193794/O – Application for outline planning permission for up to 100 dwellings including means of access onto the A480

A Flood Risk Assessment, inclusive of an Outline Drainage Assessment, was submitted to Herefordshire Council as part of the above-named planning application, document reference: LOC-BWB-ZZ-XX-RP-YE-0001_FRA. The drainage strategy proposed that infiltration techniques were used to dispose of surface water from the site, in accordance with the first level of the drainage hierarchy. The rate of infiltration used to inform the calculations was taken from the results of site-specific testing.

Following comments from the Lead Local Flood Authority (LLFA), additional investigations have been undertaken to confirm the appropriateness of infiltration techniques at this location for the disposal of surface water. Further testing has been done in accordance with BRE365 methodologies and falling head testing has also been undertaken to greater depths to establish the feasibility of infiltration within deeper strata. This note details the implications of the additional testing on the proposed drainage approach.

A plan showing the location of the additional testing locations is included as **Annex 1**, with the associated results summarised below as **Table 1** and **Table 2**.

Table 1: BRE365 Soakaway Test Results

Test Location	Infiltration Rate – Test 1	Infiltration Rate – Test 2
SA101	8.7×10^{-7}	8.4×10^{-7}
SA102	9.7×10^{-7}	8.2×10^{-7}
SA103	7.7×10^{-8}	

Table 2: Falling Head Tests

Test Location	Basic Time Lag Method	General Method
DS101 Test A	6.06×10^{-9}	5.97×10^{-9}
DS102 Test A	3.65×10^{-7}	7.89×10^{-8}
DS103 Test A	1.09×10^{-6}	5.87×10^{-6}
DS103 Test B	1.44×10^{-6}	2.17×10^{-7}
DS103 Test C	1.38×10^{-6}	2.73×10^{-7}
DS104 Test A	7.7×10^{-8}	

A revised drainage strategy has been produced, which demonstrates that a strategy relying on the previously identified principles can be delivered. This means the strategy has been designed to accommodate the 100-year storm with a 20% allowance for climate change, and there is sufficient volume available to accommodate a 10-year follow on storm. This has been

established by running two calculations, one for the 100-year plus 20% storm event and another for a 10-year storm event, then adding the resultant volumes together. The drainage strategy drawing is included in **Annex 2**, with the associate calculations in **Annex 3**.

The proposed infiltration basins have been sized using the most conservative infiltration rate, as obtained from the nearest test. This means that a rate of 8.4 x 10^{-7}m/s has been used to size the storage requirements for Catchments 1 and 2 in the east, whereas a rate of 8.2 x 10^{-7}m/s has been used for the Catchment 3 in the west.

While these rates are marginally lower than those extrapolated previously, they do still demonstrate that infiltration basins can still provide the required storage volumes in this location. Whilst the basins do increase slightly in size compared to previously, the required volumes can still be incorporated without any significant changes to the indicative layout. A comparison of the drainage requirements is presented in **Table 3**.

Table 3: Comparison of drainage parameters

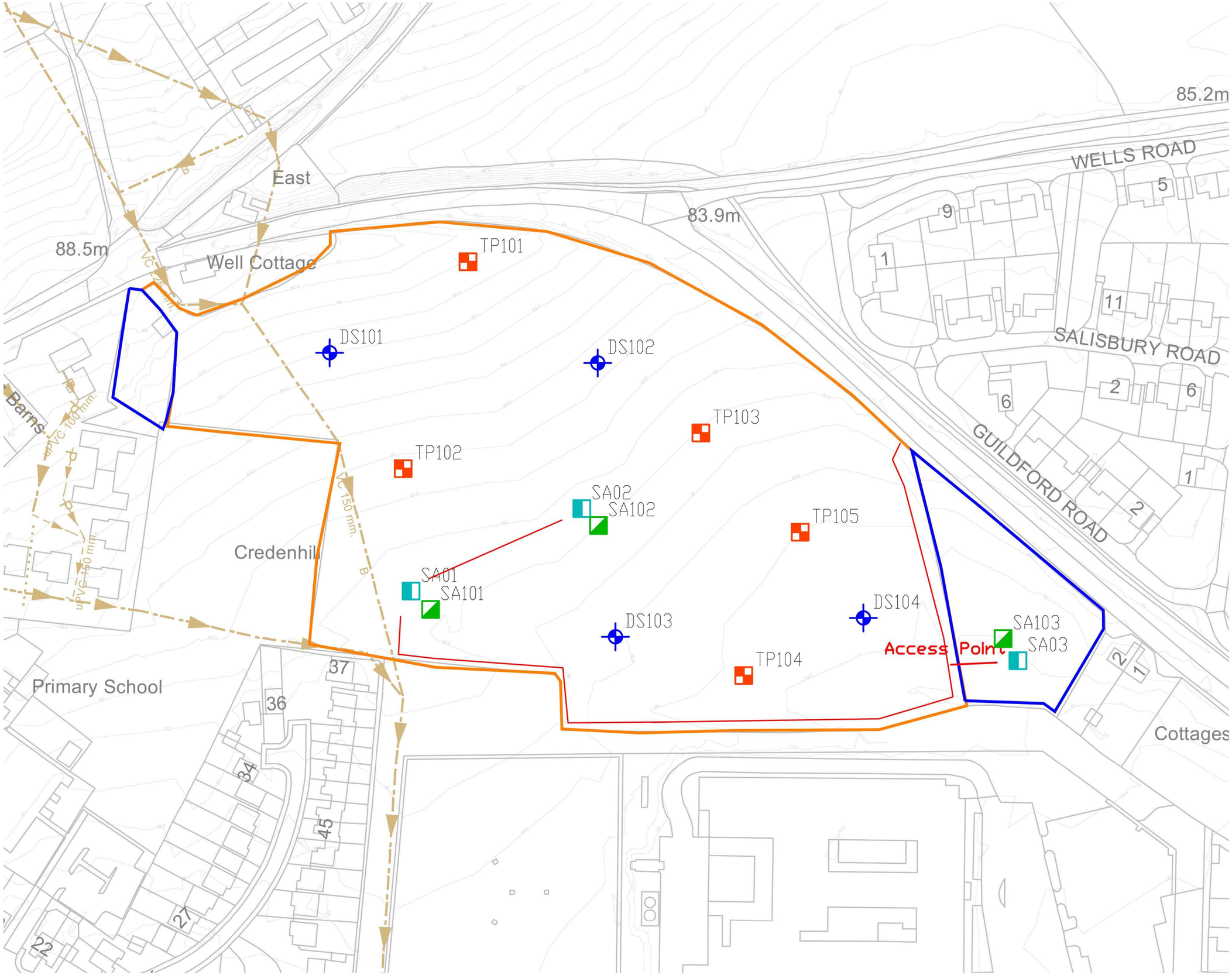
Catchment	Previous Basin Parameters (Drainage strategy provided within the Flood Risk Assessment)		Revised Basin Parameters (As attached to this note)	
	Plan Area, m^2	Volume, m^3 (100yr + 20%)	Plan Area, m^2	Volume, m^3 (100yr + 20%)
1	339	125	360	146
2	605	350	647	405
3*	529	289	975	683

