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GRAINGER PLC
PHASES 3B
BEREWOOD, WATERLOOVILLE

SUDS DESIGN DOCUMENT

MARCH 2020

the journey is the reward

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Project Code:	**GTWVILLEP_3B**
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Issue Date:	**9TH March 2020**
Status:	**Issue 02**
Document Code:	**GTWVILLEP_3B_DOC_DR_01**

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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 3B 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), which forms part of the Berewood outline planning consent.

1.2 This document is aimed at a technical reader with experience in the design of Sustainable Drainage Features.

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 3B residential areas is shown on Dwg. GTWVILLE_P3BI/SK/02 in Appendix B. The development proposals are for the construction of 162 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 were for combined system with the Phase 8 Development. Design proposals have been updated to reflect available capacity in the SuDs features provided for Phase 1 and changes in the Phase 8 SuDS strategy.

2 Existing Condition

Topography

2.1 A topographical survey of the existing site was undertaken by Mayer Brown Ltd in November 2016. The site slopes predominantly from the south to the north. Ground levels range from approximately 51.6mAOD to 45.50 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 ditch along the northern boundary of Phase 3B, which discharges to the existing as-built SuDs system for Phase 3I to the west and to an existing piped outfall to the east.

2.5 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.

Existing and Proposed impermeable area on site

2.6 Pre-development, there was no impermeable area within the site. 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.

2.7 Both of the SUDS features are located outside of the Phase 3B boundary, so these have been included but at a 90% impermeable area coverage. This is outlined in Table 2.1 below.

2.8 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, a 10% increase in the impermeable area has been allowed for 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)*
Ph3B	3.66	0	2.38	2.62
SuDS outside boundary	0.20	0	0.18	0.18
Total	3.86		2.56	2.8

* Includes a 10% increase for 'Urban Creep'

Table 2.1: Surface cover – existing and proposed

Figure 2.1 – Phase 3B Existing Flood Flow Analysis

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 QBAR rate 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 rate 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.

3.2 Dwg GTWVILLE_P3BI/SK/03 in Appendix B, shows the proposed SuDs provisions.

3.3 Phase 3B is split into 5 catchments which are 3A, 3B, 3C, 3D and 3E. An allowance has been made in the Phase 1 SuDS for a large amount of the Phase 3B catchment. The Drainage Strategy for Phase 1 (Reference SUDS Design Document, Phase 1 Infrastructure, Newlands, Waterlooville – 2nd February 2012) was prepared in February 2012 as part of the Planning Application for Phase 1 of the Berewood Development. A copy of the report is contained in Appendix D. The Phase 1 SuDs features have been designed to accommodate Catchments 3B, 3C, 3D and 3E. Specifically, Dwg. GTWVILLE3/DR/03 refers to these plots as Future Plots A27, A28, A29 and 30.

3.4 Catchment 3A is attenuated through SuDS pond A. The pond will be fitted with a flow control device, which will restrict flows to the proportional greenfield run-off rate for the catchment. Discharge from the pond will be into an existing ditch which forms part of the ditch network downstream. These ditches have been replaced where required with swales and other SuDs features in accordance with the overall Berewood drainage strategy (Document Ref. Proposed Outline SuDs Strategy Document October 2010).

3.5 Catchments 3B, 3C, 3D and 3E all have an allowance made from their attenuation in the Phase 1 Drainage. Catchment 3B, 3C and 3E discharge directly into the existing network. Catchment 3D has a SuDS pond which discharges into the existing system at 5l/s though a flow control device. Following further detailed design development the original proposed pond (Indicated on Dwg GTWVILLE3/DR03) has been increased in size. The discharge rate has has stayed as originally proposed at 5l/s.

3.6 The ponds 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 if there is a blockage in the system. The Windes Microdrainage model indicates the overflow system will not be utilised during a 1 in 100 year storm event plus 40% climate change.

3.7 The drained areas and their related SuDs feature are identified on Dwg. GTWVILLE_P3BI/SK/03 in Appendix B and in Table 3.1 below. Table 3.1 also indicates the greenfield run-off rate for each catchment.

SuDS Ref	Catchment Ref	Catchment Area(Ha)	Effective Impermeable Area (Ha)	Greenfield Run-Off Rate (l/s)	Location
Pond A	3A	1.221	0.873	6.2	Located within Town Park Phase 2
	Pond A	0.118	0.106	0.6	
	Total	**1.339**	**0.979**	**6.8**	
Pond B	3D	0.844	0.603	4.3	Adjacent Laxton Leaze
	Pond B	0.082	0.074	0.4	
	Total	**0.926**	**0.677**	**4.7**	
Phase 1 SuDS	3B	0.245	0.175	1.2	Phase 1 SuDS
	3C	0.535	0.383	2.7	
	3E	0.817	0.584	4.1	
	Total	**1.597**	**1.142**	**8.0**	
	Total	**3.862**	**2.798**	**19.5**	

Table 3.1: Catchment Areas and Related SuDs Features

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:

C(1km) = -0.027 D1(1km) = 0.461 D2(1km) =0.293
D3(1km) = 0.380 E(1km) = 0.306 F(1km) = 2.247

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 Phases 3B and Phase 8 are 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.

4 Network Details

4.1 The proposed strategic surface water drainage scheme has been modelled using Windes Source Control. Storage ponds have been modelled using the 'Cascade' feature to recognise the utilisation of the overflow facilities when necessary.

Controls

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 Drawings showing the surface water drainage layout are contained within Appendix B.

4.4 Ponds have been designed to have side slopes of 1 in 3.

4.5 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.

4.6 Table 4.1 overleaf shows the respective pond sizes and discharge properties for each of the SuDs features.

4.7 The intention is that LEEP Utilties will adopt the SuDS features. For SuDS which are purely for highway drainage, the intention is that Hampshire County Council will be the adopting organisation. 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)	Overflow	Hydro-brake optimum® reference
A	1178	819	1.5	6.8	Weir	MD-SHE-0114-6800-1500-6800
B	821	558	1.5	5.0	Weir	MD-SHE-0098-5000-1500-5000

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. Overflows provided in pond was utilised.

5.3 Discharge rate for the most critical rainfall event of 600min winter would be 6.5l/s.

5.4 Maximum pond depth would be 0.289m

5.5 No flooding reported.

Pond A 1 in 30 Year FEH

5.6 All pipework and SuDS features operating to expectations. Overflows provided in pond was utilised.

5.7 Discharge rate for the most critical rainfall event of 720min winter would be 6.8l/s.

5.8 Maximum pond depth would be 0.769m

5.9

5.10 No flooding reported.

Pond A in 100 +40% Climate Change Year FEH

5.11 All pipework and SuDS features operating to expectations. Overflows provided in pond was utilised.

5.12 Discharge rate for the most critical rainfall event of 720min winter would be 6.8l/s.

5.13 Maximum pond depth would be 1.466m

5.14 No flooding reported.

Pond B 1 in 1 Year FEH

5.15 All pipework and SuDS features operating to expectations. Overflows provided in pond was utilised.

5.16 Discharge rate for the most critical rainfall event of 480min winter would be 4.8l/s.

5.17 Maximum pond depth would be 0.302m

5.18 No flooding reported.

Pond B 1 in 30 Year FEH

5.19 All pipework and SuDS features operating to expectations. Overflows provided in pond was utilised.

5.20 Discharge rate for the most critical rainfall event of 720min winter would be 4.9l/s.

5.21 Maximum pond depth would be 0.805m

5.22 No flooding reported.

Pond B in 100 +40% Climate Change Year FEH

5.23 All pipework and SuDS features operating to expectations. Overflows provided in pond was utilised.

5.24 Discharge rate for the most critical rainfall event of 720min winter would be 4.9l/s.

5.25 Maximum pond depth would be 1.444m

5.26 No flooding reported.

Catchment Ref	Permitted discharge rate (l/s)	Max Discharges for different Return Periods (years) (l/s)		
		1 in 1	1 in 30	1in 100+40%
Pond A	6.8	6.5	6.8	6.8
Pond B	5	4.8	4.9	4.9
Total	**11.8**	**11.3**	**11.7**	**11.7**

Table 5.1: Maximum Discharges for Different return periods

5.27 Tables 5.1 above shows the summary of peak discharge rates for different return periods. The total for the peak discharge rates for a 1 in 100 + 40CC storm event does not exceed the allowable greenfield runoff rate for Pond A or the allowable rate into the Phase 1 drainage for Pond B.

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.

6.2 The SuDS features were tested with a 1 in 200 year storm event.

SuDS Pond A

6.3 Pond A is located in the Town Park area. It has an overflow weir installed which can be used in an exceedance event or a blockage in the outfall..

6.4 When simulated in Microdrage with a blocked outfall, the overflow weir was utilised. The maximum discharge rate was 7.2l/s for a 4320 minute winter event.

SuDS Pond B

6.5 Pond B is located in the North end of the Phase 3B development next to Laxton Leaze. It has an overflow weir installed which can be used in an exceedance event or a blockage in the outfall.

6.6 When simulated in Microdrage with a blocked outfall, the overflow weir was utilised. The maximum discharge rate was 5.5l/s for a 2160 minute winter event.

6.7 The results for all systems can be seen in Table 6.1.

Blocked SuDS Pond	Overflow	Max Overflow Discharge Rate (l/s)	Flooding Comments
Pond A	Ditch	7.2	No Flooding of the SuDS Pond
Pond B	Phase 1 Drainage Network	5.5	No Flooding of the SuDS Pond
	Total	**12.7**	

Table 6.1 – Blockage Analysis results

6.8 The analysis shows that there is sufficient capacity in the SuDS overflow features to deal with a blockage in the outfalls of a SuDS feature. It also shows that the extra overflow volume which enters, in general, the next SuDS feature downstream, can be accounted for without flooding the SuDS features.

7 Maintenance

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 3B main network will be equal to the equivalent QBAR greenfield run-off rate for critical rainfall events. For all other events the total discharge rate will be significantly less, thus provide betterment to the existing condition. Therefore, it can be stated that the strategic SuDS design is operating within the accepted design criteria.

APPENDIX A: Calculations and Data

All 1 in 100yr +40CC pdf files
All 1 in 30yr pdf files
All 1 in 1yr pdf files
Blocked Outfall PDF Files

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
15 min Summer	46.099	0.099	3.9	0.0	3.9	34.7	O K
30 min Summer	46.128	0.128	5.2	0.0	5.2	45.5	O K
60 min Summer	46.162	0.162	5.8	0.0	5.8	58.1	O K
120 min Summer	46.198	0.198	6.1	0.0	6.1	71.8	O K
180 min Summer	46.220	0.220	6.2	0.0	6.2	80.4	O K
240 min Summer	46.235	0.235	6.3	0.0	6.3	86.4	O K
360 min Summer	46.254	0.254	6.4	0.0	6.4	93.9	O K
480 min Summer	46.264	0.264	6.5	0.0	6.5	97.9	O K
600 min Summer	46.269	0.269	6.5	0.0	6.5	100.0	O K
720 min Summer	46.271	0.271	6.5	0.0	6.5	100.8	O K
960 min Summer	46.254	0.254	6.4	0.0	6.4	93.8	O K
1440 min Summer	46.220	0.220	6.2	0.0	6.2	80.5	O K
2160 min Summer	46.179	0.179	5.9	0.0	5.9	64.7	O K
2880 min Summer	46.150	0.150	5.6	0.0	5.6	53.7	O K
4320 min Summer	46.124	0.124	5.0	0.0	5.0	43.9	O K
5760 min Summer	46.109	0.109	4.4	0.0	4.4	38.3	O K
7200 min Summer	46.099	0.099	4.0	0.0	4.0	34.7	O K
8640 min Summer	46.092	0.092	3.6	0.0	3.6	32.2	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	34.4	0.0	22
30 min Summer	13.717	0.0	48.1	0.0	36
60 min Summer	9.440	0.0	68.2	0.0	64
120 min Summer	6.497	0.0	94.3	0.0	102
180 min Summer	5.222	0.0	113.8	0.0	136
240 min Summer	4.472	0.0	130.1	0.0	172
360 min Summer	3.594	0.0	157.0	0.0	244
480 min Summer	3.078	0.0	179.5	0.0	314
600 min Summer	2.729	0.0	199.0	0.0	384
720 min Summer	2.474	0.0	216.5	0.0	452
960 min Summer	2.016	0.0	235.3	0.0	584
1440 min Summer	1.511	0.0	264.3	0.0	840
2160 min Summer	1.133	0.0	298.6	0.0	1196
2880 min Summer	0.923	0.0	324.4	0.0	1556
4320 min Summer	0.717	0.0	377.1	0.0	2252
5760 min Summer	0.599	0.0	421.7	0.0	2952
7200 min Summer	0.521	0.0	458.5	0.0	3680
8640 min Summer	0.465	0.0	490.8	0.0	4408

