roof areas). A crated system could be used but at twice the cost of the additional granular material.

4.12 It is proposed that between 101m³ and 144m³ runoff generated by the highway areas are attenuated within lined filtration trenches. Using a design of trench approximately 2.2m wide, 1m deep, approximately 200m long and allowing 30% void ratio more than **122m³** volume of attenuation can be provided (see Appendix C.5 for the highway infiltration trench design calculations).

4.13 Through the implementation of the SuDS features described in paragraphs 4.10 – 4.12 a total of **1021m³** attenuation has been provided. Although paragraphs 4.10 - 4.12 show the site has the capacity to manage the storage requirements of the 1 in 100 year event, surface water management plans should account for exceedances where, for example, storm events exceed the 1 in 100 year return period. Appendix A.5 indicates their direction of flow which can be seen to be directed towards the north-west corner of the site.

APPROPRIATE SuDS TRAIN

4.14 Permeable paving – Permeable paving can be utilised beneath parking areas or driveways and can be lined to act as an attenuation system. The system uses a permeable block paver, which is similar to a normal block paver but has notches cut out of the corners, allowing water to permeate. The construction below is similar to that of a normal driveway construction but a layer of geo-textile material is placed on top of the upper sub-base to prevent the sand from the laying course washing through and filling the voids. The lower sub-base is made up of 10-63mm filter material.

4.15 Granular Filtration Trenches – Are long, narrow trenches back filled with 63mm – 10mm graded filter material allowing attenuation and water cleansing of the surface water runoff before discharge. They are lined with a membrane to prevent infiltration and ingress of silts (although the membrane can be replaced with a perforated geo-textile for infiltration purposes) and can either be specified with a perforated pipe at the bottom where flow direction is required or can incorporate a fin drain detail. Detailing of these trenches is important as a catch-pit should be incorporated at the inlets to the trench so that some silts can be filtered out prior to the trench which extends their practical working life.

4.16 Rainwater Harvesting – Is an above ground storage system consisting of a filtration unit connected to a storage tank which collects the runoff from the roofs, filters the runoff through several carbon filters before pumping the cleansed water through the commercial premises as grey water for use in toilets and wash facilities. Water re-cycling is becoming more popular as increase in water bills make their utilisation more desirable.

4.17 Green / Brown Roofs – Is an Architectural SuDS feature which is an attractive alternative to Rainwater Harvesting. The systems actively incorporate planting within the roof structure which allow for runoff to be stored and then used to feed the plants. Brown roofs take another step further by incorporating boulders and logs within the roof structure to encourage Bio diversity. Although the runoff is not re-utilised within the building, as it would

be with rainwater harvesting, they don't require storage tanks or pumps to move the runoff about. The additional cost of their construction can be offset by the reduction in attenuation requirements to below ground surface water drainage systems.

4.18 Swales – Are an above ground storage system consisting of an open ditch, with sloping sides and a flat base they provide attenuation and water cleansing properties. With a large surface area, they allow evaporation of contaminants as well as up to 20% of the stored runoff. They do however require large amounts of land take which are not always attractive to developers or adopting authorities and are not suitable for use with the proposed Masterplan layout.

5 RECOMMENDATIONS

5.1 Having carried out the Flood Risk Assessment and Surface Water Management Plan we can recommend the following:

- The site's commercial land use, being classified as 'Less Vulnerable', is suitably located within Flood Zone 1 which is in accordance with NPPF 'Technical Guidance' Tables 1-3 and PPS25, Annex D, Tables D1 – D3, chapter 2.

- It is recommended that parking courts use permeable block paving to cleanse and attenuate runoff from private footpaths and the driveways themselves.

- It is recommended that the main access road through the site is designed so as to drain into the lined filtration structures, located beneath footways, or Swales if space permits.

- Although priority should normally be given to using soakaways to reduce surface water run-off volume the site's geological and hydro-geological limitations make their use impractical. The location of the minor watercourse proves a more suitable discharge point.

- A detailed ground investigation, including infiltration testing and contamination analysis is carried out before detailed drainage designs are agreed, to ascertain the suitability of the SuDS recommended in Surface Water Management Plan and the scale of water cleansing required prior to discharge.

- It is recommended that the site runoff, through attenuation on site, will discharge at no greater than 8l/s into the minor watercourse in the north-west corner of the site under an agreement with Cheltenham Borough Council.

- Foul Water from the development will be drained via a separate Foul Water Sewer, to be adopted under a Section 104 agreement with Severn Trent Water. Foul water will discharge at a rate agreed with Severn Trent Water into a public Foul Water sewer within North Road West.

6 CONCLUSION

6.1 The Flood Risk Assessment identifies that the proposed development site is within Flood Zone 1 therefore posing a low risk to flooding. The flooding problem areas near to the site should benefit from the on-site attenuation provided by the SWMP.

6.2 The asset location plans provided by Severn Trent Water show no evidence of public surface water sewers that would have opportunity to cause flood risk to the development site.

6.3 The topography of the development site shows overland flows directing towards the north-west boundary.

6.4 By using rainwater harvesting to re-use runoff generated by the roof areas of the commercial premises, runoff volumes are reduced, requiring less attenuation within below ground structures.

6.5 By using SuDS features such as the lined filtration trenches and the permeable block paving to attenuate flows up to the 1 in 100 year storm event, the runoff time of entry is delayed for the extreme storms thereby actively creating betterment to the existing Greenfield flows, reducing flood risk to the surrounding areas.

6.6 The Surface Water Management Plan identifies that although the impermeable area will be increased on site from the existing scenario through using SuDS and for attenuation as well as water cleansing, runoff from the site is not increased and its water quality is improved.

6.7 Foul Water from the site will be discharged into public foul water sewers off site under agreement with the adopting water authority, Severn Trent Water.

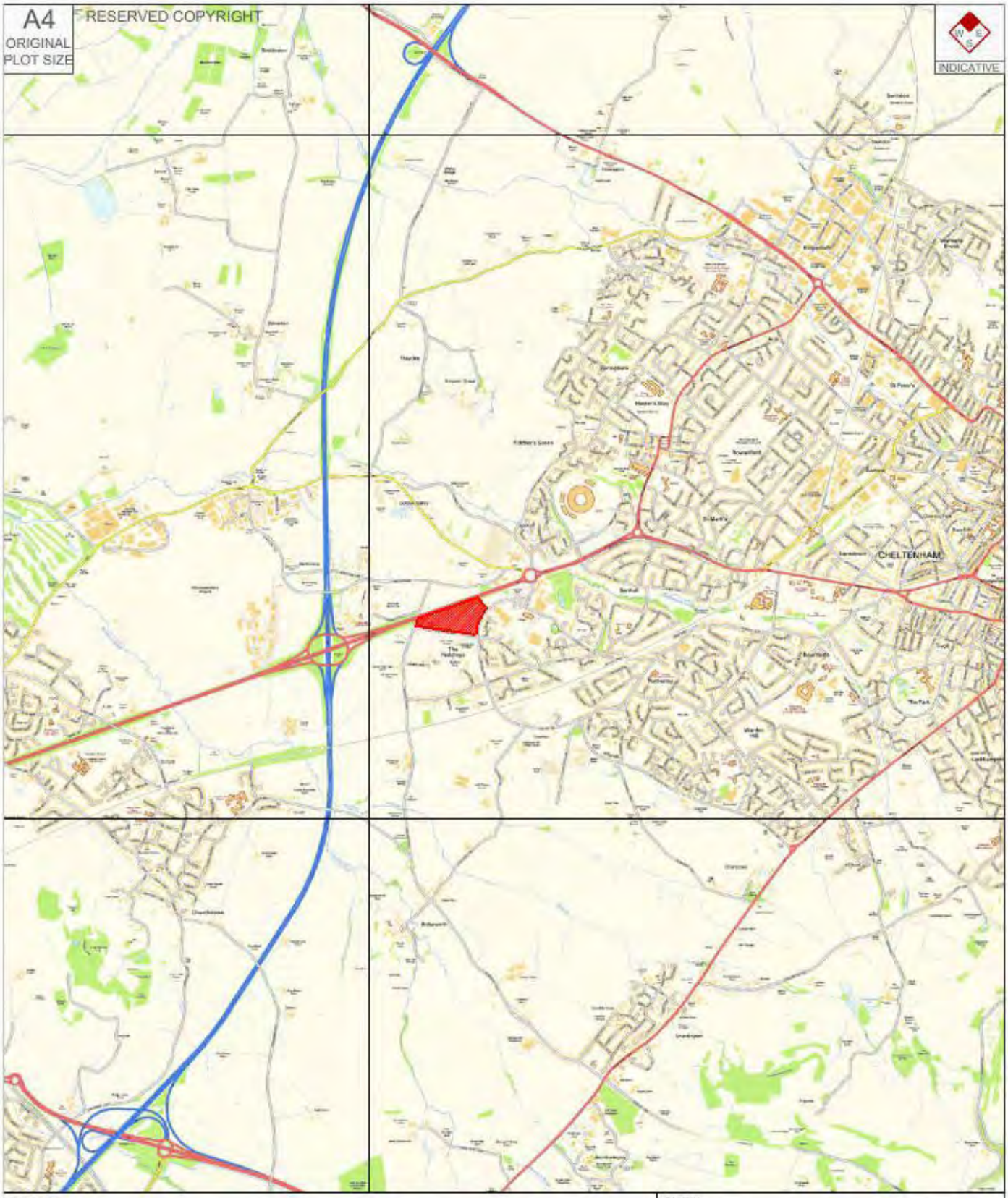
APPENDICES

APPENDIX A

SCHEME DRAWINGS

A4
ORIGINAL
PLOT SIZE

INDICATIVE



PROJECT:

LAND OFF GROVEFIELD WAY, CHELTENHAM

CLIENT:

COTSWOLD BMW GROUP

TITLE:

SITE LOCATION PLAN

NOTES:

STATUS:

INFORMATION

SCALE:	DATE:	DRAWN:	CHECKED:	APPROVED:
NTS	13.05.13	AJH	PCP	CMR

JOB NO:	DRAWING NO:	REVISION:
1303-30	Appendix A.1	-

Rev	Date	Details	Drawn by	Checked by	Approved by
-	-	-	-	-	-

Bristol
Cambridge
Cardiff
London
Welwyn Garden City

tpa
Transport Planning Associates

21 Berkeley Square
Clifton
Bristol
BS8 1HP
0117 925 9400
www.tpa.uk.com

A1
ORIGINAL
PLOT SIZE

NOTES:

KEY:

FOOD STORE IMPERMEABLE AREAS

SITE BOUNDARY	
TOTAL SITE AREA=	23495m²
EXISTING IMPERMEABLE AREA=	0m²
EXISTING VEGETATED AREA=	23495m²
PROPOSED % IMPERMEABLE AREA=	0%

Lay-by

BLADON MEWS

TIBBERTON GROV

CHALFORD AVENUE

FRAMPTON MEWS

Playground

INDICATIVE

Rev	Date	Details	Drawn by	Checked by	Approved by
-	-	-	-	-	-

Bristol
Cambridge
Cardiff
Welwyn Garden City

tpa Transport Planning Associates

Mercury House
Broadwater Road
Welwyn Garden City
AL7 3BQ
01707 385 200
www.tpa.uk.com

CLIENT:
COTSWOLD BMW GROUP

PROJECT:
GROVEFIELD WAY
CHELTENHAM

TITLE:
EXISTING IMPERMEABLE AREAS PLAN

STATUS:
INFORMATION

SCALE:	DATE:	DRAWN:	CHECKED:	APPROVED:
1:500	15.05.13	AJH	PCP	JC

JOB NO:	DRAWING NO:	REVISION:
1303-30	Appendix A.2	

A1
ORIGINAL
PLOT SIZE

NOTES:

KEY:

FOOD STORE IMPERMEABLE AREAS

SITE BOUNDARY	
TOTAL SITE AREA=	23495m²
PROPOSED IMPERMEABLE AREA=	16155m²
PROPOSED VEGETATED AREA=	7340m²
PROPOSED % IMPERMEABLE AREA=	68.7%

Lay-by

BLADON MEWS

TIBBERTON GROV

CHALFORD AVENUE

FRAMPTON MEWS

Playground

INDICATIVE

Rev	Date	Details	Drawn By	Checked By	Approved By
-	-	-	-	-	-

Bristol
Cambridge
Cardiff
Welwyn Garden City

tpa Transport Planning Associates

Mercury House
Broadwater Road
Welwyn Garden City
AL7 3BQ
01707 385 200
www.tpa.uk.com

CLIENT:
COTSWOLD BMW GROUP

PROJECT:
GROVEFIELD WAY
CHELTENHAM

TITLE:
PROPOSED IMPERMEABLE AREAS PLAN

STATUS:
INFORMATION

SCALE:	DATE:	DRAWN:	CHECKED:	APPROVED:
1:500	15.05.13	AJH	PCP	JC

JOB NO:	DRAWING NO:	REVISION:
1303-30	Appendix A.3	

A1
ORIGINAL
PLOT SIZE

NOTES:

KEY:

SITE BOUNDARY

TOTAL SITE AREA=	23495m²
PROPOSED ROOF AREA=	7605m²
PROPOSED DRIVEWAYS=	1380m²
PROPOSED PARKING BAYS=	5385m²
PROPOSED ACCESS ROAD=	1420m²
PROPOSED FOOTWAYS=	365m²
PROPOSED LANDSCAPING=	7340m²
TOTAL IMPERMEABLE AREA=	16155m²
PROPOSED % IMPERMEABLE AREA=	68.7%

DRAINAGE KEY:

SURFACE WATER SEWER/HIGHWAY DRAIN

SURFACE WATER MANHOLE

6m DRAINAGE EASEMENT

ASSUMING A LIMITED DISCHARGE RATE OF 8L/S FOR THE WHOLE SITE ATTENUATING UP TO THE 1 IN 100 YEAR RETURN PERIOD BETWEEN AND RUNOFF IS GENERATED.

ATTENUATION

ROOF AREAS INTO RAINWATER HARVESTING SYSTEM TO BE RE-USED AS GREY WATER FOR UTILITIES AS TOILETS AND FIRE SPRINKLER SYSTEMS= 50m³ (NOT TO BE INCL. IN CALCS)

REMAINING ROOF VOLUME TO ENTER INTO ADDITIONAL DEPTH OF FILTER MATERIAL PROVIDED BENEATH THE PERMEABLE PAVED CAR PARK

HIGHWAY AND FOOTWAY AREAS TO ENTER INTO 2m WIDE BY 1.5m DEEP LINED FILTRATION TRENCH RUNNING BENEATH THE FOOTWAYS. 2.2m x 1m x 200m x 30% void ratio= 122m³

PERMEABLE PAVED CAR PARKING COURTS TO TAKE RUNOFF FROM ITSELF AS WELL AS FROM THE REMAINING HARD SURFACED DRIVES. 5385m² x 555mm deep x 30% voids= 899m³

TOTAL ATTENUATION PROPOSED=

Lay-by

BLADON MEWS

TIBBERTON GROV

FRAMPTON MEWS

CHALFORD AVENUE

Playground

Rev	Date	Details	Drawn by	Checked by	Approved by
A	05.06.13	Amended strategy to suit revised attenuation calculations.	AJH	PCP	GMR

Bristol
Cambridge
Cardiff
Welwyn Garden City

Transport Planning Associates

Mercury House
Broadwater Road
Welwyn Garden City
AL7 3BQ
01707 385 200
www.tpa.uk.com

CLIENT:
COTSWOLD BMW GROUP

PROJECT:
GROVEFIELD WAY
CHELTENHAM

TITLE:
SURFACE WATER
MANAGEMENT PLAN

STATUS:
INFORMATION

SCALE:	DATE:	DRAWN:	CHECKED:	APPROVED:
1:500	15.05.13	AJH	PCP	JC

JOB NO:	DRAWING NO:	REVISION:
1303-30	Appendix A.4	A

INDICATIVE

A1
ORIGINAL
PLOT SIZE

INDICATIVE

NOTES:

KEY:

FOOD STORE IMPERMEABLE AREAS

SITE BOUNDARY

TOTAL SITE AREA= 23495m²

SURFACE WATER RUNOFF ARROWS

Rev	Date	Details	Drawn by	Checked by	Approved by
-	-	-	-	-	-

Bristol
Cambridge
Cardiff
Welwyn Garden City

tpa Transport Planning Associates

Mercury House
Broadwater Road
Welwyn Garden City
AL7 3BQ
01707 385 200
www.tpa.uk.com

CLIENT:
COTSWOLD BMW GROUP

PROJECT:
GROVEFIELD WAY
CHELTENHAM

TITLE:
FLOOD FLOW
DIRECTION ARROWS

STATUS:
INFORMATION

SCALE:	DATE:	DRAWN:	CHECKED:	APPROVED:
1:500	26.06.13	AJH	PCP	JC

JOB NO:	DRAWING NO:	REVISION:
1303-30	Appendix A.5	

APPENDIX B

SEVERN TRENT WATER ASSET LOCATION SEARCHES

SEVERN TRENT WATER Ltd
Asset Data Management
GIS Mapping Team
PO Box 5344
Coventry
CV3 9FT
Tel 0845 601 6616
Fax 02477 715862
Contact A Halford
Our Ref 68886
21 May 2013

Apparatus Location Enquiry

Further to your enquiry re: Grovefield Way Cheltenham Gloucestershire

Enclosed is a copy of the plans showing the approximate positions of public sewers situated within the vicinity of the land/property which is the subject of your enquiry.

Asset Data Management can only provide plans of the location of the Company's underground assets. Therefore service pipes and drains are the responsibility of the property owner and should be anticipated during any excavation.
However, we wish to inform you that although most private lateral drains and sewers were transferred to Severn Trent Water's ownership on 1st October 2011, the Company does not possess complete records of these assets and therefore they may not be shown on these maps.

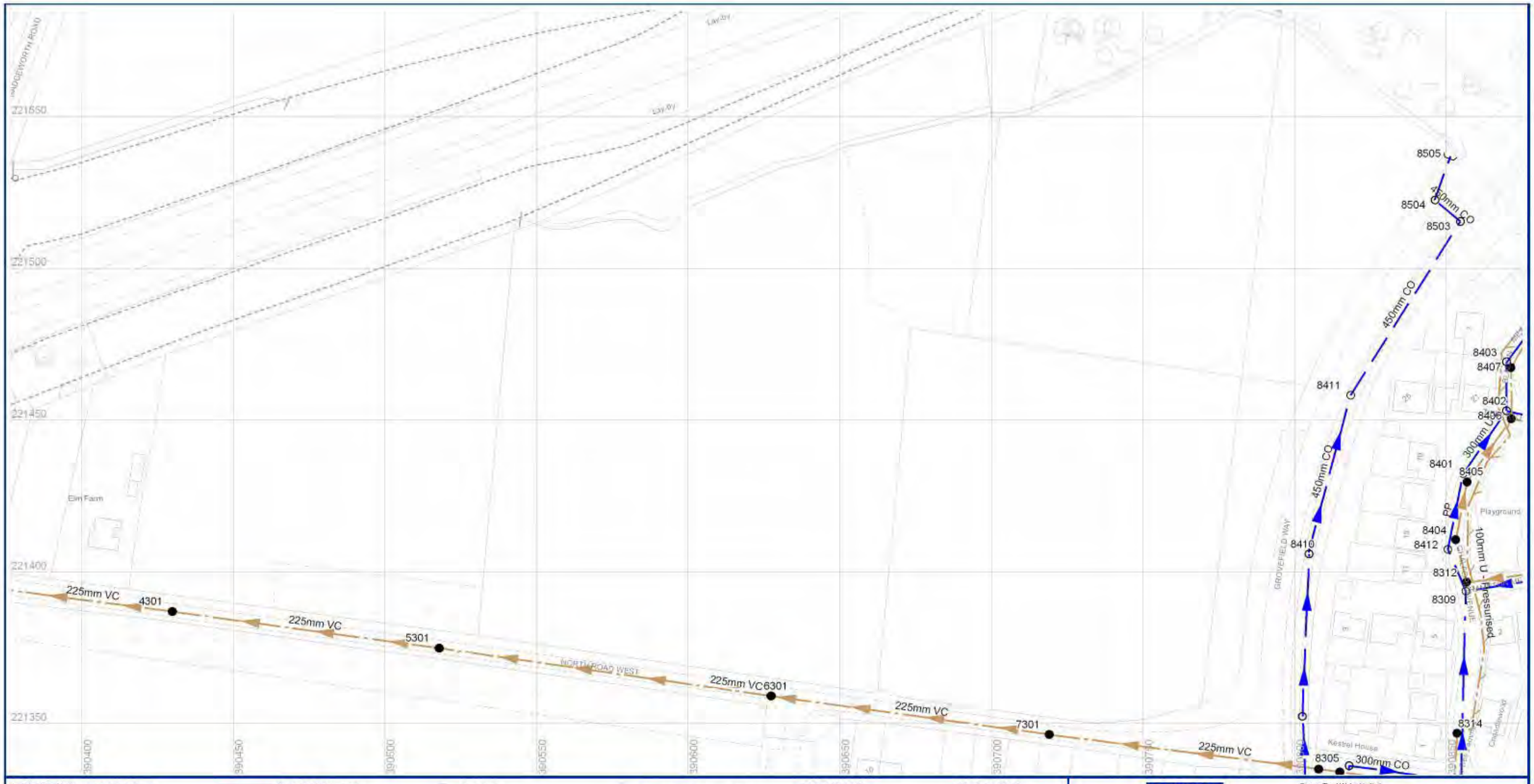
You may have to contact our Asset Protection Team at Regis Road Tettenhall with regard to records of flooding if any. (Tel 0116 234 3834).

