SuDS Statement

January 2020

EAS

The Fox Public House,

Haverhill Road, Little Wratting

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TRANSPORT PLANNING HIGHWAYS AND DRAINAGE FLOOD RISK TOPOGRAPHICAL SURVEYS
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1 Introduction

1.1 This Flood Risk Assessment has been prepared in support of an application by Darren Pomfrett for the proposed redevelopment of The Fox Public House, Haverhill Road, Little Wratting, Cambridgeshire, CB9 7UD. A location plan is included in **Appendix A**.

1.2 The proposed development consists of the demolition of the existing derelict public house with a restaurant/public house at the rear of the site with car parking to the front and sides. The total site area is approximately 0.3 ha.

1.3 The contents of this FRA and drainage report are based on the advice set out in The National Planning Policy Framework (NPPF) and the Technical Guidance to the NPPF published in February 2019 and updated June 2019 and the Planning Practice Guidance (PPG), published March 2014.

1.4 This document includes:

Section 2 - describes relevant policy;

Section 3 - site description, including site levels, proximity to watercourses etc.;

Section 4 – provides a brief review of potential sources of flooding and any mitigation measures required;

Section 5 - describes the existing site hydrology and outlines a surface water drainage strategy;

Section 6 – Details of management and maintenance

Section 7 - provides a summary and conclusions.

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2 Policy Context

Introduction

2.1 This section sets out the policy context. The contents of this SuDS Statement are based on the advice set out in The National Planning Policy Framework (NPPF) published in February 2019 and updated June 2019, and the Planning Practice Guidance (PPG) published March 2014, which is updated on an ad hoc basis.

2.2 Paragraph 164 footnote 50 of the NPPF states:

"A site-specific flood risk assessment should be provided for all developments in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use."

2.3 The flood risk zones are defined as:

- Flood Zone 1- This zone comprises land assessed as having a less than 1 in 1,000 annual probability of river flooding (<0.1%)
- Flood Zone 2- This zone comprises land assessed as having between a 1 in a 100 and 1 in 1,000 annual probability of river flooding.
- Flood Zone 3a- This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), and for tidal flooding at least a 0.5% annual probability of flooding from tidal sources.
- Flood Zone 3b- This zone comprises land where water has to flow or be stored in times of flood.

2.4 Paragraph 155 discusses the suitability of development location, particularly with regard to future risks induced by climate change:

"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere".

2.5 Paragraphs 165 NPPF discusses the application of sustainable drainage systems:

"Major developments should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems used should:

- *Take account of advice from the lead local flood authority;*
- *Have appropriate proposed minimum operational standards;*
- *Have maintenance arrangements in place to ensure an acceptable standard of operation of the lifetime of the development; and*
- *Where possible, provide multifunctional benefits."*

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Local Policy

West Suffolk Joint Development Management Policies Document (JPMPD)

2.6 The JPMPD was adopted in February 2015 by the former St Edmundsbury Borough Council and the former Forest Heath District Council. The relevant policy is DM6.

2.7 Policy DM6 Flooding and Sustainable Drainage states:

"The NPPF makes it clear in paragraph 94 that 'local planning authorities should adopt proactive strategies to mitigate and adapt to climate change, taking full account of flood risk, coastal change and water supply and demand consideration'. The impacts of climate change will increasingly affect the layout of sites and developers will have to consider the increased risk of flooding, heat gain, subsidence and the greater importance of outdoor spaces.

More severe storms during the winter period are predicted for the East of England and this means that drainage systems will be put under more strain due to the effects of increased run-off from new developments and increased risk of flash flooding, particularly in urban areas. Water resources must be more efficiently captured to make sure they do not flow straight back into rivers and drains.

Urban areas will become more adversely affected by the urban heat island effect in the future and the provision of outdoor spaces is an important adaptation method. Outdoor spaces should be permeable so as not to increase surface runoff and should provide pleasant, shaded spaces for people as demand to be outside throughout the year will be likely to increase. Surface water run-off systems should not be buried, unless there is no alternative. Overland systems will be considered preferable to piped systems for ease of maintenance and increasing public awareness of the impact of water.

Meanwhile, the East of England is the driest region in the country receiving only two thirds of the average UK annual rainfall. Many of the region's surface and ground waters are under severe pressure. Climate change will add to the pressure, altering both the pattern and the amount of rainfall.

The potential for climate change to affect infrastructure is a risk in the future with the possibility of increased flooding causing damage to electrical mains, substations and gas pipelines.

Proposals for all new development will be required to submit schemes appropriate to the scale of the proposal detailing how on-site drainage will be managed so as not to cause or exacerbate flooding elsewhere. Examples include: rainwater harvesting and greywater recycling, and run-off and water management such as Sustainable Urban Drainage Systems (SUDS) or other natural drainage systems."

Forest Heath District Council and St Edmundsbury Borough Council Level 1 Strategic Flood Risk Assessment (SFRA) and Water Cycle Study

2.8 The Forest Heath District Council and St Edmundsbury Borough Council SFRA and Water Cycle Study prepared by Hyder Consulting was published in August 2009 to produce suitable guidance and mapping to inform development control decisions.

2.9 The SFRA promotes the use of sustainable drainage systems within the district and confirms that infiltration drainage in the north of the study area is likely to be suitable but due to the presence of clay it is unlikely that infiltration drainage will be suitable in the south of the area. The site lies very close to the southern border of the district and therefore it is expected that infiltration drainage would not be acceptable.

2.10 The SFRA recognises that the following hierarchy for surface water management should be followed:

- Store rainwater for later use;
- Use infiltration techniques;
- Attenuate in open water features for gradual release to a watercourse;
- Attenuate by storing in tanks or sealed water features for gradual release to a watercourse
- Discharge direct to a watercourse
- Discharge to a surface water drain
- Discharge to the combined sewer

Suffolk Flood Risk Management Partnership – Sustainable Drainage Systems (SuDS) a Local Design Guide

2.11 The Local Design Guide states that the guiding principles for SuDS in Suffolk will be:

- Early consideration of sustainable flood and coastal risk management in production of Local Plans and master planning– promoting and protecting ‘blue and green corridors’.
- Wherever possible, the use of multifunctional, above ground SuDS that deliver drainage, enhancement of biodiversity, improvements in water quality and amenity benefits.
- Ensuring that land owners realise both the importance of reducing flood risk and how properly designed sustainable drainage systems can be an asset to their development.
- Ensuring no increase in flood risk from new development wherever possible and contributing to reducing existing risk if feasible.
- Ensuring water flows around properties when the design capacity of drainage systems is exceeded by extreme rainfall.

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3 Existing Site Assessment

Site Description

3.1 The development site is at The Fox Public House, Haverhill Road, Little Wratting, Cambridgeshire, CB9 7UD. It currently consists of a derelict public house with parking and garden to the rear. For the purposes of this assessment the site has been considered as brownfield.

3.2 The site is on the south side of Haverhill road with a new residential development to the north of Haverhill road opposite the site currently being built out and a proposed development of approximately 2500 dwellings approved to the south and east of the development. A location plan is contained in **Appendix A**.

3.3 The proposed development will include demolition of the former public house and car parking and the construction of a new restaurant/public house. The proposed development plans are included at **Appendix C.**

Local Watercourses

3.4 The site has an ordinary watercourse which runs along the eastern boundary in a southerly direction then west along the southern boundary before heading further south towards the Stour Brook which is approximately 3km to the South. The Stour Brook is considered a main river by the EA.

Site Levels

3.5 A topographical survey enclosed in **Appendix D** shows the site falls from the north east corner to the south west corner. In the north east corner levels are approximately 102.35mAOD with levels falling to 100.60mAOD in the south west corner. The site has an average gradient of approximately 1:47.

Geology

3.6 With reference to the British Geological Survey online mapping, the site is located within an area with a bedrock of Lewes Nodular Chalk and Seaford Chalk Formations – Chalk with Lowestoft formation superficial deposits recorded. BGS borehole records in the area show that the boulder clay and clayey sand are below the topsoil to depths of over 9m. Therefore it is unlikely that shallow infiltration drainage will be viable solution.

Existing Drainage

3.7 The site currently consists of a derelict public house and associated hardstanding including a large car park. The surface water runoff from the car park drains informally to the watercourse as this area is all hardstanding but doesn't have any formal drainage. The roof area is assumed to connect to the foul sewer which serves the site.

3.8 It is assumed that the outfall from the site is currently unrestricted.

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4 Potential Sources of Flooding

Fluvial

4.1 A copy of the Environment Agency's Flood Map is enclosed in **Appendix B**. The mapping shows the whole site to be located in Flood Zone 1, at 'Low' risk of flooding from fluvial or tidal sources. Areas in Flood Zone 1 have a less than 1 in 1000 probability of flooding each year.

4.2 The risk from fluvial flooding is therefore deemed low.

Surface Water

4.3 Surface water flooding refers to flooding caused when the intensity of rainfall, particularly in urban areas, can create runoff which temporarily overwhelms the capacity of the local drainage systems or does not infiltrate into the ground. The water ponds on the ground and flows towards low-lying land. This source of flood risk is also known as 'pluvial'.

4.4 The Flood Risk from Surface Water map is included as **Appendix E** and shows that the site is at 'very low' risk of surface water flooding. This means that this area has less than a 1 in 1000 chance of flooding each year.

4.5 As such the risk of surface water flooding to the site is deemed to be low.

Groundwater

4.6 The SFRA states that the study area is susceptible to groundwater flooding due to the chalk geology.

4.7 However, Figure 5-3 of the SFRA shows historic groundwater flooding within the study area. The figure shows that groundwater flooding occurs to the north of the study area but there are no recorded incidents within the south which is where the site is located.

4.1 The area is shown to have medium groundwater vulnerability in DEFRA's Magic Map.

4.2 BGS borehole records show that there are no records within 500m of the site, however, the five closest records show that groundwater was not struck at less than 5m below ground level.

4.3 As such the risk of groundwater flooding to the site is considered to be low.

Artificial

4.4 The EA Flood Map for Planning shows the site is not at risk of flooding from artificial sources therefore the risk from artificial sources can be deemed low.

Sewer Flooding

4.5 Sewer flooding generally results from localised short-term intense rainfall events overloading the capacity of the private and public drainage or due to failures within the public sewer.

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4.6 The SFRA includes Anglian Water's comprehensive list of all flooding records reported to Anglian Water for the study area. Figure 5-2 of the SFRA shows that a number of reported sewer or other flooding incidents have occurred within Haverhill but not in close proximity to the site.

4.7 Therefore, due to the absence of recorded instances of sewer flooding within the the risk from sewer flooding is low.

5 Drainage Strategy

Pre-Development Runoff Rate

5.1 The existing site comprises of a derelict public house with associated car parking and grassed areas on a 0.3 ha site. The total impermeable area within the site is approximately 1510m^2.

5.2 Using the Modified Rational Method detailed in Butler, D and Davies, J. (2006), Urban Drainage, 2nd ed., SPON, the surface water runoff for the existing site has been calculated as follows:-

Q = CiA where Q = maximum flow rate (l/s)

C= PIMP/PR

i= rainfall intensity (mm/hr),

A=area (ha)

5.3 It should be noted that a fixed rainfall intensity of 50mm/hr is used in this case, which has been recommended by Butler & Davies (2006) to avoid using inappropriately high intensities for very low concentration times, i.e. small sites.

5.4 Using the Modified Rationale Method (Butler and Davies, 2006), and based on the measured impermeable area on the existing site of approximately 1510m^2, the total rate of runoff is estimated to be **20.82 l/s**. The runoff calculations are included at **Appendix F**. This runoff rate does not include the greenfield runoff.

Relevant SuDS Policy

5.5 SuDS mimic the natural drainage system and provide a method of surface water drainage which can decrease the quantity of water discharged, and hence reduce the risk of flooding. In addition to reducing flood risk, these features can improve water quality and provide biodiversity and amenity benefits.

5.6 The SuDS management train incorporates a hierarchy of techniques and considers all three SuDS criteria of flood reduction, pollution reduction, and landscape and wildlife benefit. In decreasing order of preference, the preferred means of disposal of surface water runoff is:

- Discharge to ground.
- Discharge to a surface water body.
- Discharge to a surface water sewer.
- Discharge to a combined sewer.

5.7 The philosophy of SuDS is to replicate as closely as possible the natural drainage from a site pre-development and to treat runoff to remove pollutants, resulting in a reduced impact on the receiving watercourses. The benefits of this approach are as follows:

- Reducing runoff rates, thus reducing the flood risk downstream.

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- Reducing pollutant concentrations, thus protecting the quality of the receiving water body.
- Groundwater recharge.
- Contributing to the enhanced amenity an aesthetic value of development areas.
- Providing habitats for wildlife in developed areas, and opportunity for biodiversity enhancement.