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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
10080 min Summer	46.086	0.086	3.3	0.0	3.3	30.2	O K
15 min Winter	46.110	0.110	4.5	0.0	4.5	38.8	O K
30 min Winter	46.144	0.144	5.6	0.0	5.6	51.2	O K
60 min Winter	46.183	0.183	6.0	0.0	6.0	65.9	O K
120 min Winter	46.222	0.222	6.2	0.0	6.2	81.2	O K
180 min Winter	46.245	0.245	6.4	0.0	6.4	90.3	O K
240 min Winter	46.260	0.260	6.4	0.0	6.4	96.5	O K
360 min Winter	46.277	0.277	6.5	0.0	6.5	103.3	O K
480 min Winter	46.284	0.284	6.5	0.0	6.5	106.1	O K
600 min Winter	46.285	0.285	6.5	0.0	6.5	106.6	O K
720 min Winter	46.283	0.283	6.5	0.0	6.5	105.8	O K
960 min Winter	46.255	0.255	6.4	0.0	6.4	94.3	O K
1440 min Winter	46.204	0.204	6.1	0.0	6.1	74.1	O K
2160 min Winter	46.149	0.149	5.6	0.0	5.6	53.3	O K
2880 min Winter	46.123	0.123	5.0	0.0	5.0	43.5	O K
4320 min Winter	46.100	0.100	4.0	0.0	4.0	35.2	O K
5760 min Winter	46.088	0.088	3.4	0.0	3.4	30.9	O K
7200 min Winter	46.081	0.081	3.0	0.0	3.0	28.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
10080 min Summer	0.422	0.0	519.4	0.0	5144
15 min Winter	19.930	0.0	38.8	0.0	22
30 min Winter	13.717	0.0	54.1	0.0	35
60 min Winter	9.440	0.0	76.5	0.0	64
120 min Winter	6.497	0.0	105.7	0.0	116
180 min Winter	5.222	0.0	127.6	0.0	146
240 min Winter	4.472	0.0	145.9	0.0	186
360 min Winter	3.594	0.0	176.0	0.0	264
480 min Winter	3.078	0.0	201.1	0.0	342
600 min Winter	2.729	0.0	223.0	0.0	416
720 min Winter	2.474	0.0	242.6	0.0	488
960 min Winter	2.016	0.0	263.7	0.0	622
1440 min Winter	1.511	0.0	296.3	0.0	882
2160 min Winter	1.133	0.0	334.5	0.0	1220
2880 min Winter	0.923	0.0	363.4	0.0	1560
4320 min Winter	0.717	0.0	422.6	0.0	2256
5760 min Winter	0.599	0.0	472.4	0.0	2992
7200 min Winter	0.521	0.0	513.6	0.0	3680

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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
8640 min Winter	46.075	0.075	2.7	0.0	2.7	26.1	O K
10080 min Winter	46.071	0.071	2.4	0.0	2.4	24.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
8640 min Winter	0.465	0.0	549.8	0.0	4408
10080 min Winter	0.422	0.0	582.0	0.0	5144

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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) 0.979

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.000	4	8	0.979

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Model Details

Storage is Online Cover Level (m) 47.600

Tank or Pond Structure

Invert Level (m) 46.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	339.2	1.500	783.4	1.600	817.6

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0114-6800-1500-6800
Design Head (m)	1.500
Design Flow (l/s)	6.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	114
Invert Level (m)	46.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	6.8	Kick-Flo®	0.916	5.4
Flush-Flo™	0.444	6.8	Mean Flow over Head Range	-	5.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.0	1.200	6.1	3.000	9.4	7.000	14.1
0.200	6.1	1.400	6.6	3.500	10.1	7.500	14.6
0.300	6.6	1.600	7.0	4.000	10.8	8.000	15.0
0.400	6.7	1.800	7.4	4.500	11.4	8.500	15.5
0.500	6.7	2.000	7.8	5.000	12.0	9.000	15.9
0.600	6.6	2.200	8.1	5.500	12.5	9.500	16.3
0.800	6.1	2.400	8.5	6.000	13.1		
1.000	5.6	2.600	8.8	6.500	13.6		

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Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 47.500

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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
15 min Summer	46.298	0.298	6.6	0.0	6.6	111.8	O K
30 min Summer	46.369	0.369	6.7	0.0	6.7	141.8	O K
60 min Summer	46.449	0.449	6.8	0.0	6.8	177.1	O K
120 min Summer	46.533	0.533	6.8	0.0	6.8	216.0	O K
180 min Summer	46.579	0.579	6.8	0.0	6.8	238.3	O K
240 min Summer	46.608	0.608	6.8	0.0	6.8	252.8	O K
360 min Summer	46.642	0.642	6.8	0.0	6.8	269.6	O K
480 min Summer	46.662	0.662	6.8	0.0	6.8	280.2	O K
600 min Summer	46.675	0.675	6.8	0.0	6.8	286.9	O K
720 min Summer	46.684	0.684	6.8	0.0	6.8	291.2	O K
960 min Summer	46.653	0.653	6.8	0.0	6.8	275.3	O K
1440 min Summer	46.592	0.592	6.8	0.0	6.8	244.6	O K
2160 min Summer	46.505	0.505	6.8	0.0	6.8	203.2	O K
2880 min Summer	46.428	0.428	6.8	0.0	6.8	167.9	O K
4320 min Summer	46.328	0.328	6.6	0.0	6.6	124.4	O K
5760 min Summer	46.254	0.254	6.4	0.0	6.4	93.9	O K
7200 min Summer	46.202	0.202	6.1	0.0	6.1	73.3	O K
8640 min Summer	46.166	0.166	5.8	0.0	5.8	59.4	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	113.6	0.0	22
30 min Summer	40.885	0.0	147.3	0.0	37
60 min Summer	26.412	0.0	192.7	0.0	66
120 min Summer	17.062	0.0	249.2	0.0	126
180 min Summer	13.214	0.0	289.7	0.0	184
240 min Summer	11.023	0.0	322.2	0.0	244
360 min Summer	8.536	0.0	374.5	0.0	326
480 min Summer	7.121	0.0	416.5	0.0	392
600 min Summer	6.186	0.0	452.4	0.0	462
720 min Summer	5.515	0.0	483.9	0.0	530
960 min Summer	4.378	0.0	512.1	0.0	660
1440 min Summer	3.162	0.0	554.6	0.0	928
2160 min Summer	2.284	0.0	602.9	0.0	1324
2880 min Summer	1.813	0.0	638.0	0.0	1704
4320 min Summer	1.357	0.0	715.3	0.0	2424
5760 min Summer	1.104	0.0	777.9	0.0	3112
7200 min Summer	0.941	0.0	828.8	0.0	3816
8640 min Summer	0.826	0.0	872.6	0.0	4496

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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
10080 min Summer	46.141	0.141	5.5	0.0	5.5	50.3	O K
15 min Winter	46.331	0.331	6.7	0.0	6.7	125.6	O K
30 min Winter	46.409	0.409	6.7	0.0	6.7	159.5	O K
60 min Winter	46.498	0.498	6.8	0.0	6.8	199.9	O K
120 min Winter	46.593	0.593	6.8	0.0	6.8	245.5	O K
180 min Winter	46.648	0.648	6.8	0.0	6.8	272.7	O K
240 min Winter	46.684	0.684	6.8	0.0	6.8	291.2	O K
360 min Winter	46.727	0.727	6.8	0.0	6.8	313.9	O K
480 min Winter	46.749	0.749	6.8	0.0	6.8	325.9	O K
600 min Winter	46.760	0.760	6.8	0.0	6.8	331.8	O K
720 min Winter	46.769	0.769	6.8	0.0	6.8	336.4	O K
960 min Winter	46.728	0.728	6.8	0.0	6.8	314.5	O K
1440 min Winter	46.640	0.640	6.8	0.0	6.8	268.6	O K
2160 min Winter	46.510	0.510	6.8	0.0	6.8	205.3	O K
2880 min Winter	46.396	0.396	6.7	0.0	6.7	153.7	O K
4320 min Winter	46.256	0.256	6.4	0.0	6.4	94.7	O K
5760 min Winter	46.173	0.173	5.9	0.0	5.9	62.1	O K
7200 min Winter	46.132	0.132	5.3	0.0	5.3	47.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
10080 min Summer	0.740	0.0	911.0	0.0	5152
15 min Winter	63.289	0.0	127.5	0.0	22
30 min Winter	40.885	0.0	165.2	0.0	37
60 min Winter	26.412	0.0	215.9	0.0	66
120 min Winter	17.062	0.0	279.2	0.0	124
180 min Winter	13.214	0.0	324.5	0.0	182
240 min Winter	11.023	0.0	361.0	0.0	238
360 min Winter	8.536	0.0	419.5	0.0	350
480 min Winter	7.121	0.0	466.6	0.0	456
600 min Winter	6.186	0.0	506.7	0.0	540
720 min Winter	5.515	0.0	542.0	0.0	576
960 min Winter	4.378	0.0	573.6	0.0	724
1440 min Winter	3.162	0.0	621.1	0.0	1014
2160 min Winter	2.284	0.0	675.3	0.0	1428
2880 min Winter	1.813	0.0	714.7	0.0	1792
4320 min Winter	1.357	0.0	801.4	0.0	2472
5760 min Winter	1.104	0.0	871.3	0.0	3120
7200 min Winter	0.941	0.0	928.3	0.0	3744

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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
8640 min Winter	46.116	0.116	4.7	0.0	4.7	41.0	O K
10080 min Winter	46.105	0.105	4.2	0.0	4.2	37.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
8640 min Winter	0.826	0.0	977.5	0.0	4416
10080 min Winter	0.740	0.0	1020.7	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) 0.979

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.000	4	8	0.979

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Model Details

Storage is Online Cover Level (m) 47.600

Tank or Pond Structure

Invert Level (m) 46.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	339.2	1.500	783.4	1.600	817.6

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0114-6800-1500-6800
Design Head (m)	1.500
Design Flow (l/s)	6.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	114
Invert Level (m)	46.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	6.8	Kick-Flo®	0.916	5.4
Flush-Flo™	0.444	6.8	Mean Flow over Head Range	-	5.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.0	1.200	6.1	3.000	9.4	7.000	14.1
0.200	6.1	1.400	6.6	3.500	10.1	7.500	14.6
0.300	6.6	1.600	7.0	4.000	10.8	8.000	15.0
0.400	6.7	1.800	7.4	4.500	11.4	8.500	15.5
0.500	6.7	2.000	7.8	5.000	12.0	9.000	15.9
0.600	6.6	2.200	8.1	5.500	12.5	9.500	16.3
0.800	6.1	2.400	8.5	6.000	13.1		
1.000	5.6	2.600	8.8	6.500	13.6		

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Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 47.500

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Summary of Results for 100 year Return Period (+40%)