Please also find enclosed a copy of Severn Trent Water's General Conditions and Precautions for your information.

Please forward VAT receipt to your finance department.

Kind Regards

GISmapping Team



- Abandoned Gravity Sewer
- Private Combined Gravity Sewer
- Private Foul Gravity Sewer
- Private Surface Water Gravity Sewer
- Public Combined Gravity Sewer
- Public Foul Gravity Sewer
- Public Surface Water Gravity Sewer
- Trunk Combined Gravity Sewer
- Trunk Foul Use Gravity Sewer
- Trunk Surface Water Gravity Sewer
- Combined Use Pressurised Sewer
- Foul Use Pressurised Sewer
- Surface Water Pressurised Sewer
- Highway Drain
- Combined Lateral Drain (SS)
- Foul Lateral Drain (SS)
- Surface Water Lateral Drain (SS)

All Private Sewers are shown in magenta.
All section 104 sewers are shown in green.
All Severn Trent Water assumed to Severn Trent Water after the 1st October 2011, not have not been surveyed and confirmed by Severn Trent Water are shown in orange.

- Culverted Watercourse
- Cable, Earthing
- Cable Junction
- Cable, Optical Fibre/Instrumentation
- Cable, Low Voltage
- Cable, High Voltage
- Cable, Other
- Housing, Building
- Housing, Kiosk
- Disposal Site
- Sewage Treatment Works
- Housing, Other
- Pipe Support Structure
- Sewage Pumping Facility
- Sewer Facility Connection Inlet / Outlet

- Blind Shaft
- Combined Use Manhole
- Flushing Chamber
- Foul Use Manhole
- Grease Trap
- Head Node
- Hydrobrake
- Lamphole
- Outfall
- Overflow
- Penstock
- Petrol Interceptor

- Sewer Chemical Injection Point
- Sewer Junction
- Sewerage Air Valve
- Sewerage Hatch Box Point
- Sewerage Isolation Valve
- Soakaway
- Surface Water Manhole
- Vent Column
- Waste Water Storage
- Pre-1937 Properties

MATERIALS

- - NONE
- AC - ASBESTOS CEMENT
- BR - BRICK
- CO - CONCRETE BOX CULVERT
- CI - CAST IRON
- CO - CONCRETE
- CSB - CONCRETE SEGMENTS (BOLTED)
- CSU - CONCRETE SEGMENTS (UNBOLTED)
- DI - DUCTILE IRON
- GRC - GLASS REINFORCED CONCRETE
- GRP - GLASS REINFORCED PLASTIC
- MAC - MASONRY IN REGULAR COURSES
- MAR - MASONRY RANDOMLY COURSED
- PE - POLYETHLENE
- PF - PITCH
- PP - POLYPROPYLENE
- PSC - PLASTIC STEEL COMPOSITE
- PVC - POLYVINYL CHLORIDE
- RPM - REINFORCED PLASTIC MATRIX
- SI - SPUN (GREY) IRON
- ST - STEEL
- U - UNKNOWN
- VC - VITRIFIED CLAY
- XXX - OTHER

SHAPE

- C - CIRCULAR
- E - EGG SHAPED
- O - OTHER
- R - RECTANGLE
- S - SQUARE
- T - TRAPEZOIDAL
- U - UNKNOWN

PURPOSE

- C - COMBINED
- F - FINAL EFFLUENT
- F - FOUL
- L - SLUDGE
- S - SURFACE WATER

CATEGORIES

- W - WEIR
- C - CASCADE
- DB - DAMBOARD
- SE - SIDE ENTRY
- FV - FLAP VALVE
- BD - BACK DROP
- S - SIPHON
- HD - HIGHWAY DRAIN
- S104 - SECTION 104

N
W E
S

SEVERN TRENT WATER

Severn Trent Water Limited
Asset Data Management
PO Box 5344
Coventry
CV3 9FT
Telephone: 0845 601 6616

SEWER RECORD

O/S Map scale: 1:1250

Date of issue: 21.05.13

This map is centred upon:
O / S Grid reference:

x : 390626

y : 221459

2 St. John's Street
COVENTRY
CV1 2LZ

VAT Regn No.: 486 9855 65

VAT RECEIPT

NAME **Transport Planning Associates**

VAT NUMBER **68886**

CUSTOMER REFERENCE **1303-30/AJH/04**

DESCRIPTION PAYMENT FOR – 1 Sewer Map

NET COST	20.00	GBP
VAT at 20%	4.00	GBP
TOTAL COST	24.00	GBP

RECEIVED BY (OFFICE) GISmapping

DATE 21/05/2013

Please make cheques payable to: Severn Trent Water Ltd

And send to:
Severn Trent Water Limited
Asset Data Management
GIS Mapping Team
PO Box 5344
Coventry
CV1 2LZ

Telephone: 0845 601 6616
Fax: 02477 715 862

TERMS AND CONDITIONS AND GENERAL PRECAUTIONS

These general terms and conditions and precautions apply to the public sewerage, water distribution and telemetry systems (including sewers which are the subject of an Agreement under Section 104 of the Water Industry Act 1991 and mains installed in accordance with the Agreement for the self construction of water mains) (STW Apparatus) of Severn Trent Water Limited (STW) and are not to be taken as exhaustive.

TERMS AND CONDITIONS:

1. This plan and any information supplied with it is issued subject to these terms and conditions.
2. This plan and any information supplied with it is furnished as a general guide only and no representation or warranty as to its accuracy is given or implied.
3. In particular, the position and depth of STW Apparatus shown on the plan are approximate only. It is strongly recommended that a survey is carried out to determine the precise location of STW Apparatus. The exact positions and depths should be obtained by excavation trial holes.
4. The position of private drains, private sewers and service pipes to properties are not normally shown on this plan but their presence must be anticipated and you are strongly advised to carry out your own enquiries and investigations to locate them.
5. The position and depth of STW Apparatus may change and therefore this plan is issued subject to any such change. The onus is entirely upon you to confirm whether any changes to the plan have been made subsequent to issue and prior to any works being carried out.
6. This plan and any information shown on it must not be relied upon in the event of any development or other works (including but not limited to excavations) in the vicinity of STW Apparatus or for the purpose of determining the suitability of a point of connection to the sewerage or distribution systems.
7. No person or company shall be relieved from liability for any damage caused to STW Apparatus by reason of the actual position and/or depths of STW Apparatus being different from those shown on the plan and any information supplied with it.
8. If any provision of these terms is or becomes invalid or unenforceable, it will be taken to be removed from the rest of these terms to the extent that it is invalid or unenforceable. No other provision of these terms shall be affected.
9. These terms shall be governed by English law and all parties submit to the exclusive jurisdiction of the English courts.

PRECAUTIONS:

STW staff will visit any site at reasonable notice to assist in the location of our apparatus and advise of any precautions necessary to avoid damage.

In order to achieve safe working conditions adjacent to any apparatus the following should be observed:

1. All STW Apparatus should be located by hand digging prior to the use of mechanical excavators.
2. During construction work, where heavy plant will cross the line of STW Apparatus, specific crossing points must be agreed with STW and suitably reinforced where required. These crossing points should be clearly marked and crossing of the line of STW Apparatus at other locations must be prevented.
3. No explosives are to be used in the vicinity of any STW Apparatus without prior consultation with STW.
4. Where it is proposed to carry out piling or boring within 15 metres of any STW Apparatus, STW should be consulted to enable any affected STW Apparatus to be surveyed prior to the works commencing.
5. Where excavation of trenches adjacent to any STW Apparatus affects its support, the STW Apparatus must be supported to the satisfaction of STW. Water mains and some sewers are pressurised and can fail if excavation removes support to thrust blocks to bends and other fittings.
6. Where a trench is excavated crossing or parallel to the line of any STW Apparatus, the backfill should be adequately compacted to prevent any settlement which could subsequently cause damage to the STW Apparatus. In special cases, it may be necessary to provide permanent support to STW Apparatus which has been exposed over a length of the excavation before backfilling and reinstatement is carried out. There should be no concrete backfill in contact with the STW Apparatus.
7. No apparatus should be laid along the line of STW Apparatus irrespective of clearance. Above ground apparatus must not be located within 5.0 metres either side of the centre line of STW Apparatus without prior approval. A minimum of radial clearance of 300 millimetres should be allowed between any plant being installed and existing STW Apparatus. No manhole or chamber shall be built over or around any STW Apparatus.
8. Where any STW Apparatus coated with a special wrapping is damaged, even to a minor extent, STW must be notified and the trench left open until the damage has been inspected and the necessary repairs have been carried out. In the case of any material damage to any STW Apparatus causing leakage, weakening of the mechanical strength of the pipe or corrosion-protection damage, the necessary remedial work will be recharged.
9. With regard to any proposed resurfacing works, you are required to contact STW on the number given below to arrange a site inspection to establish the condition of any STW Apparatus in the nature of surface boxes or manhole covers and frames affected by the works. STW will then advise on any measures to be taken.
10. Trees or shrubs - please ensure that, in relation to STW Apparatus, the mature root systems and canopies of any tree planted do not encroach within the recommended distances specified in the notes overleaf.

NOTES:

PARTICULAR RISKS INVOLVED WHEN WORKING WITH SEWERAGE SYSTEMS AND WATER MAINS

The following risks can be encountered when working on STW Apparatus

- Working in deep excavations.
- Working in the public highway (NRSWA)
- Working in confined spaces.
- Contents of the sewage. i.e. Aggressive Trade Effluent, Petrol, Chemicals etc.
- Accidental spillages may enter a public sewer and cause a harmful and/or explosive atmosphere
- In times of storm the water level in sewers may rise rapidly.
- Sewage can contain rat's urine. Infection from such contaminated sewage can cause Leptospirosis (Weil's Disease) and therefore appropriate hygiene measures should be taken.