* The required volumes are split into two on the accompany drainage strategy drawing, given the contours across the infiltration basin, however this has been modelled as one volume for the purposes of this assessment. The split of the basins should be considered as the masterplan and drainage design evolve at the detailed design stage.

It is acknowledged that the results obtained during the falling head tests have generally obtained preferable infiltration rates. These rates were obtained at greater depth (c.5m), where the underlying geology is different. There may be scope to utilise these better infiltration rates during the detailed design stage, as the layout evolves. However, at this stage, the use of the shallower standard soakaway test results is considered to provide a more conservative representation of drainage conditions at the site, demonstrating that a drainage solution is available at the site.

Regardless of the final solution proposed, the above should provide comfort that a drainage strategy reliant on infiltration techniques is achievable.

Annex 1: Testing Locations



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Notes

1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
4. Any discrepancies noted on site are to be reported to the engineer immediately.
5. It has been assumed that the additional land under the clients control can be utilized for surface water attenuation.
6. All basins have been designed with a 300mm freeboard, in line with local guidance.
7. Do not construct from this drawing.

Legend

- SA** 2019 Soakaway Pit
- SA1** 2020 Soakaway Pit
- TP1** Trial Pit
- DS1** Dynamic Sampler

Rev	Date	Details of issue / revision	Drw	Rev
P1	22/01/20	PRELIMINARY ISSUE	JA	CR

Issues & Revisions

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Client
PlanIT Planning & Development

Project Title
Land off A480, Credenhill

Drawing Title
Preliminary Exploratory Hole Location Plan

Drawn:	JA		Reviewed:	CR
BWB Ref:	BMT2457	Date:	22/01/20	Scale@A3: NTS

Drawing Status
PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
LOC-BWB-ZZ-XX-SK-YE-0002_PEHQ	S4	P2