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	46.584	0.584	6.8	0.0	6.8	241.1	O K
30 min Summer	46.703	0.703	6.8	0.0	6.8	301.3	O K
60 min Summer	46.837	0.837	6.8	0.0	6.8	374.1	O K
120 min Summer	46.983	0.983	6.8	0.0	6.8	459.8	O K
180 min Summer	47.069	1.069	6.8	0.0	6.8	513.6	O K
240 min Summer	47.128	1.128	6.8	0.0	6.8	551.9	O K
360 min Summer	47.206	1.206	6.8	0.0	6.8	603.5	O K
480 min Summer	47.253	1.253	6.8	0.0	6.8	636.0	O K
600 min Summer	47.283	1.283	6.8	0.0	6.8	657.1	O K
720 min Summer	47.302	1.302	6.8	0.0	6.8	670.5	Flood Risk
960 min Summer	47.263	1.263	6.8	0.0	6.8	643.2	O K
1440 min Summer	47.195	1.195	6.8	0.0	6.8	596.6	O K
2160 min Summer	47.109	1.109	6.8	0.0	6.8	538.9	O K
2880 min Summer	47.028	1.028	6.8	0.0	6.8	487.8	O K
4320 min Summer	46.911	0.911	6.8	0.0	6.8	416.9	O K
5760 min Summer	46.773	0.773	6.8	0.0	6.8	338.7	O K
7200 min Summer	46.651	0.651	6.8	0.0	6.8	274.3	O K
8640 min Summer	46.543	0.543	6.8	0.0	6.8	221.2	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	242.9	0.0	23
30 min Summer	84.742	0.0	306.9	0.0	38
60 min Summer	53.513	0.0	391.3	0.0	68
120 min Summer	33.792	0.0	494.3	0.0	128
180 min Summer	25.824	0.0	566.6	0.0	186
240 min Summer	21.339	0.0	624.2	0.0	246
360 min Summer	16.307	0.0	715.2	0.0	366
480 min Summer	13.475	0.0	787.5	0.0	486
600 min Summer	11.621	0.0	848.1	0.0	604
720 min Summer	10.298	0.0	900.5	0.0	724
960 min Summer	8.098	0.0	941.2	0.0	858
1440 min Summer	5.772	0.0	977.9	0.0	1098
2160 min Summer	4.114	0.0	1086.2	0.0	1496
2880 min Summer	3.235	0.0	1138.7	0.0	1908
4320 min Summer	2.389	0.0	1260.5	0.0	2732
5760 min Summer	1.926	0.0	1357.1	0.0	3464
7200 min Summer	1.630	0.0	1435.4	0.0	4184
8640 min Summer	1.422	0.0	1502.6	0.0	4848

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Summary of Results for 100 year Return Period (+40%)

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
10080 min Summer	46.453	0.453	6.8	0.0	6.8	178.8	O K
15 min Winter	46.643	0.643	6.8	0.0	6.8	270.6	O K
30 min Winter	46.773	0.773	6.8	0.0	6.8	338.7	O K
60 min Winter	46.919	0.919	6.8	0.0	6.8	421.5	O K
120 min Winter	47.078	1.078	6.8	0.0	6.8	519.0	O K
180 min Winter	47.172	1.172	6.8	0.0	6.8	580.9	O K
240 min Winter	47.238	1.238	6.8	0.0	6.8	625.9	O K
360 min Winter	47.326	1.326	6.8	0.0	6.8	688.1	Flood Risk
480 min Winter	47.382	1.382	6.8	0.0	6.8	729.2	Flood Risk
600 min Winter	47.420	1.420	6.8	0.0	6.8	757.5	Flood Risk
720 min Winter	47.446	1.446	6.8	0.0	6.8	777.3	Flood Risk
960 min Winter	47.412	1.412	6.8	0.0	6.8	751.5	Flood Risk
1440 min Winter	47.332	1.332	6.8	0.0	6.8	692.1	Flood Risk
2160 min Winter	47.224	1.224	6.8	0.0	6.8	616.4	O K
2880 min Winter	47.117	1.117	6.8	0.0	6.8	544.3	O K
4320 min Winter	46.942	0.942	6.8	0.0	6.8	435.4	O K
5760 min Winter	46.715	0.715	6.8	0.0	6.8	307.8	O K
7200 min Winter	46.530	0.530	6.8	0.0	6.8	215.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
10080 min Summer	1.267	0.0	1561.2	0.0	5552
15 min Winter	134.198	0.0	272.1	0.0	23
30 min Winter	84.742	0.0	343.5	0.0	37
60 min Winter	53.513	0.0	438.3	0.0	66
120 min Winter	33.792	0.0	553.6	0.0	126
180 min Winter	25.824	0.0	634.6	0.0	184
240 min Winter	21.339	0.0	698.9	0.0	242
360 min Winter	16.307	0.0	800.6	0.0	358
480 min Winter	13.475	0.0	880.8	0.0	474
600 min Winter	11.621	0.0	947.2	0.0	588
720 min Winter	10.298	0.0	1001.8	0.0	698
960 min Winter	8.098	0.0	1030.1	0.0	916
1440 min Winter	5.772	0.0	1000.8	0.0	1156
2160 min Winter	4.114	0.0	1216.5	0.0	1608
2880 min Winter	3.235	0.0	1275.4	0.0	2076
4320 min Winter	2.389	0.0	1411.5	0.0	2984
5760 min Winter	1.926	0.0	1520.0	0.0	3688
7200 min Winter	1.630	0.0	1607.8	0.0	4328

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Summary of Results for 100 year Return Period (+40%)

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
8640 min Winter	46.385	0.385	6.7	0.0	6.7	149.0	O K
10080 min Winter	46.284	0.284	6.5	0.0	6.5	106.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
8640 min Winter	1.422	0.0	1683.0	0.0	4936
10080 min Winter	1.267	0.0	1748.9	0.0	5552

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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) 0.979

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.000	4	8	0.979

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Model Details

Storage is Online Cover Level (m) 47.600

Tank or Pond Structure

Invert Level (m) 46.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	339.2	1.500	783.4	1.600	817.6

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0114-6800-1500-6800
Design Head (m)	1.500
Design Flow (l/s)	6.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	114
Invert Level (m)	46.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	6.8	Kick-Flo®	0.916	5.4
Flush-Flo™	0.444	6.8	Mean Flow over Head Range	-	5.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.0	1.200	6.1	3.000	9.4	7.000	14.1
0.200	6.1	1.400	6.6	3.500	10.1	7.500	14.6
0.300	6.6	1.600	7.0	4.000	10.8	8.000	15.0
0.400	6.7	1.800	7.4	4.500	11.4	8.500	15.5
0.500	6.7	2.000	7.8	5.000	12.0	9.000	15.9
0.600	6.6	2.200	8.1	5.500	12.5	9.500	16.3
0.800	6.1	2.400	8.5	6.000	13.1		
1.000	5.6	2.600	8.8	6.500	13.6		

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Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 47.500

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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
15 min Summer	46.547	0.547	0.0	0.0	0.0	223.1	O K
30 min Summer	46.658	0.658	0.0	0.0	0.0	278.2	O K
60 min Summer	46.788	0.788	0.0	0.0	0.0	346.7	O K
120 min Summer	46.937	0.937	0.0	0.0	0.0	432.3	O K
180 min Summer	47.035	1.035	0.0	0.0	0.0	491.7	O K
240 min Summer	47.108	1.108	0.0	0.0	0.0	538.8	O K
360 min Summer	47.219	1.219	0.0	0.0	0.0	613.0	O K
480 min Summer	47.303	1.303	0.0	0.0	0.0	671.7	Flood Risk
600 min Summer	47.371	1.371	0.0	0.0	0.0	721.1	Flood Risk
720 min Summer	47.429	1.429	0.0	0.0	0.0	764.1	Flood Risk
960 min Summer	47.472	1.472	0.0	0.0	0.0	796.9	Flood Risk
1440 min Summer	47.515	1.515	0.0	3.1	3.1	830.4	Flood Risk
2160 min Summer	47.514	1.514	0.0	2.9	2.9	830.1	Flood Risk
2880 min Summer	47.514	1.514	0.0	2.7	2.7	829.9	Flood Risk
4320 min Summer	47.517	1.517	0.0	3.9	3.9	832.6	Flood Risk
5760 min Summer	47.520	1.520	0.0	4.7	4.7	834.6	Flood Risk
7200 min Summer	47.521	1.521	0.0	5.1	5.1	835.2	Flood Risk
8640 min Summer	47.521	1.521	0.0	5.1	5.1	835.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	121.554	0.0	0.1	0.0	23
30 min Summer	75.766	0.0	0.1	0.0	38
60 min Summer	47.225	0.0	0.3	0.0	68
120 min Summer	29.436	0.0	0.3	0.0	128
180 min Summer	22.325	0.0	0.4	0.0	188
240 min Summer	18.347	0.0	0.4	0.0	248
360 min Summer	13.915	0.0	0.4	0.0	368
480 min Summer	11.436	0.0	0.4	0.0	488
600 min Summer	9.822	0.0	0.4	0.0	608
720 min Summer	8.673	0.0	0.4	0.0	728
960 min Summer	6.784	0.0	0.4	0.0	968
1440 min Summer	4.799	0.0	26.6	26.2	1444
2160 min Summer	3.394	0.0	78.5	77.7	1844
2880 min Summer	2.655	0.0	116.9	116.1	2220
4320 min Summer	1.945	0.0	209.4	208.7	2812
5760 min Summer	1.560	0.0	281.3	279.8	3512
7200 min Summer	1.315	0.0	339.8	338.3	4240
8640 min Summer	1.143	0.0	389.9	388.4	4928

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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
10080 min Summer	47.520	1.520	0.0	4.9	4.9	835.1	Flood Risk
15 min Winter	46.602	0.602	0.0	0.0	0.0	249.9	O K
30 min Winter	46.722	0.722	0.0	0.0	0.0	311.5	O K
60 min Winter	46.862	0.862	0.0	0.0	0.0	388.4	O K
120 min Winter	47.022	1.022	0.0	0.0	0.0	484.1	O K
180 min Winter	47.127	1.127	0.0	0.0	0.0	550.7	O K
240 min Winter	47.206	1.206	0.0	0.0	0.0	603.5	O K
360 min Winter	47.324	1.324	0.0	0.0	0.0	686.6	Flood Risk
480 min Winter	47.413	1.413	0.0	0.0	0.0	752.3	Flood Risk
600 min Winter	47.485	1.485	0.0	0.0	0.0	807.6	Flood Risk
720 min Winter	47.523	1.523	0.0	5.8	5.8	837.0	Flood Risk
960 min Winter	47.525	1.525	0.0	6.6	6.6	838.4	Flood Risk
1440 min Winter	47.524	1.524	0.0	6.2	6.2	837.6	Flood Risk
2160 min Winter	47.526	1.526	0.0	7.0	7.0	839.3	Flood Risk
2880 min Winter	47.526	1.526	0.0	7.0	7.0	839.3	Flood Risk
4320 min Winter	47.526	1.526	0.0	7.2	7.2	839.7	Flood Risk
5760 min Winter	47.525	1.525	0.0	6.8	6.8	838.8	Flood Risk
7200 min Winter	47.524	1.524	0.0	6.2	6.2	837.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
10080 min Summer	1.016	0.0	433.8	432.5	5648
15 min Winter	121.554	0.0	0.1	0.0	23
30 min Winter	75.766	0.0	0.2	0.0	38
60 min Winter	47.225	0.0	0.3	0.0	68
120 min Winter	29.436	0.0	0.4	0.0	128
180 min Winter	22.325	0.0	0.4	0.0	188
240 min Winter	18.347	0.0	0.4	0.0	248
360 min Winter	13.915	0.0	0.4	0.0	368
480 min Winter	11.436	0.0	0.4	0.0	488
600 min Winter	9.822	0.0	0.4	0.0	608
720 min Winter	8.673	0.0	37.0	36.6	698
960 min Winter	6.784	0.0	73.7	73.3	886
1440 min Winter	4.799	0.0	128.1	127.7	1104
2160 min Winter	3.394	0.0	186.2	185.4	1520
2880 min Winter	2.655	0.0	229.2	228.4	1936
4320 min Winter	1.945	0.0	332.8	332.1	2684
5760 min Winter	1.560	0.0	413.3	411.8	3408
7200 min Winter	1.315	0.0	478.8	477.3	4136

