



**GRAINGER PLC
PHASE 8
BEREWOOD, WATERLOOVILLE**

SUDS DESIGN DOCUMENT

MARCH 2020

A light blue silhouette of a family riding a bicycle. The father is in the driver's seat, the mother is seated behind him, and a child is seated in front of her. The bicycle has a basket on the front.

the journey is the reward

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1 Introduction

- 1.1 This document sets out the design principles and detail for the Strategic SuDS constructed by Grainger Plc for Phase 8 of the Berewood development, West of Waterlooville. The proposed SuDs for Phase 8 forms part of a wider SuDs strategy for the Berewood development (Document Ref. Proposed Outline SuDs Strategy Document October 2010).
- 1.2 This document is aimed at a technical reader with experience in the design of Sustainable Urban Drainage Features (SuDS).
- 1.3 The development site is located within the Berewood Development, part of the West of Waterlooville Major Development area, OS Ref SU675090. A location plan of the proposed Phase 8 residential areas is shown on Dwg. GTWVILLE_P8/SK/07 in Appendix B. The development proposals are for the construction of 192 new dwellings. The housing site boundary is shown in red.
- 1.4 The site was formerly arable farmland.
- 1.5 Initial design proposals were presented in an earlier report which combined drainage proposals for Phase 3B and 8.

A feasibility study (Document Ref. Phase 3B & 8 – Alternative Drainage Attenuation – Feasibility Study) was undertaken to consider an alternative layout for the Phase 3 and Phase 8 SuDs provision to that considered in the original Outline SuDs Strategy Document. The purpose for the review was to determine if a more efficient use of the existing topography could be achieved and a reduction in catchment fragmentation.

2 Existing Condition

Topography

- 2.1 A topographical survey of the existing site was undertaken by Mayer Brown Ltd in November 2016. This is contained in Appendix B of this report. The site slopes predominantly from the south to the north across Phase 8. Ground levels ranging from approximately 60.0mAOD to 49.80 mAOD.

Geology

- 2.2 The current land use is farming, both arable and grazing. The proportion of impervious areas is very low and existing run-off is assumed as Greenfield.
- 2.3 Previous site investigations have been undertaken in the development and indicate superficial deposits of clays and medium-dense sands. As the presence of sands indicates potential infiltration, 2 BRE Digest 365 infiltration tests were undertaken. The tests indicated a low permeability and concluded that the site was unsuitable for infiltration. This is consistent with the rest of the Berewood development.

Existing Surface Water

- 2.4 Drainage on the site includes;
- A filter drain system draining a waterlogged area in the northeast corner of Phase 8, which outfalls to the existing ditch within the allotment area to the north of Phase 8. This ditch drains via a pipe which originally discharged to the field ditch network draining to the River Wallington to the north. These ditches have been replaced where required with swales and other SuDs features in accordance with the overall Berewood drainage strategy.
- 2.5 There is an existing ditch which is situated in the footprint of the proposed SuDs pond and collects run-off from the proposed Phase 8 design catchment as well as a catchment area to the south. The ditch will still be required after the development of Phase 8.
- 2.6 An analysis of the existing surface water paths was done using WinDes Microdrainage. The surface from the topographical survey was input to the model and analysis of the surface done in order to determine the flow paths. The results can be seen in Figure 2.1 overleaf

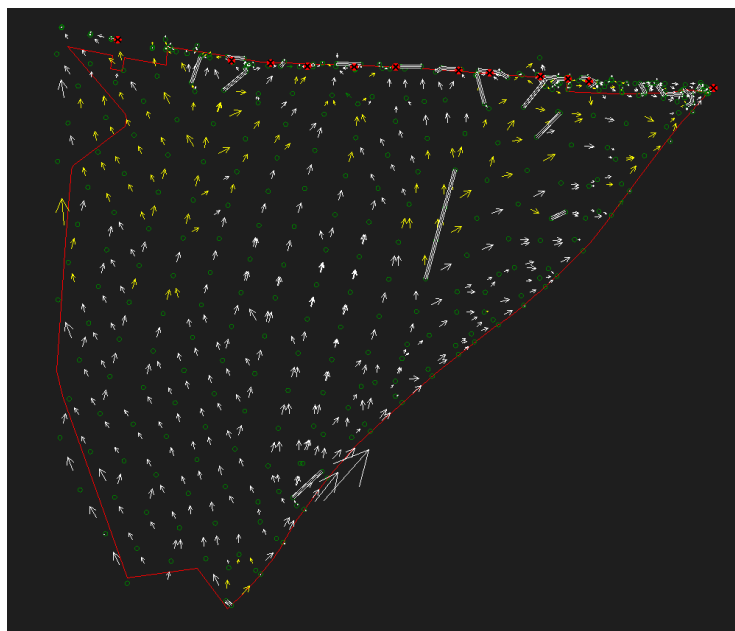


Figure 2.1 – Phase 8 Existing Flood Flow Analysis

Existing and Proposed impermeable area on site

- 2.7 There is currently no impermeable area within the proposed development site.
- 2.8 The greenfield run-off rate for the Berewood development has been calculated and agreed at the outline planning stage and is written into the S.106. A greenfield run-off rate, applying the QBAR rainfall event has been established at 5.06l/s/ha
- 2.9 It is assumed that the redevelopment of the site will result in a 65% impermeable area coverage. The increase in the impermeable area will produce a corresponding increase in the total volume of surface water runoff and in the runoff peak rates from the site. There is just one SuDS feature which attenuates Phase 8 which is located outside the catchment area. These have been included but at a 90% impermeable area coverage. This is outlined in Table 2-1 below.
- 2.10 Urban Creep can be described as future urban expansion within a development such as extensions to buildings and paving of gardens. These activities increase the impermeable area of a site and often sit outside of the development control process. Therefore, we have allowed a 10% increase in the impermeable area on the development site to allow for urban creep.

	Existing Area (Ha)	Existing Impermeable Area (Ha)	Proposed Impermeable Area (Ha)	Effective Proposed Impermeable Area (Ha)*
Ph8	5.33	0	3.46	3.81
SuDS outside boundary	0.27	0	0.24	0.24
Total	5.60	0	3.70	4.05

* Includes a 10% increase for 'Urban Creep'

Table 2.1: Impermeable Area – Existing and Proposed

3 Proposals

Permitted Discharge Rates

- 3.1 The discharge rate for the Berewood development has been agreed at the outline planning stage and is written into the S.106. A of 5.06l/s/ha shall be assumed at the outfall of the system to the existing watercourses, except for catchment areas smaller than 1ha, where a minimum rate of 5l/s is permitted. This is the same as the estimated greenfield run-off rate for the site referred to in Section 2.8 above.
- 3.2 The proposal is to have one pond to attenuate the whole of Phase 8 development. The proposed pond is located in an unused area, which was formally occupied by Plant Farm. Due to the size of the pond and the impact on the local biodiversity, a complex outfall has been designed to manage the discharge rate from the pond. Proposed discharge has been designed to align with the higher greenfield run-off rates which would occur during the 1 in 30year and 1in 100 year storm events.
- 3.3 As stated in the CIRIA Report C753 (Ref 1) growth factors can be applied to the discharge rates in order to represent the higher greenfield run off rates for more intense storm events. The two growth factors that are applied in this analysis are the 1 in 30 year and the 1 in 100 storm events.
- 3.4 The growth factors depend on the geographical location of the development. The Berewood development is located in area 7 (Figure 24.1 of Ref 1) and so from Table 24.2 in Ref 1 the following growth factors apply:
- 3.4.1. For a 1 in 30 year storm event the growth factor is 2.40
- 3.4.2. For a 1 in 100 year storm event the growth factor is 3.19
- 3.5 These discharge rates shall not be exceeded for all storm events up to the 1 in 100 year event plus an allowance for climate change, which is agreed as 40% increase in rainfall intensity against the FEH design parameters below.
- 3.6 Due to using the growth factors, additional analysis is necessaryto ensure development discharge volumes do not raise the risk of flooding downstream. This is done by analysing the volume control for a 1 in 100 year, 6 hour storm event as per CIRIA Report C753 (Ref 1). This analysis has been completed in Section 5 of this report.

- 3.7 Dwg GTWVILLE_P8/DR/04 in Appendix B, shows the proposed SuDs provision for Phase 8.

Rainfall Parameters

- 3.8 The design has been undertaken using Microdrainage WinDes software. As the critical events for the open space SuDS will be in excess of 30 minute duration, the FEH rainfall parameters have been assumed. For the Berewood development, the assumed parameters have been taken directly from exported FEH CD-ROM data as follows:

$$\begin{array}{lll} C(1km) = -0.027 & D1(1km) = 0.461 & D2(1km) = 0.293 \\ D3(1km) = 0.380 & E(1km) = 0.306 & F(1km) = 2.247 \end{array}$$

Catchment Areas

- 3.9 A permeability factor of 0.65 has been assumed for the whole of the development area. This is considered conservative but will be reviewed in more detail once details of the development layout for Phase 8 is known. The SuDs ponds were given an impermeable factor of 0.9.
- 3.10 Urban Creep can be described as future urban expansion within a development such as extensions to buildings and paving of gardens. These activities increase the impermeable area of a site and often sit outside of the development control process. Therefore, we have allowed a 10% increase in the impermeable area on the development site to allow for urban creep.
- 3.11 The drained area and its related SuDs feature are identified on Dwg. GTWVILLE_P8/SK/02 in Appendix B and in Table 3.1 below. Table 3.1 also indicates the greenfield run-off rate and Table 3.2 shows the allowable discharge rates with growth factors.

Pond Ref	Catchment Ref	Catchment Area(Ha)	PIMP	Effective Impermeable Area (Ha)	Greenfield Run-Off Rate (l/s)
A	Phase 8	5.332	0.714*	3.812	27.0
	Pond A	0.274	0.9	0.247	1.4
Grand	Total	5.606		4.086	28.4
* includes 10% for urban creep					

Table 3.1: Catchment Areas and Related SuDs Features

SuDs Provision

- 3.12 Phase 8 will discharge via one outlet, to a SuDS feature (Pond A) within an unused area, which was formally occupied by Plant Farm.

- 3.13 The pond will be fitted with two hydrobrakes, which will restrict flows to the proportional greenfield run-off rate for the catchment assuming the relevant allowable growth factors. The inverts of the hydrobrakes have been designed to ensure run-off rates and volumes do not increase flood risk downstream. Discharge from the pond will be into an existing ditch which currently collects all the greenfield run-off from the Phase 8 design catchment. The existing ditch, which runs through the site will be diverted around the perimeter of the pond to ensure overland flow, from undeveloped land, is not interrupted.
- 3.14 The pond will have sufficient capacity to attenuate a 1 in 100yr storm event plus 40% climate change allowance. An overflow facility will be provided to ensure discharge can continue during exceedance events or should there be a blockage in the system. The Windes Microdrainage model did not show any use of the overflow system during a 1 in 100 year storm event plus 40% climate change.

Storm Event	Growth Factor (<i>from table 24.2 Ref 1</i>)	Allowable Discharge Rate (l/s)
1 in 30	2.40	68.2
1 in 100	3.19	90.6

Table 3.2: Allowable discharge rates applying growth factors

4 Network Details

- 4.1 The proposed strategic surface water drainage scheme has been modelled using Windes Source Control.
- 4.2 The surface water is attenuated within the SuDS features with the use of flow control devices. The model utilises vortex flow control devices. Specifically, the Hydro International Hydrobrake Optimum® has been specified. Any equivalent alternatives will need to be tested in the model to consider the effect. The controls are scheduled in the WinDes Network Details report, see Appendix A.

SuDS Features

- 4.3 Detailed drawings showing the surface water drainage layout are contained within Appendix B.
- 4.4 Pond A has a total depth of 2m. The max design water depth is 1.9m which leaves 100mm freeboard to be utilised by the overflow weir.
- 4.5 Due to the depth of the pond and to allow it to blend into the current terrain, relaxed slopes have been used. The top 1m depth of the internal slopes of the pond are at 1 in 4, with the remaining being at 1 in 3. All cut and fill slopes to existing ground are at 1 in 3.
- 4.6 The SuDS features have been located as best as possible in the areas where the water would naturally collect under the existing topography. This, therefore, allows the outlets to discharge the water in the same patterns as the existing water flow paths.
- 4.7 Table 4.1 overleaf shows the pond size and discharge properties.
- 4.8 The intention is that LEEP Utilities will adopt the SuDS features. In the event that they do not get adopted, the SuDS ponds will be maintained by the developments estate management company.

Pond	Area (sq.m)	Volume (cu.m)	Design Head (m)	Design Flow (l/s)	Invert Level (m)	Overflow	Hydro-brake optimum® reference
A	1958	2384	1.9	28.4		Weir	MD-SHE-0219-2840-1900-2840
			0.9	62.0		Weir	MD-SHE-0324-6200-0900-6200

Table 4.1: SuDs Pond and Hydrobrake Details

5 Simulation Modelling and Results

- 5.1 The WinDes model was run for return periods of 1 in 1, 30, and 100 plus 40% for climate change. The Model results can be found in full in Appendix A.

Pond A 1 in 1 Year FEH

- 5.2 All pipework and SuDS features operating to expectations. Overflow provided in Pond was not utilised.
- 5.3 Discharge rate for the most critical rainfall event of 480 min winter is reported as 28.3l/s.
- 5.4 The maximum water depth would be 0.48m.
- 5.5 No flooding reported.

Pond A 1 in 30 Year FEH

- 5.6 All pipework and SuDS features operating to expectations. Overflow provided in Pond was not utilised.
- 5.7 Discharge rate for the most critical rainfall event of 720 min winter would be 53.5l/s.
- 5.1 The maximum water depth would be 1.19m.
- 5.2 No flooding reported.

Pond A 1 in 100 Year + 40% Climate Change FEH

- 5.3 All pipework and SuDS features operating to expectations. Overflows provided in Pond was not utilised.
- 5.4 Discharge rate for the most critical rainfall event of 600 min winter would be 89.0l/s.
- 5.1 The maximum water depth would be 1.86m.
- 5.2 No flooding reported.

Catchment Ref	Storm Event	Permitted discharge rate	Max Discharge Rate
A	1 in 1	28.4	28.3
	1 in 30	68.2	53.5
	1 in 100	90.6	89.0

Table 5.1: Maximum Discharges for Different return periods

- 5.3 Table 5.1 above shows the summary of peak discharge rates for different return periods. The total for the peak discharge rates for all storm events does not exceed the allowable greenfield runoff rates.
- 5.4 Analysis of the 360 (6 hour) rainfall event for a 1 in 100 year + climate change was done then done to determine the discharge volumes in comparison with the natural greenfield runoff volumes. It is important that these stay the same or less so not to increase flood risk downstream.
- 5.5 First of all an analysis was done for the existing catchment area in the undeveloped state. The soil index (SOIL), as per Flood Studies Report (NERC, 1975), is 4. Therefore the Standard Percentage Runoff (SPR) is 0.47. This value was used in Windes Microdrainage to model the existing catchment. In total, 3 models were done for comparison and are shown the charts below.
- 5.6 In both charts the blue line represents the current green fieldrun off volumes. The red line represents the developed catchment but with no attenuation. The green line represent the developed catchment with attenuation in the form of SuDS Pond A. The first chart shows the discharge volume per 2 minute interval. The second chart is the total cumulative discharge volume.
- 5.7 As can be seen by the Chart 1, the discharge from the SuDS pond is kept at QBAR rate until approximately 170minutes, when the water level increases enough to allow discharge from the second hydrobrake.

