



PROJECT:

Island Road, Reading

DOCUMENT TITLE:

Drainage Design Philosophy

PREPARED FOR:

Buckingham Group Contracting Ltd



Fernwood Business Park, 14 Halifax Court, Newark, Nottinghamshire, NG24 3JP. t: +44 (0) 1636 850500 www.bedesign.co.uk

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Written by:	Shawn Loo
Reviewed by:	Anna Tsartsari
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1.0 INTRODUCTION

This document with the accompanying drawings and calculations are prepared to discharge planning condition 33 under planning permission reference 141789 for the development of Land North of Island Road, Reading, RG2 0WR. This condition is related to site drainage matters and its description is:

Condition 33: *No development shall take place until a surface water drainage scheme for the site, based on sustainable drainage principles and an assessment of the hydrological and hydro geological context of the development has been submitted to and approved in writing by the local planning authority. The drainage strategy should demonstrate the surface water run-off generated up to and including the 100 year with an allowance for climate change critical storm will not exceed the run-off from the undeveloped site following the corresponding rainfall event. Open drainage channels/streams through the woodland to the north to the River Kennet should also be considered. The scheme shall also include details of how the scheme shall be maintained and managed after completion. The surface water drainage scheme shall be implemented in accordance with the approved details prior to occupation of any building on site.*

2.0 PROJECT OUTLINE

The proposed development is located to the south of Reading town centre and north of M4 Junction 11. The site is roughly centred at National Grid Reference SU710709, bounded by River Kennet to the north, A33 trunk road to the east, Island Road to the south and a former landfill site to the west.

The application site is approximately 8.59ha, but the developable area is significantly smaller as a land strip along the southern and eastern boundary are reserved for future mass rapid transit (MRT) link construction and the existing riverside landscaping along the northern boundary needs to be preserved. Consequently, the proposed development will only generate an impermeable area of approximately 4.505ha.

The existing site is elevated from the surrounding area and is relatively flat at around 43.5m AOD. As a result, the site is entirely within the Environment Agency Flood Zone 1 and is not affected by any known watercourse. This is mentioned in the Flood Risk Assessment & Proposed Drainage Strategy document prepared by T.R. Collier & Associates (Job Ref: 3241, dated May 2014).

The development will comprise the following:

- 3no. warehouse units and associated office/ancillary buildings
- Service yard for heavy goods vehicles
- Car park area
- Access road
- Landscaping zone

3.0 SURFACE WATER DRAINAGE

3.1 Existing Site Surface Water Drainage

The development area is currently vacant and undeveloped, comprising heavily vegetated land with occasional tarmacadam hardstanding. There is no formal drainage system, therefore the surface water currently either infiltrates into the ground or follows the natural topography of the site and discharges to the surrounding areas. As such, it is pertinent to treat the development area as a greenfield land and ensure that the surface water run-off from the proposed development will not exceed the existing surface water run-off.

The greenfield run-off rate from the pre-development site has been estimated using the Interim Code of Practice for Sustainable Drainage Systems (ICP SUDS). This assessment has been undertaken by T.R. Collier & Associates and can be found in their Flood Risk Assessment & Proposed Drainage Strategy (Job Ref: 3241, dated May 2014, Appendix E). The parameters relevant to the site and the assessment results are summarised below with the extracted calculation reproduced in Appendix D of this document:

Site Parameters

- Development area = 4.329ha
- SAAR (mm) = 700
- Soil = 0.30
- Region = 6

Greenfiled Run-off Rate

- 1 in 2 year storm event = 1.825 l/s/ha
- 1 in 30 year storm event = 4.135 l/s/ha
- 1 in 100 year storm event = 5.821 l/s/ha

3.2 Proposed Site Surface Water Drainage

The drainage design philosophy for the site is based on implementing sustainable drainage systems (SuDS) techniques. The philosophy of SuDS is to replicate as closely as possible the natural drainage from the site before development and to treat run-off to remove pollutants, therefore reducing the impact on the receiving watercourses.

The proposed development involves the construction of 3no. warehouse units and associated infrastructure, which will generate approximately 4.326ha of impermeable area. With the proposal of using swale for surface water attenuation purposes, they will generate a further 0.187ha of impermeable area. Therefore, the total impermeable area for this development is estimated to be 4.513ha. The drainage catchment area layout is contained in Appendix B. As the discharge from the developed site is required to mimic the greenfield run-off, the allowable discharge for the different storm events are:

- 1 in 2 year storm event: $1.825 \text{ l/s/ha} \times 4.513\text{ha} = \mathbf{8.2/s}$
- 1 in 30 year storm event: $4.135 \text{ l/s/ha} \times 4.513\text{ha} = \mathbf{18.7/s}$
- 1 in 100 year storm event: $5.821 \text{ l/s/ha} \times 4.513\text{ha} = \mathbf{26.3l/s}$

The proposed surface water drainage system can be grouped into two distinct systems, namely Southern System and Northern System.

The Southern System is generally a gravity system taking run-off from the southern (Unit C) service yard, the southern (Unit A & C) car parks, a small area of access road and a small area of (Unit C) office roof. The original intention is to form a swale adjacent to the southern boundary for attenuation purposes; however, this is not feasible as this area of land falls within a deed of surrender for possible future MRT development. The current proposal is to use attenuation tank instead. In total, the Southern System covers an impermeable area of 0.847ha. Surface water run-off from these areas will drain by gravity towards the attenuation tank, which will then be pumped at a restricted rate of 5.0l/s into the Northern System. The required attenuation volume for the Southern System is 345m³.

The Northern System is a gravity system taking run-off from the remaining site, ie all building roofs, the northern (Unit A & B) service yards, the northern (Unit B) car park and majority of the access road. Including the northern swale area, the Northern System covers an impermeable area of 3.666ha. Surface water run-off from these areas will drain by gravity towards the northern swale, and will subsequently discharge to River Kennet at the allowable discharge rates mentioned above. The required attenuation volume for the Northern System is 1900m³.

The surface water drainage system for the whole development area is proposed to discharge via a single outfall to River Kennet which has a surveyed water level of 36.890m AOD. A complex flow control (double Hydrobrake) has been utilized to optimise the attenuation volume of the northern swale and is positioned just downstream of the swale. To minimize impact on the existing northern landscaping, a spillway is proposed to connect the northern swale to River Kennet.

It is likely that the main building roofs will be drained by siphonic system, therefore the external carrier pipes have been sized larger to suit the higher intensity siphonic pipe discharge. External car park areas will be drained via linear drainage and/or local gullies prior to passing through Class 1 by-pass separators (with integral level alarms) while

delivery yard areas will be drained via Class 1 full retention separators (with integral level alarms) to ensure compliance with BS EN 858-1:2002, in accordance with Pollution Prevention Guideline document PPG3 '*Use and design of Oil Separators in Surface Water Drainage Systems*'. Penstock will be included in all manholes upstream of attenuation features (swale and oversized pipes) to contain contaminated water during fire fighting events, therefore preventing pollution to the downstream watercourses. The proposed drainage layout can be found in Appendix A.

3.3 Complex Flow Control

In order to optimise the attenuation volume, a complex flow control arrangement has been proposed for this development. Conventionally, a single Hydrobrake will be used to limit the discharge to just the 1 in 2 year storm greenfield run-off. During the 1 in 30 year and 1 in 100 year storm events, the Hydrobrake outflow will be much lower than the allowable greenfield run-off rates, hence the attenuation volume required would have been much bigger.

By using a complex flow control arrangement, which consists of two Hydrobrakes placed at two different levels, it is possible to control the outflow to closely match the allowable greenfield run-off rates.

As the proposed attenuation is in the form of a swale, headwalls will be required to accommodate the inlet and outlet pipes. It is proposed that the Hydrobrakes will attach to the outlet headwall with metal grating around the headwall structure to provide security protection. Details of the complex flow control and the headwall can be found in Appendix C.

3.4 Drainage Design Parameters and Criteria

The new surface water drainage system will be modelled using current MicroDrainage software, ensuring planning conditions and Environment Agency (EA) guidelines are satisfied to prevent uncontrolled flooding of the site and surrounding areas. The design parameters used and applicable to the site are:

- **Rainfall:** Flood Studies Report (FSR)
- **M5-60 (mm):** 18.100
- **Ratio R:** 0.400
- **Global Time of Entry:** 5min
- **Volumetric Run-off Coefficient:** 0.75 (summer), 0.84 (winter)

The drainage system has been check against the following storm return periods and durations:

- 1 in 2 year storm – 15mins to 1440mins storm duration
- 1 in 30 year storm – 15mins to 1440mins storm duration
- 1 in 100 year storm + 20% climate change – 15mins to 1440mins storm duration

The drainage system has been modelled with adequate attenuation capacity to ensure that the following criteria are met:

- 1 in 2 year storm – No Surcharge
- 1 in 30 year storm – No Flooding
- 1 in 100 year storm + 20% climate change – No Flooding

4.0 SURFACE WATER MICRODRAINAGE SUMMARY

The MicroDrainage input and output summary is included in the following pages. They are grouped into the Southern System and the Northern System which include:

- Design Criteria for Storm
- Time Area Diagram for Storm
- Network Design Table for Storm
- Online Controls for Storm
- Storage Structures for Storm (Pond)
- 2 year Return Period Summary of Critical Results by Maximum Level
- 30 year Return Period Summary of Critical Results by Maximum Level
- 100 year Return Period Summary of Critical Results by Maximum Level

It is conclusive from the simulation output that the proposed surface water drainage system is satisfactory with sufficient attenuation volume. The simulation output summary is as follows:

- 1 in 2 year storm site discharge = **8.0l/s, No Surcharge**
- 1 in 30 year storm site discharge = **18.1l/s, No Flooding**
- 1 in 100 year storm + 20% climate change site discharge = **26.2l/s, No Flooding**

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File Southern System - Stora...	Checked by	
XP Solutions	Network 2015.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	Add Flow / Climate Change (%)	0
M5-60 (mm)	18.100	Minimum Backdrop Height (m)	0.200
Ratio R	0.400	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	1	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.197	4-8	0.638	8-12	0.013

