



**Oldlands Farm, Steyning
Road,
Bognor Regis,
West Sussex**

**Access Road Drainage
Strategy**

for

Hanbury Properties Limited

August 2014

Hydrock Ref: R/14443/008



DOCUMENT CONTROL SHEET

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Client: Hanbury Properties Limited

Project: Oldlands Farm, Bognor Regis, West Sussex

Title: Access Road Drainage Strategy

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Issue Number:	1	Name	Signature
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Issue number	Date	Revision Details	Issued to
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Introduction

This report accompanies the submitted drainage drawing (Hydrock ref. C14443-302) relating to the access road as approved under hybrid application BE/61/13, dated 19 March 2014. The drawing and supporting commentary below have been prepared on behalf of Hanbury Properties Limited to discharge conditions 3 and 6 of the hybrid permission. The details relate specifically to the 'full' element of the application which in the case of surface water drainage is the access and road required to serve the uses permitted under the 'outline' element of the scheme.

Conditions 3 and 6 of BE/61/13 are set out below for the avoidance of doubt.

Condition 3

“Development shall not commence until full details of the proposed surface water drainage scheme have been submitted to and approved in writing by the Local Planning Authority.

The design should follow the hierarchy of preference for different types of surface water drainage disposal systems as set out in Approved Document H of the Building Regulations, the recommendations of the SUDS Manual produced by CIRIA.

Winter groundwater monitoring to establish highest annual ground water levels and Percolation testing to BRE 365, or similar approved, will be required to support the design of any Infiltration drainage. No building shall be occupied until the complete surface water drainage system serving the property has been implemented in accordance with the agreed details”.

Condition 6

“No development shall take place until a surface water drainage scheme for the site, based on sustainable drainage principles and an assessment of the hydrological and hydrogeological context of the development, has been submitted to and approved in writing by the Local Planning Authority. The drainage strategy should:

Demonstrate the surface water run-off generated up to and including the 1 in 100 yr plus 30% for climate change critical storm will not exceed the run-off from the undeveloped site following the corresponding rainfall event (as stated within the approved FRA ref: 13/0404/4692)

Consider pollution prevention measures.

The scheme shall subsequently be implemented in accordance with the approved details before the development is completed”



Drainage Strategy

The surface water drainage strategy for the proposed access road at Oldlands Farm is to control the surface water discharge from the new access road and restrict peak flows to a maximum rate of greenfield runoff of 5.3l/s, as agreed with the Environment Agency. The surface water drainage network has been designed to mimic the existing catchment, with the run-off being taken north towards the open ditch drain that splits Oldlands Farm. The open ditch drains runs in an easterly direction. This then is culverted under the railway line, it ultimately discharges to the Lidsey Rife approximately 300m to the east of Oldlands Farm.

The highway drainage for the proposed access road will be attenuated by 1050mm diameter oversized pipes and a hydrobrake installed within SWMH 5 with an allowable discharge rate of 5.3l/s. Refer to Proposed Access Road within Appendix A for information.

Sustainable Drainage Systems (SuDS) in the form of Prevention, Source Control and Site Control methods are incorporated within the design.

Foul water generated by the adjoining parcels of land will be discharge by gravity to a pumping station located near to the A29 roundabout. The station will then pump via a rising main to a point into the foul public sewer located in Shirpley Road, as indicated by Southern Water Sewer records.

The proposed pumping station and rising main to serve the development is being secured under a Section 98 off site sewer requisition with Southern Water. The design process for this is currently with Southern Water's consultants.

Pollution Prevention Measures

Pollution control devices such as oil / petrol interceptors will be incorporated within each of the adjoining parcels of land, as there will be higher risk of incidents within each parcel.

Highway drainage will be trapped gullies and a sump is constructed within the hydrobrake manhole SWMH 5, that will hold pollutants and avoid them directly entering the nearby watercourse.



APPENDIX A – HYDROCK DRAWINGS

CONTENTS	
Identifier	Name
Hydrock	Drawing No. C14443/302

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APPENDIX B – HYDROCK HYDRAULIC CALCULATIONS

CONTENTS	
Identifier	Name
Hydrock	Micro Drainage Calculations

Hydrock Consultants Ltd		Page 1
239 Ashley Road Hale Cheshire WA15 9NE	Hanbury Properties Ltd., Oldlands Farm Bognor Regis	
Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.000	Minimum Backdrop Height (m)	0.200
Ratio R	0.348	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.147	4-8	0.317	8-12	0.005

Total Area Contributing (ha) = 0.469

Total Pipe Volume (m³) = 191.311

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	86.500	0.363	238.3	0.185	4.00	0.0	0.600	o	300
1.001	62.000	0.114	543.9	0.101	0.00	0.0	0.600	o	1050
1.002	90.000	0.170	529.4	0.098	0.00	0.0	0.600	o	1050
1.003	60.000	0.108	555.6	0.085	0.00	0.0	0.600	o	1050
1.004	13.000	0.080	162.5	0.000	0.00	0.0	0.600	o	300
1.005	10.000	0.100	100.0	0.000	0.00	0.0	0.600	o	300