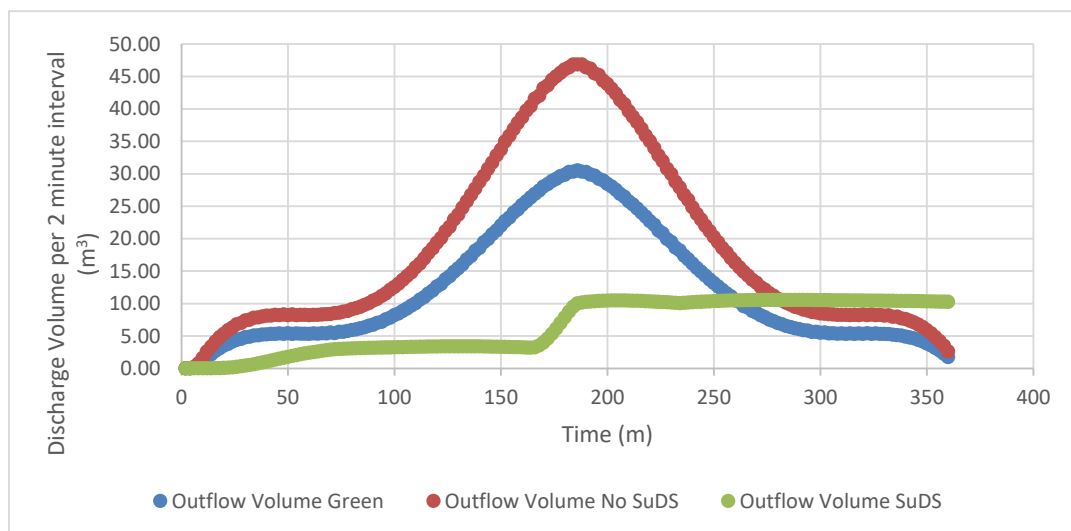


Chart 1: Discharge Volume per 2 Minute Interval

5.8 The second chart shows the total cumulative discharge from the catchment. As can be seen in chart 2, due to the initial QBAR discharge rate (and consequently the delay in max discharge rate), the total rise in volume of discharge is much more gradual than that of the greenfield runoff rate. Furthermore and more importantly, at the end of the 360 minute winter event, the total discharge volume from the SuDS pond is much less. This therefore reduces the risk of flooding downstream.

5.9 Calculations supporting Charts 1 and 2 are provided in Appendix A.

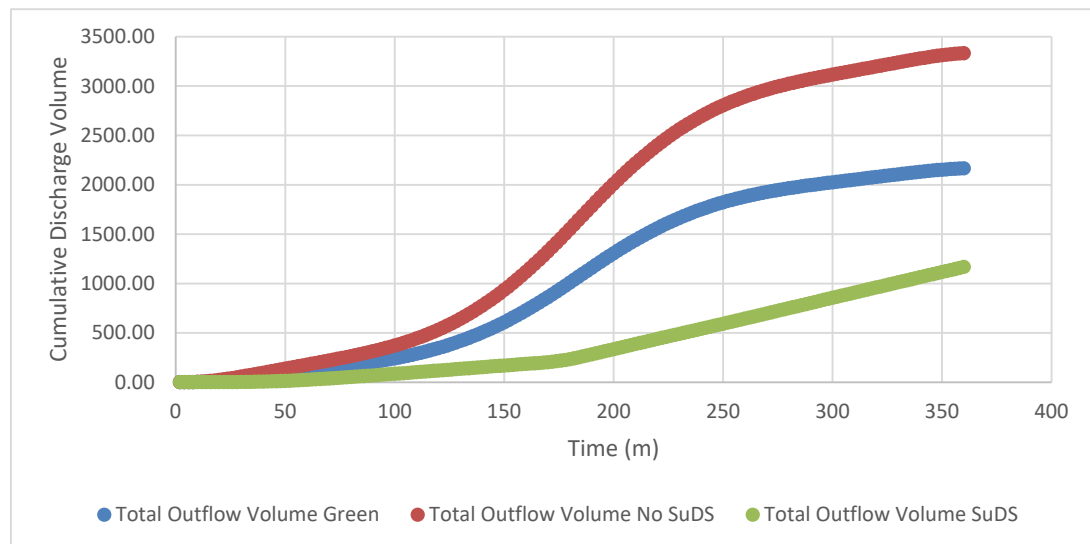


Chart 2: Total discharge volume

6 Overflow and Blockages Analysis

- 6.1 The network was tested to see the effects of blockages on the system. Each SuDS outlet was tested with a blockage to see the resulting effect on the other SuDS features.
- 6.2 The cascade of SuDS features were tested with a 1 in 200 year storm event.

Southern System

- 6.3 Pond A is located in a lower area of ground compared to the catchment area it is serving. The majority of the pond is in cutting with some fill and a headwall in the vicinity of the outfall. This means that the lowest point of the pond is directly over the outfall into an existing ditch. So in an event where the pond was to hit exceedance, the flow will go into the outfall regardless.
- 6.4 There is an overflow weir in the hydrobrake chamber which can be used in the event of a blockage. Two simulations were done to see the effects of a blockage in each of the hydrobrakes. The results can be seen in Table 6.1.
- 6.5 The results show if the higher hydrobrake becomes blocked, the weir overflow is utilised at a maximum rates of 12.5l/s. This makes the overall peak discharge rate 41.1 l/s, which is much less than the allowable limit of 90.6l/s.
- 6.6 If the lower hydrobrake gets blocked the results show that the overflow weir is not utilised. The overall peak discharge rate is 87.2 which is less than the allowable limit of 90.6l/s.

Blocked SuDS	Overflow	Max Water Level (m AoD)	Max hydrobrake discharge rate (l/s)	Max Overflow Discharge Rate (l/s)	Total Discharge Rate (l/s)
Higher Hydrobrake	Weir	46.938	28.6	12.5	41.1
Lower Hydrobrake	Weir	46.624	87.2	Not utilised	87.2

Table 6.1: Blockage Analysis results

- 6.7 The analysis shows that there is sufficient capacity in the SuDS overflow feature to deal with a blockage in the outfall.

7 Maintenance Considerations

Maintenance Strategy

- 7.1 Regular planned access will be required to the flow control chamber, the Pollution Control Valve (PCV), the Vortex Separator, the outlet headwall and the outlet from the pond. Vehicular access and a parking area will be provided off Plant Farm Crescent in the vicinity of the above features.
- 7.2 Annual to bi-annual access will also be required to the pond area and margins to ensure vegetation is managed.
- 7.3 The pond perimeter will be planted with appropriate species to discourage access and fly tipping within the pond area. It may be necessary to intersperse the planting with lengths of fence.
- 7.4 The pond will be maintained in conjunction with the wider site strategy for SuDs and drainage routes downstream of the pond.
- 7.5 Appendix C contains a schedule indicating the main SuDs features and their required maintenance requirements and frequency.

8 Conclusion

- 8.1 The total discharge rate for the worst case scenario (1 in 100 year return period +40% for climate change) from the Phase 8 main network will be equal to the equivalent QBAR greenfield run-off rate with growth factors for critical rainfall events. For all other events the total discharge rate will be significantly less, thus improving the existing condition. An analysis of the total discharge volume shows it does not increase flood risk downstream. Therefore, it can be stated that the strategic SuDS design is operating within the accepted design criteria.

APPENDIX A: Calculations and Data

Mayer Brown Limited							Page 1
Lion House Oriental Road Woking GU22 8AP			Berewood Development Phase 8 SuDS Pond A				
Date 05/03/2020 File PHASE 8 SUDS POND A.SRCX			Designed by AM Checked by RHA				
Micro Drainage			Source Control 2018.1.1				
<u>Summary of Results for 1 year Return Period</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	45.178	0.178	18.6	0.0	18.6	142.6	O K
30 min Summer	45.228	0.228	24.7	0.0	24.7	185.9	O K
60 min Summer	45.285	0.285	26.3	0.0	26.3	235.7	O K
120 min Summer	45.346	0.346	27.3	0.0	27.3	290.9	O K
180 min Summer	45.383	0.383	27.7	0.0	27.7	325.0	O K
240 min Summer	45.408	0.408	27.9	0.0	27.9	348.1	O K
360 min Summer	45.437	0.437	28.1	0.0	28.1	375.5	O K
480 min Summer	45.451	0.451	28.1	0.0	28.1	389.0	O K
600 min Summer	45.457	0.457	28.2	0.0	28.2	394.7	O K
720 min Summer	45.458	0.458	28.2	0.0	28.2	395.6	O K
960 min Summer	45.424	0.424	28.0	0.0	28.0	363.1	O K
1440 min Summer	45.360	0.360	27.4	0.0	27.4	303.2	O K
2160 min Summer	45.286	0.286	26.3	0.0	26.3	236.5	O K
2880 min Summer	45.238	0.238	25.2	0.0	25.2	194.5	O K
4320 min Summer	45.200	0.200	21.5	0.0	21.5	161.9	O K
5760 min Summer	45.179	0.179	18.8	0.0	18.8	143.6	O K
7200 min Summer	45.164	0.164	16.7	0.0	16.7	131.5	O K
8640 min Summer	45.153	0.153	15.1	0.0	15.1	122.4	O K
10080 min Summer	45.145	0.145	13.8	0.0	13.8	115.3	O K
15 min Winter	45.198	0.198	21.2	0.0	21.2	159.5	O K
30 min Winter	45.256	0.256	25.6	0.0	25.6	209.6	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
15 min Summer	19.930	0.0	143.7	0.0	22		
30 min Summer	13.717	0.0	200.5	0.0	36		
60 min Summer	9.440	0.0	283.2	0.0	64		
120 min Summer	6.497	0.0	391.3	0.0	98		
180 min Summer	5.222	0.0	472.4	0.0	134		
240 min Summer	4.472	0.0	540.0	0.0	170		
360 min Summer	3.594	0.0	651.7	0.0	242		
480 min Summer	3.078	0.0	744.5	0.0	312		
600 min Summer	2.729	0.0	825.5	0.0	382		
720 min Summer	2.474	0.0	898.1	0.0	450		
960 min Summer	2.016	0.0	976.0	0.0	582		
1440 min Summer	1.511	0.0	1096.6	0.0	828		
2160 min Summer	1.133	0.0	1238.0	0.0	1176		
2880 min Summer	0.923	0.0	1344.9	0.0	1528		
4320 min Summer	0.717	0.0	1564.0	0.0	2248		
5760 min Summer	0.599	0.0	1748.2	0.0	2944		
7200 min Summer	0.521	0.0	1900.9	0.0	3672		
8640 min Summer	0.465	0.0	2034.8	0.0	4408		
10080 min Summer	0.422	0.0	2153.6	0.0	5136		
15 min Winter	19.930	0.0	161.8	0.0	22		
30 min Winter	13.717	0.0	225.5	0.0	35		
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Lion House Oriental Road Woking GU22 8AP	Berewood Development Phase 8 SuDS Pond A	
Date 05/03/2020 File PHASE 8 SUDS POND A.SRCX	Designed by AM Checked by RHA	
Micro Drainage		Source Control 2018.1.1

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	45.321	0.321	26.9	0.0	26.9	268.2	O K
120 min Winter	45.387	0.387	27.7	0.0	27.7	328.2	O K
180 min Winter	45.425	0.425	28.0	0.0	28.0	364.4	O K
240 min Winter	45.449	0.449	28.1	0.0	28.1	387.3	O K
360 min Winter	45.474	0.474	28.2	0.0	28.2	411.0	O K
480 min Winter	45.481	0.481	28.3	0.0	28.3	418.4	O K
600 min Winter	45.479	0.479	28.3	0.0	28.3	416.8	O K
720 min Winter	45.472	0.472	28.2	0.0	28.2	409.8	O K
960 min Winter	45.417	0.417	27.9	0.0	27.9	356.8	O K
1440 min Winter	45.321	0.321	26.9	0.0	26.9	267.6	O K
2160 min Winter	45.231	0.231	25.0	0.0	25.0	188.1	O K
2880 min Winter	45.197	0.197	21.1	0.0	21.1	158.9	O K
4320 min Winter	45.165	0.165	16.8	0.0	16.8	132.2	O K
5760 min Winter	45.147	0.147	14.2	0.0	14.2	117.4	O K
7200 min Winter	45.135	0.135	12.4	0.0	12.4	107.6	O K
8640 min Winter	45.127	0.127	11.1	0.0	11.1	100.3	O K
10080 min Winter	45.120	0.120	10.1	0.0	10.1	94.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
60 min Winter	9.440	0.0	317.7	0.0	64
120 min Winter	6.497	0.0	438.7	0.0	106
180 min Winter	5.222	0.0	529.6	0.0	144
240 min Winter	4.472	0.0	605.2	0.0	184
360 min Winter	3.594	0.0	730.3	0.0	262
480 min Winter	3.078	0.0	834.4	0.0	338
600 min Winter	2.729	0.0	925.1	0.0	412
720 min Winter	2.474	0.0	1006.5	0.0	484
960 min Winter	2.016	0.0	1093.8	0.0	618
1440 min Winter	1.511	0.0	1229.0	0.0	858
2160 min Winter	1.133	0.0	1386.9	0.0	1176
2880 min Winter	0.923	0.0	1506.8	0.0	1532
4320 min Winter	0.717	0.0	1752.6	0.0	2252
5760 min Winter	0.599	0.0	1958.3	0.0	2952
7200 min Winter	0.521	0.0	2129.3	0.0	3680
8640 min Winter	0.465	0.0	2279.5	0.0	4408
10080 min Winter	0.422	0.0	2413.3	0.0	5136

Mayer Brown Limited		Page 3
Lion House Oriental Road Woking GU22 8AP	Berewood Development Phase 8 SuDS Pond A	
Date 05/03/2020 File PHASE 8 SUDS POND A.SRCX	Designed by AM Checked by RHA	
Micro Drainage		Source Control 2018.1.1

Rainfall Details

Rainfall Model	FEH
Return Period (years)	1
FEH Rainfall Version	1999
Site Location	GB 467450 109700 SU 67450 09700
C (1km)	-0.027
D1 (1km)	0.461
D2 (1km)	0.289
D3 (1km)	0.376
E (1km)	0.304
F (1km)	2.245
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 4.058

Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)
0 4	0.000	4 8	4.058

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Model Details Storage is Online Cover Level (m) 47.000 Tank or Pond Structure Invert Level (m) 45.000 <table><thead><tr><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th></tr></thead><tbody><tr><td>0.000</td><td>765.7</td><td>1.000</td><td>1235.9</td><td>1.900</td><td>1881.2</td><td>2.000</td><td>1958.0</td></tr></tbody></table> Complex Outflow Control Hydro-Brake® Optimum <table><tbody><tr><td>Unit Reference</td><td>MD-SHE-0219-2840-1900-2840</td></tr><tr><td>Design Head (m)</td><td>1.900</td></tr><tr><td>Design Flow (l/s)</td><td>28.4</td></tr><tr><td>Flush-Flo™</td><td>Calculated</td></tr><tr><td>Objective</td><td>Minimise upstream storage</td></tr><tr><td>Application</td><td>Surface</td></tr><tr><td>Sump Available</td><td>Yes</td></tr><tr><td>Diameter (mm)</td><td>219</td></tr><tr><td>Invert Level (m)</td><td>45.000</td></tr><tr><td>Minimum Outlet Pipe Diameter (mm)</td><td>300</td></tr><tr><td>Suggested Manhole Diameter (mm)</td><td>1800</td></tr></tbody></table> <table><thead><tr><th>Control Points</th><th>Head (m)</th><th>Flow (l/s)</th></tr></thead><tbody><tr><td>Design Point (Calculated)</td><td>1.900</td><td>28.4</td></tr><tr><td>Flush-Flo™</td><td>0.564</td><td>28.4</td></tr><tr><td>Kick-Flo®</td><td>1.218</td><td>22.9</td></tr><tr><td>Mean Flow over Head Range</td><td>-</td><td>24.6</td></tr></tbody></table> 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 <table><thead><tr><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th></tr></thead><tbody><tr><td>0.100</td><td>7.4</td><td>1.200</td><td>23.4</td><td>3.000</td><td>35.3</td><td>7.000</td><td>53.2</td></tr><tr><td>0.200</td><td>21.5</td><td>1.400</td><td>24.5</td><td>3.500</td><td>38.1</td><td>7.500</td><td>55.0</td></tr><tr><td>0.300</td><td>26.6</td><td>1.600</td><td>26.1</td><td>4.000</td><td>40.6</td><td>8.000</td><td>56.8</td></tr><tr><td>0.400</td><td>27.8</td><td>1.800</td><td>27.7</td><td>4.500</td><td>43.0</td><td>8.500</td><td>58.5</td></tr><tr><td>0.500</td><td>28.3</td><td>2.000</td><td>29.1</td><td>5.000</td><td>45.2</td><td>9.000</td><td>60.1</td></tr><tr><td>0.600</td><td>28.4</td><td>2.200</td><td>30.4</td><td>5.500</td><td>47.3</td><td>9.500</td><td>61.7</td></tr><tr><td>0.800</td><td>27.8</td><td>2.400</td><td>31.7</td><td>6.000</td><td>49.4</td><td></td><td></td></tr><tr><td>1.000</td><td>26.6</td><td>2.600</td><td>33.0</td><td>6.500</td><td>51.3</td><td></td><td></td></tr></tbody></table>						Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	0.000	765.7	1.000	1235.9	1.900	1881.2	2.000	1958.0	Unit Reference	MD-SHE-0219-2840-1900-2840	Design Head (m)	1.900	Design Flow (l/s)	28.4	Flush-Flo™	Calculated	Objective	Minimise upstream storage	Application	Surface	Sump Available	Yes	Diameter (mm)	219	Invert Level (m)	45.000	Minimum Outlet Pipe Diameter (mm)	300	Suggested Manhole Diameter (mm)	1800	Control Points	Head (m)	Flow (l/s)	Design Point (Calculated)	1.900	28.4	Flush-Flo™	0.564	28.4	Kick-Flo®	1.218	22.9	Mean Flow over Head Range	-	24.6	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	0.100	7.4	1.200	23.4	3.000	35.3	7.000	53.2	0.200	21.5	1.400	24.5	3.500	38.1	7.500	55.0	0.300	26.6	1.600	26.1	4.000	40.6	8.000	56.8	0.400	27.8	1.800	27.7	4.500	43.0	8.500	58.5	0.500	28.3	2.000	29.1	5.000	45.2	9.000	60.1	0.600	28.4	2.200	30.4	5.500	47.3	9.500	61.7	0.800	27.8	2.400	31.7	6.000	49.4			1.000	26.6	2.600	33.0	6.500	51.3		
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Hydro-Brake® Optimum