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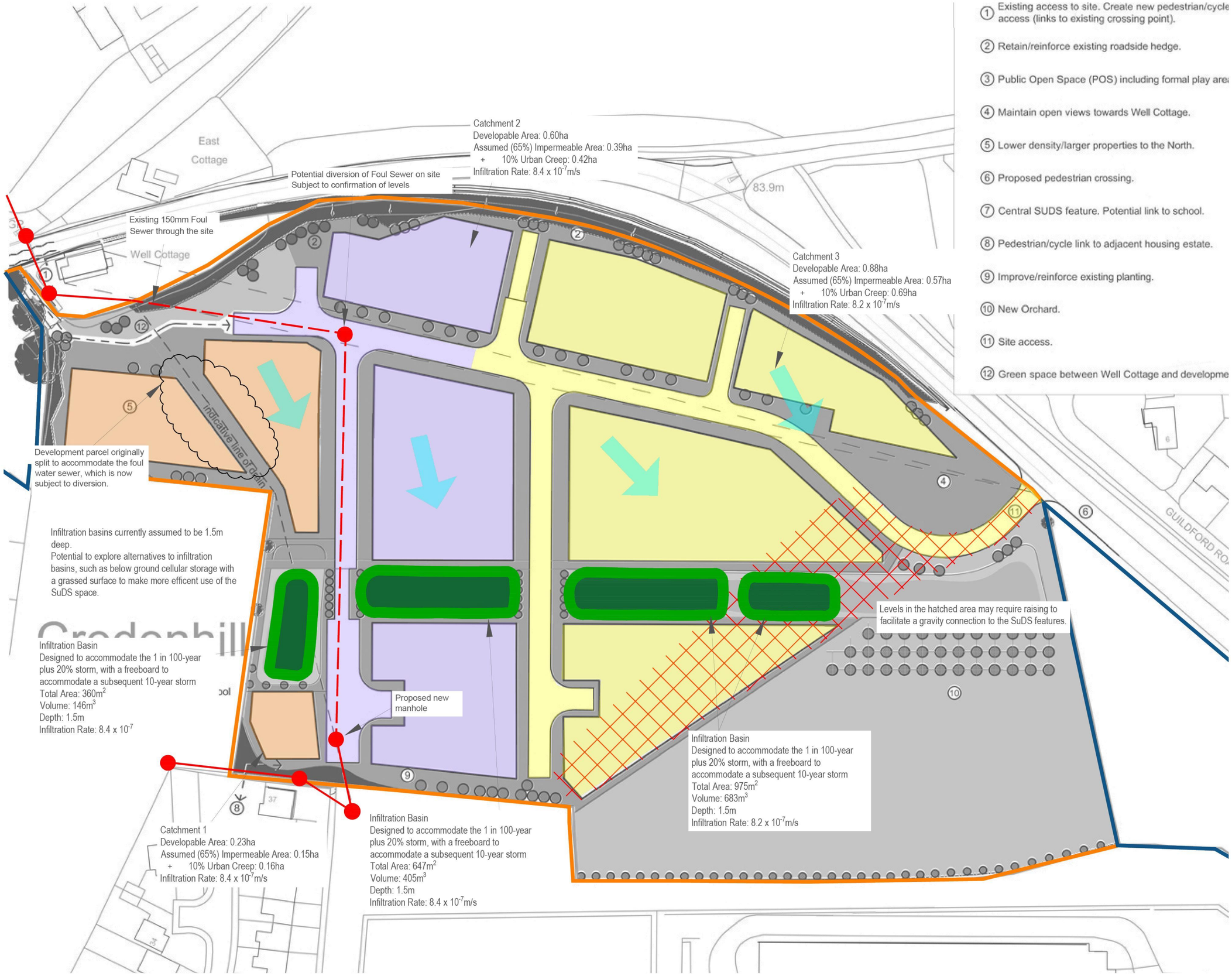
Annex 2: Illustrative Drainage Strategy



Notes

1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
4. Any discrepancies noted on site are to be reported to the engineer immediately.
5. Existing site levels shown are extracted from Castle Surveys topographical survey [Drw No. 19182-19-01]. Drawing subject to an earthworks assessment.
6. Sewer Location extracted from Welsh Water asset plans.
7. All basins have been designed with a 300mm freeboard, in line with local guidance.
8. Sewer layout will be determined following the production of a more detailed masterplan at detailed design stage.
9. Drawing is indicative only, do not construct from this drawing.

Legend

- Indicative Site Boundary
- Additional Land under Client's Control
- Existing Foul Sewer
- Potential Diversion of Foul Sewer
- Catchment 1
- Catchment 2
- Catchment 3
- Gravity connection subject to earthworks assessment
- Infiltration SuDS Feature
- Flow Route

Rev	Date	Details of issue / revision	Drw	Rev
P05	24.02.20	INDICATIVE DRAINAGE MARKUP	NJ	
P04	24.10.19	INDICATIVE DRAINAGE MARKUP	HG	-
P03	11.10.19	INDICATIVE DRAINAGE MARKUP	NJ	HG
P02	01.10.19	ADDITION OF TOPOGRAPHICAL SURVEY	NJ	HG
P01	27.09.19	PRELIMINARY ISSUE	NJ	HG

Issues & Revisions

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Client
Mrs A. Spreckley, Mrs Eleanor Van Straaten and Trustees for the children of Eleanor Van Straaten

Project Title
Land off A480, Credenhill

Drawing Title
Indicative Drainage Strategy

Drawn:	N. James		Reviewed:	H. Griffiths	
BWB Ref:	BMT2457	Date:	27.09.19	Scale@A3:	1000

Drawing Status
PRELIMINARY

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
LOC-BWB-ZZ-XX-DR-CD-0001	S2	P05

BETTER SOLUTIONS, INTELLIGENTLY ENGINEERED

Annex 3: Supporting Drainage Strategy Calculations

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 7976 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	98.916	0.416	0.1	39.9	O K
30 min Summer	98.973	0.473	0.1	47.4	O K
60 min Summer	99.036	0.536	0.1	56.2	O K
120 min Summer	99.104	0.604	0.1	66.5	O K
180 min Summer	99.146	0.646	0.1	73.4	O K
240 min Summer	99.177	0.677	0.1	78.6	O K
360 min Summer	99.221	0.721	0.1	86.4	O K
480 min Summer	99.253	0.753	0.1	92.2	O K
600 min Summer	99.278	0.778	0.1	96.9	O K
720 min Summer	99.299	0.799	0.1	100.9	O K
960 min Summer	99.329	0.829	0.2	106.8	O K
1440 min Summer	99.369	0.869	0.2	115.0	O K
2160 min Summer	99.405	0.905	0.2	122.6	O K
2880 min Summer	99.426	0.926	0.2	127.3	O K
4320 min Summer	99.432	0.932	0.2	128.5	O K
5760 min Summer	99.427	0.927	0.2	127.4	O K
7200 min Summer	99.421	0.921	0.2	126.2	O K
8640 min Summer	99.415	0.915	0.2	124.9	O K
10080 min Summer	99.409	0.909	0.2	123.6	O K
15 min Winter	98.953	0.453	0.1	44.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	133.247	0.0	27
30 min Summer	79.185	0.0	42
60 min Summer	47.057	0.0	72
120 min Summer	27.965	0.0	132
180 min Summer	20.625	0.0	192
240 min Summer	16.619	0.0	252
360 min Summer	12.257	0.0	370
480 min Summer	9.876	0.0	490
600 min Summer	8.353	0.0	610
720 min Summer	7.284	0.0	730
960 min Summer	5.849	0.0	970
1440 min Summer	4.293	0.0	1448
2160 min Summer	3.151	0.0	2168
2880 min Summer	2.530	0.0	2884
4320 min Summer	1.814	0.0	4320
5760 min Summer	1.432	0.0	5360
7200 min Summer	1.193	0.0	5984
8640 min Summer	1.027	0.0	6736
10080 min Summer	0.905	0.0	7464
15 min Winter	133.247	0.0	27

