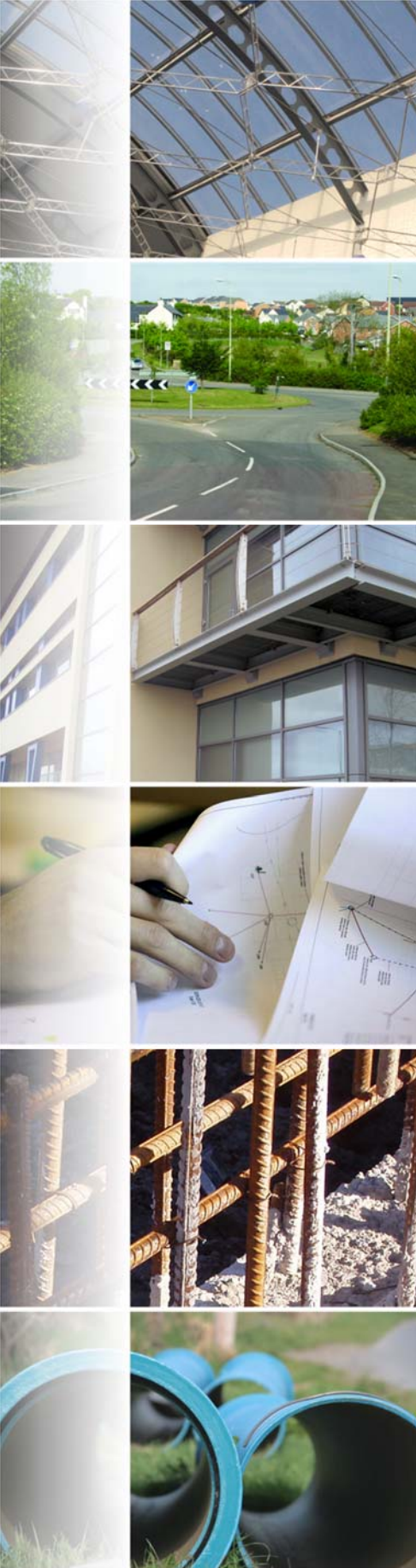




Purpose of issue:

APPROVAL

Document title:

Storm Water Analysis

Document revision: 1

Issue date: 24 Jul 15

2579 Western Gateway Development Access Road



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2579 Western Gateway Development Access Road



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1.0 Introduction

Burroughs are engaged on a design-and-build basis by Alun Griffiths (Contractors) Ltd to deliver a highway scheme, referred to as Western Gateway Access Road, Wrexham.

These works have been commissioned by Wrexham County Borough Council to provide suitable access to an identified development site, which is located in the West of Wrexham bound between the A483 and A525.

Planning permission has been granted with reference P/2014/0598.

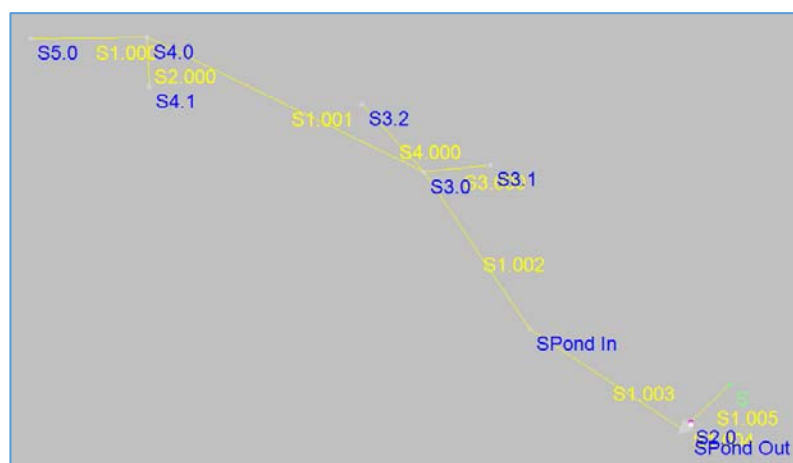
The purpose of this report is to provide an overview of the Storm Water Analysis carried out on the Western Gateway Access Road and its capacity to accommodate future development across the wider site which the access road is intending to serve.

2.0 Modelling Approach

The analysis was carried out with the use of MicroDrainage WinDes.

The geometry for the analysis was determined using the proposed surface water drainage layout as shown on the surface water general arrangement drawing, 2579-C-0500. Design coordinates and levels for each manhole were input into the model ensuring the correct pipe sizes, manhole sizes, and gradients were accurately represented.

A schematic diagram of the model is as represented below (please note the annotation of pipe numbers will be different to that shown in drawing 2579-C-0500 but will relate to the model outputs).



