DRAINAGE STRATERGY FOR HOUSING DEVELOPMENT AT OAKHILL

1. INTRODUCTION

1.1 This drainage strategy has been produced on behalf of Precious Ideals in connection with their planning application for the construction of 8No new houses at Oakhill school. The strategy will deal with both the storm water and foul drainage of the site.

1.2 The plan used is the site layout 0010

2. BASE INFORMATION

Available information

2.1 A topographical survey of the site has been carried out and is included as part of the planning application

Site geology

2.2 The site lying in a region characterised by slowly permeable seasonally wet clay soil, which are not conducive to infiltration, therefore a storm water drainage scheme has been designed with on site attenuation and a discharge rate equalling to the run off from a green field site.

Existing watercourses and features

2.3 There is an existing water course running through the site, which is to be used for final discharge of the storm water runoff from the houses and the private road.

United Utilities

2.4 A new adoptable sewer is proposed to be built on the adjoining site and have an inspection chamber at the entrance to this site as shown on the proposed site layout.

Private drainage

2.7 There is no existing private drainage on site.

Existing runoff

2.8 The present site is a field and there are no hard standing on the site therefore there is no existing flood run off routes, the existing stream at the edge of the site collects any run off , the stream is marked on the area plan.

3. DRAINAGE STRATEGY

3.1   A layout of the proposed drainage is shown on the layout plan. The enclosed plan shows the areas used in the calculations.
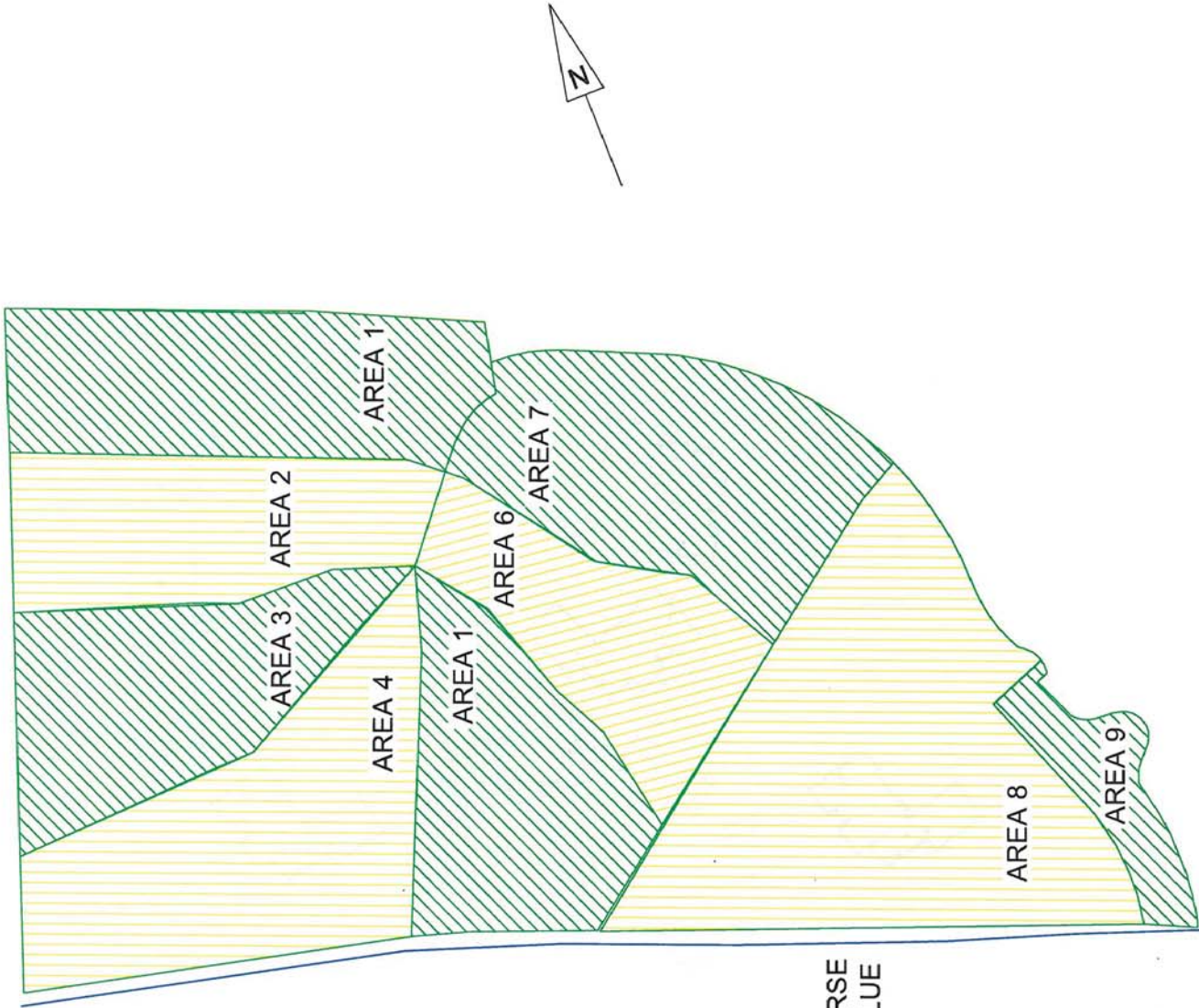
Surface water drainage

