Forge Engineering Design Solutions

SuDS Calculations – Outline Planning Stage

Proposed Recreation Ground
Milton Road
Adderbury
Banbury
OX15

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Project No.	FEDS- 220021	By:	AK	Chkd:	DKP
Title	Proposed Recreation Ground, Milton Road, Adderbury, Banbury OX15				
Sheet No.	1	Date:	February 2020		

1. Surface Water Design - Contributing Areas:

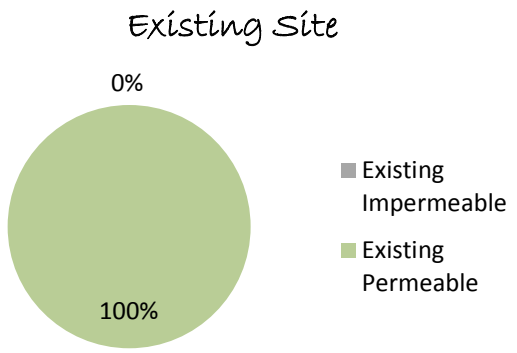
Total site area =	36253.5	m²	=	3.6254 ha

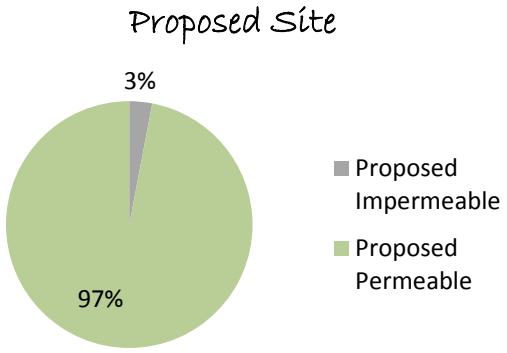
1.1 Existing Site:

Impermeable Area - Existing Building =	0.0	m²	=	0.0000 ha
Impermeable Area - Existing Hardstanding =	0.0	m²	=	0.0000 ha
Existing Impermeable Contributing Area =	0.0	m²	=	0.0000 ha
% of total site:	0.0%			
Existing Permeable Area =	36253.5	m²	=	3.6254 ha
% of total site:	100.0%			

1.1 Proposed Site:

Impermeable Area - Proposed Building =	958.0	m²	=	0.0958 ha
Impermeable Area - Proposed Hardstanding =	131.5	m²	=	0.0132 ha
Proposed Impermeable Contributing Area =	1089.5	m²	=	0.1090 ha
% of total site:	3.0%			
Proposed Permeable Area =	35164.0	m²	=	3.5164 ha
% of total site:	97.0%			





The total impremeable contributing area - post development - shows an increase compared to the existing total impermeable contributing areas.

The new SuDS are designed to mitigate the new impermeable areas of the proposed development to current design standards, therefore, reducing the post development surface water run-off to less than existing.

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2. Surface Water Run-off Flow and Volumes

2.1 Greenfield Run-off Rates, QBar $_{Green}$

IHR 124 Equation 7.1 gives:

$QBAR_{rural} = 0.00108 * AREA^{0.89} SAAR^{1.17} SOIL^{2.17}$

AREA (km^2)	0.50
SAAR (mm)	654
SOIL	0.30
$QBAR_{green}$ ($m^3/s/50ha$)	0.0842
$QBAR_{green}$ (l/s/50ha)	84.2
$QBAR_{green}$ (l/s/ha)	1.68

SITE AREA (m^2)	36253.5
SITE AREA (ha)	3.625
Existing CA (m^2)	0
Proposed CA (m^2)	1089.5

Table 2a: Greenfield run off rates:

STORM EVENT (1 in n year)	Growth Curve Factor	Site Run-off Peak Flows (l/s)	Site Run-off Peak Volume (m3)
QBARGreenfield	-	6.102	131.80
1 in 1 year	0.85	5.187	112.03
1 in 30 year	2.40	14.645	316.32
1 in 100 year	3.19	19.465	420.45
1 in 100 year +40%	4.47	27.251	588.62

2.2 Existing Brownfield Run-off Rates, QBar $_{Brown\ Existing}$

The IHR 124 method requires Brownfield run-off rates are calculated using the Greenfield run-off rates and an adjustment for urbanisastion.