Site-Specific SuDS

5.8 The various SuDS methods need to be considered in relation to site-specific constraints. Several SuDS options are available to reduce or temporarily hold back the discharge of surface water runoff. Table 5.1 outlines the constraints and opportunities to each of the SuDS devices in accordance with the hierarchical approach outlined in The SuDS Manual CIRIA C753. It also indicates what could and could not be incorporated within the development, based upon site-specific criteria.

Device	Description	Constraints / Comments	Appropriate
Living roofs (source control)	Provide soft landscaping at roof level which reduces surface water runoff.	Not suitable due to the pitch of the roof.	No
Infiltration devices & Soakaways (source control)	Store runoff and allow water to percolate into the ground via natural infiltration.	Site specific infiltration testing has not been undertaken at this stage.	No
Pervious surfaces (source control)	Storm water is allowed to infiltrate through the surface into a storage layer, from which it can either infiltrate and/or slowly release to sewers.	It is proposed that pervious surfaces will be used throughout the development to provide attenuation within the subbase and water quality improvements.	Yes
Rainwater harvesting (source control)	Reduces the annual average rate of runoff from the site by reusing water for non-potable uses e.g. toilet flushing, recycling processes.	Not proposed within the development.	No
Swales (permeable conveyance)	Broad shallow channels that convey / store runoff, and allow infiltration (ground conditions permitting).	Site use and layout not conducive to the use of swales	No
Filter drains & perforated pipes (permeable conveyance)	Trenches filled with granular materials (to take flows from adjacent impermeable areas) that convey runoff while allowing infiltration.	Not proposed within the development.	No

Filter Strips (permeable conveyance)	Wide gently sloping areas of grass or dense vegetation that remove pollutants from run-off from adjacent areas.	Site layout not conducive to filter strips.	No
Infiltration basins (end of pipe treatment)	Depressions in the surface designed to store runoff and allow infiltration.	Spatial constraints and lack of infiltration testing mean this is not feasible.	No
Wet ponds & constructed wetlands (end of pipe treatment)	Provide water quality treatment & temporary storage above the permanent water level.	Spatial constraints on site therefore not suitable.	No
Attenuation Underground (end of pipe treatment)	Oversized pipes or geo-cellular tanks designed to store water below ground level.	A cellular storage tank is proposed to provide additional attenuation before a restricted discharge into the watercourse.	Yes

Table 5.1: Site Specific Sustainable Drainage

Post Development Runoff Rate

5.9 Greenfield runoff rates were estimated using the ICP SuDS method on the WINDES Micro Drainage software. The proposed site comprises an impermeable area of 2323m^2 (0.233 ha). The runoff rates for 1 hectare has been estimated and scaled to the impermeable area for the 1 in 1 year, 1 in 30 year and 1 in 100 year events:

- QBAR – 2.8 l/s/ha (0.65 l/s)
- 1 in 1 year – 2.5 l/s/ha (0.58 l/s)
- 1 in 30 year – 6.8 l/s/ha (1.58 l/s)
- 1 in 100 year – 10.1 l/s/ha (2.35 l/s)

5.10 The MicroDrainage greenfield runoff rates are included at **Appendix G.**

5.11 The total runoff from the development will be restricted by two orifice plates at 1 l/s and 2 l/s to an overall outflow rate of 3.0 l/s for a 1 in 100 +40% climate change storm. This provides a betterment of over 85% from the existing runoff rate of 20.82 l/s.

5.12 The site will be split in to six catchment areas for surface water disposal, the access road and car park is made up of catchments 1-4 based on topography whilst catchment 5 is the front half of the new building and catchment 6 is the rear half of the new building. Please see **Appendix I** which shows each of the catchment areas. Where an area is not indicated under the catchment it is assumed that it will shed water on to an adjacent landscaped or porous surface.

5.13 There will be two discharges from the site into the adjacent watercourse, this will be via catchment 4 and the land adjacent to catchment 6. Catchment 4 will take controlled runoff from catchment 3 at 1 l/s via an orifice plate and will have a controlled discharge in to the watercourse.

5.14 The land adjacent to catchment 6 has a cellular storage tank and takes runoff from catchments, 1, 2, 5 and 6 which will all be restricted to 1 l/s by an orifice plate before

5.15 All permeable paving will be unlined to encourage any losses through infiltration; however, the losses will not be accounted for within the calculations at this stage. If infiltration testing in accordance with BRE365 is undertaken and the infiltration rates are suitable the same principles of this design could be utilised subject to detailed drainage design.

Catchment 1

5.16 Catchment 1 takes surface water from the northern section of the car park and the site entrance as shown in **Appendix I**. All rainfall will fall directly on to the surfacing and filter through the subbase of the permeable paving for storage before discharging via an orifice plate into catchment 2. The permeable paving will incorporate a type 3 or similar subbase with a minimum depth of 220mm. The system will be restricted to 1 l/s via a 33mm orifice plate with a suitable filter.

5.17 MicroDrainage was used in order to determine the depth of the subbase required in order to provide adequate attenuation for rainfall events up to and including a 1 in 100 + 40% climate change storm for the site. This catchment is required to provide at least 20.6m^3 of storage. The calculations are included within **Appendix H**.

Catchment 2

5.18 Catchment 2 takes surface water from the western section of the car park as shown in **Appendix I**. Rainfall which falls directly on to the surfacing will enter the system and filter through the subbase, this catchment will also receive the restricted discharge from catchment 1 as mentioned above, via a diffuser. The catchment will then discharge via an orifice plate into the cellular storage tank adjacent to catchment 6. The permeable paving will incorporate a type 3 or similar subbase with a minimum depth of 325mm. The system will be restricted to 1 l/s via a 29mm orifice plate with a suitable filter.

5.19 MicroDrainage was used in order to determine the depth of the subbase required in order to provide adequate attenuation for rainfall events up to and including a 1 in 100 + 40% climate change storm for the site. This catchment is required to provide at least 31m^3 of storage. The calculations are included within **Appendix H**.

Catchment 3

5.20 Catchment 3 takes surface water from the south eastern section of the car park as shown in **Appendix I**. All rainfall will fall directly on to the surfacing and filter through the subbase of the permeable paving for storage before discharging via an orifice plate into catchment 4. The permeable paving will incorporate a type 3 or similar subbase with a minimum depth of 275mm. The system will be restricted to 1 l/s via a 29mm orifice plate with a suitable filter.

5.21 MicroDrainage was used in order to determine the depth of the subbase required in order to provide adequate attenuation for rainfall events up to and including a 1 in 100 + 40% climate change storm for the site. This catchment is required to provide at least 10.5m^3 of storage. The calculations are included within **Appendix H**.

Catchment 4

5.22 Catchment 4 takes surface water from the delivery south western section of the car park as shown in **Appendix I**. Rainfall which falls directly on to the surfacing will enter the system and filter through the subbase, this catchment will also receive the restricted discharge from catchment 3 as discussed above, via a diffuser. The catchment will then discharge via an orifice plate into the adjacent watercourse. The permeable paving will incorporate a type 3 or similar subbase with a minimum depth of 380mm. The system will be restricted to 1 l/s via a 29mm orifice plate with a suitable filter.

5.23 MicroDrainage was used in order to determine the depth of the subbase required in order to provide adequate attenuation for rainfall events up to and including a 1 in 100 + 40% climate change storm for the site. This catchment is required to provide at least 18.3m³ of storage. The calculations are included within **Appendix H**.

Catchment 5

5.24 Catchment 5 takes surface water from the front half of the new restaurant roof and associated hardstanding to the north and west of the new building as shown in **Appendix I**. All roof drainage will be connected directly into the permeable paving for storage before discharging via an orifice plate into cellular storage tank adjacent to catchment 6. The permeable paving will incorporate a type 3 or similar subbase with a minimum depth of 430mm. The system will be restricted to 1 l/s via a 27mm orifice plate with a suitable filter.

5.25 MicroDrainage was used in order to determine the depth of the subbase required in order to provide adequate attenuation for rainfall events up to and including a 1 in 100 + 40% climate change storm for the site. This catchment is required to provide at least 16.6m³ of storage. The calculations are included within **Appendix H**.

Catchment 6

5.26 Catchment 6 takes surface water from the rear half of the new restaurant roof and associated hardstanding to the south of the new building as shown in **Appendix I**. All roof drainage will be connected directly into the permeable paving for storage before discharging via an orifice plate into the adjacent cellular storage tank. The permeable paving will incorporate a type 3 or similar subbase with a minimum depth of 470mm. The system will be restricted to 1 l/s via a 26mm orifice plate with a suitable filter.

5.27 MicroDrainage was used in order to determine the depth of the subbase required in order to provide adequate attenuation for rainfall events up to and including a 1 in 100 + 40% climate change storm for the site. This catchment is required to provide at least 20.1m³ of storage. The calculations are included within **Appendix H**.

Cellular Storage Tank

5.28 The cellular storage tank takes restricted runoff from Catchments 2, 5 and 6 each at 1 l/s. Whilst runoff from each of the areas are permeable paving and therefore provide high levels of treatment it is still recommended that a catch pit is installed prior to the cellular storage tank. The cellular storage tank will provide be 75m² at a depth of 800mm. The system will be restricted prior to discharging into the adjacent watercourse to 2 l/s via a 34mm orifice plate with a suitable filter.

5.29 MicroDrainage was used in order to determine the depth of the storage tank required in order to provide adequate attenuation for rainfall events up to and including a 1 in 100 + 40% climate change storm for the site. The tank is required to provide at least 50.2m³ of storage. The calculations are included within **Appendix H**.

All Catchments

5.30 All downpipes should discharge into an inspection chamber before connecting into the subbase of the permeable paving via a diffuser unit which will distribute water into the subbase rather than a single concentrated point of discharge.

5.31 The details of the sections of permeable paving, cellular storage and flow control devices for all four catchments are included in the MicroDrainage output at **Appendix H**. The proposed SuDS layout is included at **Appendix J**.

5.32 The outputs in **Appendix H** show that each of the six catchments have been suitably designed to cater for all events up to and including the 1 in 100 year + 40% climate change.

5.33 It should be noted that all areas of permeable paving have been calculated based on existing site levels which vary from gradients of 1:40 to 1:100 (which can be seen in the MicroDrainage outputs in **Appendix H**) which has an impact on the required depth of storage. Therefore, if site levels change, the required depth of subbase may increase or decrease.

Water Quality

5.34 The proposal as outlined above therefore meets the water quality requirements as set out by Table 26.2 of the CIRIA SuDS Manual C753.

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6 Maintenance of Development Drainage

6.1 It is proposed that the maintenance of all elements of the surface water drainage system within the proposed development will be the responsibility of the site owner/manager.

6.2 Regular inspections of the permeable paving, storage tanks and online controls should be made, to ensure they are effective throughout the lifetime of the development and do not become blocked or damaged over time. Some maintenance activities for the permeable paving and cellular storage tanks detailed in CIRIA C753 'The SuDS Manual' are set out in Table 5.1 and 5.2 below.

Maintenance Schedule	Required Action	Frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration as necessary	Annually
	Remove sediment from pre-treatment structures and/or internal forebays	Annually or as required
Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build up and remove if necessary.	Every 5 years or as required

Table 6.1: Maintenance tasks for attenuation tanks (Source: CIRIA C753, The SuDS Manual)

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Maintenance Schedule	Required Action	Frequency
Regular maintenance	Brushing and vacuuming.	Three times per year at end of winter, mid-summer, after autumn leaf fall, or as required based on site specific observations of clogging or manufacturer's recommendations.
Occasional maintenance	Stabilise and mow contributing and adjacent areas.	As required.
	Removal of weeds.	As required.
Remedial actions	Remediate any landscaping which, through vegetation maintenance of soil slip, has been raised to within 50mm of the level of the paving.	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance of a hazard to the user.	As required
	Rehabilitation of surface and upper sub-surface.	As required (if infiltration performance is reduced as a result of significant clogging.)
Monitoring	Initial inspection	Monthly for 3 months after installation. 3 monthly, 48 hours after large storms.
	Inspect for evidence of poor operation and/or weed growth. If required, take remedial action.	Annually.
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually.
	Monitor inspection chambers.	Annually

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Table 6.2: Maintenance tasks for permeable paving (Source: CIRIA C753, The SuDS Manual)

6.3 It is recommended that during the first 12 months of operation all SuDS and drainage features are visually inspected on a monthly basis to determine any seasonal patterns this includes all SuDS features, inspection chambers, inlets, outlets and flow control devices. This will determine whether or not the recommended service intervals set out by CIRIA in the figures above will be sufficient for maintenance beyond the first year.

6.4 After the first 12 months, the maintenance schedule should be designed to at least meet the requirements set out by CIRIA for the permeable paving and the attenuation tank based on the outcome of the monitoring.

6.5 The orifice flow control devices and filters should be maintained in accordance with the manufacturer's recommendations. After the first 12 months, the flow controls should be inspected quarterly and following large storm events.

6.6 All inspection chambers and silt traps should be inspected on a bi-annual basis with further visual checks carried out throughout the year. These assets are likely to need maintenance more frequently within catchments 5 and 6 where roof drainage is draining to the permeable paving via a silt trap but this should be based on the first years monitoring and the frequency of maintenance should be adjusted as necessary throughout the lifetime of the development.

