Flood Risk Assessment

St Georges Chapel, Round Close Road, Adderbury, Banbury, OX17 3EP

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Site Location: St Georges Chapel, Round Close Road, Adderbury, Banbury, OX17 3EP

Proposed Development: It is understood that the development is for the demolition of the existing chapel and construction of a new residential dwelling.

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Contents

1. Summary **1**

2. Policy Compliance **3**

3. Development Description and Site Area **4**

Proposed Development and Location *4*

Vulnerability Classification *5*

Geology *5*

4. Site Flood Hazards **6**

Sources of Flooding *6*

Fluvial *6*

Surface Water (Pluvial) *7*

Groundwater *10*

Sewer *11*

Surface Water Drainage Strategy *12*

Records of Historical Flooding *12*

5. SUDS Assessment **13**

6. Surface Water Drainage Strategy **16**

Runoff rates *16*

Drainage Strategy *17*

Attenuation *17*

Design Exceedance *17*

Water Quality *18*

Adoption and Maintenance *18*

7. Conclusion **19**

Appendix I - Site Plans

Appendix II - EA Data

Appendix III - Calculations

1. Summary

1.1 Ambiental Environmental Assessment has been appointed to undertake a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment (FRA) for the proposed development at St Georges Chapel, Round Close Road, Adderbury, Banbury, OX17 3EP.

1.2 The site is currently a chapel. It is understood that the development is for the demolition of the existing chapel and construction of a new residential dwelling.

1.3 With reference to the Environment Agency (EA) Flood Map for Planning, the proposed development is located within Flood Zone 1. The proposed development is considered 'More Vulnerable' under the National Planning Policy Framework (NPPF).

1.4 The site has a small watercourse passing through it and the nearby town of Adderbury has experienced severe flooding in the past. Therefore, in accordance with the Cherwell District Council Adopted Local Plan 2011-2031 and the National Planning Policy Framework (NPPF), the proposed development requires a flood risk assessment to accompany its planning application.

1.5 The EA Flood Map for Planning data and LiDAR data indicate that the edges of Flood Zones 2 and 3 are elevated at approximately 87.8mAOD, whilst the site has an elevation between approximately 89.34mAOD and 90.08mAOD, more than 1 metre higher than the edge of the Flood Zones. Using this evidence, it can be concluded that the site is at low risk of fluvial flooding.

1.6 Following the SuDS drainage hierarchy, infiltration has been considered. Based on desktop geology information, infiltration techniques could be viable at the site, however no site-specific ground investigations have been undertaken to determine a soakage rate or groundwater levels.

1.7 The next alternative option in the hierarchy above is to discharge runoff into surface waters (ditch/watercourse/waterbody). There is an adjacent ordinary water course that runs through the site and the existing building currently drains into the watercourse. Therefore, it is proposed to reuse this method of surface water runoff post-development.

1.8 The roof areas currently drain at an unrestricted rate into the adjacent watercourse. The existing runoff from the roof areas are positively drained; consequently, a reduction in the peak rate of surface water discharge will reduce the risk of flooding locally, providing betterment compared to the existing situation.

1.9 The existing site is brownfield and currently drains unrestricted to the adjacent watercourse. It is impractical to provide large amounts of storage given the size of the site and relatively low existing runoff rates. Therefore, an orifice plate 0.02m in diameter has been used as a primary method of flow control. This would result in a discharge rate below 1l/s for all storms up to the 1:100+40%CC event.

1.10 The proposal is to provide permeable paving across the hardstanding/driveway area adjacent to the proposed building. The permeable paving would be required to provide 9.2m^3 of storage in the subbase. The total plan area for the permeable paving is approximately 100m^2 and the required depth is approximately 400mm. The subbase should be laid flat to maximise storage.

1.11 The runoff from parts of the trafficked areas of the proposed site is to be treated through permeable paving. Analysis of the Mitigation Indices of the proposed SuDS techniques shows water treatment provided by the permeable pavement is sufficient to remove the pollutants.

1.12 Runoff from the roof hardstanding areas is considered to generally be uncontaminated. However, to prevent any potential sediment from impacting on the storage structure, sediment traps should be provided on the underground drainage at suitable locations to prevent sedimentation.

1.13 All onsite SuDS and drainage systems will be privately maintained. A long-term maintenance regime should be agreed with the site owners before adoption. In addition to a long-term maintenance regime, it is recommended that all drainage elements implemented on site should be inspected following the first rainfall event post construction and monthly for the first quarter following construction

Following the guidelines contained within the NPPF, the proposed development is considered to be suitable assuming appropriate mitigation (including adequate warning procedures) can be maintained for the lifetime of the development.

2. Policy Compliance

2.1 The proposed development site is located in Flood Zone 1, which is the zone of lowest flood risk, as defined by the Environment Agency (EA).

2.2 The site has a small watercourse passing through it and the nearby town of Adderbury has experienced severe flooding in the past.

2.3 The Cherwell District Council Adopted Local Plan 2011-2031 states in Policy ESD 6 that site-specific flood risk assessments are required to accompany development proposals for development sites located within 9m of any watercourses. In accordance with this policy, the proposed development must have a flood risk assessment to accompany its planning application, as a small watercourse/drain passes directly through the site.

2.4 The Oxfordshire LLFA Local Standard and Guidance for Surface Water Drainage (2018) and the Ciria SuDS manual advises that runoff rates should be limited to greenfield runoff rates or as close as possible and states the following:

‘Brownfield sites are strongly encouraged to discharge at the greenfield rate wherever possible. Where proven that greenfield rates cannot be achieved the best discharge rate needs to be quantified. As a minimum, brownfield sites should reduce the discharge by 40% to account for the impacts of climate change, from the existing site runoff OR from the original un-surcharged pipe-full capacity of the existing system, whichever is the lowest.’

2.5 In accordance with the National Planning Policy Framework (NPPF), this site requires a site-specific flood risk assessment, to identify flood risks posed to the development and set out proposed measures to mitigate those risks.

3. Development Description and Site Area

Proposed Development and Location

3.1 The proposed development is located at St Georges Chapel, Round Close Road, Adderbury, Banbury, OX17 3EP (Figure 1 and Figure 2).

3.2 The site is currently a chapel. It is understood that the proposed development is for the demolition of the existing chapel and construction of a new residential dwelling.

3.3 Elevations on site vary between approximately 89.34mAOD and 90.08mAOD (2m LiDAR data).

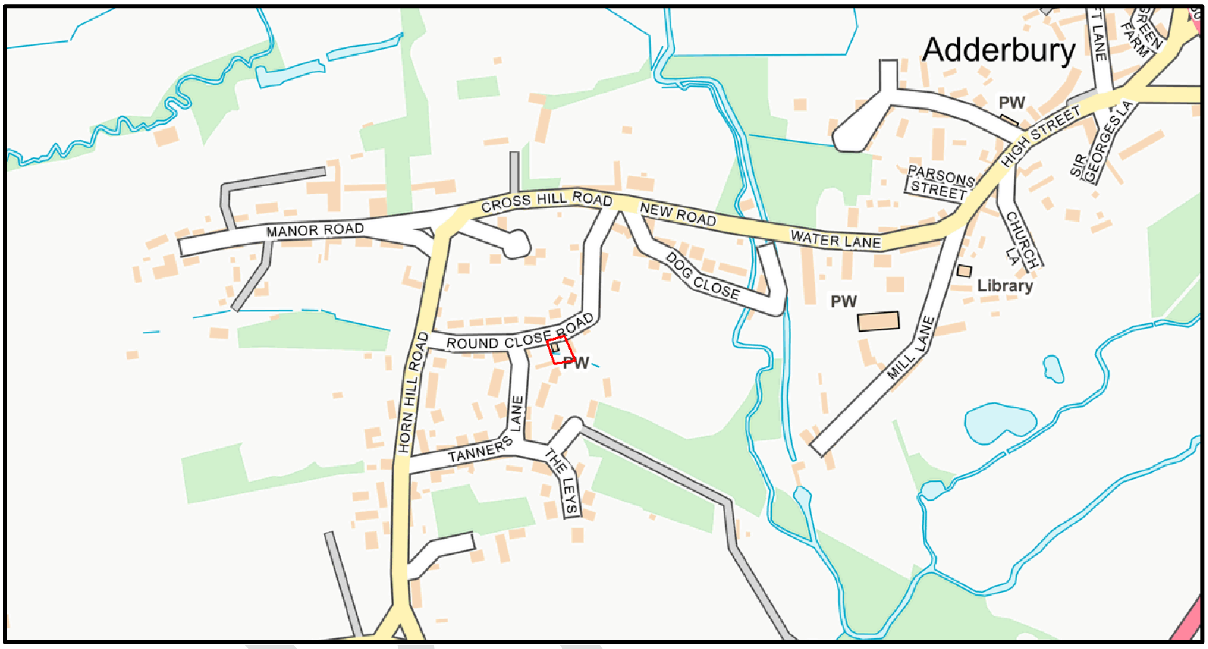

Figure 1 Location Map, identifying the location of the proposed development (Source: OS)

Figure 2 Aerial Imagery: identifying the location of the proposed development (Source: GlobalMapper)

Vulnerability Classification

3.4 The EA Flood Map for Planning (Figure 3) demonstrates that the proposed development lies within Fluvial Flood Zone 1 with a low probability of less than 1 in 1,000 (0.1%) of river flooding in any year. The EA Flood Map for Planning also indicates that the site location is situated very close to EA Main Rivers and to areas located within Flood Zone 3.

3.5 Whilst the map shows that the site is situated within Flood Zone 1 and at the lowest risk of flooding, there is a partially open and partially culverted watercourse that passes directly through the site, which could be a potential source of flooding.

3.6 Under the principles of NPPF, the proposed development is 'More Vulnerable', as it is a residential building, and the existing building is ‘Less Vulnerable’. This demonstrates an increase in the level of flood risk vulnerability to the site. Also, with this change of use from a chapel to a residential dwelling, the number of occupants residing at the property will increase.

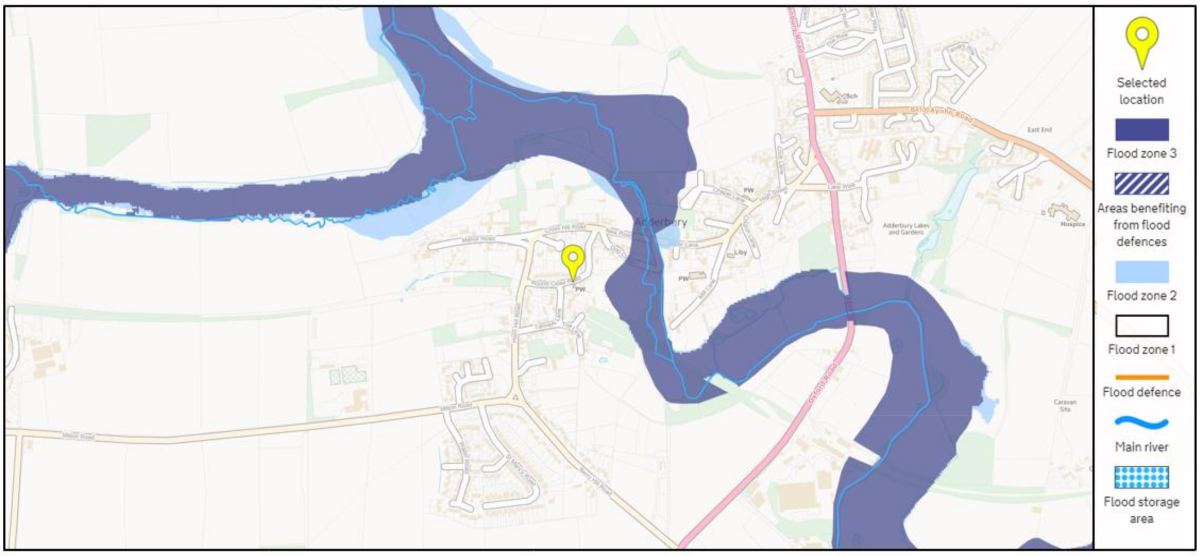

Figure 3 EA Flood Map for Planning (Source: EA)

Geology

3.7 The British Geological Survey (BGS) Geology of Britain Viewer indicates that the bedrock underlying the site is the Dyrham Formation, comprising interbedded Siltstone and Mudstone. This formation is considered to be a Secondary undifferentiated aquifer (Source: Magic Map online resource). A Secondary undifferentiated aquifer is permeable, supporting water supplies at a local scale and may contribute to base flow of rivers and/or low permeability but with limited groundwater available in fissures or thin geological horizons.