$R = QBar_{Brownfield} / QBar_{Greenfield} = (1+URBAN)^{2NC} \times (1+URBAN \times ((21/CIND) - 0.3))$

NC	0.76
CIND	21.51
CWI	92.1
URBAN	0.00
$R_{existing}$	**1.00**

Table 2b: Existing Site run off rates:

STORM EVENT (1 in n year)	Growth Curve Factor	Site Run-off Peak Flows (l/s)	Site Run-off Peak Volume (m3)
QBARBrownfield	-	6.102	131.80
1 in 1 year	0.85	5.187	112.03
1 in 30 year	2.40	14.645	316.32
1 in 100 year	3.19	19.465	420.45
1 in 100 year+40%	4.47	27.251	588.62

2.3 Proposed Brownfield Run-off Rates, QBar Brown Proposed

NC	0.76
CIND	21.51
CWI	92.1
URBAN	0.03
$R_{proposed}$	**1.07**

Therefore, the site's brownfiield run-off rates and volumes are as follows:

Table 2c: Proposed Site run off rates:

STORM EVENT (1 in n year)	Growth Curve Factor	Site Run-off Peak Flows (l/s)	Site Run-off Peak Volume (m3)
QBARBrownfield	-	6.514	140.70
1 in 1 year	0.85	5.537	119.59
1 in 30 year	2.40	15.633	337.67
1 in 100 year	3.19	20.779	448.82
1 in 100 year+40%	4.47	29.090	628.35

Tables 2b and 2c demonstrate that there is a small potential increase in the run-off peak flow rates and volumes for the proposed site development. Therefore, there would be a need to implement 'mitigating' SuDS measures. It is proposed to use infiltrating SuDS to manage surface water from all the impermebale areas to provide betterment. Furthermore, it is proposed to install land drainage below the sports pitches to ensure the quality of the pitches throughout the year. It is proposed to assume that 35% of the surface water falling onto the pitches could enter the land drainage and a sustainable drainage system is proposed to mitigate this.

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3. Surface Water SuDS Design - Infiltration via Porous Paving:

35% of Total Sports Pitches and MUGA Area =	4550.0	m²	=	0.4550 ha
Total Impermeable Area - Hardstandings =	0.0	m²	=	0.0000 ha
Proposed Total Contributing Area =	4550.0	m²	=	0.4550 ha

The SuDS are designed to mitigate impermeable areas to provide betterment. The worst case BRE 365 Infiltration test was used for the SuDS design:

T1 - Infiltration Rate =	1.85E-04
T2 - Infiltration Rate =	1.67E-04
T3 - Infiltration Rate =	1.58E-04

Sports Pitches:

New Sports pitches to discharge surface water to infiltration basin.

T3 Soil Infiltration Rate (worst case) =	1.58E-04	m/s	=	0.5688 m/hr

Design Storm Event = 1 : 100 year plus 40% Climate Change.

Allowable outflow = Zero

M5 - M60 = 20mm

R Ratio = 0.4

Urban Creep =	1.10		10%
Contributing Impermeable Area =	5005	m²	0.501 ha
Design Factor of Safety =	2.0		

Using Micro Drainage and the above design parameters:

Minimum SuDS Infiltration Basin Area Required =	323.3	m²	Average
Minimum SuDS Infiltration Basin Volume Required =	129.30	m³	Total
Minimum SuDS Infiltration Basin Depth Required =	0.400	m	Overall

From the proposed site layout:

Minimum SuDS Infiltration Basin Area Provided =	445.0	m²	Average
Minimum SuDS Infiltration Basin Volume Provided =	222.5	m³	Total
Minimum SuDS Infiltration Basin Depth Provided =	0.400	m	Overall

Therefore, the provide a grassed infiltration basin with a maximum depth of 400mm and minimum volume of 115.60 m^3. The Infiltration basin has a 100mm freeboard. See enclosed MicroDrainage Calculations. SuDS are designed with zero piped outflow for 100 yr + CC so also suitabel for 30 yr storm event.

The SuDS have been designed with a zero piped outflow. Therefore, the areas draining to them would not have a Greenfield or Brownfield surface water run-off. Subsequently, the post development site's run-off rates and volumes would be less than the existing development's run-off rates and volumes.

