Flood Risk Assessment & SuDS Report

February 2022

EAS

Garden Village
Land off Smiths Green
Takeley

Weston Homes

EAS

Document History

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1 Introduction

1.1 This Flood Risk Assessment and SuDS report has been prepared in support of an application by Weston Homes for a residential development at Warish Hall Farm, Takeley Essex. A location plan is included in **Appendix A.**

1.2 The site covers 2.1 hectares of currently undeveloped land. Proposals are for residential development, open space and associated works. A development layout is enclosed in **Appendix B.**

1.3 The site is located in Flood Zone 1, at low risk of fluvial flooding and is shown to be at very low risk of surface water flooding however, as the site exceeds 1 hectare, a full flood risk assessment is required. This report will examine all sources of flood risk to the site and consider suitable mitigation measures and a sustainable drainage strategy.

1.4 A previous application for a much larger 24ha area, which included the Garden Village site, was made in September 2021. The application was unsuccessful, however initial holding objections received from the by Essex County Council in their role as the Lead Local Flood Authority (LLFA) were addressed within the consultation period and removed as part of the application. All principles agreed with the LLFA in the previous consultation period have been retained as part of this revised application and therefore it is anticipated will be accepted on the same grounds as previously agreed.

1.5 The contents of this FRA and drainage report are based on the advice set out in The National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG). It was also based on local policy including the SuDS Design Guide for Essex and site-specific investigations.

1.6 This document includes the following sections:

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;

Section 5 – details of the proposed surface water management;

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. This FRA is based on the advice set out in the National Planning Policy Framework (NPPF) published in July 2021 and the Planning Practice Guidance (PPG) published March 2014, which is updated on an ad hoc basis.

National Planning Policy Framework

2.2 Paragraph 167 footnote 55 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."

The flood zones are defined as:

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

2.3 Paragraph 159 discusses the suitability of development location, particularly with regards 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".

2.4 Paragraph 160 of the National Planning Policy Framework (NPPF) sets out how:

"Strategic policies should be informed by a strategic flood risk assessment, and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards".

2.5 The EA Flood Map for Planning enclosed in **Appendix C** shows the site to be located in Flood Zone 1, land assessed as having a less than 1 in 1,000 (<0.1%) annual probability of flooding.

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The Sustainable Drainage Systems Design Guide for Essex

2.6 This guide was prepared by Essex County Council to aid developers, designers and consultants in the design of Sustainable Drainage Systems (SuDS) in Essex. The guidance is intended to advise on the planning, design and delivery of attractive and high-quality SuDS scheme to benefit both the environment and the community. The website contains all the information on the SuDS Design Guide for Essex and can be accessed here: [redacted]

2.7 This guidance was considered and used to inform the development of the proposed SuDS strategy for the site.

Uttlesford District Adopted Local Plan 2005

2.8 The 'Uttlesford Local Plan 2019' draft was withdrawn in April 2020 and will now commence a new draft.

2.9 Once complete the new Local Plan will guide development in the district until 2033. The new local plan will set out areas suitable for new housing and will ensure the necessary infrastructure is put in place to support the growth expected in the district.

2.10 In the meantime, the Uttlesford Adopted Local Plan 2005 is the relevant document.

2.11 Policy GEN3: Flood Protection of the Adopted Local Plan 2005 states:

"Outside flood risk areas development must not increase the risk of flooding through surface water run-off. A flood risk assessment will be required to demonstrate this. Sustainable Drainage Systems should also be considered as an appropriate flood mitigation measure in the first instance.

For all areas where development will be exposed to or may lead to an increase in the risk of flooding applications will be accompanied by a full Flood Risk Assessment (FRA) which sets out the level of risk associated with the proposed development. The FRA will show that the proposed development can be provided with the appropriate minimum standard of protection throughout its lifetime and will demonstrate the effectiveness of flood mitigation measures proposed."

2.12 This report demonstrates that the proposed development will use SuDS methods to manage the volume and rate of surface water runoff and the proposals will not increase flood risk to the local area.

Uttlesford District Council Strategic Flood Risk Assessment (May 2016)

2.13 The Uttlesford Strategic Flood Risk Assessment (SFRA) was published in May 2016, providing an update to the original report which was published in 2008 in response to several legislative changes including the Flood and Water Management Act of 2010 and SuDS guidance published in 2015.

2.14 Uttlesford is located within the headwaters of three major catchments including the Great Ouse, North Essex and Thames. Surface water flooding and flooding sourced from ordinary watercourses is noted as a significant issue across the district.

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2.15 Map 5 of the SFRA shows there have been no recorded flood incidents at the site or within the vicinity of the site.

2.16 Map 6 confirms the site is located in Flood Zone 1.

2.17 Map 7 shows there is a culvert to the south of the site within the existing residential development.

2.18 Map 8 shows the extent of surface water flood across the district. The site is shown not be located within a surface water flood extent.

2.19 Map 9 of the SFRA shows the susceptibility of groundwater flooding across the district. The site is shown to be located in an area with < 25% susceptibility of groundwater flooding.

2.20 Map 10 shows the number of recorded sewer flooding incidents across the district categorised by postcode. The site is located within an area with 1-5 sewer flooding incidents have been recorded.

2.21 Assessing the data within the SFRA, it is concluded that there are no significant flood risks at the site.

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3 Existing Site Assessment

Site Description

3.1 The red line boundary covers 2.1 ha and is located between Smiths Green and Jacks Lane, and comprises rural farmland. Existing residential areas of Takeley lie to the south and east of this land parcel. To the north is further agricultural land.

3.2 The site is approximately 2km southeast of London Stansted Airport.

3.3 The proposed development will comprise a residential development, comprising of 40 one- to five-bedroom dwellings along with garages, driveways access roads, open space and associated works. A proposed layout is included in **Appendix B**.

Local Watercourses and Ditches

3.4 The nearest EA 'Main River' is the Pincey Brook, which is located approximately 2km west of the site. A tributary of this watercourse flows through Takeley and is culverted for most of this reach.

3.5 A site walkover identified perimeter ditches on the eastern and southern border of the site, which fall to the south. They appear to act as infiltration ditches rather than conveyance as no inlet or outlet could be identified from the walkover.

Site Levels

3.6 A topographical survey is enclosed in **Appendix E.** The site falls northwest to southeast. The higher levels near to Smiths Green are around 103.9m AOD, falling to around 102.0m AOD along the south-eastern border. The perimeter ditches were not picked up due to thick vegetation.

Sewer Records

3.7 Sewer records obtained by Thames Water are enclosed in **Appendix F.** There are no adopted sewers in close proximity of the site.

Geology

3.8 With reference to the British Geological Survey online mapping, the site is located within an area with a bedrock of London Clay Formation - clay, silt and sand with superficial deposits of Lowestoft Formation – diamicton.

3.9 This type of geology typically does not favour infiltration, but infiltration tests were carried out to confirm this and have been discussed below.

Infiltration Tests

3.10 Infiltration tests were carried out across the wider earlier development site on 28th April 2021. Tests were in six locations including two on the Garden Village site.

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3.11 The infiltration test report is included in **Appendix G**, which shows the test locations on a map and summarises the details. The strata was recorded as 'orange-brown-grey silty clay with occasional chalk fragments) and 'orange-brown-grey sandy clay with occasional chalk fragments'.

3.12 Testing from the southern test pit on the Garden Village site (SA2) was carried out to BRE 365 standard and demonstrated a very good infiltration rate. The northern test at Garden Village (SA1) was not filled three times but also demonstrated a reasonable rate.

3.13 The infiltration test results suggest that infiltration would be a viable means of draining most, all of the proposed development. Where tests were not carried out to BRE 365 standard, the worst case rate can be used, with the anticipation that further testing in these locations can be conditioned.

3.14 Table 3.1 summarises the rates to be used for the different character areas.

Character Area	Test Pit	Depth	No. of Fills	Infiltration Rate
Garden Village (North)	SA1S (Worst case result)	0.60m	1	7.7×10^{-6}m/s
Garden Village (South)	SA2S	0.60m	3	7.0×10^{-4}m/s

Table 3.1: Infiltration Rate Summary (Full test results in **Appendix G**)

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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 C.** The site is located entirely in Flood Zone 1, at low risk of fluvial flooding, Land in Flood Zone 1 is defined as land having less than 1 in 1000 annual probability of river or sea flooding (<0.1%) in any year.

Surface Water

4.2 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 including sewers, rivers and watercourses 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'.

4.3 The surface water mapping on the gov.uk website shows the site is at 'very low' risk of surface water flooding. Surface water flooding is shown along the perimeter of the site however this is likely to be associated with the presence of ditches.

4.4 An effective and sustainable drainage system will prevent surface water flooding within the development. The EA's surface water flood risk map can be seen in **Appendix H.**

Groundwater

4.5 Map 9 of the SFRA shows the susceptibility of groundwater flooding across the district. The site is shown to be located in an area with < 25% susceptibility of groundwater flooding which is considered to be low.

4.6 The MAGIC Map website (https://magic.defra.gov.uk/MagicMap.aspx) confirms the site is not located in a groundwater source protection zone.

4.7 The site is located above a Secondary (undifferentiated) Aquifer based on the superficial deposits of diamicton. A Secondary (undifferentiated) aquifer is defined on the gov.uk website as: "*...aquifers where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type. These have only a minor value.*"

4.8 It is therefore unlikely that the superficial deposits would yield significant quantities of groundwater.

4.9 Given the above, the risk of flooding from groundwater is considered to be low.

Artificial

4.10 The EA Flood Map for Planning shows the site is not at risk of flooding from reservoirs. Online OS mapping shows not show any other large artificial sources nearby which would pose a significant risk to the site, so the risk of flooding from artificial sources is considered to be low.

Sewer Flooding

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4.11 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.

4.12 As there are no adopted sewers located within the site the risk from sewer flooding is considered to be low.

Flood Risk Summary

4.13 Given the risk from flooding from all assessed sources is low, there are no specific mitigation measures required.

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5 Drainage Strategy

Existing Drainage

5.1 As the site is currently undeveloped, there is no existing formal drainage strategy in place. Surface water is likely to simply infiltrate to ground and once saturated, overland flow would flow into the surrounding ditches and infiltrate to ground. Excess surface water would simply pool and either slowly infiltrate or evaporate.

Greenfield Runoff Rates

5.2 Greenfield runoff rates were estimated using the ICP SuDS method on the WINDES Micro Drainage software. The site covers an area of 2.1 ha. The runoff rates for 1 hectare has been estimated and scaled to the site area for the 1 in 1 year, 1 in 30 year and 1 in 100-year events:

- QBAR – 2.8 l/s/ha (5.9 l/s)
- 1 in 100 year- 9.1 l/s/ha (19.1 l/s)
- 1 in 30 year- 6.4 l/s/ha (13.4 l/s)
- 1 in 1 year- 2.4 l/s/ha (5.0 l/s)

5.3 The MicroDrainage greenfield runoff rates are included at **Appendix I.**

Relevant SuDS Policy

5.4 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.

5.5 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.

5.6 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.
- Reducing pollutant concentrations, thus protecting the quality of the receiving water body.

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- Groundwater recharge.
- Contributing to the enhanced amenity and aesthetic value of development areas.
- Providing habitats for wildlife in developed areas, and opportunity for biodiversity enhancement.

Site-Specific SuDS

5.7 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 roofs.	No
Infiltration devices & Soakaways (source control)	Store runoff and allow water to percolate into the ground via natural infiltration.	Not required due to other SuDS features being used.	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.	Infiltration testing confirms good rates across the site, therefore permeable surfaces are viable.	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).	Not recommended due to risk of attracting birds close to airport	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 required due to other SuDS features being used.	No
Filter Strips (permeable conveyance)	Wide gently sloping areas of grass or dense vegetation that remove pollutants from run-off from adjacent areas.	Not likely to be required for a site of this size.	No
Infiltration basins (end of pipe treatment)	Depressions in the surface designed to store runoff and allow infiltration.	Not required due to other SuDS features being used.	No

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Wet ponds & constructed wetlands (end of pipe treatment)	Provide water quality treatment & temporary storage above the permanent water level.	Not recommended due to risk of attracting birds close to airport.	No
Attenuation Underground (end of pipe treatment)	Oversized pipes or geo-cellular tanks designed to store water below ground level.	Not required due to other SuDS features being used.	No

Table 5.1: Site Specific Sustainable Drainage

Proposed Drainage Strategy

5.8 Infiltration testing across the site demonstrated that infiltration would be a viable means of draining the proposed development as identified in Section 3 of this report and **Appendix G**.

5.9 The worst-case infiltration rate from the test pit in the northern part of the site was used to design the drainage for the northern half of the site. This was a rate of 7.7 x 10^{-6}m/s. It is anticipated that infiltration tests can be conditioned and further testing can take place in this area to inform detailed design.

5.10 The southern half of the site achieved both a shallow and deep test to BRE365 standard, and exhibited very good rates. For the southern part of the site, the shallow test rate (SA2S) of 7.0 x 10^{-4}m/s was used to design the drainage.

5.11 The drainage strategy will have all impermeable areas discharging to permeable paving in the road. However, given the potentially lower infiltration rate in the northern part of the site, a cascading system will be set up whereby the permeable paving in the northern part of the site will overflow to the permeable paving in the southern section, in the event that it does not infiltrate. The sub-base for the southern sections of permeable paving have been designed accordingly. It is assumed that all private driveways will remain as tarmac/hardstanding and are not permeable.

5.12 The use of permeable surfacing will provide water quality benefits and filter the runoff from all impermeable areas, as well as providing attenuation and allowing infiltration to occur over a large surface area.

5.13 The proposed footpath/cycleway which crosses the site will utilise a semi-permeable, self bound gravel/tar spray and chipping construction to allow some infiltration to occur. Where infiltration doesn't occur, it is expected that runoff will be to the surrounding grassed areas. There is the potential to utilise a French drain or similar alongside the paths where required. Therefore, the proposed footpath/cycleway has not been included in the permeable paving calculations.

5.14 The site has been divided into five catchments, each with impermeable areas comprising roofs, roads and parking areas, along with a section of permeable paving. A 10% urban creep has also been added to the roof area of each catchment. A WINDES MicroDrainage Source Control model was set up for each catchment, to estimate the sub-base depth required to manage a 1 in 100 year (+40%CC) storm event. Catchments 1 and 2 used the lower infiltration rate of 7.7 x 10^{-6}m/s and catchments 3, 4 and 5 used the higher infiltration rate of 7.0 x 10^{-4}m/s. Catchments 1 and 2 will cascade into catchment 4 if required during high return period storm events.

5.15 The catchments, impermeable areas and permeable paving details are shown on SK11 in **Appendix J** with detailed engineering drawings of the proposed SuDS devices also included.

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The WINDES MicroDrainage for the 1 in 100 year (+40%CC) storm results are included in **Appendix K**, results for the 1 in 10 year and 1 in 30 year storm are also included. The various catchments and details of permeable paving are summarised in Table 5.7. Also in Appendix J are SuDS standard details for the permeable paving.

Section	Catchment Area (Including 10% Urban Creep)	Permeable Paving Area	Minimum Sub-Base Depth
1	2453m²	888m²	521mm
2	951m²	344m²	391mm
3	2880m²	489m²	293mm
4	1264m²	610m²	242mm
5	1370m²	410m²	83mm

Table 5.7: Summary of Permeable Paving Details at Garden Village

5.16 Although some of the minimum sub-base depths required are very thin, it is anticipated that the minimum sub-base depth required for structural requirements and water quality benefits will be at least 300mm, and therefore also provide for a greater level of attenuation. Silt traps/catchpits will also be included upstream of permeable paving connections to collect silt and debris before runoff enters the permeable paving.

5.17 The drainage system has been designed to meet the water quality requirements set out by Table 26.2 of the CIRIA SuDS Manual C753 which sets out the specific pollution hazard indices for residential roofing and low traffic roads/individual driveways in Table 5.8 below.

Land Use	Hazard Level	Pollution Hazard Indices		
		Suspended Solids	Metals	Hydrocarbons
Residential Roofing	Very Low	0.2	0.2	0.05
Low Traffic Roads/Individual Driveways	Low	0.5	0.4	0.4
Total Pollution Mitigation Required		0.5	0.4	0.4

Table 5.8: Land Use Pollution Hazard Ratings. Extracted from the CIRIA SuDS Manual C753 Simple Index Approach Tool

5.18 It is clear from Table 5.9 that the required level of pollution mitigation is provided and exceeded for removing total suspended solids, metals and hydrocarbons from the surface water runoff, and no further treatment stages are necessary.

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SuDS Component	Pollution Mitigation Indices		
	Suspended Solids	Metals	Hydrocarbons
Catchpit/Silt Trap	0.5	0.0	0.0
Permeable Paving	(0.7/2) = 0.35	0.6	0.7
Total Pollution Mitigation Provided	0.85	0.6	0.7

Table 5.9: SuDS Component Pollution Mitigation Extracted and adapted from the CIRIA SuDS Manual C753 Simple Index Approach Tool

5.19 The WINDES MicroDrainage model for Garden Village indicates the half drain time is at most 35 minutes, and this method will provide sufficient treatment of the surface water prior to infiltrating to the ground, therefore demonstrating that runoff can be managed effectively through the use of permeable paving and silt traps/catchpits.

Essex SuDS Proforma

5.20 A completed SuDS proforma is enclosed in **Appendix L.** The site has split into a number of catchments managed by a number of permeable paving sections, and the SuDS strategy is entirely based on infiltration. Therefore, it is not possible to provide some of the information required by the proforma for some parts of the form relating to the storage volume for a 1 in 30 (+CC) event and the 50% storage drain down time for a 1 in 30 year event for example, since the proforma requires a single value. As the site is split into many catchments, with each catchment having a different value, this information cannot be provided in the form requested.

5.21 However, the drainage strategy has been designed to manage runoff from a 1 in 100 year (+40%CC) event, and all half drain times are less than 24 hours.

Thames Water Pre-Development Enquiry

5.22 A pre-development enquiry was submitted to Thames Water in May 2021, to determine whether there was sufficient capacity in the foul sewers in Takeley to receive foul water flows from the wider development, inclusive of the Garden Village. The proposed connection point was the manhole 071A in Parsonage Road, to the front of the Weston Homes business park (as shown on the Thames Water sewer records in **Appendix F**), which connects to the 150mm sewer in the road.

5.23 It is anticipated that a pumped connection from the Garden Village site would be required over some of the length of the new connection to the west, before a gravity sewer can be achieved.

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5.24 Thames Water responded to say that based on the previously proposed development of 191 homes and 13 business units, there was sufficient capacity in the local foul network to take the flows from the site. Given that the site proposed is now much reduced in size there are not anticipated to be any capacity issues with regards to the commercial development only. Thames Water's response is included in **Appendix M**.

Exceedance Flow Paths and Areas

5.25 In a storm event greater than that modelled, the capacity of surface water drainage system could become overwhelmed. In this instance, surface water would pool in the shallower parts of the site and overflow to the boundary ditches, where it is likely to be captured and therefore remain within the site. An exceedance plan is included in **Appendix N**.

5.26 As all residential properties will have a freeboard a minimum of 150mm above the surrounding ground level, this should prevent internal surface water flooding in an exceedance event occur.

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6 Maintenance of Development Drainage

6.1 It is assumed that all elements of the proposed drainage system will remain private and the responsibility will remain with a maintenance company set up by the developer.

6.2 Maintenance of the drainage systems serving the private driveways and residential roofs will be the responsibility of the individual residents.

6.3 Regular inspections of the permeable paving, inspection chambers and orifice plate controls should be made, to ensure they are effective throughout the lifetime of the development and do not become blocked or damaged over time.

6.4 Some maintenance activities for permeable paving as detailed in CIRIA C753 'The SuDS Manual' are set out in Table 6.1 below.

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. Removal of weeds.	As required. 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. Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance of a hazard to the user. Rehabilitation of surface and upper sub-surface.	As required As required As required (if infiltration performance is reduced as a result of significant clogging.)
Monitoring	Initial inspection Inspect for evidence of poor operation and/or weed growth. If required, take remedial action. Inspect silt accumulation rates and establish appropriate brushing frequencies. Monitor inspection chambers.	Monthly for 3 months after installation. 3 monthly, 48 hours after large storms. Annually. Annually.

Table 6.1: Maintenance tasks for permeable paving (Source: CIRIA C753, The SuDS Manual)
Manholes and Sewers

6.5 Manhole covers should be lifted each year to remove visible debris and check for blockages – it is suggested that this is undertaken every November after the heaviest leaf-fall has occurred.

6.6 Should a blockage occur at any time, it is advised to seek professional help to jet the drainage system to clean and clear the system.

Gutters and Downpipes

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6.7 It is good practice to ensure that these are occasionally inspected to ensure they are in good order and free of leaves & debris. Once every 6 months should be sufficient

Catch Pit/Sump Unit

6.8 A maintenance schedule should be agreed with the chosen manufacture. Depending on the size and manufacture, maintenance tasks can includes removing the inner silt bucket or sucking out the silt.

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7 Summary and Conclusion

7.1 The site is in Flood Zone 1 on the EA's Flood Map for Planning. All sources of flooding have been assessed and the risk considered to be low. Therefore, no specific mitigation measures are required for the proposed development.

7.2 The geology of London Clay with deposits of Diamicton suggests that infiltration would not be viable. However, a number of infiltration tests were carried out across the site which provided good results. As a result, all impermeable areas are proposed to be drained to permeable paving on the access roads.

7.3 The drainage system was modelled for a 1 in 100 year (+40%CC) storm event using WINDES MicroDrainage Source Control. The site was divided into a number of different catchments and each was run with the infiltration rate closest to the area. The WINDES models demonstrated that all surface water runoff from the new development could be managed effectively using infiltration methods.

7.4 The CIRIA guidance on pollution hazards was also considered and the selected drainage measures also provided sufficient water quality benefit to remove suspended solids, metals and hydrocarbons from the runoff before it infiltrated to ground.

7.5 All elements of the proposed drainage system will remain private and the responsibility for maintenance will remain with a maintenance company set up by the developer.

Conclusion

7.6 The site is at a low risk of flooding and the proposals do not increase flood risk onsite or elsewhere. The proposed SuDS strategy effectively manages the surface water runoff associated with the roof, roads and other impermeable areas, using infiltration which is at the top of the SuDS hierarchy.

7.7 In conclusion, the proposals have been shown to be policy compliant on flood risk and SuDS grounds.

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8 Appendices

TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS

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Appendix: A – Location Plan

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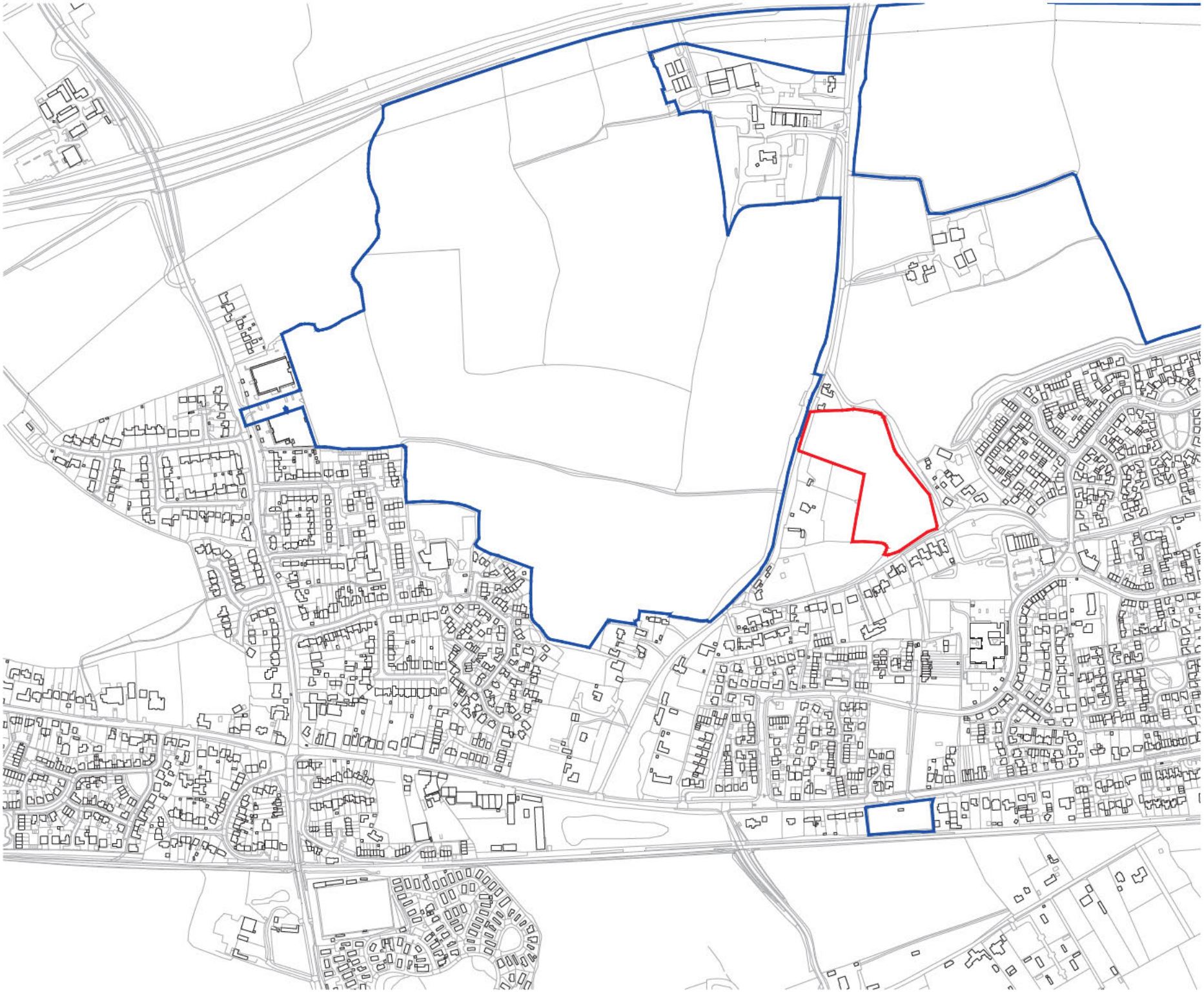

Key

- APPLICATION BOUNDARY
- OWNERSHIP BOUNDARY

Rev

-

0M 100M 200M
50M 150M

PLANNING

Title
SITE LOCATION PLAN JACKS PARCEL

Site
JACKS GREEN, TAKELEY

Date	Drawn	Checked
AUGUST 2022	PMR	PMR

Scale
1 5000@A3

Drawing No.	Rev
WH202.WST P1 ZZ DR PL.05.01	-

Weston Homes

General Notes

Head Office
Weston Group Business Centre,
Parsonage Road, Takeley, Essex.
CM22 6PU.
T: 01279 873333

London Office
10 Portman Square,
London.
W1H 6AZ
T: 0203 096 7236

www.weston-homes.com | email: info@weston-homes.com

Appendix: B – Development Plans

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House types 1:1000

Note

Rev

PLANNING

Title
MASTER PLAN - JACKS PARCEL
GENERAL ARRANGEMENT

Site
JACKS GREEN, TAKELEY

Date	Drawn	Checked
AUGUST 2022	PMR	PMR

Scale
1:500@A1

Drawing No	Rev
WH202.WST.P1.ZZ.DR.PL.10.01	-

DRAFT REV A

Weston Homes

General Notes

Appendix: C – EA Flood Map for Planning

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Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk

Flood map for planning

Your reference	Location (easting/northing)	Created
Jacks Site	**556996/221599**	**10 Mar 2021 14:14**

Your selected location is in flood zone 1, an area with a low probability of flooding.

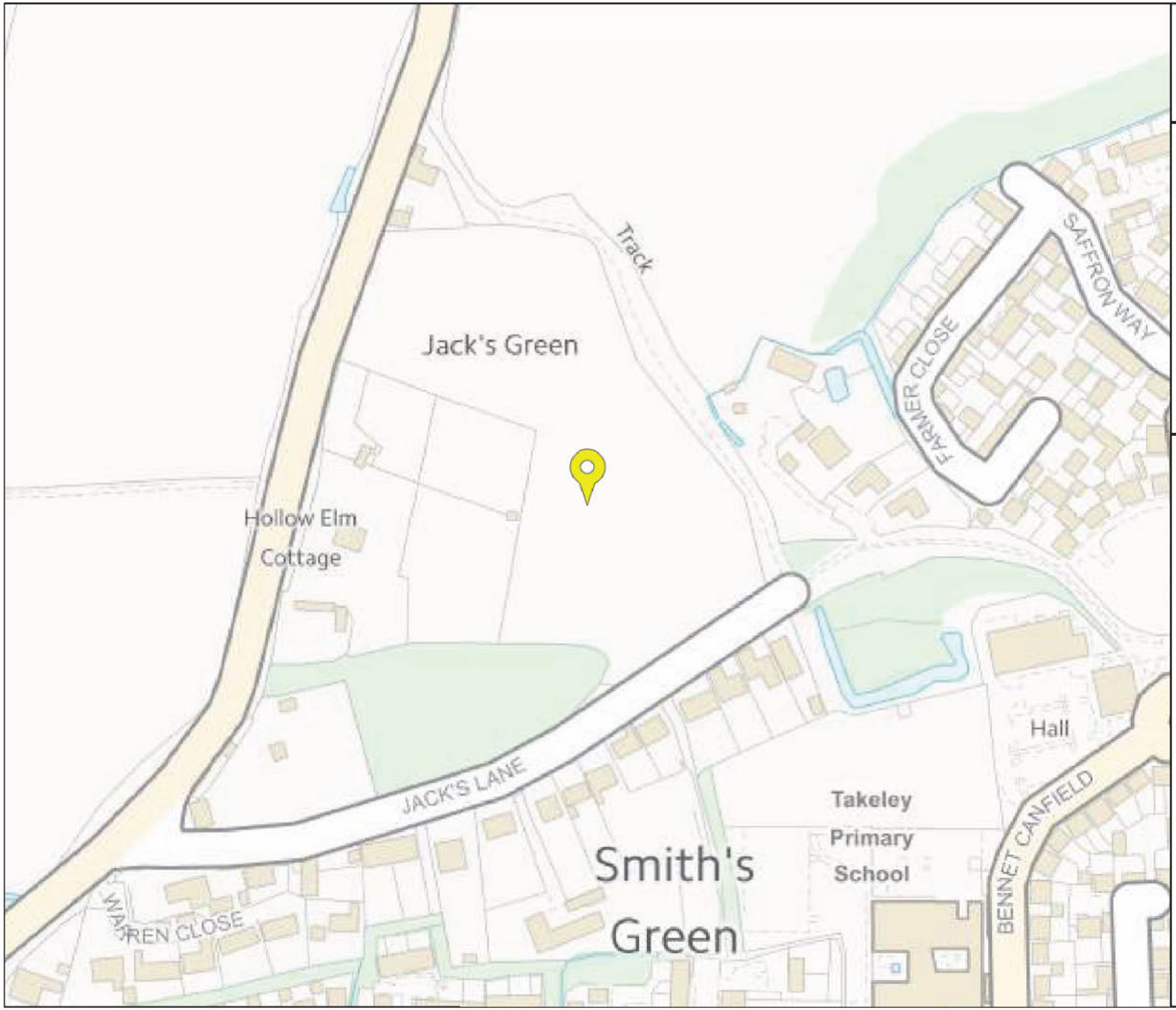
This means:

- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1 hectare or affected by other sources of flooding or in an area with critical drainage problems

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.