3.8 The BGS Geology of Britain Viewer indicates that there are no records for superficial deposits underlying the site.

3.9 The site is not within an EA groundwater Source Protection Zone.

4.

4. Site Flood Hazards

Sources of Flooding

4.1 The proposed development is located within Flood Zone 1 (low risk of flooding) and is considered to be 'More Vulnerable' according to NPPF guidelines. Table 1 summarises the potential sources of flooding to the site:

Source	Description
Fluvial/Tidal	N/A – Flood Zone 1
Surface	On site
Groundwater	Low risk
Sewer	Low risk

Table 1 Summary of flood sources.

Fluvial

4.2 A partially open and partially culverted watercourse is present on the site. Sor Brook (EA Main River), is located approximately 170m east of the development site. Bloxham Brook (EA Main River) is located approximately 420m north-west of the site.

4.3 The EA Flood Map for Planning (Figure 3) demonstrates that the proposed development lies within Flood Zone 1 with a low probability of less than 1 in 1,000 (0.1%) of flooding from rivers or seas in any year. The site is located approximately 60m west of the nearest Flood Zone 2 and 3 area.

4.4 After reviewing the EA Flood Map for Planning data and LiDAR, the data illustrates that the edges of Flood Zones 2 and 3 are elevated at approximately 87.8mAOD and the site has an elevation between approximately 89.34mAOD and 90.08mAOD, more than 1 metre higher than the edge of the Flood Zones. This is shown in Figure 4 below. Using this evidence, it can be concluded that the site is at low risk of fluvial flooding. This is supported by the EA flood mapping, which also indicates that the site is at a low risk of fluvial flooding.

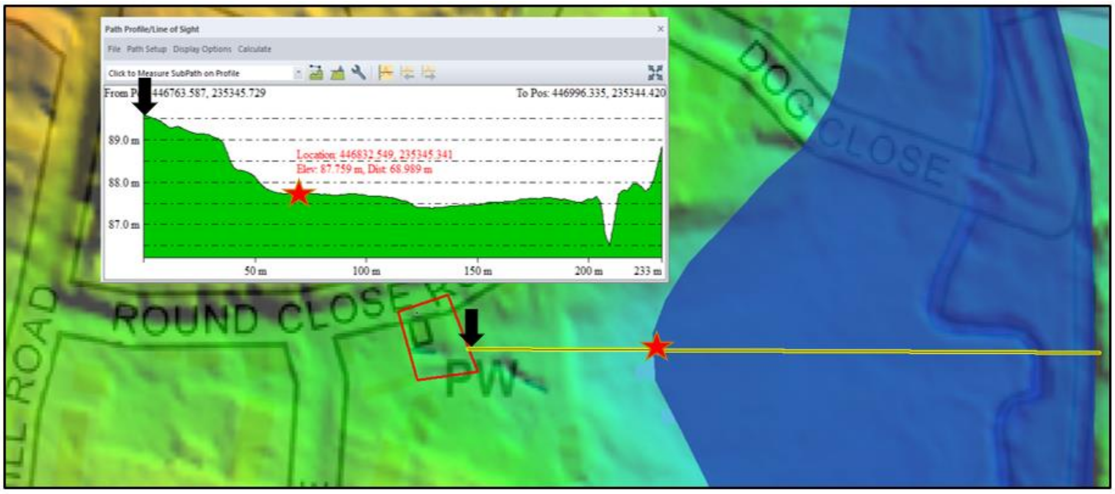

Figure 4 Elevations of site boundary and flood zone boundary, where black arrow indicates the site boundary and red star indicates edge of flood zones 2 and 3

Surface Water (Pluvial)

4.5 The Environment Agency Flood Risk from Surface Water map (Figure 5) shows that the majority of the proposed development is within an area of 'Low' risk of flooding from surface water. The south-eastern part of the site is within an area of 'Medium' risk of flooding from surface water, whilst Round Close Road at the entrance/exit of the site is within an area of 'High' risk of flooding from surface water. Areas identified to be at 'Low' risk have a 0.1% to 1% annual risk of flooding from this source. Areas identified to be at 'Medium' risk have a 1% to 3.3% annual risk of flooding from this source. Areas identified to be at 'High' risk have a greater than 3.3% annual risk of flooding from this source.

4.6 The EA Surface Water Flood Depth Map for the High Risk Scenario (Figure 6) indicates that the proposed development is not affected in this event. However, Round Close Road at the entrance/exit of the site may experience flood depths of less than 300mm in this event. A Low Risk Scenario has a 0.1% to 1% annual risk of occurring.

4.7 The EA Surface Water Flood Depth Map for the Medium Risk Scenario (Figure 7) indicates that the proposed development may experience flood depths of less than 300mm in this event, mainly in the south-eastern part of the site and on Round Close Road at the entrance/exit. A Medium Risk Scenario has a 1% to 3.3% annual risk of occurring.

4.8 The EA Surface Water Flood Depth Map for the Low Risk Scenario (Figure 8) indicates that the majority of the proposed development may experience flood depths below 300mm, whilst the south-eastern part close to the watercourse/drain and Round Close Road at the entrance/exit may experience flood depths from 300mm to 900mm in this event. A Low Risk Scenario has a 0.1% to 1% annual risk of occurring.

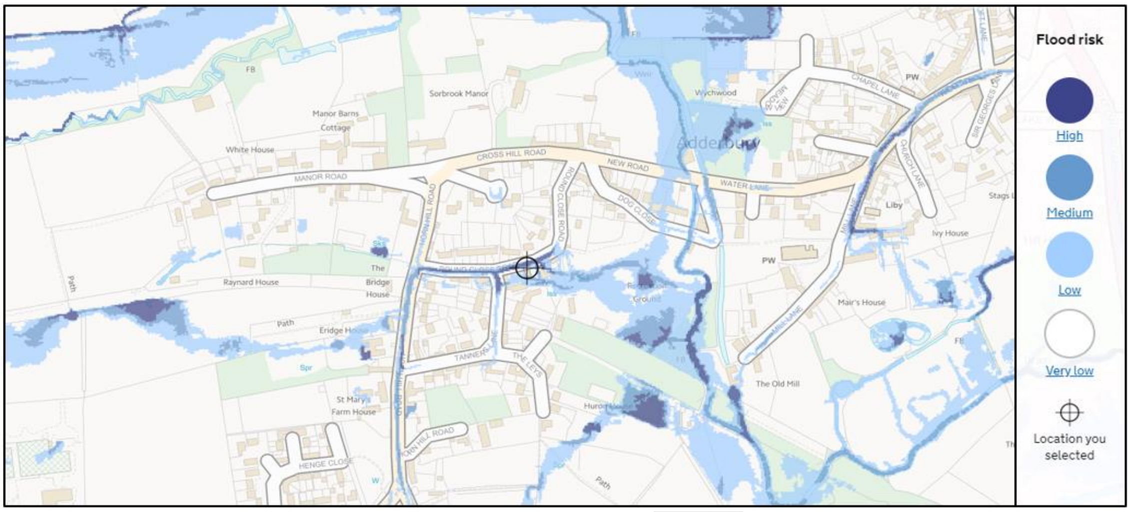

Figure 5 EA Surface Water Flood Risk Map. (Source: EA)

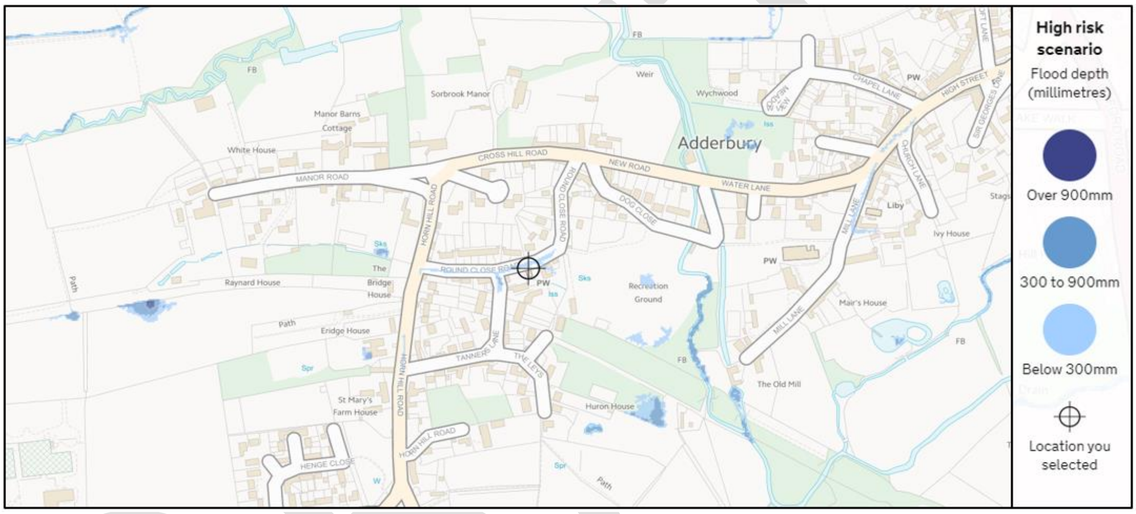

Figure 6 Surface Water Depths for a High Risk Scenario. (Source: EA)

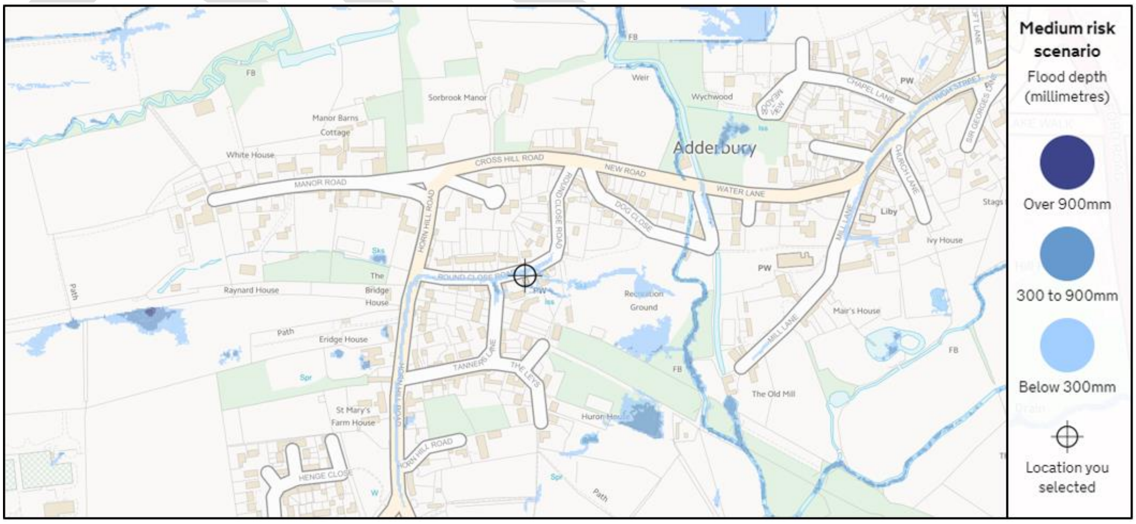

Figure 7 Surface Water Depths for a Medium Risk Scenario. (Source: EA)