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

Half Drain Time : 26 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	97.418	0.218	42.3	91.9	O K
30 min Summer	97.460	0.260	44.0	111.1	O K
60 min Summer	97.465	0.265	44.2	113.6	O K
120 min Summer	97.438	0.238	43.1	100.8	O K
180 min Summer	97.404	0.204	41.7	85.3	O K
240 min Summer	97.371	0.171	40.4	70.9	O K
360 min Summer	97.319	0.119	38.3	48.1	O K
480 min Summer	97.284	0.084	36.3	33.1	O K
600 min Summer	97.261	0.061	34.4	23.7	O K
720 min Summer	97.249	0.049	33.0	19.0	O K
960 min Summer	97.240	0.040	26.7	15.4	O K
1440 min Summer	97.230	0.030	19.5	11.5	O K
2160 min Summer	97.222	0.022	14.4	8.4	O K
2880 min Summer	97.218	0.018	11.5	6.7	O K
4320 min Summer	97.213	0.013	8.2	4.8	O K
5760 min Summer	97.210	0.010	6.6	3.8	O K
7200 min Summer	97.209	0.009	5.6	3.2	O K
8640 min Summer	97.207	0.007	4.6	2.7	O K
10080 min Summer	97.207	0.007	4.3	2.5	O K
15 min Winter	97.447	0.247	43.5	105.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	138.153	0.0	21
30 min Summer	90.705	0.0	31
60 min Summer	56.713	0.0	48
120 min Summer	34.246	0.0	82
180 min Summer	25.149	0.0	114
240 min Summer	20.078	0.0	146
360 min Summer	14.585	0.0	206
480 min Summer	11.622	0.0	264
600 min Summer	9.738	0.0	318
720 min Summer	8.424	0.0	372
960 min Summer	6.697	0.0	494
1440 min Summer	4.839	0.0	736
2160 min Summer	3.490	0.0	1100
2880 min Summer	2.766	0.0	1460
4320 min Summer	1.989	0.0	2172
5760 min Summer	1.573	0.0	2928
7200 min Summer	1.311	0.0	3608
8640 min Summer	1.129	0.0	4256
10080 min Summer	0.994	0.0	5128
15 min Winter	138.153	0.0	22

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	97.495	0.295	45.4	127.7	O K
60 min Winter	97.499	0.299	45.6	129.3	O K
120 min Winter	97.455	0.255	43.8	108.7	O K
180 min Winter	97.403	0.203	41.7	84.9	O K
240 min Winter	97.355	0.155	39.8	63.8	O K
360 min Winter	97.286	0.086	36.5	34.1	O K
480 min Winter	97.250	0.050	33.6	19.5	O K
600 min Winter	97.243	0.043	28.4	16.4	O K
720 min Winter	97.237	0.037	24.6	14.3	O K
960 min Winter	97.230	0.030	19.8	11.5	O K
1440 min Winter	97.222	0.022	14.4	8.4	O K
2160 min Winter	97.216	0.016	10.5	6.1	O K
2880 min Winter	97.213	0.013	8.2	4.8	O K
4320 min Winter	97.209	0.009	5.9	3.4	O K
5760 min Winter	97.208	0.008	4.9	2.9	O K
7200 min Winter	97.206	0.006	4.0	2.3	O K
8640 min Winter	97.205	0.005	3.3	2.0	O K
10080 min Winter	97.205	0.005	3.0	1.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	90.705	0.0	32
60 min Winter	56.713	0.0	52
120 min Winter	34.246	0.0	88
180 min Winter	25.149	0.0	122
240 min Winter	20.078	0.0	154
360 min Winter	14.585	0.0	210
480 min Winter	11.622	0.0	256
600 min Winter	9.738	0.0	314
720 min Winter	8.424	0.0	376
960 min Winter	6.697	0.0	490
1440 min Winter	4.839	0.0	728
2160 min Winter	3.490	0.0	1100
2880 min Winter	2.766	0.0	1420
4320 min Winter	1.989	0.0	2148
5760 min Winter	1.573	0.0	2904
7200 min Winter	1.311	0.0	3584
8640 min Winter	1.129	0.0	4464
10080 min Winter	0.994	0.0	4992