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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
8640 min Winter	47.522	1.522	0.0	5.7	5.7	836.7	Flood Risk
10080 min Winter	47.521	1.521	0.0	5.3	5.3	835.7	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
8640 min Winter	1.143	0.0	534.9	533.5	4848
10080 min Winter	1.016	0.0	584.2	582.8	5552

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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) 0.979

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.000	4	8	0.979

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Model Details

Storage is Online Cover Level (m) 47.600

Tank or Pond Structure

Invert Level (m) 46.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	339.2	1.500	783.4	1.600	817.6

Orifice Outflow Control

Diameter (m) 0.001 Discharge Coefficient 0.600 Invert Level (m) 46.000

Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 47.500

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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
15 min Summer	41.715	0.115	3.7	0.0	3.7	23.4	O K
30 min Summer	41.749	0.149	4.1	0.0	4.1	30.7	O K
60 min Summer	41.785	0.185	4.3	0.0	4.3	38.9	O K
120 min Summer	41.823	0.223	4.5	0.0	4.5	47.7	O K
180 min Summer	41.845	0.245	4.6	0.0	4.6	52.9	O K
240 min Summer	41.859	0.259	4.7	0.0	4.7	56.4	O K
360 min Summer	41.875	0.275	4.7	0.0	4.7	60.4	O K
480 min Summer	41.883	0.283	4.7	0.0	4.7	62.2	O K
600 min Summer	41.885	0.285	4.7	0.0	4.7	62.9	O K
720 min Summer	41.885	0.285	4.7	0.0	4.7	62.9	O K
960 min Summer	41.863	0.263	4.7	0.0	4.7	57.4	O K
1440 min Summer	41.822	0.222	4.5	0.0	4.5	47.5	O K
2160 min Summer	41.775	0.175	4.3	0.0	4.3	36.5	O K
2880 min Summer	41.742	0.142	4.0	0.0	4.0	29.2	O K
4320 min Summer	41.713	0.113	3.6	0.0	3.6	22.8	O K
5760 min Summer	41.698	0.098	3.1	0.0	3.1	19.7	O K
7200 min Summer	41.688	0.088	2.8	0.0	2.8	17.6	O K
8640 min Summer	41.681	0.081	2.5	0.0	2.5	16.1	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	24.5	0.0	22
30 min Summer	13.717	0.0	34.0	0.0	36
60 min Summer	9.440	0.0	47.6	0.0	64
120 min Summer	6.497	0.0	65.6	0.0	98
180 min Summer	5.222	0.0	79.1	0.0	134
240 min Summer	4.472	0.0	90.4	0.0	170
360 min Summer	3.594	0.0	109.1	0.0	240
480 min Summer	3.078	0.0	124.6	0.0	312
600 min Summer	2.729	0.0	138.1	0.0	380
720 min Summer	2.474	0.0	150.2	0.0	450
960 min Summer	2.016	0.0	163.2	0.0	582
1440 min Summer	1.511	0.0	183.4	0.0	828
2160 min Summer	1.133	0.0	206.8	0.0	1192
2880 min Summer	0.923	0.0	224.6	0.0	1532
4320 min Summer	0.717	0.0	261.4	0.0	2248
5760 min Summer	0.599	0.0	291.8	0.0	2944
7200 min Summer	0.521	0.0	317.3	0.0	3672
8640 min Summer	0.465	0.0	339.7	0.0	4408

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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
10080 min Summer	41.676	0.076	2.3	0.0	2.3	15.1	O K
15 min Winter	41.729	0.129	3.9	0.0	3.9	26.3	O K
30 min Winter	41.767	0.167	4.2	0.0	4.2	34.7	O K
60 min Winter	41.808	0.208	4.5	0.0	4.5	44.3	O K
120 min Winter	41.849	0.249	4.6	0.0	4.6	53.9	O K
180 min Winter	41.872	0.272	4.7	0.0	4.7	59.5	O K
240 min Winter	41.886	0.286	4.7	0.0	4.7	63.0	O K
360 min Winter	41.899	0.299	4.8	0.0	4.8	66.4	O K
480 min Winter	41.902	0.302	4.8	0.0	4.8	67.2	O K
600 min Winter	41.900	0.300	4.8	0.0	4.8	66.7	O K
720 min Winter	41.895	0.295	4.8	0.0	4.8	65.3	O K
960 min Winter	41.860	0.260	4.7	0.0	4.7	56.6	O K
1440 min Winter	41.799	0.199	4.4	0.0	4.4	42.1	O K
2160 min Winter	41.738	0.138	4.0	0.0	4.0	28.3	O K
2880 min Winter	41.710	0.110	3.5	0.0	3.5	22.3	O K
4320 min Winter	41.688	0.088	2.8	0.0	2.8	17.7	O K
5760 min Winter	41.677	0.077	2.4	0.0	2.4	15.4	O K
7200 min Winter	41.670	0.070	2.1	0.0	2.1	13.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
10080 min Summer	0.422	0.0	359.7	0.0	5136
15 min Winter	19.930	0.0	27.6	0.0	21
30 min Winter	13.717	0.0	38.2	0.0	35
60 min Winter	9.440	0.0	53.3	0.0	64
120 min Winter	6.497	0.0	73.5	0.0	106
180 min Winter	5.222	0.0	88.7	0.0	144
240 min Winter	4.472	0.0	101.3	0.0	184
360 min Winter	3.594	0.0	122.2	0.0	262
480 min Winter	3.078	0.0	139.6	0.0	338
600 min Winter	2.729	0.0	154.7	0.0	412
720 min Winter	2.474	0.0	168.3	0.0	482
960 min Winter	2.016	0.0	182.9	0.0	618
1440 min Winter	1.511	0.0	205.5	0.0	868
2160 min Winter	1.133	0.0	231.6	0.0	1212
2880 min Winter	0.923	0.0	251.6	0.0	1532
4320 min Winter	0.717	0.0	292.8	0.0	2252
5760 min Winter	0.599	0.0	326.9	0.0	2944
7200 min Winter	0.521	0.0	355.4	0.0	3672

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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
8640 min Winter	41.665	0.065	1.8	0.0	1.8	12.9	O K
10080 min Winter	41.662	0.062	1.7	0.0	1.7	12.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
8640 min Winter	0.465	0.0	380.5	0.0	4408
10080 min Winter	0.422	0.0	403.0	0.0	5072

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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) 0.677

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.000	4	8	0.677

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Model Details

Storage is Online Cover Level (m) 43.200

Tank or Pond Structure

Invert Level (m) 41.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	191.7	1.500	588.0	1.600	620.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0098-5000-1500-5000
Design Head (m)	1.500
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	98
Invert Level (m)	41.600
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	5.0	Kick-Flo®	0.878	3.9
Flush-Flo™	0.431	4.9	Mean Flow over Head Range	-	4.3

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.2	1.200	4.5	3.000	6.9	7.000	10.3
0.200	4.4	1.400	4.8	3.500	7.4	7.500	10.7
0.300	4.8	1.600	5.1	4.000	7.9	8.000	11.0
0.400	4.9	1.800	5.4	4.500	8.4	8.500	11.3
0.500	4.9	2.000	5.7	5.000	8.8	9.000	11.6
0.600	4.8	2.200	6.0	5.500	9.2	9.500	11.9
0.800	4.3	2.400	6.2	6.000	9.6		
1.000	4.1	2.600	6.5	6.500	10.0		

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Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.100

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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
15 min Summer	41.940	0.340	4.8	0.0	4.8	77.0	O K
30 min Summer	42.016	0.416	4.9	0.0	4.9	97.4	O K
60 min Summer	42.098	0.498	4.9	0.0	4.9	121.2	O K
120 min Summer	42.181	0.581	4.9	0.0	4.9	147.0	O K
180 min Summer	42.226	0.626	4.9	0.0	4.9	161.5	O K
240 min Summer	42.253	0.653	4.9	0.0	4.9	170.6	O K
360 min Summer	42.283	0.683	4.9	0.0	4.9	180.9	O K
480 min Summer	42.301	0.701	4.9	0.0	4.9	187.1	O K
600 min Summer	42.312	0.712	4.9	0.0	4.9	190.9	O K
720 min Summer	42.318	0.718	4.9	0.0	4.9	193.1	O K
960 min Summer	42.283	0.683	4.9	0.0	4.9	180.9	O K
1440 min Summer	42.216	0.616	4.9	0.0	4.9	158.3	O K
2160 min Summer	42.122	0.522	4.9	0.0	4.9	128.4	O K
2880 min Summer	42.037	0.437	4.9	0.0	4.9	103.4	O K
4320 min Summer	41.925	0.325	4.8	0.0	4.8	72.9	O K
5760 min Summer	41.844	0.244	4.6	0.0	4.6	52.7	O K
7200 min Summer	41.788	0.188	4.4	0.0	4.4	39.6	O K
8640 min Summer	41.751	0.151	4.1	0.0	4.1	31.2	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	79.4	0.0	22
30 min Summer	40.885	0.0	102.8	0.0	37
60 min Summer	26.412	0.0	133.7	0.0	66
120 min Summer	17.062	0.0	172.8	0.0	126
180 min Summer	13.214	0.0	200.8	0.0	184
240 min Summer	11.023	0.0	223.4	0.0	244
360 min Summer	8.536	0.0	259.5	0.0	318
480 min Summer	7.121	0.0	288.7	0.0	388
600 min Summer	6.186	0.0	313.5	0.0	456
720 min Summer	5.515	0.0	335.3	0.0	526
960 min Summer	4.378	0.0	354.9	0.0	658
1440 min Summer	3.162	0.0	384.4	0.0	926
2160 min Summer	2.284	0.0	417.2	0.0	1320
2880 min Summer	1.813	0.0	441.6	0.0	1680
4320 min Summer	1.357	0.0	495.3	0.0	2384
5760 min Summer	1.104	0.0	538.1	0.0	3112
7200 min Summer	0.941	0.0	573.4	0.0	3752
8640 min Summer	0.826	0.0	603.8	0.0	4488

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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
10080 min Summer	41.727	0.127	3.9	0.0	3.9	26.0	O K
15 min Winter	41.976	0.376	4.9	0.0	4.9	86.5	O K
30 min Winter	42.059	0.459	4.9	0.0	4.9	109.7	O K
60 min Winter	42.150	0.550	4.9	0.0	4.9	137.1	O K
120 min Winter	42.244	0.644	4.9	0.0	4.9	167.6	O K
180 min Winter	42.297	0.697	4.9	0.0	4.9	185.6	O K
240 min Winter	42.331	0.731	4.9	0.0	4.9	197.7	O K
360 min Winter	42.371	0.771	4.9	0.0	4.9	212.2	O K
480 min Winter	42.390	0.790	4.9	0.0	4.9	219.4	O K
600 min Winter	42.399	0.799	4.9	0.0	4.9	222.6	O K
720 min Winter	42.405	0.805	4.9	0.0	4.9	224.8	O K
960 min Winter	42.358	0.758	4.9	0.0	4.9	207.6	O K
1440 min Winter	42.261	0.661	4.9	0.0	4.9	173.2	O K
2160 min Winter	42.118	0.518	4.9	0.0	4.9	127.4	O K
2880 min Winter	41.993	0.393	4.9	0.0	4.9	91.0	O K
4320 min Winter	41.840	0.240	4.6	0.0	4.6	51.7	O K
5760 min Winter	41.755	0.155	4.1	0.0	4.1	32.1	O K
7200 min Winter	41.717	0.117	3.7	0.0	3.7	23.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
10080 min Summer	0.740	0.0	630.6	0.0	5144
15 min Winter	63.289	0.0	89.1	0.0	22
30 min Winter	40.885	0.0	115.2	0.0	37
60 min Winter	26.412	0.0	149.8	0.0	66
120 min Winter	17.062	0.0	193.6	0.0	124
180 min Winter	13.214	0.0	224.9	0.0	182
240 min Winter	11.023	0.0	250.2	0.0	238
360 min Winter	8.536	0.0	290.7	0.0	350
480 min Winter	7.121	0.0	323.3	0.0	456
600 min Winter	6.186	0.0	351.1	0.0	546
720 min Winter	5.515	0.0	375.6	0.0	576
960 min Winter	4.378	0.0	397.5	0.0	724
1440 min Winter	3.162	0.0	430.6	0.0	1012
2160 min Winter	2.284	0.0	467.3	0.0	1408
2880 min Winter	1.813	0.0	494.6	0.0	1764
4320 min Winter	1.357	0.0	554.8	0.0	2464
5760 min Winter	1.104	0.0	602.7	0.0	3112
7200 min Winter	0.941	0.0	642.2	0.0	3736