3.2   Guidance for the disposal of surface water from a development site is for soakaways to be considered as the primary solution. If this is not practical, discharge to a waterbody or watercourse is to be considered as the next available alternative. Only if neither of these options is available, and other sustainable drainage methods not possible, should the use of the public sewerage system be considered.

3.3 The soils are not conducive to infiltration on the site, therefore this cannot be used as a solution.

3.4   Surface water from the existing site is collected by an onsite private surface water drainage system, via drainage gulley's etc. We have used a run off rate of 3.5 litres per second to equate to greenfield run off.

3.5   The surface water drainage system has been calculated for each individual plot and for the roadway separately. We will collect the rainwater from the private roadway and this will diverted into the attenuation provided for the house plots as shown. The road way at the entrance to the site will be provided with attenuation and discharge in to the storm water manhole being provided at the entrance to the site. The discharge rate will be 3.5 litres per second.

Each plot will be provided with an attenuation tank of the size required in the enclosed calculation, the tanks to plots 1-7 will be formed using crates buried in the rear gardens, to plot 8 the attenuation will be formed using a pond. For the roadway the attenuation will be formed using large diameter pipes buried under the roadway.

3.6   Attenuation will be provided for rainfall events up to the 100 year critical rain storm plus 40% on stored volumes. The additional 40% is to allow for climate change and has been included in the surface water volume. As such there will be no change to the flood risk from this development

3.7   The proposal for the foul drainage is for a pumped system with min 24 hours of waste storage on site as shown. The sewage will be pumped to the adopted manhole along the roadway to the edge of the site and discharge into the public sewer. The pumps, storage tanks and private pipework will be maintained by the management company responsible for the site.

4. SUMMARY AND CONCLUSIONS

4.1   The nature of the local geology means that infiltration of surface water runoff back into the ground is not feasible on this site, the location of the water course means this can be utilised for the surface water drainage.

4.2   The site does not lend itself to a soakaway solution and the scheme as designed incorporates the principles of SUDS.

WATER COURSE
SHOWN IN BLUE

AREA 1
AREA 2
AREA 3
AREA 4
AREA 1
AREA 6
AREA 7
AREA 8
AREA 9

N

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Project Title:
Proposed New House @
Oakhill College
Wiswell Lane
Whalley
Lancashire
BB7 9AF

Date:	Drawn By:	Scale:
3rd January 2019	TH	A3 NTS

Drawing Title

Oakhill Gardens
SURFACE WATER ATTENUATION
AREAS AND WATER COURSE

Drawing No.   Revision Ref
0150

GENERAL DATA

site location:	England and Wales
60 min rainfall depth of 5 year return period 'R' [mm] =	20
M5-60 to M5-2d rainfall ratio 'r' =	0.40
proposed discharge rate 'v_1' [litre/s] =	3.50
proposed discharge rate 'v_2' [litre/s] =	10.00
allowance for climate change:	40%

SUMMARY OF CALCULATIONS

required storage volume for discharge rate 'v_1' =	39.14	m³
required storage volume for discharge rate 'v_2' =	27.95	m³

AREA DATA	impermeability [%]	effective area [m²]
impermeable area 'A_1' [m²] = 436	100.00	436
landscaping and/or green roof area 'A_2' [m²] = 881	80.00	704.8
other partially permeable area 'A_3' [m²] = 282	20.00	56.4
AREA DRAINED TO ATTENUATION TANK =	1197.2 m²	