Total Area Contributing (ha) = 0.847

Total Pipe Volume (m³) = 376.021

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I,Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
8.000	17.000	0.071	239.4	0.270	5.00	0.0	0.600	o	300	⊕
9.000	5.000	0.050	100.0	0.052	5.00	0.0	0.600	o	150	⊕
8.001	17.000	0.071	239.4	0.000	0.00	0.0	0.600	o	300	⊕
10.000	11.000	0.046	239.1	0.186	5.00	0.0	0.600	o	300	⊕

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I,Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
8.000	1.00	5.28	39.875	0.270	0.0	0.0	0.0	1.01	71.5	0.7
9.000	1.00	5.08	40.004	0.052	0.0	0.0	0.0	1.00	17.8	0.1
8.001	1.00	5.56	39.804	0.322	0.0	0.0	0.0	1.01	71.5	0.9
10.000	1.00	5.18	40.702	0.186	0.0	0.0	0.0	1.01	71.6	0.5

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
8.002	6.050	0.100	60.5	0.000	0.00	0.0	0.600	o	400	🔧
8.003	6.050	0.100	60.5	0.000	0.00	0.0	0.600	o	400	🔧
11.000	14.500	0.060	241.7	0.237	5.00	0.0	0.600	o	300	🔧
12.000	19.000	0.115	165.2	0.056	5.00	0.0	0.600	o	225	🔧
11.001	25.000	0.104	240.4	0.000	0.00	0.0	0.600	o	300	🔧
11.002	19.000	0.079	240.5	0.000	0.00	0.0	0.600	o	300	🔧
8.004	71.000	0.145	489.7	0.046	0.00	0.0	0.600	o	525	🔧
8.005	28.000	0.057	491.2	0.000	0.00	0.0	0.600	o	525	🔧
8.006	56.000	0.112	500.0	0.000	0.00	0.0	0.600	4o	-24	🔧
8.007	5.000	0.050	100.0	0.000	0.00	0.0	0.600	o	150	🔧

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
8.002	1.00	5.60	39.633	0.508	0.0	0.0	0.0	2.43	305.4	1.4
8.003	1.00	5.64	39.483	0.508	0.0	0.0	0.0	2.43	305.4	1.4
11.000	1.00	5.24	41.720	0.237	0.0	0.0	0.0	1.01	71.2	0.6
12.000	1.00	5.31	41.850	0.056	0.0	0.0	0.0	1.01	40.3	0.2
11.001	1.00	5.72	41.660	0.293	0.0	0.0	0.0	1.01	71.4	0.8
11.002	1.00	6.04	41.456	0.293	0.0	0.0	0.0	1.01	71.4	0.8
8.004	1.00	7.22	39.258	0.847	0.0	0.0	0.0	1.01	217.7	2.3
8.005	1.00	7.68	39.113	0.847	0.0	0.0	0.0	1.00	217.3	2.3
8.006	1.00	8.19	39.056	0.847	0.0	0.0	0.0	1.83	11282.3	2.3
8.007	1.00	8.27	38.944	0.847	0.0	0.0	0.0	1.00	17.8	2.3

PIPE (-24) REPRESENTS ATTENUATION TANK IN THE FORM OF 4NO. x 1400φ PIPE.

∴ ATTENUATION VOLUME

$$= 4\text{NO.} \times \pi \times \frac{1.4^2}{4} \times 56\text{m}$$

$$= \underline{\underline{345 \text{ m}^3}}$$

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Online Controls for Storm

Pump Manhole: 14, DS/PN: 8.007, Volume (m³): 358.6

Invert Level (m) 38.944

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.200	5.0000	1.800	5.0000	3.400	5.0000	5.000	5.0000
0.400	5.0000	2.000	5.0000	3.600	5.0000	5.200	5.0000
0.600	5.0000	2.200	5.0000	3.800	5.0000	5.400	5.0000
0.800	5.0000	2.400	5.0000	4.000	5.0000	5.600	5.0000
1.000	5.0000	2.600	5.0000	4.200	5.0000	5.800	5.0000
1.200	5.0000	2.800	5.0000	4.400	5.0000	6.000	5.0000
1.400	5.0000	3.000	5.0000	4.600	5.0000		
1.600	5.0000	3.200	5.0000	4.800	5.0000		

NOTE:

PUMPING STATION WITH A PUMP RATE OF 5 l/s

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2 year Return Period 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 Coefficient 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 0
Number of Online Controls 1 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 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.100 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia 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) 2, 30, 100
Climate Change (%) 0, 0, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
8.000	CP27	15 Winter	2	+0%	30/15 Summer			
9.000	Gully	15 Winter	2	+0%	30/15 Summer			
8.001	Y-branch	15 Winter	2	+0%	30/15 Summer			
10.000	CP28	15 Winter	2	+0%	100/15 Summer			
8.002	SW29	15 Winter	2	+0%	30/15 Winter			
8.003	BPS30	15 Winter	2	+0%	30/15 Summer			
11.000	CP31	15 Winter	2	+0%	30/15 Summer			
12.000	CP32	15 Winter	2	+0%	100/15 Summer			
11.001	SW33	15 Winter	2	+0%	30/15 Summer			
11.002	PI34	15 Winter	2	+0%	30/15 Summer			
8.004	SW35	15 Winter	2	+0%	30/15 Summer			
8.005	SW36	180 Winter	2	+0%	30/15 Winter			
8.006	SW37	180 Winter	2	+0%	100/240 Winter			
8.007	14	180 Winter	2	+0%	2/15 Summer			

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2 year Return Period 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
8.000	CP27	40.069	-0.106	0.000	0.70		42.7	OK	
9.000	Gully	40.089	-0.065	0.000	0.60		8.3	OK	
8.001	Y-branch	40.016	-0.088	0.000	0.84		51.3	OK	
10.000	CP28	40.859	-0.143	0.000	0.52		29.9	OK	
8.002	SW29	39.851	-0.182	0.000	0.58		81.0	OK	
8.003	BPS30	39.700	-0.183	0.000	0.57		80.5	OK	
11.000	CP31	41.899	-0.121	0.000	0.64		37.7	OK	
12.000	CP32	41.926	-0.149	0.000	0.25		8.9	OK	
11.001	SW33	41.853	-0.107	0.000	0.73		46.5	OK	
11.002	PI34	41.651	-0.105	0.000	0.75		46.3	OK	
8.004	SW35	39.573	-0.210	0.000	0.62		124.3	OK	
8.005	SW36	39.480	-0.158	0.000	0.17		30.0	OK	
8.006	SW37	39.477	-0.979	0.000	0.00		27.7	OK	
8.007	14	39.477	0.383	0.000	0.36		5.0	SURCHARGED	

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30 year Return Period 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 Coefficient 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 0
Number of Online Controls 1 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 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.100 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia 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) 2, 30, 100
Climate Change (%) 0, 0, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
8.000	CP27	15 Winter	30	+0%	30/15 Summer			
9.000	Gully	15 Winter	30	+0%	30/15 Summer			
8.001	Y-branch	15 Winter	30	+0%	30/15 Summer			
10.000	CP28	15 Winter	30	+0%	100/15 Summer			
8.002	SW29	15 Winter	30	+0%	30/15 Winter			
8.003	BPS30	15 Winter	30	+0%	30/15 Summer			
11.000	CP31	15 Winter	30	+0%	30/15 Summer			
12.000	CP32	15 Winter	30	+0%	100/15 Summer			
11.001	SW33	15 Winter	30	+0%	30/15 Summer			
11.002	PI34	15 Winter	30	+0%	30/15 Summer			
8.004	SW35	240 Winter	30	+0%	30/15 Summer			
8.005	SW36	240 Winter	30	+0%	30/15 Winter			
8.006	SW37	240 Winter	30	+0%	100/240 Winter			
8.007	14	240 Winter	30	+0%	2/15 Summer			

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

PN	US/MH Name	Water	Surcharged	Flooded	Flow / Overflow Cap. (l/s)	Pipe	Status	Level Exceeded
		Level (m)	Depth (m)	Volume (m ³)		Flow (l/s)		
8.000	CP27	40.326	0.151	0.000	1.30	79.6	SURCHARGED	
9.000	Gully	40.264	0.110	0.000	1.05	14.7	SURCHARGED	
8.001	Y-branch	40.206	0.102	0.000	1.53	93.6	SURCHARGED	
10.000	CP28	40.952	-0.050	0.000	0.99	56.3	OK	
8.002	SW29	40.043	0.010	0.000	1.03	144.5	SURCHARGED	
8.003	BPS30	39.935	0.052	0.000	1.04	145.9	SURCHARGED	
11.000	CP31	42.114	0.094	0.000	1.18	69.9	SURCHARGED	
12.000	CP32	42.071	-0.004	0.000	0.44	16.0	OK	
11.001	SW33	42.029	0.069	0.000	1.31	83.6	SURCHARGED	
11.002	PI34	41.808	0.052	0.000	1.36	83.9	SURCHARGED	
8.004	SW35	39.862	0.079	0.000	0.24	48.6	SURCHARGED	
8.005	SW36	39.860	0.222	0.000	0.27	47.9	SURCHARGED	
8.006	SW37	39.858	-0.598	0.000	0.01	45.8	OK	
8.007	14	39.857	0.763	0.000	0.36	5.0	SURCHARGED	

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100 year Return Period 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 * 10m ³ /ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coefficient	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	0
Number of Online Controls	1	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	0.400
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18,100	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia 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)	2, 30, 100
Climate Change (%)	0, 0, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surchage	First (Y) Flood	First (Z) Overflow	Overflow Act.
8.000	CP27	15 Winter	100	+20%	30/15 Summer			
9.000	Gully	15 Winter	100	+20%	30/15 Summer			
8.001	Y-branch	15 Winter	100	+20%	30/15 Summer			
10.000	CP28	15 Winter	100	+20%	100/15 Summer			
8.002	SW29	360 Winter	100	+20%	30/15 Winter			
8.003	BPS30	360 Winter	100	+20%	30/15 Summer			
11.000	CP31	15 Winter	100	+20%	30/15 Summer			
12.000	CP32	15 Winter	100	+20%	100/15 Summer			
11.001	SW33	15 Winter	100	+20%	30/15 Summer			
11.002	PI34	15 Winter	100	+20%	30/15 Summer			
8.004	SW35	360 Winter	100	+20%	30/15 Summer			
8.005	SW36	360 Winter	100	+20%	30/15 Winter			
8.006	SW37	360 Winter	100	+20%	100/240 Winter			
8.007	14	360 Winter	100	+20%	2/15 Summer			