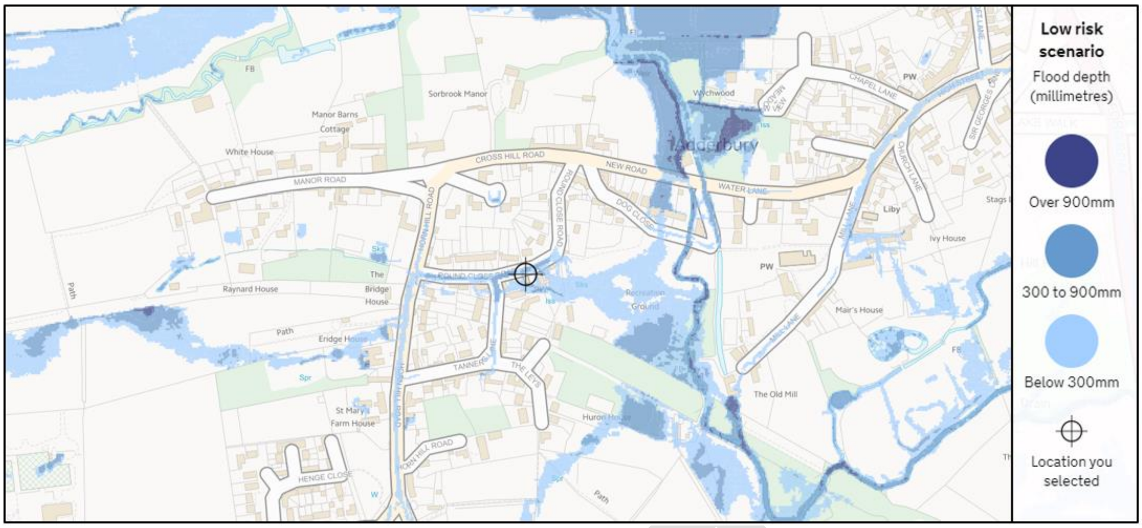

Figure 8 Surface Water Depths for a Low Risk Scenario. (Source: EA)

4.9 The Risk of Flooding from Surface Water (RoFSW) map, during a 1 in 30 year event, indicates that the majority of the site would remain unaffected by this event (Figure 9). Round Close Road could experience a flood depth up to 0.30m.

4.10 The RoFSW map, during a 1 in 100 year event, indicates that the site could experience flood depths up to 0.60m (Figure 10). The site may experience flood depths up to 0.30m, around the boundaries of the site, and there may also be some flooding where the drain/watercourse passes through, at a maximum depth of 0.60m. Also, Round Close Road could experience flood depths up to 0.30m.

4.11 The RoFSW map, during a 1 in 1000 year event, indicates that the majority of the proposed site could experience surface water flooding, up to flood depths of 0.60m (Figure 11). The entire garden could experience flooding, with the highest depths being around the drain/watercourse. Also, Round Close Road could experience depths up to 0.60m.

4.12 Overall, the risk of flooding from surface water sources to the proposed development could be considered **moderate**.

Figure 9 Risk of Flooding from Surface Water, 1 in 30 year

Figure 10 Risk of Flooding from Surface Water, 1 in 100 year

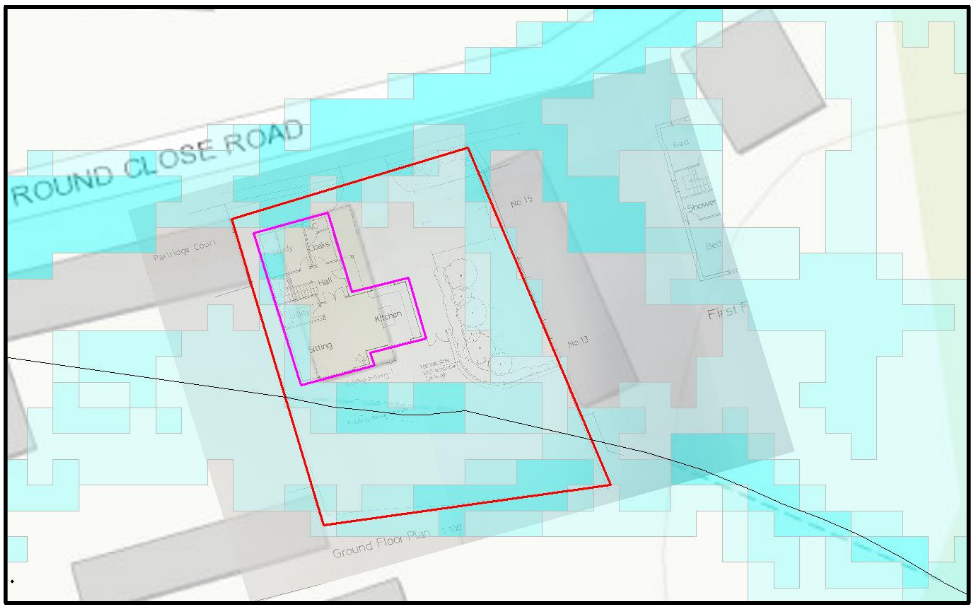

Figure 11 Risk of Flooding from Surface Water, 1 in 1000 year

Groundwater

4.13 The Cherwell Level 1 SFRA 2017 Update indicates that the proposed development site is located within a 1km grid square of which 25-50% is considered susceptible to groundwater flooding (Figure 12).

4.14 The site is not within an EA groundwater Source Protection Zone.

4.15 Thus, it can be considered that the proposed development site is at a **relatively low to moderate** risk of flooding from groundwater sources.

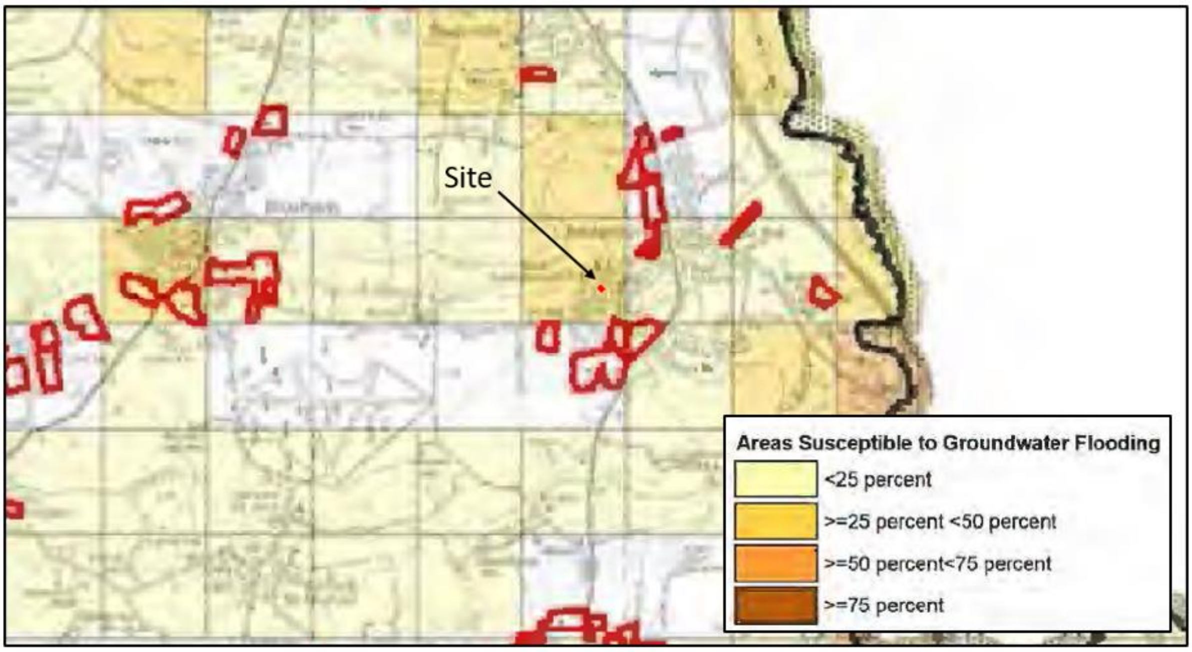

Figure 12 Groundwater Susceptibility (Source: Cherwell SFRA 2017)

Sewer

4.16 The Cherwell Level 1 SFRA 2017 Update maps records sewer flooding by postcode areas. The proposed development site is located within an area that has been affected by a total of 5 to 10 sewer flooding incidents, according to DG5 records (Figure 13).

4.17 No records could be found to indicate historical sewer flooding at the proposed development site or within its immediate vicinity.

4.18 Therefore, the risk of flooding from sewer sources could be considered **low**.

4.19 Any new sewer connection from the site should be agreed with the local sewer provider and fitted with non-return valves to mitigate the risk of sewer flooding.

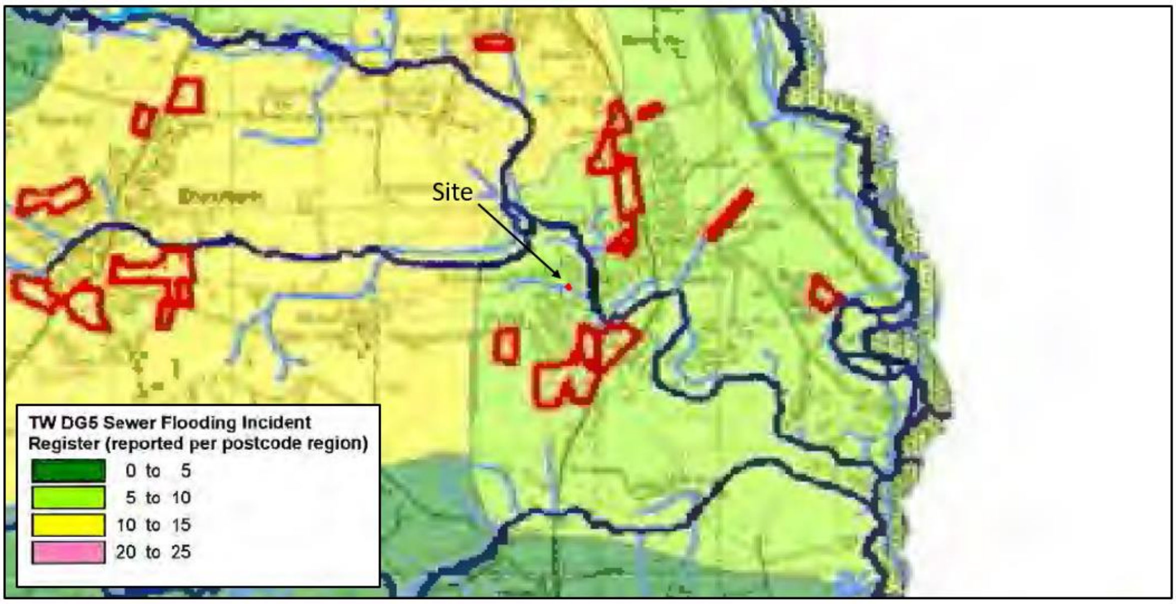

Figure 13 Sewer. (Source: SFRA, based on DG5 Register)

Records of Historical Flooding

4.20 The Cherwell Level 1 SFRA 2017 Update maps records sewer flooding by postcode areas. The proposed development site is located within an area that has been affected by a total of 5 to 10 sewer flooding incidents, according to DG5 records (Figure 13).

4.21 The EA Recorded Flood Outlines dataset indicates that there were several large flooding events that affected areas close to the site location. When compared with the EA Flood Map for Planning dataset, the EA Recorded Flood Outlines mainly corresponded with Flood Zones 2 and 3.

4.22 The Cherwell Level 1 SFRA 2017 provides information on flood history within the Cherwell District and shows records of flooding events that affected areas within the township of Adderbury.