REQUIRED STORAGE VOLUME PER RAINFALL DURATION FOR DISCHARGE RATE v_1

rainfall duration [min]	rainfall factor Z1	M5-D rainfalls [mm]	M10-D			M20-D			M30-D			outflow from attenuation tank [m³]	required storage [m³]
			Z2	rainfalls [mm]	inflow [m³]	Z2	rainfalls [mm]	inflow [m³]	Z2	rainfalls [mm]	inflow [m³]		
5	0.37	7.47	1.20	12.59	15.08	1.38	14.47	17.33	1.46	15.24	18.25	1.05	17.20
10	0.52	10.47	1.22	17.90	21.44	1.41	20.70	24.78	1.49	21.88	26.20	2.10	24.10
15	0.63	12.67	1.23	21.82	26.13	1.43	25.29	30.27	1.51	26.77	32.05	3.15	28.90
30	0.80	16.07	1.24	27.89	33.39	1.44	32.44	38.84	1.53	34.42	41.21	6.30	34.91
60	**1.00**	20.00	1.24	34.72	41.57	1.45	40.60	48.61	1.54	43.21	51.74	12.60	**39.14**
120	1.21	24.13	1.24	41.90	50.16	1.44	48.71	58.32	1.54	51.86	62.09	25.20	36.89
240	1.45	28.93	1.22	49.59	59.37	1.42	57.69	69.07	1.52	61.47	73.60	50.40	23.20
360	1.60	32.07	1.21	54.49	65.24	1.41	63.38	75.88	1.50	67.51	80.82	75.60	5.22
600	1.79	35.87	1.20	60.38	72.28	1.40	70.12	83.95	1.49	74.61	89.33	126.00	0.00
1440	2.24	44.80	1.18	74.03	88.63	1.36	85.35	102.18	1.44	90.58	108.45	302.40	0.00

* Z2 is a growth factor from M5 rainfalls

REQUIRED STORAGE VOLUME PER RAINFALL DURATION FOR DISCHARGE RATE v_2

rainfall duration [min]	rainfall factor Z1	M5-D rainfalls [mm]	M10-D			M30-D			M50-D			outflow from attenuation tank [m³]	required storage [m³]
			Z2	rainfalls [mm]	inflow [m³]	Z2	rainfalls [mm]	inflow [m³]	Z2	rainfalls [mm]	inflow [m³]		
5	0.37	7.47	1.20	12.59	15.08	1.46	15.24	18.25	1.60	16.77	20.08	3.00	17.08
10	0.52	10.47	1.22	17.90	21.44	1.49	21.88	26.20	1.65	24.25	29.03	6.00	23.03
15	0.63	12.67	1.23	21.82	26.13	1.51	26.77	32.05	1.68	29.73	35.60	9.00	26.60
30	**0.80**	16.07	1.24	27.89	33.39	1.53	34.42	41.21	1.71	38.38	45.95	18.00	**27.95**
60	1.00	20.00	1.24	34.72	41.57	1.54	43.21	51.74	1.73	48.44	57.99	36.00	21.99
120	1.21	24.13	1.24	41.90	50.16	1.54	51.86	62.09	1.72	58.17	69.64	72.00	0.00
240	1.45	28.93	1.22	49.59	59.37	1.52	61.47	73.60	1.70	69.03	82.65	144.00	0.00
360	1.60	32.07	1.21	54.49	65.24	1.50	67.51	80.82	1.69	75.76	90.70	216.00	0.00
600	1.79	35.87	1.20	60.38	72.28	1.49	74.61	89.33	1.66	83.60	100.08	360.00	0.00
1440	2.24	44.80	1.18	74.03	88.63	1.44	90.58	108.45	1.61	101.05	120.98	864.00	0.00

* Z2 is a growth factor from M5 rainfalls

AJH Associates 21 Deanfield Court, Clitheroe

PRECIOUS IDEALS
OAKHILL AREA 2

		Revision	
Job No:	3440	Page:	C/01
Prepared By:	TH	Date:	18/01/2019

Section:	SUDS drainage scheme attenuation tank size

GENERAL DATA

site location:	England and Wales
60 min rainfall depth of 5 year return period 'R' [mm] =	20
M5-60 to M5-2d rainfall ratio 'r' =	0.40
proposed discharge rate 'v_1' [litre/s] =	3.50
proposed discharge rate 'v_2' [litre/s] =	10.00
allowance for climate change:	40%

SUMMARY OF CALCULATIONS

required storage volume for discharge rate 'v_1' =	31.22	m³
required storage volume for discharge rate 'v_2' =	21.15	m³

AREA DATA	impermeability [%]	effective area [m²]
impermeable area 'A_1' [m²] = 525	100.00	525
landscaping and/or green roof area 'A_2' [m²] = 550	80.00	440
other partially permeable area 'A_3' [m²] = 245	20.00	49
AREA DRAINED TO ATTENUATION TANK =	**1014 m²**	