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	99.014	0.514	0.1	53.1	O K
60 min Winter	99.081	0.581	0.1	62.9	O K
120 min Winter	99.153	0.653	0.1	74.6	O K
180 min Winter	99.198	0.698	0.1	82.2	O K
240 min Winter	99.231	0.731	0.1	88.1	O K
360 min Winter	99.278	0.778	0.1	96.9	O K
480 min Winter	99.312	0.812	0.2	103.5	O K
600 min Winter	99.339	0.839	0.2	108.8	O K
720 min Winter	99.360	0.860	0.2	113.3	O K
960 min Winter	99.392	0.892	0.2	120.0	O K
1440 min Winter	99.436	0.936	0.2	129.4	O K
2160 min Winter	99.475	0.975	0.2	138.3	O K
2880 min Winter	99.499	0.999	0.2	143.9	O K
4320 min Winter	99.509	1.009	0.2	146.2	O K
5760 min Winter	99.507	1.007	0.2	145.8	O K
7200 min Winter	99.499	0.999	0.2	143.9	O K
8640 min Winter	99.490	0.990	0.2	141.9	O K
10080 min Winter	99.483	0.983	0.2	140.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	79.185	0.0	42
60 min Winter	47.057	0.0	72
120 min Winter	27.965	0.0	130
180 min Winter	20.625	0.0	190
240 min Winter	16.619	0.0	248
360 min Winter	12.257	0.0	366
480 min Winter	9.876	0.0	484
600 min Winter	8.353	0.0	602
720 min Winter	7.284	0.0	722
960 min Winter	5.849	0.0	958
1440 min Winter	4.293	0.0	1428
2160 min Winter	3.151	0.0	2124
2880 min Winter	2.530	0.0	2824
4320 min Winter	1.814	0.0	4188
5760 min Winter	1.432	0.0	5480
7200 min Winter	1.193	0.0	6696
8640 min Winter	1.027	0.0	7000
10080 min Winter	0.905	0.0	7864

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 345750 243300 SO 45750 43300
C (1km)	-0.028
D1 (1km)	0.378
D2 (1km)	0.366
D3 (1km)	0.308
E (1km)	0.300
F (1km)	2.289
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.160

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.053	4	8	0.053	8	12	0.053

Model Details

Storage is Online Cover Level (m) 100.000

Infiltration Basin Structure

Invert Level (m) 98.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00302 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00302

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	68.7	1.500	358.0

Summary of Results for 10 year Return Period

Half Drain Time : 6030 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	98.687	0.187	0.1	15.0	O K
30 min Summer	98.725	0.225	0.1	18.6	O K
60 min Summer	98.769	0.269	0.1	23.1	O K
120 min Summer	98.820	0.320	0.1	28.6	O K
180 min Summer	98.853	0.353	0.1	32.3	O K
240 min Summer	98.878	0.378	0.1	35.2	O K
360 min Summer	98.914	0.414	0.1	39.7	O K
480 min Summer	98.940	0.440	0.1	43.1	O K
600 min Summer	98.961	0.461	0.1	45.8	O K
720 min Summer	98.979	0.479	0.1	48.2	O K
960 min Summer	99.005	0.505	0.1	51.7	O K
1440 min Summer	99.040	0.540	0.1	56.8	O K
2160 min Summer	99.072	0.572	0.1	61.6	O K
2880 min Summer	99.091	0.591	0.1	64.6	O K
4320 min Summer	99.099	0.599	0.1	65.9	O K
5760 min Summer	99.102	0.602	0.1	66.3	O K
7200 min Summer	99.103	0.603	0.1	66.4	O K
8640 min Summer	99.102	0.602	0.1	66.3	O K
10080 min Summer	99.100	0.600	0.1	66.0	O K
15 min Winter	98.706	0.206	0.1	16.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	50.086	0.0	27
30 min Summer	31.153	0.0	42
60 min Summer	19.377	0.0	72
120 min Summer	12.053	0.0	132
180 min Summer	9.130	0.0	192
240 min Summer	7.497	0.0	250
360 min Summer	5.679	0.0	370
480 min Summer	4.663	0.0	490
600 min Summer	4.002	0.0	610
720 min Summer	3.532	0.0	728
960 min Summer	2.890	0.0	968
1440 min Summer	2.179	0.0	1446
2160 min Summer	1.642	0.0	2164
2880 min Summer	1.344	0.0	2884
4320 min Summer	0.990	0.0	4032
5760 min Summer	0.796	0.0	4728
7200 min Summer	0.673	0.0	5472
8640 min Summer	0.586	0.0	6232
10080 min Summer	0.522	0.0	7064
15 min Winter	50.086	0.0	27

