



Project:

Island Road West
Reading

Document Title:

Drainage Design Philosophy

Prepared For:

Exton Estates



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1.0 INTRODUCTION

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 SU707709, bounded by River Kennet to the north, industrial units to the east, Island Road to the south and a Foudry Brook to the west.

The application site is approximately 3.4ha, but the developable area is significantly smaller as a land strip along the southern boundary is 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 1.851ha.

The existing site is elevated from the surrounding area and slopes down gradually from the eastern boundary at around 43.5m AOD towards the western and northern boundary. 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 by BE Design (Job Ref: NWK 160016, dated 13th December 2014).

The development will comprise the following:

- 2no. warehouse units and associated office/ancillary buildings
- Service yard for heavy goods vehicles
- Car park area
- Access road
- Landscaping zone

2.0 SURFACE WATER DRAINAGE

2.1 Existing Site Surface Water Drainage

The development area is currently vacant and undeveloped, comprising heavily vegetated land. 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 BE Design and can be found in their Flood Risk Assessment (Job Ref: NWK 160016, dated 13th December 2014, Appendix F). The parameters relevant to the site and the assessment results are summarised below with the extracted calculation reproduced in Appendix C of this document:

Site Parameters

- Development area = 3.186ha
- SAAR (mm) = 700
- Soil = 0.30
- Region = 6

Greenfield Run-off Rates

- 1 in 2 year storm event = 1.82 l/s/ha
- 1 in 30 year storm event = 4.14 l/s/ha
- 1 in 100 year storm event = 5.81 l/s/ha

2.2 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 2no. warehouse units and associated infrastructure, which will generate approximately 1.851ha of impermeable area. 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 rates for the different storm events are:

- 1 in 2 year storm event: $1.82 \text{ l/s/ha} \times 1.851 \text{ ha} = 3.4 \text{ l/s}$, therefore use **5.0 l/s**
- 1 in 30 year storm event: $4.14 \text{ l/s/ha} \times 1.851 \text{ ha} = \mathbf{7.7 \text{ l/s}}$
- 1 in 100 year storm event: $5.81 \text{ l/s/ha} \times 1.851 \text{ ha} = \mathbf{10.8 \text{ l/s}}$

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 approximately half of the access road which covers an impermeable area of 0.088ha. Surface water run-off from this area will drain by gravity towards the pumping station (duty + standby), which will then be pumped at the maximum design flow of 40l/s into the Northern System.

The Northern System is a gravity system taking run-off from the remaining site, ie all building roofs, the service yards, the car parks and the remainder of the access road. In total, the Northern System covers an impermeable area of 1.763ha. Surface water run-off from these areas will drain by gravity towards the attenuation system, and will subsequently discharge to River Kennet at the allowable discharge rates mentioned above. The required attenuation volume for the Northern System is circa 835m³. This volume assessment is discussed in more detail in Section 2.4.

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 and is positioned just downstream of the attenuation system. To minimize impact on the existing northern landscaping, a spillway is proposed to provide connection 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 and service yard areas will be drained via linear drainage and/or local gullies prior to passing through 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 manhole downstream of attenuation system 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.

2.3 Complex Flow Control

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. A custom flow control chamber will be required to accommodate the two Hydrobrakes. Details of the flow controls can be found in Appendix E.

2.4 Proposed Surface Water Attenuation

The attenuation volume is determined using an iteration method to establish the optimum attenuation requirement and to ensure the design criteria are met. The proposed surface water attenuation has been modelled within MicroDrainage using custom user conduit section:

- Type -30: 10 x 1.4m diameter

Type -30 conduit has been applied to pipe number 1.004. The MicroDrainage pipe reference layout is illustrated in Appendix D. By multiplying the modelled length and the conduit section, the required attenuation volume can be established:

Type -30 modelled length = 54m

Type -30 attenuation volume = $10 \times (\pi \times 1.4\text{m} \times 1.4\text{m} \div 4) \times 54\text{m} \approx \underline{\underline{835\text{m}^3}}$

2.5 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 + 15% 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 + 15% climate change – No Flooding

3.0 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:

- Time Area Diagram for Storm
- Network Details for Storm
- Conduit Sections for Storm
- Online Controls for Storm
- 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 = **4.9l/s, No Surcharge**
- 1 in 30 year storm site discharge = **7.5l/s, No Flooding**
- 1 in 100 year storm + 20% climate change site discharge = **10.8l/s, No Flooding**

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Conduit Sections for Storm

NOTE: Diameters less than 66 refer to section numbers of hydraulic conduits. These conduits are marked by the symbols:- [] box culvert, \ / open channel, oo dual pipe, ooo triple pipe, O egg.

Section numbers < 0 are taken from user conduit table

Section Number	Conduit Type	Major Dimn. (mm)	Minor Dimn. (mm)	Side Slope (Deg)	Corner Splay (mm)	4*Hyd Radius (m)	XSect Area (m ²)
-30	10o	14000	1400			1.400	15.390

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Existing Network Details 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)	Section Type
1.000	28.000	0.280	100.0	0.056	5.00	0.0	0.600	o	150	Pipe/Conduit
2.000	8.000	0.050	160.0	0.088	5.00	0.0	0.600	o	225	Pipe/Conduit
2.001	84.000	-2.065	-40.7	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit
1.001	18.300	0.080	228.8	0.017	0.00	0.0	0.600	o	300	Pipe/Conduit
3.000	32.300	0.680	47.5	0.084	5.00	0.0	0.600	o	150	Pipe/Conduit
1.002	5.000	0.050	100.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit
1.003	5.000	0.050	100.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit
4.000	31.000	0.370	83.8	0.665	5.00	0.0	0.600	o	600	Pipe/Conduit
4.001	8.000	0.100	80.0	0.223	0.00	0.0	0.600	o	600	Pipe/Conduit
5.000	4.000	0.030	133.3	0.000	5.00	0.0	0.600	o	225	Pipe/Conduit
6.000	5.000	0.025	200.0	0.000	5.00	0.0	0.600	o	300	Pipe/Conduit
5.001	53.000	0.170	311.8	0.301	0.00	0.0	0.600	o	375	Pipe/Conduit
7.000	5.000	0.021	238.1	0.000	5.00	0.0	0.600	o	300	Pipe/Conduit

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
1.000	40.820	0.056	0.0	1.00	17.8
2.000	38.375	0.088	0.0	1.03	41.0
2.001	38.325	0.088	0.0	0.00	0.0
1.001	40.390	0.161	0.0	1.04	73.2
3.000	41.140	0.084	0.0	1.46	25.9
1.002	40.310	0.245	0.0	1.57	111.1
1.003	40.200	0.245	0.0	1.57	111.1
4.000	40.950	0.665	0.0	2.66	752.6
4.001	40.580	0.888	0.0	2.72	770.3
5.000	40.675	0.000	0.0	1.13	45.0
6.000	40.595	0.000	0.0	1.11	78.3
5.001	40.495	0.301	0.0	1.02	112.7
7.000	40.600	0.000	0.0	1.01	71.7