6.7 The watercourse along the eastern and southern boundary is assumed to be under riparian ownership and therefore should also be maintained as part of the maintenance schedule to ensure that there is a free flow of water and the outfalls from the site do not become blocked.

7 Conclusions

7.1 The site currently consists of a derelict former public house with associated hardstanding.

7.2 The site is located within Flood Zone 1 on the EA flood map, which indicates a 'low' risk of flooding from fluvial and tidal sources. 'Low' risk areas have an annual probability of flooding of less than 0.1% (or 1 in 1000 years).

7.3 The EA Flood Risk from Surface Water map included shows that the site is within an area at very low risk of surface water flooding.

7.4 The proposed SuDS drainage strategy will restrict the runoff from the proposed development to 3 l/s, significantly reducing the existing runoff from the site of 20.82 l/s.

7.5 The drainage system has been split into six catchments, each providing storage within the subbase of the permeable paving with catchments 3 and 4 discharging to the adjacent watercourse at 1 l/s via a 29mm orifice plate and suitable filter. Catchments 1, 2, 5 and 6 all discharging via an attenuation tank and restricted to 2 l/s via a 32mm orifice plate with a suitable filter.

7.6 The drainage system is proposed to outfall to an existing watercourse along the southern boundary of the site. The ditch flows south and connects to the Stour Brook approximately 3km south of the site.

7.7 It is assumed that all elements of the proposed drainage system will remain private and the responsibility for maintenance will remain with the site owner/manager.

7.8 During the first 12 months, visual inspections should be carried out on a monthly basis for all drainage assets. The maintenance schedule should then be amended to reflect specific site conditions but at a minimum must meet the requirements set out by CIRIA as shown in Tables 6.1 and 6.2 in Section 6.

7.9 Overall, the site is at low risk of flooding and development of the site with appropriate sustainable drainage features affords the opportunity to reduce flood risk downstream in accordance with local plan policies.

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8 Appendices

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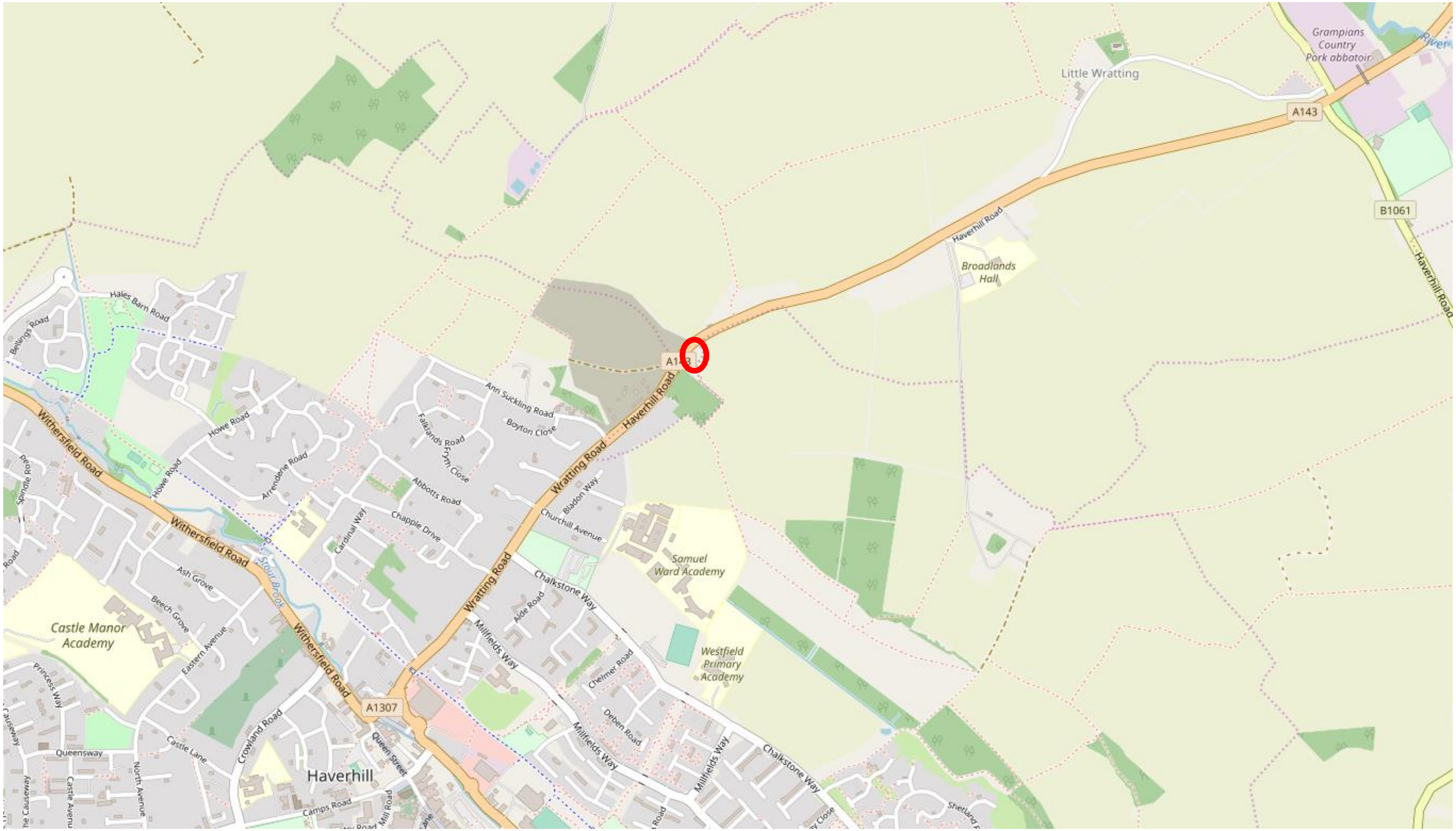
Appendix: A – Location Plan



Source: OpenStreetMap (https://www.openstreetmap.org/map)

Appendix: B – EA Flood Map for Planning

Environment Agency

Flood map for planning

Your reference
<Unspecified>

Location (easting/northing)
567915/246767

Scale
1:2500

Created
23 Jan 2020 13:43

- Selected point
- Flood zone 3
- Flood zone 3: areas benefitting from flood defences
- Flood zone 2
- Flood zone 1
- Flood defence
- Main river
- Flood storage area

0 20 40 60m

Appendix: C – Proposed Development Plans

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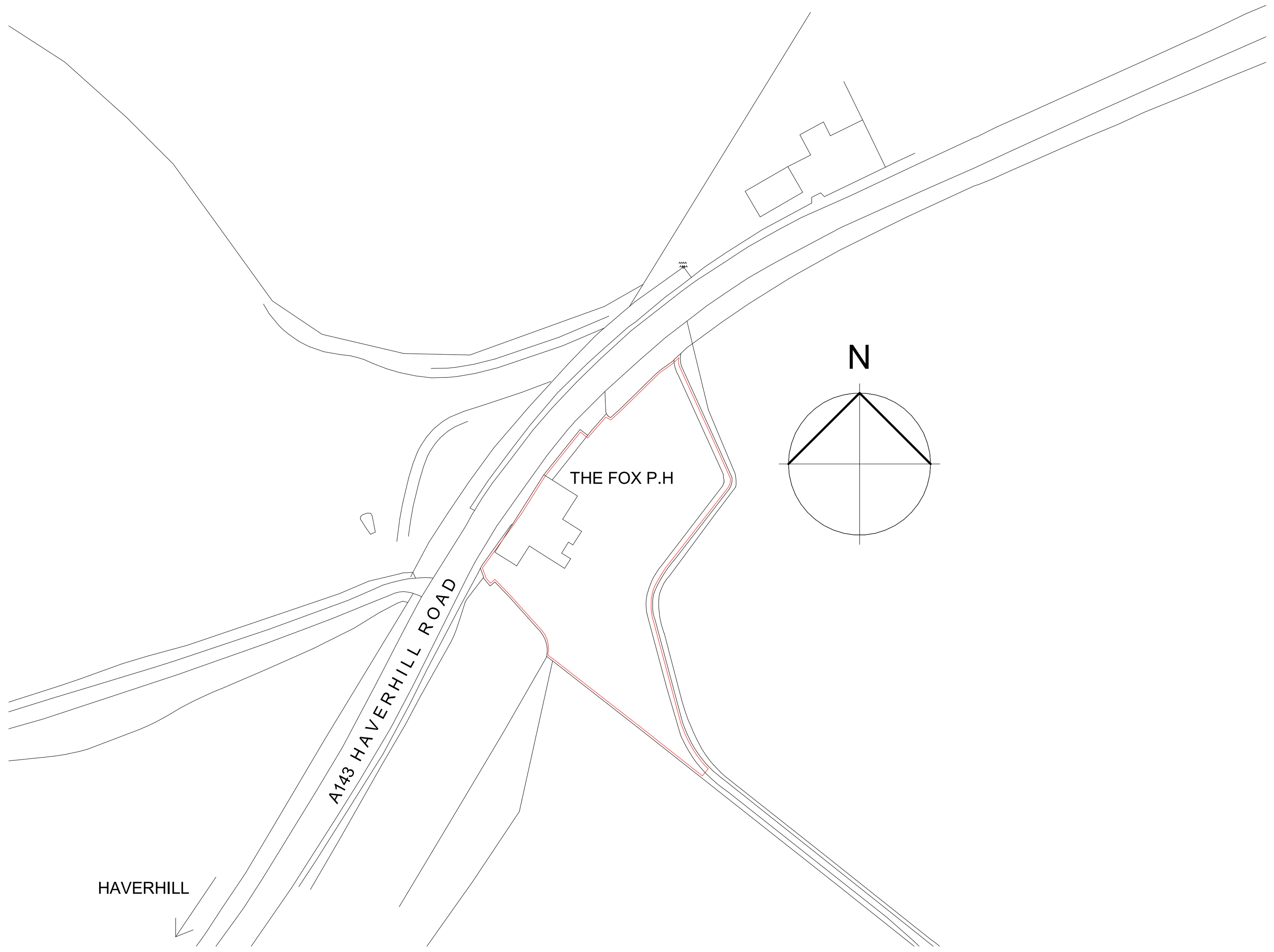
- This drawing is not to be scaled.
- Contractors must check all dimensions on site, Architect to be notified of any discrepancies in figured dimensions.
- This drawing is copyright.

Site
1 : 200



Location Plan
1 : 1250

10 0 10 20 30 40 50
SCALE 1:1250 m

2 0 2 4 6 8 10
SCALE 1:200 m

A			
Rev.	Drawn	Description	Date

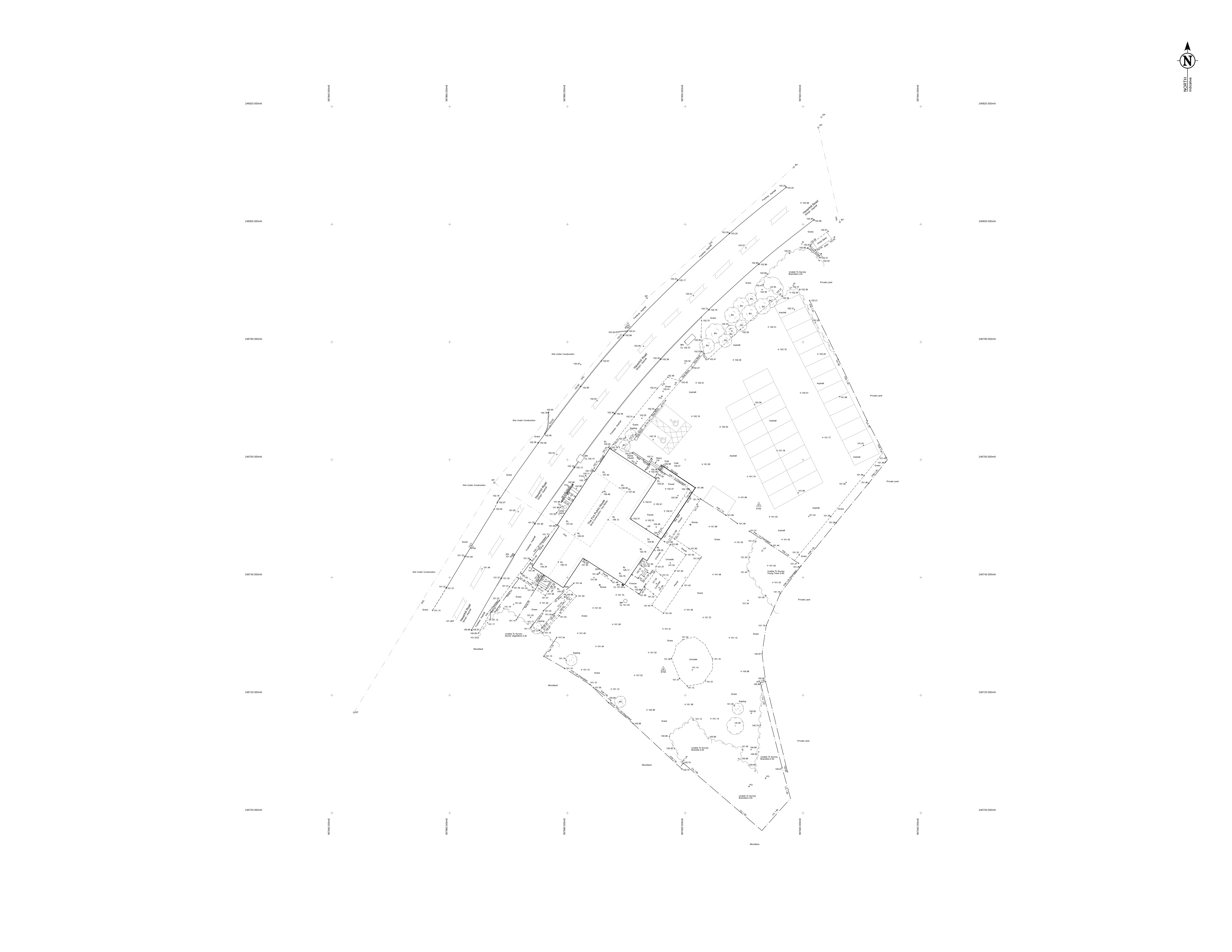
M P ARCHITECTS LLP
CHARTERED ARCHITECTS

Great Bansons, Bansons Lane, Ongar, Essex, CM5 9AR
T: 01277 364979 E: info@mparchitectsllp.co.uk
W: www.mparchitectsllp.co.uk