Summary of Results for 10 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	98.747	0.247	0.1	20.8	O K
60 min Winter	98.796	0.296	0.1	25.9	O K
120 min Winter	98.851	0.351	0.1	32.0	O K
180 min Winter	98.886	0.386	0.1	36.2	O K
240 min Winter	98.912	0.412	0.1	39.5	O K
360 min Winter	98.951	0.451	0.1	44.5	O K
480 min Winter	98.980	0.480	0.1	48.4	O K
600 min Winter	99.003	0.503	0.1	51.5	O K
720 min Winter	99.021	0.521	0.1	54.1	O K
960 min Winter	99.049	0.549	0.1	58.2	O K
1440 min Winter	99.088	0.588	0.1	64.1	O K
2160 min Winter	99.124	0.624	0.1	69.7	O K
2880 min Winter	99.146	0.646	0.1	73.4	O K
4320 min Winter	99.158	0.658	0.1	75.4	O K
5760 min Winter	99.160	0.660	0.1	75.7	O K
7200 min Winter	99.159	0.659	0.1	75.6	O K
8640 min Winter	99.157	0.657	0.1	75.3	O K
10080 min Winter	99.154	0.654	0.1	74.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	31.153	0.0	42
60 min Winter	19.377	0.0	72
120 min Winter	12.053	0.0	130
180 min Winter	9.130	0.0	188
240 min Winter	7.497	0.0	248
360 min Winter	5.679	0.0	366
480 min Winter	4.663	0.0	484
600 min Winter	4.002	0.0	602
720 min Winter	3.532	0.0	720
960 min Winter	2.890	0.0	954
1440 min Winter	2.179	0.0	1422
2160 min Winter	1.642	0.0	2120
2880 min Winter	1.344	0.0	2800
4320 min Winter	0.990	0.0	4112
5760 min Winter	0.796	0.0	5304
7200 min Winter	0.673	0.0	5696
8640 min Winter	0.586	0.0	6584
10080 min Winter	0.522	0.0	7560

Rainfall Details

Rainfall Model	FEH
Return Period (years)	10
FEH Rainfall Version	1999
Site Location	GB 345750 243300 SO 45750 43300
C (1km)	-0.028
D1 (1km)	0.378
D2 (1km)	0.366
D3 (1km)	0.308
E (1km)	0.300
F (1km)	2.289
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) 0.160

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.053	4	8	0.053	8	12	0.053

Model Details

Storage is Online Cover Level (m) 100.000

Infiltration Basin Structure

Invert Level (m) 98.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00302 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00302

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	68.7	1.500	358.0

Summary of Results for 100 year Return Period (+20%)

Half Drain Time exceeds 7 days.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	98.897	0.397	0.2	104.7	O K
30 min Summer	98.959	0.459	0.2	124.4	O K
60 min Summer	99.028	0.528	0.2	147.6	O K
120 min Summer	99.106	0.606	0.2	175.0	O K
180 min Summer	99.154	0.654	0.2	193.1	O K
240 min Summer	99.190	0.690	0.2	206.9	O K
360 min Summer	99.243	0.743	0.3	227.8	O K
480 min Summer	99.282	0.782	0.3	243.6	O K
600 min Summer	99.312	0.812	0.3	256.3	O K
720 min Summer	99.337	0.837	0.3	267.1	O K
960 min Summer	99.375	0.875	0.3	283.5	O K
1440 min Summer	99.427	0.927	0.3	306.9	O K
2160 min Summer	99.477	0.977	0.3	329.9	O K
2880 min Summer	99.509	1.009	0.3	345.1	O K
4320 min Summer	99.527	1.027	0.3	354.2	O K
5760 min Summer	99.531	1.031	0.3	356.2	O K
7200 min Summer	99.527	1.027	0.3	354.2	O K
8640 min Summer	99.521	1.021	0.3	350.9	O K
10080 min Summer	99.514	1.014	0.3	347.9	O K
15 min Winter	98.937	0.437	0.2	117.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	133.247	0.0	27
30 min Summer	79.185	0.0	42
60 min Summer	47.057	0.0	72
120 min Summer	27.965	0.0	132
180 min Summer	20.625	0.0	192
240 min Summer	16.619	0.0	252
360 min Summer	12.257	0.0	372
480 min Summer	9.876	0.0	490
600 min Summer	8.353	0.0	610
720 min Summer	7.284	0.0	730
960 min Summer	5.849	0.0	970
1440 min Summer	4.293	0.0	1448
2160 min Summer	3.151	0.0	2168
2880 min Summer	2.530	0.0	2888
4320 min Summer	1.814	0.0	4324
5760 min Summer	1.432	0.0	5760
7200 min Summer	1.193	0.0	7200
8640 min Summer	1.027	0.0	7864
10080 min Summer	0.905	0.0	8472
15 min Winter	133.247	0.0	27