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100 year Return Period 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 / Overflow Cap. (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
8.000	CP27	41.076	0.901	0.000	1.85	112.9	SURCHARGED	
9.000	Gully	40.799	0.645	0.000	2.54	35.5	FLOOD RISK	
8.001	Y-branch	40.806	0.702	0.000	1.99	121.1	SURCHARGED	
10.000	CP28	41.071	0.069	0.000	1.55	88.4	SURCHARGED	
8.002	SW29	40.712	0.679	0.000	0.24	34.1	SURCHARGED	
8.003	BPS30	40.712	0.829	0.000	0.24	34.1	SURCHARGED	
11.000	CP31	42.581	0.561	0.000	1.75	103.7	SURCHARGED	
12.000	CP32	42.468	0.393	0.000	0.64	23.1	SURCHARGED	
11.001	SW33	42.395	0.435	0.000	1.95	124.6	SURCHARGED	
11.002	PI34	41.985	0.229	0.000	2.02	125.0	SURCHARGED	
8.004	SW35	40.711	0.928	0.000	0.28	56.4	SURCHARGED	
8.005	SW36	40.710	1.072	0.000	0.31	55.7	SURCHARGED	
8.006	SW37	40.708	0.252	0.000	0.01	54.3	SURCHARGED	
8.007	14	40.708	1.614	0.000	0.36	5.0	SURCHARGED	

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	Add Flow / Climate Change (%)	0
M5-60 (mm)	18.100	Minimum Backdrop Height (m)	0.200
Ratio R	0.400	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	1	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	1.712	4-8	1.919	8-12	0.035

Total Area Contributing (ha) = 3.666

Total Pipe Volume (m³) = 130.825

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
1.000	26.500	0.083	319.3	0.357	5.00	0.0	0.600	o	375	⊕
2.000	26.000	0.158	164.6	0.059	5.00	0.0	0.600	o	225	⊕
1.001	44.000	0.138	318.8	0.000	0.00	0.0	0.600	o	375	⊕
3.000	25.000	0.250	100.0	0.041	5.00	0.0	0.600	o	150	⊕

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	1.00	5.44	41.629	0.357	0.0	0.0	0.0	1.01	111.4	1.0
2.000	1.00	5.43	41.854	0.059	0.0	0.0	0.0	1.02	40.4	0.2
1.001	1.00	6.16	41.546	0.416	0.0	0.0	0.0	1.01	111.5	1.1
3.000	1.00	5.41	41.950	0.041	0.0	0.0	0.0	1.00	17.8	0.1

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
3.001	16.000	0.067	238.8	0.213	0.00	0.0	0.600	o	300	Ø
1.002	5.000	0.016	312.5	0.000	0.00	0.0	0.600	o	400	Ø
1.003	5.000	0.016	312.5	0.000	0.00	0.0	0.600	o	400	Ø
4.000	21.000	0.210	100.0	0.035	5.00	0.0	0.600	o	150	Ø
4.001	33.000	0.330	100.0	0.000	0.00	0.0	0.600	o	150	Ø
4.002	30.000	0.125	240.0	0.211	0.00	0.0	0.600	o	300	Ø
4.003	60.000	0.250	240.0	0.000	0.00	0.0	0.600	o	300	Ø
4.004	20.000	0.083	241.0	0.000	0.00	5.0	0.600	o	300	Ø
4.005	27.000	0.084	321.4	0.225	0.00	0.0	0.600	o	450	Ø
4.006	26.000	0.052	500.0	0.449	0.00	0.0	0.600	o	600	Ø
4.007	39.000	0.078	500.0	0.225	0.00	0.0	0.600	o	675	Ø
5.000	38.000	0.095	400.0	0.268	5.00	0.0	0.600	o	450	Ø
5.001	34.000	0.068	500.0	0.536	0.00	0.0	0.600	o	600	Ø
5.002	30.000	0.060	500.0	0.268	0.00	0.0	0.600	o	675	Ø
4.008	16.000	0.032	500.0	0.000	0.00	0.0	0.600	o	825	Ø
1.004	38.000	0.076	500.0	0.000	0.00	0.0	0.600	o	900	Ø

CONSTANT FLOW
FROM SOUTHERN
SYSTEM PUMPING
STATION

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
3.001	1.00	5.68	41.550	0.254	0.0	0.0	0.0	1.01	71.6	0.7
1.002	1.00	6.24	41.383	0.670	0.0	0.0	0.0	1.06	133.5	1.8
1.003	1.00	6.32	41.267	0.670	0.0	0.0	0.0	1.06	133.5	1.8
4.000	1.00	5.35	42.902	0.035	0.0	0.0	0.0	1.00	17.8	0.1
4.001	1.00	5.90	42.692	0.035	0.0	0.0	0.0	1.00	17.8	0.1
4.002	1.00	6.39	42.212	0.246	0.0	0.0	0.0	1.01	71.4	0.7
4.003	1.00	7.38	42.037	0.246	0.0	0.0	0.0	1.01	71.4	0.7
4.004	1.00	7.71	41.787	0.246	5.0	0.0	0.0	1.01	71.3	5.7
4.005	1.00	8.11	41.554	0.471	5.0	0.0	0.0	1.13	179.5	6.3
4.006	1.00	8.51	41.320	0.920	5.0	0.0	0.0	1.08	306.0	7.5
4.007	1.00	9.07	40.580	1.145	5.0	0.0	0.0	1.17	417.0	8.1
5.000	1.00	5.63	40.950	0.268	0.0	0.0	0.0	1.01	160.7	0.7
5.001	1.00	6.15	40.705	0.804	0.0	0.0	0.0	1.08	306.0	2.2
5.002	1.00	6.58	40.562	1.072	0.0	0.0	0.0	1.17	417.0	2.9
4.008	1.00	9.27	40.352	2.217	5.0	0.0	0.0	1.32	706.1	11.0
1.004	1.00	9.72	40.245	2.887	5.0	0.0	0.0	1.39	887.1	12.8

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Auto Design
6.000	21.500	0.067	320.9	0.486	5.00	0.0	0.600	o	375	Ø
7.000	22.000	0.133	165.4	0.106	5.00	0.0	0.600	o	225	Ø
6.001	7.000	0.022	318.2	0.000	0.00	0.0	0.600	o	400	Ø
6.002	7.000	0.022	318.2	0.000	0.00	0.0	0.600	o	400	Ø
1.005	32.000	0.064	500.0	0.000	0.00	0.0	0.600	o	900	Ø
1.006	9.000	0.055	163.6	0.187	0.00	0.0	0.600	o	225	Ø

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
6.000	1.00	5.36	41.518	0.486	0.0	0.0	0.0	1.01	111.1	1.3
7.000	1.00	5.36	41.734	0.106	0.0	0.0	0.0	1.01	40.3	0.3
6.001	1.00	5.47	41.426	0.592	0.0	0.0	0.0	1.05	132.3	1.6
6.002	1.00	5.58	41.304	0.592	0.0	0.0	0.0	1.05	132.3	1.6
1.005	1.00	10.11	40.169	3.479	5.0	0.0	0.0	1.39	887.1	14.4
1.006	1.00	10.25	40.000	3.666	5.0	0.0	0.0	1.02	40.5	14.9

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Online Controls for Storm

Complex Manhole: HB39, DS/PN: 1.006, Volume (m³): 24.3

Hydro-Brake®

Design Head (m) 1.000 Hydro-Brake® Type Md6 SW Only Invert Level (m) 40.000
Design Flow (l/s) 8.2 Diameter (mm) 119

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.8	1.200	8.9	3.000	14.0	7.000	21.4
0.200	7.1	1.400	9.6	3.500	15.1	7.500	22.1
0.300	7.3	1.600	10.2	4.000	16.2	8.000	22.9
0.400	7.0	1.800	10.8	4.500	17.1	8.500	23.6
0.500	6.8	2.000	11.4	5.000	18.1	9.000	24.2
0.600	6.8	2.200	12.0	5.500	18.9	9.500	24.9
0.800	7.4	2.400	12.5	6.000	19.8		
1.000	8.1	2.600	13.0	6.500	20.6		

Hydro-Brake®

Design Head (m) 0.400 Hydro-Brake® Type Md5 SW Only Invert Level (m) 41.200
Design Flow (l/s) 16.0 Diameter (mm) 174

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.0	1.200	20.0	3.000	31.6	7.000	48.2
0.200	12.9	1.400	21.6	3.500	34.1	7.500	49.9
0.300	15.5	1.600	23.1	4.000	36.4	8.000	51.5
0.400	15.8	1.800	24.4	4.500	38.7	8.500	53.1
0.500	15.6	2.000	25.8	5.000	40.7	9.000	54.7
0.600	15.7	2.200	27.0	5.500	42.7	9.500	56.2
0.800	16.8	2.400	28.2	6.000	44.6		
1.000	18.4	2.600	29.4	6.500	46.5		

Pre-initialised control selected, excessive flows may result.