Status	Planning
Project	The Fox P.H, Haverhill Road, Little Wratting, Cambridgeshire. CB9 7UD
Drawing	Proposed Site & Location Plan

Scale	As indicated	Date	Dec 2019
Sheet Size	A1	Project no.	2234
Drawn by	mw	Drawing no.	12
Checked by	-	Revision	-

Appendix: D – Topographical Survey



TOPOGRAPHICAL & MEASURED BUILDING SURVEYS

ABBREVIATIONS & SYMBOLS

AH	Arch Head Height	FH	Fire Hydrant	RSJ	Rolled Steel Joist
AR	Assumed Route	FBD	Floor Board Direction	SI	Sign Post
AV	Air Valve	FH	Fire Hydrant	SP	Arch Spring Point Height
BB	Belisha Beacon	FL	Floor Level	SV	Stop Valve
BH	Bore Hole	FP	Flag Pole	SW	Surface Water
BL	Bed Level	FW	Foul Water	SY	Stay
BO	Bollard	GG	Gully Grate	Tac	Tactile Paving
BrP	Brace Post	GV	Gas Valve	TC	Telecom Cover
BS	Bus Stop	HH	Head Height	TH	Trial Pit
BU	Bush	IC	Inspection Cover	THL	Threshold Level
B/W	Barbed Wire Fence	IL	Invert Level	TL	Traffic Light
BX	Box (Utilities)	I/R	Iron Railings	ToW	Top of Wall
C/B	Close Board Fence	KO	Kerb Outlet	TP	Telegraph Pole
CH	Cill Height	LP	Lamp Post	TV	Cable TV Cover
CL	Cover Level	MH	Manhole	UB	Universal Beam
C/L	Chain Link Fence	MP	Marker Post	UC	Unknown Cover
C-Lev	Ceiling Level	NB	Name Board	UK	Unknown Tree
Col	Column	OHL	Overhead Line (approx)	USB	Under Side Beam
C/P	Chestnut Paling Fence	Pan	Panel Fence	UTL	Unable To Lift
CR	Cable Riser	PB	Post Box	VP	Vent Pipe
DC	Drainage Channel	PM	Parking Meter	WB	Waste Bin
DH	Door Head Height	PO	Post	WH	Weep Hole
DP	Down Pipe	P/R	Post & Rail Fence	WL	Water Level
DR	Drain	P/W	Post & Wire Fence	WM	Water Meter
EL	Eaves Level	P/Wall	Partition Wall	WO	Wash Out
EP	Electric Pole	RE	Rodding Eye	(x.xx)	Floor to Ceiling Height
ER	Earth Rod	RL	Ridge Level		
ET	EP+Transformer	RP	Reflector Post	(x.xx)F/C	Floor to False Ceiling Ht
FB	Flower Bed	RS	Road Sign		
FBD	Floor Board Direction	RSD	Roller Shutter Door	△	Survey Control Station

DRAWING NOTE

Topographical Surveys

Trees are drawn to scale showing the average canopy spread. Descriptions and heights should be used as a guide only.

All building names, descriptions, number of storeys, construction type including roof line details are indicative only and taken externally from ground level.

All below ground details including drainage, voids and services have been identified from above ground and therefore all details relating to these features including; sizes, depth, description etc will be approximate only. All critical dimensions and connections should be checked and verified prior to starting work.

Detail, services and features may not have been surveyed if obstructed or not reasonably visible at the time of the survey.

Measured Building Surveys

Measurements to internal walls are taken to the wall finishes at approx 1m above the floor level and the wall assumed to be vertical.

Cill heights are measured as floor to the cill and head heights are measured from cill to the top of window.

General

The contractor must check and verify all site and building dimensions, levels, utilities and drainage details and connections prior to commencing work. Any errors or discrepancies must be notified to Survey Solutions immediately.

The accuracy of the digital data is the same as the plotting scale implies. All dimensions are in metres unless otherwise stated.

The survey control listed is only to be used for topographical surveys at the stated scale. All control must be checked and verified prior to use.

Do not scale from this drawing.

CONTROL CO-ORDINATES

STATIONS	EASTINGS	NORTHINGS	LEVEL	DESCRIPTION
ST01	567890.281	246782.834	103.132	Mag Nail
ST02	567912.500	246752.317	101.585	Mag Nail
ST03	567896.265	246724.423	101.309	Mag Nail

SURVEY GRID AND LEVEL DATUM

The coordinate system established for this survey is related to Ordnance Survey (OS) national grid at a single point using Smartnet, then orientated to grid north with a scale factor of 1.000.

The level datum established for this survey is related to Ordnance Survey (OS) using GPS Smartnet.

To avoid discrepancies any coordinated data used in conjunction with this survey must be derived directly from this control data.

REV	DESCRIPTION	DRAWN	APPR	DATE

SURVEY SOLUTIONS

Ipswich Coventry Yeovil Norwich Perth Nottingham Brentwood

Tel No: 0845 0405 969
Fax No: 0845 0405 970
www.survey-solutions.co.uk
enquiries@survey-solutions.co.uk

LAND SURVEYING BUILDING SURVEYING UNDERGROUND SURVEYING

PROJECT TITLE
THE FOX PH, HAVERHILL ROAD,
LITTLE WRATTING, HAVERHILL, CB9 7UD.

DRAWING DETAIL
TOPOGRAPHICAL SURVEY
Sheet 1 of 1

CLIENT				SCALE
M P ARCHITECTS				1:200
SURVEYOR: JGS	SURVEY DATE: 18/12/2019	CHECKED BY: KJS	APPROVED BY: JIA	DWG STATUS: FINAL
DRAWING NUMBER: 25731ea-01			REVISION:	ISSUE DATE: 23/12/2019

Original Sheet Size A0H

Appendix: E – EA Surface Water Flood Map

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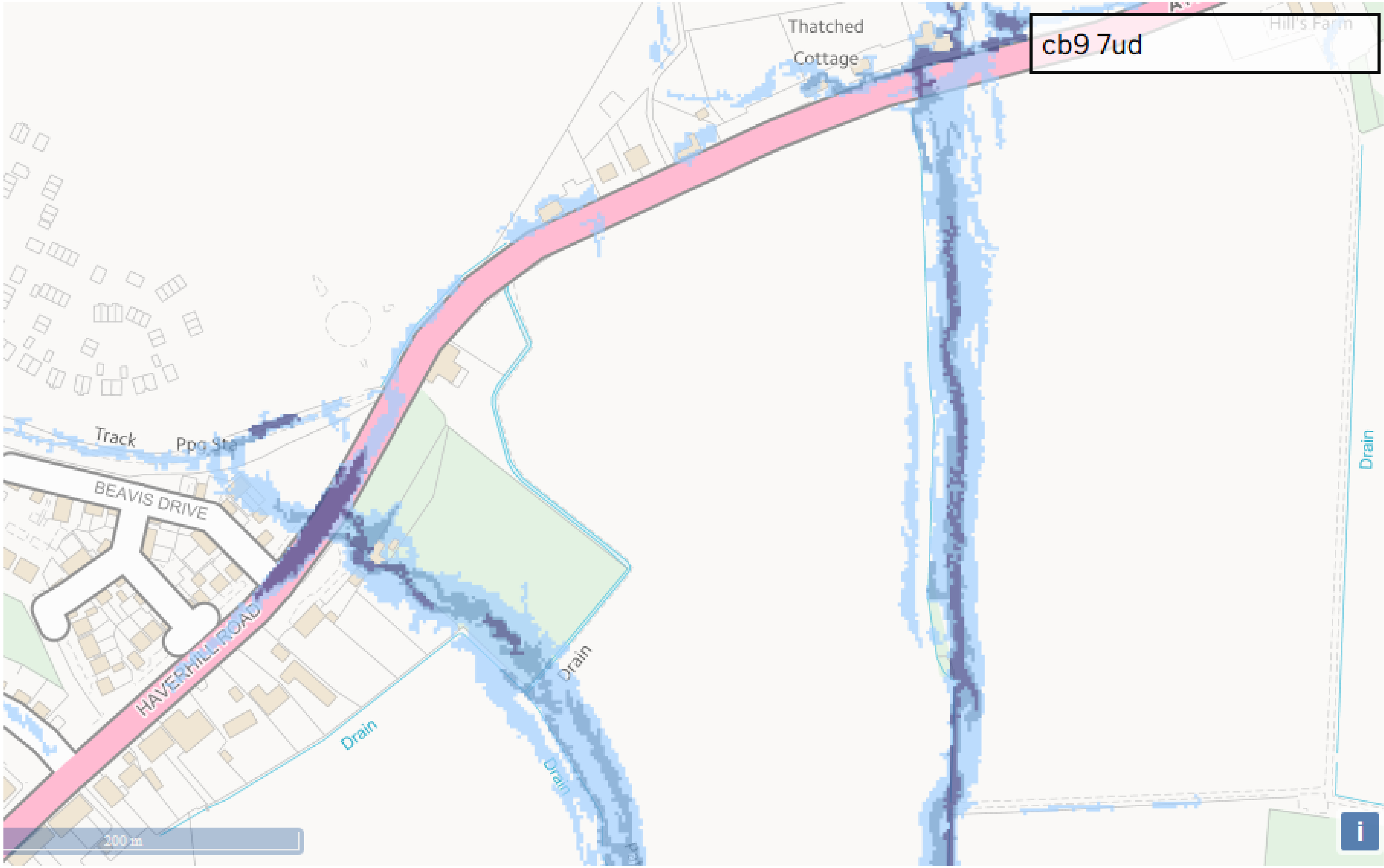

Source: Long Term Flood Risk Map (https://flood-warning-information.service.gov.uk/long-term-flood-risk/map)

Appendix: F – Existing Runoff Rate Calculations

Run-off from Existing Site

Methodology

Using the Modified Rational Method, the surface water run-off rate, has been calculated for the existing site which is assumed to be 100% impermeable.

Ref: Butler, D and Davies, J. (2006), Urban Drainage, 2nd ed, SPON.