REQUIRED STORAGE VOLUME PER RAINFALL DURATION FOR DISCHARGE RATE v_1

rainfall duration [min]	rainfall factor Z1	M5-D rainfalls [mm]	M10-D			M20-D			M30-D			outflow from attenuation tank [m³]	required storage [m³]
			Z2	rainfalls [mm]	inflow [m³]	Z2	rainfalls [mm]	inflow [m³]	Z2	rainfalls [mm]	inflow [m³]		
5	0.37	7.47	1.20	12.59	12.77	1.38	14.47	14.68	1.46	15.24	15.45	1.05	14.40
10	0.52	10.47	1.22	17.90	18.16	1.41	20.70	20.99	1.49	21.88	22.19	2.10	20.09
15	0.63	12.67	1.23	21.82	22.13	1.43	25.29	25.64	1.51	26.77	27.14	3.15	23.99
30	0.80	16.07	1.24	27.89	28.28	1.44	32.44	32.89	1.53	34.42	34.90	6.30	28.60
60	1.00	20.00	1.24	34.72	35.21	1.45	40.60	41.17	1.54	43.21	43.82	12.60	**31.22**
120	1.21	24.13	1.24	41.90	42.48	1.44	48.71	49.39	1.54	51.86	52.59	25.20	27.39
240	1.45	28.93	1.22	49.59	50.29	1.42	57.69	58.50	1.52	61.47	62.33	50.40	11.93
360	1.60	32.07	1.21	54.49	55.25	1.41	63.38	64.26	1.50	67.51	68.45	75.60	0.00
600	1.79	35.87	1.20	60.38	61.22	1.40	70.12	71.11	1.49	74.61	75.66	126.00	0.00
1440	2.24	44.80	1.18	74.03	75.07	1.36	85.35	86.54	1.44	90.58	91.85	302.40	0.00

*Z2 is a growth factor from M5 rainfalls

REQUIRED STORAGE VOLUME PER RAINFALL DURATION FOR DISCHARGE RATE v_2

rainfall duration [min]	rainfall factor Z1	M5-D rainfalls [mm]	M10-D			M30-D			M50-D			outflow from attenuation tank [m³]	required storage [m³]
			Z2	rainfalls [mm]	inflow [m³]	Z2	rainfalls [mm]	inflow [m³]	Z2	rainfalls [mm]	inflow [m³]		
5	0.37	7.47	1.20	12.59	12.77	1.46	15.24	15.45	1.60	16.77	17.01	3.00	14.01
10	0.52	10.47	1.22	17.90	18.16	1.49	21.88	22.19	1.65	24.25	24.59	6.00	18.59
15	0.63	12.67	1.23	21.82	22.13	1.51	26.77	27.14	1.68	29.73	30.15	9.00	**21.15**
30	0.80	16.07	1.24	27.89	28.28	1.53	34.42	34.90	1.71	38.38	38.92	18.00	20.92
60	1.00	20.00	1.24	34.72	35.21	1.54	43.21	43.82	1.73	48.44	49.12	36.00	13.12
120	1.21	24.13	1.24	41.90	42.48	1.54	51.86	52.59	1.72	58.17	58.99	72.00	0.00
240	1.45	28.93	1.22	49.59	50.29	1.52	61.47	62.33	1.70	69.03	70.00	144.00	0.00
360	1.60	32.07	1.21	54.49	55.25	1.50	67.51	68.45	1.69	75.76	76.82	216.00	0.00
600	1.79	35.87	1.20	60.38	61.22	1.49	74.61	75.66	1.66	83.60	84.77	360.00	0.00
1440	2.24	44.80	1.18	74.03	75.07	1.44	90.58	91.85	1.61	101.05	102.47	864.00	0.00

*Z2 is a growth factor from M5 rainfalls

GENERAL DATA

site location:	England and Wales
60 min rainfall depth of 5 year return period 'R' [mm] =	20
M5-60 to M5-2d rainfall ratio 'r' =	0.40
proposed discharge rate v_1 [litre/s] =	3.50
proposed discharge rate v_2 [litre/s] =	10.00
allowance for climate change:	40%

SUMMARY OF CALCULATIONS

required storage volume for discharge rate v_1 =	31.18	m^3
required storage volume for discharge rate v_2 =	21.12	m^3

AREA DATA

AREA DATA	impermeability [%]	effective area [m^2]
impermeable area 'A_1' [m^2] = 412	100.00	412
landscaping and/or green roof area 'A_2' [m^2] = 676	80.00	540.8
other partially permeable area 'A_3' [m^2] = 301	20.00	60.2