Unit Reference	MD-SHE-0324-6200-0900-6200
Design Head (m)	0.900
Design Flow (l/s)	62.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	324
Invert Level (m)	46.000
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	62.0
Flush-Flo™	0.464	61.9
Kick-Flo®	0.744	56.5
Mean Flow over Head Range	-	48.0

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	9.6	1.200	71.2	3.000	111.2	7.000	168.2
0.200	33.1	1.400	76.8	3.500	119.9	7.500	174.0
0.300	58.5	1.600	81.9	4.000	128.0	8.000	179.6
0.400	61.6	1.800	86.7	4.500	135.5	8.500	185.0
0.500	61.9	2.000	91.3	5.000	142.7	9.000	190.3
0.600	60.7	2.200	95.6	5.500	149.5	9.500	193.9
0.800	58.6	2.400	99.7	6.000	156.0		
1.000	65.2	2.600	103.7	6.500	162.2		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 46.900

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Micro Drainage				Source Control 2018.1.1			
<u>Summary of Results for 30 year Return Period</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max E (l/s)	Max Outflow Volume (m³)	Status
15 min Summer	45.526	0.526	28.4	0.0	28.4	462.4	O K
30 min Summer	45.646	0.646	28.4	0.0	28.4	586.1	O K
60 min Summer	45.780	0.780	28.4	0.0	28.4	731.6	O K
120 min Summer	45.918	0.918	28.4	0.0	28.4	892.1	O K
180 min Summer	45.995	0.995	28.4	0.0	28.4	984.7	O K
240 min Summer	46.040	1.040	28.4	0.0	28.4	1041.9	O K
360 min Summer	46.079	1.079	31.9	0.0	31.9	1091.2	O K
480 min Summer	46.100	1.100	35.0	0.0	35.0	1118.7	O K
600 min Summer	46.113	1.113	37.2	0.0	37.2	1135.2	O K
720 min Summer	46.120	1.120	38.5	0.0	38.5	1144.0	O K
960 min Summer	46.086	1.086	32.8	0.0	32.8	1099.7	O K
1440 min Summer	45.999	0.999	28.4	0.0	28.4	990.3	O K
2160 min Summer	45.846	0.846	28.4	0.0	28.4	807.6	O K
2880 min Summer	45.707	0.707	28.4	0.0	28.4	651.4	O K
4320 min Summer	45.521	0.521	28.4	0.0	28.4	457.7	O K
5760 min Summer	45.388	0.388	27.7	0.0	27.7	329.2	O K
7200 min Summer	45.300	0.300	26.6	0.0	26.6	249.1	O K
8640 min Summer	45.246	0.246	25.4	0.0	25.4	201.1	O K
10080 min Summer	45.221	0.221	23.9	0.0	23.9	179.1	O K
15 min Winter	45.582	0.582	28.4	0.0	28.4	519.7	O K
30 min Winter	45.715	0.715	28.4	0.0	28.4	659.7	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
15 min Summer	63.289	0.0	472.3	0.0	22		
30 min Summer	40.885	0.0	612.2	0.0	37		
60 min Summer	26.412	0.0	799.3	0.0	66		
120 min Summer	17.062	0.0	1033.7	0.0	126		
180 min Summer	13.214	0.0	1201.4	0.0	186		
240 min Summer	11.023	0.0	1336.5	0.0	244		
360 min Summer	8.536	0.0	1553.1	0.0	298		
480 min Summer	7.121	0.0	1727.6	0.0	354		
600 min Summer	6.186	0.0	1876.3	0.0	418		
720 min Summer	5.515	0.0	2007.1	0.0	488		
960 min Summer	4.378	0.0	2124.2	0.0	640		
1440 min Summer	3.162	0.0	2300.2	0.0	930		
2160 min Summer	2.284	0.0	2499.4	0.0	1324		
2880 min Summer	1.813	0.0	2645.1	0.0	1704		
4320 min Summer	1.357	0.0	2965.8	0.0	2424		
5760 min Summer	1.104	0.0	3224.7	0.0	3112		
7200 min Summer	0.941	0.0	3435.6	0.0	3752		
8640 min Summer	0.826	0.0	3617.6	0.0	4416		
10080 min Summer	0.740	0.0	3777.0	0.0	5144		
15 min Winter	63.289	0.0	529.8	0.0	22		
30 min Winter	40.885	0.0	686.5	0.0	37		
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Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	45.863	0.863	28.4	0.0	28.4	826.5	O K
120 min Winter	46.019	1.019	28.4	0.0	28.4	1015.3	O K
180 min Winter	46.096	1.096	34.4	0.0	34.4	1113.7	O K
240 min Winter	46.129	1.129	40.4	0.0	40.4	1156.6	O K
360 min Winter	46.163	1.163	47.7	0.0	47.7	1201.6	O K
480 min Winter	46.181	1.181	51.8	0.0	51.8	1225.8	O K
600 min Winter	46.187	1.187	53.4	0.0	53.4	1234.5	O K
720 min Winter	46.188	1.188	53.5	0.0	53.5	1234.9	O K
960 min Winter	46.149	1.149	44.5	0.0	44.5	1182.6	O K
1440 min Winter	46.065	1.065	30.1	0.0	30.1	1073.1	O K
2160 min Winter	45.845	0.845	28.4	0.0	28.4	806.7	O K
2880 min Winter	45.635	0.635	28.4	0.0	28.4	574.7	O K
4320 min Winter	45.377	0.377	27.6	0.0	27.6	319.4	O K
5760 min Winter	45.245	0.245	25.4	0.0	25.4	200.2	O K
7200 min Winter	45.207	0.207	22.3	0.0	22.3	167.2	O K
8640 min Winter	45.185	0.185	19.7	0.0	19.7	149.1	O K
10080 min Winter	45.171	0.171	17.7	0.0	17.7	136.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
60 min Winter	26.412	0.0	895.6	0.0	66
120 min Winter	17.062	0.0	1158.2	0.0	124
180 min Winter	13.214	0.0	1346.0	0.0	180
240 min Winter	11.023	0.0	1497.4	0.0	230
360 min Winter	8.536	0.0	1740.0	0.0	280
480 min Winter	7.121	0.0	1935.5	0.0	352
600 min Winter	6.186	0.0	2102.1	0.0	426
720 min Winter	5.515	0.0	2248.7	0.0	500
960 min Winter	4.378	0.0	2379.7	0.0	658
1440 min Winter	3.162	0.0	2576.5	0.0	1000
2160 min Winter	2.284	0.0	2799.6	0.0	1428
2880 min Winter	1.813	0.0	2963.0	0.0	1792
4320 min Winter	1.357	0.0	3322.8	0.0	2464
5760 min Winter	1.104	0.0	3611.9	0.0	3056
7200 min Winter	0.941	0.0	3848.3	0.0	3680
8640 min Winter	0.826	0.0	4052.3	0.0	4408
10080 min Winter	0.740	0.0	4231.5	0.0	5144

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Rainfall Details

Rainfall Model	FEH
Return Period (years)	30
FEH Rainfall Version	1999
Site Location	GB 467450 109700 SU 67450 09700
C (1km)	-0.027
D1 (1km)	0.461
D2 (1km)	0.289
D3 (1km)	0.376
E (1km)	0.304
F (1km)	2.245
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 4.058

Time (mins)		Area	Time (mins)		Area
From:	To:	(ha)	From:	To:	(ha)
0	4	0.000	4	8	4.058

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<u>Model Details</u> Storage is Online Cover Level (m) 47.000 <u>Tank or Pond Structure</u> Invert Level (m) 45.000 <table><tr><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th></tr><tr><td>0.000</td><td>765.7</td><td>1.000</td><td>1235.9</td><td>1.900</td><td>1881.2</td><td>2.000</td><td>1958.0</td></tr></table> <u>Complex Outflow Control</u> <u>Hydro-Brake® Optimum</u> <table><tr><td colspan="2">Unit Reference MD-SHE-0219-2840-1900-2840</td></tr><tr><td>Design Head (m)</td><td>1.900</td></tr><tr><td>Design Flow (l/s)</td><td>28.4</td></tr><tr><td>Flush-Flo™</td><td>Calculated</td></tr><tr><td>Objective</td><td>Minimise upstream storage</td></tr><tr><td>Application</td><td>Surface</td></tr><tr><td>Sump Available</td><td>Yes</td></tr><tr><td>Diameter (mm)</td><td>219</td></tr><tr><td>Invert Level (m)</td><td>45.000</td></tr><tr><td>Minimum Outlet Pipe Diameter (mm)</td><td>300</td></tr><tr><td>Suggested Manhole Diameter (mm)</td><td>1800</td></tr></table> <table><tr><th>Control Points</th><th>Head (m)</th><th>Flow (l/s)</th></tr><tr><td>Design Point (Calculated)</td><td>1.900</td><td>28.4</td></tr><tr><td>Flush-Flo™</td><td>0.564</td><td>28.4</td></tr><tr><td>Kick-Flo®</td><td>1.218</td><td>22.9</td></tr><tr><td>Mean Flow over Head Range</td><td>-</td><td>24.6</td></tr></table> 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 <table><tr><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th><th>Depth (m)</th><th>Flow (l/s)</th></tr><tr><td>0.100</td><td>7.4</td><td>1.200</td><td>23.4</td><td>3.000</td><td>35.3</td><td>7.000</td><td>53.2</td></tr><tr><td>0.200</td><td>21.5</td><td>1.400</td><td>24.5</td><td>3.500</td><td>38.1</td><td>7.500</td><td>55.0</td></tr><tr><td>0.300</td><td>26.6</td><td>1.600</td><td>26.1</td><td>4.000</td><td>40.6</td><td>8.000</td><td>56.8</td></tr><tr><td>0.400</td><td>27.8</td><td>1.800</td><td>27.7</td><td>4.500</td><td>43.0</td><td>8.500</td><td>58.5</td></tr><tr><td>0.500</td><td>28.3</td><td>2.000</td><td>29.1</td><td>5.000</td><td>45.2</td><td>9.000</td><td>60.1</td></tr><tr><td>0.600</td><td>28.4</td><td>2.200</td><td>30.4</td><td>5.500</td><td>47.3</td><td>9.500</td><td>61.7</td></tr><tr><td>0.800</td><td>27.8</td><td>2.400</td><td>31.7</td><td>6.000</td><td>49.4</td><td></td><td></td></tr><tr><td>1.000</td><td>26.6</td><td>2.600</td><td>33.0</td><td>6.500</td><td>51.3</td><td></td><td></td></tr></table>						Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	0.000	765.7	1.000	1235.9	1.900	1881.2	2.000	1958.0	Unit Reference MD-SHE-0219-2840-1900-2840		Design Head (m)	1.900	Design Flow (l/s)	28.4	Flush-Flo™	Calculated	Objective	Minimise upstream storage	Application	Surface	Sump Available	Yes	Diameter (mm)	219	Invert Level (m)	45.000	Minimum Outlet Pipe Diameter (mm)	300	Suggested Manhole Diameter (mm)	1800	Control Points	Head (m)	Flow (l/s)	Design Point (Calculated)	1.900	28.4	Flush-Flo™	0.564	28.4	Kick-Flo®	1.218	22.9	Mean Flow over Head Range	-	24.6	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	0.100	7.4	1.200	23.4	3.000	35.3	7.000	53.2	0.200	21.5	1.400	24.5	3.500	38.1	7.500	55.0	0.300	26.6	1.600	26.1	4.000	40.6	8.000	56.8	0.400	27.8	1.800	27.7	4.500	43.0	8.500	58.5	0.500	28.3	2.000	29.1	5.000	45.2	9.000	60.1	0.600	28.4	2.200	30.4	5.500	47.3	9.500	61.7	0.800	27.8	2.400	31.7	6.000	49.4			1.000	26.6	2.600	33.0	6.500	51.3		
Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	Depth (m)	Area (m ²)																																																																																																																											
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Date 05/03/2020 File PHASE 8 SUDS POND A.SRCX	Designed by AM Checked by RHA	
Micro Drainage		Source Control 2018.1.1

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0324-6200-0900-6200
Design Head (m)	0.900
Design Flow (l/s)	62.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	324
Invert Level (m)	46.000
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	62.0
Flush-Flo™	0.464	61.9
Kick-Flo®	0.744	56.5
Mean Flow over Head Range	-	48.0

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	9.6	1.200	71.2	3.000	111.2	7.000	168.2
0.200	33.1	1.400	76.8	3.500	119.9	7.500	174.0
0.300	58.5	1.600	81.9	4.000	128.0	8.000	179.6
0.400	61.6	1.800	86.7	4.500	135.5	8.500	185.0
0.500	61.9	2.000	91.3	5.000	142.7	9.000	190.3
0.600	60.7	2.200	95.6	5.500	149.5	9.500	193.9
0.800	58.6	2.400	99.7	6.000	156.0		
1.000	65.2	2.600	103.7	6.500	162.2		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 46.900