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Existing Network Details 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)	Section Type
8.000	27.000	0.270	100.0	0.079	5.00	0.0	0.600	o	150	Pipe/Conduit
8.001	48.000	0.200	240.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit
5.002	10.000	0.050	200.0	0.210	0.00	0.0	0.600	o	400	Pipe/Conduit
5.003	10.000	0.050	200.0	0.000	0.00	0.0	0.600	o	400	Pipe/Conduit
9.000	22.000	0.100	220.0	0.064	5.00	0.0	0.600	o	300	Pipe/Conduit
9.001	18.000	0.060	300.0	0.064	0.00	0.0	0.600	o	375	Pipe/Conduit
1.004	54.000	0.200	270.0	0.000	0.00	0.0	0.600	10o	-30	Pipe/Conduit
1.005	19.000	0.070	271.4	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit
1.006	26.000	0.160	162.5	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
8.000	40.600	0.079	0.0	1.00	17.8
8.001	40.180	0.079	0.0	1.01	71.4
5.002	39.880	0.590	0.0	1.33	167.3
5.003	39.730	0.590	0.0	1.33	167.3
9.000	40.810	0.064	0.0	1.06	74.6
9.001	40.635	0.128	0.0	1.04	115.0
1.004	39.680	1.851	0.0	2.50	38436.7
1.005	39.480	1.851	0.0	1.23	195.5
1.006	39.410	1.851	0.0	0.79	13.9

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Online Controls for Storm

Pump Manhole: PS5a, DS/PN: 2.001, Volume (m³): 2.2

Invert Level (m) 38.325

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.200	40.0000	1.800	40.0000	3.400	40.0000	5.000	40.0000
0.400	40.0000	2.000	40.0000	3.600	40.0000	5.200	40.0000
0.600	40.0000	2.200	40.0000	3.800	40.0000	5.400	40.0000
0.800	40.0000	2.400	40.0000	4.000	40.0000	5.600	40.0000
1.000	40.0000	2.600	40.0000	4.200	40.0000	5.800	40.0000
1.200	40.0000	2.800	40.0000	4.400	40.0000	6.000	40.0000
1.400	40.0000	3.000	40.0000	4.600	40.0000		
1.600	40.0000	3.200	40.0000	4.800	40.0000		

Complex Manhole: SW23, DS/PN: 1.006, Volume (m³): 21.0

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0105-5000-1000-5000
Design Head (m)	1.000
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	105
Invert Level (m)	39.410
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	5.0
Flush-Flo™	0.296	5.0
Kick-Flo®	0.637	4.1
Mean Flow over Head Range	-	4.3

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	3.6	0.600	4.3	1.600	6.2	2.600	7.8
0.200	4.8	0.800	4.5	1.800	6.6	3.000	8.4
0.300	5.0	1.000	5.0	2.000	6.9	3.500	9.0
0.400	4.9	1.200	5.4	2.200	7.2	4.000	9.6
0.500	4.7	1.400	5.8	2.400	7.5	4.500	10.1

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Hydro-Brake® Optimum

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
5.000	10.6	6.500	12.1	8.000	13.3	9.500	14.5
5.500	11.1	7.000	12.5	8.500	13.7		
6.000	11.6	7.500	12.9	9.000	14.1		

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0081-2400-0500-2400
Design Head (m)	0.500
Design Flow (l/s)	2.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	81
Invert Level (m)	40.210
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	2.4
Flush-Flo™	0.151	2.4
Kick-Flo®	0.349	2.0
Mean Flow over Head Range	-	2.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.3	1.200	3.6	3.000	5.5	7.000	8.3
0.200	2.4	1.400	3.9	3.500	5.9	7.500	8.5
0.300	2.2	1.600	4.1	4.000	6.3	8.000	8.8
0.400	2.2	1.800	4.3	4.500	6.7	8.500	9.1
0.500	2.4	2.000	4.5	5.000	7.0	9.000	9.4
0.600	2.6	2.200	4.8	5.500	7.3	9.500	9.6
0.800	3.0	2.400	4.9	6.000	7.6		
1.000	3.3	2.600	5.1	6.500	7.9		

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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 2 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 OFF

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, 15

US/MH		Return Climate		First (X)		First (Y)		First (Z)		Water
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Overflow	Act.	Level (m)
1.000	CP3	15 Winter	2	+0%	100/15 Summer					40.899
2.000	CP1	15 Winter	2	+0%	100/15 Summer					38.482
2.001	PS5a	15 Winter	2	+0%						38.397
1.001	CP6	15 Winter	2	+0%	30/15 Winter					40.525
3.000	CP5	15 Winter	2	+0%	100/15 Summer					41.220
1.002	SW7	15 Winter	2	+0%	30/15 Winter					40.477
1.003	PI8	15 Winter	2	+0%	30/15 Winter					40.367
4.000	SW12	15 Winter	2	+0%						41.120
4.001	SW13	15 Winter	2	+0%	100/15 Summer					40.845
5.000	CP14	120 Winter	2	+0%	100/15 Summer					40.675
6.000	CP15	15 Winter	2	+0%	100/15 Summer					40.659
5.001	SW15a	15 Winter	2	+0%	100/15 Summer					40.659
7.000	CP16	120 Winter	2	+0%	100/180 Winter					40.600
8.000	CP18	15 Winter	2	+0%	30/15 Summer					40.699
8.001	SW19	15 Winter	2	+0%	30/120 Winter					40.269
5.002	SW17	360 Winter	2	+0%	30/15 Summer					40.134
5.003	PI20	360 Winter	2	+0%	2/360 Winter					40.133
9.000	SW9	15 Winter	2	+0%	100/360 Winter					40.890

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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		Flow / Overflow Cap.	Pipe Flow (l/s)	Status	Level Exceeded
		Depth (m)	Volume (m³)				
1.000	CP3	-0.071	0.000	0.53	9.0	OK	
2.000	CP1	-0.118	0.000	0.45	14.3	OK	
2.001	PS5a	-0.228	0.000	0.38	12.6	OK	
1.001	CP6	-0.165	0.000	0.37	23.4	OK	
3.000	CP5	-0.070	0.000	0.54	13.4	OK	
1.002	SW7	-0.133	0.000	0.59	36.1	OK	
1.003	PI8	-0.133	0.000	0.59	36.3	OK	
4.000	SW12	-0.430	0.000	0.18	107.4	OK	
4.001	SW13	-0.335	0.000	0.40	138.0	OK	
5.000	CP14	-0.225	0.000	0.00	0.0	OK	
6.000	CP15	-0.236	0.000	0.00	0.1	OK	
5.001	SW15a	-0.211	0.000	0.40	41.5	OK	
7.000	CP16	-0.300	0.000	0.00	0.0	OK	
8.000	CP18	-0.051	0.000	0.75	12.7	OK	
8.001	SW19	-0.211	0.000	0.18	12.3	OK	
5.002	SW17	-0.146	0.000	0.11	13.9	OK	
5.003	PI20	0.003	0.000	0.11	13.7	SURCHARGED	
9.000	SW9	-0.220	0.000	0.16	10.2	OK	

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

US/MH		Return Climate		First (X)	First (Y)	First (Z)	Overflow	Water
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Act. Level
								(m)
9.001	SW10	15	Winter	2	+0%	100/240	Winter	40.749
1.004	SW21	360	Winter	2	+0%	100/360	Winter	40.133
1.005	SW22	360	Winter	2	+0%	2/30	Summer	40.133
1.006	SW23	360	Winter	2	+0%	2/15	Summer	40.141

US/MH		Surcharged Flooded		Pipe		Level	
PN	Name	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status Exceeded
9.001	SW10	-0.261	0.000	0.20		19.1	OK
1.004	SW21	-0.947	0.000	0.00		43.0	OK
1.005	SW22	0.203	0.000	0.06		8.7	SURCHARGED
1.006	SW23	0.581	0.000	0.37		4.9	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	2	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	OFF

