

APPENDIX D: INPUT FLOW HYDROGRAPHS

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Figure D.1 Upstream flows for the 1%, 1% climate change and 0.1% AEP events

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APPENDIX E: EXISTING AND PROPOSED PEAK LEVELS

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Node Label	100y			100CC			1000		
	Proposed	Existing	Difference	Proposed	Existing	Difference	Proposed	Existing	Difference
RALT07_1617	22.590	22.601	-0.011	22.645	22.654	-0.009	22.785	22.791	-0.006
RALT07_1517	21.888	21.826	0.062	21.956	21.887	0.069	22.144	22.054	0.090
RALT07_1516n	21.882	21.816	0.066	21.950	21.877	0.073	22.139	22.045	0.094
RALT07_1516	21.882	21.816	0.066	21.950	21.877	0.073	22.139	22.045	0.094
RALT07_1516l	21.851	21.689	0.162	21.915	21.735	0.180	22.095	21.862	0.233
RALT07_1477	21.835	-	-	21.900	-	-	22.078	-	-
NEW_1	21.835	-	-	21.900	-	-	22.078	-	-
NEW_2	21.718	-	-	21.787	-	-	21.978	-	-
NEW_3	21.617	-	-	21.674	-	-	21.832	-	-
NEW_4	21.446	-	-	21.511	-	-	21.692	-	-
RALT07_1340	21.300	-	-	21.346	-	-	21.473	-	-
RALT07_1262	21.131	21.131	0.000	21.177	21.177	0.000	21.304	21.304	0.000
RALT07_1008	20.573	20.573	0.000	20.619	20.619	0.000	20.746	20.746	0.000
RALT07_0881l	20.294	20.294	0.000	20.340	20.340	0.000	20.467	20.467	0.000

Existing and Proposed peak levels

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APPENDIX F: SENSITIVITY ANALYSIS

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Node label	1% AEP Flow	Manning's roughness n+20	Difference	Flow + 20%	Difference	Orifice coefficients + 20%	Difference	Orifice coefficients + 20%	Difference
RALT07_1617	22.590	22.658	0.068	22.645	0.055	22.591	0.001	22.588	-0.002
RALT07_1517	21.888	21.947	0.059	21.956	0.068	21.880	-0.008	21.906	0.018
RALT07_1516n	21.882	21.941	0.059	21.95	0.068	21.873	-0.009	21.900	0.018
RALT07_1516	21.882	21.941	0.059	21.95	0.068	21.873	-0.009	21.900	0.018
RALT07_1516l	21.851	21.915	0.064	21.915	0.064	21.840	-0.011	21.870	0.019
RALT07_1477	21.835	21.893	0.058	21.9	0.065	21.824	-0.011	21.857	0.022
NEW_1	21.835	21.893	0.058	21.9	0.065	21.824	-0.011	21.857	0.022
NEW_2	21.718	21.760	0.042	21.787	0.069	21.693	-0.025	21.758	0.040
NEW_3	21.617	21.671	0.054	21.674	0.057	21.617	0.000	21.617	0.000
NEW_4	21.446	21.465	0.019	21.511	0.065	21.446	0.000	21.446	0.000
RALT07_1340	21.300	21.356	0.056	21.346	0.046	21.300	0.000	21.300	0.000
RALT07_1262	21.131	21.186	0.055	21.177	0.046	21.131	0.000	21.131	0.000
RALT07_1008	20.573	20.628	0.055	20.619	0.046	20.573	0.000	20.573	0.000
RALT07_0881l	20.294	20.349	0.055	20.34	0.046	20.294	0.000	20.294	0.000
Max			0.068		0.069		0.001		0.040
Min			0.019		0.046		-0.025		-0.002
Mean			0.054		0.059		-0.006		0.011

Sensitivity Analysis

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APPENDIX I: NOTES OF LIMITATIONS

The data essentially comprised a study of available documented information from various sources together with discussions with relevant authorities and other interested parties. There may also be circumstances at the site that are not documented. The information reviewed is not exhaustive and has been accepted in good faith as providing representative and true data pertaining to site conditions. If additional information becomes available which might impact our conclusions, we request the opportunity to review the information, reassess the potential concerns and modify our opinion if warranted.

It should be noted that any risks identified in this report are perceived risks based on the available information.

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Appendix C

30118/002

24th April 2017

Mr Steve Garth
Engineering Manager
Barratt Homes Manchester
4 Brindley Road
City Park
Manchester
M16 9HQ

Dear Steve

**Waterpark Drive, Stockbridge Village (Former Brookside Community College)
Soak-away Tests**

Further to your recent instruction, please find the results of soak-away tests conducted at the Waterpark Drive site last week.

Two soak-away tests were undertaken at locations shown on Drawing No. 30118/2A, a copy of which is attached.

The locations of the soak-away tests were initially chosen to target areas underlain by sand strata, which were considered most likely to support potential soak-away drainage. However, no access was available into central parts of the site, which resulted in the second soak-away test (ST2) being located in the southwest of the site, in ground conditions less favourable to soak-away drainage.

Logs for the two soak-away tests (ST1 & ST2) are attached. Trial pit excavation ST1 located in the north of the site, encountered topsoil overlying firm clays to a depth of 1.4m, below which, clayey sand strata were encountered. Trial pit excavation ST2 was located in the southwest of the site, and encountered firm/stiff natural clays beneath 0.6m of made ground.

Due to low rates of infiltration, the soak-away tests pits were not able to be drained and filled three times, as recommended in BRE 365.

Water levels within ST1 decreased by 724mm over a period of 365 minutes, but did not reach 25% effective depth. Water levels in ST2 decreased by considerably less, dropping 36mm in 221 minutes.