Environment Agency

Flood map for planning

Your reference
Jacks Site

Location (easting/northing)
556996/221599

Scale
1:2500

Created
10 Mar 2021 14:14

- 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: D – Essex CC Pre-Application Advice and Holding Objection

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Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk

Essex County Council
Development and Flood Risk
Environment and Climate Action,
C426 County Hall
Chelmsford
Essex CM1 1QH

Essex County Council

Madeleine Jones
Uttlesford District Council
Planning Services

Date: 31th July 2021
Our Ref: SUDS-005355
Your Ref: UTT/21/1987/FUL

Dear Madeleine Jones,

Consultation Response –UTT/21/1987/FUL– Land At Warish Hall Farm Smiths Green Takeley

Thank you for your email received on 18/06/2021 which provides this Council with the opportunity to assess and advise on the proposed surface water drainage strategy for the above mentioned planning application.

As the Lead Local Flood Authority (LLFA) this Council provides advice on SuDS schemes for major developments. We have been statutory consultee on surface water since the 15th April 2015.

In providing advice this Council looks to ensure sustainable drainage proposals comply with the required standards as set out in the following documents:

- Non-statutory technical standards for sustainable drainage systems
- Essex County Council's (ECC's) adopted Sustainable Drainage Systems Design Guide
- The CIRIA SuDS Manual (C753)
- BS8582 Code of practice for surface water management for development sites.

Lead Local Flood Authority position
Having reviewed the Flood Risk Assessment and the associated documents which accompanied the planning application, , we wish to issue a **holding objection** to the granting of planning permission based on the following:

- Infiltration test location plan provided by the applicant shows that infiltration tests were performed only in the southern part of the site. As the test results shows that infiltration rates may various in different parts it is important that tests should be conducted in northern parts of the site as well. Please provide verification of the suitability of infiltration of surface water for the development across all parts of the site. This should be based on infiltration tests that have been undertaken in accordance with BRE 365 testing procedure and the infiltration testing methods found in chapter 25.3 of The CIRIA SuDS Manual C753
- Provide detailed engineering drawings of each component of the drainage scheme.

- Provide full engineering site layout of the proposed drainage network at the site. This should include the following details: manholes cover levels, invert levels of perforated pipes in the pervious paving, dimensions of perforated pipes in the pervious paving, pipe slopes, proposed site levels of the roads and car parks.
- Provide a drainage plan which details exceedance and conveyance routes, FFL and ground levels.
- Provide an updated written report summarising the final strategy and highlighting any minor changes to the approved strategy.

We also have the following advisory comments:

- We strongly recommend looking at the Essex Green Infrastructure Strategy to ensure that the proposals are implementing multifunctional green/blue features effectively. The link can be found below.
  https://www.essex.gov.uk/protecting-environment

In the event that more information was supplied by the applicants then the County Council may be in a position to withdraw its objection to the proposal once it has considered the additional clarification/details that are required.

Any questions raised within this response should be directed to the applicant and the response should be provided to the LLFA for further consideration. If you are minded to approve the application contrary to this advice, we request that you contact us to allow further discussion and/or representations from us.

Summary of Flood Risk Responsibilities for your Council

We have not considered the following issues as part of this planning application as they are not within our direct remit; nevertheless these are all very important considerations for managing flood risk for this development, and determining the safety and acceptability of the proposal. Prior to deciding this application you should give due consideration to the issue(s) below. It may be that you need to consult relevant experts outside your planning team.

- Sequential Test in relation to fluvial flood risk;
- Safety of people (including the provision and adequacy of an emergency plan, temporary refuge and rescue or evacuation arrangements);
- Safety of the building;
- Flood recovery measures (including flood proofing and other building level resistance and resilience measures);
- Sustainability of the development.

In all circumstances where warning and emergency response is fundamental to managing flood risk, we advise local planning authorities to formally consider the emergency planning and rescue implications of new development in making their decisions.

Please see Appendix 1 at the end of this letter with more information on the flood risk responsibilities for your council.

INFORMATIVES:

- Essex County Council has a duty to maintain a register and record of assets which have a significant impact on the risk of flooding. In order to capture proposed SuDS which may form part of the future register, a copy of the SuDS assets in a GIS layer should be sent to suds@essex.gov.uk.
- Any drainage features proposed for adoption by Essex County Council should be consulted on with the relevant Highways Development Management Office.
- Changes to existing water courses may require separate consent under the Land Drainage Act before works take place. More information about consenting can be found in the attached standing advice note.
- It is the applicant's responsibility to check that they are complying with common law if the drainage scheme proposes to discharge into an off-site ditch/pipe. The applicant should seek consent where appropriate from other downstream riparian landowners.
- The Ministerial Statement made on 18th December 2014 (ref. HCWS161) states that the final decision regarding the viability and reasonableness of maintenance requirements lies with the LPA. It is not within the scope of the LLFA to comment on the overall viability of a scheme as the decision is based on a range of issues which are outside of this authority's area of expertise.
- We will advise on the acceptability of surface water and the information submitted on all planning applications submitted after the 15th of April 2015 based on the key documents listed within this letter. This includes applications which have been previously submitted as part of an earlier stage of the planning process and granted planning permission based on historic requirements. The Local Planning Authority should use the information submitted within this response in conjunction with any other relevant information submitted as part of this application or as part of preceding applications to make a balanced decision based on the available information.

Yours sincerely,

Rohit Singh, Development and Flood Risk Officer
Team: Green Infrastructure and Sustainable Drainage
Service: Climate Action and Mitigation
Essex County Council

Internet: www.essex.gov.uk
[redacted]

Appendix 1 - Flood Risk responsibilities for your Council

The following paragraphs provide guidance to assist you in determining matters which are your responsibility to consider.

- Safety of People (including the provision and adequacy of an emergency plan, temporary refuge and rescue or evacuation arrangements)

You need to be satisfied that the proposed procedures will ensure the safety of future occupants of the development. In all circumstances where warning and emergency response is fundamental to managing flood risk, we advise LPAs formally consider the emergency planning and rescue implications of new development in making their decisions.
We do not normally comment on or approve the adequacy of flood emergency response procedures accompanying development proposals as we do not carry out these roles during a flood.

- Flood recovery measures (including flood proofing and other building level resistance and resilience measures)

  We recommend that consideration is given to the use of flood proofing measures to reduce the impact of flooding when it occurs. Both flood resilience and resistance measures can be used for flood proofing.

  Flood resilient buildings are designed to reduce the consequences of flooding and speed up recovery from the effects of flooding; flood resistant construction can help prevent or minimise the amount of water entering a building. The National Planning Policy Framework confirms that resilient construction is favoured as it can be achieved more consistently and is less likely to encourage occupants to remain in buildings that could be at risk of rapid inundation.

  Flood proofing measures include barriers on ground floor doors, windows and access points and bringing in electrical services into the building at a high level so that plugs are located above possible flood levels. Consultation with your building control department is recommended when determining if flood proofing measures are effective.

  Further information can be found in the Department for Communities and Local Government publications 'Preparing for Floods' and 'Improving the flood performance of new buildings'.

- Sustainability of the development

  The purpose of the planning system is to contribute to the achievement of sustainable development. The NPPF recognises the key role that the planning system plays in helping to mitigate and adapt to the impacts of climate change, taking full account of flood risk and coastal change; this includes minimising vulnerability and providing resilience to these impacts. In making your decision on this planning application we advise you consider the sustainability of the development over its lifetime.

Essex County Council
Development and Flood Risk
Environment and Climate Action,
C426 County Hall
Chelmsford
Essex CM1 1QH

Louisa Wade

Date: 18 March 2021
Our Ref SUDS-005137

Dear Ms Louisa Wade,

Pre-application Response – SUDSPA308532251 - Warish Hall Farm

Thank you for contacting us for pre-application advice which provides Essex County Council (ECC) with the opportunity to assess and advise on the proposed surface water drainage strategy for the aforementioned planning application.

As the Lead Local Flood Authority (LLFA) ECC provides advice on SuDS schemes for major developments. ECC have been statutory consultee on surface water since the 15th April 2015.

In providing advice this Council looks to ensure sustainable drainage proposals comply with the required standards as set out in the following documents:

- Non-statutory technical standards for sustainable drainage systems
- Essex County Council's (ECC's) adopted Sustainable Drainage Systems Design Guide
- The CIRIA SuDS Manual (C753)
- BS8582 Code of practice for surface water management for development sites.

Lead Local Flood Authority position

After reviewing the submitted documents please see a summary of our comments below:

ECC is statutory consultee to ensure the adoption of sustainable ways of surface water management where above ground storage is our preferred option when considering drainage strategies for new developments. Above ground storage options maximize the amenity and biodiversity benefits of SUDS. It is preferable that these are implemented throughout the development and integrated into the proposed landscaping as extensively as practicable.

The written SuDS planning advice is provided for the site Warish Hall Farm Uttlesford, Essex. The site is greenfield and is proposed for mixed used development which constitutes of 176 number of residential units, and area for employment use.

In terms of infiltration it was explained through drainage letter that the ground conditions on site are unlikely to be suitable for infiltration, however this would be evidenced through infiltration testing and if viable would be utilised as extensively as possible.

The proposed site is divided into three catchments namely Bull Field, Jacks Site, and 7 Acres. It is proposed that each catchment has a single outfall to an existing watercourse/ditch and discharge would be limited to the 1 in 1yr Greenfield rate. It is explained that due to closer vicinity of Stansted Airport the open Suds features is not found feasible due to the risk of bird strike. The proposed drainage strategy has included lined permeable paving and underground crates as a primary location for storage.

It was felt that a majority of the water quality requirements could be achieved through use of open SuDS features, however use of Proprietary features such as a Vortex Separator may be necessary, although these should be kept to a minimum and consideration should be given to the implications associated with adoption of such features. The development should address the pollution hazard rating and if traffic movements exceed 300 per day, then a medium hazard rating should be applied, along with a minimum of two stages of treatment in the SuDS Management Train.

Sewer Network Design should demonstrate that there is No Surcharging for the 1 in 1yr RP, No Flooding for the 1 in 30yr RP and if not contained within the system, details of overland flood flow routes should be provided for the 1 in 100yr +CC RP, which should demonstrate no internal flooding to properties.

Flood Risk Assessment

A flood risk assessment should consider all form of flood risk.

These include:

- Flooding from the sea or tidal flooding;
- Flooding from land;
- Flooding from groundwater;
- Flooding from sewers; and
- Flooding from reservoirs, canals, and other artificial sources.

It should be considered how any flood risk will interact with the development and drainage scheme.

Run off Destinations

Surface water run- off should be disposed of in line with the discharge hierarchy and should be investigated in the below order:

- Rainwater reuse
- Discharge via infiltration
- A hybrid Approach
- Discharge to a watercourse/surface water body
- Discharge to a surface water sewer
- Discharge to a combined sewer

Rainwater re-use

In line with the updated 2020 Essex County Council suds design guide, rainwater re-use should be considered as part of any development. If this is not proposed as part of an application a clear explanation should be provided to demonstrate why this is not a viable option of source control on site. Essex is likely to experience increasing water scarcity in the near future so rainwater re-use needs to be strongly considered as part of any application for larger sites, however it should also be considered for smaller sites. If rainwater re-use is excluded without explanation then the ECC SuDS team will ask for further information. For more detailed advice please read the following section in our new design guide:

[redacted]

Infiltration

If infiltration is proposed, groundwater testing and infiltration testing in line with BRE 365 will need to be submitted to show that infiltration is feasible. Any infiltration storage devices should have 1m between the base of the storage device and seasonal high groundwater level.

If infiltration is unlikely to be possible at the site due to ground conditions, then we will still require high level ground investigations in order to prove that this is not a viable option.

Watercourse or Sewer

If discharge to a watercourse or sewer is proposed, it must be ensured that the site discharges at a suitable rate and any appropriate permissions are in place. Details in regards to the level of the outfall in relation surface water in the outfall feature should also be submitted.

Where the discharge is to a watercourse, the outfall should be above the 1 in 100 plus climate change level or alternatively the effect of surcharging of the outfall should be modelled and appropriate measures should be put in place.

It is noted that the discharge from all catchments would be into existing ditch. It is recommended that the relevant permission/agreement to discharge from the site into any outfall should be demonstrated.

Under Section 23 of the Land Drainage act (1991) any proposed structure that impacts on the cross-sectional area of a watercourse first requires Ordinary

Watercourse consent to be sought from Essex County Council. Such applications are separate from and are required in addition to the planning process. Further information on how to apply for section 23 consent can be found at below link.

[redacted]

Peak Flow

If following the discharge hierarchy infiltration is not found to be feasible on site, discharge from the site should be limited to the Greenfield 1 in 1 year rate.

Alternatively surface water can be discharged at equivalent Greenfield rates with the inclusion of long term storage. Information would need to be provided about the values used to calculate this rate and these would be reviewed on submission.

Please also note that we do not accept a flat rate of 5l/s discharging from the site if the Greenfield 1 in1 year rate is below 5l/s. Historically 5l/s was applied to an outlet where Qbar was lower than 5l/s, as most devices would require an outlet orifice size smaller than 50mm, which would increase the susceptibility of blockage and failure.

There are now vortex flow control devices which can be designed to a discharge at 1l/s, with 600mm shallow design head and still provide a more than 50mm orifice diameter. Furthermore, it is expected that appropriate measure should be put in place to remove materials that are likely to cause blockage before they reach the flow control device.

It is proposed that the discharge from the site will be restricted to 1-year greenfield rates. The proposed discharge rates are calculated separately for each catchment. It is recommended to calculate discharge rates for Bull field and 7 Acres site as per the impermeable area within red line plan. The LLFA do not accept discharge rates calculations taken at catchment scale. It should be ensured the combined discharge from the catchments should not exceed from the 1-year discharge rate calculated for entire impermeable area under redline plan.

The location of Jacks site is separate and have separate redline plan. The discharge rates for this site can be calculated separately.

It is recommended the discharge from the site should be considered by gravity. If this seems to be impossible the pump solution can be used. However, the runoff rates from the site should be in accordance with 1-year greenfield discharge rates. Surface water discharge from the site higher than 1-year greenfield rates is not acceptable if the pump solution is proposed.

Storage requirements

It should be demonstrated how surface water up to the 1 in 100 year plus climate change event is managed within the development.

The Environment Agency updated their climate change allowance in February 2016 and we require the design to be to the upper end allowance (i.e. 40%), unless this can be shown to make the development unviable, in which case the central allowance should be used with a sensitivity analysis carried out for the effects of the upper allowance.

Please see the following link for more information on revised climate change allowances: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Furthermore a 10% allowance in storage calculations should be provided for urban creep. Details in regards to the half-drain time of any storage device should also be submitted for review. If the half drain time exceed 24-hours time then an alternative approach of follow up 10 year storm on top of 1 in 30 year plus 40% climate change can be used. It should be evidenced that storage is available for the storm event 100 year plus 40% climate change.

As part of the planning application, detailed calculations considering a range of summer and winter storms should be submitted for storage requirements.

Please note if storage is placed in a path of a surface water flow that comes from off site, it should be demonstrated that any storage features will be sized appropriately for surface water created by the site and off site flows that may enter the storage features.

In terms of onsite storage, the drainage strategy has proposed the underground crates due to the risk of bird strike. We have considered this and are flexible with the approach to discount the use of open feature such as pond with standing water, which is the main source of bird's attraction. Please also note that the risk of bird strike is higher for the areas where the particular bird's species have highest population. It is therefore recommended to use the detention basin as a potential SuDS feature, that can have multiple function in terms of water quality, landscape, and visual impact. In terms of water storage and drain down time, the LLFA would ask the half drain time within 24 hours for storage features, which will not leave the suds feature wet or with standing water for longer periods. Alternatively, to mitigate any risk of standing water the storage crates can be installed below detention basin. This way the excess water will be drain down in storage crates and SuDS feature could used as a multifunctional space.

Water Quality

There should be treatment in line with Chapter 26 of the CIRIA SuDS Manual C753 for all areas of the site.

Whether the site is considered a medium or low pollutant risk depends on the traffic movements expected on the development. If the development is expected to have over 300 traffic movements then the medium pollution indices should be applied whereas the low pollution indices should be applied if less than 300 daily traffic movements are expected.

Considering impact of water pollution, in line with Paragraph 170 of the NPPF, priority should be given to SuDS and all SuDS options should be explored. If proprietary features are used however, it should be shown how these features will provide enough treatment in terms of total suspended solids, hydrocarbons and metals in line with chapter 26.

It should be noted that trapped gullies and catch pits are generally not considered appropriate forms of pollution mitigation because of the high risk of remobilisation of pollutants using this method of treatment.

Residual Flood Risk

As part of any planning application it should be ensured that surface water is managed so that there is no flooding in a 1 in30 storm event and no internal flooding in a 1 in 100 inclusive of climate change storm event. Detail should also be given in regards to exceedance routes above the critical 1 in 100 inclusive of climate change storm event – these should be directed away from properties.

Maintenance and Adoption

The on-going maintenance of any features will be necessary to ensure that flooding does not occur due to failure of components. A maintenance plan should be provided as part of the planning application process detailing the maintenance activities and frequencies as well as who will be maintaining the system.

Additional comments:

For a summary of what we require and when, please see the following link:

Our ECC suds design guide 2020 can be found at the following link:

Our ECC new suds proforma can be found at the following link:

At some point during the planning stage, you would need to show how surface water during construction will be managed.

Impacts on drainage before and after development and how new development improves existing land drainage or surface water management.

Please note:

The advice provided by the Council's Officers is informal opinion only and is made without prejudice to any formal decision that may be given in the event of an application being submitted.

In particular, any advice given will not constitute a formal response or recommendation of the County Council. Any views of opinions expressed are in good faith and to the best of ability, without prejudice to the formal consideration of any application, which will ultimately be decided by the Local Planning Authority. The County Council cannot guarantee that new issues will not be raised following submission of a planning application and consultation upon it.

Officers cannot give guarantees about the final formal decision that will be made on planning or related applications. However the advice contained within the written response will be considered by officers when considering any future planning application. This is subject to the proviso that circumstances and information may change or come to light that could alter the position. It should be noted that the weight given to pre-application advice will change if new material considerations arise.

Whilst we have no further comments at this stage, we strongly recommend you engage in pre-application consultation with any other organisations that maybe relevant to the proposed drainage strategy to avoid potential delays at the application stage. If you have any queries about any advice we have given please do not hesitate to contact us.

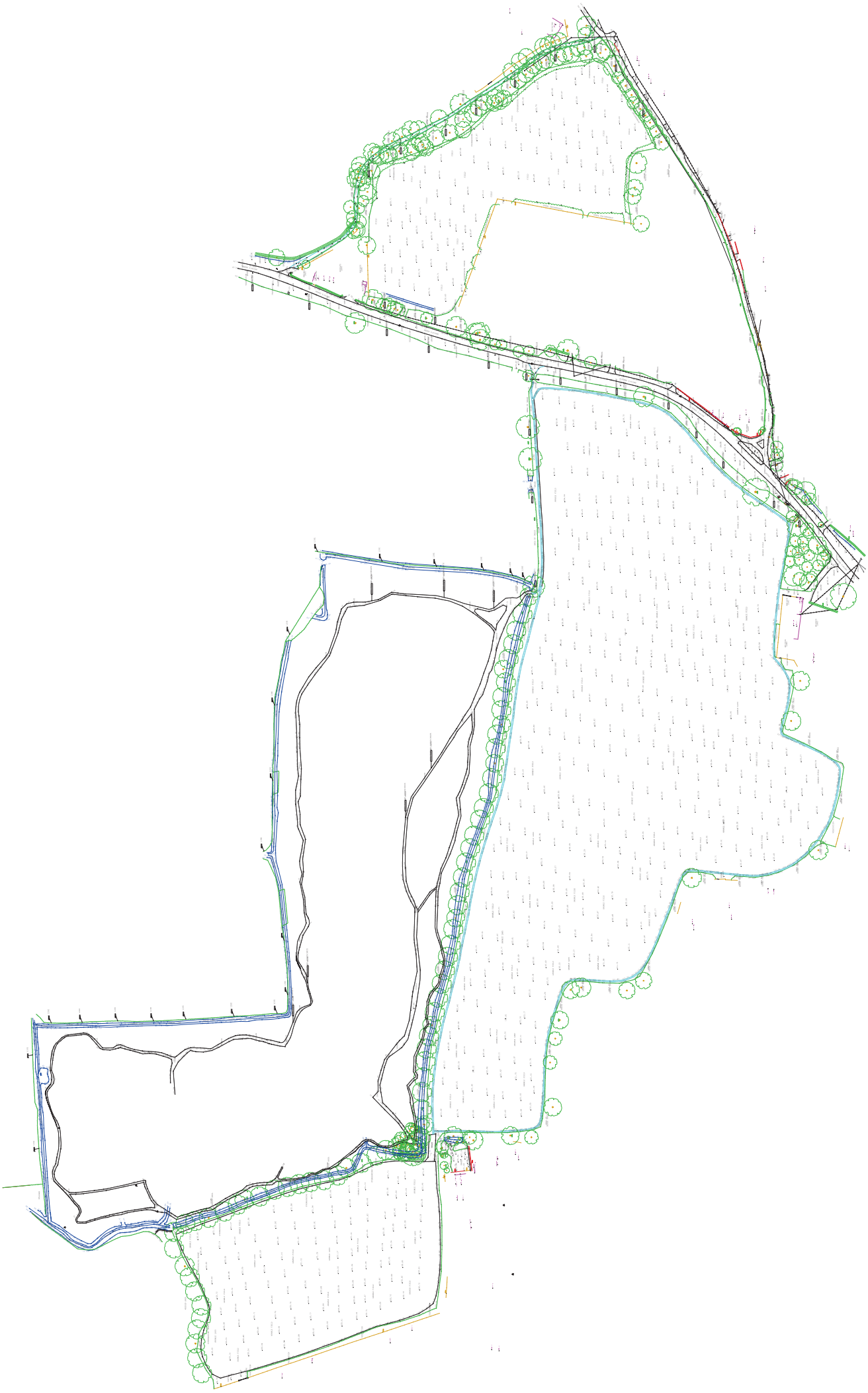
Yours sincerely,

Dr. Zahida Yousaf
Senior Development & Flood Risk Officer
Team: Development and Flood Risk
Service: Waste & Environment
Essex County Council

Internet: [redacted]
Email: suds@essex.gov.uk

Appendix: E – Topographic Survey

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



Appendix: F - Thames Water Sewer Records

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 [redacted]

Asset location search

Property Searches

Louisa Wade
EAS Transport Planning Ltd
The Maltings
Unit 23Roydon Road
STANSTEAD ABBOTTS
SG12 8HG

Search address supplied Jacks Site
Takeley
Essex
CM22 6PU

Your reference N/A

Our reference ALS/ALS Standard/2020_4273282

Search date 8 October 2020

Knowledge of features below the surface is essential for every development

The benefits of this knowledge not only include ensuring due diligence and avoiding risk, but also being able to ascertain the feasibility of any development.

Did you know that Thames Water Property Searches can also provide a variety of utility searches including a more comprehensive view of utility providers' assets (across up to 35-45 different providers), as well as more focused searches relating to specific major utility companies such as National Grid (gas and electric).

Contact us to find out more.

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
[redacted]

0845 070 9148

Asset Location Search Sewer Map - ALS/ALS Standard/2020 4273282

The width of the displayed area is 500 m and the centre of the map is located at OS coordinates 556982,221656

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

Manhole Reference	Manhole Cover Level	Manhole Invert Level
141A	98.827	n/a
141B	96.519	n/a
141C	99.254	n/a
141D	99.254	n/a
241C	99.45	n/a
241A	99.477	n/a
241D	99.47	n/a

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

Based on the Ordnance Survey Map with the sanction of the Controller of H.M Stationary Office License Number 10019345

ALS/ALS Standard/2020_4273282

0 10 20 40 60 80 Meters

Scale:	1:1792
Width:	500m
Printed By:	G1KANAGA
Print Date:	08/10/2020
Map Centre:	557250,221750
Grid Reference:	TL5721NW

Comments:

ALS/ALS Standard/2020_4273282

NB: Level quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates no Survey information is available.

REFERENCE	COVER LEVEL	INVERT LEVEL
351E	98 275	96 9
451H	98 25	97
351H		96.725
351S	98 5	97.1
371P	96 684	92 983
451D	98 255	96 91
341N		
451L	98 3	97 3
471P	95 837	91 891
371M	96 927	94 681
351G	98 275	97.1
371I	97.13	94 867
351K	98.7	97 585
351V	98.45	97.1
471Q	95 671	91 886
451K		
351T	98 65	97 95
351U		
471S	95 291	93 335
351F		96.425
451E	97 96	97.1
351J	98.7	97.775
371N	97 547	94 008
351Q	98 65	97 6
251G	98.719	97 055
371L	97 534	93 204
251H	99 328	94.73
471O	95.184	93.145
471L	95 661	93 655
361E	98 358	94 234
371Q		

REFERENCE	COVER LEVEL	INVERT LEVEL
451F	98 25	97.45
351M		
351O		
261J	99.182	96.128
471V	95 216	91.788
451C	98 27	96 65
451G	98 05	97.1
371K	97.112	93.462
261I	99 318	96 31
471N	96.125	94 082
451J	98 025	96 85
471M	96 071	91 901
351R		
261G	99.17	94 36
451I		
351P		
371J	97 65	95 229
471R	95 894	93 882
471T	95 215	93 226
251I	99 991	
351I	98 8	97 945
351L	98 35	97 275
351N		
261H	99 243	96 212
371O	96.747	94.473
361D	98 263	95 573
261F	99 256	94.47
251E	99 329	96 651
471U	95 328	91 803
251F	98.715	94 871

Based on the Ordnance Survey Map with the sanction of the Controller of H.M Stationary Office License Number 10019345

ALS/ALS Standard/2020_4273282

0 45 90 180 270 360
Meters

Scale:	1:7158
Width:	2000m
Printed By:	G1KANAGA
Print Date:	08/10/2020
Map Centre:	556982,221656
Grid Reference:	TL5621NE

Comments:

ALS Sewer Map Key

Public Sewer Types (Operated & Maintained by Thames Water)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs yards and car parks) to rivers or watercourses.

Combined: A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.

Trunk Surface Water

Trunk Foul

Storm Relief

Trunk Combined

Vent Pipe

Bio-solids (Sludge)

Proposed Thames Surface Water Sewer

Proposed Thames Water Foul Sewer

Gallery

Foul Rising Main

Surface Water Rising Main

Combined Rising Main

Sludge Rising Main

Proposed Thames Water Rising Main

Vacuum

Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

Air Valve

Dam Chase

Fitting

Meter

Vent Column

Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

Control Valve

Drop Pipe

Ancillary

Weir

End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol. Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

Outfall

Undefined End

Inlet

Other Symbols

Symbols used on maps which do not fall under other general categories

Public/Private Pumping Station

Change of characteristic indicator (C.O.C.I.)

Invert Level

Summit

Areas

Lines denoting areas of underground surveys etc.

Agreement

Operational Site

Chamber

Tunnel

Conduit Bridge

Other Sewer Types (Not Operated or Maintained by Thames Water)

Foul Sewer

Surface Water Sewer

Combined Sewer

Gulley

Culverted Watercourse

Proposed

Abandoned Sewer

Notes:

1) All levels associated with the plans are to Ordnance Datum Newlyn.

2) All measurements on the plans are metric.

3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.

4) Most private pipes are not shown on our plans as in the past this information has not been recorded.

5) 'na' or '0' on a manhole level indicates that data is unavailable.

6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan please contact a member of Property Insight on 0845 070 9148.

Appendix: G – Infiltration Test Results

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

STANSTED ENVIRONMENTAL SERVICES

The Stansted Centre
Parsonage Road,
Takeley
Essex CM22 6PU

T. 01279 873380
F. 01279 873381
E. enquiries@stansted-environmental.com

Our Ref: CON01-WARI-070
Your Ref: WH200

14 May 2021

David Poole
Weston Homes Plc
The Stansted Centre
Parsonage Road
Takeley
Essex
CM22 6PU

Dear Mr Poole ,

Re: Trial Pit Infiltration Tests – Warish Hall Farm, Takeley

Stansted Environmental Services Ltd (SES) was commissioned by Weston Homes plc (the client) to undertake trial pit soakaway testing at the above site on 28th April 2021. Soakaway tests were undertaken at six locations (SA1 to SA6) in general accordance with the methodology specified in BRE Special Digest 365.

Two trial pits were excavated by hand at each location to depths ranging from approximately 0.60m to 1.50m below ground level (bgl) as specified by Weston Homes' consultant EAS.

Beneath a surface covering of topsoil, all the trial pits encountered an orange-grey silty clay with occasional fragments of chalk believed to represent the Lowestoft Formation in this area. Locally, the strata may be described as sandy to very sandy and at one location, SA2, a band of flints was noted between 0.70m bgl and 0.85m bgl. A location plan is included within Appendix A.