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Micro Drainage			Source Control 2018.1.1				
<u>Summary of Results for 100 year Return Period (+40%)</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	46.006	1.006	28.4	0.0	28.4	999.2	O K
30 min Summer	46.189	1.189	53.9	0.0	53.9	1236.7	O K
60 min Summer	46.353	1.353	85.0	0.0	85.0	1468.9	O K
120 min Summer	46.502	1.502	87.2	0.0	87.2	1695.8	O K
180 min Summer	46.574	1.574	87.2	0.0	87.2	1811.8	O K
240 min Summer	46.624	1.624	87.2	0.0	87.2	1893.8	O K
360 min Summer	46.685	1.685	87.2	0.0	87.2	1998.0	O K
480 min Summer	46.717	1.717	87.2	0.0	87.2	2053.7	Flood Risk
600 min Summer	46.732	1.732	87.2	0.0	87.2	2079.2	Flood Risk
720 min Summer	46.736	1.736	87.2	0.0	87.2	2085.4	Flood Risk
960 min Summer	46.644	1.644	87.2	0.0	87.2	1928.7	O K
1440 min Summer	46.485	1.485	87.1	0.0	87.1	1670.1	O K
2160 min Summer	46.326	1.326	84.1	0.0	84.1	1429.4	O K
2880 min Summer	46.256	1.256	71.4	0.0	71.4	1329.3	O K
4320 min Summer	46.185	1.185	52.9	0.0	52.9	1231.8	O K
5760 min Summer	46.128	1.128	40.1	0.0	40.1	1154.6	O K
7200 min Summer	46.059	1.059	29.5	0.0	29.5	1065.8	O K
8640 min Summer	45.883	0.883	28.4	0.0	28.4	850.8	O K
10080 min Summer	45.716	0.716	28.4	0.0	28.4	661.0	O K
15 min Winter	46.101	1.101	35.1	0.0	35.1	1119.4	O K
30 min Winter	46.289	1.289	79.7	0.0	79.7	1376.2	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
15 min Summer	134.198	0.0	1008.6	0.0	23		
30 min Summer	84.742	0.0	1275.0	0.0	37		
60 min Summer	53.513	0.0	1623.4	0.0	66		
120 min Summer	33.792	0.0	2051.3	0.0	124		
180 min Summer	25.824	0.0	2352.1	0.0	160		
240 min Summer	21.339	0.0	2591.8	0.0	194		
360 min Summer	16.307	0.0	2971.5	0.0	262		
480 min Summer	13.475	0.0	3274.0	0.0	332		
600 min Summer	11.621	0.0	3529.7	0.0	404		
720 min Summer	10.298	0.0	3753.3	0.0	474		
960 min Summer	8.098	0.0	3935.0	0.0	602		
1440 min Summer	5.772	0.0	4204.1	0.0	856		
2160 min Summer	4.114	0.0	4504.0	0.0	1216		
2880 min Summer	3.235	0.0	4722.2	0.0	1592		
4320 min Summer	2.389	0.0	5226.9	0.0	2380		
5760 min Summer	1.926	0.0	5625.6	0.0	3224		
7200 min Summer	1.630	0.0	5950.2	0.0	4112		
8640 min Summer	1.422	0.0	6228.6	0.0	4920		
10080 min Summer	1.267	0.0	6472.0	0.0	5544		
15 min Winter	134.198	0.0	1130.1	0.0	23		
30 min Winter	84.742	0.0	1429.1	0.0	36		
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Date 05/03/2020 File PHASE 8 SUDS POND A.SRCX				Designed by AM Checked by RHA			
Micro Drainage				Source Control 2018.1.1			
<u>Summary of Results for 100 year Return Period (+40%)</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	46.476	1.476	87.1	0.0	87.1	1655.6	O K
120 min Winter	46.654	1.654	87.2	0.0	87.2	1945.4	O K
180 min Winter	46.742	1.742	87.2	0.0	87.2	2096.3	Flood Risk
240 min Winter	46.787	1.787	87.2	0.0	87.2	2176.3	Flood Risk
360 min Winter	46.841	1.841	87.9	0.0	87.9	2273.9	Flood Risk
480 min Winter	46.863	1.863	88.9	0.0	88.9	2315.3	Flood Risk
600 min Winter	46.866	1.866	89.0	0.0	89.0	2321.3	Flood Risk
720 min Winter	46.858	1.858	88.7	0.0	88.7	2305.9	Flood Risk
960 min Winter	46.740	1.740	87.2	0.0	87.2	2093.4	Flood Risk
1440 min Winter	46.508	1.508	87.2	0.0	87.2	1706.5	O K
2160 min Winter	46.305	1.305	83.2	0.0	83.2	1399.0	O K
2880 min Winter	46.238	1.238	66.6	0.0	66.6	1304.3	O K
4320 min Winter	46.163	1.163	47.6	0.0	47.6	1201.1	O K
5760 min Winter	46.092	1.092	33.7	0.0	33.7	1107.7	O K
7200 min Winter	45.846	0.846	28.4	0.0	28.4	807.3	O K
8640 min Winter	45.573	0.573	28.4	0.0	28.4	510.4	O K
10080 min Winter	45.394	0.394	27.8	0.0	27.8	335.2	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
60 min Winter	53.513	0.0	1818.7	0.0	64		
120 min Winter	33.792	0.0	2298.0	0.0	122		
180 min Winter	25.824	0.0	2634.9	0.0	176		
240 min Winter	21.339	0.0	2903.3	0.0	226		
360 min Winter	16.307	0.0	3328.6	0.0	282		
480 min Winter	13.475	0.0	3667.5	0.0	358		
600 min Winter	11.621	0.0	3953.8	0.0	436		
720 min Winter	10.298	0.0	4204.2	0.0	510		
960 min Winter	8.098	0.0	4407.9	0.0	658		
1440 min Winter	5.772	0.0	4709.7	0.0	900		
2160 min Winter	4.114	0.0	5044.8	0.0	1236		
2880 min Winter	3.235	0.0	5289.2	0.0	1620		
4320 min Winter	2.389	0.0	5855.2	0.0	2468		
5760 min Winter	1.926	0.0	6300.9	0.0	3456		
7200 min Winter	1.630	0.0	6664.6	0.0	4328		
8640 min Winter	1.422	0.0	6976.6	0.0	4928		
10080 min Winter	1.267	0.0	7250.0	0.0	5544		
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Micro Drainage		Source Control 2018.1.1

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 467450 109700 SU 67450 09700
C (1km)	-0.027
D1 (1km)	0.461
D2 (1km)	0.289
D3 (1km)	0.376
E (1km)	0.304
F (1km)	2.245
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 4.058

Time (mins)	Area	Time (mins)	Area
From: To:	(ha)	From: To:	(ha)
0 4	0.000	4 8	4.058

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Lion House Oriental Road Woking GU22 8AP	Berewood Development Phase 8 SuDS Pond A	
Date 05/03/2020 File PHASE 8 SUDS POND A.SRCX	Designed by AM Checked by RHA	
Micro Drainage		Source Control 2018.1.1

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0324-6200-0900-6200
Design Head (m)	0.900
Design Flow (l/s)	62.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	324
Invert Level (m)	46.000
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	62.0
Flush-Flo™	0.464	61.9
Kick-Flo®	0.744	56.5
Mean Flow over Head Range	-	48.0

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	9.6	1.200	71.2	3.000	111.2	7.000	168.2
0.200	33.1	1.400	76.8	3.500	119.9	7.500	174.0
0.300	58.5	1.600	81.9	4.000	128.0	8.000	179.6
0.400	61.6	1.800	86.7	4.500	135.5	8.500	185.0
0.500	61.9	2.000	91.3	5.000	142.7	9.000	190.3
0.600	60.7	2.200	95.6	5.500	149.5	9.500	193.9
0.800	58.6	2.400	99.7	6.000	156.0		
1.000	65.2	2.600	103.7	6.500	162.2		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 46.900

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Lion House Oriental Road Woking GU22 8AP			Berewood Development Phase 8 SuDS Pond A - Hydrobrake Failure				
Date 05/03/2020 File Phase 8 SuDS Pond A - B...			Designed by AM Checked by RA				
Micro Drainage			Source Control 2018.1.1				
<u>Summary of Results for 200 year Return Period</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	45.927	0.927	28.4	0.0	28.4	903.2	O K
30 min Summer	46.096	1.096	28.4	0.0	28.4	1113.0	O K
60 min Summer	46.279	1.279	28.4	0.0	28.4	1361.5	O K
120 min Summer	46.464	1.464	28.4	0.0	28.4	1637.4	O K
180 min Summer	46.568	1.568	28.4	0.0	28.4	1801.6	O K
240 min Summer	46.635	1.635	28.4	0.0	28.4	1912.5	O K
360 min Summer	46.715	1.715	28.4	0.0	28.4	2048.7	Flood Risk
480 min Summer	46.756	1.756	28.4	0.0	28.4	2120.8	Flood Risk
600 min Summer	46.775	1.775	28.4	0.0	28.4	2155.0	Flood Risk
720 min Summer	46.785	1.785	28.4	0.0	28.4	2173.3	Flood Risk
960 min Summer	46.720	1.720	28.4	0.0	28.4	2057.5	Flood Risk
1440 min Summer	46.607	1.607	28.4	0.0	28.4	1865.6	O K
2160 min Summer	46.459	1.459	28.4	0.0	28.4	1628.6	O K
2880 min Summer	46.317	1.317	28.4	0.0	28.4	1416.5	O K
4320 min Summer	46.066	1.066	28.4	0.0	28.4	1074.4	O K
5760 min Summer	45.834	0.834	28.4	0.0	28.4	794.0	O K
7200 min Summer	45.645	0.645	28.4	0.0	28.4	584.6	O K
8640 min Summer	45.498	0.498	28.3	0.0	28.3	435.1	O K
10080 min Summer	45.392	0.392	27.7	0.0	27.7	332.7	O K
15 min Winter	46.018	1.018	28.4	0.0	28.4	1013.8	O K
30 min Winter	46.200	1.200	28.4	0.0	28.4	1252.1	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
15 min Summer	121.554	0.0	913.1	0.0	23		
30 min Summer	75.766	0.0	1139.1	0.0	38		
60 min Summer	47.225	0.0	1431.8	0.0	68		
120 min Summer	29.436	0.0	1785.5	0.0	126		
180 min Summer	22.325	0.0	2031.4	0.0	186		
240 min Summer	18.347	0.0	2226.1	0.0	246		
360 min Summer	13.915	0.0	2532.3	0.0	366		
480 min Summer	11.436	0.0	2774.5	0.0	484		
600 min Summer	9.822	0.0	2977.9	0.0	590		
720 min Summer	8.673	0.0	3154.7	0.0	646		
960 min Summer	6.784	0.0	3288.3	0.0	764		
1440 min Summer	4.799	0.0	3481.9	0.0	1016		
2160 min Summer	3.394	0.0	3715.1	0.0	1432		
2880 min Summer	2.655	0.0	3874.1	0.0	1848		
4320 min Summer	1.945	0.0	4255.4	0.0	2600		
5760 min Summer	1.560	0.0	4556.4	0.0	3296		
7200 min Summer	1.315	0.0	4799.0	0.0	3968		
8640 min Summer	1.143	0.0	5006.2	0.0	4664		
10080 min Summer	1.016	0.0	5186.2	0.0	5344		
15 min Winter	121.554	0.0	1023.2	0.0	23		
30 min Winter	75.766	0.0	1275.7	0.0	37		
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Lion House Oriental Road Woking GU22 8AP	Berewood Development Phase 8 SuDS Pond A - Hydrobrake Failure	
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Micro Drainage		Source Control 2018.1.1

Summary of Results for 200 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	46.396	1.396	28.4	0.0	28.4	1533.0	O K
120 min Winter	46.597	1.597	28.4	0.0	28.4	1849.3	O K
180 min Winter	46.711	1.711	28.4	0.0	28.4	2042.0	Flood Risk
240 min Winter	46.786	1.786	28.4	0.0	28.4	2175.5	Flood Risk
360 min Winter	46.881	1.881	28.4	0.0	28.4	2347.7	Flood Risk
480 min Winter	46.926	1.926	28.6	7.2	35.8	2433.5	Flood Risk
600 min Winter	46.934	1.934	28.6	10.8	39.4	2448.6	Flood Risk
720 min Winter	46.938	1.938	28.6	12.5	41.1	2455.7	Flood Risk
960 min Winter	46.902	1.902	28.4	0.1	28.5	2387.6	Flood Risk
1440 min Winter	46.771	1.771	28.4	0.0	28.4	2148.0	Flood Risk
2160 min Winter	46.578	1.578	28.4	0.0	28.4	1818.9	O K
2880 min Winter	46.382	1.382	28.4	0.0	28.4	1511.8	O K
4320 min Winter	45.983	0.983	28.4	0.0	28.4	970.5	O K
5760 min Winter	45.638	0.638	28.4	0.0	28.4	577.8	O K
7200 min Winter	45.405	0.405	27.9	0.0	27.9	345.6	O K
8640 min Winter	45.277	0.277	26.1	0.0	26.1	228.0	O K
10080 min Winter	45.224	0.224	24.2	0.0	24.2	181.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
60 min Winter	47.225	0.0	1603.9	0.0	66
120 min Winter	29.436	0.0	2000.0	0.0	124
180 min Winter	22.325	0.0	2275.3	0.0	184
240 min Winter	18.347	0.0	2493.2	0.0	242
360 min Winter	13.915	0.0	2835.9	0.0	356
480 min Winter	11.436	0.0	3106.9	22.6	464
600 min Winter	9.822	0.0	3334.6	75.5	558
720 min Winter	8.673	0.0	3532.4	114.3	574
960 min Winter	6.784	0.0	3679.0	0.9	862
1440 min Winter	4.799	0.0	3887.9	0.0	1098
2160 min Winter	3.394	0.0	4161.1	0.0	1560
2880 min Winter	2.655	0.0	4339.2	0.0	1996
4320 min Winter	1.945	0.0	4767.2	0.0	2768
5760 min Winter	1.560	0.0	5103.4	0.0	3400
7200 min Winter	1.315	0.0	5375.3	0.0	4032
8640 min Winter	1.143	0.0	5607.5	0.0	4584
10080 min Winter	1.016	0.0	5809.9	0.0	5144

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Micro Drainage		Source Control 2018.1.1

Rainfall Details

Rainfall Model	FEH
Return Period (years)	200
FEH Rainfall Version	1999
Site Location	GB 467450 109700 SU 67450 09700
C (1km)	-0.027
D1 (1km)	0.461
D2 (1km)	0.289
D3 (1km)	0.376
E (1km)	0.304
F (1km)	2.245
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+0

Time Area Diagram

Total Area (ha) 4.058

Time (mins)		Area	Time (mins)		Area
From:	To:	(ha)	From:	To:	(ha)
0	4	0.000	4	8	4.058

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0.400	27.8	1.800	27.7	4.500	43.0	8.500	58.5																																																																																																					
0.500	28.3	2.000	29.1	5.000	45.2	9.000	60.1																																																																																																					
0.600	28.4	2.200	30.4	5.500	47.3	9.500	61.7																																																																																																					
0.800	27.8	2.400	31.7	6.000	49.4																																																																																																							
1.000	26.6	2.600	33.0	6.500	51.3																																																																																																							
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Lion House Oriental Road Woking GU22 8AP	Berewood Development Phase 8 SuDS Pond A - Hydrobrake Failure	
Date 05/03/2020 File Phase 8 SuDS Pond A - B...	Designed by AM Checked by RA	
Micro Drainage		Source Control 2018.1.1
<u>Weir Overflow Control</u> Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 46.900		
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Mayer Brown Limited							Page 1
Lion House Oriental Road Woking GU22 8AP				Berewood Development Phase 8 SuDS Pond A - Lower Hydrobrake Fail			
Date 05/03/2020 File Phase 8 SuDS Pond A - B...				Designed by AM Checked by RA			
Micro Drainage				Source Control 2018.1.1			
<u>Summary of Results for 200 year Return Period</u>							
Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	45.927	0.927	28.4	0.0	28.4	903.2	O K
30 min Summer	46.094	1.094	34.1	0.0	34.1	1110.6	O K
60 min Summer	46.246	1.246	68.8	0.0	68.8	1315.6	O K
120 min Summer	46.349	1.349	84.9	0.0	84.9	1462.9	O K
180 min Summer	46.403	1.403	86.2	0.0	86.2	1543.0	O K
240 min Summer	46.439	1.439	86.7	0.0	86.7	1598.0	O K
360 min Summer	46.480	1.480	87.1	0.0	87.1	1661.6	O K
480 min Summer	46.496	1.496	87.2	0.0	87.2	1687.0	O K
600 min Summer	46.499	1.499	87.2	0.0	87.2	1691.2	O K
720 min Summer	46.493	1.493	87.2	0.0	87.2	1682.3	O K
960 min Summer	46.411	1.411	86.3	0.0	86.3	1555.3	O K
1440 min Summer	46.297	1.297	81.6	0.0	81.6	1387.6	O K
2160 min Summer	46.215	1.215	60.2	0.0	60.2	1271.7	O K
2880 min Summer	46.153	1.153	45.5	0.0	45.5	1188.7	O K
4320 min Summer	46.052	1.052	28.7	0.0	28.7	1056.1	O K
5760 min Summer	45.834	0.834	28.4	0.0	28.4	794.0	O K
7200 min Summer	45.645	0.645	28.4	0.0	28.4	584.6	O K
8640 min Summer	45.498	0.498	28.3	0.0	28.3	435.1	O K
10080 min Summer	45.392	0.392	27.7	0.0	27.7	332.7	O K
15 min Winter	46.018	1.018	28.4	0.0	28.4	1013.7	O K
30 min Winter	46.191	1.191	54.3	0.0	54.3	1239.1	O K
Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)		
15 min Summer	121.554	0.0	913.1	0.0	23		
30 min Summer	75.766	0.0	1139.3	0.0	37		
60 min Summer	47.225	0.0	1432.1	0.0	66		
120 min Summer	29.436	0.0	1786.3	0.0	120		
180 min Summer	22.325	0.0	2032.7	0.0	150		
240 min Summer	18.347	0.0	2227.8	0.0	182		
360 min Summer	13.915	0.0	2534.9	0.0	252		
480 min Summer	11.436	0.0	2778.0	0.0	320		
600 min Summer	9.822	0.0	2982.4	0.0	390		
720 min Summer	8.673	0.0	3160.4	0.0	458		
960 min Summer	6.784	0.0	3295.3	0.0	590		
1440 min Summer	4.799	0.0	3493.8	0.0	840		
2160 min Summer	3.394	0.0	3715.5	0.0	1240		
2880 min Summer	2.655	0.0	3874.5	0.0	1676		
4320 min Summer	1.945	0.0	4255.4	0.0	2556		
5760 min Summer	1.560	0.0	4556.4	0.0	3296		
7200 min Summer	1.315	0.0	4799.0	0.0	3968		
8640 min Summer	1.143	0.0	5006.2	0.0	4664		
10080 min Summer	1.016	0.0	5186.2	0.0	5344		
15 min Winter	121.554	0.0	1023.2	0.0	23		
30 min Winter	75.766	0.0	1276.8	0.0	37		
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Lion House Oriental Road Woking GU22 8AP	Berewood Development Phase 8 SuDS Pond A - Lower Hydrobrake Fail	
Date 05/03/2020 File Phase 8 SuDS Pond A - B...	Designed by AM Checked by RA	
Micro Drainage		Source Control 2018.1.1

