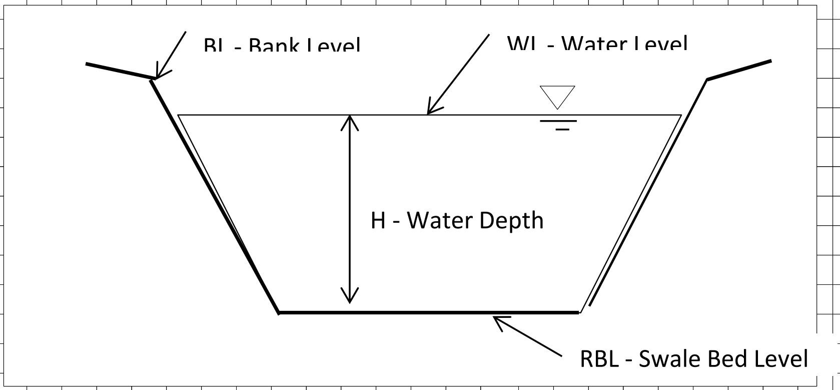
Maximum Contributing area to Swale = 90m2
Swale Length 13m
Minimum Vegitated area receiving runoff = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

Project	Woodbrook Development	Sheet No. 5	Rev -
Sub Section	Storm Drainage - Conveyance Swale A5	Job No: 5154251	
Calc By AC	Date 09/08/2019	Check By GH	Date 09/08/2019

ATKINS

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0100	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.43 m/s

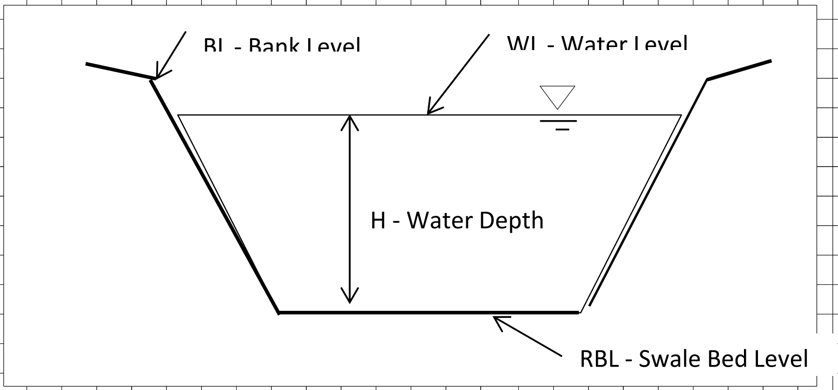
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 30m
Minimum Vegitated area receiving runoff = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: Woodbrook Development	Sheet No.: 6	Rev: -
	Sub Section: Storm Drainage - Conveyance Swale A6	Job No: 5154251	
	Calc By: AC — Date: 09/08/2019	Check By: GH	Date: 09/08/2019

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0080	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.38 m/s

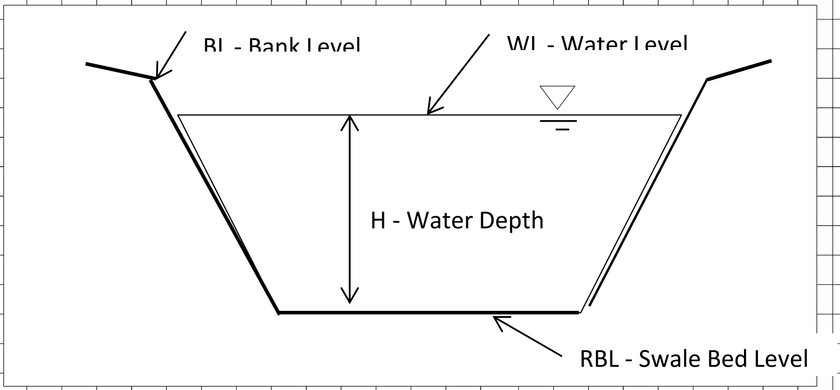
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 30m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: **Woodbrook Development**	Sheet No. 7	Rev -
	Sub Section: **Storm Drainage - Conveyance Swale A7**	Job No: **5154251**	
	Calc By **AC** Date **09/08/2019**	Check By **GH**	Date **09/08/2019**

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3} S^{1/2}}{n}$$

Parameters

n	=	Mannings Roughness Value
S	=	Slope
A	=	Area
P	=	Wetted Perimeter
R	=	Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0100	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.43 m/s

For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

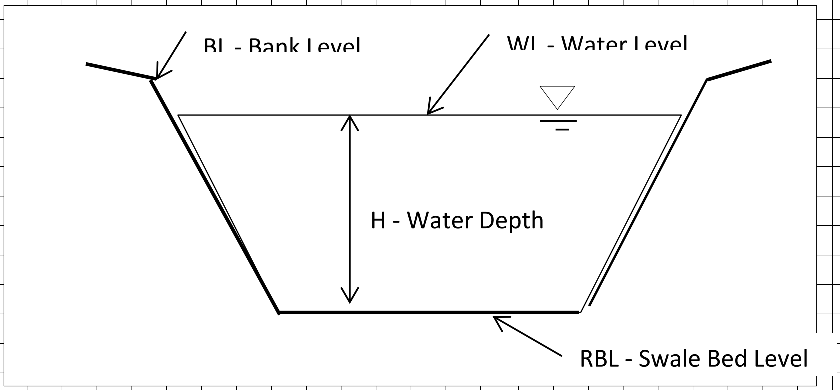
Maximum Contributing area to Swale = 90m2
Swale Length 15m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

Project	Woodbrook Development	Sheet No. 8	Rev -
Sub Section	Storm Drainage - Conveyance Swale B1	Job No: 5154251	
Calc By	AC	Check By	GH
Date	09/08/2019	Date	09/08/2019

ATKINS

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3} S^{1/2}}{n}$$

Parameters

n	=	Mannings Roughness Value
S	=	Slope
A	=	Area
P	=	Wetted Perimeter
R	=	Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0090	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.41 m/s

