Forge Engineering Design Solutions

Phase 1 Sports Pitches SuDS Calculations

Proposed Recreation Ground at Land Off Milton Road, Adderbury, Banbury OX15

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Project No.	FEDS- 218132	By:	AK	Chkd:	DKP
Title					
New Recreation Ground, Milton Road, Adderbury, Banbury, OX15					
Sheet No.	1	Date:	October 2018		

1. Surface Water Design - Contributing Areas:

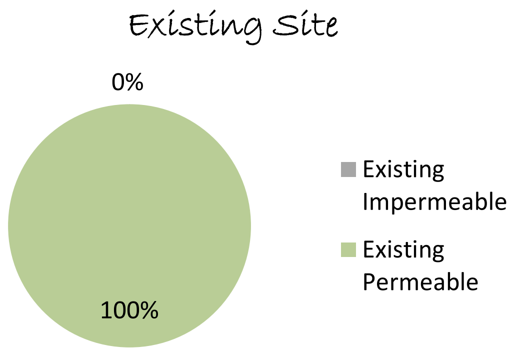
Total site area =	36259.0	m²	=	3.6259 ha

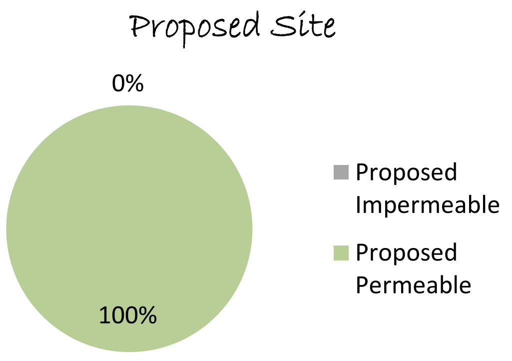
1.1 Existing Site:

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 =	36259.0	m²	=	3.6259 ha
% of total site:	100.0%			

1.1 Proposed Site:

Impermeable Area - Proposed Building =	0.0	m²	=	0.0000 ha
Impermeable Area - Proposed Hardstanding =	0.0	m²	=	0.0000 ha
Proposed Impermeable Contributing Area =	0.0	m²	=	0.0000 ha
% of total site:	0.0%			
Proposed Permeable Area =	36259.0	m²	=	3.6259 ha
% of total site:	100.0%			





There is no change in the pre and post development impermeable contributing area at the site. Which remains at zero.

The new SuDS are designed to mitigate the newsports pitch land drainage of the proposed development to ensure that there is no increase in surface water run-off from the site. As a worst case scenario, for the SuDS design, it is assumed that 35% of the surface water falling onto the pitches could enter the land drainage.

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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)	0.5
SAAR (mm)	654
SOIL	0.15
$QBAR_{green}$ (m^3/s/50ha)	0.0187
$QBAR_{green}$ (l/s/50ha)	18.7
$QBAR_{green}$ (l/s/ha)	0.37

SITE AREA (m^2)	36259
SITE AREA (ha)	3.626
Existing CA (m^2)	0
Proposed CA (m^2)	0

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	-	1.356	29.29
1 in 1 year	0.85	1.153	24.90
1 in 30 year	2.40	3.255	70.30
1 in 100 year	3.19	4.326	93.44
1 in 100 year +40%	4.47	6.056	130.82

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	6.15
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	-	1.356	29.29
1 in 1 year	0.85	1.153	24.90
1 in 30 year	2.40	3.255	70.30
1 in 100 year	3.19	4.326	93.44
1 in 100 year+40%	4.47	6.056	130.82

2.3 Proposed Brownfield Run-off Rates, QBar $_{Brown\ Proposed}$

NC	0.76
CIND	6.15
CWI	92.1
URBAN	0.00
$R_{proposed}$	1.00

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	-	1.356	29.29
1 in 1 year	0.85	1.153	24.90
1 in 30 year	2.40	3.255	70.30
1 in 100 year	3.19	4.326	93.44
1 in 100 year+40%	4.47	6.056	130.82

Tables 2b and 2c demonstrate that there is no increase in the run-off peak flow rates and volumes for Phase 1 of the proposed site development. Therefore, there would not be a need to implement 'mitigating' SuDS measures. However, 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.