Calculated permeability characteristics of the soil over the depth of the test zones are presented in the table below:

TABLE 1: Summary of Test Results

Test	Strata Description	Test Depth	No of Tests	Indicative Infiltration Rate
SA1S	Orange-brown-grey silty clay with occasional chalk fragments	0.60m	1	7.7×10^{-6} m/s
SA1D	Orange-brown-grey silty clay with occasional chalk fragments	1.50	2	1.5×10^{-6} m/s
SA2S	Orange-brown-grey silty clay with occasional chalk fragments. Band of flints noted at 0.70m	0.70m	3	7.0×10^{-4} m/s
SA2D	Orange-brown-grey silty clay with occasional chalk fragments. Band of flints noted at 0.70m	1.50m	3	1.6×10^{-4} m/s
SA3S	Orange-brown-grey sandy clay with occasional chalk fragments.	0.60m	2	5.9×10^{-6} m/s
SA3D	Orange-brown-grey sandy clay with occasional chalk fragments.	1.50m	2	6.2×10^{-6} m/s
SA4S	Orange-brown-grey sandy clay with occasional chalk fragments.	0.50m	2	5.5×10^{-6} m/s
SA4D	Orange-brown-grey sandy clay with occasional chalk fragments.	1.50m	2	4.1×10^{-6} m/s
SA5S	Orange-brown-grey sandy clay with occasional chalk fragments.	0.60m	3	1.6×10^{-5} m/s
SA5D	Orange-brown-grey sandy clay with occasional chalk fragments.	1.50m	2	1.6×10^{-5} m/s
SA6S	Orange-brown-grey sandy clay with occasional chalk fragments.	0.60m	3	2.9×10^{-4} m/s
SA6D	Orange-brown-grey sandy clay with occasional chalk fragments.	1.50m	2	1.1×10^{-5} m/s

Soakaway test sheets are appended to this report in Appendix B.

Average infiltration rates for the soils ranged between 5.9×10^{-6} m/s and 2.9×10^{-4} m/s.

I hope the information presented above meets your requirements. Should you wish to discuss the findings of the report, please do not hesitate to contact me.

Yours sincerely

For and on behalf of Stansted Environmental Services Limited

[redacted]

Gavin Greenwood
Associate Director (Geoenvironmental)

Encs: *Appendix A - Infiltration Test Location Plan*
Appendix B - Infiltration Test Results

APPENDIX A
PLANS & FIGURES

LEGEND

⊗ Infiltration Test Location

Originator	GB	**WARISH HALL FARM** **CON01-WARI-070**
Checked & Approved	WGG	**INFILTRATION TEST LOCATION PLAN**

SES STANSTED ENVIRONMENTAL SERVICES

16/08/2017

APPENDIX B
INFILTRATION TEST SHEETS

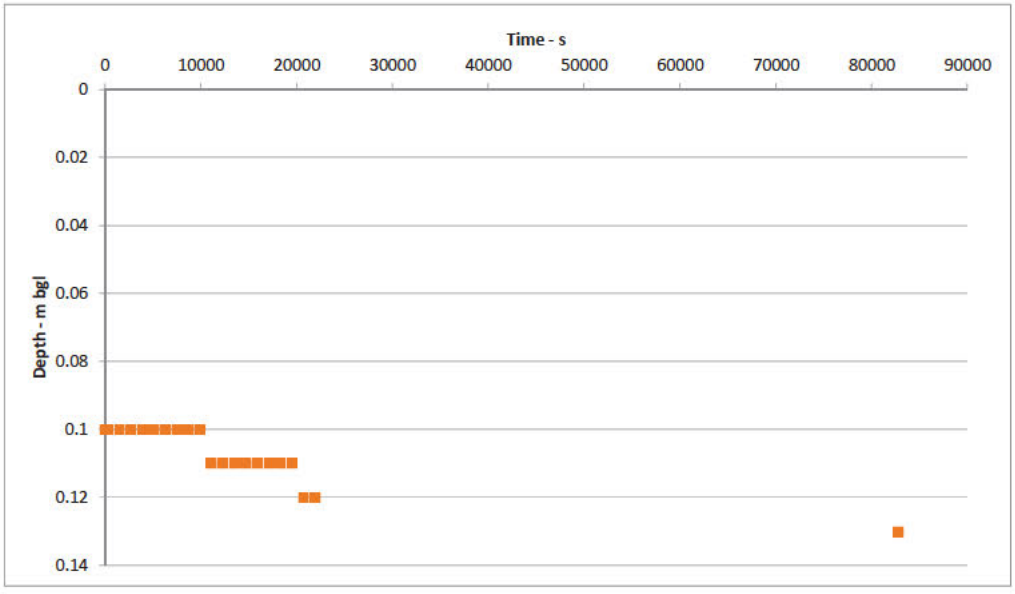
SOIL INFILTRATION RATE TEST

Test No.	SA1S No 1	Date:	05/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Jacks

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0.10
Length	0.50	WaterLevel at End - m bgl	0.13
		V_{p75}	0.09
Width	0.50	V_{p25}	0.03
		V_{p75-25}	0.06
Depth	0.60	a_{p50}	0.75
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	7.72E-06

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.10	0.50
1	60	0.10	0.50
2	120	0.10	0.50
3	180	0.10	0.50
4	240	0.10	0.50
5	300	0.10	0.50
25	1500	0.10	0.50
45	2700	0.10	0.50
65	3900	0.10	0.50
85	5100	0.10	0.50
105	6300	0.10	0.50
125	7500	0.10	0.50
145	8700	0.10	0.50
165	9900	0.10	0.50
185	11100	0.11	0.49
205	12300	0.11	0.49
225	13500	0.11	0.49
245	14700	0.11	0.49
265	15900	0.11	0.49
285	17100	0.11	0.49
305	18300	0.11	0.49
325	19500	0.11	0.49
345	20700	0.12	0.48
365	21900	0.12	0.48
1380	82800	0.13	0.47



SOIL INFILTRATION RATE TEST

Test No.	SA1D No 1	Date:	04/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Jacks

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0.11
Length	0.50	WaterLevel at End - m bgl	0.13
		V_{p75}	0 26
Width	0.50	V_{p25}	0.09
		V_{p75-25}	0.17
Depth	1.50	a_{p50}	1.64
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	1.48E-06

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.11	1.39
1	60	0.11	1.39
2	120	0.11	1.39
3	180	0.11	1.39
4	240	0.11	1.39
5	300	0.11	1.39
25	1500	0.11	1.39
45	2700	0.11	1.39
65	3900	0.11	1.39
85	5100	0.11	1.39
105	6300	0.11	1.39
125	7500	0.11	1.39
145	8700	0.11	1.39
165	9900	0.12	1.39
185	11100	0.12	1.39
205	12300	0.12	1.38
225	13500	0.12	1.38
245	14700	0.12	1.38
265	15900	0.12	1.38
285	17100	0.12	1.38
305	18300	0.12	1.38
325	19500	0.12	1.38
345	20700	0.12	1.38
365	21900	0.12	1.38
1380	82800	0.13	1.37

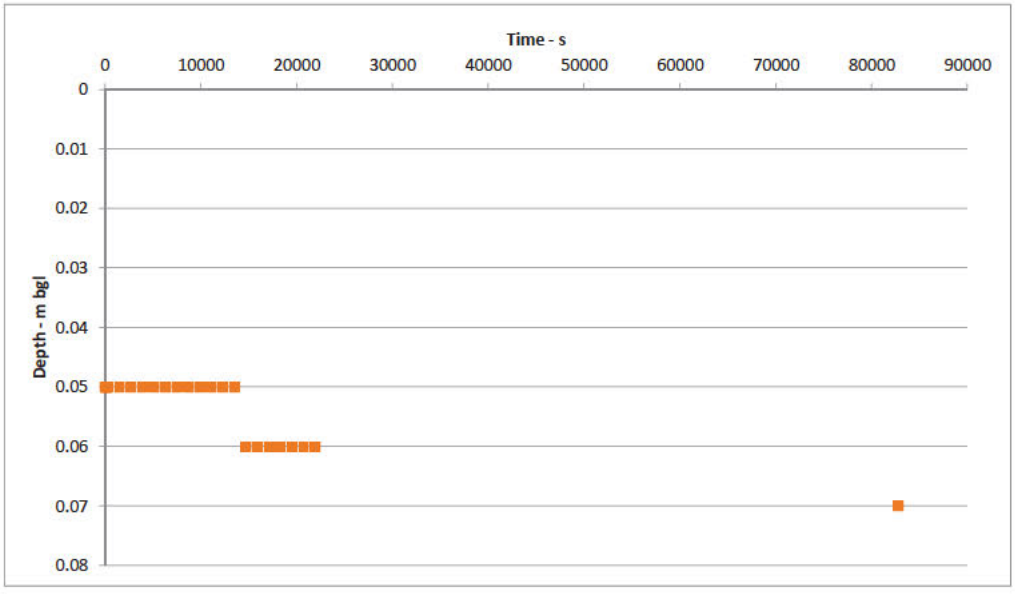
SOIL INFILTRATION RATE TEST

Test No.	SA1D No 2	Date:	05/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Jacks

Trial Pit Dimensions (m)			
Length	0.50	Water Level at Start - m bgl	0.05
		WaterLevel at End - m bgl	0.07
		V_{p75}	0 27
Width	0.50	V_{p25}	0.09
		V_{p75-25}	0.18
Depth	1.50	a_{p50}	1.70
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	1.57E-06

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.05	1.45
1	60	0.05	1.45
2	120	0.05	1.45
3	180	0.05	1.45
4	240	0.05	1.45
5	300	0.05	1.45
25	1500	0.05	1.45
45	2700	0.05	1.45
65	3900	0.05	1.45
85	5100	0.05	1.45
105	6300	0.05	1.45
125	7500	0.05	1.45
145	8700	0.05	1.45
165	9900	0.05	1.45
185	11100	0.05	1.45
205	12300	0.05	1.45
225	13500	0.05	1.45
245	14700	0.06	1.44
265	15900	0.06	1.44
285	17100	0.06	1.44
305	18300	0.06	1.44
325	19500	0.06	1.44
345	20700	0.06	1.44
365	21900	0.06	1.44
1380	82800	0.07	1.43



SOIL INFILTRATION RATE TEST

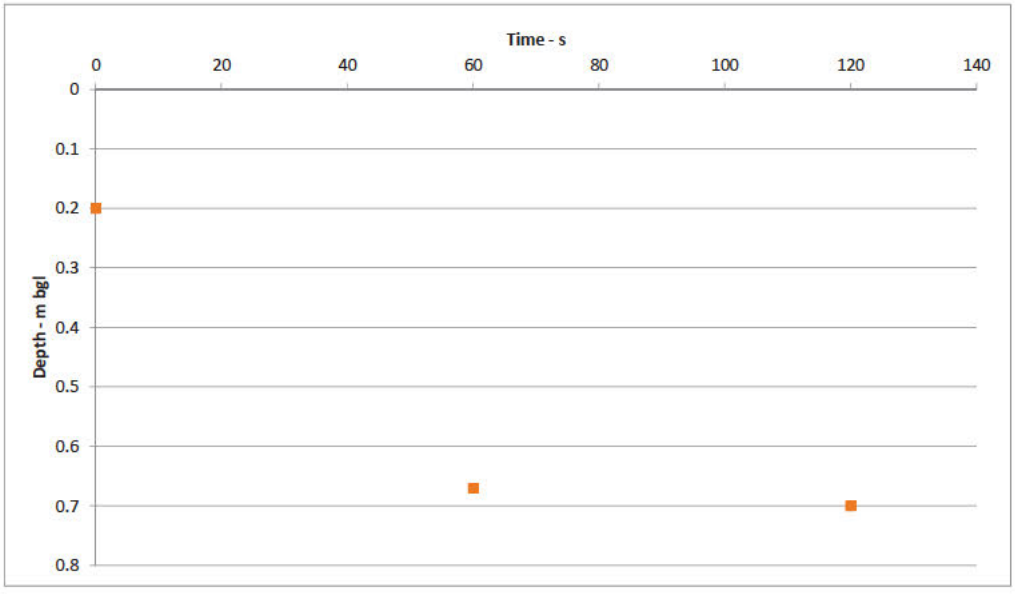
Test No.	SA2S No 1	Date:	04/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Jacks

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0 20
Length	0.50	WaterLevel at End - m bgl	0.70
		V_{p75}	0.09
Width	0.50	V_{p25}	0.03
		V_{p75-25}	0.06
Depth	0.70	a_{p50}	0.75
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	1.19E-03

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.20	0.50
1	60	0.67	0.03
2	120	0.70	0.00

NB: Band of flints noted at 0.70m bgl



SOIL INFILTRATION RATE TEST

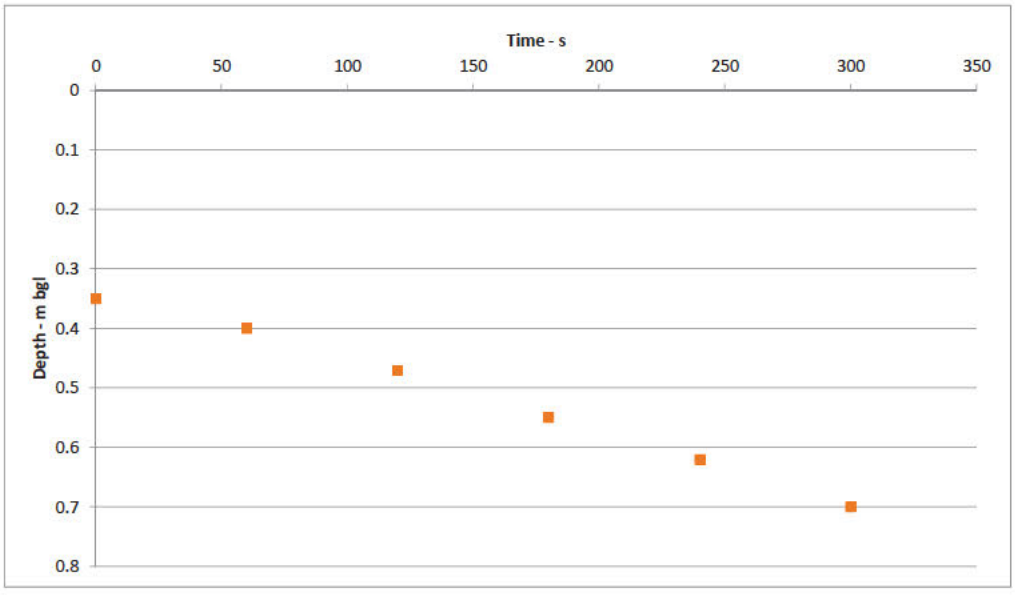
Test No.	SA2S No 2	Date:	04/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Jacks

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0 35
Length	0.50	WaterLevel at End - m bgl	0.70
		V_{p75}	0.07
Width	0.50	V_{p25}	0.02
		V_{p75-25}	0.04
Depth	0.70	a_{p50}	0.60
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	5.21E-04

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.35	0.35
1	60	0.40	0.30
2	120	0.47	0.23
3	180	0.55	0.15
4	240	0.62	0.08
5	300	0.70	0.00

NB: Band of flints noted at 0.70m



SOIL INFILTRATION RATE TEST

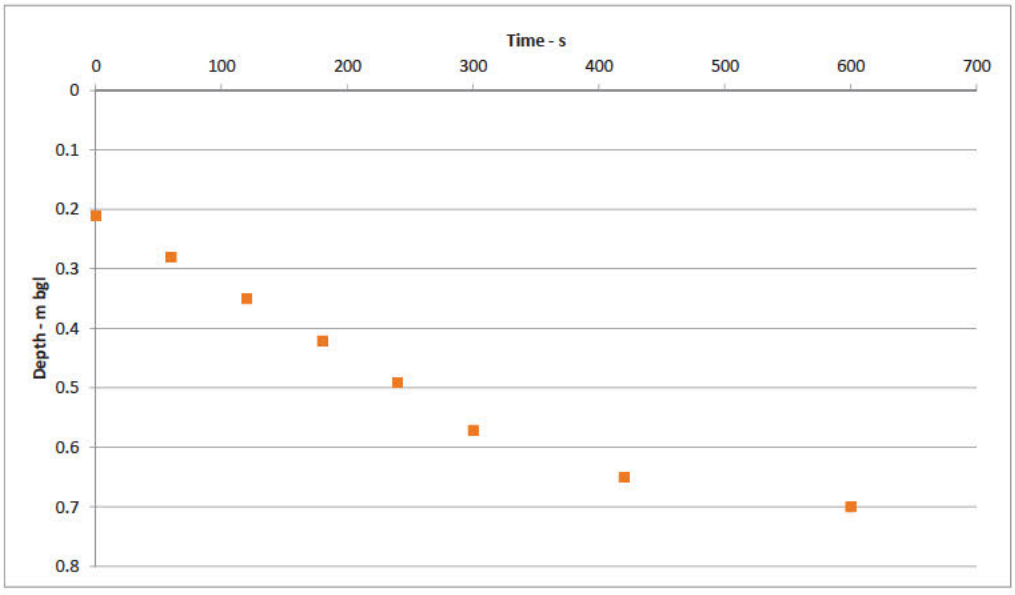
Test No.	SA2S No 3	Date:	04/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Jacks

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0 21
Length	0.50	WaterLevel at End - m bgl	0.70
		V_{p75}	0.09
Width	0.50	V_{p25}	0.03
		V_{p75-25}	0.06
Depth	0.70	a_{p50}	0.74
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	3.76E-04

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.21	0.49
1	60	0.28	0.42
2	120	0.35	0.35
3	180	0.42	0.28
4	240	0.49	0.21
5	300	0.57	0.13
7	420	0.65	0.05
10	600	0.70	0.00

NB: Band of flints noted at 0.70m



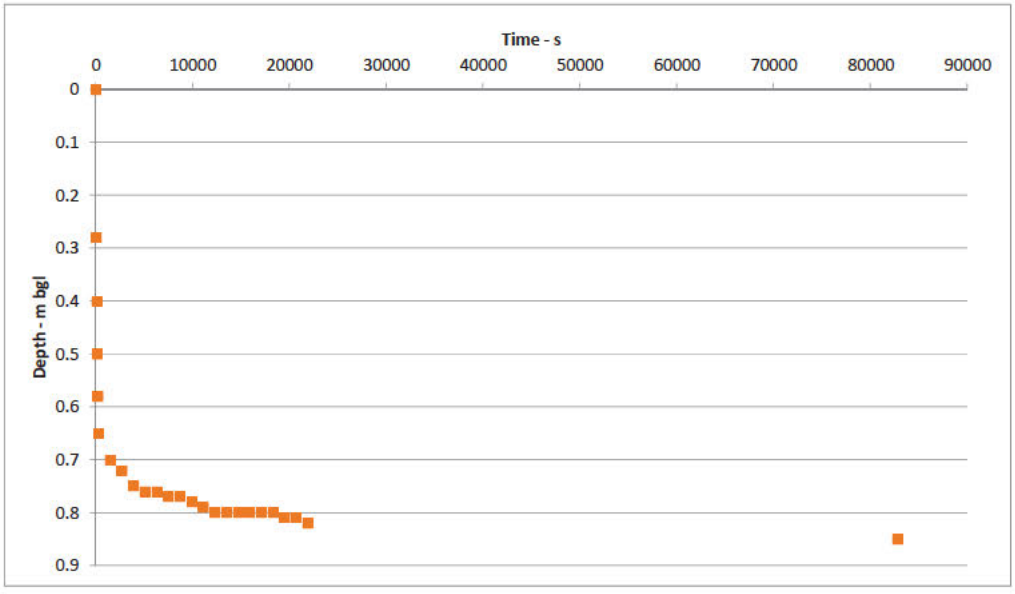
SOIL INFILTRATION RATE TEST

Test No.	SA2D No 1	Date:	04/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Jacks

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0.00
Length	0.50	WaterLevel at End - m bgl	0.85
		V_{p75}	0 28
Width	0.50	V_{p25}	0.09
		V_{p75-25}	0.19
Depth	1.50	a_{p50}	1.75
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	4.20E-04

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.00	1.50
1	60	0.28	1.22
2	120	0.40	1.10
3	180	0.50	1.00
4	240	0.58	0.92
5	300	0.65	0.85
25	1500	0.70	0.80
45	2700	0.72	0.78
65	3900	0.75	0.75
85	5100	0.76	0.74
105	6300	0.76	0.74
125	7500	0.77	0.73
145	8700	0.77	0.73
165	9900	0.78	0.72
185	11100	0.79	0.71
205	12300	0.80	0.70
225	13500	0.80	0.70
245	14700	0.80	0.70
265	15900	0.80	0.70
285	17100	0.80	0.70
305	18300	0.80	0.70
325	19500	0.81	0.69
345	20700	0.81	0.69
365	21900	0.82	0.68
1380	82800	0.85	0.65



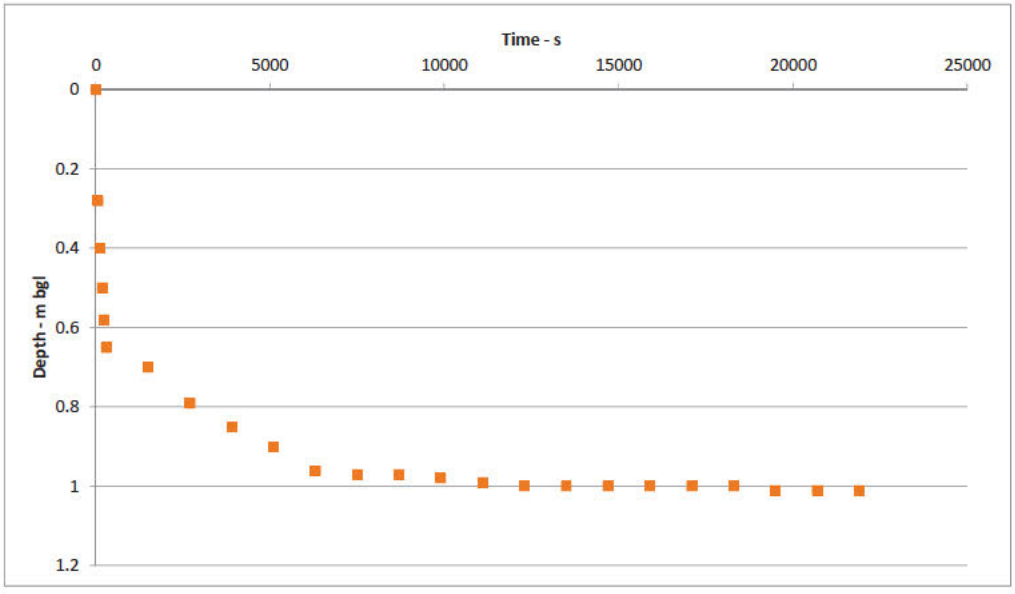
SOIL INFILTRATION RATE TEST

Test No.	SA2D No 2	Date:	05/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Jacks

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0.00
Length	0.50	WaterLevel at End - m bgl	1.01
		V_{p75}	0 28
Width	0.50	V_{p25}	0.09
		V_{p75-25}	0.19
Depth	1.50	a_{p50}	1.75
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	5.21E-05

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.00	1.50
1	60	0.28	1.22
2	120	0.40	1.10
3	180	0.50	1.00
4	240	0.58	0.92
5	300	0.65	0.85
25	1500	0.70	0.80
45	2700	0.79	0.71
65	3900	0.85	0.65
85	5100	0.90	0.60
105	6300	0.96	0.54
125	7500	0.97	0.53
145	8700	0.97	0.53
165	9900	0.98	0.52
185	11100	0.99	0.51
205	12300	1.00	0.50
225	13500	1.00	0.50
245	14700	1.00	0.50
265	15900	1.00	0.50
285	17100	1.00	0.50
305	18300	1.00	0.50
325	19500	1.01	0.49
345	20700	1.01	0.49
365	21900	1.01	0.49



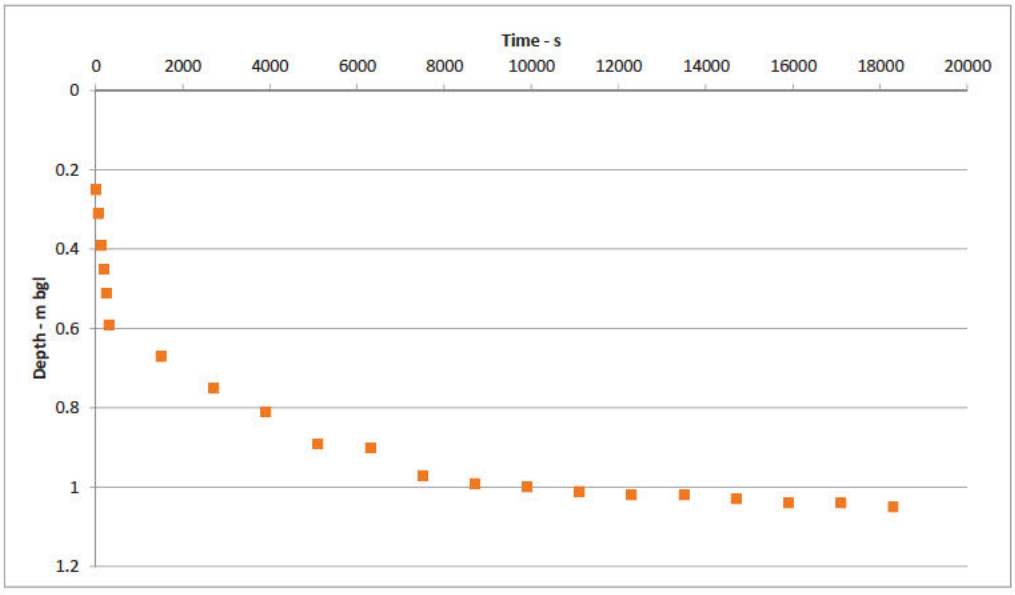
SOIL INFILTRATION RATE TEST

Test No.	SA2D No 3	Date:	05/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Jacks

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0 25
Length	0.50	WaterLevel at End - m bgl	1.00
		V_{p75}	0 23
Width	0.50	V_{p25}	0.08
		V_{p75-25}	0.16
Depth	1.50	a_{p50}	1 50
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	2.78E-05

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.25	1.25
1	60	0.31	1.19
2	120	0.39	1.11
3	180	0.45	1.05
4	240	0.51	0.99
5	300	0.59	0.91
25	1500	0.67	0.83
45	2700	0.75	0.75
65	3900	0.81	0.69
85	5100	0.89	0.61
105	6300	0.90	0.60
125	7500	0.97	0.53
145	8700	0.99	0.51
165	9900	1.00	0.50
185	11100	1.01	0.49
205	12300	1.02	0.48
225	13500	1.02	0.48
245	14700	1.03	0.47
265	15900	1.04	0.46
285	17100	1.04	0.46
305	18300	1.05	0.45



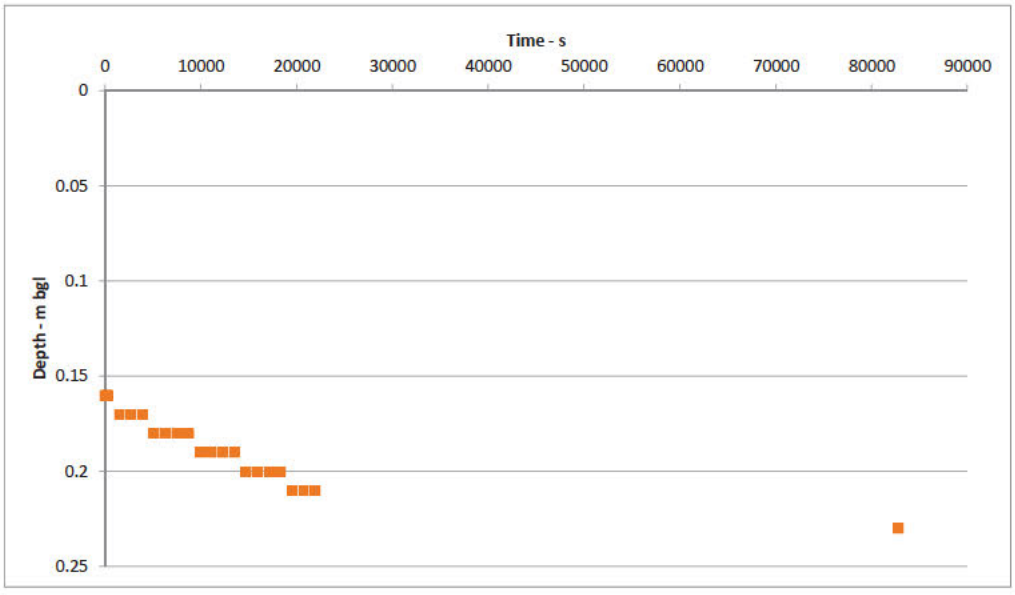
SOIL INFILTRATION RATE TEST

Test No.	SA3S No1	Date:	05/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Bulls Field

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0.16
Length	0.50	WaterLevel at End - m bgl	0 23
		V_{p75}	0.08
Width	0.50	V_{p25}	0.03
		V_{p75-25}	0.06
Depth	0.60	a_{p50}	0.69
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	4.74E-06

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.16	0.44
1	60	0.16	0.44
2	120	0.16	0.44
3	180	0.16	0.44
4	240	0.16	0.44
5	300	0.16	0.44
25	1500	0.17	0.43
45	2700	0.17	0.43
65	3900	0.17	0.43
85	5100	0.18	0.42
105	6300	0.18	0.42
125	7500	0.18	0.42
145	8700	0.18	0.42
165	9900	0.19	0.41
185	11100	0.19	0.41
205	12300	0.19	0.41
225	13500	0.19	0.41
245	14700	0.20	0.40
265	15900	0.20	0.40
285	17100	0.20	0.40
305	18300	0.20	0.40
325	19500	0.21	0.39
345	20700	0.21	0.39
365	21900	0.21	0.39
1380	82800	0.23	0.37