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, 15

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surchage	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	CP3	15 Winter	30	+0%	100/15 Summer				40.947
2.000	CP1	15 Winter	30	+0%	100/15 Summer				38.537
2.001	PS5a	15 Winter	30	+0%					38.461
1.001	CP6	15 Winter	30	+0%	30/15 Winter				40.714
3.000	CP5	15 Winter	30	+0%	100/15 Summer				41.287
1.002	SW7	15 Winter	30	+0%	30/15 Winter				40.628
1.003	PI8	480 Winter	30	+0%	30/15 Winter				40.521
4.000	SW12	15 Winter	30	+0%					41.191
4.001	SW13	15 Winter	30	+0%	100/15 Summer				40.990
5.000	CP14	15 Winter	30	+0%	100/15 Summer				40.783
6.000	CP15	15 Winter	30	+0%	100/15 Summer				40.783
5.001	SW15a	15 Winter	30	+0%	100/15 Summer				40.783
7.000	CP16	120 Winter	30	+0%	100/180 Winter				40.600
8.000	CP18	15 Winter	30	+0%	30/15 Summer				40.972
8.001	SW19	480 Winter	30	+0%	30/120 Winter				40.522
5.002	SW17	480 Winter	30	+0%	30/15 Summer				40.522
5.003	PI20	480 Winter	30	+0%	2/360 Winter				40.521
9.000	SW9	15 Winter	30	+0%	100/360 Winter				40.923

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

PN	US/MH Name	Surcharged Flooded		Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
		Depth (m)	Volume (m³)					
1.000	CP3	-0.023	0.000	0.99		16.9	OK	
2.000	CP1	-0.063	0.000	0.86		27.0	OK	
2.001	PS5a	-0.164	0.000	0.72		24.0	OK	
1.001	CP6	0.024	0.000	0.66		41.6	SURCHARGED	
3.000	CP5	-0.003	0.000	1.00		24.9	OK	
1.002	SW7	0.018	0.000	1.05		64.4	SURCHARGED	
1.003	PI8	0.021	0.000	0.14		8.5	SURCHARGED	
4.000	SW12	-0.359	0.000	0.33		203.8	OK	
4.001	SW13	-0.190	0.000	0.78		271.2	OK	
5.000	CP14	-0.117	0.000	0.00		0.0	OK	
6.000	CP15	-0.112	0.000	0.00		0.2	OK	
5.001	SW15a	-0.087	0.000	0.92		96.4	OK	
7.000	CP16	-0.300	0.000	0.00		0.0	OK	
8.000	CP18	0.222	0.000	1.34		22.7	SURCHARGED	
8.001	SW19	0.042	0.000	0.04		2.7	SURCHARGED	
5.002	SW17	0.242	0.000	0.16		19.9	SURCHARGED	
5.003	PI20	0.391	0.000	0.16		19.7	SURCHARGED	
9.000	SW9	-0.187	0.000	0.29		19.3	OK	

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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) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
9.001	SW10	15 Winter	30	+0%	100/240 Winter				40.806
1.004	SW21	480 Winter	30	+0%	100/360 Winter				40.521
1.005	SW22	480 Winter	30	+0%	2/30 Summer				40.519
1.006	SW23	480 Winter	30	+0%	2/15 Summer				40.525

		Surcharged Flooded				Pipe		
PN	US/MH Name	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
9.001	SW10	-0.204	0.000	0.42		39.4	OK	
1.004	SW21	-0.559	0.000	0.00		62.1	OK	
1.005	SW22	0.589	0.000	0.06		9.0	SURCHARGED	
1.006	SW23	0.965	0.000	0.56		7.5	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 * 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 2 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 OFF

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, 15

US/MH		Return Climate		First (X)		First (Y)		First (Z)		Overflow		Water
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Act.				Level (m)
1.000	CP3	600 Winter	100	+15%	100/15 Summer							41.533
2.000	CP1	15 Winter	100	+15%	100/15 Summer							38.622
2.001	PS5a	15 Winter	100	+15%								38.529
1.001	CP6	600 Winter	100	+15%	30/15 Winter							41.531
3.000	CP5	15 Winter	100	+15%	100/15 Summer							41.855
1.002	SW7	600 Winter	100	+15%	30/15 Winter							41.530
1.003	PI8	600 Winter	100	+15%	30/15 Winter							41.530
4.000	SW12	600 Winter	100	+15%								41.534
4.001	SW13	600 Winter	100	+15%	100/15 Summer							41.530
5.000	CP14	600 Winter	100	+15%	100/15 Summer							41.532
6.000	CP15	600 Winter	100	+15%	100/15 Summer							41.533
5.001	SW15a	600 Winter	100	+15%	100/15 Summer							41.533
7.000	CP16	600 Winter	100	+15%	100/180 Winter							41.531
8.000	CP18	15 Winter	100	+15%	30/15 Summer							41.659
8.001	SW19	600 Winter	100	+15%	30/120 Winter							41.531
5.002	SW17	600 Winter	100	+15%	30/15 Summer							41.531
5.003	PI20	600 Winter	100	+15%	2/360 Winter							41.530
9.000	SW9	600 Winter	100	+15%	100/360 Winter							41.529

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

PN	US/MH Name	Surcharged Flooded		Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
		Depth (m)	Volume (m³)					
1.000	CP3	0.563	0.000	0.14		2.4	FLOOD RISK	
2.000	CP1	0.022	0.000	1.28		40.2	SURCHARGED	
2.001	PS5a	-0.096	0.000	1.06		35.4	OK	
1.001	CP6	0.841	0.000	0.11		6.9	SURCHARGED	
3.000	CP5	0.565	0.000	1.29		32.1	SURCHARGED	
1.002	SW7	0.920	0.000	0.17		10.4	SURCHARGED	
1.003	PI8	1.030	0.000	0.17		10.4	SURCHARGED	
4.000	SW12	-0.016	0.000	0.05		28.8	OK	
4.001	SW13	0.350	0.000	0.11		38.5	SURCHARGED	
5.000	CP14	0.632	0.000	0.00		0.0	SURCHARGED	
6.000	CP15	0.638	0.000	0.00		0.0	SURCHARGED	
5.001	SW15a	0.663	0.000	0.12		13.1	SURCHARGED	
7.000	CP16	0.631	0.000	0.00		0.1	SURCHARGED	
8.000	CP18	0.909	0.000	1.82		30.8	FLOOD RISK	
8.001	SW19	1.051	0.000	0.05		3.2	SURCHARGED	
5.002	SW17	1.251	0.000	0.20		23.9	SURCHARGED	
5.003	PI20	1.400	0.000	0.20		23.8	SURCHARGED	
9.000	SW9	0.419	0.000	0.04		2.8	SURCHARGED	

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

PN	US/MH		Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
	Name	Storm							
9.001	SW10	600 Winter	100	+15%	100/240 Winter				41.529
1.004	SW21	600 Winter	100	+15%	100/360 Winter				41.529
1.005	SW22	600 Winter	100	+15%	2/30 Summer				41.530
1.006	SW23	600 Winter	100	+15%	2/15 Summer				41.526

PN	US/MH Name	Surcharged		Flooded		Pipe		Status	Level Exceeded
		Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)			
9.001	SW10	0.519	0.000	0.06		5.6		SURCHARGED	
1.004	SW21	0.449	0.000	0.00		77.3		SURCHARGED	
1.005	SW22	1.600	0.000	0.08		12.1		SURCHARGED	
1.006	SW23	1.966	0.000	0.82		10.8		SURCHARGED	

4.0 **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
Kerb Drains / 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.

5.0 FOUL WATER DRAINAGE

It is proposed that the foul water from the development will discharge to Thames Water's foul public sewer, located at the southern side of Island Road. As the connection point invert level is higher than the site's foul drainage invert level, it will be necessary to pump the overall site foul discharge to the foul public sewer.

