Report No: 16/040.01
Revision: 00
Dated: 24th January 2017

Development of land at Bondfield Close, Wombwell, Barnsley

Flood Risk Assessment

Client:

Gleeson Developments Ltd
5 Europa Court
Sheffield Business Park
Sheffield
S9 1XE

Prepared by:

joc consultants ltd

Park Farm House
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Leathley
Otley
LS21 2JU

SITE	Land at Bondfield Close, Wombwell, Barnsley.
PURPOSE OF THIS REPORT	This site-specific flood risk assessment is required in connection with a planning application to Barnsley Metropolitan Borough Council for residential development of the site.
PLANNING APPLICATION NUMBER	Not yet issued

ANNEXES TO THIS REPORT

Annex A	Figures 1 to 5
Annex B	Topographical Survey Plan
Annex C	Yorkshire Water sewer map
Annex D	Site Layout Plan
Annex E	Environment Agency fluvial flood map
Annex F	Surface water run-off volumes: Tables F1 to F8
SITE LOCATION AND DESCRIPTION	See Figure 1 at Annex A.
National Grid Reference	439570E, 402904N
Gross Site Area	1.37ha
Ground surface	Approximately 88% permeable surface. 12% impermeable surface comprises hard standing areas and former roadways.

Topography	See topographical survey plan at Annex B. Ground levels are generally in the range 72.0m to 73.0m AOD but a small mound in the SE corner rises to 74.66m AOD.
History	Formerly a football ground, then a greyhound stadium, then 'The Gables School'.
Watercourses	The River Dove is approximately 1km to the north of the site, flowing eastwards. There is an un-named ordinary watercourse approximately 0.75km to the south of the site, flowing eastwards.
Reservoirs and Canals	There is a disused canal approximately 0.70km to the east of the site.
Existing site drainage	There is evidence of existing site drainage in the access road on the topographical survey plan. A 225mm diameter combined sewer crosses the site as shown on the extract from the sewer plan at Annex C
THE DEVELOPMENT	A development of 49 dwellings is proposed as shown in the Site Layout Plan at Annex D. The impermeable area will be approximately 50% of the gross site area.
VULNERABILITY CLASSIFICATION	The development is classified as **'More Vulnerable'**, in accordance with Table 2 of the Technical Guidance to the National Planning Policy Framework (NPPF).
FLOOD ZONE	Flood zone 1. See Environment Agency flood map at Annex E.
REQUIREMENT TO CONSULT THE ENVIRONMENT AGENCY	Not required when the development is in flood zone 1 and not within 20m of a main river or in a critical drainage area.
REQUIREMENT FOR THE SEQUENTIAL TEST	Not required when the development is in flood zone 1.
REQUIREMENT FOR THE EXCEPTION TEST	In accordance with Table 3 of the NPPF Technical Guidance, there is no requirement for the Exception Test.

HISTORY OF FLOODING	No known incidents.
FLUVIAL FLOODING	
Functional floodplain	The site is not in the functional floodplain.
Annual probability of fluvial flooding	0.1% or less.
Flood defences	None
Fluvial flood hazard	None
Loss of floodplain storage	None
Obstruction to overland flow routes	None
Flood warning area	The site is not in a flood warning area.
SURFACE WATER FLOODING	
Risk of surface water flooding	The Long Term Flood Risk surface water flood map indicates a small area in the NW corner of the site where a medium to high risk is indicated. Elsewhere, a low risk is indicated. There appears to be a flow path from the site to Bondfield Close.
Critical Drainage Areas	The site is not in a critical drainage area.
GROUNDWATER FLOODING	Groundwater flooding occurs when the water table rises above the ground surface or enters basements. It is typically associated with highly permeable rock such as chalk and highly fissured limestone. These conditions are not present at the site and so this risk is assessed to be low (less than 0.1%)

SEWER FLOODING

Sewer flooding can occur when the capacity of the sewerage system is exceeded by exceptional rainfall. There is no evidence that the site has been affected by this type of flooding. The capacity of the local sewers will, from time to time, be exceeded, but this is unlikely to occur more frequently than once in 30 years.

The risk of this type of flooding affecting the site is assessed to be low.

FLOODING FROM RESERVOIRS AND CANALS

The Environment Agency reservoirs flood map shows the site is not in an area at risk from the uncontrolled release of water from reservoirs.

The site is not in an area at risk from the uncontrolled release of water from canals.

EFFECT OF THE DEVELOPMENT ON FLOOD RISK

Fluvial and tidal flood risk

No effect

Surface water flood risk

It is estimated that the development will increase surface water run-off volumes by approximately 56% overall, as shown in Tables F1 - F4 at Annex F and Figures 2 and 3. This is due to the creation of impermeable over approximately 50% of the gross site area.

Groundwater flood risk

No effect

Sewer flooding risk

No effect

EFFECT OF CLIMATE CHANGE

Climate change must be considered over the expected lifetime of the development which, for residential development is defined to be 100 years in paragraph 026 of the Planning Practice Guidance. Climate change must therefore be considered up to 2116.

New guidance on the application of climate change allowances was issued in February 2016 and updated on 12th April 2016. The guidance provides the anticipated changes to peak river flow and rainfall intensity for different scenarios of carbon dioxide emissions over future epochs up to 2115.

The effects of climate change on peak river flow are not relevant to this FRA as the site is not at risk from fluvial flooding.

The current guidance requires the Central and Upper End allowances to be used when assessing the effects of increases to peak rainfall intensities. The allowances apply across the whole of England and in the period 2070 to 2115 are:

- Central allowance: 20%
- Upper end allowance: 40%

The detailed drainage design must therefore take into account the range of climate change effects on rainfall intensity.

The effect of the new climate change allowances on surface water run-off is shown in Figures 4 and 5.

FLOOD RISK MANAGEMENT

Fluvial flood risk

No recommendations

Surface water flood risk

The effect of the development on surface water flood risk can be mitigated by the inclusion of sustainable drainage principles in the detailed drainage design. The ground investigation report[1] confirms that infiltration drainage is a feasible option for the development. The average infiltration rate across the site was found to be 80.1 $x10^{-6}$ m/s, based on the BRE 365 methodology.

Attenuation storage

Attenuation storage will be required, and the form that this will take will be a matter for the detailed design of the drainage system. Preliminary estimates of attenuation storage, assuming a discharge of 5 l/s and based on the average of the central and upper end CCA are as follows:

- 1 in 30 years event: 505m^3
- 1 in 100 years event: 795m^3.

See Tables F5 to F8 (Annex F) and Figures 4 and 5.

Residual surface water flood risks

The detailed drainage design should ensure that provision is made for the surface water flow path in the NW part of the site and that exceedance flow routes are managed to minimise risks to people and property.

[1] Geotechnical and Geoenvironmental Site Investigation, Eastwood and Partners Report No: 40547-001, 11th November 2016

Groundwater flood risk	No recommendations.
Sewer flooding risk	No recommendations.
Reservoir flood risk	No recommendations.

CONCLUSIONS

1. The development classification is **More Vulnerable.**

2. The site is in flood zone 1 where the annual probability of fluvial flooding is less than 0.1%.

3. There is no requirement for the Environment Agency to be consulted on this development.

4. There is no requirement for the development to be subjected to the Sequential Test or the Exception Test.

5. There is no evidence of the site having been affected by flooding in the past.

6. The annual probability of surface water flooding within the site is indicated to be generally 'Low', but there is a small medium to high risk in the NW part of the site. The drainage system for the development will mitigate this risk.