You must not enter the public sewerage system without prior approval.

TREE PLANTING RESTRICTIONS

There are many problems with the location of trees adjacent to sewers, water mains and other STW Apparatus and these can lead to the loss of trees and hence amenity to the area which many people may have become used to. It is best if the problem is not created in the first place. Set out below are the recommendations for tree planting in close proximity to public sewers, water mains and other STW Apparatus.

1 Both Poplar and Willow trees have extensive root systems and should not be planted within 10 metres of a sewer, water main or other STW Apparatus.

2 The following trees and those of similar size, be they deciduous or evergreen, should not be planted within 6 metres of a sewer, water main or other STW Apparatus. e.g. Ash, Beech, Birch, most Conifers, Elm, Horse Chestnut, Lime, Oak, Sycamore, Apple and Pear.

3 STW personnel require a clear path to conduct surveys etc. No shrubs or bushes should be planted within 1 metre of the centre line of a sewer, water main or other STW Apparatus.

4 In certain circumstances, both STW and landowners may wish to plant shrubs/bushes in close proximity to a sewer, water main of other STW Apparatus for screening purposes. The following are shallow rooting and are suitable for this purpose: Blackthorn, Broom, Cotoneaster, Elder, Hazel, Laurel, Privet, Quickthorn, Snowberry, and most ornamental flowering shrubs.

Please ensure that a copy of this is passed to your representative and/or your Contractor on site. If any damage is caused to STW apparatus, the person, Contractor or Subcontractor responsible must inform STW immediately on

0800 783 4444 (24 hours)

APPENDIX C

WINDES QBAR ANALYSIS & STORAGE ESTIMATES

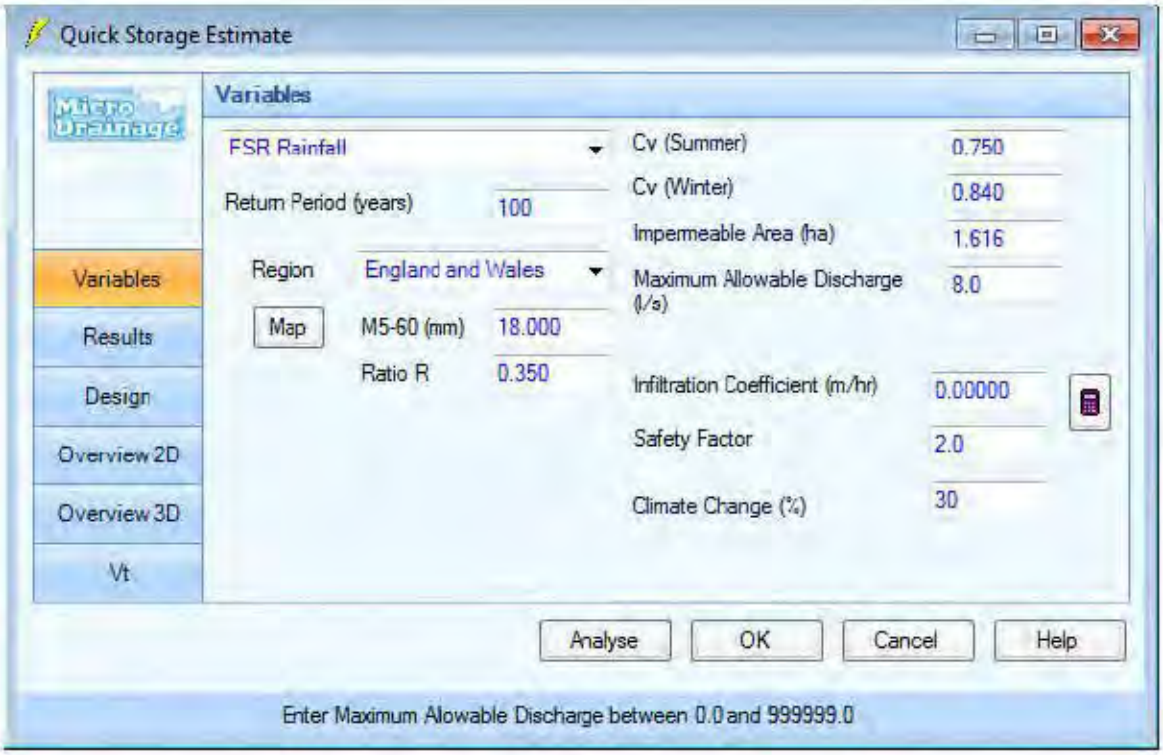
ICP SUDS Mean Annual Flood

Input

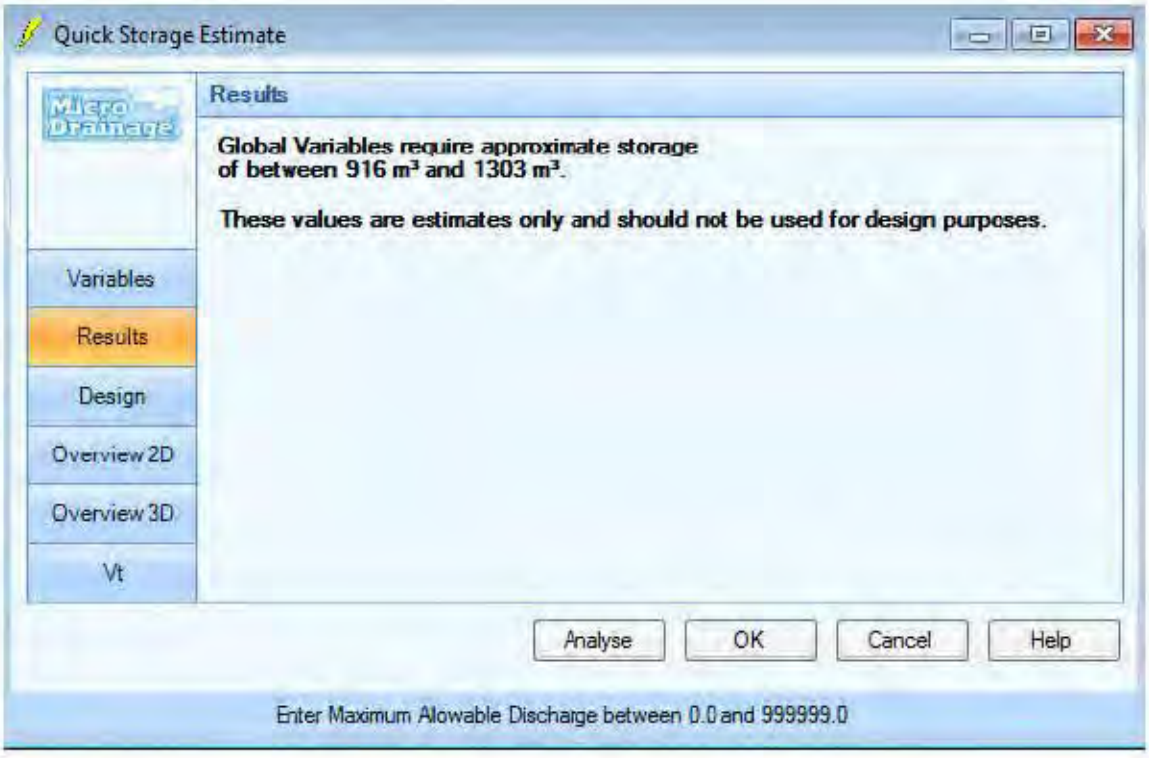
Return Period (years)	2	Soil	0.400
Area (ha)	2.350	Urban	0.000
SAAR (mm)	700	Region Number	Region 6

Results l/s

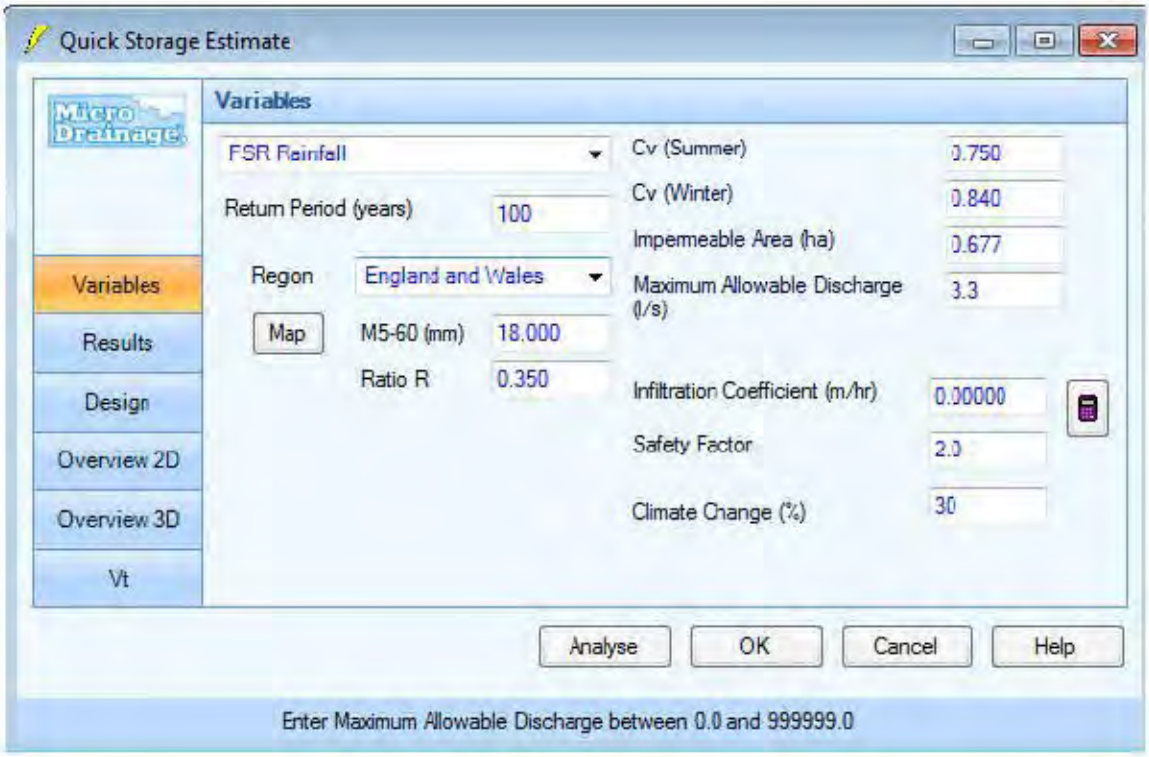
QBAR Rural	8.0
QBAR Urban	8.0
Q2 years	7.0
Q1 year	6.8
Q30 years	18.1
Q100 years	25.5