The proposed design is inclusive of a flow control, attenuation and an emergency overflow that have been suitably modelled and included within the drainage model, details of which are as follows:

- Flow control to limit forward flows from storm water design
Proposed flow control modelled as Hydrobrake Optimum flow control limited to 5l/s design forward flow at MHS2.0, which represents the limited permitted discharge from the attenuation pond (refer to Appendix A);
- Emergency Overflow
An emergency overflow has been modelled as a weir located within MHS2.0 to limit the attenuation pond filling above the designed top water level as further discussed below (refer to Appendix B); and
- Attenuation Pond Storage
Storage of the proposed attenuation pond is modelled as a Pond Storage Structure located as the structure labelled 'SPondOut', which is also representative of the outlet headwall from the attenuation pond. The volume of storage is 315m³ where water level limits are as follows:
 - Design Top Water Level = 95.036mAOD
 - Overflow Level = 95.336mAOD refer to Appendix 3) Located downstream of pipe 1.004, this structure represents the attenuation pond.

Refer to Appendix C.

General design criteria input to the drainage model has been included in Appendix D for reference, which includes geometrical information.

3.0 Storm Water Analysis

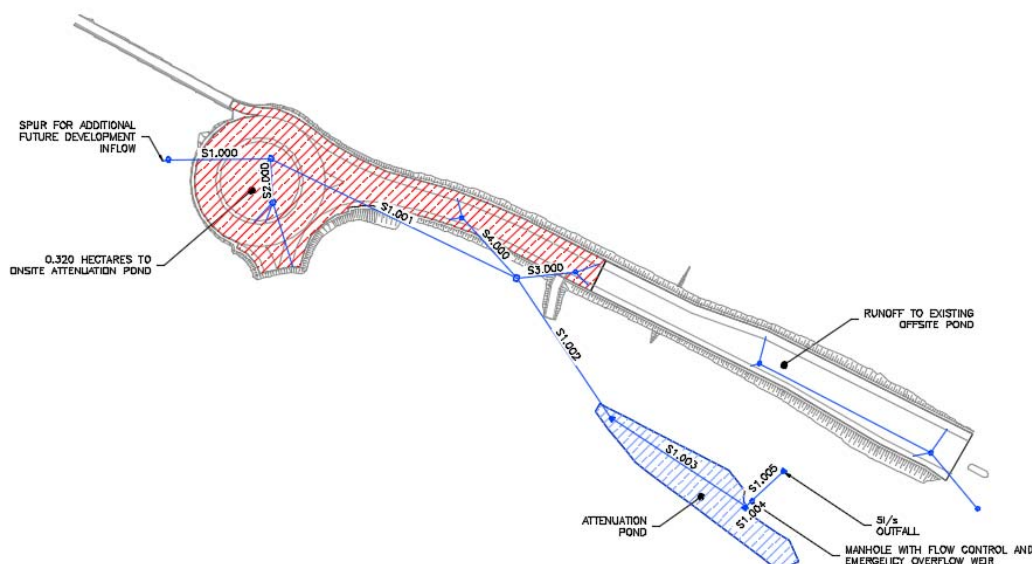
To carry out the analysis, the model was placed under various scenarios to determine how the system would react, where the scenarios of interest are as follows:

1. Scenario 1 – Flows from proposed access road ONLY; and
2. Scenario 2 – as Scenario 1 with additional flows from a determined area indicative of future development surface water runoff.

Please note that a section of the proposed highway

3.1 Scenario 1 – Highway Only

The contributing area is that of the new highway ONLY with no other contributing flows at this stage. The contributing area is 0.320ha (3200m²), shown in the sketch diagram below:



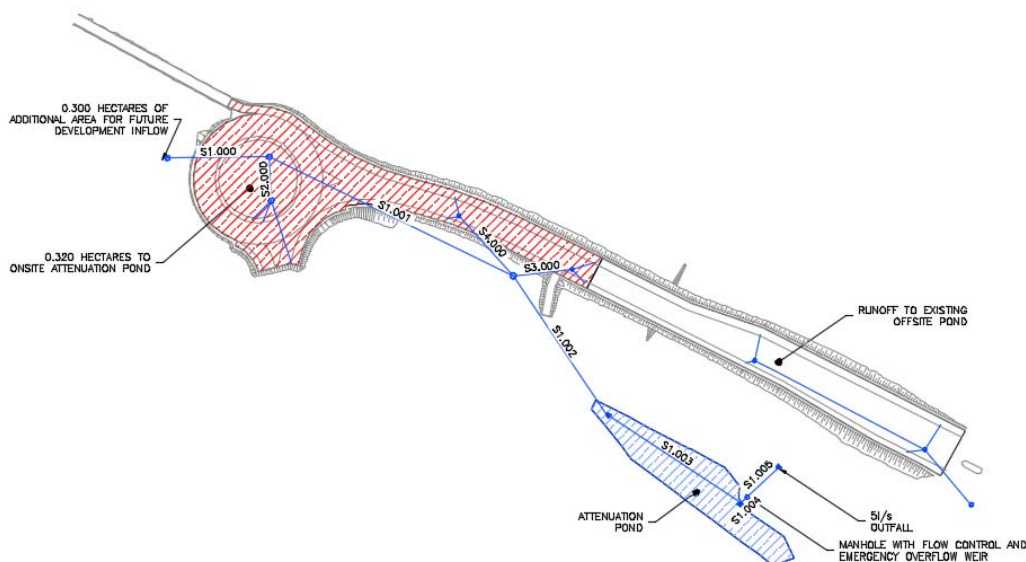
For this scenario, all surface water runoff flows from the highway only (as hatched) are directed to the pond for attenuation and will be subjected to the 5l/s forward flow control. In this scenario the pond does not completely fill, where:

- the maximum top water level = 94.672mAOD. This is 364mm below max design water level and the top of emergency overflow weir;
- there are no flooding or exceedance of flow limits from the model; and
- a max forward flow of 5.0l/s at MHS2.0.

Full model results for this scenario can be found in Appendix E.

3.2 Scenario 2 – Highway & Additional future Development Area

The contributing highway area identified as part of Scenario 1 is retained, but now with an additional area added to the upstream spur (at MHS5.0), which is considered to be the potential inflow and contribution from any future development as shown in the sketch diagram below:



Failure of the model is considered to be when the emergency overflow weir in MHS2.0 is activated, ensuring that the attenuation pond does not overtop; this represents full utilisation of the attenuation pond while maintaining 300mm freeboard to the pond and a restricted forward flow to the Afon Gwenfro of 5.0l/s. In this scenario the results are as follows:

- the maximum top water level = 95.003mAOD. This is 33mm below max design water level and the top of emergency overflow weir, again evident that the pond is being fully utilised;
- there are no flooding or exceedance of flow limits from the model; and
- a max forward flow of 5.0l/s at MHS2.0 is maintained.

Therefore, an additional 0.32ha can be added to the system, subject to detailed future modelling of the future development; this area was determined through assessment of both Time-Area diagrams and inflow of the area simultaneously, but had little effect in this case.

Full model results for this scenario can be found in Appendix F.

3.3 Scenario 3 – Sensitivity Assessment

A sensitivity assessment of the model was undertaken by further developing Scenario 2, which suggests that the model could manage up to 0.95ha of additional area at MHS5.0 before a catastrophic failure was identified in the form of the attenuation pond overtopping. This results in a potential (temporary) peak flow to the adjacent water course of 140l/s.

No other failures within the system were identified.

4.0 Summary

- The pond has sufficient capacity to attenuate and limit the pass forward flow from the proposed development to 5l/s for the 100yr + 20% climate change without flooding.
- The pond has sufficient extra capacity to accommodate up to 0.3ha (subject to detailed modelling) of additional development/road area to attenuate and limit the pass forward flow to 5l/s for the 100 year + 20% climate change without flooding.

Appendix A

*Model Details:
Online Controls*

Burroughs		Page 1
4 Radnor Court 256 Cowbridge Road East Cardiff CF5 1GZ	Surface Water Model Revised Layout	
Date 09/06/15	Designed by RDT	
File 2579-150723-RPJ-REVISED-BASE.MDX	Checked by DDH	
Micro Drainage	Network 2014.1	

Online Controls for Storm

Hydro-Brake Optimum® Manhole: S2.0, DS/PN: S1.005, Volume (m³): 1.5

Unit Reference	MD-SHE-0110-5000-0623-5000
Design Head (m)	0.623
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	110
Invert Level (m)	94.407
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.623	4.9	Kick-Flo®	0.439	4.2
Flush-Flo™	0.197	4.9	Mean Flow over Head Range	-	4.2

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.8	0.800	5.6	2.000	8.5	4.000	11.9	7.000	15.5
0.200	4.9	1.000	6.2	2.200	8.9	4.500	12.5	7.500	16.0
0.300	4.8	1.200	6.7	2.400	9.3	5.000	13.2	8.000	16.5
0.400	4.5	1.400	7.2	2.600	9.7	5.500	13.8	8.500	17.1
0.500	4.5	1.600	7.7	3.000	10.3	6.000	14.4	9.000	17.6
0.600	4.9	1.800	8.1	3.500	11.1	6.500	14.9	9.500	18.0