The peak design flow for the development is estimated using a value of 0.6 l/s/ha of developable land as suggested in the Sewer for Adoption.

With the developable land measuring approximately 3.2ha, the peak design flow
= 0.6l/s/ha x 3.4ha
= 2.04 l/s

By inspection, 150mm diameter pipes laid at a gradient of 1:150 will be adequate. Storage equivalent to 1 hour of peak design flow will be provided at the pumping station in accordance with recommendation from the Sewer for Adoption.

Required storage volume
= 2.04 l/s x 1 hr
= 2.04 l/s x 3600 s
= 7344 l
≈ 8 m³

As the peak design flow is less than the minimum pump rate of 5.0 l/s, allow foul discharge into public sewer to be 5.0 l/s.



APPENDIX A: DRAINAGE LAYOUT



- Key:
- SW19 - Surface water manhole
 - PS24 - Surface water pumping station
 - FW - Foul water manhole
 - PS - Foul water pumping station
 - SW - Surface water pipe
 - PS - Pumped surface water rising main
 - FW - Foul water pipe (1500 @ 1:150 UNO)
 - PS - Pumped foul water rising main
 - LD - Land Drain
 - 3750 @ 1:320 - Surface water pipe diameter and gradient
 - P120 - Oil interceptor
 - AT - Attenuation Tank
 - SD - Slot Drain
 - KD - Kerb Drain
 - SDP - Siphonic down pipe
 - CP18 - Catch pit
 - AP - Access point
 - HW - Head wall
 - G - Road Gully
 - SP - Spillway
 - Secondary - Indicative Route of secondary siphonic drainage
 - MRT - MRT Mass transit zone (safeguarding zone)
 - E - Easement
 - T - Thicket

NOTES:

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

Greenfield runoff rate:

1 in 2 year storm	= 1.82 l/s/ha
1 in 30 year storm	= 4.14 l/s/ha
1 in 100 year storm	= 5.81 l/s/ha
Proposed Impermeable area = 1.851ha	

Interceptor specification:

P120	- Spel P125/1CSC Full retention separator
P18	- Spel P050/1CSC Full retention separator

Note:

For Foul Drainage Public Sewer Connection drawing please refer to BE Design drawing:

- BED-DRG-160016-00-XX-C-0360.

For Drainage Schedule drawing please refer to BE Design drawing:

- BED-DRG-160016-00-XX-C-0301

PS5a Surface Water Pumping Station:

Cover level = 40.000

Lowest Incoming I.L. = 38.325

Rising Main Discharge I.L. = 40.390

Rising Main Length = 84m

Pump Rate = 40 l/s

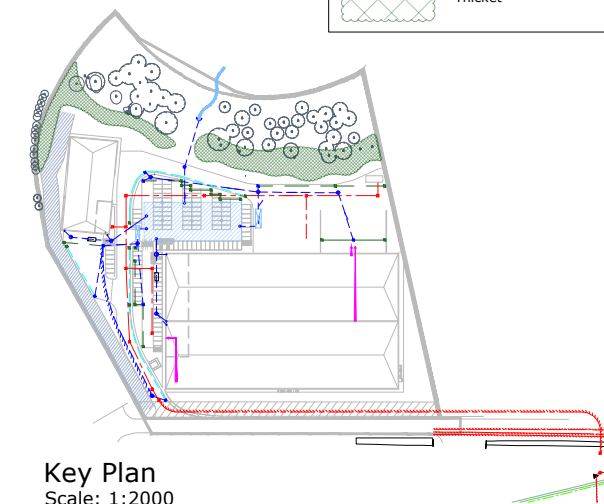
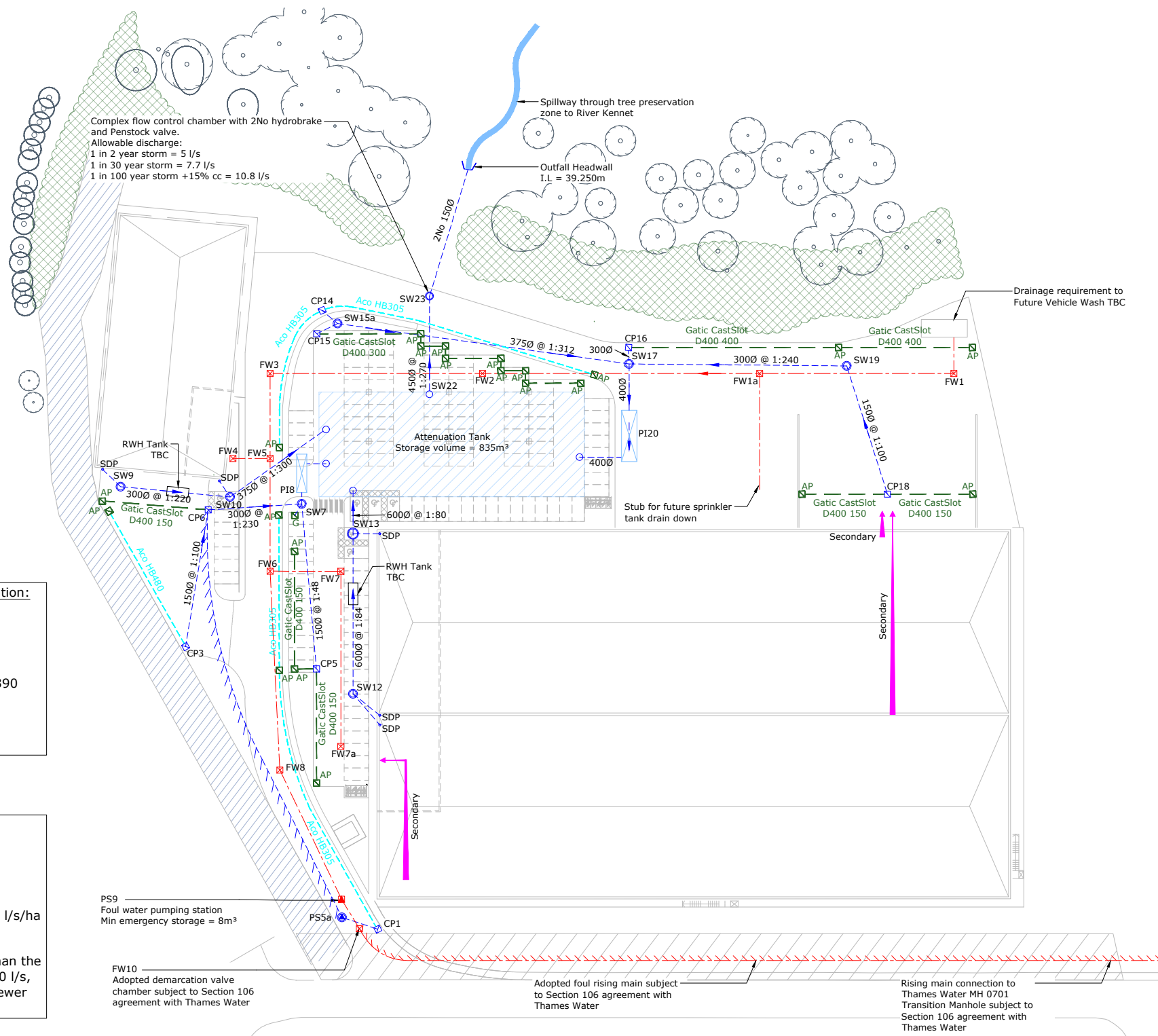
Foul Peak Flow Rate Estimation:

Site area = 3.41 ha

Flow rate = 0.6 l/s/ha

Peak design flow = 3.41 ha x 0.6 l/s/ha
= 2.046 l/s

As the peak design flow is less than the minimum design pump rate of 5.0 l/s, allow foul discharge into public sewer to be 5.0 l/s.