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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
8640 min Winter	41.702	0.102	3.3	0.0	3.3	20.6	O K
10080 min Winter	41.692	0.092	3.0	0.0	3.0	18.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
8640 min Winter	0.826	0.0	676.3	0.0	4408
10080 min Winter	0.740	0.0	706.4	0.0	5136

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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) 0.677

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.000	4	8	0.677

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Model Details

Storage is Online Cover Level (m) 43.200

Tank or Pond Structure

Invert Level (m) 41.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	191.7	1.500	588.0	1.600	620.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0098-5000-1500-5000
Design Head (m)	1.500
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	98
Invert Level (m)	41.600
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	5.0	Kick-Flo®	0.878	3.9
Flush-Flo™	0.431	4.9	Mean Flow over Head Range	-	4.3

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.2	1.200	4.5	3.000	6.9	7.000	10.3
0.200	4.4	1.400	4.8	3.500	7.4	7.500	10.7
0.300	4.8	1.600	5.1	4.000	7.9	8.000	11.0
0.400	4.9	1.800	5.4	4.500	8.4	8.500	11.3
0.500	4.9	2.000	5.7	5.000	8.8	9.000	11.6
0.600	4.8	2.200	6.0	5.500	9.2	9.500	11.9
0.800	4.3	2.400	6.2	6.000	9.6		
1.000	4.1	2.600	6.5	6.500	10.0		

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Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.100

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Summary of Results for 100 year Return Period (+40%)

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	42.241	0.641	4.9	0.0	4.9	166.4	O K
30 min Summer	42.359	0.759	4.9	0.0	4.9	207.9	O K
60 min Summer	42.490	0.890	4.9	0.0	4.9	258.0	O K
120 min Summer	42.627	1.027	4.9	0.0	4.9	315.7	O K
180 min Summer	42.707	1.107	4.9	0.0	4.9	351.5	O K
240 min Summer	42.760	1.160	4.9	0.0	4.9	376.7	O K
360 min Summer	42.828	1.228	4.9	0.0	4.9	410.1	O K
480 min Summer	42.868	1.268	4.9	0.0	4.9	430.4	O K
600 min Summer	42.893	1.293	4.9	0.0	4.9	443.0	O K
720 min Summer	42.907	1.307	4.9	0.0	4.9	450.3	Flood Risk
960 min Summer	42.868	1.268	4.9	0.0	4.9	430.2	O K
1440 min Summer	42.801	1.201	4.9	0.0	4.9	396.6	O K
2160 min Summer	42.717	1.117	4.9	0.0	4.9	356.1	O K
2880 min Summer	42.638	1.038	4.9	0.0	4.9	320.5	O K
4320 min Summer	42.527	0.927	4.9	0.0	4.9	272.9	O K
5760 min Summer	42.382	0.782	4.9	0.0	4.9	216.4	O K
7200 min Summer	42.249	0.649	4.9	0.0	4.9	169.3	O K
8640 min Summer	42.135	0.535	4.9	0.0	4.9	132.4	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	169.1	0.0	23
30 min Summer	84.742	0.0	213.6	0.0	38
60 min Summer	53.513	0.0	271.2	0.0	68
120 min Summer	33.792	0.0	342.5	0.0	126
180 min Summer	25.824	0.0	392.6	0.0	186
240 min Summer	21.339	0.0	432.5	0.0	246
360 min Summer	16.307	0.0	495.8	0.0	366
480 min Summer	13.475	0.0	546.1	0.0	484
600 min Summer	11.621	0.0	588.5	0.0	604
720 min Summer	10.298	0.0	625.4	0.0	720
960 min Summer	8.098	0.0	655.1	0.0	822
1440 min Summer	5.772	0.0	695.4	0.0	1070
2160 min Summer	4.114	0.0	751.6	0.0	1476
2880 min Summer	3.235	0.0	788.0	0.0	1880
4320 min Summer	2.389	0.0	872.5	0.0	2728
5760 min Summer	1.926	0.0	938.7	0.0	3456
7200 min Summer	1.630	0.0	992.9	0.0	4176
8640 min Summer	1.422	0.0	1039.4	0.0	4840

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Summary of Results for 100 year Return Period (+40%)

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
10080 min Summer	42.037	0.437	4.9	0.0	4.9	103.6	O K
15 min Winter	42.300	0.700	4.9	0.0	4.9	186.8	O K
30 min Winter	42.428	0.828	4.9	0.0	4.9	233.8	O K
60 min Winter	42.569	0.969	4.9	0.0	4.9	290.6	O K
120 min Winter	42.718	1.118	4.9	0.0	4.9	356.6	O K
180 min Winter	42.805	1.205	4.9	0.0	4.9	398.3	O K
240 min Winter	42.864	1.264	4.9	0.0	4.9	428.3	O K
360 min Winter	42.943	1.343	4.9	0.0	4.9	469.3	Flood Risk
480 min Winter	42.991	1.391	4.9	0.0	4.9	495.7	Flood Risk
600 min Winter	43.023	1.423	4.9	0.0	4.9	513.4	Flood Risk
720 min Winter	43.044	1.444	4.9	0.0	4.9	525.3	Flood Risk
960 min Winter	43.007	1.407	4.9	0.0	4.9	504.3	Flood Risk
1440 min Winter	42.927	1.327	4.9	0.0	4.9	461.2	Flood Risk
2160 min Winter	42.821	1.221	4.9	0.0	4.9	406.5	O K
2880 min Winter	42.715	1.115	4.9	0.0	4.9	355.4	O K
4320 min Winter	42.543	0.943	4.9	0.0	4.9	279.6	O K
5760 min Winter	42.304	0.704	4.9	0.0	4.9	188.0	O K
7200 min Winter	42.105	0.505	4.9	0.0	4.9	123.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
10080 min Summer	1.267	0.0	1080.2	0.0	5544
15 min Winter	134.198	0.0	189.5	0.0	23
30 min Winter	84.742	0.0	239.2	0.0	37
60 min Winter	53.513	0.0	303.7	0.0	66
120 min Winter	33.792	0.0	383.6	0.0	126
180 min Winter	25.824	0.0	439.7	0.0	184
240 min Winter	21.339	0.0	484.4	0.0	242
360 min Winter	16.307	0.0	555.1	0.0	358
480 min Winter	13.475	0.0	611.3	0.0	472
600 min Winter	11.621	0.0	658.5	0.0	586
720 min Winter	10.298	0.0	699.1	0.0	696
960 min Winter	8.098	0.0	729.8	0.0	908
1440 min Winter	5.772	0.0	732.5	0.0	1130
2160 min Winter	4.114	0.0	841.8	0.0	1588
2880 min Winter	3.235	0.0	882.6	0.0	2052
4320 min Winter	2.389	0.0	977.1	0.0	2944
5760 min Winter	1.926	0.0	1051.3	0.0	3632
7200 min Winter	1.630	0.0	1112.0	0.0	4256

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Summary of Results for 100 year Return Period (+40%)

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
8640 min Winter	41.954	0.354	4.8	0.0	4.8	80.6	O K
10080 min Winter	41.854	0.254	4.7	0.0	4.7	55.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
8640 min Winter	1.422	0.0	1164.2	0.0	4920
10080 min Winter	1.267	0.0	1210.0	0.0	5456

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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) 0.677

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.000	4	8	0.677

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Model Details

Storage is Online Cover Level (m) 43.200

Tank or Pond Structure

Invert Level (m) 41.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	191.7	1.500	588.0	1.600	620.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0098-5000-1500-5000
Design Head (m)	1.500
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	98
Invert Level (m)	41.600
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	5.0	Kick-Flo®	0.878	3.9
Flush-Flo™	0.431	4.9	Mean Flow over Head Range	-	4.3

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.2	1.200	4.5	3.000	6.9	7.000	10.3
0.200	4.4	1.400	4.8	3.500	7.4	7.500	10.7
0.300	4.8	1.600	5.1	4.000	7.9	8.000	11.0
0.400	4.9	1.800	5.4	4.500	8.4	8.500	11.3
0.500	4.9	2.000	5.7	5.000	8.8	9.000	11.6
0.600	4.8	2.200	6.0	5.500	9.2	9.500	11.9
0.800	4.3	2.400	6.2	6.000	9.6		
1.000	4.1	2.600	6.5	6.500	10.0		

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Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.100

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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
15 min Summer	42.204	0.604	0.0	0.0	0.0	154.3	O K
30 min Summer	42.316	0.716	0.0	0.0	0.0	192.3	O K
60 min Summer	42.444	0.844	0.0	0.0	0.0	239.8	O K
120 min Summer	42.589	0.989	0.0	0.0	0.0	298.9	O K
180 min Summer	42.682	1.082	0.0	0.0	0.0	340.0	O K
240 min Summer	42.752	1.152	0.0	0.0	0.0	372.6	O K
360 min Summer	42.856	1.256	0.0	0.0	0.0	423.9	O K
480 min Summer	42.934	1.334	0.0	0.0	0.0	464.5	Flood Risk
600 min Summer	42.996	1.396	0.0	0.0	0.0	498.6	Flood Risk
720 min Summer	43.049	1.449	0.0	0.0	0.0	528.4	Flood Risk
960 min Summer	43.089	1.489	0.0	0.0	0.0	551.0	Flood Risk
1440 min Summer	43.112	1.512	0.0	2.3	2.3	564.8	Flood Risk
2160 min Summer	43.112	1.512	0.0	2.2	2.2	564.5	Flood Risk
2880 min Summer	43.112	1.512	0.0	2.2	2.2	564.5	Flood Risk
4320 min Summer	43.115	1.515	0.0	3.1	3.1	566.4	Flood Risk
5760 min Summer	43.117	1.517	0.0	3.7	3.7	567.5	Flood Risk
7200 min Summer	43.117	1.517	0.0	3.7	3.7	567.7	Flood Risk
8640 min Summer	43.117	1.517	0.0	3.7	3.7	567.5	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	121.554	0.0	0.1	0.0	23
30 min Summer	75.766	0.0	0.2	0.0	38
60 min Summer	47.225	0.0	0.3	0.0	68
120 min Summer	29.436	0.0	0.4	0.0	128
180 min Summer	22.325	0.0	0.4	0.0	188
240 min Summer	18.347	0.0	0.4	0.0	248
360 min Summer	13.915	0.0	0.4	0.0	368
480 min Summer	11.436	0.0	0.4	0.0	488
600 min Summer	9.822	0.0	0.4	0.0	608
720 min Summer	8.673	0.0	0.4	0.0	728
960 min Summer	6.784	0.0	0.4	0.0	968
1440 min Summer	4.799	0.0	27.1	26.7	1398
2160 min Summer	3.394	0.0	63.1	62.3	1744
2880 min Summer	2.655	0.0	89.6	88.9	2096
4320 min Summer	1.945	0.0	153.5	152.8	2732
5760 min Summer	1.560	0.0	203.5	201.9	3456
7200 min Summer	1.315	0.0	243.8	242.4	4176
8640 min Summer	1.143	0.0	278.4	277.0	4880