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Storage Structures for Storm

Tank or Pond Manhole: HB39, DS/PN: 1.006

Invert Level (m) 40.000

Depth (m) Area (m²)			Depth (m) Area (m²)		Depth (m) Area (m²)		Depth (m) Area (m²)	
40.000	0.000	570.0	2.000	0.0	5.600	0.0	8.400	0.0
40.400	0.400	829.0	3.200	0.0	6.000	0.0	8.800	0.0
40.800	0.800	1088.0	3.600	0.0	6.400	0.0	9.200	0.0
41.200	1.200	1347.0	4.000	0.0	6.800	0.0	9.600	0.0
41.600	1.600	1606.0	4.400	0.0	7.200	0.0	10.000	0.0
41.700	1.700	1670.0	4.800	0.0	7.600	0.0		
	1.999	1991.9	5.200	0.0	8.000	0.0		

Top of SWALE = 42.000

ALLOWING FOR 300mm FREEBOARD

MAXIMUM ALLOWABLE WATER LEVEL = 42.000 - 0.3
= 41.700

$$\begin{aligned}
 \therefore \text{TOTAL SWALE VOLUME FROM } 40.000 \rightarrow 41.700 \\
 &= \frac{570\text{m}^3 + 1670\text{m}^3}{2} \times 1.7\text{m} \\
 &= \underline{\underline{1904\text{m}^3}}
 \end{aligned}$$

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2 year Return Period 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 Coefficient 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 1
Number of Online Controls 1 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 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.100 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia 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) 2, 30, 100
Climate Change (%) 0, 0, 20

US/MH		Return Climate		First (X)	First (Y)	First (Z)	Overflow	Water
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Level
							Act.	(m)
1.000	CP01	15 Winter	2	+0%	30/15 Summer			41.842
2.000	CP02	15 Winter	2	+0%	30/15 Summer			41.931
1.001	SW03	15 Winter	2	+0%	30/15 Summer			41.777
3.000	CP04	15 Winter	2	+0%	30/15 Summer			42.016
3.001	CP05	15 Winter	2	+0%	30/15 Summer			41.760
1.002	SW06	15 Winter	2	+0%	30/15 Summer			41.726
1.003	PI07	15 Winter	2	+0%	30/15 Summer			41.588
4.000	SW08	15 Winter	2	+0%	100/15 Summer			42.963
4.001	SW09	15 Winter	2	+0%	100/15 Summer			42.751
4.002	SW11	15 Winter	2	+0%	30/15 Summer			42.368
4.003	BPS12	15 Winter	2	+0%	30/15 Summer			42.187
4.004	SW13	15 Winter	2	+0%	30/15 Summer			41.955
4.005	SW14	15 Winter	2	+0%	100/15 Summer			41.757
4.006	SW15	15 Winter	2	+0%	100/15 Summer			41.618
4.007	SW16	1440 Winter	2	+0%	30/480 Winter			40.976
5.000	SW17	15 Winter	2	+0%	30/15 Summer			41.121
5.001	SW18	15 Winter	2	+0%	30/600 Winter			41.003
5.002	SW19	1440 Winter	2	+0%	30/15 Winter			40.974

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

PN	US/MH Name	Surcharged Flooded		Pipe		Level Exceeded
		Depth (m)	Volume (m³)	Flow / Overflow Cap. (l/s)	Flow (l/s)	
1.000	CP01	-0.162	0.000	0.58	56.2	OK
2.000	CP02	-0.148	0.000	0.25	9.4	OK
1.001	SW03	-0.144	0.000	0.60	61.1	OK
3.000	CP04	-0.084	0.000	0.39	6.5	OK
3.001	CP05	-0.090	0.000	0.57	34.7	OK
1.002	SW06	-0.057	0.000	1.00	88.7	OK
1.003	PI07	-0.079	0.000	1.00	88.7	OK
4.000	SW08	-0.089	0.000	0.33	5.6	OK
4.001	SW09	-0.091	0.000	0.33	5.6	OK
4.002	SW11	-0.144	0.000	0.53	34.1	OK
4.003	BPS12	-0.150	0.000	0.48	32.6	OK
4.004	SW13	-0.132	0.000	0.60	37.4	OK
4.005	SW14	-0.247	0.000	0.41	62.5	OK
4.006	SW15	-0.302	0.000	0.49	119.1	OK
4.007	SW16	-0.279	0.000	0.04	14.6	OK
5.000	SW17	-0.279	0.000	0.30	42.5	OK
5.001	SW18	-0.302	0.000	0.42	106.3	OK
5.002	SW19	-0.263	0.000	0.03	8.8	OK

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2 year Return Period 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)
4.008	SW20	1440 Winter	2	+0%	30/15 Summer				40.974
1.004	SW21	1440 Winter	2	+0%	30/15 Summer				40.972
6.000	CP22	15 Winter	2	+0%	30/15 Summer				41.845
7.000	CP23	15 Winter	2	+0%	30/15 Summer				41.843
6.001	SW24	15 Winter	2	+0%	30/15 Summer				41.791
6.002	PI25	15 Winter	2	+0%	30/15 Summer				41.625
1.005	SW26	1440 Winter	2	+0%	30/180 Winter				40.965
1.006	HB39	1440 Winter	2	+0%	2/15 Summer				40.956

		Surcharged		Flooded	Pipe		Level	
PN	US/MH Name	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status	Exceeded
4.008	SW20	-0.203	0.000	0.06		22.7	OK	
1.004	SW21	-0.173	0.000	0.04		27.9	OK	
6.000	CP22	-0.048	0.000	0.77		72.9	OK	
7.000	CP23	-0.116	0.000	0.46		16.9	OK	
6.001	SW24	-0.035	0.000	1.00		84.5	OK	
6.002	PI25	-0.079	0.000	1.00		84.5	OK	
1.005	SW26	-0.104	0.000	0.05		31.9	OK	
1.006	HB39	0.731	0.000	0.24		8.0	SURCHARGED	< 8.2 m/s

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File Northern System - 20160...	
XP Solutions	Designed by Shawn Checked by Network 2015.1

30 year Return Period 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 Coefficient 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 1
Number of Online Controls 1 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 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.100 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia 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) 2, 30, 100
Climate Change (%) 0, 0, 20

US/MH		Return Climate		First (X)	First (Y)	First (Z)	Overflow	Water
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Level
							Act.	(m)
1.000	CP01	15 Winter	30	+0%	30/15 Summer			42.201
2.000	CP02	15 Winter	30	+0%	30/15 Summer			42.150
1.001	SW03	15 Winter	30	+0%	30/15 Summer			42.113
3.000	CP04	15 Winter	30	+0%	30/15 Summer			42.139
3.001	CP05	15 Winter	30	+0%	30/15 Summer			42.028
1.002	SW06	15 Winter	30	+0%	30/15 Summer			41.941
1.003	PI07	15 Winter	30	+0%	30/15 Summer			41.784
4.000	SW08	15 Winter	30	+0%	100/15 Summer			42.990
4.001	SW09	15 Winter	30	+0%	100/15 Summer			42.779
4.002	SW11	15 Winter	30	+0%	30/15 Summer			42.558
4.003	BPS12	15 Winter	30	+0%	30/15 Summer			42.354
4.004	SW13	15 Winter	30	+0%	30/15 Summer			42.099
4.005	SW14	15 Winter	30	+0%	100/15 Summer			41.964
4.006	SW15	15 Winter	30	+0%	100/15 Summer			41.893
4.007	SW16	1440 Winter	30	+0%	30/480 Winter			41.341
5.000	SW17	15 Summer	30	+0%	30/15 Summer			41.418
5.001	SW18	1440 Winter	30	+0%	30/600 Winter			41.340
5.002	SW19	1440 Winter	30	+0%	30/15 Winter			41.339

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XP Solutions		Network 2015.1

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

PN	US/MH Name	Surcharged		Flooded		Pipe Flow (l/s)	Status	Level Exceeded
		Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)			
1.000	CP01	0.197	0.000	1.00		97.1	SURCHARGED	
2.000	CP02	0.071	0.000	0.43		15.9	SURCHARGED	
1.001	SW03	0.192	0.000	1.07		109.3	SURCHARGED	
3.000	CP04	0.039	0.000	0.66		11.2	SURCHARGED	
3.001	CP05	0.178	0.000	1.24		75.0	SURCHARGED	
1.002	SW06	0.158	0.000	1.94		172.1	SURCHARGED	
1.003	PI07	0.117	0.000	1.95		173.1	SURCHARGED	
4.000	SW08	-0.062	0.000	0.63		10.5	OK	
4.001	SW09	-0.063	0.000	0.62		10.5	OK	
4.002	SW11	0.046	0.000	1.17		75.9	SURCHARGED	
4.003	BPS12	0.017	0.000	1.01		68.8	SURCHARGED	
4.004	SW13	0.012	0.000	1.13		70.2	SURCHARGED	
4.005	SW14	-0.040	0.000	0.81		123.0	OK	
4.006	SW15	-0.027	0.000	1.00		243.2	OK	
4.007	SW16	0.086	0.000	0.06		21.8	SURCHARGED	
5.000	SW17	0.018	0.000	0.50		71.2	SURCHARGED	
5.001	SW18	0.035	0.000	0.04		11.3	SURCHARGED	
5.002	SW19	0.102	0.000	0.05		15.1	SURCHARGED	

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30 year Return Period 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)
4.008	SW20	1440 Winter	30	+0%	30/15 Summer				41.339
1.004	SW21	1440 Winter	30	+0%	30/15 Summer				41.338
6.000	CP22	15 Winter	30	+0%	30/15 Summer				42.117
7.000	CP23	15 Winter	30	+0%	30/15 Summer				42.059
6.001	SW24	15 Winter	30	+0%	30/15 Summer				41.964
6.002	PI25	15 Winter	30	+0%	30/15 Summer				41.813
1.005	SW26	1440 Winter	30	+0%	30/180 Winter				41.336
1.006	HB39	1440 Winter	30	+0%	2/15 Summer				41.335

PN	US/MH Name	Surcharged		Flooded		Pipe		Level	
		Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status	Exceeded	
4.008	SW20	0.162	0.000	0.10		36.5	SURCHARGED		
1.004	SW21	0.193	0.000	0.07		45.9	SURCHARGED		
6.000	CP22	0.224	0.000	1.51		142.1	SURCHARGED		
7.000	CP23	0.100	0.000	0.82		30.3	SURCHARGED		
6.001	SW24	0.138	0.000	2.03		171.6	SURCHARGED		
6.002	PI25	0.109	0.000	2.02		170.9	SURCHARGED		
1.005	SW26	0.267	0.000	0.08		54.4	SURCHARGED		
1.006	HB39	1.110	0.000	0.55		18.1	SURCHARGED		< 18.7 l/s

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100 year Return Period 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 Coefficient 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 1
Number of Online Controls 1 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 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.100 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia 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) 2, 30, 100
Climate Change (%) 0, 0, 20