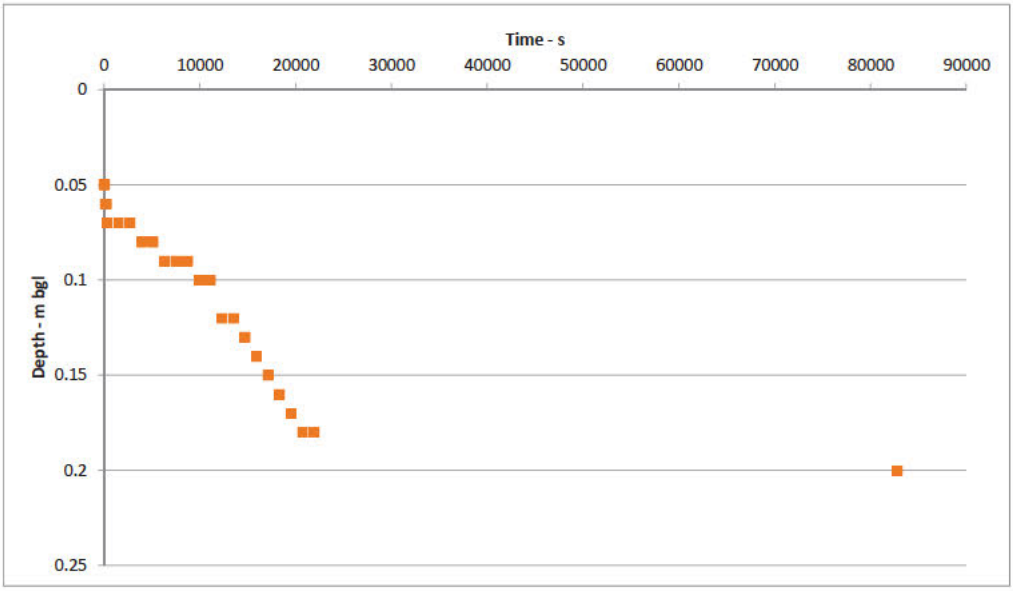
SOIL INFILTRATION RATE TEST

Test No.	SA3S No 2	Date:	06/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Bulls Field

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0.05
Length	0.50	WaterLevel at End - m bgl	0 20
		V_{p75}	0.10
Width	0.50	V_{p25}	0.03
		V_{p75-25}	0.07
Depth	0.60	a_{p50}	0.80
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	7.16E-06

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.05	0.55
1	60	0.05	0.55
2	120	0.06	0.54
3	180	0.06	0.54
4	240	0.06	0.54
5	300	0.07	0.53
25	1500	0.07	0.53
45	2700	0.07	0.53
65	3900	0.08	0.52
85	5100	0.08	0.52
105	6300	0.09	0.51
125	7500	0.09	0.51
145	8700	0.09	0.51
165	9900	0.10	0.50
185	11100	0.10	0.50
205	12300	0.12	0.48
225	13500	0.12	0.48
245	14700	0.13	0.47
265	15900	0.14	0.46
285	17100	0.15	0.45
305	18300	0.16	0.44
325	19500	0.17	0.43
345	20700	0.18	0.42
365	21900	0.18	0.42
1380	82800	0.20	0.40



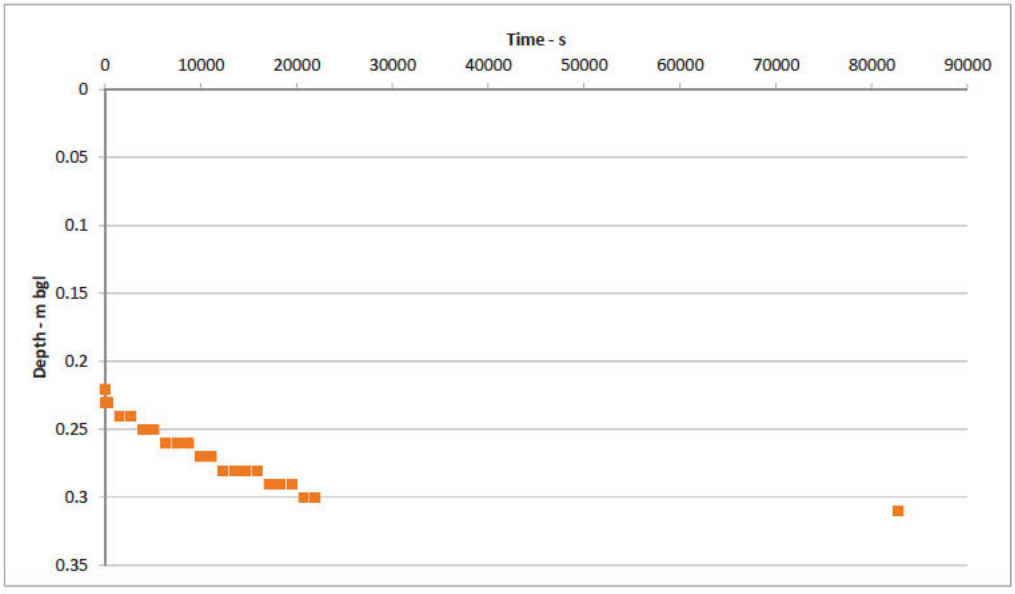
SOIL INFILTRATION RATE TEST

Test No.	SA3D No 1	Date:	05/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Bulls Field

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0 22
Length	0.50	WaterLevel at End - m bgl	0 31
		V_{p75}	0 24
Width	0.50	V_{p25}	0.08
		V_{p75-25}	0.16
Depth	1.50	a_{p50}	1 53
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	6.22E-06

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.22	1.28
1	60	0.23	1.27
2	120	0.23	1.27
3	180	0.23	1.27
4	240	0.23	1.27
5	300	0.23	1.27
25	1500	0.24	1.26
45	2700	0.24	1.26
65	3900	0.25	1.25
85	5100	0.25	1.25
105	6300	0.26	1.24
125	7500	0.26	1.24
145	8700	0.26	1.24
165	9900	0.27	1.23
185	11100	0.27	1.23
205	12300	0.28	1.22
225	13500	0.28	1.22
245	14700	0.28	1.22
265	15900	0.28	1.22
285	17100	0.29	1.21
305	18300	0.29	1.21
325	19500	0.29	1.21
345	20700	0.30	1.20
365	21900	0.30	1.20
1380	82800	0.31	1.19



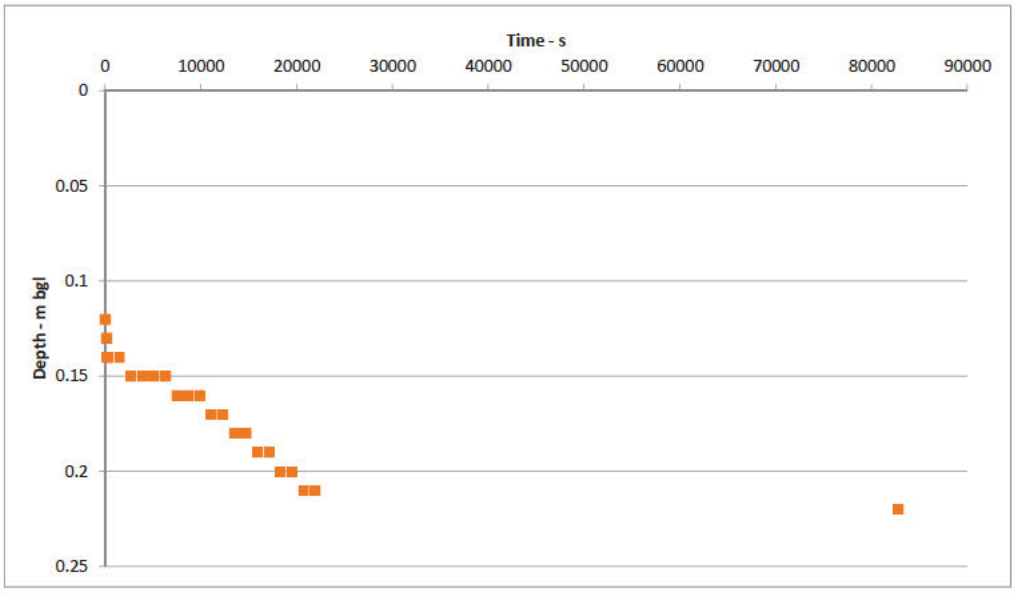
SOIL INFILTRATION RATE TEST

Test No.	SA3D No 2	Date:	06/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Bulls Field

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0.12
Length	0.50	WaterLevel at End - m bgl	0 22
		V_{p75}	0 26
Width	0.50	V_{p25}	0.09
		V_{p75-25}	0.17
Depth	1.50	a_{p50}	1.63
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	6.30E-06

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.12	1.38
1	60	0.12	1.38
2	120	0.13	1.37
3	180	0.13	1.37
4	240	0.14	1.36
5	300	0.14	1.36
25	1500	0.14	1.36
45	2700	0.15	1.35
65	3900	0.15	1.35
85	5100	0.15	1.35
105	6300	0.15	1.35
125	7500	0.16	1.34
145	8700	0.16	1.34
165	9900	0.16	1.34
185	11100	0.17	1.33
205	12300	0.17	1.33
225	13500	0.18	1.32
245	14700	0.18	1.32
265	15900	0.19	1.31
285	17100	0.19	1.31
305	18300	0.20	1.30
325	19500	0.20	1.30
345	20700	0.21	1.29
365	21900	0.21	1.29
1380	82800	0.22	1.28



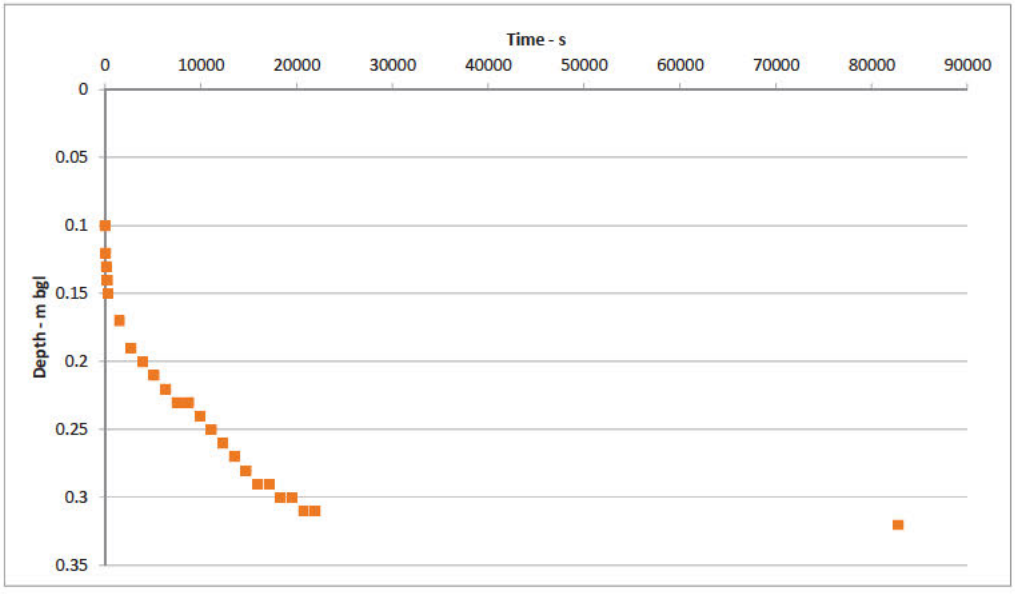
SOIL INFILTRATION RATE TEST

Test No.	SA4S No 1	Date:	05/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Bulls Field

Trial Pit Dimensions (m)			
Length	0.50	Water Level at Start - m bgl	0.10
		WaterLevel at End - m bgl	0 32
		V_{p75}	0.09
Width	0.50	V_{p25}	0.03
		V_{p75-25}	0.06
Depth	0.60	a_{p50}	0.75
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	6.67E-06

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.10	0.50
1	60	0.12	0.48
2	120	0.13	0.47
3	180	0.14	0.46
4	240	0.14	0.46
5	300	0.15	0.45
25	1500	0.17	0.43
45	2700	0.19	0.41
65	3900	0.20	0.40
85	5100	0.21	0.39
105	6300	0.22	0.38
125	7500	0.23	0.37
145	8700	0.23	0.37
165	9900	0.24	0.36
185	11100	0.25	0.35
205	12300	0.26	0.34
225	13500	0.27	0.33
245	14700	0.28	0.32
265	15900	0.29	0.31
285	17100	0.29	0.31
305	18300	0.30	0.30
325	19500	0.30	0.30
345	20700	0.31	0.29
365	21900	0.31	0.29
1380	82800	0.32	0.28



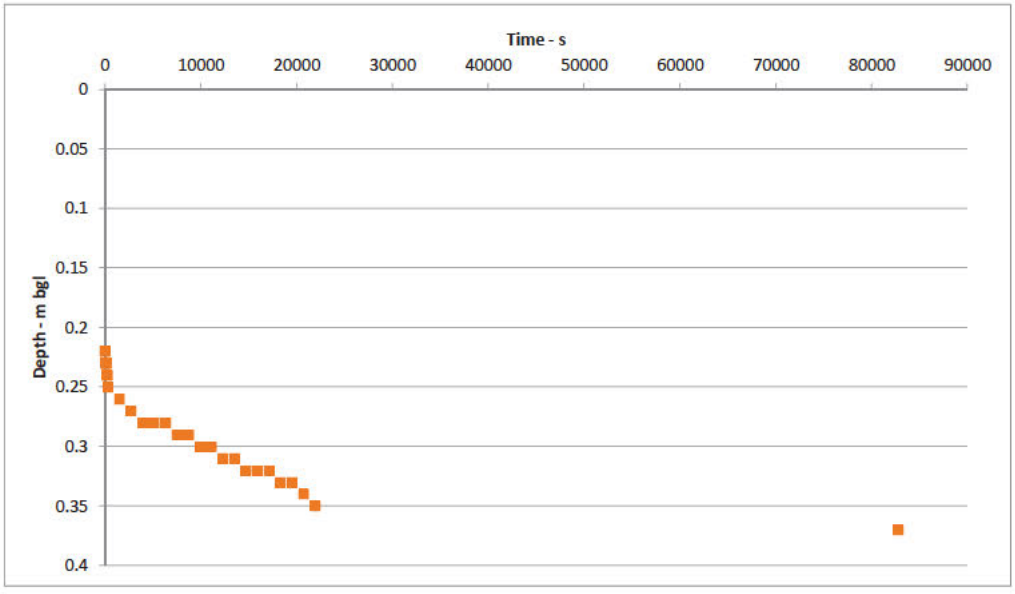
SOIL INFILTRATION RATE TEST

Test No.	SA4S No 1	Date:	06/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Bulls Field

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0 22
Length	0.50	WaterLevel at End - m bgl	0 37
		V_{p75}	0.07
Width	0.50	V_{p25}	0.02
		V_{p75-25}	0.05
Depth	0.60	a_{p50}	0.63
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	4.19E-06

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.22	0.38
1	60	0.23	0.37
2	120	0.23	0.37
3	180	0.24	0.36
4	240	0.24	0.36
5	300	0.25	0.35
25	1500	0.26	0.34
45	2700	0.27	0.33
65	3900	0.28	0.32
85	5100	0.28	0.32
105	6300	0.28	0.32
125	7500	0.29	0.31
145	8700	0.29	0.31
165	9900	0.30	0.30
185	11100	0.30	0.30
205	12300	0.31	0.29
225	13500	0.31	0.29
245	14700	0.32	0.28
265	15900	0.32	0.28
285	17100	0.32	0.28
305	18300	0.33	0.27
325	19500	0.33	0.27
345	20700	0.34	0.26
365	21900	0.35	0.25
1380	82800	0.37	0.23



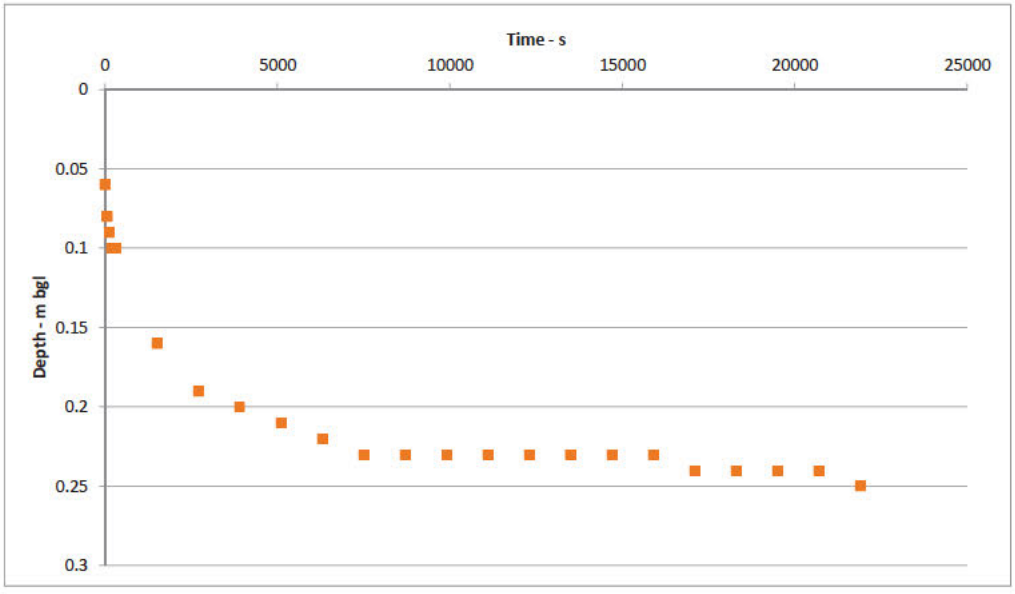
SOIL INFILTRATION RATE TEST

Test No.	SA4D No 1	Date:	05/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Bulls Field

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0.06
Length	0.50	WaterLevel at End - m bgl	0 25
		V_{p75}	0 27
Width	0.50	V_{p25}	0.09
		V_{p75-25}	0.18
Depth	1.50	a_{p50}	1.69
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	3.13E-05

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.06	1.44
1	60	0.08	1.42
2	120	0.09	1.41
3	180	0.10	1.40
4	240	0.10	1.40
5	300	0.10	1.40
25	1500	0.16	1.34
45	2700	0.19	1.31
65	3900	0.20	1.30
85	5100	0.21	1.29
105	6300	0.22	1.28
125	7500	0.23	1.27
145	8700	0.23	1.27
165	9900	0.23	1.27
185	11100	0.23	1.27
205	12300	0.23	1.27
225	13500	0.23	1.27
245	14700	0.23	1.27
265	15900	0.23	1.27
285	17100	0.24	1.26
305	18300	0.24	1.26
325	19500	0.24	1.26
345	20700	0.24	1.26
365	21900	0.25	1.25



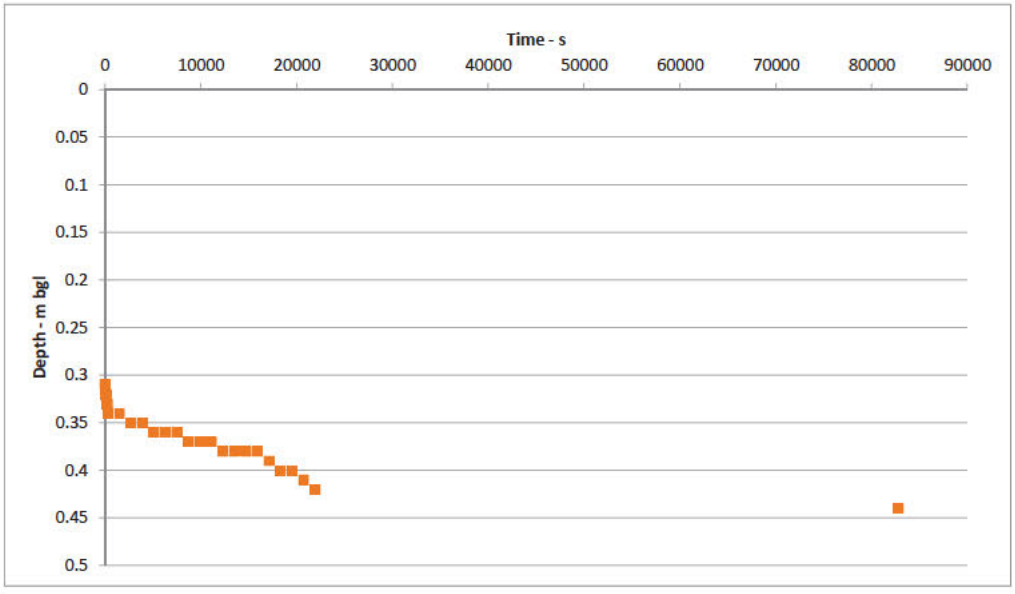
SOIL INFILTRATION RATE TEST

Test No.	SA4D No 2	Date:	06/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Bulls Field

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0 31
Length	0.50	WaterLevel at End - m bgl	0.44
		V_{p75}	0 22
Width	0.50	V_{p25}	0.07
		V_{p75-25}	0.15
Depth	1.50	a_{p50}	1.44
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	5.06E-06

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.31	1.19
1	60	0.32	1.18
2	120	0.32	1.18
3	180	0.33	1.17
4	240	0.33	1.17
5	300	0.34	1.16
25	1500	0.34	1.16
45	2700	0.35	1.15
65	3900	0.35	1.15
85	5100	0.36	1.14
105	6300	0.36	1.14
125	7500	0.36	1.14
145	8700	0.37	1.13
165	9900	0.37	1.13
185	11100	0.37	1.13
205	12300	0.38	1.12
225	13500	0.38	1.12
245	14700	0.38	1.12
265	15900	0.38	1.12
285	17100	0.39	1.11
305	18300	0.40	1.10
325	19500	0.40	1.10
345	20700	0.41	1.09
365	21900	0.42	1.08
1380	82800	0.44	1.06



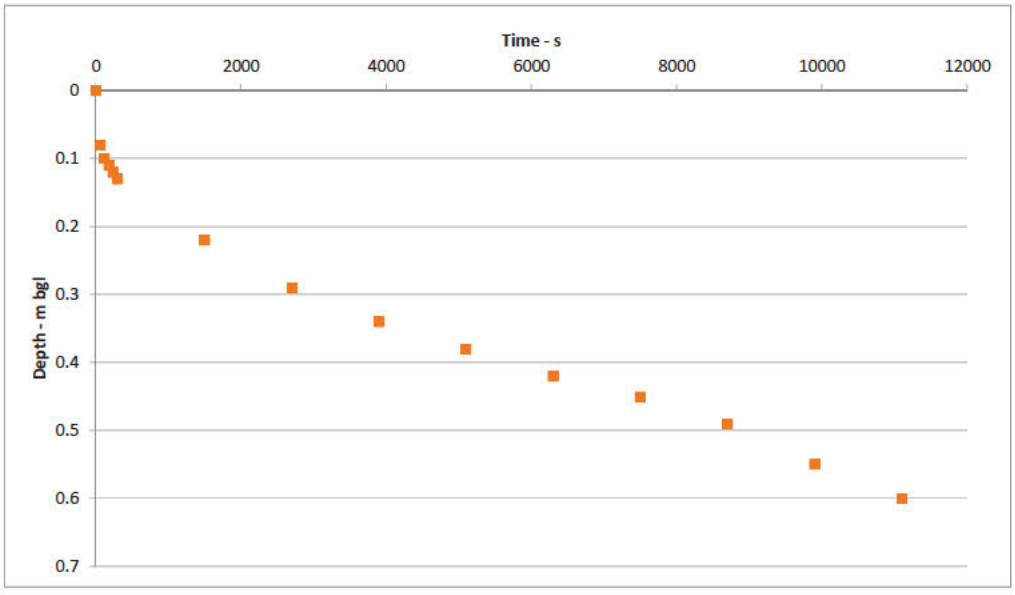
SOIL INFILTRATION RATE TEST

Test No.	SA5S No 1	Date:	06/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Bulls Field

Trial Pit Dimensions (m)			
Length	0.50	Water Level at Start - m bgl	0.00
		WaterLevel at End - m bgl	0.60
		V_{p75}	0.11
Width	0.50	V_{p25}	0.04
		V_{p75-25}	0.08
Depth	0.60	a_{p50}	0.85
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	1.25E-05

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.00	0.60
1	60	0.08	0.52
2	120	0.10	0.50
3	180	0.11	0.49
4	240	0.12	0.48
5	300	0.13	0.47
25	1500	0.22	0.38
45	2700	0.29	0.31
65	3900	0.34	0.26
85	5100	0.38	0.22
105	6300	0.42	0.18
125	7500	0.45	0.15
145	8700	0.49	0.11
165	9900	0.55	0.05
185	11100	0.60	0.00



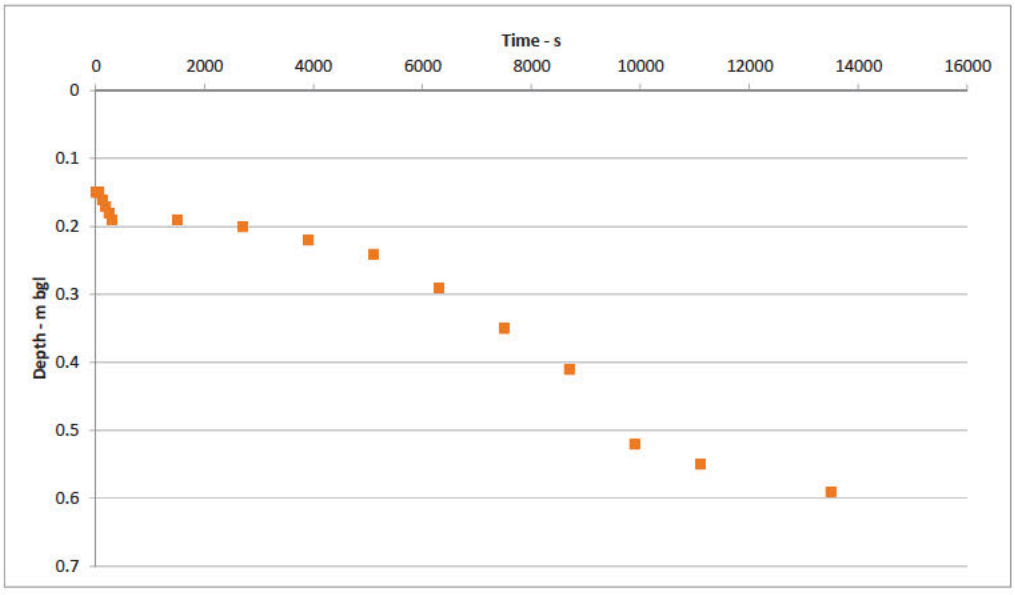
SOIL INFILTRATION RATE TEST

Test No.	SA5S No2	Date:	06/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Bulls Field

Trial Pit Dimensions (m)			
Length	0.50	Water Level at Start - m bgl	0.15
		WaterLevel at End - m bgl	0 59
		V_{p75}	0.08
Width	0.50	V_{p25}	0.03
		V_{p75-25}	0.06
Depth	0.60	a_{p50}	0.70
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	2.11E-05

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.15	0.45
1	60	0.15	0.45
2	120	0.16	0.44
3	180	0.17	0.43
4	240	0.18	0.42
5	300	0.19	0.41
25	1500	0.19	0.41
45	2700	0.20	0.40
65	3900	0.22	0.38
85	5100	0.24	0.36
105	6300	0.29	0.31
125	7500	0.35	0.25
145	8700	0.41	0.19
165	9900	0.52	0.08
185	11100	0.55	0.05
225	13500	0.59	0.01



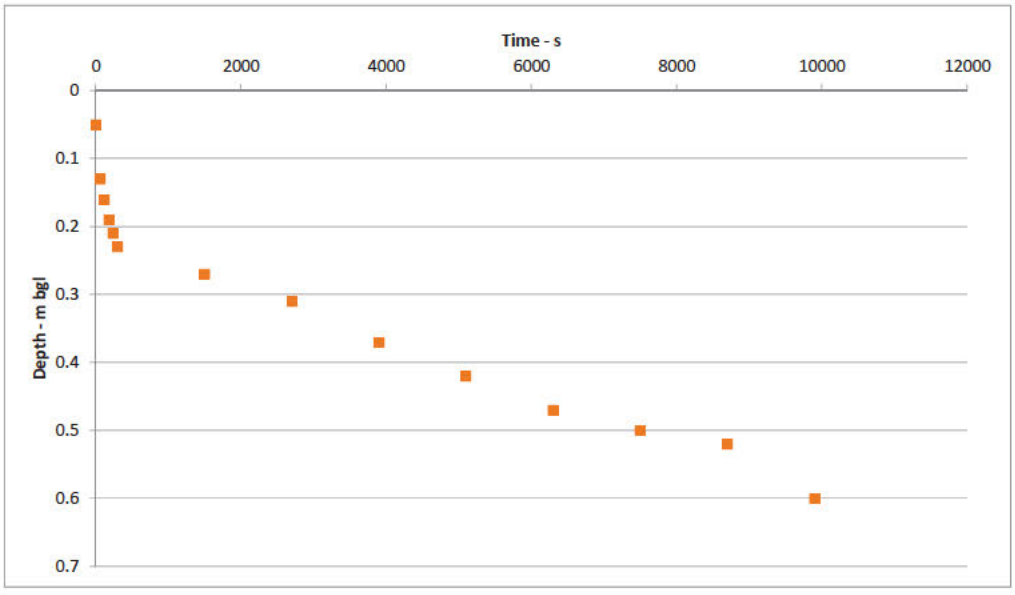
SOIL INFILTRATION RATE TEST

Test No.	SA5S No 3	Date:	07/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Bulls Field

Trial Pit Dimensions (m)			
Length	0.50	Water Level at Start - m bgl	0.05
		WaterLevel at End - m bgl	0.60
		V_{p75}	0.10
Width	0.50	V_{p25}	0.03
		V_{p75-25}	0.07
Depth	0.60	a_{p50}	0.80
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	1.48E-05

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.05	0.55
1	60	0.13	0.47
2	120	0.16	0.44
3	180	0.19	0.41
4	240	0.21	0.39
5	300	0.23	0.37
25	1500	0.27	0.33
45	2700	0.31	0.29
65	3900	0.37	0.23
85	5100	0.42	0.18
105	6300	0.47	0.13
125	7500	0.50	0.10
145	8700	0.52	0.08
165	9900	0.60	0.00