AREA DRAINED TO ATTENUATION TANK = 1013 m^2

REQUIRED STORAGE VOLUME PER RAINFALL DURATION FOR DISCHARGE RATE v_1

rainfall duration [min]	rainfall factor Z1	M5-D rainfalls [mm]	M10-D			M20-D			M30-D			outflow from attenuation tank [m^3]	required storage [m^3]
			Z2	rainfalls [mm]	inflow [m^3]	Z2	rainfalls [mm]	inflow [m^3]	Z2	rainfalls [mm]	inflow [m^3]		
5	0.37	7.47	1.20	12.59	12.76	1.38	14.47	14.66	1.46	15.24	15.44	1.05	14.39
10	0.52	10.47	1.22	17.90	18.14	1.41	20.70	20.97	1.49	21.88	22.17	2.10	20.07
15	0.63	12.67	1.23	21.82	22.11	1.43	25.29	25.62	1.51	26.77	27.12	3.15	23.97
30	0.80	16.07	1.24	27.89	28.25	1.44	32.44	32.86	1.53	34.42	34.87	6.30	28.57
60	1.00	20.00	1.24	34.72	35.17	1.45	40.60	41.13	1.54	43.21	43.78	12.60	31.18
120	1.21	24.13	1.24	41.90	42.44	1.44	48.71	49.34	1.54	51.86	52.54	25.20	27.34
240	1.45	28.93	1.22	49.59	50.24	1.42	57.69	58.44	1.52	61.47	62.27	50.40	11.87
360	1.60	32.07	1.21	54.49	55.20	1.41	63.38	64.20	1.50	67.51	68.38	75.60	0.00
600	1.79	35.87	1.20	60.38	61.16	1.40	70.12	71.04	1.49	74.61	75.58	126.00	0.00
1440	2.24	44.80	1.18	74.03	75.00	1.36	85.35	86.46	1.44	90.58	91.76	302.40	0.00

* Z2 is a growth factor from M5 rainfalls

REQUIRED STORAGE VOLUME PER RAINFALL DURATION FOR DISCHARGE RATE v_2

rainfall duration [min]	rainfall factor Z1	M5-D rainfalls [mm]	M10-D			M30-D			M50-D			outflow from attenuation tank [m^3]	required storage [m^3]
			Z2	rainfalls [mm]	inflow [m^3]	Z2	rainfalls [mm]	inflow [m^3]	Z2	rainfalls [mm]	inflow [m^3]		
5	0.37	7.47	1.20	12.59	12.76	1.46	15.24	15.44	1.60	16.77	16.99	3.00	13.99
10	0.52	10.47	1.22	17.90	18.14	1.49	21.88	22.17	1.65	24.25	24.56	6.00	18.56
15	0.63	12.67	1.23	21.82	22.11	1.51	26.77	27.12	1.68	29.73	30.12	9.00	21.12
30	0.80	16.07	1.24	27.89	28.25	1.53	34.42	34.87	1.71	38.38	38.88	18.00	20.88
60	1.00	20.00	1.24	34.72	35.17	1.54	43.21	43.78	1.73	48.44	49.07	36.00	13.07
120	1.21	24.13	1.24	41.90	42.44	1.54	51.86	52.54	1.72	58.17	58.93	72.00	0.00
240	1.45	28.93	1.22	49.59	50.24	1.52	61.47	62.27	1.70	69.03	69.93	144.00	0.00
360	1.60	32.07	1.21	54.49	55.20	1.50	67.51	68.38	1.69	75.76	76.75	216.00	0.00
600	1.79	35.87	1.20	60.38	61.16	1.49	74.61	75.58	1.66	83.60	84.68	360.00	0.00
1440	2.24	44.80	1.18	74.03	75.00	1.44	90.58	91.76	1.61	101.05	102.37	864.00	0.00

* Z2 is a growth factor from M5 rainfalls

GENERAL DATA

site location:	England and Wales
60 min rainfall depth of 5 year return period 'R' [mm] =	20
M5-60 to M5-2d rainfall ratio 'r' =	0.40
proposed discharge rate 'v_1' [litre/s] =	3.50
proposed discharge rate 'v_2' [litre/s] =	10.00
allowance for climate change:	40%

SUMMARY OF CALCULATIONS

required storage volume for discharge rate 'v_1' =	55.05	m^3
required storage volume for discharge rate 'v_2' =	41.39	m^3

AREA DATA	impermeability [%]	effective area [m^2]
impermeable area 'A_1' [m^2] = 412	100.00	412
landscaping and/or green roof area 'A_2' [m^2] = 1341	80.00	1072.8
other partially permeable area 'A_3' [m^2] = 312	20.00	62.4
AREA DRAINED TO ATTENUATION TANK =		**1547.2 m^2**