Key Plan
Scale: 1:2000

P08	General update to optimise drainage arrangement.	CG	DE	22/11/17
P07	MH FW1a & stub for future sprinkler tank added. Pipe run from Attenuation tank to outfall headwall re-located in-between thicket area. Attenuation Tank updated. Drainage MH Schedule updated & moved onto separate drawing: BED-DRG-170055-00-XX-C-0301	CG	DE	16/11/17
P06	Foul Peak Flow Rate Estimation note added to drawing. Manhole schedule updated, PS9 & FW11 MH's added. SW 19a and 23a added.	CG	SL	23/10/17
P05	Drawing updated to suit revised site layout. Foul water pumping station & adopted valve chamber moved beyond transit zone adoption line.	CG	DE	12/10/17
P04	Land drain removed as requested.	CG	SO	29/08/17
P03	Drawing updated to suit Michael Sparks, Site Layout Plan, Rev C, 16/01/17.	CG	DE	07/07/17
P02	Foul manhole schedule added. SW 22 & SW 23 updated.	DE	SL	01/03/17
Rev	Amendments	By	Chk	Date

Project:
**Island Road West
Reading**

Title:
Proposed Drainage Plan

Drawing Number:
BED-DRG-160016-00-XX-C-0300

Status:	Suitability Code:	Model Ref:	Rev:	
Preliminary	S0	ACAD	P08	
Scale:	Sheet:	By:	Check By:	Date Created:
1:500	A1	DE	SL	21/02/17

Exton Estates

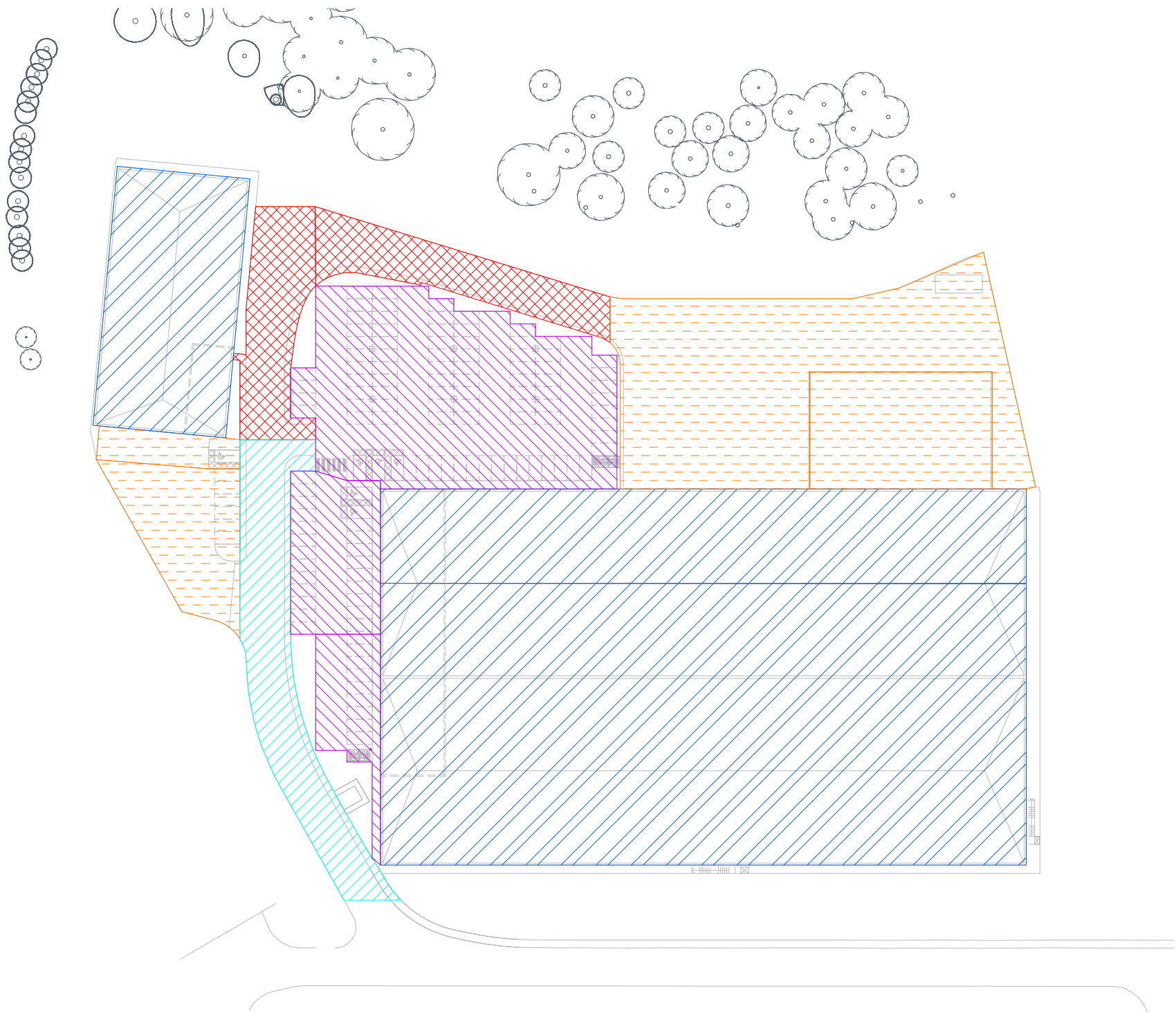
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APPENDIX B: DRAINAGE CATCHMENT AREA LAYOUT



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



Catchment Area Summary:		
	Roof	= 1.016ha
	Service Yard	= 0.362ha
	Car Park	= 0.284ha
	Northern Access Road	= 0.101ha
	Southern Access Road	= 0.088ha
Total impermeable area = 1.851ha		

Rev	Amendments	By	Chk	Date
Project: Island Road West Reading				
Title: Drainage Catchment Areas				
Drawing Number: BED-DRG-160016-00-XX-C-0305				
Status:	Suitability Code:	Model Ref:	Rev:	
Preliminary	S0	ACAD	P01	
Scale:	Sheet:	By:	Check By:	Date Created:
1:500	A1	DE	SL	21/11/17
Client:				

Exton Estates

BE
DESIGN

APPENDIX C: GREENFIELD RUN-OFF CALCULATION

ICP SUDS

ICP SUDS Input (FSR Method)

Return Period (Years)

Area (ha)

SAAR (mm)

Soil

Growth Curve

Partly Urbanised Catchment (QBAR)

Urban

Region

Results

QBAR rural (l/s)
 5.8

QBAR urban (l/s)
 5.8

Return Period Flood

Region	QBAR (l/s)	Q (1yrs) (l/s)	Q (1 yrs) (l/s)	Q (30 yrs) (l/s)	Q (100 yrs) (l/s)
Region 1	5.8	4.9	4.9	11.0	14.4
Region 2	5.8	5.1	5.1	11.0	15.3
Region 3	5.8	5.0	5.0	10.2	12.1
Region 4	5.8	4.8	4.8	11.4	14.9
Region 5	5.8	5.1	5.1	13.9	20.7
Region 6/Region 7	5.8	4.9	4.9	13.2	18.5
Region 8	5.8	4.5	4.5	11.1	14.1
Region 9	5.8	5.1	5.1	10.2	12.7
Region 10	5.8	5.1	5.1	9.8	12.1