Extrapolation of the recorded infiltration in ST1 gives an estimated time of 960 minutes to reach 25% effective depth, and allows the calculation of an estimated infiltration rate of 2.74×10^{-6} m/s. No infiltration rate has been calculated for ST2.



If you require any further information please contact me.

Yours sincerely

A handwritten signature in black ink, appearing to read 'David Lyon'.

Director
ALM CONSULT LTD

Enc. ALM Drawing No.30118/2A
Exploratory Hole Logs ST1 & ST2
Soak-away Calculation Sheets

		ALM Consult Ltd Tel: 01695 213160 Fax: 01695 567275		Trialpit No ST1 Sheet 1 of 1			
Project Name Waterpark Drive, Stockbridge		Project No. 30118		Co-ords: 342787E - 393133N Level: 24.05 m AOD Date 20/04/2017			
Location: Waterpark Drive, Stockbridge				Dimensions: -		Scale 1:20	
Client: Barratt Homes Manchester				Depth 1.70m		Logged By KL	
Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
			0.40	23.65		Dark brown sandy CLAY with roots and occasional fine subrounded gravel of sandstone (CLAY)	
			1.40	22.65		Firm pale orange brown sandy CLAY with occasional fine to coarse subrounded gravel of sandstone (CLAY)	
			1.70	22.35		Orange brown clayey SAND with occasional fine to coarse subrounded gravel of sandstone (SAND)	
						Trialpit Complete at 1.70 m	
Remarks:		1. Groundwater seepage encountered at 1.6m. 2. Stable excavation.					
Groundwater:							



FooterBASE 3.1 (Bld 426; 72) Standard Trialpit Log v2 dated 27th Nov 03

		ALM Consult Ltd Tel: 01695 213160 Fax: 01695 567275		Trialpit No ST2 Sheet 1 of 1			
Project Name Waterpark Drive, Stockbridge		Project No. 30118		Co-ords: 342704E - 393066N Level: 23.75 m AOD Date 20/04/2017			
Location: Waterpark Drive, Stockbridge				Dimensions: -		Scale 1:20	
Client: Barratt Homes Manchester				Depth 2.40m		Logged By KL	
Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
Depth (m)	Type	Results					
			0.25	23.50		Dark brown sandy CLAY with roots and occasional fine subrounded gravel of sandstone (MG)	
			0.65	23.10		MADE GROUND: Firm orange brown clay with much coarse angular gravel of limestone and brick (MG)	
						Firm to stiff orange brown sandy CLAY with much fine to coarse subrounded gravel of sandstone (CLAY)	
			2.40	21.35		Trialpit Complete at 2.40 m	
Remarks:		1. No groundwater encountered. 2. Stable excavation.					
Groundwater:							



NotesBASE 3.1 (Bld 426; 72) Standard Trialpit Log v2 dated 27th Nov 03

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client: **Barratt Homes Manchester**
 Job Name: **Waterpark Drive, Stockbridge**
 Job No.: **30118**



Trial Pit No.	ST1
Test No.	1

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
	0	0.47	470
	2	0.49	491
	5	0.51	513
	9	0.55	551
	15	0.59	586
	45	0.76	756
	60	0.81	812
	95	0.91	912
	125	0.97	972
	155	1.02	1022
	185	1.06	1058
	220	1.10	1100
	245	1.12	1122
	275	1.15	1146
	305	1.17	1170
	335	1.18	1182
	365	1.19	1194

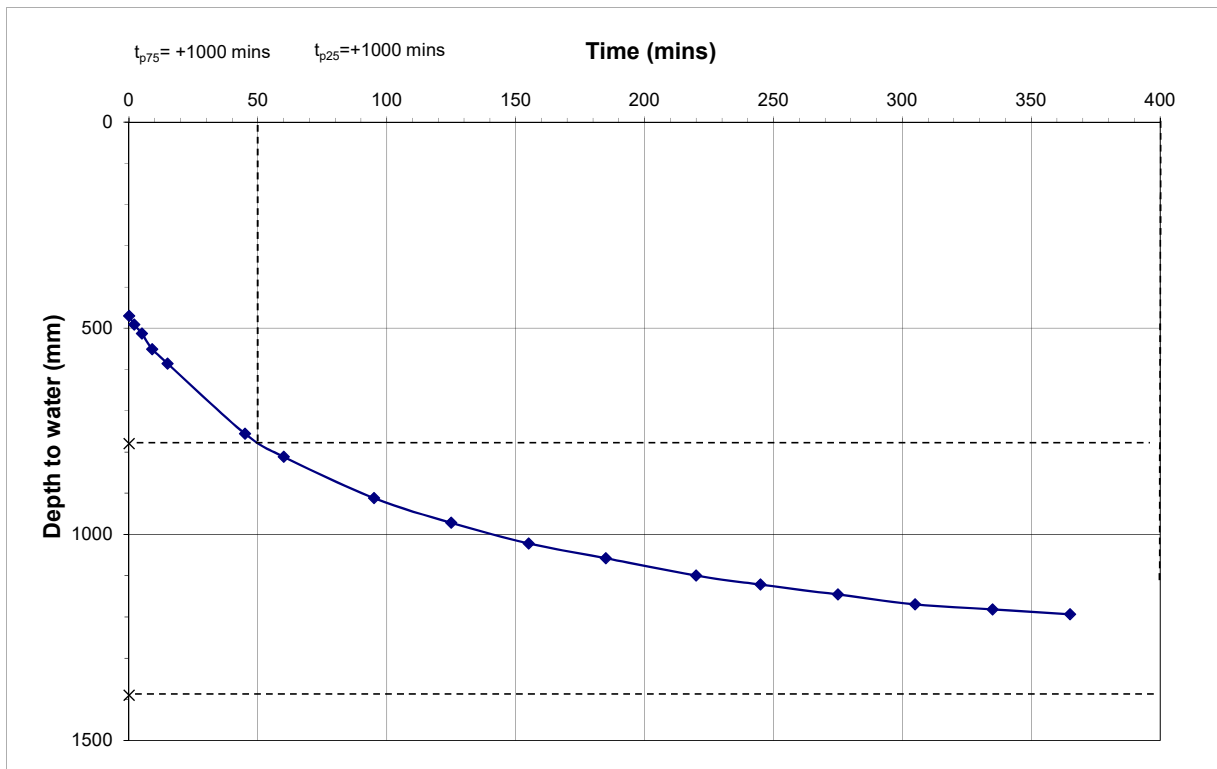
SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	1.90	1900
Width	=	0.50	500
Depth	=	1.70	1700