Q = CiA

where

$$C = \frac{PIMP}{PR}$$

PIMP = Percentage of impervious area to total area
PR = Percentage Runoff

	Surface Area (m^2)
Existing Impervious Areas	1510
Total Area	3000

i (Rainfall intensity, mm/hr) = 50.00
i (Rainfall intensity, m/hr) = 0.050
i (Rainfall intensity, m/s) = 1.38×10^{-5}

Percentage run-off (PR)
Existing Impervious Area = 100%

Percentage of impervious area to total area (PIMP)
PIMP = 1510/3000 = 50.3%

Therefore $C = \frac{PIMP}{PR} = 0.503$

Runoff from existing site:
Q = CiA
$Q = 0.503 \times 1.38 \times 10^{-5} \times 3000 m^2$
$Q = 0.0208242\ m^3 s^{-1}$
$Q = 20.82\ ls^{-1}$

Total Q for the existing site = 20.82 ls^{-1}

Appendix: G – MicroDrainage Greenfield Runoff Rates

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ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.400
Area (ha)	1.000	Urban	0.000
SAAR (mm)	600	Region Number	Region 5

Results	**l/s**
QBAR Rural	2.8
QBAR Urban	2.8
Q100 years	10.1
Q1 year	2.5
Q30 years	6.8
Q100 years	10.1

Appendix: H - MicroDrainage Output

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

Half Drain Time : 196 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	101.541	0.131	0.0	0.8	0.8	9.4	Flood Risk
30 min Summer	101.564	0.154	0.0	0.8	0.8	12.7	Flood Risk
60 min Summer	101.585	0.175	0.0	0.9	0.9	15.6	Flood Risk
120 min Summer	101.598	0.188	0.0	0.9	0.9	17.5	Flood Risk
180 min Summer	101.600	0.190	0.0	0.9	0.9	17.8	Flood Risk
240 min Summer	101.600	0.190	0.0	0.9	0.9	17.7	Flood Risk
360 min Summer	101.597	0.187	0.0	0.9	0.9	17.3	Flood Risk
480 min Summer	101.592	0.182	0.0	0.9	0.9	16.7	Flood Risk
600 min Summer	101.587	0.177	0.0	0.9	0.9	16.0	Flood Risk
720 min Summer	101.582	0.172	0.0	0.9	0.9	15.2	Flood Risk
960 min Summer	101.572	0.162	0.0	0.9	0.9	13.8	Flood Risk
1440 min Summer	101.554	0.144	0.0	0.8	0.8	11.3	Flood Risk
2160 min Summer	101.533	0.123	0.0	0.7	0.7	8.4	Flood Risk
2880 min Summer	101.517	0.107	0.0	0.7	0.7	6.3	O K
4320 min Summer	101.493	0.083	0.0	0.6	0.6	3.8	O K
5760 min Summer	101.476	0.066	0.0	0.5	0.5	2.4	O K
7200 min Summer	101.465	0.055	0.0	0.4	0.4	1.7	O K
8640 min Summer	101.457	0.047	0.0	0.4	0.4	1.2	O K
10080 min Summer	101.453	0.043	0.0	0.4	0.4	1.0	O K
15 min Winter	101.551	0.141	0.0	0.8	0.8	10.8	Flood Risk
30 min Winter	101.577	0.167	0.0	0.9	0.9	14.6	Flood Risk
60 min Winter	101.601	0.191	0.0	0.9	0.9	17.9	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.590	0.0	10.0	25
30 min Summer	91.753	0.0	13.8	39
60 min Summer	57.005	0.0	17.7	66
120 min Summer	34.214	0.0	21.6	122
180 min Summer	25.048	0.0	24.0	162
240 min Summer	19.960	0.0	25.6	192
360 min Summer	14.451	0.0	27.9	256
480 min Summer	11.492	0.0	29.6	326
600 min Summer	9.614	0.0	30.9	394
720 min Summer	8.306	0.0	32.1	462
960 min Summer	6.589	0.0	33.9	596
1440 min Summer	4.748	0.0	36.4	856
2160 min Summer	3.416	0.0	38.9	1232
2880 min Summer	2.702	0.0	40.5	1588
4320 min Summer	1.939	0.0	42.6	2296
5760 min Summer	1.531	0.0	43.8	3000
7200 min Summer	1.274	0.0	44.5	3680
8640 min Summer	1.096	0.0	44.8	4408
10080 min Summer	0.965	0.0	44.9	5136
15 min Winter	140.590	0.0	11.5	25
30 min Winter	91.753	0.0	15.7	39
60 min Winter	57.005	0.0	20.1	66

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
120 min Winter	101.617	0.207	0.0	1.0	1.0	20.2	Flood Risk
180 min Winter	101.620	0.210	0.0	1.0	1.0	20.6	Flood Risk
240 min Winter	101.618	0.208	0.0	1.0	1.0	20.3	Flood Risk
360 min Winter	101.614	0.204	0.0	1.0	1.0	19.7	Flood Risk
480 min Winter	101.607	0.197	0.0	1.0	1.0	18.8	Flood Risk
600 min Winter	101.600	0.190	0.0	0.9	0.9	17.7	Flood Risk
720 min Winter	101.592	0.182	0.0	0.9	0.9	16.6	Flood Risk
960 min Winter	101.577	0.167	0.0	0.9	0.9	14.5	Flood Risk
1440 min Winter	101.552	0.142	0.0	0.8	0.8	11.0	Flood Risk
2160 min Winter	101.524	0.114	0.0	0.7	0.7	7.1	Flood Risk
2880 min Winter	101.503	0.093	0.0	0.6	0.6	4.7	O K
4320 min Winter	101.474	0.064	0.0	0.5	0.5	2.2	O K
5760 min Winter	101.458	0.048	0.0	0.4	0.4	1.3	O K
7200 min Winter	101.452	0.042	0.0	0.3	0.3	1.0	O K
8640 min Winter	101.448	0.038	0.0	0.3	0.3	0.8	O K
10080 min Winter	101.445	0.035	0.0	0.3	0.3	0.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
120 min Winter	34.214	0.0	24.5	120
180 min Winter	25.048	0.0	27.1	174
240 min Winter	19.960	0.0	28.9	202
360 min Winter	14.451	0.0	31.5	276
480 min Winter	11.492	0.0	33.5	352
600 min Winter	9.614	0.0	35.0	426
720 min Winter	8.306	0.0	36.3	500
960 min Winter	6.589	0.0	38.3	640
1440 min Winter	4.748	0.0	41.2	908
2160 min Winter	3.416	0.0	44.1	1280
2880 min Winter	2.702	0.0	46.1	1624
4320 min Winter	1.939	0.0	48.6	2300
5760 min Winter	1.531	0.0	50.1	2992
7200 min Winter	1.274	0.0	51.1	3680
8640 min Winter	1.096	0.0	51.6	4392
10080 min Winter	0.965	0.0	52.0	5096

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)	20.100	Shortest Storm (mins)	15
Ratio R	0.414	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.047

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.016	4	8	0.016	8	12	0.016

Model Details

Storage is Online Cover Level (m) 101.820

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	47.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	130.6	Slope (1:X)	78.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	101.410	Cap Volume Depth (m)	0.000

Orifice Outflow Control

Diameter (m) 0.033 Discharge Coefficient 0.600 Invert Level (m) 101.410

Cascade Summary of Results for Catchment 2.srcx

Upstream Structures	Outflow To	Overflow To
Catchment 1.srcx	(None)	(None)

Half Drain Time : 302 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	101.036	0.146	0.0	0.6	0.6	9.3	O K
30 min Summer	101.064	0.174	0.0	0.7	0.7	12.8	O K
60 min Summer	101.093	0.203	0.0	0.8	0.8	16.4	O K
120 min Summer	101.123	0.233	0.0	0.8	0.8	20.0	Flood Risk
180 min Summer	101.139	0.249	0.0	0.9	0.9	22.0	Flood Risk
240 min Summer	101.151	0.261	0.0	0.9	0.9	23.4	Flood Risk
360 min Summer	101.166	0.276	0.0	0.9	0.9	25.3	Flood Risk
480 min Summer	101.175	0.285	0.0	0.9	0.9	26.4	Flood Risk
600 min Summer	101.180	0.290	0.0	0.9	0.9	27.0	Flood Risk
720 min Summer	101.180	0.290	0.0	0.9	0.9	27.1	Flood Risk
960 min Summer	101.176	0.286	0.0	0.9	0.9	26.5	Flood Risk
1440 min Summer	101.165	0.275	0.0	0.9	0.9	25.2	Flood Risk
2160 min Summer	101.148	0.258	0.0	0.9	0.9	23.0	Flood Risk
2880 min Summer	101.130	0.240	0.0	0.8	0.8	20.8	Flood Risk
4320 min Summer	101.094	0.204	0.0	0.8	0.8	16.5	O K
5760 min Summer	101.064	0.174	0.0	0.7	0.7	12.7	O K
7200 min Summer	101.040	0.150	0.0	0.6	0.6	9.7	O K
8640 min Summer	101.020	0.130	0.0	0.6	0.6	7.4	O K
10080 min Summer	101.005	0.115	0.0	0.6	0.6	5.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.590	0.0	18.8	130
30 min Summer	91.753	0.0	25.8	165
60 min Summer	57.005	0.0	33.1	198
120 min Summer	34.214	0.0	40.5	238
180 min Summer	25.048	0.0	44.8	272
240 min Summer	19.960	0.0	47.8	302
360 min Summer	14.451	0.0	52.2	372
480 min Summer	11.492	0.0	55.4	488
600 min Summer	9.614	0.0	57.9	606
720 min Summer	8.306	0.0	60.0	722
960 min Summer	6.589	0.0	63.4	856
1440 min Summer	4.748	0.0	68.2	1080
2160 min Summer	3.416	0.0	72.8	1448
2880 min Summer	2.702	0.0	75.9	1824
4320 min Summer	1.939	0.0	79.8	2556
5760 min Summer	1.531	0.0	82.0	3256
7200 min Summer	1.274	0.0	83.3	3936
8640 min Summer	1.096	0.0	83.9	4624
10080 min Summer	0.965	0.0	84.1	5336

Cascade Summary of Results for Catchment 2.srcx

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	101.047	0.157	0.0	0.7	0.7	10.7	O K
30 min Winter	101.079	0.189	0.0	0.7	0.7	14.6	O K
60 min Winter	101.111	0.221	0.0	0.8	0.8	18.6	Flood Risk
120 min Winter	101.144	0.254	0.0	0.9	0.9	22.6	Flood Risk
180 min Winter	101.163	0.273	0.0	0.9	0.9	24.9	Flood Risk
240 min Winter	101.176	0.286	0.0	0.9	0.9	26.5	Flood Risk
360 min Winter	101.193	0.303	0.0	0.9	0.9	28.6	Flood Risk
480 min Winter	101.205	0.315	0.0	1.0	1.0	30.0	Flood Risk
600 min Winter	101.211	0.321	0.0	1.0	1.0	30.8	Flood Risk
720 min Winter	101.213	0.323	0.0	1.0	1.0	31.0	Flood Risk
960 min Winter	101.209	0.319	0.0	1.0	1.0	30.6	Flood Risk
1440 min Winter	101.193	0.303	0.0	0.9	0.9	28.7	Flood Risk
2160 min Winter	101.166	0.276	0.0	0.9	0.9	25.3	Flood Risk
2880 min Winter	101.135	0.245	0.0	0.8	0.8	21.5	Flood Risk
4320 min Winter	101.080	0.190	0.0	0.7	0.7	14.7	O K
5760 min Winter	101.039	0.149	0.0	0.6	0.6	9.7	O K
7200 min Winter	101.010	0.120	0.0	0.6	0.6	6.3	O K
8640 min Winter	100.988	0.098	0.0	0.5	0.5	4.2	O K
10080 min Winter	100.972	0.082	0.0	0.5	0.5	2.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	140.590	0.0	21.5	142
30 min Winter	91.753	0.0	29.4	176
60 min Winter	57.005	0.0	37.6	206
120 min Winter	34.214	0.0	45.9	246
180 min Winter	25.048	0.0	50.8	280
240 min Winter	19.960	0.0	54.2	310
360 min Winter	14.451	0.0	59.0	372
480 min Winter	11.492	0.0	62.7	482
600 min Winter	9.614	0.0	65.6	596
720 min Winter	8.306	0.0	67.9	706
960 min Winter	6.589	0.0	71.8	904
1440 min Winter	4.748	0.0	77.2	1120
2160 min Winter	3.416	0.0	82.6	1524
2880 min Winter	2.702	0.0	86.2	1908
4320 min Winter	1.939	0.0	91.0	2636
5760 min Winter	1.531	0.0	93.8	3296
7200 min Winter	1.274	0.0	95.6	3976
8640 min Winter	1.096	0.0	96.7	4640
10080 min Winter	0.965	0.0	97.3	5288

Cascade Rainfall Details for Catchment 2.srcx

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)	20.100	Shortest Storm (mins)	15
Ratio R	0.414	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.041

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.014	4	8	0.014	8	12	0.014

Cascade Model Details for Catchment 2.srcx

Storage is Online Cover Level (m) 101.400

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	41.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	113.9	Slope (1:X)	71.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	100.890	Cap Volume Depth (m)	0.000