US/MH		Return Climate		First (X)	First (Y)	First (Z)	Overflow	Water
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Level
							Act.	(m)
1.000	CP01	15 Winter	100	+20%	30/15 Summer			42.883
2.000	CP02	15 Winter	100	+20%	30/15 Summer			42.753
1.001	SW03	15 Winter	100	+20%	30/15 Summer			42.685
3.000	CP04	15 Winter	100	+20%	30/15 Summer			42.732
3.001	CP05	15 Winter	100	+20%	30/15 Summer			42.509
1.002	SW06	15 Winter	100	+20%	30/15 Summer			42.311
1.003	PI07	15 Winter	100	+20%	30/15 Summer			41.967
4.000	SW08	15 Winter	100	+20%	100/15 Summer			43.366
4.001	SW09	15 Winter	100	+20%	100/15 Summer			43.242
4.002	SW11	15 Winter	100	+20%	30/15 Summer			43.113
4.003	BPS12	15 Winter	100	+20%	30/15 Summer			42.828
4.004	SW13	15 Winter	100	+20%	30/15 Summer			42.320
4.005	SW14	15 Winter	100	+20%	100/15 Summer			42.124
4.006	SW15	15 Winter	100	+20%	100/15 Summer			41.999
4.007	SW16	15 Winter	100	+20%	30/480 Winter			41.810
5.000	SW17	15 Winter	100	+20%	30/15 Summer			41.929
5.001	SW18	15 Winter	100	+20%	30/600 Winter			41.869
5.002	SW19	15 Winter	100	+20%	30/15 Winter			41.779

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Date 01/03/2016 12:24	Designed by Shawn	
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XP Solutions		Network 2015.1

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

PN	US/MH Name	Surcharged		Flooded		Pipe Flow (l/s)	Status	Level Exceeded
		Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)			
1.000	CP01	0.879	0.000	1.49		144.7	FLOOD RISK	
2.000	CP02	0.674	0.000	0.62		23.2	SURCHARGED	
1.001	SW03	0.764	0.000	1.61		164.4	SURCHARGED	
3.000	CP04	0.632	0.000	1.03		17.4	FLOOD RISK	
3.001	CP05	0.659	0.000	1.78		107.8	SURCHARGED	
1.002	SW06	0.528	0.000	2.92		258.5	SURCHARGED	
1.003	PI07	0.300	0.000	2.92		258.7	SURCHARGED	
4.000	SW08	0.314	0.000	0.85		14.3	SURCHARGED	
4.001	SW09	0.400	0.000	1.01		17.3	SURCHARGED	
4.002	SW11	0.601	0.000	1.53		99.2	SURCHARGED	
4.003	BPS12	0.491	0.000	1.40		95.1	SURCHARGED	
4.004	SW13	0.233	0.000	1.66		103.3	SURCHARGED	
4.005	SW14	0.120	0.000	1.19		181.2	SURCHARGED	
4.006	SW15	0.079	0.000	1.58		383.3	SURCHARGED	
4.007	SW16	0.555	0.000	1.25		434.3	SURCHARGED	
5.000	SW17	0.529	0.000	0.72		102.0	FLOOD RISK	
5.001	SW18	0.564	0.000	1.14		291.3	SURCHARGED	
5.002	SW19	0.542	0.000	1.15		380.6	SURCHARGED	

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Date 01/03/2016 12:24	
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XP Solutions	Network 2015.1

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
4.008	SW20	1440 Winter	100	+20%	30/15 Summer				41.705
1.004	SW21	1440 Winter	100	+20%	30/15 Summer				41.704
6.000	CP22	15 Winter	100	+20%	30/15 Summer				42.677
7.000	CP23	15 Winter	100	+20%	30/15 Summer				42.535
6.001	SW24	15 Winter	100	+20%	30/15 Summer				42.329
6.002	PI25	15 Winter	100	+20%	30/15 Summer				41.994
1.005	SW26	1440 Winter	100	+20%	30/180 Winter				41.701
1.006	HB39	1440 Winter	100	+20%	2/15 Summer				41.699

		Surcharged		Flooded		Pipe			
PN	US/MH Name	Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded	
4.008	SW20	0.528	0.000	0.15		54.1	SURCHARGED		
1.004	SW21	0.559	0.000	0.10		69.0	SURCHARGED		
6.000	CP22	0.784	0.000	2.23		210.3	SURCHARGED		
7.000	CP23	0.576	0.000	1.21		44.5	SURCHARGED		
6.001	SW24	0.503	0.000	3.01		254.2	SURCHARGED		
6.002	PI25	0.290	0.000	3.02		255.4	SURCHARGED		
1.005	SW26	0.632	0.000	0.12		82.2	SURCHARGED		
1.006	HB39	1.474	0.000	0.79		26.2	SURCHARGED		< 26.3 l/s

WATER LEVEL IN SWALE IS LESS THAN THE LIMIT OF 41.700

5.0 DRAINAGE MAINTENANCE PLAN

The following table indicates the maintenance regime that will need to be followed by the landlord.

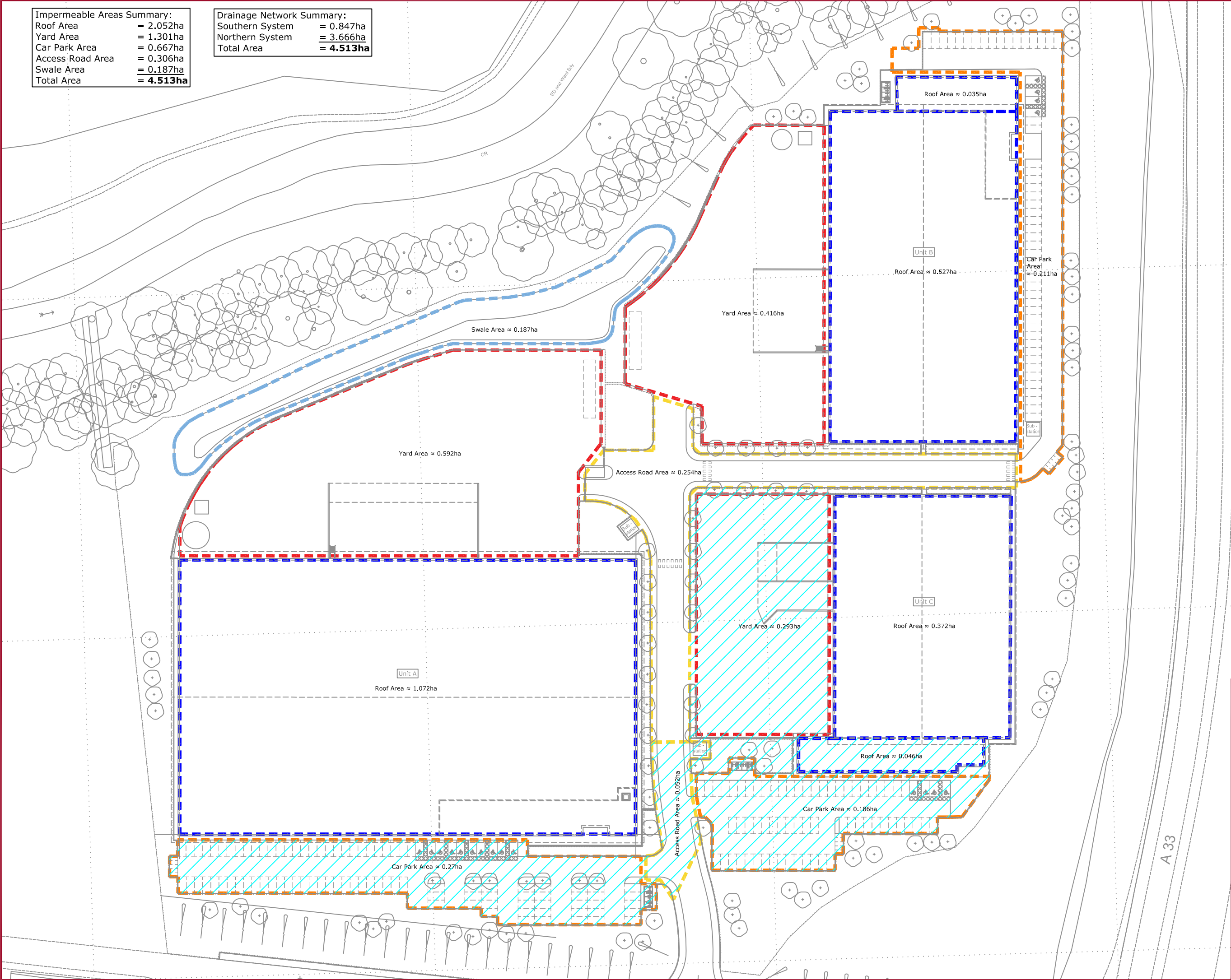
Element	Access Method	Method of Maintenance	Frequency Required
Roof Gutters	Scaffolding / Cherry pickers to be used where required	General cleaning of gutters. Jet cleaning where required.	Periodic inspection of gutters to ensure rainwater outlets do not become blocked. Periodic renewal of gutter coatings to prevent corrosion.
Oil / Petrol Separators	In accordance with health and safety regulations	Refer to manufacturer's guidance.	Bi-annual inspection and emptying
Channel Drains	In accordance with health and safety regulations	Monitored to ensure no blockages develop. Jet cleaning where required.	Bi-annual jet cleaning of channel drains.
Silt-traps and Gullies	In accordance with health and safety regulations	Monitored to ensure no blockages develop. Removal of rubbish and debris where required.	Bi-annual inspection and clearance of all silt traps and gullies.
Pumps	In accordance with health and safety regulations	Monitored to ensure no blockages develop in accordance with the manufacturer's recommendations	Bi-annual inspection or in accordance with the manufacturer's recommendations, whichever occurs sooner.

APPENDIX A: DRAINAGE LAYOUT

APPENDIX B: DRAINAGE CATCHMENT AREA LAYOUT

Impermeable Areas Summary:	
Roof Area	= 2.052ha
Yard Area	= 1.301ha
Car Park Area	= 0.667ha
Access Road Area	= 0.306ha
Swale Area	= 0.187ha
Total Area	= 4.513ha

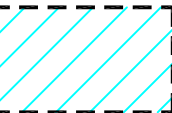
Drainage Network Summary:	
Southern System	= 0.847ha
Northern System	= 3.666ha
Total Area	= 4.513ha



- NOTES:
1. If this drawing has been received electronically it is the recipients responsibility to print the document to the correct scale.
 2. All dimensions are in millimetres unless stated otherwise. It is recommended that information is not scaled off this drawing.
 3. This drawing should be read in conjunction with all other relevant drawings and specifications.