7. The risk of groundwater flooding is assessed to be low.

8. The risk of sewer flooding is assessed to be low.

9. The site is not in an area at risk of flooding from reservoir failure.

10. The site is not in a flood warning area.

11. The development will create impermeable area amounting to approximately 50% of the gross area. This could increase rapid response run-off volume by approximately 56% but the effect of this can be mitigated by the implementation of sustainable drainage principles.

12. Infiltration tests have confirmed the feasibility of infiltration drainage for this development.

13. Preliminary estimates of attenuation storage, assuming a discharge of 5 l/s and based on greenfield run-off rates indicate 270m^3 and 407.5 m^3 for the 1 in 30 and 1 in 100 years events respectively. The actual storage capacity will depend on the form of the drainage system and soakaway design.

14. Subject to the implementation of the flood risk management measures recommended in this report, the development will not increase flood risk elsewhere.

RECOMMENDATIONS

1. A detailed drainage design should be prepared and submitted to Barnsley Metropolitan Borough Council and Yorkshire Water for approval, prior to construction of the development.

2. The flood risk management measures recommended in this report should be implemented in the design and construction of the development.

3. The above recommendations can be secured by appropriately worded planning conditions.

USE OF REPORT

This report is prepared specifically for Gleeson Homes Ltd for the purpose of the aforementioned planning application and the report may not be used for any other purpose and it may not be assigned to any third party without our written permission.

DISCLAIMER

This flood risk assessment is based on data available at the time of its preparation and JOC Consultants Ltd accepts no liability for the consequences of any changes to or re-assessment of this data in the future.

ANNEX A

Figures 1 to 5

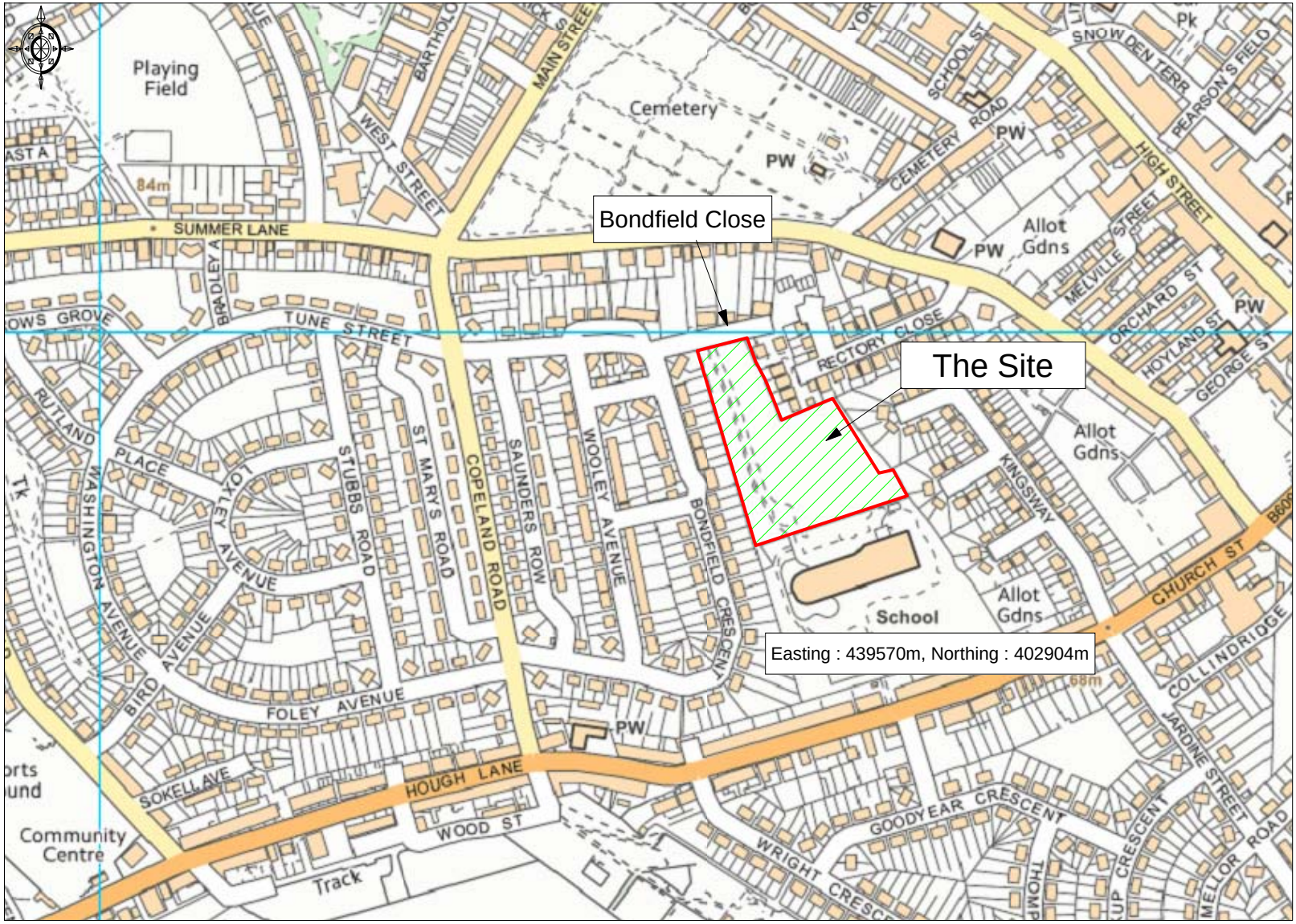


Figure 1: Location Plan

Figure 2: Effect of the development on rapid response surface water run-off (3.3% A.E.P event)