For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

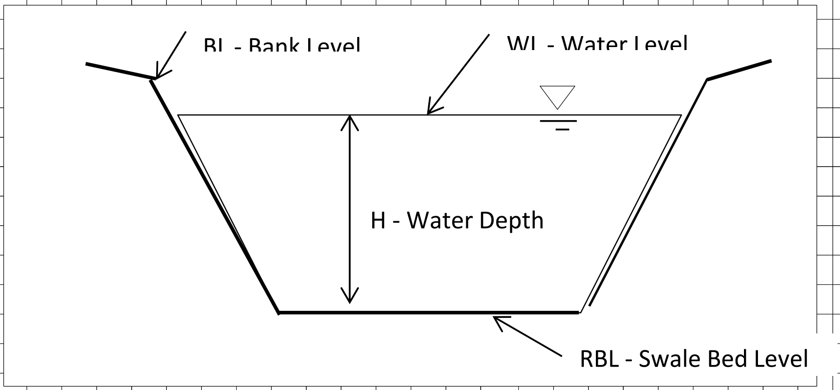
Maximum Contributing area to Swale = 90m2
Swale Length 13m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

Project	Woodbrook Development	Sheet No. 9	Rev -
Sub Section	Storm Drainage - Conveyance Swale B2	Job No: 5154251	
Calc By AC	Date 09/08/2019	Check By GH	Date 09/08/2019

ATKINS

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0140	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.51 m/s

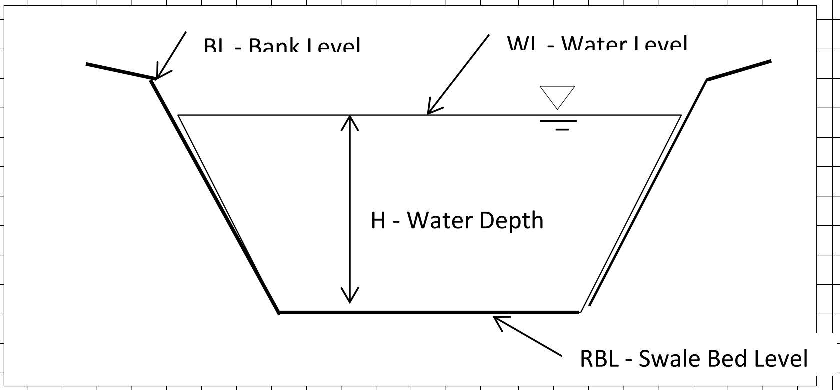
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 5m (Note length of swale to be increased at phase 2 stage)
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: Woodbrook Development		Sheet No. 10 / Rev -
	Sub Section: Storm Drainage - Conveyance Swale B3		Job No: 5154251
	Calc By: AC / Date: 09/08/2019		Check By: GH / Date: 09/08/2019

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0100	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

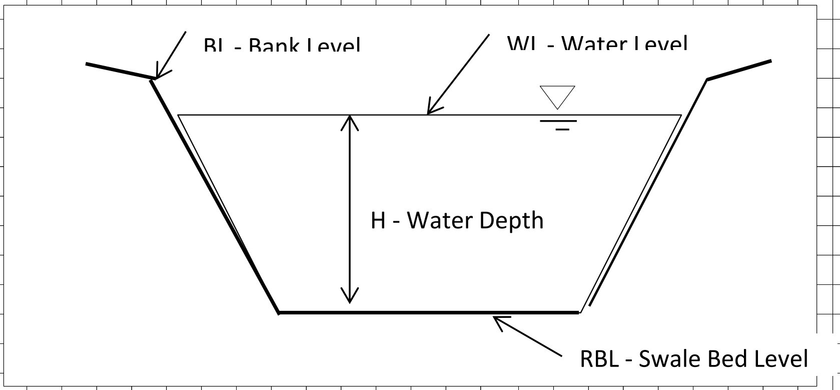
V = 0.43 m/s

For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 18m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3} S^{1/2}}{n}$$

Parameters

n	=	Mannings Roughness Value
S	=	Slope
A	=	Area
P	=	Wetted Perimeter
R	=	Hydraulic Radius

Values

RBL	=	123	m.AD Malin
n	=	0.04	(grassed areas)
S	=	0.0100	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.43 m/s

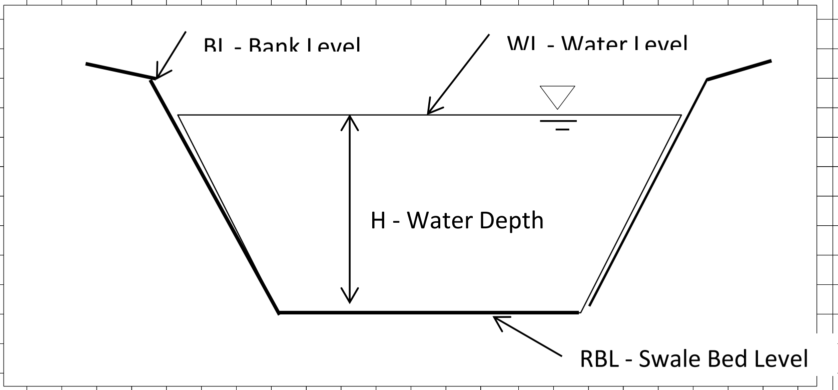
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 16m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

Project	Woodbrook Development	Sheet No. 12	Rev -
Sub Section	Storm Drainage - Conveyance Swale B5	Job No: 5154251	
Calc By: AC	Date: 09/08/2019	Check By: GH	Date: 09/08/2019

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3} S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0130	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.49 m/s

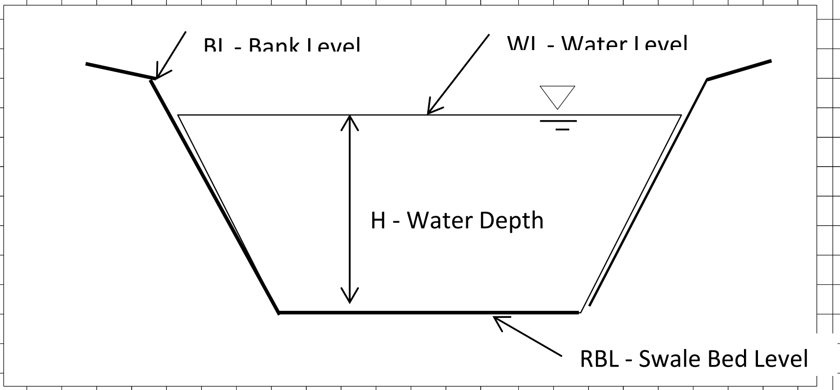
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 14m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: **Woodbrook Development**		Sheet No. **13** Rev **-**
	Sub Section: **Storm Drainage - Conveyance Swale B6**		Job No: **5154251**
	Calc By **AC** Date **09/08/2019**		Check By **GH** Date **09/08/2019**