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 = $1.85x10^{-4}$ m/s
T2 - Infiltration Rate = $1.67x10^{-4}$ m/s
T3 - Infiltration Rate = $1.58x10^{-4}$ m/s

Sports Pitches:

New Sports pitches to discharge surface water to infiltration basin.

T3 Soil Infiltration Rate (worst case) = 1.58E-04 m/s = 0.5705 m/hr

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

Allowable outflow = Zero

M5 - M60 = 20mm

R Ratio = 0.4

Contributing Impermeable Area = 4550 m² 0.4550 ha

Design Factor of Safety = 2.0

Using Micro Drainage and the above design parameters:

Minimum SuDS Infiltration Basin Area Required =	252.0	m²	Average
Minimum SuDS Infiltration Basin Volume Required =	100.80	m³	Total
Minimum SuDS Infiltration Basin Depth Required =	0.400	m	Overall

From the proposed site layout:

Minimum SuDS Infiltration Basin Area Provided =	300.0	m²	Average
Minimum SuDS Infiltration Basin Volume Provided =	150.0	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 100.8 m^3. See enclosed MicroDrainage Calculations and Construction details.

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 : 16 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	97.505	0.305	56.2	76.4	O K
30 min Summer	97.535	0.335	61.0	89.1	O K
60 min Summer	97.534	0.334	60.8	88.6	O K
120 min Summer	97.505	0.305	56.2	76.2	O K
180 min Summer	97.473	0.273	51.1	64.1	O K
240 min Summer	97.446	0.246	46.8	54.2	O K
360 min Summer	97.402	0.202	39.9	40.1	O K
480 min Summer	97.370	0.170	34.8	31.1	O K
600 min Summer	97.345	0.145	30.8	24.8	O K
720 min Summer	97.326	0.126	27.7	20.1	O K
960 min Summer	97.297	0.097	23.2	14.1	O K
1440 min Summer	97.263	0.063	17.6	8.0	O K
2160 min Summer	97.244	0.044	13.1	5.2	O K
2880 min Summer	97.236	0.036	10.4	4.2	O K
4320 min Summer	97.227	0.027	7.4	3.0	O K
5760 min Summer	97.222	0.022	5.8	2.5	O K
7200 min Summer	97.219	0.019	5.0	2.1	O K
8640 min Summer	97.217	0.017	4.2	1.8	O K
10080 min Summer	97.215	0.015	3.8	1.6	O K
15 min Winter	97.529	0.329	60.1	86.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	138.153	0.0	20
30 min Summer	90.705	0.0	29
60 min Summer	56.713	0.0	46
120 min Summer	34.246	0.0	78
180 min Summer	25.149	0.0	110
240 min Summer	20.078	0.0	140
360 min Summer	14.585	0.0	200
480 min Summer	11.622	0.0	260
600 min Summer	9.738	0.0	320
720 min Summer	8.424	0.0	380
960 min Summer	6.697	0.0	498
1440 min Summer	4.839	0.0	738
2160 min Summer	3.490	0.0	1092
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	3584
8640 min Summer	1.129	0.0	4384
10080 min Summer	0.994	0.0	5024
15 min Winter	138.153	0.0	21

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	97.561	0.361	65.1	100.8	O K
60 min Winter	97.554	0.354	63.9	97.3	O K
120 min Winter	97.507	0.307	56.5	77.2	O K
180 min Winter	97.463	0.263	49.5	60.3	O K
240 min Winter	97.426	0.226	43.6	47.6	O K
360 min Winter	97.372	0.172	35.1	31.6	O K
480 min Winter	97.335	0.135	29.2	22.4	O K
600 min Winter	97.309	0.109	25.1	16.5	O K
720 min Winter	97.290	0.090	22.0	12.8	O K
960 min Winter	97.264	0.064	17.8	8.2	O K
1440 min Winter	97.244	0.044	13.1	5.2	O K
2160 min Winter	97.233	0.033	9.4	3.8	O K
2880 min Winter	97.228	0.028	7.5	3.1	O K
4320 min Winter	97.221	0.021	5.4	2.2	O K
5760 min Winter	97.217	0.017	4.2	1.8	O K
7200 min Winter	97.214	0.014	3.5	1.5	O K
8640 min Winter	97.213	0.013	3.1	1.3	O K
10080 min Winter	97.211	0.011	2.7	1.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	90.705	0.0	30
60 min Winter	56.713	0.0	48
120 min Winter	34.246	0.0	82
180 min Winter	25.149	0.0	114
240 min Winter	20.078	0.0	144
360 min Winter	14.585	0.0	204
480 min Winter	11.622	0.0	264
600 min Winter	9.738	0.0	322
720 min Winter	8.424	0.0	382
960 min Winter	6.697	0.0	498
1440 min Winter	4.839	0.0	736
2160 min Winter	3.490	0.0	1104
2880 min Winter	2.766	0.0	1448
4320 min Winter	1.989	0.0	2164
5760 min Winter	1.573	0.0	2888
7200 min Winter	1.311	0.0	3616
8640 min Winter	1.129	0.0	4264
10080 min Winter	0.994	0.0	5232