Effective Depth (empty)		mm	m
75%	=	1390.00	1.39
50%	=	1085.00	1.085
25%	=	780.00	0.78

Depth at start of test (mm)	=	470
Depth at end of test (mm)	=	1194

Base area of pit	=	0.95
a_{p50} - 50% internal surface area inc. base	=	3.878
V_{p75-25} - Volume 75 - 25%	=	0.5795

Read from the graph:		
t_{p75} (min)	=	50
t_{p25} (min)	=	-



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

SOIL INFILTRATION RATE IN ACCORDANCE WITH BRE DIGEST 365: 1991

Client: **Barratt Homes Manchester**
 Job Name: **Waterpark Drive, Stockbridge**
 Job No.: **30118**



Trial Pit No.	ST2
Test No.	2

Time	Elapsed Time	Depth to water from ground level	
	(min)	(m)	(mm)
	0	0.786	786
	1.00	0.788	788
	2.00	0.79	790
	3.00	0.79	790
	4.00	0.791	791
	11.00	0.793	793
	21.00	0.794	794
	31.00	0.795	795
	41.00	0.796	796
	51.00	0.798	798
	61.00	0.8	800
	71.00	0.802	802
	81.00	0.804	804
	111.00	0.81	810
	141.00	0.814	814
	171.00	0.816	816
	201.00	0.82	820
	221.00	0.822	822

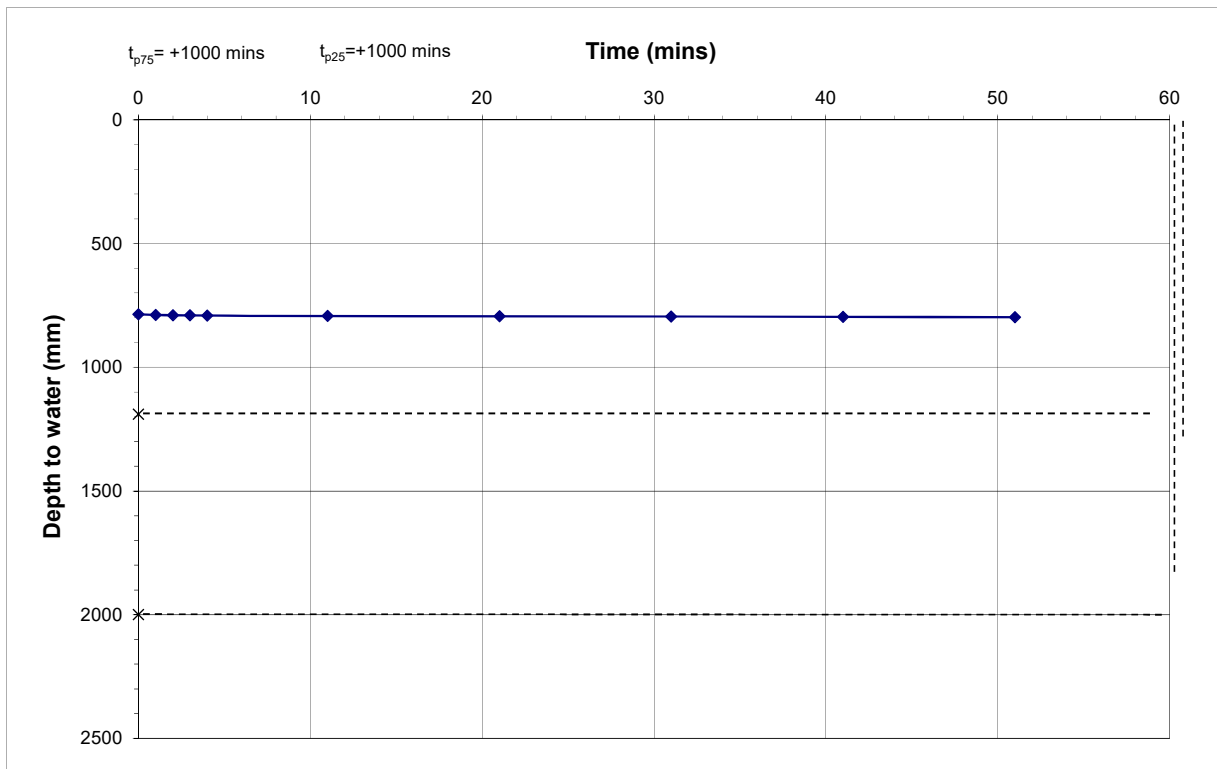
SOAKAWAY TRIAL PIT			
Dimensions		(m)	(mm)
Length	=	2.50	2500
Width	=	0.50	500
Depth	=	2.40	2400

Effective Depth (empty)	mm	m
75% =	2000.0	2.00
50% =	1593.0	1.59
25% =	1190.0	1.19

Depth at start of test (mm)	=	786
Depth at end of test (mm)	=	822

Base area of pit	=	1.25
a_{p50} - 50% internal surface area inc. base	=	6.11
V_{p75-25} - Volume 75 - 25%	=	1.0125