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.501

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.167	4	8	0.167	8	12	0.167

Model Details

Storage is Online Cover Level (m) 97.600

Infiltration Basin Structure

Invert Level (m) 97.200 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.56880 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.56880

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	375.0	0.700	0.0	1.400	0.0	2.100	0.0
0.100	425.0	0.800	0.0	1.500	0.0	2.200	0.0
0.200	450.0	0.900	0.0	1.600	0.0	2.300	0.0
0.300	475.0	1.000	0.0	1.700	0.0	2.400	0.0
0.400	500.0	1.100	0.0	1.800	0.0	2.500	0.0
0.500	0.0	1.200	0.0	1.900	0.0		
0.600	0.0	1.300	0.0	2.000	0.0		

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3. Surface Water SuDS Design - Sports Pavilion - Infiltration via Soakaways:

Total Impermeable Area - Buidlings =	958.0	m²	=	0.0958 ha
Total Impermeable Area - Hardstandings =	0.0	m²	=	0.0000 ha
Proposed Impermeable Contributing Area =	958.0	m²	=	0.0958 ha

The SuDS are designed to mitigate impermeable areas to provide betterment. The worst case BRE 365 Infiltration test was used for the SuDS design:

T1 - Infiltration Rate =	1.85E-04
T2 - Infiltration Rate =	1.67E-04
T3 - Infiltration Rate =	1.58E-04

Sports Pavilion:

Roof to discharge surface water to soakaway to the north east of the site.

T3 Soil Infiltration Rate (worst case) = 1.58E-04 m/s = 0.5688 m/hr

Design Storm Event = 1 : 100 year plus 40% Climate Change.

Allowable outflow = Zero

M5 - M60 = 20mm

R Ratio = 0.4

Urban Creep =	1.10		10%
Contributing Impermeable Area =	1054	m²	0.105 ha
Design Factor of Safety =	2.0		

Using Micro Drainage and the above design parameters:

Minimum SuDS Soakaway Plan Area Required =	52.1	m²
Minimum SuDS Soakaway Volume Required =	39.60	m³
Minimum SuDS Soakaway Depth Required =	0.800	m

From the proposed site layout:

Minimum SuDS Soakaway Plan Area Provided =	52.5	m²
Minimum SuDS Soakaway Volume Provided =	39.90	m³
Minimum SuDS Soakaway Depth Provided =	0.800	m

Therefore, provide soakaways with a minimum volume of 39.60m^3. See enclosed MicroDrainage Calculations. SuDS are designed with zero piped outflow for 100 yr + CC so also suitabel for 30 yr storm event.

The SuDS have been designed with a zero piped outflow. Therefore, the areas draining to them would not have a Greenfield or Brownfield surface water run-off. Subsequently, the post development site's run-off rates and volumes would be less than the existing development's run-off rates and volumes.

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

Half Drain Time : 65 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	100.975	0.575	5.6	28.7	O K
30 min Summer	101.117	0.717	5.9	35.8	O K
60 min Summer	101.188	0.788	6.1	39.3	O K
120 min Summer	101.171	0.771	6.0	38.4	O K
180 min Summer	101.124	0.724	5.9	36.1	O K
240 min Summer	101.073	0.673	5.8	33.6	O K
360 min Summer	100.977	0.577	5.6	28.8	O K
480 min Summer	100.891	0.491	5.4	24.5	O K
600 min Summer	100.815	0.415	5.2	20.7	O K
720 min Summer	100.748	0.348	5.0	17.3	O K
960 min Summer	100.638	0.238	4.7	11.9	O K
1440 min Summer	100.498	0.098	4.4	4.9	O K
2160 min Summer	100.444	0.044	3.8	2.2	O K
2880 min Summer	100.435	0.035	3.0	1.8	O K
4320 min Summer	100.425	0.025	2.2	1.3	O K
5760 min Summer	100.420	0.020	1.7	1.0	O K
7200 min Summer	100.417	0.017	1.4	0.8	O K
8640 min Summer	100.415	0.015	1.3	0.7	O K
10080 min Summer	100.413	0.013	1.1	0.6	O K
15 min Winter	100.975	0.575	5.6	28.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	138.153	0.0	23
30 min Summer	90.705	0.0	35
60 min Summer	56.713	0.0	60
120 min Summer	34.246	0.0	92
180 min Summer	25.149	0.0	126
240 min Summer	20.078	0.0	160
360 min Summer	14.585	0.0	228
480 min Summer	11.622	0.0	292
600 min Summer	9.738	0.0	356
720 min Summer	8.424	0.0	418
960 min Summer	6.697	0.0	538
1440 min Summer	4.839	0.0	762
2160 min Summer	3.490	0.0	1100
2880 min Summer	2.766	0.0	1456
4320 min Summer	1.989	0.0	2200
5760 min Summer	1.573	0.0	2936
7200 min Summer	1.311	0.0	3664
8640 min Summer	1.129	0.0	4384
10080 min Summer	0.994	0.0	5088
15 min Winter	138.153	0.0	23