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	46.88	5.42	2.320	0.185	0.0	0.0	0.0	1.01	71.7	23.5
1.001	44.43	6.12	0.693	0.286	0.0	0.0	0.0	1.47	1273.4	34.4
1.002	41.40	7.13	0.579	0.384	0.0	0.0	0.0	1.49	1290.8	43.1
1.003	39.59	7.82	0.409	0.469	0.0	0.0	0.0	1.45	1259.8	50.3
1.004	39.15	7.99	0.301	0.469	0.0	0.0	0.0	1.23	87.0	50.3
1.005	38.90	8.10	0.221	0.469	0.0	0.0	0.0	1.57	111.1	50.3

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Hydrock Consultants Ltd							Page 2			
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Date 20th June 2014 File HSW.MDX				Designed by JH Checked by						
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<u>Manhole Schedules for Storm</u>										
MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)
1	3.720	1.500	Open Manhole	1200	1.000	2.220	300			
3	2.820	2.127	Open Manhole	2400	1.001	0.623	1050	1.000	1.857	300
10	2.740	2.161	Open Manhole	2400	1.002	0.579	1050	1.001	0.579	1050
5	3.080	2.671	Open Manhole	2400	1.003	0.409	1050	1.002	0.409	1050
6	2.540	2.239	Open Manhole	1800	1.004	0.301	300	1.003	0.301	1050
6	2.540	2.319	Open Manhole	1200	1.005	0.221	300	1.004	0.221	300
	2.400	2.279	Open Manhole	0		OUTFALL		1.005	0.121	300
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Hydrock Consultants Ltd		Page 3
239 Ashley Road Hale Cheshire WA15 9NE	Hanbury Properties Ltd., Oldlands Farm Bognor Regis	
Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
Micro Drainage	Network 2013.1.1	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	300	1	3.720	2.220	1.200	Open Manhole	1200
1.001	o	1050	3	2.820	0.693	1.077	Open Manhole	2400
1.002	o	1050	10	2.740	0.579	1.111	Open Manhole	2400
1.003	o	1050	5	3.080	0.409	1.621	Open Manhole	2400
1.004	o	300	6	2.540	0.301	1.939	Open Manhole	1800
1.005	o	300	6	2.540	0.221	2.019	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	86.500	238.3	3	2.820	1.857	0.663	Open Manhole	2400
1.001	62.000	543.9	10	2.740	0.579	1.111	Open Manhole	2400
1.002	90.000	529.4	5	3.080	0.409	1.621	Open Manhole	2400
1.003	60.000	555.6	6	2.540	0.301	1.189	Open Manhole	1800
1.004	13.000	162.5	6	2.540	0.221	2.019	Open Manhole	1200
1.005	10.000	100.0		2.400	0.121	1.979	Open Manhole	0

Hydrock Consultants Ltd		Page 4
239 Ashley Road Hale Cheshire WA15 9NE	Hanbury Properties Ltd., Oldlands Farm Bognor Regis	
Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
Micro Drainage Network 2013.1.1		

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.185	0.185	0.185
1.001	-	-	100	0.101	0.101	0.101
1.002	-	-	100	0.098	0.098	0.098
1.003	-	-	100	0.085	0.085	0.085
1.004	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.469	0.469	0.469

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.005		2.400	0.121	0.150	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
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	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.348		

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Hydrock Consultants Ltd		Page 5
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Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
Micro Drainage	Network 2013.1.1	

Online Controls for Storm

Hydro-Brake® Manhole: 5, DS/PN: 1.003, Volume (m³): 87.9

Design Head (m) 1.000 Hydro-Brake® Type Md4 Invert Level (m) 0.409
 Design Flow (l/s) 5.3 Diameter (mm) 82

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.5	1.200	5.7	3.000	9.1	7.000	13.9
0.200	3.7	1.400	6.2	3.500	9.8	7.500	14.3
0.300	3.2	1.600	6.6	4.000	10.5	8.000	14.8
0.400	3.4	1.800	7.0	4.500	11.1	8.500	15.3
0.500	3.7	2.000	7.4	5.000	11.7	9.000	15.7
0.600	4.1	2.200	7.8	5.500	12.3	9.500	16.2
0.800	4.7	2.400	8.1	6.000	12.8		
1.000	5.2	2.600	8.4	6.500	13.4		

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Hydrock Consultants Ltd		Page 6
239 Ashley Road Hale Cheshire WA15 9NE	Hanbury Properties Ltd., Oldlands Farm Bognor Regis	
Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
Micro Drainage Network 2013.1.1		

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

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	0
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	0.350
Region England and Wales Cv (Summer)	0.750		
M5-60 (mm)	19.000	Cv (Winter)	0.840

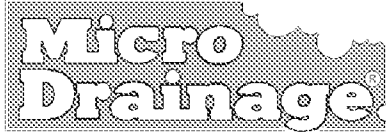
Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960
Return Period(s) (years)	1
Climate Change (%)	0

PN	Storm	Return Period	Climate Change	First X Surcharge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
1.000	15 Winter	1	0%					
1.001	180 Winter	1	0%					
1.002	180 Winter	1	0%					
1.003	180 Winter	1	0%					
1.004	180 Winter	1	0%					
1.005	180 Winter	1	0%					