Read from the graph:		
t_{p75} (min)	=	-
t_{p25} (min)	=	-



Test did not attain 25% Effective depth. Unable to calculate soil infiltration rate

Appendix D

a. Network 1

i. Online Controls & Storage Structures

Barratt Homes Manchester		Page 0
4 Brindley Road City Park Manchester M16 9HQ		
Date 20/09/2018 15:21	Designed by kielyd	
File waterpark revG Culvert ...	Checked by	
Micro Drainage		Network 2017.1.2

Online Controls for Surface Network 1

Crown Vortex Valve® Manhole: S9, DS/PN: 1.008, Volume (m³): 26.2

Design Head (m) 1.500 Vortex Valve® Type R1 SW Only Invert Level (m) 21.706
Design Flow (l/s) 8.8 Diameter (mm) 110

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.9	1.200	7.8	3.000	12.4	7.000	18.9
0.200	3.7	1.400	8.5	3.500	13.4	7.500	19.6
0.300	3.9	1.600	9.1	4.000	14.3	8.000	20.2
0.400	4.5	1.800	9.6	4.500	15.2	8.500	20.9
0.500	5.1	2.000	10.1	5.000	16.0	9.000	21.5
0.600	5.5	2.200	10.6	5.500	16.8	9.500	22.1
0.800	6.4	2.400	11.1	6.000	17.5		
1.000	7.2	2.600	11.5	6.500	18.2		

Barratt Homes Manchester		Page 1								
4 Brindley Road City Park Manchester M16 9HQ										
Date 20/09/2018 15:21	Designed by kielyd									
File waterpark revG Culvert ...	Checked by									
Micro Drainage		Network 2017.1.2								
<u>Storage Structures for Surface Network 1</u> <u>Tank or Pond Manhole: S9, DS/PN: 1.008</u> Invert Level (m) 23.425 <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Depth (m)</th> <th>Area (m²)</th> <th>Depth (m)</th> <th>Area (m²)</th> </tr> </thead> <tbody> <tr> <td>0.000</td> <td>250.0</td> <td>0.400</td> <td>250.0</td> </tr> </tbody> </table>			Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	0.000	250.0	0.400	250.0
Depth (m)	Area (m ²)	Depth (m)	Area (m ²)							
0.000	250.0	0.400	250.0							
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a. Network 1

ii. Summary of Critical Results by Maximum Level

1. 1 in 1 Year

Barratt Homes Manchester

4 Brindley Road

City Park

Manchester M16 9HQ

Date 25/10/2018 15:14

File waterpark revG Culvert ...

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Micro Drainage

Network 2017.1.2

Page 0



Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

Simulation Criteria

Areal Reduction Factor 1.000

Additional Flow - % of Total Flow 0.000

Hot Start (mins) 0

MADD Factor * 10m³/ha Storage 2.000

Hot Start Level (mm) 0

Inlet Coeffiecient 0.800

Manhole Headloss Coeff (Global) 0.500

Flow per Person per Day (l/per/day) 0.000

Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0

Number of Storage Structures 1

Number of Online Controls 1

Number of Time/Area Diagrams 0

Number of Offline Controls 0

Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR

Ratio R 0.382

Region England and Wales Cv (Summer) 0.750

M5-60 (mm) 19.600 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0

Analysis Timestep 2.5 Second Increment (Extended)

DTS Status OFF

DVD Status ON

Inertia Status ON

Profile(s) Summer and Winter

Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080

Return Period(s) (years) 1

Climate Change (%) 0

									Water
PN	US/MH		Return	Climate	First (X)	First (Y)	First (Z)	Overflow	Level
	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Act.	(m)
1.000	S1	15 Winter	1	+0%					22.812
1.001	S2	15 Winter	1	+0%					22.590
1.002	S3	15 Winter	1	+0%					22.489
1.003	S4	120 Winter	1	+0%					22.296
1.004	S5	120 Winter	1	+0%					22.296
1.005	S6	120 Winter	1	+0%					22.295
1.006	S7	120 Winter	1	+0%					22.295
1.007	S8	120 Winter	1	+0%					22.295
1.008	S9	120 Winter	1	+0%	1/15 Summer				22.294

Surcharged Flooded

Pipe

PN	US/MH	Depth	Volume	Flow /	Overflow	Pipe	Level
	Name	(m)	(m³)	Cap.	(l/s)	Flow	Exceeded
						(l/s)	
1.000	S1	-0.086	0.000	0.37		6.2	OK
1.001	S2	-0.130	0.000	0.37		13.4	OK
1.002	S3	-0.127	0.000	0.39		15.1	OK

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4 Brindley Road City Park Manchester M16 9HQ		
Date 25/10/2018 15:14 File waterpark revG Culvert ...	Designed by kielyd Checked by	
Micro Drainage		Network 2017.1.2

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

PN	US/MH Name	Surcharged		Flooded		Pipe		Status	Level Exceeded
		Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)			
1.003	S4	-0.343	0.000	0.03		8.1		OK	
1.004	S5	-0.563	0.000	0.01		9.9		OK	
1.005	S6	-0.490	0.000	0.01		7.4		OK	
1.006	S7	-0.399	0.000	0.01		5.2		OK	
1.007	S8	-0.362	0.000	0.01		8.4		OK	
1.008	S9	0.363	0.000	0.13		5.5	SURCHARGED		