REQUIRED STORAGE VOLUME PER RAINFALL DURATION FOR DISCHARGE RATE v_1

rainfall duration [min]	rainfall factor Z1	M5-D rainfalls [mm]	M10-D Z2	M10-D rainfalls [mm]	M10-D inflow [m^3]	M20-D Z2	M20-D rainfalls [mm]	M20-D inflow [m^3]	M30-D Z2	M30-D rainfalls [mm]	M30-D inflow [m^3]	outflow from attenuation tank [m^3]	required storage [m^3]
5	0.37	7.47	1.20	12.59	19.49	1.38	14.47	22.39	1.46	15.24	23.58	1.05	22.53
10	0.52	10.47	1.22	17.90	27.70	1.41	20.70	32.03	1.49	21.88	33.86	2.10	31.76
15	0.63	12.67	1.23	21.82	33.77	1.43	25.29	39.13	1.51	26.77	41.42	3.15	38.27
30	0.80	16.07	1.24	27.89	43.15	1.44	32.44	50.19	1.53	34.42	53.25	6.30	46.95
60	1.00	20.00	1.24	34.72	53.72	1.45	40.60	62.82	1.54	43.21	66.86	12.60	54.26
120	1.21	24.13	1.24	41.90	64.82	1.44	48.71	75.37	1.54	51.86	80.25	25.20	**55.05**
240	1.45	28.93	1.22	49.59	76.73	1.42	57.69	89.26	1.52	61.47	95.11	50.40	44.71
360	1.60	32.07	1.21	54.49	84.31	1.41	63.38	98.06	1.50	67.51	104.44	75.60	28.84
600	1.79	35.87	1.20	60.38	93.41	1.40	70.12	108.50	1.49	74.61	115.44	126.00	0.00
1440	2.24	44.80	1.18	74.03	114.55	1.36	85.35	132.05	1.44	90.58	140.15	302.40	0.00

* Z2 is a growth factor from M5 rainfalls

REQUIRED STORAGE VOLUME PER RAINFALL DURATION FOR DISCHARGE RATE v_2

rainfall duration [min]	rainfall factor Z1	M5-D rainfalls [mm]	M10-D Z2	M10-D rainfalls [mm]	M10-D inflow [m^3]	M30-D Z2	M30-D rainfalls [mm]	M30-D inflow [m^3]	M50-D Z2	M50-D rainfalls [mm]	M50-D inflow [m^3]	outflow from attenuation tank [m^3]	required storage [m^3]
5	0.37	7.47	1.20	12.59	19.49	1.46	15.24	23.58	1.60	16.77	25.95	3.00	22.95
10	0.52	10.47	1.22	17.90	27.70	1.49	21.88	33.86	1.65	24.25	37.51	6.00	31.51
15	0.63	12.67	1.23	21.82	33.77	1.51	26.77	41.42	1.68	29.73	46.00	9.00	37.00
30	0.80	16.07	1.24	27.89	43.15	1.53	34.42	53.25	1.71	38.38	59.39	18.00	**41.39**
60	1.00	20.00	1.24	34.72	53.72	1.54	43.21	66.86	1.73	48.44	74.95	36.00	38.95
120	1.21	24.13	1.24	41.90	64.82	1.54	51.86	80.25	1.72	58.17	90.00	72.00	18.00
240	1.45	28.93	1.22	49.59	76.73	1.52	61.47	95.11	1.70	69.03	106.81	144.00	0.00
360	1.60	32.07	1.21	54.49	84.31	1.50	67.51	104.44	1.69	75.76	117.22	216.00	0.00
600	1.79	35.87	1.20	60.38	93.41	1.49	74.61	115.44	1.66	83.60	129.34	360.00	0.00
1440	2.24	44.80	1.18	74.03	114.55	1.44	90.58	140.15	1.61	101.05	156.35	864.00	0.00

* Z2 is a growth factor from M5 rainfalls

calculations are based on CIRIA C697 2007: The SUDS Manual

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PRECIOUS IDEALS OAKHILL AREA 5		Revision	
Job No:	3440	Page:	C/01
Section: SUDS drainage scheme attenuation tank size		Prepared By: TH	Date: 18/01/2019

GENERAL DATA

site location:	**England and Wales**
60 min rainfall depth of 5 year return period 'R' [mm] =	20
M5-60 to M5-2d rainfall ratio 'r' =	0.40
proposed discharge rate 'v_1' [litre/s] =	3.50
proposed discharge rate 'v_2' [litre/s] =	10.00
allowance for climate change:	40%