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	101.119	0.719	5.9	35.9	O K
60 min Winter	101.195	0.795	6.1	39.6	O K
120 min Winter	101.164	0.764	6.0	38.1	O K
180 min Winter	101.097	0.697	5.9	34.8	O K
240 min Winter	101.023	0.623	5.7	31.1	O K
360 min Winter	100.887	0.487	5.3	24.3	O K
480 min Winter	100.770	0.370	5.1	18.4	O K
600 min Winter	100.670	0.270	4.8	13.5	O K
720 min Winter	100.588	0.188	4.6	9.4	O K
960 min Winter	100.474	0.074	4.3	3.7	O K
1440 min Winter	100.440	0.040	3.4	2.0	O K
2160 min Winter	100.429	0.029	2.5	1.4	O K
2880 min Winter	100.423	0.023	1.9	1.1	O K
4320 min Winter	100.417	0.017	1.4	0.8	O K
5760 min Winter	100.413	0.013	1.1	0.7	O K
7200 min Winter	100.411	0.011	0.9	0.5	O K
8640 min Winter	100.409	0.009	0.8	0.5	O K
10080 min Winter	100.408	0.008	0.7	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	90.705	0.0	35
60 min Winter	56.713	0.0	60
120 min Winter	34.246	0.0	96
180 min Winter	25.149	0.0	134
240 min Winter	20.078	0.0	170
360 min Winter	14.585	0.0	240
480 min Winter	11.622	0.0	306
600 min Winter	9.738	0.0	368
720 min Winter	8.424	0.0	428
960 min Winter	6.697	0.0	528
1440 min Winter	4.839	0.0	726
2160 min Winter	3.490	0.0	1088
2880 min Winter	2.766	0.0	1468
4320 min Winter	1.989	0.0	2188
5760 min Winter	1.573	0.0	2912
7200 min Winter	1.311	0.0	3672
8640 min Winter	1.129	0.0	4224
10080 min Winter	0.994	0.0	5032

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.950
Region	England and Wales	Cv (Winter)	0.950
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.105

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.035	4	8	0.035	8	12	0.035

Model Details

Storage is Online Cover Level (m) 101.800

Cellular Storage Structure

Invert Level (m) 100.400 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.56880 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.56880

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	52.5	52.5	0.900	0.0	77.3
0.800	52.5	77.3			

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3. Surface Water SuDS Design - Access Road Infiltration via Porous Paving:

Total Impermeable Area - Buidlings =	0.0	m²	=	0.0000 ha
Total Permeable Area - Hardstandings =	3157.4	m²	=	0.3157 ha
Proposed Impermeable Contributing Area =	3157.4	m²	=	0.3157 ha

The SuDS are designed to mitigate impermeable areas to provide betterment. The worst case BRE 365 Infiltration test was used for the SuDS design:

T1 - Infiltration Rate =	1.85E-04
T2 - Infiltration Rate =	1.67E-04
T3 - Infiltration Rate =	1.58E-04

Access Road and Permeable Parking Areas:

Access Road and permeable parking areas to discharge surface water to pervious paving.

T3 Soil Infiltration Rate (worst case) = 1.58E-04 m/s = 0.5688 m/hr

Design Storm Event = 1 : 100 year plus 40% Climate Change.