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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
10080 min Summer	43.116	1.516	0.0	3.5	3.5	567.4	Flood Risk
15 min Winter	42.260	0.660	0.0	0.0	0.0	172.8	O K
30 min Winter	42.380	0.780	0.0	0.0	0.0	215.4	O K
60 min Winter	42.516	0.916	0.0	0.0	0.0	268.6	O K
120 min Winter	42.670	1.070	0.0	0.0	0.0	334.8	O K
180 min Winter	42.769	1.169	0.0	0.0	0.0	380.8	O K
240 min Winter	42.843	1.243	0.0	0.0	0.0	417.3	O K
360 min Winter	42.953	1.353	0.0	0.0	0.0	474.8	Flood Risk
480 min Winter	43.035	1.435	0.0	0.0	0.0	520.2	Flood Risk
600 min Winter	43.101	1.501	0.0	0.1	0.1	558.4	Flood Risk
720 min Winter	43.121	1.521	0.0	5.1	5.1	570.0	Flood Risk
960 min Winter	43.120	1.520	0.0	4.7	4.7	569.3	Flood Risk
1440 min Winter	43.121	1.521	0.0	5.1	5.1	569.9	Flood Risk
2160 min Winter	43.122	1.522	0.0	5.5	5.5	570.5	Flood Risk
2880 min Winter	43.121	1.521	0.0	5.3	5.3	570.3	Flood Risk
4320 min Winter	43.121	1.521	0.0	5.3	5.3	570.3	Flood Risk
5760 min Winter	43.120	1.520	0.0	4.9	4.9	569.6	Flood Risk
7200 min Winter	43.119	1.519	0.0	4.4	4.4	568.9	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
10080 min Summer	1.016	0.0	308.7	307.4	5640
15 min Winter	121.554	0.0	0.1	0.0	23
30 min Winter	75.766	0.0	0.2	0.0	38
60 min Winter	47.225	0.0	0.3	0.0	68
120 min Winter	29.436	0.0	0.4	0.0	128
180 min Winter	22.325	0.0	0.4	0.0	188
240 min Winter	18.347	0.0	0.4	0.0	248
360 min Winter	13.915	0.0	0.4	0.0	368
480 min Winter	11.436	0.0	0.4	0.0	488
600 min Winter	9.822	0.0	1.1	0.7	608
720 min Winter	8.673	0.0	34.4	33.9	684
960 min Winter	6.784	0.0	59.7	59.3	870
1440 min Winter	4.799	0.0	97.3	96.9	1072
2160 min Winter	3.394	0.0	137.6	136.8	1492
2880 min Winter	2.655	0.0	167.3	166.5	1904
4320 min Winter	1.945	0.0	238.9	238.1	2644
5760 min Winter	1.560	0.0	294.7	293.2	3384
7200 min Winter	1.315	0.0	340.0	338.5	4112

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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
8640 min Winter	43.118	1.518	0.0	4.0	4.0	568.2	Flood Risk
10080 min Winter	43.117	1.517	0.0	3.7	3.7	567.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
8640 min Winter	1.143	0.0	378.7	377.3	4840
10080 min Winter	1.016	0.0	412.7	411.3	5544

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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) 0.677

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.000	4	8	0.677

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Model Details

Storage is Online Cover Level (m) 43.200

Tank or Pond Structure

Invert Level (m) 41.600

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	191.7	1.500	588.0	1.600	620.0

Orifice Outflow Control

Diameter (m) 0.001 Discharge Coefficient 0.600 Invert Level (m) 41.600

Weir Overflow Control

Discharge Coef 0.544 Width (m) 1.000 Invert Level (m) 43.100

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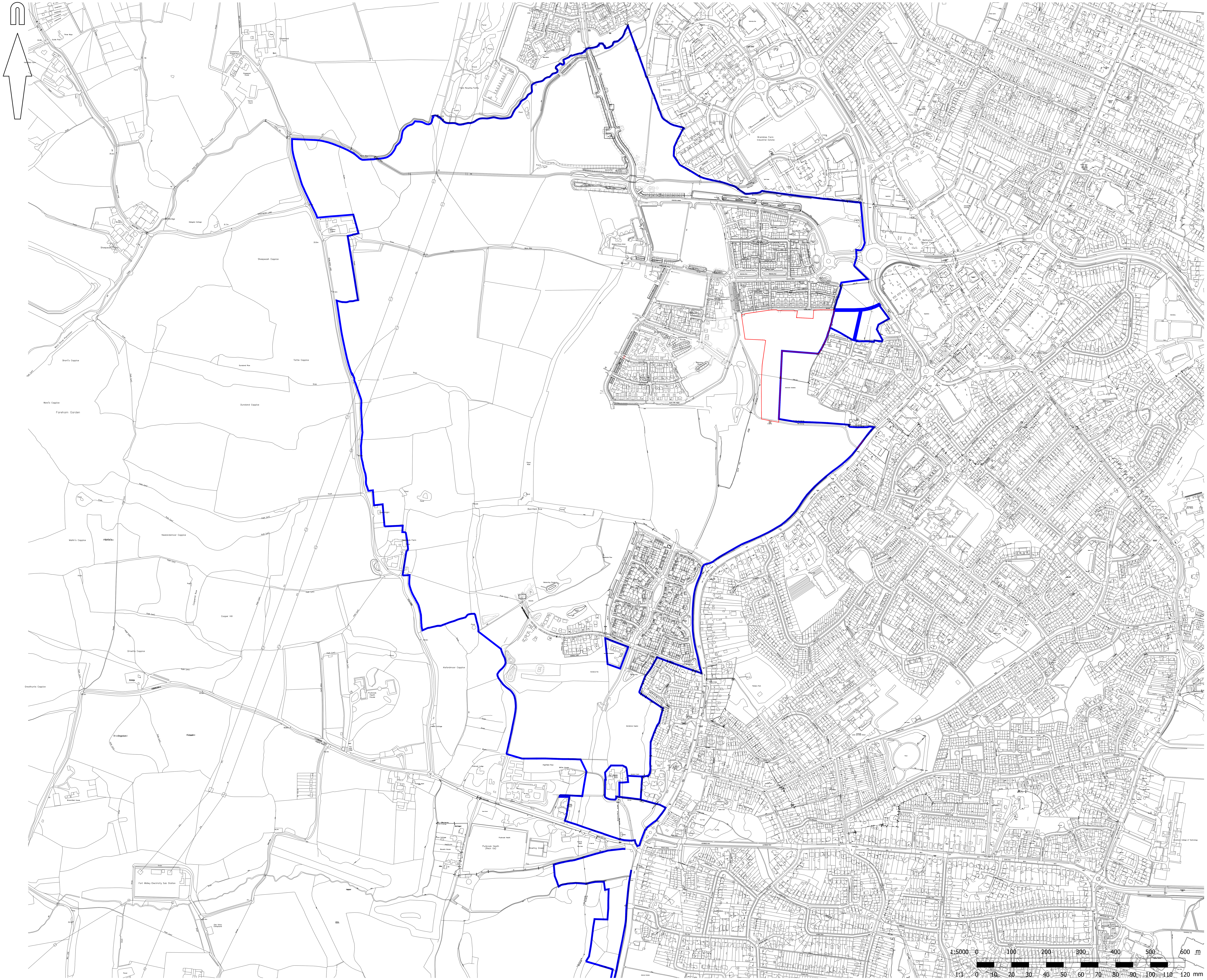
APPENDIX B: Drawings

Location Plan
Proposed SuDS Layout
Hydrobrake Detail
Outfall Detail



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KEY

PHASE 8 BOUNDARY

GRAINGER BOUNDARY

Berewood
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BEREWOOD, WATERLOOVILLE
PHASE 3B AND 8

scale	1:5000	drawn by	KDB	checked by	RHA
date	December 2019	cad file	SK_02.dwg		

title
PHASE 3B LOCATION PLAN

drawing number
GTWVILLE_P3BI/SK/02

rev.

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 Phase 3B 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 Phase 3B Infrastructure and the Town Park Landscape design packages, 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
3A	Pond	HydroBrake Optimum	Yes	N/A	Yes	Yes	Yes	Yes	Yes	Yes (Surface Build-up)	Yes
3B	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 de-silting 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.
- 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

APPENDIX D: Phase 1 Drainage Strategy

Extract of Phase 1 Drainage Strategy

SuDS Design Document

Phase 1 Infrastructure
Newlands, Waterlooville
SuDS Design Document

Introduction

1.1 This document sets out the design principles and detail for the Strategic SuDS constructed by Grainger Plc for the Phase 1 Development at Newlands, West of Waterlooville.

1.2 This document is aimed at a technical reader with an experience in the design of Sustainable Drainage Features.

Principles

Permitted Discharge Rates

1.3 The discharge rate for the Newlands development has been agreed at outline planning stage and is written into the S.106. A QBAR rate of 5.06l/s/ha shall be assumed at the outfall of the system to the existing watercourse. For this design phase there is a single outfall into a ditch close to its Junction with the River Wallington. This rate shall not be exceeded for all storm events exceeding the 1 in 2 year event up to the 1 in 100 year event plus an allowance for climate change, which is agreed as 30% increase in rainfall intensity against the FEH design parameters below.

1.4 In addition, the discharge from the site for the 1 in 1 year return period shall not exceed the calculated greenfield rate of 4.3l/s/ha, which is calculated using the FSSR 2 factor of 0.85.

1.5 For the design catchment area of 12.325Ha the maximum permitted discharge rates from the final SuDS control point are:

1 in 1 year = 53l/s
All other events up to 1 in 100 year + 30% = 62.4l/s

1.6 This restriction to QBAR negates the requirement to calculate additional 'Long Term Storage' volumes.

Rainfall Parameters

1.7 The design has been undertaken using Microdrainage WinDes software. As the critical events for the open space SuDS will be in excess of 60minute duration, the FEH rainfall parameters have been assumed. For the Newlands development, the assumed parameters have been taken directly from exported FEH CD-ROM data as follows:

C(1km) = -0.028	D1(1km) = 0.459	D2(1km) = 0.297
D3(1km) = 0.38	E(1km) = 0.306	F(1km) = 2.248

Design Catchments

1.8 Drawing GTWVILLE2/DR/03 (Appendix B) shows the developed catchment areas assumed for design purposes. To the south, future flows will be diverted to a different catchment as demonstrated in the overall indicative SuDS masterplan, which was submitted with the outline planning application. This plan is included in Appendix B for ease of reference.

1.9 For the catchments with detailed planning consent, and the strategic roads, where impermeable areas are well defined, the impermeable areas have been measured. Within the development plots, an allowance of either 5% or 10% of this area has been counted as pervious paving.

1.10 For the future catchment areas, an impervious proportion of 75% has typically been assumed, of which 10% is assumed as pervious paving. The exception to this principle is the proposed employment plot, which is assumed as 90% impervious with 10% pervious paving.

1.11 Catchments with allowances for pervious pavements have been entered as 2 time/area diagrams, 1 for the impermeable, and one for the pervious pavement. The pervious pavement time/area diagrams are inputted as ‘green roofs’ with the default decay factor.

1.12 All roof and paved areas (including pervious paving) are assumed to discharge 100% of run-off to the network. No losses are assumed. All gardens and soft landscaped areas are assumed not to contribute run-off to the network.

1.13 The catchment areas are presented in Appendix A,Table 1.

Network details

1.14 The proposed strategic surface water drainage scheme consists of a number of open space landscaped SuDS features linked by pipes and in some places open space swales. The WinDes model, which has been created is georeferenced, and as SuDs attenuation features are defined on nodes (manholes) it is necessary to insert dummy pipes in the model which represent the distance between the inlet and the outlet of the SuDS features. These pipes are sized such that the capacity is not less than the upstream pipe.

1.15 The extra volume created in the model by the dummy pipes has been calculated and manually compensated for in the depth/area inputs for the SuDS. Tables 2 to 10 in Appendix A show the depth/area inputs for the SuDS features and the adjustments made.

1.16 Swales and ditches have been inputted in the model where they exist, so that true account is taken of the volumes within them.

1.17 Typical default headloss coefficients have been used in the model these are:

<30° = 0.15
30°<60° = 0.5
60°<90° = 0.9
>90° = 1.2

Controls

1.18 The surface water is attenuated within the SuDS features with the use of flow control devices. The model utilises simple orifice plates and vortex flow control devices. Specifically, the Hydro International Hydrobrake has been specified. Any equivalent alternatives will need to be tested in the model to consider the effect. In places 2 controls at different levels are specified. These are imputed into the model using the WinDes 'complex control' facility. The controls are inputted as on-line controls in the model and these are scheduled in the WinDes Network Details report, see Appendix A.