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	99.004	0.504	0.2	139.3	O K
60 min Winter	99.079	0.579	0.2	165.4	O K
120 min Winter	99.162	0.662	0.2	196.1	O K
180 min Winter	99.215	0.715	0.3	216.4	O K
240 min Winter	99.253	0.753	0.3	231.9	O K
360 min Winter	99.310	0.810	0.3	255.4	O K
480 min Winter	99.352	0.852	0.3	273.2	O K
600 min Winter	99.385	0.885	0.3	287.7	O K
720 min Winter	99.412	0.912	0.3	299.8	O K
960 min Winter	99.452	0.952	0.3	318.4	O K
1440 min Winter	99.509	1.009	0.3	345.2	O K
2160 min Winter	99.563	1.063	0.3	371.7	O K
2880 min Winter	99.598	1.098	0.4	389.5	O K
4320 min Winter	99.621	1.121	0.4	401.4	O K
5760 min Winter	99.629	1.129	0.4	405.5	O K
7200 min Winter	99.629	1.129	0.4	405.4	O K
8640 min Winter	99.624	1.124	0.4	402.8	O K
10080 min Winter	99.616	1.116	0.4	398.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	79.185	0.0	42
60 min Winter	47.057	0.0	72
120 min Winter	27.965	0.0	130
180 min Winter	20.625	0.0	190
240 min Winter	16.619	0.0	248
360 min Winter	12.257	0.0	368
480 min Winter	9.876	0.0	486
600 min Winter	8.353	0.0	604
720 min Winter	7.284	0.0	722
960 min Winter	5.849	0.0	960
1440 min Winter	4.293	0.0	1432
2160 min Winter	3.151	0.0	2140
2880 min Winter	2.530	0.0	2832
4320 min Winter	1.814	0.0	4232
5760 min Winter	1.432	0.0	5592
7200 min Winter	1.193	0.0	6912
8640 min Winter	1.027	0.0	8208
10080 min Winter	0.905	0.0	9384

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 345750 243300 SO 45750 43300
C (1km)	-0.028
D1 (1km)	0.378
D2 (1km)	0.366
D3 (1km)	0.308
E (1km)	0.300
F (1km)	2.289
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.420

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.140	4	8	0.140	8	12	0.140

Model Details

Storage is Online Cover Level (m) 100.000

Infiltration Basin Structure

Invert Level (m) 98.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00304 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00304

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	219.2	1.500	647.3

Summary of Results for 10 year Return Period

Half Drain Time : 8180 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	98.666	0.166	0.1	39.3	O K
30 min Summer	98.703	0.203	0.1	48.8	O K
60 min Summer	98.746	0.246	0.1	60.6	O K
120 min Summer	98.798	0.298	0.2	75.1	O K
180 min Summer	98.832	0.332	0.2	85.0	O K
240 min Summer	98.858	0.358	0.2	92.7	O K
360 min Summer	98.897	0.397	0.2	104.6	O K
480 min Summer	98.926	0.426	0.2	113.7	O K
600 min Summer	98.949	0.449	0.2	121.2	O K
720 min Summer	98.969	0.469	0.2	127.6	O K
960 min Summer	98.999	0.499	0.2	137.5	O K
1440 min Summer	99.041	0.541	0.2	152.0	O K
2160 min Summer	99.082	0.582	0.2	166.3	O K
2880 min Summer	99.108	0.608	0.2	175.9	O K
4320 min Summer	99.126	0.626	0.2	182.5	O K
5760 min Summer	99.131	0.631	0.2	184.3	O K
7200 min Summer	99.132	0.632	0.2	184.8	O K
8640 min Summer	99.132	0.632	0.2	184.7	O K
10080 min Summer	99.131	0.631	0.2	184.3	O K
15 min Winter	98.684	0.184	0.1	44.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	50.086	0.0	27
30 min Summer	31.153	0.0	42
60 min Summer	19.377	0.0	72
120 min Summer	12.053	0.0	132
180 min Summer	9.130	0.0	192
240 min Summer	7.497	0.0	252
360 min Summer	5.679	0.0	370
480 min Summer	4.663	0.0	490
600 min Summer	4.002	0.0	610
720 min Summer	3.532	0.0	730
960 min Summer	2.890	0.0	968
1440 min Summer	2.179	0.0	1448
2160 min Summer	1.642	0.0	2168
2880 min Summer	1.344	0.0	2884
4320 min Summer	0.990	0.0	4320
5760 min Summer	0.796	0.0	5592
7200 min Summer	0.673	0.0	6192
8640 min Summer	0.586	0.0	6912
10080 min Summer	0.522	0.0	7672
15 min Winter	50.086	0.0	27

Summary of Results for 10 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	98.725	0.225	0.1	54.7	O K
60 min Winter	98.773	0.273	0.2	67.9	O K
120 min Winter	98.829	0.329	0.2	84.2	O K
180 min Winter	98.867	0.367	0.2	95.3	O K
240 min Winter	98.895	0.395	0.2	104.0	O K
360 min Winter	98.937	0.437	0.2	117.4	O K
480 min Winter	98.969	0.469	0.2	127.7	O K
600 min Winter	98.995	0.495	0.2	136.2	O K
720 min Winter	99.016	0.516	0.2	143.4	O K
960 min Winter	99.049	0.549	0.2	154.7	O K
1440 min Winter	99.095	0.595	0.2	171.3	O K
2160 min Winter	99.141	0.641	0.2	188.0	O K
2880 min Winter	99.171	0.671	0.2	199.4	O K
4320 min Winter	99.194	0.694	0.3	208.2	O K
5760 min Winter	99.203	0.703	0.3	211.8	O K
7200 min Winter	99.205	0.705	0.3	212.4	O K
8640 min Winter	99.202	0.702	0.3	211.5	O K
10080 min Winter	99.201	0.701	0.3	210.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	31.153	0.0	42
60 min Winter	19.377	0.0	72
120 min Winter	12.053	0.0	130
180 min Winter	9.130	0.0	188
240 min Winter	7.497	0.0	248
360 min Winter	5.679	0.0	366
480 min Winter	4.663	0.0	484
600 min Winter	4.002	0.0	602
720 min Winter	3.532	0.0	722
960 min Winter	2.890	0.0	956
1440 min Winter	2.179	0.0	1428
2160 min Winter	1.642	0.0	2124
2880 min Winter	1.344	0.0	2824
4320 min Winter	0.990	0.0	4192
5760 min Winter	0.796	0.0	5488
7200 min Winter	0.673	0.0	6768
8640 min Winter	0.586	0.0	7792
10080 min Winter	0.522	0.0	7976