PN	US/MH Name	Water		Flooded		Pipe		Status
		Level (m)	Surch'd Depth (m)	Volume (m³)	Flow / Cap.	O'flow (l/s)	Flow (l/s)	
1.000	1	2.344	-0.176	0.000	0.36	0.0	25.0	OK
1.001	3	0.903	-0.840	0.000	0.01	0.0	9.6	OK
1.002	10	0.903	-0.726	0.000	0.01	0.0	9.7	OK
1.003	5	0.903	-0.556	0.000	0.00	0.0	3.7	OK
1.004	6	0.345	-0.256	0.000	0.05	0.0	3.7	OK
1.005	6	0.262	-0.259	0.000	0.05	0.0	3.7	OK

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Hydrock Consultants Ltd		Page 7
239 Ashley Road Hale Cheshire WA15 9NE	Hanbury Properties Ltd., Oldlands Farm Bognor Regis	
Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
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Rainfall Hyetograph for 15 minute 1 year Winter I+0%
for Pipe 1.000 (Storm)

Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)
1	6.692	4	16.101	7	60.016	10	42.167	13	12.719
2	12.212	5	26.062	8	69.713	11	26.062	14	12.212
3	12.719	6	42.167	9	60.016	12	16.101	15	6.692

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239 Ashley Road Hale Cheshire WA15 9NE		Hanbury Properties Ltd., Oldlands Farm Bognor Regis							
Date 20th June 2014 File HSW.MDX		Designed by JH Checked by							
Micro Drainage		Network 2013.1.1							
<u>Rainfall Hyetograph for 180 minute 1 year Winter I+0%</u> <u>for Pipe 1.001 (Storm)</u>									
Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)
3	0.418	39	2.920	75	11.273	111	10.231	147	2.746
6	1.202	42	3.156	78	12.160	114	9.296	150	2.661
9	1.777	45	3.469	81	12.987	117	8.375	153	2.621
12	2.203	48	3.929	84	13.800	120	7.382	156	2.615
15	2.428	51	4.436	87	14.376	123	6.556	159	2.621
18	2.557	54	5.025	90	14.791	126	5.792	162	2.614
21	2.614	57	5.792	93	14.791	129	5.025	165	2.557
24	2.621	60	6.556	96	14.376	132	4.436	168	2.428
27	2.615	63	7.382	99	13.800	135	3.929	171	2.203
30	2.621	66	8.375	102	12.987	138	3.469	174	1.777
33	2.661	69	9.296	105	12.160	141	3.156	177	1.202
36	2.746	72	10.231	108	11.273	144	2.920	180	0.418

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239 Ashley Road Hale Cheshire WA15 9NE		Hanbury Properties Ltd., Oldlands Farm Bognor Regis							
Date 20th June 2014 File HSW.MDX		Designed by JH Checked by							
Micro Drainage		Network 2013.1.1							
<u>Rainfall Hyetograph for 180 minute 1 year Winter I+0%</u> <u>for Pipe 1.002 (Storm)</u>									
Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)
3	0.418	39	2.920	75	11.273	111	10.231	147	2.746
6	1.202	42	3.156	78	12.160	114	9.296	150	2.661
9	1.777	45	3.469	81	12.987	117	8.375	153	2.621
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30	2.621	66	8.375	102	12.987	138	3.469	174	1.777
33	2.661	69	9.296	105	12.160	141	3.156	177	1.202
36	2.746	72	10.231	108	11.273	144	2.920	180	0.418

Hydrock Consultants Ltd				Page 10					
239 Ashley Road Hale Cheshire WA15 9NE		Hanbury Properties Ltd., Oldlands Farm Bognor Regis							
Date 20th June 2014 File HSW.MDX		Designed by JH Checked by							
Micro Drainage		Network 2013.1.1							
<u>Rainfall Hyetograph for 180 minute 1 year Winter I+0%</u> <u>for Pipe 1.003 (Storm)</u>									
Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)
3	0.418	39	2.920	75	11.273	111	10.231	147	2.746
6	1.202	42	3.156	78	12.160	114	9.296	150	2.661
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33	2.661	69	9.296	105	12.160	141	3.156	177	1.202
36	2.746	72	10.231	108	11.273	144	2.920	180	0.418
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Hydrock Consultants Ltd				Page 11					
239 Ashley Road Hale Cheshire WA15 9NE		Hanbury Properties Ltd., Oldlands Farm Bognor Regis							
Date 20th June 2014 File HSW.MDX		Designed by JH Checked by							
Micro Drainage		Network 2013.1.1							
<u>Rainfall Hyetograph for 180 minute 1 year Winter I+0%</u> <u>for Pipe 1.004 (Storm)</u>									
Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)
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27	2.615	63	7.382	99	13.800	135	3.929	171	2.203
30	2.621	66	8.375	102	12.987	138	3.469	174	1.777
33	2.661	69	9.296	105	12.160	141	3.156	177	1.202
36	2.746	72	10.231	108	11.273	144	2.920	180	0.418