KEY:-

 Northern System

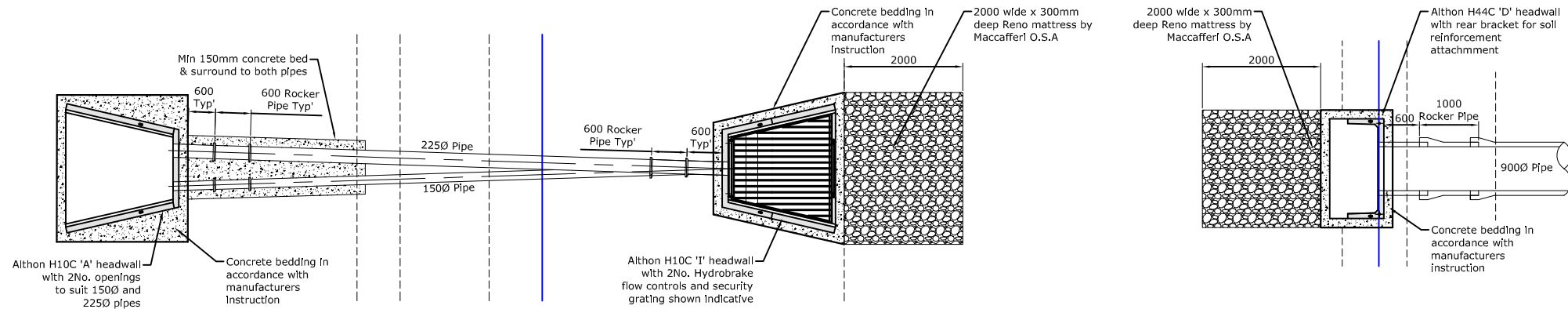
 Southern System

rev/amendments		by ckd date	
Project: Island Road Reading			
Title: Drainage Catchment Area Layout			
Drawing Status: Preliminary	Date Created: 18/01/16	Drawing Scale: 1:500	
Project Leader: AT	Drawn By: DE	Checked By: SL	
Drawing Number: BED-DRG-150088-52(00)0305		Size: Rev: A1 P1	
Client:			
BUCKINGHAM Group Contracting			
BE Design			

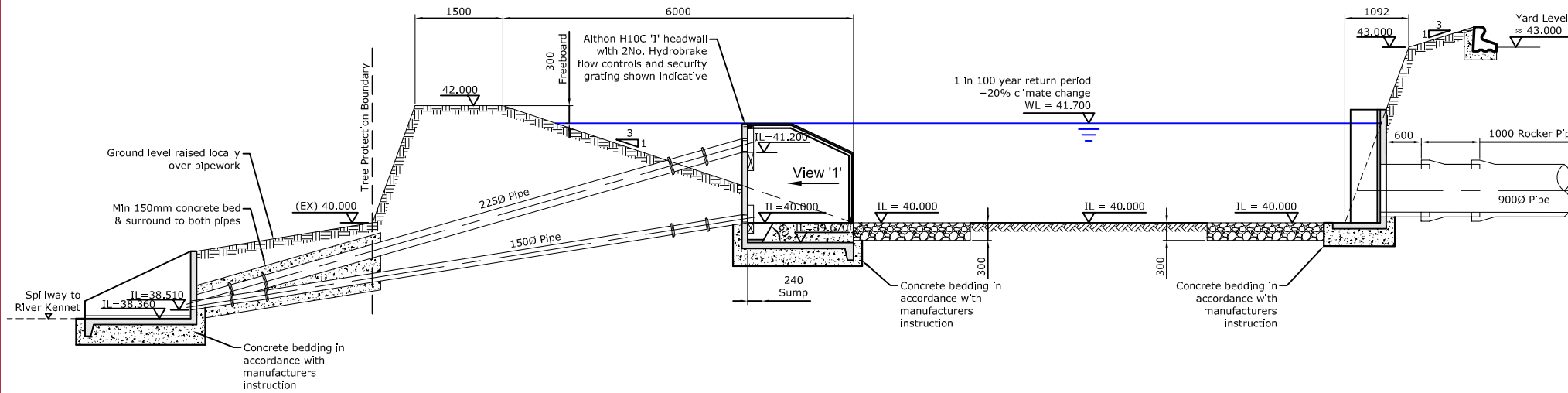
APPENDIX C: PROPOSED HEADWALL AND SWALE DETAILS

NOTES:

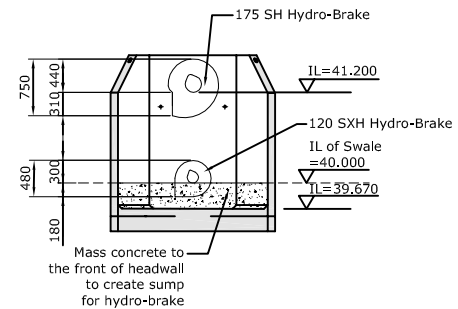
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3. This drawing should be read in conjunction with all other relevant drawings and specifications.



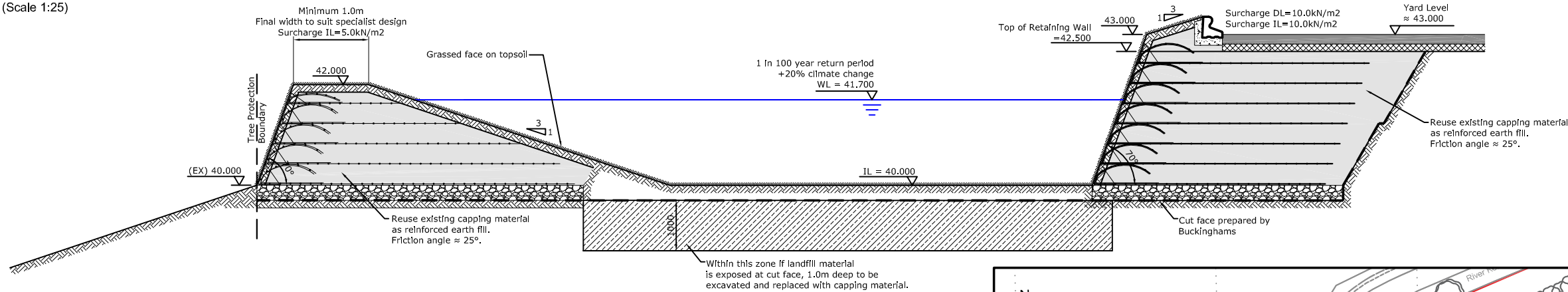
Plan On Headwalls
(Scale 1:25)



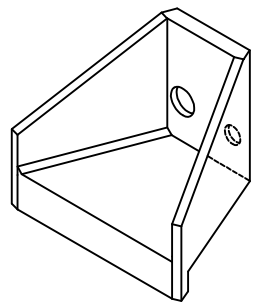
Section A-A Showing Headwall and Pipework Details
(Scale 1:25)



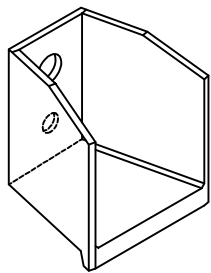
View '1' on Althon Headwall H10C 'I'
Showing Complex Flow Control Details
(1:50)



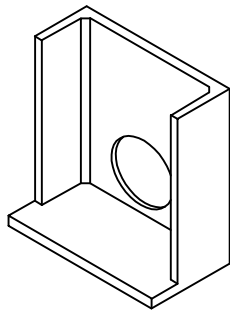
Section A'-A' Showing Swale Details
(Scale 1:50)



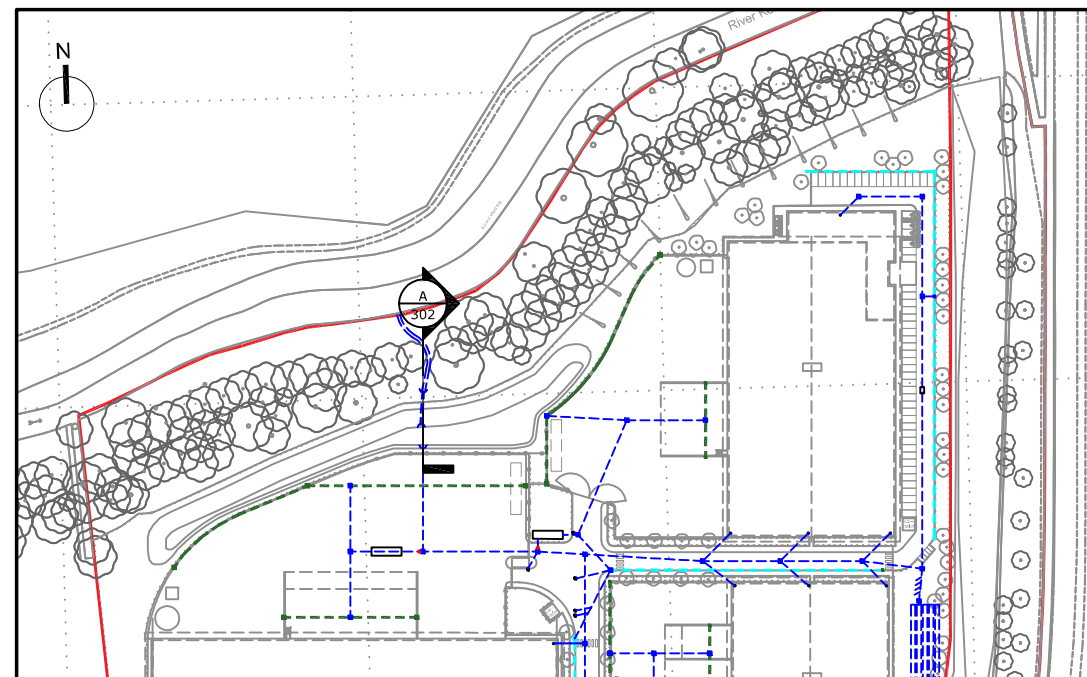
Isometric View On Althon Headwall
Type H10C 'A' Above
(NTS)



Isometric View On Althon
Headwall Type H10C 'I' Above
(NTS)



Isometric View On Althon
Headwall Type H44C 'D' Above
(NTS)



Part Site Plan Showing Swale and Headwall Locations
(Scale 1:1250)

rev/amendments by ckd date

Project:
Island Road Reading

Title:
Proposed Headwall and Swale Details

Drawing Status: Preliminary Date Created: 27/01/16 Drawing Scale: 1:50

Project Leader: AT Drawn By: IGD Checked By: SL

Drawing Number: BED-DRG-150088-52(00)0302 A1 P1 Size: Rev:

Client:

BUCKINGHAM
Group Contracting

BE
Design

Hydro International

120mm Type SXH Hydro-Brake® Flow Control

Project Information

Our Reference: FOR INTERNAL USE ONLY
Client: 16_21_0501
Site: Island Road, Reading