1.19 In some locations high level overflows, which bypass the online control are inputted as offline controls, with the discharge linked to the first pipe downstream of the online control. These will be constructed on site as weirs, either, via a lowered bank or a row of weir gullies.

Specific Features

1.20 The open space SuDS features are divided into 2 categories based on their proposed ownership these will be referred to as Highway SuDS and SAB SuDS.

1.21 The Highway SuDS are those features which solely drain areas of public highway, and will be adopted by the Highway Authority under S.38 of the Highways Act. These include some swales adjacent to the highway and some small rain garden areas of landscaping. The defined Highway SuDS are shown on the S.38 adoption plans GTWVILLE3/LG/10 & 11, see Appendix B.

1.22 SAB is an acronym for SuDS Approval Body, as defined in the Flood and Water Management Act 2010. At the time of writing the SAB powers have not commenced, but are anticipated to do so shortly. Hampshire County Council (HCC) will be the SAB and have agreed in principle to retrospectively adopt the Phase 1 SuDS once empowered to do so and subject to adequate funding. It is possible that HCC may involve the Local Authorities in the maintenance of SuDS features, therefore Havant Borough Council and Winchester City Council are included in the design approval process, as are the Environment Agency as the main SuDS consultee.

1.23 The SAB SuDS are all SuDS features not adopted as public highway or public sewer. The defined SAB SuDS are shown on the SuDS Adoption plans GTWVILLE3/LG/20 & 21, see Appendix B.

1.24 Detailed drawings showing the surface water drainage layout and sections through the principal SuDS features are also contained within Appendix B.

Highway SuDS

1.25 Carriageway Edge Swales – The main access link road cross section included a shallow swale either side, as does Broad Street along some of its northern edge. The function of the swales is to provide initial pollution treatment and promote initial volume losses (interception storage).

1.26 Hampshire Highways have been consulted on the options for draining the carriageway surface. Over the edge drainage by the removal of a kerb or intermittent drop kerbs has been rejected, and the discharge is by weir gullies connecting to the swale by 150mm diameter pipes. The swales themselves are relatively shallow (400mm) with 1 in 3 side slopes. These swales are underdrained with a standard filter drain, which falls towards the

specified outfall. The filter drain terminates in combined catchpit gullies to facilitate maintenance and provide a high level overflow for the swales.

1.27 Back of Footway Swales – The initial section of the industrial area link (the road north off the first internal junction) has a highway swale to the rear of the footway/cycleway. The carriageway is crossfalled towards chute gullies on the swale side of the road, which are piped directly to the swale, via 150mm diameter connections. These swales are slightly wider and deeper (700mm) than the carriageway edge swales. The edge slope is 1 in 2.5 to the rear of the footway and 1 in 3 to interface with the existing ground level. The 1 in 2.5 slope is slightly steeper than CIRIA guidance, however has been approved by HCC to deliver the required cover to pipework under the footway whilst maintaining footway support and miminising highway land take.

SAB SuDS

Features A & B

1.28 These are located on Broad Street and take the form of linear basins. They both accept piped inflow (and the highway swale underdrain discharge) at one end, with the outfall located at the opposite end, ensuring a good linear flow through the feature.

1.29 Shallow micropools (0.3m deep) are located at either end to provide some habitat biodiversity. The pools also avoid aesthetically negative muddy areas at these locations and the inlet pool in particular provides a designed area for initial silt deposition and dissipation of energy to reduce scour.

1.30 The central area is intended to be predominantly dry and planting is predominantly grasses to further promote removal of settleable solids and biological treatment in the aerobic soils.

1.31 Liners are only provided to underly the micropools, and the termination of the liners is set below the level of the outlet. This promotes the rest water level to drain down below the level of the outlet to encourage some soakage to ground (interception storage) for more frequent rainfall events of low intensity.

1.32 The regular shape of these features is well defined by the boundaries of the surrounding roads. Bank slopes have been designed to a maximum slope of 1 in 3, although slacker slopes are designed in where feasible to assist maintenance access. Options for formal maintenance access ramps were discussed with HCC, WCC, HBC and the EA, but were

rejected. It was agreed that the design was more aesthetically appropriate without them, and maintenance could be adequately achieved without them.

1.33 Discharge rates from both SuDS features are controlled by hydrobrakes and weir gully overflows set 100mm below the overspill level, which bypass the control. Pollution control valves are installed on the pipework between the outfall and the flow control. These are located under a surface cover and can be operated by the fire service using standard hydrant tools.

Features C, D & E

1.34 These are located in the vicinity of the first junction into the site, where the strategic infrastructure roads divide. C lies to the south of Broad Street, with D & E lying to the north, adjacent to the industrial area link road. These 3 features cascade sequentially from C to E. C & D have a single inlets and outlets, whilst E has triple inlets and a single outlet. The principle of inlets located at opposite ends from the outlets is maintained for these features to ensure a good flow through them.

1.35 These features contain deep water pools (typically up to 0.5 to 1m) associated with each inlet and outlet. The pools are separated by gravel beaches. The liners to the pools are designed to terminate below the outfall level and do not run below the gravel beaches, to encourage some soakage to ground (interception storage) as described above.

1.36 The slopes into the deep water pools do not exceed 1 in 3 for reasons of safety, and there is a marginal shelf at the edges of the pool at gradients not exceeding 1 in 10). These provide a zone of marginal planting for habitat biodiversity and aesthetic effect. The main slopes from the marginal benches to ground level are at gradients not exceeding 1 in 3, although the gradients have been designed shallower than this in places to assist maintenance access as described previously.

1.37 Discharge rates from these SuDS features are also controlled by hydrobrakes and weir gully overflows set 100mm below the overspill level are provided for C & E, with the weir of D being a low point in the bank which discharges directly to the swales between D & E. All the features have pollution control valves as described previously.

Features F & G

1.38 These are located to the north of the haul road which will form the future industrial area link road. These are large linear features, which will be the final attenuation for phase 1 and other future development. These features have inlets at either end and a single outlet

at the centre, however their shape and size permit this whilst retaining a good length to width ratio.

1.39 The inlets outfall to micropools as described for features A & B. From these pools the base of the feature rises gently towards the outlet. Adjacent to the pool a bog garden is intended, which is formed by the provision of a semi-permeable liner. The bog garden transitions into a wet woodland area before a deeper pool located in the centre of the features at the outlet. The area of partially lined and unlined ground rising from the inlet pool to the outlet pool is again intended to promote initial losses (interception storage).

1.40 The arrangement of the deep pools are as described previously. Again, banks gradients do not exceed 1 in 3 and the slope of the northern bank is much shallower to facilitate maintenance access.

1.41 There is a lowered strip of land joining these 2 features 35mm below the minimum spill level, to enable overflow from F to G. There is a weir gully overflow arrangement to the final ouffall pipework, 100mm below the spill level.

1.42 Discharge rates from these SuDS features are also controlled by hydrobrakes, and both the features have pollution control valves as described previously.

1.43 The final discharge from these features to the River Wallington is a pipe run, to avoid encroachment on a Portsmouth Water main easement, which a swale or ditch outfall would have entailed. There is a final hydrobrake at the river outfall to buffer flows to the agreed discharge rates.

Feature H

1.44 This is a twin feature of 2 adjacent basins. They shall be predominantly dry, although the levels of the base are set below the outfall to encourage initial losses and settling of solids. Bank slopes are set at a gradient of 1 in 3. This feature offers initial interception storage to a traditionally drained length of road, however it also provides some additional general attenuation storage volume in the SuDS System.

Feature J

1.45 This is a swale cascade in the south west corner of Phase 1. The swale is divided into 4 separate ‘levels’ by a stepped weir wall, through which an orifice control is positioned at the base of the upper side. The levels fall at a gradient not exceeding 1 in 50 and the side slopes of the swale vary to a maximum of 1 in 3. The weir walls are set 100mm below the adjacent ground levels to bypass the orifice plates before flooding occurs. The final

overflow outlet is via a large horizontal grating level with the top of the lower end headwall. This grating is a key feature to be cleared regularly. This cascade will take a main piped inflow at the upper end from future development and lateral inflows from adjacent local development areas of Phase 1. The swale will be designed as a dry feature, without pools.

Simulation Modelling and Results

1.46 The WinDes model was run using the design wizard function, which runs a range of storm durations at the same time, to determine the critical events for each of the modelled pipe lengths. The model was run for the 15 to 1440 minute storm durations, both winter and summer profiles.

1.47 As stated above, the model was run for return periods of 1 in 1, 30, 100 and 100 plus 30% for climate change.

1 in 1 year

- All pipework and SuDS features operating to expectations.
- Some surcharging is indicated, but this represents the location of SuDS controls, which would be expected to be operating in a surcharged condition to provide the attenuation.
- No overflows operating.
- No flooding reported.
- Final discharge rate = 46.9l/s (allowable = 53l/s)

1 in 30 year

- All pipework and SuDS features operating to expectations.
- Widespread surcharging of pipework is indicated, demonstrating efficient selection of pipes.
- No overflows are operating
- Flooding is noted on two 'pipes', although these are actually at swales.
  - 4.000 is the outfall from the main access highway link swales and shows a relatively low volume of 'flooding' (1.325m^3). In practice, this volume would be easily contained within the highway swale and underdrain pipework, which is not included in the strategic model.

- Final discharge rate = 60.0l/s (allowable = 62.4l/s)

1 in 100 year

- All pipework and SuDS features operating to expectations.
- Widespread surcharging of pipework is indicated.
- Overflows are operating for SuDS Features C, E & J (J is online complex control)
- Flooding is noted on a number of conveyance pipes. The volumes are small (<31m3 combined), and most importantly they are critical for the shorter duration 15 minute storms, for which adequate capacity exists in the main SuDS features, into which these overland flows will be routed. No flooding of the principal openspace SuDS features is reported.
- Final discharge rate = 61.3l/s (allowable = 62.4l/s)

1 in 100 year + Climate Change

- All pipework and SuDS features operating to expectations.
- Widespread surcharging of pipework is indicated.
- Overflows are operating for all SuDS features, with the exception of F.
- Flooding is noted on a number of conveyance pipes. The volumes are again relatively small (<155m^3 combined), and are also critical for the shorter duration storms, for which adequate capacity exists in the main SuDS features. No flooding of the principal openspace SuDS features is reported, with the exception of Swale J, although they are being fully utilised, with the exception of F.
- Final discharge rate = 61.9l/s (allowable = 62.4l/s)

Conclusion

1.48 The strategic SuDS design is operating within the accepted design criteria, as stated below.

- 1 in 1 year – No pipe surcharge, no flooding, final discharge <4.3l/s/Ha.
- 1 in 30 year – Surcharge permitted , no flooding, final discharge <5.06l/s/Ha.
- 1 in 100 year – Overland Flow permitted, volume contained in SuDS Features, final discharge <5.06l/s/Ha.
- 1 in 100 year + 30% Climate Change – Overland Flow permitted, volume contained on site, final discharge <5.06l/s/Ha.