Hydrock Consultants Ltd				Page 12																																																																																																																																			
239 Ashley Road Hale Cheshire WA15 9NE		Hanbury Properties Ltd., Oldlands Farm Bognor Regis																																																																																																																																					
Date 20th June 2014 File HSW.MDX		Designed by JH Checked by																																																																																																																																					
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<u>Rainfall Hyetograph for 180 minute 1 year Winter I+0%</u> <u>for Pipe 1.005 (Storm)</u> <table><thead><tr><th>Time (mins)</th><th>Rain (mm/hr)</th><th>Time (mins)</th><th>Rain (mm/hr)</th><th>Time (mins)</th><th>Rain (mm/hr)</th><th>Time (mins)</th><th>Rain (mm/hr)</th><th>Time (mins)</th><th>Rain (mm/hr)</th></tr></thead><tbody><tr><td>3</td><td>0.418</td><td>39</td><td>2.920</td><td>75</td><td>11.273</td><td>111</td><td>10.231</td><td>147</td><td>2.746</td></tr><tr><td>6</td><td>1.202</td><td>42</td><td>3.156</td><td>78</td><td>12.160</td><td>114</td><td>9.296</td><td>150</td><td>2.661</td></tr><tr><td>9</td><td>1.777</td><td>45</td><td>3.469</td><td>81</td><td>12.987</td><td>117</td><td>8.375</td><td>153</td><td>2.621</td></tr><tr><td>12</td><td>2.203</td><td>48</td><td>3.929</td><td>84</td><td>13.800</td><td>120</td><td>7.382</td><td>156</td><td>2.615</td></tr><tr><td>15</td><td>2.428</td><td>51</td><td>4.436</td><td>87</td><td>14.376</td><td>123</td><td>6.556</td><td>159</td><td>2.621</td></tr><tr><td>18</td><td>2.557</td><td>54</td><td>5.025</td><td>90</td><td>14.791</td><td>126</td><td>5.792</td><td>162</td><td>2.614</td></tr><tr><td>21</td><td>2.614</td><td>57</td><td>5.792</td><td>93</td><td>14.791</td><td>129</td><td>5.025</td><td>165</td><td>2.557</td></tr><tr><td>24</td><td>2.621</td><td>60</td><td>6.556</td><td>96</td><td>14.376</td><td>132</td><td>4.436</td><td>168</td><td>2.428</td></tr><tr><td>27</td><td>2.615</td><td>63</td><td>7.382</td><td>99</td><td>13.800</td><td>135</td><td>3.929</td><td>171</td><td>2.203</td></tr><tr><td>30</td><td>2.621</td><td>66</td><td>8.375</td><td>102</td><td>12.987</td><td>138</td><td>3.469</td><td>174</td><td>1.777</td></tr><tr><td>33</td><td>2.661</td><td>69</td><td>9.296</td><td>105</td><td>12.160</td><td>141</td><td>3.156</td><td>177</td><td>1.202</td></tr><tr><td>36</td><td>2.746</td><td>72</td><td>10.231</td><td>108</td><td>11.273</td><td>144</td><td>2.920</td><td>180</td><td>0.418</td></tr></tbody></table>						Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	3	0.418	39	2.920	75	11.273	111	10.231	147	2.746	6	1.202	42	3.156	78	12.160	114	9.296	150	2.661	9	1.777	45	3.469	81	12.987	117	8.375	153	2.621	12	2.203	48	3.929	84	13.800	120	7.382	156	2.615	15	2.428	51	4.436	87	14.376	123	6.556	159	2.621	18	2.557	54	5.025	90	14.791	126	5.792	162	2.614	21	2.614	57	5.792	93	14.791	129	5.025	165	2.557	24	2.621	60	6.556	96	14.376	132	4.436	168	2.428	27	2.615	63	7.382	99	13.800	135	3.929	171	2.203	30	2.621	66	8.375	102	12.987	138	3.469	174	1.777	33	2.661	69	9.296	105	12.160	141	3.156	177	1.202	36	2.746	72	10.231	108	11.273	144	2.920	180	0.418
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Hydrock Consultants Ltd		Page 1
239 Ashley Road Hale Cheshire WA15 9NE	Hanbury Properties Ltd., Oldlands Farm Bognor Regis	
Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
Micro Drainage	Network 2013.1.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	30	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.000	Minimum Backdrop Height (m)	0.200
Ratio R	0.348	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.147	4-8	0.317	8-12	0.005

Total Area Contributing (ha) = 0.469

Total Pipe Volume (m³) = 191.311

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	86.500	0.363	238.3	0.185	4.00	0.0	0.600	o	300
1.001	62.000	0.114	543.9	0.101	0.00	0.0	0.600	o	1050
1.002	90.000	0.170	529.4	0.098	0.00	0.0	0.600	o	1050
1.003	60.000	0.108	555.6	0.085	0.00	0.0	0.600	o	1050
1.004	13.000	0.080	162.5	0.000	0.00	0.0	0.600	o	300
1.005	10.000	0.100	100.0	0.000	0.00	0.0	0.600	o	300

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.42	2.320	0.185	0.0	0.0	0.0	1.01	71.7	25.1
1.001	50.00	6.12	0.693	0.286	0.0	0.0	0.0	1.47	1273.4	38.7
1.002	50.00	7.13	0.579	0.384	0.0	0.0	0.0	1.49	1290.8	52.0
1.003	50.00	7.82	0.409	0.469	0.0	0.0	0.0	1.45	1259.8	63.5
1.004	50.00	7.99	0.301	0.469	0.0	0.0	0.0	1.23	87.0	63.5
1.005	50.00	8.10	0.221	0.469	0.0	0.0	0.0	1.57	111.1	63.5