a. Network 1

ii. Summary of Critical Results by Maximum Level

2. 1 in 2 Year

Barratt Homes Manchester								Page 0	
4 Brindley Road City Park Manchester M16 9HQ									
Date 25/10/2018 15:22				Designed by kielyd					
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Micro Drainage					Network 2017.1.2				
Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1									
Simulation Criteria									
Areal Reduction Factor		1.000		Additional Flow - % of Total Flow		0.000			
Hot Start (mins)		0		MADD Factor * 10m³/ha Storage		2.000			
Hot Start Level (mm)		0		Inlet Coeffiecient		0.800			
Manhole Headloss Coeff (Global)		0.500		Flow per Person per Day (l/per/day)		0.000			
Foul Sewage per hectare (l/s)		0.000							
Number of Input Hydrographs		0		Number of Storage Structures		1			
Number of Online Controls		1		Number of Time/Area Diagrams		0			
Number of Offline Controls		0		Number of Real Time Controls		0			
Synthetic Rainfall Details									
Rainfall Model		FSR		Ratio R		0.382			
Region England and Wales Cv (Summer)		0.750							
M5-60 (mm)		19.600		Cv (Winter)		0.840			
Margin for Flood Risk Warning (mm)						300.0			
Analysis Timestep		2.5		Second Increment (Extended)					
DTS Status						OFF			
DVD Status						ON			
Inertia Status						ON			
Profile(s)						Summer and Winter			
Duration(s) (mins)		15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080							
Return Period(s) (years)						2			
Climate Change (%)						0			
Water									
US/MH	Return	Climate	First (X)	First (Y)	First (Z)	Overflow	Level		
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Act.	(m)
1.000	S1	15 Winter	2	+0%					22.823
1.001	S2	15 Winter	2	+0%					22.606
1.002	S3	15 Winter	2	+0%					22.505
1.003	S4	120 Winter	2	+0%					22.402
1.004	S5	120 Winter	2	+0%					22.401
1.005	S6	120 Winter	2	+0%					22.401
1.006	S7	120 Winter	2	+0%					22.401
1.007	S8	120 Winter	2	+0%					22.400
1.008	S9	120 Winter	2	+0%	2/15 Summer				22.399
Surcharged Flooded									
US/MH	Depth	Volume	Flow /	Overflow	Pipe				
PN	Name	(m)	(m³)	Cap.	(l/s)	Flow (l/s)	Status	Level Exceeded	
1.000	S1	-0.075	0.000	0.48		8.0	OK		
1.001	S2	-0.114	0.000	0.48		17.3	OK		
1.002	S3	-0.111	0.000	0.50		19.3	OK		
©1982-2017 XP Solutions									

Barratt Homes Manchester		Page 1
4 Brindley Road City Park Manchester M16 9HQ		
Date 25/10/2018 15:22 File waterpark revG Culvert ...	Designed by kielyd Checked by	
Micro Drainage		Network 2017.1.2

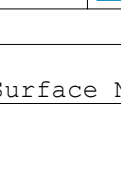
Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

PN	US/MH Name	Surcharged Flooded		Pipe		Status	Level Exceeded
		Depth (m)	Volume (m ³)	Flow / Overflow Cap.	Flow (l/s)		
1.003	S4	-0.237	0.000	0.04	9.9	OK	
1.004	S5	-0.458	0.000	0.02	11.4	OK	
1.005	S6	-0.384	0.000	0.01	7.6	OK	
1.006	S7	-0.293	0.000	0.01	5.1	OK	
1.007	S8	-0.257	0.000	0.01	9.4	OK	
1.008	S9	0.468	0.000	0.14	6.0	SURCHARGED	

a. Network 1

ii. Summary of Critical Results by Maximum Level

3. 1 in 30 Year

Barratt Homes Manchester		Page 0
4 Brindley Road City Park Manchester M16 9HQ		
Date 25/10/2018 15:29 File waterpark revG Culvert ...		
Designed by kielyd Checked by		
Micro Drainage		Network 2017.1.2

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

Simulation Criteria

Areal Reduction Factor 1.000	Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0	MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0	Inlet Coefficient 0.800
Manhole Headloss Coeff (Global) 0.500	Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000	

Number of Input Hydrographs 0	Number of Storage Structures 1
Number of Online Controls 1	Number of Time/Area Diagrams 0
Number of Offline Controls 0	Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R 0.382
Region England and Wales Cv	(Summer)	0.750
M5-60 (mm)	19.600 Cv	(Winter) 0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep 2.5 Second Increment (Extended)	
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	30
Climate Change (%)	0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S1	120 Winter	30	+0%	30/60 Winter				23.437
1.001	S2	120 Winter	30	+0%	30/30 Winter				23.434
1.002	S3	120 Winter	30	+0%	30/15 Winter				23.430
1.003	S4	120 Winter	30	+0%	30/30 Summer				23.423
1.004	S5	120 Winter	30	+0%	30/60 Summer				23.423
1.005	S6	120 Winter	30	+0%	30/30 Winter				23.423
1.006	S7	120 Winter	30	+0%	30/30 Winter				23.423
1.007	S8	120 Winter	30	+0%	30/30 Winter				23.422
1.008	S9	120 Winter	30	+0%	30/15 Summer				23.422

Surcharged Flooded					Pipe		
PN	US/MH Name	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status
1.000	S1	0.539	0.000	0.30		5.1	SURCHARGED
1.001	S2	0.714	0.000	0.33		11.8	SURCHARGED
1.002	S3	0.814	0.000	0.33		12.7	SURCHARGED

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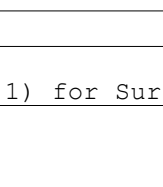
Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