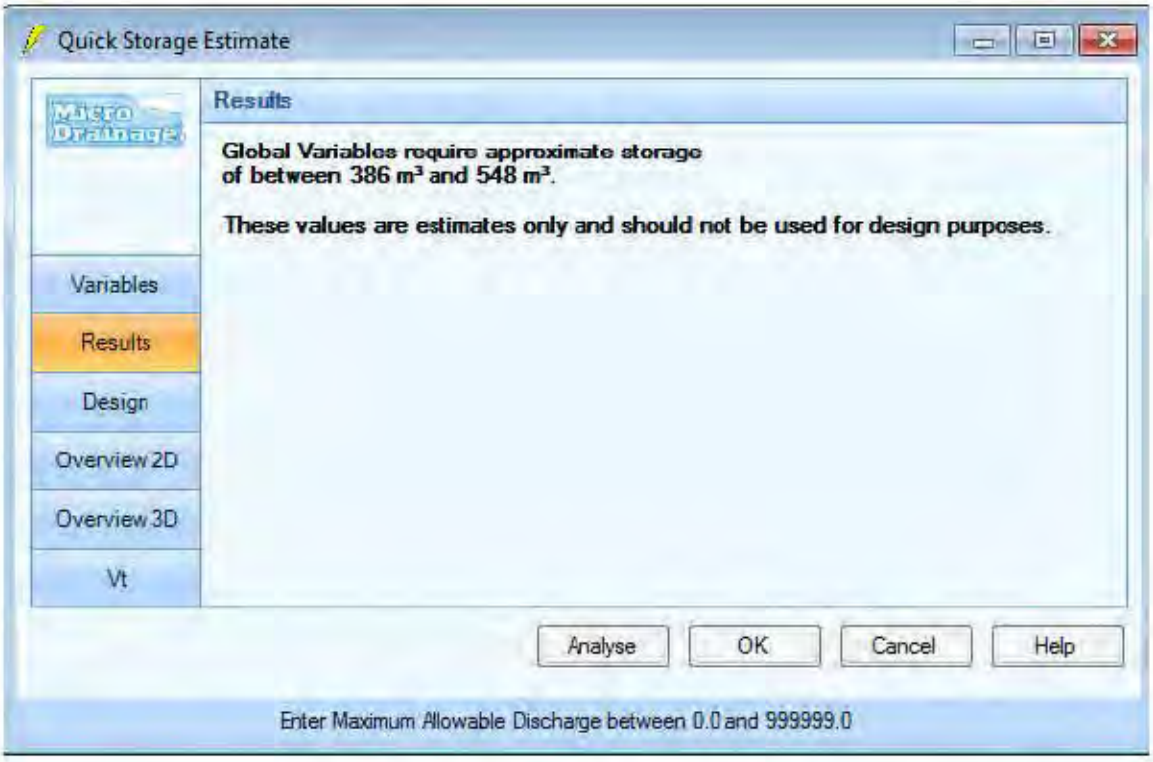
C.2a - Variables for calculating proposed attenuation requirements.



C.2b - Attenuation requirements for the site overall site.



C.3a - Variables for calculating proposed attenuation requirements of western car parking court.



C.3b - Attenuation requirements for western parking court.

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 1145 minutes.

	Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15	min Summer	31.969	0.069	0.0	1.6	1.6	110.5	O K
30	min Summer	31.998	0.098	0.0	2.4	2.4	156.6	O K
60	min Summer	32.029	0.129	0.0	2.9	2.9	206.4	O K
120	min Summer	32.061	0.161	0.0	3.1	3.1	257.8	O K
180	min Summer	32.079	0.179	0.0	3.2	3.2	286.8	O K
240	min Summer	32.091	0.191	0.0	3.2	3.2	305.6	O K
360	min Summer	32.105	0.205	0.0	3.2	3.2	327.9	O K
480	min Summer	32.114	0.214	0.0	3.2	3.2	342.0	O K
600	min Summer	32.119	0.219	0.0	3.2	3.2	350.5	O K
720	min Summer	32.122	0.222	0.0	3.2	3.2	355.5	O K
960	min Summer	32.125	0.225	0.0	3.2	3.2	359.9	O K
1440	min Summer	32.127	0.227	0.0	3.2	3.2	363.1	O K
2160	min Summer	32.125	0.225	0.0	3.2	3.2	359.3	O K
2880	min Summer	32.119	0.219	0.0	3.2	3.2	349.6	O K
4320	min Summer	32.102	0.202	0.0	3.2	3.2	323.4	O K
5760	min Summer	32.085	0.185	0.0	3.2	3.2	295.2	O K
7200	min Summer	32.068	0.168	0.0	3.2	3.2	268.8	O K
8640	min Summer	32.054	0.154	0.0	3.1	3.1	245.7	O K
10080	min Summer	32.042	0.142	0.0	3.1	3.1	226.5	O K

	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15	min Summer	109.059	0.0	69.3	27
30	min Summer	73.366	0.0	106.0	41
60	min Summer	47.182	0.0	161.8	70
120	min Summer	29.362	0.0	234.8	130
180	min Summer	21.949	0.0	266.4	188
240	min Summer	17.740	0.0	288.3	248
360	min Summer	13.035	0.0	317.9	366
480	min Summer	10.480	0.0	339.2	484
600	min Summer	8.842	0.0	355.1	602
720	min Summer	7.691	0.0	367.3	720
960	min Summer	6.166	0.0	383.7	844
1440	min Summer	4.508	0.0	394.9	1090
2160	min Summer	3.288	0.0	523.0	1488
2880	min Summer	2.626	0.0	548.1	1900
4320	min Summer	1.908	0.0	572.2	2688
5760	min Summer	1.520	0.0	640.2	3464
7200	min Summer	1.273	0.0	636.7	4248
8640	min Summer	1.101	0.0	666.0	4936
10080	min Summer	0.974	0.0	669.0	5656

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	31.979	0.079	0.0	1.9	1.9	126.9	O K
30 min Winter	32.012	0.112	0.0	2.7	2.7	178.6	O K
60 min Winter	32.047	0.147	0.0	3.1	3.1	234.7	O K
120 min Winter	32.083	0.183	0.0	3.2	3.2	293.2	O K
180 min Winter	32.104	0.204	0.0	3.2	3.2	326.4	O K
240 min Winter	32.118	0.218	0.0	3.2	3.2	348.2	O K
360 min Winter	32.134	0.234	0.0	3.2	3.2	374.7	O K
480 min Winter	32.145	0.245	0.0	3.2	3.2	392.0	O K
600 min Winter	32.152	0.252	0.0	3.2	3.2	403.2	O K
720 min Winter	32.157	0.257	0.0	3.2	3.2	410.4	O K
960 min Winter	32.161	0.261	0.0	3.2	3.2	416.2	O K
1440 min Winter	32.160	0.260	0.0	3.2	3.2	414.8	O K
2160 min Winter	32.153	0.253	0.0	3.2	3.2	404.9	O K
2880 min Winter	32.142	0.242	0.0	3.2	3.2	386.8	O K
4320 min Winter	32.114	0.214	0.0	3.2	3.2	342.1	O K
5760 min Winter	32.086	0.186	0.0	3.2	3.2	297.5	O K
7200 min Winter	32.062	0.162	0.0	3.1	3.1	258.9	O K
8640 min Winter	32.042	0.142	0.0	3.1	3.1	227.7	O K
10080 min Winter	32.028	0.128	0.0	2.9	2.9	204.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	109.059	0.0	82.1	26
30 min Winter	73.366	0.0	123.9	41
60 min Winter	47.182	0.0	208.4	70
120 min Winter	29.362	0.0	267.2	126
180 min Winter	21.949	0.0	302.1	184
240 min Winter	17.740	0.0	326.1	242
360 min Winter	13.035	0.0	357.9	358
480 min Winter	10.480	0.0	380.5	474
600 min Winter	8.842	0.0	396.7	588
720 min Winter	7.691	0.0	408.6	700
960 min Winter	6.166	0.0	422.8	920
1440 min Winter	4.508	0.0	425.4	1186
2160 min Winter	3.288	0.0	591.4	1624
2880 min Winter	2.626	0.0	619.9	2076
4320 min Winter	1.908	0.0	647.2	2936
5760 min Winter	1.520	0.0	729.5	3696
7200 min Winter	1.273	0.0	750.4	4464
8640 min Winter	1.101	0.0	763.5	5184
10080 min Winter	0.974	0.0	769.6	5856

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.677

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.226	4	8	0.226	8	12	0.226

Model Details

Storage is Online Cover Level (m) 32.500

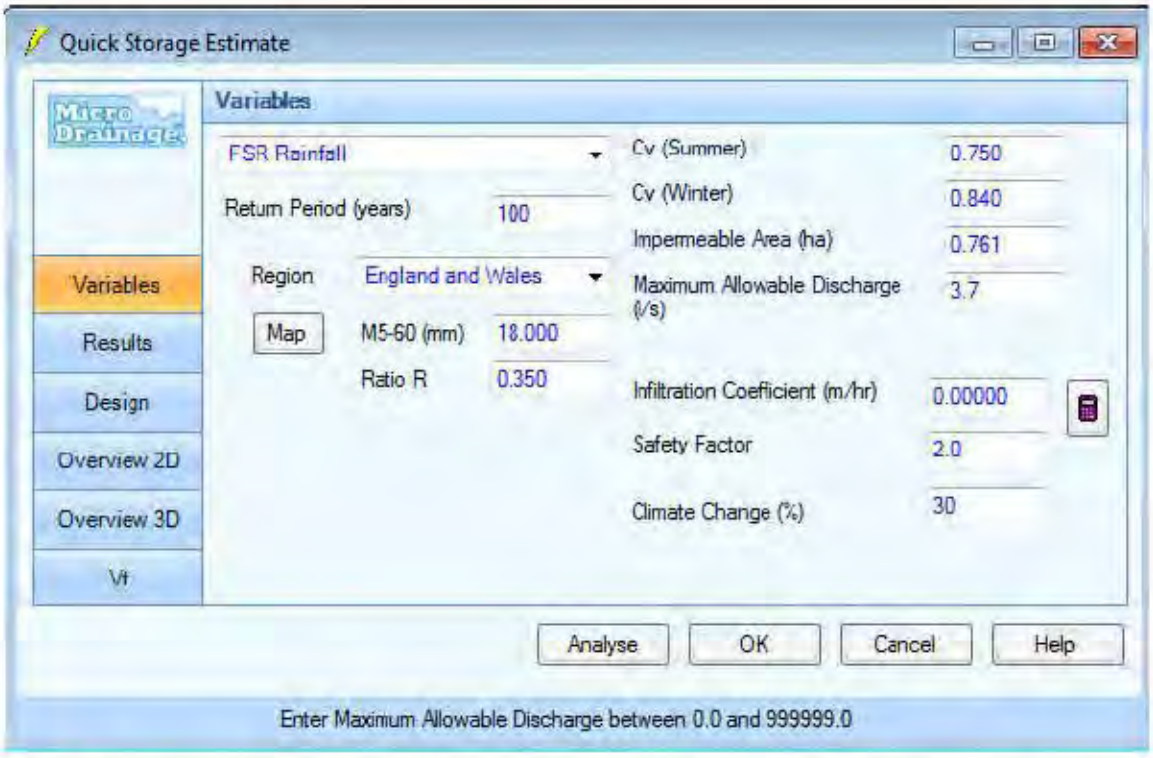
Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	72.0
Membrane Percolation (mm/hr)	1000	Length (m)	74.0
Max Percolation (l/s)	1480.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	31.900	Cap Volume Depth (m)	0.000