SUMMARY OF CALCULATIONS

required storage volume for discharge rate 'v_1' =	33.95	m^3
required storage volume for discharge rate 'v_2' =	23.35	m^3

AREA DATA

		impermeability [%]	effective area [m^2]
impermeable area 'A_1' [m^2] =	426	100.00	426
landscaping and/or green roof area 'A_2' [m^2] =	768	80.00	614.4
other partially permeable area 'A_3' [m^2] =	184	20.00	36.8

AREA DRAINED TO ATTENUATION TANK = 1077.2 m^2

REQUIRED STORAGE VOLUME PER RAINFALL DURATION FOR DISCHARGE RATE v_1

rainfall duration [min]	rainfall factor Z1	M5-D rainfalls [mm]	M10-D			M20-D			M30-D			outflow from attenuation tank [m^3]	required storage [m^3]
			Z2	rainfalls [mm]	inflow [m^3]	Z2	rainfalls [mm]	inflow [m^3]	Z2	rainfalls [mm]	inflow [m^3]		
5	0.37	7.47	1.20	12.59	13.57	1.38	14.47	15.59	1.46	15.24	16.42	1.05	15.37
10	0.52	10.47	1.22	17.90	19.29	1.41	20.70	22.30	1.49	21.88	23.57	2.10	21.47
15	0.63	12.67	1.23	21.82	23.51	1.43	25.29	27.24	1.51	26.77	28.84	3.15	25.69
30	0.80	16.07	1.24	27.89	30.04	1.44	32.44	34.94	1.53	34.42	37.08	6.30	30.78
60	1.00	20.00	1.24	34.72	37.40	1.45	40.60	43.73	1.54	43.21	46.55	12.60	33.95
120	1.21	24.13	1.24	41.90	45.13	1.44	48.71	52.47	1.54	51.86	55.87	25.20	30.67
240	1.45	28.93	1.22	49.59	53.42	1.42	57.69	62.15	1.52	61.47	66.22	50.40	15.82
360	1.60	32.07	1.21	54.49	58.70	1.41	63.38	68.27	1.50	67.51	72.72	75.60	0.00
600	1.79	35.87	1.20	60.38	65.04	1.40	70.12	75.54	1.49	74.61	80.38	126.00	0.00
1440	2.24	44.80	1.18	74.03	79.75	1.36	85.35	91.94	1.44	90.58	97.58	302.40	0.00

* Z2 is a growth factor from M5 rainfalls

REQUIRED STORAGE VOLUME PER RAINFALL DURATION FOR DISCHARGE RATE v_2

rainfall duration [min]	rainfall factor Z1	M5-D rainfalls [mm]	M10-D			M30-D			M50-D			outflow from attenuation tank [m^3]	required storage [m^3]
			Z2	rainfalls [mm]	inflow [m^3]	Z2	rainfalls [mm]	inflow [m^3]	Z2	rainfalls [mm]	inflow [m^3]		
5	0.37	7.47	1.20	12.59	13.57	1.46	15.24	16.42	1.60	16.77	18.07	3.00	15.07
10	0.52	10.47	1.22	17.90	19.29	1.49	21.88	23.57	1.65	24.25	26.12	6.00	20.12
15	0.63	12.67	1.23	21.82	23.51	1.51	26.77	28.84	1.68	29.73	32.03	9.00	23.03
30	0.80	16.07	1.24	27.89	30.04	1.53	34.42	37.08	1.71	38.38	41.35	18.00	23.35
60	1.00	20.00	1.24	34.72	37.40	1.54	43.21	46.55	1.73	48.44	52.18	36.00	16.18
120	1.21	24.13	1.24	41.90	45.13	1.54	51.86	55.87	1.72	58.17	62.66	72.00	0.00
240	1.45	28.93	1.22	49.59	53.42	1.52	61.47	66.22	1.70	69.03	74.36	144.00	0.00
360	1.60	32.07	1.21	54.49	58.70	1.50	67.51	72.72	1.69	75.76	81.61	216.00	0.00
600	1.79	35.87	1.20	60.38	65.04	1.49	74.61	80.38	1.66	83.60	90.05	360.00	0.00
1440	2.24	44.80	1.18	74.03	79.75	1.44	90.58	97.58	1.61	101.05	108.86	864.00	0.00

* Z2 is a growth factor from M5 rainfalls

calculations are based on CIRIA C697 2007: The SUDS Manual

GENERAL DATA

site location:	England and Wales
60 min rainfall depth of 5 year return period 'R' [mm] =	20
M5-60 to M5-2d rainfall ratio 'r' =	0.40
proposed discharge rate 'v_1' [litre/s] =	3.50
proposed discharge rate 'v_2' [litre/s] =	10.00
allowance for climate change:	40%