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3} S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0040	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.27 m/s

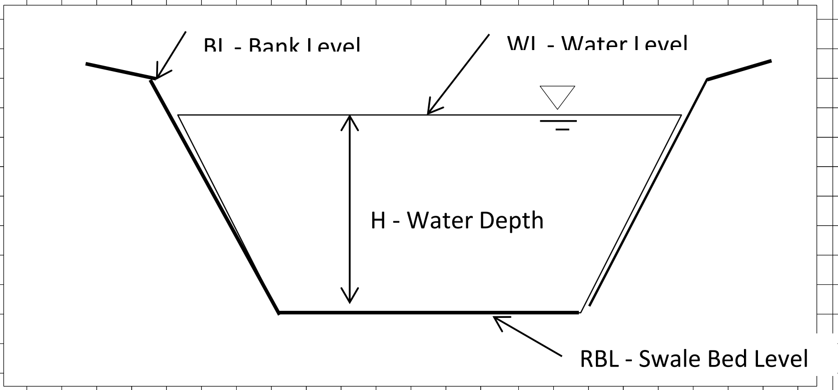
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 17m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: **Woodbrook Development**	Sheet No. **14**	Rev **-**
	Sub Section: **Storm Drainage - Conveyance Swale B7**	Job No: **5154251**	
	Calc By **AC** Date **09/08/2019**	Check By **GH**	Date **09/08/2019**

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0110	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.45 m/s

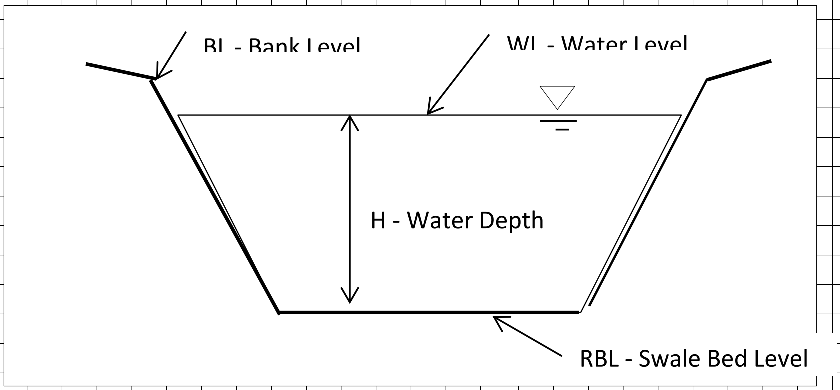
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 20m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: **Woodbrook Development**	Sheet No. 15	Rev -
	Sub Section: **Storm Drainage - Conveyance Swale D1**	Job No: **5154251**	
	Calc By **AC** Date **09/08/2019**	Check By **GH**	Date **09/08/2019**

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3} S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0110	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

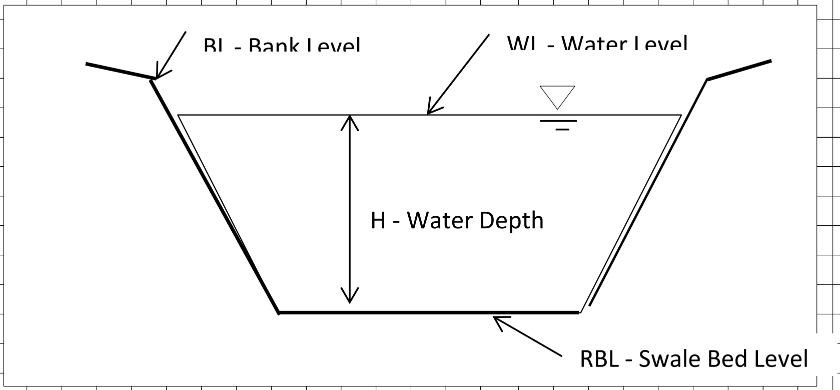
V = 0.45 m/s

For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 4m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n	=	Mannings Roughness Value
S	=	Slope
A	=	Area
P	=	Wetted Perimeter
R	=	Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0250	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.68 m/s

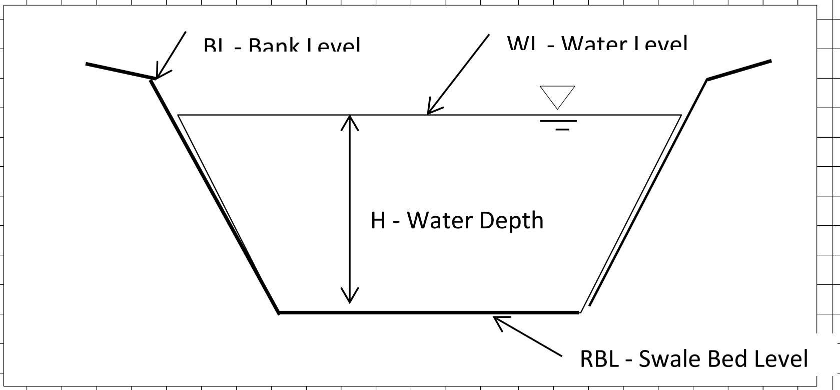
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 15m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: **Woodbrook Development**	Sheet No. 17	Rev -
	Sub Section: **Storm Drainage - Conveyance Swale E2**	Job No: **5154251**	
	Calc By **AC** Date **09/08/2019**	Check By **GH**	Date **09/08/2019**

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n	=	Mannings Roughness Value
S	=	Slope
A	=	Area
P	=	Wetted Perimeter
R	=	Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0250	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.68 m/s