Method Selection

IH 124 ☐

ICP SUDS ☒

ADAS 345 ☐

FEH ☐

Greenfield Volume ☐

GREENFIELD RUN-OFF RATES:

$$Q_1 \approx Q_{BAR} \approx \frac{5.8 \text{ l/s}}{3.186 \text{ ha}} = 1.82 \text{ l/s/ha}$$

$$Q_{30} = \frac{13.2 \text{ l/s}}{3.186 \text{ ha}} = 4.14 \text{ l/s/ha}$$

$$Q_{100} = \frac{18.5 \text{ l/s}}{3.186 \text{ ha}} = 5.81 \text{ l/s/ha}$$

DEVELOPMENT IMPERMEABLE AREA = 1.851 ha

ALLOWABLE DISCHARGE RATES:

$$1 \text{ in } 2 \text{ YEAR} = 1.82 \text{ l/s/ha} \times 1.851 \text{ ha} = 3.4 \text{ l/s}$$

∵ 3.4 l/s is less than the minimum 5.0 l/s

∴ Allowable discharge increased to 5.0 l/s

$$1 \text{ in } 30 \text{ YEAR} = 4.14 \text{ l/s/ha} \times 1.851 \text{ ha} = \underline{7.7 \text{ l/s}}$$

$$1 \text{ in } 100 \text{ YEAR} = 5.81 \text{ l/s/ha} \times 1.851 \text{ ha} = \underline{10.8 \text{ l/s}}$$

APPENDIX D: MICRODRAINAGE PIPE REFERENCE LAYOUT

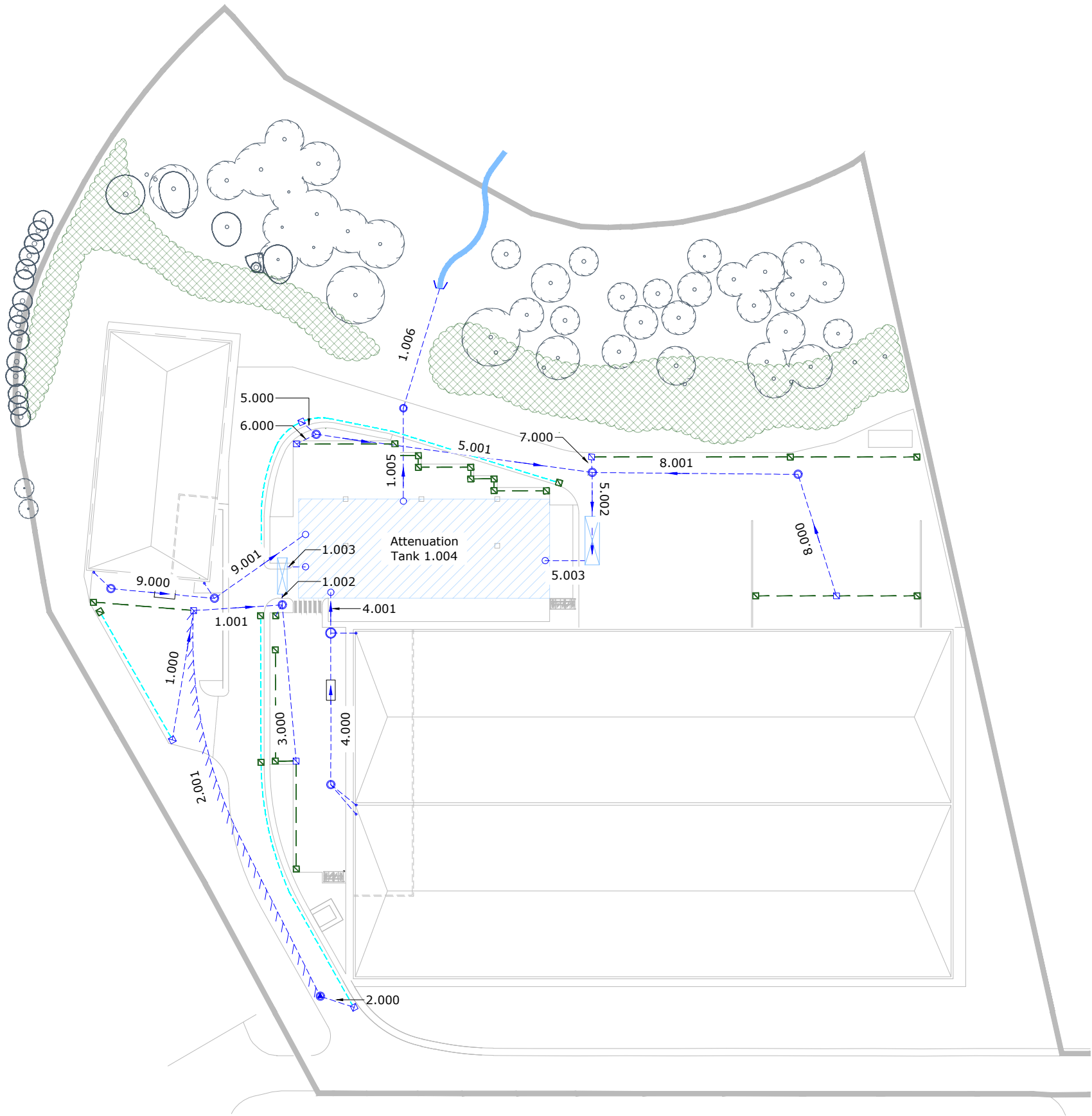


NOTES:

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

Key:

- Kerb Drain
- Slot Drain
- Surface Water Pipe



Rev	Amendments	By	Chk	Date
Project: Island Road West Reading				
Title: MicroDrainage Pipe References				
Drawing Number: BED-DRG-160016-00-XX-C-0306				

Status:	Suitability Code:	Model Ref:	Rev:
Preliminary	S0	ACAD	P01
Scale:	Sheet:	By:	Check By:
1:500	A1	DE	SL
Date Created:			
21/11/17			
Client:			