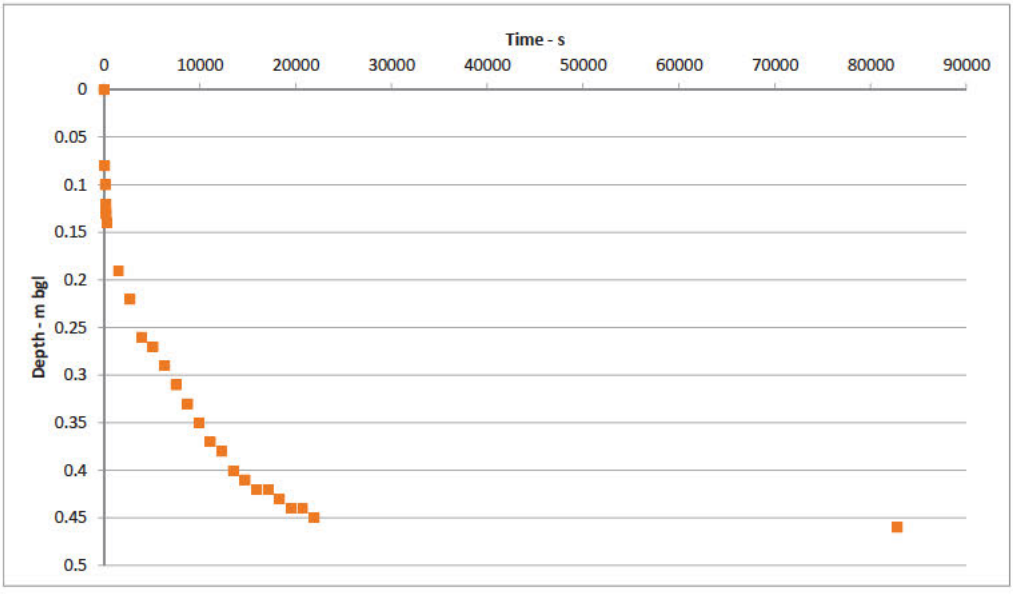
SOIL INFILTRATION RATE TEST

Test No.	SA5D No 1	Date:	06/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Bulls Field

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0.00
Length	0.50	WaterLevel at End - m bgl	0.46
		V_{p75}	0 28
Width	0.50	V_{p25}	0.09
		V_{p75-25}	0.19
Depth	1.50	a_{p50}	1.75
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	1.10E-05

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.00	1.50
1	60	0.08	1.42
2	120	0.10	1.40
3	180	0.12	1.38
4	240	0.13	1.37
5	300	0.14	1.36
25	1500	0.19	1.31
45	2700	0.22	1.28
65	3900	0.26	1.24
85	5100	0.27	1.23
105	6300	0.29	1.21
125	7500	0.31	1.19
145	8700	0.33	1.17
165	9900	0.35	1.15
185	11100	0.37	1.13
205	12300	0.38	1.12
225	13500	0.40	1.10
245	14700	0.41	1.09
265	15900	0.42	1.08
285	17100	0.42	1.08
305	18300	0.43	1.07
325	19500	0.44	1.06
345	20700	0.44	1.06
365	21900	0.45	1.05
1380	82800	0.46	1.04



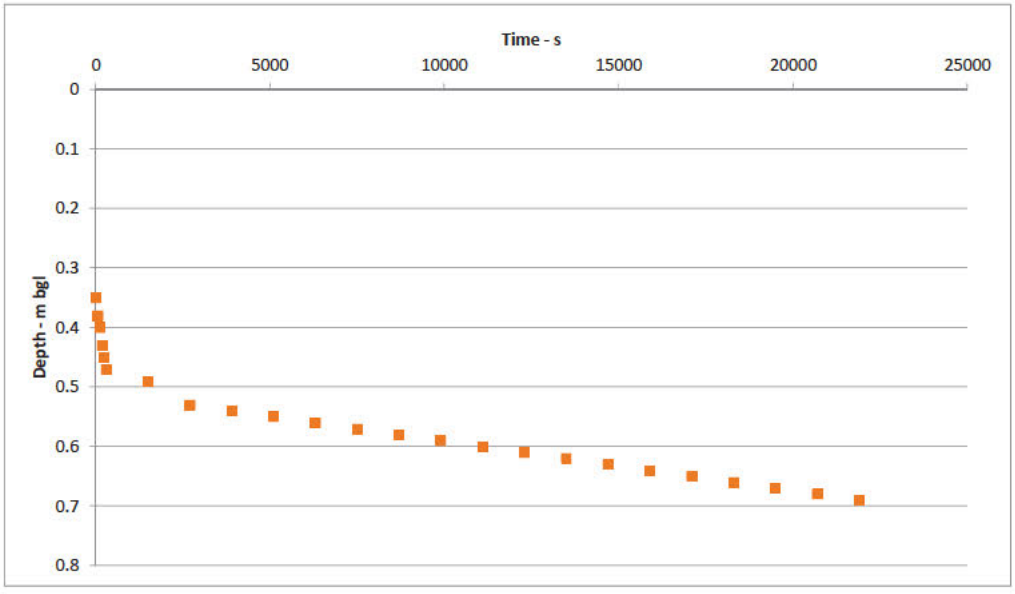
SOIL INFILTRATION RATE TEST

Test No.	SA5D No 2	Date:	07/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - Bulls Field

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0 35
Length	0.50	WaterLevel at End - m bgl	0.69
		V_{p75}	0 22
Width	0.50	V_{p25}	0.07
		V_{p75-25}	0.14
Depth	1.50	a_{p50}	1.40
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	8.49E-06

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.35	1.15
1	60	0.38	1.12
2	120	0.40	1.10
3	180	0.43	1.07
4	240	0.45	1.05
5	300	0.47	1.03
25	1500	0.49	1.01
45	2700	0.53	0.97
65	3900	0.54	0.96
85	5100	0.55	0.95
105	6300	0.56	0.94
125	7500	0.57	0.93
145	8700	0.58	0.92
165	9900	0.59	0.91
185	11100	0.60	0.90
205	12300	0.61	0.89
225	13500	0.62	0.88
245	14700	0.63	0.87
265	15900	0.64	0.86
285	17100	0.65	0.85
305	18300	0.66	0.84
325	19500	0.67	0.83
345	20700	0.68	0.82
365	21900	0.69	0.81



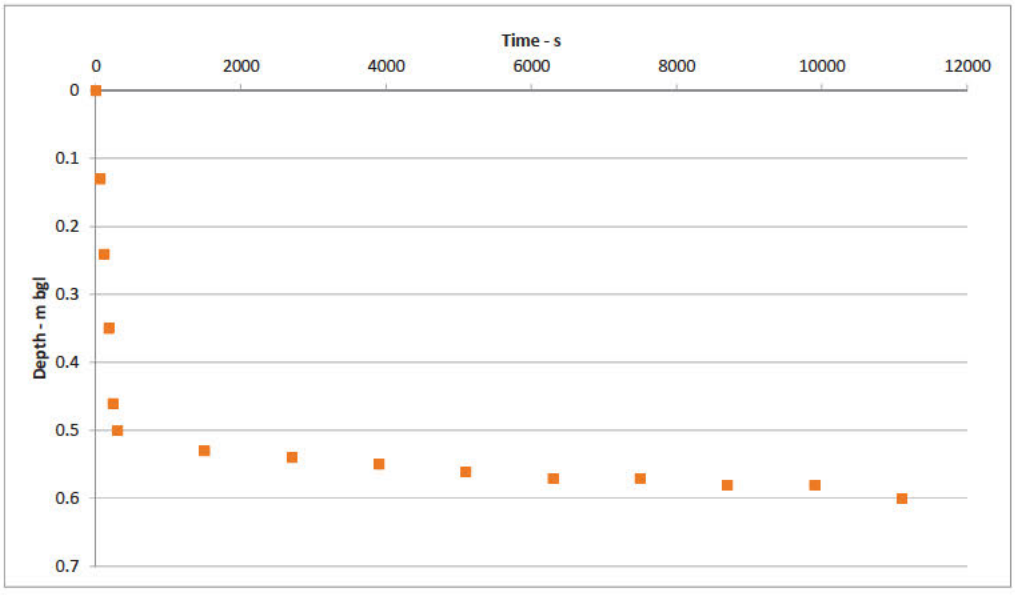
SOIL INFILTRATION RATE TEST

Test No.	SA6S No 1	Date:	06/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - 7 Acres

Trial Pit Dimensions (m)			
Length	0.50	Water Level at Start - m bgl	0.00
		WaterLevel at End - m bgl	0.60
		V_{p75}	0.11
Width	0.50	V_{p25}	0.04
		V_{p75-25}	0.08
Depth	0.60	a_{p50}	0.85
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	8.02E-04

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.00	0.60
1	60	0.13	0.47
2	120	0.24	0.36
3	180	0.35	0.25
4	240	0.46	0.14
5	300	0.50	0.10
25	1500	0.53	0.07
45	2700	0.54	0.06
65	3900	0.55	0.05
85	5100	0.56	0.04
105	6300	0.57	0.03
125	7500	0.57	0.03
145	8700	0.58	0.02
165	9900	0.58	0.02
185	11100	0.60	0.00



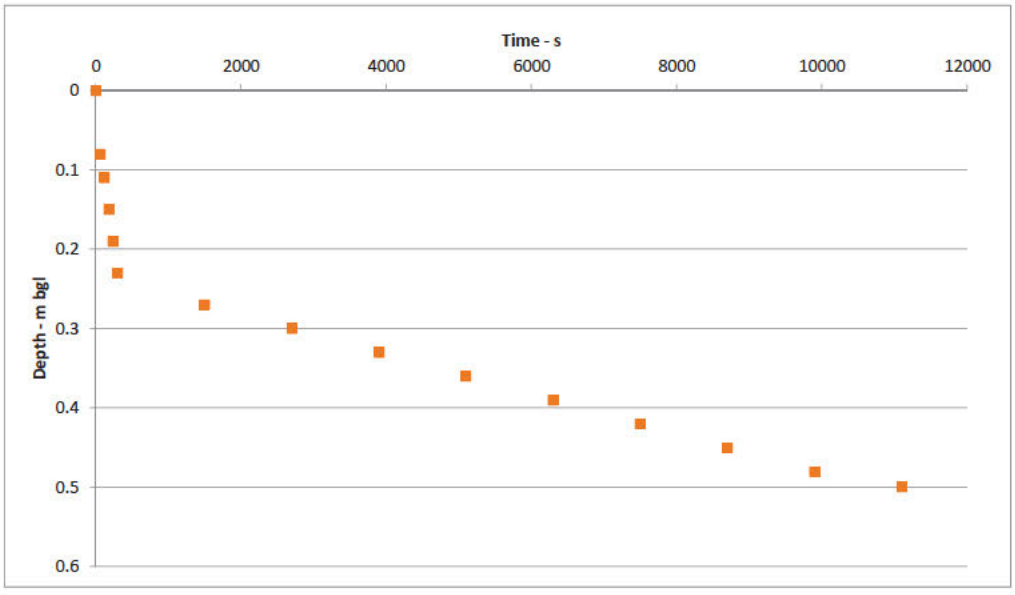
SOIL INFILTRATION RATE TEST

Test No.	SA6S No 2	Date:	06/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - 7 Acres

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0.00
Length	0.50	WaterLevel at End - m bgl	0 50
		V_{p75}	0.11
Width	0.50	V_{p25}	0.04
		V_{p75-25}	0.08
Depth	0.60	a_{p50}	0.85
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	1.51E-05

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.00	0.60
1	60	0.08	0.52
2	120	0.11	0.49
3	180	0.15	0.45
4	240	0.19	0.41
5	300	0.23	0.37
25	1500	0.27	0.33
45	2700	0.30	0.30
65	3900	0.33	0.27
85	5100	0.36	0.24
105	6300	0.39	0.21
125	7500	0.42	0.18
145	8700	0.45	0.15
165	9900	0.48	0.12
185	11100	0.50	0.10



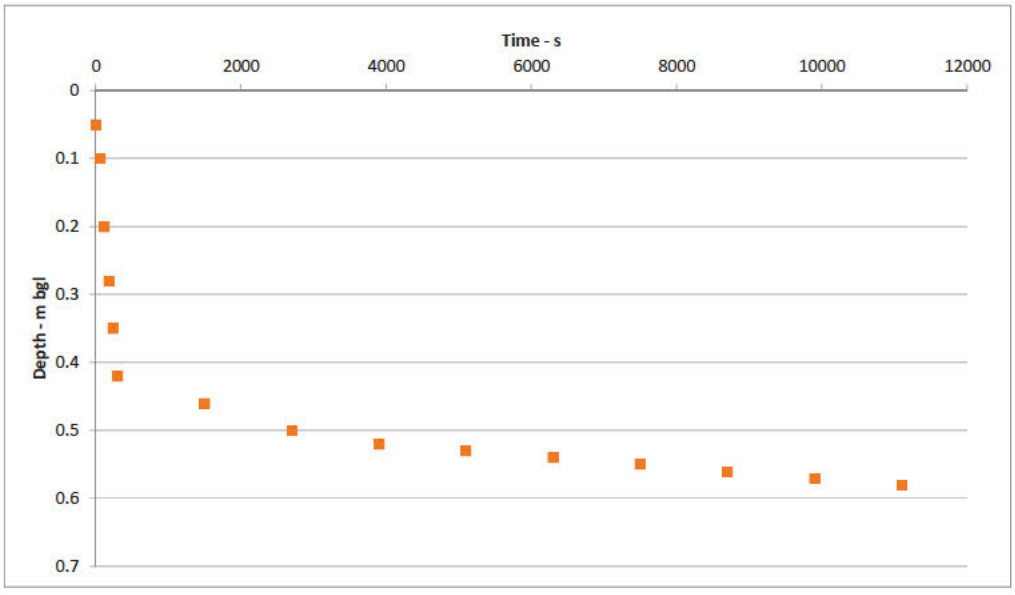
SOIL INFILTRATION RATE TEST

Test No.	SA6S No 3	Date:	07/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - 7 Acres

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0.05
Length	0.50	WaterLevel at End - m bgl	0 58
		V_{p75}	0.10
Width	0.50	V_{p25}	0.03
		V_{p75-25}	0.07
Depth	0.60	a_{p50}	0.80
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	6.61E-05

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.05	0.55
1	60	0.10	0.50
2	120	0.20	0.40
3	180	0.28	0.32
4	240	0.35	0.25
5	300	0.42	0.18
25	1500	0.46	0.14
45	2700	0.50	0.10
65	3900	0.52	0.08
85	5100	0.53	0.07
105	6300	0.54	0.06
125	7500	0.55	0.05
145	8700	0.56	0.04
165	9900	0.57	0.03
185	11100	0.58	0.02



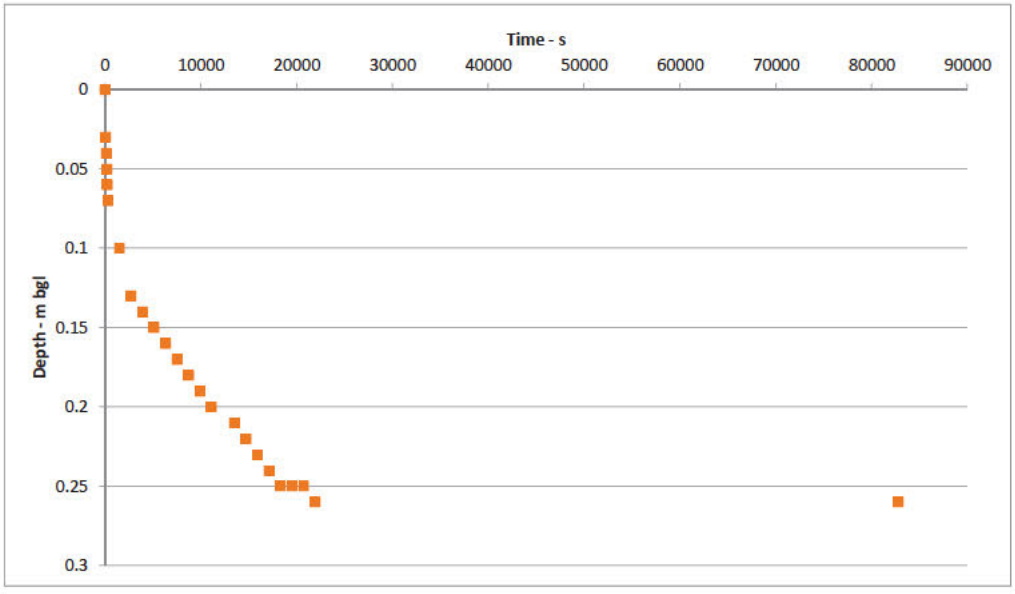
SOIL INFILTRATION RATE TEST

Test No.	SA6D No 1	Date:	06/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - 7 Acres

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0.00
Length	0.50	WaterLevel at End - m bgl	0 26
		V_{p75}	0 27
Width	0.50	V_{p25}	0.09
		V_{p75-25}	0.18
Depth	1.45	a_{p50}	1.70
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	9.87E-06

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.00	1.45
1	60	0.03	1.42
2	120	0.04	1.41
3	180	0.05	1.40
4	240	0.06	1.39
5	300	0.07	1.38
25	1500	0.10	1.35
45	2700	0.13	1.32
65	3900	0.14	1.31
85	5100	0.15	1.30
105	6300	0.16	1.29
125	7500	0.17	1.28
145	8700	0.18	1.27
165	9900	0.19	1.26
185	11100	0.20	1.25
225	13500	0.21	1.24
245	14700	0.22	1.23
265	15900	0.23	1.22
285	17100	0.24	1.21
305	18300	0.25	1.20
325	19500	0.25	1.20
345	20700	0.25	1.20
365	21900	0.26	1.19
1380	82800	0.26	1.19



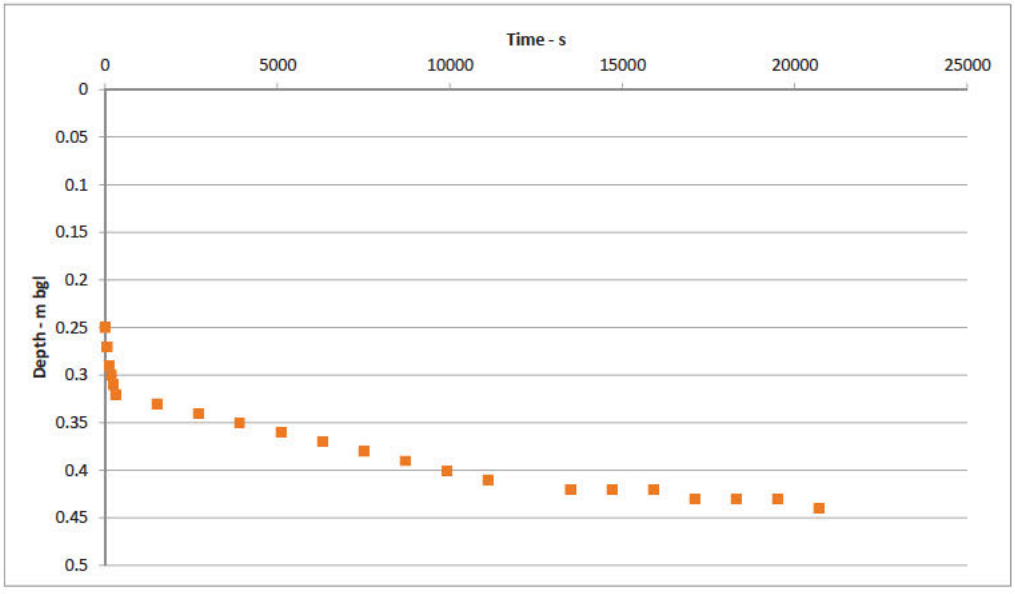
SOIL INFILTRATION RATE TEST

Test No.	SA6D No 2	Date:	07/05/2021	Job No:	CON01-WARI-070

Client:	Weston Homes plc	Site Name:	Warish Hall Farm - 7 Acres

Trial Pit Dimensions (m)		Water Level at Start - m bgl	0 25
Length	0.50	WaterLevel at End - m bgl	0.44
		V_{p75}	0 23
Width	0.50	V_{p25}	0.08
		V_{p75-25}	0.15
Depth	1.45	a_{p50}	1.45
Height of pipe above ground level (if applicable)	N/A	Infiltration Rate - m/s	1.21E-05

Elapsed Time		Depth recorded on dip meter (m bgl)	Head of Water above Base (m)
Minutes	Seconds		
0	0	0.25	1.20
1	60	0.27	1.18
2	120	0.29	1.16
3	180	0.30	1.15
4	240	0.31	1.14
5	300	0.32	1.13
25	1500	0.33	1.12
45	2700	0.34	1.11
65	3900	0.35	1.10
85	5100	0.36	1.09
105	6300	0.37	1.08
125	7500	0.38	1.07
145	8700	0.39	1.06
165	9900	0.40	1.05
185	11100	0.41	1.04
225	13500	0.42	1.03
245	14700	0.42	1.03
265	15900	0.42	1.03
285	17100	0.43	1.02
305	18300	0.43	1.02
325	19500	0.43	1.02
345	20700	0.44	1.01



Appendix: H – Surface Water Flood Maps

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

Flood risk

Extent of flooding

Location

Enter a place or postcode

Extent of flooding from surface water

High Medium Low Very low Location you selected

Appendix: I – Greenfield Runoff Rates

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

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.400
Area (ha)	1.000	Urban	0.000
SAAR (mm)	600	Region Number	Region 6

Results l/s

QBAR Rural	2.8
QBAR Urban	2.8
Q1 year	2.4
Q1 year	2.4
Q30 years	6.4
Q100 years	9.1

Appendix: J – Proposed SuDS Layout and Details

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


PERMEABLE PAVING SECTION 2
PERMEABLE PAVING – 344m²
IMPERMEABLE AREA – 607m²
MINIMUM SUB-BASE DEPTH OF 391mm REQUIRED TO PROVIDE ADEQUATE ATTENUATION FOR RAINFALL EVENTS UP TO AND INCLUDING A 1 IN 100YR +40%CC STORM. SUB-BASE DEPTH BASED ON INFILTRATION RATE OF 7.7 X 10⁻⁶ m/s
PERMEABLE PAVING SECTION 2 CL: 103.500 MIN SUBBASE IL: 103.000
PERMEABLE PAVING SECTION 1 CL: 103.200 MIN SUBBASE IL: 102.500
PERMEABLE PAVING SECTION 2 TO "CASCADE" TO PERMEABLE PAVING SECTION 1 VIA 70mm OVERFLOW PIPE AT RATE OF 6.1 l/s
PERMEABLE PAVING SECTION 1 TO "CASCADE" TO PERMEABLE PAVING SECTION 4 VIA 150mm OVERFLOW PIPE AT RATE OF 31.4 l/s
LAP
PERMEABLE PAVING SECTION 1
PERMEABLE PAVING – 888m²
IMPERMEABLE AREA – 1565m²
MINIMUM SUB-BASE DEPTH OF 521mm REQUIRED TO PROVIDE ADEQUATE ATTENUATION FOR RAINFALL EVENTS UP TO AND INCLUDING A 1 IN 100YR +40%CC STORM. SUB-BASE DEPTH BASED ON INFILTRATION RATE OF 7.7 X 10⁻⁶ m/s
PERMEABLE PAVING SECTION 4
PERMEABLE PAVING – 610m²
IMPERMEABLE AREA – 654m²
MINIMUM SUB-BASE DEPTH OF 242mm REQUIRED TO PROVIDE ADEQUATE ATTENUATION FOR RAINFALL EVENTS UP TO AND INCLUDING A 1 IN 100YR +40%CC STORM. SUB-BASE DEPTH BASED ON INFILTRATION RATE OF 7.0 X 10⁻⁴ m/s (LIKELY MINIMUM SUB-BASE DEPTH FOR STRUCTURAL REQUIREMENTS 300mm TO PROVIDE WATER QUALITY BENEFITS)
PERMEABLE PAVING SECTION 3
PERMEABLE PAVING – 489m²
IMPERMEABLE AREA – 2,391m²
MINIMUM SUB-BASE DEPTH OF 293mm REQUIRED TO PROVIDE ADEQUATE ATTENUATION FOR RAINFALL EVENTS UP TO AND INCLUDING A 1 IN 100YR +40%CC STORM. SUB-BASE DEPTH BASED ON INFILTRATION RATE OF 7.0 X 10⁻⁴ m/s (LIKELY MINIMUM SUB-BASE DEPTH FOR STRUCTURAL REQUIREMENTS 300mm TO PROVIDE WATER QUALITY BENEFITS)
PERMEABLE PAVING SECTION 3 CL: 102.700 MIN SUBBASE IL: 102.200
PERMEABLE PAVING SECTION 4 CL: 102.500 MIN SUBBASE IL: 102.000
PERMEABLE PAVING SECTION 5
PERMEABLE PAVING – 410m²
IMPERMEABLE AREA – 960m²
MINIMUM SUB-BASE DEPTH OF 83mm REQUIRED TO PROVIDE ADEQUATE ATTENUATION FOR RAINFALL EVENTS UP TO AND INCLUDING A 1 IN 100YR +40%CC STORM. SUB-BASE DEPTH BASED ON INFILTRATION RATE OF 7.0 X 10⁻⁴ m/s (LIKELY MINIMUM SUB-BASE DEPTH FOR STRUCTURAL REQUIREMENTS 300mm TO PROVIDE WATER QUALITY BENEFITS)
PERMEABLE PAVING SECTION 5 CL: 102.300 MIN SUBBASE IL: 101.800

KEY:

- PROPOSED ROOF AREA – 3401m² (3677m² – INCLUDING 10% URBAN CREEP)
- PROPOSED HARDSTANDINGS – 2455m²
- PROPOSED PERMEABLE PAVING – 2741m²
- PROPOSED FOOTPATH/CYCLEWAY TO UTILISE SEMI-PERMEABLE SELF BOUND GRAVEL/TAR SPRAY AND CHIPPING CONSTRUCTION TO ALLOW SOME INFILTRATION WITH SOME RUNOFF TO THE SURROUNDING GRASSED AREAS

NOTE: ALL PERMEABLE PAVING TO BE UNLINED TO ALLOW SURFACE WATER RUNOFF TO NATURALLY INFILTRATE TO THE GROUND

- SURFACE WATER DIFFUSER UNIT
- PROPOSED RIDGISTORM SILT TRAP OR SIMILAR APPROVED
- OVERLAND SURFACE WATER FLOW ROUTE – TAKING INTO ACCOUNT PROPOSED COVER LEVELS

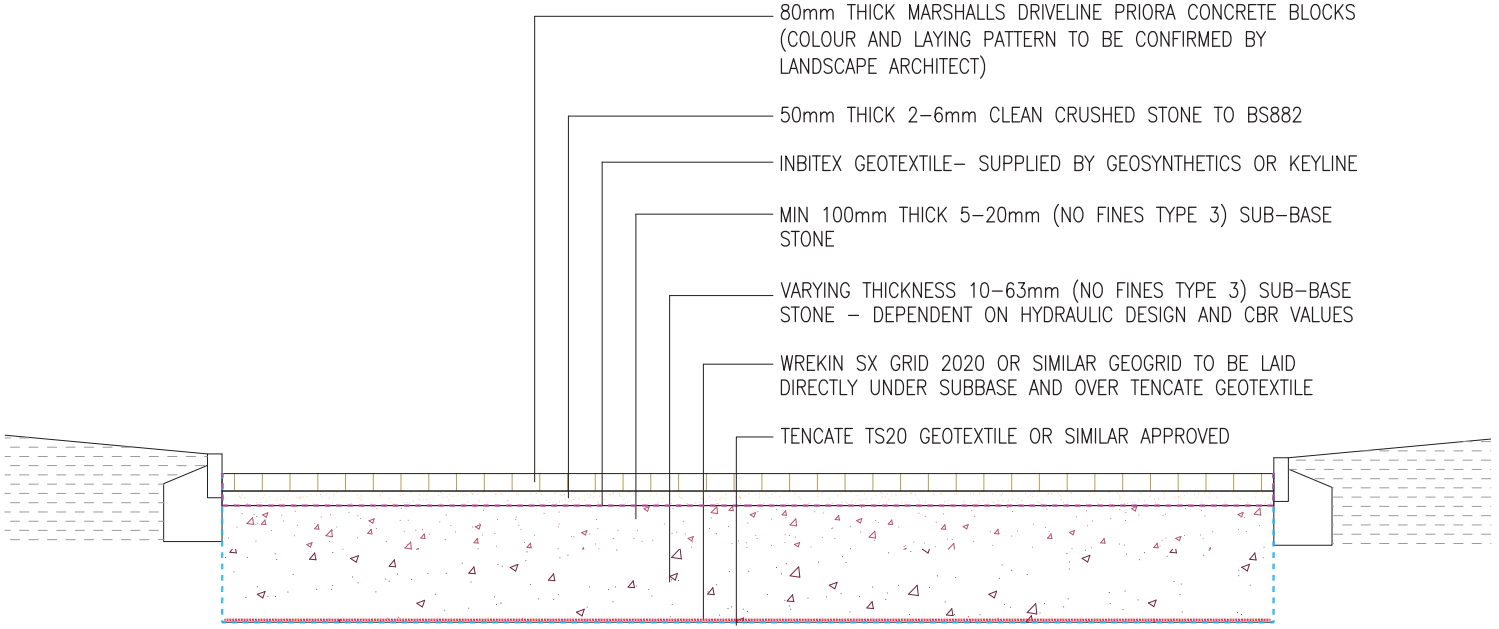
EAS
Unit 23, The Maltings, Stanstead Abbotts, Hertfordshire, SG12 8HG
Tel: 01920 871777
www.eastp.co.uk

CLIENT: WESTON HOMES

PROJECT: WARISH HALL FARM TAKELEY

TITLE: GARDEN VILLAGE PROPOSED SuDS ARRANGEMENT

SCALE @ A1: 1:500	DESIGN–DRAWN: MC	DATE: 16/02/2023
PROJECT No: 2951	DRAWING No: SK11–E	



TYPICAL PERMEABLE PAVING
CONSTRUCTION DETAIL
NTS

SUB–BASE SPECIFICATION FOR PERMEABLE PAVING SUB–BASE

THE GRANULAR SUB–BASE MATERIAL SHALL COMPRISE CRUSHED ROCK OR CONCRETE POSSESSING WELL DEFINED EDGES. IT MUSH BE SOUND, CLEAN, NON FRIABLE AND FREE FROM CLAY OR OTHER DELETRIOUS MATTER.

THE MATERIAL MUST NOT BE PLASTIC WHEN TESTED IN ACCORDANCE WITH BS1377 TEST No 4.

THE CRUSHED STONE USED FOR THE LAYING COURSE AND SUB–BASE MUST HAVE A MINIMUM 10% FINES VALUE OF 150kN WHEN TESTED IN ACCORDANCE WITH BS812 PART 111.

THE SELECTED TEST SAMPLES MUST NOT BE OVER DRIED AND SHOULD BE SOAKED IN WATER AT ROOM TEMPERATURE FOR 48 HOURS BEFORE THE TEST. THE 100mm DEEP UPPER LAYER OF SUB–BASE MATERIAL SHOULD BE GRADED 20mm–5mm TO BS882.