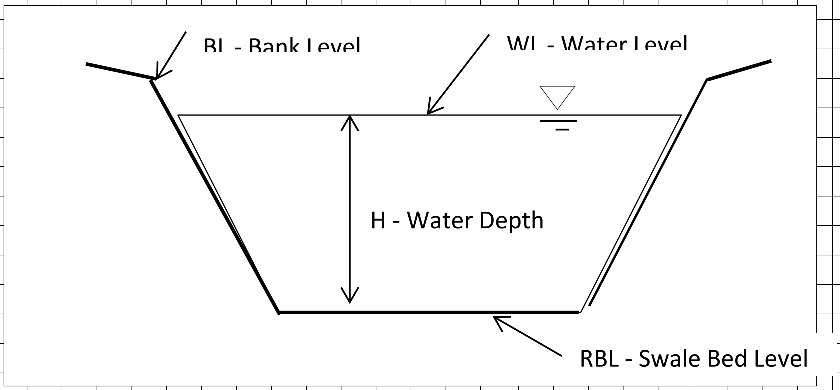
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 30m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: Woodbrook Development	Sheet No. 18	Rev -
	Sub Section: Storm Drainage - Conveyance Swale E3	Job No: 5154251	
	Calc By: AC / Date: 09/08/2019	Check By: GH	Date: 09/08/2019

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3} S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0230	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.65 m/s

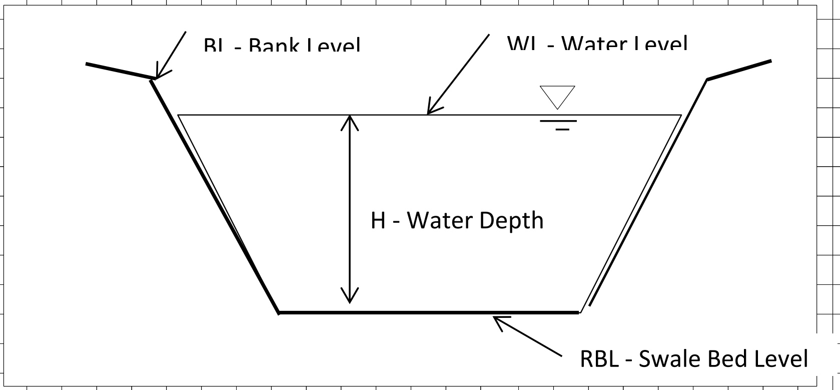
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 20m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: **Woodbrook Development**	Sheet No. **19**	Rev **-**
	Sub Section: **Storm Drainage - Conveyance Swale H1**	Job No: **5154251**	
	Calc By **AC** Date **09/08/2019**	Check By **GH**	Date **09/08/2019**

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0340	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.79 m/s

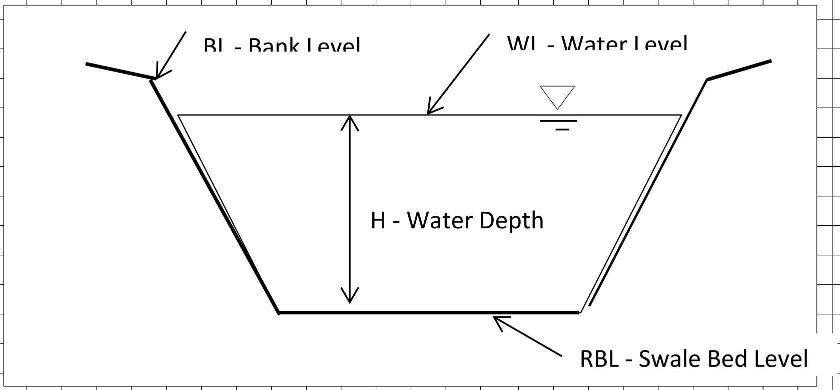
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 5m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

Project	Woodbrook Development	Sheet No. 20	Rev -
Sub Section	Storm Drainage - Conveyance Swale H2	Job No: 5154251	
Calc By AC	Date 09/08/2019	Check By GH	Date 09/08/2019

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n	=	Mannings Roughness Value
S	=	Slope
A	=	Area
P	=	Wetted Perimeter
R	=	Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0330	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.78 m/s

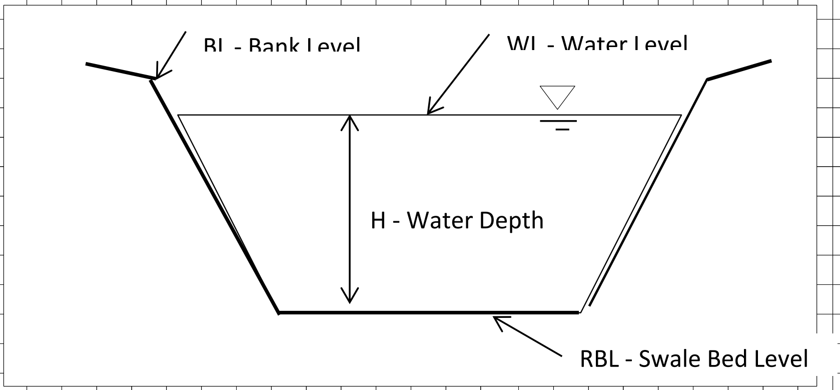
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 14m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: **Woodbrook Development**			Sheet No. **21**	Rev **-**
	Sub Section: **Storm Drainage - Conveyance Swale I1**			Job No: **5154251**	
		Calc By **AC**	Date **09/08/2019**	Check By **GH**	Date **09/08/2019**

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0070	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.36 m/s

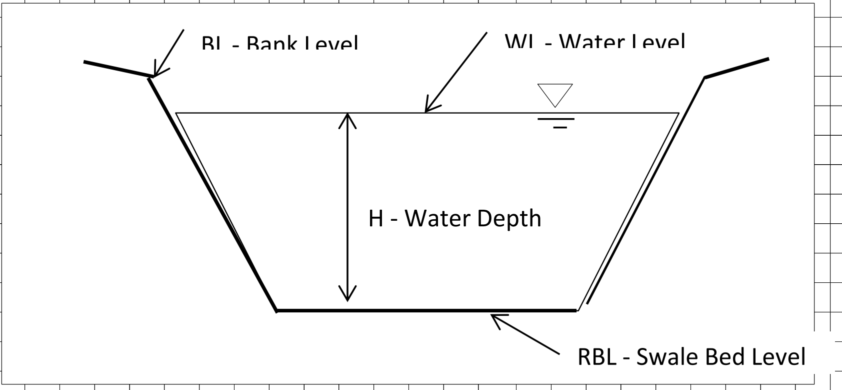
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 30m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: **Woodbrook Development**	Sheet No. **22**	Rev **-**
	Sub Section: **Storm Drainage - Conveyance Swale I2**	Job No: **5154251**	
	Calc By **AC** Date **09/08/2019**	Check By **GH**	Date **09/08/2019**