Appendix B

*Model Details:
Offline Controls*

Burroughs		Page 1
4 Radnor Court 256 Cowbridge Road East Cardiff CF5 1GZ	Surface Water Model Revised Layout	
Date 09/06/15 File 2579-150723-RPJ-REVISED-BASE.MDX	Designed by RDT Checked by DDH	
Micro Drainage	Network 2014.1	

Offline Controls for Storm

Weir Manhole: S2.0, DS/PN: S1.005, Loop to PN: None

Discharge Coef 0.544 Width (m) 1.200 Invert Level (m) 95.036

Appendix C

Model Details: Storage

Burroughs		Page 1
4 Radnor Court 256 Cowbridge Road East Cardiff CF5 1GZ	Surface Water Model Revised Layout	
Date 09/06/15 File 2579-150723-RPJ-REVISED-BASE.MDX	Designed by RDT Checked by DDH	
Micro Drainage	Network 2014.1	

Storage Structures for Storm

Tank or Pond Manhole: SPond Out, DS/PN: S1.004

Invert Level (m) 94.436

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	525.0	0.600	525.0	1.200	0.0	1.800	0.0	2.400	0.0
0.100	525.0	0.700	0.0	1.300	0.0	1.900	0.0	2.500	0.0
0.200	525.0	0.800	0.0	1.400	0.0	2.000	0.0		
0.300	525.0	0.900	0.0	1.500	0.0	2.100	0.0		
0.400	525.0	1.000	0.0	1.600	0.0	2.200	0.0		
0.500	525.0	1.100	0.0	1.700	0.0	2.300	0.0		

Appendix D

Design Criteria

Burroughs		Page 1
4 Radnor Court 256 Cowbridge Road East Cardiff CF5 1GZ	Surface Water Model Revised Layout	
Date 09/06/15 File 2579-150723-RPJ-REVISED-BASE.MDX	Designed by RDT Checked by DDH	
Micro Drainage	Network 2014.1	

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)	18.000	Minimum Backdrop Height (m)	0.200
Ratio R	0.322	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	0.600
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	0.000	4-8	0.167	8-12	0.153

Total Area Contributing (ha) = 0.320

Total Pipe Volume (m³) = 39.891

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)	Auto Design
S1.000	37.523	0.375	100.1	0.000	4.00	0.0	0.600	o	375	
S2.000	16.074	0.107	150.2	0.120	4.00	0.0	0.600	o	225	
S1.001	100.000	1.000	100.0	0.000	0.00	0.0	0.600	o	375	
S3.000	21.742	0.870	25.0	0.100	4.00	0.0	0.600	o	225	
S4.000	29.775	1.489	20.0	0.100	4.00	0.0	0.600	o	225	
S1.002	61.409	0.614	100.0	0.000	0.00	0.0	0.600	o	375	

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)
S1.000	50.00	4.35	96.425	0.000	0.0	0.0	0.0	1.81	200.1	0.0
S2.000	50.00	4.25	96.337	0.120	0.0	0.0	0.0	1.06	42.3	16.2
S1.001	50.00	5.27	96.050	0.120	0.0	0.0	0.0	1.81	200.1	16.2
S3.000	50.00	4.14	95.920	0.100	0.0	0.0	0.0	2.63	104.5	13.5
S4.000	50.00	4.17	96.539	0.100	0.0	0.0	0.0	2.94	116.9	13.5
S1.002	50.00	5.83	95.050	0.320	0.0	0.0	0.0	1.81	200.1	43.3

Burroughs		Page 2
4 Radnor Court 256 Cowbridge Road East Cardiff CF5 1GZ	Surface Water Model Revised Layout	
Date 09/06/15 File 2579-150723-RPJ-REVISED-BASE.MDX	Designed by RDT Checked by DDH	
Micro Drainage	Network 2014.1	

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)	Auto Design
S1.003	59.600	0.006	9933.3	0.000	0.00	0.0	0.600	0	525	
S1.004	2.875	0.029	99.1	0.000	0.00	0.0	0.600	0	375	
S1.005	18.220	0.182	100.1	0.000	0.00	0.0	0.600	0	375	

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)
S1.003	50.00	10.45	94.286	0.320	0.0	0.0	0.0	0.22	46.6	43.3
S1.004	50.00	10.47	94.436	0.320	0.0	0.0	0.0	1.82	201.0	43.3
S1.005	50.00	10.64	94.407	0.320	0.0	0.0	0.0	1.81	200.0	43.3