Rainfall Details

Rainfall Model	FEH
Return Period (years)	10
FEH Rainfall Version	1999
Site Location	GB 345750 243300 SO 45750 43300
C (1km)	-0.028
D1 (1km)	0.378
D2 (1km)	0.366
D3 (1km)	0.308
E (1km)	0.300
F (1km)	2.289
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) 0.420

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.140	4	8	0.140	8	12	0.140

Model Details

Storage is Online Cover Level (m) 100.000

Infiltration Basin Structure

Invert Level (m) 98.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00304 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00304

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	219.2	1.500	647.3

Summary of Results for 100 year Return Period (+20%)

Half Drain Time exceeds 7 days.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	98.859	0.359	0.3	172.1	O K
30 min Summer	98.919	0.419	0.3	204.4	O K
60 min Summer	98.986	0.486	0.3	242.6	O K
120 min Summer	99.062	0.562	0.3	287.6	O K
180 min Summer	99.111	0.611	0.3	317.4	O K
240 min Summer	99.147	0.647	0.4	340.2	O K
360 min Summer	99.201	0.701	0.4	374.7	O K
480 min Summer	99.240	0.740	0.4	400.9	O K
600 min Summer	99.272	0.772	0.4	422.1	O K
720 min Summer	99.298	0.798	0.4	440.0	O K
960 min Summer	99.337	0.837	0.4	467.5	O K
1440 min Summer	99.393	0.893	0.4	507.1	O K
2160 min Summer	99.446	0.946	0.5	546.6	O K
2880 min Summer	99.482	0.982	0.5	573.3	O K
4320 min Summer	99.506	1.006	0.5	591.6	O K
5760 min Summer	99.514	1.014	0.5	598.3	O K
7200 min Summer	99.515	1.015	0.5	598.4	O K
8640 min Summer	99.509	1.009	0.5	594.3	O K
10080 min Summer	99.502	1.002	0.5	588.6	O K
15 min Winter	98.897	0.397	0.3	192.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	133.247	0.0	27
30 min Summer	79.185	0.0	42
60 min Summer	47.057	0.0	72
120 min Summer	27.965	0.0	132
180 min Summer	20.625	0.0	192
240 min Summer	16.619	0.0	252
360 min Summer	12.257	0.0	372
480 min Summer	9.876	0.0	490
600 min Summer	8.353	0.0	610
720 min Summer	7.284	0.0	730
960 min Summer	5.849	0.0	970
1440 min Summer	4.293	0.0	1450
2160 min Summer	3.151	0.0	2168
2880 min Summer	2.530	0.0	2888
4320 min Summer	1.814	0.0	4324
5760 min Summer	1.432	0.0	5760
7200 min Summer	1.193	0.0	7200
8640 min Summer	1.027	0.0	8640
10080 min Summer	0.905	0.0	9184
15 min Winter	133.247	0.0	27

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	98.962	0.462	0.3	229.0	O K
60 min Winter	99.036	0.536	0.3	271.8	O K
120 min Winter	99.118	0.618	0.4	322.3	O K
180 min Winter	99.171	0.671	0.4	355.8	O K
240 min Winter	99.211	0.711	0.4	381.4	O K
360 min Winter	99.269	0.769	0.4	420.2	O K
480 min Winter	99.312	0.812	0.4	449.7	O K
600 min Winter	99.346	0.846	0.4	473.7	O K
720 min Winter	99.374	0.874	0.4	493.9	O K
960 min Winter	99.417	0.917	0.4	525.0	O K
1440 min Winter	99.478	0.978	0.5	570.2	O K
2160 min Winter	99.537	1.037	0.5	615.6	O K
2880 min Winter	99.576	1.076	0.5	646.9	O K
4320 min Winter	99.605	1.105	0.5	670.1	O K
5760 min Winter	99.618	1.118	0.5	680.4	O K
7200 min Winter	99.622	1.122	0.5	683.5	O K
8640 min Winter	99.620	1.120	0.5	682.1	O K
10080 min Winter	99.615	1.115	0.5	677.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	79.185	0.0	42
60 min Winter	47.057	0.0	72
120 min Winter	27.965	0.0	130
180 min Winter	20.625	0.0	190
240 min Winter	16.619	0.0	250
360 min Winter	12.257	0.0	368
480 min Winter	9.876	0.0	486
600 min Winter	8.353	0.0	604
720 min Winter	7.284	0.0	724
960 min Winter	5.849	0.0	960
1440 min Winter	4.293	0.0	1434
2160 min Winter	3.151	0.0	2144
2880 min Winter	2.530	0.0	2852
4320 min Winter	1.814	0.0	4240
5760 min Winter	1.432	0.0	5600
7200 min Winter	1.193	0.0	6984
8640 min Winter	1.027	0.0	8296
10080 min Winter	0.905	0.0	9584