4.23 There are no records of previous flooding at the proposed development site.

5. SUDS Assessment

5.1 In accordance with the SuDS management train approach, the use of various SuDS measures to reduce and control surface water flows have been considered in detail for the development.

5.2 The management of surface water has been considered in respect to the SuDS hierarchy (below) (as detailed in the *CIRIA 753 'The SUDS Manual', Section 3.2.3)*:

SuDS Drainage Hierarchy				
			Suitability	**Comment**
	1.	Infiltration	✓/x (to be confirmed)	Potentially viable, however given the proximity of the adjacent watercourse, the groundwater levels are currently unknown
	2.	Discharge to Surface Waters	✓	Existing connection from building into adjacent watercourse. Proposed to reuse this connection
	3.	Discharge to Surface Water Sewer, Highway Drain or another Drainage System	-	Proposed reuse of existing connection to adjacent watercourse is a preferred option in the drainage hierarchy compared to discharge to surface water sewer
	4.	Discharge to Combined Sewer	-	Proposed reuse of existing connection to adjacent watercourse is a preferred option in the drainage hierarchy, compared to discharge to combined sewer
	5.	Discharge to a foul sewer (should not be considered as a possible option)	-	Proposed reuse of existing connection to adjacent watercourse is a preferred option in the drainage hierarchy, compared to discharge to foul sewer

Table 2 SuDS Hierarchy

5.3 Following the SuDS drainage hierarchy, infiltration has been considered. Based on desktop geology information infiltration techniques could be viable at the site, however no site-specific ground investigations have been undertaken to determine a soakage rate or groundwater levels.

5.4 The next alternative option in the hierarchy above is to discharge runoff into surface waters (ditch/watercourse/waterbody). There is an adjacent ordinary water course that runs through the site and the existing building currently drains into the watercourse. Therefore, it is proposed to reuse this method of surface water runoff post-development.

5.5 The suitability of SuDS components has been assessed in order to provide a sustainable means of providing the required attenuation volumes. The following components have been assessed as in the below table:

Suitability of SuDS Components		
SuDS Component	Description	Suitability
Infiltrating SuDS	Infiltration can contribute to reducing runoff rates and volumes while supporting baseflow and groundwater recharge processes. The suitability and infiltration rate depends on the permeability of the surrounding soils	x
Permeable Pavement	Pervious surfaces can be used in combination with aggregate sub-base and/or geocellular/modular storage to attenuate and/or infiltrate runoff from surrounding surfaces and roofs. Liners can be used where ground conditions are not suitable for infiltration	✓
Green / Blue Roofs	Green Roofs provide areas of visual benefit, ecological value, enhanced building performance and the reduction of surface water runoff. They are generally more costly to install and maintain than conventional roofs but can provide many long-term benefits and reduce the on-site storage volumes. Blue roofs provide additional attenuation by storing the rainwater in crates located in the roof structure. Runoff from these structures can be reduced significantly using small orifice devices due to the low risk of blockage.	x
Rainwater Harvesting	Rainwater Harvesting is the collection of rainwater runoff for use. It can be collected form roofs or other impermeable area, stored, treated (where required) and then used as a supply of water for domestic, commercial and industrial properties	✓
Swales	Swales are designed to convey, treat and attenuate surface water runoff and provide aesthetic and biodiversity benefits. They can replace conventional pipework as a means of conveying runoff, however space constraints of some sites can make it difficult incorporating them into the design	x
Rills and Channels	Rills and Channels keep runoff on the surface and convey runoff along the surface to downstream SuDS components. They can be incorporated into the design to provide a visually appealing method of conveyance, they also provide effectiveness in pre-treatment removal of silts	x
Bioretention Systems	Bioretention systems can reduce runoff rates and volumes and treat pollution through the use of engineer soils and vegetation. They are particularly effective in delivering interception, but can also be an attractive landscape feature whilst providing habitat and biodiversity	x
Retention Ponds and Wetlands	Ponds and Wetlands are features with a permanent pool of water that provide both attenuation and treatment of surface water runoff. They enhance treatment processes and have great amenity and biodiversity benefits. Often a flow control system at the outfall controls the rates of discharge for a range of water levels during storm events	x
Detention Basins	Detention Basins are landscaped depressions that are usually dry except during and immediately following storm events, and can be used as a recreational or other amenity facility. They generally appropriate to manage high volumes of surface water from larger sites such as a neighbourhoods	x
Geocellular Systems	Attenuation storage tanks are used to create a below-ground void space for the temporary storage of surface water before infiltration, controlled release or use. The inherent flexibility in size and shape means they can be tailored to suit the specific characteristics and requirements of any site	if required could be implemented
Proprietary Treatment Systems	Proprietary treatment systems are manufactured products that remove specific pollutants from surface water runoff. They are especially useful where site constraints preclude the use of other methods and can be useful in reducing the maintenance requirements of downstream SuDS	x
Filter Drains and Filter Strips	Filter drains are shallow trenches filled with stone, gravel that cerate temporary subsurface storage for the attenuation, conveyance and filtration of surface water runoff. Filter strips are uniformly graded and gently sloping strips of grass or dense vegetation, designed to treat runoff from adjacent impermeable areas by promoting sedimentation, filtration and infiltration	x

Table 3: Suitability of SuDS Components

5.6 Permeable paving would be suitable for use across the site. The permeable paving would be a type C lined system to provide attenuation prior to outfall to the watercourse. Permeable paving would provide treatment to the remaining hardstanding areas around the site and provide adequate treatment to mitigate against pollutants entering the watercourse.

5.7 Large scale SuDS devices such as swales, ponds, wetland and detention basins have been discounted on this site as they require large land take. These types of SuDS are better suited to large residential developments.

5.8 As such, permeable pavement is deemed the most suitable form of SUDs for the site.

6. Surface Water Drainage Strategy

6.1 In order to mitigate flood risk posed by the proposed development, adequate control measures are required to be considered. This will ensure that surface water runoff is dealt with at source and the flood risk on/off site is not increased over the lifetime of the development.

Runoff rates

6.2 Greenfield runoff rates have been calculated using Micro Drainage Software and applying the *Institute of Hydrology Report 124* (Marshall and Bayliss, 1994), as recommended in *CIRIA 753 'The SUDS Manual'* for calculating the greenfield runoff rates. *Calculations are included in Appendix 3.*

6.3 In addition, the existing brownfield runoff rates have also been calculated using a network simulation in Micro Drainage (see Table 4 below and Appendix 3).

6.4 The existing site has a curtilage of approximately 240m^2. The existing building is approximately 90m^2 and post development, the built footprint would be approximately 90m^2. Post development it is recommended that approximately 100m^2 permeable paving is adopted for the driveway area.

SURFACE WATER DISCHARGE RATES SUMMARY					
Impermeable Area (m^2)			**Discharge Rates (l/s)**		
		Q_{BAR}	**1 year**	**30 year**	**100 year**
Greenfield	240	0.0	0.01	0.03	0.03
Existing Brownfield	90		1.3	3.3	4.3
Limiting Runoff (greenfield)[1]	196		0.098	0.025	0.025

Table 4: Runoff rates

6.5 The Oxfordshire LLFA Local Standard and Guidance for Surface Water Drainage (2018) and the Ciria SuDS manual advises that runoff rates should be limited to greenfield runoff rates or as close as possible and states the following:

'Brownfield sites are strongly encouraged to discharge at the greenfield rate wherever possible. Where proven that greenfield rates cannot be achieved the best discharge rate needs to be quantified. As a minimum, brownfield sites should reduce the discharge by 40% to account for the impacts of climate change, from the existing site runoff OR from the original un-surcharged pipe-full capacity of the existing system, whichever is the lowest.

It is understood that some guidance recommends minimum discharge rates of 5 l/s, to minimise use of small orifice openings that could be at risk of blockages. However, appropriate consideration of filtration features to remove suspended matter and suitable maintenance regimes should minimise this risk and therefore the minimum limit of 5l/s ***does not*** *apply in Oxfordshire.'*

6.6 The roof areas currently drain at an unrestricted rate into the adjacent watercourse. The existing runoff from the roof areas are therefore positively drained, consequently, a reduction in the peak rate of surface water discharge will reduce the risk of flooding locally, providing betterment compared to the existing situation.

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[1] Greenfield rate scaled to post-development 'green' area of 44m^2

6.7 The existing site is brownfield and currently drains unrestricted to the adjacent watercourse. It is impractical to provide large amounts of storage given the size of the site and relatively low existing runoff rates (Table 4). Therefore, an orifice plate 0.02m in diameter is recommended as a primary method of flow control. This would result in a discharge rate below 1l/s for all storms up to the 1:100+40%CC event.

Drainage Strategy

6.8 Runoff from the whole site, including the roofs and the hardstanding surfaces on site would be directed to a system comprising permeable pavement.

6.9 The proposal is to provide permeable pavement across the hardstanding/driveway area adjacent to the proposed building. The permeable paving would be required to provide 9.2m^3 of storage in the subbase. The total plan area for the permeable paving is approximately 100m^2 and the required depth is approximately 400mm. The subbase should be laid flat to maximise storage.

6.10 A Microdrainage model has been constructed to demonstrate the hydraulic behaviour of the proposed drainage network, showing the site to not be flooded for all events up to and including 1:100 +40% climate change. Full details of the results can be found in Appendix III.

6.11 Areas of hardstanding could either be laid to direct runoff towards areas of permeable paving or directed towards the sub-base through gullies or ACO drains. If drained through ACO drains or gullies, the runoff would need to be treated prior to entering the sub-base.

6.12 Runoff from the roof is to be treated through sediment traps prior to outflow. This would reduce the risk of silting in the tank and blockage of the flow control device.

6.13 Runoff from the hardstanding surfaces (including trafficked areas) would be treated through the proposed permeable pavement. This would both filter the runoff and provide hydrocarbon treatment.

6.14 An orifice plate 0.02m in diameter has been used as a primary method of flow control. The invert level of the outfall has not been provided; therefore, the permeable paving has been kept as shallow as possible.

6.15 The client has confirmed that the existing building currently drains into the adjacent ordinary watercourse. It is proposed to reuse this outfall post-development. The connection should be agreed with the LLFA prior to construction.

Attenuation

6.16 Surface water attenuation is needed to temporarily store water during periods when the runoff rates from the development site exceed the infiltration rates or the allowable discharge rates from the site.

6.17 Rainfall depths for the 1 in 100 years return period plus 40% of CC were produced using MicroDrainage software to estimate the largest volume, critical storm, for typical storm durations. A network model has been implemented to simulate the proposed drainage network and storage devices.

6.18 The total attenuation storage volume required for the site is 9.2m^3. The critical storm is the 180min winter event.

Design Exceedance

6.19 In the event of drainage system failure under extreme rainfall events or blockage, flooding may occur within the site. In the event of the development's drainage system failure, the runoff direction will be dictated by topography on site.

6.20 A topographic survey of the site has shown the levels to be relatively flat. It is recommended to lay new hardstanding to fall away from the proposed entry points into the new dwelling to reduce the risk of flooding due to overland flows.

6.21 It is advised that the finished floor level of the proposed building should be 150mm above external ground level to ensure that water runoff would not impact on the building in the event of drainage system failure, extreme rainfall events or blockage.

Water Quality

6.22 The proposal is to discharge all runoff to the watercourse. As such, it is important to provide suitable water quality treatment, at source to minimise the overall impact on the sewerage network.

6.23 Adequate treatment must be delivered to the surface water runoff to remove pollutants through SuDS devices, which are able to provide pollution mitigation. Pollution Hazards and the SuDS Mitigation have been indexed in the specialized literature *CIRIA 753 'The SUDS Manual'*.