Hydrock Consultants Ltd							Page 2			
239 Ashley Road Hale Cheshire WA15 9NE				Hanbury Properties Ltd., Oldlands Farm Bognor Regis						
Date 20th June 2014 File HSW.MDX				Designed by JH Checked by						
Micro Drainage				Network 2013.1.1						
<u>Manhole Schedules for Storm</u>										
MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)
1	3.720	1.500	Open Manhole	1200	1.000	2.220	300			
3	2.820	2.127	Open Manhole	2400	1.001	0.623	1050	1.000	1.857	300
10	2.740	2.161	Open Manhole	2400	1.002	0.579	1050	1.001	0.579	1050
5	3.080	2.671	Open Manhole	2400	1.003	0.409	1050	1.002	0.409	1050
6	2.540	2.239	Open Manhole	1800	1.004	0.301	300	1.003	0.301	1050
6	2.540	2.319	Open Manhole	1200	1.005	0.221	300	1.004	0.221	300
	2.400	2.279	Open Manhole	0		OUTFALL		1.005	0.121	300
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Hydrock Consultants Ltd		Page 3
239 Ashley Road Hale Cheshire WA15 9NE	Hanbury Properties Ltd., Oldlands Farm Bognor Regis	
Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
Micro Drainage	Network 2013.1.1	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	300	1	3.720	2.220	1.200	Open Manhole	1200
1.001	o	1050	3	2.820	0.693	1.077	Open Manhole	2400
1.002	o	1050	10	2.740	0.579	1.111	Open Manhole	2400
1.003	o	1050	5	3.080	0.409	1.621	Open Manhole	2400
1.004	o	300	6	2.540	0.301	1.939	Open Manhole	1800
1.005	o	300	6	2.540	0.221	2.019	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	86.500	238.3	3	2.820	1.857	0.663	Open Manhole	2400
1.001	62.000	543.9	10	2.740	0.579	1.111	Open Manhole	2400
1.002	90.000	529.4	5	3.080	0.409	1.621	Open Manhole	2400
1.003	60.000	555.6	6	2.540	0.301	1.189	Open Manhole	1800
1.004	13.000	162.5	6	2.540	0.221	2.019	Open Manhole	1200
1.005	10.000	100.0		2.400	0.121	1.979	Open Manhole	0

Hydrock Consultants Ltd		Page 4
239 Ashley Road Hale Cheshire WA15 9NE	Hanbury Properties Ltd., Oldlands Farm Bognor Regis	
Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
Micro Drainage	Network 2013.1.1	

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.185	0.185	0.185
1.001	-	-	100	0.101	0.101	0.101
1.002	-	-	100	0.098	0.098	0.098
1.003	-	-	100	0.085	0.085	0.085
1.004	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.469	0.469	0.469

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.005		2.400	0.121	0.150	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
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	Profile Type	Summer
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.348		

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Hydrock Consultants Ltd		Page 5
239 Ashley Road Hale Cheshire WA15 9NE	Hanbury Properties Ltd., Oldlands Farm Bognor Regis	
Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
Micro Drainage	Network 2013.1.1	

Online Controls for Storm

Hydro-Brake® Manhole: 5, DS/PN: 1.003, Volume (m³): 87.9

Design Head (m) 1.000 Hydro-Brake® Type Md4 Invert Level (m) 0.409
 Design Flow (l/s) 5.3 Diameter (mm) 82

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.5	1.200	5.7	3.000	9.1	7.000	13.9
0.200	3.7	1.400	6.2	3.500	9.8	7.500	14.3
0.300	3.2	1.600	6.6	4.000	10.5	8.000	14.8
0.400	3.4	1.800	7.0	4.500	11.1	8.500	15.3
0.500	3.7	2.000	7.4	5.000	11.7	9.000	15.7
0.600	4.1	2.200	7.8	5.500	12.3	9.500	16.2
0.800	4.7	2.400	8.1	6.000	12.8		
1.000	5.2	2.600	8.4	6.500	13.4		