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) 0.455

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.152	4	8	0.152	8	12	0.152

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) 0.57050 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.57050

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	100.0	0.700	0.0	1.400	0.0	2.100	0.0
0.100	200.0	0.800	0.0	1.500	0.0	2.200	0.0
0.200	300.0	0.900	0.0	1.600	0.0	2.300	0.0
0.300	400.0	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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4. Surface Water Design - Manholes & Connecting Pipes:

FGL (m) = 100.900

Manhole		Invert Level	Cover Level	Depth
SWMH01 =	100.90 - 0.600 - (1/150 x 7.365) - 0.050 =	100.201	100.900	0.699
SWMH02 =	99.550 - 0.600 - (1/150 x 37.125) - 0.050 =	98.653	99.550	0.897
SWMH03 =	97.850 - 0.600 - (1/150 x 4.525) =	97.220	97.850	0.630

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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 = $\frac{Vp_{75\text{-}25}}{ap_{50} \times tp_{75\text{-}25}}$

$Vp_{75\text{-}25}$	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	
$tp_{75\text{-}25}$	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

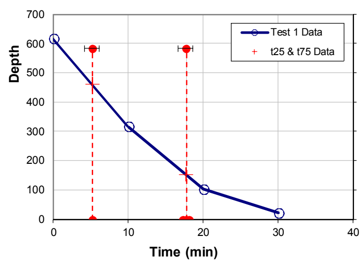
TEST 2

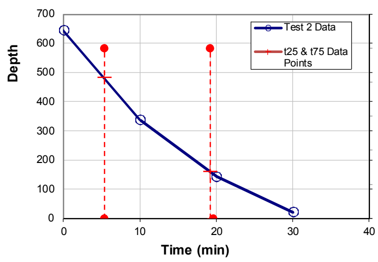
Time	Water level	Water Depth
0	355	645
10	662	338
20	856	144
30	978	22

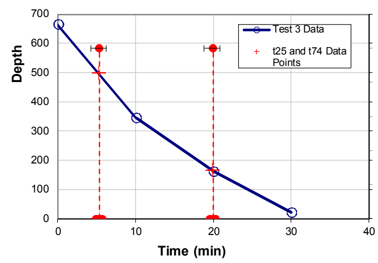
TEST 3

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			

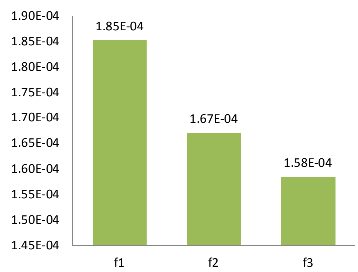
Depth at t=0	645			
Depth 75%	483.75			
Depth 25%	161.25			
5.2525	483.75			
19.111	161.25			
tp75-25	13.8585	minutes	831.51	seconds
f2 =	1.67E-04 m/s			

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



Infiltration Basin Operation and Maintenance in Accordance with The SuDS Manual 2015

Maintenance Schedule	**Required Action**	**Typical Frequency**
Regular Maintenance	Remove litter and debris	Monthly, or as required
	Cut grass – to retain grass height within specified design range	Monthly (during growing season), or as required
	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 infiltration surfaces for ponding, compaction, silt accumulation, record areas where water is ponding for >48 hours	Monthly, or when required.
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional Maintenance	Reseed areas of poor vegetation growth, alter plant types to better suit conditions, if required	As required or if bare soil is exposed over 10% or m ore of the swale treatment area
Remedial Action	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

CIRIA (2015), The CIRIA C753 SuDS Manual, Part D, 17 Swales, Table 17.1, London.