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	1999
Site Location	GB 345750 243300 SO 45750 43300
C (1km)	-0.028
D1 (1km)	0.378
D2 (1km)	0.366
D3 (1km)	0.308
E (1km)	0.300
F (1km)	2.289
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.690

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.230	4	8	0.230	8	12	0.230

Model Details

Storage is Online Cover Level (m) 100.000

Infiltration Basin Structure

Invert Level (m) 98.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00295 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00295

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	424.3	1.500	975.6

Summary of Results for 10 year Return Period

Half Drain Time : 9222 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	98.645	0.145	0.2	64.6	O K
30 min Summer	98.678	0.178	0.2	80.2	O K
60 min Summer	98.718	0.218	0.2	99.6	O K
120 min Summer	98.766	0.266	0.2	123.4	O K
180 min Summer	98.798	0.298	0.3	139.7	O K
240 min Summer	98.822	0.322	0.3	152.4	O K
360 min Summer	98.859	0.359	0.3	172.0	O K
480 min Summer	98.887	0.387	0.3	187.1	O K
600 min Summer	98.910	0.410	0.3	199.5	O K
720 min Summer	98.929	0.429	0.3	210.1	O K
960 min Summer	98.958	0.458	0.3	226.6	O K
1440 min Summer	99.000	0.500	0.3	250.9	O K
2160 min Summer	99.042	0.542	0.3	275.3	O K
2880 min Summer	99.069	0.569	0.3	291.9	O K
4320 min Summer	99.090	0.590	0.3	304.5	O K
5760 min Summer	99.097	0.597	0.3	309.1	O K
7200 min Summer	99.098	0.598	0.3	309.7	O K
8640 min Summer	99.098	0.598	0.3	309.6	O K
10080 min Summer	99.097	0.597	0.3	308.8	O K
15 min Winter	98.661	0.161	0.2	72.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	50.086	0.0	27
30 min Summer	31.153	0.0	42
60 min Summer	19.377	0.0	72
120 min Summer	12.053	0.0	132
180 min Summer	9.130	0.0	192
240 min Summer	7.497	0.0	252
360 min Summer	5.679	0.0	370
480 min Summer	4.663	0.0	490
600 min Summer	4.002	0.0	610
720 min Summer	3.532	0.0	730
960 min Summer	2.890	0.0	970
1440 min Summer	2.179	0.0	1448
2160 min Summer	1.642	0.0	2168
2880 min Summer	1.344	0.0	2884
4320 min Summer	0.990	0.0	4324
5760 min Summer	0.796	0.0	5760
7200 min Summer	0.673	0.0	6696
8640 min Summer	0.586	0.0	7344
10080 min Summer	0.522	0.0	8064
15 min Winter	50.086	0.0	27

Summary of Results for 10 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	98.698	0.198	0.2	89.9	O K
60 min Winter	98.742	0.242	0.2	111.6	O K
120 min Winter	98.795	0.295	0.3	138.3	O K
180 min Winter	98.830	0.330	0.3	156.6	O K
240 min Winter	98.857	0.357	0.3	170.9	O K
360 min Winter	98.898	0.398	0.3	193.0	O K
480 min Winter	98.929	0.429	0.3	210.1	O K
600 min Winter	98.954	0.454	0.3	224.2	O K
720 min Winter	98.975	0.475	0.3	236.2	O K
960 min Winter	99.007	0.507	0.3	255.0	O K
1440 min Winter	99.054	0.554	0.3	282.8	O K
2160 min Winter	99.101	0.601	0.3	311.2	O K
2880 min Winter	99.132	0.632	0.4	330.9	O K
4320 min Winter	99.158	0.658	0.4	347.3	O K
5760 min Winter	99.170	0.670	0.4	354.9	O K
7200 min Winter	99.174	0.674	0.4	357.5	O K
8640 min Winter	99.174	0.674	0.4	357.2	O K
10080 min Winter	99.170	0.670	0.4	355.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	31.153	0.0	42
60 min Winter	19.377	0.0	72
120 min Winter	12.053	0.0	130
180 min Winter	9.130	0.0	190
240 min Winter	7.497	0.0	248
360 min Winter	5.679	0.0	366
480 min Winter	4.663	0.0	484
600 min Winter	4.002	0.0	604
720 min Winter	3.532	0.0	722
960 min Winter	2.890	0.0	958
1440 min Winter	2.179	0.0	1430
2160 min Winter	1.642	0.0	2132
2880 min Winter	1.344	0.0	2828
4320 min Winter	0.990	0.0	4200
5760 min Winter	0.796	0.0	5536
7200 min Winter	0.673	0.0	6848
8640 min Winter	0.586	0.0	8120
10080 min Winter	0.522	0.0	9176

Rainfall Details

Rainfall Model	FEH
Return Period (years)	10
FEH Rainfall Version	1999
Site Location	GB 345750 243300 SO 45750 43300
C (1km)	-0.028
D1 (1km)	0.378
D2 (1km)	0.366
D3 (1km)	0.308
E (1km)	0.300
F (1km)	2.289
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) 0.690

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.230	4	8	0.230	8	12	0.230

Model Details

Storage is Online Cover Level (m) 100.000

Infiltration Basin Structure

Invert Level (m) 98.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00295 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00295

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	424.3	1.500	975.6