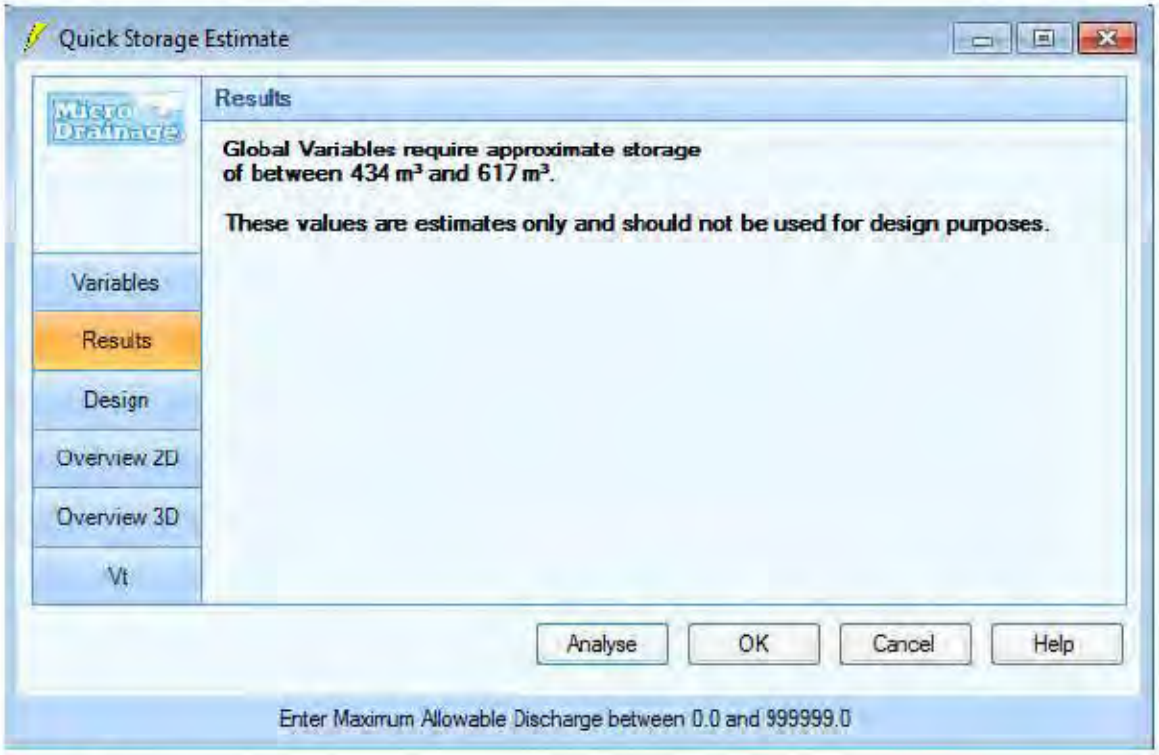
Hydro-Brake® Outflow Control

Design Head (m)	0.600	Hydro-Brake® Type	Md6 SW Only
Design Flow (l/s)	3.3	Diameter (mm)	85
		Invert Level (m)	31.900

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.8	1.200	4.5	3.000	7.1	7.000	10.9
0.200	3.2	1.400	4.9	3.500	7.7	7.500	11.3
0.300	3.0	1.600	5.2	4.000	8.2	8.000	11.7
0.400	2.9	1.800	5.5	4.500	8.7	8.500	12.0
0.500	3.0	2.000	5.8	5.000	9.2	9.000	12.4
0.600	3.2	2.200	6.1	5.500	9.7	9.500	12.7
0.800	3.7	2.400	6.4	6.000	10.1		
1.000	4.1	2.600	6.6	6.500	10.3		



C.4a - Variables for calculating proposed attenuation requirements for roof areas.



C.4b - Attenuation requirements for roof areas.

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 1145 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	32.062	0.162	0.0	5.7	5.7	262.5	O K
30 min Summer	32.123	0.223	0.0	6.3	6.3	360.1	O K
60 min Summer	32.188	0.288	0.0	6.4	6.4	466.0	O K
120 min Summer	32.256	0.356	0.0	6.4	6.4	575.7	Flood Risk
180 min Summer	32.294	0.394	0.0	6.4	6.4	637.4	Flood Risk
240 min Summer	32.319	0.419	0.0	6.4	6.4	677.0	Flood Risk
360 min Summer	32.348	0.448	0.0	6.4	6.4	723.6	Flood Risk
480 min Summer	32.366	0.466	0.0	6.5	6.5	752.1	Flood Risk
600 min Summer	32.376	0.476	0.0	6.5	6.5	768.8	Flood Risk
720 min Summer	32.381	0.481	0.0	6.5	6.5	777.7	Flood Risk
960 min Summer	32.384	0.484	0.0	6.5	6.5	782.1	Flood Risk
1440 min Summer	32.382	0.482	0.0	6.5	6.5	779.1	Flood Risk
2160 min Summer	32.370	0.470	0.0	6.5	6.5	759.5	Flood Risk
2880 min Summer	32.352	0.452	0.0	6.4	6.4	730.3	Flood Risk
4320 min Summer	32.310	0.410	0.0	6.4	6.4	661.7	Flood Risk
5760 min Summer	32.266	0.366	0.0	6.4	6.4	591.1	Flood Risk
7200 min Summer	32.224	0.324	0.0	6.4	6.4	524.1	Flood Risk
8640 min Summer	32.187	0.287	0.0	6.4	6.4	464.3	O K
10080 min Summer	32.156	0.256	0.0	6.4	6.4	413.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	109.059	0.0	213.3	26
30 min Summer	73.366	0.0	306.3	41
60 min Summer	47.182	0.0	455.7	70
120 min Summer	29.362	0.0	572.9	130
180 min Summer	21.949	0.0	643.4	188
240 min Summer	17.740	0.0	692.6	248
360 min Summer	13.035	0.0	759.3	366
480 min Summer	10.480	0.0	807.7	484
600 min Summer	8.842	0.0	843.5	602
720 min Summer	7.691	0.0	870.4	722
960 min Summer	6.166	0.0	903.6	882
1440 min Summer	4.508	0.0	907.4	1118
2160 min Summer	3.288	0.0	1203.5	1512
2880 min Summer	2.626	0.0	1271.2	1928
4320 min Summer	1.908	0.0	1353.0	2728
5760 min Summer	1.520	0.0	1476.4	3520
7200 min Summer	1.273	0.0	1532.3	4264
8640 min Summer	1.101	0.0	1574.6	5016
10080 min Summer	0.974	0.0	1605.1	5744

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	32.084	0.184	0.0	6.0	6.0	297.4	O K
30 min Winter	32.152	0.252	0.0	6.4	6.4	407.3	O K
60 min Winter	32.226	0.326	0.0	6.4	6.4	526.6	Flood Risk
120 min Winter	32.303	0.403	0.0	6.4	6.4	650.9	Flood Risk
180 min Winter	32.346	0.446	0.0	6.4	6.4	721.1	Flood Risk
240 min Winter	32.374	0.474	0.0	6.5	6.5	766.6	Flood Risk
360 min Winter	32.408	0.508	0.0	6.6	6.6	821.1	Flood Risk
480 min Winter	32.429	0.529	0.0	6.7	6.7	855.4	Flood Risk
600 min Winter	32.443	0.543	0.0	6.7	6.7	876.6	Flood Risk
720 min Winter	32.450	0.550	0.0	6.8	6.8	889.4	Flood Risk
960 min Winter	32.456	0.556	0.0	6.8	6.8	898.9	Flood Risk
1440 min Winter	32.449	0.549	0.0	6.7	6.7	886.3	Flood Risk
2160 min Winter	32.430	0.530	0.0	6.7	6.7	856.4	Flood Risk
2880 min Winter	32.403	0.503	0.0	6.6	6.6	811.9	Flood Risk
4320 min Winter	32.338	0.438	0.0	6.4	6.4	707.6	Flood Risk
5760 min Winter	32.272	0.372	0.0	6.4	6.4	600.4	Flood Risk
7200 min Winter	32.209	0.309	0.0	6.4	6.4	499.8	Flood Risk
8640 min Winter	32.157	0.257	0.0	6.4	6.4	414.8	O K
10080 min Winter	32.117	0.217	0.0	6.3	6.3	351.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	109.059	0.0	250.2	26
30 min Winter	73.366	0.0	395.4	40
60 min Winter	47.182	0.0	514.1	70
120 min Winter	29.362	0.0	644.0	128
180 min Winter	21.949	0.0	721.4	186
240 min Winter	17.740	0.0	774.9	244
360 min Winter	13.035	0.0	845.9	360
480 min Winter	10.480	0.0	895.6	474
600 min Winter	8.842	0.0	930.0	588
720 min Winter	7.691	0.0	953.2	700
960 min Winter	6.166	0.0	973.8	920
1440 min Winter	4.508	0.0	949.1	1182
2160 min Winter	3.288	0.0	1352.6	1628
2880 min Winter	2.626	0.0	1427.6	2084
4320 min Winter	1.908	0.0	1512.8	2980
5760 min Winter	1.520	0.0	1665.1	3800
7200 min Winter	1.273	0.0	1730.3	4544
8640 min Winter	1.101	0.0	1780.5	5200
10080 min Winter	0.974	0.0	1818.5	5864