Allowable outflow = Zero

M5 - M60 = 20mm

R Ratio = 0.4

Urban Creep = 1.10 10%

Contributing Impermeable Area = 3473 m² 0.347 ha

Design Factor of Safety = 2.0

Using Micro Drainage and the above design parameters:

Minimum SuDS Porous Paving Area Required =	310.9	m²
Minimum SuDS Porous Paving Volume Required =	51.30	m³
Minimum SuDS Porous Paving Depth Required =	0.550	m

From the proposed site layout:

Minimum SuDS Porous Paving Area Provided =	3150.0	m²
Minimum SuDS Porous Paving Volume Provided =	524.5	m³
Minimum SuDS Porous Paving Sub-base Depth Provided =	0.555	m

Therefore, the new SuDS porous paving hardstanding should be constructed with a clean washed stone sub-base depth of 555mm and a minimum plan area of 310.9m². See enclosed MicroDrainage Calculations. SuDS are designed with zero piped outflow for 100 yr + CC so also suitabel for 30 yr storm event.

The SuDS have been designed with a zero piped outflow. Therefore, the areas draining to them would not have a Greenfield or Brownfield surface water run-off. Subsequently, the post development site's run-off rates and volumes would be less than the existing development's run-off rates and volumes.

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

Half Drain Time : 6 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	101.728	0.283	80.6	43.4	O K
30 min Summer	101.753	0.308	87.7	51.3	O K
60 min Summer	101.744	0.299	85.1	48.3	O K
120 min Summer	101.703	0.258	73.4	36.1	O K
180 min Summer	101.668	0.223	63.4	26.8	O K
240 min Summer	101.640	0.195	55.4	20.5	O K
360 min Summer	101.600	0.155	44.2	13.1	O K
480 min Summer	101.575	0.130	36.9	9.1	O K
600 min Summer	101.556	0.111	31.6	6.7	O K
720 min Summer	101.543	0.098	27.8	5.2	O K
960 min Summer	101.524	0.079	22.5	3.4	O K
1440 min Summer	101.503	0.058	16.4	1.8	O K
2160 min Summer	101.491	0.046	11.9	1.1	O K
2880 min Summer	101.486	0.041	9.4	0.9	O K
4320 min Summer	101.479	0.034	6.7	0.7	O K
5760 min Summer	101.476	0.031	5.4	0.5	O K
7200 min Summer	101.473	0.028	4.5	0.4	O K
8640 min Summer	101.471	0.026	3.8	0.4	O K
10080 min Summer	101.469	0.024	3.3	0.3	O K
15 min Winter	101.726	0.281	80.0	42.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	138.153	0.0	19
30 min Summer	90.705	0.0	27
60 min Summer	56.713	0.0	42
120 min Summer	34.246	0.0	74
180 min Summer	25.149	0.0	104
240 min Summer	20.078	0.0	132
360 min Summer	14.585	0.0	192
480 min Summer	11.622	0.0	252
600 min Summer	9.738	0.0	312
720 min Summer	8.424	0.0	370
960 min Summer	6.697	0.0	490
1440 min Summer	4.839	0.0	732
2160 min Summer	3.490	0.0	1076
2880 min Summer	2.766	0.0	1464
4320 min Summer	1.989	0.0	2164
5760 min Summer	1.573	0.0	2936
7200 min Summer	1.311	0.0	3608
8640 min Summer	1.129	0.0	4352
10080 min Summer	0.994	0.0	4960
15 min Winter	138.153	0.0	19