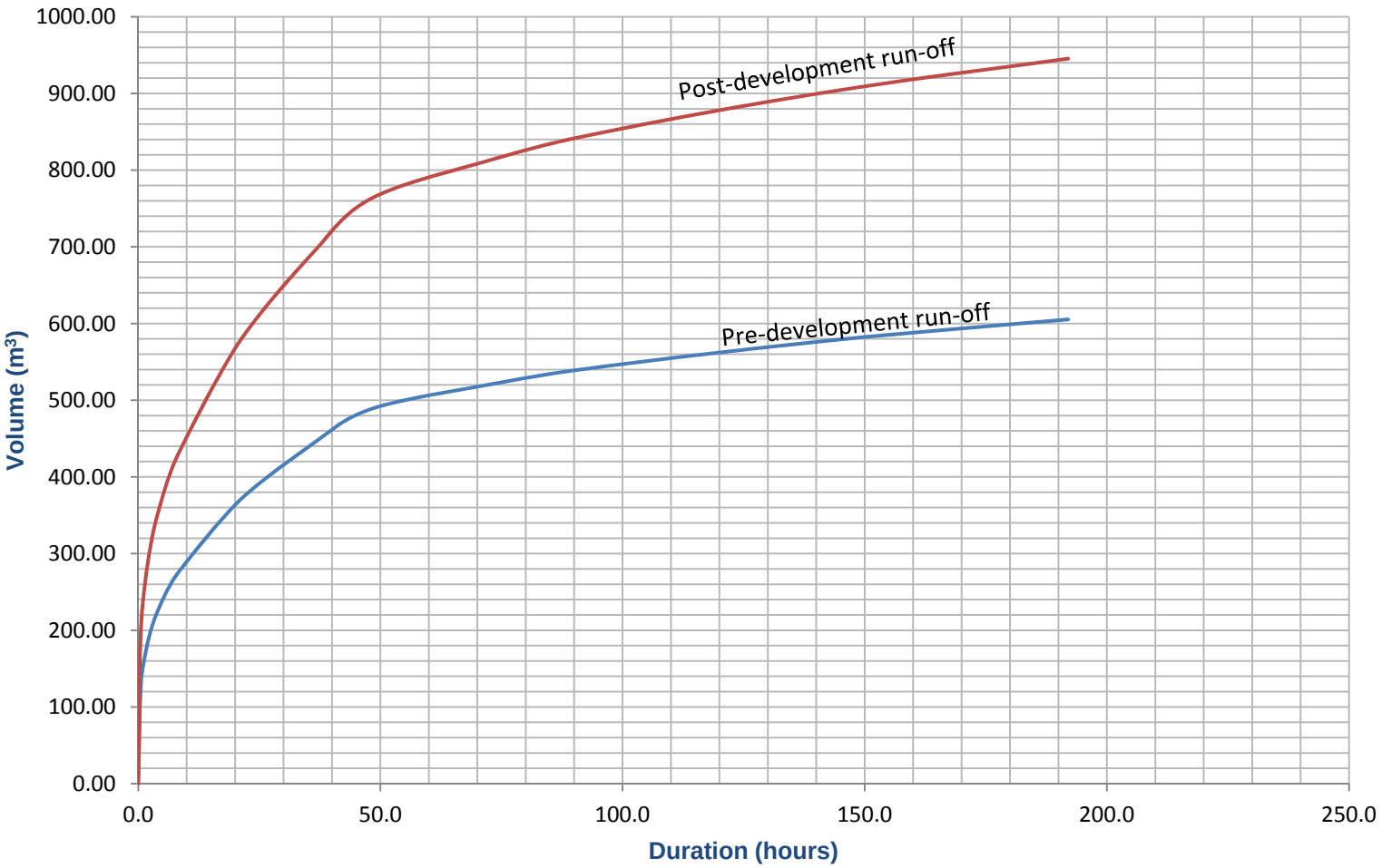


Figure 3: Effect of the development on rapid response surface water run-off (1% A.E.P. event)

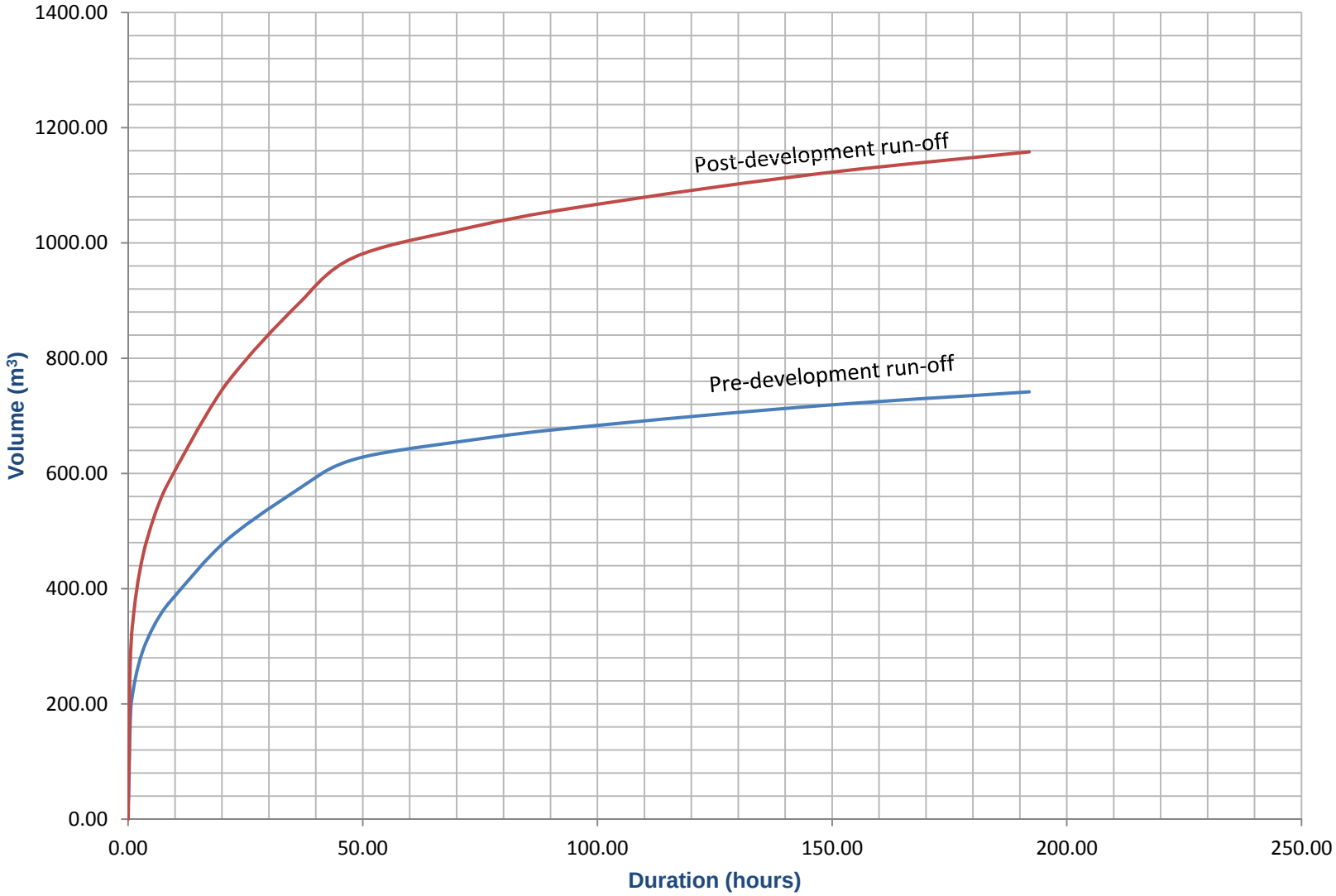


Figure 4: Surface water run-off from a 3.3% A.E.P. rainfall event including CCA (post-development)