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 1.438

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.479	4	8	0.479	8	12	0.479

Model Details

Storage is Online Cover Level (m) 32.500

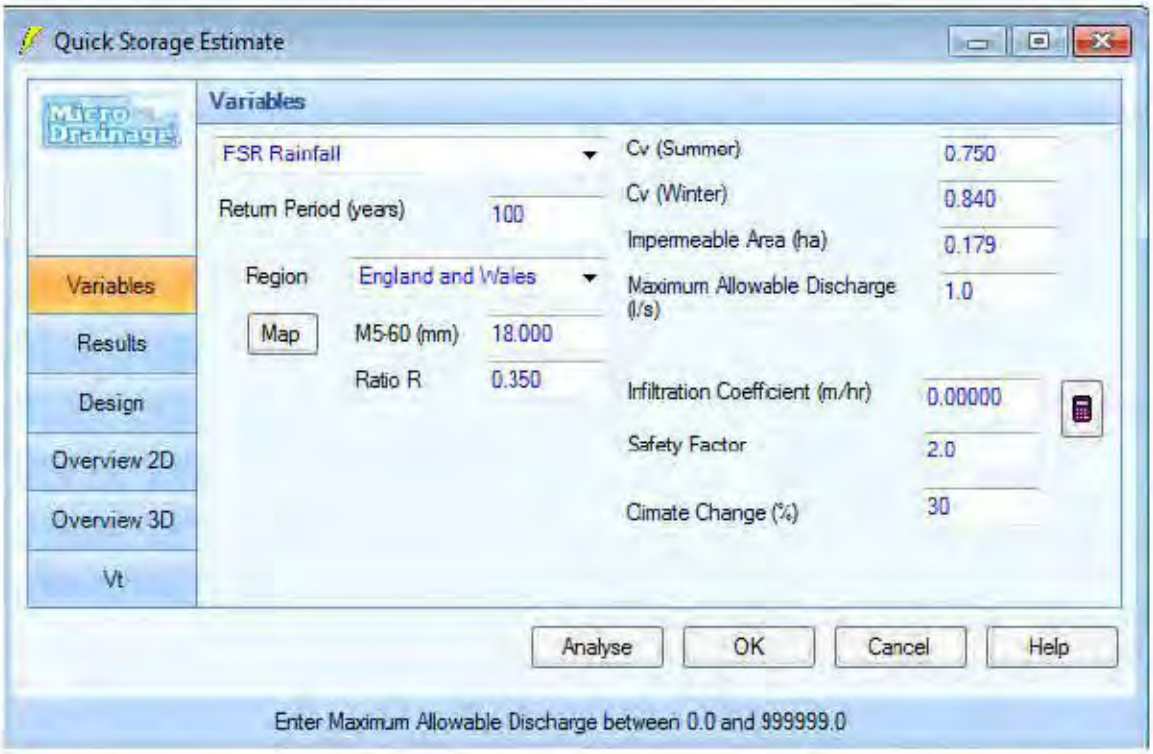
Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	72.0
Membrane Percolation (mm/hr)	1000	Length (m)	74.8
Max Percolation (l/s)	1496.0	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	31.900	Cap Volume Depth (m)	0.000

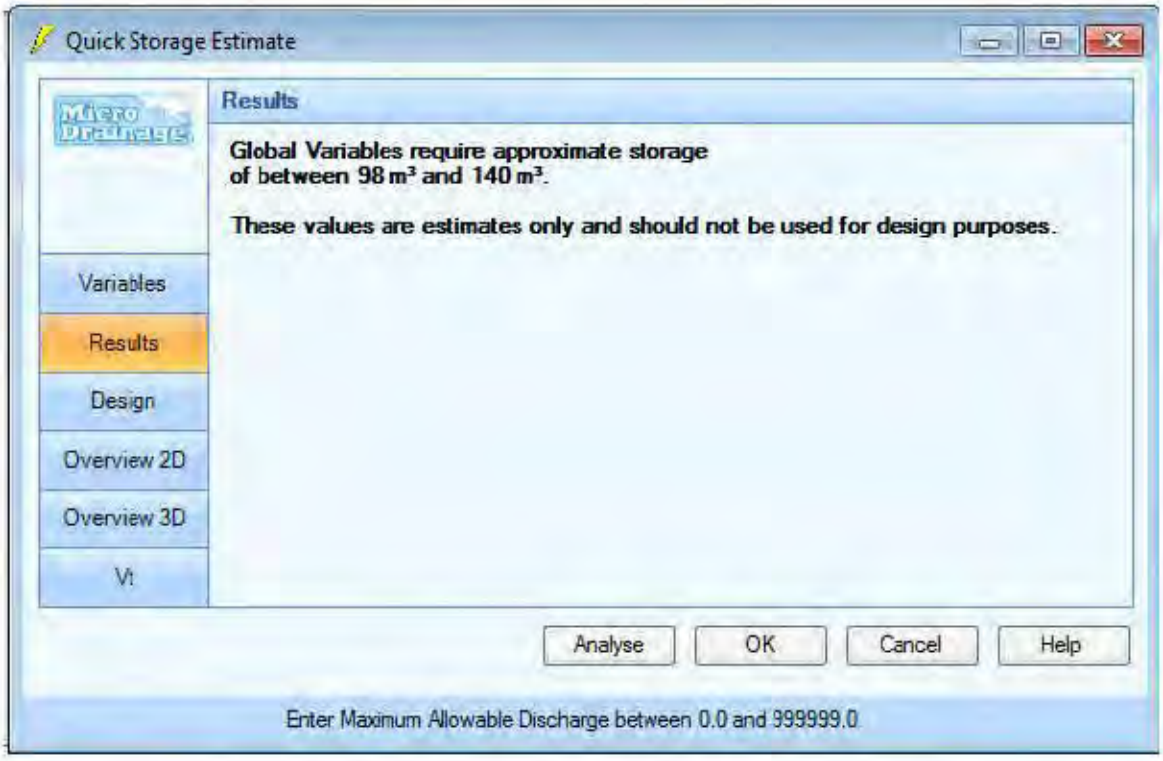
Hydro-Brake® Outflow Control

Design Head (m) 0.600 Hydro-Brake® Type Md5 SW Only Invert Level (m) 31.900
Design Flow (l/s) 7.0 Diameter (mm) 121

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.8	1.200	9.7	3.000	15.3	7.000	23.3
0.200	6.2	1.400	10.4	3.500	16.5	7.500	24.1
0.300	6.4	1.600	11.1	4.000	17.6	8.000	24.9
0.400	6.3	1.800	11.8	4.500	18.7	8.500	25.7
0.500	6.6	2.000	12.5	5.000	19.7	9.000	26.4
0.600	7.0	2.200	13.1	5.500	20.7	9.500	27.2
0.800	7.9	2.400	13.7	6.000	21.6		
1.000	8.8	2.600	14.2	6.500	22.5		



C.5a - Variables for calculating proposed attenuation requirements for carriageway and footway impermeable areas.



C.5b - Attenuation requirements for all highway drainage systems

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 1231 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	31.869	0.369	0.0	0.0	0.0	36.6	O K
30 min Summer	31.958	0.458	0.0	0.6	0.6	48.9	O K
60 min Summer	32.053	0.553	0.0	0.7	0.7	62.1	O K
120 min Summer	32.156	0.656	0.0	0.7	0.7	76.3	O K
180 min Summer	32.215	0.715	0.0	0.7	0.7	84.5	Flood Risk
240 min Summer	32.254	0.754	0.0	0.8	0.8	89.9	Flood Risk
360 min Summer	32.301	0.801	0.0	0.8	0.8	96.5	Flood Risk
480 min Summer	32.332	0.832	0.0	0.8	0.8	100.8	Flood Risk
600 min Summer	32.352	0.852	0.0	0.8	0.8	103.5	Flood Risk
720 min Summer	32.364	0.864	0.0	0.9	0.9	105.2	Flood Risk
960 min Summer	32.378	0.878	0.0	0.9	0.9	107.1	Flood Risk
1440 min Summer	32.395	0.895	0.0	0.9	0.9	109.5	Flood Risk
2160 min Summer	32.404	0.904	0.0	0.9	0.9	110.8	Flood Risk
2880 min Summer	32.401	0.901	0.0	0.9	0.9	110.3	Flood Risk
4320 min Summer	32.375	0.875	0.0	0.9	0.9	106.7	Flood Risk
5760 min Summer	32.338	0.838	0.0	0.8	0.8	101.6	Flood Risk
7200 min Summer	32.298	0.798	0.0	0.8	0.8	96.0	Flood Risk
8640 min Summer	32.256	0.756	0.0	0.8	0.8	90.2	Flood Risk
10080 min Summer	32.216	0.716	0.0	0.7	0.7	84.7	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	109.059	0.0	0.0	27
30 min Summer	73.366	0.0	7.9	41
60 min Summer	47.182	0.0	22.2	70
120 min Summer	29.362	0.0	37.7	130
180 min Summer	21.949	0.0	47.2	188
240 min Summer	17.740	0.0	54.0	248
360 min Summer	13.035	0.0	63.6	366
480 min Summer	10.480	0.0	71.1	484
600 min Summer	8.842	0.0	77.1	602
720 min Summer	7.691	0.0	82.1	720
960 min Summer	6.166	0.0	90.2	856
1440 min Summer	4.508	0.0	99.8	1088
2160 min Summer	3.288	0.0	117.8	1480
2880 min Summer	2.626	0.0	128.0	1884
4320 min Summer	1.908	0.0	142.8	2720
5760 min Summer	1.520	0.0	154.9	3520
7200 min Summer	1.273	0.0	164.1	4320
8640 min Summer	1.101	0.0	171.8	5096
10080 min Summer	0.974	0.0	178.5	5848