Exton Estates

BE
Design

APPENDIX E: FLOW CONTROL DETAILS

Technical Specification

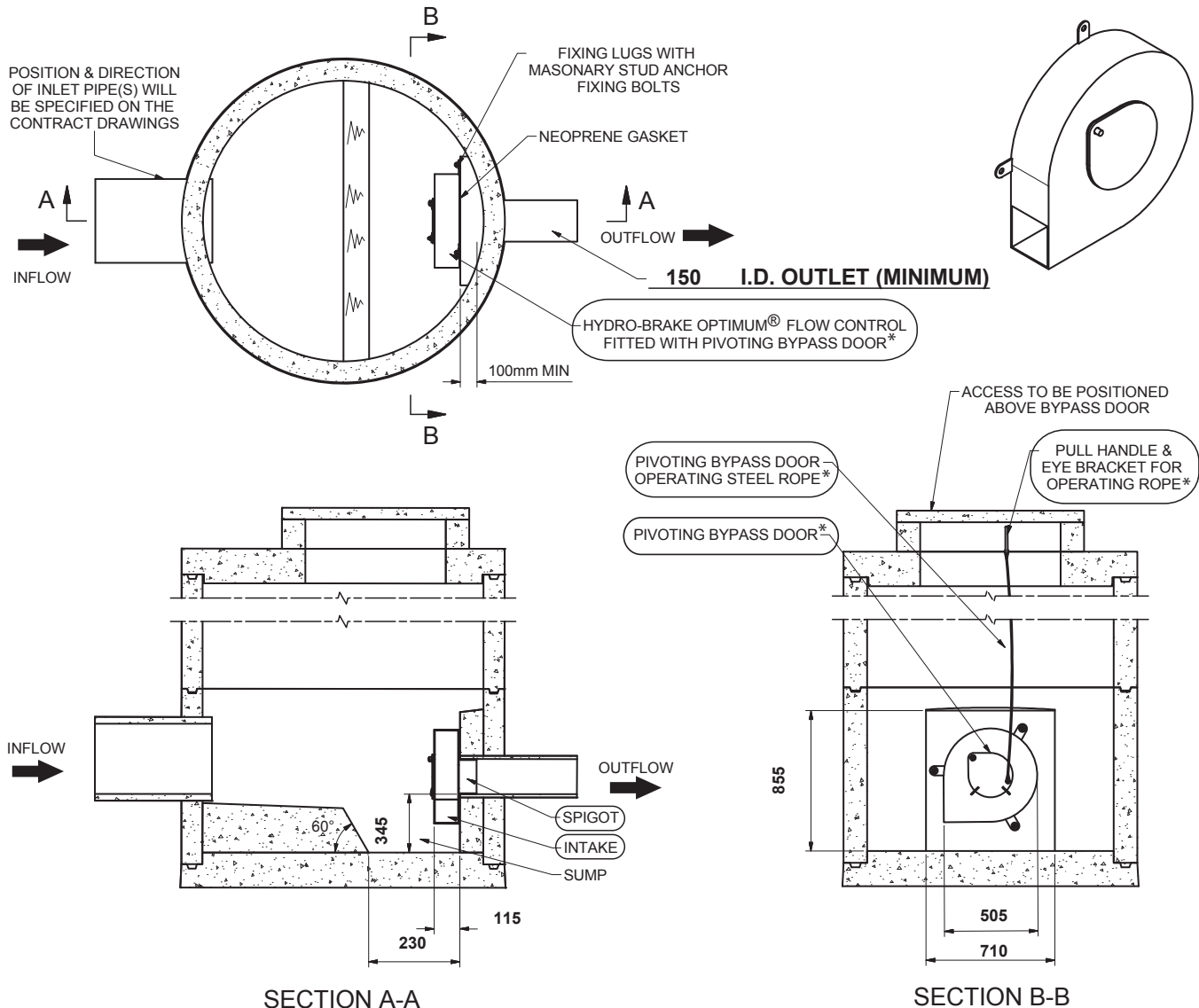
Control Point	Head (m)	Flow (l/s)
Primary Design	1.000	5.000
Flush-Flo™	0.296	4.975
Kick-Flo®	0.637	4.060
Mean Flow		4.335

Hydro-Brake Optimum® Flow Control including:

- 3 mm grade 304L stainless steel
- Integral stainless steel pivoting bypass door allowing clear line of sight through to outlet, c/w stainless steel operating rope
- Bead blasted finish to maximise corrosion resistance
- Stainless steel fixings
- Neoprene gasket to seal outlet



PT/329/0412



IMPORTANT:  LIMIT OF HYDRO INTERNATIONAL SUPPLY
 THE DEVICE WILL BE HANDED TO SUIT SITE CONDITIONS
 FOR SITE SPECIFIC DETAILS AND MINIMUM CHAMBER SIZE REFER TO HYDRO INTERNATIONAL
 ALL CIVIL AND INSTALLATION WORK BY OTHERS
 * WHERE SUPPLIED
 HYDRO-BRAKE® FLOW CONTROL & HYDRO-BRAKE OPTIMUM® FLOW CONTROL ARE REGISTERED TRADEMARKS FOR FLOW
 CONTROLS DESIGNED AND MANUFACTURED EXCLUSIVELY BY HYDRO INTERNATIONAL

THIS DESIGN LAYOUT IS FOR ILLUSTRATIVE PURPOSES ONLY. NOT TO SCALE.

DESIGN ADVICE



The head/flow characteristics of this SHE-0106-5000-1000-5000 Hydro-Brake Optimum® Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.
The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.

Hydro
International

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SITE	Island Road, Reading
DESIGNER	EUJstenzel
REF	17_21_5463

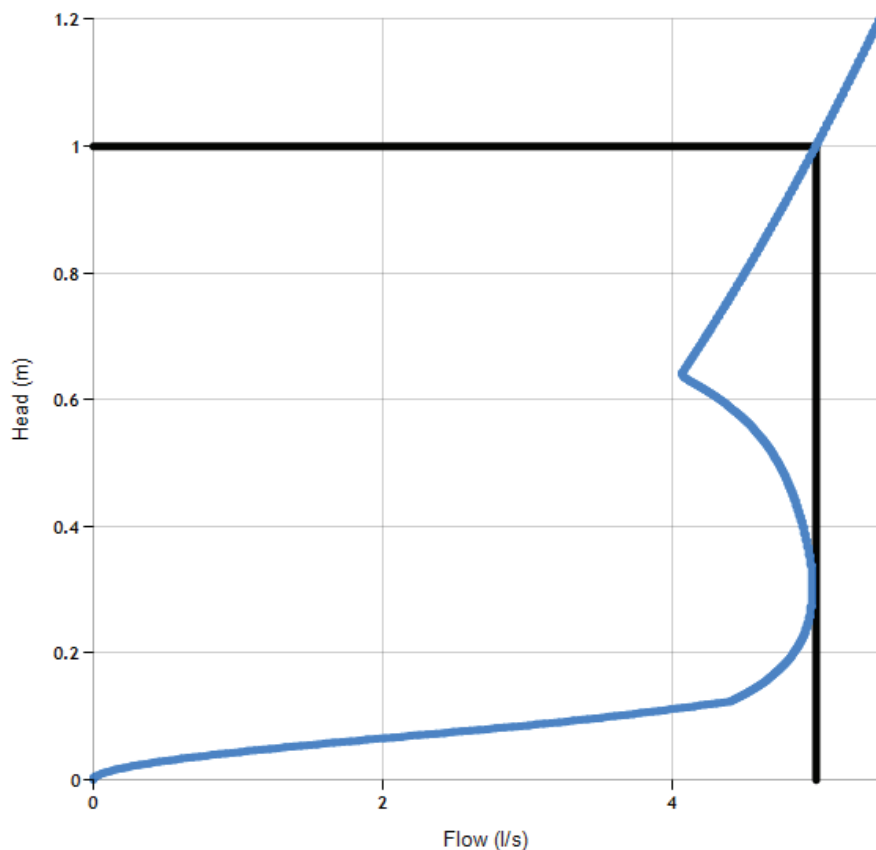
SHE-0106-5000-1000-5000
 Hydro-Brake Optimum®

Technical Specification

Control Point	Head (m)	Flow (l/s)
Primary Design	1.000	5.000
Flush-Flo™	0.296	4.975
Kick-Flo®	0.637	4.060
Mean Flow		4.335



PT/329/0412



Head (m)	Flow (l/s)
0.000	0.000
0.034	0.638
0.069	2.160
0.103	3.704
0.138	4.528
0.172	4.738
0.207	4.868
0.241	4.940
0.276	4.970
0.310	4.973
0.345	4.956
0.379	4.926
0.414	4.886
0.448	4.837
0.483	4.773
0.517	4.689
0.552	4.572
0.586	4.412
0.621	4.194
0.655	4.114
0.690	4.212
0.724	4.308
0.759	4.401
0.793	4.492
0.828	4.581
0.862	4.669
0.897	4.754
0.931	4.838
0.966	4.920
1.000	5.000

DESIGN ADVICE



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SHE-0106-5000-1000-5000
Hydro-Brake Optimum®