Orifice Outflow Control

Diameter (m) 0.029 Discharge Coefficient 0.600 Invert Level (m) 100.890

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

Half Drain Time : 113 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	101.258	0.198	0.0	0.8	0.8	5.7	Flood Risk
30 min Summer	101.286	0.226	0.0	0.8	0.8	7.5	Flood Risk
60 min Summer	101.305	0.245	0.0	0.8	0.8	8.7	Flood Risk
120 min Summer	101.310	0.250	0.0	0.9	0.9	9.1	Flood Risk
180 min Summer	101.308	0.248	0.0	0.8	0.8	9.0	Flood Risk
240 min Summer	101.304	0.244	0.0	0.8	0.8	8.7	Flood Risk
360 min Summer	101.293	0.233	0.0	0.8	0.8	7.9	Flood Risk
480 min Summer	101.282	0.222	0.0	0.8	0.8	7.2	Flood Risk
600 min Summer	101.271	0.211	0.0	0.8	0.8	6.5	Flood Risk
720 min Summer	101.261	0.201	0.0	0.8	0.8	5.9	Flood Risk
960 min Summer	101.243	0.183	0.0	0.7	0.7	4.9	Flood Risk
1440 min Summer	101.212	0.152	0.0	0.7	0.7	3.4	Flood Risk
2160 min Summer	101.177	0.117	0.0	0.6	0.6	2.0	O K
2880 min Summer	101.153	0.093	0.0	0.5	0.5	1.3	O K
4320 min Summer	101.123	0.063	0.0	0.4	0.4	0.6	O K
5760 min Summer	101.106	0.046	0.0	0.3	0.3	0.3	O K
7200 min Summer	101.099	0.039	0.0	0.3	0.3	0.2	O K
8640 min Summer	101.095	0.035	0.0	0.2	0.2	0.2	O K
10080 min Summer	101.092	0.032	0.0	0.2	0.2	0.1	O K
15 min Winter	101.273	0.213	0.0	0.8	0.8	6.6	Flood Risk
30 min Winter	101.302	0.242	0.0	0.8	0.8	8.6	Flood Risk
60 min Winter	101.323	0.263	0.0	0.9	0.9	10.0	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	143.954	0.0	6.4	24
30 min Summer	92.629	0.0	8.5	37
60 min Summer	56.713	0.0	10.7	64
120 min Summer	33.583	0.0	12.9	104
180 min Summer	24.424	0.0	14.1	136
240 min Summer	19.389	0.0	15.0	170
360 min Summer	13.924	0.0	16.2	238
480 min Summer	11.018	0.0	17.1	304
600 min Summer	9.182	0.0	17.8	370
720 min Summer	7.908	0.0	18.4	436
960 min Summer	6.245	0.0	19.3	562
1440 min Summer	4.471	0.0	20.6	802
2160 min Summer	3.197	0.0	21.9	1156
2880 min Summer	2.518	0.0	22.8	1504
4320 min Summer	1.796	0.0	23.8	2208
5760 min Summer	1.413	0.0	24.5	2936
7200 min Summer	1.172	0.0	24.8	3640
8640 min Summer	1.006	0.0	25.0	4304
10080 min Summer	0.884	0.0	25.0	5072
15 min Winter	143.954	0.0	7.3	24
30 min Winter	92.629	0.0	9.7	37
60 min Winter	56.713	0.0	12.1	64

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)	Σ Max Outflow (l/s)	Max Volume (m³)	Status
120 min Winter	101.330	0.270	0.0	0.9	0.9	10.5	Flood Risk
180 min Winter	101.327	0.267	0.0	0.9	0.9	10.3	Flood Risk
240 min Winter	101.320	0.260	0.0	0.9	0.9	9.9	Flood Risk
360 min Winter	101.305	0.245	0.0	0.8	0.8	8.8	Flood Risk
480 min Winter	101.290	0.230	0.0	0.8	0.8	7.7	Flood Risk
600 min Winter	101.275	0.215	0.0	0.8	0.8	6.8	Flood Risk
720 min Winter	101.261	0.201	0.0	0.8	0.8	5.9	Flood Risk
960 min Winter	101.235	0.175	0.0	0.7	0.7	4.5	Flood Risk
1440 min Winter	101.193	0.133	0.0	0.6	0.6	2.6	Flood Risk
2160 min Winter	101.151	0.091	0.0	0.5	0.5	1.2	O K
2880 min Winter	101.126	0.066	0.0	0.4	0.4	0.6	O K
4320 min Winter	101.102	0.042	0.0	0.3	0.3	0.3	O K
5760 min Winter	101.095	0.035	0.0	0.2	0.2	0.2	O K
7200 min Winter	101.091	0.031	0.0	0.2	0.2	0.1	O K
8640 min Winter	101.088	0.028	0.0	0.2	0.2	0.1	O K
10080 min Winter	101.086	0.026	0.0	0.1	0.1	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
120 min Winter	33.583	0.0	14.5	116
180 min Winter	24.424	0.0	16.0	144
240 min Winter	19.389	0.0	16.9	182
360 min Winter	13.924	0.0	18.3	258
480 min Winter	11.018	0.0	19.3	328
600 min Winter	9.182	0.0	20.1	396
720 min Winter	7.908	0.0	20.8	464
960 min Winter	6.245	0.0	21.8	590
1440 min Winter	4.471	0.0	23.3	828
2160 min Winter	3.197	0.0	24.8	1168
2880 min Winter	2.518	0.0	25.8	1504
4320 min Winter	1.796	0.0	27.1	2184
5760 min Winter	1.413	0.0	27.9	2904
7200 min Winter	1.172	0.0	28.4	3648
8640 min Winter	1.006	0.0	28.7	4248
10080 min Winter	0.884	0.0	28.8	5056

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)	20.000	Shortest Storm (mins)	15
Ratio R	0.450	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.028

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.009	4	8	0.009	8	12	0.009

Model Details

Storage is Online Cover Level (m) 101.490

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	23.7
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	65.8	Slope (1:X)	41.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	101.060	Cap Volume Depth (m)	0.000

Orifice Outflow Control

Diameter (m) 0.029 Discharge Coefficient 0.600 Invert Level (m) 101.060

Cascade Summary of Results for Catchment 4.srcx

Upstream Structures	Outflow To	Overflow To
Catchment 3.srcx	(None)	(None)

Half Drain Time : 215 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	100.869	0.199	0.0	0.5	0.5	6.7	O K
30 min Summer	100.899	0.229	0.0	0.6	0.6	8.8	O K
60 min Summer	100.930	0.260	0.0	0.7	0.7	11.0	O K
120 min Summer	100.962	0.292	0.0	0.7	0.7	13.2	O K
180 min Summer	100.981	0.311	0.0	0.8	0.8	14.6	Flood Risk
240 min Summer	100.995	0.325	0.0	0.8	0.8	15.6	Flood Risk
360 min Summer	101.011	0.341	0.0	0.8	0.8	16.7	Flood Risk
480 min Summer	101.016	0.346	0.0	0.8	0.8	17.0	Flood Risk
600 min Summer	101.015	0.345	0.0	0.8	0.8	17.0	Flood Risk
720 min Summer	101.013	0.343	0.0	0.8	0.8	16.9	Flood Risk
960 min Summer	101.008	0.338	0.0	0.8	0.8	16.5	Flood Risk
1440 min Summer	100.994	0.324	0.0	0.8	0.8	15.5	Flood Risk
2160 min Summer	100.967	0.297	0.0	0.7	0.7	13.6	O K
2880 min Summer	100.941	0.271	0.0	0.7	0.7	11.8	O K
4320 min Summer	100.900	0.230	0.0	0.6	0.6	8.9	O K
5760 min Summer	100.873	0.203	0.0	0.5	0.5	7.0	O K
7200 min Summer	100.854	0.184	0.0	0.5	0.5	5.7	O K
8640 min Summer	100.840	0.170	0.0	0.4	0.4	4.9	O K
10080 min Summer	100.830	0.160	0.0	0.4	0.4	4.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.590	0.0	9.8	132
30 min Summer	91.753	0.0	14.1	156
60 min Summer	57.005	0.0	18.5	178
120 min Summer	34.214	0.0	23.0	206
180 min Summer	25.048	0.0	25.6	228
240 min Summer	19.960	0.0	27.4	252
360 min Summer	14.451	0.0	30.0	366
480 min Summer	11.492	0.0	32.0	478
600 min Summer	9.614	0.0	33.5	526
720 min Summer	8.306	0.0	34.8	580
960 min Summer	6.589	0.0	36.9	694
1440 min Summer	4.748	0.0	39.8	942
2160 min Summer	3.416	0.0	42.7	1312
2880 min Summer	2.702	0.0	44.6	1672
4320 min Summer	1.939	0.0	47.1	2380
5760 min Summer	1.531	0.0	48.7	3064
7200 min Summer	1.274	0.0	49.6	3760
8640 min Summer	1.096	0.0	50.2	4488
10080 min Summer	0.965	0.0	50.4	5160

Cascade Summary of Results for Catchment 4.srcx

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	100.881	0.211	0.0	0.5	0.5	7.5	O K
30 min Winter	100.914	0.244	0.0	0.6	0.6	9.8	O K
60 min Winter	100.948	0.278	0.0	0.7	0.7	12.2	O K
120 min Winter	100.983	0.313	0.0	0.8	0.8	14.8	Flood Risk
180 min Winter	101.005	0.335	0.0	0.8	0.8	16.3	Flood Risk
240 min Winter	101.020	0.350	0.0	0.9	0.9	17.4	Flood Risk
360 min Winter	101.039	0.369	0.0	0.9	0.9	18.6	Flood Risk
480 min Winter	101.045	0.375	0.0	0.9	0.9	19.1	Flood Risk
600 min Winter	101.044	0.374	0.0	0.9	0.9	19.0	Flood Risk
720 min Winter	101.041	0.371	0.0	0.9	0.9	18.8	Flood Risk
960 min Winter	101.033	0.363	0.0	0.9	0.9	18.2	Flood Risk
1440 min Winter	101.006	0.336	0.0	0.8	0.8	16.4	Flood Risk
2160 min Winter	100.961	0.291	0.0	0.7	0.7	13.2	O K
2880 min Winter	100.924	0.254	0.0	0.7	0.7	10.6	O K
4320 min Winter	100.875	0.205	0.0	0.5	0.5	7.1	O K
5760 min Winter	100.847	0.177	0.0	0.4	0.4	5.3	O K
7200 min Winter	100.829	0.159	0.0	0.4	0.4	4.3	O K
8640 min Winter	100.818	0.148	0.0	0.3	0.3	3.7	O K
10080 min Winter	100.811	0.141	0.0	0.3	0.3	3.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	140.590	0.0	11.5	140
30 min Winter	91.753	0.0	16.3	161
60 min Winter	57.005	0.0	21.2	182
120 min Winter	34.214	0.0	26.3	206
180 min Winter	25.048	0.0	29.2	224
240 min Winter	19.960	0.0	31.2	250
360 min Winter	14.451	0.0	34.2	360
480 min Winter	11.492	0.0	36.4	470
600 min Winter	9.614	0.0	38.1	560
720 min Winter	8.306	0.0	39.6	600
960 min Winter	6.589	0.0	41.9	726
1440 min Winter	4.748	0.0	45.2	988
2160 min Winter	3.416	0.0	48.6	1360
2880 min Winter	2.702	0.0	50.9	1712
4320 min Winter	1.939	0.0	53.9	2396
5760 min Winter	1.531	0.0	55.8	3080
7200 min Winter	1.274	0.0	57.0	3752
8640 min Winter	1.096	0.0	57.8	4488
10080 min Winter	0.965	0.0	58.3	5112

Cascade Rainfall Details for Catchment 4.srcx

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)	20.100	Shortest Storm (mins)	15
Ratio R	0.414	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.025

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.008	4	8	0.008	8	12	0.008

Cascade Model Details for Catchment 4.srcx

Storage is Online Cover Level (m) 101.280

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	23.5
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	65.3	Slope (1:X)	48.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	100.670	Cap Volume Depth (m)	0.000

Orifice Outflow Control

Diameter (m) 0.029 Discharge Coefficient 0.600 Invert Level (m) 100.770

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

Half Drain Time : 166 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	100.667	0.247	0.0	0.7	0.7	8.6	Flood Risk
30 min Summer	100.725	0.305	0.0	0.8	0.8	11.2	Flood Risk
60 min Summer	100.774	0.354	0.0	0.9	0.9	13.3	Flood Risk
120 min Summer	100.799	0.379	0.0	0.9	0.9	14.4	Flood Risk
180 min Summer	100.800	0.380	0.0	0.9	0.9	14.4	Flood Risk
240 min Summer	100.795	0.375	0.0	0.9	0.9	14.2	Flood Risk
360 min Summer	100.781	0.361	0.0	0.9	0.9	13.6	Flood Risk
480 min Summer	100.766	0.346	0.0	0.9	0.9	12.9	Flood Risk
600 min Summer	100.750	0.330	0.0	0.9	0.9	12.3	Flood Risk
720 min Summer	100.734	0.314	0.0	0.8	0.8	11.6	Flood Risk
960 min Summer	100.707	0.287	0.0	0.8	0.8	10.4	Flood Risk
1440 min Summer	100.662	0.242	0.0	0.7	0.7	8.4	Flood Risk
2160 min Summer	100.613	0.193	0.0	0.6	0.6	6.3	O K
2880 min Summer	100.578	0.158	0.0	0.6	0.6	4.7	O K
4320 min Summer	100.534	0.114	0.0	0.5	0.5	2.8	O K
5760 min Summer	100.509	0.089	0.0	0.4	0.4	1.7	O K
7200 min Summer	100.492	0.072	0.0	0.4	0.4	1.1	O K
8640 min Summer	100.479	0.059	0.0	0.3	0.3	0.8	O K
10080 min Summer	100.470	0.050	0.0	0.3	0.3	0.5	O K
15 min Winter	100.693	0.273	0.0	0.8	0.8	9.8	Flood Risk
30 min Winter	100.760	0.340	0.0	0.9	0.9	12.7	Flood Risk
60 min Winter	100.816	0.396	0.0	0.9	0.9	15.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.590	0.0	9.3	25
30 min Summer	91.753	0.0	12.3	38
60 min Summer	57.005	0.0	15.5	66
120 min Summer	34.214	0.0	18.7	120
180 min Summer	25.048	0.0	20.6	148
240 min Summer	19.960	0.0	21.9	180
360 min Summer	14.451	0.0	23.9	248
480 min Summer	11.492	0.0	25.3	318
600 min Summer	9.614	0.0	26.5	386
720 min Summer	8.306	0.0	27.5	454
960 min Summer	6.589	0.0	29.0	586
1440 min Summer	4.748	0.0	31.3	844
2160 min Summer	3.416	0.0	33.7	1216
2880 min Summer	2.702	0.0	35.4	1584
4320 min Summer	1.939	0.0	37.7	2292
5760 min Summer	1.531	0.0	39.4	3000
7200 min Summer	1.274	0.0	40.6	3680
8640 min Summer	1.096	0.0	41.6	4408
10080 min Summer	0.965	0.0	42.4	5136
15 min Winter	140.590	0.0	10.5	25
30 min Winter	91.753	0.0	13.9	38
60 min Winter	57.005	0.0	17.4	64