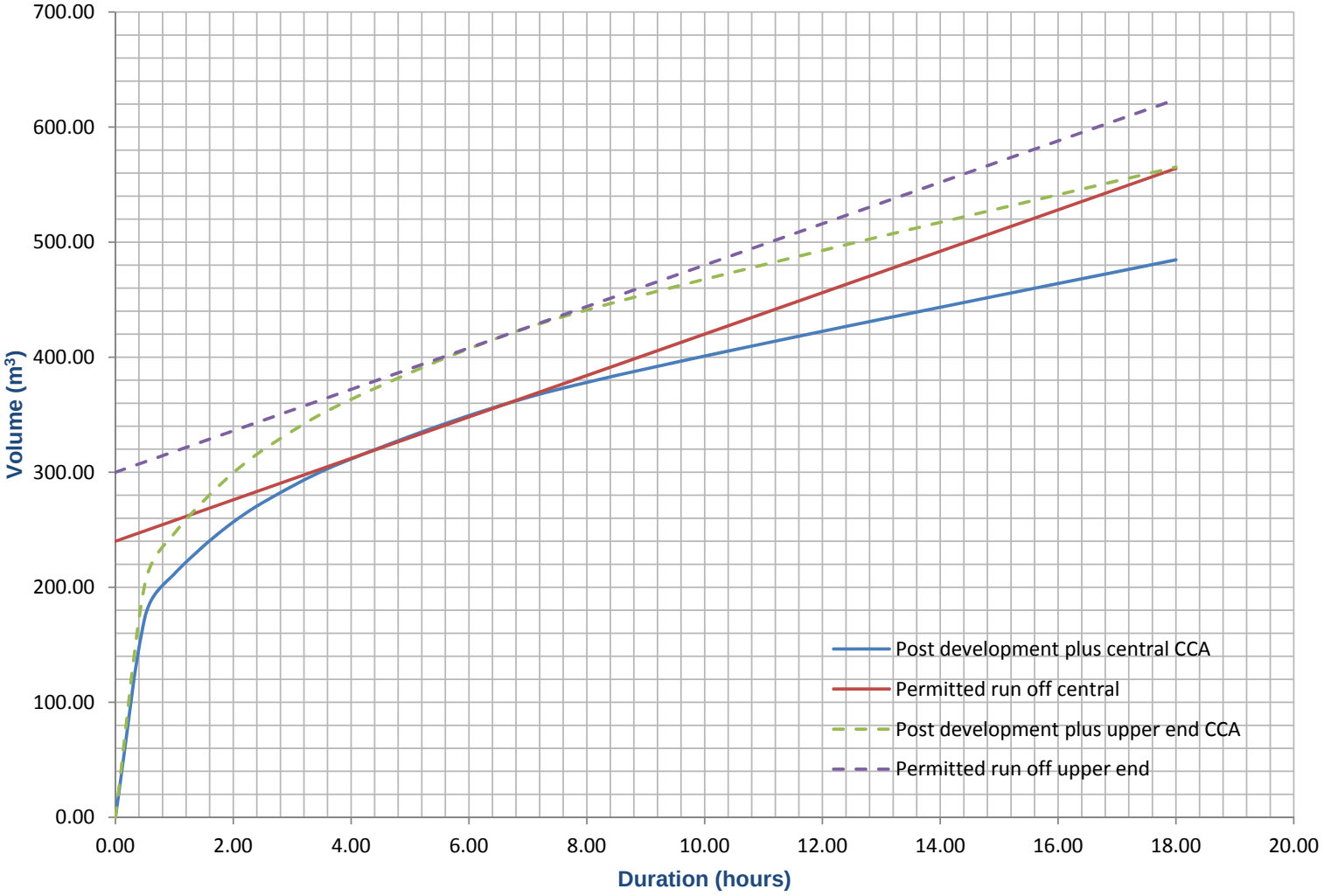
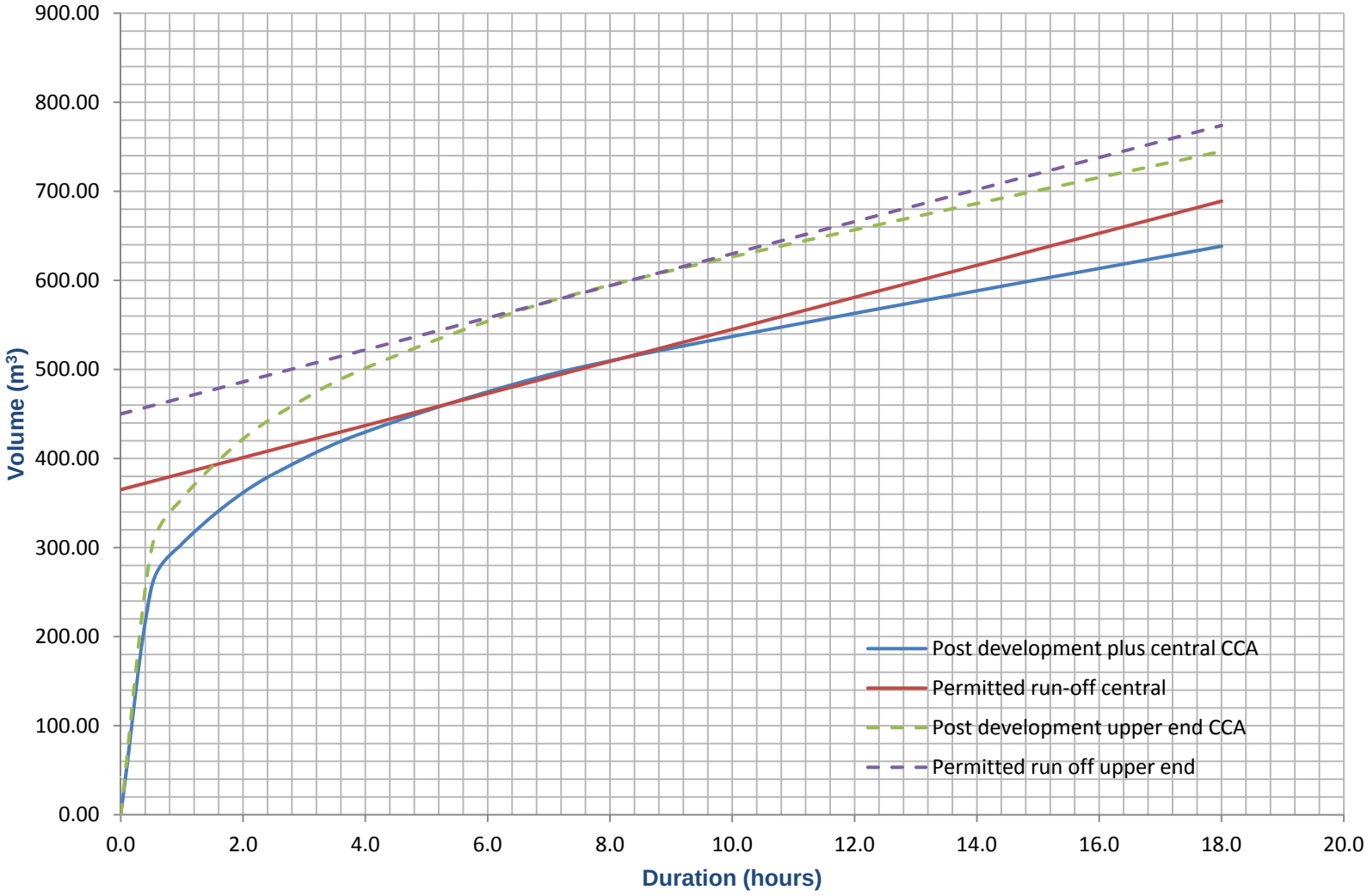


Figure 5: Surface water run-off from a 1% A.E.P. rainfall event including CCA (post-development)