Summary of Results for 200 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	46.347	1.347	84.8	0.0	84.8	1460.8	O K
120 min Winter	46.486	1.486	87.1	0.0	87.1	1670.6	O K
180 min Winter	46.544	1.544	87.2	0.0	87.2	1764.0	O K
240 min Winter	46.580	1.580	87.2	0.0	87.2	1821.0	O K
360 min Winter	46.617	1.617	87.2	0.0	87.2	1882.7	O K
480 min Winter	46.624	1.624	87.2	0.0	87.2	1893.6	O K
600 min Winter	46.614	1.614	87.2	0.0	87.2	1877.1	O K
720 min Winter	46.594	1.594	87.2	0.0	87.2	1844.9	O K
960 min Winter	46.476	1.476	87.1	0.0	87.1	1655.8	O K
1440 min Winter	46.312	1.312	83.6	0.0	83.6	1409.7	O K
2160 min Winter	46.219	1.219	61.3	0.0	61.3	1278.3	O K
2880 min Winter	46.153	1.153	45.3	0.0	45.3	1188.1	O K
4320 min Winter	45.983	0.983	28.4	0.0	28.4	970.5	O K
5760 min Winter	45.638	0.638	28.4	0.0	28.4	577.8	O K
7200 min Winter	45.405	0.405	27.9	0.0	27.9	345.6	O K
8640 min Winter	45.277	0.277	26.1	0.0	26.1	228.0	O K
10080 min Winter	45.224	0.224	24.2	0.0	24.2	181.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
60 min Winter	47.225	0.0	1604.5	0.0	64
120 min Winter	29.436	0.0	2001.2	0.0	120
180 min Winter	22.325	0.0	2277.2	0.0	172
240 min Winter	18.347	0.0	2495.7	0.0	196
360 min Winter	13.915	0.0	2839.6	0.0	274
480 min Winter	11.436	0.0	3111.9	0.0	350
600 min Winter	9.822	0.0	3340.9	0.0	426
720 min Winter	8.673	0.0	3540.3	0.0	496
960 min Winter	6.784	0.0	3691.6	0.0	630
1440 min Winter	4.799	0.0	3914.0	0.0	870
2160 min Winter	3.394	0.0	4161.7	0.0	1280
2880 min Winter	2.655	0.0	4339.8	0.0	1736
4320 min Winter	1.945	0.0	4767.2	0.0	2768
5760 min Winter	1.560	0.0	5103.4	0.0	3400
7200 min Winter	1.315	0.0	5375.3	0.0	4032
8640 min Winter	1.143	0.0	5607.5	0.0	4584
10080 min Winter	1.016	0.0	5809.9	0.0	5144

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Lion House Oriental Road Woking GU22 8AP	Berewood Development Phase 8 SuDS Pond A - Lower Hydrobrake Fail																																															
Date 05/03/2020 File Phase 8 SuDS Pond A - B...	Designed by AM Checked by RA																																															
Micro Drainage																																																
Source Control 2018.1.1																																																
Rainfall Details <table><tr><td>Rainfall Model</td><td>FEH</td></tr><tr><td>Return Period (years)</td><td>200</td></tr><tr><td>FEH Rainfall Version</td><td>1999</td></tr><tr><td>Site Location</td><td>GB 467450 109700 SU 67450 09700</td></tr><tr><td>C (1km)</td><td>-0.027</td></tr><tr><td>D1 (1km)</td><td>0.461</td></tr><tr><td>D2 (1km)</td><td>0.289</td></tr><tr><td>D3 (1km)</td><td>0.376</td></tr><tr><td>E (1km)</td><td>0.304</td></tr><tr><td>F (1km)</td><td>2.245</td></tr><tr><td>Summer Storms</td><td>Yes</td></tr><tr><td>Winter Storms</td><td>Yes</td></tr><tr><td>Cv (Summer)</td><td>0.750</td></tr><tr><td>Cv (Winter)</td><td>0.840</td></tr><tr><td>Shortest Storm (mins)</td><td>15</td></tr><tr><td>Longest Storm (mins)</td><td>10080</td></tr><tr><td>Climate Change %</td><td>+0</td></tr></table> Time Area Diagram Total Area (ha) 4.058 <table><tr><th>Time (mins)</th><th>Area</th><th>Time (mins)</th><th>Area</th></tr><tr><th>From: To:</th><th>(ha)</th><th>From: To:</th><th>(ha)</th></tr><tr><td>0 4</td><td>0.000</td><td>4 8</td><td>4.058</td></tr></table>			Rainfall Model	FEH	Return Period (years)	200	FEH Rainfall Version	1999	Site Location	GB 467450 109700 SU 67450 09700	C (1km)	-0.027	D1 (1km)	0.461	D2 (1km)	0.289	D3 (1km)	0.376	E (1km)	0.304	F (1km)	2.245	Summer Storms	Yes	Winter Storms	Yes	Cv (Summer)	0.750	Cv (Winter)	0.840	Shortest Storm (mins)	15	Longest Storm (mins)	10080	Climate Change %	+0	Time (mins)	Area	Time (mins)	Area	From: To:	(ha)	From: To:	(ha)	0 4	0.000	4 8	4.058
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Mayer Brown Limited				Page 4																																																																																																													
Lion House Oriental Road Woking GU22 8AP		Berewood Development Phase 8 SuDS Pond A - Lower Hydrobrake Fail																																																																																																															
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Model Details Storage is Online Cover Level (m) 47.000 Tank or Pond Structure Invert Level (m) 45.000 <table><tr><td>Depth (m)</td><td>Area (m²)</td><td>Depth (m)</td><td>Area (m²)</td><td>Depth (m)</td><td>Area (m²)</td><td>Depth (m)</td><td>Area (m²)</td></tr><tr><td>0.000</td><td>765.7</td><td>1.000</td><td>1235.9</td><td>1.900</td><td>1881.2</td><td>2.000</td><td>1958.0</td></tr></table> Complex Outflow Control Hydro-Brake® Optimum Unit Reference MD-SHE-0219-2840-1900-2840 Design Head (m) 1.900 Design Flow (l/s) 28.4 Flush-Flo™ Calculated Objective Minimise upstream storage Application Surface Sump Available Yes Diameter (mm) 219 Invert Level (m) 45.000 Minimum Outlet Pipe Diameter (mm) 300 Suggested Manhole Diameter (mm) 1800 <table><tr><td colspan="2">Control Points</td><td>Head (m)</td><td>Flow (l/s)</td></tr><tr><td colspan="2">Design Point (Calculated)</td><td>1.900</td><td>28.4</td></tr><tr><td colspan="2">Flush-Flo™</td><td>0.564</td><td>28.4</td></tr><tr><td colspan="2">Kick-Flo®</td><td>1.218</td><td>22.9</td></tr><tr><td colspan="2">Mean Flow over Head Range</td><td>-</td><td>24.6</td></tr></table> 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 <table><tr><td>Depth (m)</td><td>Flow (l/s)</td><td>Depth (m)</td><td>Flow (l/s)</td><td>Depth (m)</td><td>Flow (l/s)</td><td>Depth (m)</td><td>Flow (l/s)</td></tr><tr><td>0.100</td><td>7.4</td><td>1.200</td><td>23.4</td><td>3.000</td><td>35.3</td><td>7.000</td><td>53.2</td></tr><tr><td>0.200</td><td>21.5</td><td>1.400</td><td>24.5</td><td>3.500</td><td>38.1</td><td>7.500</td><td>55.0</td></tr><tr><td>0.300</td><td>26.6</td><td>1.600</td><td>26.1</td><td>4.000</td><td>40.6</td><td>8.000</td><td>56.8</td></tr><tr><td>0.400</td><td>27.8</td><td>1.800</td><td>27.7</td><td>4.500</td><td>43.0</td><td>8.500</td><td>58.5</td></tr><tr><td>0.500</td><td>28.3</td><td>2.000</td><td>29.1</td><td>5.000</td><td>45.2</td><td>9.000</td><td>60.1</td></tr><tr><td>0.600</td><td>28.4</td><td>2.200</td><td>30.4</td><td>5.500</td><td>47.3</td><td>9.500</td><td>61.7</td></tr><tr><td>0.800</td><td>27.8</td><td>2.400</td><td>31.7</td><td>6.000</td><td>49.4</td><td></td><td></td></tr><tr><td>1.000</td><td>26.6</td><td>2.600</td><td>33.0</td><td>6.500</td><td>51.3</td><td></td><td></td></tr></table>						Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	0.000	765.7	1.000	1235.9	1.900	1881.2	2.000	1958.0	Control Points		Head (m)	Flow (l/s)	Design Point (Calculated)		1.900	28.4	Flush-Flo™		0.564	28.4	Kick-Flo®		1.218	22.9	Mean Flow over Head Range		-	24.6	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	0.100	7.4	1.200	23.4	3.000	35.3	7.000	53.2	0.200	21.5	1.400	24.5	3.500	38.1	7.500	55.0	0.300	26.6	1.600	26.1	4.000	40.6	8.000	56.8	0.400	27.8	1.800	27.7	4.500	43.0	8.500	58.5	0.500	28.3	2.000	29.1	5.000	45.2	9.000	60.1	0.600	28.4	2.200	30.4	5.500	47.3	9.500	61.7	0.800	27.8	2.400	31.7	6.000	49.4			1.000	26.6	2.600	33.0	6.500	51.3		
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Date 05/03/2020 File Phase 8 SuDS Pond A - B...	Designed by AM Checked by RA	
Micro Drainage		Source Control 2018.1.1

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0324-6200-0900-6200
Design Head (m)	0.900
Design Flow (l/s)	62.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	324
Invert Level (m)	46.000
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	62.0
Flush-Flo™	0.464	61.9
Kick-Flo®	0.744	56.5
Mean Flow over Head Range	-	48.0

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	9.6	1.200	71.2	3.000	111.2	7.000	168.2
0.200	33.1	1.400	76.8	3.500	119.9	7.500	174.0
0.300	58.5	1.600	81.9	4.000	128.0	8.000	179.6
0.400	61.6	1.800	86.7	4.500	135.5	8.500	185.0
0.500	61.9	2.000	91.3	5.000	142.7	9.000	190.3
0.600	60.7	2.200	95.6	5.500	149.5	9.500	193.9
0.800	58.6	2.400	99.7	6.000	156.0		
1.000	65.2	2.600	103.7	6.500	162.2		

Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 46.900

Berewood Phase 8 Greenfield Run-Off Calculation

Growth Factor Calculation

SuDS Pond	Pond Area	Catchment	Catchment Size	Pimp Factor	Urban Creep	Windes Area	Windes Pond Area	Total Windes Area	Hydrobrake Size	Grown Factor 1 in 30	Allowable discharge 1 in 30	Grown Factor 1 in 100	Allowable discharge 1 in 100	Pond Volume	Max Volume	% Ful
Pond A	2737	Phase 8	53315	65%	10%	3.8120225	0.24633	4.0583525	28.36	2.3	65.228	3.19	90.4684	2384	2321.3	97.37%

Berewood Phase 8 Greenfield Run-Off Calculation

Volume Calculations (estimated)

Simple method for green field run-off volume	
Qbar	5.06
Area	5.61
Growth Factor	3.19
Time Period (mins)	360
Volume (m ³)	1955.9503

Estimating the EXTRA runoff volume from a developmehnt site compared to the greenfield equivalent

Rd	63
Pimp	72
A	5.61
SPR	0.47
α	1
β	1
Run off Coefficient	0.9

Part 1 of equation	0.648
Part 2 of equation	0.1316

Vol_{xs} 1094.21928

Berewood Phase 8 Greenfield Run-Off Calculation
Cumulative Volume Calculations (extracted from Microdrainage)

Critical Storm (60mins)