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)
------------------------	-----------------	-----------------	-----------------	------------------------	-------------	-----------

S1.005	S	95.100	94.225	94.225	0	0
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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 Offline Controls 1 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 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)	18.000	Storm Duration (mins)	30
Ratio R	0.322		

Appendix E

Scenario 1:

Base Model (Highway Flows Only):

Results

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4 Radnor Court 256 Cowbridge Road East Cardiff CF5 1GZ	Surface Water Model Revised Layout	
Date 09/06/15 File 2579-150723-RPJ-REVISED-BASE.MDX	Designed by RDT Checked by DDH	
Micro Drainage	Network 2014.1	

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 18.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.325 Cv (Winter) 0.840

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

Profile(s) 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 (%) 20

PN	Storm	Return Period	Climate Change	First X Surge	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
S1.000	2160 Winter	100	+20%					
S2.000	15 Winter	100	+20%	100/15 Winter				
S1.001	15 Winter	100	+20%					
S3.000	15 Winter	100	+20%					
S4.000	15 Winter	100	+20%					
S1.002	15 Winter	100	+20%					
S1.003	15 Winter	100	+20%					
S1.004	240 Winter	100	+20%					
S1.005	240 Winter	100	+20%				0	

PN	US/MH Name	Water Level (m)	Surch'd Depth (m)	Flooded Volume (m³)	Flow / Cap. (l/s)	Pipe O'flow (l/s)	Status
S1.000	S5.0	96.425	-0.375	0.000	0.00	0.0	OK
S2.000	S4.1	96.688	0.126	0.000	1.51	0.0	SURCHARGED
S1.001	S4.0	96.188	-0.237	0.000	0.28	0.0	OK
S3.000	S3.1	96.032	-0.113	0.000	0.50	0.0	OK
S4.000	S3.2	96.642	-0.122	0.000	0.43	0.0	OK
S1.002	S3.0	95.300	-0.125	0.000	0.76	0.0	OK
S1.003	SPond In	94.683	-0.128	0.000	0.87	0.0	OK*
S1.004	SPond Out	94.672	-0.139	0.000	0.07	0.0	OK*
S1.005	S2.0	94.695	-0.087	0.000	0.03	0.0	OK

Appendix F

Scenario 2:

Additional Surface Water Runoff Area:

Results

Burroughs		Page 1
4 Radnor Court 256 Cowbridge Road East Cardiff CF5 1GZ	Surface Water Model Revised Layout	
Date 09/06/15 File 2579-150723-RPJ-revised-add	Designed by RDT Checked by DDH	
Micro Drainage	Network 2014.1	

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 18.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.325 Cv (Winter) 0.840

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

Profile(s) 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 (%) 20

PN	Storm	Return Period	Climate Change	First X Surchage	First Y Flood	First Z Overflow	O/F Act.	Lvl Exc.
S1.000	15 Winter	100	+20%					
S2.000	15 Winter	100	+20%	100/15 Winter				
S1.001	15 Winter	100	+20%	100/15 Winter				
S3.000	15 Winter	100	+20%					
S4.000	15 Winter	100	+20%					
S1.002	15 Winter	100	+20%	100/15 Winter				
S1.003	600 Winter	100	+20%					
S1.004	480 Winter	100	+20%	100/120 Winter				
S1.005	600 Winter	100	+20%	100/60 Winter		100/240 Winter	3	

PN	US/MH Name	Water Level (m)	Surch'd Depth (m)	Flooded Volume (m³)	Flow / Cap.	O'flow (l/s)	Pipe Flow (l/s)	Status
S1.000	S5.0	96.775	-0.025	0.000	0.81	0.0	146.1	OK
S2.000	S4.1	96.766	0.204	0.000	1.48	0.0	55.5	SURCHARGED
S1.001	S4.0	96.593	0.168	0.000	0.89	0.0	170.2	SURCHARGED
S3.000	S3.1	96.032	-0.113	0.000	0.50	0.0	47.2	OK
S4.000	S3.2	96.642	-0.122	0.000	0.43	0.0	47.2	OK
S1.002	S3.0	95.803	0.378	0.000	1.27	0.0	238.0	SURCHARGED
S1.003	SPond In	94.811	0.000	0.000	0.11	0.0	31.7	SURCHARGED*
S1.004	SPond Out	95.003	0.192	0.000	0.09	0.0	9.2	SURCHARGED*
S1.005	S2.0	95.042	0.260	0.000	0.03	0.0	4.9	SURCHARGED



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