ANNEX B

Topographical Survey Plan

Station	Easting	Northing	Level
S1	439479.905	402986.462	73.740
S2	439511.203	402992.814	72.410
S3	439507.961	402970.665	72.613
S4	439534.234	402967.159	72.377
S5	439518.270	402947.694	72.346
S6	439541.789	402938.532	72.932
S7	439528.181	402915.332	72.414
S8	439551.267	402906.333	72.165
S9	439533.787	402896.907	72.629
S10	439523.518	402894.837	73.919
S11	439555.338	402845.845	73.027
S12	439548.713	402834.400	73.963
S13	439594.173	402901.020	72.262
S14	439566.099	402922.734	72.093
S15	439602.678	402928.479	72.631
S16	439611.995	402910.677	72.646
S17	439631.965	402867.724	74.677
S18	439601.977	402881.060	72.123
S19	439663.168	402928.897	70.114
S20	439676.522	402937.818	69.341
S21	439719.755	402883.669	68.738
S22	439704.007	402874.174	69.427
S23	439453.352	402974.682	74.544
S24	439487.510	402873.422	74.948
S25	439624.237	402859.840	74.107

HAYCOCK & TODD
LAND SURVEY CONSULTANTS•ARCHITECTURAL SURVEYORS
The Hollies, 43 Church Street, Royston, Barnsley, S71 4QU
T : 01226 709630 F : 01226 709631
E : info@land-surveying.co.uk W : land-surveying.co.uk

LEGEND

Manhole shown thus
Inspection Cover
Lamphole
Gully
Lampost
Telegraph Post
Electricity Poles
Road Traffic Signs
Traffic Lights
General Post Office
Post Office Telephones
Fire Hydrant
Safety Valve
Stopcock Water
Stopcock Gas
Unknown Stoptap

MH
IC
LH
G
LP
TP
EP
RS
TL
GPO
POT
FH
SV
SCW
Gas
ST

Spot Level
Kerb Line
Fence Line
Wood post & rail
Or
Hedge Line
Contours 5m interval
Contours 1m interval
Tree Spread
Girth
Cover Level
Invert Level
Foul Drain
Surface Water
Unknown Service
Survey Station
Serv
Or S3

+123.562
105
33
S 5.0
G 1.30
CL 112.335
IL 111.733

Floor Level
Height floor to structural soffit
Height floor to false ceiling
Height floor to sill
Height of window
Height of Door
Height floor to underside of Beam
Vent
Fall Pipe
Sky Light
Water Closet
Sink
Boxed Column
Shop fitting or cladding

FL 10.907
SS 2.87
FC 2.22
S 0.67
W 1.23
D 1.98
US 3.61
V
FP
SL
WC
S
C

SITE SURVEY

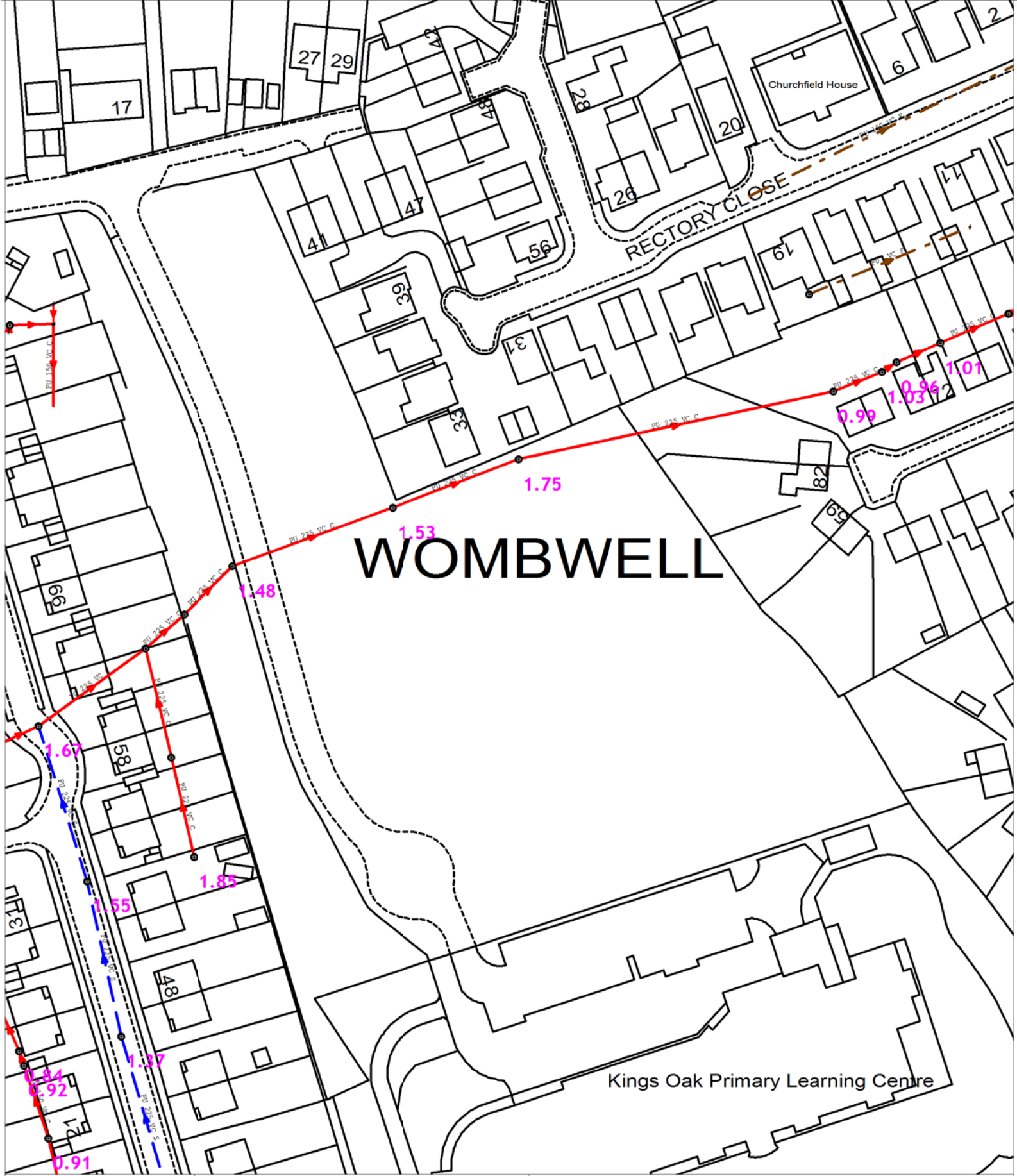
BONDFIELD CLOSE, WOMBWELL
BARNSLEY

Sheet Diagram

Datum	Sheet 1 of 1	Survey Job No. S8715	Scale 1/500
GRID– Related to Ordnance Survey using One Point Localisation on Station S9. Orientation at OS Grid North.	Surveyed by PF	Date of Survey October 2016	S8715
	Drawn by PF		
LEVEL– Related to Ordnance Survey by connection to the OS Active Network by G.P.S	Checked by PBT		

ANNEX C

Yorkshire Water Sewer Map



439461 : 402766	Map Name : SE3902NW	Title
YorkshireWater	Yorkshire Water, PO Box 500, Halifax Road, Bradford BD6 2LZ Contact Name : YorMap Advisor C ROBERTS Contact Tel : 87 2582	Notes
		Partial Key Foul Sewer = F Combined Sewer = C Surface Water Sewer = SW Trade Sewer = TD Partially Separate = PS
		This plan is furnished as a general guide only and no warranty as to its correctness is given or implied. This plan must not be relied upon in the event of excavations or other works made in the vicinity of public sewers. No house or property connections are shown.
		Date Req : 01/12/2016, 09:51:20 Date Gen : 01/12/2016, 09:52:12
		Source : Sewer Network Enquiry