Greenfield (2.637 microdrainage 60mins)					Greenfield (4.058 microdrainage 60mins)							
Time (mins)	Σ Outflow (l/s)	Outflow Volume (m³)	Cumulative Volume (m³)	Discharge for Period	Time (mins)	Σ Outflow (l/s)	Outflow Volume (m³)	Cumulative Discharge for Period	Time (mins)	Σ Outflow (l/s)	Outflow Volume (m³)	Cumulative Discharge for Period
2	0	0.00	0.00	1166.30	2	0	0.00	0.00	2	0	0.00	3332.24
4	0	0.00	0.00		4	0	0.00	0.00	4	0	0.00	0.00
6	0	0.00	0.00		6	1.2	0.14	0.14	6	2	0.24	0.24
8	0	0.00	0.00		8	4.2	0.50	0.65	8	6.5	0.78	1.02
10	0	0.00	0.00		10	8.6	1.03	1.68	10	13.5	1.62	2.64
12	0	0.00	0.00		12	14.4	1.73	3.41	12	21.8	2.62	5.26
14	0.1	0.01	0.01		14	18.1	2.17	5.58	14	28.1	3.37	8.63
16	0.2	0.02	0.04		16	22.6	2.71	8.29	16	34.4	4.13	12.76
18	0.3	0.04	0.07		18	25.7	3.08	11.38	18	40.1	4.81	17.57
20	0.6	0.07	0.14		20	29.3	3.52	14.89	20	44.6	5.35	22.92
22	1	0.12	0.26		22	31.5	3.78	18.67	22	49.2	5.90	28.82
24	1.4	0.17	0.43		24	34.4	4.13	22.80	24	52.4	6.29	35.11
26	2	0.24	0.67		26	36.6	4.39	27.19	26	56.7	6.80	41.92
28	2.7	0.32	1.00		28	37.9	4.55	31.74	28	58.3	7.00	48.91
30	3.5	0.42	1.42		30	40.1	4.81	36.55	30	61.5	7.38	56.29
32	4.4	0.53	1.94		32	40.6	4.87	41.42	32	62.6	7.51	63.80
34	5.4	0.65	2.59		34	42.2	5.06	46.49	34	65	7.80	71.60
36	6.4	0.77	3.36		36	42.5	5.10	51.59	36	65.5	7.86	79.46
38	7.6	0.91	4.27		38	43.6	5.23	56.82	38	66.8	8.02	87.48
40	8	1.06	5.33		40	43.8	5.26	62.08	40	67.7	8.12	95.60
42	11.3	1.36	6.53		42	44.4	5.33	67.40	42	67.7	8.12	103.73
44	11.3	1.36	7.88		44	44.4	5.33	72.73	44	68.8	8.26	111.98
46	12.4	1.49	9.37		46	44.9	5.39	78.12	46	68.4	8.21	120.19
48	13.6	1.63	11.00		48	44.4	5.33	83.45	48	69.2	8.30	128.50
50	14.8	1.78	12.78		50	45.2	5.42	88.87	50	68.4	8.21	136.70
52	16	1.92	14.70		52	44.4	5.33	94.20	52	69.2	8.30	145.01
54	17.1	2.05	16.75		54	44.9	5.39	99.59	54	68.4	8.21	153.22
56	18.2	2.18	18.94		56	44.6	5.35	104.94	56	68.8	8.26	161.47
58	19.2	2.30	21.24		58	44.6	5.35	110.29	58	68.8	8.26	169.73
60	20	2.40	23.64		60	44.4	5.33	115.62	60	68.4	8.21	177.94
62	20.9	2.51	26.15		62	44.9	5.39	121.01	62	68.8	8.26	186.19
64	21.8	2.62	28.76		64	44.6	5.35	126.36	64	68.8	8.26	194.45
66	22.5	2.70	31.46		66	45.2	5.42	131.78	66	69.2	8.30	202.75
68	23.2	2.78	34.25		68	44.9	5.39	137.17	68	69.6	8.35	211.10
70	24	2.88	37.13		70	46	5.52	142.69	70	69.9	8.39	219.49
72	24.7	2.96	40.09		72	45.4	5.45	148.14	72	71	8.52	228.01
74	25.1	3.01	43.10		74	47	5.64	153.78	74	71.4	8.57	236.58
76	25.3	3.04	46.14		76	47	5.64	159.42	76	72.9	8.75	245.33
78	25.5	3.06	49.20		78	48.1	5.77	165.19	78	73.7	8.84	254.17
80	25.6	3.07	52.27		80	49.2	5.90	171.10	80	75.9	9.11	263.28
82	25.8	3.10	55.37		82	50.2	6.02	177.12	82	77.4	9.29	272.57
84	25.9	3.11	58.48		84	51.6	6.19	183.31	84	79.2	9.50	282.07
86	26.1	3.13	61.61		86	52.7	6.32	189.64	86	81.5	9.78	291.85
88	26.3	3.16	64.76		88	54.8	6.58	196.21	88	83.7	10.04	301.90
90	26.4	3.17	67.93		90	56.1	6.73	202.94	90	87	10.44	312.34
92	26.6	3.19	71.12		92	58.5	7.02	209.96	92	89.3	10.72	323.05
94	26.7	3.20	74.33		94	59.9	7.19	217.15	94	93	11.16	334.21
96	26.9	3.23	77.56		96	63.1	7.57	224.72	96	96.3	11.56	345.77
98	27	3.24	80.80		98	65	7.80	232.52	98	100.8	12.10	357.86
100	27.1	3.25	84.05		100	68.4	8.21	240.73	100	104.5	12.54	370.40
102	27.3	3.28	87.32		102	70.7	8.48	249.22	102	109	13.08	383.48
104	27.4	3.29	90.61		104	74	8.88	258.10	104	113.8	13.66	397.14
106	27.5	3.30	93.91		106	77	9.24	267.34	106	118.7	14.24	411.38
108	27.7	3.32	97.34		108	80.7	9.66	277.02	108	123.5	14.82	426.20
110	27.8	3.34	100.57		110	83.7	10.04	287.06	110	129.8	15.58	441.78
112	27.9	3.35	103.92		112	88.2	10.58	297.65	112	134.7	16.36	457.94
114	28	3.36	107.28		114	91.5	10.98	308.63	114	141.1	16.93	474.88
116	28.1	3.37	110.65		116	96.3	11.56	320.18	116	148.4	17.81	492.68
118	28.2	3.38	114.04		118	100.1	12.01	332.20	118	154.2	18.50	511.19
120	28.2	3.38	117.42		120	105.3	12.64	344.83	120	161.5	19.38	530.57
122	28.3	3.40	120.82		122	108.6	13.03	357.86	122	167.7	20.12	550.69
124	28.3	3.40	124.21		124	114.6	13.75	371.62	124	176.1	21.13	571.82
126	28.4	3.41	127.62		126	118.3	14.20	385.81	126	181.8	21.82	593.64
128	28.4	3.41	131.03		128	123.9	14.87	400.68	128	191.2	22.94	616.58
130	28.4	3.41	134.44		130	128.7	15.44	416.12	130	197.5	23.70	640.28
132	28.4	3.41	137.84		132	133.5	16.02	432.14	132	206.3	24.76	665.04
134	28.4	3.41	141.25		134	140.1	16.81	448.96	134	214.7	25.76	690.80
136	28.3	3.40	144.65		136	144.3	17.32	466.27	136	223	26.76	717.56
138	28.3	3.40	148.04		138	151	18.12	484.39	138	230.9	27.71	745.27
140	28.3	3.40	151.44		140	154.7	18.56	502.96	140	239.7	28.76	774.04

Chart 1

Time	Outflow Volume Green	Outflow Volume No Suds	Outflow Volume Suds
2	0.00	0.00	0.00
4	0.00	0.00	0.00
6	0.14	0.24	0.00
8	0.50	0.78	0.00
10	1.03	1.62	0.00
12	1.73	2.62	0.00
14	2.17	3.37	0.01
16	2.71	4.13	0.02
18	3.08	4.81	0.04
20	3.52	5.35	0.07
22	3.78	5.90	0.12
24	4.13	6.29	0.17
26	4.39	6.80	0.24
28	4.55	7.00	0.32
30	4.81	7.38	0.42
32	4.87	7.51	0.53
34	5.06	7.80	0.65
36	5.10	7.86	0.77
38	5.23	8.02	0.91
40	5.26	8.12	1.06
42	5.33	8.12	1.20
44	5.33	8.26	1.36
46	5.39	8.21	1.49
48	5.33	8.30	1.63
50	5.42	8.21	1.78
52	5.33	8.30	1.92
54	5.39	8.21	2.05
56	5.35	8.26	2.18
58	5.35	8.26	2.30
60	5.33	8.21	2.40
62	5.39	8.26	2.51
64	5.35	8.26	2.62
66	5.42	8.30	2.70
68	5.39	8.35	2.78
70	5.52	8.39	2.88
72	5.45	8.52	2.96
74	5.64	8.57	3.01
76	5.64	8.75	3.04
78	5.77	8.84	3.06
80	5.90	9.11	3.07
82	6.02	9.29	3.10
84	6.19	9.50	3.11
86	6.32	9.78	3.13
88	6.58	10.04	3.16
90	6.73	10.44	3.17
92	7.02	10.72	3.20
94	7.19	11.16	3.23
96	7.57	11.56	3.23
98	7.80	12.10	3.24
100	8.21	12.54	3.25
102	8.48	13.08	3.28
104	8.88	13.66	3.29
106	9.24	14.24	3.30
108	9.68	14.82	3.32
110	10.04	15.58	3.34
112	10.58	16.16	3.35
114	10.98	16.93	3.36
116	11.56	17.81	3.37
118	12.01	18.50	3.38
120	12.64	19.38	3.38
122	13.03	20.12	3.40
124	13.75	21.13	3.40
126	14.20	21.82	3.41
128	14.87	22.94	3.41
130	15.44	23.70	3.41
132	16.02	24.76	3.41
134	16.81	25.76	3.41
136	17.32	26.76	3.40
138	18.12	27.71	3.40
140	18.56	28.76	3.40

Chart 2

Time	Total Outflow Volume Green	Total Outflow Volume No Suds	Total Outflow Volume Suds
2	0.00	0.00	0.00
4	0.00	0.00	0.00
6	0.14	0.24	0.00
8	0.50	0.78	0.00
10	1.03	1.62	0.00
12	1.73	2.62	0.00
14	2.17	3.37	0.01
16	2.71	4.13	0.02
18	3.08	4.81	0.04
20	3.52	5.35	0.07
22	3.78	5.90	0.12
24	4.13	6.29	0.17
26	4.39	6.80	0.24
28	4.55	7.00	0.32
30	4.81	7.38	0.42
32	4.87	7.51	0.53
34	5.06	7.80	0.65
36	5.10	7.86	0.77
38	5.23	8.02	0.91
40	5.26	8.12	1.06
42	5.33	8.12	1.20
44	5.33	8.26	1.36
46	5.39	8.21	1.49
48	5.33	8.30	1.63
50	5.42	8.21	1.78
52	5.33	8.30	1.92
54	5.39	8.21	2.05
56	5.35	8.26	2.18

Berewood Phase 8 Greenfield Run-Off Calculation
Cumulative Volume Calculations (extracted from Microdrainage)

Critical Storm (60mins)

Time (mins)	Σ Outflow (l/s)	Outflow Volume (m³)	Cumulative e Volume	Discharge for Period
142	28.2	3.38	154.82	
144	28.1	3.37	158.20	
146	28	3.36	161.56	
148	27.9	3.35	164.90	
150	27.8	3.34	168.24	
152	27.7	3.32	171.56	
154	27.6	3.31	174.88	
156	27.4	3.29	178.16	
158	27.3	3.28	181.44	
160	27.1	3.25	184.69	
162	26.8	3.22	187.91	
164	26.6	3.19	191.10	
166	26.1	3.15	194.35	
168	25.5	3.1	197.89	
170	25.3	3.07	201.89	
172	25.4	3.08	206.50	
174	25.6	3.1	211.85	
176	25.9	3.14	217.99	
178	26.3	3.19	224.98	
180	26.8	3.25	232.84	
182	27.3	3.31	241.58	
184	27.8	3.37	251.11	
186	28.3	3.43	261.44	
188	28.8	3.49	272.8	
190	29.3	3.55	285.2	
192	29.8	3.61	298.83	
194	30.3	3.67	313.59	
196	30.8	3.73	329.59	
198	31.3	3.79	346.82	
200	31.8	3.85	364.27	
202	32.3	3.91	382.94	
204	32.8	3.97	401.81	
206	33.3	4.03	420.94	
208	33.8	4.09	440.33	
210	34.3	4.15	460.0	
212	34.8	4.21	480.0	
214	35.3	4.27	500.3	
216	35.8	4.33	521.0	
218	36.3	4.39	542.0	
220	36.8	4.45	563.3	
222	37.3	4.51	584.9	
224	37.8	4.57	606.8	
226	38.3	4.63	629.0	
228	38.8	4.69	651.4	
230	39.3	4.75	674.1	
232	39.8	4.81	697.0	
234	40.3	4.87	720.2	
236	40.8	4.93	743.6	
238	41.3	4.99	767.2	
240	41.8	5.05	791.0	
242	42.3	5.11	815.0	
244	42.8	5.17	839.2	
246	43.3	5.23	863.6	
248	43.8	5.29	888.2	
250	44.3	5.35	913.0	
252	44.8	5.41	937.9	
254	45.3	5.47	963.0	
256	45.8	5.53	988.2	
258	46.3	5.59	1013.6	
260	46.8	5.65	1039.2	
262	47.3	5.71	1064.9	
264	47.8	5.77	1090.8	
266	48.3	5.83	1116.8	
268	48.8	5.89	1143.0	
270	49.3	5.95	1169.3	
272	49.8	6.01	1195.8	
274	50.3	6.07	1222.4	
276	50.8	6.13	1249.2	
278	51.3	6.19	1276.1	
280	51.8	6.25	1303.2	

Greenfield (2.637 microdrainage 60mins)

Time (mins)	Σ Outflow (l/s)	Outflow Volume (m³)	Cumulative e Volume	Discharge for Period
142	162	19.44	522.40	
144	166.2	19.94	542.34	
146	172.4	20.69	563.03	
148	177.1	21.25	584.28	
150	183.4	22.01	606.29	
152	189.1	22.69	628.98	
154	193.8	23.26	652.24	
156	200.1	24.01	676.25	
158	204.3	24.52	700.76	
160	210	25.20	725.96	
162	214.7	25.76	751.73	
164	219.4	26.33	778.06	
166	224.1	26.89	804.95	
168	228.3	27.40	832.34	
170	233.5	28.02	860.36	
172	236.6	28.59	888.76	
174	240.8	29.16	917.65	
176	243.4	29.71	946.86	
178	247	29.64	976.50	
180	248.6	29.83	1006.33	
182	252.3	30.28	1036.61	
184	252.8	30.34	1066.94	
186	254.3	30.52	1097.46	
188	252.8	30.34	1127.80	
190	252.3	30.28	1158.07	
192	249.1	29.89	1187.96	
194	247.6	29.71	1217.68	
196	243.4	29.21	1246.88	
198	241.3	28.96	1275.84	
200	237.1	28.45	1304.29	
202	233.5	28.02	1332.31	
204	229.3	27.52	1359.83	
206	224.1	26.89	1386.72	
208	220.4	26.45	1413.17	
210	214.7	25.76	1438.93	
212	210.5	25.26	1464.19	
214	205.3	24.64	1488.83	
216	200.1	24.01	1512.84	
218	194.9	23.39	1536.23	
220	189.1	22.69	1558.92	
222	184.4	22.13	1581.05	
224	177.1	21.25	1602.30	
226	173.5	20.82	1623.12	
228	166.2	19.94	1643.06	
230	162.5	19.50	1662.56	
232	155.2	18.62	1681.19	
234	151.6	18.19	1699.38	
236	144.8	17.38	1716.76	
238	140.1	16.81	1733.57	
240	134.7	16.16	1749.73	
242	129.1	15.49	1765.22	
244	124.2	14.90	1780.13	
246	119.4	14.33	1794.46	
248	114.2	13.70	1808.16	
250	108.7	13.16	1821.32	
252	103.3	12.64	1833.96	
254	100.8	12.10	1846.06	
256	96.3	11.56	1857.61	
258	92.6	11.11	1868.72	
260	87.4	10.49	1879.21	
262	85.2	10.22	1889.44	
264	80	9.60	1899.04	
266	78.1	9.37	1908.41	
268	73.7	8.84	1917.25	
270	71.4	8.57	1925.82	
272	68.1	8.17	1934.99	
274	65.8	7.90	1943.89	
276	62.8	7.54	1949.42	
278	60.7	7.28	1956.71	
280	58.3	7.00	1963.70	

Greenfield (4.058 microdrainage 60mins)

Time (mins)	Σ Outflow (l/s)	Outflow Volume (m³)	Cumulative ve Volume	Discharge for Period
142	247.6	29.71	803.75	
144	256.4	30.77	834.52	
146	264.3	31.72	866.23	
148	273.7	32.84	899.08	
150	281	33.72	932.80	
152	291.4	34.97	967.76	
154	298.7	35.84	1003.61	
156	307.2	36.86	1040.47	
158	315.3	37.84	1078.31	
160	322.4	38.69	1117.00	
162	331.3	39.76	1156.75	
164	336.7	40.40	1197.16	
166	346.5	41.58	1238.74	
168	350.1	42.01	1280.75	
170	359.9	43.19	1323.94	
172	363.5	43.62	1367.56	
174	370.6	44.47	1412.03	
176	375.1	45.01	1457.04	
178	379.6	45.55	1502.59	
180	384	46.08	1548.67	
182	386.7	46.40	1595.08	
184	390.3	46.84	1641.91	
186	390.3	46.84	1688.75	
188	386.7	46.40	1735.58	
190	386.7	46.40	1781.99	
192	384.9	46.19	1828.18	
194	378.7	45.44	1873.62	
196	376.9	45.23	1918.85	
198	369.7	44.36	1963.21	
200	365.3	43.84	2007.05	
202	359	43.08	2050.13	
204	352.8	42.34	2092.46	
206	344.7	41.36	2133.83	
208	339.4	40.73	2174.56	
210	330.4	39.65	2214.20	
212	323.3	38.80	2253.00	
214	316.2	37.94	2290.94	
216	308.1	36.97	2327.92	
218	299.1	35.90	2363.82	
220	291.9	35.03	2398.85	
222	283	33.96	2432.81	
224	273.7	32.84	2465.65	
226	266.3	31.96	2497.61	
228	256.4	30.77	2528.38	
230	249.7	29.96	2558.34	
232	239.7	28.76	2587.10	
234	232.4	27.89	2614.99	
236	223	26.76	2641.75	
238	216.3	25.96	2667.71	
240	206.9	24.83	2692.54	
242	198.5	23.82	2716.36	
244	191.2	22.94	2739.30	
246	183.4	22.01	2761.31	
248	176.1	21.13	2782.44	
250	168.8	20.26	2802.70	
252	162	19.44	2822.14	
254	154.7	18.56	2840.70	
256	149	17.88	2858.58	
258	141.7	17.00	2875.58	
260	135.8	16.30	2891.88	
262	129.8	15.58	2907.46	
264	124.2	14.90	2922.36	
266	119.4	14.33	2936.69	
268	113.8	13.66	2950.34	
270	110.1	13.21	2963.56	
272	104.5	12.54	2976.10	
274	101.2	12.14	2988.24	
276	96.7	11.60	2999.84	
278	93.4	11.21	3011.05	
280	89.6	10.75	3021.80	