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
120 min Winter	100.848	0.428	0.0	1.0	1.0	16.6	Flood Risk
180 min Winter	100.847	0.427	0.0	1.0	1.0	16.5	Flood Risk
240 min Winter	100.841	0.421	0.0	1.0	1.0	16.3	Flood Risk
360 min Winter	100.822	0.402	0.0	0.9	0.9	15.4	Flood Risk
480 min Winter	100.799	0.379	0.0	0.9	0.9	14.4	Flood Risk
600 min Winter	100.776	0.356	0.0	0.9	0.9	13.4	Flood Risk
720 min Winter	100.754	0.334	0.0	0.9	0.9	12.4	Flood Risk
960 min Winter	100.715	0.295	0.0	0.8	0.8	10.7	Flood Risk
1440 min Winter	100.653	0.233	0.0	0.7	0.7	8.0	Flood Risk
2160 min Winter	100.591	0.171	0.0	0.6	0.6	5.3	O K
2880 min Winter	100.551	0.131	0.0	0.5	0.5	3.5	O K
4320 min Winter	100.505	0.085	0.0	0.4	0.4	1.6	O K
5760 min Winter	100.481	0.061	0.0	0.3	0.3	0.8	O K
7200 min Winter	100.467	0.047	0.0	0.3	0.3	0.5	O K
8640 min Winter	100.459	0.039	0.0	0.2	0.2	0.3	O K
10080 min Winter	100.455	0.035	0.0	0.2	0.2	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
120 min Winter	34.214	0.0	21.1	120
180 min Winter	25.048	0.0	23.2	164
240 min Winter	19.960	0.0	24.7	192
360 min Winter	14.451	0.0	26.8	268
480 min Winter	11.492	0.0	28.5	342
600 min Winter	9.614	0.0	29.8	416
720 min Winter	8.306	0.0	30.9	486
960 min Winter	6.589	0.0	32.6	624
1440 min Winter	4.748	0.0	35.2	888
2160 min Winter	3.416	0.0	37.9	1260
2880 min Winter	2.702	0.0	39.8	1620
4320 min Winter	1.939	0.0	42.5	2300
5760 min Winter	1.531	0.0	44.4	2992
7200 min Winter	1.274	0.0	45.9	3672
8640 min Winter	1.096	0.0	47.0	4368
10080 min Winter	0.965	0.0	48.0	5128

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)	20.100	Shortest Storm (mins)	15
Ratio R	0.414	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.038

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.013	4	8	0.013	8	12	0.013

Model Details

Storage is Online Cover Level (m) 100.950

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	14.6
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	40.6	Slope (1:X)	100.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	100.420	Cap Volume Depth (m)	0.000

Orifice Outflow Control

Diameter (m) 0.027 Discharge Coefficient 0.600 Invert Level (m) 100.420

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

Half Drain Time : 226 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	100.498	0.288	0.0	0.7	0.7	11.1	Flood Risk
30 min Summer	100.548	0.338	0.0	0.8	0.8	14.5	Flood Risk
60 min Summer	100.593	0.383	0.0	0.9	0.9	17.6	Flood Risk
120 min Summer	100.622	0.412	0.0	0.9	0.9	19.6	Flood Risk
180 min Summer	100.626	0.416	0.0	0.9	0.9	19.8	Flood Risk
240 min Summer	100.624	0.414	0.0	0.9	0.9	19.6	Flood Risk
360 min Summer	100.615	0.405	0.0	0.9	0.9	19.1	Flood Risk
480 min Summer	100.604	0.394	0.0	0.9	0.9	18.4	Flood Risk
600 min Summer	100.593	0.383	0.0	0.9	0.9	17.6	Flood Risk
720 min Summer	100.582	0.372	0.0	0.8	0.8	16.8	Flood Risk
960 min Summer	100.560	0.350	0.0	0.8	0.8	15.3	Flood Risk
1440 min Summer	100.523	0.313	0.0	0.8	0.8	12.8	Flood Risk
2160 min Summer	100.479	0.269	0.0	0.7	0.7	9.8	Flood Risk
2880 min Summer	100.445	0.235	0.0	0.7	0.7	7.5	Flood Risk
4320 min Summer	100.393	0.183	0.0	0.6	0.6	4.5	O K
5760 min Summer	100.355	0.145	0.0	0.5	0.5	2.9	O K
7200 min Summer	100.327	0.117	0.0	0.5	0.5	1.9	O K
8640 min Summer	100.307	0.097	0.0	0.4	0.4	1.3	O K
10080 min Summer	100.291	0.081	0.0	0.4	0.4	0.9	O K
15 min Winter	100.520	0.310	0.0	0.8	0.8	12.6	Flood Risk
30 min Winter	100.577	0.367	0.0	0.8	0.8	16.5	Flood Risk
60 min Winter	100.629	0.419	0.0	0.9	0.9	20.0	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.590	0.0	11.8	25
30 min Summer	91.753	0.0	15.7	39
60 min Summer	57.005	0.0	19.8	66
120 min Summer	34.214	0.0	24.0	122
180 min Summer	25.048	0.0	26.4	174
240 min Summer	19.960	0.0	28.1	202
360 min Summer	14.451	0.0	30.6	264
480 min Summer	11.492	0.0	32.4	332
600 min Summer	9.614	0.0	33.9	402
720 min Summer	8.306	0.0	35.1	470
960 min Summer	6.589	0.0	37.2	606
1440 min Summer	4.748	0.0	40.1	870
2160 min Summer	3.416	0.0	43.0	1252
2880 min Summer	2.702	0.0	45.2	1616
4320 min Summer	1.939	0.0	48.1	2332
5760 min Summer	1.531	0.0	50.1	3008
7200 min Summer	1.274	0.0	51.6	3744
8640 min Summer	1.096	0.0	52.8	4416
10080 min Summer	0.965	0.0	53.7	5144
15 min Winter	140.590	0.0	13.3	25
30 min Winter	91.753	0.0	17.7	39
60 min Winter	57.005	0.0	22.3	66

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
120 min Winter	100.664	0.454	0.0	0.9	0.9	22.4	Flood Risk
180 min Winter	100.672	0.462	0.0	0.9	0.9	22.9	Flood Risk
240 min Winter	100.668	0.458	0.0	0.9	0.9	22.7	Flood Risk
360 min Winter	100.656	0.446	0.0	0.9	0.9	21.9	Flood Risk
480 min Winter	100.642	0.432	0.0	0.9	0.9	20.9	Flood Risk
600 min Winter	100.626	0.416	0.0	0.9	0.9	19.8	Flood Risk
720 min Winter	100.610	0.400	0.0	0.9	0.9	18.7	Flood Risk
960 min Winter	100.578	0.368	0.0	0.8	0.8	16.6	Flood Risk
1440 min Winter	100.525	0.315	0.0	0.8	0.8	12.9	Flood Risk
2160 min Winter	100.464	0.254	0.0	0.7	0.7	8.8	Flood Risk
2880 min Winter	100.419	0.209	0.0	0.6	0.6	6.0	O K
4320 min Winter	100.353	0.143	0.0	0.5	0.5	2.8	O K
5760 min Winter	100.312	0.102	0.0	0.4	0.4	1.4	O K
7200 min Winter	100.287	0.077	0.0	0.4	0.4	0.8	O K
8640 min Winter	100.271	0.061	0.0	0.3	0.3	0.5	O K
10080 min Winter	100.260	0.050	0.0	0.3	0.3	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
120 min Winter	34.214	0.0	27.0	122
180 min Winter	25.048	0.0	29.7	176
240 min Winter	19.960	0.0	31.6	226
360 min Winter	14.451	0.0	34.4	282
480 min Winter	11.492	0.0	36.5	358
600 min Winter	9.614	0.0	38.1	434
720 min Winter	8.306	0.0	39.5	508
960 min Winter	6.589	0.0	41.8	652
1440 min Winter	4.748	0.0	45.1	926
2160 min Winter	3.416	0.0	48.5	1308
2880 min Winter	2.702	0.0	50.9	1672
4320 min Winter	1.939	0.0	54.3	2344
5760 min Winter	1.531	0.0	56.6	3008
7200 min Winter	1.274	0.0	58.4	3680
8640 min Winter	1.096	0.0	59.8	4408
10080 min Winter	0.965	0.0	60.9	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)	20.100	Shortest Storm (mins)	15
Ratio R	0.414	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.049

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.016	4	8	0.016	8	12	0.016

Model Details

Storage is Online Cover Level (m) 100.740

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	22.7
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	63.1	Slope (1:X)	40.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	100.210	Cap Volume Depth (m)	0.475

Orifice Outflow Control

Diameter (m) 0.026 Discharge Coefficient 0.600 Invert Level (m) 100.210

Cascade Summary of Results for Tank Revised.srcx

Upstream Structures	Outflow To	Overflow To
Catchment 2.srcx	(None)	(None)
Catchment 1.srcx		
Catchment 5.srcx		
Catchment 6.srcx		

Half Drain Time : 227 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	99.227	0.227	0.0	1.1	1.1	16.1	O K
30 min Summer	99.287	0.287	0.0	1.3	1.3	20.4	O K
60 min Summer	99.347	0.347	0.0	1.4	1.4	24.7	O K
120 min Summer	99.406	0.406	0.0	1.5	1.5	28.9	O K
180 min Summer	99.439	0.439	0.0	1.6	1.6	31.3	O K
240 min Summer	99.461	0.461	0.0	1.6	1.6	32.8	O K
360 min Summer	99.489	0.489	0.0	1.7	1.7	34.9	O K
480 min Summer	99.508	0.508	0.0	1.7	1.7	36.2	O K
600 min Summer	99.520	0.520	0.0	1.7	1.7	37.0	O K
720 min Summer	99.528	0.528	0.0	1.7	1.7	37.6	O K
960 min Summer	99.533	0.533	0.0	1.7	1.7	38.0	O K
1440 min Summer	99.517	0.517	0.0	1.7	1.7	36.8	O K
2160 min Summer	99.484	0.484	0.0	1.6	1.6	34.5	O K
2880 min Summer	99.452	0.452	0.0	1.6	1.6	32.2	O K
4320 min Summer	99.389	0.389	0.0	1.5	1.5	27.7	O K
5760 min Summer	99.332	0.332	0.0	1.4	1.4	23.6	O K
7200 min Summer	99.284	0.284	0.0	1.2	1.2	20.2	O K
8640 min Summer	99.245	0.245	0.0	1.2	1.2	17.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	140.590	0.0	39.4	310
30 min Summer	91.753	0.0	53.3	375
60 min Summer	57.005	0.0	68.2	440
120 min Summer	34.214	0.0	83.0	514
180 min Summer	25.048	0.0	91.7	566
240 min Summer	19.960	0.0	97.7	608
360 min Summer	14.451	0.0	106.4	684
480 min Summer	11.492	0.0	112.9	756
600 min Summer	9.614	0.0	118.1	826
720 min Summer	8.306	0.0	122.4	898
960 min Summer	6.589	0.0	129.3	1042
1440 min Summer	4.748	0.0	139.1	1296
2160 min Summer	3.416	0.0	149.4	1636
2880 min Summer	2.702	0.0	156.3	1984
4320 min Summer	1.939	0.0	165.5	2688
5760 min Summer	1.531	0.0	171.5	3376
7200 min Summer	1.274	0.0	175.5	4064
8640 min Summer	1.096	0.0	178.2	4760