Technical Specification Criteria

Primary Design Point (A)

Head = 1.000 m

Flow = 8.200 l/s

Control Points	Head (m)	Flow (l/s)
Flush-Flo™ (B)	0.275	7.450
Kick-Flo® (C)	0.514	6.847

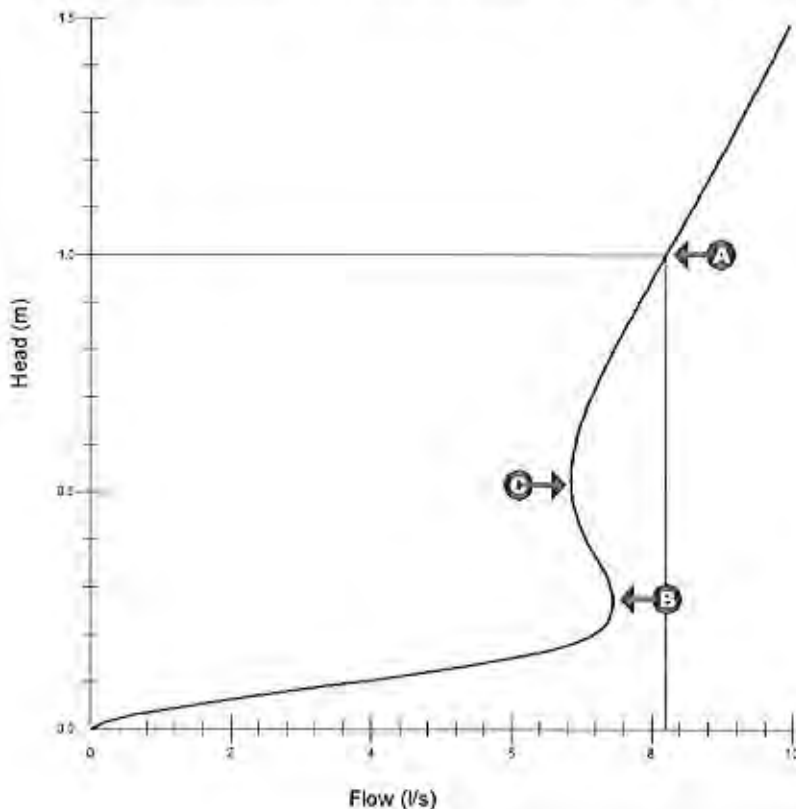
Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
0.075	2.577	0.825	7.548
0.150	6.010	0.900	7.823
0.225	7.365	0.975	8.105
0.300	7.415	1.050	8.389
0.375	7.159	1.125	8.669
0.450	6.925	1.200	8.945
0.525	6.845	1.275	9.215
0.600	6.908	1.350	9.479
0.675	7.069	1.425	9.737
0.750	7.291	1.500	9.989

Design Advice



The head / flow characteristics of this 120mm Type SXH Hydro-Brake® Flow Control are unique, fully verifiable and proven by computational design, physical modelling and in-situ testing. The use of any other flow control will invalidate any design based on this data which may lead to adverse hydraulic effects including loss of upstream storage, under / over discharge and increased potential for flooding, any of which could cause non-compliance with the original hydraulic model.

Specific Head / Flow characteristic for 120mm Type SXH



Flush-Flo™ (B)

The point at which the vortex begins to initiate and have a throttling effect. This point on the Hydro-Brake® curve is usually much nearer to the maximum design flow (Design Point) than other vortex flow controls leading to more water passing through the unit during the earlier stages of a storm, thus reducing the amount of water that needs to be stored upstream.

Kick-Flo® (C)

The point at which the vortex has initiated and at which the curve begins to return back to follow the orifice curve and reach the same design point or desired head / flow condition.

HYDRO INTERNATIONAL PLC

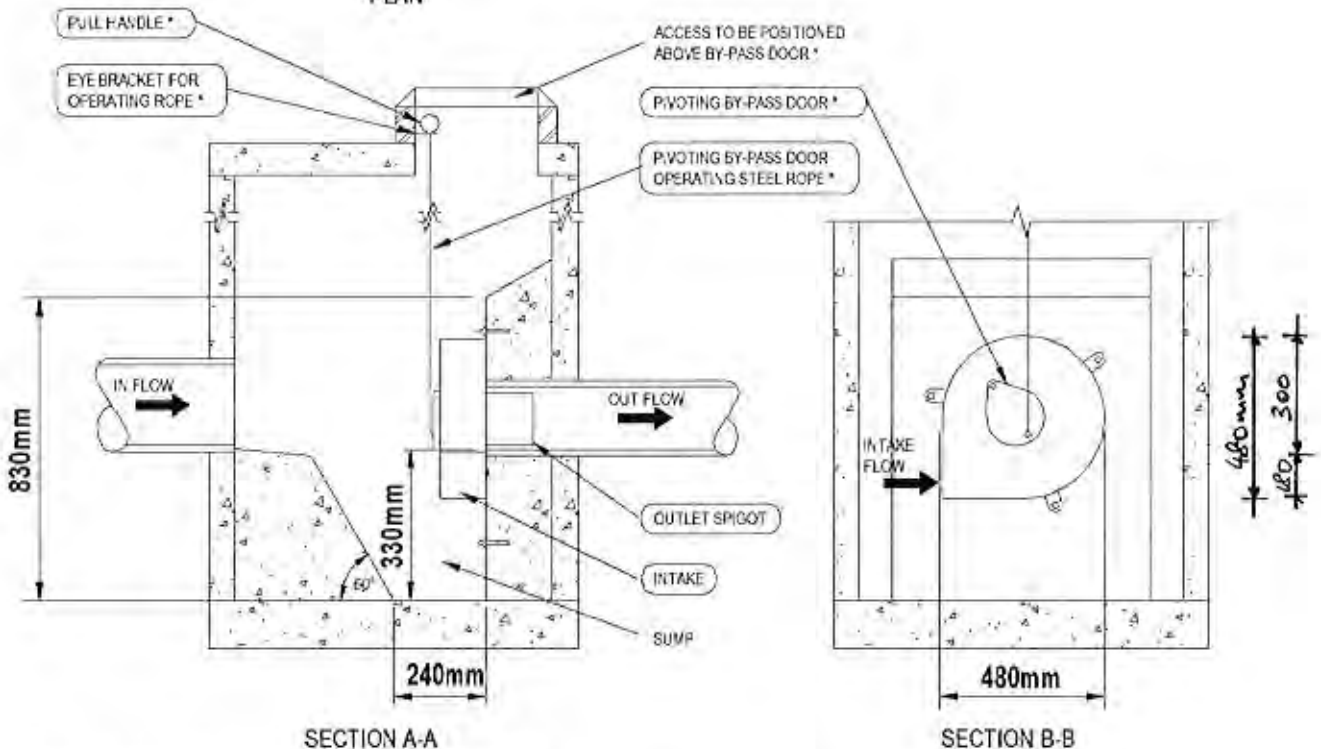
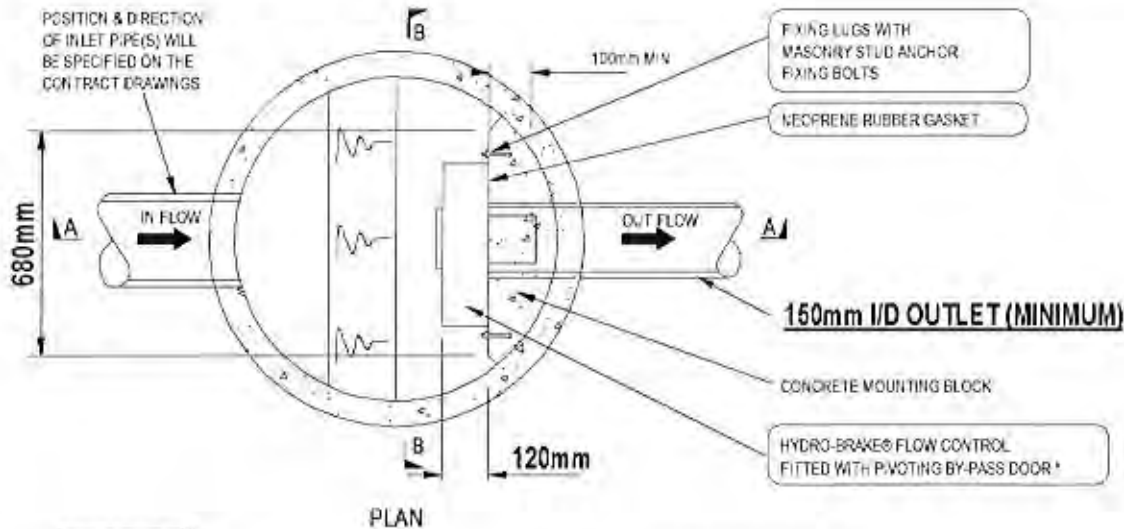
Design Layout with Approximate Dimensions of a 120 SXH Hydro-Brake® Flow Control

Project Information

Our Reference : FOR INTERNAL USE ONLY

Client : 16_21_0501

Site : Island Road, Reading



IMPORTANT:  UNIT OF HYDRO INTERNATIONAL PLC SUPPLY
THE DEVICE WILL BE HANDLED TO SUIT SITE CONDITIONS
FOR SITE SPECIFIC DETAILS AND MINIMUM CHAMBER SIZE REFER TO HYDRO INTERNATIONAL PLC
ALL CIVIL AND INSTALLATION WORK BY OTHERS
* WHERE SUPPLIED

FOR ILLUSTRATIVE PURPOSES ONLY

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The head-flow characteristics of this 120mm Type SXH Hydro-Brake® Flow Control are unique, fully verifiable and proven by computational design, physical modelling and in-situ testing. The use of any other flow control will invalidate any design based on this data which may lead to adverse hydraulic effects including loss of upstream storage, under- or over discharge and increased potential for flooding, any of which could cause non-compliance with the original hydraulic model. Hydro-Brake® Flow Control is the registered trademark for flow controls designed exclusively by Hydro International plc.

naslams

February 25, 2016

15:46

HBFCDesign Version 3.6.4

SXH_D_SR_(1.0) (3.0)