UPN: Undefined Originator: C ROBERTS, YorMap, 87 2582

ANNEX D

Site Layout Plan

Bondfield Crescent, WOMBWELL

DO NOT SCALE - ALL DIMENSIONS & LEVELS TO BE CHECKED ON SITE - THIS DRAWING IS COPYRIGHT

Schedule of Accommodation

To be read in conjunction with drawing no. 2897-0-001-A

Housetype	No. of Beds	Type	No. of Units	Percentage
201	2 Bedrooms	Semi-detached	7	14.29
202	2 Bedrooms	Semi-detached	6	12.24
212	2 Bedrooms	Semi-detached	4	8.16
301	3 Bedrooms	Semi-detached	11	22.45
309	3 Bedrooms	Semi-detached	2	4.08
318	3 Bedrooms	Semi-detached	2	4.08
304	3 Bedrooms	Detached	5	10.20
307	3 Bedrooms	Detached	7	14.29
314	3 Bedrooms	Detached	3	6.12
401	4 Bedrooms	Detached	2	4.08
		Totals	49	100.00

APPROX. GROSS SITE AREA: 13951.88M² / 3.44 ACRES

SKETCH
subject to structural review
subject to accurate measured survey

PROPOSED RESIDENTIAL
BONDFIELD CRESCENT
WOMBWELL

Client: GLEESON HOMES

Title: SCHEMATIC SITE LAYOUT

Date: 02.09.15 | Scale: 1:500@A2 | Drawn: SAN

Drawing number: 2897-0-001-A

Niemen Architects
Deck 2 The Waterscape
42 Leeds & Bradford Road
Kirkstall Leeds LS5 3EG
Tel: 0113 239 5400
Fax: 0113 239 5401
office@niemen.co.uk
www.niemen.co.uk

ANNEX E

Environment Agency Flood Map

Environment Agency

Enter a postcode or place name: S73 8TX Go

Other topics for this area... Flood Map for Planning (Rivers and Sea)

Flood Map for Planning (Rivers and Sea)

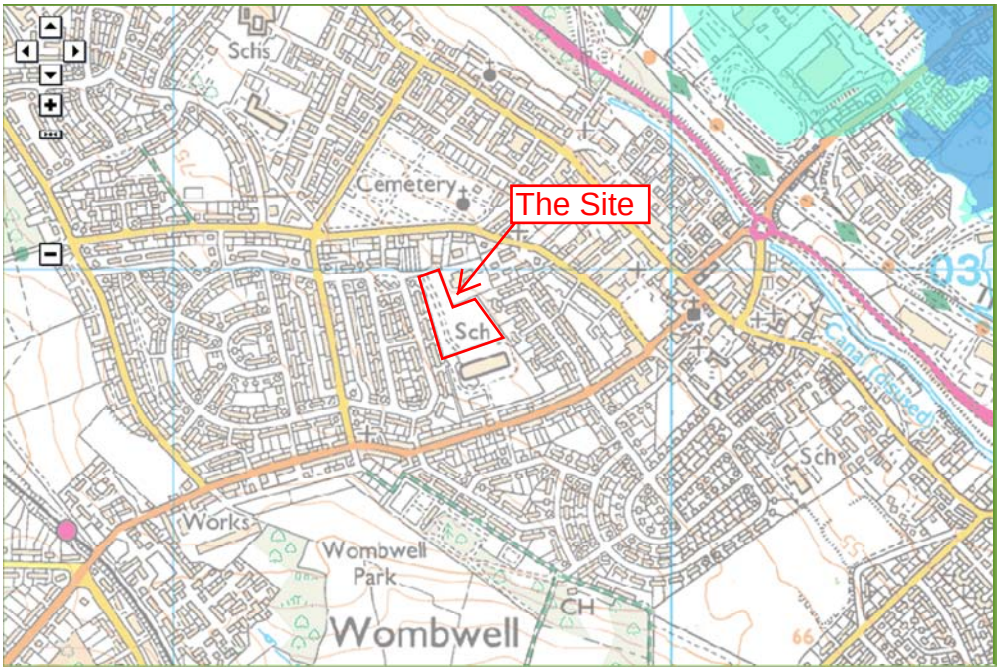
Map legend

Click on the map to see what Flood Zone (National Planning Policy Guidance definitions) the proposed development is in.

- Flood Map for Planning (Rivers and Sea)
  - Flood Zone 3
  - Flood Zone 2
  - Flood defences (Not all may be shown*)
  - Areas benefiting from flood defences (Not all may be shown*)
- Main River
  - Main River
- Other national environmental organisations
  - Natural Resources Wales Area of responsibility
  - Scottish Environment Protection Agency Area of responsibility

S73 8TX at scale 1:10,000

Other maps | Data search | Text only version



Information about Flood Map for Planning:

Understanding the Flood Map for Planning (Rivers and Sea)

A more detailed explanation to help you understand the flood map shown above.

Current flood warnings

We provide flood warnings online 24 hours a day. Find out the current flood warning status in your local area.

*** Legend Information:** Flood defences and the areas benefiting from them are gradually being added through updates. Please contact your local environment agency office for further details.

creating a better place

Author: Environment Agency | wiybysupport@environment-agency.gov.uk
Last updated: 4th January 2017

ANNEX F

Surface water run-off volumes: Tables F1 to F8

Table F1: Rapid response run-off from 3.3% A.E.P. rainfall event: existing condition

Duration	Rainfall	Area (m^2)			Volume (m^3)		
	at Site	Impervious	Pervious	Total	Impervious	Pervious	Run-off
hours	mm	Area (ha)	Area (ha)	Area (ha)	Area	Area	Volume
		C_v	SPR HOST				
		90.0%	31.8%				
0.0	0.0	0.17	1.20	1.37	0.00	0.00	0.00
0.5	23.5	0.17	1.20	1.37	35.81	89.76	125.57
1.0	28.6	0.17	1.20	1.37	43.58	109.23	152.82
2.0	34.7	0.17	1.20	1.37	52.88	132.53	185.41
3.0	38.9	0.17	1.20	1.37	59.28	148.57	207.85
4.0	42.1	0.17	1.20	1.37	64.15	160.80	224.95
6.0	47.2	0.17	1.20	1.37	71.93	180.27	252.20
8.0	51.1	0.17	1.20	1.37	77.87	195.17	273.04
12.0	57.1	0.17	1.20	1.37	87.01	218.09	305.10
18.0	65.5	0.17	1.20	1.37	99.81	250.17	349.98
24.0	72.3	0.17	1.20	1.37	110.17	276.14	386.31
36.0	82.9	0.17	1.20	1.37	126.33	316.63	442.95
48.0	91.4	0.17	1.20	1.37	139.28	349.09	488.37
72.0	97.3	0.17	1.20	1.37	148.27	371.63	519.89
96.0	101.8	0.17	1.20	1.37	155.13	388.81	543.94
144.0	108.3	0.17	1.20	1.37	165.03	413.64	578.67
192.0	113.3	0.17	1.20	1.37	172.65	432.74	605.39