Cascade Summary of Results for Tank Revised.srcx

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
10080 min Summer	99.214	0.214	0.0	1.1	1.1	15.2	O K
15 min Winter	99.251	0.251	0.0	1.2	1.2	17.9	O K
30 min Winter	99.317	0.317	0.0	1.3	1.3	22.6	O K
60 min Winter	99.384	0.384	0.0	1.5	1.5	27.3	O K
120 min Winter	99.449	0.449	0.0	1.6	1.6	32.0	O K
180 min Winter	99.486	0.486	0.0	1.7	1.7	34.6	O K
240 min Winter	99.510	0.510	0.0	1.7	1.7	36.4	O K
360 min Winter	99.543	0.543	0.0	1.7	1.7	38.7	O K
480 min Winter	99.564	0.564	0.0	1.8	1.8	40.2	O K
600 min Winter	99.578	0.578	0.0	1.8	1.8	41.2	O K
720 min Winter	99.586	0.586	0.0	1.8	1.8	41.8	O K
960 min Winter	99.593	0.593	0.0	1.8	1.8	42.3	O K
1440 min Winter	99.575	0.575	0.0	1.8	1.8	41.0	O K
2160 min Winter	99.526	0.526	0.0	1.7	1.7	37.5	O K
2880 min Winter	99.473	0.473	0.0	1.6	1.6	33.7	O K
4320 min Winter	99.371	0.371	0.0	1.4	1.4	26.5	O K
5760 min Winter	99.291	0.291	0.0	1.3	1.3	20.8	O K
7200 min Winter	99.233	0.233	0.0	1.1	1.1	16.6	O K
8640 min Winter	99.189	0.189	0.0	1.0	1.0	13.5	O K
10080 min Winter	99.156	0.156	0.0	0.9	0.9	11.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Summer	0.965	0.0	179.9	5456
15 min Winter	140.590	0.0	44.9	334
30 min Winter	91.753	0.0	60.5	402
60 min Winter	57.005	0.0	77.2	470
120 min Winter	34.214	0.0	93.8	548
180 min Winter	25.048	0.0	103.5	600
240 min Winter	19.960	0.0	110.3	642
360 min Winter	14.451	0.0	120.0	718
480 min Winter	11.492	0.0	127.4	790
600 min Winter	9.614	0.0	133.2	860
720 min Winter	8.306	0.0	138.1	930
960 min Winter	6.589	0.0	145.9	1074
1440 min Winter	4.748	0.0	157.0	1360
2160 min Winter	3.416	0.0	168.8	1700
2880 min Winter	2.702	0.0	176.8	2060
4320 min Winter	1.939	0.0	187.6	2756
5760 min Winter	1.531	0.0	194.9	3440
7200 min Winter	1.274	0.0	199.8	4120
8640 min Winter	1.096	0.0	203.4	4800
10080 min Winter	0.965	0.0	205.9	5472

Cascade Rainfall Details for Tank Revised.srcx

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)	20.100	Shortest Storm (mins)	15
Ratio R	0.414	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.000

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.000

Cascade Model Details for Tank Revised.srcx

Storage is Online Cover Level (m) 100.100

Cellular Storage Structure

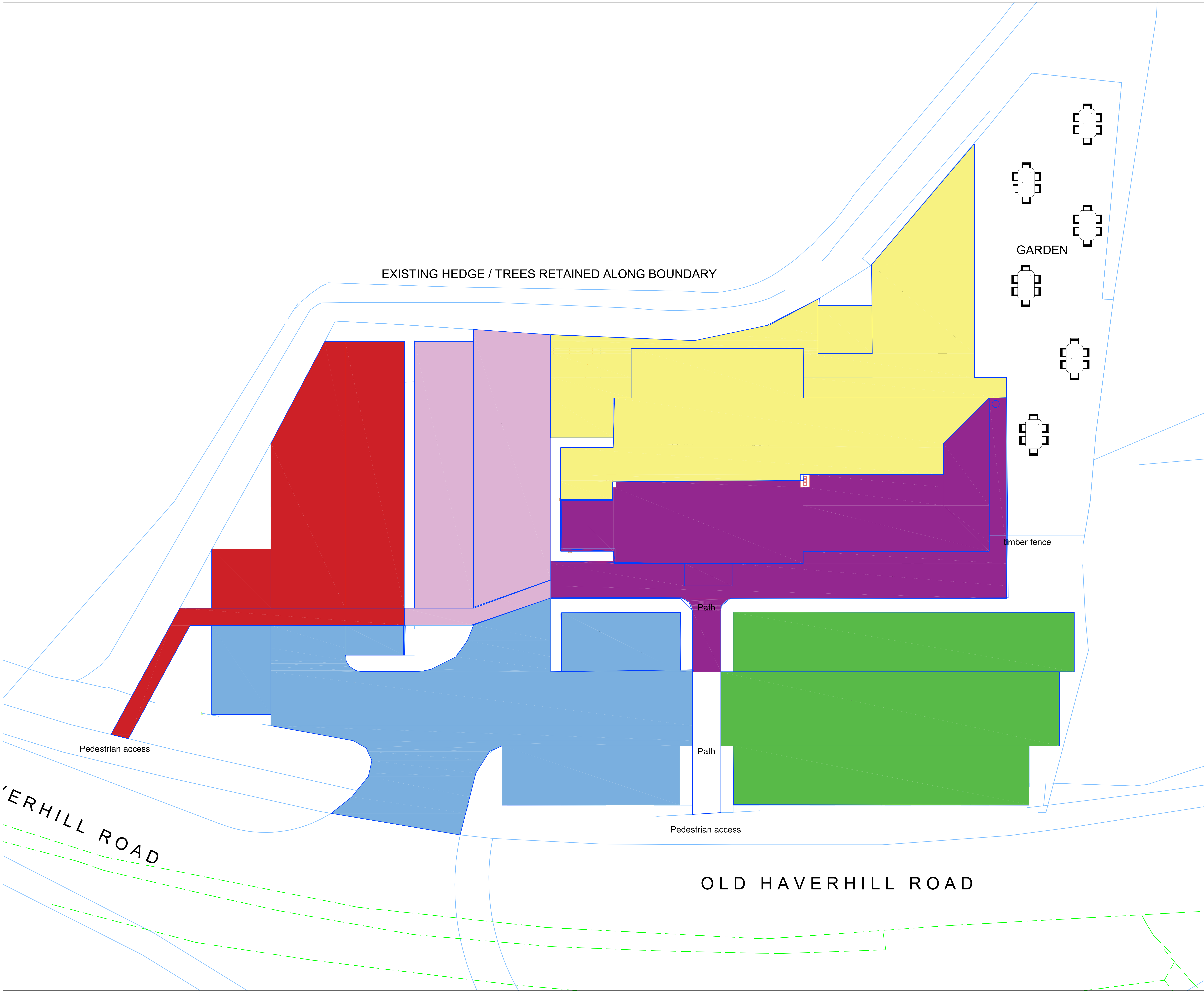
Invert Level (m) 99.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	75.0	75.0	0.700	0.0	99.0
0.600	75.0	99.0			

Orifice Outflow Control

Diameter (m) 0.034 Discharge Coefficient 0.600 Invert Level (m) 99.000

Appendix: I - Drainage Catchment Areas



KEY

- CATCHMENT 1
- CATCHMENT 2
- CATCHMENT 3
- CATCHMENT 4
- CATCHMENT 5
- CATCHMENT 6

REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS: PLANNING

EAS
Unit 23, The Maltings, Stanstead Abbotts, Hertfordshire, SG12 8HG
Tel: 01920 871777
www.eastp.co.uk

CLIENT:

ARCHITECT:

PROJECT: THE FOX PH

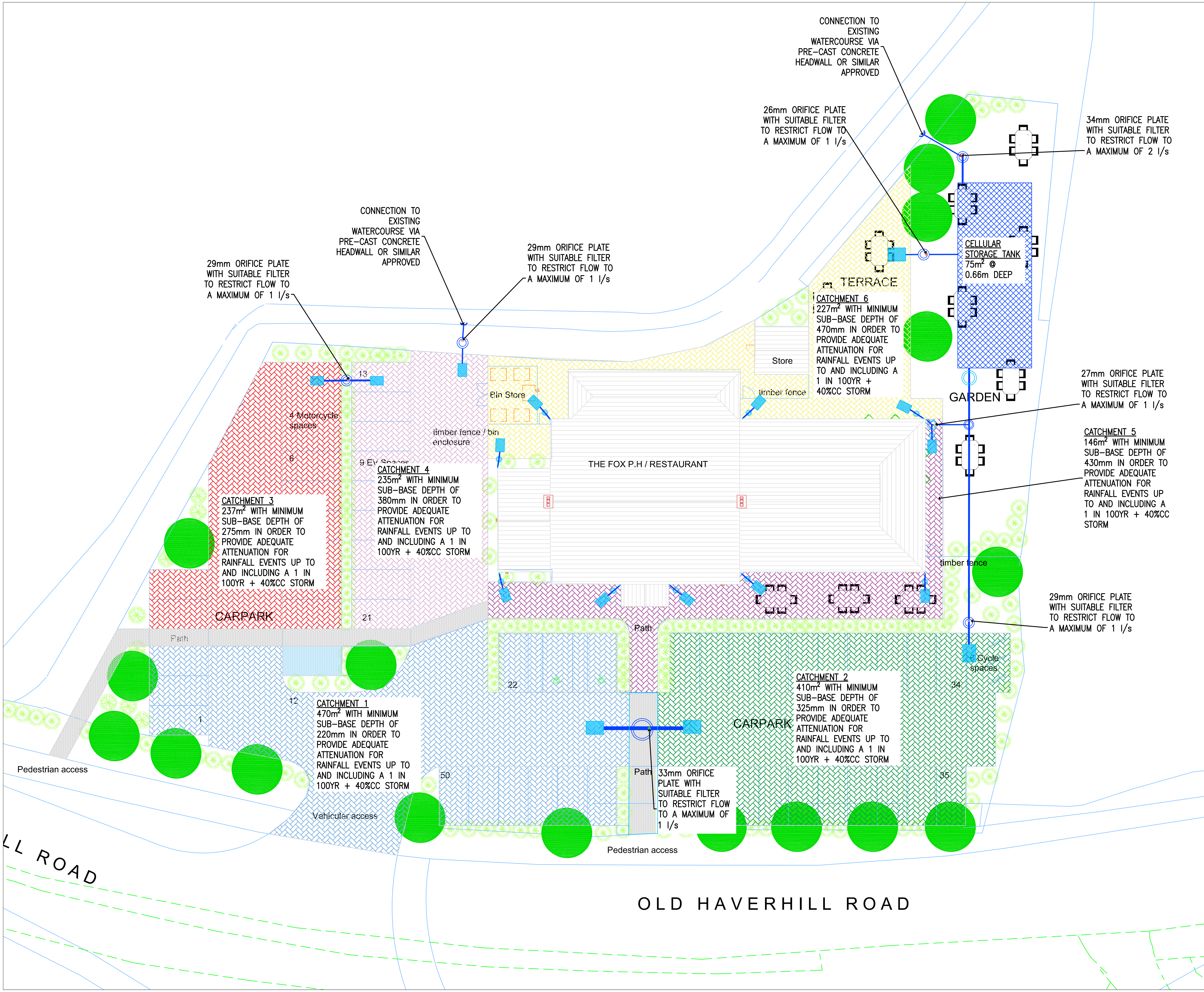
TITLE: SURFACE WATER DRAINAGE CATCHMENTS

SCALE @ A2:	DESIGN–DRAWN:	DATE:
1:200	ML	29/01/2020

PROJECT No:	DRAWING No:
2581	SK01

Appendix: J – SuDS Layout

TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG **Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk**



KEY

- CATCHMENT 1 PERMEABLE PAVING
- CATCHMENT 2 PERMEABLE PAVING
- CATCHMENT 3 PERMEABLE PAVING
- CATCHMENT 4 PERMEABLE PAVING
- CATCHMENT 5 PERMEABLE PAVING
- CATCHMENT 6 PERMEABLE PAVING
- CELLULAR STORAGE TANK
- PRIVATE SURFACE WATER SEWERS
- SURFACE WATER INSPECTION CHAMBER
- RAINWATER DOWNPIPES
- SILT TRAP SUCH AS RIDGISTORMSEPERATE PREFABRICATED SILT TRAPS OR SIMILAR APPROVED.
- DISTRIBUTION BOX SUCH AS PERMAVOID DIFFUSER UNITS OR SIMILAR APPROVED
- 33mm ORIFICE PLATE
- 29mm ORIFICE PLATE
- 27mm ORIFICE PLATE
- 26mm ORIFICE PLATE
- 34mm ORIFICE PLATE

REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS: PLANNING

EAS

Unit 23, The Maltings, Stanstead Abbotts, Hertfordshire, SG12 8HG
Tel: 01920 871777
www.eastp.co.uk

CLIENT:

ARCHITECT:

PROJECT: THE FOX PUBLIC HOUSE

TITLE: SUDS LAYOUT

SCALE @ A2:	DESIGN-DRAWN:	DATE:
1:200	ML	30/01/2020

PROJECT No:	DRAWING No:
2581	SK02