Technical Specification

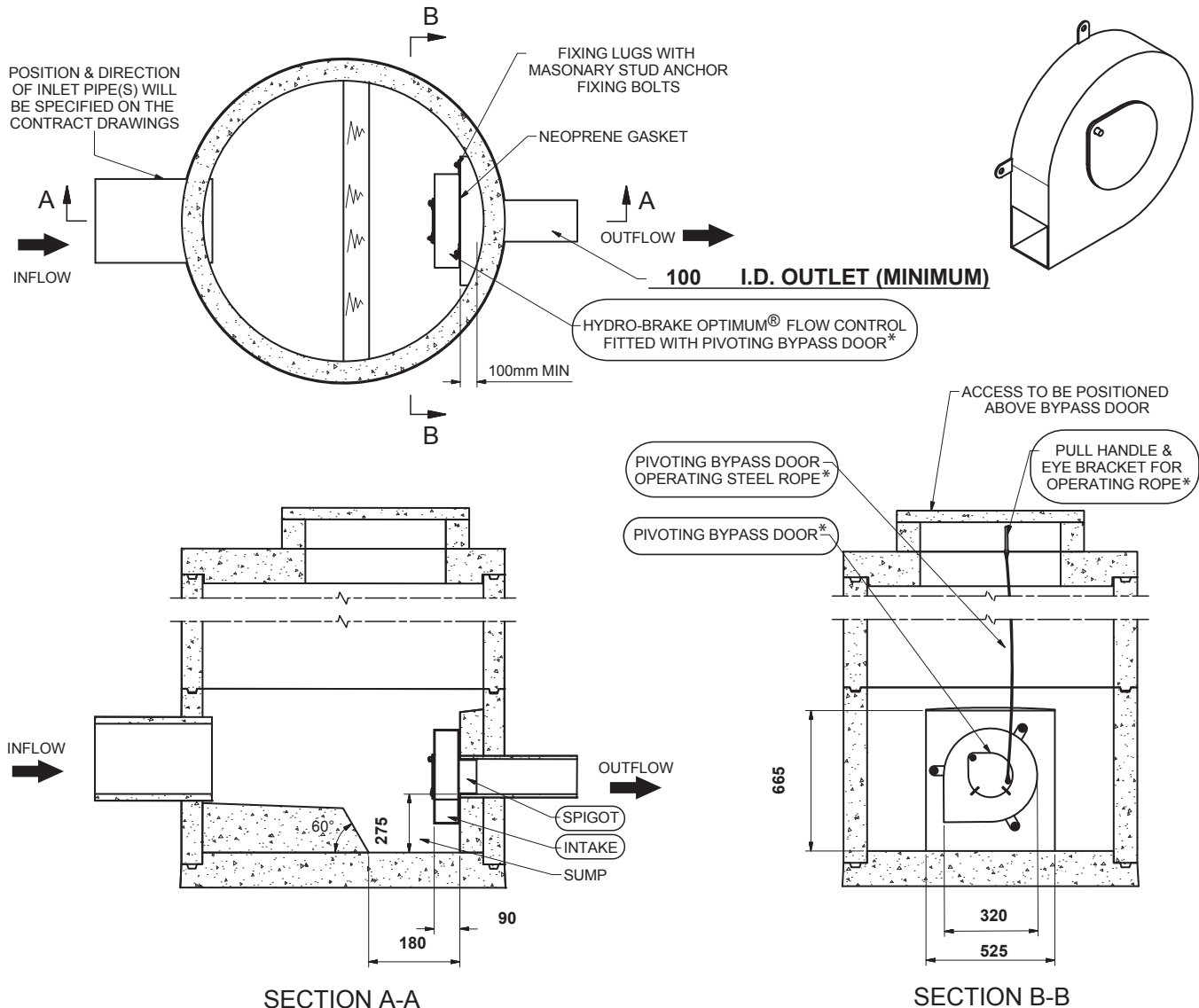
Control Point	Head (m)	Flow (l/s)
Primary Design	0.500	2.401
Flush-Flo™	0.151	2.400
Kick-Flo®	0.349	2.040
Mean Flow		2.038

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DESIGN ADVICE



The head/flow characteristics of this SHE-0081-2400-0500-2400 Hydro-Brake Optimum® Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.
The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.

Hydro
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DESIGNER	EUJstenzel
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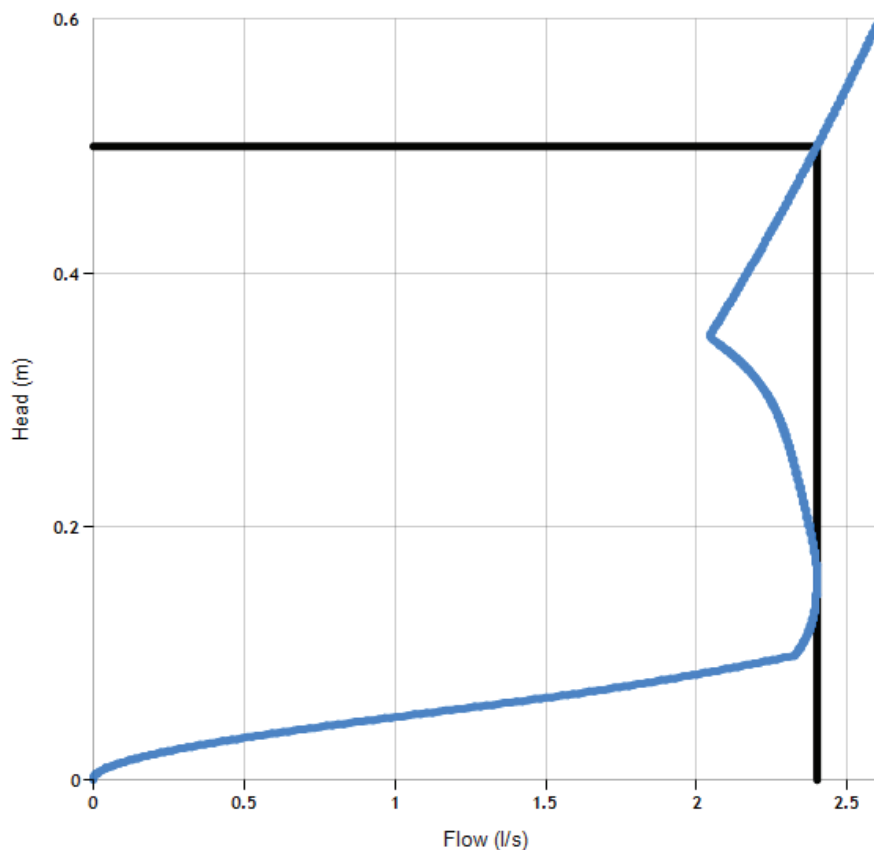
SHE-0081-2400-0500-2400
 Hydro-Brake Optimum®

Technical Specification

Control Point	Head (m)	Flow (l/s)
Primary Design	0.500	2.401
Flush-Flo™	0.151	2.400
Kick-Flo®	0.349	2.040
Mean Flow		2.038



PT/329/0412



Head (m)	Flow (l/s)
0.000	0.000
0.017	0.145
0.034	0.533
0.052	1.069
0.069	1.625
0.086	2.065
0.103	2.343
0.121	2.379
0.138	2.397
0.155	2.400
0.172	2.393
0.190	2.381
0.207	2.365
0.224	2.347
0.241	2.329
0.259	2.310
0.276	2.287
0.293	2.257
0.310	2.215
0.328	2.154
0.345	2.067
0.362	2.075
0.379	2.119
0.397	2.162
0.414	2.204
0.431	2.245
0.448	2.285
0.466	2.324
0.483	2.363
0.500	2.401

DESIGN ADVICE



The head/flow characteristics of this SHE-0081-2400-0500-2400 Hydro-Brake Optimum® Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.

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