PN	US/MH Name	Surcharged Flooded		Flow / Overflow		Pipe Flow	Status	Level Exceeded
		Depth (m)	Volume (m ³)	Cap.	(l/s)	(l/s)		
1.003	S4	0.784	0.000	0.06		16.5	SURCHARGED	
1.004	S5	0.564	0.000	0.03		21.4	SURCHARGED	
1.005	S6	0.638	0.000	0.01		10.9	SURCHARGED	
1.006	S7	0.729	0.000	0.01		7.9	SURCHARGED	
1.007	S8	0.765	0.000	0.02		15.6	SURCHARGED	
1.008	S9	1.491	0.000	0.21		9.4	SURCHARGED	

a. Network 1

ii. Summary of Critical Results by Maximum Level

4. 1 in 100 Year + 40% Climate Change

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4 Brindley Road City Park Manchester M16 9HQ		
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Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coefficient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Storage Structures	1
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.382
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.600	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	100
Climate Change (%)	40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S1	30 Winter	100	+40%	100/15 Summer				23.931
1.001	S2	180 Winter	100	+40%	100/15 Summer				23.901
1.002	S3	180 Winter	100	+40%	100/15 Summer				23.896
1.003	S4	180 Winter	100	+40%	100/15 Summer				23.888
1.004	S5	180 Winter	100	+40%	100/15 Summer				23.887
1.005	S6	180 Winter	100	+40%	100/15 Summer				23.887
1.006	S7	180 Winter	100	+40%	100/15 Summer				23.887
1.007	S8	180 Winter	100	+40%	100/15 Summer				23.887
1.008	S9	180 Winter	100	+40%	100/15 Summer				23.886

Surcharged Flooded					Pipe		
PN	US/MH Name	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status
1.000	S1	1.033	0.000	0.94		15.6	FLOOD RISK
1.001	S2	1.181	0.000	0.41		15.0	FLOOD RISK
1.002	S3	1.280	0.000	0.44		16.9	FLOOD RISK

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Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 1

PN	US/MH Name	Surcharged		Flooded		Pipe		Status	Level Exceeded
		Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)			
1.003	S4	1.249	0.000	0.09		25.4		SURCHARGED	
1.004	S5	1.028	0.000	0.05		38.9		FLOOD RISK	
1.005	S6	1.102	0.000	0.05		40.7		SURCHARGED	
1.006	S7	1.193	0.000	0.09		50.0		FLOOD RISK	
1.007	S8	1.230	0.000	0.11		70.0		FLOOD RISK	
1.008	S9	1.955	0.000	0.24		10.6		SURCHARGED	

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b. Network 2

i. Online Controls & Storage Structures

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Online Controls for Surface Network 1

Crown Vortex Valve® Manhole: S9, DS/PN: 1.008, Volume (m³): 26.2

Design Head (m) 1.500 Vortex Valve® Type R1 SW Only Invert Level (m) 21.706
Design Flow (l/s) 8.8 Diameter (mm) 110

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.9	1.200	7.8	3.000	12.4	7.000	18.9
0.200	3.7	1.400	8.5	3.500	13.4	7.500	19.6
0.300	3.9	1.600	9.1	4.000	14.3	8.000	20.2
0.400	4.5	1.800	9.6	4.500	15.2	8.500	20.9
0.500	5.1	2.000	10.1	5.000	16.0	9.000	21.5
0.600	5.5	2.200	10.6	5.500	16.8	9.500	22.1
0.800	6.4	2.400	11.1	6.000	17.5		
1.000	7.2	2.600	11.5	6.500	18.2		

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4 Brindley Road City Park Manchester M16 9HQ										
Date 20/09/2018 15:21	Designed by kielyd									
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<u>Storage Structures for Surface Network 1</u> <u>Tank or Pond Manhole: S9, DS/PN: 1.008</u> Invert Level (m) 23.425 <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Depth (m)</th> <th>Area (m²)</th> <th>Depth (m)</th> <th>Area (m²)</th> </tr> </thead> <tbody> <tr> <td>0.000</td> <td>250.0</td> <td>0.400</td> <td>250.0</td> </tr> </tbody> </table>			Depth (m)	Area (m ²)	Depth (m)	Area (m ²)	0.000	250.0	0.400	250.0
Depth (m)	Area (m ²)	Depth (m)	Area (m ²)							
0.000	250.0	0.400	250.0							
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b. Network 2

ii. Summary of Critical Results by Maximum Level

1. 1 in 1 Year

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Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 2

PN	US/MH Name	Surcharged		Flooded		Pipe		Status	Level Exceeded
		Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)			
3.000	S15	-0.460	0.000	0.01		5.4		OK	
1.003	S16	-0.384	0.000	0.01		8.7		OK	
1.004	S17	-0.326	0.000	0.01		8.5		OK	
1.005	S18	0.399	0.000	0.16		5.7	SURCHARGED		

b. Network 2

ii. Summary of Critical Results by Maximum Level

2. 1 in 2 Year

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Micro Drainage		Network 2017.1.2

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 2

PN	US/MH Name	Surcharged Flooded		Pipe		Status	Level Exceeded
		Depth (m)	Volume (m ³)	Flow / Overflow Cap.	Flow (l/s)		
3.000	S15	-0.349	0.000	0.01	6.8	OK	
1.003	S16	-0.273	0.000	0.01	9.5	OK	
1.004	S17	-0.215	0.000	0.01	9.5	OK	
1.005	S18	0.509	0.000	0.17	6.1	SURCHARGED	

b. Network 2

ii. Summary of Critical Results by Maximum Level

3. 1 in 30 Year

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4 Brindley Road City Park Manchester M16 9HQ		
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Micro Drainage	Network 2017.1.2	

Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 2

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coefficient 0.800
 Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
 Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 1
 Number of Online Controls 1 Number of Time/Area Diagrams 0
 Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.382
 Region England and Wales Cv (Summer) 0.750
 M5-60 (mm) 19.600 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status OFF
 DVD Status ON
 Inertia Status ON

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600,
 720, 960, 1440, 2160, 2880, 4320, 5760,
 7200, 8640, 10080
 Return Period(s) (years) 30
 Climate Change (%) 0