THE 63–10mm MATERIAL SHOULD BE GRADED AS FOLLOWS:

BS Sieve size	%passing
100mm	100
63mm	90–100
37.5mm	60–80
20mm	15–30
10mm	0–5

THE BLOCKS SHOULD BE VIBRATED USING A VIBRATING PLATE TYPEDVP75/22" OR SIMILAR. FOLLOWING THE FIRST PASS WITH A VIBRATING PLATE A LIGHT DRESSING OF 3mm SINGLE SIZE CLEAN STONE SHOULD BE APPLIED TO THE SURFACE AND BRUSHED IN, APPROX 2kg PER m² (AVAILABLE FROM BRETT). BLOCKS SHOULD AGAIN BE VIBRATED AND ANY DEBRIS BRUSHED OFF.

REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS: PLANNING

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

CLIENT: WESTON HOMES

ARCHITECT:

PROJECT: WARISH HALL FARM, TAKELEY

TITLE: JACK'S SITE
TYPICAL DRAINAGE
STANDARD DETAILS

SCALE @ A2:	DESIGN–DRAWN:	DATE:
NTS	MC	11.01.2023

PROJECT No:	DRAWING No:
2951	SK21

Appendix: K – WINDES MicroDrainage Results

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 [redacted]

Cascade Summary of Results for PP2 REV A - 16.02.23.srcx

Upstream Structures	Outflow To	Overflow To
(None)	PP1 REV A - 16.02.23.srcx	(None)

Half Drain Time : 35 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	103.318	0.318	1.3	5.4	6.8	17.4	Flood Risk
30 min Summer	103.351	0.351	1.3	5.8	7.1	20.9	Flood Risk
60 min Summer	103.362	0.362	1.3	5.8	7.2	21.9	Flood Risk
120 min Summer	103.346	0.346	1.3	5.7	7.0	20.3	Flood Risk
180 min Summer	103.323	0.323	1.3	5.5	6.8	17.9	Flood Risk
240 min Summer	103.301	0.301	1.3	5.3	6.6	15.6	Flood Risk
360 min Summer	103.263	0.263	1.2	4.9	6.0	12.0	Flood Risk
480 min Summer	103.232	0.232	1.0	4.5	5.6	9.3	Flood Risk
600 min Summer	103.206	0.206	0.9	4.2	5.1	7.4	Flood Risk
720 min Summer	103.185	0.185	0.8	4.0	4.8	5.9	O K
960 min Summer	103.152	0.152	0.7	3.5	4.2	4.0	O K
1440 min Summer	103.111	0.111	0.5	2.8	3.3	2.1	O K
2160 min Summer	103.086	0.086	0.4	2.1	2.5	1.3	O K
2880 min Summer	103.073	0.073	0.3	1.6	2.0	0.9	O K
4320 min Summer	103.059	0.059	0.3	1.1	1.4	0.6	O K
5760 min Summer	103.050	0.050	0.2	0.9	1.1	0.4	O K
7200 min Summer	103.044	0.044	0.2	0.7	0.9	0.3	O K
8640 min Summer	103.040	0.040	0.1	0.7	0.8	0.3	O K
10080 min Summer	103.038	0.038	0.1	0.6	0.7	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	133.177	0.0	22.0	19
30 min Summer	86.691	0.0	29.1	30
60 min Summer	53.779	0.0	36.6	48
120 min Summer	32.287	0.0	44.2	82
180 min Summer	23.671	0.0	48.7	114
240 min Summer	18.896	0.0	52.0	146
360 min Summer	13.655	0.0	56.4	208
480 min Summer	10.845	0.0	59.7	270
600 min Summer	9.067	0.0	62.4	328
720 min Summer	7.829	0.0	64.7	388
960 min Summer	6.207	0.0	68.3	504
1440 min Summer	4.468	0.0	73.7	740
2160 min Summer	3.212	0.0	79.1	1100
2880 min Summer	2.539	0.0	83.1	1468
4320 min Summer	1.821	0.0	88.6	2200
5760 min Summer	1.437	0.0	92.5	2912
7200 min Summer	1.195	0.0	95.3	3560
8640 min Summer	1.028	0.0	97.6	4408
10080 min Summer	0.905	0.0	99.4	5080

Cascade Summary of Results for PP2 REV A - 16.02.23.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	103.342	0.342	1.3	5.7	7.0	20.0	Flood Risk
30 min Winter	103.382	0.382	1.3	6.0	7.3	24.0	Flood Risk
60 min Winter	103.391	0.391	1.3	6.1	7.4	25.0	Flood Risk
120 min Winter	103.365	0.365	1.3	5.9	7.2	22.3	Flood Risk
180 min Winter	103.330	0.330	1.3	5.6	6.9	18.7	Flood Risk
240 min Winter	103.298	0.298	1.3	5.2	6.6	15.4	Flood Risk
360 min Winter	103.246	0.246	1.1	4.7	5.8	10.5	Flood Risk
480 min Winter	103.205	0.205	0.9	4.2	5.1	7.3	Flood Risk
600 min Winter	103.173	0.173	0.8	3.8	4.6	5.2	O K
720 min Winter	103.148	0.148	0.7	3.4	4.1	3.8	O K
960 min Winter	103.114	0.114	0.5	2.9	3.4	2.2	O K
1440 min Winter	103.086	0.086	0.4	2.1	2.5	1.3	O K
2160 min Winter	103.069	0.069	0.3	1.5	1.8	0.8	O K
2880 min Winter	103.059	0.059	0.3	1.1	1.4	0.6	O K
4320 min Winter	103.047	0.047	0.2	0.8	1.0	0.4	O K
5760 min Winter	103.040	0.040	0.1	0.7	0.8	0.3	O K
7200 min Winter	103.037	0.037	0.1	0.6	0.7	0.2	O K
8640 min Winter	103.035	0.035	0.1	0.5	0.6	0.2	O K
10080 min Winter	103.033	0.033	0.1	0.4	0.5	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	133.177	0.0	24.8	19
30 min Winter	86.691	0.0	32.8	31
60 min Winter	53.779	0.0	41.1	50
120 min Winter	32.287	0.0	49.7	88
180 min Winter	23.671	0.0	54.8	122
240 min Winter	18.896	0.0	58.4	154
360 min Winter	13.655	0.0	63.4	218
480 min Winter	10.845	0.0	67.2	276
600 min Winter	9.067	0.0	70.2	336
720 min Winter	7.829	0.0	72.7	392
960 min Winter	6.207	0.0	76.8	506
1440 min Winter	4.468	0.0	82.8	736
2160 min Winter	3.212	0.0	89.0	1100
2880 min Winter	2.539	0.0	93.5	1468
4320 min Winter	1.821	0.0	99.8	2160
5760 min Winter	1.437	0.0	104.3	2928
7200 min Winter	1.195	0.0	107.6	3640
8640 min Winter	1.028	0.0	110.3	4368
10080 min Winter	0.905	0.0	112.4	5136

Cascade Rainfall Details for PP2 REV A - 16.02.23.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)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.095

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.034	4	8	0.061

Cascade Model Details for PP2 REV A - 16.02.23.srcx

Storage is Online Cover Level (m) 103.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.02772	Width (m)	4.2
Membrane Percolation (mm/hr)	1000	Length (m)	81.9
Max Percolation (l/s)	95.6	Slope (1:X)	275.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	103.000	Cap Volume Depth (m)	0.000

Orifice Outflow Control

Diameter (m) 0.070 Discharge Coefficient 0.600 Invert Level (m) 103.000

Cascade Summary of Results for PP1 REV A - 16.02.23.srcx

Upstream Structures	Outflow To	Overflow To
PP2 REV A - 16.02.23.srcx PP4 REV A - 16.02.23.srcx		(None)

Half Drain Time : 16 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	102.942	0.442	2.2	28.5	30.7	37.9	Flood Risk
30 min Summer	102.987	0.487	2.4	30.1	32.6	45.9	Flood Risk
60 min Summer	102.990	0.490	2.4	30.3	32.7	46.6	Flood Risk
120 min Summer	102.955	0.455	2.3	28.9	31.2	40.1	Flood Risk
180 min Summer	102.914	0.414	2.1	27.3	29.4	33.2	Flood Risk
240 min Summer	102.876	0.376	1.9	25.8	27.6	27.4	O K
360 min Summer	102.814	0.314	1.6	23.0	24.5	19.2	O K
480 min Summer	102.769	0.269	1.3	20.7	22.0	14.0	O K
600 min Summer	102.736	0.236	1.2	18.8	20.0	10.8	O K
720 min Summer	102.713	0.213	1.1	17.4	18.4	8.8	O K
960 min Summer	102.686	0.186	0.9	14.4	15.3	6.7	O K
1440 min Summer	102.655	0.155	0.8	10.9	11.6	4.6	O K
2160 min Summer	102.627	0.127	0.6	7.8	8.4	3.1	O K
2880 min Summer	102.608	0.108	0.5	6.1	6.7	2.3	O K
4320 min Summer	102.586	0.086	0.4	4.3	4.8	1.4	O K
5760 min Summer	102.577	0.077	0.4	3.4	3.8	1.1	O K
7200 min Summer	102.571	0.071	0.4	2.8	3.1	1.0	O K
8640 min Summer	102.565	0.065	0.3	2.4	2.7	0.8	O K
10080 min Summer	102.560	0.060	0.3	2.1	2.4	0.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	133.177	0.0	74.2	20
30 min Summer	86.691	0.0	98.5	30
60 min Summer	53.779	0.0	123.7	46
120 min Summer	32.287	0.0	149.6	78
180 min Summer	23.671	0.0	165.1	110
240 min Summer	18.896	0.0	176.1	142
360 min Summer	13.655	0.0	191.3	200
480 min Summer	10.845	0.0	202.9	260
600 min Summer	9.067	0.0	212.2	318
720 min Summer	7.829	0.0	220.0	376
960 min Summer	6.207	0.0	232.5	496
1440 min Summer	4.468	0.0	250.3	736
2160 min Summer	3.212	0.0	268.3	1100
2880 min Summer	2.539	0.0	281.1	1456
4320 min Summer	1.821	0.0	299.3	2160
5760 min Summer	1.437	0.0	312.2	2936
7200 min Summer	1.195	0.0	321.9	3664
8640 min Summer	1.028	0.0	329.2	4344
10080 min Summer	0.905	0.0	335.1	5000

Cascade Summary of Results for PP1 REV A - 16.02.23.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	102.975	0.475	2.4	29.7	32.1	43.7	Flood Risk
30 min Winter	103.021	0.521	2.6	31.4	33.9	52.6	Flood Risk
60 min Winter	103.017	0.517	2.6	31.2	33.8	51.8	Flood Risk
120 min Winter	102.962	0.462	2.3	29.2	31.5	41.3	Flood Risk
180 min Winter	102.902	0.402	2.0	26.9	28.9	31.4	Flood Risk
240 min Winter	102.850	0.350	1.7	24.6	26.4	23.8	O K
360 min Winter	102.771	0.271	1.3	20.8	22.2	14.3	O K
480 min Winter	102.721	0.221	1.1	18.0	19.1	9.5	O K
600 min Winter	102.697	0.197	1.0	15.6	16.5	7.5	O K
720 min Winter	102.680	0.180	0.9	13.6	14.5	6.2	O K
960 min Winter	102.656	0.156	0.8	11.0	11.7	4.7	O K
1440 min Winter	102.627	0.127	0.6	7.9	8.5	3.1	O K
2160 min Winter	102.601	0.101	0.5	5.6	6.1	2.0	O K
2880 min Winter	102.586	0.086	0.4	4.4	4.8	1.4	O K
4320 min Winter	102.574	0.074	0.4	3.1	3.4	1.1	O K
5760 min Winter	102.565	0.065	0.3	2.4	2.7	0.8	O K
7200 min Winter	102.558	0.058	0.3	1.9	2.2	0.7	O K
8640 min Winter	102.554	0.054	0.3	1.7	1.9	0.6	O K
10080 min Winter	102.550	0.050	0.2	1.4	1.7	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	133.177	0.0	83.9	21
30 min Winter	86.691	0.0	111.1	31
60 min Winter	53.779	0.0	139.3	48
120 min Winter	32.287	0.0	168.4	84
180 min Winter	23.671	0.0	185.6	116
240 min Winter	18.896	0.0	198.0	146
360 min Winter	13.655	0.0	215.3	206
480 min Winter	10.845	0.0	228.4	260
600 min Winter	9.067	0.0	239.0	318
720 min Winter	7.829	0.0	247.8	378
960 min Winter	6.207	0.0	261.8	496
1440 min Winter	4.468	0.0	281.4	738
2160 min Winter	3.212	0.0	301.5	1088
2880 min Winter	2.539	0.0	316.0	1460
4320 min Winter	1.821	0.0	337.5	2188
5760 min Winter	1.437	0.0	352.5	2912
7200 min Winter	1.195	0.0	363.5	3632
8640 min Winter	1.028	0.0	372.2	4272
10080 min Winter	0.905	0.0	379.3	4976

Cascade Rainfall Details for PP1 REV A - 16.02.23.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)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.245

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.089	4	8	0.078	8	12	0.078

Cascade Model Details for PP1 REV A - 16.02.23.srcx

Storage is Online Cover Level (m) 103.200

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.02772	Width (m)	5.5
Membrane Percolation (mm/hr)	1000	Length (m)	177.6
Max Percolation (l/s)	271.3	Slope (1:X)	235.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	102.500	Cap Volume Depth (m)	0.000

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 102.500

Cascade Summary of Results for PP4 REV A - 16.02.23.srcx

Upstream Structures	Outflow To	Overflow To
PP1 REV A - 16.02.23.srcx	(None)	(None)
PP2 REV A - 16.02.23.srcx		

Half Drain Time : 1 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m^3)	Status
15 min Summer	102.227	0.227	69.2	6.7	Flood Risk
30 min Summer	102.232	0.232	70.7	7.0	Flood Risk
60 min Summer	102.211	0.211	64.3	5.8	Flood Risk
120 min Summer	102.175	0.175	53.4	4.0	O K
180 min Summer	102.153	0.153	46.5	3.0	O K
240 min Summer	102.137	0.137	41.6	2.4	O K
360 min Summer	102.115	0.115	34.9	1.7	O K
480 min Summer	102.101	0.101	30.7	1.3	O K
600 min Summer	102.090	0.090	27.5	1.1	O K
720 min Summer	102.082	0.082	24.9	0.9	O K
960 min Summer	102.068	0.068	20.6	0.6	O K
1440 min Summer	102.051	0.051	15.5	0.3	O K
2160 min Summer	102.043	0.043	11.4	0.3	O K
2880 min Summer	102.038	0.038	8.9	0.2	O K
4320 min Summer	102.032	0.032	6.3	0.1	O K
5760 min Summer	102.028	0.028	4.9	0.1	O K
7200 min Summer	102.026	0.026	4.0	0.1	O K
8640 min Summer	102.024	0.024	3.6	0.1	O K
10080 min Summer	102.023	0.023	3.2	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m^3)	Time-Peak (mins)
15 min Summer	133.177	0.0	15
30 min Summer	86.691	0.0	22
60 min Summer	53.779	0.0	38
120 min Summer	32.287	0.0	68
180 min Summer	23.671	0.0	98
240 min Summer	18.896	0.0	128
360 min Summer	13.655	0.0	190
480 min Summer	10.845	0.0	250
600 min Summer	9.067	0.0	308
720 min Summer	7.829	0.0	372
960 min Summer	6.207	0.0	492
1440 min Summer	4.468	0.0	736
2160 min Summer	3.212	0.0	1092
2880 min Summer	2.539	0.0	1464
4320 min Summer	1.821	0.0	2176
5760 min Summer	1.437	0.0	2904
7200 min Summer	1.195	0.0	3672
8640 min Summer	1.028	0.0	4264
10080 min Summer	0.905	0.0	5088

Cascade Summary of Results for PP4 REV A - 16.02.23.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	102.242	0.242	73.6	7.6	Flood Risk
30 min Winter	102.237	0.237	72.2	7.3	Flood Risk
60 min Winter	102.204	0.204	62.0	5.4	Flood Risk
120 min Winter	102.161	0.161	49.1	3.4	O K
180 min Winter	102.138	0.138	41.9	2.5	O K
240 min Winter	102.122	0.122	37.1	1.9	O K
360 min Winter	102.099	0.099	30.2	1.3	O K
480 min Winter	102.085	0.085	25.8	0.9	O K
600 min Winter	102.073	0.073	22.2	0.7	O K
720 min Winter	102.064	0.064	19.4	0.5	O K
960 min Winter	102.051	0.051	15.6	0.3	O K
1440 min Winter	102.043	0.043	11.4	0.2	O K
2160 min Winter	102.037	0.037	8.2	0.2	O K
2880 min Winter	102.032	0.032	6.3	0.1	O K
4320 min Winter	102.027	0.027	4.5	0.1	O K
5760 min Winter	102.025	0.025	3.7	0.1	O K
7200 min Winter	102.022	0.022	3.0	0.1	O K
8640 min Winter	102.020	0.020	2.5	0.1	O K
10080 min Winter	102.019	0.019	2.3	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Winter	133.177	0.0	15
30 min Winter	86.691	0.0	22
60 min Winter	53.779	0.0	38
120 min Winter	32.287	0.0	70
180 min Winter	23.671	0.0	100
240 min Winter	18.896	0.0	132
360 min Winter	13.655	0.0	196
480 min Winter	10.845	0.0	256
600 min Winter	9.067	0.0	310
720 min Winter	7.829	0.0	380
960 min Winter	6.207	0.0	484
1440 min Winter	4.468	0.0	736
2160 min Winter	3.212	0.0	1084
2880 min Winter	2.539	0.0	1476
4320 min Winter	1.821	0.0	2156
5760 min Winter	1.437	0.0	2872
7200 min Winter	1.195	0.0	3784
8640 min Winter	1.028	0.0	4376
10080 min Winter	0.905	0.0	5128

Cascade Rainfall Details for PP4 REV A - 16.02.23.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)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.126

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.061	4	8	0.065

Cascade Model Details for PP4 REV A - 16.02.23.srcx

Storage is Online Cover Level (m) 102.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	2.52000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	101.6
Max Percolation (l/s)	169.3	Slope (1:X)	145.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	102.000	Cap Volume Depth (m)	0.000

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

Half Drain Time : 1 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	102.470	0.270	96.3	11.1	Flood Risk
30 min Summer	102.473	0.273	97.4	11.4	Flood Risk
60 min Summer	102.439	0.239	85.4	8.8	Flood Risk
120 min Summer	102.379	0.179	63.8	4.9	O K
180 min Summer	102.341	0.141	50.4	3.0	O K
240 min Summer	102.317	0.117	41.7	2.1	O K
360 min Summer	102.288	0.088	31.3	1.2	O K
480 min Summer	102.271	0.071	25.3	0.8	O K
600 min Summer	102.260	0.060	21.3	0.5	O K
720 min Summer	102.252	0.052	18.5	0.4	O K
960 min Summer	102.245	0.045	14.6	0.3	O K
1440 min Summer	102.239	0.039	10.7	0.2	O K
2160 min Summer	102.233	0.033	7.7	0.2	O K
2880 min Summer	102.229	0.029	6.1	0.1	O K
4320 min Summer	102.225	0.025	4.4	0.1	O K
5760 min Summer	102.222	0.022	3.5	0.1	O K
7200 min Summer	102.220	0.020	2.9	0.1	O K
8640 min Summer	102.219	0.019	2.6	0.1	O K
10080 min Summer	102.218	0.018	2.2	0.1	O K
15 min Winter	102.493	0.293	104.7	13.2	Flood Risk
30 min Winter	102.483	0.283	100.9	12.2	Flood Risk
60 min Winter	102.423	0.223	79.5	7.6	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	133.177	0.0	18
30 min Summer	86.691	0.0	25
60 min Summer	53.779	0.0	40
120 min Summer	32.287	0.0	70
180 min Summer	23.671	0.0	100
240 min Summer	18.896	0.0	128
360 min Summer	13.655	0.0	188
480 min Summer	10.845	0.0	248
600 min Summer	9.067	0.0	306
720 min Summer	7.829	0.0	366
960 min Summer	6.207	0.0	490
1440 min Summer	4.468	0.0	720
2160 min Summer	3.212	0.0	1100
2880 min Summer	2.539	0.0	1468
4320 min Summer	1.821	0.0	2168
5760 min Summer	1.437	0.0	2840
7200 min Summer	1.195	0.0	3656
8640 min Summer	1.028	0.0	4304
10080 min Summer	0.905	0.0	5000
15 min Winter	133.177	0.0	18
30 min Winter	86.691	0.0	25
60 min Winter	53.779	0.0	40

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
120 min Winter	102.348	0.148	52.7	3.3	O K
180 min Winter	102.311	0.111	39.7	1.9	O K
240 min Winter	102.289	0.089	31.9	1.2	O K
360 min Winter	102.265	0.065	23.3	0.6	O K
480 min Winter	102.252	0.052	18.5	0.4	O K
600 min Winter	102.247	0.047	15.6	0.3	O K
720 min Winter	102.243	0.043	13.4	0.3	O K
960 min Winter	102.239	0.039	10.7	0.2	O K
1440 min Winter	102.233	0.033	7.7	0.2	O K
2160 min Winter	102.228	0.028	5.7	0.1	O K
2880 min Winter	102.225	0.025	4.6	0.1	O K
4320 min Winter	102.221	0.021	3.2	0.1	O K
5760 min Winter	102.219	0.019	2.6	0.1	O K
7200 min Winter	102.217	0.017	2.1	0.1	O K
8640 min Winter	102.217	0.017	2.0	0.1	O K
10080 min Winter	102.216	0.016	1.8	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
120 min Winter	32.287	0.0	70
180 min Winter	23.671	0.0	98
240 min Winter	18.896	0.0	130
360 min Winter	13.655	0.0	186
480 min Winter	10.845	0.0	248
600 min Winter	9.067	0.0	302
720 min Winter	7.829	0.0	374
960 min Winter	6.207	0.0	472
1440 min Winter	4.468	0.0	734
2160 min Winter	3.212	0.0	1128
2880 min Winter	2.539	0.0	1504
4320 min Winter	1.821	0.0	2252
5760 min Winter	1.437	0.0	2648
7200 min Winter	1.195	0.0	3376
8640 min Winter	1.028	0.0	4232
10080 min Winter	0.905	0.0	4768

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)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.289

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.049	4	8	0.120	8	12	0.120

Model Details

Storage is Online Cover Level (m) 102.700

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	2.52000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	81.5
Max Percolation (l/s)	135.8	Slope (1:X)	170.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	102.200	Cap Volume Depth (m)	0.000

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

Half Drain Time : 0 minutes.

	Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15	min Summer	101.879	0.079	66.1	2.2	O K
30	min Summer	101.873	0.073	61.5	1.9	O K
60	min Summer	101.857	0.057	48.1	1.2	O K
120	min Summer	101.844	0.044	32.9	0.7	O K
180	min Summer	101.839	0.039	25.2	0.6	O K
240	min Summer	101.835	0.035	20.3	0.4	O K
360	min Summer	101.830	0.030	15.4	0.3	O K
480	min Summer	101.827	0.027	12.0	0.3	O K
600	min Summer	101.825	0.025	10.3	0.2	O K
720	min Summer	101.823	0.023	9.1	0.2	O K
960	min Summer	101.821	0.021	7.2	0.2	O K
1440	min Summer	101.818	0.018	5.3	0.1	O K
2160	min Summer	101.815	0.015	3.9	0.1	O K
2880	min Summer	101.813	0.013	2.9	0.1	O K
4320	min Summer	101.811	0.011	2.1	0.1	O K
5760	min Summer	101.810	0.010	1.8	0.1	O K
7200	min Summer	101.810	0.010	1.6	0.0	O K
8640	min Summer	101.809	0.009	1.3	0.0	O K
10080	min Summer	101.808	0.008	1.1	0.0	O K
15	min Winter	101.883	0.083	69.5	2.5	O K
30	min Winter	101.870	0.070	58.6	1.8	O K
60	min Winter	101.850	0.050	41.6	0.9	O K

	Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15	min Summer	133.177	0.0	14
30	min Summer	86.691	0.0	21
60	min Summer	53.779	0.0	36
120	min Summer	32.287	0.0	66
180	min Summer	23.671	0.0	94
240	min Summer	18.896	0.0	126
360	min Summer	13.655	0.0	182
480	min Summer	10.845	0.0	246
600	min Summer	9.067	0.0	302
720	min Summer	7.829	0.0	362
960	min Summer	6.207	0.0	490
1440	min Summer	4.468	0.0	734
2160	min Summer	3.212	0.0	1088
2880	min Summer	2.539	0.0	1432
4320	min Summer	1.821	0.0	2144
5760	min Summer	1.437	0.0	2904
7200	min Summer	1.195	0.0	3592
8640	min Summer	1.028	0.0	4360
10080	min Summer	0.905	0.0	5248
15	min Winter	133.177	0.0	14
30	min Winter	86.691	0.0	21
60	min Winter	53.779	0.0	34

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
120 min Winter	101.839	0.039	25.9	0.6	O K
180 min Winter	101.834	0.034	19.1	0.4	O K
240 min Winter	101.830	0.030	15.4	0.3	O K
360 min Winter	101.826	0.026	11.6	0.2	O K
480 min Winter	101.823	0.023	8.7	0.2	O K
600 min Winter	101.821	0.021	7.6	0.2	O K
720 min Winter	101.820	0.020	6.6	0.1	O K
960 min Winter	101.818	0.018	5.3	0.1	O K
1440 min Winter	101.815	0.015	3.7	0.1	O K
2160 min Winter	101.813	0.013	2.9	0.1	O K
2880 min Winter	101.811	0.011	2.1	0.1	O K
4320 min Winter	101.810	0.010	1.6	0.0	O K
5760 min Winter	101.809	0.009	1.3	0.0	O K
7200 min Winter	101.808	0.008	1.1	0.0	O K
8640 min Winter	101.808	0.008	1.0	0.0	O K
10080 min Winter	101.807	0.007	0.9	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
120 min Winter	32.287	0.0	68
180 min Winter	23.671	0.0	96
240 min Winter	18.896	0.0	126
360 min Winter	13.655	0.0	176
480 min Winter	10.845	0.0	250
600 min Winter	9.067	0.0	306
720 min Winter	7.829	0.0	360
960 min Winter	6.207	0.0	470
1440 min Winter	4.468	0.0	736
2160 min Winter	3.212	0.0	1096
2880 min Winter	2.539	0.0	1504
4320 min Winter	1.821	0.0	2052
5760 min Winter	1.437	0.0	3024
7200 min Winter	1.195	0.0	3576
8640 min Winter	1.028	0.0	4152
10080 min Winter	0.905	0.0	4976

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)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.137

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.041	4	8	0.096

Model Details

Storage is Online Cover Level (m) 102.300

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	2.52000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	68.3
Max Percolation (l/s)	113.8	Slope (1:X)	400.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	101.800	Cap Volume Depth (m)	0.000

Cascade Summary of Results for PP2 REV A - 16.02.23.srcx

Upstream Structures	Outflow To	Overflow To
(None)	PP1 REV A - 16.02.23.srcx	(None)

Half Drain Time : 18 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	103.218	0.218	1.0	4.4	5.3	8.2	Flood Risk
30 min Summer	103.236	0.236	1.1	4.6	5.6	9.7	Flood Risk
60 min Summer	103.239	0.239	1.1	4.6	5.7	9.9	Flood Risk
120 min Summer	103.221	0.221	1.0	4.4	5.4	8.5	Flood Risk
180 min Summer	103.201	0.201	0.9	4.2	5.1	7.0	Flood Risk
240 min Summer	103.183	0.183	0.8	3.9	4.8	5.8	O K
360 min Summer	103.153	0.153	0.7	3.5	4.2	4.1	O K
480 min Summer	103.131	0.131	0.6	3.2	3.7	3.0	O K
600 min Summer	103.114	0.114	0.5	2.9	3.4	2.3	O K
720 min Summer	103.102	0.102	0.5	2.6	3.1	1.8	O K
960 min Summer	103.088	0.088	0.4	2.2	2.6	1.3	O K
1440 min Summer	103.072	0.072	0.3	1.6	1.9	0.9	O K
2160 min Summer	103.058	0.058	0.3	1.1	1.4	0.6	O K
2880 min Summer	103.049	0.049	0.2	0.9	1.1	0.4	O K
4320 min Summer	103.040	0.040	0.1	0.7	0.8	0.3	O K
5760 min Summer	103.036	0.036	0.1	0.5	0.6	0.2	O K
7200 min Summer	103.034	0.034	0.1	0.4	0.5	0.2	O K
8640 min Summer	103.031	0.031	0.1	0.4	0.5	0.2	O K
10080 min Summer	103.029	0.029	0.1	0.3	0.4	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	73.387	0.0	11.3	18
30 min Summer	47.368	0.0	15.1	27
60 min Summer	29.238	0.0	19.1	44
120 min Summer	17.536	0.0	23.2	78
180 min Summer	12.878	0.0	25.7	108
240 min Summer	10.306	0.0	27.5	140
360 min Summer	7.490	0.0	30.0	200
480 min Summer	5.971	0.0	32.0	258
600 min Summer	5.006	0.0	33.5	316
720 min Summer	4.333	0.0	34.8	374
960 min Summer	3.449	0.0	36.9	494
1440 min Summer	2.498	0.0	40.0	736
2160 min Summer	1.807	0.0	43.1	1088
2880 min Summer	1.435	0.0	45.3	1468
4320 min Summer	1.037	0.0	48.4	2140
5760 min Summer	0.823	0.0	50.4	2864
7200 min Summer	0.687	0.0	51.9	3584
8640 min Summer	0.593	0.0	53.0	4368
10080 min Summer	0.524	0.0	53.8	5032