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	101.745	0.300	85.4	48.6	O K
60 min Winter	101.724	0.279	79.3	41.9	O K
120 min Winter	101.665	0.220	62.5	26.1	O K
180 min Winter	101.622	0.177	50.3	16.9	O K
240 min Winter	101.592	0.147	41.7	11.7	O K
360 min Winter	101.555	0.110	31.4	6.5	O K
480 min Winter	101.533	0.088	25.1	4.2	O K
600 min Winter	101.519	0.074	21.1	3.0	O K
720 min Winter	101.510	0.065	18.4	2.3	O K
960 min Winter	101.496	0.051	14.6	1.4	O K
1440 min Winter	101.488	0.043	10.6	1.0	O K
2160 min Winter	101.482	0.037	7.7	0.7	O K
2880 min Winter	101.478	0.033	6.1	0.6	O K
4320 min Winter	101.473	0.028	4.4	0.4	O K
5760 min Winter	101.469	0.024	3.3	0.3	O K
7200 min Winter	101.467	0.022	2.8	0.3	O K
8640 min Winter	101.466	0.021	2.4	0.2	O K
10080 min Winter	101.464	0.019	2.1	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	90.705	0.0	28
60 min Winter	56.713	0.0	44
120 min Winter	34.246	0.0	74
180 min Winter	25.149	0.0	104
240 min Winter	20.078	0.0	134
360 min Winter	14.585	0.0	192
480 min Winter	11.622	0.0	252
600 min Winter	9.738	0.0	312
720 min Winter	8.424	0.0	370
960 min Winter	6.697	0.0	490
1440 min Winter	4.839	0.0	732
2160 min Winter	3.490	0.0	1064
2880 min Winter	2.766	0.0	1428
4320 min Winter	1.989	0.0	2192
5760 min Winter	1.573	0.0	2832
7200 min Winter	1.311	0.0	3672
8640 min Winter	1.129	0.0	4392
10080 min Winter	0.994	0.0	5208

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.900
Region	England and Wales	Cv (Winter)	0.900
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.400	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.347

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.116	4	8	0.116	8	12	0.116

Model Details

Storage is Online Cover Level (m) 102.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.56880	Width (m)	45.0
Membrane Percolation (mm/hr)	1000	Length (m)	70.0
Max Percolation (l/s)	875.0	Slope (1:X)	80.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	101.445	Membrane Depth (m)	0

Project No.	FEDS- 218132	By:	AK	Chkd:	DKP
Title	Recreation Ground, Milton Road, Adderbury, Banbury, OX15				
Sheet No.	19	Date:	October 2018		

Notes: Tests carried out on 3rd June 2018

Weather conditions: Damp

Trial Pit: Two

1. INPUTS

Trial Pit Dimensions

Length	1.500	m
Width	0.700	m
Depth	1.000	m
Inlet Depth	0.335	m
Effective Depth	0.665	m

Soil Infiltration Rate = $\frac{Vp_{75-25}}{ap_{50} \times tp_{75-25}}$

Vp_{75-25} the effective storage volume of water in the trial pit between 75% and 25% effective depth = 0.349 m^3

ap_{50} the internal surface area of the trial pit up to 50% effective depth and including the base = 2.513 m^2

tp_{75-25} the time for the water level to fall from 75% and 25% effective depth = 14.6 minutes 876.66 seconds (lowest)

f = **Soil Infiltration Rate for Design** = **1.6E-04** m/s (lowest)

= **0.5705** m/hr (lowest)

2. INPUT OF PERMEABILITY TEST DATA

TEST 1

Time	Water level	Water Depth
0	383	617
10	683	317
20	896	104
30	978	22

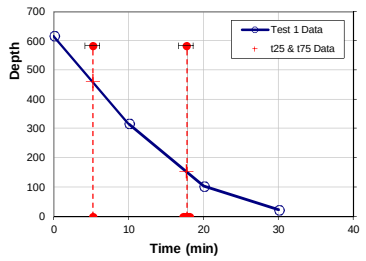
TEST 2

Time	Water level	Water Depth
0	355	645
10	662	338
20	856	144
30	978	22

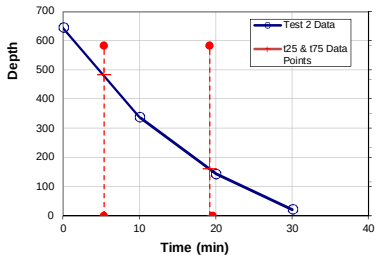
TEST 3

Time	Water level	Water Depth
0	335	665
10	654	346
20	837	163
30	978	22

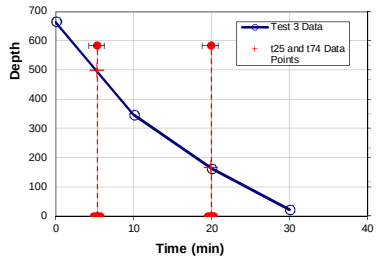
3. DATA ANALYSIS



Depth at t= 617
Depth 75% 462.75
Depth 25% 154.25
5.14155 462.75
17.641 154.25
tp75-25 12.49945 minutes 749.967 seconds
f1 = 1.85E-04 m/s