Chart 1

Time	Green	No SuDS	SuDS
142	522.40	803.75	154.82
144	542.34	834.52	158.20
146	563.03	866.23	161.56
148	584.28	899.08	164.90
150	606.29	932.80	168.24
152	628.98	967.76	171.56
154	652.24	1003.61	174.88
156	676.25	1040.47	178.16
158	700.76	1078.31	181.44
160	725.96	1117.00	184.69
162	751.73	1156.75	187.91
164	778.06	1197.16	191.10
166	804.95	1238.74	194.35
168	832.34	1280.75	197.89
170	860.36	1323.94	201.89
172	888.76	1367.56	206.50
174	917.65	1412.03	211.85
176	946.86	1457.04	217.99
178	976.50	1502.59	224.98
180	1006.33	1548.67	232.84
182	1036.61	1595.08	241.58
184	1066.94	1641.91	251.11
186	1097.46	1688.75	261.44
188	1127.80	1735.58	271.28
190	1158.07	1781.99	281.52
192	1187.96	1828.18	291.83
194	1217.68	1872.30	302.19
196	1246.88	1918.85	312.95
198	1275.84	1963.21	323.03
200	1304.29	2007.05	332.47
202	1332.31	2050.13	343.99
204	1359.83	2092.46	354.48
206	1386.72	2133.82	364.88
208	1413.17	2174.56	375.35
210	1438.93	2214.20	385.78
212	1464.19	2253.00	396.26
214	1488.83	2290.94	406.66
216	1512.84	2327.92	417.07
218	1536.23	2363.85	427.37
220	1558.92	2398.85	437.70
222	1581.05	2432.61	448.00
224	1602.30	2465.65	458.28
226	1623.12	2497.61	468.48
228	1643.06	2528.38	478.63
230	1662.56	2558.34	488.83
232	1681.19	2587.10	498.93
234	1699.38	2614.99	508.97
236	1716.76	2641.75	519.07
238	1733.57	2667.71	529.22
240	1749.73	2692.54	539.42
242	1765.22	2716.36	549.66
244	1780.13	2739.30	559.93
246	1794.46	2761.31	570.20
248	1808.16	2782.44	580.50
250	1821.32	2802.70	590.99
252	1833.96	2822.14	601.34
254	1846.06	2840.58	611.71
256	1857.61	2858.38	622.20
258	1867.72	2875.58	632.66
260	1879.21	2891.88	643.13
262	1889.44	2907.46	653.63
264	1899.04	2922.36	664.13
266	1908.41	2936.69	674.63
268	1917.25	2950.34	685.18
270	1925.82	2963.50	695.75
272	1933.99	2976.10	706.25
274	1941.89	2988.24	716.86
276	1949.42	2999.84	727.34
278	1956.71	3011.05	737.89
280	1963.70	3021.80	748.44

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GTWVILLE_P8/CD/504
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APPENDIX B: Drawings

Location Plan
Existing Condition
General Arrangement
Outfall Detail
Hydrobrake/Weir Overflow Detail
Headwall Detail
Pollution Control Valve Detail

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KEY

DEVELOPER BOUNDARY

LOCATION OF PROPOSED POND

DISCHARGE ROUTE TO RIVER



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client **grainger plc**
trading in houses since 1912

project

BEREWOOD, WATERLOOVILLE
PHASE 8 INFRASTRUCTURE

scale 1:1250 drawn by KDB checked by RHA

date MARCH 2020 cad file GA_04.dwg

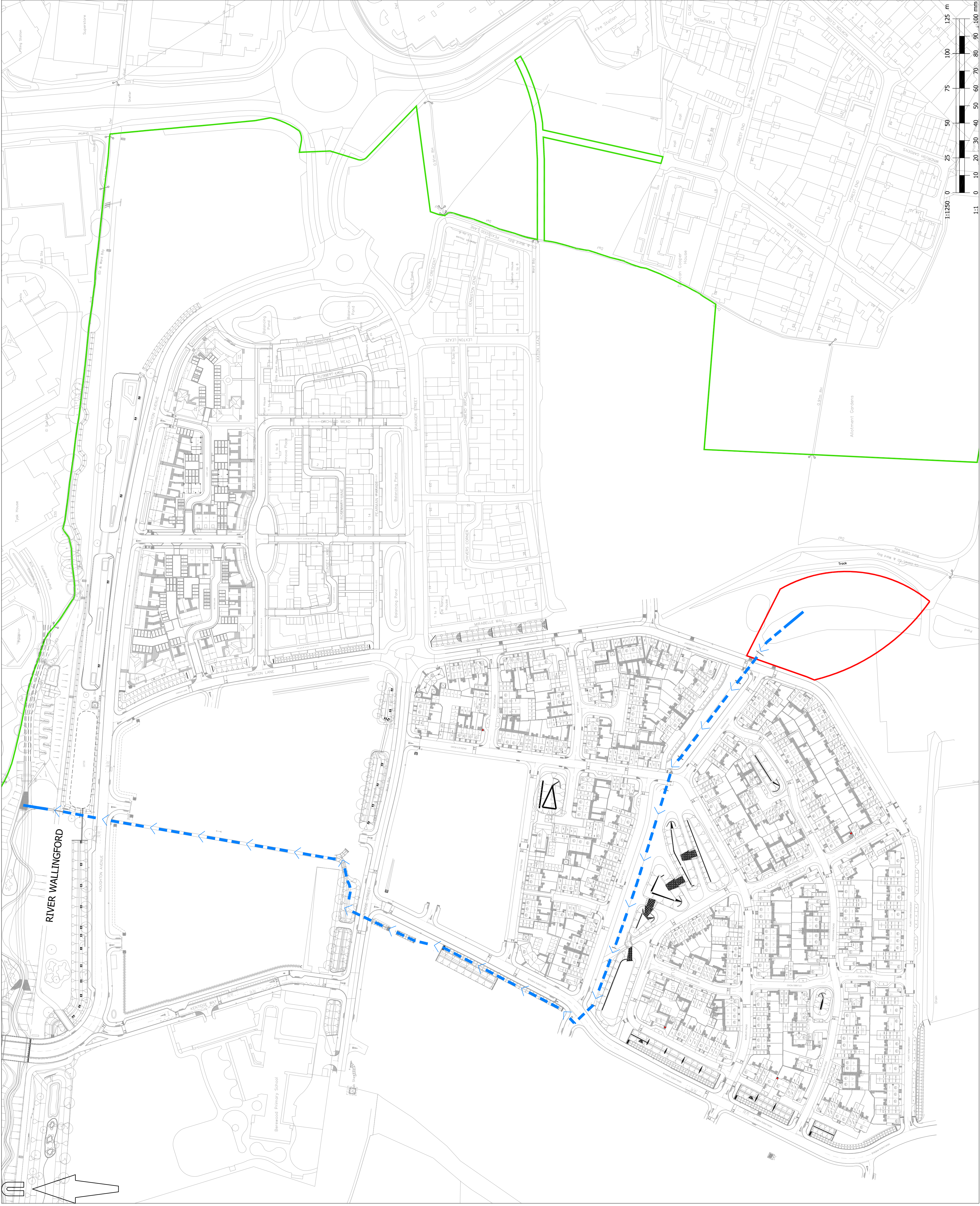
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SUDS PROVISION
LOCATION PLAN

drawing number

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PHASE 8 INFRASTRUCTURE

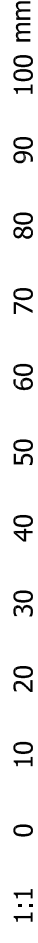
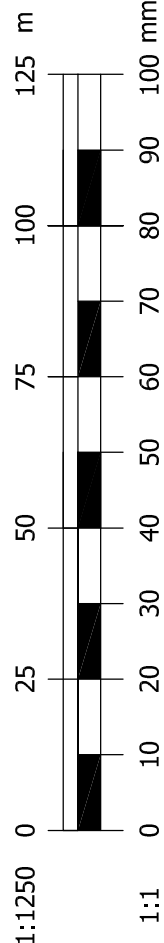
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date	MARCH 2020		cad file GA_05.dwg		

title

EXISTING CONDITION

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BEREWOOD, WATERLOOVILLE
PHASE 8 INFRASTRUCTURE

SUDS PROVISION
GENERAL ARRANGEMENT

drawing number

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Notes:

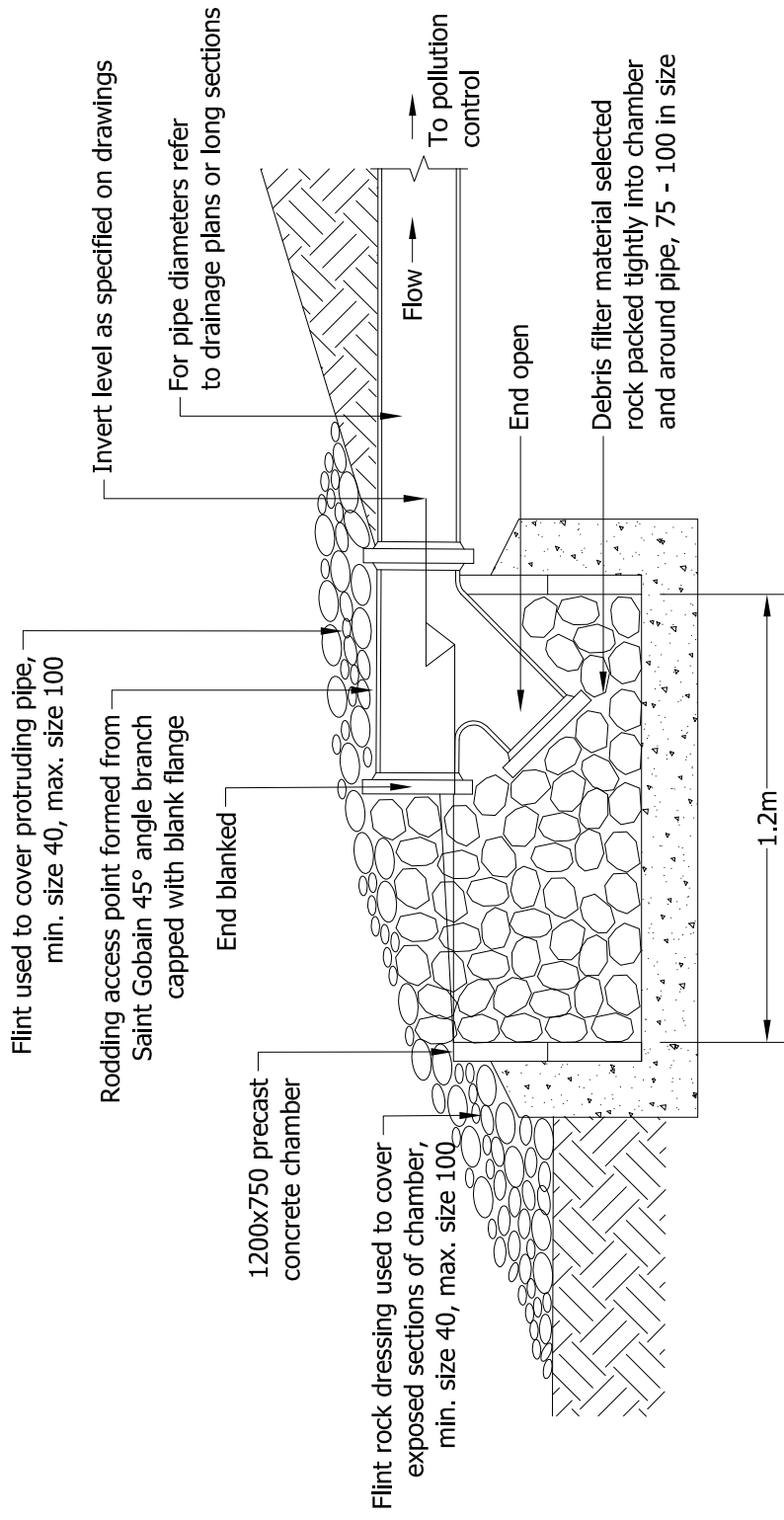
1. All dimensions are in millimetres unless stated otherwise.
2. All exposed ductile pipe to be painted black. Colour - RAL 9005 (Jet Black). Finish - Matt 30% gloss mix.
3. All pipework from the outfall to the first chamber beyond the pollution control valve shall be ductile iron.

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scale	1:20	drawn by	LS	checked by	RHA
date	JANUARY 2020	cad file	502.dwg		
drawing number	GTWVILLE_P8/CD/502				



client	grainger plc	title	TYPICAL SUDS OUTFALL DETAIL TYPE 1
project	BEREWOOD, WATERLOOVILLE PHASE 8 INFRASTRUCTURE		

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Notes:

- 1. Flow controls are critical to the drainage design, alternative proposals for flow controls to be provided to the Designer for verification. The Contractor will pay re-design fees directly to the Designer in this instance.
- 2. All dimensions are in mm unless stated otherwise.



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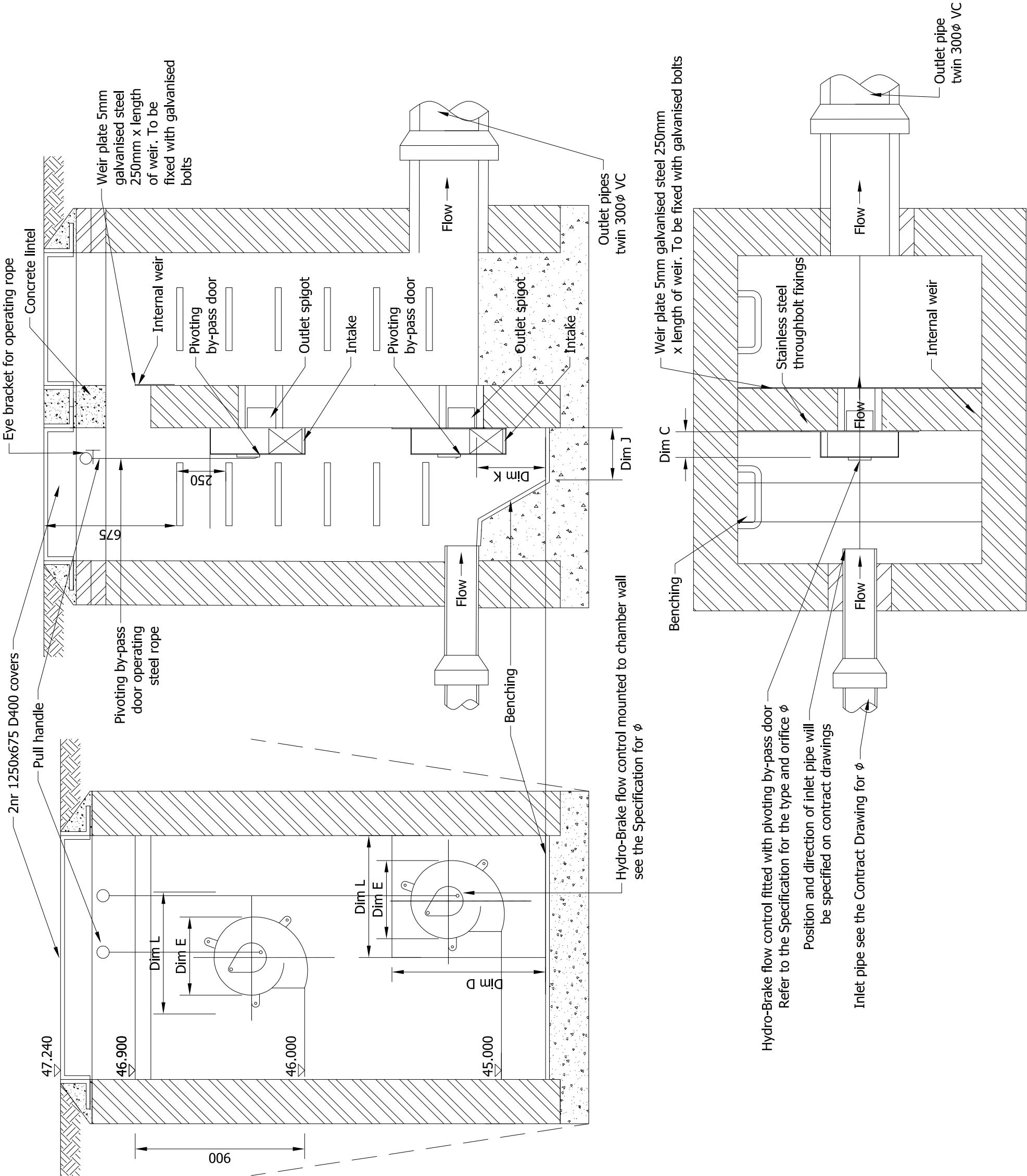
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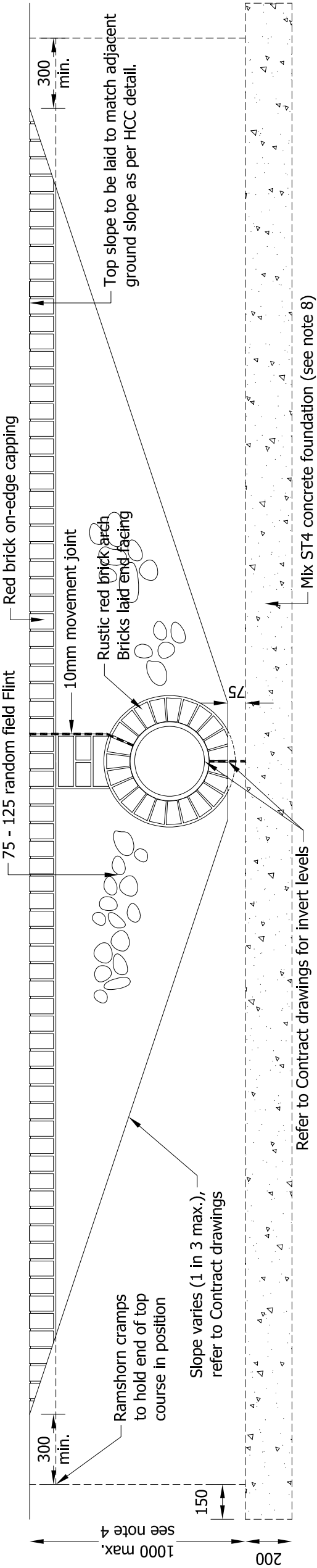