Table F2: Rapid response run-off from 1% A.E.P. rainfall event: existing condition

Duration	Rainfall	Area (m^2)			Volume (m^3)		
	at Site	Impervious	Pervious	Total	Impervious	Pervious	Run-off
hours	mm	Area (ha)	Area (ha)	Area (ha)	Area	Area	Volume
		Cv 90.0%	SPR HOST 31.8%				
0.00	0.0	0.17	1.20	1.37	0.00	0.00	0.00
0.50	34.4	0.17	1.20	1.37	52.42	131.39	183.81
1.00	41.1	0.17	1.20	1.37	62.63	156.98	219.61
2.00	48.9	0.17	1.20	1.37	74.52	186.77	261.28
3.00	54.1	0.17	1.20	1.37	82.44	206.63	289.07
4.00	58.1	0.17	1.20	1.37	88.53	221.91	310.44
6.00	64.2	0.17	1.20	1.37	97.83	245.20	343.03
8.00	68.9	0.17	1.20	1.37	104.99	263.16	368.15
12.00	76.1	0.17	1.20	1.37	115.96	290.65	406.62
18.00	86.3	0.17	1.20	1.37	131.51	329.61	461.12
24.00	94.3	0.17	1.20	1.37	143.70	360.17	503.87
36.00	106.9	0.17	1.20	1.37	162.90	408.29	571.19
48.00	116.8	0.17	1.20	1.37	177.98	446.10	624.09
72.0	122.9	0.17	1.20	1.37	187.28	469.40	656.68
96.0	127.3	0.17	1.20	1.37	193.98	486.21	680.19
144.0	133.9	0.17	1.20	1.37	204.04	511.41	715.46
192.0	138.8	0.17	1.20	1.37	211.51	530.13	741.64

Table F3: Rapid response run-off from 3.3% A.E.P. rainfall event: post development condition

Duration	Rainfall	Area (m^2)			Volume (m^3)			
	at Site	Impervious	Pervious	Total	Impervious	Pervious	Run-off	% increase
hours	mm	Area (ha)	Area (ha)	Area (ha)	Area	Area	Volume	in run-off volume
		Cv 90.0%	SPR HOST 31.8%					
0.0	0.0	0.69	0.69	1.37	0.00	0.00	0.00	
0.5	23.5	0.69	0.69	1.37	144.88	51.21	196.08	56%
1.0	28.6	0.69	0.69	1.37	176.32	62.32	238.64	56%
2.0	34.7	0.69	0.69	1.37	213.93	75.61	289.54	56%
3.0	38.9	0.69	0.69	1.37	239.82	84.76	324.58	56%
4.0	42.1	0.69	0.69	1.37	259.55	91.74	351.28	56%
6.0	47.2	0.69	0.69	1.37	290.99	102.85	393.84	56%
8.0	51.1	0.69	0.69	1.37	315.03	111.35	426.38	56%
12.0	57.1	0.69	0.69	1.37	352.02	124.42	476.44	56%
18.0	65.5	0.69	0.69	1.37	403.81	142.72	546.53	56%
24.0	72.3	0.69	0.69	1.37	445.73	157.54	603.27	56%
36.0	82.9	0.69	0.69	1.37	511.08	180.64	691.72	56%
48.0	91.4	0.69	0.69	1.37	563.48	199.16	762.64	56%
72.0	97.3	0.69	0.69	1.37	599.85	212.02	811.87	56%
96.0	101.8	0.69	0.69	1.37	627.60	221.82	849.42	56%
144.0	108.3	0.69	0.69	1.37	667.67	235.98	903.65	56%
192.0	113.3	0.69	0.69	1.37	698.49	246.88	945.37	56%

Table F4: Rapid response run-off from 1% A.E.P. rainfall event: post development condition

Duration	Rainfall	Area (m^2)			Volume (m^3)			
	at Site	Impervious	Pervious	Total	Impervious	Pervious	Run-off	% increase
hours	mm	Area (ha)	Area (ha)	Area (ha)	Area	Area	Volume	in run-off volume
		C_v 90.0%	C_v 31.8%					
0.00	0.0	0.69	0.69	1.37	0.00	0.00	0.00	
0.50	34.4	0.69	0.69	1.37	212.08	74.96	287.03	56%
1.00	41.1	0.69	0.69	1.37	253.38	89.56	342.94	56%
2.00	48.9	0.69	0.69	1.37	301.47	106.55	408.02	56%
3.00	54.1	0.69	0.69	1.37	333.53	117.88	451.41	56%
4.00	58.1	0.69	0.69	1.37	358.19	126.60	484.79	56%
6.00	64.2	0.69	0.69	1.37	395.79	139.89	535.68	56%
8.00	68.9	0.69	0.69	1.37	424.77	150.13	574.90	56%
12.00	76.1	0.69	0.69	1.37	469.16	165.82	634.98	56%
18.00	86.3	0.69	0.69	1.37	532.04	188.05	720.09	56%
24.00	94.3	0.69	0.69	1.37	581.36	205.48	786.84	56%
36.00	106.9	0.69	0.69	1.37	659.04	232.93	891.97	56%
48.00	116.8	0.69	0.69	1.37	720.07	254.51	974.58	56%
72.00	122.9	0.69	0.69	1.37	757.68	267.80	1025.48	56%
96.00	127.3	0.69	0.69	1.37	784.80	277.38	1062.19	56%
144.00	133.9	0.69	0.69	1.37	825.49	291.77	1117.26	56%
192.00	138.8	0.69	0.69	1.37	855.70	302.44	1158.15	56%

Table F5: Post-development rapid response run-off from impervious area (3.3% A.E.P. rainfall including central CCA)

Duration	Rainfall	Area (m^2)			Volume (m^3)			Controlled run off	Tangent
	at Site	Impervious	Pervious	Total	Impervious	Pervious	Run-off	m^3	
hours	mm	Area (ha)	Area (ha)	Area (ha)	Area	Area	Volume		m^3
		C_v	C_v					Controlled rate (l/s)	
		90.0%	0.0%					5.0	
0.00	0.0	0.69	0.69	1.37	0.00	0.00	0.00	0.00	240.00
0.50	28.2	0.69	0.69	1.37	173.85	0.00	173.85	9.00	249.00
1.00	34.3	0.69	0.69	1.37	211.58	0.00	211.58	18.00	258.00
2.00	41.6	0.69	0.69	1.37	256.71	0.00	256.71	36.00	276.00
3.00	46.7	0.69	0.69	1.37	287.78	0.00	287.78	54.00	294.00
4.00	50.5	0.69	0.69	1.37	311.46	0.00	311.46	72.00	312.00
6.00	56.6	0.69	0.69	1.37	349.19	0.00	349.19	108.00	348.00
8.00	61.3	0.69	0.69	1.37	378.04	0.00	378.04	144.00	384.00
12.00	68.5	0.69	0.69	1.37	422.43	0.00	422.43	216.00	456.00
18.00	78.6	0.69	0.69	1.37	484.57	0.00	484.57	324.00	564.00
24.00	86.8	0.69	0.69	1.37	534.88	0.00	534.88	432.00	672.00
36.00	99.5	0.69	0.69	1.37	613.29	0.00	613.29	648.00	888.00
48.00	109.7	0.69	0.69	1.37	676.18	0.00	676.18	864.00	1104.00
72.00	116.8	0.69	0.69	1.37	719.83	0.00	719.83	1296.00	1536.00
96.00	122.2	0.69	0.69	1.37	753.12	0.00	753.12	1728.00	1968.00
144.00	130.0	0.69	0.69	1.37	801.20	0.00	801.20	2592.00	2832.00
192.00	136.0	0.69	0.69	1.37	838.19	0.00	838.19	3456.00	3696.00
								Total Storage Requirement (m^3)	240.00