Author: Paul Stewart
Date: 2nd February 2012
Revision: First Issue

Appendix A – Calculations and Data

Appendix B – Drawings

Appendix C – SuDS Maintenance Plan

Paul Stewart, Mayer Brown Ltd
& Simon Grieg, Fabrik Ltd

Introduction

This document sets out the planned maintenance requirements for the (non-highways) Sustainable Drainage System (SuDS) to be publicly maintained on Phase 1 of the Newlands 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 is shown on drawings GTWVILLE3/LG/20 & 21, the SuDS Adoption Plan, included in Appendix B of the SuDS Design Document. These drawings also shows the reference numbers for the various features referred to in this document. Appendix B also contains the following engineering drawings:-

Proposed SuDS & Surface Water Layout – GTWVILLE3/DR/10 to 12
Surface Water Drainage Longitudinal Sections – GTWVILLE3/DR/30 to 33
Proposed Pond Details – GTWVILLE3/DR/ 20 to 26

This SuDS maintenance plan shall also be read in conjunction with the Phase 1 Landscape Management Plan and the following General Arrangement Drawings, produced by Fabrik, incorporated in Appendix B:-

D1821.L.300 – Plant Schedule & Specification
D1821.L.301 to 307 – Soft Landscape General Arrangement

Schedule of Open Space SuDS Maintenance Requirements

SuDS Ref	Description	Inspect flow control(s)	Inspect Shut-Off Valve	Inspect Weirs	Inspect Gratings (Inlet >300Ø)	Inspect Rock Outlet Screen	Remove Litter	Mowing	Leaf removal	Landscape Maintenance	Monitor & removal of Silt	Inspect Downstream Defender
A	Linear basin with twin micropools	HydroBrake Type SXH	Yes	Kerb Gully Type	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A
B	Linear basin with twin micropools	HydroBrake Type SXH	Yes	Kerb Gully Type	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A
C	Pond with twin deep pools	HydroBrake Type SXH	Yes	Kerb Gully Type	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
D	Pond with twin deep pools	HydroBrake Type SXH	Yes	Earth Weir Type	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes
E	Pond with Triple deep pools	HydroBrake Type SXH	Yes	Kerb Gully Type	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F	Basin with twin micropools and single deep pool	HydroBrake Type SXH	Yes	Earth Weir Type	Yes (West Inlet)	Yes	Yes	Yes	Yes	Yes	Yes	Yes (2Nr)
G	Basin with twin micropools and single deep pool	HydroBrake Type SXH	Yes	Kerb Gully Type	Yes (West Inlet)	Yes	Yes	Yes	Yes	Yes	Yes	Yes (2Nr)
H	Basin	Hydrobrake Type SXH	Yes	Earth Weir Type	N/A	Yes	Yes	Yes	Yes	Yes	Yes (Surface Build-up)	No
J	Stepped swale with brick weirs	Orifice Plates on Weirs	Yes	Brick Weirs & Final Overflow Grating	N/A	N/A	Yes	Yes	Yes	Yes	Yes (Surface Build-up)	Yes
N/A	General Swales	N/A	N/A	N/A	N/A	N/A	Yes	Yes	Yes	Yes	Yes (Surface Build-up)	N/A

Activity Breakdown

Flow Controls (HydroBrakes & Orifice Plates)

Frequency – 6 Monthly Inspection

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 defecst for repair.

Shut-Off Valves

Frequency – 6 Monthly Inspection

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 (Kerb Gully Type)

Frequency – 6 Monthly or where defects reported

Tasks

- Remove covers, remove any debris and rod through to junction
- File Record of Visit and report any defects for repair or blockage for jetting.

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.

Weirs (Brick Type)

Frequency – 6 Monthly or where defects reported

Tasks

- Check for excessive erosion or settlement at edges
- Check for cracking or vandalism to structure
- File Record of Visit and report any defects for repair.

Inlet Gratings

Frequency – 6 Monthly or where defects reported

Tasks

- Check for secure fixing and signs of corrosion
- Check for and clear any debris caught behind the screen.
- 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 detention basins 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.
- Ponds may require de-silting after several years if more than 100mm average of silt builds up on the ponds bed, the silt depth at any single point shall not be pertmitted to exceed 300mm depth. Before de-silting a particular pond it should be trapped and netted out for amphibians and macroinvertebrates which should be transferred to a nearby pond assuming no fish are present. Not all ponds are to be de-silted in the same year.
- 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.
- 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.
- Inspect inlets and facility surface for silt accumulation and establish appropriate silt removal frequencies. Check mechanical devices.
- Inspect inlets, outlets and overflows for blockages and clear as required. Inspect bank sides, structures, pipework etc. for evidence of physical damage.

Tasks (Grass Cutting)

*__***GCE1: Damp Meadow Grass***__ ***- refer to Landscape management plan***

- ***Performance*** Height 25-50mm

To a natural height to all banked grass areas but without woody plant encroachment and a height of 25-50mm to the publically accessible terraced areas during the growing period. Cut grass with an approved strimmer or mower capable of dealing with woody stems up to 25mm diameter.

Damp meadow grass banks are to be cut once a year, the cut being in September / October to 70mm, timing subject to whether damp areas are inundated. Lightly rake and remove all arisings to designated area for disposal.

Regime F – Damp Wildflower (EP1F seed mix) - *refer to landscape management plan*

GCF1: Damp Wildflower

- ***Performance*** Height 25-50mm

To a natural height to all banked grass areas but without woody plant encroachment and a height of 25-50mm to the publically accessible terraced areas during the growing period. Cut grass with an approved strimmer or mower capable of dealing with woody stems up to 25mm diameter.

Damp wildflower banks are to be cut once a year, the cut being in September / October to 70mm, timing subject to whether damp areas are inundated. Lightly rake and remove all arisings to designated area for disposal.

Tasks (Aquatic Planting)

****AQO1: General Maintenance Visits - refer to landscape management plan***

- The Contractor shall provide a minimum of 10 weekly visits to ensure that human litter is removed from the water body, but no dead plant material and leaf litter should be removed as this would have detrimental effects on the aquatic invertebrate populations and diversity. The contractor is, however, to skim floating leaves from the ponds surfaces monthly in late autumn and early winter to prevent excessive build up and decaying material in the ponds.

- `The Contractor shall monitor growth of reeds and marginal plants (as a percentage cover of pond area) and carry out control by pulling, if plants become too dominant (retaining 80% of the areas as open water). Control of shading and succession in pond by hand pulling of woody species (allow up to 10% cover of woody species only) establishing in areas of marginal planting. Removal of non-native invasive species (such as Indian Balsam) as they occur. Cutting and removal of marginal, emergent and aquatic plants is to be carried out on a 2 – 3 year rotational basis in autumn if deemed necessary. Arisings are to be left by the water body to allow fauna to escape into the water body for 48 hours before removal. Not all ponds are to be managed in this way in the same year.
- The Contractor shall monitor water quality and the growth of algal blooms and treat if necessary, seeking specialist advice.

Tasks (Shrub Planting)

SBB1: Native Shrub Area Maintenance refer to landscape management plan

- The Contractor shall visit each shrub bed identified for Regime B Maintenance on a minimum of 12 occasions equally spaced through the year, i.e. monthly visits. The Contractor shall undertake the following operations on each visit;
- Remove, using correct horticultural practices, all fallen flowers, leaves and other debris. All cultivated areas shall be cleared of litter and other debris. The Contractor shall ensure that each maintenance visit coincides with a litter removal visit.

- The Contractor shall at each visit remove all dead, damaged, infested, reverted or diseased branches and stems using correct horticultural practices. The Contractor shall otherwise prune all plant material that can be correctly pruned in accordance with 14.4 of General Landscape Management Plan. Any flowering materials or plants grown for winter stem effect, that would have their display value reduced if pruned at this time, shall not be pruned. The Supervisor will instruct the Contractor to prune such shrubs in accordance with the timing for pruning detailed in Section 14.4.3 of the General Landscape Management Plan.
- All dead shrubs and plants shall be removed and the Supervisor advised.
- The Supervisor may instruct the Contractor to supply and plant new plant material in accordance with the Planting Specification, at the same time as the plant material is removed or as specified by the Supervisor within the planting season.

- Remove weeds by pulling by hand, hoeing and raking, avoiding damage to stems, branches and plant roots, leaving a clean weed free surface cultivated to a medium tilth. No herbicides shall be used.

**** SBB2: Cultivation and Pruning Visit - refer to landscape management plan***

- The Contractor shall visit each shrub bed on one occasion in the winter during November (PP11) to March (PP3). The Contractor shall undertake all the following operations during this visit.
- The Contractor shall cultivate beds to relieve areas of compaction to a depth of 75mm in order to maintain a high standard of appearance, by forking or similar approved method. Care will be taken not to damage or disturb roots, branches and stems, and avoid excessive treading of the surface. The Contractor shall break down any lumps and leave the surface weed free with a medium/fine tilth.
- All arisings shall be collected and disposed of as specified in 13.0 of the General Landscape Management.
- The Contractor shall allow in their rates to cut back shrubs when necessary by not more than one-third of the previous year's incremental growth in order to prevent obstructions to paths, roads, signs, steps, sight lines, windows, doors and other similar situations to allow access as specified by the Supervisor. Where plant material becomes an obstruction, the Contractor shall be required to reprune the material within 48 hours of notification by the Supervisor and at no additional cost to the Supervisor.

Tasks (Tree Planting)

- ****TMSG01: Tree Stakes and Ties - refer to landscape management plan***
- The Contractor should check on a two monthly basis the condition of Tree Stakes and Guys. In addition further inspections should be carried out immediately after strong winds.
- Stakes – replace loose, broken or decayed stakes to original specification. If longer than half of clear tree stem height, cut to this height in spring. Retie to tree firmly but not tightly with a single tie.
- Ties – Adjust, refix or replace loose or defective ties, allowing for growth and prevent chaffing. Where chaffing has occurred, reposition or replace ties to prevent further chaffing.

- Removal of Stakes and Ties – remove stakes and ties two years after planting. Fill stake holes with lightly compacted soil.

- ***TMFP01: Formative Pruning - refer to landscape management plan***

- Formative Pruning of young trees – This work should be undertaken to ensure the successful establishment of the trees. The works should not be carried out during the late winter/early spring sap flow period.
- Young trees up to 4m high should be crown pruned by removing dead branches and reducing selected side branches by one third to preserve a well balanced head and ensure the development of a single strong leader. Remove duplicated branches and potentially weak or tight forks. In each case cut back to live wood.
- Extensive pruning of young trees and any surgery to larger trees must be carried out by an approved member of the Arboricultural Association or other approved specialist.

TMCP01: Cutting and Pruning Generall - refer to landscape management plan

- All the tools used should be appropriate, well maintained and sharp. Final pruning cuts – do not use chainsaws on branches of less than 50 cm diameter. When -using handsaws, cut in one continuous operation to form a smooth cut surface. Do not use anvil type secateurs.
- When removing branches do not damage of tear the stem.
- Keep wounds as small as possible, cut cleanly back to sound wood leaving a smooth surface, and angled so that water will not collect on the cut area.
- When cutting, cut at fork or at the main stem to avoid stumps wherever possible.
- Large branches – remove only if unavoidable. Remove in small sections and lower to the ground with ropes and slings.
- Dead branches and stubs – when removing do not cut into live wood.
- Unsafe branches – remove epicormic shoots and potentially weak forks that could fail in adverse weather conditions.
- Disease of fungus – give notice if detected. Do not apply fungicide or sealant unless instructed.

- Bark Damage – wounds – do not attempt to stop sap bleeding. Gently remove ragged edges and remove splintered wood from deep wounds as small as possible. Give notice if there is any liquid or flux oozing form apparently healthy bark.
- Cavities in Trees – Cavities should be investigated. Old cavities in mature trees should be left alone subject to health and safety audit. New cavities are likely to have been made by woodpeckers and may reflect nesting in which case disturbance is illegal. Where the extent of a cavity is not visible, there is also a risk a bat or bats may be present. Such cavities should be notified but no further action taken without advice from a suitably qualified ecologist. For new small cavities in ornamental species, where bats or nesting birds are obviously absent, rubbish and rotten wood should be removed. The cavity should be probed to find the extent of any decay, and give notice. The cavities should not be covered.

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
- Remove silts in dry basins where it threatens to restrict the capacity of inlets or outlets or is unsightly.

Downstream Defenders

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 Ancilliaries

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.
- 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

Final Flow Control (Hydrobrake at final outlet)

Regime as per controls above

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

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A3 ORIGINAL

rev.	amendment	checked	date

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NEWLANDS
WATERLOOVILLE

scale	1:2000	drawn by	HJ	checked by	PAS
date	JANUARY 2012	cad file	GTWVILLE3_DR_03		

title
PHASE 1 INFRASTRUCTURE
SUDS CATCHMENTS

drawing number
GTWVILLE3/DR/03

rev.