Tel : 01275 878371

Fax : 01275 874979

Hydro International

175mm Type SH Hydro-Brake® Flow Control

Project Information

Our Reference: FOR INTERNAL USE ONLY
 Client: 16_21_0501
 Site: Island Road, Reading

Technical Specification Criteria

Primary Design Point (A)

Head = 0.400 m

Flow = 16.000 l/s

Control Points	Head (m)	Flow (l/s)
Flush-Flo™ (B)	0.375	16.024
Kick-Flo® (C)	0.525	15.792

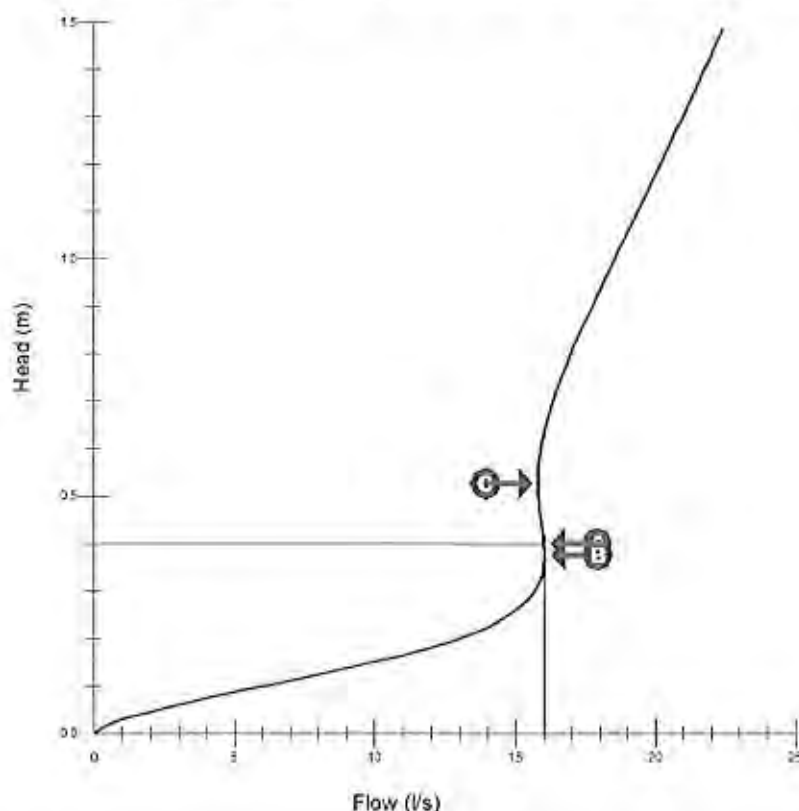
Head (m)	Flow (l/s)	Head (m)	Flow (l/s)
0.075	4.066	0.825	17.144
0.150	9.958	0.900	17.723
0.225	14.055	0.975	18.329
0.300	15.662	1.050	18.946
0.375	16.024	1.125	19.564
0.450	15.892	1.200	20.176
0.525	15.792	1.275	20.778
0.600	15.892	1.350	21.368
0.675	16.185	1.425	21.946
0.750	16.619	1.500	22.511

Design Advice



The head / flow characteristics of this 175mm Type SH Hydro-Brake® Flow Control are unique, fully verifiable and proven by computational design, physical modelling and in-situ testing. The use of any other flow control will invalidate any design based on this data which may lead to adverse hydraulic effects including loss of upstream storage, under / over discharge and increased potential for flooding, any of which could cause non-compliance with the original hydraulic model.

Specific Head / Flow characteristic for 175mm Type SH



Flush-Flo™ (B)

The point at which the vortex begins to initiate and have a throttling effect. This point on the Hydro-Brake® curve is usually much nearer to the maximum design flow (Design Point) than other vortex flow controls leading to more water passing through the unit during the earlier stages of a storm, thus reducing the amount of water that needs to be stored upstream.

Kick-Flo® (C)

The point at which the vortex has initiated and at which the curve begins to return back to follow the orifice curve and reach the same design point or desired head / flow condition.

HYDRO INTERNATIONAL PLC

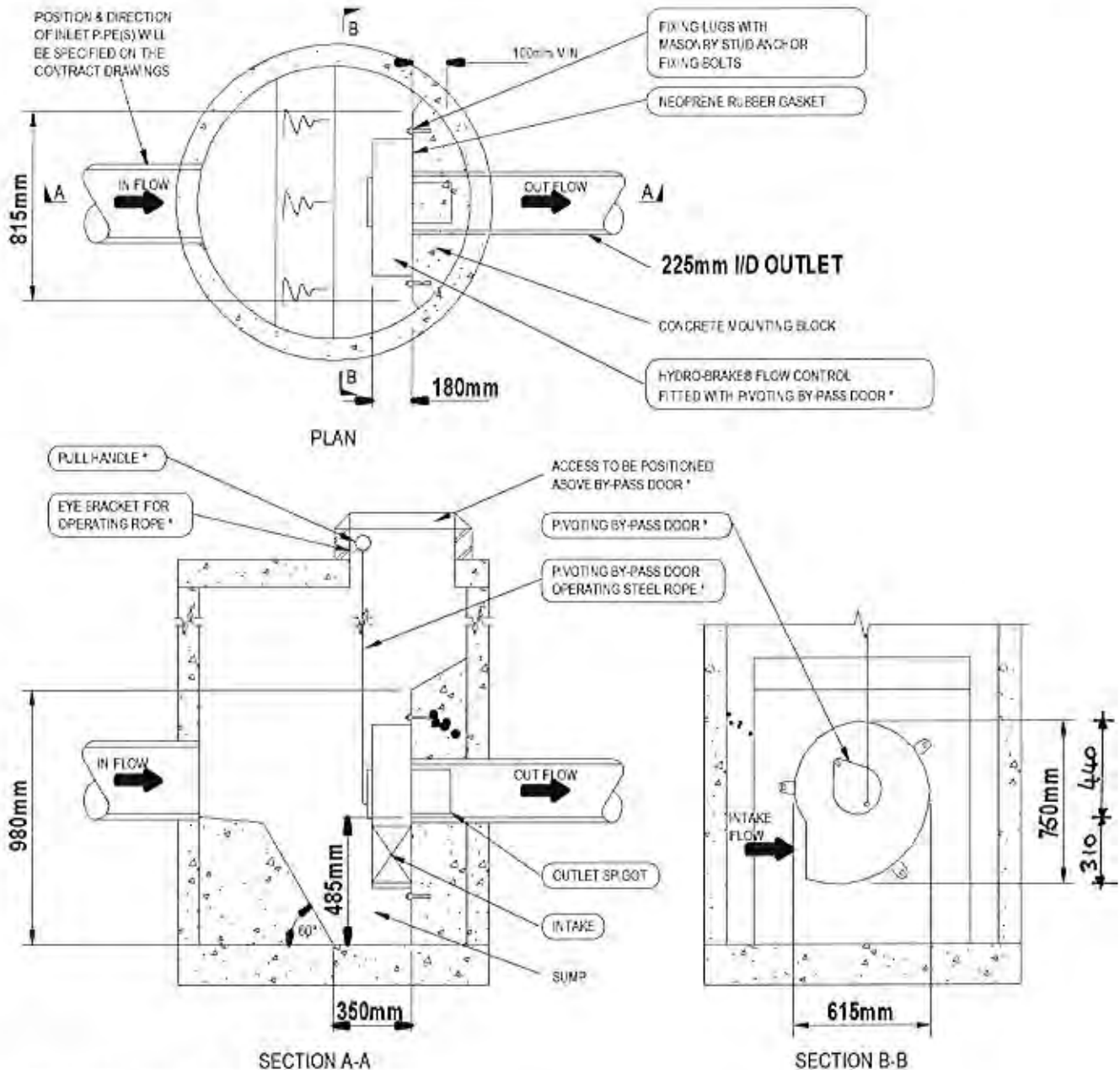
Design Layout with Approximate Dimensions of a 175 SH Hydro-Brake® Flow Control

Project Information

Our Reference : FOR INTERNAL USE ONLY

Client : 16_21_0501

Site : Island Road, Reading



IMPORTANT: LIMIT OF HYDRO INTERNATIONAL PLC SUPPLY
THE DEVICE WILL BE HANDLED TO SUIT SITE CONDITIONS
FOR SITE SPECIFIC DETAILS AND MINIMUM CHAMBER SIZE REFER TO HYDRO INTERNATIONAL PLC
ALL CIVIL AND INSTALLATION WORK BY OTHERS
* WHERE SUPPLIED

FOR ILLUSTRATIVE PURPOSES ONLY

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The head / flow characteristics of this 175mm Type SH Hydro-Brake® Flow Control are unique, fully verifiable and proven by computational design, physical modelling and in-situ testing. The use of any other flow control will invalidate any design based on this data which may lead to adverse hydraulic effects including loss of upstream storage, under / over discharge and increased potential for flooding, any of which could cause non-compliance with the original hydraulic model. Hydro-Brake® Flow Control is the registered trademark for flow controls designed exclusively by Hydro International plc.

naadsm

February 25, 2016

15:47

HBFCDesign Version 3.6.4

SH_D_SR_(2-1)(3.0)

Tel : 01275 878371

Fax : 01275 874979

APPENDIX D: GREENFIELD RUN-OFF CALCULATION

T.R. Collier & Associates Ltd		Page 1
Rochester House 275 Baddow Road Chelmsford CM2 7QA		
Date 16/05/2014 15:27	Designed by Clark	
File Swale 3.srcx	Checked by	
Micro Drainage	Source Control 2014.1.1	

ICP SUDS Mean Annual Flood

Input

Return Period (years)	10	Soil	0.300
Area (ha)	4.329	Urban	0.000
SAAR (mm)	700	Region Number	Region 6

Results 1/s

QBAR Rural	7.9
QBAR Urban	7.9

Q10 years 12.8

Q1 year	6.7
Q30 years	17.9
Q100 years	25.2

$$Q_{BAR} = \frac{7.9 \text{ l/s}}{4.329 \text{ ha}} = 1.825 \text{ l/s/ha}$$

$$Q_{30} = \frac{17.9 \text{ l/s}}{4.329 \text{ ha}} = 4.135 \text{ l/s/ha}$$

$$Q_{100} = \frac{25.2 \text{ l/s}}{4.329 \text{ ha}} = 5.821 \text{ l/s/ha}$$