POLLUTION HAZARD INDICES FOR DIFFERENT LAND USE CLASSIFICATIONS				
LAND USE	Pollution Hazard Level	Total suspended Solids (TSS)	Metals	Hydro-carbons
Other roofs (typically commercial/industrial roofs)	Low	0.3	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (e.g cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change. i.e. <300 traffic movements/day	Low	0.5	0.4	0.4

Table 5: Summary of Pollution hazard Indices for different Land Use

6.24 The runoff from parts of the trafficked areas of the proposed site is to be treated through permeable paving. The Mitigation Indices of the proposed SuDS techniques are summarized in Table 6 below. It can be seen the water treatment provided by the permeable pavement is sufficient to remove the pollutants.

INDICATIVE SuDS MITIGATION INDICES FOR DISCHARGES TO SURFACE WATER			
SuDS Component	**Total suspended Solids (TSS)**	**Metals**	**Hydrocarbons**
Permeable Paving	0.7	0.6	0.7

Table 6: Indicative SuDS Mitigation Indices

6.25 Runoff from the roof hardstanding areas is considered to generally be uncontaminated. However, to prevent any potential sediment from impacting on the storage structure, sediment traps should be provided on the underground drainage at suitable locations to prevent sedimentation.

Adoption and Maintenance

6.26 All onsite SuDS and drainage systems will be privately maintained. A long-term maintenance regime should be agreed with the site owners before occupation. In addition to a long-term maintenance regime, it is recommended that all drainage elements implemented on site should be inspected following the first rainfall event post construction and monthly for the first quarter following construction, see Appendix 4.

6.27 The maintenance of the proposed permeable paving is to be in accordance with manufacturer's instructions.

7. Conclusion

7.1 Ambiental Environmental Assessment has been appointed to undertake a National Planning Policy Framework (NPPF) compliant Flood Risk Assessment (FRA) for the proposed development at St Georges Chapel, Round Close Road, Adderbury, Banbury, OX17 3EP.

7.2 The site is currently a chapel. It is understood that the development is for the demolition of the existing chapel and construction of a new residential dwelling.

7.3 With reference to the Environment Agency (EA) Flood Map for Planning, the proposed development is located within Flood Zone 1. The proposed development is considered 'More Vulnerable' under the National Planning Policy Framework (NPPF).

7.4 The site has a small watercourse passing through it and the nearby town of Adderbury has experienced severe flooding in the past. Therefore, in accordance with the Cherwell District Council Adopted Local Plan 2011-2031 and the National Planning Policy Framework (NPPF), the proposed development requires a flood risk assessment to accompany its planning application.

7.5 The EA Flood Map for Planning data and LiDAR data indicate that the edges of Flood Zones 2 and 3 are elevated at approximately 87.8mAOD, whilst the site has an elevation between approximately 89.34mAOD and 90.08mAOD, more than 1 metre higher than the edge of the Flood Zones. Using this evidence, it can be concluded that the site is not at risk of fluvial flooding.

7.6 Following the SuDS drainage hierarchy, infiltration has been considered. Based on desktop geology information infiltration techniques could be viable at the site, however no site-specific ground investigations have been undertaken to determine a soakage rate or groundwater levels.

7.7 The next alternative option in the hierarchy above is to discharge runoff into surface waters (ditch/watercourse/waterbody). There is an adjacent ordinary water course that runs through the site and the existing building currently drains into the watercourse. Therefore, it is proposed to reuse this method of surface water runoff post-development.

7.8 The roof areas currently drain at an unrestricted rate into the adjacent watercourse. The existing runoff from the roof areas are therefore positively drained, consequently, a reduction in the peak rate of surface water discharge will reduce the risk of flooding locally, providing betterment compared to the existing situation.

7.9 The existing site is brownfield and currently drains unrestricted to the adjacent watercourse. It is impractical to provide large amounts of storage given the size of the site and relatively low existing runoff rates. Therefore, an orifice plate 0.02m in diameter has been used as a primary method of flow control. This would result in a discharge rate below 1l/s for all storms up to the 1:100+40%CC event.

7.10 The proposal is to provide permeable across the hardstanding/driveway area adjacent to the proposed building. The permeable paving would be required to provide 9.2m^3 of storage in the subbase. The total plan area for the permeable paving is approximately 100m^2 and the required depth is approximately 400mm. The subbase should be laid flat to maximise storage.

7.11 The runoff from parts of the trafficked areas of the proposed site is to be treated through permeable paving. Analysis of the Mitigation Indices of the proposed SuDS techniques shows water treatment provided by the permeable pavement is enough to remove the pollutants.

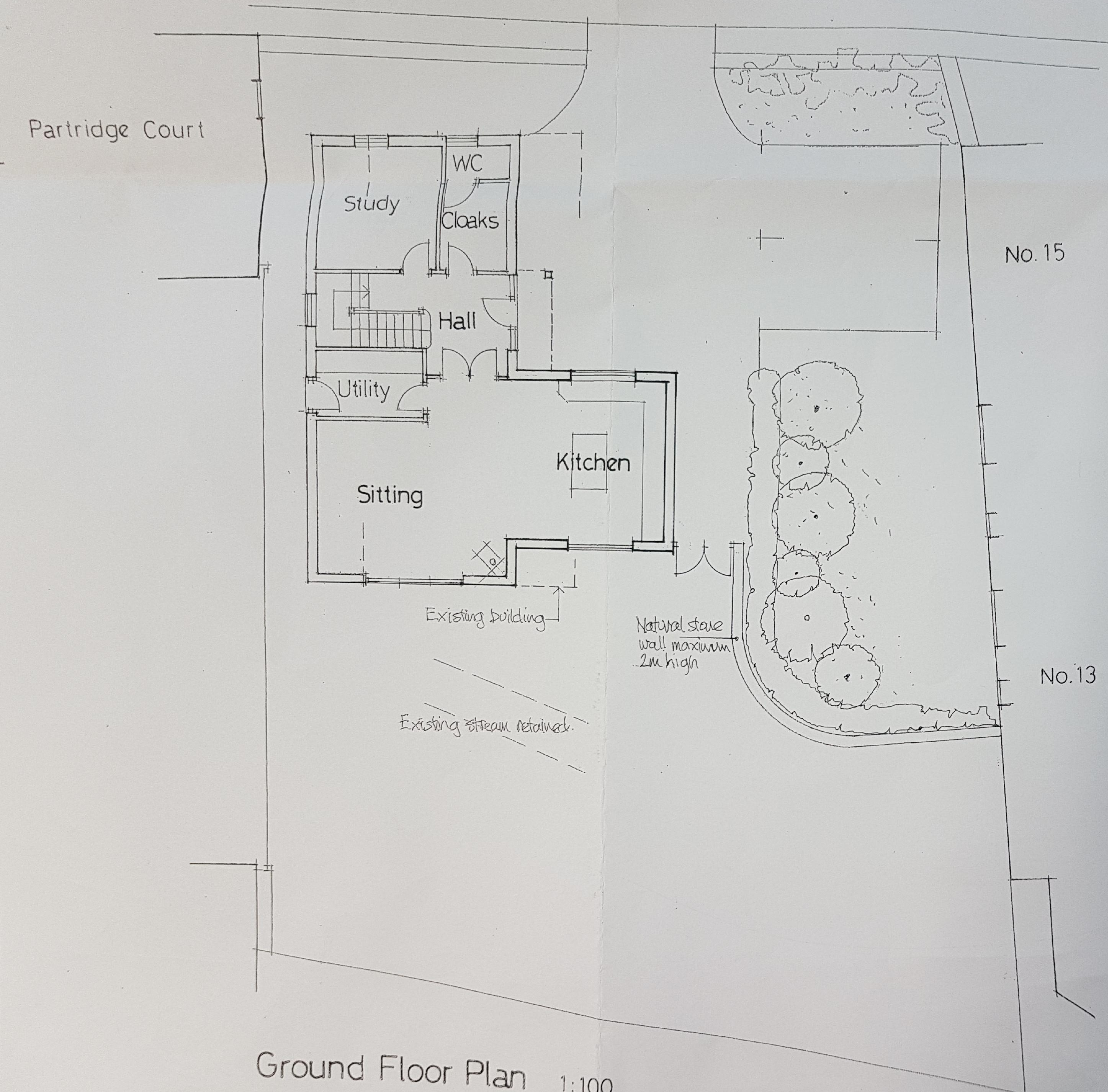
7.12 Runoff from the roof hardstanding areas is considered to generally be uncontaminated. However, to prevent any potential sediment from impacting on the storage structure, sediment traps should be provided on the underground drainage at suitable locations to prevent sedimentation.

7.13 All onsite SuDS and drainage systems will be privately maintained. A long-term maintenance regime should be agreed with the site owners before adoption. In addition to a long-term maintenance regime, it is recommended that all drainage elements implemented on site should be inspected following the first rainfall event post construction and monthly for the first quarter following construction

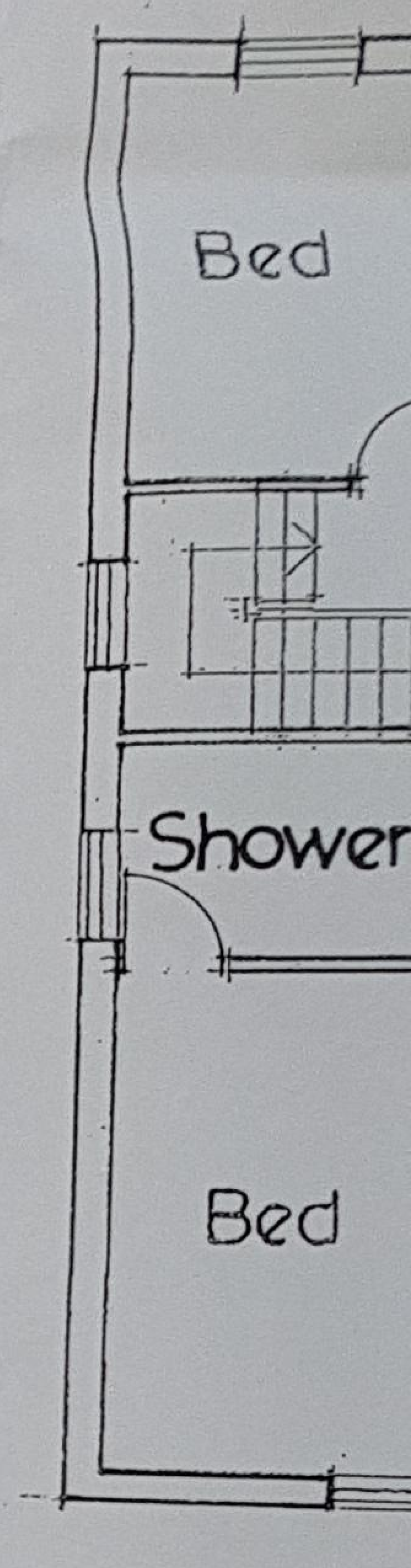
Following the guidelines contained within the NPPF, the proposed development is considered to be suitable assuming appropriate mitigation (including adequate warning procedures) can be maintained for the lifetime of the development.