Water									
US/MH			Return Climate	First (X)	First (Y)	First (Z)	Overflow	Level	
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Act.	(m)
1.000	S11	180 Winter	30	+0%	30/60 Winter				23.414
1.001	S12	180 Winter	30	+0%	30/60 Winter				23.414
2.000	S13	180 Winter	30	+0%	30/60 Winter				23.415
1.002	S14	180 Winter	30	+0%	30/60 Winter				23.414
3.000	S15	180 Winter	30	+0%	30/60 Winter				23.414
1.003	S16	180 Winter	30	+0%	30/30 Winter				23.414
1.004	S17	180 Winter	30	+0%	30/30 Winter				23.413
1.005	S18	180 Winter	30	+0%	30/15 Summer				23.412

US/MH		Surcharged	Flooded	Pipe		Level	
PN	Name	Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Exceeded
1.000	S11	0.468	0.000	0.01		6.6	SURCHARGED
1.001	S12	0.535	0.000	0.01		5.6	SURCHARGED
2.000	S13	0.511	0.000	0.07		9.8	SURCHARGED
1.002	S14	0.590	0.000	0.02		15.2	SURCHARGED

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4 Brindley Road City Park Manchester M16 9HQ		
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Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 2

PN	US/MH Name	Surcharged	Flooded	Flow / Cap.	Overflow (l/s)	Pipe	Status	Level Exceeded
		Depth (m)	Volume (m³)			Flow (l/s)		
3.000	S15	0.644	0.000	0.01		9.6	SURCHARGED	
1.003	S16	0.720	0.000	0.01		10.3	SURCHARGED	
1.004	S17	0.778	0.000	0.02		12.8	SURCHARGED	
1.005	S18	1.503	0.000	0.27		9.4	SURCHARGED	

b. Network 2

ii. Summary of Critical Results by Maximum Level

4. 1 in 100 Year + 40% Climate Change

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4 Brindley Road City Park Manchester M16 9HQ		
Date 25/10/2018 15:01 File waterpark revG Culvert ...	Designed by kielyd Checked by	
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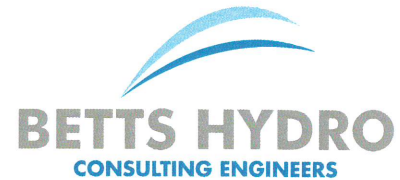
Summary of Critical Results by Maximum Level (Rank 1) for Surface Network 2

PN	US/MH Name	Surcharged	Flooded	Flow / Cap.	Overflow (l/s)	Pipe	Status	Level Exceeded
		Depth (m)	Volume (m³)			Flow (l/s)		
3.000	S15	1.094	0.000	0.02		15.2	SURCHARGED	
1.003	S16	1.170	0.000	0.09		65.1	SURCHARGED	
1.004	S17	1.228	0.000	0.11		74.3	SURCHARGED	
1.005	S18	1.953	0.000	0.30		10.6	FLOOD RISK	

Appendix E

15th November 2018

Mr. S. Garth
Engineering Manager
Barratt Homes Manchester
4 Brindley Road
Stretford
Manchester
M16 9HQ



Dear Steve,

**WATERPARK DRIVE, KNOWSLEY
FLOOD RISK ASSESSMENT ADDENDUM**

This addendum to the FRA has been prepared due to scheme changes which have resulted in the intention to leave the existing culvert in place and not to 'de-culvert' as was proposed within the original approved FRA and addresses the comments raised by the LLFA relating to flood risk and de-culverting.

Flood Risk

Although the FRA demonstrates opening the culvert as not increasing the risk of flooding, the de-culverting scheme does increase the residual risk of blockage due to the introduction of an open section and new structures (headwalls and access grates/debris screens). The blockage risk can be from unintentional debris entering the system such as blown litter and also intentional vandalism/misuse. Not introducing an open-channel removes the need for the new structures and as a result removes this residual risk.

It should be noted that the culvert condition is such that no remedial work to the existing structure is required to facilitate development; the removal of the culvert was not a decision that related to the condition of the existing culvert.

Health and Safety

Observations of the flow through the culverted section have shown approx. 800mm (depth) of fast flowing water during Autumn months. The potentially fast flowing water presents a hazard in terms of the accessibility of the watercourse due to the shallow side slopes (battered back at a 1 in 3 gradient). Barratt Homes own SUDS risk assessment form dictates that the watercourse will need to be fenced off to prevent access with the need for life rings to be mounted. Life rings will likely need regular replacement, which is another burden in terms of ongoing maintenance. The new headwalls will have vertical sides, with fenced edge protection, which may encourage children to climb and congregate. The trash screens of the headwalls may also encourage children to use as climbing frames. The introduction of fencing to prevent access to the channel will also reduce natural observation of this area as well as being unsightly.

Management and Maintenance Responsibility

The EA have stated that they will not be responsible for maintenance of the de-culverted watercourse including the headwalls and debris screen clearance; in spite of the fact that the River Alt is designated as Main River and that they are currently maintaining the river upstream and downstream of the site. Therefore the watercourse will ultimately have to be transferred to a management company. The EA have also burdened the developer with an onerous weekly inspection in the winter months and fortnightly inspections in the summer. Funds need to be set

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Flintshire CH5 2LY
Telephone: 01244 289 041

aside for maintenance should problems occur, and maintenance will be a difficult task. I believe managing agents will be loathed to take on such a liability, as the liability of such areas is high risk.

Estate Charges

For the reasons given above, I expect the estate charge covering maintenance of all the non-deeded or adoptable areas to be high. This cost will ultimately be borne by the residents of the new development. Given that there are only 79 units on the site, this will be a considerable and unnecessary financial burden on the future residents for maintenance of a feature that serves them no purpose.