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Hydrock Consultants Ltd					Page 6																																																																										
239 Ashley Road Hale Cheshire WA15 9NE			Hanbury Properties Ltd., Oldlands Farm Bognor Regis																																																																												
Date 20th June 2014 File HSW.MDX			Designed by JH Checked by																																																																												
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<u>Summary of Results for 30 minute 30 year Summer (Storm)</u> Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF Analysis Timestep Fine Inertia Status OFF DTS Status ON <table><tr><th rowspan="2">PN</th><th rowspan="2">US/MH Name</th><th colspan="2">Water</th><th colspan="2">Surcharged</th><th colspan="2">Flooded</th><th colspan="2">Pipe</th></tr><tr><th>Level (m)</th><th>Depth (m)</th><th>Volume (m³)</th><th>Flow / Cap.</th><th>Overflow (l/s)</th><th>Flow (l/s)</th><th>Status</th></tr><tr><td>1.000</td><td>1</td><td>2.421</td><td>-0.099</td><td>0.000</td><td>0.77</td><td>0.0</td><td>53.2</td><td>OK</td></tr><tr><td>1.001</td><td>3</td><td>1.114</td><td>-0.629</td><td>0.000</td><td>0.07</td><td>0.0</td><td>75.5</td><td>OK</td></tr><tr><td>1.002</td><td>10</td><td>1.114</td><td>-0.515</td><td>0.000</td><td>0.05</td><td>0.0</td><td>60.4</td><td>OK</td></tr><tr><td>1.003</td><td>5</td><td>1.114</td><td>-0.345</td><td>0.000</td><td>0.00</td><td>0.0</td><td>4.4</td><td>OK</td></tr><tr><td>1.004</td><td>6</td><td>0.349</td><td>-0.252</td><td>0.000</td><td>0.06</td><td>0.0</td><td>4.4</td><td>OK</td></tr><tr><td>1.005</td><td>6</td><td>0.266</td><td>-0.255</td><td>0.000</td><td>0.06</td><td>0.0</td><td>4.4</td><td>OK</td></tr></table>									PN	US/MH Name	Water		Surcharged		Flooded		Pipe		Level (m)	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)	Status	1.000	1	2.421	-0.099	0.000	0.77	0.0	53.2	OK	1.001	3	1.114	-0.629	0.000	0.07	0.0	75.5	OK	1.002	10	1.114	-0.515	0.000	0.05	0.0	60.4	OK	1.003	5	1.114	-0.345	0.000	0.00	0.0	4.4	OK	1.004	6	0.349	-0.252	0.000	0.06	0.0	4.4	OK	1.005	6	0.266	-0.255	0.000	0.06	0.0	4.4	OK
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Hydrock Consultants Ltd				Page 7																																																																									
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Hydrock Consultants Ltd		Page 1
239 Ashley Road Hale Cheshire WA15 9NE	Bericote Properties L... Oldlands Farm Bognor Regis	
Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.000	Minimum Backdrop Height (m)	0.200
Ratio R	0.348	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	1.200
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.147	4-8	0.317	8-12	0.005

Total Area Contributing (ha) = 0.469

Total Pipe Volume (m³) = 191.311

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	86.500	0.363	238.3	0.185	4.00	0.0	0.600	o	300
1.001	62.000	0.114	543.9	0.101	0.00	0.0	0.600	o	1050
1.002	90.000	0.170	529.4	0.098	0.00	0.0	0.600	o	1050
1.003	60.000	0.108	555.6	0.085	0.00	0.0	0.600	o	1050
1.004	13.000	0.080	162.5	0.000	0.00	0.0	0.600	o	300
1.005	10.000	0.100	100.0	0.000	0.00	0.0	0.600	o	300

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.42	2.320	0.185	0.0	0.0	0.0	1.01	71.7	25.1
1.001	50.00	6.12	0.693	0.286	0.0	0.0	0.0	1.47	1273.4	38.7
1.002	50.00	7.13	0.579	0.384	0.0	0.0	0.0	1.49	1290.8	52.0
1.003	50.00	7.82	0.409	0.469	0.0	0.0	0.0	1.45	1259.8	63.5
1.004	50.00	7.99	0.301	0.469	0.0	0.0	0.0	1.23	87.0	63.5
1.005	50.00	8.10	0.221	0.469	0.0	0.0	0.0	1.57	111.1	63.5

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Hydrock Consultants Ltd						Page 2					
239 Ashley Road Hale Cheshire WA15 9NE				Bericote Properties L... Oldlands Farm Bognor Regis							
Date 20th June 2014 File HSW.MDX				Designed by JH Checked by							
Micro Drainage				Network 2013.1.1							
<u>Manhole Schedules for Storm</u>											
MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	
1	3.720	1.500	Open Manhole	1200	1.000	2.220	300				
3	2.820	2.127	Open Manhole	2400	1.001	0.623	1050	1.000	1.857	300	
10	2.740	2.161	Open Manhole	2400	1.002	0.579	1050	1.001	0.579	1050	
5	3.080	2.671	Open Manhole	2400	1.003	0.409	1050	1.002	0.409	1050	
6	2.540	2.239	Open Manhole	1800	1.004	0.301	300	1.003	0.301	1050	
6	2.540	2.319	Open Manhole	1200	1.005	0.221	300	1.004	0.221	300	
	2.400	2.279	Open Manhole	0		OUTFALL		1.005	0.121	300	
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239 Ashley Road Hale Cheshire WA15 9NE	Bericote Properties L... Oldlands Farm Bognor Regis	
Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
Micro Drainage	Network 2013.1.1	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	300	1	3.720	2.220	1.200	Open Manhole	1200
1.001	o	1050	3	2.820	0.693	1.077	Open Manhole	2400
1.002	o	1050	10	2.740	0.579	1.111	Open Manhole	2400
1.003	o	1050	5	3.080	0.409	1.621	Open Manhole	2400
1.004	o	300	6	2.540	0.301	1.939	Open Manhole	1800
1.005	o	300	6	2.540	0.221	2.019	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	86.500	238.3	3	2.820	1.857	0.663	Open Manhole	2400
1.001	62.000	543.9	10	2.740	0.579	1.111	Open Manhole	2400
1.002	90.000	529.4	5	3.080	0.409	1.621	Open Manhole	2400
1.003	60.000	555.6	6	2.540	0.301	1.189	Open Manhole	1800
1.004	13.000	162.5	6	2.540	0.221	2.019	Open Manhole	1200
1.005	10.000	100.0		2.400	0.121	1.979	Open Manhole	0

Hydrock Consultants Ltd		Page 4
239 Ashley Road Hale Cheshire WA15 9NE	Bericote Properties L... Oldlands Farm Bognor Regis	
Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
Micro Drainage Network 2013.1.1		