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0080	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

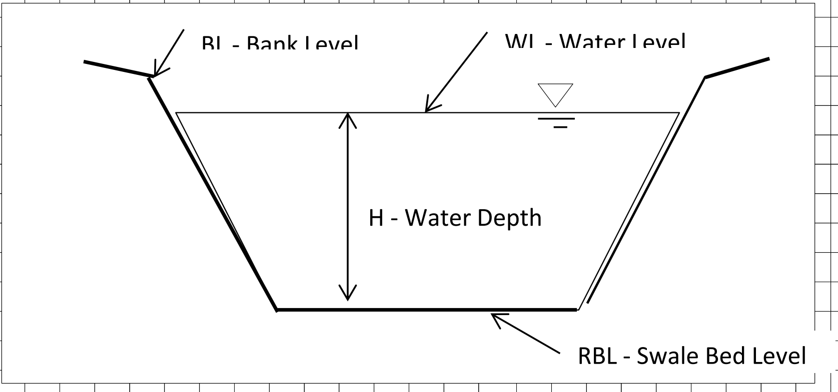
V = 0.38 m/s

For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 26m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3} S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0050	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.30 m/s

For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

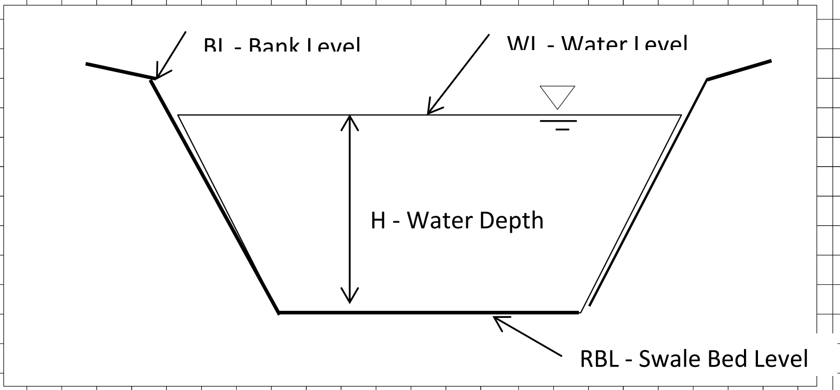
Maximum Contributing area to Swale = 90m2
Swale Length 30m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

Project	Woodbrook Development	Sheet No. 24	Rev -
Sub Section	Storm Drainage - Conveyance Swale J1	Job No: 5154251	
Calc By AC	Date 09/08/2019	Check By GH	Date 09/08/2019

ATKINS

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3} S^{1/2}}{n}$$

Parameters

n	=	Mannings Roughness Value
S	=	Slope
A	=	Area
P	=	Wetted Perimeter
R	=	Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0110	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.45 m/s

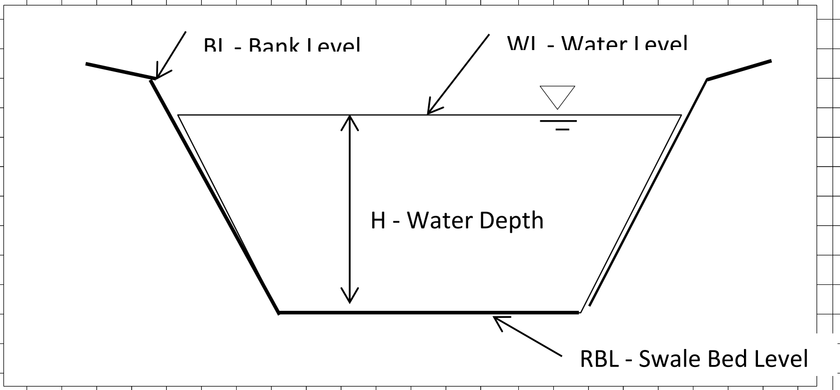
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 18m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: **Woodbrook Development**	Sheet No. 25	Rev -
	Sub Section: **Storm Drainage - Conveyance Swale J2**	Job No: **5154251**	
	Calc By **AC** Date **09/08/2019**	Check By **GH**	Date **09/08/2019**

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0060	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.33 m/s

For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

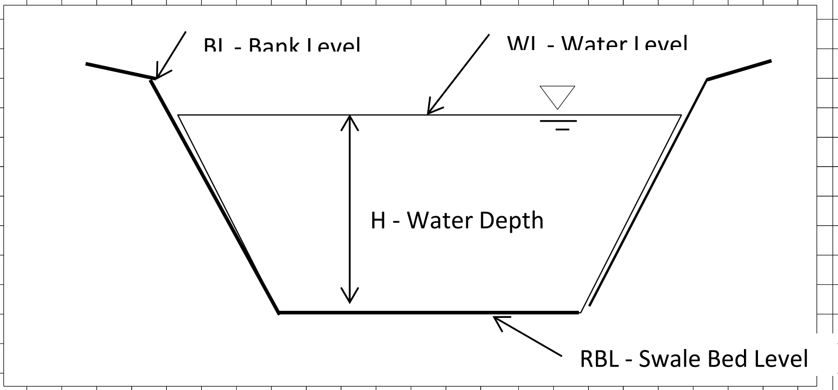
Maximum Contributing area to Swale = 90m2
Swale Length 26m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

Project	Woodbrook Development	Sheet No. 26	Rev -
Sub Section	Storm Drainage - Conveyance Swale J3	Job No: 5154251	
Calc By AC	Date 09/08/2019	Check By GH	Date 09/08/2019

ATKINS

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3} S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0190	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.59 m/s

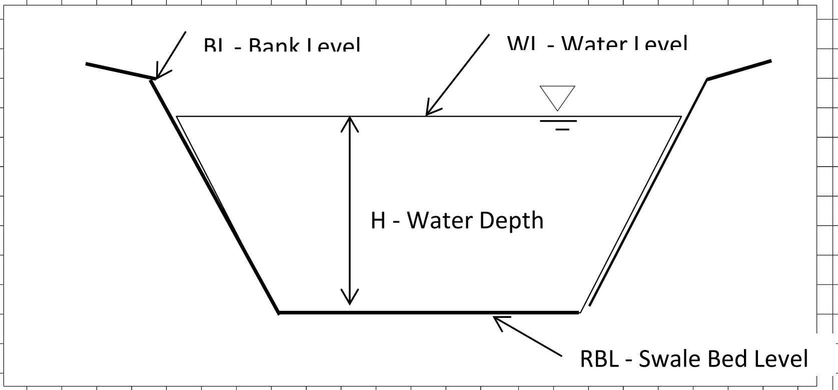
For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 26m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