Appendix I - Site Plans

Ambiental Environmental Assessment
Sussex Innovation Centre,
Science Park Square,
Brighton, BN1 9SB



Ground Floor Plan 1:100



First F

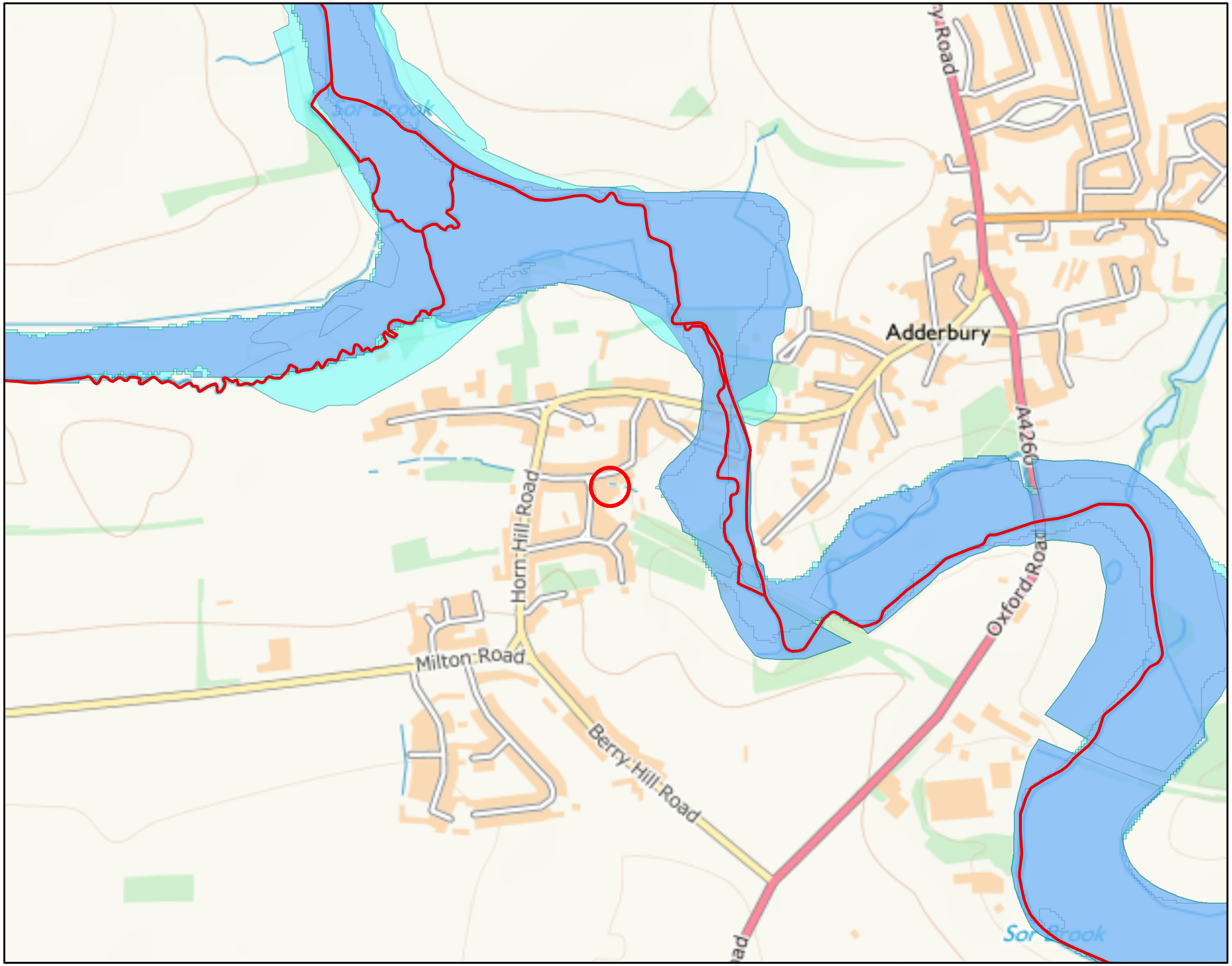
Ground Floor Plan 1:100

JOHN E. WRIGHT 526657

Appendix II - EA Data

Ambiental Environmental Assessment
Sussex Innovation Centre,
Science Park Square,
Brighton, BN1 9SB

Flood Map for Planning centred on St Georges Chapel, Round Close Road, Adderbury
Created on 01/08/2019 REF: THM_136113



Environment Agency

Kilometres

0 0.25 0.5

Legend

- Main River
- Flooding from rivers or sea (FZ3)
- Extent of extreme flood (FZ2)

Flooding from rivers or sea without defences (Flood Zone 3) shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

The Extent of an extreme flood (Flood Zone 2) shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Appendix III - Calculations

Ambiental Environmental Assessment
Sussex Innovation Centre,
Science Park Square,
Brighton, BN1 9SB

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.150
Area (ha)	1.000	Urban	0.000
SAAR (mm)	700	Region Number	Region 6

Results	**l/s**
QBAR Rural	0.4
QBAR Urban	0.4
Q100 years	1.3
Q1 year	0.3
Q30 years	0.9
Q100 years	1.3

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	99.500	0.000	1.3	0.0	O K
30 min Summer	99.500	0.000	1.2	0.0	O K
60 min Summer	99.500	0.000	0.8	0.0	O K
120 min Summer	99.500	0.000	0.6	0.0	O K
180 min Summer	99.500	0.000	0.4	0.0	O K
240 min Summer	99.500	0.000	0.4	0.0	O K
360 min Summer	99.500	0.000	0.3	0.0	O K
480 min Summer	99.500	0.000	0.2	0.0	O K
600 min Summer	99.500	0.000	0.2	0.0	O K
720 min Summer	99.500	0.000	0.2	0.0	O K
960 min Summer	99.500	0.000	0.1	0.0	O K
1440 min Summer	99.500	0.000	0.1	0.0	O K
2160 min Summer	99.500	0.000	0.1	0.0	O K
2880 min Summer	99.500	0.000	0.1	0.0	O K
4320 min Summer	99.500	0.000	0.0	0.0	O K
5760 min Summer	99.500	0.000	0.0	0.0	O K
7200 min Summer	99.500	0.000	0.0	0.0	O K
8640 min Summer	99.500	0.000	0.0	0.0	O K
10080 min Summer	99.500	0.000	0.0	0.0	O K
15 min Winter	99.500	0.000	1.3	0.0	O K
30 min Winter	99.500	0.000	1.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	31.133	0.0	0.5	0
30 min Summer	20.212	0.0	0.7	0
60 min Summer	12.728	0.0	0.9	0
120 min Summer	7.850	0.0	1.1	0
180 min Summer	5.888	0.0	1.2	0
240 min Summer	4.795	0.0	1.3	0
360 min Summer	3.573	0.0	1.4	0
480 min Summer	2.889	0.0	1.6	0
600 min Summer	2.450	0.0	1.7	0
720 min Summer	2.141	0.0	1.7	0
960 min Summer	1.731	0.0	1.9	0
1440 min Summer	1.283	0.0	2.1	0
2160 min Summer	0.952	0.0	2.3	0
2880 min Summer	0.770	0.0	2.5	0
4320 min Summer	0.570	0.0	2.8	0
5760 min Summer	0.461	0.0	3.0	0
7200 min Summer	0.391	0.0	3.2	0
8640 min Summer	0.342	0.0	3.3	0
10080 min Summer	0.306	0.0	3.5	0
15 min Winter	31.133	0.0	0.6	0
30 min Winter	20.212	0.0	0.8	0

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m^3)	Status
60 min Winter	99.500	0.000	0.7	0.0	O K
120 min Winter	99.500	0.000	0.4	0.0	O K
180 min Winter	99.500	0.000	0.3	0.0	O K
240 min Winter	99.500	0.000	0.3	0.0	O K
360 min Winter	99.500	0.000	0.2	0.0	O K
480 min Winter	99.500	0.000	0.2	0.0	O K
600 min Winter	99.500	0.000	0.1	0.0	O K
720 min Winter	99.500	0.000	0.1	0.0	O K
960 min Winter	99.500	0.000	0.1	0.0	O K
1440 min Winter	99.500	0.000	0.1	0.0	O K
2160 min Winter	99.500	0.000	0.1	0.0	O K
2880 min Winter	99.500	0.000	0.0	0.0	O K
4320 min Winter	99.500	0.000	0.0	0.0	O K
5760 min Winter	99.500	0.000	0.0	0.0	O K
7200 min Winter	99.500	0.000	0.0	0.0	O K
8640 min Winter	99.500	0.000	0.0	0.0	O K
10080 min Winter	99.500	0.000	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m^3)	Discharge Volume (m^3)	Time-Peak (mins)
60 min Winter	12.728	0.0	1.0	0
120 min Winter	7.850	0.0	1.2	0
180 min Winter	5.888	0.0	1.3	0
240 min Winter	4.795	0.0	1.5	0
360 min Winter	3.573	0.0	1.6	0
480 min Winter	2.889	0.0	1.7	0
600 min Winter	2.450	0.0	1.9	0
720 min Winter	2.141	0.0	1.9	0
960 min Winter	1.731	0.0	2.1	0
1440 min Winter	1.283	0.0	2.3	0
2160 min Winter	0.952	0.0	2.6	0
2880 min Winter	0.770	0.0	2.8	0
4320 min Winter	0.570	0.0	3.1	0
5760 min Winter	0.461	0.0	3.3	0
7200 min Winter	0.391	0.0	3.6	0
8640 min Winter	0.342	0.0	3.7	0
10080 min Winter	0.306	0.0	3.9	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.900	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.009

Time (mins) From:	**To:**	**Area (ha)**
0	4	0.009

Model Details

Storage is Online Cover Level (m) 99.900

Pipe Structure

Diameter (m)	0.150	Length (m)	5.000
Slope (1:X)	80.000	Invert Level (m)	99.500

Pipe Outflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	80.0	Coefficient of Contraction	0.600
Length (m)	5.000	Upstream Invert Level (m)	99.370
Roughness k (mm)	0.600		

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	99.500	0.000	3.3	0.0	O K
30 min Summer	99.500	0.000	2.9	0.0	O K
60 min Summer	99.500	0.000	2.0	0.0	O K
120 min Summer	99.500	0.000	1.3	0.0	O K
180 min Summer	99.500	0.000	1.0	0.0	O K
240 min Summer	99.500	0.000	0.8	0.0	O K
360 min Summer	99.500	0.000	0.6	0.0	O K
480 min Summer	99.500	0.000	0.5	0.0	O K
600 min Summer	99.500	0.000	0.4	0.0	O K
720 min Summer	99.500	0.000	0.3	0.0	O K
960 min Summer	99.500	0.000	0.3	0.0	O K
1440 min Summer	99.500	0.000	0.2	0.0	O K
2160 min Summer	99.500	0.000	0.1	0.0	O K
2880 min Summer	99.500	0.000	0.1	0.0	O K
4320 min Summer	99.500	0.000	0.1	0.0	O K
5760 min Summer	99.500	0.000	0.1	0.0	O K
7200 min Summer	99.500	0.000	0.1	0.0	O K
8640 min Summer	99.500	0.000	0.0	0.0	O K
10080 min Summer	99.500	0.000	0.0	0.0	O K
15 min Winter	99.500	0.000	3.3	0.0	O K
30 min Winter	99.500	0.000	2.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	76.391	0.0	1.3	0
30 min Summer	49.493	0.0	1.7	0
60 min Summer	30.654	0.0	2.1	0
120 min Summer	18.432	0.0	2.5	0
180 min Summer	13.548	0.0	2.7	0
240 min Summer	10.844	0.0	2.9	0
360 min Summer	7.900	0.0	3.2	0
480 min Summer	6.308	0.0	3.4	0
600 min Summer	5.295	0.0	3.6	0
720 min Summer	4.588	0.0	3.7	0
960 min Summer	3.657	0.0	3.9	0
1440 min Summer	2.654	0.0	4.3	0
2160 min Summer	1.923	0.0	4.7	0
2880 min Summer	1.530	0.0	5.0	0
4320 min Summer	1.107	0.0	5.4	0
5760 min Summer	0.879	0.0	5.7	0
7200 min Summer	0.735	0.0	6.0	0
8640 min Summer	0.635	0.0	6.2	0
10080 min Summer	0.561	0.0	6.4	0
15 min Winter	76.391	0.0	1.4	0
30 min Winter	49.493	0.0	1.9	0