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.185	0.185	0.185
1.001	-	-	100	0.101	0.101	0.101
1.002	-	-	100	0.098	0.098	0.098
1.003	-	-	100	0.085	0.085	0.085
1.004	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.469	0.469	0.469

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.005		2.400	0.121	0.150	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
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	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.348		

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Hydrock Consultants Ltd		Page 5
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Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
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Online Controls for Storm

Hydro-Brake® Manhole: 5, DS/PN: 1.003, Volume (m³): 87.9

Design Head (m) 1.000 Hydro-Brake® Type Md4 Invert Level (m) 0.409
 Design Flow (l/s) 5.3 Diameter (mm) 82

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.5	1.200	5.7	3.000	9.1	7.000	13.9
0.200	3.7	1.400	6.2	3.500	9.8	7.500	14.3
0.300	3.2	1.600	6.6	4.000	10.5	8.000	14.8
0.400	3.4	1.800	7.0	4.500	11.1	8.500	15.3
0.500	3.7	2.000	7.4	5.000	11.7	9.000	15.7
0.600	4.1	2.200	7.8	5.500	12.3	9.500	16.2
0.800	4.7	2.400	8.1	6.000	12.8		
1.000	5.2	2.600	8.4	6.500	13.4		

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Hydrock Consultants Ltd		Page 6
239 Ashley Road Hale Cheshire WA15 9NE	Bericote Properties L... Oldlands Farm Bognor Regis	
Date 20th June 2014 File HSW.MDX	Designed by JH Checked by	
Micro Drainage Network 2013.1.1		

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

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	0
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	0.350
Region England and Wales	Cv (Summer)		0.750
M5-60 (mm)	19.000 Cv (Winter)		0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 30

PN	Storm	Return Period	Climate Change	First X Surchage	First Y Flood	First Z O/F Overflow Act.	Lvl Exc.
1.000	15 Winter	100	+30%	100/15 Summer			
1.001	480 Summer	100	+30%	100/60 Summer	100/120 Winter		6
1.002	720 Winter	100	+30%	100/30 Winter	100/60 Winter		15
1.003	480 Summer	100	+30%	100/30 Summer	100/60 Winter		11
1.004	240 Winter	100	+30%	100/120 Winter	100/240 Winter		1
1.005	240 Winter	100	+30%	100/120 Winter			

PN	US/MH Name	Water	Surch'd Depth (m)	Flooded	Flow / Cap.	O'flow (l/s)	Pipe	Status
		Level (m)		Volume (m³)			Flow (l/s)	
1.000	1	2.902	0.382	0.000	1.42	0.0	98.4	SURCHARGED
1.001	3	2.835	1.092	17.152	0.03	0.0	36.1	FLOOD
1.002	10	2.871	1.242	150.514	0.06	0.0	64.1	FLOOD
1.003	5	3.138	1.679	71.024	0.01	0.0	7.9	FLOOD
1.004	6	2.556	1.955	18.051	2.71	0.0	192.2	FLOOD
1.005	6	1.463	0.342	0.000	2.54	0.0	201.2	SURCHARGED