ATKINS	Project: **Woodbrook Development**	Sheet No. 27	Rev -
	Sub Section: **Storm Drainage - Conveyance Swale J4**	Job No: 5154251	
	Calc By: **AC** Date: **09/08/2019**	Check By: **GH**	Date: **09/08/2019**

Ref	Calculations	Output

Hydraulic Capacity of Channel



Mannings Equation:

$$V(m/s) = \frac{R^{2/3}S^{1/2}}{n}$$

Parameters

n = Mannings Roughness Value
S = Slope
A = Area
P = Wetted Perimeter
R = Hydraulic Radius

Values

n	=	0.04	(grassed areas)
S	=	0.0170	
H	=	0.100	m
A	=	0.08	m^2
P	=	1.13	m
R	=	0.071	

1 in 100 year flow event

V = 0.56 m/s

For 100mm depth of water flow rate has a veloctity below 1.0m/s which is in accordance
in accordance with CIRIA report C753 SuDS manual section 17.4.1

Maximum Contributing area to Swale = 90m2
Swale Length 10m
Minimum Vegitated area receiving runoff (including grass strip) = 36m2
Outfall perforrated manhole to be raised 50mm to provide interception within 5m from swale outfall

Appendix M. Golf Course

M.1. Simulation Criteria

Simulation Criteria for Storm

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	5	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.700	Storm Duration (mins)	30
Ratio R	0.269		

M.2. Pipeline Schedules

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	225	S1	24.330	23.205	0.900	Open Manhole	1200
S1.001	o	225	S2	24.390	22.691	1.474	Open Manhole	1200
S2.000	o	225	S3	24.110	22.985	0.900	Open Manhole	1200
S2.001	o	225	S4	22.760	21.620	0.915	Open Manhole	1200
S3.000	o	225	S5	21.550	20.425	0.900	Open Manhole	1200
S3.001	o	300	S6	22.000	20.235	1.465	Open Manhole	1200
S3.002	o	300	S7	22.400	20.131	1.969	Open Manhole	1200
S2.002	o	375	S8	22.330	20.030	1.925	Open Manhole	1350
S4.000	o	225	S9	23.500	22.375	0.900	Open Manhole	1200
S4.001	o	225	S10	23.700	21.900	1.575	Open Manhole	1200
S4.002	o	300	S11	21.500	20.274	0.926	Open Manhole	1200
S4.003	o	300	S12	21.500	20.109	1.091	Open Manhole	1200
S2.003	o	375	S13	21.000	19.919	0.706	Open Manhole	1350
S5.000	o	225	S14	24.000	22.400	1.375	Open Manhole	1200
S5.001	o	225	S15	22.500	21.337	0.938	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	46.283	90.0	S2	24.390	22.691	1.474	Open Manhole	1200
S1.001	21.982	90.0	S	24.000	22.447	1.329	Open Manhole	0
S2.000	47.790	35.0	S4	22.760	21.620	0.915	Open Manhole	1200
S2.001	37.872	90.0	S8	22.330	21.199	0.906	Open Manhole	1350
S3.000	34.450	300.0	S6	22.000	20.310	1.465	Open Manhole	1200
S3.001	31.126	300.0	S7	22.400	20.131	1.969	Open Manhole	1200
S3.002	8.050	300.0	S8	22.330	20.105	1.925	Open Manhole	1350
S2.002	48.515	500.2	S13	21.000	19.933	0.692	Open Manhole	1350
S4.000	33.335	300.0	S10	23.700	22.264	1.211	Open Manhole	1200
S4.001	46.522	30.0	S11	21.500	20.349	0.926	Open Manhole	1200
S4.002	49.551	300.3	S12	21.500	20.109	1.091	Open Manhole	1200
S4.003	57.209	497.5	S13	21.000	19.994	0.706	Open Manhole	1350
S2.003	50.421	37.1	S24	19.600	18.559	0.666	Open Manhole	1500
S5.000	31.890	30.0	S15	22.500	21.337	0.938	Open Manhole	1200
S5.001	33.334	30.0	S19	21.560	20.226	1.109	Open Manhole	1200

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S6.000	o	225	S16	21.300	20.175	0.900	Open Manhole	1200
S7.000	o	225	S17	21.700	20.575	0.900	Open Manhole	1200
S7.001	o	225	S18	22.000	20.296	1.479	Open Manhole	1200
S5.002	o	300	S19	21.560	19.921	1.339	Open Manhole	1200
S5.003	o	300	S20	21.500	19.838	1.362	Open Manhole	1200
S8.000	o	225	S21	20.600	19.475	0.900	Open Manhole	1200
S5.004	o	300	S22	20.450	19.038	1.112	Open Manhole	1200
S5.005	o	300	S23	20.200	18.868	1.032	Open Manhole	1200
S2.004	o	225	S24	19.600	18.400	0.975	Open Manhole	1500
S2.005	o	225	S25	19.700	18.312	1.163	Open Manhole	1500
S2.006	o	225	S26	19.700	18.299	1.176	Open Manhole	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S6.000	18.443	103.0	S19	21.560	19.996	1.339	Open Manhole	1200
S7.000	28.715	102.9	S18	22.000	20.296	1.479	Open Manhole	1200
S7.001	16.707	297.3	S19	21.560	20.240	1.095	Open Manhole	1200
S5.002	41.724	502.7	S20	21.500	19.838	1.362	Open Manhole	1200
S5.003	30.357	57.2	S22	20.450	19.307	0.843	Open Manhole	1200
S8.000	37.249	102.9	S22	20.450	19.113	1.112	Open Manhole	1200
S5.004	72.303	425.3	S23	20.200	18.868	1.032	Open Manhole	1200
S5.005	47.983	102.5	S24	19.600	18.400	0.900	Open Manhole	1500
S2.004	44.094	501.1	S25	19.700	18.312	1.163	Open Manhole	1500
S2.005	6.484	498.8	S26	19.700	18.299	1.176	Open Manhole	1500
S2.006	8.490	84.9	S	19.400	18.199	0.976	Open Manhole	0