Depth at t=0 645
Depth 75% 483.75
Depth 25% 161.25
5.2525 483.75
19.111 161.25
tp75-25 13.8585 minutes 831.51 seconds
f2 = 1.67E-04 m/s

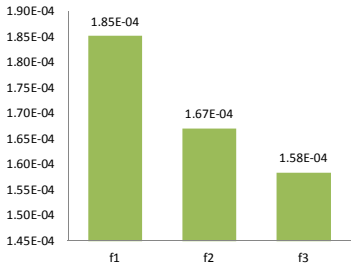


Depth at t=0 665
Depth 75% 498.75
Depth 25% 166.25
5.2115 498.75
19.8225 166.25
tp75-25 14.611 minutes 876.66 seconds
f3= 1.58E-04 m/s

4. SUMMARY

Infiltration Rate

f1	1.85E-04
f2	1.67E-04
f3	1.58E-04



Detention Basin Operation and Maintenance in accordance with The SuDS Manual 2015

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season), or as required
	Cut grass – meadow grass in and around basin	Half yearly (spring- before nesting season, and autumn
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies	Monthly (for first year) then annually or as required
	Check and penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlets and forebay	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually (as set out in Chapter 23)
Occasional Maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets and forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided
Remedial Actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Realignment of rip-rap	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstall design levels	As required

CIRIA (2015), The CIRIA C753 SuDS Manual, Part D, 22 Detention Basins, Table 22.1, London.

Cellular Soakaway Operation and Maintenance in accordance with The SuDS Manual 2015

Maintenance Schedule	Required Action	Typical Frequency
Monitoring	Inspect and check all inlets, vents and overflows to ensure that they are in good condition and operating as designed,	Annually
	Survey inside of soakaway for sediment build-up and remove if necessary.	Every 5 years or as required.
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, and then annually.
	Remove debris from the catchment surface (where it may cause risks to performance).	Monthly
	For systems where rainfall infiltrates into the soakaway from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
	Remove sediment from pre-treatment structures and/or internal forebays.	Annually, or as required.
Remedial Actions	Repairs/rehabilitate inlets, outlet, overflows and vents.	As required.

CIRIA (2015), The CIRIA C753 SuDS Manual, Part D, 21 Attenuation Storage Tanks, Table 20.15, London.

Pervious Pavements Operation and Maintenance in Accordance with The SuDS Manual 2015

Maintenance Schedule	Required Action	Typical Frequency
Monitoring	Initial inspection	Monthly for three months after installation.
	Inspect for evidence of poor operation and weed growth. Take remedial action if required.	Three-monthly and 48 hours after large storms for the first six months.
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually
	Monitor inspection chambers	Annually
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	One year after construction, annually after autumn leaf fall or reduced frequency as required, based on site specific conditions of clogging. Particular attention should be paid to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment.
Occasional Maintenance	Removal of weeds or management using glyphosate applied directly to the weeds by an applicator rather than a spray.	As required or once per year on less frequently used pavements
Remediation Actions	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance, or a hazard to users and replacement of lost jointing material.	Check within the first 12 months of construction and then annually and arrange remedial works if/as required.
	Rehabilitation of surface and upper substructure by remedial sweeping.	Every 10 to 15 years or as required if infiltration performance appears to be reduced due to significant clogging.
	Remediate any landscaping that through vegetation maintenance or soil slip has been raised to within 50mm of the level of the paving.	Check within the first 12 months of construction and then annually and arrange remedial works if/as required.
Sump Manholes and Inspection Chambers	Monitor for silt build up and empty/de-silt as required.	One year after construction, annually after autumn leaf fall or reduced frequency as required, based on site specific conditions of clogging.
Roof gutters and downpipes	Monitor for silt build up and empty/de-silt as required.	One year after construction, annually after autumn leaf fall or reduced frequency as required, based on site specific conditions of clogging.