Cascade Summary of Results for PP2 REV A - 16.02.23.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	103.234	0.234	1.0	4.6	5.6	9.5	Flood Risk
30 min Winter	103.253	0.253	1.1	4.8	5.9	11.1	Flood Risk
60 min Winter	103.251	0.251	1.1	4.8	5.9	10.9	Flood Risk
120 min Winter	103.224	0.224	1.0	4.4	5.4	8.7	Flood Risk
180 min Winter	103.195	0.195	0.9	4.1	5.0	6.6	O K
240 min Winter	103.170	0.170	0.8	3.8	4.5	5.0	O K
360 min Winter	103.131	0.131	0.6	3.2	3.7	3.0	O K
480 min Winter	103.106	0.106	0.5	2.7	3.2	1.9	O K
600 min Winter	103.092	0.092	0.4	2.3	2.7	1.5	O K
720 min Winter	103.084	0.084	0.4	2.0	2.4	1.2	O K
960 min Winter	103.072	0.072	0.3	1.6	1.9	0.9	O K
1440 min Winter	103.058	0.058	0.3	1.1	1.4	0.6	O K
2160 min Winter	103.046	0.046	0.2	0.8	1.0	0.4	O K
2880 min Winter	103.040	0.040	0.1	0.7	0.8	0.3	O K
4320 min Winter	103.035	0.035	0.1	0.5	0.6	0.2	O K
5760 min Winter	103.031	0.031	0.1	0.4	0.5	0.2	O K
7200 min Winter	103.028	0.028	0.1	0.3	0.4	0.1	O K
8640 min Winter	103.026	0.026	0.1	0.3	0.3	0.1	O K
10080 min Winter	103.024	0.024	0.1	0.2	0.3	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	73.387	0.0	12.9	18
30 min Winter	47.368	0.0	17.2	29
60 min Winter	29.238	0.0	21.6	48
120 min Winter	17.536	0.0	26.2	82
180 min Winter	12.878	0.0	29.0	114
240 min Winter	10.306	0.0	31.0	144
360 min Winter	7.490	0.0	33.9	204
480 min Winter	5.971	0.0	36.1	258
600 min Winter	5.006	0.0	37.8	316
720 min Winter	4.333	0.0	39.3	374
960 min Winter	3.449	0.0	41.6	492
1440 min Winter	2.498	0.0	45.1	724
2160 min Winter	1.807	0.0	48.6	1104
2880 min Winter	1.435	0.0	51.2	1432
4320 min Winter	1.037	0.0	54.8	2152
5760 min Winter	0.823	0.0	57.2	2936
7200 min Winter	0.687	0.0	59.0	3560
8640 min Winter	0.593	0.0	60.3	4296
10080 min Winter	0.524	0.0	61.4	4968

Cascade Rainfall Details for PP2 REV A - 16.02.23.srcx

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)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.095

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.034	4	8	0.061

Cascade Model Details for PP2 REV A - 16.02.23.srcx

Storage is Online Cover Level (m) 103.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.02772	Width (m)	4.2
Membrane Percolation (mm/hr)	1000	Length (m)	81.9
Max Percolation (l/s)	95.6	Slope (1:X)	275.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	103.000	Cap Volume Depth (m)	0.000

Orifice Outflow Control

Diameter (m) 0.070 Discharge Coefficient 0.600 Invert Level (m) 103.000

Cascade Summary of Results for PP1 REV A - 16.02.23.srcx

Upstream Structures	Outflow To	Overflow To
PP2 REV A - 16.02.23.srcx PP4 REV A - 16.02.23.srcx		(None)

Half Drain Time : 9 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	102.795	0.295	1.5	22.0	23.5	16.9	O K
30 min Summer	102.822	0.322	1.6	23.4	25.0	20.1	O K
60 min Summer	102.821	0.321	1.6	23.3	24.9	19.9	O K
120 min Summer	102.787	0.287	1.4	21.6	23.0	16.0	O K
180 min Summer	102.754	0.254	1.3	19.9	21.1	12.5	O K
240 min Summer	102.728	0.228	1.1	18.4	19.5	10.0	O K
360 min Summer	102.695	0.195	1.0	15.4	16.4	7.4	O K
480 min Summer	102.674	0.174	0.9	13.0	13.9	5.9	O K
600 min Summer	102.660	0.160	0.8	11.4	12.2	4.9	O K
720 min Summer	102.648	0.148	0.7	10.1	10.8	4.2	O K
960 min Summer	102.630	0.130	0.6	8.2	8.8	3.3	O K
1440 min Summer	102.606	0.106	0.5	6.0	6.5	2.2	O K
2160 min Summer	102.585	0.085	0.4	4.3	4.7	1.4	O K
2880 min Summer	102.576	0.076	0.4	3.3	3.7	1.1	O K
4320 min Summer	102.565	0.065	0.3	2.4	2.7	0.8	O K
5760 min Summer	102.557	0.057	0.3	1.9	2.1	0.6	O K
7200 min Summer	102.551	0.051	0.3	1.5	1.8	0.5	O K
8640 min Summer	102.548	0.048	0.2	1.3	1.5	0.4	O K
10080 min Summer	102.545	0.045	0.2	1.1	1.3	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	73.387	0.0	38.2	20
30 min Summer	47.368	0.0	51.1	28
60 min Summer	29.238	0.0	64.5	44
120 min Summer	17.536	0.0	78.6	76
180 min Summer	12.878	0.0	87.1	106
240 min Summer	10.306	0.0	93.3	134
360 min Summer	7.490	0.0	102.0	194
480 min Summer	5.971	0.0	108.5	254
600 min Summer	5.006	0.0	113.7	314
720 min Summer	4.333	0.0	118.1	374
960 min Summer	3.449	0.0	125.0	494
1440 min Summer	2.498	0.0	135.0	736
2160 min Summer	1.807	0.0	145.3	1100
2880 min Summer	1.435	0.0	152.8	1468
4320 min Summer	1.037	0.0	163.0	2172
5760 min Summer	0.823	0.0	169.7	2872
7200 min Summer	0.687	0.0	174.4	3648
8640 min Summer	0.593	0.0	177.9	4304
10080 min Summer	0.524	0.0	180.4	5048

Cascade Summary of Results for PP1 REV A - 16.02.23.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	102.818	0.318	1.6	23.1	24.7	19.6	O K
30 min Winter	102.844	0.344	1.7	24.4	26.1	23.0	O K
60 min Winter	102.832	0.332	1.7	23.8	25.4	21.3	O K
120 min Winter	102.778	0.278	1.4	21.2	22.6	15.0	O K
180 min Winter	102.732	0.232	1.2	18.6	19.8	10.5	O K
240 min Winter	102.704	0.204	1.0	16.3	17.4	8.1	O K
360 min Winter	102.671	0.171	0.8	12.6	13.5	5.7	O K
480 min Winter	102.650	0.150	0.7	10.3	11.1	4.4	O K
600 min Winter	102.635	0.135	0.7	8.7	9.4	3.6	O K
720 min Winter	102.625	0.125	0.6	7.6	8.2	3.0	O K
960 min Winter	102.606	0.106	0.5	6.0	6.5	2.2	O K
1440 min Winter	102.585	0.085	0.4	4.3	4.7	1.4	O K
2160 min Winter	102.573	0.073	0.4	3.0	3.4	1.0	O K
2880 min Winter	102.565	0.065	0.3	2.4	2.7	0.8	O K
4320 min Winter	102.554	0.054	0.3	1.7	1.9	0.6	O K
5760 min Winter	102.548	0.048	0.2	1.3	1.5	0.4	O K
7200 min Winter	102.543	0.043	0.2	1.1	1.3	0.4	O K
8640 min Winter	102.540	0.040	0.2	0.9	1.1	0.3	O K
10080 min Winter	102.537	0.037	0.1	0.8	1.0	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	73.387	0.0	43.5	20
30 min Winter	47.368	0.0	57.9	29
60 min Winter	29.238	0.0	72.9	46
120 min Winter	17.536	0.0	88.8	78
180 min Winter	12.878	0.0	98.4	108
240 min Winter	10.306	0.0	105.4	136
360 min Winter	7.490	0.0	115.3	196
480 min Winter	5.971	0.0	122.6	256
600 min Winter	5.006	0.0	128.3	316
720 min Winter	4.333	0.0	133.1	374
960 min Winter	3.449	0.0	140.8	494
1440 min Winter	2.498	0.0	152.2	734
2160 min Winter	1.807	0.0	164.3	1096
2880 min Winter	1.435	0.0	172.9	1468
4320 min Winter	1.037	0.0	184.6	2136
5760 min Winter	0.823	0.0	192.7	2848
7200 min Winter	0.687	0.0	198.6	3672
8640 min Winter	0.593	0.0	203.0	4368
10080 min Winter	0.524	0.0	206.3	5128

Cascade Rainfall Details for PP1 REV A - 16.02.23.srcx

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)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.245

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.089	4	8	0.078	8	12	0.078

Cascade Model Details for PP1 REV A - 16.02.23.srcx

Storage is Online Cover Level (m) 103.200

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.02772	Width (m)	5.5
Membrane Percolation (mm/hr)	1000	Length (m)	177.6
Max Percolation (l/s)	271.3	Slope (1:X)	235.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	102.500	Cap Volume Depth (m)	0.000

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 102.500

Cascade Summary of Results for PP4 REV A - 16.02.23.srcx

Upstream Structures	Outflow To	Overflow To
PP1 REV A - 16.02.23.srcx PP2 REV A - 16.02.23.srcx	(None)	(None)

Half Drain Time : 1 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m^3)	Status
15 min Summer	102.144	0.144	43.8	2.7	O K
30 min Summer	102.149	0.149	45.3	2.9	O K
60 min Summer	102.137	0.137	41.6	2.4	O K
120 min Summer	102.115	0.115	34.9	1.7	O K
180 min Summer	102.100	0.100	30.5	1.3	O K
240 min Summer	102.090	0.090	27.3	1.0	O K
360 min Summer	102.073	0.073	22.2	0.7	O K
480 min Summer	102.061	0.061	18.7	0.5	O K
600 min Summer	102.053	0.053	16.2	0.4	O K
720 min Summer	102.049	0.049	14.5	0.3	O K
960 min Summer	102.044	0.044	11.9	0.3	O K
1440 min Summer	102.038	0.038	8.7	0.2	O K
2160 min Summer	102.032	0.032	6.3	0.1	O K
2880 min Summer	102.029	0.029	5.0	0.1	O K
4320 min Summer	102.024	0.024	3.6	0.1	O K
5760 min Summer	102.022	0.022	2.9	0.1	O K
7200 min Summer	102.020	0.020	2.4	0.1	O K
8640 min Summer	102.018	0.018	2.0	0.1	O K
10080 min Summer	102.017	0.017	1.8	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m^3)	Time-Peak (mins)
15 min Summer	73.387	0.0	15
30 min Summer	47.368	0.0	22
60 min Summer	29.238	0.0	36
120 min Summer	17.536	0.0	68
180 min Summer	12.878	0.0	98
240 min Summer	10.306	0.0	128
360 min Summer	7.490	0.0	190
480 min Summer	5.971	0.0	252
600 min Summer	5.006	0.0	308
720 min Summer	4.333	0.0	366
960 min Summer	3.449	0.0	494
1440 min Summer	2.498	0.0	732
2160 min Summer	1.807	0.0	1084
2880 min Summer	1.435	0.0	1448
4320 min Summer	1.037	0.0	2144
5760 min Summer	0.823	0.0	2880
7200 min Summer	0.687	0.0	3720
8640 min Summer	0.593	0.0	4384
10080 min Summer	0.524	0.0	4984

Cascade Summary of Results for PP4 REV A - 16.02.23.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	102.154	0.154	46.8	3.1	O K
30 min Winter	102.153	0.153	46.5	3.0	O K
60 min Winter	102.133	0.133	40.4	2.3	O K
120 min Winter	102.106	0.106	32.2	1.5	O K
180 min Winter	102.090	0.090	27.3	1.0	O K
240 min Winter	102.077	0.077	23.5	0.8	O K
360 min Winter	102.059	0.059	18.0	0.5	O K
480 min Winter	102.049	0.049	14.8	0.3	O K
600 min Winter	102.045	0.045	12.5	0.3	O K
720 min Winter	102.042	0.042	10.9	0.2	O K
960 min Winter	102.038	0.038	8.7	0.2	O K
1440 min Winter	102.032	0.032	6.3	0.1	O K
2160 min Winter	102.027	0.027	4.5	0.1	O K
2880 min Winter	102.024	0.024	3.6	0.1	O K
4320 min Winter	102.021	0.021	2.6	0.1	O K
5760 min Winter	102.018	0.018	2.0	0.1	O K
7200 min Winter	102.016	0.016	1.6	0.0	O K
8640 min Winter	102.016	0.016	1.5	0.0	O K
10080 min Winter	102.015	0.015	1.4	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Winter	73.387	0.0	15
30 min Winter	47.368	0.0	22
60 min Winter	29.238	0.0	38
120 min Winter	17.536	0.0	68
180 min Winter	12.878	0.0	100
240 min Winter	10.306	0.0	134
360 min Winter	7.490	0.0	196
480 min Winter	5.971	0.0	252
600 min Winter	5.006	0.0	308
720 min Winter	4.333	0.0	382
960 min Winter	3.449	0.0	486
1440 min Winter	2.498	0.0	736
2160 min Winter	1.807	0.0	1044
2880 min Winter	1.435	0.0	1436
4320 min Winter	1.037	0.0	2088
5760 min Winter	0.823	0.0	2872
7200 min Winter	0.687	0.0	3608
8640 min Winter	0.593	0.0	4256
10080 min Winter	0.524	0.0	5016

Cascade Rainfall Details for PP4 REV A - 16.02.23.srcx

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)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.126

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.061	4	8	0.065

Cascade Model Details for PP4 REV A - 16.02.23.srcx

Storage is Online Cover Level (m) 102.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	2.52000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	101.6
Max Percolation (l/s)	169.3	Slope (1:X)	145.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	102.000	Cap Volume Depth (m)	0.000

Summary of Results for 30 year Return Period

Half Drain Time : 1 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	102.358	0.158	56.3	3.8	O K
30 min Summer	102.358	0.158	56.3	3.8	O K
60 min Summer	102.334	0.134	47.9	2.8	O K
120 min Summer	102.299	0.099	35.3	1.5	O K
180 min Summer	102.278	0.078	27.8	0.9	O K
240 min Summer	102.264	0.064	22.9	0.6	O K
360 min Summer	102.249	0.049	17.3	0.4	O K
480 min Summer	102.244	0.044	14.0	0.3	O K
600 min Summer	102.241	0.041	11.9	0.3	O K
720 min Summer	102.238	0.038	10.4	0.2	O K
960 min Summer	102.234	0.034	8.4	0.2	O K
1440 min Summer	102.229	0.029	6.1	0.1	O K
2160 min Summer	102.225	0.025	4.6	0.1	O K
2880 min Summer	102.222	0.022	3.5	0.1	O K
4320 min Summer	102.219	0.019	2.6	0.1	O K
5760 min Summer	102.217	0.017	2.1	0.1	O K
7200 min Summer	102.216	0.016	1.8	0.0	O K
8640 min Summer	102.214	0.014	1.4	0.0	O K
10080 min Summer	102.214	0.014	1.3	0.0	O K
15 min Winter	102.373	0.173	61.9	4.6	O K
30 min Winter	102.363	0.163	58.3	4.1	O K
60 min Winter	102.324	0.124	44.4	2.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	73.387	0.0	17
30 min Summer	47.368	0.0	24
60 min Summer	29.238	0.0	38
120 min Summer	17.536	0.0	68
180 min Summer	12.878	0.0	98
240 min Summer	10.306	0.0	128
360 min Summer	7.490	0.0	188
480 min Summer	5.971	0.0	248
600 min Summer	5.006	0.0	306
720 min Summer	4.333	0.0	368
960 min Summer	3.449	0.0	484
1440 min Summer	2.498	0.0	720
2160 min Summer	1.807	0.0	1108
2880 min Summer	1.435	0.0	1432
4320 min Summer	1.037	0.0	2156
5760 min Summer	0.823	0.0	2904
7200 min Summer	0.687	0.0	3600
8640 min Summer	0.593	0.0	4432
10080 min Summer	0.524	0.0	5152
15 min Winter	73.387	0.0	17
30 min Winter	47.368	0.0	24
60 min Winter	29.238	0.0	38

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
120 min Winter	102.281	0.081	28.8	1.0	O K
180 min Winter	102.261	0.061	21.7	0.6	O K
240 min Winter	102.249	0.049	17.3	0.4	O K
360 min Winter	102.243	0.043	13.0	0.3	O K
480 min Winter	102.238	0.038	10.2	0.2	O K
600 min Winter	102.235	0.035	8.6	0.2	O K
720 min Winter	102.232	0.032	7.4	0.2	O K
960 min Winter	102.229	0.029	6.1	0.1	O K
1440 min Winter	102.225	0.025	4.4	0.1	O K
2160 min Winter	102.221	0.021	3.2	0.1	O K
2880 min Winter	102.219	0.019	2.5	0.1	O K
4320 min Winter	102.216	0.016	1.9	0.0	O K
5760 min Winter	102.215	0.015	1.6	0.0	O K
7200 min Winter	102.214	0.014	1.3	0.0	O K
8640 min Winter	102.212	0.012	1.1	0.0	O K
10080 min Winter	102.212	0.012	1.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
120 min Winter	17.536	0.0	68
180 min Winter	12.878	0.0	98
240 min Winter	10.306	0.0	130
360 min Winter	7.490	0.0	194
480 min Winter	5.971	0.0	252
600 min Winter	5.006	0.0	310
720 min Winter	4.333	0.0	366
960 min Winter	3.449	0.0	478
1440 min Winter	2.498	0.0	698
2160 min Winter	1.807	0.0	1092
2880 min Winter	1.435	0.0	1420
4320 min Winter	1.037	0.0	2120
5760 min Winter	0.823	0.0	2672
7200 min Winter	0.687	0.0	3560
8640 min Winter	0.593	0.0	4328
10080 min Winter	0.524	0.0	4480

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)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.289

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.049	4	8	0.120	8	12	0.120

Model Details

Storage is Online Cover Level (m) 102.700

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	2.52000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	81.5
Max Percolation (l/s)	135.8	Slope (1:X)	170.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	102.200	Cap Volume Depth (m)	0.000

Summary of Results for 30 year Return Period

Half Drain Time : 0 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	101.848	0.048	38.3	0.8	O K
30 min Summer	101.846	0.046	35.2	0.7	O K
60 min Summer	101.840	0.040	27.2	0.6	O K
120 min Summer	101.832	0.032	17.5	0.4	O K
180 min Summer	101.828	0.028	13.4	0.3	O K
240 min Summer	101.826	0.026	11.1	0.2	O K
360 min Summer	101.823	0.023	8.7	0.2	O K
480 min Summer	101.820	0.020	6.9	0.1	O K
600 min Summer	101.819	0.019	5.9	0.1	O K
720 min Summer	101.817	0.017	5.0	0.1	O K
960 min Summer	101.816	0.016	4.2	0.1	O K
1440 min Summer	101.813	0.013	2.9	0.1	O K
2160 min Summer	101.812	0.012	2.3	0.0	O K
2880 min Summer	101.810	0.010	1.8	0.0	O K
4320 min Summer	101.809	0.009	1.3	0.0	O K
5760 min Summer	101.808	0.008	1.0	0.0	O K
7200 min Summer	101.808	0.008	1.0	0.0	O K
8640 min Summer	101.807	0.007	0.8	0.0	O K
10080 min Summer	101.806	0.006	0.7	0.0	O K
15 min Winter	101.848	0.048	39.1	0.9	O K
30 min Winter	101.844	0.044	32.2	0.7	O K
60 min Winter	101.837	0.037	22.7	0.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	73.387	0.0	14
30 min Summer	47.368	0.0	21
60 min Summer	29.238	0.0	36
120 min Summer	17.536	0.0	66
180 min Summer	12.878	0.0	96
240 min Summer	10.306	0.0	122
360 min Summer	7.490	0.0	184
480 min Summer	5.971	0.0	242
600 min Summer	5.006	0.0	302
720 min Summer	4.333	0.0	366
960 min Summer	3.449	0.0	486
1440 min Summer	2.498	0.0	718
2160 min Summer	1.807	0.0	1096
2880 min Summer	1.435	0.0	1452
4320 min Summer	1.037	0.0	2200
5760 min Summer	0.823	0.0	2960
7200 min Summer	0.687	0.0	3488
8640 min Summer	0.593	0.0	4416
10080 min Summer	0.524	0.0	5040
15 min Winter	73.387	0.0	13
30 min Winter	47.368	0.0	21
60 min Winter	29.238	0.0	34

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
120 min Winter	101.829	0.029	13.9	0.3	O K
180 min Winter	101.825	0.025	10.3	0.2	O K
240 min Winter	101.822	0.022	8.3	0.2	O K
360 min Winter	101.819	0.019	6.2	0.1	O K
480 min Winter	101.817	0.017	5.0	0.1	O K
600 min Winter	101.816	0.016	4.2	0.1	O K
720 min Winter	101.815	0.015	3.7	0.1	O K
960 min Winter	101.813	0.013	2.9	0.1	O K
1440 min Winter	101.811	0.011	2.1	0.0	O K
2160 min Winter	101.810	0.010	1.6	0.0	O K
2880 min Winter	101.809	0.009	1.3	0.0	O K
4320 min Winter	101.808	0.008	1.0	0.0	O K
5760 min Winter	101.807	0.007	0.8	0.0	O K
7200 min Winter	101.807	0.007	0.8	0.0	O K
8640 min Winter	101.806	0.006	0.6	0.0	O K
10080 min Winter	101.806	0.006	0.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
120 min Winter	17.536	0.0	62
180 min Winter	12.878	0.0	90
240 min Winter	10.306	0.0	124
360 min Winter	7.490	0.0	194
480 min Winter	5.971	0.0	244
600 min Winter	5.006	0.0	310
720 min Winter	4.333	0.0	362
960 min Winter	3.449	0.0	488
1440 min Winter	2.498	0.0	744
2160 min Winter	1.807	0.0	1144
2880 min Winter	1.435	0.0	1416
4320 min Winter	1.037	0.0	2040
5760 min Winter	0.823	0.0	2728
7200 min Winter	0.687	0.0	3544
8640 min Winter	0.593	0.0	4392
10080 min Winter	0.524	0.0	4848

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)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.137

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.041	4	8	0.096

Model Details

Storage is Online Cover Level (m) 102.300

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	2.52000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	68.3
Max Percolation (l/s)	113.8	Slope (1:X)	400.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	101.800	Cap Volume Depth (m)	0.000

Cascade Summary of Results for PP2 REV A - 16.02.23.srcx

Upstream Structures	Outflow To	Overflow To
(None)	PP1 REV A - 16.02.23.srcx	(None)

Half Drain Time : 14 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	103.185	0.185	0.8	4.0	4.8	6.0	O K
30 min Summer	103.200	0.200	0.9	4.2	5.0	7.0	Flood Risk
60 min Summer	103.201	0.201	0.9	4.2	5.1	7.0	Flood Risk
120 min Summer	103.184	0.184	0.8	3.9	4.8	5.9	O K
180 min Summer	103.165	0.165	0.7	3.7	4.4	4.7	O K
240 min Summer	103.148	0.148	0.7	3.4	4.1	3.8	O K
360 min Summer	103.123	0.123	0.5	3.0	3.6	2.6	O K
480 min Summer	103.105	0.105	0.5	2.7	3.2	1.9	O K
600 min Summer	103.094	0.094	0.4	2.4	2.8	1.5	O K
720 min Summer	103.086	0.086	0.4	2.1	2.5	1.3	O K
960 min Summer	103.075	0.075	0.3	1.7	2.1	1.0	O K
1440 min Summer	103.062	0.062	0.3	1.3	1.5	0.7	O K
2160 min Summer	103.050	0.050	0.2	0.9	1.1	0.4	O K
2880 min Summer	103.043	0.043	0.2	0.7	0.9	0.3	O K
4320 min Summer	103.037	0.037	0.1	0.5	0.7	0.2	O K
5760 min Summer	103.033	0.033	0.1	0.4	0.5	0.2	O K
7200 min Summer	103.030	0.030	0.1	0.3	0.4	0.2	O K
8640 min Summer	103.028	0.028	0.1	0.3	0.4	0.1	O K
10080 min Summer	103.026	0.026	0.1	0.3	0.3	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	57.917	0.0	8.6	18
30 min Summer	37.094	0.0	11.5	26
60 min Summer	22.792	0.0	14.5	44
120 min Summer	13.657	0.0	17.7	76
180 min Summer	10.045	0.0	19.6	106
240 min Summer	8.058	0.0	21.1	138
360 min Summer	5.887	0.0	23.2	196
480 min Summer	4.708	0.0	24.8	254
600 min Summer	3.958	0.0	26.0	312
720 min Summer	3.433	0.0	27.1	374
960 min Summer	2.743	0.0	28.9	494
1440 min Summer	1.997	0.0	31.4	736
2160 min Summer	1.453	0.0	34.0	1088
2880 min Summer	1.159	0.0	35.9	1460
4320 min Summer	0.843	0.0	38.4	2204
5760 min Summer	0.672	0.0	40.1	2912
7200 min Summer	0.564	0.0	41.3	3608
8640 min Summer	0.488	0.0	42.2	4384
10080 min Summer	0.432	0.0	42.8	4984

Cascade Summary of Results for PP2 REV A - 16.02.23.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	103.200	0.200	0.9	4.2	5.0	6.9	Flood Risk
30 min Winter	103.214	0.214	1.0	4.3	5.3	8.0	Flood Risk
60 min Winter	103.210	0.210	0.9	4.3	5.2	7.6	Flood Risk
120 min Winter	103.183	0.183	0.8	3.9	4.7	5.8	O K
180 min Winter	103.155	0.155	0.7	3.5	4.2	4.2	O K
240 min Winter	103.133	0.133	0.6	3.2	3.8	3.1	O K
360 min Winter	103.102	0.102	0.5	2.7	3.1	1.8	O K
480 min Winter	103.088	0.088	0.4	2.2	2.6	1.3	O K
600 min Winter	103.078	0.078	0.3	1.8	2.2	1.1	O K
720 min Winter	103.071	0.071	0.3	1.6	1.9	0.9	O K
960 min Winter	103.062	0.062	0.3	1.3	1.5	0.7	O K
1440 min Winter	103.050	0.050	0.2	0.9	1.1	0.4	O K
2160 min Winter	103.041	0.041	0.1	0.7	0.8	0.3	O K
2880 min Winter	103.037	0.037	0.1	0.5	0.7	0.2	O K
4320 min Winter	103.032	0.032	0.1	0.4	0.5	0.2	O K
5760 min Winter	103.028	0.028	0.1	0.3	0.4	0.1	O K
7200 min Winter	103.025	0.025	0.1	0.3	0.3	0.1	O K
8640 min Winter	103.023	0.023	0.0	0.2	0.3	0.1	O K
10080 min Winter	103.022	0.022	0.0	0.2	0.2	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	57.917	0.0	9.8	18
30 min Winter	37.094	0.0	13.1	28
60 min Winter	22.792	0.0	16.4	46
120 min Winter	13.657	0.0	20.0	80
180 min Winter	10.045	0.0	22.2	112
240 min Winter	8.058	0.0	23.8	140
360 min Winter	5.887	0.0	26.2	196
480 min Winter	4.708	0.0	28.0	254
600 min Winter	3.958	0.0	29.4	314
720 min Winter	3.433	0.0	30.6	372
960 min Winter	2.743	0.0	32.6	494
1440 min Winter	1.997	0.0	35.5	734
2160 min Winter	1.453	0.0	38.5	1092
2880 min Winter	1.159	0.0	40.6	1468
4320 min Winter	0.843	0.0	43.6	2180
5760 min Winter	0.672	0.0	45.7	2896
7200 min Winter	0.564	0.0	47.2	3608
8640 min Winter	0.488	0.0	48.3	4240
10080 min Winter	0.432	0.0	49.1	5144

Cascade Rainfall Details for PP2 REV A - 16.02.23.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.095

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.034	4	8	0.061

Cascade Model Details for PP2 REV A - 16.02.23.srcx

Storage is Online Cover Level (m) 103.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.02772	Width (m)	4.2
Membrane Percolation (mm/hr)	1000	Length (m)	81.9
Max Percolation (l/s)	95.6	Slope (1:X)	275.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	103.000	Cap Volume Depth (m)	0.000

Orifice Outflow Control

Diameter (m) 0.070 Discharge Coefficient 0.600 Invert Level (m) 103.000

Cascade Summary of Results for PP1 REV A - 16.02.23.srcx

Upstream Structures	Outflow To	Overflow To
PP2 REV A - 16.02.23.srcx PP4 REV A - 16.02.23.srcx		(None)

Half Drain Time : 7 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	102.749	0.249	1.2	19.6	20.8	12.0	O K
30 min Summer	102.771	0.271	1.3	20.8	22.1	14.2	O K
60 min Summer	102.767	0.267	1.3	20.6	21.9	13.9	O K
120 min Summer	102.738	0.238	1.2	19.0	20.2	11.0	O K
180 min Summer	102.712	0.212	1.1	17.2	18.3	8.7	O K
240 min Summer	102.694	0.194	1.0	15.3	16.2	7.3	O K
360 min Summer	102.669	0.169	0.8	12.4	13.3	5.5	O K
480 min Summer	102.652	0.152	0.8	10.5	11.3	4.5	O K
600 min Summer	102.639	0.139	0.7	9.1	9.8	3.7	O K
720 min Summer	102.628	0.128	0.6	8.0	8.6	3.2	O K
960 min Summer	102.612	0.112	0.6	6.5	7.0	2.4	O K
1440 min Summer	102.590	0.090	0.4	4.7	5.2	1.6	O K
2160 min Summer	102.577	0.077	0.4	3.4	3.8	1.1	O K
2880 min Summer	102.570	0.070	0.3	2.7	3.0	0.9	O K
4320 min Summer	102.558	0.058	0.3	1.9	2.2	0.6	O K
5760 min Summer	102.551	0.051	0.3	1.5	1.7	0.5	O K
7200 min Summer	102.547	0.047	0.2	1.3	1.5	0.4	O K
8640 min Summer	102.543	0.043	0.2	1.1	1.2	0.4	O K
10080 min Summer	102.540	0.040	0.2	1.0	1.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	57.917	0.0	28.8	20
30 min Summer	37.094	0.0	38.7	28
60 min Summer	22.792	0.0	48.9	44
120 min Summer	13.657	0.0	59.8	74
180 min Summer	10.045	0.0	66.5	104
240 min Summer	8.058	0.0	71.4	134
360 min Summer	5.887	0.0	78.6	194
480 min Summer	4.708	0.0	83.9	254
600 min Summer	3.958	0.0	88.2	314
720 min Summer	3.433	0.0	91.7	374
960 min Summer	2.743	0.0	97.4	494
1440 min Summer	1.997	0.0	105.8	736
2160 min Summer	1.453	0.0	114.5	1088
2880 min Summer	1.159	0.0	120.8	1456
4320 min Summer	0.843	0.0	129.2	2184
5760 min Summer	0.672	0.0	134.7	2920
7200 min Summer	0.564	0.0	138.6	3608
8640 min Summer	0.488	0.0	141.4	4368
10080 min Summer	0.432	0.0	143.3	5048