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m^3)	Status
60 min Winter	99.500	0.000	1.6	0.0	O K
120 min Winter	99.500	0.000	1.0	0.0	O K
180 min Winter	99.500	0.000	0.7	0.0	O K
240 min Winter	99.500	0.000	0.6	0.0	O K
360 min Winter	99.500	0.000	0.4	0.0	O K
480 min Winter	99.500	0.000	0.3	0.0	O K
600 min Winter	99.500	0.000	0.3	0.0	O K
720 min Winter	99.500	0.000	0.2	0.0	O K
960 min Winter	99.500	0.000	0.2	0.0	O K
1440 min Winter	99.500	0.000	0.1	0.0	O K
2160 min Winter	99.500	0.000	0.1	0.0	O K
2880 min Winter	99.500	0.000	0.1	0.0	O K
4320 min Winter	99.500	0.000	0.1	0.0	O K
5760 min Winter	99.500	0.000	0.0	0.0	O K
7200 min Winter	99.500	0.000	0.0	0.0	O K
8640 min Winter	99.500	0.000	0.0	0.0	O K
10080 min Winter	99.500	0.000	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m^3)	Discharge Volume (m^3)	Time-Peak (mins)
60 min Winter	30.654	0.0	2.3	0
120 min Winter	18.432	0.0	2.8	0
180 min Winter	13.548	0.0	3.1	0
240 min Winter	10.844	0.0	3.3	0
360 min Winter	7.900	0.0	3.6	0
480 min Winter	6.308	0.0	3.8	0
600 min Winter	5.295	0.0	4.0	0
720 min Winter	4.588	0.0	4.2	0
960 min Winter	3.657	0.0	4.4	0
1440 min Winter	2.654	0.0	4.8	0
2160 min Winter	1.923	0.0	5.2	0
2880 min Winter	1.530	0.0	5.6	0
4320 min Winter	1.107	0.0	6.0	0
5760 min Winter	0.879	0.0	6.4	0
7200 min Winter	0.735	0.0	6.7	0
8640 min Winter	0.635	0.0	6.9	0
10080 min Winter	0.561	0.0	7.1	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.900	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.009

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.009

Model Details

Storage is Online Cover Level (m) 99.900

Pipe Structure

Diameter (m)	0.150	Length (m)	5.000
Slope (1:X)	80.000	Invert Level (m)	99.500

Pipe Outflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	80.0	Coefficient of Contraction	0.600
Length (m)	5.000	Upstream Invert Level (m)	99.370
Roughness k (mm)	0.600		

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	99.500	0.000	4.3	0.0	O K
30 min Summer	99.500	0.000	3.7	0.0	O K
60 min Summer	99.500	0.000	2.7	0.0	O K
120 min Summer	99.500	0.000	1.7	0.0	O K
180 min Summer	99.500	0.000	1.3	0.0	O K
240 min Summer	99.500	0.000	1.0	0.0	O K
360 min Summer	99.500	0.000	0.8	0.0	O K
480 min Summer	99.500	0.000	0.6	0.0	O K
600 min Summer	99.500	0.000	0.5	0.0	O K
720 min Summer	99.500	0.000	0.4	0.0	O K
960 min Summer	99.500	0.000	0.3	0.0	O K
1440 min Summer	99.500	0.000	0.2	0.0	O K
2160 min Summer	99.500	0.000	0.2	0.0	O K
2880 min Summer	99.500	0.000	0.1	0.0	O K
4320 min Summer	99.500	0.000	0.1	0.0	O K
5760 min Summer	99.500	0.000	0.1	0.0	O K
7200 min Summer	99.500	0.000	0.1	0.0	O K
8640 min Summer	99.500	0.000	0.1	0.0	O K
10080 min Summer	99.500	0.000	0.1	0.0	O K
15 min Winter	99.500	0.000	4.3	0.0	O K
30 min Winter	99.500	0.000	3.2	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	99.159	0.0	1.7	0
30 min Summer	64.782	0.0	2.2	0
60 min Summer	40.301	0.0	2.7	0
120 min Summer	24.226	0.0	3.3	0
180 min Summer	17.754	0.0	3.6	0
240 min Summer	14.159	0.0	3.8	0
360 min Summer	10.253	0.0	4.2	0
480 min Summer	8.157	0.0	4.4	0
600 min Summer	6.825	0.0	4.6	0
720 min Summer	5.898	0.0	4.8	0
960 min Summer	4.681	0.0	5.1	0
1440 min Summer	3.375	0.0	5.5	0
2160 min Summer	2.429	0.0	5.9	0
2880 min Summer	1.922	0.0	6.2	0
4320 min Summer	1.380	0.0	6.7	0
5760 min Summer	1.090	0.0	7.1	0
7200 min Summer	0.907	0.0	7.3	0
8640 min Summer	0.780	0.0	7.6	0
10080 min Summer	0.687	0.0	7.8	0
15 min Winter	99.159	0.0	1.9	0
30 min Winter	64.782	0.0	2.4	0

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	99.500	0.000	2.1	0.0	O K
120 min Winter	99.500	0.000	1.3	0.0	O K
180 min Winter	99.500	0.000	0.9	0.0	O K
240 min Winter	99.500	0.000	0.8	0.0	O K
360 min Winter	99.500	0.000	0.5	0.0	O K
480 min Winter	99.500	0.000	0.4	0.0	O K
600 min Winter	99.500	0.000	0.4	0.0	O K
720 min Winter	99.500	0.000	0.3	0.0	O K
960 min Winter	99.500	0.000	0.2	0.0	O K
1440 min Winter	99.500	0.000	0.2	0.0	O K
2160 min Winter	99.500	0.000	0.1	0.0	O K
2880 min Winter	99.500	0.000	0.1	0.0	O K
4320 min Winter	99.500	0.000	0.1	0.0	O K
5760 min Winter	99.500	0.000	0.1	0.0	O K
7200 min Winter	99.500	0.000	0.0	0.0	O K
8640 min Winter	99.500	0.000	0.0	0.0	O K
10080 min Winter	99.500	0.000	0.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	40.301	0.0	3.0	0
120 min Winter	24.226	0.0	3.7	0
180 min Winter	17.754	0.0	4.0	0
240 min Winter	14.159	0.0	4.3	0
360 min Winter	10.253	0.0	4.7	0
480 min Winter	8.157	0.0	4.9	0
600 min Winter	6.825	0.0	5.2	0
720 min Winter	5.898	0.0	5.4	0
960 min Winter	4.681	0.0	5.7	0
1440 min Winter	3.375	0.0	6.1	0
2160 min Winter	2.429	0.0	6.6	0
2880 min Winter	1.922	0.0	7.0	0
4320 min Winter	1.380	0.0	7.5	0
5760 min Winter	1.090	0.0	7.9	0
7200 min Winter	0.907	0.0	8.2	0
8640 min Winter	0.780	0.0	8.5	0
10080 min Winter	0.687	0.0	8.7	0

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)	19.900	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.009

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.009

Model Details

Storage is Online Cover Level (m) 99.900

Pipe Structure

Diameter (m)	0.150	Length (m)	5.000
Slope (1:X)	80.000	Invert Level (m)	99.500

Pipe Outflow Control

Diameter (m)	0.150	Entry Loss Coefficient	0.500
Slope (1:X)	80.0	Coefficient of Contraction	0.600
Length (m)	5.000	Upstream Invert Level (m)	99.370
Roughness k (mm)	0.600		

Summary of Results for 1 year Return Period (+40%)

Half Drain Time : 119 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	99.406	0.036	0.0	0.1	0.1	1.1	O K
30 min Summer	99.419	0.049	0.0	0.2	0.2	1.5	O K
60 min Summer	99.431	0.061	0.0	0.2	0.2	1.8	O K
120 min Summer	99.439	0.069	0.0	0.2	0.2	2.1	O K
180 min Summer	99.443	0.073	0.0	0.2	0.2	2.2	O K
240 min Summer	99.445	0.075	0.0	0.2	0.2	2.3	O K
360 min Summer	99.446	0.076	0.0	0.2	0.2	2.3	O K
480 min Summer	99.445	0.075	0.0	0.2	0.2	2.2	O K
600 min Summer	99.443	0.073	0.0	0.2	0.2	2.2	O K
720 min Summer	99.440	0.070	0.0	0.2	0.2	2.1	O K
960 min Summer	99.435	0.065	0.0	0.2	0.2	1.9	O K
1440 min Summer	99.425	0.055	0.0	0.2	0.2	1.7	O K
2160 min Summer	99.415	0.045	0.0	0.2	0.2	1.3	O K
2880 min Summer	99.408	0.038	0.0	0.1	0.1	1.1	O K
4320 min Summer	99.399	0.029	0.0	0.1	0.1	0.9	O K
5760 min Summer	99.395	0.025	0.0	0.1	0.1	0.8	O K
7200 min Summer	99.393	0.023	0.0	0.1	0.1	0.7	O K
8640 min Summer	99.391	0.021	0.0	0.1	0.1	0.6	O K
10080 min Summer	99.390	0.020	0.0	0.1	0.1	0.6	O K
15 min Winter	99.412	0.042	0.0	0.1	0.1	1.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	43.587	0.0	1.1	18
30 min Summer	28.297	0.0	1.6	32
60 min Summer	17.819	0.0	2.1	60
120 min Summer	10.990	0.0	2.7	98
180 min Summer	8.243	0.0	3.1	130
240 min Summer	6.713	0.0	3.5	164
360 min Summer	5.002	0.0	3.9	232
480 min Summer	4.045	0.0	4.2	300
600 min Summer	3.430	0.0	4.5	366
720 min Summer	2.998	0.0	4.7	432
960 min Summer	2.424	0.0	5.1	560
1440 min Summer	1.797	0.0	5.6	808
2160 min Summer	1.333	0.0	6.2	1168
2880 min Summer	1.078	0.0	6.6	1528
4320 min Summer	0.799	0.0	7.2	2208
5760 min Summer	0.646	0.0	7.6	2944
7200 min Summer	0.548	0.0	7.8	3680
8640 min Summer	0.479	0.0	8.0	4408
10080 min Summer	0.428	0.0	8.2	5136
15 min Winter	43.587	0.0	1.3	18

Summary of Results for 1 year Return Period (+40%)

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
30 min Winter	99.427	0.057	0.0	0.2	0.2	1.7	O K
60 min Winter	99.441	0.071	0.0	0.2	0.2	2.1	O K
120 min Winter	99.449	0.079	0.0	0.2	0.2	2.4	O K
180 min Winter	99.453	0.083	0.0	0.2	0.2	2.5	O K
240 min Winter	99.454	0.084	0.0	0.2	0.2	2.5	O K
360 min Winter	99.453	0.083	0.0	0.2	0.2	2.5	O K
480 min Winter	99.449	0.079	0.0	0.2	0.2	2.4	O K
600 min Winter	99.445	0.075	0.0	0.2	0.2	2.2	O K
720 min Winter	99.441	0.071	0.0	0.2	0.2	2.1	O K
960 min Winter	99.432	0.062	0.0	0.2	0.2	1.9	O K
1440 min Winter	99.420	0.050	0.0	0.2	0.2	1.5	O K
2160 min Winter	99.407	0.037	0.0	0.1	0.1	1.1	O K
2880 min Winter	99.400	0.030	0.0	0.1	0.1	0.9	O K
4320 min Winter	99.394	0.024	0.0	0.1	0.1	0.7	O K
5760 min Winter	99.391	0.021	0.0	0.1	0.1	0.6	O K
7200 min Winter	99.389	0.019	0.0	0.1	0.1	0.6	O K
8640 min Winter	99.387	0.017	0.0	0.1	0.1	0.5	O K
10080 min Winter	99.386	0.016	0.0	0.0	0.0	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	28.297	0.0	1.8	32
60 min Winter	17.819	0.0	2.5	60
120 min Winter	10.990	0.0	3.1	110
180 min Winter	8.243	0.0	3.6	138
240 min Winter	6.713	0.0	3.9	176
360 min Winter	5.002	0.0	4.4	252
480 min Winter	4.045	0.0	4.8	322
600 min Winter	3.430	0.0	5.1	392
720 min Winter	2.998	0.0	5.4	458
960 min Winter	2.424	0.0	5.8	588
1440 min Winter	1.797	0.0	6.4	836
2160 min Winter	1.333	0.0	7.1	1192
2880 min Winter	1.078	0.0	7.6	1532
4320 min Winter	0.799	0.0	8.2	2220
5760 min Winter	0.646	0.0	8.7	3000
7200 min Winter	0.548	0.0	9.1	3680
8640 min Winter	0.479	0.0	9.3	4416
10080 min Winter	0.428	0.0	9.5	5096