M.3. Storage Structures

Storage Structures for Storm

Tank or Pond Manhole: S13, DS/PN: S2.003

Invert Level (m) 19.919

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	2260.0	1.400	0.0	2.800	0.0	4.200	0.0
0.200	2260.0	1.600	0.0	3.000	0.0	4.400	0.0
0.400	2260.0	1.800	0.0	3.200	0.0	4.600	0.0
0.600	2260.0	2.000	0.0	3.400	0.0	4.800	0.0
0.800	0.0	2.200	0.0	3.600	0.0	5.000	0.0
1.000	0.0	2.400	0.0	3.800	0.0		
1.200	0.0	2.600	0.0	4.000	0.0		

Tank or Pond Manhole: S20, DS/PN: S5.003

Invert Level (m) 19.838

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	1340.0	1.400	1340.0	2.800	0.0	4.200	0.0
0.200	1340.0	1.600	0.0	3.000	0.0	4.400	0.0
0.400	1340.0	1.800	0.0	3.200	0.0	4.600	0.0
0.600	1340.0	2.000	0.0	3.400	0.0	4.800	0.0
0.800	1340.0	2.200	0.0	3.600	0.0	5.000	0.0
1.000	1340.0	2.400	0.0	3.800	0.0		
1.200	1340.0	2.600	0.0	4.000	0.0		

Tank or Pond Manhole: S25, DS/PN: S2.005

Invert Level (m) 18.312

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	200.0	1.400	0.0	2.800	0.0	4.200	0.0
0.200	200.0	1.600	0.0	3.000	0.0	4.400	0.0
0.400	200.0	1.800	0.0	3.200	0.0	4.600	0.0
0.600	200.0	2.000	0.0	3.400	0.0	4.800	0.0
0.800	0.0	2.200	0.0	3.600	0.0	5.000	0.0
1.000	0.0	2.400	0.0	3.800	0.0		
1.200	0.0	2.600	0.0	4.000	0.0		

M.4. Online Controls

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S13, DS/PN: S2.003, Volume (m^3): 10.7

Unit Reference	MD-SHE-0073-2000-0600-2000
Design Head (m)	0.600
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	73
Invert Level (m)	19.919
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	2.0
Flush-Flo™	0.177	2.0
Kick-Flo®	0.397	1.7
Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.9	1.200	2.7	3.000	4.2	7.000	6.3
0.200	2.0	1.400	2.9	3.500	4.5	7.500	6.5
0.300	1.9	1.600	3.1	4.000	4.8	8.000	6.7
0.400	1.7	1.800	3.3	4.500	5.1	8.500	6.9
0.500	1.8	2.000	3.5	5.000	5.3	9.000	7.1
0.600	2.0	2.200	3.6	5.500	5.6	9.500	7.3
0.800	2.3	2.400	3.8	6.000	5.8		
1.000	2.5	2.600	3.9	6.500	6.0		

Hydro-Brake® Optimum Manhole: S22, DS/PN: S5.004, Volume (m^3): 5.1

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	19.038
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Hydro-Brake® Optimum Manhole: S22, DS/PN: S5.004, Volume (m^3): 5.1

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.0
Flush-Flo™	0.296	1.9
Kick-Flo®	0.599	1.6
Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.6	1.200	2.2	3.000	3.3	7.000	4.9
0.200	1.9	1.400	2.3	3.500	3.5	7.500	5.1
0.300	1.9	1.600	2.5	4.000	3.8	8.000	5.2
0.400	1.9	1.800	2.6	4.500	4.0	8.500	5.4
0.500	1.8	2.000	2.7	5.000	4.2	9.000	5.5
0.600	1.6	2.200	2.9	5.500	4.4	9.500	5.7
0.800	1.8	2.400	3.0	6.000	4.6		
1.000	2.0	2.600	3.1	6.500	4.7		

Hydro-Brake® Optimum Manhole: S26, DS/PN: S2.006, Volume (m^3): 2.7

Unit Reference	MD-SHE-0146-9200-0600-9200
Design Head (m)	0.600
Design Flow (l/s)	9.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	146
Invert Level (m)	18.299
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	9.2
Flush-Flo™	0.229	9.2
Kick-Flo®	0.453	8.1
Mean Flow over Head Range	-	7.5

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	5.2	0.300	9.1	0.500	8.4	0.800	10.5
0.200	9.2	0.400	8.6	0.600	9.2	1.000	11.7

Hydro-Brake® Optimum Manhole: S26, DS/PN: S2.006, Volume (m³): 2.7

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
1.200	12.7	2.400	17.7	5.000	25.2	8.000	31.6
1.400	13.7	2.600	18.4	5.500	26.4	8.500	32.6
1.600	14.6	3.000	19.7	6.000	27.5	9.000	33.6
1.800	15.5	3.500	21.2	6.500	28.5	9.500	34.5
2.000	16.2	4.000	22.6	7.000	29.6		
2.200	17.0	4.500	24.0	7.500	30.6		

M.5. Summary of Results

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.269
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 16.700 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 5, 30
Climate Change (%) 10, 10

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	30	+10%					23.258
S1.001	S2	15 Winter	30	+10%					22.745
S2.000	S3	600 Winter	5	+10%					22.985
S2.001	S4	15 Winter	30	+10%					21.778
S3.000	S5	15 Winter	30	+10%	30/15 Summer				20.715
S3.001	S6	15 Winter	30	+10%	30/15 Summer				20.564
S3.002	S7	15 Winter	30	+10%	30/15 Summer				20.457
S2.002	S8	15 Winter	30	+10%	30/15 Summer				20.418
S4.000	S9	600 Winter	5	+10%					22.375
S4.001	S10	600 Winter	5	+10%					21.900
S4.002	S11	15 Winter	30	+10%	30/15 Summer				20.664
S4.003	S12	15 Winter	30	+10%	30/15 Summer				20.487
S2.003	S13	1440 Winter	30	+10%					20.102
S5.000	S14	600 Winter	5	+10%					22.400
S5.001	S15	600 Winter	5	+10%					21.337
S6.000	S16	15 Summer	30	+10%					20.290
S7.000	S17	15 Winter	30	+10%					20.673
S7.001	S18	15 Winter	30	+10%					20.486
S5.002	S19	15 Winter	30	+10%	30/15 Summer				20.224
S5.003	S20	600 Winter	30	+10%					19.898
S8.000	S21	30 Summer	30	+10%	5/15 Summer				20.165