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Hydrock Consultants Ltd				Page 7					
239 Ashley Road		Bericote Properties L...							
Hale		Oldlands Farm							
Cheshire WA15 9NE		Bognor Regis							
Date 20th June 2014		Designed by JH							
File HSW.MDX		Checked by							
Micro Drainage		Network 2013.1.1							
<u>Rainfall Hyetograph for 15 minute 100 year Winter I+30%</u> <u>for Pipe 1.000 (Storm)</u>									
Time	Rain	Time	Rain	Time	Rain	Time	Rain	Time	Rain
(mins)	(mm/hr)	(mins)	(mm/hr)	(mins)	(mm/hr)	(mins)	(mm/hr)	(mins)	(mm/hr)
1	27.552	4	66.290	7	247.086	10	173.604	13	52.366
2	50.278	5	107.299	8	287.010	11	107.299	14	50.279
3	52.366	6	173.604	9	247.086	12	66.290	15	27.552
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239 Ashley Road Hale Cheshire WA15 9NE		Bericote Properties L... Oldlands Farm Bognor Regis																																																																																																																																					
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<u>Rainfall Hyetograph for 480 minute 100 year Summer I+30%</u> <u>for Pipe 1.001 (Storm)</u> <table><thead><tr><th>Time (mins)</th><th>Rain (mm/hr)</th><th>Time (mins)</th><th>Rain (mm/hr)</th><th>Time (mins)</th><th>Rain (mm/hr)</th><th>Time (mins)</th><th>Rain (mm/hr)</th><th>Time (mins)</th><th>Rain (mm/hr)</th></tr></thead><tbody><tr><td>8</td><td>3.556</td><td>104</td><td>5.136</td><td>200</td><td>19.446</td><td>296</td><td>15.978</td><td>392</td><td>4.894</td></tr><tr><td>16</td><td>3.643</td><td>112</td><td>5.399</td><td>208</td><td>22.826</td><td>304</td><td>13.498</td><td>400</td><td>4.719</td></tr><tr><td>24</td><td>3.731</td><td>120</td><td>5.663</td><td>216</td><td>26.469</td><td>312</td><td>11.347</td><td>408</td><td>4.543</td></tr><tr><td>32</td><td>3.841</td><td>128</td><td>6.014</td><td>224</td><td>31.210</td><td>320</td><td>9.679</td><td>416</td><td>4.346</td></tr><tr><td>40</td><td>3.929</td><td>136</td><td>6.387</td><td>232</td><td>36.038</td><td>328</td><td>8.560</td><td>424</td><td>4.192</td></tr><tr><td>48</td><td>4.016</td><td>144</td><td>6.892</td><td>240</td><td>41.525</td><td>336</td><td>7.638</td><td>432</td><td>4.104</td></tr><tr><td>56</td><td>4.104</td><td>152</td><td>7.638</td><td>248</td><td>41.525</td><td>344</td><td>6.892</td><td>440</td><td>4.016</td></tr><tr><td>64</td><td>4.192</td><td>160</td><td>8.560</td><td>256</td><td>36.038</td><td>352</td><td>6.387</td><td>448</td><td>3.929</td></tr><tr><td>72</td><td>4.346</td><td>168</td><td>9.679</td><td>264</td><td>31.210</td><td>360</td><td>6.014</td><td>456</td><td>3.841</td></tr><tr><td>80</td><td>4.543</td><td>176</td><td>11.347</td><td>272</td><td>26.469</td><td>368</td><td>5.663</td><td>464</td><td>3.731</td></tr><tr><td>88</td><td>4.719</td><td>184</td><td>13.498</td><td>280</td><td>22.826</td><td>376</td><td>5.399</td><td>472</td><td>3.643</td></tr><tr><td>96</td><td>4.894</td><td>192</td><td>15.978</td><td>288</td><td>19.446</td><td>384</td><td>5.136</td><td>480</td><td>3.556</td></tr></tbody></table>						Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	8	3.556	104	5.136	200	19.446	296	15.978	392	4.894	16	3.643	112	5.399	208	22.826	304	13.498	400	4.719	24	3.731	120	5.663	216	26.469	312	11.347	408	4.543	32	3.841	128	6.014	224	31.210	320	9.679	416	4.346	40	3.929	136	6.387	232	36.038	328	8.560	424	4.192	48	4.016	144	6.892	240	41.525	336	7.638	432	4.104	56	4.104	152	7.638	248	41.525	344	6.892	440	4.016	64	4.192	160	8.560	256	36.038	352	6.387	448	3.929	72	4.346	168	9.679	264	31.210	360	6.014	456	3.841	80	4.543	176	11.347	272	26.469	368	5.663	464	3.731	88	4.719	184	13.498	280	22.826	376	5.399	472	3.643	96	4.894	192	15.978	288	19.446	384	5.136	480	3.556
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Hydrock Consultants Ltd				Page 9					
239 Ashley Road Hale Cheshire WA15 9NE		Bericote Properties L... Oldlands Farm Bognor Regis							
Date 20th June 2014 File HSW.MDX		Designed by JH Checked by							
Micro Drainage		Network 2013.1.1							
<u>Rainfall Hyetograph for 720 minute 100 year Winter I+30%</u> <u>for Pipe 1.002 (Storm)</u>									
Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)
12	0.572	156	3.995	300	15.425	444	13.999	588	3.758
24	1.645	168	4.318	312	16.639	456	12.720	600	3.641
36	2.432	180	4.747	324	17.771	468	11.460	612	3.586
48	3.014	192	5.376	336	18.882	480	10.101	624	3.578
60	3.323	204	6.069	348	19.671	492	8.971	636	3.586
72	3.498	216	6.876	360	20.239	504	7.925	648	3.576
84	3.576	228	7.925	372	20.239	516	6.876	660	3.498
96	3.586	240	8.971	384	19.671	528	6.069	672	3.323
108	3.578	252	10.101	396	18.882	540	5.376	684	3.014
120	3.586	264	11.460	408	17.771	552	4.746	696	2.432
132	3.641	276	12.720	420	16.639	564	4.318	708	1.645
144	3.758	288	13.999	432	15.425	576	3.995	720	0.572

Hydrock Consultants Ltd				Page 10																																																																																																																																			
239 Ashley Road Hale Cheshire WA15 9NE		Bericote Properties L... Oldlands Farm Bognor Regis																																																																																																																																					
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<u>Rainfall Hyetograph for 240 minute 100 year Winter I+30%</u> <u>for Pipe 1.004 (Storm)</u>									
Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)
4	1.321	52	9.224	100	35.611	148	32.320	196	8.676
8	3.797	56	9.969	104	38.414	152	29.367	200	8.406
12	5.615	60	10.958	108	41.028	156	26.459	204	8.280
16	6.958	64	12.412	112	43.594	160	23.320	208	8.261
20	7.671	68	14.012	116	45.414	164	20.711	212	8.279
24	8.077	72	15.875	120	46.727	168	18.296	216	8.256
28	8.256	76	18.296	124	46.727	172	15.875	220	8.077
32	8.278	80	20.711	128	45.414	176	14.012	224	7.671
36	8.261	84	23.320	132	43.594	180	12.412	228	6.958
40	8.280	88	26.459	136	41.028	184	10.958	232	5.615
44	8.406	92	29.367	140	38.414	188	9.969	236	3.797
48	8.676	96	32.320	144	35.611	192	9.224	240	1.320
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