SUMMARY OF CALCULATIONS

required storage volume for discharge rate 'v_1' =	26.11	m^3
required storage volume for discharge rate 'v_2' =	17.63	m^3

AREA DATA

AREA DATA		impermeability [%]	effective area [m^2]
impermeable area 'A_1' [m^2] =	467	100.00	467
landscaping and/or green roof area 'A_2' [m^2] =	485	80.00	388
other partially permeable area 'A_3' [m^2] =	204	20.00	40.8
AREA DRAINED TO ATTENUATION TANK =			**895.8 m^2**

REQUIRED STORAGE VOLUME PER RAINFALL DURATION FOR DISCHARGE RATE v_1

rainfall duration [min]	rainfall factor Z1	M5-D rainfalls [mm]	M10-D Z2	M10-D rainfalls [mm]	M10-D inflow [m^3]	M20-D Z2	M20-D rainfalls [mm]	M20-D inflow [m^3]	M30-D Z2	M30-D rainfalls [mm]	M30-D inflow [m^3]	outflow from attenuation tank [m^3]	required storage [m^3]
5	0.37	7.47	1.20	12.59	11.28	1.38	14.47	12.97	1.46	15.24	13.65	1.05	12.60
10	0.52	10.47	1.22	17.90	16.04	1.41	20.70	18.55	1.49	21.88	19.60	2.10	17.50
15	0.63	12.67	1.23	21.82	19.55	1.43	25.29	22.65	1.51	26.77	23.98	3.15	20.83
30	0.80	16.07	1.24	27.89	24.99	1.44	32.44	29.06	1.53	34.42	30.83	6.30	24.53
60	1.00	20.00	1.24	34.72	31.10	1.45	40.60	36.37	1.54	43.21	38.71	12.60	**26.11**
120	1.21	24.13	1.24	41.90	37.53	1.44	48.71	43.64	1.54	51.86	46.46	25.20	21.26
240	1.45	28.93	1.22	49.59	44.42	1.42	57.69	51.68	1.52	61.47	55.07	50.40	4.67
360	1.60	32.07	1.21	54.49	48.81	1.41	63.38	56.77	1.50	67.51	60.47	75.60	0.00
600	1.79	35.87	1.20	60.38	54.09	1.40	70.12	62.82	1.49	74.61	66.84	126.00	0.00
1440	2.24	44.80	1.18	74.03	66.32	1.36	85.35	76.46	1.44	90.58	81.15	302.40	0.00

* Z2 is a growth factor from M5 rainfalls

REQUIRED STORAGE VOLUME PER RAINFALL DURATION FOR DISCHARGE RATE v_2

rainfall duration [min]	rainfall factor Z1	M5-D rainfalls [mm]	M10-D Z2	M10-D rainfalls [mm]	M10-D inflow [m^3]	M30-D Z2	M30-D rainfalls [mm]	M30-D inflow [m^3]	M50-D Z2	M50-D rainfalls [mm]	M50-D inflow [m^3]	outflow from attenuation tank [m^3]	required storage [m^3]
5	0.37	7.47	1.20	12.59	11.28	1.46	15.24	13.65	1.60	16.77	15.02	3.00	12.02
10	0.52	10.47	1.22	17.90	16.04	1.49	21.88	19.60	1.65	24.25	21.72	6.00	15.72
15	0.63	12.67	1.23	21.82	19.55	1.51	26.77	23.98	1.68	29.73	26.63	9.00	**17.63**
30	0.80	16.07	1.24	27.89	24.99	1.53	34.42	30.83	1.71	38.38	34.38	18.00	16.38
60	1.00	20.00	1.24	34.72	31.10	1.54	43.21	38.71	1.73	48.44	43.39	36.00	7.39
120	1.21	24.13	1.24	41.90	37.53	1.54	51.86	46.46	1.72	58.17	52.11	72.00	0.00
240	1.45	28.93	1.22	49.59	44.42	1.52	61.47	55.07	1.70	69.03	61.84	144.00	0.00
360	1.60	32.07	1.21	54.49	48.81	1.50	67.51	60.47	1.69	75.76	67.87	216.00	0.00
600	1.79	35.87	1.20	60.38	54.09	1.49	74.61	66.84	1.66	83.60	74.88	360.00	0.00
1440	2.24	44.80	1.18	74.03	66.32	1.44	90.58	81.15	1.61	101.05	90.52	864.00	0.00

* Z2 is a growth factor from M5 rainfalls