Aesthetics

The section of culvert to be opened up is now relatively short due to geology and other technical constraints, with large cast in-situ concrete headwalls and wing-walls both upstream and downstream. The original intention/vision was to have a stream meandering through the Public Open Space, but instead what would result in pursuing this open-channel option would be a wide, deep channel with large concrete and steel structures at either end. The addition of a fence will further impact on the visual appeal which I consider will result in a thoroughly unattractive feature, which will be challenging and expensive to maintain.

Biodiversity

Due to the length of the de-culverting works being minimal due to technical constraints by comparison to what was originally proposed; the significant size and hard engineering nature of structures; plus requirements for peoples safety; regular and frequent maintenance regime imposed by the EA, then any improvement in biodiversity that may have resulted from the de-culverting works would be minimal. Therefore the proposal to retain the existing culverted watercourse has minimal impact in the potential for biodiversity improvement.

Local Benefit

I do not consider there to be any net benefit to either new or existing adjacent residents in having a deep, fast flowing, hard-engineered scar running through green space. It will cost our clients a significant annual fee for maintenance of an area they will actively be deterred from entering.

When all of these key aspects above are considered it is my opinion that the proposal to retain the existing culverted watercourse is entirely appropriate and justified.

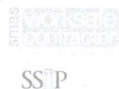
I trust you will find the above of assistance, however, if you have any queries or require further information please do not hesitate to contact me.

Yours sincerely,



Richard Nicholas BEng (Hons) MBA GMICE GradCIWEM
Director
BETTS HYDRO LIMITED

Old Marsh Farm Barns
Welsh Road, Sealand
Flintshire CH5 2LY
Telephone: 01244 289 041



Appendix F

Sustainable Drainage: Operation and Maintenance Plan

Your Sustainable Drainage Strategy must also set out ongoing access, operational and maintenance requirements to ensure that the sustainable drainage system will continue to perform as intended throughout its design life. This pro-forma supports developers in devising an effective Operation and Maintenance Plan for all surface water features proposed within a development, aiming to mitigate the risk of failure through robust operation and maintenance protocols for all features.

You **must** submit this proforma along with your Sustainable Drainage Strategy to the Local Planning Authority.

The Planning Practice Guidance sets out that developers must “*ensure their [sustainable drainage] design takes account of the construction, operation and maintenance requirements of both surface and subsurface components, allowing for any personnel, vehicle or machinery access required to undertake this work.*” You must satisfy Knowsley Council that “*the proposed minimum standards of operation are appropriate and that there are clear arrangements in place for ongoing maintenance.*”

Development Details	
Development Name	Nomvula Park
Address	Off Waterpark Drive, Knowsley
Development Grid Reference	X = 342782 Y = 393074
Planning Application Reference	19/00519/FUL

Sustainable Drainage: Operation and Maintenance Plan

Sustainable Drainage Feature 1		Dimensions of Sustainable Drainage Feature (as appropriate)	
Type of Sustainable Drainage Feature	Geocellular Storage Tank	Surface area (m)	154m2
Manufacturer and Model Number	Polystorm PSM1	Length (m)	14m
Unique Identification Number (if available)		Width (m)	14m
Design Life	50 Years Creep Life Expectancy	Depth (m)	1.6m deep Geocellular Crates
Grid Reference Location of Feature	X = 342738 Y = 392990	Side slope (m)	0
Access Details	<i>The geocellular storage tank is located in areas of POS. The POS is to be transferred ownership to the management company therefore there should be no ownership issues. Access to the POS is via the adoptable highway. Access is NOT to be taken via the adjacent shared driveways, though provision in the deeds to repair and maintain drains has been included in plot deeds.</i>	Bed slope (m)	0
Party Responsible for Maintenance		Owner of Feature	
Name	Trustgreen	Name	Trust Management
Address	Unit 7, Portal Business Park, Eaton Lane, Tarporley, CW6 9DL.	Address	See Above
Email	enquiries@trustmgt.co.uk	Email	
Telephone 1	0845 544 2924	Telephone 1	
Telephone 2		Telephone 2	
Is the party responsible the Owner?	YES	Is the Owner the party responsible for maintenance?	Yes
Regular Maintenance Schedule			Expected Maintenance Cost (£)
Weekly	None		
Monthly	None		
Quarterly	None		
Bi-annually	None		
Annually	Inspect Access chambers. Check for excessive siltation in Tanks. CCTV pipes and Tanks as necessary. Jet and clean where excessive siltation evident. Check free movement of one way check valves.		£1000
Other (specify)			
Replacement of Feature	<i>Design life is 50 years, from a structural integrity point of view, though a lifespan in excess of that may be experienced. Should the crates need to be replaced, it will be funded by the management company whom are funded by an annual fee paid by residents to cover upkeep of the POS and SUDS.</i>		
Remedial Maintenance Schedule			
Tasks in advance of a significant storm			
Inspection following a significant storm	Inspect Access chambers. Check for excessive siltation in Geocellular storage. CCTV pipes and Tanks as necessary. Check free movement of one way check valves.		
Likely tasks following of a significant storm	Jet and clean where excessive siltation evident.		

Sustainable Drainage: Operation and Maintenance Plan

Contingency Plan
<i>In the event of storms greater than the design event, or failure of the geocellular tank, localized flooding may occur. The location of the localized flooding is shown on drg 463/ED/19. Contours show where flood water is likely to pond. Volumes will be dependednt on the severity of the storm, and likely be limited to highway areas. Flood Durations will be short until the SUDS network drains down. All plots are a minimum of 150mm above surrounding levels to protect against minor flooding.</i> <i>Where a failure of the Geocullular tank is suspected, contact in the first instance should be made to the “Responsible Party” listed above. In the event of an emergency, where the “Responsible Party” is NOT contactable, the Knowsley Council Fllood Risk Team could be contacted, who could use their statutory powers to carry out emergency works.</i> Knowsley Council Flood Risk Team 0151 443 2704 or LLFA@knowsley.gov.uk