Table F6: Post-development rapid response run-off from impervious area (3.3% A.E.P. rainfall including upper end CCA)

Duration	Rainfall	Area (m^2)			Volume (m^3)			Controlled run off	Tangent
	at Site	Impervious	Pervious	Total	Impervious	Pervious	Run-off	m^3	
hours	mm	Area (ha)	Area (ha)	Area (ha)	Area	Area	Volume		m^3
		C_v	C_v					Controlled rate (l/s)	
		90.0%	0.0%					5.0	
0.0	0.0	0.69	0.69	1.37	0.00	0.00	0.00	0.00	300.00
0.5	32.9	0.69	0.69	1.37	202.83	0.00	202.83	9.00	309.00
1.0	40.0	0.69	0.69	1.37	246.85	0.00	246.85	18.00	318.00
2.0	48.6	0.69	0.69	1.37	299.50	0.00	299.50	36.00	336.00
3.0	54.5	0.69	0.69	1.37	335.75	0.00	335.75	54.00	354.00
4.0	58.9	0.69	0.69	1.37	363.37	0.00	363.37	72.00	372.00
6.0	66.1	0.69	0.69	1.37	407.38	0.00	407.38	108.00	408.00
8.0	71.5	0.69	0.69	1.37	441.04	0.00	441.04	144.00	444.00
12.0	79.9	0.69	0.69	1.37	492.83	0.00	492.83	216.00	516.00
18.0	91.7	0.69	0.69	1.37	565.33	0.00	565.33	324.00	624.00
24.0	101.2	0.69	0.69	1.37	624.02	0.00	624.02	432.00	732.00
36.0	116.1	0.69	0.69	1.37	715.51	0.00	715.51	648.00	948.00
48.0	128.0	0.69	0.69	1.37	788.87	0.00	788.87	864.00	1164.00
72.0	136.2	0.69	0.69	1.37	839.80	0.00	839.80	1296.00	1596.00
96.0	142.5	0.69	0.69	1.37	878.64	0.00	878.64	1728.00	2028.00
144.0	151.6	0.69	0.69	1.37	934.74	0.00	934.74	2592.00	2892.00
192.0	158.6	0.69	0.69	1.37	977.89	0.00	977.89	3456.00	3756.00
								Total Storage Requirement (m^3)	300.00

Average: 270.00

Table F7: Post-development rapid response run-off from impervious area (1% A.E.P. rainfall including central CCA)

Duration	Rainfall	Area (m^2)			Volume (m^3)			Controlled run off	Tangent
hours	at Site mm	Impervious Area (ha)	Pervious Area (ha)	Total Area (ha)	Impervious Area	Pervious Area	Run-off Volume	m^3	m^3
		C_v 90.0%	C_v 0.0%					Controlled rate (l/s) 20.2	
0.0	0.0	0.69	0.69	1.37	0.00	0.00	0.00	0.00	365.00
0.5	41.3	0.69	0.69	1.37	254.49	0.00	254.49	9.00	374.00
1.0	49.3	0.69	0.69	1.37	304.06	0.00	304.06	18.00	383.00
2.0	58.7	0.69	0.69	1.37	361.76	0.00	361.76	36.00	401.00
3.0	64.9	0.69	0.69	1.37	400.23	0.00	400.23	54.00	419.00
4.0	69.7	0.69	0.69	1.37	429.82	0.00	429.82	72.00	437.00
6.0	77.0	0.69	0.69	1.37	474.95	0.00	474.95	108.00	473.00
8.0	82.7	0.69	0.69	1.37	509.72	0.00	509.72	144.00	509.00
12.0	91.3	0.69	0.69	1.37	562.99	0.00	562.99	216.00	581.00
18.0	103.6	0.69	0.69	1.37	638.45	0.00	638.45	324.00	689.00
24.0	113.2	0.69	0.69	1.37	697.63	0.00	697.63	432.00	797.00
36.0	128.3	0.69	0.69	1.37	790.85	0.00	790.85	648.00	1013.00
48.0	140.2	0.69	0.69	1.37	864.09	0.00	864.09	864.00	1229.00
72.0	147.5	0.69	0.69	1.37	909.21	0.00	909.21	1296.00	1661.00
96.0	152.8	0.69	0.69	1.37	941.77	0.00	941.77	1728.00	2093.00
144.0	160.7	0.69	0.69	1.37	990.59	0.00	990.59	2592.00	2957.00
192.0	166.6	0.69	0.69	1.37	1026.84	0.00	1026.84	3456.00	3821.00
								Total Storage Requirement (m^3)	365.00

Table F8: Post-development rapid response run-off from impervious area (1% A.E.P. rainfall including upper end CCA)

Duration	Rainfall	Area (m^2)			Volume (m^3)			Controlled run off	Tangent
hours	at Site mm	Impervious Area (ha)	Pervious Area (ha)	Total Area (ha)	Impervious Area	Pervious Area	Run-off Volume	m^3	m^3
		C_v 90.0%	C_v 0.0%					Controlled rate (l/s) 20.2	
0.0	0.0	0.69	0.69	1.37	0.00	0.00	0.00	0.00	450.00
0.5	48.2	0.69	0.69	1.37	296.91	0.00	296.91	9.00	459.00
1.0	57.5	0.69	0.69	1.37	354.73	0.00	354.73	18.00	468.00
2.0	68.5	0.69	0.69	1.37	422.06	0.00	422.06	36.00	486.00
3.0	75.7	0.69	0.69	1.37	466.94	0.00	466.94	54.00	504.00
4.0	81.3	0.69	0.69	1.37	501.46	0.00	501.46	72.00	522.00
6.0	89.9	0.69	0.69	1.37	554.11	0.00	554.11	108.00	558.00
8.0	96.5	0.69	0.69	1.37	594.68	0.00	594.68	144.00	594.00
12.0	106.5	0.69	0.69	1.37	656.82	0.00	656.82	216.00	666.00
18.0	120.8	0.69	0.69	1.37	744.86	0.00	744.86	324.00	774.00
24.0	132.0	0.69	0.69	1.37	813.90	0.00	813.90	432.00	882.00
36.0	149.7	0.69	0.69	1.37	922.65	0.00	922.65	648.00	1098.00
48.0	163.5	0.69	0.69	1.37	1008.10	0.00	1008.10	864.00	1314.00
72.0	172.1	0.69	0.69	1.37	1060.75	0.00	1060.75	1296.00	1746.00
96.0	178.2	0.69	0.69	1.37	1098.73	0.00	1098.73	1728.00	2178.00
144.0	187.5	0.00	0.00	0.00	0.00	0.00	0.00	2592.00	3042.00
192.0	194.3	0.00	0.00	0.00	0.00	0.00	0.00	3456.00	3906.00
								Total Storage Requirement (m^3)	450.00

Average: 407.50

End of Report