client	BEREWOOD, WATERLOOVILLE		
project	PHASE 8 INFRASTRUCTURE		
scale	NTS	drawn by	KDB
checked by	RHA	date	JANUARY 2020
cad file	503.dwg	title	TYPICAL HYDROBRAKE CHAMBER

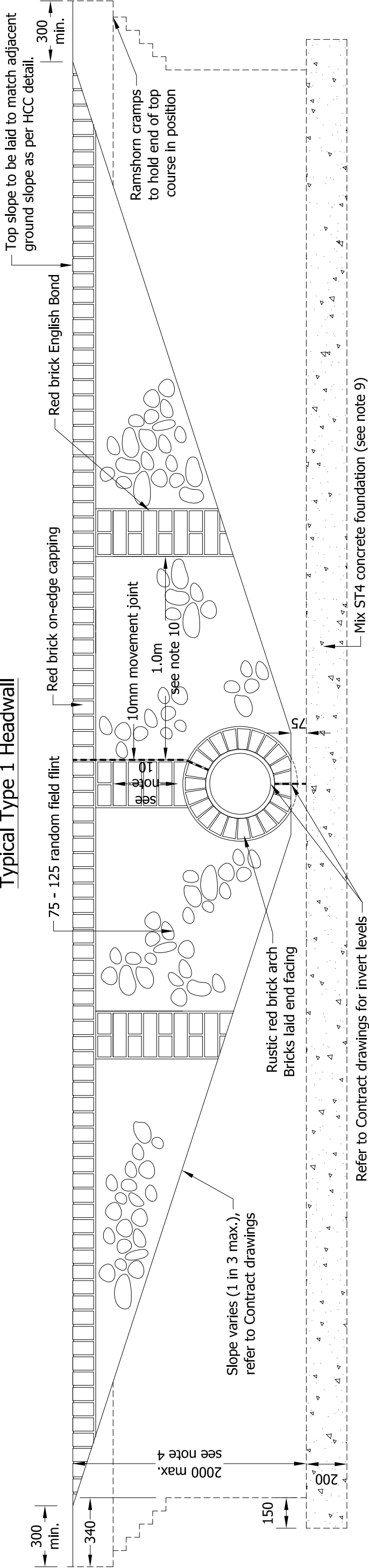
drawing number

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Typical Type 1 Headwall



Typical Type 2 Headwall

Notes:

1. All dimensions are in mm unless stated otherwise.
2. Brickwork shall be high density type Facing brick, as per the specification. Laid on class(i) mortar to Clause 2404.
3. Flint blocks may be used and to be as per the specification or approved alternative. To achieve slope on top edge or around pipe, blocks shall be neatly cut or loose flint used to infill. Flint to be pointed using natural hydraulic lime mortar (NHL5) In a 3:1 mix sharp stand : lime.
4. Wall dimensions shall be as shown on the contract drawings.
5. Unless otherwise specified backfill around headwall shall be in accordance with Clause 507.7.
6. For any ditch protection adjacent to headwall refer to Contract drawings.
7. The pipe connecting to the headwall shall have an articulated section all as Clause 507.17.
8. Joint finish to exposed brickwork shall be 'bucket handle'.
9. All cement used in insitu concrete shall be CII(A or B)-S or CIII A or B to BS 8500-2, Table 1 and Annex A.
10. See contract drawings for location of headwall.
11. Minimum width of flint panel to be 1m min./2m max.. Bricklayer shall check pattern for each wall and agree with engineer.
12. Refer to HCC details HCC10/D/090A & 095A for cross section detail.

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project



BEREWOOD, WATERLOOVILLE
PHASE 8 INFRASTRUCTURE

TYPICAL HEADWALL DETAIL
TYPE 1 AND TYPE 2

title

scale 1:20
date JANUARY 2020
drawing number

checked by RHA

KDB

drawn by

504.dwg

cad file

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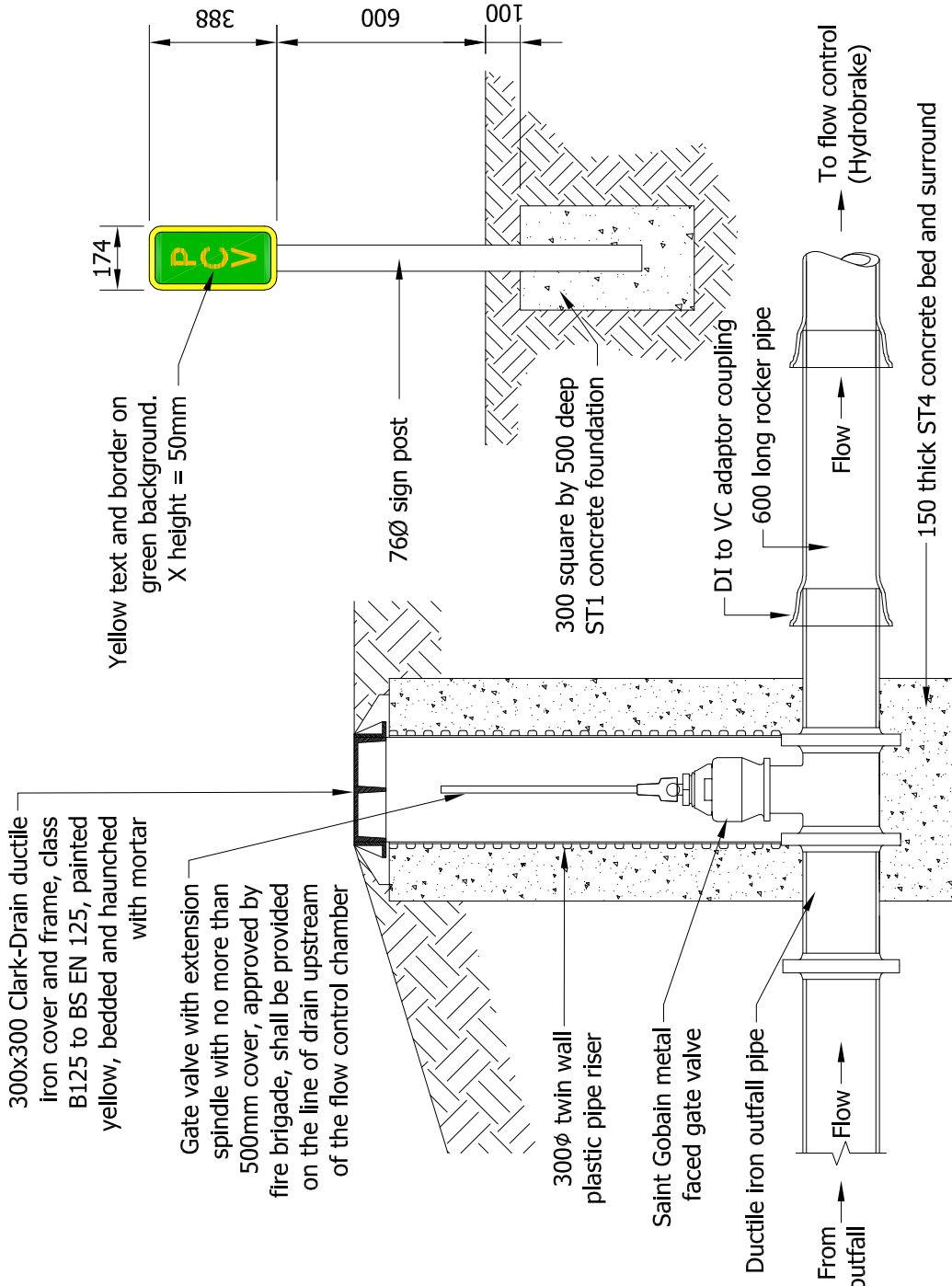
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Notes:

- 1. All dimensions are in millimetres unless stated otherwise.
- 2. Sign post to be painted black.

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drawing number	GTWVILLE_P8/CD/505				

POLLUTION SHUT OFF CHAMBER AND
POLLUTION CONTROL VALVE SIGN

client
grainger plc
project
BEREWOOD, WATERLOOVILLE
PHASE 8 INFRASTRUCTURE

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APPENDIX C: SuDS Maintenance Plan

Introduction

This document sets out the planned maintenance requirements for the (non-highways) Sustainable Drainage System (SuDS) to be maintained on Phases 8 of the Berewood Development. This plan should be reviewed and updated periodically by the adopting authority as additional experience is gained. The SuDS consist of open space features, distribution pipework and swales.

This SuDS maintenance plan shall also be read in conjunction with the Phases 8 Infrastructure Landscape design package, which is to be completed at a later date and approved as part of the same planning condition.

During the initial period after the pond has been commissioned it is advised that visual inspections are carried out monthly (for a minimum of 6 months) to determine if fly tipping or vandalism is occurring. Repairs or removal of rubbish will need to be removed where critical to the operation of the pond. It may be necessary to consider additional security measures if the above present a longer term problem.

Schedule of Open Space SuDS Maintenance Requirements

SuDS Ref	Description	Inspect flow control(s)	Inspect Shut-Off Valve	Inspect Weirs	Inspect Gratings (Inlet>375Ø)	Inspect drain down feature (gravel trench & perforated- pipe)	Remove Litter & Leaf	Mowing	Landscape Maintenance	Monitor & removal of Silt	Inspect Downstream Defender
A	Pond	HydroBrake Optimum	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes (Surface Build-up)	Yes

Activity Breakdown

Flow Controls (HydroBrakes)

Frequency – 6 Monthly Inspections

Tasks

- Remove covers to chambers and enter where safe to do to. Staff to be appropriately trained and equipped for confined entry.
- Inspect visually for damage or corrosion.
- Check for and clear any obstructions. Wash down if required.
- Check correct operation of Bypass door and handle on HydroBrakes, grease lightly if required
- File Record of Visit and Actions Taken, report any defects for repair.

Shut-Off Valves (PCV's)

Frequency – 6 Monthly Inspections

Tasks

- Remove covers & attach operating tool
- Confirm valve was previously left in the open position
- Operate Valve to fully closed and reopen
- Repeat operation 3 times and leave in fully open position
- File Record of Visit and report any defect or stiff operation for repair.

Weirs (Earth Type)

Frequency – 6 monthly or where defects reported

Tasks

- Check for excessive erosion or settlement lowering spill level
- Check for build up of vegetation or other obstructions
- File Record of Visit and report any defects for repair.

Rock Outlets

Frequency – 6 Monthly or where defects reported

Tasks

- Ensure that pipe and basket are covered by rocks as intended.
- Reposition or replace any rocks that have been removed.
- Check for and clear any debris or self sown vegetation caught between the rocks.
- File Record of Visit and report any defects for repair.

Landscape Maintenance

Frequency – As Specified in the Landscape Management Plan

- The Contractor shall regularly inspect and maintain SuDS features to ensure their effective operation as designed. Regular mowing in and around detention basins is required only along maintenance access routes, amenity areas (e.g. footpaths), across embankments and main storage area. The remaining areas can be managed as damp meadow grass, unless additional management is required for landscaping purposes.
- Management of vegetation and removal of nuisance plants.
- Remove sediment from inlets, outlet and fore bay. Tidy all dead growth before start of growing season.
- Repair erosion or other damage by re-seeding or re-turfing. Realignment of rip-rap, repair and rehabilitation of inlets, outlets and overflows, re-level uneven surfaces and reinstate design levels as required.

Silt Monitoring & Removal

Frequency – Monitor Annually, Remove as required (Assumed 5 yearly)

Tasks

- Take measurements and record depths of silt annually in pool areas of SuDS

- Arrange Removal of Silts in deep pools, where average depth is approximately 100mm, and a maximum not exceeding 300mm. Before desilting a particular pond it should be trapped and netted out for amphibians and macro-invertebrates which should be transferred to a nearby pond assuming no fish are present.
- Remove silts in dry basins where it threatens to restrict the capacity of inlets or outlets or is unsightly.
- NOTE - Sediments excavated from detention basins that receive runoff from residential or standard road and roof areas are generally not toxic or hazardous material and can therefore be safely disposed of by either land application or land filling. However, consultation should take place with the environmental regulator to confirm appropriate protocols. Sediment testing may be required before sediment excavation to determine its classification and appropriate disposal methods. In the majority of cases it will be acceptable to distribute the sediment on site if there is an appropriate safe and acceptable location to do so.

Vortex separators

Frequency – 6 monthly

Tasks

- Remove covers and inspect from the surface- **DO NOT ENTER CHAMBER**
- Floatable debris can be removed with a net
- Measure and record the depth of sediment and oil. The first few visits will determine future emptying intervals
- Remove oils and sediment using a vacuum tanker where necessary.
- File Record of Visit and report any defects for repair.

SuDS Ancillaries

In Addition to the open space SuDS and associated maintenance activities as listed above, there are a number of other items requiring periodic inspection and maintenance as follows:

Pipes

Frequency –Annual visit initially, then adjust as necessary

Tasks

- CCTV survey and jetting of areas of sediment build-up, repeat after 1 year.

West of Waterloooville MDA – Berewood Phase 8 Infrastructure
Sustainable Drainage Maintenance Plan

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- Re-jet Jet identified sedimentation areas on a cycle as determined
- CCTV survey on a 10 year cycle to identify blockages and structural defects.

Chambers

Frequency –Annual Surface Inspection, below ground inspection as above

Tasks

- Visual inspection of covers and frames to identify defects on an annual basis
- View internal chamber structure when CCTV surveys of pipework are carried out to identify structural defects or maintenance issues.

Signage

Frequency – 6 monthly

Tasks

- Check that pollution shut-off signage is intact.
- Clean sign face with soapy water
- Report any defects for repair

Fencing

Frequency – 6 monthly

Tasks

- Check that fencing is intact and secure, check for signs of corrosion / rot.
- Report any defects for repair or replacement