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.900	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.020

Time From:	(mins) To:	Area (ha)
0	4	0.020

Model Details

Storage is Online Cover Level (m) 99.900

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	27.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.370	Membrane Depth (m)	130

Orifice Outflow Control

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 99.370

Summary of Results for 30 year Return Period (+40%)

Half Drain Time : 173 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	99.482	0.112	0.0	0.3	0.3	3.4	O K
30 min Summer	99.516	0.146	0.0	0.3	0.3	4.4	O K
60 min Summer	99.545	0.175	0.0	0.3	0.3	5.2	O K
120 min Summer	99.562	0.192	0.0	0.4	0.4	5.8	O K
180 min Summer	99.566	0.196	0.0	0.4	0.4	5.9	O K
240 min Summer	99.567	0.197	0.0	0.4	0.4	5.9	O K
360 min Summer	99.565	0.195	0.0	0.4	0.4	5.8	O K
480 min Summer	99.560	0.190	0.0	0.4	0.4	5.7	O K
600 min Summer	99.553	0.183	0.0	0.3	0.3	5.5	O K
720 min Summer	99.547	0.177	0.0	0.3	0.3	5.3	O K
960 min Summer	99.533	0.163	0.0	0.3	0.3	4.9	O K
1440 min Summer	99.509	0.139	0.0	0.3	0.3	4.2	O K
2160 min Summer	99.481	0.111	0.0	0.3	0.3	3.3	O K
2880 min Summer	99.462	0.092	0.0	0.2	0.2	2.8	O K
4320 min Summer	99.437	0.067	0.0	0.2	0.2	2.0	O K
5760 min Summer	99.422	0.052	0.0	0.2	0.2	1.5	O K
7200 min Summer	99.412	0.042	0.0	0.1	0.1	1.3	O K
8640 min Summer	99.405	0.035	0.0	0.1	0.1	1.1	O K
10080 min Summer	99.401	0.031	0.0	0.1	0.1	0.9	O K
15 min Winter	99.498	0.128	0.0	0.3	0.3	3.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	106.947	0.0	3.5	18
30 min Summer	69.291	0.0	4.6	33
60 min Summer	42.916	0.0	5.9	62
120 min Summer	25.805	0.0	7.2	118
180 min Summer	18.967	0.0	8.0	146
240 min Summer	15.181	0.0	8.5	176
360 min Summer	11.059	0.0	9.3	244
480 min Summer	8.831	0.0	10.0	312
600 min Summer	7.413	0.0	10.5	380
720 min Summer	6.423	0.0	10.9	448
960 min Summer	5.119	0.0	11.6	580
1440 min Summer	3.715	0.0	12.5	838
2160 min Summer	2.693	0.0	13.6	1212
2880 min Summer	2.142	0.0	14.3	1584
4320 min Summer	1.550	0.0	15.3	2292
5760 min Summer	1.231	0.0	16.0	3000
7200 min Summer	1.029	0.0	16.5	3744
8640 min Summer	0.889	0.0	16.9	4416
10080 min Summer	0.786	0.0	17.2	5144
15 min Winter	106.947	0.0	3.9	18

Summary of Results for 30 year Return Period (+40%)

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
30 min Winter	99.536	0.166	0.0	0.3	0.3	5.0	O K
60 min Winter	99.569	0.199	0.0	0.4	0.4	6.0	O K
120 min Winter	99.590	0.220	0.0	0.4	0.4	6.6	O K
180 min Winter	99.593	0.223	0.0	0.4	0.4	6.7	O K
240 min Winter	99.593	0.223	0.0	0.4	0.4	6.7	O K
360 min Winter	99.587	0.217	0.0	0.4	0.4	6.5	O K
480 min Winter	99.578	0.208	0.0	0.4	0.4	6.2	O K
600 min Winter	99.568	0.198	0.0	0.4	0.4	5.9	O K
720 min Winter	99.557	0.187	0.0	0.4	0.4	5.6	O K
960 min Winter	99.537	0.167	0.0	0.3	0.3	5.0	O K
1440 min Winter	99.504	0.134	0.0	0.3	0.3	4.0	O K
2160 min Winter	99.469	0.099	0.0	0.2	0.2	3.0	O K
2880 min Winter	99.446	0.076	0.0	0.2	0.2	2.3	O K
4320 min Winter	99.420	0.050	0.0	0.2	0.2	1.5	O K
5760 min Winter	99.407	0.037	0.0	0.1	0.1	1.1	O K
7200 min Winter	99.399	0.029	0.0	0.1	0.1	0.9	O K
8640 min Winter	99.396	0.026	0.0	0.1	0.1	0.8	O K
10080 min Winter	99.394	0.024	0.0	0.1	0.1	0.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	69.291	0.0	5.3	32
60 min Winter	42.916	0.0	6.7	60
120 min Winter	25.805	0.0	8.1	116
180 min Winter	18.967	0.0	9.0	164
240 min Winter	15.181	0.0	9.6	186
360 min Winter	11.059	0.0	10.5	264
480 min Winter	8.831	0.0	11.2	338
600 min Winter	7.413	0.0	11.8	410
720 min Winter	6.423	0.0	12.3	482
960 min Winter	5.119	0.0	13.0	618
1440 min Winter	3.715	0.0	14.1	882
2160 min Winter	2.693	0.0	15.3	1256
2880 min Winter	2.142	0.0	16.2	1616
4320 min Winter	1.550	0.0	17.3	2332
5760 min Winter	1.231	0.0	18.2	3048
7200 min Winter	1.029	0.0	18.8	3744
8640 min Winter	0.889	0.0	19.2	4408
10080 min Winter	0.786	0.0	19.6	5080

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.900	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.020

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.020

Model Details

Storage is Online Cover Level (m) 99.900

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	27.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.370	Membrane Depth (m)	130

Orifice Outflow Control

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 99.370

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 202 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	99.521	0.151	0.0	0.3	0.3	4.5	O K
30 min Summer	99.567	0.197	0.0	0.4	0.4	5.9	O K
60 min Summer	99.608	0.238	0.0	0.4	0.4	7.1	O K
120 min Summer	99.633	0.263	0.0	0.4	0.4	7.9	O K
180 min Summer	99.637	0.267	0.0	0.4	0.4	8.0	O K
240 min Summer	99.638	0.268	0.0	0.4	0.4	8.0	O K
360 min Summer	99.633	0.263	0.0	0.4	0.4	7.9	O K
480 min Summer	99.626	0.256	0.0	0.4	0.4	7.7	O K
600 min Summer	99.618	0.248	0.0	0.4	0.4	7.4	O K
720 min Summer	99.609	0.239	0.0	0.4	0.4	7.2	O K
960 min Summer	99.591	0.221	0.0	0.4	0.4	6.6	O K
1440 min Summer	99.559	0.189	0.0	0.4	0.4	5.7	O K
2160 min Summer	99.523	0.153	0.0	0.3	0.3	4.6	O K
2880 min Summer	99.497	0.127	0.0	0.3	0.3	3.8	O K
4320 min Summer	99.462	0.092	0.0	0.2	0.2	2.7	O K
5760 min Summer	99.440	0.070	0.0	0.2	0.2	2.1	O K
7200 min Summer	99.426	0.056	0.0	0.2	0.2	1.7	O K
8640 min Summer	99.417	0.047	0.0	0.2	0.2	1.4	O K
10080 min Summer	99.410	0.040	0.0	0.1	0.1	1.2	O K
15 min Winter	99.541	0.171	0.0	0.3	0.3	5.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.823	0.0	4.6	18
30 min Summer	90.695	0.0	6.2	33
60 min Summer	56.422	0.0	7.9	62
120 min Summer	33.916	0.0	9.6	120
180 min Summer	24.855	0.0	10.6	154
240 min Summer	19.822	0.0	11.3	184
360 min Summer	14.355	0.0	12.3	250
480 min Summer	11.419	0.0	13.1	318
600 min Summer	9.556	0.0	13.7	386
720 min Summer	8.258	0.0	14.2	456
960 min Summer	6.554	0.0	15.0	588
1440 min Summer	4.725	0.0	16.2	852
2160 min Summer	3.401	0.0	17.4	1232
2880 min Summer	2.691	0.0	18.3	1588
4320 min Summer	1.932	0.0	19.4	2296
5760 min Summer	1.526	0.0	20.3	3048
7200 min Summer	1.270	0.0	20.8	3744
8640 min Summer	1.093	0.0	21.3	4416
10080 min Summer	0.962	0.0	21.6	5152
15 min Winter	138.823	0.0	5.3	18

Summary of Results for 100 year Return Period (+40%)

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
30 min Winter	99.593	0.223	0.0	0.4	0.4	6.7	O K
60 min Winter	99.639	0.269	0.0	0.4	0.4	8.1	O K
120 min Winter	99.671	0.301	0.0	0.5	0.5	9.0	O K
180 min Winter	99.676	0.306	0.0	0.5	0.5	9.2	O K
240 min Winter	99.674	0.304	0.0	0.5	0.5	9.1	O K
360 min Winter	99.666	0.296	0.0	0.4	0.4	8.9	O K
480 min Winter	99.654	0.284	0.0	0.4	0.4	8.5	O K
600 min Winter	99.641	0.271	0.0	0.4	0.4	8.1	O K
720 min Winter	99.628	0.258	0.0	0.4	0.4	7.7	O K
960 min Winter	99.602	0.232	0.0	0.4	0.4	6.9	O K
1440 min Winter	99.557	0.187	0.0	0.4	0.4	5.6	O K
2160 min Winter	99.510	0.140	0.0	0.3	0.3	4.2	O K
2880 min Winter	99.478	0.108	0.0	0.3	0.3	3.2	O K
4320 min Winter	99.441	0.071	0.0	0.2	0.2	2.1	O K
5760 min Winter	99.421	0.051	0.0	0.2	0.2	1.5	O K
7200 min Winter	99.409	0.039	0.0	0.1	0.1	1.2	O K
8640 min Winter	99.402	0.032	0.0	0.1	0.1	1.0	O K
10080 min Winter	99.398	0.028	0.0	0.1	0.1	0.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	90.695	0.0	7.0	32
60 min Winter	56.422	0.0	8.9	60
120 min Winter	33.916	0.0	10.8	118
180 min Winter	24.855	0.0	12.0	170
240 min Winter	19.822	0.0	12.7	192
360 min Winter	14.355	0.0	13.9	268
480 min Winter	11.419	0.0	14.7	344
600 min Winter	9.556	0.0	15.4	418
720 min Winter	8.258	0.0	16.0	490
960 min Winter	6.554	0.0	16.9	628
1440 min Winter	4.725	0.0	18.2	896
2160 min Winter	3.401	0.0	19.6	1276
2880 min Winter	2.691	0.0	20.6	1644
4320 min Winter	1.932	0.0	21.9	2340
5760 min Winter	1.526	0.0	22.9	3056
7200 min Winter	1.270	0.0	23.6	3752
8640 min Winter	1.093	0.0	24.1	4496
10080 min Winter	0.962	0.0	24.5	5144

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)	19.900	Shortest Storm (mins)	15
Ratio R	0.412	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.020

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.020

Model Details

Storage is Online Cover Level (m) 99.900

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	27.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.370	Membrane Depth (m)	130

Orifice Outflow Control

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 99.370