Cascade Summary of Results for PP1 REV A - 16.02.23.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	102.769	0.269	1.3	20.7	22.0	14.0	O K
30 min Winter	102.788	0.288	1.4	21.7	23.1	16.1	O K
60 min Winter	102.775	0.275	1.4	21.0	22.4	14.6	O K
120 min Winter	102.727	0.227	1.1	18.3	19.5	10.0	O K
180 min Winter	102.696	0.196	1.0	15.4	16.4	7.4	O K
240 min Winter	102.675	0.175	0.9	13.1	14.0	5.9	O K
360 min Winter	102.648	0.148	0.7	10.1	10.8	4.2	O K
480 min Winter	102.630	0.130	0.6	8.1	8.8	3.3	O K
600 min Winter	102.617	0.117	0.6	6.9	7.4	2.7	O K
720 min Winter	102.606	0.106	0.5	6.0	6.5	2.2	O K
960 min Winter	102.590	0.090	0.4	4.7	5.1	1.6	O K
1440 min Winter	102.577	0.077	0.4	3.4	3.8	1.1	O K
2160 min Winter	102.566	0.066	0.3	2.4	2.7	0.8	O K
2880 min Winter	102.557	0.057	0.3	1.9	2.2	0.6	O K
4320 min Winter	102.548	0.048	0.2	1.3	1.6	0.4	O K
5760 min Winter	102.543	0.043	0.2	1.1	1.2	0.4	O K
7200 min Winter	102.539	0.039	0.1	0.9	1.0	0.3	O K
8640 min Winter	102.536	0.036	0.1	0.8	0.9	0.2	O K
10080 min Winter	102.534	0.034	0.1	0.7	0.8	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	57.917	0.0	33.1	20
30 min Winter	37.094	0.0	44.1	29
60 min Winter	22.792	0.0	55.5	44
120 min Winter	13.657	0.0	67.8	76
180 min Winter	10.045	0.0	75.4	106
240 min Winter	8.058	0.0	80.9	136
360 min Winter	5.887	0.0	89.0	196
480 min Winter	4.708	0.0	94.8	256
600 min Winter	3.958	0.0	99.6	314
720 min Winter	3.433	0.0	103.5	374
960 min Winter	2.743	0.0	110.0	496
1440 min Winter	1.997	0.0	119.7	736
2160 min Winter	1.453	0.0	129.8	1088
2880 min Winter	1.159	0.0	136.9	1440
4320 min Winter	0.843	0.0	146.9	2164
5760 min Winter	0.672	0.0	153.7	2872
7200 min Winter	0.564	0.0	158.5	3672
8640 min Winter	0.488	0.0	162.1	4224
10080 min Winter	0.432	0.0	164.8	5120

Cascade Rainfall Details for PP1 REV A - 16.02.23.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.245

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.089	4	8	0.078	8	12	0.078

Cascade Model Details for PP1 REV A - 16.02.23.srcx

Storage is Online Cover Level (m) 103.200

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.02772	Width (m)	5.5
Membrane Percolation (mm/hr)	1000	Length (m)	177.6
Max Percolation (l/s)	271.3	Slope (1:X)	235.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	102.500	Cap Volume Depth (m)	0.000

Orifice Outflow Control

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 102.500

Cascade Summary of Results for PP4 REV A - 16.02.23.srcx

Upstream Structures	Outflow To	Overflow To
PP1 REV A - 16.02.23.srcx PP2 REV A - 16.02.23.srcx	(None)	(None)

Half Drain Time : 1 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m^3)	Status
15 min Summer	102.117	0.117	35.7	1.8	O K
30 min Summer	102.123	0.123	37.5	2.0	O K
60 min Summer	102.114	0.114	34.6	1.7	O K
120 min Summer	102.097	0.097	29.5	1.2	O K
180 min Summer	102.083	0.083	25.2	0.9	O K
240 min Summer	102.072	0.072	22.0	0.7	O K
360 min Summer	102.059	0.059	17.9	0.4	O K
480 min Summer	102.050	0.050	15.1	0.3	O K
600 min Summer	102.046	0.046	13.0	0.3	O K
720 min Summer	102.043	0.043	11.4	0.3	O K
960 min Summer	102.039	0.039	9.4	0.2	O K
1440 min Summer	102.034	0.034	6.9	0.2	O K
2160 min Summer	102.028	0.028	4.9	0.1	O K
2880 min Summer	102.026	0.026	4.0	0.1	O K
4320 min Summer	102.022	0.022	2.9	0.1	O K
5760 min Summer	102.019	0.019	2.3	0.1	O K
7200 min Summer	102.018	0.018	1.9	0.1	O K
8640 min Summer	102.017	0.017	1.8	0.0	O K
10080 min Summer	102.016	0.016	1.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m^3)	Time-Peak (mins)
15 min Summer	57.917	0.0	15
30 min Summer	37.094	0.0	22
60 min Summer	22.792	0.0	38
120 min Summer	13.657	0.0	68
180 min Summer	10.045	0.0	98
240 min Summer	8.058	0.0	130
360 min Summer	5.887	0.0	188
480 min Summer	4.708	0.0	248
600 min Summer	3.958	0.0	312
720 min Summer	3.433	0.0	368
960 min Summer	2.743	0.0	492
1440 min Summer	1.997	0.0	726
2160 min Summer	1.453	0.0	1076
2880 min Summer	1.159	0.0	1464
4320 min Summer	0.843	0.0	2168
5760 min Summer	0.672	0.0	2792
7200 min Summer	0.564	0.0	3568
8640 min Summer	0.488	0.0	4368
10080 min Summer	0.432	0.0	5040

Cascade Summary of Results for PP4 REV A - 16.02.23.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Winter	102.127	0.127	38.7	2.1	O K
30 min Winter	102.127	0.127	38.7	2.1	O K
60 min Winter	102.111	0.111	33.9	1.6	O K
120 min Winter	102.089	0.089	27.0	1.0	O K
180 min Winter	102.073	0.073	22.3	0.7	O K
240 min Winter	102.061	0.061	18.7	0.5	O K
360 min Winter	102.049	0.049	14.5	0.3	O K
480 min Winter	102.044	0.044	11.7	0.3	O K
600 min Winter	102.040	0.040	9.9	0.2	O K
720 min Winter	102.038	0.038	8.7	0.2	O K
960 min Winter	102.034	0.034	6.9	0.1	O K
1440 min Winter	102.028	0.028	4.9	0.1	O K
2160 min Winter	102.025	0.025	3.7	0.1	O K
2880 min Winter	102.022	0.022	2.9	0.1	O K
4320 min Winter	102.018	0.018	2.0	0.0	O K
5760 min Winter	102.017	0.017	1.7	0.0	O K
7200 min Winter	102.015	0.015	1.4	0.0	O K
8640 min Winter	102.014	0.014	1.2	0.0	O K
10080 min Winter	102.013	0.013	1.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Winter	57.917	0.0	15
30 min Winter	37.094	0.0	22
60 min Winter	22.792	0.0	38
120 min Winter	13.657	0.0	70
180 min Winter	10.045	0.0	100
240 min Winter	8.058	0.0	132
360 min Winter	5.887	0.0	186
480 min Winter	4.708	0.0	252
600 min Winter	3.958	0.0	326
720 min Winter	3.433	0.0	372
960 min Winter	2.743	0.0	500
1440 min Winter	1.997	0.0	726
2160 min Winter	1.453	0.0	1072
2880 min Winter	1.159	0.0	1456
4320 min Winter	0.843	0.0	2136
5760 min Winter	0.672	0.0	2832
7200 min Winter	0.564	0.0	3728
8640 min Winter	0.488	0.0	4432
10080 min Winter	0.432	0.0	4928

Cascade Rainfall Details for PP4 REV A - 16.02.23.srcx

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.126

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.061	4	8	0.065

Cascade Model Details for PP4 REV A - 16.02.23.srcx

Storage is Online Cover Level (m) 102.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	2.52000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	101.6
Max Percolation (l/s)	169.3	Slope (1:X)	145.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	102.000	Cap Volume Depth (m)	0.000

Summary of Results for 10 year Return Period

Half Drain Time : 1 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	102.326	0.126	45.1	2.4	O K
30 min Summer	102.325	0.125	44.7	2.4	O K
60 min Summer	102.307	0.107	38.1	1.7	O K
120 min Summer	102.277	0.077	27.6	0.9	O K
180 min Summer	102.261	0.061	21.7	0.6	O K
240 min Summer	102.250	0.050	17.9	0.4	O K
360 min Summer	102.244	0.044	13.7	0.3	O K
480 min Summer	102.239	0.039	11.0	0.2	O K
600 min Summer	102.236	0.036	9.4	0.2	O K
720 min Summer	102.234	0.034	8.1	0.2	O K
960 min Summer	102.230	0.030	6.5	0.1	O K
1440 min Summer	102.226	0.026	4.9	0.1	O K
2160 min Summer	102.222	0.022	3.5	0.1	O K
2880 min Summer	102.220	0.020	2.8	0.1	O K
4320 min Summer	102.217	0.017	2.1	0.1	O K
5760 min Summer	102.215	0.015	1.7	0.0	O K
7200 min Summer	102.214	0.014	1.4	0.0	O K
8640 min Summer	102.213	0.013	1.3	0.0	O K
10080 min Summer	102.212	0.012	1.1	0.0	O K
15 min Winter	102.339	0.139	49.7	3.0	O K
30 min Winter	102.330	0.130	46.3	2.6	O K
60 min Winter	102.297	0.097	34.7	1.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	57.917	0.0	17
30 min Summer	37.094	0.0	24
60 min Summer	22.792	0.0	38
120 min Summer	13.657	0.0	68
180 min Summer	10.045	0.0	98
240 min Summer	8.058	0.0	126
360 min Summer	5.887	0.0	184
480 min Summer	4.708	0.0	244
600 min Summer	3.958	0.0	308
720 min Summer	3.433	0.0	368
960 min Summer	2.743	0.0	488
1440 min Summer	1.997	0.0	730
2160 min Summer	1.453	0.0	1084
2880 min Summer	1.159	0.0	1464
4320 min Summer	0.843	0.0	2200
5760 min Summer	0.672	0.0	2912
7200 min Summer	0.564	0.0	3568
8640 min Summer	0.488	0.0	4264
10080 min Summer	0.432	0.0	5000
15 min Winter	57.917	0.0	17
30 min Winter	37.094	0.0	24
60 min Winter	22.792	0.0	38

Summary of Results for 10 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
120 min Winter	102.263	0.063	22.6	0.6	O K
180 min Winter	102.249	0.049	17.0	0.4	O K
240 min Winter	102.244	0.044	13.7	0.3	O K
360 min Winter	102.238	0.038	10.2	0.2	O K
480 min Winter	102.234	0.034	8.1	0.2	O K
600 min Winter	102.231	0.031	6.8	0.2	O K
720 min Winter	102.229	0.029	5.9	0.1	O K
960 min Winter	102.226	0.026	4.7	0.1	O K
1440 min Winter	102.222	0.022	3.5	0.1	O K
2160 min Winter	102.219	0.019	2.5	0.1	O K
2880 min Winter	102.217	0.017	2.1	0.1	O K
4320 min Winter	102.215	0.015	1.6	0.0	O K
5760 min Winter	102.213	0.013	1.3	0.0	O K
7200 min Winter	102.212	0.012	1.1	0.0	O K
8640 min Winter	102.212	0.012	1.0	0.0	O K
10080 min Winter	102.211	0.011	0.8	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
120 min Winter	13.657	0.0	68
180 min Winter	10.045	0.0	98
240 min Winter	8.058	0.0	130
360 min Winter	5.887	0.0	188
480 min Winter	4.708	0.0	244
600 min Winter	3.958	0.0	304
720 min Winter	3.433	0.0	368
960 min Winter	2.743	0.0	488
1440 min Winter	1.997	0.0	726
2160 min Winter	1.453	0.0	1092
2880 min Winter	1.159	0.0	1448
4320 min Winter	0.843	0.0	2144
5760 min Winter	0.672	0.0	3056
7200 min Winter	0.564	0.0	3184
8640 min Winter	0.488	0.0	4496
10080 min Winter	0.432	0.0	5352

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.289

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.049	4	8	0.120	8	12	0.120

Model Details

Storage is Online Cover Level (m) 102.700

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	2.52000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	81.5
Max Percolation (l/s)	135.8	Slope (1:X)	170.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	102.200	Cap Volume Depth (m)	0.000

Summary of Results for 10 year Return Period

Half Drain Time : 0 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	101.842	0.042	30.0	0.6	O K
30 min Summer	101.840	0.040	26.5	0.6	O K
60 min Summer	101.835	0.035	20.9	0.4	O K
120 min Summer	101.829	0.029	13.9	0.3	O K
180 min Summer	101.825	0.025	10.7	0.2	O K
240 min Summer	101.823	0.023	8.7	0.2	O K
360 min Summer	101.820	0.020	6.6	0.1	O K
480 min Summer	101.818	0.018	5.3	0.1	O K
600 min Summer	101.816	0.016	4.4	0.1	O K
720 min Summer	101.815	0.015	3.9	0.1	O K
960 min Summer	101.814	0.014	3.2	0.1	O K
1440 min Summer	101.812	0.012	2.3	0.1	O K
2160 min Summer	101.810	0.010	1.8	0.0	O K
2880 min Summer	101.809	0.009	1.4	0.0	O K
4320 min Summer	101.808	0.008	1.1	0.0	O K
5760 min Summer	101.807	0.007	0.9	0.0	O K
7200 min Summer	101.806	0.006	0.7	0.0	O K
8640 min Summer	101.806	0.006	0.7	0.0	O K
10080 min Summer	101.806	0.006	0.6	0.0	O K
15 min Winter	101.843	0.043	30.7	0.7	O K
30 min Winter	101.839	0.039	25.9	0.5	O K
60 min Winter	101.832	0.032	17.5	0.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	57.917	0.0	14
30 min Summer	37.094	0.0	21
60 min Summer	22.792	0.0	34
120 min Summer	13.657	0.0	66
180 min Summer	10.045	0.0	94
240 min Summer	8.058	0.0	128
360 min Summer	5.887	0.0	184
480 min Summer	4.708	0.0	246
600 min Summer	3.958	0.0	310
720 min Summer	3.433	0.0	366
960 min Summer	2.743	0.0	490
1440 min Summer	1.997	0.0	716
2160 min Summer	1.453	0.0	1096
2880 min Summer	1.159	0.0	1428
4320 min Summer	0.843	0.0	2104
5760 min Summer	0.672	0.0	2776
7200 min Summer	0.564	0.0	3648
8640 min Summer	0.488	0.0	4352
10080 min Summer	0.432	0.0	5000
15 min Winter	57.917	0.0	14
30 min Winter	37.094	0.0	20
60 min Winter	22.792	0.0	36

Summary of Results for 10 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
120 min Winter	101.826	0.026	11.1	0.2	O K
180 min Winter	101.822	0.022	8.3	0.2	O K
240 min Winter	101.820	0.020	6.6	0.2	O K
360 min Winter	101.817	0.017	5.0	0.1	O K
480 min Winter	101.815	0.015	3.9	0.1	O K
600 min Winter	101.814	0.014	3.2	0.1	O K
720 min Winter	101.813	0.013	2.9	0.1	O K
960 min Winter	101.812	0.012	2.3	0.1	O K
1440 min Winter	101.810	0.010	1.8	0.0	O K
2160 min Winter	101.809	0.009	1.3	0.0	O K
2880 min Winter	101.808	0.008	1.1	0.0	O K
4320 min Winter	101.807	0.007	0.8	0.0	O K
5760 min Winter	101.806	0.006	0.7	0.0	O K
7200 min Winter	101.806	0.006	0.6	0.0	O K
8640 min Winter	101.805	0.005	0.5	0.0	O K
10080 min Winter	101.805	0.005	0.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
120 min Winter	13.657	0.0	64
180 min Winter	10.045	0.0	94
240 min Winter	8.058	0.0	126
360 min Winter	5.887	0.0	192
480 min Winter	4.708	0.0	258
600 min Winter	3.958	0.0	318
720 min Winter	3.433	0.0	352
960 min Winter	2.743	0.0	476
1440 min Winter	1.997	0.0	734
2160 min Winter	1.453	0.0	1032
2880 min Winter	1.159	0.0	1496
4320 min Winter	0.843	0.0	2044
5760 min Winter	0.672	0.0	2648
7200 min Winter	0.564	0.0	3112
8640 min Winter	0.488	0.0	4160
10080 min Winter	0.432	0.0	4448

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	10	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.423	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 0.137

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.041	4	8	0.096

Model Details

Storage is Online Cover Level (m) 102.300

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	2.52000	Width (m)	6.0
Membrane Percolation (mm/hr)	1000	Length (m)	68.3
Max Percolation (l/s)	113.8	Slope (1:X)	400.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	101.800	Cap Volume Depth (m)	0.000

Appendix: L – Essex CC SuDS Proforma

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

Essex County Council

SuDS Water quantity and Quality – LLFA Technical Assessment Proforma

Introduction

This proforma identifies the information required by Essex LLFA to enable technical assessment the Designers approach to water quantity and water quality as part of SuDS design approach in compliance with Essex SuDS Design Guide.

Completion of the proforma will also allow for technical assessment against Non-statutory technical standards (NSTS) for Sustainable Drainage. The proforma will accompany the site specific Flood Risk Assessment and Drainage Strategy submitted as part of the planning application.

Please complete this form in full for full applications and the coloured sections for outline appllications. This will help us identify what information has been included and will assist with a smoother and quicker application.

Instructions for use

Use the units defined for input of figures

Numbers in brackets refer to accompanying notes.

Where .....m^3 .....m^3/m^2 are noted – both values should be filled in.

Site details

1.1	Planning application reference (if known)			
1.2	Site name	Garden Village (Warish Hall Farm)		
1.3	Total application site area (1)	2.1	ha	
1.4	Predevelopment use (4)	Greenfield		
1.5	Post development use	Residential		
	If other, please sepcify			
1.6	Urban creep applicable	Yes	if yes, factor applied:	10%
1.7	Proposed design life / planning application life	100		
1.8	Method(s) of discharge: (5)			

☐ *Reuse* ☑ *Infiltration* ☐ *Hybrid* ☐ *Waterbody* ☐ *Storm sewer* ☐ *Combined sewer*

1.9	Is discharge direct to estuary / sea	No	
1.10	Have agreements in principle (where applicable) for discharge been provided	No	

Essex County Council

SuDS Water quantity and Quality – LLFA Technical Assessment

Calculation inputs

2.1	Area within site which is drained by SuDS (2)	8601	m^2
2.2	Impermeable area drained pre development (3)	0	m^2
2.3	Impermeable area drained post development (3)	8601	m^2
2.4	Additional impermeable area (2.3 minus 2.2)	8601	m^2
2.5	Method for assessing greenfield runoff rate	ICP SuDS Mean Annual Flood Rural Runoff	
2.6	Method for assessing brownfield runoff rate	N/A	
2.7	Coefficient of runoff (Cv) (6)	Default	
2.8	Source of rainfall data (FEH Preferred)	FSR	
2.9	Climate change factor applied 40	%	

Attenuation (positive outlet)

2.10 Drainage outlet at risk of drowning (tidal locking, elevated water levels in watercourse/sewer)
Note: Vortex controls require conditions of free discharge to operate as per manufacturers specification.

2.11 Invert level at final outlet N/A mAOD

2.12 Design level used for surcharge water level at point of discharge (16) N/A mAOD

Infiltration (Discharge to Ground)

2.13	Have infiltration tests been undertaken	Yes	
2.14	If yes, which method has been used	BRE Digest 365	
2.15	Infiltration rate (where applicable)	Various	m/s
2.16	Depth to highest known ground water table	N/A	mAOD
2.17	If there are multiple infiltration features please specify where they can be found in the FRA	Section 5	
2.18	Depth of infiltration feature	Various	mAOD
2.19	Factor of safety used for sizing infiltration storage	2	

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SuDS Water quantity and Quality – LLFA Technical Assessment Proforma

Calculation outputs

Sections 3 and 4 refer to site where storage is provided by full attenuation or partial infiltration. Where all flows are infiltrated to ground go straight to Section 6.

3.0 Greenfield runoff rates (incl. Urban Creep)

3.1	1 in 1 year rainfall	l/s/ha,	l/s for the site
3.2	1 in 30 year rainfall	l/s/ha,	l/s for the site
3.3	1 n 100 year rainfall + CCA	l/s/ha,	l/s for the site

4.0 Brownfield runoff rates (incl. Urban Creep)

4.1	1 in 1 year rainfall	l/s/ha,	l/s for the site
4.2	1 in 30 year rainfall	l/s/ha,	l/s for the site
4.3	1 n 100 year rainfall + CCA	l/s/ha,	l/s for the site

5.0 Proposed maximum rate of runoff from site (incl. Urban Creep) (7)

5.1	1 in 1 year rainfall	l/s/ha,	l/s for the site
5.2	1 in 30 year rainfall	l/s/ha,	l/s for the site
5.3	1 in 100 year rainfall + CCA	l/s/ha,	l/s for the site

6.0 Attenuation storage to manage flow rates from site (incl. Climate Change Allowance (CCA) and Urban Creep)

6.1	Storage - 1 in 100 year + CCA (9)	m^3	m^3/m^2
6.2	50% storage drain down time 1 in 30 years		hours

7.0 Controlling volume of runoff from the site(10)

7.1	Pre development runoff volume(12) (development area)	m^3 for the site
7.2	Post development runoff volume (unmitigated) (12)	m^3 for the site
7.3	Volume to be controlled (5.2 - 5.1)	m^3 for the site

Essex County Council

7.4 Volume control provided by:

- Interception losses[13] m^3
- Rain harvesting [14] m^3
- Infiltration m^3
- Attenuation m^3
- Separate volume designated as long term storage[15] m^3

7.5 Total volume control (sum of inputs for 5.4) m^3 [17]

8.0 Site storage volumes (full infiltration only)

8.1	Storage - 1in 30 year + CCA [8]	m^3	m^3/m^2 (of developed impermeable area)
8.2	Storage - 1 in 100 year + CCA [11]	m^3	m^3/m^2

SuDS Water quantity and Quality – LLFA Technical Assessment Proforma

Design Inputs

Proposed site use Residential

Pollution hazard category (see C753 Table 26.2) Very Low/Low

High risk area defined as area storing fuels chemicals, refuelling area, washdown area, loading bay.

Design Outputs

List order of SuDS techniques proposed for treatment

Note that gully pots, pipes and tanks are not accepted by Essex LLFA as a form of treatment (for justification see C753 Section 4.1, Table 26.15 and Box B.2)

Are very high pollution risk areas drained separate from SuDS to foul system No

Other

Please include any other information that is relevant to your application

Essex County Council

SuDS Water quantity and Quality – LLFA Technical Assessment Proforma

Notes

1. All area with the proposed application site boundary to be included.
2. The site area which is positively drained includes all green areas which drain to the SuDS system and area of surface SuDS features. It excludes large open green spaces which do not drain to the SuDS system.
3. Impermeable area should be measured pre and post development. Impermeable surfaces include, roofs, pavements, driveways and paths where runoff is conveyed to the drainage system.
4. Predevelopment use may impact on the allowable discharge rate. The LLFA will seek for reduction in flow rates to GF (Essex SuDS Design Guide).
5. Runoff may be discharge via one or more methods.
6. Sewers for Adoption 6th Edition recommends a Cv of 100% when designing drainage for impermeable area (assumes no loss of runoff from impermeable surfaces) and 0% for permeable areas. Where lower Cv's are used the applicant should justify the selection of Cv.
7. It is Essex County Council's preference that discharge rates for all events up to the 1 in 100 year event plus climate change are limited to the 1 in 1 greenfield rate. This is also considered to mitigate the increased runoff volumes that occur with the introduction of impermeable surfaces. If discharge rates are limited to a range of matched greenfield flows then it is necessary to provide additional mitigation of increased runoff volumes by the provision of Long-term Storage.
8. Storage for the 1 in 30 year must be fully contained within the SuDS components. Note that standing water within SuDS components such as ponds, basins and swales is not classified as flooding. Storage should be calculated for the critical duration rainfall event.
9. Runoff generated from rainfall events up to the 1 in 100 year will not be allowed to leave the site in an uncontrolled way. Temporary flooding of designated areas to shallow depths and velocities may be acceptable.
10. The following information should only be provided if increased runoff volumes are not mitigated by limiting all discharge rates back to the greenfield 1 in 1 year rate.
11. Climate change is specified as 40% increase to rainfall intensity, unless otherwise agreed with the LLFA / EA.
12. To be determined using the 100 year return period 6 hour duration winter rainfall event.
13. Where Source Control is provided Interception losses will occur. An allowance of 5mm rainfall depth can be subtracted from the net inflow to the storage calculation where interception losses are demonstrated. The Applicant should demonstrate use of subcatchments and source control techniques. Further information is available in the SuDS Design Guide.
14. Please refer to Rain harvesting BS for guidance on available storage.
15. Flows within long term storage areas should be infiltrated to the ground or discharged at low flow rate of maximum 2 l/s/ha.
16. Careful consideration should be used for calculations where flow control / storage is likely to be influenced by surcharged sewer or peak levels within a watercourse. Outlets can be tidally locked where discharge is direct to estuary or sea. Calculations should demonstrate that risk of downed outlet has been taken into consideration. Vortex controls require conditions of free discharge to operate as per specification.
17. In controlling the volume of runoff the total volume from mitigation measures should be greater than or equal to the additional volume generated.

Appendix M – Thames Water Correspondence

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

Miss L Wade
EAS
Unit 23 The Maltings
Roydon Road Stanstead Abbotts
SG12 8HG

Our ref: DS6084619

0800 009 3921
Monday to Friday, 8am to 5pm

31st May 2021

Pre-planning enquiry: Wastewater Capacity check

Dear Miss Wade

Thank you for providing details of your development with the Pre-Planning application dated 25th May 21 for development @ Warish Hall Farm site Takeley CM22 6PU

Greenfield site developed to { 191 dwellings + Business site with 13 units } as detailed in your above application.

We have completed the current assessment of the foul water flows & surface water discharges based on the information submitted in your application with the purpose of assessing sewerage capacity within the existing Thames Water sewer network, in liaison with TW Asset Planners.

Foul

If your proposals progress in line with the details you've provided as above, we're pleased to confirm that there will be sufficient sewerage capacity in the adjacent TW foul sewer network to serve your foul discharges from your proposed development, as detailed in your application, provided its by gravity.

This confirmation is valid for 12 months or for the life of any planning approval that this information is used to support, to a maximum of three years.

You'll need to keep us informed of any changes to your design – for example, an increase in the number or density of homes. Such changes could mean there is no longer sufficient capacity and has to be investigated again.

Surface Water

In accordance with the Building Act 2000 Clause H3.3, positive connection of surface water to a public sewer will only be consented when it can be demonstrated that the hierarchy of disposal methods have been examined and proven to be impracticable. Before we can consider your surface water needs, you'll need written approval from the lead local flood authority that you have followed the sequential approach to the disposal of surface water and considered all practical means.

When developing a site, policy SI 13 of the London Plan states “Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. There should also be a preference for green over grey features, in line with the following drainage hierarchy:

The disposal hierarchy being:

1. store rainwater for later use.
2. use infiltration techniques where possible.
3. attenuate rainwater in ponds or open water features for gradual release.
4. attenuate rainwater by storing in tanks or sealed water features for gradual release.
5. discharge rainwater direct to a watercourse.;; and if above cannot be achieved
6. discharge rainwater to a surface water sewer/drain.
7. discharge rainwater to the combined sewer.

Where connection to the public sewerage network is still required after examining the hierarchy {1-5} to manage surface water flows we will accept these flows at a discharge rate in line with ***CIRIA’s best practice guide on SuDS or that stated within the si*****tes planning approval.**

Please note that , we will need you to provide LLFA/LA approval for surface water discharges prior to TW accepting flows in the TW sewer network, if applicable.
However we note that you are discharging surfacecwater by Infiltration techniques which is encouraged.

Please see the attached ‘Planning your wastewater’ leaflet for additional information. At the appropriate time, you will have to apply for a S106 connection application to DS Connection team

Source Protection Zone

Please check whether your development falls within a Source Protection Zone for groundwater abstraction. These zones may be at particular risk from polluting activities on or below the land surface. To prevent pollution, the Environment Agency and Thames Water (or other local water undertaker) will use a tiered, risk-based approach to regulate activities that may impact groundwater resources. The applicant is encouraged to read the Environment Agency’s approach to groundwater protection (available at https://www.gov.uk/government/publications/ groundwater-protection-position-statements) and may wish to discuss the implications for their development with a suitably qualified environmental consultant.

This confirmation is valid for 12 months or for the life of any planning approval that this information is used to support, to a maximum of three years.

Please note that you must keep us informed of any changes to your design – for example, an increase in the number or density of homes. Such changes could mean there is no longer sufficient sewerage capacity.

What happens next?

Please make sure you submit your connection application, when you are ready, giving us at least 21 days' notice of the date you wish to make your new connection/s.

If you've any further questions, please contact me.

Yours sincerely

[redacted]

Siva Sivarajan

Developer Services- Wastewater Adoptions Engineer

Office [redacted] Mobile [redacted]
siva.sivarajan@thameswater.co.uk

Thames Water Utilities Ltd, Clearwater Court, Vastern Road, Reading, Berkshire, RG1 8DB
Find us online at [redacted]

DS6084619

TW Int ref ;; DTS31745

Appendix: N – Exceedance and Conveyance Routes

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

KEY:

OVERLAND SURFACE WATER FLOW ROUTE – TAKING INTO ACCOUNT PROPOSED COVER LEVELS

Rev	Date	By	Description	Chd	App

DRAWING STATUS: PLANNING

EAS

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

CLIENT: WESTON HOMES

ARCHITECT:

PROJECT: WARISH HALL FARM
TAKELEY

TITLE: JACK'S SITE
SURFACE WATER FLOW PATHS
AND EXCEEDANCE ROUTES

SCALE @ A1:	DESIGN-DRAWN:	DATE:
1:500	MC	16.09.2021

PROJECT No:	DRAWING No:
2951	SK20 – REV B