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	31.901	0.401	0.0	0.0	0.0	41.0	O K
30 min Winter	31.999	0.499	0.0	0.7	0.7	64.6	O K
60 min Winter	32.108	0.608	0.0	0.7	0.7	69.7	O K
120 min Winter	32.223	0.723	0.0	0.7	0.7	85.7	Flood Risk
180 min Winter	32.289	0.789	0.0	0.8	0.8	94.9	Flood Risk
240 min Winter	32.333	0.833	0.0	0.8	0.8	100.9	Flood Risk
360 min Winter	32.387	0.887	0.0	0.9	0.9	108.4	Flood Risk
480 min Winter	32.422	0.922	0.0	0.9	0.9	113.3	Flood Risk
600 min Winter	32.445	0.945	0.0	0.9	0.9	116.4	Flood Risk
720 min Winter	32.460	0.960	0.0	0.9	0.9	118.5	Flood Risk
960 min Winter	32.476	0.976	0.0	1.0	1.0	120.7	Flood Risk
1440 min Winter	32.485	0.985	0.0	1.0	1.0	122.0	Flood Risk
2160 min Winter	32.483	0.983	0.0	1.0	1.0	121.7	Flood Risk
2880 min Winter	32.465	0.965	0.0	0.9	0.9	119.2	Flood Risk
4320 min Winter	32.411	0.911	0.0	0.9	0.9	111.7	Flood Risk
5760 min Winter	32.350	0.850	0.0	0.8	0.8	103.3	Flood Risk
7200 min Winter	32.289	0.789	0.0	0.8	0.8	94.7	Flood Risk
8640 min Winter	32.228	0.728	0.0	0.7	0.7	86.3	Flood Risk
10080 min Winter	32.167	0.667	0.0	0.7	0.7	77.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	109.059	0.0	0.0	27
30 min Winter	73.366	0.0	13.7	41
60 min Winter	47.182	0.0	29.8	70
120 min Winter	29.362	0.0	47.1	128
180 min Winter	21.949	0.0	57.7	186
240 min Winter	17.740	0.0	65.4	244
360 min Winter	13.035	0.0	76.1	358
480 min Winter	10.480	0.0	84.4	474
600 min Winter	8.842	0.0	91.1	586
720 min Winter	7.691	0.0	96.6	698
960 min Winter	6.166	0.0	105.2	910
1440 min Winter	4.508	0.0	109.4	1134
2160 min Winter	3.288	0.0	136.8	1588
2880 min Winter	2.626	0.0	148.2	2048
4320 min Winter	1.908	0.0	164.7	2904
5760 min Winter	1.520	0.0	178.4	3752
7200 min Winter	1.273	0.0	188.7	4552
8640 min Winter	1.101	0.0	197.3	5368
10080 min Winter	0.974	0.0	204.9	6168

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+30

Time Area Diagram

Total Area (ha) 0.179

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.060	4	8	0.060	8	12	0.060

Model Details

Storage is Online Cover Level (m) 32.500

Infiltration Trench Structure

Infiltration Coefficient Base (m/hr)	0.00000	Trench Width (m)	2.2
Infiltration Coefficient Side (m/hr)	0.00000	Trench Length (m)	210.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	0.30	Cap Volume Depth (m)	0.000
Invert Level (m)	31.500	Cap Infiltration Depth (m)	0.000

Hydro-Brake® Outflow Control

Design Head (m)	0.600	Hydro-Brake® Type	Md6 SW Only	Invert Level (m)	31.900
Design Flow (l/s)	1.0	Diameter (mm)	85		

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	1.200	4.5	3.000	7.1	7.000	10.9
0.200	3.2	1.400	4.9	3.500	7.7	7.500	11.3
0.300	3.0	1.600	5.2	4.000	8.2	8.000	11.7
0.400	2.9	1.800	5.5	4.500	8.7	8.500	12.0
0.500	3.0	2.000	5.8	5.000	9.2	9.000	12.4
0.600	3.2	2.200	6.1	5.500	9.7	9.500	12.7
0.800	3.7	2.400	6.4	6.000	10.1		
1.000	4.1	2.600	6.6	6.500	10.5		

APPENDIX D

FLOODING CONSULTATION

Gloucestershire County Council

Preliminary Flood Risk Assessment

Preliminary Assessment Report

November 2011

Gloucestershire
COUNTY COUNCIL

ANNEX 1: Records of past floods and their significant consequences (preliminary assessment report spreadsheet)

Field:	Flood ID	Summary description	Name of Location	National Grid Reference	Location Description	Start date
Mandatory / optional:	**Mandatory**	**Mandatory**	**Mandatory**	**Mandatory**	Optional	Optional for first cycle
Format:	Unique number between 1-9999	Max 5,000 characters	Max 250 characters	12 characters: 2 letters, 10 numbers	Max 250 characters	'yyyy' or 'yyyy-mm' or 'yyyy-mm-dd'
Notes:	A sequential number starting at 1 and incrementing by 1 for each record.	Description of the flood and its adverse or potentially adverse consequences. Where available, information from other fields (Start date, Days duration, Probability, Main source, Main mechanism, Main characteristics, Significant consequences) should be repeated here.	Name of the locality associated with the flood, using recognised postal address names such as streets, towns, counties. If the flood affected the whole LLFA, then record the name of the LLFA.	National Grid Reference of the centroid (centre point, falls within polygon) of the flood extent, or of the area affected if there is no extent information.	A description of the general location that was flooded.	The date when the flood commenced - when land not normally covered by water became covered by water.
Example:	1	On the 14 April 1998 an intense storm system produced surface water flooding across Essex, concentrated in the west of the county. The flooding lasted about 6 hours, and 23 residential properties were recorded as suffering internal flooding, in Epping and North Weald. The surface runoff exceeded the drainage capacity in several places, and so probably had a 1 in 30 to 1 in 50 chance of occuring in any given year.	Essex	SX1234512345	Several towns and villages across west Essex	1998-04-15
Records begin here:	1	In June and July 2007 severe storm events across Gloucestershire causes widespread flooding throighout the county. . Heavy rainfall at the end of June led to flooding in some areas in Gloucestershire, both from surface water overloading the drainage systems and very high water levels in rivers and brooks. Heavier rain fell in July and on the 20th July the equivalent of two months' rain fell in 14 hours. Flooding came from numerous sources including surface runoff, rivers and watercourses, and exceedance of drainage systems (including highway and surface water drainage). The July 2007 event was estimated to have a 1 in 125 to 1 in 400 chance of occurring in any given year.	Gloucestershire		Communities across Gloucestershire	2007

Annex 1 Past floods

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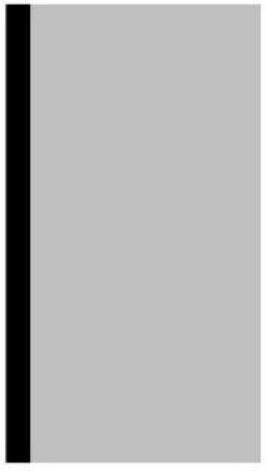

Days duration	Probability	Main source of flooding	Additional source(s) of flooding	Confidence in main source of flooding
Optional for first cycle Number with two decimal places	Optional for first cycle Max 25 characters	Optional for first cycle Pick from drop-down	Optional Max 250 characters, same source terms	Optional Pick from drop-down
The number of days (duration) of the flood - that land not normally covered by water was covered by water. Values should be within the range 0.01 - 999.99 (permitting records to the nearest quarter of an hour, where appropriate).	The chance of the flood occuring in any given year - record X from "a 1 in X chance of occurring in any given year". Where this is difficult to estimate, a range can be recorded.	Pick the source from which the majority of flooding occurred. Refer to the PFRA guidance for definitions of sources.	If flooding occurred from, or interacted with, any other sources (other than the Main source of flooding), report the source(s) here, using the same source terms.	Pick a broad level of confidence in the Main source of flooding from; 'High' (compelling evidence of source - about 80% confident that source is correct), 'Medium' (some evidence of source but not compelling - about 50% confident that source is correct) 'Low' (source assumed - about 20% confident that source is correct) or 'Unknown'.
0.25	20-50	Surface runoff		High
	125-400	Surface runoff	Main River, ordinary watercourses, exceedance of drainage systems	High

Annex 1 Past floods

Annex 1 Past floods

Annex 1 Past floods

Main mechanism of flooding	Main characteristic of flooding	Significant consequences to human health	Human health consequences - residential properties	Property count method	Other human health consequences	Significant economic consequences	Number of non-residential properties flooded	Property count method	Other economic consequences
Optional for first cycle Pick from drop-down	Optional for first cycle Pick from drop-down	Mandatory Pick from drop-down	Optional Number between 1-10,000,000	Optional Pick from drop-down	Optional Max 250 characters	Mandatory Pick from drop-down	Optional Number between 1-10,000,000	Optional Pick from drop-down	Optional Max 250 characters
Pick a mechanism from; 'Natural exceedance' (of capacity), 'Defence exceedance' (floodwater overtopping defences), 'Failure' (of natural or artificial defences or infrastructure, or of pumping), 'Blockage or restriction' (natural or artificial blockage or restriction of a conveyance channel or system), or 'No data'.	Pick a characteristic from; 'Flash flood' (rises and falls quite rapidly with little or no advance warning), 'Natural flood' (due to significant precipitation, at a slower rate than a flash flood), 'Snow melt flood' (due to rapid snow melt), 'Debris flow' (conveying a high degree of debris), or 'No data'. Most UK floods are 'Natural floods'.	Were there any significant consequences to human health when the flood occurred, or would there be if it were to re-occur?	Record the number of residential properties where the building structure was affected either internally or externally by the flood, or that would be so affected if the flood were to re-occur.	Where residential or non-residential properties have been counted, it is important to record the method of counting, to aid comparisons between counts. Choose from; 'Detailed GIS' (using property outlines, as per Environment Agency guidance), 'Simple GIS' (using property points), 'Estimate from map', or 'Observed number'.	If there were other Significant consequences to human health, describe them including information such as the number of critical services flooded.	Were there any significant economic consequences when the flood occurred, or would there be if it were to re-occur?	Record the number of non-residential properties where the building structure was affected either internally or externally by the flood, or that would be so affected if the flood were to re-occur.	Where residential or non-residential properties have been counted, it is important to record the method of counting, to aid comparisons between counts. Choose from; 'Detailed GIS' (using property outlines, as per Environment Agency guidance), 'Simple GIS' (using property points), 'Estimate from map', or 'Observed number'.	If there were other Significant economic consequences, describe them including information such as the area of agricultural land flooded, length of roads and rail flooded.
Natural exceedance	Natural flood	Yes	23	Observed number		No			
Natural exceedance	Natural flood	Yes	>5000	Observed number	Mythe treatment works flooded - 135,000 homes without water for up to 17 days. 48,000 homes without electricity for 2 days.	Yes	>500	Observed number	Gloucester and Cheltenham train stations flooded. 10,000 people stranded on M5 overnight.

Annex 1 Past floods

Annex 1 Past floods

Annex 1 Past floods

Significant consequences to the environment	Environment consequences	**Significant consequences to cultural heritage**	Cultural heritage consequences
Mandatory Pick from drop-down	Optional Max 250 characters	**Mandatory** Pick from drop-down	Optional Max 250 characters
Were there any significant consequences to the environment when the flood occurred, or would there be if it were to re-occur?	If there were Significant consequences to the environment, describe them including information such as national and international designated sites flooded, and pollution sources flooded.	Were there any significant consequences to cultural heritage when the flood occurred, or would there be if it were to re-occur?	If there were Significant consequences to cultural heritage, describe them including information such as the number and type of heritage assets flooded.
No		No	

No	No