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.172	0.000	0.13		6.6	OK	
S1.001	S2	-0.171	0.000	0.13		6.5	OK	
S2.000	S3	-0.225	0.000	0.00		0.0	OK	
S2.001	S4	-0.067	0.000	0.84		43.5	OK	
S3.000	S5	0.065	0.000	1.20		33.6	SURCHARGED	
S3.001	S6	0.029	0.000	0.96		56.0	SURCHARGED	
S3.002	S7	0.026	0.000	1.20		57.3	SURCHARGED	
S2.002	S8	0.013	0.000	1.15		94.4	SURCHARGED	
S4.000	S9	-0.225	0.000	0.00		0.0	OK	
S4.001	S10	-0.225	0.000	0.00		0.0	OK	
S4.002	S11	0.090	0.000	1.10		66.3	SURCHARGED	
S4.003	S12	0.078	0.000	1.34		63.0	SURCHARGED	
S2.003	S13	-0.192	0.000	0.01		2.0	OK	
S5.000	S14	-0.225	0.000	0.00		0.0	OK	
S5.001	S15	-0.225	0.000	0.00		0.0	OK	
S6.000	S16	-0.110	0.000	0.52		23.9	OK	
S7.000	S17	-0.127	0.000	0.39		18.7	OK	
S7.001	S18	-0.035	0.000	1.00		26.6	OK	
S5.002	S19	0.003	0.000	1.05		47.9	SURCHARGED	
S5.003	S20	-0.240	0.000	0.02		2.2	OK	
S8.000	S21	0.465	0.000	0.10		5.0	SURCHARGED	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S5.004	S22	30 Summer	30	+10%	5/15 Summer				20.148
S5.005	S23	15 Winter	30	+10%					18.986
S2.004	S24	15 Winter	30	+10%	30/15 Summer				18.700
S2.005	S25	180 Winter	30	+10%					18.441
S2.006	S26	1440 Winter	30	+10%					18.483

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S5.004	S22	0.810	0.000	0.04		2.0	SURCHARGED	
S5.005	S23	-0.182	0.000	0.32		32.8	OK	
S2.004	S24	0.075	0.000	1.36		29.8	SURCHARGED	
S2.005	S25	-0.096	0.000	0.37		7.8	OK	
S2.006	S26	-0.041	0.000	0.13		5.9	OK	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.269
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 16.700 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360
Return Period(s) (years) 100
Climate Change (%) 10

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	100	+10%					23.266
S1.001	S2	15 Winter	100	+10%					22.753
S2.000	S3	60 Winter	100	+10%					22.985
S2.001	S4	15 Winter	100	+10%	100/15 Summer				21.875
S3.000	S5	15 Winter	100	+10%	100/15 Summer				20.980
S3.001	S6	15 Winter	100	+10%	100/15 Summer				20.759
S3.002	S7	15 Winter	100	+10%	100/15 Summer				20.596
S2.002	S8	15 Winter	100	+10%	100/15 Summer				20.513
S4.000	S9	60 Winter	100	+10%					22.375
S4.001	S10	60 Winter	100	+10%					21.900
S4.002	S11	15 Winter	100	+10%	100/15 Summer				20.921
S4.003	S12	15 Winter	100	+10%	100/15 Summer				20.618
S2.003	S13	360 Winter	100	+10%					20.095
S5.000	S14	60 Winter	100	+10%					22.400
S5.001	S15	60 Winter	100	+10%					21.337
S6.000	S16	15 Winter	100	+10%					20.359
S7.000	S17	15 Winter	100	+10%					20.689
S7.001	S18	15 Winter	100	+10%	100/15 Summer				20.553
S5.002	S19	15 Winter	100	+10%	100/15 Summer				20.282
S5.003	S20	360 Winter	100	+10%					19.919
S8.000	S21	15 Winter	100	+10%	100/15 Summer				20.206
S5.004	S22	15 Winter	100	+10%	100/15 Summer				20.183

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.164	0.000	0.16		8.6	OK	
S1.001	S2	-0.162	0.000	0.17		8.4	OK	
S2.000	S3	-0.225	0.000	0.00		0.0	OK	
S2.001	S4	0.030	0.000	1.04		53.8	SURCHARGED	
S3.000	S5	0.330	0.000	1.39		38.9	SURCHARGED	
S3.001	S6	0.224	0.000	1.22		71.1	SURCHARGED	
S3.002	S7	0.164	0.000	1.49		71.0	SURCHARGED	
S2.002	S8	0.108	0.000	1.50		122.9	SURCHARGED	
S4.000	S9	-0.225	0.000	0.00		0.0	OK	
S4.001	S10	-0.225	0.000	0.00		0.0	OK	
S4.002	S11	0.347	0.000	1.34		80.3	SURCHARGED	
S4.003	S12	0.209	0.000	1.71		80.1	SURCHARGED	
S2.003	S13	-0.199	0.000	0.01		2.0	OK	
S5.000	S14	-0.225	0.000	0.00		0.0	OK	
S5.001	S15	-0.225	0.000	0.00		0.0	OK	
S6.000	S16	-0.041	0.000	0.64		29.4	OK	
S7.000	S17	-0.111	0.000	0.51		24.2	OK	
S7.001	S18	0.032	0.000	1.29		34.5	SURCHARGED	
S5.002	S19	0.061	0.000	1.38		63.0	SURCHARGED	
S5.003	S20	-0.219	0.000	0.02		3.0	OK	
S8.000	S21	0.506	0.000	0.16		7.8	SURCHARGED	
S5.004	S22	0.845	0.000	0.04		2.1	FLOOD RISK	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S5.005	S23	15 Winter	100	+10%					19.004
S2.004	S24	15 Winter	100	+10%	100/15 Summer				18.782
S2.005	S25	180 Winter	100	+10%					18.465
S2.006	S26	180 Winter	100	+10%					18.473

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S5.005	S23	-0.164	0.000	0.41		42.0	OK	
S2.004	S24	0.157	0.000	1.67		36.6	SURCHARGED	
S2.005	S25	-0.072	0.000	0.43		9.2	OK	
S2.006	S26	-0.051	0.000	0.19		8.6	OK	

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